D2.2 Final Report:

Evaluation of Indicators for EU Policy Objectives

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List of Acronyms

ANS	Adjusted Net Savings
APR	Annual Progress Report
CEC	Commission of the European Communities
CIP	Competitiveness and Innovation Framework Programme
CO_2	Carbon dioxide
eaNNP	Environmentally adjusted Net National Product
EDP	Excessive deficit procedure
EEA	European Environment Agency
EESC	European Economic and Social Committee
EMU	Economic and Monetary Union
ERM	Exchange Rate Mechanism
Eurostat	Statistical Office of the European Community
EU	European Union
GDP	Gross Domestic Product
GNI	Gross National Income
GNS	Gross National Savings
GS	Genuine Savings
ISEW	Index of Sustainable Economic Welfare
JTI	Joint Technology Initiatives

MTO	Medium-term Budgetary Objective
NAMEA	National Accounting Matrix with Environmental Accounts
NNP	Net National Product
NNS	Net National Savings
NRP	National Reform Program
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
PM	Particulate matter
PPS	Purchasing Power Standards
R&D	Research and Development
SD	Sustainable Development
SDI	Sustainable Development Indicators
SDS	Sustainable Development Strategy
SEEA	System of Integrated Environmental and Economic Accounting
SGP	Stability and Growth Pact
SNA	System of National Accounts
TEC	Treaty Establishing the European Community
TEU	Treaty on European Union (Maastricht Treaty)
UN	United Nations
UNCED	United Nations Conference on Environment and Development 1992, Rio de Janeiro, Brazil

UNDSD	United Nations Division for Sustainable Development
UNSD	United Nations Statistics Division

Executive Summary

The EU is committed to enhancing the economic prospects and human well-being of Europe’s people. Through the Lisbon Strategy, EU policy-makers aim to increase the international competitiveness of the European economy and expand employment opportunities. Since 2010 this commitment has been followed up by the Europe 2020 Strategy, which aims at sustainable and inclusive growth, encompassing all three pillars of a sustainable development process. In this context, IN-STREAM aimed at undertaking and quantitative assessments necessary for linking mainstream economic indicators with key well-being and sustainability indicators, thus providing needed insight into the synergies and trade-offs implicit in Europe’s simultaneous pursuit of economic growth, social inclusion and environmental sustainability.

Being subject of this report, the qualitative evaluation of a subset of sustainability indicators aimed at analysing the key characteristics, strengths and weaknesses of each selected indicator. This includes an analysis of the institutional needs and opportunities regarding uniform implementation of the indicator in the EU. A total of 16 qualitative evaluations have been carried out, including three economic indicators and accounting frameworks, three subjective wellbeing indicators and frameworks, five biodiversity indicators, four resource efficiency indicators and a basket of four resource indicators. The subset of sustainability indicators has been selected by applying a total of nine selection filters and criteria, of which the most important one was relevance of the indicator or accounting framework to EU policy, i.e. the objectives of the Lisbon Strategy and the Europe 2020 Strategy.

An evaluation framework named RACER, developed for assessing the value of scientific tools for use in policy making and assessing an indicator’s relevance, acceptance, credibility, easiness and robustness, formed the core of the evaluation methodology. The RACER framework originates from the European Commission’s Impact Assessment Guidelines and has been amended by the project team in order to ensure a profound analysis of the selected indicators: additional evaluation criteria make each RACER criterion more explicit, tailor it to the specific objectives of IN-STREAM, and bring to the fore the more nuanced differences among the selected indicators. The results of the analyses show that the (extended) RACER methodology is a powerful tool to evaluate individual indicators, basket of indicators and overall accounting frameworks.

The RACER analysis has been complemented by a SWOT analysis, which was applied to evaluate the strengths, weaknesses, opportunities and threats of each indicator in terms of the stated objectives. It proved useful to evaluate the internal and external factors that influence the probability of success regarding implementation of the selected indicators in the EU and beyond.

The two methodologies are able to summarize the key advantages and key challenges of indicators in a very concise and precise manner. The results can be used by policy makers and researchers who are looking for indicators to assess specific policy problems. The analyses can give them the information to choose the right indicator and to interpret the results in the right way.

Within the policy cycle this information is especially needed in the late and the early stages. Policy makers looking for indicators to monitor the impacts of their policies or to define policy objectives need a clear understanding on what effects the indicators can and cannot measure. The analysis in this paper can help them to find the right indicator.

Within IN STREAM the qualitative analysis performed a very important function in identifying the indicators for the more quantitative work packages and in guiding the thinking on what qualifies a good indicator.

1 Introduction

1.1 Background

The EU is committed to enhancing the economic prospects and well-being of Europe's people. Through the Lisbon Strategy,[1] EU policy-makers aim to increase the international competitiveness of the European economy and expand employment opportunities. Since 2010, this commitment has been followed up by the Europe 2020 Strategy which aims at sustainable and inclusive growth and tries to encompass all three pillars of a sustainable development.

While political strategies have at least caught up with all dimensions of sustainability, the public discussion is still very much dominated by mainstream economic indicators like the GDP. However, Stiglitz et al. (2009) note that "[t]hough mainstream economic measures such as GDP are useful measures with great influence on public and private decisions, they are flawed as measures of human welfare" (). There is therefore a critical need in Europe for indicators and measurement systems that – working in conjunction with and complementing mainstream economic indicators – provide a useful measure of progress toward economic success, human well-being, environmental protection and, thereby, long-term sustainability.

Some initiatives have already been taken to address this need. For example, a comprehensive set of indicators has been developed by the Sustainable Development Indicator (SDI) Task Force to assist the EU in achieving the objectives of its renewed Sustainable Development Strategy. This set of 12 headline indicators, 45 core policy indicators and 98 analytical indicators covers ten themes related to the policy priorities of the SDS.[2] And world-wide, since the early 1990s, there has been significant work on indicators and green accounting as a means of providing information not offered by traditional economic indicators. *The Compendium of Sustainable Development Indicator Initiatives* lists over 680 different indicator efforts going on around the world.[3] In recent years, significant progress has been made on sustainability indicators and green accounting measures, as evidenced in the report*, Indicators for Sustainable Development: Proposals for a Way Forward* (IISD, 2005), prepared by the United Nations Division for Sustainable Development. However, despite the significant work undertaken on indicators, indicator sets and composite indicators, these initiatives have failed to end the hegemony of mainstream economic measures as the dominating indicators of human progress.

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[1] See http://ec.europa.eu/growthandjobs/.
[2] The ten SDI themes are: economic development; poverty and social exclusion; aging society; public health; climate change and energy; production and consumption patterns; management of natural resources; transport; good governance; and global partnership.
[3] See http://www.iisd.org/measure/compendium/

Over the years, ambitions regarding indicators seem to have been scaled back, moving away from an integrated system of "greened" national accounts to the more modest goal of complementary headline indicators that, taken together, can capture economic performance, human well-being and sustainability. There is now renewed interest and momentum on the part of policy-makers and researchers in developing headline indicators that go beyond economics to more comprehensively assess societal progress. Examples are the high-level conference 'Beyond GDP'[4] which took place in November 2007 and the establishment of the 'Commission on the Measurement of Economic Performance and Social Progress'[5] (Stiglitz Commission) by French President Nicolas Sarkozy. The Stiglitz Commission has in some way shaped the discussion on Beyond GDP by providing a comprehensive summary of the key deficits of GDP as a welfare measure, which consisted of the following factors:

- Stock versus flow: Current income measures are solely flow measures based on production. The commission recommended including consumption measures and also including wealth (capital stocks) into the measures.

- Quality improvements: The commission recommended working on more precise methodologies to capture quality improvements in services (especially in services provided by government)

- Environmental pressures: Pressures interpretable as variations of some underlying "stocks" should be included in an economic welfare indicator and other environmental pressures should be included in a physical environmental index.

- Social indicators: The commission also recommended developing robust indicators for social interactions , political representation, and lack of financial or job security that can be shown to predict life satisfaction.

1.2 Objectives of the Project

The objective of the IN-STREAM project is to undertake the qualitative and quantitative assessments necessary for linking mainstream economic indicators with key well-being and sustainability indicators, thus providing needed insight into the synergies and trade-offs implicit in Europe's simultaneous pursuit of economic growth and environmental sustainability. The project has the following key objectives:

Qualitative analysis objectives

[4] See http://www.beyond-gdp.eu/
[5] See http://www.stiglitz-sen-fitoussi.fr/

1. **Evaluate key indicators and indicator efforts.** Research will result in a summary evaluation of mainstream economic indicators as well as selected measures designed to incorporate sustainability concerns (especially environmental metrics). Policy-makers and researchers need guidance regarding what is feasible, what is useful, and how indicator efforts can be adapted to supplement the national level data collection that Eurostat and national governments currently undertake. Of particular interest for the assessment will be the ability of mainstream economic indicators to assess progress towards the objectives of the SDS as well as the ability of sustainable development (SD) indicators to yield insights into the economic implications of pursuing sustainable development.

2. **Evaluate institutional needs and opportunities.** Central to the qualitative analysis will be an effort to understand the key drivers and obstacles to institutional adoption of the reviewed indicators. Through stakeholder participation and outreach activities, the project will seek to increase the level of knowledge and acceptance among key policy-makers and statistical offices of an integrated approach to assessing economic growth, human well-being and sustainable development. It will also help clarify the way forward, developing a road map for development at the EU level with insights from national practice.

Quantitative analysis objectives

3. **Improve quantitative models linking indicators.** The project will build on previous modelling and statistical work that has attempted to bridge the gap between macroeconomic indicators and sustainability measures, particularly the GARP,[6] GREENSTAMP, GREENSENSE (FP5),[7] and MOSUS (FP5)[8] projects as well as the more recent research efforts INDI-LINK (FP6)[9] and EXIOPOL (FP6).[10]

4. **Assess the costs of reaching sustainability targets.** Using the models developed in the project, forecasts for selected Member States will be generated, using both partial and general equilibrium techniques. The analyses will estimate the expected costs in traditional economic terms of pursuing targets for selected sustainability indicators.

Summary evaluation objectives

5. **Recommend composite indicator approaches and implementation strategies.** Based on the qualitative and quantitative analyses, recommendations for new indicator approaches will be proposed. Recommended indicators (and sets of indicators) will be

[6] See http://www.cru.uea.ac.uk/cru/projects/wise/feem.htm
[7] See http://people.bath.ac.uk/hssam/greensense/home.html
[8] See http://www.mosus.net/
[9] See http://www.indi-link.net/
[10] See http://www.feem-project.net/exiopol/

those that perform best in terms of their robustness, feasibility and suitability to EU policy objectives. Strategies for implementing these approaches will be identified and developed in consultation with stakeholders. The recommended indicator approaches should not only aim at complementing GDP in policy debates but also at establishing links with the Lisbon and Maastricht criteria.

1.3 Objectives of the Deliverable

This report summarises the results of Work Package 2, which forms an important part of the qualitative analysis of the IN-STREAM project. For an important subset of sustainability indicators, the analysis lays out the key characteristics, strengths and weaknesses of each indicator. With that, the work package 2 and this publication have both an internal and an external aim.

Internal: The contents of Work package 2 informed all other work packages in their choices of indicators and evaluation methodology. In particular, the discussions in the qualitative methods workshop influenced the choice of indicators in the quantitative work packages 5 and 6. The work of work package 2 also influenced important decisions in work package 7 (dissemination). Resource efficiency and green growth were chosen as examples for the application of IN-STREAM ideas, partly because the indicator assessments in this work package indicated them as important policy areas where alternative indicators can make a difference compared to assessment based solely on economic indicators.

External: Additionally, this deliverable should provide a robust summary of the key characteristics, strengths and weaknesses of each indicator. These summaries will enable policy makers and researchers working with sustainability indicators to choose the right indicator for the right analysis. The work showed again how much the robustness of an indicator is dependent on the particular policy question at hand and on where in the policy cycle indicators are used. So this overview on the specific strength and weaknesses of an indicator can help policy makers to decide which indicator best fits their specific needs.

The report can be read in two different ways. Readers interested in a specific indicator can use this report as a reference book and can concentrate on the summaries provided in chapter 4 and the detailed material provided in chapter 6 on each of the indicators. Readers more interested in the general approach chosen to qualitative assessment of indicators can concentrate on chapters 1-5 without delving into the detail provided on each indicator.

1.4 Structure of the Report

The remainder of the report is structured as follows.

- Part 2 sets the background by establishing the policy context for the analysis. It specifically looks at the historical policy background.

- Part 3 explains the methodology for choosing and evaluating the indicators. It elaborates on two existing evaluation methodologies, RACER and SWOT, and how they have been adapted to provide more nuanced indicator analyses.

- Part 4 summarises the results from all indicator assessments.

- Part 5 highlights the key conclusions

- Part 6 provides the detailed analysis for all 16 evaluations that were carried out.

- Part 7 and part 8 provide references and technical annexes

2 EU Policy Context

The 1992 UN Conference on Environment and Development (UNCED) and resulting Agenda 21 provide the foundation for the EU's commitment to sustainable development.[11] The EU's overarching goal of balancing economic, social and environmental well-being has since become a central tenant in three key EU policy areas: the Lisbon Strategy, the Sustainable Development Strategy and (to a lesser extent) the Maastricht criteria. However, a key question remains on how to best measure progress toward sustainability goals. This study focuses on identifying which indicators, and sets of indicators, are most effective for monitoring progress toward this policy objective.

2.1 Policy Timeline

The European discussion on indicators for sustainable development started in principle with the Maastricht treaty, concluded in 1992, which set key limits for public debt both on a yearly basis and in total. The very limited criteria were adapted to defend the common currency but had no wider sustainability agenda attached to them. But during the decade that followed the Maastricht treaty the discussion on sustainability widened from a solely fiscal interpretation to an inclusion of other sustainability objectives.

The Lisbon Strategy, agreed by the Lisbon European Council in March 2000, aims to increase competitiveness and employment within the EU. Following the model of the Maastricht criteria, which determine Member State entry into the European Economic and Monetary Union (EMU), it identifies goals and objectives to improve Member State economies (Collignon, 2006). However, the Lisbon Strategy was immediately criticised for ignoring the environment in its socio-economic goals. Therefore, at the June 2001 Gothenburg European Council, the European Commission adopted the Sustainable Development Strategy, which aimed to provide an environmental pillar to the Lisbon Agenda.

[11] The Treaty Establishing the European Community (Article 2) establishes sustainable development and protection of the environment as a core principle of the European Community, tasking the Community to promote a "harmonious, balanced and sustainable development of economic activities" and "a high level of protection and improvement of the quality of the environment", among other key goals.

Figure 1 Policy timeline

In 2006, the Lisbon Strategy and the SDS were separately revised and renewed. Both revisions promote enhanced communication among local, national and EU levels of government to achieve stated objectives and create mechanisms for frequent evaluation. The revised Lisbon Strategy aims to streamline the co-operation between the Commission and the Member States and focuses on two primary targets for 2010: 1) invest 3% of Europe's GDP in research and development, and 2) reach an employment rate of 70%. Similarly, the revised SDS sets enhanced objectives and action items for seven key priority areas and proposes ways to improve government co-ordination. A key contribution is the clarification of its synergies with the Lisbon Strategy (Steinbuka and Wolff, 2007). The revised SDS is to be reviewed every two years to monitor progress towards its goals.

The 2009 review of the SDS highlights the opportunity presented by the global financial crisis to include incentives in economic stimulus and recovery packages and to promote regulatory changes with a view toward shifting to a low-carbon economy. It emphasizes the synergies with the Commission's Recovery Plan from November 2008, and focuses on green growth as a goal for both the SDS and the Lisbon Strategy.

The review work of both the SDS and the Lisbon Strategy was then merged into a new Strategy called Europe 2020 which aimed for inclusive and sustainable growth merging environmental, social and economic objectives into one framework.

The following section provides further detail on four key policy areas: the Maastricht criteria, the Lisbon Strategy, the Sustainable Development Strategy and the Europe 2020 Strategy. Furthermore, the Communication 'GDP and beyond' will be described. This integrated policy framework provides a backdrop for the indicator analyses performed for this study, and shows the timeliness of this research.

2.2 Maastricht Criteria

With the adoption of the Maastricht Treaty on European Union (TEU) by the European Council in 1992, the EU implemented the single market and entered the final stage for the completion of the Economic and Monetary Union. The main objective of EMU was the establishment of an area of monetary stability. A high degree of sustainable convergence of the economies of the Member States is a precondition for EMU.[12] The convergence criteria – commonly known as the Maastricht criteria – comprise:[13]

- Price stability – reflected by a rate of inflation which is not more than 1.5 percentage points above the rate of the three best-performing Member States;
- Sound public finances – reflected by a government deficit that is no higher than 3% of GDP;
- Sustainable public finances – reflected by a government debt that is no higher than 60% of GDP;
- Exchange rate stability – reflected by normal fluctuation margins provided by the exchange rate mechanism (ERM) for at least two years, without devaluing against the currency of any other Member State;
- Durability of convergence – reflected in long-term interest-rate levels that are not more than 2 percentage points above the rates of the three best performing Member States.

The goals enshrined in the Maastricht Treaty specify little in terms of competitive growth and employment and even less regarding sustainable development. However, the Maastricht Treaty is the foundation without which the Lisbon and SDS strategies could not have been built.

Box 1 Maastricht criteria – further links

European Central Bank – Economic and Monetary Union: http://www.ecb.int/ecb/history/emu/html/index.en.html

European Commission – Stability and Growth Pact: http://ec.europa.eu/economy_finance/sg_pact_fiscal_policy/index_en.htm?cs_mid=570

[12] As stipulated in Article 121(1) TEC.
[13] See European Commission – Economic and Financial Affairs: http://ec.europa.eu/economy_finance/the_euro/joining_euro9413_en.htm

2.3 The Lisbon Strategy – A Response to Socio-economic Challenges

Toward the end of the 1990s, in an increasingly globalized world, the EU was faced with demographic change and decreasing international competitiveness. In 2000, the European Council agreed on the Lisbon Strategy for Growth and Competitiveness, which aims to make the EU "the most dynamic and competitive knowledge-based economy" in the world. The following outlines the key components of the Strategy.

Central targets. The Lisbon Strategy has set up two central targets, which are to be achieved by 2010:

- investing 3% of the EU's GDP in research and development (R&D) activities; and
- reaching an employment rate of 70%.

Key strategies. Strategies for reaching these targets include: better policies for the information society and R&D; structural reforms for competitiveness and innovation; completion of the internal market; and a modernization of the European social model. Macro-economic policy shall ensure economic growth, which is seen as a prerequisite for maintaining and increasing prosperity and thus for preserving and enhancing the European social model. Demographic change is also identified as a major challenge that needs to be addressed. In order to be able to finance increasing pensions and health care costs, economic growth is regarded as a means to generate taxes and contributions by businesses and the working population.

Environmental dimension. In 2001, the European Council decided that a "strategy for sustainable development which completes the Union's political commitment to economic and social renewal, adds a third, environmental dimension to the Lisbon Strategy." The heads of state and government concluded that "clear and stable objectives for sustainable development will present significant economic opportunities" (European Council, 2001). Environmental protection should lead to technological innovation and increased investment spending, which, in turn, should result in economic growth and increased employment. In 2006, the Sustainable Development Strategy was renewed to provide "a single, coherent strategy on how the EU will more effectively live up to its long-standing commitment to meet the challenges of sustainable development" (CEC, 2005c).

Key measures. After a mid-term review (CEC, 2005d) showed that little progress has been made in terms of achieving the goals, it was decided in 2005 to relaunch the Lisbon Strategy with a stronger focus on growth, employment and better regulation (European Council, 2005). In the 2005 Community Lisbon Programme, the Commission has grouped several initiatives into eight key measures (CEC, 2005b):

- support of knowledge and innovation;
- reform of state aid policy;
- simplification of the regulatory framework;
- completion of the internal market for services;
- global agreement on the Doha round;
- removal to obstacles to physical, labour and academic mobility;
- development of a common approach to economic integration;
- support of efforts to deal with the social effects of economic restructuring.

Structural indicators. In order to have a stable statistical basis for assessing the Lisbon Strategy, a set of 14 structural indicators[14] has been set up. It is monitored by Eurostat – *inter alia* to support the Commission's analysis of the Annual Progress Reports, in which Member States declare the progress made in achieving the objectives of the Lisbon Strategy. The following structural indicators cover six issue areas:

1. **General Economic Background (**GDP per capita in PPS, Labour productivity)
2. **Employment (**Employment rate, Employment rate of older workers**)**
3. **Innovation and Research (**Youth education attainment level by gender, Gross domestic expenditure on R&D)
4. **Economic Reform** (Comparative price levels, Business investment)
5. **Social Cohesion (**At risk-of-poverty rate after social transfers, Long-term unemployment rate, Dispersion of regional employment rates
6. **Environment** (Greenhouse gas emissions, Energy intensity of the economy, Volume of freight transport relative to GDP)

Box 2 Lisbon Agenda – further links

- The Lisbon Strategy: http://ec.europa.eu/growthandjobs/index_en.htm
- Competitiveness and Innovation Framework Programme (CIP): http://ec.europa.eu/cip/index_en.htm
- Seventh Framework Programme: http://cordis.europa.eu/fp7/
- Joint Technology Initiatives (JTIs): http://www.e2b-jti.eu/default.php
- EU Structural Funds: http://ec.europa.eu/regional_policy/funds/prord/sf_en.htm
- EU Cohesion Fund: http://ec.europa.eu/regional_policy/funds/procf/cf_en.htm
- Education & Training programmes: http://ec.europa.eu/education/index_en.htm
- Better Regulation Strategy: http://ec.europa.eu/governance/better_regulation/index_en.htm

[14] Eurostat Structural indicators available at http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

2.4 Sustainable Development Strategy

The European Union considers sustainable development a global objective and is committed to its implementation inside Europe and around the world. Internationally, the EU is a signatory to the 1992 United Nations Rio Declaration. At the 19^{th} Special Session of the United Nations' General Assembly in 1997, the EU committed itself to developing a sustainable development strategy for the 2002 World Summit on Sustainable Development. The strategy developed in 2001 formed part of the EU's preparation for the World Summit, and was also integrated into the EU's broader (and domestic) Lisbon Strategy.

As done for the Lisbon Strategy, the European Commission also reviewed its Sustainable Development Strategy and, in light of EU expansion and slow progress toward meeting the initial set of goals, saw the need for expedited action in the face of negative trends. In response, the European Commission developed a renewed Sustainable Development Strategy in 2006.

Overarching objectives. In the development of the renewed Strategy, policy-makers paid special attention to areas of overlap and possible integration with the Lisbon Agenda and identified four key overarching objectives:

- Environmental protection;
- Social equity and cohesion;
- Economic prosperity;
- Meeting our international responsibilities.

Key challenges. The renewed Strategy identified seven key challenges and established a set of targets and actions to guide progress in each area. The Strategy also created a bi-annual review process, through which policy-makers in the EU and also in Member States could see progress made (and not made) in addressing these challenges. Importantly, strong links exist between the key challenges of the renewed Strategy and the Lisbon Agenda, whereby addressing the Strategy's key challenges are also positive outcomes from the Lisbon perspective. Of course, the links between the Renewed Strategy and the Lisbon Agenda also mean trade-offs. Resources put to use on developing energy infrastructure or supporting sustainable transport come at the expense of other possible projects and could even damper the achievement of some of the Lisbon objectives. Both sides of the connection – positive and negative – must be considered. The seven key challenges are:

- Climate change and energy;
- Sustainable transport;
- Sustainable consumption and production;
- Conservation and management of natural resources;
- Public health;
- Social inclusion, demography and migration;

- Global poverty and sustainable development challenges.

Targets and actions. Each challenge was framed by an overall objective, as well as a list of targets and actions in order to meet the challenge. Using climate change and energy as an example, the overarching objective was to "limit climate change and its costs and negative effects to society and the environment" and the targets were:

1. Fulfil the EU's Kyoto commitments;
2. Renewable sources of energy will be 12% of the EU total and 21% of electricity consumption by 2010 (option to raise to 15% by 2015);
3. 5.75% of transport fuel from biofuels by 2010;
4. Overall savings of 9% of final energy consumption over 9 years until 2017.

To meet these climate and energy targets, the SDS proposed a number of actions. These actions included: developing a long-term European plan on energy efficiency; reviewing and extending the EU Emissions trading scheme; promoting power station efficiency and the expanded use of combined heat and power; creating a plan to cost-effectively increase the use of renewable energy; and exploring options, working with partners, and offering suggestions for a new climate agreement to follow Kyoto.

Box 3 Sustainable Development Strategy – further links

- Mainstreaming sustainable development into EU policies: 2009 Review of the European Union Strategy for Sustainable Development: http://ec.europa.eu/environment/eussd/
- Renewed EU Sustainable Development Strategy (2006): http://register.consilium.europa.eu/pdf/en/06/st10/st10917.en06.pdf
- European Commission First Progress Report on the Renewed Strategy: http://ec.europa.eu/sustainable/docs/com_2007_642_en.pdf
- Commission Staff Working Document for First Progress Report: http://ec.europa.eu/sustainable/docs/sec_2007_1416_en.pdf
- European Council conclusions from progress report: http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/97669.pdf
- The Gothenburg Sustainable Strategy (2001): http://ec.europa.eu/sustainable/sds2001/index_en.htm

2.5 GDP and Beyond: Measuring Progress in a Changing World

In August 2009, the Commission released its Communication 'GDP and beyond: Measuring progress in a changing world' in response to strong support from *inter alia* the international community to develop indicators that measure progress beyond traditional macro-economic indicators, leading among them GDP. The Communication echoes the 2009 review of the SDS in calling for a rapid transition to a low-carbon economy, and states that sustainability indicators 'could contribute to setting new strategic goals for the post-2010 Lisbon Strategy'.

The Communication outlines five action items that the Commission will implement to improve the measurement of progress by 2012:

1. **Develop indicators to complement GDP.** The Commission intends to pilot its comprehensive environmental index in 2011. The index will measure negative environmental effects related to a broad range of environmental policy areas. The Commission has studied the potential for quality of life and well-being indicators, but there are no concrete plans to launch a new initiative in this area.[15]

2. **Improve data availability.** The Communication recognises that environmental and social data is often out of date, making it difficult to measure progress in areas beyond the economy. The Commission will support technological developments to allow for 'near real-time reporting' and work to streamline surveys to collect social data.

3. **Improve reporting on distribution and inequality.** The EU is committed to reducing inequality across and within regions of Europe. Indicators are being developed that measure equal access to e.g., housing and transport.

4. **Develop European Sustainable Development Scoreboard.** The Commission piloted the SD Scoreboard in 2009. The scoreboard will be based on the EU Sustainable Indicator set and may include additional up-to-date information.

5. **Expand European System of Accounts beyond traditional economic indicators.** The European System of Accounts will be extended to include aspects of sustainable development. Environmental indicators will be implemented first, followed by social indicators as data becomes available.

[15] The importance of developing well-being indicators was reiterated at the recent presentation o fand discussion of the communication by the Commission on 8 September 2009.

The Communication clearly states that GDP is “still the best single measure of how the market economy is performing”, but is not enough to capture all important aspects of peoples’ lives. The ongoing research on indicator development at the international, national and EU levels is expected to be revitalised by the EU’s commitment to these five actions over the next four years. The Communication builds on the goals of the Lisbon Strategy, Sustainable Development Strategy and (to a lesser extent) the Maastricht criteria, as described above.

2.6 Europe 2020

The Europe 2020 Strategy is the European Commission’s socio-economic ten year plan, which follows up on the Lisbon Strategy. It was adopted by the European Council in June 2010 and sets out the EU’s growth strategy until 2020.

Its outlines three mutually reinforcing priorities:

- **Smart growth.** Developing an economy based on knowledge and innovation.
- **Sustainable growth.** Promoting a more resource efficient, greener and more competitive economy.
- **Inclusive growth.** Fostering a high-employment economy delivering economic, social and territorial cohesion.

To support these priorities, the Europe 2020 Strategy sets the following EU targets which have been translated into different initial country circumstances. By 2020:

- **75 % of the population aged 20-64 should be employed,** including a greater involvement of women, older workers and better integration of migrants into the work force.
- **3% of the EU's GDP should be invested in R&D,** with an emphasis on improving the conditions for private R&D and the development of a R&D and innovation intensity indicator.
- **The "20/20/20" climate/energy targets should be met,** greenhouse gas emissions should be reduced by at least 20% (30% under the right conditions) compared to 1990 levels; renewable energy should compose of 20% of final energy consumption sources and a 20% increase in energy efficiency should be achieved.

- **School drop-out rates should be reduced to below 10% and at least 40% of 30 to 34 year olds should complete third level education.**

- **20 million fewer people should be in/at risk of poverty and social exclusion,** a reduction of 25% of Europeans living below national poverty lines.

To catalyse progress, in conjunction with Member State initiatives, the EU is undertaking seven flagship initiatives:

1. **Innovation union**. In order to ensure that innovative ideas can be turned into products and services that create jobs, framework conditions and access to finance for research and innovation will be improved. In February 2011 the European Commission presented a Green Paper proposing a common strategic framework for EU research and Innovation Funding, which would come into the next EU budget after 2013.

2. **Youth on the move.** The overall aim of this initiative is to enhance the performance of education systems and facilitate the entry of young people into the labour market. In January 2011 the European Commission launched an action plan to reduce school dropout rates and as well set economic priorities in response to the crisis.

3. **A digital agenda for Europe.** To deliver sustainable economic and social benefits from a digital single market, access to high-speed internet will be promoted with the goal of universal access to internet with speeds of 30Mbps or higher, and 50% of European households subscribed to internet connections above 100 Mbps by 2020. As of May 2011, this was still in the planning phase.

4. **Resource efficient Europe.** This initiative seeks to decouple economic growth from resource and energy use, support the shift towards a low carbon economy, increase the use of renewable energy sources, modernise the transport sector, enhance energy security and promote energy efficiency. In March 2011, the European Commission established the Energy Efficiency Plan 2011, and in April 2011, the European Commission completed consultations on the roadmap to a resource-efficient Europe.

5. **An industrial policy for the globalisation era.** Given the impact of the economic crisis on SMEs and industry, the European Commission will cooperate with stakeholders to draw a framework for a modern industrial policy to support entrepreneurship as well as guide and help industry overcome post-crisis and low-carbon economic challenges. This will lead to a sustainable industrial base able to compete globally. In October 2010, the European Commission adopted "an integrated industrial policy for the globalisation era" which emphasized ten key actions for European industrial competitiveness.

6. **An agenda for new skills and jobs.** The aim is to modernise labour markets and empower people through the acquisition of new skills to increase labour participation and productivity; reduce unemployment; and better match supply and demand. As of May 2011, under this initiative forecasting of the labour markets, analysis of trends, and research with the ILO and OECD are being conducted. Furthermore a University-Business Forum, a European Qualifications Framework, and a European Framework for key competences for lifelong learning have been developed and ESCO (the Classification of European Skills/Competences, qualifications and Occupations) is under development.

7. **European platform against poverty.** In order to ensure economic, social and territorial cohesion, this initiative seeks to raise awareness and recognise the fundamental rights of people experiencing poverty and social exclusion, such that the benefits of growth and jobs are widely shared and that they are able to live in dignity and take an active part in society. As of May 2011, the European Commission is in the process of identifying best practices and promoting mutual learning, setting up EU-wide rules and making funding available.

Based on a series of integrated (macro, micro and employment) guidelines, country reporting, selected indicators, and the issuing of recommendations, the European Commission issues an annual survey in January on the state of growth, which serves as input for discussion in the European Council. The European Parliament plays an important strategic role as co-legislator and as a driving force for mobilizing national parliaments and citizens.

Box 4 The Europe 2020 Strategy – further links

- EUROPE 2020: A strategy for smart, sustainable and inclusive growth http://europa.eu/press_room/pdf/complet_en_barroso___007_-_europe_2020_-_en_version.pdf
- European Commission – EU economic reform package – http://ec.europa.eu/europe2020/

3 Evaluation Methodologies

In order to evaluate the capacity of indicators to complement and expand the message sent by mainstream macro-economic indicators, most of all GDP, the IN-STREAM needed to develop a comprehensive indicator selection and evaluation methodology. The foundation is laid by three existing approaches for the development and evaluation of indicators and programs: the RACER approach, the SWOT approach, and the European Commission's SDI criteria for indicator selection. While these approaches certainly allow a grouping of indicators according to their capacity to meet the stated objectives, they were found to be insufficient for characterizing the specific policy linkages and methodological nuances that set them apart. IN-STREAM therefore combined the three approaches and expanded them to include additional items on policy relevance, complementarity, capacity to bridge economic and environmental and economic and social aspects, as well as their utility, as baskets of indicators. Each approach and the project team's adjustments or extensions of it is explained in the following paragraphs.

3.1 Choice of indicators

A total of 16 qualitative evaluations have been carried out within IN-STREAM, including three economic indicators and accounting frameworks, three subjective wellbeing indicators and frameworks, five biodiversity indicators and four resource efficiency indicators. An evaluation of a basket of four resource indicators, which has been carried out by Best, Giljum et al. (2008) under the project "Potential of the Ecological Footprint for monitoring environmental impacts from natural resource use" complements the analysis.

The selection of indicators was based on a number of filters and criteria. These were defined in an internal Scoping Paper on Indicator Selection at the beginning of the IN-STREAM project on October 2009. The selection filters and criteria were applied to all work packages, including work package 2.

Selection filters:

1. **Relevance to EU policy** – each indicator/approach should be relevant to the EU policy needs of the EU, especially those of the Lisbon Agenda, the renewed Sustainable Development Strategy (SDS), or (to a lesser extent) the Maastricht criteria.
2. **Bridging of sustainable development/economic divide** – each indicator/approach should be relevant to the effort to bridge economic and SD issues. A single-issue

indicator can still be relevant to bridging if it could be used within a compound indicator, indicator set or index.

3. **Feasibility of analysis –** each indicator/approach and the related research questions should match the capabilities of the IN-STREAM project partners, and the work required must stay within the budgets of the work packages. For the quantitative analysis, this includes the ability to incorporate indicators/approaches in the models used by the project team.

4. **Progress beyond the state-of-the-art:** The analysis is expected to yield insights into the relationships between economic performance and socio-environmental indicators that goes beyond the current state of knowledge while avoiding duplication with past research.

5. **Little overlap with other efforts** – duplication with other current research projects should be avoided and attention paid to generating synergies among projects.

Selection criteria

1. **Quantitative linking indicators** – for analysis in work packages 3-6, an adequate number of quantitative linking indicators should be identified so that quantitative relationships among SD pillars can be investigated. Additional indicators can be addressed in the qualitative analysis undertaken in work package 2, where policy relevance and institutional issues are central but quantitative links cannot yet be established.

2. **Stock v. Flow –** both stock and flow issues are relevant to sustainability and both types should be included in the set of indicators examined in IN-STREAM.

3. **Economic v. social v. environmental indicators** – the focus of the analyses should be on improving our understanding of the links among SD pillars using indicators. Thus indicators from each pillar (as well as linking indicators) should be included, though the IN-STREAM Description of Work shows a stronger focus on environmental indicators than on social indicators.

4. **Mix of indicator types** – many types of indicator approaches – individual, sets, headline, composite, and aggregate indicators – are of interest and this diversity should be reflected in the selected set of indicators.

For the work under work package 2, *relevance to EU policy* has been the primary selection filter. It is important to note that in selecting indicators for inclusion in IN-STREAM, the project team took into account the selection filters and selection criteria detailed above. However, a formal scoring system using the filters and criteria was not used because they are persistently challenging to quantify and because one risk of a formal point system is that overarching objectives like a comprehensive mix of indicators are not properly taken into account.

3.2 RACER Analysis

The European Commission's Impact Assessment Guidelines" (European Commission, 2005) specify the so-called RACER criteria for useful indicators. It is an evaluation framework developed for assessing the value of scientific tools for use in policy making. RACER is an acronym for:

Relevant	=	closely linked to the objectives to be reached
Accepted	=	by staff, stakeholders, and other users
Credible	=	accessible to non experts, unambiguous and easy to interpret
Easy	=	feasible to monitor and collect data at reasonable cost
Robust	=	not easily manipulated

We developed additional sub-criteria, shown in detail in the Technical Annex and summarized below, which aim at making the meaning of each RACER criterion more explicit, tailor it to the specific objectives of IN-STREAM, and to bring to the fore the more nuanced differences among the selected indicators. These sub-criteria have already been successfully applied in the project "Potential of the Ecological Footprint for monitoring environmental impacts from natural resource use" which was carried out for the European Commission's DG Environment (Best, Giljum et al., 2008).

Relevant

- Policy support, identification of targets and gaps
- Identification of trends
- Forecasting and modelling
- Scope/levels of application

- Function- and needs-related analysis

Accepted

- Stakeholder acceptance

Credible

- Unambiguous
- Transparency of the method

Easy

- Data availability
- Technical feasibility
- Complementarity and integration

Robust

- Defensible theory
- Sensitivity
- Data quality
- Reliability
- Completeness

3.3 SWOT Analysis

SWOT analysis stands for Strengths – Weaknesses – Opportunities – Threats and is a tool for assessing an organization's, business' or program's ability to achieve a stated objective. It evaluates the internal and external factors that influence the probability of success of the objective and is credited to Albert Humphrey at Stanford University who used it for evaluating Fortune 500 companies in the 1960s and 1970s.

	Helpful To achieving the objective	Harmful To achieving the objective
Internal origin attributes of the organization	Strengths	Weaknesses
External origin attributes of the environment	Opportunities	Threats

Table 1 Visualization of the four poles of a SWOT analysis.

Source: adjusted from Wikipedia, http://en.wikipedia.org/wiki/SWOT_analysis (last accessed, 26 August 2009).

In this study, the objects to be evaluated are the indicators, individually and in groups. For this purpose, we adapted and defined the SWOT criteria as follows:

Strengths

- Positive aspects of the methodology/indicator grouped as 'core' or 'important' strengths (core = specific to methodology/indicator, important = shared with other methodologies/indicators).

Weaknesses

- Negative aspects of the methodology/indicator re-categorized into critical and important weaknesses (critical = inadvisable to use methodology/indicator; important = limiting usefulness of methodology/indicator)

- Third category: outside the scope of the methodology/indicator' and to be covered by complementary indicators.

Opportunities

- Those aspects of the institutional, political, intellectual and technological environments that could help improve the methodology/indicator, lead to its successful adoption, or both.

Threats

- Those aspects of the institutional, political, intellectual and technological environments that could hinder the successful adoption of the methodology/indicator.

3.4 Correspondence between SDI Criteria and IN-STREAM Evaluation Methodologies

The Sustainable Development Strategy adopted by the European Council in 2001 (renewed in 2006) entails a commitment to regular monitoring: "[The Strategy will be] *comprehensively reviewed at the start of each Commission's term of office*" (SDS, 2001). A Sustainable Development Indicator Task Force was created to develop the indicators that would allow such monitoring and also inform decision-makers and the general public about achievements, trade-offs, and failures in attaining the agreed upon objectives of the SDS.

The Task Force subsequently developed indicator selection criteria as outlined in the Communication "Sustainable Development Indicators to monitor the implementation of the EU Sustainable Development Strategy" (2005) to the Members of the Commission. These criteria govern the selection of individual metrics and sets principles, which the collection of selected indicators should follow. They are:

Individual indicator criteria:

- An indicator should capture the essence of the problem and have a clear and accepted normative interpretation.

- An indicator should be robust and statistically validated.

- An indicator should be responsive to policy interventions but not subject to manipulation.

- An indicator should be measurable in a sufficiently comparable way across Member States, and comparable as far as practicable with the standards applied internationally by the UN and the OECD.

- An indicator should be timely and susceptible to revision.

- The measurement of an indicator should not impose on Member States, on enterprises, nor on the Union's citizens a burden disproportionate to its benefits.

Portfolio principles:

- The portfolio of indicators should, as far as possible, be balanced across different dimensions.

- The indicators should be mutually consistent within a theme.

- The portfolio of indicators should be as transparent and accessible as possible to the citizens of the European Union.

There is substantial agreement and correspondence between the SDI Task Force criteria and the evaluation methods synthesized and further developed as part of the IN-STREAM project, which is demonstrated in a cross-section in Table 2. This led us to integrate the SDI criteria into our suite of assessment criteria.

SDI criteria	RACER criteria	RACER sub-criteria
Individual indicator selection criteria.		
An indicator should capture the essence of the problem and have a clear and accepted normative interpretation.	Relevant	Policy support, identification of targets and gaps
	Accepted	Stakeholder acceptance
	Credible	Unambiguous
An indicator should be robust and statistically validated.	Robust	Defensible theory
		Sensitivity
		Data quality
		Reliability
		Completeness

An indicator should be responsive to policy interventions but not subject to manipulation.	Relevant	Policy support, identification of targets and gaps
	Robust	Sensitivity
	Credible	Unambiguous
An indicator should be measurable in a sufficiently comparable way across Member States, and comparable as far as practicable with the standards applied internationally by the UN and the OECD.	Relevant	Scope/levels of application
An indicator should be timely and susceptible to revision.	Robust	Sensitivity
The measurement of an indicator should not impose on Member States, on enterprises, nor on the Union's citizens a burden disproportionate to its benefits.	Easy	Data availability
Portfolio criteria:		
The portfolio of indicators should, as far as possible, be balanced across different dimensions.	Synergy between indicators	
The indicators should be mutually consistent within a theme.	--	--
The portfolio of indicators should be as transparent and	Easy	Data availability

accessible as possible to the citizens of the European Union.	Credible	Unambiguous

Table 2 SDI Task Force criteria and RACER criteria

3.5 Unresolved Methodological Issues

The present indicator evaluation has to be seen in the context of several limitations and shortcomings. It becomes clear, for example, that no single indicator is as of yet measuring environmental or social sustainability of economic activity. Indicators based on and derived from accepted accounting frameworks such as the SNA see their strengths originating from the ties to and systematic application of economic accounting rules diminished by methodological difficulties comparable to those identified for more loosely organized indicator frameworks, including how to make items measured in different units comparable, how to determine weights for aggregating items, and how to value the future compared to the present.

The present evaluation paid particular attention to capturing the more nuanced differences among the selected indicators. For example, it takes a close look at the underlying explicit or implicit sustainability criterion. On the other hand, this attention to detail meant that the number of selected indicators had to be quite small in relation to the magnitude of existing measures. A number of additional challenges remain, which are discussed in the following sections.

3.5.1 Methodological Challenges

Often, the criteria for selecting an indicator for a study are well explained but the reasons for excluding an indicator in the basket are not given. This report is no exception although we tried to define an a-priori set of indicators to which we then applied the selection criteria. The reasons for choosing the Eurostat list of 14 structural indicators, however, are mainly convenience and its relative comprehensiveness vis-à-vis the diversity of measures it represents. Restricting our attention to this list means that metrics not included in it had an a-priori probability of being selected of zero even though they might be more suitable for the purpose of this study than those on our final list.

A second methodological issue is given by the evaluation methodology itself, i.e., by the RACER and SWOT analysis and their extensions. Judging a diverse group of indicators according to a fair standard requires a certain abstraction from detail. Yet, at the same time we wanted to make sure to be able to detect the nuanced differences among indicators that are otherwise very similar, e.g. Adjusted Net Savings (ANS) and Environmentally Adjusted

Net National Product (eaNNP). We accomplished this by formulating open-ended questions that leave some leeway to inject specific characteristics unique to the indicator being evaluated. We also allowed frameworks such as the System of Integrated Environmental and Economic Accounting (SEEA) to be evaluated even though this does not lead to the recommendation of a single indicator. However, we felt that although systems such as the SEEA represent an important step towards the systematic integration of environmental and economic concerns, choosing an indicator that can be calculated from it would not adequately reflect the utility of the whole framework. The RACER method applied proved highly suitable for analysing SEEA and other accounting frameworks.

A side effect of the evaluation methodology is that it is not meaningful to try and derive quantitative statements about the indicators regarding their ability to bridge economic and environmental or social aspects of sustainable development. It is an inherently qualitative description of this ability and any scoring mechanism would be subjective. Therefore, decisions in favour of or against using an indicator also remain to some extent subjective.

3.5.2 Communicating Uncertainties

The proper estimation and communication of uncertainties in the values of an indicator is often overlooked in policy reports and the decisions based thereon. On the other hand, speaking already about a positive trend when the concentration of a pollutant in freshwater bodies has been declining slightly for the past few years without considering the error due to sampling and measurement methods is risky and can be misleading. The degree to which indicators are subject to different types of errors varies, but in most cases the potential for random and systematic variation in the indicator values should be made transparent.

The present indicator evaluation looks at data quality and completeness as a source for uncertainty, but cannot give estimates of uncertainty for any of the indicators. If nothing else is available, data quality – broadly understood – should always be factored into the decision to adopt or reject an indicator. Even if the indicator truly measures sustainability, a large measurement uncertainty could render it useless. Uncertainty in an indicator may also change over time or from place to place, which also needs to be communicated. For example, technological and scientific advances may have led to an increase in the precision and accuracy with which the indicator can be measured while differences in resources, staff, and effectiveness of the monitoring network may mean the indicator is measured with different levels of accuracy and precision in different places. When the indicator is based on a sample survey, the design effect and sampling error can often be estimated. Macro-economic aggregates such as GDP are usually reported as a single figure, suggesting a false level of precision and accuracy.

On the other hand, the checks and balances of the accounting system and its continued improvement over decades mean that GDP and other figures come with a high level of confidence. This is less likely the case for new indicators of sustainability where the methodology is still under development and assumptions made have not yet been tested empirically for their effect on the indicator. Thus, it is important for an indicator to become accepted and used in order for its inherent uncertainties to be discussed and made transparent.

3.5.3 Advantages of different Methodologies used

4 Results Overview

The tables below summarize the individual strengths and weaknesses of each indicator and thereby also visualize where they complement each other and how synergies are created that enhance the value of the individual indicator.

4.1 Economic Indicators and accounting frameworks

Criterion	GDP	ANS	SEEA-2003
Policy relevance for IN-STREAM	High	High	High
Used to measure sustainability	No	Yes	Yes
Definition of sustainability	None	Weak	Weak (strong possible)
Link to sustainable development	Yes, via economic development	Yes, by adjusting GDP for depreciation and degradation of environmental capital and investment in human capital	Yes, by expanding boundary of economic system to include environmental assets and services

Criterion	GDP	ANS	SEEA-2003
Level of methodological development	High	High with possibility to include additional environmental assets and forms of human capital and their valuation	High with possibility to further develop valuation methods and additional satellite accounts
Defensible theory	Yes	Yes	Yes
Level of adoption of the indicator by targeted users	High	Reported by World Bank and limited uptake by countries and researchers	Limited and incomplete uptake primarily by OECD and resource-rich countries
Driving forces of institutional adoption	Main indicator of economic performance since 1930s	Controversial methods to value resource rents and investments in human capital, lack of monetary values for environmental goods and services, hesitation of national accountants and statisticians to 'water down' stringent rules and assumptions for calculating GDP	Substantial investment in resources (people, knowledge, data), conceptual disagreements on methodology on how to measure sustainability, lack of emphasis on how and which sustainability indicators to calculate
Links to international and EU law, conventions and agreements	Lisbon Strategy, Maastricht Treaty, ODA goals	EU SD Strategy, Lisbon Strategy, Johannesburg Plan of Implementation	1992 Rio Summit, Link to SNA and NAMEA, potential to become international statistical standard in 2010

Criterion	GDP	ANS	SEEA-2003
Data availability (in EU)	Complete	Incomplete	Incomplete
Data quality (in EU)	High	Good to satisfactory	Good to satisfactory
Accuracy	High	Satisfactory	Good to satisfactory
Trends and forecasting	Yes	Yes	Yes
Geographical scale of application	Sub-national to global	National at present	Mostly national but sub-national has been done
Sensitivity	High	Good	High
Reliability	High	Good	High to good
Completeness	High to good	Satisfactory	Good to satisfactory
Transparency	High	High	High
Key value added	-	The robust accounting framework allows an inclusion of many	Shows the impact of economic activity on stocks (including environmental and

Criterion	GDP	ANS	SEEA-2003
		environmental impacts.	human resource stocks).
Key Challenges	Ignores all effects on stocks including environmental, economic and human capital stocks	Environmental impacts without a robust valuation are still not included.	Difficult to include environmental stocks have critical threshold values. Some environmental and human capital cannot be valued robustly.

4.2 Subjective wellbeing indicators / frameworks

Criterion	Happy Planet Index	National Accounts of Wellbeing (NAW)	Human Development Index (HDI)
Policy relevance for IN-STREAM	High	High	High
Used to measure sustainability	Yes	No	No
Definition of sustainability	Strong	N/A	N/A
Link to sustainable development	The HPI incorporates an element of sustainable consumption and is, therefore, at best a measure of weak sustainability.	NAW do not include environmental or economic aspects as far as they do not directly relate to human wellbeing.	The HDI indicator does not cover the environmental dimension and only in rudimentary form covers the economic and social spheres of sustainability.
Level of methodological development	Medium	Medium	Medium
Defensible theory	Medium	Medium	Medium

Criterion	Happy Planet Index	National Accounts of Wellbeing (NAW)	Human Development Index (HDI)
Level of adoption of the indicator by targeted users	Low	Low	Medium
Driving forces of institutional adoption	HPI has been taken up by the sustainability community as a noteworthy contribution to the challenge of measuring subjective wellbeing and linking it with economic and environmental goals.	N/A	Methodological limitations hamper institutional adoption.
Links to international and EU law, conventions and agreements	Relevant to the European Commission’s “Beyond GDP” process	Relevant to the European Commission’s “Beyond GDP” process	No
Data availability (in EU)	Complete	Most EU Member States are covered.	Complete
Data quality (in EU)	Medium	Medium	Medium
Accuracy	Medium	Medium	Medium

Criterion	Happy Planet Index	National Accounts of Wellbeing (NAW)	Human Development Index (HDI)
Trends and forecasting	Yes	No	Limited
Geographical scale of application	National	National	National
Sensitivity	No sensitivity analysis has been carried out.	No sensitivity has been carried out to,	Medium
Reliability	No robustness analysis has been carried out.	No information on the NAW's reliability is available.	Medium
Completeness	Medium	Medium	Medium
Transparency	Yes	High	High
Key Value added	The indicator measures the happiness of people not consumption or production levels. Inclusion of environmental impacts with the ecological footprint	The indicator is a robust measurement system for human well being.	Inclusion of social indicators (education and health) additionally to environmental indicators

Criterion	Happy Planet Index	National Accounts of Wellbeing (NAW)	Human Development Index (HDI)
Key Challenges	Still relatively unexplored is the relationship between economic/social welfare and happiness and whether and how policy can influence happiness.	Data only available on a 2 year basis and only for a small set of countries No inclusion of environmental or economic indicators.	No inclusion of environmental damages and no assessment of stocks.

4.3 Biodiversity Indicators

Criterion	Red List Index	Pan European Common Bird Monitoring Scheme (PECBMS) Index	Potentially Disappeared Fraction (PDF)	Favourable Conservation Status (of habitats and species)	The Marine Trophic Index (MTI)
Policy relevance for IN-STREAM	High?	High?	High?	High?	High?
Used to measure sustainability	No	No	No	No	Yes –of fisheries only.
Definition of sustainability	None	None	None	None	Weak/None –no reference level

Criterion	Red List Index	Pan European Common Bird Monitoring Scheme (PECBMS) Index	Potentially Disappeared Fraction (PDF)	Favourable Conservation Status (of habitats and species)	The Marine Trophic Index (MTI)
					defined.
Link to sustainable development	Yes –by measuring extinction risk	Yes –significant population declines from human activities indicates unsustainable development	No	No	Yes
Level of methodological development	High	No major changes to methodology	Low/ unsatisfactory	Low	Low -No major changes but criticisms voiced
Defensible theory	Yes	Yes	No	Yes	Yes
Level of adoption of the indicator by targeted users	High	High	Low	High	High
Driving forces of institutional	International targets	International and EU	None (low institutional	EU targets (Habitats	International and EU

Criterion	Red List Index	Pan European Common Bird Monitoring Scheme (PECBMS) Index	Potentially Disappeared Fraction (PDF)	Favourable Conservation Status (of habitats and species)	The Marine Trophic Index (MTI)
adoption		targets	adoption)	Directive)	sustainability targets
Links to international and EU law, conventions and agreements	CBD, Millennium Development Goals, EU Biodiversity targets, Ramsar Convention, Convention on Migratory Species	EU 2010 Biodiversity target, CAP Pillar 2	None	Habitats Directive	CBD
Data availability (in EU)	Incomplete (especially for poorly known taxa)	Partially complete	Complete for all major European biomes	Complete at EU level	Partially complete
Data quality (in EU)	Good but variable	Good	Poor	Variable with significant gaps	Poor
Accuracy	High	High	Low	Low	Moderate/ Low
Trends and forecasting	Trends –Yes Forecasting - No	Yes	Trends -Yes Forecasting -No	No	Trends –Yes (annually) Forecasting -No

Criterion	Red List Index	Pan European Common Bird Monitoring Scheme (PECBMS) Index	Potentially Disappeared Fraction (PDF)	Favourable Conservation Status (of habitats and species)	The Marine Trophic Index (MTI)
Geographical scale of application	Supranational (regional)	European, National and sub-national	Sub-national, but national and regional feasible	EU and national	Sea basin scale, national level possible but accuracy lost
Sensitivity	Low	High	Low	Low	Low
Reliability	High to good	High to good	Low	Moderate	High to good
Completeness	Low	Low	Low	Moderate (since it needs complementing with more common species)	Low
Transparency	High	High	Moderate	Moderate	High
Key value added	The Red List Index serves a tool to assess performance regarding global and EU biodiversity targets	The PECBM index is a key indicator of the EU's progress towards achieving its biodiversity targets.	The PDF incorporates indirect measures of pollution in the form of acidification and eutrophication, and so is relevant to some EU	Being the principal measure of the performance of the Habitats Directive and therefore , the indicator has a considerable influence on the	The indicator is a suitable tool for raising awareness of the poor state of the worlds' fish stocks and fisheries

Criterion	Red List Index	Pan European Common Bird Monitoring Scheme (PECBMS) Index	Potentially Disappeared Fraction (PDF)	Favourable Conservation Status (of habitats and species)	The Marine Trophic Index (MTI)
			policy areas.	implementation of biodiversity conservation measures in all EU Member States.	
Key challenge	The weightings given to the Red List categories are subjective, thus comparability with purely objective indicators is limited. Assessments vary greatly, and depend on the taxon and region under consideration.	The index it only covers common species of birds and therefore needs to be complemented by other indicators of impacts on other taxa and rarer species.	The indicator risks producing inaccurate results through its over-simplifications including the use of very broad baselines.	A comparison between Member States in terms of their achievements is problematic. The indicator does not cover widespread species that are not under threat, thus it needs to be complemented by other biodiversity measures.	As of now, the indicator is limited in terms of its usefulness for policy makers and improving fisheries management towards sustainability targets.

4.4 Resource Efficiency Indicators

Criterion	Energy Intensity	GHG emissions	Waste indicators	Basket of resource indicators
Policy relevance for IN-STREAM	High	High	High	High
Used to measure sustainability	No	Yes	Yes	Yes
Definition of sustainability	Weak	Strong	Strong	N/A
Link to sustainable development	Yes, reducing energy intensity and improving energy efficiency are important sustainable development objectives. Improvements in intensities can imply a more effective utilization of energy resources and reductions of negative environmental impacts. It is linked to environmental indicators	Yes, this indicator is one of the headline indicators in the sets of sustainable development as well as one of the main targets in the Europe 2020 strategy. It is linked to many other socio-economic and environmental indicators.	Yes, Waste represents an enormous loss of resources in the form of both materials and energy. The amount of waste produced can be seen as an indicator of how efficient a society is particularly in relation to the use of natural resources and waste treatment operations. It is linked to other socio-economic and environmental	Yes, the basket of resource indicators is applied to measure whether resource use takes place in a sustainable manner.

Criterion	Energy Intensity	GHG emissions	Waste indicators	Basket of resource indicators
	(energy consumption, GHG emissions) and economic indicators (GDP)		indicators especially those related to income level and economic growth.	
Level of methodological development	High	High	High	High
Defensible theory	Yes	Yes	Yes	Yes
Level of adoption of the indicator by targeted users	Energy intensity is a synthetic indicator of energy consumption weighted with the magnitude of country's economic system. The indicator can be complemented by sectoral energy intensity indicators to understand specific drivers of change.	There is a wide scientific consensus that emissions of greenhouse gases are responsible for global warming, with potentially dramatic economic, social and environmental consequences at global level.	The reduction of waste generation can be informative for the resource use reduction policy. The link between waste and climate change is due to CH4 emission generation during the process of decomposition of waste, this gas is more than 20 times as effective as CO_2.	With the exception of EMC (which cannot be finally judged yet), stakeholder acceptance of the indicators is high.
Driving forces of institutional	This indicator is able to capture economic and	The greenhouse gas emissions indicator is used	This indicator can inform health and climate policy.	Due to its clear message, especially the Ecological

Criterion	Energy Intensity	GHG emissions	Waste indicators	Basket of resource indicators
adoption	behavioral drivers of energy consumption, which are lacking for example in energy efficiency indicator. Moreover, energy intensity measures energy-savings behavior, or change in industrial structure and in lifestyle., but can highlight an important component in stabilizing global emissions and temperature: the efficiency in energy production.	to track progress in countries' efforts to lower emissions and reach environmental performance objectives. GHG emissions forecast provides a fundamental instrument in setting, improving and evaluating environmental policies	Waste generation is an indicator of pressure of population growth and population concentration in cities. Waste generation has a strong impact on the everyday life of consumers and producers.	Footprint indicators is used by NGOs to compare resource use among countries.
Links to international and EU law, conventions and agreements	There are no specific international conventions or agreements directly related to the reduction of energy intensities. The importance of energy efficiency and the rational use of energy have been highlighted by Agenda 21, at the World Summit on Sustainable Development in Johannesburg and by	EU Kyoto target of a reduction of 8% compared to 1990 is achieved by 2008-2012. EU commitment to reduce greenhouse gas emissions to 20% with respect to 1990 by 2020. Copenhagen Accord with different pledges for each	Waste generation indicator is further developed in the Community's 6th Environmental Action Programme (6EAP). All international and European agreement are more concentrated on waste management than on total amount of waste generation.	The basket of indicators relates to the objectives of the EU Resource Strategy and other policy documents (6th EAP, EU SDS)

Criterion	Energy Intensity	GHG emissions	Waste indicators	Basket of resource indicators
	various European Union treaties.	country.		
Data availability (in EU)	Complete	Complete	Limited	Very good for LEAC and EF, limited for HANPP and EMC.
Data quality (in EU)	High	High	Good	Good
Accuracy	High	High	Good	Good
Trends and forecasting	Yes	Yes	Yes	Yes, where data is available
Geographical scale of application	Country based	Global, Country based and sub-National	Global, Country based and sub-National	National (EF, EMC) and local (HANPP, LEAC) level
Sensitivity	High	High	High	Medium
Reliability	Good	High	Good	Good

Criterion	Energy Intensity	GHG emissions	Waste indicators	Basket of resource indicators
Completeness	Good for EU	High	Good for EU	High
Transparency	High	High	Good	High
Key value added	The key added value of the indicator is that it identifies to what extent there is a decoupling between energy consumption and economic growth.	The key added value of the indicator is that it is strategic to inform health policy. It is widely recognized that GHG emission cuts will provide health benefits. Moreover, the level of GHG emission gives important information on global poverty and inequality of distribution in sustainable development.	The key added value of the indicator is that it is strategic for measuring the environmental pressure..	The key added value of the basket is that it can add the dimension of resource use and consumption to national accounting systems
Key challenge	.Energy intensity is influenced by the structure of the economy, the energy intensities of sectors or activities, technological as well as geographical, natural and environmental factors. It is difficult to compare energy	Indicator may be used together with energy intensity and waste production indicators to provide a more comprehensive picture of the environmental impact of an economy.	Waste generation indicator must be complemented with additional detail on typology of waste, amount of recycled, incinerated and land filled waste, waste to energy and emissions from landfill. The composition and treatment of waste is	The missing link to ecosystem and biodiversity is one of the major drawbacks of the basket. Parts of the calculation methodologies are still under discussion, particularly the

Criterion	Energy Intensity	GHG emissions	Waste indicators	Basket of resource indicators
	intensity among products and among countries. This indicator is not informative on changes in energy mix and on developments of clean technologies and it analyzes the energy consumption on GDP and not the environmental damage of that consumption.		fundamental in assessing possible harmful effects, space necessary to the storage and effectiveness of all process.	assumptions underlying HANPP and EMC may lead to different results.

5 Final Summary and Conclusions

The analysis conducted covers a wide range of indicators, each of them chosen for its potential to add value to a policy assessment or analysis made simply on the basis of economic indicators like GDP. As the above tables show each of indicators has its specific strength and weaknesses and so any general conclusions on them will be oversimplifying and will leave out an important part of the information provided. Nonetheless some common trends can be identified, not with any claim to be exhaustive, but as an attempt to raise discussion points and to attract more detailed reading.

Economic indicators and accounting frameworks: Both the ANS and the SEEA-2003 attempt to fill specific gaps of the GDP in measuring sustainability. The ANS focuses on addressing the negligence of stock movements of GDP. While GDP does not take any changes in stock (physical, environmental and human capital stock) into account the ANS estimates and includes these changes in stocks. The SEEA-2003 is a refined and robust environmental accounting system that can be used to add the environmental dimension to economic indicators.

Both indicators do provide important additions to GDP although they also face significant challenges in achieving their objectives. Important environmental pressures (like ecosystem services) cannot easily be integrated into an accounting system because valuations of the pressures are not robust enough (or do not have a common consensus). The same is true for some social dimensions of sustainability.

Wellbeing indicators: One other important deficit of GDP according to some commentators is that it is a production indicator which measures only a mean of improving wellbeing or happiness (consumption of products) but not the “real” policy objective of improving people’s well-being or happiness, as the advocates of these indicators claim. One of the indicators assessed, the “Happy Planet Index”, includes the environmental dimension into its assessment to better take this into account.

An important limitation of the indicators is the unclear relationship between social and economic welfare and happiness or wellbeing. This means that the way that public policy can address happiness or well-being is not well established which limits the policy responsiveness of any indicator based on those principles. The data sources of the indicators also suffer from time lags and small geographical coverage.

Biodiversity indicators: Several biodiversity indicators were assessed, some covering only specific taxa (birds, fish) some with a more general coverage. The indicators are very important in giving policy makers a more general overview of development in the field of biodiversity. Without overview indicators, policy makers have to rely on spotlight information (like the population of a specific species increasing or dropping) which may distort policies towards certain high profile species.

The indicators analysed must deal with some common challenges. All indexes have to find a way of aggregating numerous species with sometimes very differing developments into one indicator. This aggregation process requires judgements on the relative weights or valuations that each species should receive which will always have some subjective element to them.

Some indicators track the conservation status of species. This means that the number of species with favourable conservations status (or the number of species in danger) is counted. These measures are very useful in concentrating on species in danger, but they have the inherent disadvantage that any changes within a group (a species getting less endangered or the population of a species dropping close to endangerment) are not taken into account.

Resource efficiency indicators: The analysed resource efficiency / pollution indicators add another important environmental dimension to assessments solely based on economic indicators.

The indicators have some common and some indicator specific challenges to overcome. Indicators like energy intensity do not reflect only the environmental pressure, but do weight it by economic indicators like GDP. This gives a very good measure of environmental efficiency but nonetheless environmental pressures can increase in an unsustainable way even if efficiency rises. As the indicator does not describe changes in the energy mix, energy intensity is a good proxy for energy efficiency it is therefore, linked to sustainability.

Another challenge is that many indicators do not reflect the environmental damage, but the environmental pressure which makes it difficult to compare the pressure with economic indicators or combine them in common indices.

Moreover, to provide a more comprehensive picture of the environmental damages and impact of an economy GHG emission Indicator may be used together with energy intensity and waste production and management indicators and with other socio-economic indicators.

General: As said general conclusions on such a diverse set of indicators cannot aim to be complete but the following common themes were identified.

- Aggregation and weighting: All attempts to add indicators with additional environmental or social dimensions to GDP have to combine a diverse set of impacts. Even at very low levels of aggregation (biodiversity indicator for birds) any common indicator has to weight different developments and this will always be a matter of intense discussion and in most cases some level of subjectivity will stay. For higher aggregated indexes that include impacts from environmental, economic and social impacts the problem becomes more poignant as a common denominator has to be found, which often means applying monetary valuations to environmental and social developments.

- Methodological issues: Not surprisingly, some of the recently developed indicator approaches still face methodological shortcomings. However, some of these shortcomings must be regarded as fundamental deficiencies which hamper the indicators' widespread implementation. A solid comparison between countries may not often be possible, which is the reason behind one of the main arguments against institutional adoption of an indicator.

- Stakeholder acceptance: Methodological shortcomings and practical challenges, such as limited data availability, hamper the widespread implementation of some of the evaluated indicator approaches. As GDP's main advantage is its global application, alternative approaches will have to catch up with GDP in terms of data availability. The acceptance of wellbeing and biodiversity indicators in particular is often hampered by the fact that the information provided is – in some cases – highly subjective. GDP, on the opposite, is considered to provide unambiguous and objective information to policy-makers.

Overall the analysis shows how difficult the search for sustainability indicators is as all indicators have specific value added but also specific challenges that have to be taken into account when interpreting their values.

The value of an indicator is dependent on the policy field or problem for which is it used but also on the policy cycle as different stages in the policy cycle require different types of indicators or measurements:

- **Problem definition:** This phase requires indicators which are credible, since policy endorsement and effectiveness benefit from public recognition of the problem. Such indicators should therefore be especially communicable and easy to understand.

- **Objective setting:** Setting quantitative targets and timetables is increasingly seen as a precondition for effective policy making. Identifying ambitious but realistically achievable objectives requires indicators that are widely available both over time and across different countries. This would enable policy makers to make useful comparisons, learn from best practices, and set benchmarks for policy performance. A good example, for instance, are the five headline European targets of the EU 2020 strategy, which are translated into national targets. Indicators which allow comparisons can contribute to the quality of that target setting.
- **Impact Assessment:** Formalised impact assessment procedures need indicators that reflect causal relationships and allow for ex-ante evaluations of a planned policy and its alternatives. Robust monetary valuations for indirect impacts and impacts

without market value can help policy makers to not underrate those effects in a formalized, quantitative policy assessment. Valuations and modelling exercises like these can be seen as one part of the Beyond GDP process which aims to achieve that readily available economic indicators like GDP do not solely determine important policy decisions.

- **Policy monitoring:** For this phase indicators should provide timely, up-to-date information, to allow for revisions and adjustments of a policy. The translation of Europe 2020 targets into national targets is a positive example, as the national indicators require regularly updates to allow a robust evaluation of the success of national policies.

This means that any policy maker or researcher with a specific set of objectives has to be completely aware of the value and the limitations of the indicator to be able to use it appropriately. The qualitative analysis conducted in this paper can help with gaining this understanding and choosing the right indicator.

6 Single Evaluations of the Selected Indicators

6.1 Economic indicators and accounting frameworks

6.1.1 Gross Domestic Product

I. Indicator Summary	
Name of indicator	Gross domestic product (GDP) per capita
Indicator category	Economic
II. Background information on the indicator	
a. What is the official definition of the indicator?	GDP is an aggregate measure of aggregate economic activity within the national account systems (NAS). According to the official definition, GDP measures, in monetary terms, income and output for a country's or region's economy. It is defined as the total market value of all final goods and services produced within a country or region in a given period of time (OECD, 2002). While GDP values all goods and services produced *within* a country or region, gross national product (GNP) adds the income earned by its citizens *abroad* and subtracts the income earned by foreigners within the country or region.
b. Unit(s) of measurement of the indicator	In the EU, the GDP's unit of measurement is the euro or – where applicable – national currencies, expressed in Purchasing Power Standards (PPS) at current prices or in volume terms (Eurostat, 2009). On a global scale, GDP is usually expressed in current, constant, or international US dollars.
c. What does the indicator seek to measure?	GDP is a measure for the economic activity within a certain country or a region. This is possible in three ways: 1. By measuring the total spending on all final goods and services (expenditures approach): *(Consumption goods and services (C) + Gross Investments (I) + Government Purchases (G) + (Exports (X) - Imports (M))* 2. By adding up the factor incomes to the factors of production in the society (income approach): *Employee compensation + Corporate profits + Proprietor's Income + Rental income + Net Interest* 3. By valuing the sales of goods (value added approach): *Value of sales of goods - purchase of intermediate goods to produce the goods sold.*
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	GDP has its roots in the aftermath of the Great Depression (1929 – mid 1930s). In the early 1930s, Simon Kuznets was commissioned by the US National Bureau of Economic Research to "develop a set of national accounts" in order to have a measurement for the effects of the Depression. In the early 1940s, estimates of national income were complemented by annual estimates of gross national product, and input-output accounts were developed. This development was also spurred by demands of economic planners and decision-makers during World War II, when it turned out to be crucial to be well-informed about

	the state of the national economy (Bureau of Economic Analysis, 2000). After World War II, GDP was also introduced in Europe and quickly became the main indicator for a nation's economic performance.
e. What are the known limitations of the indicator?	GDP implies a range of limitations; the following list outlines the key problems: • GDP does not include non-market transactions, such as voluntary, unpaid services. • GDP does not take into account the 'black economy' - • GDP considers investment in capital but ignores the depreciation of capital. Depreciation is usually relatively constant when the structure of production stays the same - in this case capital depreciation would be a relatively constant deduction from GDP. However, this is not the case. US and European economies have become more technology-based. This shift in the structure of production means that depreciation of capital has concomitantly changed. In this case, ignoring capital depreciation could be an enormous oversight. • GDP does not account for human capital, which can account for 80% or more of all wealth (Stiglitz, Sen and Fitoussi, 2009b). • GDP does not account for depletion of natural capital or ecosystem quality. In contrast, GDP increases if natural resources are (over-) depleted. • GDP considers only income flows, not stocks, while standard of living considerations should include stocks of wealth. • GDP per capita measures do not account for household size and does not incorporate household services, which could equate to 30-40% of GDP. • GDP gives no indication of the distribution of wealth. It caters to the statistical mean and does not capture the spectrum of experience from wealthy to poor in a particular country. These limitations of GDP have also been addressed by the Stiglitz Commission (Stiglitz, Sen and Fitoussi, 2008; 2009b).
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	With regard to methodological developments of national income accounts, a number of innovations and adjustments have taken place since its first application in the early 1930s (Bureau of Economic Analysis, 2000): • development of product or expenditure estimates (early 1940s); • evolvement into a consolidated set of income and product accounts (mid 1940s); • development of official input-output tables and capital stock estimates (late 1950s); • integration of more detailed and timely regional and local personal income estimates (early 1960s); • improvement of measures of prices and inflation-adjusted output (late 1960's and 1970's); • expansion of estimates of international trade in services (1980s); • development of quality-adjusted price and output measures for computers (1980s); • introduction of more accurate measures of prices and inflation-adjusted output (1990s). Today, GDP is applied on a world-wide scale and is the main indicator for measuring a nation's state of the economy. It is used to compare national economies against each other. Recently, individual countries and international organisations (EU, World Bank etc.) have moved away from focussing only on GDP as a measure of well-being.

III. Data	
g. How is the underlying data gathered and by whom?	Data are gathered by national statistical offices and reported to international organizations. In the EU, Eurostat estimates the aggregate for the EU and the euro area; all other data are produced by the statistical offices of the respective Member States. Eurostat states that "[t]he coverage for national data varies from country to country, partly due to derogations provided for in the transmission and back-projection programme, and can, in some cases, be substantially longer than for the European aggregates" (Eurostat, 2009).
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	In general, the published results are "accurate enough to meet the user demand for current data" (German Statistical Office, no date). However, often the published data are preliminary data, which might have to updates several times in order to take account of new statistical information. Therefore, initial results can differ from the final results. In Germany, final results are only published after about four years, while preliminary and final results differ by about 0.5 percentage points based on a multi-annual comparison (German Statistical Office, no date). Even the final dataset may contain data gaps and imputations.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	At Eurostat, the accounting period is the calendar year (Eurostat, 2009). Coverage differs among the Member States. Germany, for instance, calculates GDP on an annual and on a quarterly basis. The annual figure is published in mid-January of the subsequent year; the quarterly figure about 45 days after the end of the quarter (German Statistical Office, no date).
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	There is no operational definition of sustainability 'built-in' to GDP. However, GDP can be expressed in ways, which provide a more balanced picture of the state of the economy. For instance, GDP can be expressed on a per-household basis, thereby taking account of distributional aspects. Moreover, GDP can be applied to portray the resource and carbon intensity of an economy.
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	GDP does not measure 'strong' nor 'weak' sustainability, as there is no operational definition of sustainability 'built-in' to the indicator.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities below which a region/activity is not sustainable)?	GDP does not have numerical values assigned to sustainability, as there is no operational definition of sustainability 'built-in' to the indicator.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	As the discussion about 'Green GDP' shows, there are approaches to link the indicator to sustainable development. Furthermore, there are a number of specific sustainable developments indicators, which are based on frameworks similar to the NAS, for instance the System of Integrated Environmental and Economic Accounting (SEEA) and Adjusted Net Savings (ANS) / Genuine Savings (GS).

n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	GDP as an economic indicators links to the social dimension of sustainability with its connection to unemployment, which is expressed in Okun's Law. In the early 1960s, economist Arthur Okun began to describe an empirical, linear relationship between GDP growth and unemployment; lower GDP growth correlated with higher unemployment and robust GDP growth with low unemployment (Knotek, 2007). According to Freeman (2000), every two percent change in GDP roughly corresponds to a one point change in unemployment. However, this equation is highly dependent on the country under investigation. The relationship between GDP and unemployment is not a direct cause and effect relationship per se, but rather arises from a variety of different factors in the economy. Although termed an economic law, Knotek (2007) points out that "[i]n reality, though, Okun's law is a statistical relationship rather than a structural feature of the economy." Links to the environmental dimension of sustainability can be established by integrating, for instance, measures of greenhouse gas emissions or resource uses with GDP. This hybrid measure informs about the intensity of negative environmental impacts in relation to economic activity.
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	GDP is currently the standard measurement for a country's or a region's economic performance. It is used by national statistical offices around the world. They report their data to international organizations, which calculate regional or global GDP aggregates. Among the intergovernmental institutions, which use GDP to compare countries' economic performances against each other are the UN, World Bank, OECD and the EU.
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	The high degree of institutional adoption of GDP relates to the indicator's ability to inform policy-makers, economic planners and businesses to monitor the state of the national economy and to assess "the impact of different tax and spending plans, the impact of oil and other price shocks, and the impact of monetary policy on the economy as a whole and on specific components of final demand, incomes, industries, and regions" (Bureau of Economic Analysis, 2000). GDP presents the data in an organized way, so that they can be used as a basis for political decisions.
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	In the EU, GDP is considered the most important structural indicator. The EU's Lisbon Strategy for economic, social and environmental renewal targets an annual GDP growth of 3%.
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ GDP provides a consistent methodological framework for measuring the state of national economies. + GDP is used as the main structural indicators in most of the world's countries and accordingly in intergovernmental organisation. + GDP is considered the most important structural indicator in the EU and achieving 3% GDP growth is an explicit policy target mentioned in the EU's Lisbon Strategy.

	– Recently, a global movement among governments and policy-makers towards alternative well-being measures is observable, especially to those which also take sustainability aspects into account.
IDENTIFICATION OF TRENDS	+ GDP provides policy-makers, economic planners and business with clear indications of the overall state and trend of the economy. + GDP allows tracking trends over time and cross-sectorally in flows. – GDP does allow tracking trends in some stocks, such as minerals and fossil materials, but not in built capital.
FORECASTING AND MODELLING	+ GDP data are the main input for economic scenarios. + Analysts can deduce from (forecasted) trends in GDP growth how other indicators, such as employment, may behave. – Economic shocks cannot be predicted with certainty, so that forecasts are always subject to uncertainty.
SCOPE/LEVELS OF APPLICATION	+ GDP is applied as the main structural indicator in countries around the world. Data are calculated on a local, national, regional and international level.
Accepted	
STAKEHOLDER ACCEPTANCE	+ GDP is accepted as the most important structural indicator by economic planners and policy-makers world-wide. – Its failure to take sustainability aspects into account has recently led to an interest in alternative welfare indicators among the policy community. – Among scientists (sociologists and economists) alternative well-being indicators gain more and more acceptance, as GDP is increasingly regarded as an inappropriate measure of welfare – For the public, it is often difficult to see the relevance of GDP data in their daily lives.
Credible	
UNAMBIGUOUS	+ Unambiguous due to clearly defined parameters and results.
TRANSPARENCY OF THE METHOD	+ Calculation of the indicator is standardised, thus it can be regarded as one of the most transparent indicators.
Easy	
DATA AVAILABILITY	+ Data are collected by national statistical offices and are usually sufficiently available.
TECHNICAL FEASIBILITY	+ Data collection is resource intensive. Once the monitoring and reporting system is established, data processing is a relatively simple task.
COMPLEMENTARITY AND INTEGRATION	± GDP can be monitored and analysed in relation to other dimensions, such as natural and human capital (cf. the System of Integrated Environmental and Economic Accounting (SEEA) and Adjusted Net Savings (ANS) / Genuine Savings (GS)).
Robust	

DEFENSIBLE THEORY	+ Based on a sound accounting methodology backed by most national and international institutions.
SENSITIVITY	+ There is a high data density. + Data are produced on an annual or even quarterly basis. + Some components (economic sectors) may dominate the indicator, which may result in fluctuations of the indicator. – Final data may only be published after an extended period of time.
DATA QUALITY	– The data collection system is usually developed. However, countries differ in the frequency of data reported.
RELIABILITY	+ Coherent, consistent framework that yields reliable information on the state of the economy. – According to a growing number of sceptics, GDP does not inform about true welfare.
COMPLETENESS	– GDP does not directly take into account sustainability aspects, such as effects of production on the environments or the distribution of welfare among the population.
Summary appraisal	The fact that GDP is a worldwide recognised and established indicator gives it a relative advantage over new, alternative indicators. It is highly accepted among policy-makers and the scientific community. Its credibility and robustness relates to the sufficient availability of data. Its completeness, however, is curtailed due to the fact that GDP does not directly take sustainability aspects into account.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	GDP does not reflect climate change and clean energy as a policy target.
SUSTAINABLE TRANSPORT	GDP does not reflect sustainable transport as a policy target.
SUSTAINABLE CONSUMPTION AND PRODUCTION	GDP does not reflect sustainable consumption and production as a policy target.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	GDP does not reflect conservation and management of natural resources as a policy target.
PUBLIC HEALTH	GDP does not reflect public health as a policy target.
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	GDP does not reflect social inclusion, demography, and migration as a policy target.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	GDP does not reflect global poverty and sustainable development challenges as a policy target.

INVESTMENT IN RESEARCH AND DEVELOPMENT	Investment in research and development is captured within the general accounting framework. It is not identified as an explicit target, but can be identified from the collected data (conversion of money into goods and services).
UNEMPLOYMENT RATE	GDP does not directly reflect the unemployment rate as a policy target. One could, however, apply Okun's Law (Knotek, 2007) to deduce an impact from a change in economic growth on the employment rate, but should not assume a distinct cause-effect relationship (Freeman, 2000).
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	GDP on its own does not help measure progress of any policy target related to sustainability. The indicator, can however, be combined with other indicators to portray the sustainable performance of an economy.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	GDP on its own does not help measure progress of any policy target related to sustainability.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	In theory, all other mainstream economic and sustainable development indicators could be analysed in relation to GDP. Especially the policy target of decoupling economic growth from pollution (waste and emission) and resource use can be monitored in such a way. Especially close links exist to the System of Integrated Environmental and Economic Accounting (SEEA) and Adjusted Net Savings (ANS) / Genuine Savings (GS), which are based on frameworks similar to the national accounts system (NAS).
IX. SWOT Analysis	
*u. Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	GDP is used on a world-wide scale and is supported by all major institutions. Its calculation based on a standardized methodological framework, which makes GDP figures comparable among countries and regions. GDP measures economic growth, which is still regarded as the prerequisite for prosperity and well-being by a large share of the stakeholders (policy-makers, scientists, the public).
*v. Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	Accounting frameworks are implemented in most countries around the world. Thus, GDP figures can be generated at no additional costs, while alternative indicators often lack a sound data basis.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or	GDP is incorporated in the core set of structural indicators at national and EU level. From that, one can conclude that no critical weakness has been observed so far.

impractical to use the indicator at the national or EU level.)	
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	There is a growing consensus that GDP does not measure true well-being, as it does not take account of sustainability aspects. This has also been recognized by policy-makers at the EU level and led to initiatives, which aim at developing alternative indicators, which can be used supplementary to GDP. Although these important weaknesses have been recognized, official statements show that GDP is likely to remain the most important structural indicator in the future.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	The increasing importance of sustainability aspects in the public debate might offer the opportunity for an adjustment of the indicator. Adjustments could take account of the sustainability of economic growth, the externalities generated by economic growth, and welfare distribution. Moreover, GDP could be calculated on per-household basis as suggested by Stiglitz, Sen and Fitoussi (2009b) rather than on a per-capita basis.
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	The movement "beyond GDP" may eventually lead to the development of alternative wellbeing- indicators. This movement is observable among both scientists and policy-makers. However, GDP will most likely remain the premier structural indicator in the future, while additional indicators might serve as a supplement.

6.1.2 SEEA Framework

I. *Indicator Summary*	
Name of indicator	System of Integrated Environmental and Economic Accounting (SEEA), 2003 version
Indicator category	Economic
II. *Background information on the indicator*	
a. What is the official definition of the indicator?	The SEEA-2003 (United Nations, 2003) is an international coherent and comprehensive accounting framework for measuring objectively and consistently how environmental functions contribute to the economy and how the economy exerts pressures on the environment (Pedersen and de Haan, 2006). It is not a sustainable development indicator or set of indicators, although it is possible to derive indicators of mostly weak sustainability from the SEEA, e.g., environmentally adjusted Net National Product (eaNNP), Genuine Savings (GS, aka ANS), and Index of Sustainable Economic Welfare (ISEW) (Dietz and Neumayer, 2007).
b. Unit(s) of measurement of the indicator	Physical and monetary; Indicators derived from SEEA accounts are measured in physical, monetary, or dimensionless units (fractions, percentages).
c. What does the indicator seek to measure?	The SEEA measures the contributions of the environment to economic activity and the pressures of the economy on the environment in an integrated accounting framework closely linked to the international standard of economic accounting, i.e., the System of National Accounts (United Nations, 1993a). The SNA fails to account for negative consequences of economic activity through pollution emissions (Smith, 2007).
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	The SEEA has its roots in the System of National Accounts (SNA), which grew out of post-WWII reconstruction efforts including the Marshall Plan. In developing the SNA, the United Nations and collaborating agencies established a standard method for keeping track of economic activity and growth but failed to include the environment and natural resource depletion as major aspects of this accounting system (Smith, 2007). As the concepts of environmental protection and sustainable development became increasingly prominent, the shortfalls of the SNA also became apparent (Lange, 2007). For example, while SNA records the income from harvesting forests or extracting minerals, it does not account for the corresponding loss of natural capital (Lange, 2007). In 1993, the United Nations Statistics Division developed the first (interim) international handbook for environmental accounting. This publication, entitled the *Handbook of National Accounting: Integrated Environmental and Economic Accounting* is known as SEEA-1993 (Smith, 2007). Lange (2007) reports that, by 2000, SEEA-1993 had become the leading approach to environmental accounting, used in several developed and a few developing countries. A revision was commissioned by the UN Statistical Commission, which was finalized in 2003 and is known as the SEEA-2003. The UN Statistical Commission in 2005 requested the 2nd revision of the SEEA by 2010 to be elevated to an International Statistical Standard. The UNCEEA (UN Committee on Environmental-Economic Environmental Accounting) was

	tasked with the revision in cooperation with the London Group and other key players in environmental accounting (UNSD, 2009).
e. What are the known limitations of the indicator?	The SEEA-2003 has the following key limitations: • The valuation of environmental resources, depletion, and degradation depends on normative values, discount rates chosen, and methods to determine prices (e.g., willingness to pay, shadow prices, etc.). • The SEEA-2003 does not endorse or provide clear guidance on valuation, accounting, and modeling techniques necessary to monetarize environmental resources and services. Where methodological or philosophical controversy remains among national accountants, statisticians, and others involved in environmental accounting, the SEEA attempts to highlight those issues and presents different approaches to solving them (it could also be argued that this approach is a reflection of the SEEA's objectivity). • The SEEA-2003 makes references to sustainable development but remains vague on its operational definition and does not promote actual sustainability indicators (or evaluates their utility with respect to the selected sustainability definition). SEEA-2003 suggests indicators 'warning of threats to sustainability' but does not measure sustainability (Bartelmus, 2007) • The SEEA-2003 vaguely favors a 'capital maintenance' approach to sustainability which it then links to a micro-economic Hicksian income concept. Bartelmus (2007) points out that Hicks and national accountants have shown that micro-economic Hicksian income "… cannot be aggregated and is incompatible with the 'net worth' definition of wealth in the national accounts." • The aggregation of items based on mass units as opposed to monetary units is also controversial because of their different environmental impacts (e.g., a ton of wood wastes from a timber mill does not have the same environmental impacts as a ton of mining wastes). • The SEEA-2003 is very data intensive, although the modular set-up means that the entire SEEA does not need to be implemented. • The SEEA-2003 does not capture other sustainability concepts such as 'resilience' or 'vulnerability', nor does it represent the emerging field of accounting for ecosystems (Heal, 2007)
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	The SEEA grew out of SNA and the first handbook was published in 1993. The SEEA-2003 revision provides a full set of accounts with 4 types: physical and hybrid flow accounts, environmental protection and management accounts, asset accounts, and environmentally modified macro-aggregates. The revision was completed by 2010.
III. Data	
g. How is the underlying data gathered and by whom?	Because of the close linkage to the SNA, the SEEA-2003 data are primarily collected by national statistical agencies (account sections) through surveys, registers, and other means. Sub-national as well as international environmental accounts are also possible with the necessary data being collected by appropriate agencies or drawn from national environmental accounts.
h. How accurate are the results (e.g. is the result an estimate, are there data	The accuracy of the SEEA-2003 depends on the following issues: • The quality and comprehensiveness of the collected data. The accounting framework itself ensures a high degree of consistency,

gaps, imputations, assumptions, etc)?	coherence, and completeness (if implemented fully). • The methods used to impute missing data, e.g., as residual in an accounting identity, or via known or estimated associations, or via proxies such as average resource extraction costs for marginal extraction costs. • The extent and validity of the necessary assumptions, e.g., for converting physical accounts into monetary units.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	The SEEA-2003 is not fully implemented in any country. Many countries now use some form of environmental resource account (usually in physical terms). The frequency of updates varies but is usually annual. The initial SEEA 1993 was revised as SEEA-2003 and a second revision under the auspices of the UNCEEA was finalized in 2010.
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	The SEEA-2003, while referring to the need for and paradigm of sustainable development, does not itself provide an operationalized definition and only suggests some indicators for measuring it.
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	The capital maintenance approach, which is vaguely favoured in the SEEA-2003 would give rise to a weak sustainability paradigm but in principle many different sustainability indicators can be calculated on the basis of SEEA accounts.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities below which a region/activity is not sustainable)?	The availability of sustainability values or thresholds depends on the choice of indicator(s) calculated. For example, environmentally adjusted Net National Product (eaNNP, calculated as GNP-Dp-Dn where GNP is Gross National Product, Dp is depreciation of produced capital, and Dn is depreciation of natural capital) would at a minimum be required to be non-negative, but other indicators such as Total Material Requirements (TMR) do not have a pre-specified sustainability value or threshold.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	The SEEA-2003's close link to the SNA means that SEEA-based indicators are based on the consistent definitions and classifications of the SNA (e.g., with respect to industry and product classifications). The SEEA-2003 derived indicators such as eaNNP or 'green' GDP are linked to main economic aggregates such as NNP or GDP via explicit accounting identities.
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	The SEEA-2003's primary value lies in the bridging of the economic and environmental spheres, recognizing the environment as a critical input to economic activities and recipient of residuals of economic production. The SEEA-2003 is a tool for environmental-economic management and the indicators that can be derived from the accounts link economic and environmental aspects. The social dimension of SD is not reflected in the SEEA-2003.
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	Leading institutions in the promotion and development of the SEEA-2003 are the UN, World Bank, IMF, CEC, and OECD. National users include the statistical offices in a number of countries, primarily

	industrialized countries such as NOR, NLD, DEU, JPN, DNK, AUS, NZL, CAN; some developing countries such as the PHL and IDN have built some satellite accounts for important environmental resources.
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	The main barriers to adoption of the SEEA-2003 are the substantial investment in resources (people, knowledge, data) required to develop even a subset of the SEEA accounts as well as conceptual disagreements among accountants, environmental economists, and others involved in the measurement of sustainability. The accounts per se also do not lend themselves to environmental policy-making; indicators need to be calculated from the accounts to convey key messages to decision-makers. This has not been emphasized in the past and the SEEA's neutral stand on controversial methodological issues has hampered wide implementation of the system. Many countries are also hesitant to change their national accounting systems.
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	Links to international or European laws, conventions, or agreements include: • The 1992 Rio Summit, which calls for development of sustainable development indicators and environmental accounting (the latter is not part of 2002 Johannesburg Plan of Action though). • The SNA link and adherence to national accounting norms and standards. • The prospect of becoming an international statistical standard. • The de-facto EU-wide application of NAMEA (National Accounting Matrix with Environmental Accounts developed in The Netherlands).
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ SEEA-2003 provides a consistent methodological framework for measuring and tracking economy-environment interactions and is linked to the widely implemented SNA. + SEEA has been developed with substantial European involvement (EUROSTAT and members of the London Group). + NAMEA accounts were developed in The Netherlands and are a blue-print for physical flow accounts in SEEA-2003. NAMEA implementation has also been actively promoted and supported by EUROSTAT. – SEEA-2003 does not endorse a single methodology to value environmental goods, services, and degradation. – SEEA-2003 only suggests some indicators for measuring 'threats to sustainability'. – While a number of indicators linked to sustainability can be calculated from the SEEA-2003, they by and large (a) measure weak sustainability and (b) only reflect necessary and not sufficient conditions for sustainability.
IDENTIFICATION OF TRENDS	+ Accounting framework of SEEA-2003 allows tracking trends over time and cross-sectorally in stocks and flows. + Can reflect changes in behaviour and environmental expenditures and taxation over time. – Certainty of such trends depends on data quality and completeness of the accounts.

FORECASTING AND MODELLING	+ SEEA-2003 itself does not engage in modelling but discusses ways to use the accounts to perform economic and environmental modelling and has been used in econometric equilibrium models. + Consistency of data and definitions makes cross-temporal and cross-sectoral comparisons possible. – Strong assumptions may need to be made in the modelling, e.g., when predicting prices into the future.
SCOPE/LEVELS OF APPLICATION	+ Can be applied at international, regional, national, and sub-national level.
Accepted	
STAKEHOLDER ACCEPTANCE	+ Sound methodology and linkage to the SNA means the SEEA-2003 has found a growing following among national accountants, statisticians, environmental economists, researchers, and practitioners. + Supported by UN Statistical Commission, London Group members, WB, IMF, OECD, and CEC. – Acceptance by policy-makers more limited and hesitantly because of high degree of technical expertise required to understand the methodological foundations and because the SEEA publications did not take a guiding role in the measurement of sustainability and did not provide a single, well-defined set of sustainability indicators. – Limited data and resource intensive, controversial valuation methods and assumptions, link to sustainability not clear enough. – Countries hesitant to change their national accounting systems.
Credible	
UNAMBIGUOUS	± Less ambiguous than many loosely organised sets of indicators but no operationalised definition of sustainability. – Different valuation methods may lead to very different conclusions about sustainability of economy.
TRANSPARENCY OF THE METHOD	+ Calculations clearly explained. – Requires substantial knowledge of national accounting and environmental resources.
Easy	
DATA AVAILABILITY	+ Builds and expands on SNA and corrects its main failures, so data collection can be tied to national accounts data collection. + Not all accounts need to be implemented to reap the benefits of the SEEA-2003, countries can decide according to their needs. – Overall, very data intensive and in many developed and developing countries not all data even for selected accounts are available.
TECHNICAL FEASIBILITY	± Resource intensive but designed for widespread application in a broad range of circumstances.
COMPLEMENTARITY AND INTEGRATION	+ High potential for integration and complementarity given the link to the SNA. – Implementation must consider policy relevance and with that usefulness.
Robust	

DEFENSIBLE THEORY	+ Based on sound accounting theory backed by many international and national institutions. – SEEA does not provide guidance in choosing one method of valuation over another.
SENSITIVITY	+ Yes if data density is high enough and accounts (or indicators derived from them) are updated often enough (at least annually) – Big items may dominate smaller but important ones, e.g., oil in Norway dominates other resources
DATA QUALITY	± Depends on completeness and quality of collection system, e.g., developing countries struggling to deliver complete and accurate SNA accounts will find the SEEA-2003 difficult to implement, while countries with long experience in the design and use of natural resource accounts such as The Netherlands, Canada, and Germany produce high quality accounts. On the other hand, no country has and needs to implement all SEEA-2003 accounts but should focus on its high priority natural assets. – Subjective decisions and assumptions may be hidden in neutral-looking aggregate indicators
RELIABILITY	+ Coherent, consistent framework that yields reliable information on economy-environment interactions when the data are of sufficient quality – Different indicators or the same indicator calculated from SEEA-2003 with different methods may send different signals (e.g., different discount rates, different marginal cost)
COMPLETENESS	+ SEEA-2003 is a comprehensive framework for describing and explaining economy-environment interactions and better integrating the environment into the economic sphere. + Modular form of the SEEA-2003 means that each country can focus on the implementation of the high priority natural assets (physical and monetary) and thereby be comprehensive without having to use the full set of SEEA-2003 accounts.
Summary appraisal	The SEEA-2003 does not provide indicators for whether a country's economic activity is sustainable or not (and may therefore not realize its full potential) but is a comprehensive accounting system for tracking environmental and economic capital, rents, and expenditures. The revised SEEA (2010) can bring consistency, coherence, and wider cross-applications to environmental accounting. The accounting system does not engage in debates over environmental accounting, and therefore does not give the end user much guidance in determining whether a country is either weakly or strongly sustainable.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	The SEEA-2003 can be used to examine contributions to climate change and use of clean energy.
SUSTAINABLE TRANSPORT	The SEEA-2003 is better suited than other indicator systems for measuring sustainable transport because it allocates transport emissions to the producer and not to the point of origin, i.e., all international transport is allocated to the country and its resident units that undertake it. Sustainability criteria need to be defined though.

SUSTAINABLE CONSUMPTION AND PRODUCTION	Sustainable consumption and production can be measured because the SEEA-2003 allows calculation of total consumption and accounts for all environmental inputs, environmental resources, and wastes used and generated for. Sustainability criteria need to be defined though.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	The conservation and management of natural resources is a primary purpose of the SEEA-2003.
PUBLIC HEALTH	The public health aspect can be captured indirectly through accounting of harmful substances and pollution emissions, but no public health profiles or exposure or dose-response data are collected.
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	Social inclusion, demography, and migration are not directly measured in the SEEA-2003. However, these dimensions could be added and exist in part via the link to the SNA.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	The SEEA-2003 does not measure per capita poverty as conventionally defined (static poverty threshold or relative income measure) but allows the measurement of national and global wealth.
INVESTMENT IN RESEARCH AND DEVELOPMENT	Investment in research and development is not directly measured in the SEEA-2003 but is captured in the SNA.
UNEMPLOYMENT RATE	The unemployment rate is not directly measured in the SEEA-2003 but can be calculated from the SNA.
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	The SEEA-2003 framework offers a consistent framework for tracking economy-environment interactions and follows standard accounting principles. Its direct link to the SNA is appealing for defining and tracking indicators aimed at environmental sustainability. The number of indicators that can be generated should the available data allow it is nearly endless.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	The most controversial issue in the SEEA-2003 is the valuation of natural assets and services. Also, the capital maintenance approach favoured by the SEEA-2003 still requires decisions regarding weak or strong sustainability paradigms and hence affects if and how sustainability indicators would be calculated.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	Possible complementary indicators to those that can be calculated from the SEEA-2003 include biophysical measures such as EF, ecosystem accounts (for strong sustainability), social indicators such as social and human capital, and ecological indicators such as ecological resilience.
IX. SWOT Analysis	
u. *Core strengths* (Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the	• The SEEA-2003 methodology makes more apparent the rationale for sustainable development. It guides economic ministries to calculate not only the cost of natural resource extraction but also increases in savings achieved by reinvesting this rent in wealth-generating capital (Auty, 2007). It also provides a system for determining the amount of

indicator in question.)	resource rent that is retained through taxes and quantifies any loss of resource rents to excess corporate profits or inefficient labour and labour contracts (Auty, 2007). • The SEEA-2003 brings a high level of coherence to economic and environmental data, including both internal and external coherence: the ability to compare quantities within a particular topic as well as the ability to compare quantities from diverse economic and environmental areas (Smith, 2007). Lange (2007) explains, "The SEEA is especially important for economic modellers, who often must put great effort into making environmental statistics consistent with the input-output tables at the core of their models. The SEEA offers environmental statistics that are compiled in a manner that is consistent with IO tables, hence eliminating the need for that data work by modellers." The SEEA-2003 not only puts economic and environmental data on a comparable playing field but also eliminates much superfluous work in making statistics comparable. Additionally, because of the close link between SNA and SEEA-2003, environmental data compiled with SEEA-2003 methodology is immediately coherent with a wide variety of economic measures and statistics (Smith, 2007).
*v. Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	• The SEEA-2003 gives focus and direction to data collection. It provides guidelines on what kind of data to collect, how to collect it, and how to report the data. The accounting system helps to ensure that end users receive the information they need and those collecting data do not spend time and money collecting unneeded information (Smith, 2007). • The SEEA-2003 promotes comprehensiveness in environmental accounting, if nothing else, by factor of the comprehensiveness and thoroughness of SEEA itself. Smith (2007) explains that, over many years, SNA has brought a new level of consistency and comprehensiveness to economic accounting; he argues that SEEA promises the same. SEEA similarly emphasizes the need for consistency in economic accounting (Smith, 2007). • The SEEA-2003 framework, if implemented widely and to a high extent, would allow the aggregation of data from local to national, regional, and international level.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	• The only critical weakness of the SEEA-2003 might be that over several decades of work no consensus has emerged on the valuation of environmental goods and services and that hence expression of damages and depletion in monetary values remains fraught with assumptions and normative standpoints.
x. Important weaknesses (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as	• The SEEA-2003 may overlook the weakening or collapse of some natural and biological resources, suggesting that the SEEA-2003 may not be sufficiently comprehensive. Walker and Pearson (2007) point out that the SEEA-2003 does not measure underlying ecosystem variables that may, to a large part, determine the resilience and supply of valued natural resource stocks. As a consequence, the SEEA-2003 may miss conservation priorities and may overvalue natural resource

an EU policy tool.)	stocks. • The aversion of the SEEA-2003 framework to controversy may also limit the applications of the accounting system. First, the SEEA-2003 often declines to cost environmental impacts because pricing these impacts is a subject of modeling, not the strict descriptive accounting to which the SEEA-2003 is tasked (3). Additionally, the SEEA-2003 does not systematically provide guidance in differentiating between weak and strong sustainability. Dietz and Neumayer (2007) explain that the SEEA-2003 begins with a discussion of sustainability but drops this distinction further in the text and fails to provide real, aggregate measures of both weak and strong sustainability. Additionally, when there are differing methods for weak versus strong sustainability, the SEEA-2003 simply presents each method side by side without providing any guidance or recommendations for which method may be more appropriate (Dietz and Neumayer, 2007).
y. Opportunities (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	• The SEEA-2003 has the institutional support and technical expertise of the UN, WB, IMF, EU, OECD, and several – mostly developed – countries. The agencies involved in the development of the SEEA and primarily the London Group have a proven track record of supporting and improving the accounting framework. This history and level of support would facilitate wider adoption of SEEA.
z. Threats ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	• Adoption of the SEEA-2003 implies fundamental changes to a country's entire system of economic and environmental accounting which could be costly or could meet opposition because of the scale of the accounting change. • More focus should be given to developing indicators from the SEEA-2003 that have immediate and high policy relevance to amplify the utility of the SEEA.

6.1.3 Adjusted Net Savings (Genuine Savings)

I. Indicator Summary	
Name of indicator	Adjusted Net Savings (ANS) / Genuine Savings (GS)
Indicator category	Economic
II. Background information on the indicator	
a. What is the official definition of the indicator?	ANS (GS) measures the true rate of savings in an economy after taking into account investments in human capital, depletion of natural resources and damage caused by pollution (World Bank, 2009). Formula: GROSS NATIONAL SAVING - CONSUMPTION of fixed capital = NET NATIONAL SAVING + Education expenditure (investment in human capital) - Energy depletion - Mineral depletion - Net forest depletion - Damage from CO2 emissions - Damage from PM emissions (optional) = ADJUSTED NET SAVING
b. Unit(s) of measurement of the indicator	ANS is measured as percent of GNI or in monetary units.
c. What does the indicator seek to measure?	The ANS aims to be a measure of the sustainability of investment policies by measuring changes in wealth during a specified accounting period. In particular, it allows to test whether rents from natural resources and changes human capital are balanced by net saving in man-made capital. ANS expands the notion of 'assets' by including natural resources and human capital (Bolt et al., 2002).
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	The first application of accounting methods designed to augment the concepts of savings and investment by expanding assets to include natural and human capital was by Pearce and Atkinson (1993) for 20 countries. The analysis indicated that many countries are on unsustainable path because GROSS SAVINGS was less than combined conventional CAPITAL DEPRECIATION and NATURAL RESOURCE DEPLETION. Their modified index is known as GENUINE SAVINGS, now referred to as ADJUSTED NET SAVINGS. The World Bank began formally using the index in 1997 and first incorporated ANS into its *World Development Indicators* publication in 1999 (Ferreira and Vincent, 2005). Concerning the theoretical motivation for ANS (GS) Hamilton (2000) explains, „Given the centrality of savings and investment in economic theory, it is perhaps surprising that the effects of depleting natural resources and the environment have not, until recently, been considered in the measurement of national saving." The World Bank published the indicator annually for nearly all economies worldwide.
e. What are the known limitations of the indicator?	The key limitations of ANS are: • The underlying concept of sustainability is weak sustainability. • The addition of education expenditures to savings assumes that $1 in

	expenditures equals $1 in human capital. • Private education expenditure is not included in ANS. • There is no exhaustive accounting of natural resource depletion and degradation (missing are, for example, water resources, fisheries, soils, and biodiversity). • The accounting of net forest depletion includes only timber but not non-timber benefits provided by standing forests (e.g., soil protection, mineral cycling, biodiversity). • The accounting of natural resource depletion and degradation suffers from the same problems as other accounting-based sustainability indicators, incl. calculation of resource rents as difference between market value of extracted resource and average extraction cost instead of marginal cost. • Missing data on prices, extraction costs, amounts of resources extracted, education expenditures, etc. require imputation and hence frequently untestable assumptions. • Population growth not factored into the relationship that current changes in ANS equate to net present value of changes in future consumption. • ANS does not reflect technological changes. • ANS does not address the problem of how to treat transboundary damages. Sources: Bolt et al. (2002), UNDSD (2007), Hamilton (2000).
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	The GS indicator was first proposed by Pearce and Atkinson (1993) in study of 20 countries and was subsequently picked up by the World Bank in its 1997 "Expanding the Measure of Wealth" and then termed ANS. Since 1999 the ANS indicator is part of the World Bank's "World Development Indicators" and now covers more than 130 economies. Recently, the ANS pollution damages were expanded to include not only CO2 but also PM. There is no information on ongoing or future plans to revise the ANS methodology.
III. Data	
g. How is the underlying data gathered and by whom?	The ANS indicator is compiled by the World Bank using official and publicly available data from many sources including the UN family of organizations, agencies, and programs, national statistical offices, academic research studies, and corporations (e.g., BP).
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	The data sources used to calculate ANS are generally considered reliable. However, many data gaps persist including within available time series as well as across countries. Certain types of information that are required for the estimation of human and natural capital, such as private education expenditure or marginal costs of extraction, are generally not available. Such data gaps are addressed either by omitting the item (e.g., not including private education expenditure in ANS) or by imputation using regression methods and inter- or extrapolation. Thus, the resulting ANS values must be considered estimates.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	Since 1999 the World Bank publishes ANS in its annual World Development Indicators. The most recent year available is 2007 for 130 countries. Country coverage has been increasing since first release. No major revisions have happened aside from the inclusion of estimated pollution damages from PM in addition to CO2.

IV. *Link to sustainable development*	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	The operational definition of sustainability used in the ANS derives from a growth theory perspective: **Current change in net savings equates to present value of changes in future consumption** (Ferreira et al., 2008). Thus, ANS implies weak sustainability because all forms of capital (man-made, human, and environmental) are considered equally important with no requirement to maintain natural capital so as to ensure critical or life-preserving environmental services can flow ad-infinitum. Positive ANS does not guarantee sustainability, i.e., is necessary but not sufficient condition. Negative ANS indicates unsustainable state but the analysis of time trends is more relevant since sporadically negative ANS could still mean long-term sustainability if investments overall exceed consumption of all three types of capital.
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	The ANS indicator may indicate weak sustainability if non-negative but necessitates more comprehensive accounting of investments in human capital and depletion and degradation of natural resources.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilites below which a region/activity is not sustainable)?	Negative ANS values are indicative of unsustainability. Non-negative values, especially if maintained over long periods of time and significantly above zero provide cautious evidence for weak sustainability.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	Methodological links to conventional economic accounting measures include: • Net National Savings via the identity ANS=Net National Savings + education expenditures – natural resource depletion • Consumption measures because changes in ANS correlate positively with present value of changes in consumption in future (Dasgupta, 2001; Hamilton and Hartwick, 2005) • Links to the SNA and the SEEA-2003 because it can be calculated from these frameworks Methodological links to social indicators include: • Accounting measures of human welfare because it focuses on consumption and not GDP growth and as such is more welfare oriented. Methodological links to environmental indicators include: • Accounting measures of natural resource depletion and degradation measures because ANS accounts for the depletion and pollution damages of a limited set of natural resources.
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG	The ANS indicator is a hybrid measure linking all three dimensions of SD, i.e., • The economic dimension is captured because ANS is a savings measure and derived from GROSS NATIONAL SAVINGS. • It captures a social element due to the inclusion of human capital. However, this dimension requires expansion and better theory for estimating investment in human capital. • The environmental dimension is captured via the subtraction of natural resource depletion and pollution damages. ANS is also linked via the accounting framework to:

intensity—GHG emissions per unit of GDP).	• GNP
	• Adjusted versions of GDP such as Environmentally Adjusted GDP (EDP) and Environmentally Adjusted Capital Formation (ECF) because:
	  o ANS=GNS-CFC+E-NCD
	  o NDP=GDP-CFC and EDP=NDP-NCD, which means:
	  o ANS = GNS+E+EDP-GDP
	  o Where GNS is Gross National Savings, E is education expenditures, EDP is Env. Adjusted GDP, CFC is Fixed Capital Consumption, NCD is Natural Capital Depletion, and GDP is Gross Domestic Product.

V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	The institutions currently using ANS include: • The World Bank, which produces and releases ANS annually. • The UN Division for Sustainable Development, which included ANS in 3rd revision of its Blue Book (UNDSD, 2007). • The WRI, which reports ANS in its EarthTrends database. No government or regional governmental entity (e.g., EU) has legally adopted ANS as of yet as a measure of genuine savings
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	Institutional adoption is primarily hampered by these issues: • There remain limitations and controversies in the accounting methodologies used to calculate ANS such as for estimating resource rents and investments in human capital. • The extent of missing data on the extraction cost and damages arising from natural resource use. • The lack of monetary values for non-market environmental services (e.g., non-timber benefits of forests). • The hesitation on the side of economists, national accountants, and statisticians to adjust key macro-economic indicators such as GDP, Capital Formation, and Income.
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	Links of ANS to international and European laws, conventions, or agreements include: • The EU SD Strategy, which does not specify ANS but its underlying growth theory perspective and savings methodology would make it a potential candidate indicator. • The EU Lisbon Strategy, for the link to economic growth. • The Johannesburg Summits Plan of Implementation Chapters III and IV, which renews the call for measurement of sustainable development.
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ ANS directly relates to the Lisbon Strategy because it informs about the potential growth/decline of economic growth as a result of current savings patterns. + ANS is directly related to SD Strategy because it informs whether current economic activity is causing an increase or decrease in wealth and hence the potential for weak sustainability or unsustainability.

	+ ANS quantifies present value of future consumption levels. – ANS uses weak sustainability criterion. – ANS excludes many important natural resources and environmental services. – ANS implies that public education expenditure translates 1:1 to human capital. – ANS's current methodology does not incorporate population growth, which could have measurable impact on future consumption levels on a per capita basis for countries with high population growth rates.
IDENTIFICATION OF TRENDS	+ ANS reflects changes over time in a consistent manner. + ANS quickly reacts to changes in savings attributable to the selected resources. – ANS may not reflect changes in depletion or disinvestment in other resources that are not included in the formula. – In developed countries ANS correlates little with changes in future consumption because it does not factor in technological change and innovation. – Exclusion of population growth in ANS may overestimate potential future consumption on a per capita basis, especially in countries with rapidly growing populations. – There exists no systematic sensitivity and robustness analysis of the methodology and hence the impacts on trends of different assumptions and data used are not fully known.
FORECASTING AND MODELLING	+ The consistent methodology of ANS allows the forecasting of future savings and consumption potentials with the limitations stated above. – Is has not been tested how shocks to the economy due to, for example, resource scarcity or economic crisis affect the indicator. – It has been shown that economic growth and ANS are weakly correlated in developed countries. – The current ANS methodology implies weak sustainability so that thresholds or irreversibility in natural resources and environmental services may not be detected ahead of time. – There exists no systematic sensitivity and robustness analysis of the methodology and hence the impacts on trends of different assumptions and data used are not fully known.
SCOPE/LEVELS OF APPLICATION	+ ANS is theoretically applicable at various scales from local and national to regional and global. – The calculation of the ANS indicator is data intensive and partly due to this ANS does not account for several important items for human and natural capital.
Accepted	
STAKEHOLDER ACCEPTANCE	+ Aside from SEEA-2003 the ANS is probably the most advanced accounting-based indicator with some level of international credibility and endorsement. – The limitations of methodology and concern over weak sustainability paradigm hamper wider adoption of the ANS.
Credible	
UNAMBIGUOUS	+ If calculated with consistent data, the ANS is quite unambiguous in trend and comparable across countries. However, important trends or effects may go unnoticed, because these items are not included.

	– The exclusion of many types of natural resources and services may hide important increases or decreases in wealth and thus yield misleading results. – The exclusion of technological developments may limit its use as a predictor for future consumption levels in developed countries. – The exclusion of population growth may limit its use as a predictor of future consumption levels in developing countries. – The ANS's weak sustainability paradigm may lead to wrong policy conclusions regarding sustainability of the economy.
TRANSPARENCY OF THE METHOD	+ The ANS formula is clear, transparent, and systematically described in Bolt et al. (2002). + Empirical studies exist for ANS, which shed further light on the methodology and its problems.
Easy	
DATA AVAILABILITY	+ World Bank calculates national ANS annually for more than 130 countries, so data is available, albeit imputations and assumptions are necessary. – Data intensive and for most countries no complete time series and no complete set of the necessary data are available so that imputations and assumptions have to be made.
TECHNICAL FEASIBILITY	+ Calculation of the ANS is technically feasible as World Bank exercise has shown. – Full cost accounting for all forms of natural and human capital most likely prohibitive at present (aside from the controversies surrounding their monetary valuation).
COMPLEMENTARITY AND INTEGRATION	+ The ANS has a direct link to the SNA and SEEA. + The ANS is among the more feasible bridge indicators for integrating SD concerns into conventional macro-economic indicators. – ANS is nonetheless a limited indicator of sustainability as methodological limitations show and should thus be used with caution.
Robust	
DEFENSIBLE THEORY	+ The ANS methodology is integrated into economic growth theory (albeit with a welfare focus) and linked to national accounting standards, although estimation of human capital could be developed further. – The ANS implies a weak sustainability criterion. – The ANS comprises an incomplete accounting of human and environmental capital. – To date there is no generally accepted compromise on valuation methods.
SENSITIVITY	+ ANS can detect year-to-year changes in savings patterns for the components that are included. – Due to incomplete accounting of all forms of human and environmental capital ANS might miss important trends in other forms of capital. – Weak sustainability means all forms of capital are interchangeable and hence positive ANS may mask ongoing deterioration of environmental capital, which may ultimately lead to permanently reduced consumption potential.
DATA QUALITY	+ The accuracy of the ANS indicator depends on accuracy of input data, which varies from country to country but World Bank analysis claims that data are of generally high quality.

RELIABILITY	– Does not measure sustainability with present methodology.
COMPLETENESS	– The ANS represents an incomplete accounting of all forms of human and environmental capital.
Summary appraisal	+ ANS is a widely accepted first step toward adjusting conventional macro-economic accounting measures within the framework of the SNA. As such it is a useful complement to GDP and other key economic indices. + ANS has been shown in empirical studies to be able to identify economic patterns that are not sustainable, primarily for resource rich developing countries ('resource curse'). + Calculation of ANS is transparent and a step-by-step manual exists (Bolt et al., 2002). + Annual figures are available for a growing number of countries from the World Bank. + ANS methodology is under ongoing review by the World Bank and has potential to be expanded to include other environmental assets. + ANS can be used for sensitivity studies, for example, for testing the effect of different valuation or costing methods. + The ANS can estimate time trends. – The ANS is not a true sustainability measure due to limitations in the included forms of capital and the underlying sustainability paradigm (weak sustainability). – Many methodological issues remain to be solved. – Data intensive, especially when considering full cost accounting, and thus not easily implemented in resource scare settings. – ANS is not widely adopted in governmental reporting and policy-making. – There is no known international strategy to further develop and ultimately adopt ANS.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	ANS partially measures climate change and clean energy because it includes energy depletion of crude oil, natural gas and coal (hard and lignite) and damages from CO_2 emissions but no renewable energy sources and no comprehensive assessment of damages from all GHG emissions.
SUSTAINABLE TRANSPORT	ANS does not cover sustainable transport.
SUSTAINABLE CONSUMPTION AND PRODUCTION	The ANS compares consumption versus income as a first step to obtain GROSS NATIONAL SAVINGS and if ANS is non-negative current consumption patterns allow for increase in future consumption. Its use of a weak sustainability paradigm, however, means that sustainability of consumption and production vis-a-vis critical ecosystem functions cannot be assessed.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	ANS corrects conventional savings (GNS) by subtracting resource depletion and damages from pollution. Thus, indirectly, ANS can shed light on whether resource extraction and pollution trends exceed the production of man-made capital and create negative savings. ANS does not guarantee preservation of critical environmental services and goods.

PUBLIC HEALTH	The ANS does not cover public health.
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	The ANS does not cover social inclusion, demography, and migration.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	The ANS does not cover global poverty and sustainable development challenges.
INVESTMENT IN RESEARCH AND DEVELOPMENT	The ANS includes only public education expenditures.
UNEMPLOYMENT RATE	The ANS does not include the unemployment rate.
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	The ANS combines conventional concepts of economic growth and income with adjustments for the depletion of natural resources, pollution damages, and investments in human capital; All in the context of an accounting system such as the SNA. Substantial limits as a sustainability indicator. Time series data available from World Bank for some 130 countries in 2007. Thus, ANS is a useful bridging measure of economic performance and sustainable development. ANS is relatively data intensive but has already been tested and implemented by the World Bank. Methodology offers much room for expansion of the assets covered as well as testing of different valuation and costing methods.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	An important pitfall is to equate positive ANS with sustainability. At best, negative ANS is indicative of diminished consumption potential in the future and consistently well above zero ANS may indicate weakly sustainable economy. Omission of population growth and technological change may obscure the signals of ANS.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	GDP, ANS, ISEW (GPI), and EF together can give more information than any single indicator on: • Economic growth. • National savings (per unit GPD or as %GNI). • Trends in national and per capita welfare and a comparison of income and consumption levels. • Consumption patterns and carrying capacity.
IX. SWOT Analysis	
*u. Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	• The ANS is linked to GNI and GROSS NATIONAL SAVINGS while making adjustments for depletion of key environmental assets and pollution damages as well as investment in human capital. • Its theory is also easy to understand.

v. *Important strengths* *(*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	• ANS offers several advantages over other traditional economic indicators. First, it highlights the need to increase domestic savings and therefore can help promote sound government macroeconomic policies. In comparison, GDP rises as resource depletion increases. This can distort estimates of national income and growth, especially for resource-dependent economies (Hamilton, 2000). ANS can provide a more balanced measure. • ANS can make resource use and environmental decisions much more apparent in economic decision-making: environmental trade-offs immediately become much more explicit (World Bank, 2009). The indicator translates resource issues into a framework that financial and economic ministries can easily understand. It also highlights the financial consequences of resource use and may suggest collection of resource royalties in order to more efficiently use the rents gained from resource extraction. • Possibility to expand the list of environmental assets and pollution sources included in ANS, so it's flexible and adopting countries or institutions can gradually expand the list of assets.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	• There are large uncertainties in estimates of fixed capital consumption, natural resource depletion, and in total wealth estimates (Hamilton, 2005). In particular, incomplete data in a 2001 World Bank analysis affected ANS estimates for 92 countries or 4.6 billion people (Pillarisetti, 2005). • Empirical evidence shows that the relationship between ANS and social welfare is positive, but this relationship is not necessarily very strong (i.e.: Hamilton, 2005; Hamilton, 2000; Ferreira and Vincent, 2005; Gnegne, 2009). Hamilton (2000) found that there are many countries with declining wealth but positive genuine savings. Ferreira and Vincent (2005) and Gnegne (2009) add that ANS provides a better gauge of the difference between current and future consumption for non-OECD countries than OECD countries. • In calculating ANS, the World Bank does not account for changes in population. Hamilton (2000) points out that for the most countries below the median per capita income, the population is growing faster than national savings or wealth.
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	• Economists and scholars debate the utility of ANS as an indicator because of its orientation toward weak sustainability. • The indicator, as computed by the World Bank, does not include changes in all capital stocks. • ANS adds, dollar for dollar, educational expenses to the estimate of national savings. Calculations do not account for the efficiency of educational spending and exclude private educational spending. • ANS receives criticism for unfairly biasing measures of sustainability towards wealthy countries and against developing states. The World Bank does not thoroughly consider the implications of imported resources, making developing countries look less sustainable then they otherwise would. • Calculations of damages caused by CO_2 emissions may also unfairly shed a more positive light on developed countries over their developing neighbours. The US accounts for nearly one quarter of global anthropogenic CO_2 emissions even though it contains just under 5% of the world's population (Pillarisetti, 2005). The ratio of CO_2 damages to GDP, however, is one of the lowest of any country in the

	world at 0.4%. Azerbaijan, in comparison, emits only 0.18% of the total global CO_2 emissions, but the ratio of damage to GDP in this country is 5.4%. The United States is arguably causing far more harm in terms of climate change than is Azerbaijan, but in terms of genuine savings, the US appears much more sustainable.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	• ANS is both compiled and advocated by the World Bank. This means that ANS currently has a high level of both technical and some institutional support. Although there are major shortfalls in the ANS, the indicator has sufficient institutional backing to facilitate future methodological improvements and better data collection.
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	• Institutional and market barriers could prohibit improved data collection. For example, most mining companies will not release production costs for metals and minerals, making it difficult to reliably calculate reductions in natural capital.

6.1.4 Evaluation of the Indicators as a Group / RACER Analysis of the Basket of Indicators

I. Indicator Summary	
Name of indicators in the basket	GDP, ANS, SEEA
Indicator category	Economic
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ GDP, ANS, and SEEA together measure (1) the total market value of all goods and services produced in the market sphere in an economy during the accounting period, (2) the monetary savings rate taking depletion and degradation of selected environmental capital as well as an estimate of the investment into human capital into account, and (3) offer a framework for a host of further indicators of economic-environmental relationships (and sustainability). Thus, as a basket the three indicators support and enhance each other and have demonstrated policy relevance for characterizing the degree to which an economy is on a sustainable path with respect to its use of environmental goods and services. – None of the three indicators/frameworks individually and as a group measure true sustainability with respect to either a strong or weak sustainability criterion. However, especially the SEEA and the ANS could be expanded to cover a maximum of natural resources and their

	depletion or degradation. – Human capital and other aspects of sustainability are not adequately measured in the basket and it can hence not inform about the social dimension of sustainability.
IDENTIFICATION OF TRENDS	+ If calculated on a regular basis from high quality data, all three indicators/frameworks individually provide reliable trend information. To what extent the individual trends agree with each other in terms of giving an unambiguous overall perspective on environmental sustainability would need to be tested. + Trends might go into opposite directions, e.g., positive GDP but negative ANS, which does not pose a contradiction but an opportunity for a more fine-grained and truthful sustainability analysis. + ANS as a savings measure is a more forward-looking sustainability indicator because positive savings today are likely to permit increased consumption in the future (although ANS as currently calculated does not account for population growth or preservation of critical environmental services) – There is debate about how to interpret a negative ANS value: although it indicates that the capital base was being reduced in the accounting period, it could be possible that the net present value of the capital (built, human, environmental) that is generated in the future from the resources extracted in this accounting period may exceed the value of the current decline in assets. It can be compared with going into debt to start a new business, which if successful generates more revenue than the initial amount borrowed. Several periods of negative ANS may therefore be a more reliable sign of unsustainability than a single negative value. – The basket of GDP, ANS, and SEEA cannot set an unequivocal sustainability value or threshold. It also does not warn of reaching critical tipping points or thresholds with no reversibility.
FORECASTING AND MODELLING	+ The shared and expanded accounting principles on which all three indicators/frameworks rest offer themselves to forecasting and modelling, e.g., it allows the identification of the processes that might underlie a growing GDP but declining ANS. The rich SEEA information can shed further light on economy-environment relationships that can be used to forecast and model items such as resource stocks and flows and their effects on pollution levels. – All three measures/frameworks, if implemented fully, are very data intensive, although the data overlap to some extent due to the shared accounting basis. Thus, substantial investment is needed into data collection and analysis infrastructure in order to obtain informative, reliable, and comprehensive forecasts.
Accepted	
STAKEHOLDER ACCEPTANCE	+ The basket of GDP, ANS, and SEEA is one of the most widely accepted set of indicators/frameworks in the sustainable development community, although all individually and taken as a group have limitations and shortcomings (e.g., the items included and the valuation methods used). + If the debate in the EU continues to move toward ‘complementing GDP’ instead of replacing it, ANS and SEEA are well positioned to do that. – There are disagreements among stakeholders regarding a number of methodological issues concerning the individual measures (discussed in the single indicator reports), although it seems to be accepted that relying on a single (flawed) measure of sustainability is not useful.

Credible	
UNAMBIGUOUS	+ ANS and SEEA-based indicators can inform about whether the achieved GDP is unsustainable (e.g., negative ANS). – Ambiguity exists with respect to the interpretation of the indicators (incl., those derived from the SEEA) individually and as a basket as to whether the economy is on a sustainable path. – The basket of GDP, ANS, and SEEA cannot set an unequivocal sustainability value or threshold. It also does not warn of reaching critical tipping points or thresholds with no reversibility.
TRANSPARENCY OF THE METHOD	+ The methods to calculate GDP, ANS, and indicators in the SEEA are transparent. – Calculating the measures requires specialized training in national and environmental accounting principles and methods.
Easy	
DATA AVAILABILITY	± Data to calculate GDP are generally available but are usually incomplete for ANS and SEEA. – In most instances it is not possible to calculate the basket of GDP, ANS, and SEEA-derived indicators on a regular and accurate basis.
TECHNICAL FEASIBILITY	+ The data basis for calculating the basket is growing slowly but there is a renewed interest by EU countries and poor countries with economies relying strongly on the extraction of natural resources to develop the data collection and analysis infrastructure to compile environmentally adjusted macro-economic indicators and/or SEEA satellite accounts. + The continued development and publication of methodological handbooks also facilitates the calculation of the indicators in the basket. + Further impetus is expected to come from the elevation of the SEEA to an international statistical standard by the UN Statistical Commission in 2010. – The degree of technical expertise and the required amount of data poses a hurdle in the widespread adoption of this basket. – In addition, where methodological disagreement exists the SEEA discusses the different approaches without giving clear guidance on which one to choose in what situation. This neutral stand has been cited as a hindrance to the more widespread and faster adoption of the SEEA since its inception in 1992.
COMPLEMENTARITY AND INTEGRATION	+ The GDP, ANS, and SEEA complement each other in several ways: GDP measures economic performance, which is supplemented by a environmentally and socially adjusted savings (i.e., a forward-looking capital maintenance measure) and further supported by information on the stock and flows (perhaps also value) of environmental assets, the pollution generated by economic activity, and the resulting damages to future environmental resource streams. + GDP, ANS, and SEEA are all linked and to a high degree integrated via the System of National Accounts. – None of the measures/frameworks adequately assesses the social dimension of sustainability, e.g., human capital and wellbeing.
Robust	
DEFENSIBLE THEORY	+ The underlying accounting principles are to a high degree accepted and based on sound accounting theory. – Valuation of environmental goods and services becomes problematic

	when they are not traded in the market place, have inter-generational value, represent critical forms of capital, or are traded or exchanged in such small quantities or such diverse forms that monetary values are not reliable or comparable. – Different valuation methods have been developed but they sometimes lead to very different results (e.g., WTP v. WTA) and no uniformly accepted standard has yet emerged.
SENSITIVITY	+ The basket of GDP, ANS, and SEEA allows for a more nuanced depiction of economic performance and its relationships to the environment. + Although sustainability cannot be measured with confidence and accuracy by the indicators in the basket, the information on the status of the environment added by ANS and SEEA indicators increases the sensitivity of GDP to detect unsustainable trends. – It has not yet been tested to what extent the combined picture offered by GDP, ANS, and SEEA-based measures are sensitive to assumptions or specific conditions in the economy-environment nexus.
DATA QUALITY	+ In an EU context it can be assumed that data quality is generally adequate. – Data may not be complete to calculate ANS or SEEA-based indicators.
RELIABILITY	+ The basket increases reliability of the conclusions regarding sustainability compared to any single indicator in the basket. – The omission of a number of components and concepts reduces the reliability of the basket as a sustainability measurement tool.
COMPLETENESS	+ The combination of GDP, ANS, and SEEA can shed a fairly complete picture on the interactions between the economy and the environment. – Several important components of sustainable development are not covered, including: • Risks and their severity and probability • Thresholds and tipping points • Social aspects and social capital • Weighting of environmental impacts according to their severity, e.g., toxics • Environmental goods and services not covered by ANS and SEEA
Summary appraisal	+ GDP, ANS, and SEEA as a basket may offer one of the more appealing combinations of economic and environmental indicators. + ANS and SEEA are gaining momentum as tools to complement GDP. + While not measuring sustainability, they can be used to identify trends and relationships in GDP growth and the protection of natural resource streams into the future. – Many methodological issues remain to be resolved. – Social dimension is not adequately represented. – So far, all sustainability values mentioned in connection with ANS and SEEA are based on a weak sustainability definition and are at best approximations.
Bridging shortfalls: How does the basket of indicators either bridge or augment the shortfalls in the individual indicator?	The known shortcomings of the ubiquitous GDP as a sustainability indicator are partially overcome by ANS and the SEEA framework. ANS adds a savings dimension that takes into account environmental depletion and degradation (albeit incompletely due to data and methodological issues) and to a very limited extent by counting public education expenditures as

	investment in human capital. As a savings measure, it is focused on a capital maintenance approach, which is a natural way of looking at sustainable production and consumption patterns. The SEEA framework corrects the accounting flaws in GDP to (a) not count environmental goods and services not traded in a market place, (b) internalizing the externalities of economic activities, (c) attempting to put monetary values on environmental assets, their depletion and degradation, and (d) allowing a more complete stock-taking of environmental capital.
Ease of interpretation: When listed side-by-side, are the indicators in the basket easy to read and interpret as indicators? (For example, what if one indicator listed a positive trend while another listed a negative trend?) Alternately, is it more difficult to interpret the indicators as a basket than if each indicator were used stand-alone?	The addition of ANS to GDP allows for a more nuanced analysis of economic performance and the impacts it might have on natural resources and environmental degradation. Thus, GDP and ANS may show opposing trends, but they can be interpreted within a sustainability framework and used to identify the driving factors of the trends in GDP and ANS. Adding additional detail from the SEEA to the picture can further illuminate what processes and activities are causing an upward trend in one measure and a downward trend in the other. Thus they enhance each other.
Key advantages and disadvantages of the basket: What are the main advantages and disadvantages of using the basket over using either indicator as a stand-alone measure?	Key advantages: • ANS and SEEA-derived indicators tell more about the environmental 'toll' of economic growth measured in GDP. • SEEA expands the economic boundaries of the accounting system and, hence, more complete accounting (internalization) of environmental goods and services as well as depletion and degradation. • ANS adds a forward-looking, capital maintenance perspective to GDP and accounts partially for environmental depletion and degradation and a proxy for investment in human capital. • All three use accounting principles and share to some extent the same data basis. • The accounting framework facilitates adoption by economic planners and other line ministries used to thinking in terms of monetary values. Key disadvantages: • No sustainability value available, only indicative of unsustainability or sustainability (such as negative and non-negative ANS). • Data intensive. • High degree of technical expertise required to be able to compile the accounts and calculate the measures, although handbooks are available. • Methodological issues remain, including regarding the valuation of many types of environmental goods and services.
a. Critical strengths	GDP, ANS, and SEEA are probably the most developed troika of economy-environment indicators and frameworks. They share many established and widely used accounting principles and have appeal because they expand the economic boundaries of the system while maintaining close linkages to the System of National Accounts.
b. Important strengths	The basket can be developed further, e.g., by incorporating additional components into ANS or expanding the SEEA set of satellite accounts. Continued methodological refinement is taking place under leadership of major international organizations (WB, UN, Eurostat, IMF, OECD). Long time

	series and nearly global coverage are available for GDP and to a lesser extent for ANS. Joint analysis of GDP, ANS, and SEEA-derived indicators can shed light on the drivers of economic growth and their environmental costs and impacts. Unsustainability can be gauged from negative ANS and indicators derived from the SEEA.
c. Critical weaknesses	No intrinsic sustainability threshold or value associated with an individual indicator or jointly as a group.
d. Important weaknesses	Methodological issues remain with respect to the valuation of environmental goods and services and the factoring in of intergenerational equity. Several important aspects of sustainable development are also not covered by the basket, incl.: • Risks and their severity and probability • Thresholds and tipping points • Social aspects and social capital • Weighting of environmental impacts according to their severity, e.g., toxics • Environmental goods and services not covered by ANS and SEEA ANS may be of limited use in developed countries as it does not reflect technological innovation. In countries with rapid population growth ANS may also be problematic because it does not take population growth into account. Additional hurdles are posed by the relative data intensity and level of technical expertise needed to develop the necessary accounts, although the ongoing and further development of publications and handbooks together with training workshops can reduce this obstacle.
e. Opportunities	The revision of the SEEA-2003 was completed in 2010. This can boost the acceptance and uptake of the SEEA. Further refinement of the ANS, e.g., by improving valuation methods and including additional types of environmental capital.
f. Threats	Perhaps the biggest threat might arise from a continued disagreement over certain methodological aspects and the continued absence of clear advice on the construction of sustainability indicators in the revised SEEA.

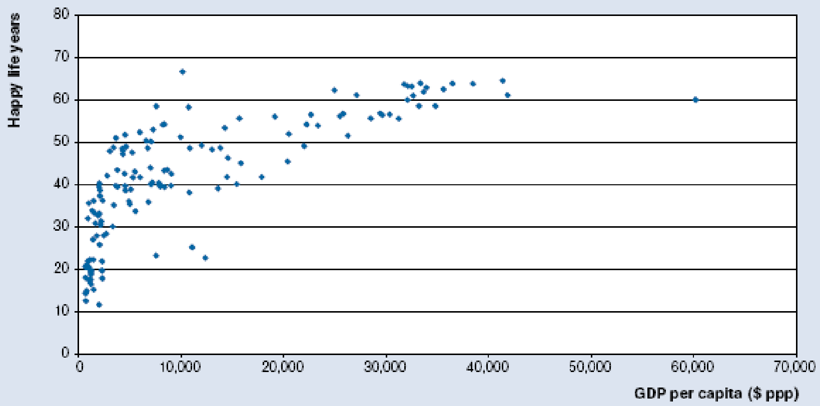
6.2 Subjective wellbeing indicators / frameworks

6.2.1 Happy Planet Index

I. Indicator Summary	
Name of indicator	Happy Planet Index
Indicator category	Wellbeing
II. Background information on the indicator	
a. What is the official definition of the indicator?	The index combines environmental impact with human well-being to measure the environmental efficiency with which, country by country, people live long and happy lives.
b. Unit(s) of measurement of the indicator	The HPI is a score between 0 and 100 with 100 corresponding to the highest level of happiness attainable in line with the index's method.
c. What does the indicator seek to measure?	The HPI seeks to measure how efficiently people use environmental goods and services to achieve long and happy lives, which is measured as life expectancy and life satisfaction. The HPI is calculated at the country level. Efficient environmental resource use is measured through the Ecological Footprint, a well-established approach to measuring human consumption and the biocapacity needed to produce it (cf. Best et al., 2008).
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	The first HPI was published in 2006 by the New Economics Foundation (NEF), which was founded in 1986 by the leaders of The Other Economic Summit, (TOES) which forced issues such as international debt onto the agenda of the G7 and G8 summits. A European HPI followed in July 2007 and the second global HPI (called HPI 2.0) was released in July 2009 with updated data sets with minor methodological modifications, which, resulted in the exclusion of several, often small, countries due to more limited imputation of missing data. The 2006 HPI includes178 countries and the 2009 HPI 143 countries. The 2009 report also includes a time series of the HPI going back to 1961 for OECD countries. The HPI remains a flagship publication of the NEF.
e. What are the known limitations of the indicator?	The HPI relies on three components: • Ecological Footprint to measure a country's consumption expressed in global hectares, gha, (see Ecological Footprint as explained, for example in Best et al. (2008), for details on the methodology) • Life expectancy

	- Life satisfaction using data from several sources, including the Gallup World Poll, the Eurobarometer, and the World Values Survey. The HPI then combines the three components as follows: $$\text{Happy Planet Index} = \frac{\text{Happy Life Years}}{\text{Ecological Footprint} + \alpha} \times \beta$$ $\alpha = 3.35;\ \beta = 6.42$ (Source: NEF, 2009). Happy life years are calculated as Life Expectancy x Life Satisfaction. The constant α ensures that the coefficient of variation for Happy Life Years equals that of the Ecological Footprint to avoid the latter dominates the HPI. The factor β is then used to calibrate the index such that a country with a Life Satisfaction score of 10, Life Expectancy of 85, and an EF of 2.1 gha/person (equivalent to 1 planet) achieves an HPI of 100. This methodology has a number of limitations: • It's consistency over time depends in part on the consistency of the inputs, especially the EF and Life Satisfaction • The HPI suffers from the limitations of its underlying components, especially the known methodological and conceptual challenges afflicting the EF and measurement of Life Satisfaction. • Life Satisfaction is not an absolute measure and varies across cultures and time. While this is not per se a reason to not use it, users need to be aware of the fact that a score of 7 means different things to different people. • The Life Satisfaction score is based on a single question in the survey(s), which is known to lead respondents to focus on specific aspects of their lives while excluding others, is likely to be biased and overall is a crude tool to gauge a person's overall sense of wellbeing as well as to base policy decisions on. • The index results show some counter-intuitive results such as the 1st place of Vanuatu in the first HPI of 2006 and generally shows that medium-income countries in Central and Latin America perform best, a non-surprising result since the HPI balances material wellbeing (measured through consumption) with physical wellbeing (measured through Life Expectancy). It remains to be seen whether these countries are indeed on a more sustainable path than high-income countries. • The index, like many others, uses aggregate information at the country level and thereby masks sub-national variation, which can be substantial. • As a composite indicator, the HPI needs to be viewed within the common problems of (a) selection of components and their transformation to a common scale, (b) weighting of the components, and (3) aggregation formula.

	Other critiques leveled at the HPI include: • The HPI ignores issues such as political freedom, human and labor rights. • The World Value Survey covers only a small proportion of the world's nations and is done every five years. • General suspicions toward subjective measures of wellbeing.
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	The global HPI has been published only two times and the second release had only marginal changes in the methodology, i.e., the decision to not impute Life Satisfaction data for mostly very small countries. Therefore, country coverage dropped from 178 to 143 but it still covers 99% of the world population.
III. Data	
g. How is the underlying data gathered and by whom?	The HPI's three components are sourced as follows: • Ecological Footprint from the WWF's Living Planet Index (WWF, 2008) • Life Expectancy at birth from UNDP 2007/8 Human Development Report, which includes the HDI and life expectancy data for 2005 • Life Satisfaction data from Gallup World Poll, Eurobarometer, and World Values Survey
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	The HPI is a composite indicator, i.e., an artificial construct for a concept that cannot be measured directly. It is an approximation of what the NEW describes as economics for the people and the planet. How well it approaches the unknown truth cannot currently be calculated. There is a modest amount of data imputation for the Life Satisfaction component, although small countries with missing values on multiple components have been excluded in the 2009 HPI. Data gaps persist in the Life Satisfaction and Ecological Footprint but are largely complete for Life Expectancy.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	The global HPI was calculated in 2006 and 2009. A European HPI was calculated in 2007. The 2009 HPI also includes time series dating back to 1961 for OECD countries.
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	The HPI makes two assumptions: • Happy and healthy lives are sought-after around the world. • This should not be a privilege of the current generation, i.e., future generations should also be able to pursue happy, healthy lives. The HPI combines progress towards these two goals in a single figure. Building on the Brundtland report's de-facto definition of sustainability, the HPI

	adds the concept of human well-being, echoing the IUCN's (The World Conservation Union) call for a metric capable of measuring 'the production of human well-being ... per unit of extraction from or imposition upon nature'.36 In doing so, it also incorporates, for the first time in the policy discourse around sustainability, measures of people's lived *experience* of their lives, rather than just external judgments made by experts. (Source: NEF, 2009, p.10)
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	The HPI is primarily a human wellbeing index, which incorporates an element of sustainable consumption. The HPI is, therefore, at best a measure of weak sustainability.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities below which a region/activity is not sustainable)?	The HPI does not have a value associated with sustainability. Its maximum score of 100 simply corresponds to a country achieving 85 years of Life Expectancy at birth with a perfect score of 10 on Life Satisfaction and an Ecological Footprint not exceeding a 1-planet consumption pressure (2.1 gha/person). No tipping points are defined.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	The HPI is a simple construct combining at least two well-defined measures, i.e., that of the EF and that of Life Expectancy. It also incorporates the subjective evaluation of satisfaction with life. The HPI therefore exhibits correlations with all three components and also correlates positively but non-linearly with GDP. The HPI is closely related with the broader National Accounts of Wellbeing, another initiative of the NEF that uses an accounting framework to define and measure multiple indicators of wellbeing. **Figure 6: Scatter plot of happy life years vs. GDP per capita, by country** 
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG	Probably the strongest link is to environmental sustainability via the inclusion of the EF. Since the EF is not a comprehensive sustainability metric (it covers important aspects of resource consumption and carrying capacity but does not cover a full array of environmental resources nor does it employ a strong sustainability approach that ensures that vital ecosystem services are maintained indefinitely), the HPI is also not a measure of environmental sustainability. Social aspects enter through the Life Satisfaction and Life Expectancy components but again, it is a very limited consideration of the

intensity—GHG emissions per unit of GDP).	social dimension of sustainability.
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	The HPI received substantial media coverage following its releases and is analyzed in scientific studies. It is known and considered by the European Commission in its endeavour to supplement or replace GDP with better measures of human wellbeing and sustainability (cf. www.beyond-gdo.eu). However, beyond these scientific debates and occasional uses the HPI has not found widespread application.
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	The HPI suffers from the same barriers to adoption that all newly created composite indicators for wellbeing and sustainable development suffer from, i.e., historical dominance of GDP and other macro-economic indicators, predominance of growth thinking as an engine of human development and happiness, and institutional inertia to actively promote the adoption of better metrics of wellbeing.
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	The HPI is relevant to the EU Commission's "Beyond GDP" process as well as the Stiglitz Commission's work on measuring human wellbeing.
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ The HPI can support policymaking by shedding light on the pitfalls of growth thinking and offering a more nuanced analysis of the linkages between economic wellbeing and happiness (e.g., the fact that happiness appears to rise linearly and strongly up to per capita incomes of ca. 10,000 USD) + The HPI also shows an interesting logistic relationship between Happy Life Years and Ecological Footprint.

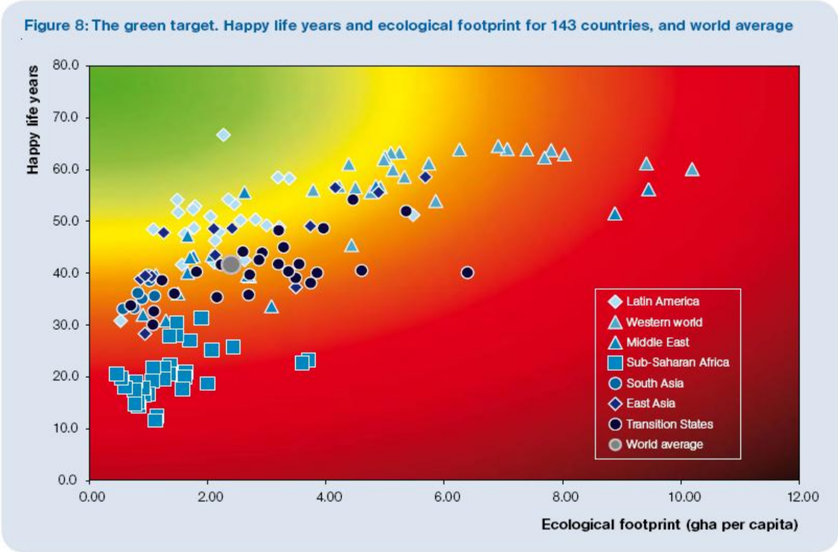
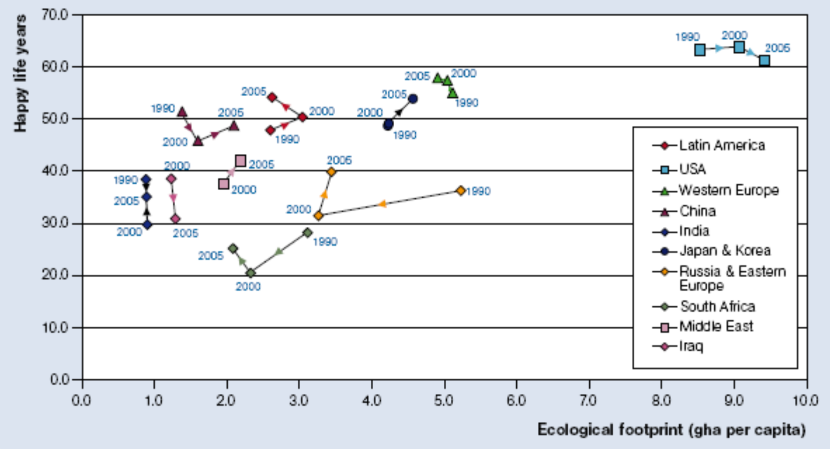
	 – The HPI is affected by the problems associated generally with composite indicators, including selection and scaling of components, weighting, and aggregation. – The HPI is not a sustainability metric, it simply aims to show how environmentally efficient a country is in generating happiness. – Happiness is a subjective state of being, which varies spatially as well as temporally. ± The HPI has not found noteworthy application in national policy processes.
IDENTIFICATION OF TRENDS	The HPI 2009 includes time series for the OECD countries dating back to 1961.
FORECASTING AND MODELLING	The HPI has a limited potential for forecasting and modelling, primarily due to its reliance on a highly aggregate composite indicator, the EF, and difficulties in modelling future Life Satisfaction. Despite these challenges, the HPI can be used to make short-term predictions on the likely trajectory of countries, although a regional assessment of HPI in 1990, 2000, and 2005 has shown rather erratic movement.

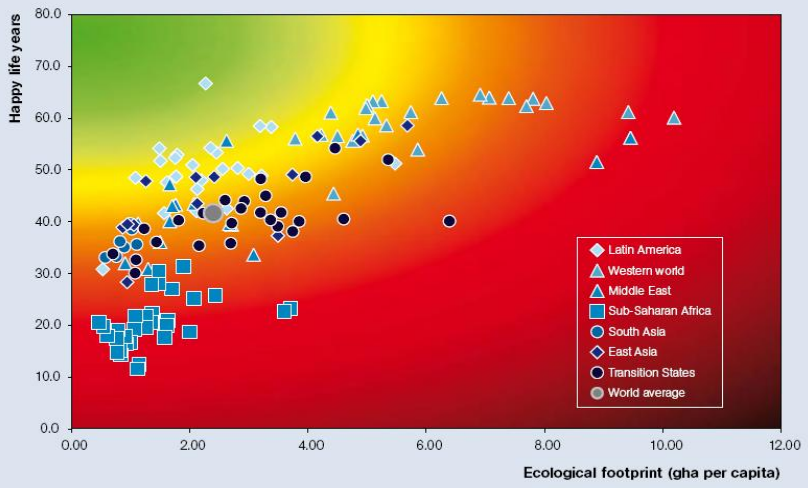
Figure 11: Ecological footprint and happy life year trajectories over time for selected countries and regions



SCOPE/LEVELS OF APPLICATION	The HPI is designed for application at the national level, however, the concept can be transferred to sub-national (although the EF concept is more appropriate at the global level) as well as to regional and global levels as long as the necessary data inputs are available.
Accepted	
STAKEHOLDER ACCEPTANCE	The HPI is not widely accepted but has found an audience among happiness/wellbeing researchers as well as within the larger sustainability community as a noteworthy contribution to the challenge of measuring subjective wellbeing and linking it with economic and environmental goals.
Credible	
UNAMBIGUOUS	The HPI is probably not very ambiguous in its goal to show which countries tend to have higher levels of subjective wellbeing (albeit aggregated to the national level and thereby potentially masking large sub-national variations), and its relation to environmental resource consumption and carrying capacity. It is ambiguous in its conclusions with respect to the sustainability of the level and trajectory of the leading countries in the HPI.
TRANSPARENCY OF THE METHOD	The HPI is transparent in the description of its methodology and data sources. Details on data imputation, especially for Life Satisfaction, may need to be inquired from the NEF.

Easy	
DATA AVAILABILITY	The HPI draws on publicly available information. However, data gaps in the EF accounts and measurement of life satisfaction are persistent and substantial in some countries.
TECHNICAL FEASIBILITY	The HPI is technically very feasible.
COMPLEMENTARITY AND INTEGRATION	The HPI complements and supplements important mainstream indicators such as GDP but also more recent metrics such as the EF, subjective wellbeing/happiness, HDI, and EPI.
Robust	
DEFENSIBLE THEORY	The HPI is built on new and largely empirically untested but clearly laid out theory. It remains to be seen if the HPI's conclusions hold up over time and can point to strategies or interventions that can lead to higher human wellbeing while reducing countries' EF.
SENSITIVITY	No sensitivity analysis has been carried out to date for the HPI.
DATA QUALITY	Data quality is certainly variable across HPI components, countries, and time. However, all three components are sourced from data collection efforts that aim to achieve a high degree of accuracy and comparability. It is probably fair to say that Life Expectancy is likely the most accurate measure as it is a single metric based on vital registration systems in many countries (albeit not all and in those, life expectancy figures are likely to be less accurate).
RELIABILITY	No robustness analysis has been carried out to date for the HPI.
COMPLETENESS	The completeness of the HPI depends on the definition of environmental resource efficiency and human wellbeing. Both aspects are integrated into the HPI using metrics that have been judged to be incomplete. E.g., the EF fails to account for biodiversity loss and protection of essential, life-sustaining environmental services while Life Satisfaction is based on a single survey question.
Summary appraisal	

VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	Yes, through the EF components of CO2 emissions and consumption of energy.
SUSTAINABLE TRANSPORT	No.
SUSTAINABLE CONSUMPTION AND PRODUCTION	Yes, through the EF.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	Partially, through the EF.
PUBLIC HEALTH	Only through the inclusion of Life Expectancy, which is a proxy measure for public health (cf. UNDP's Human Development Index).
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	At best partially and indirectly through the Life Satisfaction component.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	At best partially and indirectly through the Life Satisfaction component.
INVESTMENT IN RESEARCH AND DEVELOPMENT	No.
UNEMPLOYMENT RATE	At best indirectly through the Life Satisfaction component.
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	The HPI's linkage to climate change and energy is not direct. One would need to unpack the HPI and EF to understand the linkages better. The NEF has not taken this step so far. The strongest link is between the HPI and the EF as shown in the figure:

	Figure 8: The green target. Happy life years and ecological footprint for 143 countries, and world average 
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	The HPI seems to suggest that highest levels of human happiness are achieved at medium-income level and moderate Ecological Footprints. While it is certainly relevant to examine countries that achieved high levels of happiness at relatively low environmental resource consumption levels, one should be careful to jump to quick conclusions. First, happiness is measured subjectively in ways that modern science of wellbeing would describe as not state of the art. Second, leaping to a reduced or no-growth argument is short-sighted and potentially misleading. The HPI authors have yet to uncover the complex relationships through which happiness, economic performance, and environmental sustainability are linked.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	The HPI should be compared with other measures of happiness/wellbeing as well as established economic and environmental benchmarks. Examples include Gross National Happiness, Genuine Progress Indicator, EF, EPI, HDI.
IX. SWOT Analysis	
u. *Core strengths* (Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	The HPI's strengths are: • Simple, transparent combination of measures of environmental consumption pressure and human happiness/wellbeing • Considers actual 'ends' of economic activity in the form of life satisfaction and longevity • Comparability of results across countries and in time • Data available freely online

v. *Important strengths* *(*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	Important strengths include: • Limited use of imputation of missing data, although data gaps remain and affect country coverage • Mixture of 'soft' and 'hard' criteria • Demonstrated capacity to show linkages between happiness, income, life satisfaction, and longevity that are worth exploring in depth
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	Critical weaknesses include: • Problems in the measurement of wellbeing including the subjective measurement scale used, the frequency and size of the survey sample, and aggregation to national averages of happiness • Continued shortcomings of the EF • Dependence of the HPI on methodological changes in the underlying components
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	Important weaknesses include: • Lack of understanding of how human wellbeing/happiness are a result of and/or influence economic and environmental performance (as well as longevity) • Time series only available for OECD countries
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	The HPI offers several opportunities to gain further insight into: • The relationships between human wellbeing/happiness are a result of and/or influence economic and environmental performance • Improving measurement of happiness • Expanding the use of happiness metrics in sustainability strategies • Helping to change the prevailing paradigm of growth = happiness
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	The HPI suffers from the following threats: • Institutional inertia to change • Prevailing growth thinking • Aversion of public and governmental institutions to use subjective metrics in decisionmaking • Lack of uptake by policymakers of the HPI to date

6.2.2 National Accounts of Wellbeing (NAW)

<table>
<tr><th colspan="2">I. Indicator Summary</th></tr>
<tr><td>Name of indicator</td><td>National Accounts of Wellbeing (NAW)</td></tr>
<tr><td>Indicator category</td><td>Wellbeing</td></tr>
<tr><th colspan="2">II. Background information on the indicator</th></tr>
<tr><td>a. What is the official definition of the indicator?</td><td>A set of indicators, embedded in an accounting framework, aimed at measuring the extent to which an individual experiences:

• A sense of individual vitality

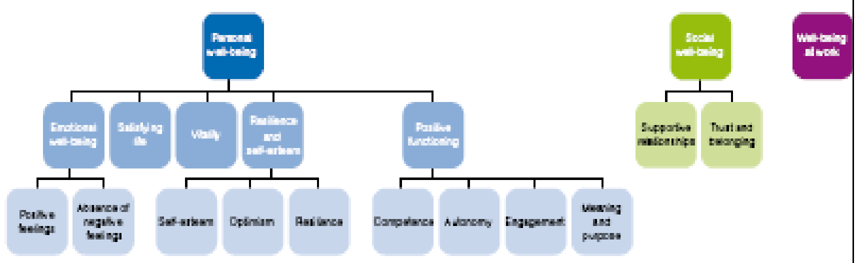
• Undertakes activities which are meaningful, engaging and which make him/her feel competent and autonomous

• A stock of inner resources to help him/her cope when things go wrong and be resilient to changes beyond his/her immediate control

In addition, individuals want to have a sense of relatedness to other people and society, i.e.,

• The extent to which they have supportive relationships and a sense of connection with others.

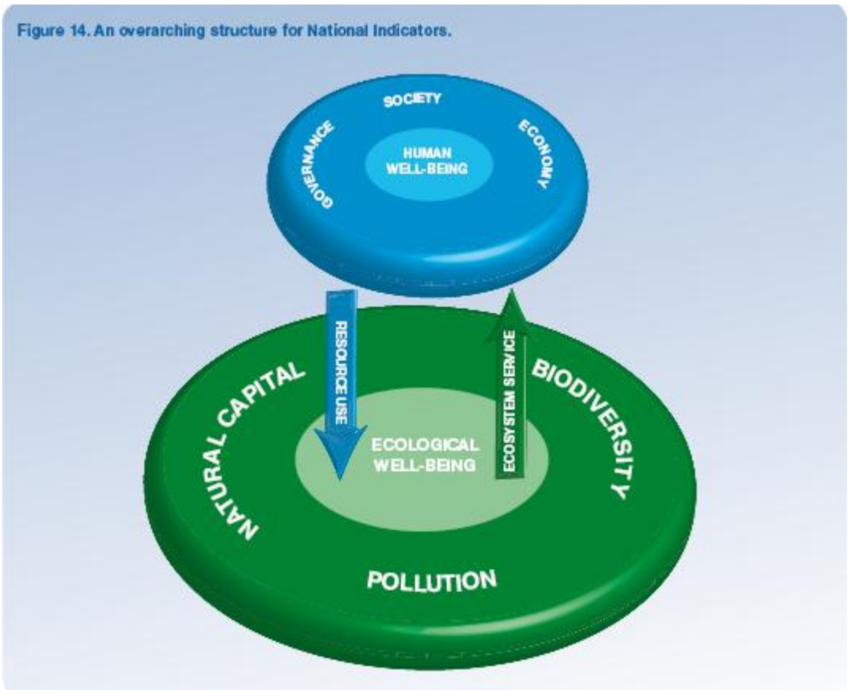
The general framework is visualized here (Source: NEF, 2009):

Figure 1 – Indicator structure within the example national accounts framework.

</td></tr>
<tr><td>b. Unit(s) of measurement of</td><td>The indicators are scaled to range from 0 to 10 (unit-free scores) and are</td></tr>
</table>

the indicator	calibrated so that 5 always represents the average score across Europe.
c. What does the indicator seek to measure?	The National Accounts of Wellbeing aim to provide a revolutionary framework for measuring the extent to which a person has achieved a subjective sense of wellbeing. It is aimed at governments for systematically tracking the wellbeing of their citizens as a better guide to public policy than conventional metrics of income, consumption, inequality, etc.
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	The NEF's National Accounts of Wellbeing are intricately linked to the NEF's work on the Happy Planet Index, published in 2006 and 2009. The reports have to be placed within the larger context of measuring economic, social, and environmental performance in Europe and globally. In the National Accounts of Wellbeing report, the NEF cites the following influential circumstances for the their development: • 2000: The UK Local Government Act gives local authorities the power to promote social, economic and environmental well-being in their areas. • 2002: UK Prime Minister's Strategy Unit publishes paper Life Satisfaction: the state of knowledge and implications for government. • 2004: Academics in the UK and US call for governments to use well-being measures in policy-making, as did nef's A well-being manifesto for a flourishing society. And Bhutan hosts its first international conference on the development of a Gross National Happiness Measure. • 2005: UK Sustainable Development Strategy, Securing the Future, commits the Government to exploring policy implications of wellbeing research. • 2006: UK local government White Paper Strong and Prosperous Communities defines a new place-shaping role for local government and its partners as 'the creative use of powers and influence to promote the general well-being of a community and its citizens. • 2008: French Prime Minister Nikolas Sarkozy forms the Stiglitz Commission with Nobel Prize winners Joseph Stiglitz and Amartya Sen, and French economist Jean-Paul Fitoussi to study the measurement of economic performance and social progress.
e. What are the known limitations of the indicator?	Among the prime challenges of the NAW are ongoing theoretical debates on (a) what human wellbeing is, (b) how to measure it, and (c) gathering the necessary data and aggregate them in a systematic, inherently consistent, and meaningful framework. The framework aims to reflect the multifaceted, dynamic combination of the

	many factors that contribute to human wellbeing. Specifically, it aims to: • Overcome the limitations of using answers to the single question on Live Satisfaction in the survey(s) as the sole basis for judgment and decision-making. • Combines personal and social dimensions of wellbeing such as security, autonomy, and self-fulfilment but also trust, connectedness, and being part of society at large. • Moving beyond the traditional focus on positive feelings and positive judgments as signs of happiness and wellbeing to also include metrics on people's functioning and realisation of their potential as well as on psychological resources to deal with problems and/or set-backs.
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	The NAW have been published for the first time in January 2009. There is no update yet and methodological development, data collection, and analysis of the first findings are ongoing.
III. Data	
g. How is the underlying data gathered and by whom?	The data are gathered through the European Social Survey (ESS), which started in 2001 but to which – upon invitation from Prof. Felicia Huppert from Cambridge University – the NEF in collaboration with four other research centres added a questionnaire module consisting of 50-items designed to measure both feelings and functioning as aspects of wellbeing as well as psychological measures of resilience. The questionnaires were completed in face-to-face interviews across Europe between fall of 2006 and summer 2007. The data were released in the fall of 2007 (Round 3, edition 3.1). Sample sizes in each country started with an initial 1500 adults, total final sample size is nearly 45,000 and yielded NAW for 22 countries (both EU and non-EU members). The data are available for download from the ESS website (ESS, 2007).
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	A main source of error is related to sample size and design. Romania and Latvia were excluded due to lack of survey weights, as were all countries missing data for at least one of the questions included in the accounts, with the exception of Hungary, where one question was not asked. Russia was excluded because its large population would have entailed the application of large survey weights (appr. a quarter of the total), which might lead to distortions in the results because conditions in Russia are not 'typical' for most of Europe.

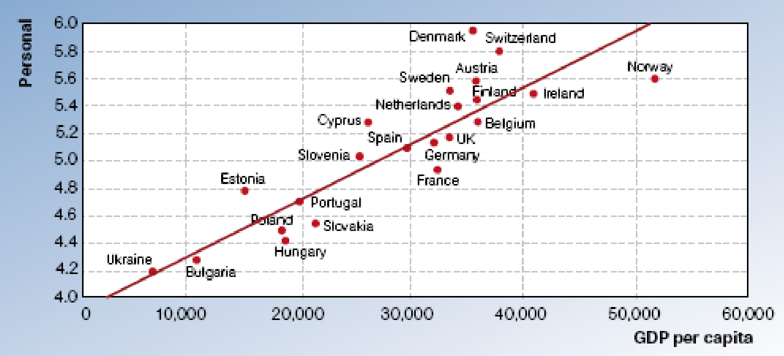
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	The NAW was first released in 2009. Subsequent calculations could follow with every new ESS wave, which takes place every two years. Ongoing research is considering the following aspects and may lead to a revision of the accounts: • Refining the components of wellbeing included in the framework. • Improving survey measures • Exploring geographically nested and detailed sub-group measurements.
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	NAWs aim to revolutionise the way people think about and measure progress. Ultimately, the goal is that countries use wellbeing accounts to shape and inform policy. As such, it is closer to prescribing a sustainability paradigm than GDP and other conventional macroeconomic metrics currently in widespread use. However, the NAW do not include environmental or economic aspects as far as they do not directly relate to human wellbeing since the definition of wellbeing is 'a person's cognitive and emotional resources' and well-being as 'a dynamic state, in which the individual is able to develop their potential, work productively and creatively, build strong and positive relationships with others, and contribute to their community (NEF, 2009).
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	The NAW are not a sustainability measurement framework, and hence does not measure weak or strong sustainability. However, human wellbeing is a core focus of sustainable development theories and the NAW could provide useful information in this regard.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities below which a region/activity is not sustainable)?	There are no specific values attached to a state of sustainability or thresholds/tipping points beyond which irreversabilities occur. However, the NAW are based on indicators that are scaled to a range of 0 to 10 with 10 being the best outcome.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	A lot of the thinking that went into the creation of the NAW derives from the Happy Planet Index (HPI), an initiative by the same organization, NEF, which was published in 2006 and 2009 and for the European countries in 2007. The similarities encapsulate the concept of human wellbeing, measurement thereof, and how it relates to the quest for a new economic and social paradigm that parts with economic growth thinking as the way to achieve increased human wellbeing toward a more nuanced and quality-oriented approach that sees the person's subjective feelings and his/her sense of belonging to the community and society at the heart of what's desirable.

n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	The NAW do not build on environmental and/or economic conditions to determine levels of wellbeing but embed the framework in the larger context of environment – economy – society:
	
	
	
	Indirect or implicit links to the environmental dimension are embedded in these NAW components:
	
	• Vitality. Having energy, feeling well-rested and healthy, and being physically active.
	
	• Emotional well-being. The overall balance between the frequency of experiencing positive and negative emotions, with higher scores showing that positive emotions are felt more often than negative ones. This is comprised of the subcomponents:
	
	  ○ *Positive feelings* – How often positive emotions are felt.
	
	  ○ *Absence of negative feelings* – The frequency with which negative emotions are felt, with higher scores representing less frequent negative emotions.
	
	Indirect or implicit links to the economic dimension are embedded in these NAW components:
	
	- Emotional well-being. The overall balance between the frequency of experiencing positive and negative emotions, with higher scores showing that positive emotions are felt more often than negative ones.

This is comprised of the subcomponents:

- *Positive feelings* – How often positive emotions are felt.
- *Absence of negative feelings* – The frequency with which negative emotions are felt, with higher scores representing less frequent negative emotions.

Figure 12. Personal well-being and GDP per capita, all countries.



V. Institutional Analysis

o. Which institutions are currently using the indicator, and for which purposes?	The NEF developed the NAW. The Questionnaire Design Team for the Well-being Module of the European Social Survey was led by Professor Felicia Huppert, University of Cambridge, UK and also included Dr. Andrew Clark, DELTA, Paris, France; Nic Marks, nef, London, UK; Professor Johannes Siegrist, University of Dusseldorf, Germany; Dr Alois Stutzer, Zurich University, Switzerland; Professor Joar Vittersø, University of Tromsø, Norway. There are no governments known to currently implement or pilot test the NAWs.
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	The radical shift in how and where to set the goalposts of national performance is very challenging for governments to even actively contemplate. In addition, the NAW are still very new and have not been tested extensively empirically and theoretically to determine their utility, accuracy, and links to established economic (and environmental) accounting systems. The NAWs also do not explicitly link to economic and environmental performance metrics and frameworks, an important shortcoming that is likely to hamper their adoption for policy purposes since no country is likely to give up these types of information systems.
q. Are there links to international or European laws, conventions or agreements (this could	The NAW are relevant to the EU Commission's "Beyond GDP" process as well as the Stiglitz Commission's work on measuring human wellbeing.

range from an explicit legal requirement to a general policy concern)?	
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ The NAW aim to address an important aspect of the ongoing debate on developing more relevant measures of human wellbeing and societal progress. + The NAWs are based on an accounting framework, which would facilitate their incorporation in econometric analysis of the progress of society – The NAW are not explicitly linked to nor do they incorporate economic or environmental aspects/accounts. This decreases their utility and the conclusions that can be drawn from it. – The NAW are still very new, having been released for the first time in January 2009. Much remains to be analysed and tested empirically and validated against existing theory. ± Country coverage is still relatively small (22) and the data come from the European Social Survery, hence further expansion of the NAW beyond Europe is limited. ± The ESS is a widely used and respected questionnaire instrument, therefore, the data can be judged to be of above average quality and cross-country comparability. However, the ESS is only conducted every two years, thereby generating a noticeable time lag for NAW calculation – and political action.
IDENTIFICATION OF TRENDS	No trend analysis is possible at present.
FORECASTING AND MODELLING	No forecasting and modelling is possible at present.
SCOPE/LEVELS OF APPLICATION	The NAW is geared toward application at national level. ESS sample sizes are likely to be too small to allow sub-national small area/sub-population application. Due to the 2-year cycle of the ESS, the NAW cannot be used for real-time policymaking and evaluation. The NAW do not currently link to economic and/or environmental accounts so that their utility for comprehensive

	policy debate and implementation under a sustainable development perspective is very limited. Furthermore, the NAW do not incorporate a sustainability criterion or definition.
Accepted	
STAKEHOLDER ACCEPTANCE	The NAW do not currently have widespread stakeholder acceptance. The group of developers of the ESS module also does not reflect the broad base of stakeholders with interests in metrics of individual and social wellbeing.
Credible	
UNAMBIGUOUS	The NAW have not yet undergone in-depth analysis and testing to ensure that the results are unambiguous. They do not deliver a clear message with respect to the sustainability of the development path (or current situation) of a country due to the lack of consideration of other dimensions of sustainable development.
TRANSPARENCY OF THE METHOD	The NEF clearly explains the methodology and the aggregate data for each of the 22 countries are available for download from the NAW website and in more complete form from the ESS website (NEF, 2009; ESS, 2007).
Easy	
DATA AVAILABILITY	Data availability is limited to the countries included in the ESS and is further reduced due to methodological issues (design weights for Russia, for example) and data completeness.
TECHNICAL FEASIBILITY	The calculation of the NAW is technically feasible and does not require very specialized expertise. It is also presented in easy-to-understand and appealing visual ways:

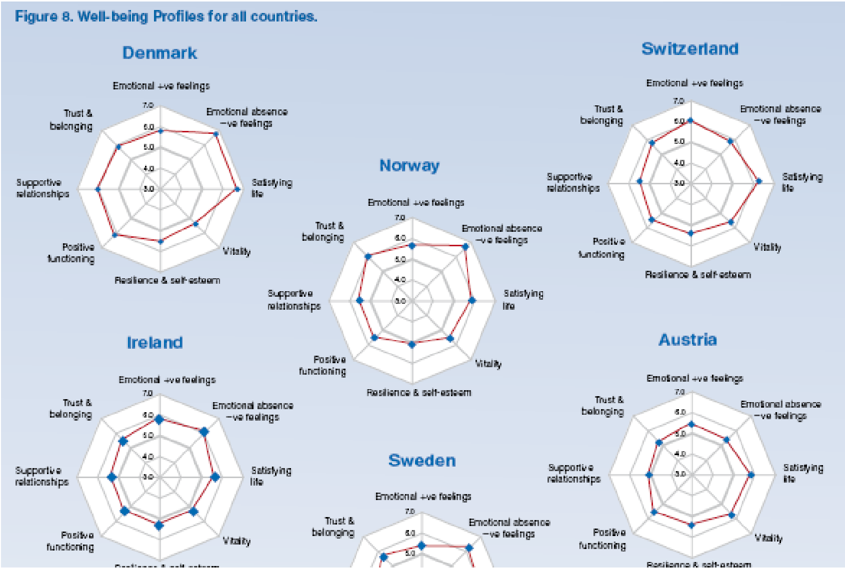


Figure 8. Well-being Profiles for all countries.

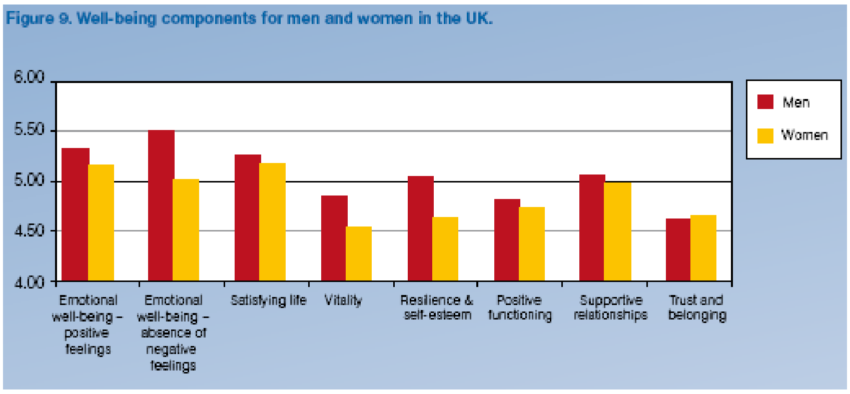
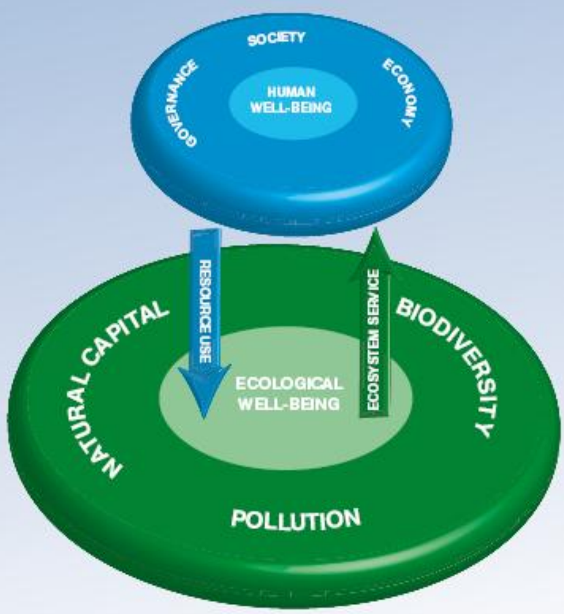


Figure 9. Well-being components for men and women in the UK.

COMPLEMENTARITY AND INTEGRATION	The NAW can support economic and environmental decision-making but are not explicitly linked to them. Rather, the NEF shows graphically what portion of the dimensions of sustainability NAWs can cover.

	Figure 14. An overarching structure for National Indicators. 
Robust	
DEFENSIBLE THEORY	The NAW build on the extensive literature on measuring subjective wellbeing. They also expand on this body of knowledge by including a societal dimension, which states that humans need to feel trust, connectedness, and being part of a community and society at large. In addition, the NAW also recognize the important part that professional life is playing in people's happiness and developed a satellite account on the workplace.
SENSITIVITY	No sensitivity analysis of the results of the first set of 22 NAWs has been carried out to date.
DATA QUALITY	Data quality in general is judged to be sufficient because the data used derive from the ESS. However, it is noted that the NAW questionnaire is a new and previously not tested module in the ESS developed under the leadership of Prof. Huppert from Cambridge University. Of the ESS countries, 22 are included in the first NAW sets. Countries missing data on at least one of the NAW questions and Russia are excluded.
RELIABILITY	It is not known how reliable the NAW are.

COMPLETENESS	While substantially expanding the scope of the Life Satisfaction indicator in the HPI and expanding the scope of human wellbeing to include societal and work aspects, the number of indicators, for which data are collected in the ESS is limited (50 items). The NAW also does not establish explicit links to econometric and/or environmental indicators or accounts.
Summary appraisal	
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	No.
SUSTAINABLE TRANSPORT	No.
SUSTAINABLE CONSUMPTION AND PRODUCTION	No.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	No.
PUBLIC HEALTH	Only to the extent that it measures: • Vitality. Having energy, feeling well-rested and healthy, and being physically active.
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	The NAW include: • Supportive relationships. The extent and quality of interactions in close relationships with family, friends and others who provide support. • Trust and belonging. Trusting other people, being treated fairly and respectfully by them, and feeling a sense of belonging with and support from people where you live. • In addition to these indicators, as an example of a well-being indicator within a specific life domain, a satellite indicator of well-being at work has also been created. This measures job satisfaction, satisfaction with work-life balance, the emotional experience of work, and

	assessment of work conditions.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	No.
INVESTMENT IN RESEARCH AND DEVELOPMENT	No.
UNEMPLOYMENT RATE	No.
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	The NAW measure progress on Social Wellbeing through normalized indicators on a scale of 1 to 10 measuring: • Supportive relationships. The extent and quality of interactions in close relationships with family, friends and others who provide support. • Trust and belonging. Trusting other people, being treated fairly and respectfully by them, and feeling a sense of belonging with and support from people where you live. • In addition to these indicators, as an example of a well-being indicator within a specific life domain, a satellite indicator of well-being at work has also been created. This measures job satisfaction, satisfaction with work-life balance, the emotional experience of work, and assessment of work conditions. The indicators are directly linked to corresponding questions in the ESS module developed for the NAW.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	The ESS measures subjective wellbeing and its judgment is influenced by immediate and space- and time-dependent conditions, that is, they may not even be consistent for the same person at time t_0 and t_1. Policy decisions based thereon may thus be completely misguided. The NAW indicators need to be placed within a broader context to be interpreted correctly.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the	Candidates for a basket of indicators include: • HPI (in the same field)

EU policy framework?	• EF, HANPP, LEAC (to add the environmental dimension of SD) • ISEW, ANS, Genuine Progress Indicator, GDP (to add the economic dimension of SD)
IX. SWOT Analysis	
u. *Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	The NAW offers a new way to approach the measurement of subjective wellbeing using an accounting framework.
v. *Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	The NAW uses the probably most extensive and tailored survey module on subjective wellbeing that currently exists and is comparable across countries.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	Lack of explicit links to economic and/or environmental performance indicators or frameworks. The accounting framework would lend itself to establishing such links, for example to the SEEA and ANS.
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	Use of ESS data limits the NAW to (a) 2-year cycle and (b) relatively small country set.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the	Opportunities to establish the NAW framework include: • Test its empirical relations with leading economic and environmental indicators • Verify its instrument validity by comparing it with other measures of

indicator.)	subjective wellbeing that aim to measure the same or similar issues. • Conduct case studies on how to link the NAW to policymaking • Expand the country set • Increase data collection frequency to at least annually
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	The main threats to the adoption of the NAW include: • Radical shift from historical thinking on what matters (and should get measured) in human development • Lack of explicit links to conventional measures of progress

6.2.3 Human Development Index (HDI)

I. Indicator Summary	
Name of indicator	Human Development Index (HDI)
Indicator category	Social
II. Background information on the indicator	
a. What is the official definition of the indicator?	The HDI is a measure of the average development of a country in three basic areas of human development: Gross Domestic Product, Life expectancy, Educational enrolment and Literacy. Formula: $\text{Index} = \frac{\text{actual value - lower critical value}}{\text{upper critical value - lower critical value}}$

	A: Life expectancy at birth lower critical value: 25 years upper critical value: 85 years Weight in HDI: 33.33 % B1: Adult literacy rate lower critical value: 0 % upper critical value: 100 % Weight in HDI: 22.22 % B2: Gross - Primary enrollment rate lower critical value: 0 % upper critical value: 100% Weight in HDI: 11.11 % C: purchasing power in real terms per capita lower critical value: 100 US-$ upper critical value: 40000 US-$ Weight in HDI: 33.33 % Countries with high levels of human development: HDI ≥ 0.8 Countries with middle levels of human development: HDI < 0.8; ≥ 0.5 Countries with low levels of human development: HDI < 0.5
b. Unit(s) of measurement of the indicator	HDI is indexed between zero and one (best possible value)

c. What does the indicator seek to measure?	The HDI was developed to measure "the basic concept of human development to enlarge people´s choices" (ul Haq I, 1995, p.47). The HDI computes and assigns a single, scalar value to each country of the world based on three components of human development: Life expectancy, Gross Domestic Product and the education index consisting of Adult literacy rate (2/3 weight) and Gross-Primary enrolment (1/3 weight).
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	• The HDI was released for the first time in 1990 by the United Nations Development Programme (UNDP) in the World Development report. Therein the concept and measure of human development was illustrated. The development of the HDI began with an economist, called Mahmoud ul Haq while he was working at the World Bank in the late 1970s. There he worked with the president of the World Bank at the time, Robert McNamara, on the concept of human development and promoted a change in the bank's approach from absolute economic growth to the fight against poverty. Following internal criticism both left the bank. A short time later ul Haq began the work on the Human Development report under William Draper III, the administrator and venture capitalist. The HDI had a central part in this report. Following its release other publications dealt with the topic of human development, for example.
e. What are the known limitations of the indicator?	The key limitations of HDI are: • Does not take into account if a country is at risk of violating human rights and sovereignty of other nations. • Because it relies on average values, the HDI cannot capture diversity, social inequality, and the status of marginal groups • Not suited for comparisons of quality of life because literacy and life expectancy increase relatively early in the development process and are relatively cheap to achieve • Does not consider ecological and environmental factors • Life expectancy and purchasing powers are capped at the top using best performance in developed countries and so the HDI does not increase when these caps are exceeded • Gross - primary enrolment rate can only exceed the maximum value when all children are enrolled • Only material factors are considered, no moral and qualitative aspects despite their recognized importance for human welfare and wellbeing • Released annually and therefore lagging behind current developments

	since the data are on average 2 years old • Comparison of two countries with same HDI not trivial because of underlying differences (e.g., substitutability of educational achievements with life expectancy or income)
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	The HDI was first published in 1990 in the World Development Report published annually by the UNDP. The development of the HDI involved several modifications, e.g., related to the handling of income and the critical values specified as upper caps. The HDI also created several spin-offs, including the Gender Development Index (GDI) and the Human Poverty Index (HPI). The HDI continues to be further developed in the sense that it produces more "output" and needs fewer "inputs" such as time, money and resources. Questions the HDI should be able to answer in the future include "In which factor should be invested: education, economy or health?" and "What are the other areas in which the HDI can be used?"
III. Data	
g. How is the underlying data gathered and by whom?	For a country to be included, data ideally should be available from the relevant international data agencies for all four components of the index (the primary sources of data are the United Nations Population Division for life expectancy at birth, the UNESCO Institute for Statistics for the adult literacy rate and combined gross enrolment ratio for primary, secondary and tertiary schools and the World Bank for GDP per capita [PPP US$]). But for a significant number of countries data are missing for one or more of these components.
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	The reliability of the results depends on the countries, because of different data collection and control systems as well as differences in methodologies and definitions. Often data are missing and estimates must be made. International data agencies are a good aid. In a few cases the Human Development Report Office has attempted to make an estimate in consultation with regional and national statistical offices or other experts.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	HDI is published annually by the UNDP Office for the Human Development Report. Data are generally from two years ago. For example the report from 2009 published data from 2007. Often there are revisions due to political reasons. Women´s groups bemoan the high position of Japan. Other countries claim that their own position in comparison to other countries is false. India filed an application to avoid that the HDI is mentioned or used in any official UN documents.

IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	The HDI does not have an operational definition of sustainability aside from the implicit statement that sustainability can only be reached if humans can enjoy the freedom and ability to reach their full potential to live a healthy, productive life.
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	At best weak sustainability, but the HDI is not a sustainability index and it therefore makes no claim to measure sustainability of any form.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities below which a region/activity is not sustainable)?	There is no numerical value associated with sustainability. It is noted however, that HDI>0.8 is assumed to equal a high level of human development, which could be seen as a pre-requisite to achieving sustainable development. However, considering the countries that fall into this category makes clear that they are also mostly high-consumption countries, with among other things high ecological footprints, a contradiction to a sustainable development path. A study by Pulselli et al. (2006) intersected the EF with the HDI and found that only Cuba had good scores on both, which raises the question as to whether jointly the indices measure anything akin to sustainability.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	Methodological links to conventional economic accounting measures include: • Links to the GDP because it is a part of the HDI Methodological links to social indicators include: • Measures life expectancy and educational enrolment, which reflects human welfare. Methodological links to environmental indicators include: Very indirectly via life expectancy since high levels of environmental degradation are likely to reduce life expectancy.
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG	The HDI indicator is primarily a development indicator that does not cover the environmental dimension and only in rudimentary form covers the economic and social spheres: • The economic dimension is captured only by GDP. • It captures a social element only through the inclusion of life

intensity—GHG emissions per unit of GDP).	expectancy and educational enrolment. • No environmental aspects are included.
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	The institutions currently using HDI include: • The UNDP uses the HDI for the World Development Report. • Some governments use the HDI as an indicator: The government of Egypt uses the HDI at the village level. Since 1999, the HDI has been used as an official tool in district and municipal-level policy planning in Indonesia. The Ministry of Planning in Jordon decided to use the HDI, particularly at the governorate level, and in combination with other indicators, to allocate resources to the country's municipalities, within the government's 'Social Productivity Programme' for poverty alleviation. The HDI also has been adopted as a measure of development progress by the government of Vietnam. Other countries that use the HDI are Venezuela and Philippines.
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	Institutional adoption is primarily hampered by these issues: • The limitations and controversies in the accounting methodologies used to calculate HDI. • The extent of missing data and uneven data quality in the poor countries. The hesitation on the side of economists, national accountants, and politicians to adjust key macro-economic indicators such as GDP, Capital Formation, and Income.
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	• HDI is not enshrined in any international, regional, or national law as a compulsory measure to track human development • However, the HDI is used as a metric (among others) to allocate development assistance, aid deliverance, and selection of countries for targeted programs. • Researchers use the HDI as a proxy for development in cross-country and panel studies. • Countries such as Egypt and Indonesia have begun using the HDI for

	internal policy implementation (see above).
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ HDI is used by some national and sub-national governments to track local human development and is further developed at and adapted to these levels. – HDI is often criticized by governments regarding their position in the ranking
IDENTIFICATION OF TRENDS	+ HDI reflects trends but for the underlying reasons the index must be unpacked and additional contextual information used. + Due to several methodological modifications temporal comparisons may not be possible.
FORECASTING AND MODELLING	– The current HDI methodology does not imply sustainability, so that thresholds or irreversibilities in human development are not detected ahead of time. – Due to methodological modifications, forecasting based on historic HDIs may be difficult unless the raw data are used.
SCOPE/LEVELS OF APPLICATION	+ HDI is used in several countries at the local, regional, and national levels. – The calculation of the HDI indicator is data intensive and partly due to this HDI does not account for several important items for human Development.
Accepted	
STAKEHOLDER ACCEPTANCE	+ HDI has become relatively widely accepted by non-governmental organisations, media, researchers/analysts and the public (perhaps more due to its regular publication by a highly credible UN Programme than sound methodological science). + HDI has developed a "life of its own" due to regular, annual reporting, embedded in the highly regarded UNDP Development Report and the fairly

	high quality of its background analysis (according to the theme of the HDR), and UNDPs credibility. – On the other hand, the HDI is not used as a complementary measure to GDP and other mainstream economic indicators.
Credible	
UNAMBIGUOUS	+ If calculated with consistent data, the HDI is unambiguous in trend and cross-nationally.
TRANSPARENCY OF THE METHOD	+ The HDI formula is clear, transparent, and systematically described in "The Human Development Index : Past, Present and Future, an independent Study by Christopher Moriarty + Empirical studies exist for HDI, which shed further light on the methodology and its problems.
Easy	
DATA AVAILABILITY	+ UNDP calculates national HDI annually for more than 170 countries, so data is available. Albeit imputations and assumptions are necessary. – Data intensive and for most countries no complete time series and no complete set of the necessary data are available so that imputations and assumptions have to be made.
TECHNICAL FEASIBILITY	+ Calculation of the HDI is technically feasible and easy as UNDP exercise has shown.
COMPLEMENTARITY AND INTEGRATION	+ The HDI has a direct link to the Gross Domestic Product, Gender-related Development Index, and Happy Planet Index + The HDI is cited and used widely (often as a proxy for development) in the media and development studies.
Robust	
DEFENSIBLE THEORY	– The HDI does not reflect all dimensions of human development . – It does not include aspects such as environment and sustainability.

SENSITIVITY	+ HDI reacts to changing trends. But this can also be negative. For example, when an affluent population group improves its average income, the HDI rises, but at the same time inequality also rises. Often this sensitivity is counter-productive. – It is also possible that the HDI shows change in the wrong direction. Example: In a country big parts of a forest are cut down. Consequence: HDI appreciates but only because the GDP has grown and not development or wellbeing. – HDI due to 2 year time lag is not very sensitive to current developments. It always portrays change that is already history.
DATA QUALITY	a. - The HDI depents on correct and consistent data. But often in developing countries they are not available.
RELIABILITY	– Particularly in poor countries data are insufficient and often lack the quality needed to yield reliable information. – There are also problems with the calculation as a study showed that a change in life expectancy (a difficult metric to measure correctly in the absence of functioning vital statistics registration systems) from 78 to 73 years resulted in a change of rank for 32 of 177 countries.
COMPLETENESS	– The HDI is not a complete measure of human development.
Summary appraisal	+ HDI is used and supported by some governments. + There are some studies which deal with the HDI. + Calculation of HDI is transparent and easy. + Annual figures are available for a growing number of countries. + HDI is available for a large number of countries. – HDi is not able to predict future developments in a meaningful way. – Methodological issues remain to be solved. – It is relatively data intensive – HDI does not capture socio-economic inequalities in a country.

	– There is no known international strategy to further develop and ultimately adopt the HDI. – HDI is not complete, because it does not reflect the complexity of human development – It does not consider important factors such as the environment and sustainability. – In poor countries the HDI may be less reliable, because of missing data.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	b. No, the HDI does not cover climate change and clean energy because it does not include environmental factors.
SUSTAINABLE TRANSPORT	c. No, the HDI does not cover sustainable transport.
SUSTAINABLE CONSUMPTION AND PRODUCTION	d. No, the HDI does not cover sustainable consumption and production.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	e. No, the HDI does not cover conservation and management of natural resources.
PUBLIC HEALTH	f. Partially, the HDI does cover public health through Life expectancy.
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	g. No, the HDI does not cover social inclusion, demography (only life expectancy), and migration.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	h. Partially, the HDI does cover global poverty and sustainable development challenges indirectly through GDP.
INVESTMENT IN RESEARCH AND DEVELOPMENT	i. No, the HDI does not include investments in research and development.
UNEMPLOYMENT RATE	j. No, the HDI does not consider unemployment.

r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	k. In principle, the HDI is not a useful metric to gauge any of the policy targets listed above.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	l. All things considered there exist far more specific indicators to measure the above-mentioned political aims.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	m. HDI, GDP, Gender-related Development Index (GDI), and Human Poverty Index (HPI) together can give more information than any single indicator on: • Human development • Economic growth • Consequences of inequalities in the quality of life and opportunities afforded to man and woman. • Relative representation of the women in political and economic domains. • Poverty not measured by income but by indicators that show defects in quality of life: a short life, disparities in access to education and to public and private resources
IX. SWOT Analysis	
u. *Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	• Method and theory is easy to understand and transparent. • Captures prominent aspects of development, which reflect direct and indirect aspects of the more complex concept. • Prepared in rigorous process and integrated into annual Human Development Report that provides more contextual information.

v. *Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	• Possible to compare different countries and comparisons over time (allowing for some methodological changes)
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	• Does not capture all dimensions of human development, including breach of human rights, freedom of speech and assembly, equality between men and women, rights of minorities • Use of average values omits socio-economic diversity and marginal groups • Not suited for comparison of quality of life, because literacy and life expectancy are relative early fruits of human development • No consideration of environmental factors • Purchasing power in real terms and life expectancy are capped, for that reason no increase of HDI when upper critical value is achieve • Gross primary enrolment rate has a maximal value when all children are enrolled so values for developed countries do not differ much. • Only considers material factors no moral factors although these are also important for well-being • Published annually but actual data are on average 2 years old • Comparison of two states with same HDI is not as straightforward as it may seem, because of substitutability
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	• HDI does not consider inequalities. • Another critical point is the choice of factors within the HDI. On the one hand there are too few factors to reflect the complexity of human development, meaning they must serve as proxies for important issues. Take, for example, the Gross - primary enrolment rate. While the number can be very high, it does not reflect the real state of education when there is also a high number of early school leavers. • Missing and unreliable data, especially in poorest countries. • Another critical point is that the indicator does only include factors related to the daily routine of the people. Important are also happiness

	and satisfaction. • Methodological changes hamper temporal comparisons.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	• A method to improve the HDI is the extension of the data network to obtain more recent and consistent data. • To expand the significance of the HDI a change in its constituent indicators may be needed • It may also be possible to create a supplementary indicator to address the HDI's weaknesses. • The removal of the caps on income and life expectancy should be considered.
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	• Further adoption is possible but also challenging because indicator efforts are maturing and the HDI may be too simplistic • Different stakeholders who like/dislike the HDI would not change their opinion because of the continued arguments in favour/against it. • This causes another problem. Often you need financial aid to reduce the weaknesses. For example the extension of the data network. But this funding often comes from stakeholders that dislike the HDI.

6.3 Biodiversity indicators

6.3.1 Red List Index

I. Indicator Summary	
Name of indicator	Red List Index
Indicator category	Biodiversity
II. Background information on the indicator	
a. What is the official definition of the indicator?	No official definition, but the indicator measures trends in projected extinction risk for taxa groups or sampled taxa.
b. Unit(s) of measurement of the indicator	The Red List Index (RLI) ranges from 0 to 1, with a value of 1.0 indicating that none of the species being categorized are expected to go extinct in the near future, whilst an RLI value of zero indicates that all species have gone extinct. Thus, a downwards trend based on two or more assessments (i.e. decreasing RLI values) indicates that the expected rate of species extinctions is increasing, i.e. that the rate of biodiversity loss is increasing.
c. What does the indicator seek to measure?	As summarized by the Biodiversity Indicators Partnership[16], the RLI indicates the proportion of species expected to remain extant in the near future without additional conservation action. It does this by measuring the overall rate at which species move through IUCN Red List categories (see 'c' below), which are the globally accepted standards against which extinction risk is assessed. It is calculated from the number of species in each IUCN category and the number changing categories between assessments as a result of genuine improvement or deterioration in status (category changes owing to improved knowledge or revised taxonomy are excluded).
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what	The RLI is based on the Red Data Lists and Red Data Books that were first conceived by IUCN in 1963 (then the International Union for the Conservation of Nature, now the World Conservation Union). These list species that are considered to be threatened with global extinction. The lists are prepared under the auspices of the Species Survival Commission, one of the commissions of

[16] http://www.twentyten.net/rli

year)? Which organizations currently advocate for the indicator's use?	the IUCN. The initial assessments were relatively simple and subjective, but revised criteria (Version 2.3) that were more precise and quantitative were adopted in 1994[17]. Further revisions were then undertaken in 2000 to produce the Version 3.1 criteria and threat categories that are used to date (ie Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct). Some assessments carried out prior to 2000 have been converted to the current criteria and codes. The taxa coverage of global Red Lists has become increasingly comprehensive, with global assessments completed for all species in several major classes (including mammals, birds, amphibians, freshwater crabs, warm-water reef building corals, conifers and cycads) and underway for several more groups. The RLI was developed by IUCN and partner organizations including BirdLife International to measure changes in extinction risk and help assess progress with the CBD target of reducing the rate of biodiversity. It was initially designed and tested using data on bird species (Butchart et al., 2004, 2005). Subsequently it has been applied to mammals, corals and amphibians (with the latter two based on preliminary data), and an RLI for cycads is due very soon. Baseline estimates for reptiles and selected freshwater fish, plant and marine groups are also being calculated. The IUCN Red List criteria have been widely used and adapted to produce regional and national Red Lists of threatened species (see www.nationalredlist.org). Thus, regional and national RLI trends can be calculated where such assessments have been completed twice with consistent criteria and methods. The RLI can also be disaggregated to show trends for species in different biogeographic realms, ecosystems, habitats, taxonomic groups and for species relevant to different international agreements and treaties. The RLI is widely accepted amongst biodiversity conservation scientists as a useful and robust indicator of biodiversity losses amongst rarer and restricted range taxa. It is consequently widely used, particularly in relation to measuring progress towards: • The CBD's target of achieving, "by 2010, a significant reduction of the current rate of biodiversity loss at the global, regional and national levels…"

17 http://www.iucnredlist.org/technical-documents/categories-and-criteria

	• The United Nation's Millennium Development Goal 7 of ensuring environmental sustainability.
	
	• The conservation of migratory water birds under the Ramsar Convention.
	
	• The Convention on Migratory Species, with respect to the:
	
	    o Agreement on the Conservation of Albatrosses and Petrels
	
	    o African-Eurasian Waterbird Agreement.
	
	• The EU target of halting the loss of biodiversity by 2010, as part of the Streamlining European Biodiversity Indicators (SEBI-2010) set (EEA, 2009).

e. What are the known limitations of the indicator?	A significant constraint on expanding the taxonomic coverage of the RLI is that repeated Red List assessments of all species in poorly known, species-rich groups (e.g. insects, fungi, plants, etc) is not practical and would be extremely costly. As a result, a sampled based version (SRLI) has been developed by IUCN and the Institute of Zoology to provide a more taxonomically representative measure of changes in extinction risk (Baillie et al., 2008). The SRLI is based on a representative sample of species selected from taxonomic groups within vertebrates, invertebrates, plants, and fungi. Assessment of the selected species will provide baseline information on the current status of biodiversity and it is anticipated that regular reassessments will identify changes in threat status over time to provide a more broadly representative picture of biodiversity change. A more fundamental limitation of the RLI is that it only assesses extinction risk and therefore does not capture biodiversity losses amongst more common and widespread taxa. Many such species are undergoing widespread range reductions and populations declines, which constitute major biodiversity losses. Consequently it is important that this indicator be complemented by others, such as the Common Bird Indicator which provides a broader assessment of biodiversity change, especially in regions such as Europe, where many habitats and species are undergoing widespread change.
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	See 'd' above. Further work is also underway on a method for calculating an aggregated RLI based on the data for multiple taxonomic groups.

III. Data	
g. How is the underlying data gathered and by whom?	The RLI and underlying Red List assessments are based on huge amounts of data that are compiled and reviewed by conservation specialists and organizations. For each species, relevant data are reviewed and assessed, in particular regarding their range and population status, supported by information on their ecology, habitat use and threats, etc. This information comes from a variety of sources, including field surveys by conservation NGOs and agencies, scientists and local communities.
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	Although great efforts have been made to refine the Red List criteria and RLI, the assessments are not an exact science, and some subjectivity is involved. Assessments are also dependent on the quality and availability of data on each species. Assessments are therefore less accurate for poorly know taxa groups, but this problem is reduced by allocating particularly poorly known species to the “data deficient category”. The RLI also excludes species from the analysis if it is considered that a change ins status is due to better information. It should be possible in future to validate the assessments by comparing past extinction risk predictions with outcomes, although this would not be straightforward as it would be necessary to take account of changes in conservation efforts.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	The indicator is recalculated each time a new Red List assessment is carried out for a group of species. As experience with the application of the RLI increased (with non-avian taxa in particular) some shortcomings became apparent. In particular it performed inappropriately when a value of zero is reached; RLI values were affected by the frequency of assessments; and newly evaluated species may introduce bias. Revised RLI formulae have therefore been developed and published to overcome these issues (Butchart et al., 2007).
IV. Link to sustainable development	
j. Is there an operational definition of sustainability ‘built-in’ to the methodology?	There is no operational definition of sustainability ‘built-in’ to the methodology.
k. If yes, does the indicator measure ‘strong’ or ‘weak’ sustainability?	
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a	The approach does not have numerical values assigned to sustainability. But, by definition, species that are threatened by extinction as a result of human

thresholds/ irreversabilities below which a region/activity is not sustainable)?	activities are indicators of unsustainable practices.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	The indicator is not linked to any other indicator.
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	The indicator is not closely linked to other sustainability dimensions.
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	As noted above, the RLI is widely accepted amongst NGOs, multi-lateral environmental agreements, inter-governmental bodies and governmental institutions concerned with conserving and monitoring biodiversity, including: • CBD • The United Nations (re Millennium Development Goal 7). • Ramsar Convention. • Convention on Migratory Species • The EU Commission and EEA (as one of the SEBI indicator set)
p. What are the driving forces and characteristics that affect institutional adoption	As noted above, the main driving forces for the adoption of the indicator relate to recent CBD, MDG and EU targets concerning biodiversity.

(consider this question from the perspectives of political science, sociology and political economy)?	
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	The indicator is closely linked to international conventions and EU biodiversity policies (see p above).
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT 2	+ The indicator is one of a number (ie SEBI indicators) used to monitor biodiversity trends and progress towards biodiversity conservation targets (EEA, 2009). – The indicator only measures the most extreme biodiversity losses (ie extinction risks) and therefore needs to be supplemented by other measures of more widespread biodiversity change.
IDENTIFICATION OF TRENDS 2	+ The RLI was developed to measure trends (Butchart et al, 2004). – The indicator is not very sensitive to changes in extinction risk and can be slow to detect change as the interval between reassessments can be several years.
FORECASTING AND MODELLING 3	+ The Red Lists are, to some extent, forecasts of extinction risk and the RLI has the potential to be linked to landuse and other models to provide a means of assessing policy impacts, etc. – To date, the index has not been linked to large-scale modelling exercises.
SCOPE/LEVELS OF APPLICATION 3	+ The indicator can be used at a variety of scales, depending on data availability and the capacity for conducting Red List assessments (Butchart et al 2004). – The RLI is best suited to large-scale regional assessments (eg EU-level),

		rather than national, as the biodiversity conservation significance of extinction risks at national levels can be difficult to interpret.
Accepted		
STAKEHOLDER ACCEPTANCE 3	+	Very wide acceptance amongst stakeholders (see p above).
Credible		
UNAMBIGUOUS 3	+	The index is relatively simple and easy to understand.
TRANSPARENCY OF THE METHOD 5	+	The calculation methods are published (Butchart et al, 2007) and all the assessments (and underlying key data) used in the calculations of the RLI are published by IUCN and others.
Easy		
DATA AVAILABILITY 3	±	The RLI is dependent on a vast amount of underlying data, but this is unavoidable as biodiversity is by definition diverse. The indicator builds on existing Red List assessment methods and the sample RLI methodology aims to reduce data requirement needs to manageable levels for poorly known and large taxa groups (Baillie et al, 2008).
TECHNICAL FEASIBILITY 5	+	The RLI uses a relatively simple methodology that builds on existing and well established Red List assessment methods and criteria (Butchart et al, 2004, 2007).
COMPLEMENTARITY AND INTEGRATION 4	±	As described above, the RLI measures extreme biodiversity losses, in terms of extinctions, and therefore needs to be complemented by indicators that measure biodiversity losses (eg population and range declines) in more widespread and common species that are not (currently) at significant risk of extinction (ie those considered under IUCN Red List criteria to be of “least concern”) – hence the inclusion of the common bird indictaor in the SEBI list.

Robust	
DEFENSIBLE THEORY 4	+ The theoretical principles underlying Red List assessments have been debated and developed over several decades and are generally well accepted. – The weightings given to the Red List categories are subjective. It is not clear if observed species extinction rates actually do match predicted risk of extinction when additional conservation measures are not undertaken. This needs to be tested.
SENSITIVITY 2	– The RLI is not very sensitive to change, mainly because the Red List categories are relatively few and broad. Therefore, for example, species may undergo moderate declines in population or range without triggering a change in their IUCN extinction risk category.
DATA QUALITY 3	+ Data quality underlying the IUCN Red List assessments are very variable, and especially depend on the taxon and region under consideration. However, the methodology and involvement of appropriate specialists and publication of assessments and data help to ensure that the best available data are used in assessments.
RELIABILITY 4	+ All the methods and key underlying data are published and Red List assessment criteria are standardised. However, some subjective judgements are sometimes necessary for the assessment of some taxa, which can lead to some variability in assessments.
COMPLETENESS 3	± As noted above, the RLI should not be used by itself as a measure of biodiversity loss, as it only related to the highest levels of loss (ie extinctions) and should be complemented by other biodiversity pressure, state and response indicators (including Common Bird and Favourable Conservation Status indicators.
Summary appraisal	The RLI is an important and well established biodiversity indicator that is being used to assess performance regarding global and EU biodiversity targets.

	However, it focuses on extreme biodiversity loss (ie extinction), and is relatively insensitive and slow to respond, and therefore needs to be complemented by other broader and more sensitive indicators of overall biodiversity impacts.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	No
SUSTAINABLE TRANSPORT	Partly and indirectly
SUSTAINABLE CONSUMPTION AND PRODUCTION	Partly and indirectly
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	Yes, main focus
PUBLIC HEALTH	No
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	No
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	No
INVESTMENT IN RESEARCH AND DEVELOPMENT	No
UNEMPLOYMENT RATE	No
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	The RLI can help indicate if transport and consumption / production policies are sustainable with respect to some components of biodiversity, ie species that are at risk of global, regional, or national extinction. The RLI is an adopted measure of progress with achieving the EU Biodiversity

	target (see detailed discussions above).
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	The indicator focuses on extreme biodiversity loss (ie extinction), and is relatively insensitive and slow to respond to impacts, and therefore needs to be complemented by other indicators.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	The RLI should be complemented by other biodiversity pressure, state and response indicators (including Common Bird and Favourable Conservation Status indicators.
IX. SWOT Analysis	
u. *Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	The RLI is a well established biodiversity indicator that builds on globally accepted standards for the assessment of extinction, and is consequently being used to assess performance regarding global and EU biodiversity targets.
v. *Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	The index is relatively simple, and all the underlying assessments of species and key data sets are published and easily accessible.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	The index has no critical weaknesses.

x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	The indicator focuses on extreme biodiversity loss (ie extinction), and is relatively insensitive and slow to respond, and therefore needs to be complemented by other broader and more sensitive indicators of overall biodiversity impacts.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	The RLI is being extended to other taxa groups as more Red List assessments are carried out and repeated. Improved knowledge of habitat suitability and other factors affecting threatened species and landuse modeling may increasingly support Red List assessments and improve their forecasting potential and reliability.
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	The underlying Red List assessments rely on large amounts of data, including detailed field data, much of which is collated by NGOs and volunteers. Reduced funding and volunteer interest/capacity could jeopardize the availability of data and the reliability of future Red List assessments.

6.3.2 Pan European Common Bird Monitoring Scheme (PECBMS) index

I. Indicator Summary	
Name of indicator	Pan European Common Bird Monitoring Scheme (PECBMS) index.
Indicator category	Biodiversity
II. Background information on the indicator	
a. What is the official definition of the indicator?	There is no known official definition.

b. Unit(s) of measurement of the indicator	The indicator measures changes in bird populations according to a 1990 baseline index of 100.
c. What does the indicator seek to measure?	The indicator measures changes in biodiversity as reflected by a wide suite of common bird populations, primarily of farmland and forest habitats (Gregory et al 2005).
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	The PECBM and common bird index was developed by a consortium of organizations involved in bird monitoring in Europe (mainly through voluntary fieldwork), coordinated by the European Bird Census Council (EBCC). The overall aim is to develop the use of bird population trends as indicators of biodiversity in Europe and to develop indices capable of measuring progress towards achieving the 2010 biodiversity target. The specific aim was an assessment of the mean change in breeding bird populations of farmland and woodland habitats, as these are the most extensive terrestrial habitats in Europe and are subject to considerable human influence (Gregory et al 2005). The index was initially trialed by Van Strien et al (2001), and then calculated in 2002 on the basis of data from 18 countries[18]. However, the range of countries and coverage of species has increased in recent years, such that by 2010 national trend data were received from 22 countries (ie Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, United Kingdom)[19] with trend data calculated for 137 species. The index is therefore based on wide geographical coverage and a wide-range of species. With its wide coverage, the indicator is able to detect changes in a range of different types and levels of pressure, and thereby alert decision makers to changes in these, as well as their potential drivers. Furthermore, birds are also reasonably well accepted as being good indicators of broad patterns of environmental change (Furness et al 1993), although with some limitations (see below). Consequently the indicator is widely accepted as being perhaps the most comprehensive and robust biodiversity indicator available in Europe, and is promoted widely by conservation NGOs and adopted by key institutions including the EEA and European Commission, as well as national

[18] http://www.eea.europa.eu/data-and-maps/indicators/abundance-and-distribution-of-selected-species/

[19] http://www.ebcc.info/index.php?ID=387

	governments and their agencies (see below).
e. What are the known limitations of the indicator?	Gregory et al (2005) note that despite its strengths (see above), the indicator has some limitations, in particular: • coverage of only two broad habitat types in Europe (and the simplistic allocation of species to habitat type); • temporal gaps in the data (particularly early in the time-series), • potential bias within national schemes and significant spatial gaps in the south and east of Europe; • restriction to assessment of trends in common and widespread species); and • restriction to birds, which are one small element of biodiversity.
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	There have been no major changes in the index methodology, although as described above, the coverage of species and countries has increased since its development in 2002. The methods for calculating the index were updated in 2005 with an improved hierarchical computation procedure to calculate supranational indices. Supranational indices for species were then combined on a geometric scale to create multi-species indicators (Gregory et al 2005). PECBM population index values have recently been used to create an indicator of bird climate change (Gregory et al 2009). This indicator measures divergence in population trend between bird species predicted by climatic envelope models to be favourably affected by climatic change and those adversely affected. The indicator shows a rapid increase in the past twenty years, coinciding with a period of rapid warming.
III. Data	
g. How is the underlying data gathered and by whom?	The index is compiled from the results of national annual breeding bird surveys in Europe, which are principally carried out by skilled volunteers using well developed and standardized field methods.
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	The accuracy of the national population estimates will vary according the methods used, sampling approaches and sample sizes, which vary amongst countries. This variability may reduce the precision of the national estimates and therefore the combined index. However, there has been a move towards more formal sampling strategies through time, which is likely to increase the precision and accuracy of the schemes. It is argued that such changes have

	not introduced systematic bias in national or European trends (Gregory et al 2005, Freeman et al 2007). The index is also based on consistent sophisticated statistical analysis (using the software package named TRIM), which allows for missing counts in the time series and yields unbiased yearly indices and standard errors using Poisson regression. Although national schemes differ in count methods in the field, these differences do not influence the supranational results because the indices are standardised before being combined.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	Breeding bird surveys are carried out annually and therefore the index can be updated annually.
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	There is no operational definition of sustainability 'built-in' to the methodology.
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities below which a region/activity is not sustainable)?	The approach does not have numerical values assigned to sustainability. Although it is considered that significant population declines as a result of human activities are indicators of unsustainable practices it is not always clear what levels of decline indicate significant or risk irreversible environmental changes.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	The indicator is not linked to any other indicator.
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social,	The indicator is not closely linked to other sustainability dimensions.

economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	The indicator is widely used throughout Europe. The Common Birds indicator has already been adopted by the European Union as one of a number (ie SEBI indicators) used to monitor biodiversity trends and progress towards biodiversity conservation targets (EEA, 2009). Farmland bird trends (a subset of this index) have also been selected as a baseline indicator under the Rural Development Regulation (Council Regulation (EC) No 1698/2005). National component data are also often used by national governments and other institutions, such as in the UK where bird populations have been adopted as a headline sustainability indicator[20].
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	The main driving force for the adoption of the indicator relates to the EU's 2010 biodiversity target and sectoral contributions to the achievement of the target (eg under Rural Development Programmes).
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	The indicator is closely linked to EU biodiversity policies (see p above).

[20] http://www.defra.gov.uk/sustainable/government/progress/national/20.htm

VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT 2	+ The indicator is one of a number (ie SEBI indicators) used to monitor biodiversity trends and progress towards biodiversity conservation targets (EEA, 2009), and the environmental performance of national Rural Development Programmes. – The indicator only measures changes in widespread bird species and therefore needs to be supplemented by measures of scarce / rare bird species, as well as other taxa groups.
IDENTIFICATION OF TRENDS 2	+ The indicator was developed to measure annual trends (Gregory et al 2009).
FORECASTING AND MODELLING 3	+ The PECBM index has the potential to be linked to landuse and other models to provide a means of assessing policy impacts, etc – To date, the index has not been linked to large-scale modelling exercises.
SCOPE/LEVELS OF APPLICATION 3	+ The indicator is derived from national data, so can be applied at this level, and sub-national levels where appropriate.
Accepted	
STAKEHOLDER ACCEPTANCE 3	+ Wide acceptance amongst EU stakeholders (see p above).
Credible	
UNAMBIGUOUS 3	+ The index is relatively simple and easy to understand.

TRANSPARENCY OF THE METHOD 5	+	The index and methodological principles are published (Gregory et al, 2005, EBCC[21]), as well as the trend analysis programme (Pannekoek & van Strien, 2001), but the detailed underlying national statistics do not appear to be readily available at the EBCC /PECBM website.
Easy		
DATA AVAILABILITY 3	±	The index is dependent on a vast amount of underlying data, but this is unavoidable as biodiversity is by definition diverse. However, the indicator utilises data collected mostly from established bird monitoring schemes that are carried out by trained volunteer fieldworkers.
TECHNICAL FEASIBILITY 5	+	The index is relatively simple but uses sophisticated statistical analysis tools to overcome data gaps etc (Gregory et al 2005).
COMPLEMENTARITY AND INTEGRATION 4	±	As described above, the index only monitors common bird species and therefore needs to be complemented by indicators that measure biodiversity losses in other taxa and rarer species (eg by the Red List Index).
Robust		
DEFENSIBLE THEORY 4	+	The index is based on a simple robust rationale.
SENSITIVITY 2	+	The index is sensitive to relatively rapid changes as it is updated annually.
	–	Birds tend to be fairly adaptable and resilient to some environmental changes (Furness et al 1993; Gregory et al 2005) and therefore the indicator may not reflect changes in other more sensitive taxa.
DATA QUALITY 3	+	Data will vary amongst countries and species in quality, however, monitoring standards, and sample sizes are improving and the underlying data are considered to be of a sufficiently high standard to provide a robust

[21] http://www.ebcc.info/index.php?ID=387

	and reliable indicator.
RELIABILITY 4	+ As above.
COMPLETENESS 3	± As noted above, the indicator should not be used by itself as a measure of biodiversity loss, but should be complemented by other biodiversity pressure, state and response indicators (including the Red List Index and Favourable Conservation Status indicators).
Summary appraisal	The PECBM index is carefully developed and well established biodiversity indicator that utilises large amounts of data from established standardised field surveys across Europe, and is consequently a key indicator of the EU's progress towards achieving its biodiversity targets. However, it only covers common species of birds and therefore needs to be complemented by other indicators of impacts on other taxa and rarer species.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	No
SUSTAINABLE TRANSPORT	No
SUSTAINABLE CONSUMPTION AND PRODUCTION	Partly and indirectly
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	Yes, main focus
PUBLIC HEALTH	No
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	No

GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	No
INVESTMENT IN RESEARCH AND DEVELOPMENT	No
UNEMPLOYMENT RATE	No
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	The indicator provides an efficient way of assessing the impacts of natural resource use in agricultural and forest habitats, utilising established widespread and standardised bird monitoring schemes.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	The indicator only covers common species of birds and therefore needs to be complemented by other indicators of impacts on other taxa and rarer species.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	The indicator should be combined with other SEBI indicators (EEA 2009), in particular other biodiversity state indicators (including the Red List Index and Favourable Conservation Status indicators).
IX. SWOT Analysis	
u. *Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	The index provides annual assessments of biodiversity trends relating to extensive areas of agricultural and forest habitats,
v. *Important strengths (*Important strengths are those strengths that are highly significant but that	The index is relatively simple, and utilizes established widespread and standardised bird monitoring schemes.

may be shared with a host of other indicators.)	
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	The index has no critical weaknesses.
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	The indicator only covers common species of birds and therefore needs to be complemented by other indicators of impacts on other taxa and rarer species
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	The methodology could be extended to other taxa groups, where sufficient field monitoring data are available.
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	The underlying assessments rely on large amounts of data, including detailed field data, much of which is collated by NGOs and volunteers. Reduced funding and volunteer interest/capacity could jeopardize the availability of such data.

6.3.3 Potentially Disappeared Fraction (PDF)

I. Indicator Summary	
Name of indicator	Potentially Disappeared Fraction (PDF)
Indicator category	Biodiversity
II. Background information on the indicator	
a. What is the official definition of the indicator?	The Potentially Disappeared Fraction (PDF) has no official definition, but can be referred to as the number of species missing in an area of a particular land use relative to a reference state.
b. Unit(s) of measurement of the indicator	The PDF is measured in fractions. The PDF of vascular plant species is expressed as the relative difference between the number of species (S) in the reference conditions and in the conditions following land use conversion. The formula for calculating the PDF is: $PDF=1-S_{use}/S_{reference}$. S_{use} is the species richness of a converted land use type while $S_{reference}$ is the average species number in the reference area. For example, an area of built up land with the original Swiss Lowlands as the reference scenario scores 0.97, while natural grassland with the same reference scores 0.02 (Koellner, 2001). The indicator can be expanded to calculate the costs involved when repairing low quality habitat to high quality habitat, measured in €/m^2 or €/PDF/m^2. PDF can also be multiplied by the area and the time period to obtain the damage done to an ecosystem's quality.
c. What does the indicator seek to measure?	The indicator seeks to measure the biodiversity loss incurred by land use change. By analyzing the change in local plant species richness the PDF indicates the change in value of ecosystem functioning for different land use types. The expanded version seeks to measure the costs of restoring a low quality

	habitat to a high quality habitat.
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	The first form of the indicator was developed by Eco-indicator in 1999 (Goedkoop & Spriensma, 2000), and was based on the Life Cycle Assessments that were popular during the 1990's. This was the basic indicator as described above. Koellner refined the indicator in his 2001 thesis where he used a modelling approach to produce three different stages. First a qualitative land use model was developed to create a link to ecosystem quality. Then ecosystem quality was split into the more specific attributes of biodiversity, ecosystem functions, and ecosystem resources. Land use impacts on local and regional species diversity were quantified, and the use of effect-damage curves allowed observed effects on species diversity to be transformed into potential damage/benefits. The latest adaptation of the model was by Econcept AG in 2006, who expanded its role to allow calculations of habitat restoration per m^2 for different biotypes around the EU (Econcect AG, 2006). Studies based on this form of life cycle impact assessment by Goedkoop et al., (2008) and Wegener Sleeswijk et al., (2008) have recently gained traction with UNEP in their Primary Products and Materials Assessment (2010).
e. What are the known limitations of the indicator?	The indicator does not individually measure the damage done by toxicity, acidification, eutrophication, and land use change. Instead it indirectly measures their cumulative effect on vascular plant communities. The indicator also assumes that habitats were uniform and homogenous before degradation, facilitating their comparison to the reference scenarios. However land use change does not happen in a uniform fashion, but targets particularly suitable areas such as those with good soils and flat ground. Therefore it is hard to make reliable comparisons to generalized reference conditions. Further uncertainty is introduced by multiplying the PDF by time and area to calculate total ecosystem damage. For example, multiplying by (t) assumes that the rate of degradation has been constant through time. However, degradation often happens in non-linear, episodic events such as construction or land development, and so multiplying by (t) represents an over-simplification which will produce an inaccurate indication of damage. The use of CORINE maps also limits the indicator's accuracy as CORINE is a fairly basic land use classification which does not reflect the value of biodiversity. The indicator only takes vascular plant species richness into account, which limits its relevance to the responses of other taxa to environmental degradation.

f.	What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	The indicator and, especially, the baseline $S_{reference}$ data require further work to verify their accuracy.
III. Data		
g.	How is the underlying data gathered and by whom?	Underlying data involves CORINE land use maps and vascular plant itineraries used to produce species richness estimates. These are collected on a project specific basis. Further data have been gathered by Econcept AG for European biotypes. They have created a database of the restoration costs per PDF and per m^2 for 31 countries, analyzing all the major land use types (Econcept AG, 2006).
h.	How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	See 'e' above.
i.	How often is the indicator recalculated/released? Have there already been any major indicator revisions?	The indicator is recalculated for each project that uses it, as it works best on a regional scale. The major revisions and advances do not affect the original indicator, but are more focussed derivatives of the original model. They are summarised in 'd' above.
IV. Link to sustainable development		
j.	Is there an operational definition of sustainability 'built-in' to the methodology?	There is no operational definition of sustainability 'built-in' to the methodology.
k.	If yes, does the indicator measure 'strong' or 'weak' sustainability?	N/A
l.	Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities	This approach has no numerical values assigned to sustainability.

below which a region/activity is not sustainable)?	
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	The only related indicators are treated as sub-types of the PDF and are described in 'd' above.
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	This indicator has no links to other dimensions of sustainability.
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	UNEP used the indicator to measure ecosystem damage in their 2010 Primary Products and Materials Assessment.
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	It is based on Life Cycle Assessments which indicates the damage to an area's ecosystem health. This is a different approach to the Millennium Ecosystem Assessment which assesses the relative importance of past and present pressures on the state of the environment. Therefore it may be a useful tool to make comparisons between the two approaches.
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	There are no links between this indicator and international or European laws, conventions or agreements.

VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ The PDF incorporates indirect measures of pollution in the form of acidification and eutrophication, and so is relevant to some EU policy areas. – However, because of the methodology involved, this indicator is more useful for comparisons between baselines and real situations than monitoring progress towards set targets.
IDENTIFICATION OF TRENDS	+ The indicator employs baseline scenarios, and so can be useful in tracking changes through time. + It can also react to short term changes in condition, and is ready for implementation in Europe's major biotypes.
FORECASTING AND MODELLING	± The indicator is not designed to forecast changes in the environment, but can predict the deterioration in ecosystem health following land use change or increased pollution.
SCOPE/LEVELS OF APPLICATION	± The PDF is regionally specific. However, following the creation of a database for all Member States, it can be applied to all the major biotypes found within the EU.
Accepted	
STAKEHOLDER ACCEPTANCE	– The indicator is not widely used. For example, it is not one of the EU SEBI indicators (EEA, 2009).
Credible	
UNAMBIGUOUS	± Provided that one particular interpretation or derivative of the PDF indicator is clearly selected, the theory is unambiguous.

TRANSPARENCY OF THE METHOD	+	The methodology is largely transparent, except for the process of $S_{reference}$ data collection which may be based on inadequate sample sizes or involve too much subjectivity in study site selection.
Easy		
DATA AVAILABILITY	+	Data has been gathered for the $S_{reference}$ values of all major European biomes by Econcept AG (2006).
TECHNICAL FEASIBILITY	+	Species richness surveys have been a fundamental part of biodiversity conservation for some time; the techniques involved are well understood.
COMPLEMENTARITY AND INTEGRATION	±	N/A
Robust		
DEFENSIBLE THEORY	–	The methodological theory relies on several simplistic assumptions and employs extrapolations which have weak justification.
	–	It uses poorly quantified parameters and makes unreasonable spatio-temporal generalisations.
SENSITIVITY	–	A key flaw with the model is that it does not recognise the nonlinearity of ecosystem functions or land use change.
DATA QUALITY	–	The data used for baseline calculations in the form of $S_{reference}$ may be unreliable as they may be sourced from localities with unusually high or low vascular plant species richness. The spatial generalisations inherent in the indicator may also make it inaccurate.
RELIABILITY	–	The indicator incorporates large degrees of inaccuracy.
COMPLETENESS	–	The indicator only studies vascular plants, even though in some cases pollution may actually increase the number of plant species, and so does not necessarily provide a true representation of overall ecosystem health.
Summary appraisal	–	The indicator risks producing inaccurate results through its over-simplifications, including the use of very broad baselines in $S_{reference}$ data, the use of CORINE land use maps, and by solely focussing on vascular plants.

VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	No
SUSTAINABLE TRANSPORT	No
SUSTAINABLE CONSUMPTION AND PRODUCTION	Yes, in terms of land use.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	Yes, in terms of land use.
PUBLIC HEALTH	No
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	No
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	No
INVESTMENT IN RESEARCH AND DEVELOPMENT	No
UNEMPLOYMENT RATE	No
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	It provides a clear assessment of which land use types support an area's original plant communities and which do not. It could help monitor progress towards targets as land uses change towards habitat types with a better rating.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy	It is likely to be inaccurate as it makes generalised spatio-temporal assumptions, and there are better alternative biodiversity indicators.

targets (marked 'Yes' and 'Somewhat', above)?	
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	The use of this indicator in combination with others is not recommended.
IX. SWOT Analysis	
u. *Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	Simple formula.
v. *Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	Can be used to monitor change in vascular plant communities from all forms of environmental degradation, including land use change, acidification, and eutrophication.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	It is probably inaccurate as it makes generalisations and unreasonable spatio-temporal assumptions. In particular, the use of (t) to provide a figure of ecosystem damage over time makes unjustified assumptions, as does the use of specific reference data which are generalised to a regional scale.
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as	The collection of $S_{reference}$ data may be contentious, as the importance of this database for defining the indicators results puts the institutions that collect the data under great credibility pressure.

an EU policy tool.)	It may be inappropriate to apply $S_{reference}$ data at the regional level.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	If it was highly spatio-temporally limited it may be useful. This would reduce the inaccuracies inherent to its application across long land use change time scales and across wide geographical areas.
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	Likely to be rejected by scientific institutions for conceptual flaws due to over-simplification.

6.3.4 Favourable Conservation Status (of habitats and species)

I. Indicator Summary	
Name of indicator	Favourable Conservation Status (of habitats and species)
Indicator category	Biodiversity
II. Background information on the indicator	
a. What is the official definition of the indicator?	The indicator specifically relates to the overall aims of the EU Habitats Directive (92/43/EEC), which is to maintain or achieve favourable conservation status (FCS) of species and natural habitats considered to be of Community interest and listed in Annexes I, II, IV & V. The Habitats Directive defines FCS with respect to habitats and species in Article 1 as follows. The conservation status of a habitat type shall be taken as being "favourable" when: • its natural range and areas it covers within that range are stable or increasing,

	• and the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, • and the conservation status of its typical species is favourable as defined below in the description of the conservation status of the species. The conservation status of a species will be taken as being “favourable” when: • population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, • and the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, • and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.
b. Unit(s) of measurement of the indicator	FCS is a categorical metric, with a habitat or species categorised (according to the Directive) as in FCS or not. However, the unfavourable category has been subdivided into ‘unfavourable-inadequate’ and ‘unfavourable-bad’, according to the four parameters as defined in Article 1 of the Directive and guidance on assessments (see below).
c. What does the indicator seek to measure?	In general terms the indicator attempts to assess whether a habitat or species is in a good / acceptable ecological condition and is likely to remain so. Assessments are often made at site levels (ie Special Areas of Conservation) but are reported on at national and biogeograghical levels. Birds are not covered by the Habitats Directive.
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations	Discussions for a reporting format began in 2004 with discussions held by the EC Habitats Committee and its Scientific Working Group together with dedicated workshops organised by the European Topic Centre on Biological Diversity (ETC/BD). This led to the reporting format being adopted by the Habitats Committee in March 2004[22]. Supplementary guidance was provided by the Commission in 2006[23]. Further discussions led to an agreed methodology

[22] Assessment, monitoring and reporting of conservation status – Preparing the 2001-2006 report under Article 17 of the Habitats Directive. Note to the Habitats Committee, DG Environment, Brussels, 15 March 2005 http://circa.europa.eu/Public/irc/env/monnat/library?l=/habitats_reporting/reporting_2001-2007/reporting_framework&vm=detailed&sb=Title

[23] Assessment, monitoring and reporting under Article 17 of the Habitats Directive: Explanatory Notes & Guidelines October 2006 http://circa.europa.eu/Public/irc/env/monnat/library?l=/habitats_reporting/reporting_2001-2007/guidlines_reporting&vm=detailed&sb=Title

currently advocate for the indicator's use?	for preparing assessments for biogeographical regions based on the Member State reports[24].
e. What are the known limitations of the indicator?	The Directive sets standard criteria for assessing FCS, which should facilitate aggregation and comparisons between Member States and biogeographical regions. However, the Directive's criteria for FCS are rather general and cannot, therefore, be directly applied to each species or habitat or Community interest. Furthermore, the ecological requirements of species and habitats vary among countries, biogeographical regions and local conditions (eg as a result of varying physical, climatic and ecological conditions). Thus, each Member State has to define its own criteria and set parameters for assessing FCS, based on its ecological conditions. It is also often difficult to objectively set measurable criteria for the assessment of FCS, especially for habitats and species that are poorly known and/or difficult to monitor. As a result, in practice, it is difficult to compare the results of FCS assessments across Members States as the criteria used and overall standards are inconsistent, and cannot be easily calibrated. FCS only covers the most threatened habitats and species in the EU, and focuses on important sites for them. There is also no requirement under the Habitats Directive to directly assess birds, although the assessment of some habitats may be indirectly relevant. The indicator, therefore, needs to be complemented by data on more common, widespread and less threatened species in the wider environment.
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	See d above – no revisions of the Directive have arisen to date.
III. Data	
g. How is the underlying data gathered and by whom?	Monitoring of conservation status is an obligation arising from Article 11 of the Habitats Directive for all habitats (as listed in Annex I) and species (as listed in Annex II, IV and V) of Community interest. Consequently this provision is not restricted to Natura 2000 sites and data need to be collected both in and outside the Natura 2000 network to achieve a full appreciation of conservation status.

[24] Article 17 Reporting – Habitats Directive - Guidelines for assessing conservation status of habitats and species at the biogeographic level http://circa.europa.eu/Public/irc/env/monnat/library?l=/habitats_reporting/reporting_2001-2007/biogeographic_assessment&vm=detailed&sb=Title

	FCS is therefore primarily assessed by field work carried out by state conservation bodies or contractors. Data from NGO conservation bodies may also contribute to some assessments, for example where habitats or species occur in nature reserves owned or managed by NGOs, or when species are covered by voluntary biodiversity monitoring schemes.
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	FCS is based on subjective criteria, which differ between habitats, species and countries, and therefore its accuracy cannot be easily. The assessment methods and accuracy similarly vary for each FCS criterion. There are significant data gaps and, as a result, in the 2001-2006 assessment, 13% of regional habitat assessments and 27% of regional species assessments were reported by Member States as 'unknown'[25]. The number of 'unknown' classifications was particularly high for species found in the countries of southern Europe (eg Cyprus, Greece, Spain and Portugal). There was also a particular problem with assessments in the marine environment, where 57% of the marine species assessments and about 40 % of the marine habitats assessments were classed as 'unknown'.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	Article 17 requires Member States to report every six years on the progress made with the implementation of the Habitats Directive, in particular whether their habitats and species of community interest are in FCS. The first assessment of FCS covers the period 2001-2006 and reports on 216 habitats and 1182 species[26]. The resulting composite report was adopted by the European Commission in July 2009.
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	There is no operational definition of sustainability 'built-in' to the methodology.
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	N/A

[25] http://ec.europa.eu/environment/nature/knowledge/rep_habitats/docs/com_2009_358_en.pdf

[26] http://biodiversity.eionet.europa.eu/article17/chapter1

l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities below which a region/activity is not sustainable)?	This approach has no numerical values assigned to sustainability.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	There are no closely related indicators.
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	This indicator has no links to other dimensions of sustainability.
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	FCS is monitored by all EU Members States, as it is a requirement of the Habitats Directive (see g above) and the results are used by the European Commission to assess the achievements of the Directive.
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	Legal requirements under the Habitats Directive are the primary driver of the use of the FCS indicator.
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general	Yes - see q.

policy concern)?	
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
Policy Support	+ The indicator directly supports the implementation of the Habitats Directive, being the main measure of its performance with respect to the achievement of its principle objectives.
Identification of Trends	± The indicator may be able to detect broad trends in the status of habitats and species in future, but only (officially) at intervals of 6 years.
Forecasting and Modelling	– The indicator cannot be easily linked to models or be used for forecasting.
Scope/Levels of Application	– There have been problems with its application in countries with poor / scarce biodiversity data, especially in southern Europe and in marine habitats.
Accepted	
Stakeholder Acceptance	+ It has high stakeholder acceptance as it is linked to the Habitats Directive. – It could be better used if its concepts were more widely known and adopted outside Member State conservation bodies.
Credible	
Unambiguous	± The Directive and associated Commission guidance sets standard criteria for assessing FCS, which should facilitate aggregation and comparisons between Member States and biogeographical regions. However, in practice, they are rather general and cannot therefore be directly applied to each species or habitat or Community interest. Thus Member States define their own criteria, which differ according to local circumstances. Consequently it is difficult to compare results between Member States etc.
Transparency of the method	+ The underlying criteria are published in the Directive and guidance

	documents are available on the Commission's website. – The methods and criteria used by each Member State are not summarised in the Commission documents.
Easy	
DATA AVAILABILITY	+ The overall data are readily available via the Commission and ETC/BD websites. – Underlying data used by each Member State are less easily available.
TECHNICAL FEASIBILITY	+ The assessments are relatively simple where sufficient data are available.
COMPLEMENTARITY AND INTEGRATION	± Integration with other biodiversity indicators is not likely to be easy, but is not necessary.
Robust	
DEFENSIBLE THEORY	+ The key assessment criteria are based on widely accepted ecological principles.
SENSITIVITY	– The indicator only detects broad changes and only every 6 years.
DATA QUALITY	± The quality of the underlying data vary amongst habitats, species and countries. Many assessments are likely to be reliable, whilst others are incomplete.
RELIABILITY	+ The overall assessment methodology is relatively simple. – Many assessments will need to rely on subjective and/or expert judgements and therefore may not be consistent.
COMPLETENESS	+ FCS covers the most threatened habitats and species, and focuses on important sites for them, and therefore captures key biodiversity information. – The indicator needs to be complemented by data on more common, widespread and less threatened species in the wider environment (eg as measured by the Common Bird Indicator).

Summary appraisal	+ The indicator is the principal measure of the performance of the Habitats Directive and therefore has a considerable influence on the implementation of biodiversity conservation measures in all EU Member States. It focuses on habitats and species of high conservation importance, is based on common criteria, and is relatively simple, so it should be able to provide broad assessments of the status of these habitats and species. – The criteria for assessing FCS are rather broad, so in practice comparisons between Member States in terms of their achievements is problematical. The indicator also does not cover widespread species that are not under threat, and therefore it needs to be complemented by other biodiversity measures.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	n. No o.
SUSTAINABLE TRANSPORT	p. No
SUSTAINABLE CONSUMPTION AND PRODUCTION	q. No
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	r. Yes, in terms of land use.
PUBLIC HEALTH	s. No
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	t. No
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	u. No
INVESTMENT IN RESEARCH AND DEVELOPMENT	v. No

UNEMPLOYMENT RATE	w. No
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially, above)? What are the advantages of using this indicator?	x. The indicator measures the performance of the Habitats Directive, which is a key element of the EUs biodiversity conservation framework, which aims to halt the loss of biodiversity.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	y. Care needs to be taken in comparing the status of species and habitats across Member States. Also, the indicator also does not cover widespread species that are not under threat, and therefore it needs to be complemented by other biodiversity measures.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	z. The Common Bird indicator would complement the FCS indicator well, as birds are not covered by the Habitats Directive and the FCS assessments only cover the most threatened habitats and species in the EU, and focus on important sites for them.
IX. SWOT Analysis	
u. *Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	The FCS indicator is the principal measure of the performance of the Habitats Directive and must be monitored by all Member States, it therefore has a considerable influence on the implementation of biodiversity conservation measures in across the EU.
v. *Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	FCS is based on common criteria and is relatively simple, so it should be able to provide broad assessments of the status of habitats and species of high conservation importance.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level.	z. None

Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	The criteria for assessing FCS are rather broad, so, in practice, comparisons between Member States in terms of their achievements are problematical. The indicator also does not cover widespread species that are not under threat, and therefore it needs to be complemented by other biodiversity measures.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	With increasing experience, it should be possible to improve the assessments of FCS (by producing further guidance and drawing on previous assessment data and growing ecological knowledge). This should allow more habitats and species to be assessed and make assessments more consistent, thereby facilitating comparisons amongst Member States.
z. *Threats* ('Threats' are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	As a result of the recent financial problems some Member States may be tempted to reduce monitoring resources, which may reduce the number of habitats and species that are assessed and the reliability of the assessments (if inadequate data or poor methods are used).

6.3.5 The Marine Trophic Index (MTI)

I. Indicator Summary	
Name of indicator	The Marine Trophic Index (MTI)
Indicator category	Biodiversity
II. Background information on the indicator	

a. What is the official definition of the indicator?	The Marine Trophic Index (MTI) measures the change in mean trophic level of fisheries landings by region and globally. Trophic level is defined as the position of an organism in the food chain (CBD, 2004 (1)). For each year (k), the mean trophic level (TL) of fisheries catches is calculated in aggregate: $$\overline{\mathrm{TL}}_k = \frac{\sum_i (\mathrm{TL}_i) \cdot (Y_{ik})}{\sum_i Y_{ik}};$$ where TL_i denotes the mean trophic level of species *i* (or species group *i*) and Y_{ik} refers to fish landings of species (group) *i* in a year *k.*
b. Unit(s) of measurement of the indicator	The MTI is, by definition, the mean trophic level of fisheries catches in a year. The trophic level of most fishes and other aquatic consumers can take any value between 2.0 and 5.0, the latter being very rare occurring only in specialized predators of marine mammals (e.g. killer whales or polar bears).
c. What does the indicator seek to measure?	The preferred fisheries catches consist of large, high value, high trophic level predatory fish, such as tuna, cod, and swordfishes. As a result, unsustainable fishing leads to depletion of these large predatory fish, so that the relative numbers of low trophic level small fish and invertebrates increase. A time series of MTI showing a steady declining trend in mean trophic level indicates the long term deterioration of fisheries.
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	The conceptual model is based on the theory of "fishing down marine food webs" (Pauly *et al*., 1998 (2)). It was endorsed by the Convention on Biological Diversity (CBD) in 2004, when it was identified for 'immediate testing' of their ability to measure progress towards the 2010 target. The CBD actually coined the name MTI, as Pauly *et al*. (1998) had so far simply termed it the 'mean trophic level of fisheries landings' (Pauly and Watson, 2005 (3)). The MTI is one of the outputs of the Sea Around Us project, a scientific collaboration between the University of British Columbia and the Pew Environment Group.
e. What are the known limitations of the indicator?	The main limitation of the indicator is that the composition of landings does not necessarily reflect relative abundance in the underlying ecosystems, and hence the taxonomic composition of the landings cannot be assumed to represent relative abundances in the ecosystem. The accuracy and quality of underlying fisheries landings or catch data is also a

	limitation.
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	The original demonstration of the use of the indicator was by Pauly *et al*. (1998)(2), and the indicator has not been revised since then. This work had a large impact on the mass media as its message was relatively simple and easy to convey. It inspired a strong response and a large number of replications. A number of FAO staff (Caddy *et al*. 1998 (4)) wrote an important critique of the theory, including the argument that the index overlooks the fact that fishing down does not account for 'bottom-up' effects, for example, increases in low-TL fishes owing to increased eutrophication and thus primary production. Pauly and Watson (2005)(4) responded to these criticisms. To the criticisms cited here they proposed that the CBD's MTI should be based on time-series data that exclude low-TL organisms. They propose a standard cut off TL of around 3.25 to eliminate (besides herbivores and detritivores) the planktivores whose high biomass tends to vary widely in response to environmental factors (e.g. the case of the Peruvian anchoveta).
III. Data	
g. How is the underlying data gathered and by whom?	The MTI is based on the database of fish landings assembled by the FAO. The database contains annual fisheries catches since 1950 and is based on the information of more than 200 species. It is also produced by the Sea Around Us Project, which presents FAO catch data complemented with regional and national catch statistics all re-expressed on a spatial basis.
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	The accuracy of the indicator (at measuring mean trophic level) has been questioned in the literature because the composition of landings does not necessarily reflect relative abundance in the ecosystem (because of the selectivity of fishers and the practice of discarding bycatch). Pauly and Watson (2005)(4) argue that mean TL should be based on catches (landings plus discards) rather than only landings included in the FAO statistics. They also argue that estimated IUU (illegal, unregulated and unreported) catches should be included within national and international catch statistics datasets.
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	The indicator is calculated on an annual basis. Regarding any major revisions of the indicator, the use of mean TL as a measure of the impact of fisheries on marine ecosystems was questioned by Caddy *et al*. (1998)(4), and two items they highlighted led to improved definitions of the 'fishing down' concept as implemented by the CBD and the Sea Around Us Project collaboration. The first criticism from Caddy *et al*. (1998) is that fishing down marine food webs does not account for bottom up processes (e.g. eutrophication or decadal oscillations, etc, responsible for increases in biomass and production of small pelagic fishes such as anchovies and sardines). Analysed naively, increases in small pelagic fishes would lead, via a decrease of computed mean TL, to an inference of high-TL fishes becoming scarcer, although they may not have

	declined in absolute terms. Because of the biasing effect of small pelagic fishes, the Sea Around Us Project proposes that mean TL (if used to document fisheries impact on marine ecosystems) should generally be computed after excluding low-TL species from the analysis. This would lead to an indicator that may be labeled ^{cut}MTI, with the superscript referring to the lowest ('cutoff') TL value used in the computation, e.g. 3.25MTI. The value of 3.25 is here suggested as standard cutoff TL to eliminate, besides herbivores and detritivores, the planktivores whose high biomass tend to vary widely in response to environmental factors and thus mask TL changes induced by fishing. The Sea Around Us Project website allows computation of the MTI for any cuttoff value, or excluding any number of species (or groups) from the calculation.
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in' to the methodology?	Yes, there is an operational definition of sustainability 'built-in' to the methodology. Sustainability implies some notion of permanence in at least some of the entities being evaluated. Thus, if there is a clear trend of relative abundance of high-TL vis-à-vis low-TL fishes, as indicated by declining MTI values, this indicates the absence of sustainability and the need for intervention.
k. If yes, does the indicator measure 'strong' or 'weak' sustainability?	It is not clear at this point what strong or weak sustainability is in terms of mean trophic level, as reference values have not yet been identified (see part I). The present usefulness of the indicator is not based on a certain threshold value (or values) assigned to sustainability. Instead, its usefulness is in presenting trends.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversabilities below which a region/activity is not sustainable)?	No, the indicator does not have any numerical values assigned to sustainability.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	Mean maximum length is another closely linked index (Pauly and Watson, 2005 (3)). Besides trophic level, which is needed for computing the MTI, each taxon included in the world marine fisheries statistics (species, genus, family, etc.) has an approximate maximum length (ML, in cm) assigned to it. This enables computation of time series of mean ML as another ecosystem and biodiversity indicator - again on the assumption that an ecosystem is not managed for sustainability if the catch extracted from it consists of ever-smaller species. Another closely related indicator is the fishing-in-balance (FiB) index, a measure of the 'balance' between catches and trophic level (Pauly and Watson, 2005 (3)). The FiB index is designed so that its value remains constant if a decline in trophic level is matched by an ecologically appropriate increase in catch, and conversely for increasing trophic level. Thus, a time series of the FiB

	index can be useful in interpreting a series of MTI values, as it allows us to determine whether a decrease in trophic level was 'worth it', in terms of increasing catches.
n. What are the key "bridging" links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	Catch-per-unit-effort (CPUE) is an indicator that could be considered to bridge a link between the MTI and the economic sustainability of fisheries. CPUE relies on catch data, like the MTI, but also measures cost-effectiveness through the inclusion of a cost (effort) and is thereby a partly economic indicator.
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	The Sea Around Us Project is a scientific collaboration between the University of British Columbia and the Pew Environment Group, with Dr Pauly as its principal investigator, and they produce the MTI annually in collaboration with the CBD. The Conference of the Parties to the CBD uses the indicator to monitor progress toward reaching the target to "achieve by 2010 a significant reduction in the current rate of biodiversity loss" (CBD, 2004(1)). The MTI is also a component of the Commission on Sustainable Development (CSD) set of indicators for the area Oceans, seas and coasts/ marine environment (Hak, 2009 (5)). MTI is also a sub-indicator of the 2008 Environmental Performance Index (EPI) in the objective called Ecosystem Vitality, policy category Productive Natural Resources (Hak, 2009 (5)).
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	Public pressure for sustainable and better management of fisheries has led to the development of indicators and better methods of assessing the impacts of fishing, including the MTI. However, this indicator requires further refinement to ensure political adoption. Stakeholder confidence in the science underpinning current management decisions is already low and, as this indicator is based on information used in the traditional assessment, its usefulness is likely to be questioned.
q. Are there links to international or European laws, conventions or agreements (this could range from an explicit legal requirement to a general policy concern)?	The index is strongly linked to the CBD (see above). The MTI has its place in a number of international programs mostly because of increasing cooperation and fine-tuning between the monitoring and assessment programs of the different conventions. It is the only indicator that looks at the sustainability of fisheries and, as such, is likely to receive an even more official status in the future by the OSPAR convention, the EU Marine strategy Framework Directive, and the EU Common Fisheries Policy (Fey-Hofstede and Meesters, 2007 (6)). The MTI is also relevant to targets in the Millennium Development Goals, and the Plan of Implementation of the World Summit on

	Sustainable Development (CBD, 2004 (1)).
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant 1	
POLICY SUPPORT **0**	– The indicator does not have reference levels, targets or thresholds at this moment in time. ± The MTI relates to the objectives of the Common Fisheries Policy, and the Marine Strategy Framework Directive; however it is not actually used within these policy frameworks yet. – Because it combines all fisheries statistics into one figure it offers no possibilities for precise intervention (Fey-Hofstede and Meesters, 2007 (6)).
IDENTIFICATION OF TRENDS **3**	+ The MTI tracks trends annually. – The indicator is not particularly sensitive to short-term changes because it is calculated annually; hence there is a considerable time delay.
FORECASTING AND MODELLING **0**	– The MTI has no predictive or forecasting capacity.
SCOPE/LEVELS OF APPLICATION **1**	– In theory, there is nothing preventing the wide and diverse application of the indictor. – However, in practice the data quality varies significantly by country and by region. It is most accurate at the sea basin scale, and loses accuracy as one goes down to the national level (Fey-Hofstede and Meesters, 2007 (6)). The data from developed countries is likely to be of better quality than that of developing countries.
Accepted 3	
STAKEHOLDER ACCEPTANCE **3**	– The original demonstration of declining mean TL trends by Pauly *et al*. (1998) had a large impact in the mass media, as its message was relatively simple and easy to convey (Pauly and Watson, 2005 (3)). It inspired a strong response and a large number of replications (Pauly and

		Watson, 2005 (3)).
Credible 2.5		
UNAMBIGUOUS **1**	±	According to Pauly and Watson (2005) the message of the MTI is simple and easy to convey.
	–	The index has no reference value, no average TL corresponding to an 'acceptable state' of the ecosystem or sustainable fisheries. Therefore it remains unclear how to define the difference between natural temporal and spatial changes and fisheries induced changes in the MTI. According to Fey-Hofstede and Meesters (2007) this makes it difficult to understand by non-scientists and those who will decide on its use.
TRANSPARENCY OF THE METHOD **4**	±	The data is fully accessible and the calculation methods are explained in depth (see: http://www.seaaroundus.org/sponsor/cbd.aspx)
Easy 3.3		
DATA AVAILABILITY **4**	±	The indicator relies on data that are already collected and readily available in electronic form.
TECHNICAL FEASIBILITY **4**	±	The input and calculation methodology are clearly defined, and the Sea Around Us Project website has a user-friendly interface that allows easy calculation of the MTI for countries and large marine ecosystems.
COMPLEMENTARITY AND INTEGRATION **2**	±	Although it can be used on its own, measurements of the 'fishing down the food web' phenomenon with the MTI can benefit from being used alongside the mean maximum length index and the FiB index (see part m).
Robust 2.2		
DEFENSIBLE THEORY **4**	±	The theory of fishing down marine food webs is robust, having been demonstrated numerous times through replications (Pauly and Watson, 2005 (3)).
	±	The assumptions that the indicator relies upon have been discussed publicly in peer reviewed journals. Moreover, where the index has been produced the assumptions have been clearly stated, and any changes in the methodology (e.g. use of ^{cut}MTI rather than simply MTI) are justified and made explicit.

SENSITIVITY **0**	– The absence of any reference value or threshold means that it is unclear how to define differences between natural temporal and spatial changes and fisheries induced changes in the MTI (Fey-Hofstede and Meesters, 2007 (6)).
DATA QUALITY **2**	– The Sea Around Us project suggests that caution be taken on the use of the MTI when the underlying catch data are not sufficiently detailed and accurate. For example, some countries only report the species extracted that happen to be of high value, and others choose to report much of their catch as 'miscellaneous fishes', which clearly have no distinct trophic level and, consequently, the MTI cannot be computed for them (Sea Around Us, 2010 (7)).
RELIABILITY **4**	+ The methodology is reliable in terms of its accuracy, repeatability, and the clear specification of protocol and formulas used in the calculations. Various methodologies have been openly discussed but any methodological differences used are accounted for.
COMPLETENESS **1**	– The indicator is simple and uses catch data in describing trends. It does not take into account biological parameters and ecosystem interactions and functioning, or other anthropogenic factors which may affect the state of the fish stock.
Summary appraisal 2.4	The MTI is an important indicator for raising awareness of the poor state of the worlds' fish stocks and fisheries, and for increasing the understanding for a broad range of stakeholders. However it is limited in terms of its usefulness for policy makers and improving fisheries management towards sustainability targets.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	No, the MTI does not reflect the 'climate change and clean energy' target.
SUSTAINABLE TRANSPORT	No, the MTI does not reflect the 'sustainable transport' target.
SUSTAINABLE CONSUMPTION AND PRODUCTION	No, the MTI does not reflect the 'sustainable consumption and production' target.
CONSERVATION AND MANAGEMENT	The MTI partially measures the 'conservation and management of natural

OF NATURAL RESOURCES	resources' target.
PUBLIC HEALTH	No, the MTI does not reflect the 'public health' target.
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	No, the MTI does not reflect the 'social inclusion, demography and migration' target.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	No, the MTI does not reflect the 'global poverty and sustainable development challenges' target.
INVESTMENT IN RESEARCH AND DEVELOPMENT	No, the MTI does not reflect the 'investment in research and development' target.
UNEMPLOYMENT RATE	No, the MTI does not reflect the 'unemployment rate' target.
r. How does the indicator help measure progress toward the policy targets (marked 'Yes' and 'Partially', above)? What are the advantages of using this indicator?	The MTI helps measure progress towards the management of the natural resources target because it monitors the phenomenon of 'fishing down marine food webs' which is an indication of unsustainable fisheries. The MTI offers the possibility to encapsulate data on fisheries landings in one figure, making changes in fisheries behaviour visible in one glance. The MTI can be calculated for all FAO member countries in the world using the same database, facilitating international comparison (between countries and ocean areas) of fisheries behaviour (Fey-Hofstede and Meesters, 2007 (6)). It is also used by the CBD as an indicator of ecosystem integrity, because landings supposedly reflect the composition of species in an area, an absence of higher trophic level species among the landings suggests that they are no longer present in the ecosystem, thereby decreasing ecosystem integrity (Fey-Hofstede and Meesters, 2007 (6)).
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes' and 'Somewhat', above)?	Besides the obvious 'pitfall' that the MTI only measures progress towards sustainability in the fisheries sector, the indicator has a few other limitations. For example, the value of the MTI is highly dependent on the quality of underlying fisheries landings or catch data, and of the estimated TL of the landed species. The FAO landings data are flawed because they are aggregated by the country in which they were landed (not caught); 30% of landings are not identified on the species level; it does not include discards and unrecorded catches, and it can contain misreported data (Caddy, 1998 (4); Pauly *et al*., 1998 (2)). Another problem is that assigning one TL to a fish species is inaccurate since the TL of fish species changes with size and age.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to	• Abundance of commercial stocks– a high proportion of current research and assessment effort in the CFP is devoted to fish stock assessment. This is a long time series of data and this indicator can use existing work

address specific policy challenges relevant to the EU policy framework?	and requires little further development (Lutchman *et al*,2007 (8)). • Species composition including biodiversity of the fish community – this will help contribute directly to the high priority of halting biodiversity. Biodiversity indicators can easily be calculated from survey data and many time series are available. • Abundance of the fish community – sustained fishing activities require a healthy and productive community, which is important for meeting CFP objectives. Indices of community numbers and biomass are available from survey time-series data.
IX. SWOT Analysis	
u. *Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	• The underlying rationale and the meaning of the indicator is easily understood, widely reported by the mass media, and generally accepted by stakeholders. • The MTI is very feasible technically, as the methodology is clearly defined and simple to carry out. Moreover, the Sea Around Us project website has a user-friendly interface which allows for easy calculation of the index.
v. *Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	• The MTI tracks annual trends, • It can be widely and diversely applied, • The underlying data is fully accessible and the calculation methods are explained in depth, • It relies on data that are already collected and readily available in electronic format, • It is based on robust and defensible theory, • It has a reliable, repeatable and clear methodology.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or	None (It could potentially be among the indicators selected to monitor Good Environmental Status under the Marine Strategy Framework Directive, but these are yet to be decided).

EU level.)	
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	The usefulness of the indicator would be limited by: • The lack of reference value or threshold TL corresponding to an ‘acceptable state’ of fisheries or ecosystem integrity. • The MTI has no predictive or forecasting capacity. • The data quality is not consistent and needs improving in many areas (though this is less of a problem in the EU than globally). • The indicator is not particularly sensitive to short term changes in fisheries.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	The MTI could be best improved by: • Improving the data series on fisheries landings, or using survey data. • Estimating trophic levels of fish species by using stable isotope analysis combined with species-size abundances. • Determine a cut off value MTI for the EU member states. • Determine a reference value and natural fluctuations of MTI for the EU member states. (Fey-Hofstede and Meesters, 2007 (6); Pauly and Watson, 2005 (3))
z. *Threats* (‘Threats’ are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	Institutional threat – current EU institutional arrangements for decision making (with final decisions on catches made by the Council of Ministers) mean that decisions can still be influenced at the last minute by the sector. Political threat – EU Ministers often have a vested interested in securing higher quotas for their national sector, ignoring scientific advice. Another very important threat is the challenge of translating the results of the indicator into concrete operational management actions. Barrier – lack of good quality and adequate data for the index. Lack of definition of reference level.

6.4 Resource efficiency indicators

6.4.1 Energy Intensity

I. Indicator Summary	
Name of indicator	Energy Intensity
Indicator category	Energy
II. Background information on the indicator	
a. What is the official definition of the indicator?	• Total final energy intensity is defined as total final energy consumption divided by Gross Domestic Product (GDP) at constant prices. [EEA] as total final energy consumption is calculated as the sum of the gross consumption of the five sources of energy: solid fuels, oil, gas, nuclear and renewable sources. To monitor trends, GDP is in constant prices to avoid the impact of inflation [EEA] • A common way to measure and compare the energy intensity of different countries, and how this changes over time, is to look at the ratio of energy supply to GDP. [OECD] • Energy Intensity is measured by the quantity of energy required per unit of output or activity, [so that using less energy to produce reduces the intensity.] [US department of Energy] • Ratio of total energy use to GDP. [UN] • Ratio of total primary energy supply (TPES), total final consumption (TFC) and electricity use to gross domestic product (GDP). [IAEA]
b. Unit(s) of measurement of the indicator	• Total primary energy supply (TPES) per thousand US dollars of GDP. The ratios are calculated by dividing each country's annual TPES by each country's annual GDP expressed in constant 2000 prices and converted to US dollars using purchasing power parities (PPPs) for the year 2000. [OECD]

	• Final energy consumption (energy supplied to the final consumer for all energy uses) is measured in 1000 tonnes of oil equivalent (ktoe) and GDP in million Euro at 1995 market prices. Comparisons of intensity in specific years, however, are made using GDP in purchasing power standards. Total final energy intensity is defined as total final energy consumption (consumption of transformed energy such as electricity, publicly supplied heat, refined oil products, coke, etc, and the direct use of primary fuels such as gas or renewables, e.g. solar heat or biomass) divided by gross domestic product (GDP). Sectoral energy intensity is measured in tonnes of oil equivalent per million Euro (GDP or GVA), except in the case of household energy intensity, which is measured in tonnes of oil equivalent per 1000 people. [EEA] • Energy: tonnes of oil equivalent (toe) per US dollar; Megajoules (mJ) per US$. [UN] • Electricity: kilowatt-hours (kWh) per US dollar [IAEA]
c. What does the indicator seek to measure?	The energy intensity indicator is the most often used indicator to measure developments in energy efficiency even if it is not fully exhaustive. Energy intensity can signal to what extent there is a decoupling between the final energy consumption and economic performance of a country, sector, process, etc. A shift towards decoupling would generally indicate that pressures on the environment from energy production and consumption are decreasing. Note that the exact quantification of this lower pressure depends not only on the total amount of avoided energy consumption but also on energy efficiency and on the quality of energy mix consumed. This indicator is indeed able to capture economic and behavioral drivers of energy consumption, which are lacking for example in the energy efficiency indicator. Moreover, energy intensity measures energy-saving behavior or changes in industrial structure and lifestyle. It is a measure of “energy conservation”. Trends in overall energy use relative to GDP indicate the general relationship of energy consumption to economic development and provide a rough basis for projecting energy consumption and its environmental impacts with economic growth. For energy policy-making, however, sectoral or sub-sectoral energy intensities should be used. [UN] This indicator reflects the trends in overall energy use relative to GDP, indicating the general relationship of energy use to economic development. [IAEA] On a national or economy-wide level, the energy-GDP ratio is frequently used as a broad indicator of aggregate energy efficiency. Economic intensity indicators can provide policy-makers with a single number that reflects the state of energy use in the economy in a way that physical energy intensity indicators cannot. [**Nanduri 1998**]

d. Brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	For the last decade, indicators that reflect changes in energy intensity have been used to monitor efficiency progress and identify market trends and opportunities to improve energy efficiency. Governments routinely produce documents displaying trends in these indicators, and cross-country comparisons of energy intensity abound in energy policy literature. Trends in energy intensity indicators increasingly serve not just as a monitoring tool but as a basis for energy efficiency policies and regulations aimed at achieving greater energy conservation. Before the mid-1980s, however, policy-makers were primarily concerned with the effect of shifting energy consumption on economic growth. As a result, energy policies were often coupled with economic policies that were typically implemented to boost a nation's economic performance. Although the maintenance of economic growth is still a priority for governments, the policy focus has shifted to capitalizing on the environmental benefits associated with more efficient energy use rather than just the economic benefits of conservation (Golove and Schipper 1997; Bosseboeuf et al. 1997). Consequently, many believe that measuring changes in energy intensity can provide both international and national policy-makers with the information needed to design appropriate greenhouse gas mitigation strategies. Through the use of energy intensity indicators, governments may be able to identify which industries need to be targeted for mitigation strategies. As a result, energy intensity indicators (particularly transnational comparisons of them) are increasingly being touted as a very useful and necessary instrument for climate change negotiations and policy-making (Eichhammer and Mannsbart 1997)
e. What are the known limitations of the indicator?	Measurement and interpretation of energy intensities are complicated by differences among products within a category such as size (e.g., automobile weight or refrigerator capacity), features (power steering and automatic transmission in cars, freezer compartments in refrigerators), and utilization (hours per year a stove is used, vehicle occupancy if passenger-km is the measure of output). Comparison among countries of the ratio of energy use to GDP is complicated by geographical factors. Large countries, for example, tend to have high levels of freight transportation as many goods are distributed nationwide. Compared with countries with moderate climates, cold countries may consume as much as 20 per cent more energy per capita due to demand for space heating, while hot countries may use 5 per cent more energy per capita, due to demand for air conditioning. Countries with large raw material industries may use twice as much energy per unit of manufacturing output compared to countries that import processed materials, due to the high-energy intensity of raw material processing. Canada, for example, has a high ratio of energy use to GDP, due in part to that fact that it is a large, cold country with a large raw material processing sector. In Japan, the climate is milder,

	raw materials are limited, and high population density results in smaller residential units and less distance travelled, contributing to a lower ratio of energy use to GDP. [UN] The intensity of energy consumption is relative to changes in real GDP. Comparisons of energy intensity based on real GDP between different countries are relevant for trends but not for comparing energy intensity levels in specific years and specific countries. [EEA] The aggregate ratio depends as much on the structure of the economy as on the energy intensities of sectors or activities, and changes in the ratio over time are influenced almost as much by changes in the structure of the economy as by changes in sectoral energy intensities. It is necessary to look at sectoral energy intensity indicators in order to understand drivers of change of total energy intensity. Overall energy intensity is also influenced by the structure of the economy, the energy intensities of particular sectors or activities, technological as well as geographical, natural and environmental factors. It is difficult to compare energy intensity among products and among countries. The ratio of aggregate energy use to GDP, often called "energy intensity" or the "energy ratio", is not an ideal indicator of energy efficiency, sustainability of energy use, or technological development, as it has been commonly used. [UN] **Methodological Issues**. The construction of indices that show the performance of energy intensity over time and account for structural changes is an exercise in decomposition of effects. Advances have been made recently that allow for this decomposition so that many of the attributes of an "ideal index" are captured in the decomposition used here. One of these attributes is "perfect aggregation," which allows all higher level indices to be constructed so that they include all the information available at the lower levels and allows this information to be integrated at the higher level. Unfortunately, that attribute distorts the activity measure in a way that would make these measures deviate from published figures, so the approach used to construct intensity indices for this web site was modified to allow almost perfect aggregation and yet have the activity measures conform to the published numbers. [US DoE] It is important to note the poor ability of monetary indicators to pick up underlying improvements in energy efficiency. [**Nanduri 1998**]
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major	Intensity-efficiency dichotomy: it is possible to observe improving energy efficiency while energy consumption is still rising. When fuel prices are high and GDP is growing, there can be an improvement of energy intensity (lower energy consumption) not attributable to higher energy

revisions, current efforts, future plans/initiatives)?	efficiency. [IEA] The ratio of energy use to GDP as well as sectoral and sub-sectoral energy intensities, are in widespread use, but without a standardized methodology. The ratio of sectoral or sub-sectoral energy use to the output or activity of the sector or sub-sector provides a more useful indicator of energy intensity, but this coincides with a loss in synthetic properties of the general indicator [UN].
III. Data	
g. How is the underlying data gathered and by whom?	The International Energy Agency maintains the most thorough set of energy balances and energy accounts, based primarily on national data or data collected from reliable regional agencies. For OECD countries, the OECD maintains the most reliable set of national accounts with a breakdown of GDP by sector and sub-sector. IEA energy data now cover virtually all developing countries. GDP and value-added by industry are published in the United Nations National Accounts Statistics. The IMF "International Financial Statistics" provides nominal and real GDP for most countries. Data on components of GDP are often available from regional development banks or national sources. [UN] Energy commodity data for production and use, and population data are regularly available for most countries at the national level and for some countries at the sub-national level. Both types of data are compiled by and available from national statistical offices and country publications. [IAEA]
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	Despite increasing support for the use of energy intensity indicators as a basis for climate change policy-making, numerous uncertainties and disagreements continue to surround the development, interpretation and application of these indicators. Specifically, disagreements exist as to the best method for constructing the indicators. Issues regarding the interpretation of trends depicted by the indicators also exist, since energy intensity indicators sometimes show different trends. Lastly, uncertainties surround the application of these indicators (Nanduri 1998). The results value is usually accurate if the use of GDP for each country is consistent. The "volatility" inherent in GDP-related values (because of its cyclical nature) causes larger year-to-year changes in economic energy intensity (Freeman et al. 1997). In this perspective, it is preferable to use the real GDP, or constant dollar GDP.
i. How often is the indicator recalculated/released? Have there already been	Data are produced on an annual basis following the change in GDP data.

any major indicator revisions?	
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in" to the methodology?	The EU climate change and energy package includes a 20% target in increasing energy efficiency. The energy intensity indicator is the most often used indicator to measure developments in energy efficiency even if it is not fully exhaustive. Trends in energy intensity indicators increasingly serve not just as a monitoring tool but as a basis for energy efficiency policies and regulations aimed at achieving greater energy conservation. Reducing energy intensity and improving energy efficiency in industrial processes are important sustainable development objectives for countries all over the world. Improvements in intensities can imply a more effective utilisation of energy resources and reductions of negative environmental impacts. Therefore, this indicator may also provide useful information concerning the evolution of economic and technological development in a geographical area. According to the Directive on energy end-use efficiency and energy services, each Member State should each year save 1% more energy than in the previous year through increased energy efficiency, which, it is hoped, will lead to annual energy savings of around 6% by 2012 Measures of sustainability energy intensity should therefore be put in the broader context of the actual fuel mix used to generate the energy. [EEA] Energy is essential for economic and social development, but consumption of fossil fuels is the major cause of air pollution and climate change. Improving energy efficiency and delinking economic development from energy consumption, particularly of fossil fuels, is essential to sustainable development. [UN]
k. If yes, does the indicator measure "strong" or "weak" sustainability?	Energy intensity measures "weak" sustainability as it is connected to economic performance indicator such as GDP, and it is not sufficient for measuring the environmental impact of energy use and production.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. thresholds/ irreversibility below which a region/activity is not sustainable)?	No specific target for energy intensity. [UN] According to the Directive on energy end-use efficiency and energy services, each Member State should each year save 1% more energy than in the previous year through increased energy efficiency, which, it is hoped, will lead to annual energy savings of around 6% by 2012 In its 5 years plan, China has decided to decrease the energy intensity by

	16% by 2015. Germany has introduced in 2002 a target for energy intensity (To double energy productivity by 2020 compared to 1994).
m. key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	Because there is no unequivocal quantitative measure of energy efficiency, the tendency is to rely on various energy intensity indicators, typically constructed in the form of a quantitative index, in order to approximate changes in energy efficiency. There are two main types of energy intensity indicators that can be used to track progress in energy efficiency: physical and economic. Physical energy intensity indicators can only be constructed using disaggregate data due to the diverse output of different sectors, sub-sectors and industries. In other words, when there are numerous outputs / services produced by many different industries, it becomes difficult to develop an aggregate measure of energy intensity. Economic energy intensity uses monetary measures of value (dollars). Economic intensity indicators can provide policy-makers with a single number that reflects the state of energy use in the economy in a way that physical energy intensity indicators cannot.
n. What are the key bridging links to other dimensions of sustainability (environmental, social, economic), and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP)?	The ratio of energy use to GDP is an aggregate of sectoral energy intensity indicators and is thus linked to the energy intensities of the manufacturing, transportation, commercial/services and residential sectors, for which separate methodology sheets have been prepared. This indicator is also linked to environmental indicators (total energy consumption, greenhouse gas emissions and air pollution emissions) and economic indicators (GDP and GVA) [UN]

V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	Virtually every national and international energy agency uses the ratio of total energy use to GDP, often inappropriately. Key agencies involved in more detailed development of sectoral and sub-sectoral indicators, including energy intensity and energy efficiency indicators[UN], are: • Eurostat • Directorate-General for Energy and Transport of the European Commission. • IEA with a particular focus on non-EU countries. • APERC, with a focus on the Asia-Pacific Region • OLADE for Latin America.
p. What are the driving forces and characteristics that affect institutional adoption? (consider this question from the perspectives of political science, sociology and political economy)	
q. Are there links to international or European laws, conventions or agreements? (this could range from an explicit legal requirement to a general policy concern)	There are no specific international conventions or agreements directly related to the reduction of energy intensities. The importance of energy efficiency and the rational use of energy have been highlighted by Agenda 21, at the World Summit on Sustainable Development in Johannesburg and by various European Union treaties. Although there are no specific international targets regarding energy intensities, many industrialised countries have targets for reducing energy use and carbon emissions and other pollutants from industrial and manufacturing branches. Even though there is no target for total energy intensity, a number of EU Directives, Action Plans and community strategies directly or indirectly relate to energy efficiency, e.g. the sixth Environmental Action Plan calls for the promotion of energy efficiency. The indicative target for final energy consumption intensity in the EU, set in the 1998 Communication 'Energy Efficiency in the European Community: Towards a Strategy for the Rational Use of Energy', COM(98) 246 final, proposes an improvement in the intensity of final energy consumption from 1998 of 1 % per year “over and above that which would otherwise be attained”. Following on from this, the directive on energy end-use efficiency and energy services (2006/32/EC) sets indicative targets for Member States to save 9 % per year of energy compared with business-as-usual after nine years of its implementation. In addition, most of the new Member States have officially made energy efficiency a priority goal, and all have some policies aimed at improving

	the energy intensity of the national economy. These will play an important role in meeting the EU's and new Member States targets under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) to reduce greenhouse gas emissions. [EEA] Currently, there are no conventions or agreements that specifically refer to the regulation and/or limitation of energy use per capita. However, calls have been made for the prudent and rational utilisation of natural resources (Article 174 of the Treaty Establishing the European Community — Nice, 2001), improved energy efficiency (The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects — Lisbon, 1994) and a switch to cleaner forms of energy. The United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol call for limitations on total greenhouse gas (GHG) emissions, which result mainly from the combustion of fossil fuels. [IAEA]
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ Energy intensity is a synthetic indicator of energy consumption weighted with the magnitude of country's economic system. This indicator can be complemented by the sectoral energy intensity indicator, which helps to understand specific drivers of change. + Energy intensity is linked to the aggregate energy use per unit of GDP, final and primary energy use, electricity use, greenhouse gas emissions, air pollutant emissions and depletion of energy resources. + The indicator identifies to what extent there is a decoupling between energy consumption and economic growth. + Changes in intensities are affected by factors other than energy efficiency; therefore, analysing intensity trends provides important insights into how energy efficiency and other factors affect energy use. + several energy and environment targets are indirectly influenced by or directly influence changes in energy intensity, by improving energy efficiency (Kiev Declaration) and reforming energy prices and subsidies to achieve more sustainable energy consumption (UNECE Guidelines).

	- There are no specific international conventions or agreements directly related to the reduction of energy intensities. - There are no specific international targets regarding energy intensities. Only China has decided to decrease the energy intensity by 16% by 2015.
IDENTIFICATION OF TRENDS	+ Energy intensity provides policy-makers and economic planners with indications of the trend between energy consumption and economic growth. + Changes in intensities are affected by factors other than energy efficiency; therefore, analysing intensity trends provides important insights into how energy efficiency and other factors affect energy use. + Decoupling may result from reducing the demand for energy services (e.g. heating, lighting, passenger or freight transport), by using energy in a more efficient way (thereby using less energy per unit of output), or a combination of the two. - Because energy is produced using different fuels in different countries, the environmental impact of changes in energy intensity is country-specific.
FORECASTING AND MODELLING	+ Energy intensity data make up one of the main inputs for economic scenarios - Differences between countries may be due either to variances in energy efficiency, in the energy and economic structure of the manufacturing, agricultural and services sector or in consumer behavior.
SCOPE/LEVELS OF APPLICATION	+ Energy intensity is calculated based on specific countries, and it might also be calculated based on sectoral level (industries, agriculture and services/private).
Accepted	
STAKEHOLDER ACCEPTANCE	+ Energy intensity is not an independent area but is viewed within energy security. - Among scientists, the acceptance of the indicator is low because differences across countries of this indicator do not necessarily reflect actual disparities. In addition, improvements in energy intensity do not shed light on variations of energy mix and on the magnitude of emission reduction.

Credible	
UNAMBIGUOUS	- Given the large number of factors that affect energy consumption, the ratio of total energy consumption to GDP should not be used as an indicator of energy efficiency for policy-making purposes. + Energy intensity combined with others indicators can contribute to an accurate assessment of environmental sustainability
TRANSPARENCY OF THE METHOD	+ Calculation of the indicator is standardised.
Easy	
DATA AVAILABILITY	+ Data are collected by different institutions such as: Eurostat, Directorate-General for Energy and Transport of the European Commission, IEA with a particular focus on non-EU countries, APERC, with a focus on the Asia-Pacific Region, OLADE for Latin America. + Data are often collected systematically by national statistical agencies: energy commodity data for production and use and population data are regularly available for most countries at the national level and for some countries at the sub-national level. - One persistent data problem at the aggregate level is distinguishing between ‘industry’ (ISIC, Divisions C, D, F and E) and ‘manufacturing’ (ISIC, Division D). Some countries also lump agriculture, forestry and fishing (ISIC, Divisions A and B) into the aggregate ‘industrial sector’ classification. For these reasons, it is strongly recommended that data be checked to ascertain exactly what sectors are covered.
TECHNICAL FEASIBILITY	- Complications arise for the typical sectoral energy intensities which penalise countries specialised in high energy intensive sectors. - Interpretation is also complicated when a particular branch has significant internal energy resources, such as captive hydropower, biofuels or coal.
COMPLEMENTARITY AND INTEGRATION	- It is also possible to measure total energy use, internal and external for any final product, by using input-output tables. This approach allows for the measuring of the energy embodied in materials and intermediate products; however, this is a very data intensive task, and input-output tables are not produced regularly.
Robust	

DEFENSIBLE THEORY	+ Based on a sound accounting methodology backed by most national and international institutions. -Energy consumption is determined by the structure of the economy, the energy intensities of sectors or activities, and technological as well as geographical, natural and environmental factors. It is difficult to compare energy intensity among countries. -Therefore, the ratio of total energy consumption to GDP should not be used as an indicator of energy efficiency or environmental sustainability for policy-making purposes.
SENSITIVITY	+There is a high data-collection density: several institutions compile GDP and energy use data. +Data are produced on an annual basis following the change in GDP data. -Some components (sectoral and other factors) may dominate the indicator, which may result in fluctuations of the indicator. - Final data may only be published after an extended period of time.
DATA QUALITY	- The data collection system is usually developed. However, countries differ in the frequency of data reported.
RELIABILITY	- Given the large number of factors that affect energy consumption, the ratio of total energy consumption to GDP should not be used as an indicator of energy efficiency or environmental sustainability for policy-making purposes: it considers too many drivers with respect to the former and too few with respect to the latter.
COMPLETENESS	- Given the large number of factors that affect energy consumption, the ratio of total energy consumption to GDP should not be used as an indicator of energy efficiency or sustainability for policy-making purposes.
Summary appraisal	

VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	Energy intensity helps to inform policy makers on climate change (through GHG emission reduction linked to lower energy consumption). It does not clarify the contribution of clean energy over the total energy mix
SUSTAINABLE TRANSPORT	Energy intensity of this sector helps to inform policy makers on sustainable transport as a policy target.
SUSTAINABLE CONSUMPTION AND PRODUCTION	Energy intensity helps to inform policy makers on sustainable energy consumption and production as a policy target.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	Energy intensity helps to inform policy makers on conservation of natural resources.
PUBLIC HEALTH	Energy intensity does not help to inform policy makers on public health as a policy target.
SOCIAL INCLUSION, DEMOGRAPHY, AND MIGRATION	Energy intensity does not reflect social inclusion, demography, and migration as a policy target.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	Energy intensity helps to inform policy makers on sustainable development as a policy target.
INVESTMENT IN RESEARCH AND	Energy intensity helps to inform policy makers on research and development as

DEVELOPMENT	a policy target.
UNEMPLOYMENT RATE	Energy intensity does not inform policy makers on unemployment as a policy target.
r. How does the indicator help measure progress toward the policy targets (marked 'Yes" and "Partially" above)? What are the advantages of using this indicator?	The energy intensity indicator can support and help to explain the results of other environmental indicators such as GHG and CO_2 emissions intensity. For example, a contraction in GHG and CO_2 intensity, coupled with a reduction in energy intensity, could represent an improvement in energy efficiency, if GDP does not grow too much during that period. This indicator is not informative on changes in energy mix and on developments of clean technologies but can highlight an important component in stabilising global emissions and temperature: the efficiency in energy production. Transport energy intensity (i.e. a sectoral version of the general indicator) is a useful indicator of technological advancement of this sector and could complement an indicator relative to renewable fuel used. Energy intensity is an important indicator in describing sustainable consumption, in particular energy use: a good performance of the indicator corresponds to decreasing or slow increasing energy use compared to GDP growth. It is worth noticing that this indicator captures only a small portion of consumption and cannot assess sustainability in production. The energy intensity indicator is able to capture the effort towards a more rational and efficient use of natural resources in energy production: this can be the result of a design to reduce fossil fuel use (e.g. as the outcome of a climate policy) or of an increased ability to reduce losses in production. In addition, the indicator helps to assess technological progress, i.e. the effects of R&D investment; indeed it embodies energy efficiency, but it is necessary to remember that this is not the only component and that the performance depends also on GDP growth. In fact, energy intensity can highlight the sustainable growth path for developing countries, showing the balance between energy consumption and GDP growth
s. What are the most common pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes" and 'Somewhat", above)?	Given that energy consumption is also determined by the structure of the economy, the energy intensities of sectors or activities, and technological, geographical, natural and environmental factors, it is difficult to compare energy intensity among countries. Given that this indicator is influenced by many variables, it is often difficult to focus the drivers of change that other more specific indicators can track (e.g. it would be wrong to consider energy intensity equivalent to energy efficiency).

VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')

t. What other indicators could be combined with the one in question to address specific policy challenges relevant to the EU policy framework?	The sectoral energy intensity can give additional information to the total energy efficiency indicator. In addition, a breakdown of energy mix or the share of renewable over total energy consumption can clarify the picture. GHG Emissions (by industry sector), the usual policy benchmark, provide a more comprehensive assessment of environmental sustainability that concentrates mainly on production side.
IX. SWOT Analysis	
*u. Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	Energy intensity provides information about the relative energy use per unit of output. The set is used to complement analysis on energy efficiency patterns, on trends in technological improvements and changes in the structure of sectors and sub-sectors. This indicator is in fact able to capture economic and behavioral drivers of energy consumption, which are lacking for example in the energy efficiency indicator. Improving energy efficiency and reducing energy intensities in industrial processes are important sustainable development objectives for countries all over the world. Improvements in intensities can imply a more effective utilisation of energy resources and reductions of negative environmental impacts. Therefore, it may also provide useful information concerning the evolution of economic and technological development in a geographical area.
*v. Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	Changes in energy intensity are affected by factors other than energy efficiency; therefore, analysing this synthetic indicator in addition to its single components provides important insights into how energy efficiency and other factors affect energy use. The indicator identifies to what extent there is a decoupling between energy consumption and economic growth.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	The aggregate indicator for the industrial sector reflects the energy intensity of various branches of manufacturing. Changes in the aggregate indicator can therefore be due either to changes in energy consumption or to changes in relative branch output (structure). Similarly, differences between countries may be due either to differences in energy efficiency or to differences in the structure of the sectors. A country with large energy-intensive industries, such as a pulp sector, primary metals or fertilizers, for example, will have a high energy intensity, even if the industry is energy efficient. For this reason, it is desirable to complement energy intensity through manufacturing branch and with industry details; it is also necessary to bear in mind the non-overlapping definition of energy intensity and energy efficiency indicators.
x. Important weaknesses (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	Energy intensity is influenced by the structure of the economy, the energy intensities of sectors or activities and technological, geographical, natural and environmental factors. It is difficult to compare energy intensity among products and among countries. Therefore, the ratio of total energy consumption to GDP should not be used as an indicator of energy efficiency or sustainability for policy-making purposes.

y. Opportunities (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	The energy intensity indicator has many opportunities to be included in EU research at various levels. There is the opportunity to use it as a tool to study and interpret eco-efficiency performance and targets of processes, products, services and even more complex systems at the meso- or macro-level. The energy intensity indicator may be used together with the GHG emissions indicator to provide a more comprehensive picture of energy production and consumption.
z. Threats ("Threats" are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	Energy intensity alone does not seem to be sufficient for comprehensive environmental analysis. Energy intensity is focused on a narrow, though relevant, part of sustainability.

6.4.2 GHG emissions

I. Indicator Summary	
Name of indicator	Greenhouse Gases (GHG) Emissions
Indicator category	Environmental
II. Background information on the indicator	
a. What is the official definition of the indicator?	Greenhouse gases emission indicators encompass a variety of measurements on the emission and concentration of Greenhouse gases. Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. • Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere such as the halocarbons and other chlorine and bromine containing substances dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). **[IPCC fourth assessment report]** • Anthropogenic emissions, less removal by sinks, of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), together with the indirect greenhouse gases nitrogen oxides (NOx), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs**)**. **[UN]** GHG emission per capita: Emissions of greenhouse gases (GHGs) from energy production and use, per capita GHG emission intensity: Emissions of greenhouse gases (GHGs) per unit of gross domestic product (GDP), including carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). **[UN]**

	Anthropogenic (man-made) emissions of six greenhouse gases (GHG), weighted by their global warming potentials.**[Eurostat]** **[EEA]**
b. Unit(s) of measurement of the indicator	Annual GHG emissions in tons (or gigagrams (Gg)) of CO_2 equivalent or of Carbon. Emissions of CH_4 and N_2O are to be converted to CO_2 equivalents using the 100-year global warming potentials (GWPs) provided in the Intergovernmental Panel on Climate Change (IPCC) Synthesis report (2007). [UN] The equivalent CO_2 emissions from fuel combustion are calculated by multiplying the energy use for each fuel type by an associated global warming potential coefficient. Wherever possible, GHG emissions should be measured directly at the source of energy use. More commonly, however, measured data are incomplete or unavailable. In the absence of measured data, emissions are calculated by multiplying some known data such as coal production or natural gas throughput by an associated emission factor derived from a small sample from a relevant emission source or through laboratory experiments. ***CO2-equivalent emission*** is the amount of CO_2 emission that would cause the same time-integrated radiative forcing, over a given time horizon, as an emitted amount of a long-lived GHG or a mixture of GHGs. The equivalent CO_2 emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for the given time horizon. For a mix of GHGs, it is obtained by combining the equivalent CO_2 emissions of each gas. Equivalent CO_2 emission is a standard and useful metric for comparing emissions of different GHGs but does not imply the same climate change responses. **[IPCC Climate Change 2007 Synthesis report]** The IPCC recommends monitoring of anthropogenic emissions and removals involving emissions of: • carbon dioxide (CO_2) • methane (CH_2) • nitrous oxide (N_2O) • hydrofluorocarbons (HFCs) • perfluorocarbons (PFCs) • sulphur hexafluoride (SF_2) • nitrogen trifluoride (NF_3) • trifluoromethyl sulphur pentafluoride (SF_5CF_3) • halogenated ethers • and other halocarbons not covered by the Montreal Protocol **[IPCC 2006 Guidelines for National Greenhouse Gas Inventories]**

c. What does the indicator seek to measure?	This indicator measures the emissions of the six main GHGs which have a direct impact on climate change, less so the removal of the main GHG CO_2 through sequestration as a result of land-use change and forestry activities. [UN] The indicator does not include the impact of land use changes and forestry. The removal of GHG from the atmosphere by different sinks (forestry, oceanic uptake) is one the most controversial issues in climate change studies. The missing carbon sink is as large as the oceanic uptake and the net emissions from changes in land use. [Eurostat]
d. Provide a brief history of the indicator. Which organization or body originally proposed the indicator (and in what year)? Which organizations currently advocate for the indicator's use?	Scientists have known since 1896 that CO2 affects surface temperatures. Arrhenius first proposed that changes in atmospheric CO2 levels could alter surface temperatures through the greenhouse effect. In 1956, Charles 'David' Keeling developed a way to measure CO2 accurately. Today, CO2 is sampled cooperatively in 45 countries, with over 20,000 flask samples in 2009 from observatories, ships, planes, & towers [NOAA presentation] The United Nations Framework Convention on Climate Change (UNFCCC) entered into force in March 1994. The Convention included a commitment by Parties, both developed countries and economies in transition (Annex I Parties), to aim to return emissions of CO2 and other GHGs not controlled by the Montreal Protocol to their 1990 levels by 2000, although relatively few Parties actually met this goal. The Kyoto Protocol was adopted in December 1997. It was designed to enter into force after being ratified by at least 55 Parties to the Convention, including developed countries accounting for at least 55% of the total 1990 CO2 emissions from this group. With the 2004 decision by the Russian Federation to ratify the Protocol, it entered into force in early 2005. In any event, countries are also bound by their commitments under the Convention. Ozone-depleting GHGs are controlled by the Vienna Convention and the Montreal Protocol. [UN] The 'Climate Action and Renewable Energy' package adopted by the European Council on 6 April 2009 underlined the objective of limiting the rise in global average temperature to no more than two degrees Celsius above preindustrial levels. To achieve this goal Member States agreed to reduce total EU greenhouse gas emissions by 20 % compared to 1990 by 2020. On the one hand, minimising overall reduction costs to meet the 20% objective implies a 21 % reduction in emissions from sectors covered by the EU ETS compared to 2005 by 2020. This is to be achieved via a single EU-wide cap on ETS emissions. On the other hand, it also implies a reduction of 10 % in emissions for sectors outside the EU ETS. All Member States have agreed to country-specific greenhouse gas emission limits in 2020 compared to 2005 for sectors outside the EU ETS (Council Decision 2009/406/EC). The Europe 2020 strategy reiterates the significance of the 'Climate Action and Renewable energy' package and includes the greenhouse gas emissions indicator

	among the headline indicators measuring the success of the strategy. The European Union, as a party to the United Nations Framework Convention on Climate change (UNFCCC), reports annually on the greenhouse gas emissions within the area covered by its Member States. The Annual European Union greenhouse gas inventory and inventory report, officially submitted to the UNFCCC Secretariat, is prepared on behalf of the European Commission (DG CLIMA) by the European Environment Agency's European Topic Centre for Air and Climate Change (ETC/ACC) supported by the Joint Research Centre and Eurostat. [Eurostat]
e. What are the known limitations of the indicator?	This indicator shows the net amount of GHGs entering the atmosphere for each reporting country each year. It does not show how much the climate will be affected by the increased accumulation of GHGs or the consequent effect of climate change on countries. Data is available and reported mainly for developed countries and economies in transition. [UN] For most countries, carbon dioxide (CO2) from the combustion of fossil fuels for activities such as transportation or electricity generation is the dominant source of emissions. However, in some countries with proportionately large agriculture sectors, such as Developing Countries, other emission sources and sectors are the highest contributors.This should be taken into account when considering this indicator. In the Eurostat description, the indicator does not include emissions and removals related to land use, land-use change and forestry (LULUCF), nor does it include emissions from international aviation and international maritime transport. [Eurostat] UNFCC provides data on GHG emission including and excluding land use, land-use change and forestry (LULUCF) calculation. CO2 emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC Guidelines and not included in national greenhouse gas totals. There are no restrictions to the use of this indicator. It is noteworthy however that careful treatment and interpretation of data is necessary when comparing air emissions accounts of Eurostat and the greenhouse gas emission inventory compiled by EEA. This is due to the fact that the methodology of the UNFCCC for preparing GHG inventories is based on different principles than that of the ESS for accounting air emissions. One of the major differences is that the air emissions accounts of ESS cover emissions stemming from national economic activities, i.e. those generated by economic activities of resident units rather than emissions from all sources located on the national territory. Therefore, most air emissions totals for air emissions accounts of the ESS differ from totals in UNFCCC air emissions inventories, which do not apply national accounts concepts. In order to show the exact components that make up discrepancies in two reporting systems, Eurostat has prepared a

	table bridging air emission accounts and UNFCCC totals in order to be discussed with the Member States. [Eurostat]
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	Developed country Parties to the Convention have been reporting GHG data beginning with 1990 data since 1994. The IPCC has published two sets of guidelines on methodologies for the estimation of GHG inventories and further elaborated this with guidance on good practice in 2000. [UN] IPCC 1996 guidelines, IPCC 2006 guidelines GHG emissions can alternatively be measured on a gross instead of net basis in which case no account is taken of removal by sinks. There are a number of other gases that indirectly produce GHGs and these could also be included in the scope of the definition. The GWP potential can be calculated over different time horizons, such as 20 years or 500 years. [UN] The annual review process under the UNFCCC and the Kyoto Protocol guarantees the continuous improvement of the quality of greenhouse gas estimates. In addition, an annual internal review mechanism has been established within the EU to improve the quality of the EU's official submission to the UNFCCC. [**Eurostat Quality Profile of GHG Indicator**]
III. Data	
g. How is the underlying data gathered and by whom?	National communications from Parties to the Convention, including both developed and developing countries are available. Developing countries report on a limited basis. At the international level, the UNFCCC Secretariat database has information based on annual data inventory submissions from developed and economy in transition countries. [UN] Countries that are Parties to the United Nations Framework Convention on Climate Change (UNFCCC) are committed to reporting their national greenhouse gas inventories to the Secretariat of the convention. Developed countries report stand-alone inventories on an annual basis, which are then peer-reviewed by technical experts. Developing countries report their national greenhouse gas inventories on a less frequent basis as part of a broader national report called a

	‘national communication‘. The UNFCCC secretariat provides an online greenhouse gas database that allows users to make greenhouse gas data queries from all countries and download the results. Developed and developing countries all use the Intergovernmental Panel on Climate Change (IPCC) Guidelines as a basis for their inventories. Other datasets are available that provide comprehensive estimates of emissions from other regions and countries: • IEA: The International Energy Agency publishes country-by-country estimates of CO2 emissions from fossil fuel combustion. • CDIAC: The Carbon Dioxide Information Analysis Center at Oak Ridge National Laboratory publishes data on global, regional and national fossil fuel CO2 emissions. More information. • The EPA compiles a database of non-CO2 greenhouse gases by region and by country. This database is a combination of estimates generated by other countries and by the EPA. More information. • WRI: The World Resources Institute has developed a Climate Analysis Indicators Tool (CAIT) to which users can subscribe and examine international emissions. CAIT contains many other data sets, including data from the UNFCCC, EPA and IEA. More information
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	According to the IPCC Guidelines, greenhouse gas estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable. Moreover, appropriate methodologies should be used in accordance with the IPCC good practice guidalines, to promote accuracy in inventories. Greenhouse gases contribute in varying degrees to global warming depending on their heat absorptive capacity and their lifetime in the atmosphere. The global warming potential (GWP) describes the cumulative effect of a gas over a time horizon (usually 100 years) compared to that of CO2. The global warming potentials of ozone-depleting greenhouse gases (such as CFCs and HCFCs) are highly uncertain, since they depend on the depletion of ozone, itself a greenhouse gas. No global warming potentials are provided for indirect greenhouse gases. The degree of confidence associated with CO2 data, in particular from fuel combustion, is high and the estimates are consistent with other authoritative sources. A number of potential inconsistencies and difficulties in aggregating and comparing inventory data arose on what type of guidance is needed. Parties were requested to discuss the level of uncertainty associated with quantitative inventory data, at least qualitatively. Eleven did so by providing information on uncertainty either on a gas-by-gas basis or at the source/sink category level, with four Parties doing so quantitatively. The information provided on the level of confidence by gas may be summarised as follows:

	- CO_2 : high, except for land use change (low) and forestry (medium) - CH_4 : medium - N_2O: low to medium - NO_x : high to medium - CO and NMVOC: medium to low Six Parties also provided a self-assessment of the completeness and quality of their inventories using the IPCC recommended format.[UNFCC - First review of information communicated by each party included in annex I to the convention 1994]
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	The annual review process under the UNFCCC and the Kyoto Protocol guarantees the continuous improvement of the quality of greenhouse gas estimates. In addition, an annual internal review mechanism has been established within the EU to improve the quality of the EU's official submission to the UNFCCC. [**Eurostat Quality Profile of GHG Indicator**]
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in" to the methodology?	The "output" indicator is one of the main indicators in the sets of structural and sustainable development indicators as well as one of the main targets in the Europe 2020 strategy. [**Eurostat Quality Profile of GHG Indicator**]
k. If yes, does the indicator measure "strong" or "weak" sustainability?	This indicator measures "strong" sustainability. From an ecological perspective, the ("strong") sustainability rule requires that the total sum of greenhouse gas emissions should not exceed the assimilative capacity of the atmosphere and that at least irreversible and catastrophic effects on the global ecosystem should be avoided (Rennings 1997).
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a thresholds/ irreversibility below which a region/activity is not sustainable)?	The UNFCCC recommendation is to stabilise greenhouse gas concentration in the atmosphere at a level which would prevent dangerous anthropogenic interferences with the climate system. In order to meet that objective, the overall global annual mean surface temperature increase should not exceed 2° C above pre-industrial levels. Consequently it is necessary to constrain greenhouse gas emissions in such way as to reach this target. The Kyoto Protocol set binding targets for 37 industrialised countries and the European community for reducing greenhouse gas (GHG) emissions. These amount to an average of five per cent against 1990 levels over the five-year period 2008-2012. [UNFCCC] The GHG targets can be expressed either as a percentage change

	reduction in absolute emissions from a base year (as specified by the Kyoto Protocol, 1990) or concentration levels in a specific year.
m. Please describe the key methodological links to highly related indicators (what exactly are the commonalities and differences among these indicators)?	***Air emissions accounts* of Eurostat VS *greenhouse gas emission inventory* compiled by EEA.** The methodology of the UNFCCC for preparing GHG inventories is based on different principles than that of the ESS for accounting air emissions. […] Therefore, most air emissions totals for *air emissions accounts* of the ESS differ from totals in UNFCCC air emissions inventories that do not apply national account concepts. **[Eurostat Quality Profile of GHG Indicator]** • Greenhouse gas emissions by sector (including sinks) [Eurostat] • Greenhouse gas emissions intensity of energy consumption [Eurostat] • Greenhouse gas emissions per capita and per unit of GDP in purchasing power standards [Eurostat] The emissions of different gases are measured. At their simplest, measurements involve only CO_2 emissions. [IEA 2010 CO2 Emissions from Fuel Combustion].
n. What are the key bridging links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP).	This indicator is linked to many other socio-economic and environmental indicators, including energy use per capita and per unit of GDP, primary and final energy use and electricity generation, fuel mix, atmospheric emissions, GDP growth rate, energy consumption, environmental protection expenditures, and expenditures on air pollution abatement. [UN] Total quantities of annual GHG emissions or GHG emissions normalised per unit of energy use could be alternative indicators. This analysis would provide an indication of the trend of increasing or decreasing carbonisation of the energy system. There are a number of other gases resulting from energy use that indirectly produce GHGs, and these could also be included in the scope of the definition.

V. Institutional Analysis	

o. Which institutions are currently using the indicator, and for which purposes?	• UNFCC
	• IPCC
	• UN
	  ○ United Nations Statistics Division Millennium Development Goals Indicators
	  ○ UN Data
	  ○ United Nations Environment Programme (UNEP) Global Environment Outlook (GEO)
	  ○ United Nations Environment Programme/Global Resource Information Database (UNEP/GRID) Arendal
	  ○ Food and Agriculture Organization of the United Nations (FAO)
	• European Environment Agency
	• United States Environmental Protection Agency (USEPA)
	• International Energy Agency (IEA)
	• OECD
	• Eurostat
	• World Bank
	  ○ World Development Indicators (WDI) Online Database
	• The World Meteorological Organization (WMO)
	• Carbon Dioxide Information Analysis Center (CDIAC)
	• International Iron and Steel Institute (IISI)
	• International Aluminium Institute (IAI)
	• International Rice Research Institute (IRRI)
	• World Resources Institute (WRI)
	  ○ World Resources Institute (WRI) Climate Analysis Indicators Tool
	• MNP (Netherlands Environmental Assessment Agency)
	[UNFCCC]

p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	Growing widespread concern for environmental sustainability and climate change impacts.
q. Are there links to international or European laws, conventions or agreements	The 'Climate Action and Renewable Energy' package adopted by the Council on 6 April 2009 underlined the objective of limiting the rise in global average temperature to no more than two degrees Celsius above

(this could range from an explicit legal requirement to a general policy concern)?	preindustrial levels. To achieve this goal, Member States agreed to reduce total EU greenhouse gas emissions by 20 % compared to 1990 levels by 2020. On the one hand, minimising overall reduction costs to meet the 20% objective implies a 21 % reduction in emissions from sectors covered by the EU ETS compared to 2005 by 2020. This is to be achieved via a single EU-wide cap on ETS emissions. On the other hand, it also implies a reduction of 10 % in emissions for sectors outside the EU ETS. All Member States have agreed to country-specific greenhouse gas emission limits in 2020 compared to 2005 for sectors outside the EU ETS (Council Decision 2009/406/EC). **[Eurostat Quality Profile of GHG Indicator]**

Copenhagen Accord:

	Low pledge	High pledge
EU27	-20% (wrt.1990)	-30% (wrt. 1990)
US	-17% (wrt. 2005)	-17% (wrt. 2005)
Russia	-15% (wrt. 1990)	-25% (wrt. 1990)
RoA1	-29% (wrt.2005)	-32% (wrt. 2005)
China	-40% (CO2/GDP by 2020)	-45%(CO2/GDP by 2020)
India	-20% (C/GDP)	-25% (C/GDP)
Brazil	-5,3%(BAU)	-9,4%(BAU)
NonA1_T	-2%(wrt. 2005)	-10,5%(wrt. 2005)

Relevant European legislation:

- Council Decision 2002/358/EC in which Member States agreed that some countries be allowed to increase their emissions, within limits, provided these are off-set by reductions on others and the EU Kyoto target of a reduction of 8% compared to 1990 is achieved by 2008-2012.
- The legal basis for the compilation of the EC inventory is the Decision 280/2004/EC (replacing the Council Decisions 99/296/EC and 93/389/EC) on the monitoring of greenhouse gas emissions in the EU.
- Decision 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments by 2020

The outcome of the COP-15, the Copenhagen Accord, recognises the scientific evidence that an increase in global temperature **below 2 degrees** is required but, does not specify any quantified emission reduction target. The Accord requires to Annex I Parties to submit individual or joint reduction targets and to Non-Annex I Parties to

	communicate their mitigation actions by **January 31, 2010** to the UNFCCC Secretariat.
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ There is a wide scientific consensus that emissions of greenhouse gases are responsible for global warming, with potentially dramatic economic, social and environmental consequences at the global level. +The greenhouse gas emissions indicator is used to track progress in countries' efforts to lower emissions and reach environmental performance objectives. + Measuring the greenhouse gas emissions indicator in conjunction with economic performance indicators such as the gross domestic product (GDP) and waste indicators will help to support national-level decision making on sustainable development. + Sectoral and geographic breakdowns have been used to inform policy development and emissions reduction plans. + Greenhouse gas emissions measurement and forecasts provide a fundamental instrument in setting, improving and evaluating environmental policies (e.g. Cap-and-Trade regulation). - Some sources (Eurostat) do not include emissions and removals related to land use, land-use change and forestry (LULUCF); nor does it include emissions from international aviation and international maritime transport.
IDENTIFICATION OF TRENDS	+ The outcome of the COP-15, the Copenhagen Accord, recognises the scientific evidence that an increase in global temperature below 2 degrees is required and that emission reduction must therefore be informed in order to achieve this result.

	+The annual review process under the UNFCCC and the Kyoto Protocol guarantees the continuous improvement of the quality of greenhouse gas estimates. In addition, an annual internal review mechanism has been established within the EU to improve the quality of the EU's official submission to the UNFCCC. This methodology provides annual complete coverage of GHG emissions and allows assessing environmental policy implications.
FORECASTING AND MODELLING	+ A large number of simulations are available from a broad number of models (including SRES emissions scenarios for the 2000 to 2100 period). [IPCC WG1] + Greenhouse gas emissions forecasts, based on climate models, are fundamental in shaping environmental policies (e.g. Cap-and-Trade regulation). + Clear and transparent definitions of the modeling approaches used are absolutely essential. Particularly important are the assumptions about the time frame in which the models are being applied.
SCOPE/LEVELS OF APPLICATION	+ Annex I Parties submit individual or joint reduction targets and Non-Annex I Parties have to communicate their mitigation actions. + National communications from Parties to the Convention are publicly available.
Accepted	
STAKEHOLDER ACCEPTANCE	+ The GHG emission indicator is accepted as the most important structural indicator of climate change. - There is common agreement about the link between GHG emissions and climate change, but the magnitude of effects are not completely foreseeable. - The GHG emission indicator measures the input of pollutants in the atmosphere, which is clearly country-specific information, but it does not clarify the effective concentration of emissions in a specific region in a determined period, given the dispersion determined by atmospheric flows. - Data might not be available for some sources in some countries.
Credible	
UNAMBIGUOUS	- There is some ambiguity as to which GHG are considered according to different sources, but all institutions consider the main pollutant to be CO_2, CH_4, CFC…

TRANSPARENCY OF THE METHOD	+ Data is collected from reliable sources applying clearly defined and consistent standards with regard to the methodology. + Shortcomings with regard to comparability across countries are well documented.
Easy	
DATA AVAILABILITY	The main institutions involved in the compilation of the EU greenhouse gas inventory are the EU Member States, the European Commission Directorate General for Climate Action (DG CLIMA), the European Environment Agency (EEA) and its European Topic Centre on Air and Climate Change (ETC/ACC),Eurostat, and the Joint Research Centre (JRC). The Climate Change Committee, made up of all EU Member States, assists the European Commission in its tasks under Council Decision No 280/2004/EC. Within the EU inventory system, the EEA and its ETC ACC are responsible for the annual compilation of the EU inventory and for the implementation of the EU QA/QC Programme. The European Commission has overall responsibility – official submission to the UNFCCC on behalf of the EU by 15 April every year. Eurostat is responsible for the IPCC reference approach for CO2 emissions from energy combustion. The JRC is responsible for the chapters related to agriculture and LULUCF.
TECHNICAL FEASIBILITY	+ The same methodologies are used for the base and all subsequent years. + Data is revised and updated for all years to ensure that the same methodology is applied for the whole time series. + Comparability between Annex I Parties is possible and means that estimates of emissions and removals reported in inventories should be comparable among Annex I Parties. + Differences in the methodologies, background activity data or emission factors used in the Member States are documented in the inventory reports.
COMPLEMENTARITY AND INTEGRATION	This indicator is linked to many other socio-economic and environmental indicators, including energy intensity, primary and final energy use and electricity generation, fuel mix, GDP growth rate, environmental protection expenditures, and expenditures on air pollution abatement. [UN] The additional indicators using GHG emission data are: • Greenhouse gas emissions by sector (including sinks) [Eurostat] • Greenhouse gas emissions intensity [Eurostat] • Greenhouse gas emissions per capita [Eurostat] GHG emissions can be complemented also by gas specific indicators (CO2 emissions, CO2 intensity…)
Robust	

DEFENSIBLE THEORY	+ There is a wide scientific consensus that emissions of greenhouse gases are responsible for global warming, with potentially dramatic economic, social and environmental consequences at the global level. + Data is collected from reliable sources, applying high standards with regard to the methodology.
SENSITIVITY	+ Shortcomings with regard to comparability across countries are well documented. + GHG emissions are strictly correlated to the industrial setting of a country (predominance of energy intensive productions, low investment in R&D and clean energy…); this characteristic allows to capture the drawbacks of a not sustainable development.
DATA QUALITY	+ Data can be compared across countries and over time + The same methodologies are used for the base and all subsequent years. + Data is revised and updated every year to ensure that the same methodology is applied for the whole time series. - Data might not be available for some sources in some countries.
RELIABILITY	+ The GHG emission indicator provides some degree of information regarding environmental pressure. - The GHG emission indicator does not measure explicitly how much the climate will be affected by the increased accumulation of GHGs or the consequent effect of climate change on countries.
COMPLETENESS	+ Data is available and reported mainly for developed countries and economies in transition. - There is common agreement about linkage between GHG emissions and climate change, but the magnitude of effects is not completely foreseeable. - This indicator gives information on pollutant trends in the atmosphere but does not specifiythe reasons behind this pattern (a breakdown by sector and gas can be useful).
Summary appraisal	The GHG emission indicator clearly tracks drawbacks of economic activity and then, combined with an economic performance indicator, can be helpful in assessing progress in decoupling these two elements and in combining environmental and economic sustainability. There is common agreement about linkage between GHG emissions and climate change, but the magnitude of effects is not completely foreseeable. This indicator gives information on pollutant trends in the atmosphere but

	does not specify the reasons behind this pattern (a breakdown by sector and gas can be useful). There are no restrictions to the use of this indicator. It is noteworthy however that careful treatment and interpretation of data is necessary when comparing *air emissions accounts* of Eurostat and the *greenhouse gas emission inventory* compiled by EEA. This is due to the fact that the methodology of the UNFCCC for preparing GHG inventories is based on different principles than that of the ESS for accounting air emissions. One of the major differences is that the *air emissions accounts* of ESS cover emissions stemming from national economic activities, i.e. those generated by economic activities of resident units rather than emissions from all sources located on the national territory. Therefore, most air emissions totals for *air emissions accounts* of the ESS differ from totals in UNFCCC air emissions inventories that do not apply national accounts concepts.
VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	The GHG emission indicator helps to inform policy makers on climate change and clean energy as a policy target.
SUSTAINABLE TRANSPORT	The GHG emission indicator helps to inform policy makers on sustainable transport as a policy target.
SUSTAINABLE CONSUMPTION AND PRODUCTION	The GHG emission indicator helps to inform policy makers on sustainable consumption and production as a policy target.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	The GHG emission indicator helps to inform policy makers on the managemnet of natural resources as a policy target.
PUBLIC HEALTH	The GHG emission indicator helps to inform policy makers on public health as a policy target.
SOCIAL INCLUSION, DEMOGRAPHY,AND	The GHG emission indicator does not reflect social inclusion, demography, and migration as a policy target.

MIGRATION	
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	The GHG emission indicator helps to inform policy makers on sustainable development as a policy target.
INVESTMENT IN RESEARCH AND DEVELOPMENT	The GHG emission indicator helps to inform policy makers on investment in R&D as a policy target.
UNEMPLOYMENT RATE	The GHG emission indicator does not reflect unemployment rate
r. How does the indicator help measure progress toward the policy targets (marked'Yes" and "Partially" above)?What are the advantages of using this indicator?	The GHG emissions indicator provides accurate and timely measurements on fundamental aspects of climate change (given the well known link between GHGs, global warming and climate changes); a clean energy indicator can complement the GHG emissions indicator, explaining for example how renewable energies contribute to a cut in the emissions level. The GHG emission indicator gives important information connected to most of the policy here considered. Climate change resulting from carbon and greenhouse gas emissions poses potentially catastrophic risks to human health and threatens to widen health inequalities between developed and developing countries. It is a widely recognised fact that GHG emission cuts will provide health benefits, so this indicator is strategic in informing health policy. Moreover, the level of GHG emissions gives important information on global poverty and inequality of distribution in sustainable development. Despite contributing the least to greenhouse gas emissions, low-income groups will suffer greater exposure to extreme weather risks whilst lacking insurance and other material resources to cope with the effects of climate change. In fact, opportunities for low-carbon living should be equally distributed to reduce vulnerability. The GHG emission indicator has mainly informed transport policy by putting in place a strategy to reduce emissions from cars and vans, including emissions targets for intensity of fuels. Aviation has been included in the EU Emissions Trading System (ETS). Carbon reduction is strictly linked to development in R&D in order to investigate new technologies to reach the goal of a low-carbon society.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes" and'Somewhat", above)?	Whenever GHG emission indicators (for example in the Eurostat database) do not take land use, land use change and forestry (LULUCF) into account, they provide only limited information concerning the conservation and measurement of natural resources. At the moment this indicator is not sensitive to new abatement technologies such as carbon capture and storage.

VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined in a basket with the one in question to address specific policy challenges relevant to the EU policy framework?	The GHG emission indicator combined with gas-specific ones, energy intensity and waste indicators may provide a comprehensive picture of the sustainability of manufacturing, consumption and disposal of products in an economy, thereby measuring holistically its environmental impact and sustainability.
IX. SWOT Analysis	
*u. Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique)	• There is a wide scientific consensus that emissions of greenhouse gases are responsible for global warming, with potentially dramatic economic, social and environmental consequences at the global level. • The GHG emission indicator is accepted as the most important structural indicator of climate change and environmental pressure. It can be helpful in assessing progress in decoupling economic growth and environmental damage, and in conciliating economic and environmental sustainability.
*v. Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	• The greenhouse gas emissions indicator is used to track progress in different countries' efforts to lower emissions and reach environmental performance objectives. • Measuring the greenhouse gas emissions indicator in conjunction with economic performance indicators such as the gross domestic product (GDP) will help to support national-level decision making on sustainable development.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	• The GHG emission indicator does not show how much the climate will be affected by the increased accumulation of GHGs or the consequent effect of climate change on various countries. • Data might not be available for some sources in some countries. • This indicator gives information on pollutant trends in the atmosphere but does not specify the reasons behind this pattern (a breakdown by sector and gas can therefore be useful).
x. Important weaknesses (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	• Concerning the Kyoto target, the indicator does not include emissions and removals related to land use, land-use change and forestry (LULUCF); nor does it include emissions from international aviation and international maritime transport. • Due to different methodologies used, careful treatment and interpretation of data is necessary when comparing air emissions accounts from different sources.
y. Opportunities (This	• GHG emissions indicator may be used together with energy intensity

category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	and waste production and management indicators to provide a more comprehensive picture of the environmental impact of an economy. • They could provide information on the effectiveness of R&D policies in the field of emissions abatement and provide additional information on health indicators and policies.
z. Threats (“Threats” are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	• The acceptance of GHG emissions indicators as measures of sustainability may be hampered by the fact that they do not measure directly the environmental impact of GHG emissions and do not provide a built-in sustainability measure.

6.4.3 Waste

Generation of Industrial and Municipal Solid Waste Generation of hazardous wastes Management of Radioactive Waste.

I. Indicator Summary	
Name of indicator	Generation of Industrial and Municipal Solid Waste. [UN] Municipal waste generation [EEA] Generation of hazardous wastes [UN] Management of Radioactive Waste. [UN]
Indicator category	
II. Background information on the indicator	
a. What is the official definition of the indicator?	The generation of industrial and municipal solid waste is derived from the production of waste on a weight basis at the point of production. The precise definition of what constitutes solid waste is variable, but principally it can be considered that material which has no further useful purpose and is discarded. Solid waste is generally produced in three ways: through the production and consumption of goods and services; through the processing of wastes from these services; and through end-of-pipe control or treatment of emissions. Waste is generally reported by and divided into the following categories: mining and construction wastes, energy production wastes, agricultural wastes, municipal wastes and industrial waste or sludge. [UN] The indicator measures municipal waste generation, expressed in kg per person. Municipal waste refers to waste collected by or on behalf of municipalities; the most substantial part originates from households, but waste from commerce and trade, office buildings, institutions and small businesses is also included. [EEA] The total amount of hazardous wastes generated per year through

	industrial or other waste generating activities, according to the definition of hazardous waste as referred to in the Basel Convention and other related conventions. [UN] Radioactive waste arises from various sources, such as nuclear power generation and other nuclear fuel cycle related activities, radioisotope production and use for applications in medicine, agriculture, industry and research. The indicator provides a measure of both the current status of radioactive waste management at any point in time and the progress made over time towards the overall sustainability of radioactive waste management. [UN]
b. Unit(s) of measurement of the indicator	Tonnes per capita per year. [UN] Kilogramme per person per year, percentage change with respect to a base year. [EEA] Tonnes (European totals are rounded to 10,000 tonnes for confidentiality reasons) [Eurostat] Kg per capita [Eurostat] Metric tonnes or tonnes per unit of Gross Domestic Product (GDP). [UN] A dimensionless indicator ranging from 0 (least sustainable condition) to 100 (most sustainable condition) in increments depending on the progress towards safe storage or disposal. The factor may be calculated for each waste class used by a country, or it may be presented as an average for all waste classes. [UN]
c. What does the indicator seek to measure?	The main purpose is to represent the production of solid waste produced by all types of activity in human settlements. [UN] The amount of waste produced can be seen as an indicator of how efficient and sustainable a society is, particularly in relation to our use of natural resources and waste treatment operations. Municipal waste is currently the best indicator available for describing the general development of waste generation and treatment in European countries. This is because all countries collect data on municipal waste; data coverage for other wastes, for example total waste or household waste, is more limited. Municipal waste constitutes only around 10 % of total waste generated, but because of its complex character and its distribution among many waste generators, environmentally sound management of this waste is complicated. Municipal waste contains many materials for which recycling is environmentally beneficial. [EEA]

	It provides a measure of the extent and type of a country's industrialisation and, in so doing, the nature of its industrial activities including technologies and processes generating hazardous wastes. [UN] The purpose is to represent the progress in managing the various radioactive wastes that arise from the nuclear fuel cycle and/or from nuclear applications. Quantitative information is required to indicate this progress. [UN]
d. Provide a brief history of the indicator. Which organisation or body originally proposed the indicator (and in what year)? Which organisations currently advocate for the indicator's use?	The waste generation indicator first(?) appeared in discussion at the World Summit on Sustainable Development (Johannesburg, 2002). It builds on Agenda 21 and calls for further action to "prevent and minimise waste and maximise reuse, recycling and use of environmentally friendly alternative materials, in order to minimise adverse effects on the environment and improve resource efficiency". The very history of environmental policy in the EU begins with waste policy and therefore with waste generation indicators. The Member States began taking national measures to control and manage waste, which then led to the Waste Framework Directive and the Hazardous Waste Directive, both adopted in 1975, and later to the Waste Shipment Regulation. The Commission's proposal for a European Union strategy for sustainable development also highlights the need to decouple economic growth, the use of resources and the generation of waste. This theme is further developed in the Community's 6th Environmental Action Programme (6EAP). This document sets out a vision for integrating resource, product and waste policies. Since the strategy on waste therefore has to have strong links with the resource strategy, they have been developed and adopted by the Commission together. In order to add precision to the definition of whether a waste is hazardous or not, the Technical Working Group established under the Basel Convention has developed lists of wastes that are hazardous and wastes that are not subject to the Convention as well as an outline of a review procedure for the inclusion, or deletion, of wastes from those lists. These lists were approved at the Fourth Meeting of the Conference of the Parties (UNEP, 1998). [UN] The Radioactive Waste indicator was developed between late 1999 to early 2001 and used from July 2001 to March 2002 to collect radioactive waste information from IAEA Member States The indicator has been used to collect and compile some nationally based information. [UN]
e. What are the known limitations of the indicator?	Solid waste production is expensive to measure at source; thus, consistent and comparable statistics are difficult to obtain. The indicator does not distinguish between toxic and hazardous wastes, and those more benign; nor does it cover waste stored on site. It is often confused with the amount of solid waste disposed, which is measured by recording the weight or volume of waste disposed at the disposal or treatment site. [UN] Waste statistics is part of European waste legislation. As a consequence, waste statistics have to find some way of coping with the

	deficits of the legal definitions, in particular the problem of distinguishing between waste and non-waste. […] Measurement errors might result from the use of imprecise conversion factors. Landfills not yet equipped with weighbridges are still quite a common problem. In such cases the reported figures are usually based on the volume of the collection vehicles and converted by means of average waste densities. [EC report] The problem of defining whether a waste is hazardous or not will, in some cases, cause difficulties in relation to the use of an indicator on hazardous wastes generation. The quantity of the hazardous wastes generated alone may not reflect changes towards a more "sustainable" society. Consideration of the nature of the different kinds of hazardous wastes generated would be a better indicator of sustainable development progress. Availability and accuracy of data represents another limitation of this indicator. Finally, the nature of the waste itself makes it sometimes difficult to use them as indicators because wastes are often mixed and not produced to specifications. Data availability may limit the disaggregation of the indicator to the desired level. Considerable work is often required to disaggregate energy balances into various modes of transportation. Data are available for many developed countries, but, so far, few developing countries are collecting data on hazardous waste generation. The Parties of the Basel Convention are requested to provide data to the Conference of the Parties through the Secretariat of the Convention on a yearly basis. [UN] Data on quantities of radioactive waste produced, by activity category and level of radiation, are difficult to find and often include inconsistent definitions of activity categories, as they relate to a mixture of nuclear wastes generated from all sources (i.e. military, medical, industrial isotope and research activities as well as nuclear power production). Spent fuel reprocessing is the predominant source of high level waste (i.e. waste with high levels of radioactivity), and together. The improper management of radioactive waste can have serious impact on human health and on e environment especially in the long run. The radioactive waste indicator does not capture the long-run consequences on health and environment. Nonetheless, this indicator gives a measure of progress towards reduction in the volume of waste generation quantity..
f. What is the history and status of the methodological development and adoption of the indicator (e.g. major revisions, current efforts, future plans/initiatives)?	Although waste prevention (i.e. reducing the generation of municipal waste) is the most difficult to measure and implement, it is clearly considered the most important goal in the waste sector to pave the way towards sustainable development. Based on the data, it is difficult to imagine that we could achieve a decreasing trend in total waste generation or absolute decoupling of waste generation from economic growth without a structural economic change towards less material intensive branches of industry. The focus should be on the development of waste prevention indicators (able to synthesise all waste management indicators). [EEA quoting OECD] Despite considerable progress, data on waste generation and disposal

	remains sparse in many countries. Further efforts are needed to: • Ensure an appropriate monitoring of waste flows and of related management practices, and their changes over time; • Improve the completeness and international comparability of the data as well as their promtness. More work needs to be done to improve data on industrial and hazardous wastes and to develop indicators that better reflect waste minimisation efforts, and in particular waste prevention measures. The usefulness of indicators derived from material flow accounting should be further explored. [OECD] Eurostat is considering several possible extensions of the indicator: 1. Generation of hazardous waste 2. Total waste incinerated 3. Total waste landfilled 4. Generation of municipal waste 4.1 Indicator for prevention of waste => Consumption trends for selected goods 4.2 Indicator for recycling of waste => Landfill and incineration of municipal waste 5. Generation and disposal of industrial (nonhazardous) waste 6. Designed capacity and actual capacity of waste treatment plants[Eurostat] The methodology has not at present been considered by Parties of the Basel Convention. However, Decision V/14 of the Fifth Meeting of the Conference of the Parties requested the Secretariat of the Convention to explore possibilities of developing indicators on hazardous wastes to facilitate decision-making and report thereon to the Conference of the Parties at its sixth meeting. [UN] Safety assessment of the radiological hazard of radioactive waste disposal is considerably advanced and is used as the basis for regulatory decisions in many countries (the milestones of factors are related to specified regulatory decisions, such as the approval of a disposal facility for operation). [UN]
III. Data	
g. How is the underlying data gathered and by whom?	Generally, data is scattered, may be difficult to obtain, and consists of only rough estimates. Where it is available, data for municipal wastes can be obtained from studies of representative cross-sections of the population. For industrial sources, data on the volume of waste is monitored by waste collection contractors. At the international level, specialised research surveys have been

	conducted by the Settlement Infrastructure and Environment Programme of the United Nations Centre for Human Settlements (UNCHS or Habitat). At the national level, data sources would include ministries responsible for urban affairs and the environment and statistical agencies. [UN] The Member States are free to decide on the data collection methods. The general options are: surveys, administrative sources, statistical estimations or some combination of methods. The Member States describe the sources and methods in the quality report. Member States collect data from administrative sources and in many cases conduct business surveys on waste generation stratified by NACE activity. The survey method and sampling strategy varies from country to country (paper questionnaire, web questionnaire, CATI, etc.). [Eurostat] The Basel Convention's Secretariat requests information from the Parties to the Convention on a yearly basis regarding the amount of hazardous wastes generated at the national level. This information is being introduced in the SBC database, which includes data and information on hazardous waste related issues in accordance with Articles 13 and 16 of the Convention. Other agencies, such as OECD, are also collecting information on hazardous wastes generated by OECD countries. [UN] At the national level, the volume or masses of radioactive waste occurring can be obtained from the waste accountancy records maintained by the various waste generators or, in consolidated form, from either national waste management organisations or regulatory bodies. Almost one third of the IAEA member states keep some type of national radioactive waste registry. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management requires contracting parties to report an inventory of radioactive waste that is subject to the Convention. Through this mechanism, both the availability and the quality of data are likely to increase over time. [UN]
h. How accurate are the results (e.g. is the result an estimate, are there data gaps, imputations, assumptions, etc)?	Because of different definitions of the concept of municipal waste and the fact that some countries have reported data on municipal waste and others on household waste data in general cannot be compared between Member Countries.household waste data are in general not comparable between member countries. […] If no data are available for a certain country and year, estimations are made by the Topic Centre to fill the gap.[…] The term, "waste from household and commercial activities" is an attempt to identify common and comparable parts of municipal waste. [EEA] Eurostat validates national data is in cooperation with the Member States. All data are approved by the Member States unless the value is indicated

	as Eurostat estimate. [Eurostat] Assistance to developing countries will be needed in identifying the main hazardous waste streams being generated in their countries in order to prepare and maintain inventories of hazardous wastes. In this connection difficulties may be encountered in relation to hazardous waste generation by small scale enterprises, since they are scattered and often operating on an informal basis and are therefore not registered. It may be less of a problem to identify amounts of hazardous waste generated by larger industries, since they are normally registered. [UN]
i. How often is the indicator recalculated/released? Have there already been any major indicator revisions?	Every two years [Eurostat] Yearly [UN] Almost one third of the IAEA member states compiles national radioactive waste registry yearly.
IV. Link to sustainable development	
j. Is there an operational definition of sustainability 'built-in" to the methodology?	Waste represents an enormous loss of resources in the form of both materials and energy. The amount of waste produced can be seen as an indicator of how efficient a society is, particularly in relation to the use of natural resources and waste treatment operations. Municipal waste is currently the best indicator available for describing the general development of waste generation and treatment in European countries. Sound and efficient use of natural resources is an important part of sustainable development. In fact, the treatment and disposal of waste generated may cause environmental pollution and expose humans to harmful substances and bacteria and therefore have an impact on human health. Waste generation is intimately linked to the level of economic activity in a country. It reflects society's production and consumption patterns, with wealthier economies tending to produce more waste. In many developed countries, a reduction in the volume of waste generated is an indication of a development towards less material-intensive production and consumption patterns, particularly as the economy moves from a heavy industry base to a more service base. The generation of hazardous wastes has a direct impact on health and the environment. Normally, long-term exposure is required before harmful effects are seen. Reduced generation of hazardous wastes may indicate either reduced industrial activities in a country, introduction of cleaner production in the industrial processes, changing patterns in consumers' habits, or changes in national legistlation on hazardous waste. Generation of waste is only the starting point in judging the efficiency and effectiveness of waste management. For radioactive waste, a dimensionless indicator ranging from 0 (least sustainable condition) to 100 (most sustainable condition) in increments depending on progress towards safe storage or disposal. [UN]

	Radioactive waste, if not properly managed, can have a direct impact on health and the environment through exposure to ionising radiation. In order to protect human health and the environment, appropriate waste management strategies and technologies must be employed. Fundamental principles of radioactive waste management as well as activities such as minimisation of waste produced involve systematically considering the various steps in treatment, conditioning, storage and disposal. Effective management of waste (control of inventory) has a positive impact on sustainability as it reduces the pressure on the environment and the commitment of resources.
k. If yes, does the indicator measure “strong” or “weak” sustainability?	Sound and efficient use of natural resources is an important part of sustainable development. All the three indicators measure “strong” sustainability.
l. Does the approach have numerical value(s) assigned to sustainability (e.g. a threshold/ irreversibility below which a region/activity is not sustainable)?	An important objective of EU policy is to decouple waste generation from economic growth. The evidence shows that for Municipal Solid Waste generation, which is around 10 % of the total waste generated in the EU, levels have stabilised since 2000 at a high level of 520 kg/capita, despite the economic growth. However, the objective of reducing waste generation has not yet been achieved for Municipal Solid Waste. [Waste Framework Directive (2008/98/EC) and the 6th Environmental Action Programme (EAP)] No quantitative targets exist at the international level. In Agenda 21, Chapter 20, an overall target of "preventing or minimizing the generation of hazardous wastes as part of an overall integrated cleaner production approach" is provided. Targets exist at the national level in many countries. [UN] The International Atomic Energy Agency (IAEA) has established Safety Standards, Fundamentals, Requirements and Guides [Ref 2 - 4] applicable to the management of radioactive wastes. It has also established Basic Safety Standards for the Protection of Humans against Ionizing Radiation [Ref 5], that are consistent with recommendations of the International Commission on Radiological Protection (Ref 6,7). [UN]
m. key methodological links to highly related indicators (I.e. what exactly are the commonalities and differences among these indicators)?	This indicator is linked with and needs to be complemented with more detailed information on the typology of waste, structure of recycled and landfilled waste or waste used in energy production. One important side effect of waste management is GHG emissions (especially CH_4). Effects on water and air quality; effects on land use and soil quality; toxic contamination indicators[OECD] This indicator is linked to the amount of hazardous wastes exported or imported as well as to the indicators on area of land contaminated by hazardous wastes and expenditures on hazardous waste treatment or disposal. It is furthermore directly connected to indicators related to material consumption and energy use, including intensity of material use,

	annual energy consumption per capita, and intensity in energy use. In a wider context, it is also related to the indicators on international cooperation concerning implementation of ratified global agreements. [UN]
n. What are the key bridging links to other dimensions of sustainability (environmental, social, economic) and are there any explicit hybrid measures incorporating multiple dimensions in a single metric (e.g. GHG intensity—GHG emissions per unit of GDP)?	This indicator is intimately linked to other socio-economic and environmental indicators, especially those related to income level and economic growth. These include rate of growth of urban population, Gross Domestic Product (GDP) per capita, waste disposal, and waste recycling. [UN] The generation of waste is attributed to either production or consumption activities. The actor handing the waste over to the waste management system is regarded as the source. For production activities, a further breakdown is supplied through a classification into 19 economic activities by the NACE rev. 2. Three of these activities are linked to waste management and contain secondary waste: waste collection, treatment and disposal activities; materials recovery (division 38), remediation activities and other waste management services (division 39); and wholesale of waste and scrap (class 46.77). Waste is generated by both businesses and households. [Eurostat] This indicator is linked to the amount of hazardous wastes exported or imported; as well as to the indicators on area of land contaminated by hazardous wastes, and expenditures on hazardous waste treatment or disposal. It is furthermore directly connected to indicators related to material consumption and energy use, including intensity of material use, annual energy consumption per capita, and intensity in energy use. In a wider context, it is also related to the indicators on international cooperation concerning implementation of ratified global agreements. [UN] A large portion of radioactive waste arises from practices within the nuclear fuel cycle; therefore major current waste sources are related to a significant generation of electricity by nuclear means with an equivalent reduction of environmental impacts by other energy sources (Chapter 4 of Agenda 21). This implies a reduction in the release of atmospheric pollutants, notably greenhouse gases, which would contribute to the protection of the atmosphere (Chapter 9 of Agenda 21) [UN]
V. Institutional Analysis	
o. Which institutions are currently using the indicator, and for which purposes?	The United Nations Centre for Human Settlements (Habitat) […] United Nations Environment Programme (UNEP), the World Bank, the World Health Organization (WHO), the Organisation for Economic Co-operation and Development (OECD), and Eurostat are involved in the development of this indicator. [UN] United Nations Environment Programme (UNEP). UNEP, ICRED, OECD, European Topic Centre for Wastes, Denmark, US Environmental

	Protection Agency, Institute for Applied Environmental Economics, the Netherlands, European Institute of Business Administration, France, Technical University, Graz, Austria, Wuppertal Institute, CEFIC, Netherlands National Institute of Public Health and Environment, Canada. Additional organisations with expertise in the domain of hazardous waste generation are: UN-ECE (Transport); IMO (Maritime); FAO (Pesticides); WHO; ILO; IAEA; UNIDO, SPREP. [UN] Governments and inter-governmental organisations, possibly the European Commission (EC), the OECD/NEA, the United Nations Environment Programme (UNEP), non-governmental and other organisations such as the International Union of Producers and Distributors of Electrical Energy (UNIPEDE) and the Electric Power Research Institute (EPRI). [UN]
p. What are the driving forces and characteristics that affect institutional adoption (consider this question from the perspectives of political science, sociology and political economy)?	"If there is one environmental policy field where the need for indicators as tools for monitoring is particularly significant, this is the waste field. Possibly no other environmental issue has such a strong and relevant 'management' side as waste and no other has the same impact on the everyday life of consumers and producers. Although the relevance of the waste theme is unchallenged, from a statistical perspective there are weaknesses which result in an incomplete information picture, and which prevent the establishment of indicators that could provide powerful and comprehensive signals." [EC report]
q. Are there links to international or European laws, conventions or agreements? This could range from an explicit legal requirement to a general policy concern?	No international agreements exist for a reduction in solid waste production. However, some countries have set national targets for the reduction of solid waste within a specified time frame. [UN] All international and European agreements are more concentrated on waste management than on total amount of waste generation: • 6th Community Environment Action Programme • Commission Communication COM(2005) 666 "Taking sustainable use of resources forward: A Thematic Strategy on the prevention and recycling of waste" • Waste Framework Directive (2008/98/EC) • Directive on the landfill of waste (1999/31/EC) [EEA] Data on municipal waste were collected via the Eurostat / OECD Joint Questionnaire. Data are currently provided under a so-called gentlemen's agreement. [Eurostat] The following conventions and agreements pertain to this indicator: *Basel Convention* on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; *Bamako Convention* on the Ban on the Import into Africa and the Control of Transboundary Movement of Hazardous Wastes within Africa; *Waigani Convention* to Ban the Importation of Hazardous and Radioactive Wastes into Forum Island Countries, and to

	Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region; *Central American Agreement*; Protocol for the *Prevention of Pollution of the Mediterranean Sea* by Transboundary Movements of Hazardous Wastes and Their Disposal; *Organisation for Economic Co-operation and Development (OECD), Council Decisions,* and *EC Council Directives* and Regulation on Waste and Hazardous Wastes. [UN] The Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management [Ref 1] entered into force June 2001. This convention binds contracting parties to manage spent nuclear fuel and radioactive wastes using sustainable waste management practices [UN].
VI. RACER Analysis	
Criteria and Sub-criteria	**Analysis**
Relevant	
POLICY SUPPORT	+ The waste generation indicator is needed to implement waste prevention policies, an important component of sustainable development. This indicator tracks the overall amount of waste at the source and, complemented with other indicators on waste management, enables decision-makers to judge the effectiveness of the process. + Waste production is regulated by European waste legislation (namely the 6th Community Environment Action Programme, the Commission Communication COM(2005) 666, the Waste Framework Directive (2008/98/EC) and the Directive on the landfill of waste (1999/31/EC.) + Indicators of hazardous and nuclear waste provide information on how waste is managed and to what extent it poses a threat to the environment, thereby shaping policies on safe and sustainable waste management. + Amount of waste generated and its management is extremely relevant for measuring the extent of environmental pressure. Waste production and disposal has a substantial impact on the everyday life of consumers and producers.
IDENTIFICATION OF TRENDS	+ Changes in quantities of municipal, industrial and hazardous waste should be comparable over time, thereby measuring trends.

	- The nuclear waste indicator measures progress towards sustainable management and disposal of radioactive waste but does not allow for historic comparisons as such.
FORECASTING AND MODELLING	+ Forecast of waste indicators has been envisaged by Eurostat to overcome the present data limitations for waste. - The indicator may differ on the definition of waste (whether it is hazardous or not), which may undermine time and cross-country comparisons.
SCOPE/LEVELS OF APPLICATION	Municipal and industrial waste generated from households is measured at the international, national and local level,. Waste from commerce and trade, office buildings, institutions and small businesses is also included.
Accepted	
STAKEHOLDER ACCEPTANCE	International waste measurements are sanctioned by EU legislation. Several (more or less explicit or binding) national and regional commitments exist to measure trends in waste production and disposal.
Credible	
UNAMBIGUOUS	-There are some ambiguities regarding the measurement target and quantities involved in the case of municipal and industrial waste. There are many differences depending on the composition of waste: time necessary to transform them, space taken up for the same weight and future disposition (recycle, re-use or landfill). -There are different definitions of what constitutes hazardous waste.
TRANSPARENCY OF THE METHOD	+ International institutions (eg. EEA, IAEA) strive to develop measurements and reporting frameworks for member countries.
Easy	

DATA AVAILABILITY	+Data for municipal and industrial waste is often self-reported by local authorities. -The coverage of these data is not always exhaustive (illegal dumping phenomenon). +Member States collect data from administrative sources and in many cases conduct business surveys on waste generation stratified by NACE. -Compliance to measurement standards may be difficult to verify. -Many developed countries collect data on hazardous waste, but few developing countries do. -The Member States are free to decide on the data collection methods (surveys, administrative sources, statistical estimations). The survey method and sampling strategy varies from country to country.
TECHNICAL FEASIBILITY	+ For nuclear waste, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management requires Contracting Parties to report an inventory of radioactive waste that is subject to the Convention. Through this mechanism, both the availability and the quality of data are likely to increase over time. -The nature of the waste itself makes it sometimes difficult to use data as indicator because wastes are often mixed and statistics do not reflect that diversity.
COMPLEMENTARITY AND INTEGRATION	+ The waste generation indicator must be complemented with additional detail on waste typology, amount of recycled, incinerated and landfilled waste, waste to energy, and emissions from landfill. The composition and treatment of waste is fundamental in assessing possible harmful effects, space necessary for storage and effectiveness of the entire process. + Eurostat suggests several improvements on the indicator based on the relation between waste and economic activity: 1. Waste flows connected with household incomes or 2. Waste flows connected with consumption level by goods category, 3. Incentives for establishing a market of waste materials, 4. Product life cycle analysis (waste per product) 5. Trade of wastes (export and import) 6. Environmental impacts of waste generation & treatment (emissions to groundwater and air, contaminated soil, etc.)
Robust	

DEFENSIBLE THEORY	+Waste indicators are backed by an accounting methodology developed by international institutions and accepted at the national level. + There is widespread recognition of the need for indicators as tools for monitoring waste in the environmental policy field. - It must be complemented with indicators on waste management, which are the main objective of the current policy targets.
SENSITIVITY	-Measurements of municipal and industrial waste are vulnerable to the lack of standardised methodologies and measurement practices. - Data availability, especially at the local level, is limited and of variable quality. - There is limited scope for cross-time and cross-country comparison.
DATA QUALITY	-For municipal waste, data is scattered, may be difficult to obtain, and consists of only rough estimates. -Where it is available, data for municipal waste can be obtained from studies of representative cross-sections of the population. +For industrial sources, data on the volume of waste is monitored by waste collection contractors.
RELIABILITY	-Data is in some cases based on rough estimates, the necessary improvements in data collection will therefore lead to inevitable revisions of time series.
COMPLETENESS	+Waste generation is far from being a compete indicator, but it is the starting point in calculating all waste management indicators.
Summary appraisal	Although waste indicators are known to provide essential information concerning sustainability, they still provide only an incomplete, somewhat narrow and difficult-to-compare picture of waste production and disposal.

VII. Supplemental RACER policy analysis	
Policy Target	**Does the indicator reflect this target?**
CLIMATE CHANGE AND CLEAN ENERGY	Waste indicators help to inform policy makers on climate change and clean energy as a policy target.
SUSTAINABLE TRANSPORT	Waste indicators do not help to inform policy makers on sustainable transport as a policy target.
SUSTAINABLE CONSUMPTION AND PRODUCTION	Waste indicators help to inform policy makers on sustainable consumption and production as a policy target.
CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES	Waste indicators help to inform policy makers on the conservation and management of natural resources as a policy target.
PUBLIC HEALTH	Waste indicators help to inform policy makers on public health as a policy target.
SOCIALINCLUSION, DEMOGRAPHY, AND MIGRATION	Waste indicators do not help to inform policy makers on social inclusion, demography and migration as a policy target.
GLOBAL POVERTY AND SUSTAINABLE DEVELOPMENT CHALLENGES	Waste indicators help to inform policy makers on global poverty and sustainable development challenges as a policy target.
INVESTMENT IN RESEARCH AND DEVELOPMENT	Waste indicators do not to help to inform policy makers on investment in research and development as a policy target.
UNEMPLOYMENT RATE	Waste indicators do not to help to inform policy makers on unemployment rate as a policy target.

r. How does the indicator help measure progress toward the policy targets? (marked 'Yes" and "Partially" above) What are the advantages of using this indicator?	The reduction of waste generation can be informative for resource use reduction policy. The link between waste and climate change is due to CH4 emission generation during the process of decomposition of waste; this gas is more than 20 times as potent as CO_2. Municipal and industrial waste indicators are closely related to household consumption patterns and industrial production processes because they account for the quantity of materials and natural resources used. In particular waste generation can inform health and climate policy. Hazardous waste indicators are an indirect signal of exposure to harmful chemicals. Waste generation is an indicator of pressure of population growth and population concentration in cities.
s. What are the most important pitfalls of using this indicator as a measure of progress to the policy targets (marked 'Yes" and 'Somewhat", above)?	Sheer amounts of waste generated and disposed provide only partial information concerning the sustainability of waste management. In particular, it is only an indirect indicator of environmental impact, not looking at the final disposition but only at the generation.
VIII. Potential Links with Other Indicators (further detail to be collected in the 'basket analysis')	
t. What other indicators could be combined with the one in question to address specific policy challenges relevant to the EU policy framework?	Waste management indicators may provide a comprehensive picture of the sustainability of manufacturing, consumption and disposal of products in an economy, thereby measuring holistically its environmental impact and sustainability. Life cycle analysis can give important information on consumption patterns and on their sustainability. The CH_4 emissions indicator is also useful in assessing sectoral contributions to global warming. Indicators related to pollution levels and deriving health effects can help promote an efficient and effective waste management.
IX. SWOT Analysis	
*u. Core strengths (*Core strengths are the strongest aspects and main advantages of the indicator that may be unique to the indicator in question.)	Given the increasing population growth and the spreading of mass consumption, it is vital to curb waste amounts and to manage them in a sustainable way. Waste production focuses explicitly on environmental pressures and to what extent it poses a threat to the environment, thereby shaping policies on safe and sustainable waste management

v. *Important strengths (*Important strengths are those strengths that are highly significant but that may be shared with a host of other indicators.)	Waste production is an essential component of sustainable development from an environmental and social perspective. Such indicators are sanctioned by EU legislation and are involved in formal and informal targets of national and regional waste policies. The waste indicator has a built-in measure of sustainability and gives a measure of progress towards reduction of waste i volume that could impact health and the environment.
w. *Critical weaknesses* (Critical weaknesses are any weaknesses that may preclude implementing the indicator at an EU level. Unless a critical weakness is fixed, it is inadvisable or impractical to use the indicator at the national or EU level.)	The municipal and industrial waste indicator does not distinguish between toxic, hazardous and more benign wastes. Solid waste production is expensive to measure at source; thus, consistent and comparable statistics are difficult to obtain. These data are not always completely representative of the actual state of waste (illegal dumping phenomenon). As far as the hazardous waste indicator is concerned, the quantity of the hazardous wastes generated alone may not reflect changes towards a more "sustainable" society. The nature of the waste itself makes it sometimes difficult to use the amounts of hazardous waste as indicators because wastes are often mixed and statistics do not reflect that diversity. Availability and accuracy of data represents another limitation of this indicator. Finally, the management of radioactive waste is only a first approximation of its hazard. It is implicitly assumed that only improperly managed waste can have an impact on human health and the environment.
x. *Important weaknesses* (Important weaknesses, in contrast, limit the usefulness of the indicator in question but do not wholly prevent the indicator from being implemented as an EU policy tool.)	Waste generation is only an indirect indicator of environmental impact, not looking at the final disposition but only at the generation. For hazardous waste, data availability may limit the disaggregation of the indicator to the desired level. Data are available for many developed countries, but, so far, few developing countries are collecting data on hazardous waste.
y. *Opportunities* (This category of the SWOT analysis lists the most important opportunities that could help improve the indicator or that could help guide successful implementation of the indicator.)	The waste generation indicator must be complemented with additional information such as waste typology, amount of recycled, incinerated and landfilled waste, waste to energy and emissions from landfills. The composition and treatment of waste is fundamental in assessing possible harmful effects, space necessary for storage and effectiveness of the whole process. Several extensions and complementary analyses have been suggested by Eurostat relating to various aspects of waste production and treatment. These include: 1. Waste flows connected with household incomes 2. Waste flows connected with consumption level by goods category 3. Incentives for establishing a market of waste materials 4. Product life cycle analysis (waste per product) 5. Trade of wastes (export and import) 6. Environmental impacts of waste generation & treatment (emissions to

	groundwater and air, contaminated soil, etc.) The sustainability of waste production, storage and disposal may be measured directly (as is the case for nuclear waste), by comparing actual processes to best practices and benchmark levels. Likewise, considerations of the nature of the different kinds of hazardous wastes generated would be a better indicator of sustainable development progress.
z. *Threats* ("Threats" are institutional, political, intellectual, and technological environments that could most likely act as barriers in the future to successful adoption of the indicator.)	In developing countries, economic development is usually coupled with an increasing amount of pollution and of waste generation; this pattern continues until a maximum point after which the decoupling between economic wellbeing and environmental damage begins (environmental Kuznet curve). The lack of decoupling, in developing countries, can be a disincentive to use waste indicators for sustainable development. Moreover, obtaining high-quality measurements hinges crucially on the full cooperation of national statistical agencies. These may be unable or unwilling to comply with standardised measurement standards, at least in the short term.

6.4.4 Basket of resource indicators

The following evaluation was carried out under the project "Potential of the Ecological Footprint for monitoring environmental impacts from natural resource use" (Best, Giljum et al., 2008):

Criteria and Subcriteria	Analysis
Relevant	
Policy support, identification of targets and gaps	The basket of tools/indicators is based on the objectives of the Resource Strategy and the key policy priorities stated in other related environmental and sustainability policy documents (such as the 6th EAP and the EU SDS). All four tools/indicators suggested for inclusion in the basket allow for monitoring of past trends of different types of impacts related to resource use. Different aspects of strategic environmental policy-making are supported by the basket of tools/indicators. The Footprint highlights those consumption areas (in particular fossil energy consumption), which cause environmental pressures beyond the carrying capacity of local or global ecosystems. EMC allows for the identification of those natural resources with the most severe impacts on climate change and on pollution-related and health impacts. HANPP and LEAC enable one to identify the geographical areas with the highest pressures on land area, ecosystems and, indirectly, on biodiversity. LEAC in addition allows establishing links between socio-economic pressures on land areas (e.g. expansion of commercial areas). In terms of target setting, the Footprint is the only indicator which itself sets a reduction target by comparing Footprint against biocapacity. All other indicators require an external setting of (policy) targets. In terms of target setting, the ecological footprint is the only indicator which sets a reduction target endogenously from the structure of the (Footprint and biocapacity) accounts. All other indicators require setting (policy) targets external to the method. All four methods allow for quantification of these gaps, whether the target can be derived directly from the accounts (Footprint) or is externally defined (EMC, HANPP, LUA). On the global level, the Footprint terms this gap "overshoot", defined as the gap between the current annual use of biocapacity and the available supply by ecosystems. Targets can also be defined for the other tools/indicators, and gaps can be quantified. Targets for extensification of the use of natural systems (e.g. through reforms in agricultural policies) can be monitored with HANPP. Targets for land cover change within a given territory (e.g. maximum annual level of increase in developed land) can be monitored quantitatively with LEAC. The basket is relatively weak in terms of early warning messages for policy makers, as all four indicators are outcome measures. In other words, they are designed to document past and current occurrences rather than predict the likely future impacts. The Footprint illustrates human pressures that could lead to degradation of natural capital (e.g. reduced quality of land or reduced biodiversity), but does not predict this degradation. Current high HANPP, i.e., an intensive harvesting of ecosystems, could be seen as a proxy measure for issues such as degradation. Also, overshoot, as measured by the Footprint, indicates that somewhere ecosystems are being degraded or ecological assets liquidated, with

Criteria and Subcriteria	Analysis
	detrimental implications for future productivity. For this criterion, it is important to note that either all tools/indicators in the basket can be applied on an aggregated level (e.g. total Footprint, overall EMC) or selected parts of the underlying accounts can be extracted to monitor more specific changes (carbon Footprint, GHG component of EMC, etc.). The more detailed sub-accounts and derived sub-indicators are more appropriate to monitor short-term changes and to evaluate the effectiveness of policies.
Identification of trends	Time series are available for most tools/indicators in the basket. Footprint time series are currently available for the period from 1961 to 2003 for over 150 countries. Estimations of HANPP for certain areas go back as far as to the year 1700. LEAC data are available for a time series from around 1990 to around 2000 for most of the 24 countries currently included in the data base. EMC is the only indicator which so far has only been calculated for one year (around 2000) but could be transformed into a time series, as material consumption data becomes available. Changes in used LCA factors over time, however, would need to be tested and, if necessary, adapted.
Forecasting and modelling	The tools/indicators in the basket are outcome measures and have all been designed to monitor past developments, so the predictive strength of the methodologies as such is limited. Outcome measures are a powerful base for understanding future possibilities. The measures of this basket have predictive power similar to financial accounts that can help assess the financial health of an organisation and its potential for bankruptcy. In addition, some broad scenarios for future developments of the Footprint have been included in the latest Living Planet Report (2006). Only very few studies on HANPP and LUA exist, which provide future land cover change scenarios. EMC has not been predicted for the future. However, methods could be linked to predictive economic models to address these questions. As explained above, the basket is relatively weak in terms of early warning messages but provides a basis for identifying future threats.
Scope/levels of application	Footprint and EMC are indicators mainly applied on the national level. Regional/city Footprints have been calculated in pilot studies, but standards for making assessments more comparable have only existed since June 2006 (www.footprintstandards.org). EMC has only been calculated for the national level. On the other hand, HANPP and LEAC are strictly local analyses and are based on very

Criteria and Subcriteria	Analysis
	detailed geographical information and work with grids of a magnitude of a few km² or even lower. Therefore, for land-use related tools in the basket, local information is available. For EMC and Footprint, one would find business-oriented applications for a variety of uses: from production and product use analysis, to plant performance, supply chain analysis, etc. More standardised methods for businesses are currently under development for the updated Footprint standards. EF data has also been linked to industries (in the format of input-output tables) in some pilot studies. EMC has only been compiled on the macro level. HANPP does not consider industries as a separate category, as its focus is on the appropriation of biomass, in particular in agricultural and forestry systems. LEAC does provide land cover and land use data, but only on a very aggregated level (e.g. one category for industrial/commercial sites).
Function- and needs related analysis	This aspect is only partly covered by the basket. The Footprint can illustrate trade-offs between different human needs, e.g. with regard to bioproductive land appropriated for different purposes (e.g. food versus biofuels production). With EMC as a score card approach, which aggregates different sub-components, which cannot directly be compared, such trade-offs cannot be analysed. LUA can show changes in land use functions for different types of land cover. If land use data were combined with economic data, it could also show impacts on land cover and land use from alternative ways to fulfil specific needs.
Accepted	
Stakeholder acceptance	Among the four tools/indicators in the basket, LEAC is probably the most widely accepted and least contested approach, providing a detailed data base on land cover (change), which can be used for a range of analyses. The Footprint is widely accepted as a communication and education tool and is widely published in academic literature. Yet it is less accepted as a headline indicator in official indicator sets, although the governments of several countries have or are exploring the validity of the Footprint accounts for their respective countries. Furthermore, work is ongoing to strengthen the scientific basis of the Footprint. HANPP is widely accepted in the academic community but has not been considered in indicator sets on the European level so far. Stakeholder acceptance of EMC cannot yet be judged, as only one study exists so far.
Credible	

Criteria and Subcriteria	Analysis
Unambiguous	With regard to the negative environmental impacts related to natural resource use, the basket provides a clear message. It can be expected that messages derived from one tool will be reinforced by other tools (e.g. if the carbon Footprint is the fastest growing part of the overall Footprint, this trend would also be identified by the GHG sub-indicator of EMC). The tools in the basket allow or all impact categories to be covered, with the most significant gap being the missing explicit link to ecosystem quality and biodiversity. However, further methodological improvements are needed in order to make the tools/indicators more robust (see separate chapter "research agenda" in the final report). The basket provides a wide range of information, which allows clear conclusions for political action to be drawn: the basket provides information about the main consumption areas driving overshoot beyond carrying capacity, identifies those resource flows contributing most to negative environmental impacts and establishes a clear link between resource use and land cover/land use. However, one weak point is that the explicit link to specific sectors is rather tenuous, as most indicators are designed for application at the macro level. This decreases the potential of the basket to provide clear policy action on the sectoral level. Most of the different tools and indicators in the basket can be easily communicated to and interpreted by the public. HANPP and LEAC are illustrated via maps, which can easily be understood by non-experts as well. The Footprint is well known as a visual tool very well suited to communicate the general ideas of environmental sustainability and limited carrying capacity. For EMC, results so far have been presented in graphs and illustrations; for this tool, there is potential to better visualise the results for this indicator.
Transparency of the method	Detailed methodological descriptions are available for all of the four tools/indicators in the basket, although expert knowledge is required to judge the quality of the underlying data and data conversions undertaken to calculate the indicators.
Easy	
Data availability	Data availability is very good for LEAC, where data sets can be obtained from the EEA website. Also, aggregated Footprint data is freely available through the Global Footprint Network, and detailed national accounts for all countries can be purchased. Availability of HANPP data is more limited, but some data sets (e.g. data sets on HANPP by product and country) are freely available. Detailed data on the results of the EMC calculations have also been published in corresponding reports, but the basic data to calculate EMC (in particular, the LCA factors) are not freely available.

Criteria and Subcriteria	Analysis
Technical feasibility	Calculation methodologies are clearly defined for all four tools in the basket. However, application of the methods requires expert knowledge, e.g. on LCA, on geographic information systems or on the conversion of consumption data into corresponding areas of global productivity (Footprint accounts).
Complementarity and integration	Only those tools were selected for the basket, which best complement each other in monitoring environmental impacts. Further integration is possible in particular with regard to underlying basic data. LEAC data could be one key input to calculate HANPP in European ecosystems. Both EF and EMC are to a large extent based on material flow data on the national level, so the establishment of a common and harmonised data base of material flows would be one important step towards integration. The Footprint (and to a less extent, EMC) also covers the environmental impact dimension outside of the country – a significant component – since more than half of Europe's demand on ecosystems is provided by ecosystems outside of Europe.
Robust	
Defensible theory	The tools and indicators selected for the basket contain several types of approaches. The basket includes accounts based on one single unit (land cover in the case of LEAC), approaches with a specific research question (Ecological Footprint, HANPP) and one approach which combines various indicators into a single aggregated index (EMC). No score-card approaches (apart from EMC) were selected for the basket, which are less defensible from a theoretical point of view than accounting-oriented approaches (EMC is somehow an exception to this rule since it is a hybrid between the score card and accounting approaches: it covers a broad dimension of issues. Pure accounting is therefore not possible) Overall, therefore, the defensibility of the theories of the approaches selected in the basket is high.
Sensitivity	Again with this criterion, a main distinction must be made regarding the aggregated indicator versus the more detailed underlying accounts. While the sensitivity of the aggregated indicators (total Footprint, overall EMC) will not be sufficient to reflect short-term policy changes, the more detailed underlying accounts will react more sensitively to policy changes. This is similar to the GDP, which moves little from year to year, while aspects of the accounts can shift widely due to policy shifts.

Criteria and Subcriteria	Analysis
Data quality	Data quality can be rated as good, although differences between the four indicators of the basket can be observed. LEAC data quality can be regarded as reliable, although quality differs between countries. Estimations on the potential NPP of different ecosystems can differ considerably according to different assumptions and reveal different results for HANPP. Most parts of the Footprint accounts have good data quality and are standardised across countries, but improvements are still needed in some areas (e.g. embodied energy of traded products).
Reliability	Reliability of the methodologies and generated results can in general be regarded as good. Clear specifications of the procedures applied to arrive at the results exist for all four tools. However, parts of the calculation methodologies are still under discussion. Progress has been undertaken with the Footprint, for which a Standard Committee has been established to produce international and transparent standards for Footprint accounting. A National Footprint Accounting Committee is also guiding the methodological development of the national Footprint assessments. With regard to HANPP, different approaches still exist alongside how to estimate NPP potentials and to assess current NPP appropriation. Application of different assumptions may lead to significantly different results of HANPP. The reliability of EMC results depends largely on the applied LCA factors and on the weight placed on various categories of environmental impacts.
Completeness	This criterion is fully fulfilled by the basket as a whole, with single components covering specific objectives. The basket is complete in terms of environmental impact categories covered. It allows shift of burdens from one environmental category to another to be illustrated (e.g. increased production of biofuels will improve the performance with regard to GHG emissions but will increase competition between different demands on land). Footprint and EMC include trade flows and can thus illustrate possible shifting of environmental burdens from one country/region to another. However, in particular in this regard, improvements are required to more accurately assess embodied resources and energy flows in trade.

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8 Technical Annex: RACER Criteria and Subcriteria

The following lists the RACER analysis sub-criteria developed by Ecologic to fine-tune the indicator assessment.

Relevant

Policy support, identification of targets and gaps

Does the indicator/methodology…

- Relate to existing EU-specific policy objectives?
- Provide guidance in monitoring, strategic policy making and/or target setting?
- Identify gaps between the current situation and specified targets?
- Offer adequate and early warning to guide policy action?
- React to short-term changes that can (among other things) show whether policies are having an effect?

Identification of trends

Does the indicator/methodology…

- Track change over time?

Forecasting and modelling

Does/Is the indicator/methodology…

- Allow for forecasting of future environmental impacts?
- suitable for modelling of the impact of different potential policies or of technology progress and/or change of consumption patterns?
- function as an early warning indicator?

Scope/levels of application

Does/Is the indicator/methodology…

- Provide information on the effective levels of application (e.g., local, national, international)?
- disaggregated (spatially, by product, by industry or by ecosystem type)?

Function and needs-related analysis

Does the indicator/methodology…

- Permit comparisons among material and energy resources in terms of their functions and competition in the real world?

- Permit comparisons between different ways of fulfilling basic human needs (housing, mobility, food, etc.) with regard to their resource-use implications?

Accepted

Stakeholder acceptance

Does the indicator/methodology…

- have an underlying rationale and meaning that is easily understood and accepted?

Credible

Unambiguous

Does the indicator/methodology…

- send an unambiguous message to political decision-makers and the general public?

Transparency of the method

Does the indicator/methodology…

- Fully disclose the underlying data and calculation methods and is it interpretable and reproducible?

Easy

Data availability

Does the indicator/methodology…

- Not require data inputs that are excessive, too expensive or onerous to collect, or that cannot be properly measured?

- Require only data that are already available in electronic form?

Technical feasibility

Is the indicator/methodology…

- simple enough to be calculated using software and expertise appropriate to the scale of application and the typical capabilities of the institution doing the calculations?

Complementarity and integration

Does the indicator/methodology…

- Complement to the remaining methodologies/indicators that are being assessed?

- Allow for further integration of the methodology/indicator with the remaining methodologies/indicators?

Robust

Defensible theory

Does/Is the indicator/methodology…

- based on sound theory?

- Avoid double counting or omissions of resources used?

- Consistent in its units of measurement?

- Rely on assumptions that are clearly stated and reasonable and require the use of ill-defined or poorly quantified parameters?

- Avoid the use of subjective factors to weigh different components?

Sensitivity

Does the indicator/methodology…

- Change rapidly enough with respect to input parameters to pick up policy-significant changes and detect non-linearities, discontinuities and thresholds?

Data quality

Does the indicator/methodology…

- Use data of sufficient quality?

Reliability

Is the indicator/methodology…

- Reliable in terms of its accuracy, repeatability, and the clear specification of protocol and formulas used in the calculations?

Completeness

Does/Is the indicator/methodology…

- Complete in terms of the objective it is assessing?

- Avoid shifting burdens from one problem/impact to another (e.g., from climate change to nuclear risks) or from one region to another (e.g., relocation of production may shift environmental burden away from the place of consumption)?