Scoping study to identify potential circular economy actions, priority sectors, material flows & value chains

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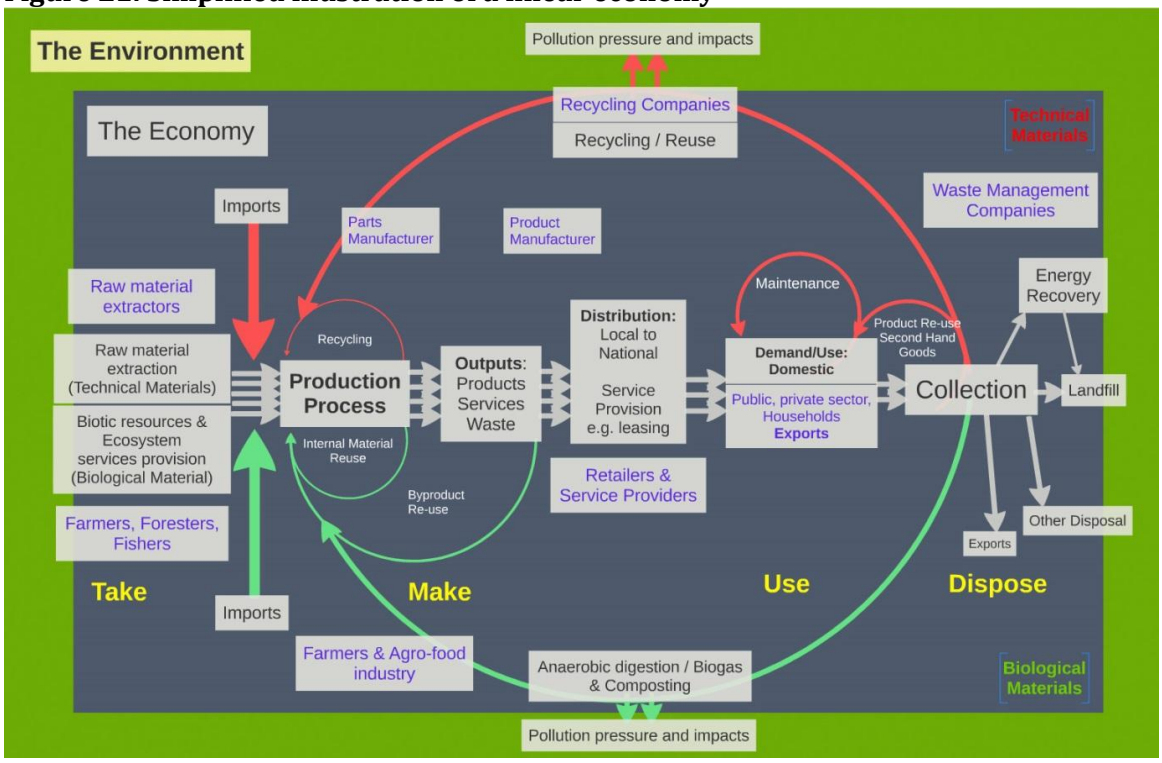
Executive Summary

The circular economy is rapidly rising up political and business agendas. In contrast to today's largely linear, 'take-make-use-dispose' economy, a circular economy represents a development strategy that enables economic growth while aiming to optimise the chain of consumption of biological and technical materials. A deep transformation of production chains and consumption patterns is envisaged to keep materials circulating in the economy for longer, re-designing industrial systems and encouraging cascading use of materials and waste. Although there are some elements of circularity such as recycling and composting in the linear economy (see Figure E1) where progress needs to be maintained, a circular economy goes beyond the pursuit of waste prevention and waste reduction to inspire technological, organisational and social innovation across and within value chains (see Figure E2). There are already several policies in place and activities underway that support a circular economy; however there remain a range of untapped opportunities, costs to be avoided and obstacles to be addressed in order to accelerate the move towards a circular economy in the EU.

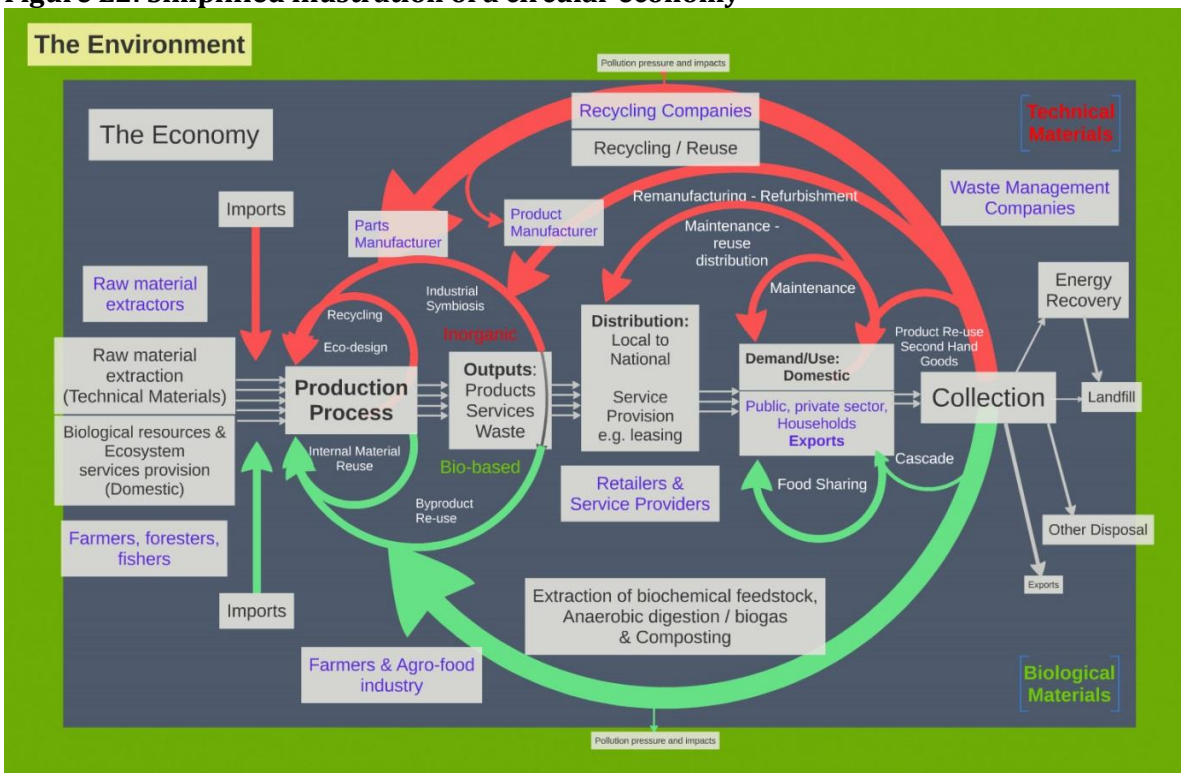
Against this backdrop, the European Commission (DG Environment) launched a *Scoping study to identify potential circular economy actions, priority sectors, material flows & value chains*. The study was carried out by the Policy Studies Institute (PSI), Institute for European Environmental Policy (IEEP), BIO and Ecologic Institute between November 2013 and July 2014. The aim of the study was to provide an **initial scoping assessment of potential priorities and policy options to support the transition to a circular economy in the EU**. The study reviewed existing literature, identified potential priority areas for action where accelerating the circular economy would be beneficial and where EU policy has a particular role to play, and developed policy options for consideration across a range of areas.

Figure E1: Simplified illustration of a linear economy



Source: Own representation, P ten Brink, P Razzini, S. Withana and E. van Dijl (IEEP), 2014

Figure E2: Simplified illustration of a circular economy



Source: Own representation, P ten Brink, P Razzini, S. Withana and E. van Dijl (IEEP), 2014

Barriers to the circular economy

While the benefits of the circular economy are increasingly recognised, there remain a range of barriers to the transition which include:

- **Insufficient skills and investment** in circular product design and production which could facilitate greater re-use, remanufacture, repair and recycling;
- Current levels of **resource pricing** which create economic signals that do not encourage efficient resource use, pollution mitigation or innovation;
- Lack of **sufficient incentives** due *inter alia* to the insufficient **internalisation of externalities** through policy or other measures;
- **Non-alignment of power and incentives between actors** within and across value chains (e.g. between producers and recyclers) to improve cross-cycle and cross-sector performance;
- Still limited **consumer and business acceptance** of potentially more efficient service oriented business models, e.g. leasing rather than owning, performance-based payment models;
- Limited **information, know-how and economic incentives** for key elements in the supply and maintenance chain, e.g for repair and reuse, on chemical composition of certain products such as substances in electronic devices;
- Shortfalls in **consumer awareness** (e.g. perishability of food products);
- Insufficient **waste separation at source** (e.g. for food waste, packaging);
- Limited **sustainable public procurement incentives in most public agencies** (i.e. Green Public Procurement);
- Insufficient **investment** in recycling and recovery infrastructure, innovation and technologies (related to this is the lock-in of existing technologies and infrastructure);

- Challenges in obtaining suitable **finance** for such investment;
- **Weaknesses in policy coherence at different levels** (e.g. bioenergy and waste policies);
- Widespread **planned obsolescence** in products.

Many of these barriers are specific to particular materials, products and sectors; requiring different types of action at the EU, national, regional and local level according to the nature of the barrier faced.

Priority materials, products and sectors for the EU

The circular economy is a complex concept encompassing a range of materials, products and actors, different stages in product and value chains, with varying potential for circularity across different sectors, products and value chains. Furthermore, the transition to a circular economy is a multi-level governance challenge, where actions can be taken at different levels (EU, Member State, local authority, private sector, citizen). Thus, there is a need to identify priority areas for action at different governance levels.

A number of key existing studies explore the opportunities for actions to enhance circularity in various resource areas and product sectors from different perspectives. For example, the Ellen MacArthur Foundation in its 2013 report analyses the consumer goods sector to identify priority goods where the most substantial and underexploited opportunities for circularity lie, highlighting products such as furniture and washing machines as priorities within this sector (EMF, 2013). In contrast, a study by Green Alliance takes the priority materials of metals, water and phosphorus as a starting point due to their role as key inputs to the economy and the large quantities of these currently lost (Green Alliance, 2011).

This study identifies the following priorities where accelerating the circular economy would be beneficial and where EU policy has a particular role to play:

- **Priority materials** include: agricultural products and waste, wood and paper, plastics, metals and phosphorus.
- **Priority sectors** include**:** packaging; food; electronic and electrical equipment; transport; furniture; buildings and construction.

To better understand circular economy opportunities in different areas which could be supported through targeted policy interventions, the following cases were developed in the study:

- **Mobile and smart phones** since they are a high profile and economically significant example of high-tech products with signs of growing consumer interest and participation in the circular economy. There are also major potential benefits in terms of material savings and a need to reduce health and environmental impacts of disposal at present.
- **Food supply chains** are large in volume terms, significant in economic and environmental terms and central to the management of many biological materials. These chains currently generate significant amounts of waste (despite major global challenges of ensuring adequate nutrition) and are associated with high environmental impacts.
- The use of large volumes of high-strength **steel** and the associated potential for de-materialisation within different products illustrates how a priority material has systems level links with a number of product supply chains, including construction and transport.
- **Plastics** have a huge range of applications including in packaging and food products as well as light-weight structural applications such as in automobiles. They are also an

important example to explore the range of cascading options for materials and the transition to a bio-based economy.

The analysis in these case studies indicates that the **relationship between actors in the value chain** can be an important limitation on the realisation of opportunities from the circular economy, particularly when innovation (in products, organisational structure, knowledge, or value chain relationships) is required. This is an additional barrier to the transition to a circular economy beyond the barriers frequently emphasised in the literature and may require policy intervention to be overcome.

Policy options to support a circular economy in the EU

There is a **range of policies and measures already in place** at EU, national, regional and local levels, and a range of initiatives underway by private actors and other stakeholders that address part of the transition to a circular economy. These efforts are closely related to parallel policy discussions including:

- The **Circular Economy Package** published in July 2014 which includes an overarching communication (COM2014)398), a proposal to amend aspects of six EU waste Directives (COM(2014)397), and related communications on sustainable buildings (COM(2014)445), green employment (COM(2014)446) and green action for SMEs (COM(2014)440);
- Implementation of the **Roadmap to a Resource Efficient Europe** (COM(2011)571), the 7th Environmental Action Programme - 7th EAP (Decision No 1386/2013/EU) and the recommendations of the European Resource Efficiency Platform (EREP);
- Taking forward ambitions on advancing the **green economy within and beyond the EU** (including work on the post-2015 development framework and the drafting of global Sustainable Development Goals);
- Taking forward the **bio-economy in the EU** building on *inter alia* the Bioeconomy Strategy (COM(2012)60) and on-going work in DG ENTR, DG AGRI, DG RTD and DG ENV to identify new value chains and markets in this area;
- Implementation of the **Europe 2020 Strategy**, including relevant roadmaps and flagship initiatives beyond resource efficiency, e.g. Innovation Union, Industrial Policy, Skills and Jobs; and
- The associated on-going **European Semester process** (including the adoption of country-specific recommendations).

These commitments and initiatives offer a good base on which to build and will generate interesting insights to encourage further action. However while useful, by themselves they are insufficient to secure progress towards the circular economy in the EU as they address only certain parts of the transition focusing on individual sectors, products or policy 'silos'. The transition to a circular economy requires **systemic change and a more holistic, integrated approach** which takes into account the myriad of inter-linkages within and between sectors, within and across value chains and between actors. Such an approach would help to take into account the different incentives in play, the distribution of economic rewards and impacts of specific measures along a value chain, across different sectors and policy areas.

This transition requires a **mix of complementary instruments and approaches** which can be taken forward by actors at different levels from the private sector, to individuals and public

actors at all levels from local to the EU. Potential policy actions include regulatory measures, economic incentives, targeted and increased funding, efforts to engage and link actors along the value chain and initiatives to raise awareness of the benefits of the circular economy and available solutions. There is a need for policies which can **support existing efforts and opportunities** (by revising existing policies, removing barriers); building on current efforts on waste management and recycling to **support other loops in the circular economy** (i.e. expanded reuse, remanufacturing and refurbishment); provide support for **bottom-up initiatives**, **develop skills** and **provide incentives for innovation** and **closer collaboration** between actors along the value chain.

Opportunities for increased circularity vary considerably across different firms, sectors, products and value chains. Moreover, the need for policy intervention beyond private initiatives (if any) and the type of intervention needed will vary according to the issue at hand. In some areas, the transition to a circular economy might materialise without intervention (particularly where products have high embedded material values, where incentives within the private sector allow moves towards more circular and/or service-based models independently); while in other areas support including funding and targeted public intervention is needed to encourage the transition. It is therefore important that the **value chain structure and the business case** for circularity for different actors is understood in detail and taken into account in the policy development process.

Given its key role in a range of related policy areas, including *inter alia* resource efficiency, recycling and waste management, product policy, trade policy, industrial policy, the bio-economy, research and development it is important to include an **appropriate EU dimension** in any catalogue of measures to advance the circular economy. The aim of this study has been to provide a first scoping assessment of **potential options for EU consideration across a range of areas** which could be taken forward, each with different strengths and weaknesses. The study identified a number of areas where EU action might most productively focus in the short to medium term to support the transition to a circular economy on a European scale. The study has not been designed to explore these options in detail, but rather provides an **initial assessment of potential areas of interest which could be explored in further detail in the future.** These options can be clustered into three broad areas as briefly described below (and elaborated in section 6 of the report):

- **Regulatory instruments** including ***better implementation and enforcement of related existing legislation*** (e.g. on waste, product policy etc.); ***revisions to relevant legislation*** including those which act as barriers to a circular economy (e.g. definitions in EU waste legislation) and those which can better integrate circular concepts (e.g. eco-design, extended producer responsibility (EPR) related legislation, requirements on packaging and packaging waste, labelling, reporting and accounting, REACH); and ***new measures or regulations*** such as new targets (e.g. on food waste as proposed in (COM(2014)397)), restrictions or selective bans (e.g. on landfilling of plastics or recyclable materials as proposed in (COM(2014)397)), mandatory product or process requirements (e.g. mandatory phosphorous recovery from sewage sludge), potential measures to address issue of intentional obsolescence (e.g. broad policy objective, extended warrantee/guarantee periods).

- **Other instruments and approaches** to support legislative measures include ***voluntary agreements*** (e.g. between retailers and government, between actors along a supply

chain); **fiscal incentives including taxes, charges and levies** at the national or local level (e.g. taxes/charges on aggregates or construction materials, products (e.g. phosphorous in mineral fertilizers), pollution (e.g. CO_2) and waste disposal (e.g. PAYT schemes, landfill taxes) and encouraged at EU level (e.g. through the European Semester and adoption of country-specific recommendations in this area); targeted **information and advisory services** (e.g. for companies on alternative uses for their by-products) **awareness raising campaigns** (e.g. among consumers on ways to reduce food waste, producers and local authorities).

- **Public investment** could play a useful supporting role alongside substantial private financing of relevant activities for example to support further ***R&D and innovation*** (e.g. through the Horizon 2020 and COSME programmes, leveraging both public and private financing and building on existing efforts such as the European Innovation Partnerships (EIPs), ***develop skills and training*** in the current workforce (e.g. on refurbishment or remanufacturing, skills of food chain personnel) as well as in the future workforce (e.g. through young designer awards etc.) e.g. through the European Social Fund, ***support investments in infrastructure*** including specific infrastructure (e.g. centralised collection points) and better use of existing infrastructure/services (e.g. postal service for collection) e.g. through EU Structural and Cohesion Funds. Public investment could also support ***clustering, industrial symbiosis and best practice platforms*** , e.g. EU Cohesion Policy funding could be used to set up 'facilitators' at regional/national level across European regions which connect companies and other actors including municipalities. Further action to encourage ***Green Public Procurement*** (GPP) can also be useful in incentivising more circular procurement practices among public authorities. Furthermore, the potential to use ***other EU funding instruments such as LIFE+, European Fisheries Fund, and the CAP*** to support the transition to the circular economy should be systematically explored (e.g. to support cascading use of biological materials) as well as avoid or minimise EU funding of investments that go against the circular economy, e.g. investment in energy recovery from untreated waste.

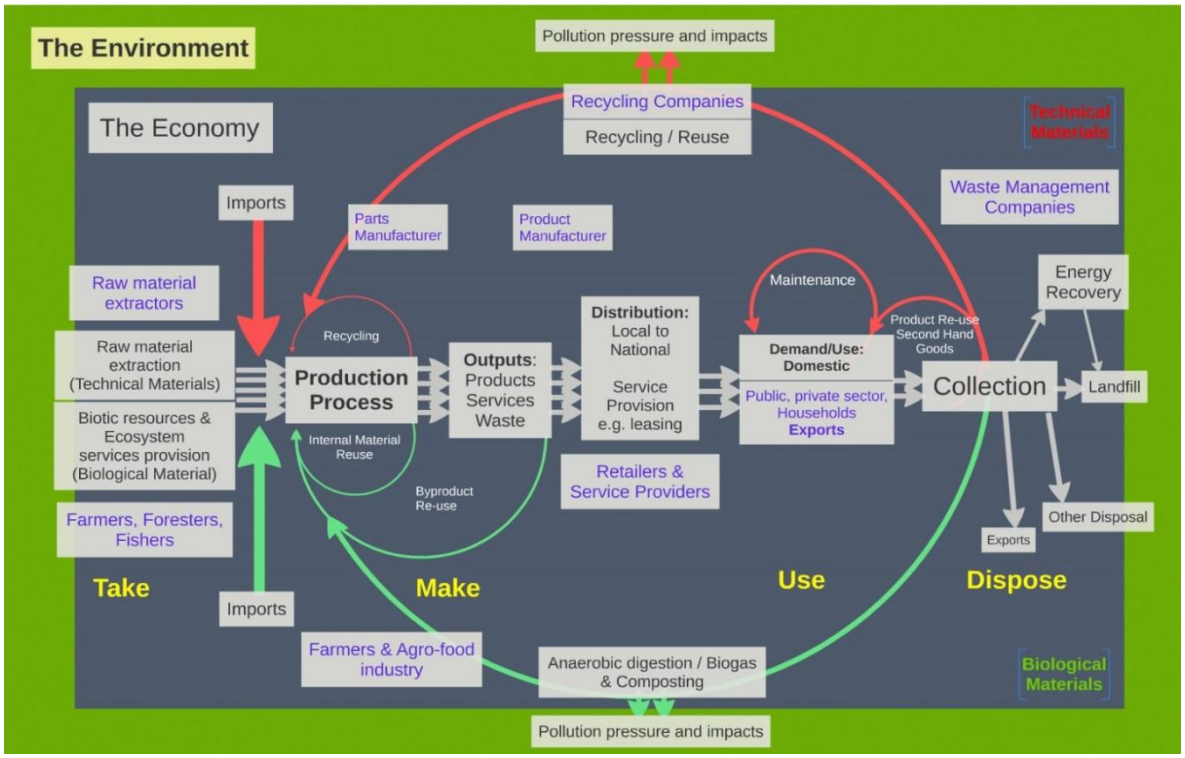
Policy discussions on the circular economy should reflect both **technical and biological resources** as well as the interplay between them (i.e. move to a bio-economy and nature based solutions). Furthermore the **interactions, synergies and potential trade-offs** between the circular economy and related policy initiatives on resource efficiency, bio-economy, green economy, dematerialisation etc., need consideration to ensure the overall coherence of policy initiatives. The recently published circular economy package from the Commission can be a useful framework for taking forward EU initiatives that support the transition to a circular economy, engaging a range of stakeholders across sectors, value chains and countries both within the EU and internationally.

Résumé Analytique

L'économie circulaire occupe une place de plus en plus importante dans les agendas politique et économique. Contrairement à l'économique actuelle qui repose sur une logique essentiellement linéaire « produire, consommer, jeter », l'économie circulaire représente une véritable stratégie de développement qui permet d'atteindre la croissance économique tout en visant à optimiser la chaîne de consommation des matériaux biologiques et techniques. Dans ce nouveau système, une profonde transformation des chaînes de production et des modèles de consommation est prévue afin de redessiner les systèmes industriels, de conserver plus longtemps les matériaux qui circulent dans l'économie et d'encourager l'utilisation en cascade des matériaux et des déchets. Il existe certes déjà quelques éléments de circularité dans l'économie linéaire tels que le compostage et le recyclage (voir Figure E1) dont les progrès doivent être maintenus, mais une économie circulaire dépasse la simple prévention et réduction des déchets et vise à inspirer l'innovation technologique, organisationnelle et sociale à travers les chaînes de valeur (voir Figure E2). Il existe d'ores et déjà plusieurs politiques et activités qui ont été mises en place pour soutenir le développement de l'économie circulaire. Cependant, un éventail de possibilités inexploitées demeure, des coûts qui pourraient être évités et des obstacles à dépasser afin d'accélérer la transition vers une économie circulaire dans l'Union Européenne (UE).

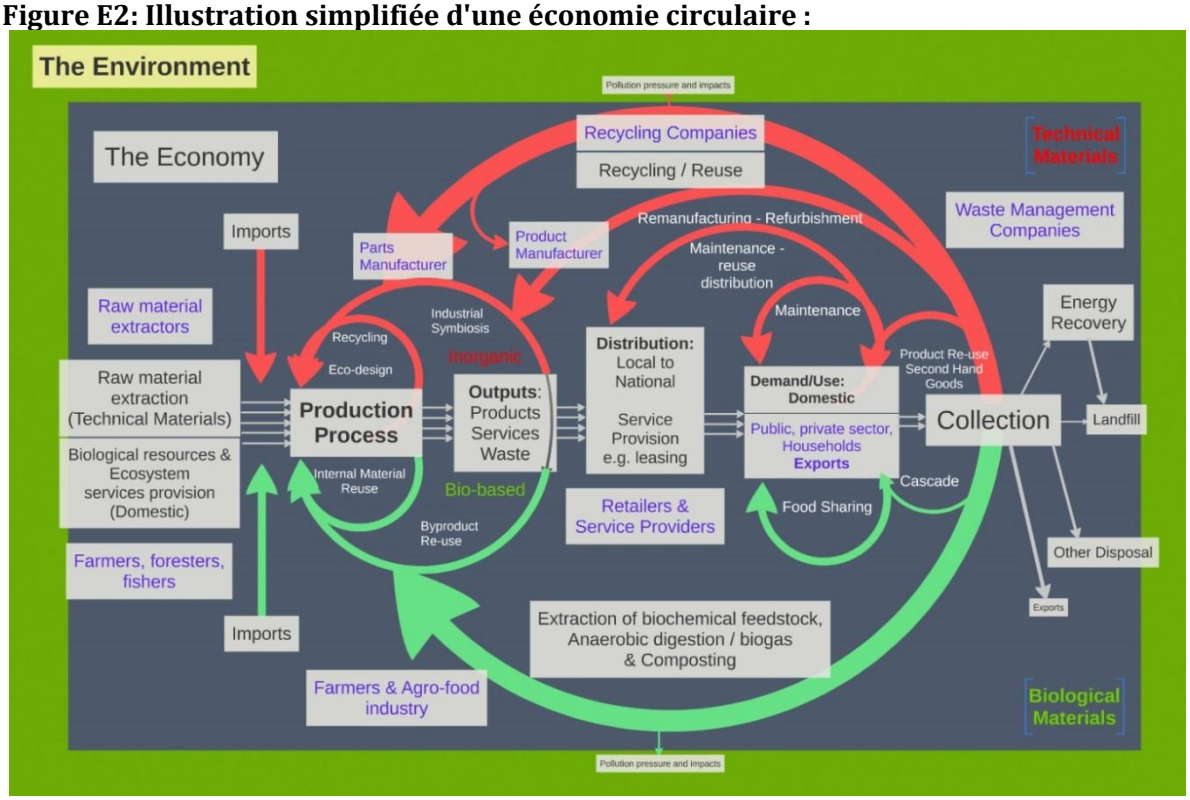
Dans ce contexte, la Commission européenne (DG Environnement) a lancé une *Etude exploratoire pour identifier les secteurs prioritaires, les actions potentielles d'économie circulaire, les flux de matières et les chaînes de valeur*. Cette étude a été réalisée par le Policy Studies Institue (PSI), l'Institute for European Environmental Policy (IEEP), BIO et Ecologic Institute entre les mois de novembre 2013 et juillet 2014. L'objectif de cette étude était **de fournir une évaluation initiale sur la portée des priorités potentielles et des options politiques pour soutenir la transition vers l'économie circulaire dans l'UE**. Cette étude a examiné la littérature existante, identifié les domaines prioritaires d'action potentiels dans lesquels l'accélération de l'économie circulaire serait bénéfique et la politique de l'UE pourrait jouer un rôle importante, puis a élaboré des options politiques à prendre en compte dans un ensemble de domaines.

Figure E1: Illustration simplifiée d'une économie linéaire :



Source: Représentation personnelle, P. ten Brink, P. Razzini, S. Withana et E. van Dijl (IEEP), 2014

Figure E2: Illustration simplifiée d'une économie circulaire :



Source: Représentation personnelle, P. ten Brink, P. Razzini, S. Withana et E. van Dijl (IEEP), 2014

Les obstacles à l'économie circulaire

Bien que les avantages de l'économie circulaire soient de plus en plus reconnus, un ensemble d'obstacles gênent la transition vers une économie circulaire à savoir :

- **L'insuffisance des investissements et des compétences pourtant nécessaires** à la conception circulaire des produits et dans la production afin de faciliter la réutilisation, la remise à neuf, la réparation et le recyclage des produits ;
- Les niveaux actuels des **prix des matières premières**, qui créent des signaux économiques qui ne favorisent ni une utilisation efficace des ressources, ni une atténuation de la pollution, ni n'encouragent l'innovation ;
- L'insuffisance voire l'absence de **mesures de soutiens** due notamment à l'insuffisance de **l'internalisation des externalités** par la politique ou tout autre mesure ;
- **Le non-alignement du pouvoir et des incitations entre les différents acteurs** au sein et à travers les chaînes de valeur (par exemple, entre les producteurs et les recycleurs) pour améliorer l'intra-cycle et la performance intersectorielle;
- **Le degré limité d'acceptation par les consommateurs et par le monde des affaires** aux modèles d'affaires, orientées plutôt vers les services (par exemple, la location plutôt que la possession, de même que les modèles de paiement basés sur la performance);
- **La quantité limitée d'informations, de savoir-faire et d'incitations économiques** disponibles à des éléments clés de la chaîne d'approvisionnement et de maintenance (par exemple, à la réparation et la réutilisation, à la composition chimique de certains produits tels que les substances dans des dispositifs électroniques) ;
- L'insuffisante **sensibilisation des consommateurs** sur certains sujets (par exemple, sur la périssabilité des produits alimentaires);
- L'insuffisante **séparation des déchets à la source** (par exemple, les déchets alimentaires ou de packagings) ;
- Les faibles incitations en faveur du **développement des marchés publics durables** au sein d'organismes publics (par exemple, les marchés publics écologiques);
- **L'insuffisance des investissements** dans les infrastructures de recyclage et de récupération, l'innovation et les nouvelles technologies (lié à cela, il y a aussi le problème de l'immobilisation des technologies et infrastructures existantes) ;
- La difficulté à obtenir un **financement** approprié pour de tels investissements ;
- **Le manque de cohérence** politique à différentes niveaux (par exemple, la bioénergie et les politiques des déchets) ;
- **L'obsolescence programmée** généralisée dans les produits.

Plusieurs de ces obstacles sont spécifiques à certains matériaux, produits et secteurs et nécessitent donc un type d'action spécifique à une échelle territoriale (à savoir l'échelle locale, régionale, nationale ou européenne) et de la nature de ces obstacles.

Matières prioritaires, Produits et Secteurs pour l'UE

L'économie circulaire est un concept complexe qui englobe une vaste gamme de matériaux, produits, acteurs, différentes étapes dans les chaînes de produits et de valeur, avec un potentiel de circularité qui varie en fonction des différents secteurs, produits et chaînes de valeur. En outre, la transition vers une économie circulaire est un défi de gouvernance à plusieurs niveaux, dans lequel des actions peuvent être prises à différents niveaux (européen, national, autorité

locale, secteur privé et citoyens). Par conséquent, il est nécessaire d'identifier les domaines prioritaires d'action aux différents niveaux administratifs.

Un certain nombre d'études clés avait déjà exploré des possibilités d'actions visant à améliorer la circularité dans divers domaines des ressources et des secteurs de produits à partir des différents points de vue. Par exemple, la Fondation Ellen MacArthur, dans son rapport publié en 2013, a analysé le secteur des biens de consommation pour identifier quels sont les produits prioritaires ayant les chances les plus élevée en matière de circularité, mettant ainsi en évidence que les produits comme les meubles et les machines à laver sont prioritaires dans ce secteur (EMF, 2013). En revanche, une étude menée par Green Alliance désigne des matériaux prioritaires tels que les métaux, l'eau et le phosphore comme point de départ en raison de leur rôle en tant qu'éléments essentiels pour l'économie et des importantes quantités de ces matériaux qui sont gaspillées (Green Alliance, 2011).

Cette étude identifie les priorités suivantes pour lesquelles une accélération de l'économie circulaire serait bénéfique et où la politique de l'UE pourrait jouer un rôle particulier :

- **Matières prioritaires** (*priority materials*): produits agricoles et déchets, bois et papier, plastiques, métaux et phosphore ;
- **Secteurs prioritaires** (*priority sectors*): emballage, aliments, équipements électriques et électroniques, transport, meubles, bâtiments et matériel pour la construction.

L'étude a développé les suivants cas pratiques pour aider à mieux comprendre comment les opportunités de l'économie circulaire dans les différents domaines pourraient être saisies grâce à des interventions ciblées:

- **Téléphones portables et Smartphones** car ils jouissent d'une grande visibilité et sont un exemple économiquement significatif de produits de haute technologie qui suscitent un intérêt croissant de la part des consommateurs et qui sont porteurs d'un potentiel au sein de l'économie circulaire. Ils présentent également de nombreux avantages potentiels en termes d'économie des matériaux et qui nécessitent la réduction des impacts négatifs de leur élimination sur l'environnement et sur la santé humaine ;
- Les **chaînes d'approvisionnement alimentaire** sont très grandes en termes de volume, importantes au regard de leur dimension économique et environnementale, et centrales au regard de la gestion de nombreux matériaux biologiques. Actuellement, ces chaînes génèrent des quantités importantes de déchets (malgré les grands défis mondiaux d'assurer une nutrition alimentaire adéquate) et sont aussi associées à de forts impacts environnementaux.
- L'utilisation de grandes quantités d'**acier** à haute résistance et le potentiel associé à la dématérialisation au sein des différents produits, illustre comment un matériau prioritaire peut avoir de liens systémiques avec un certain nombre de chaînes d'approvisionnement de produits, y compris les bâtiments et le transport.
- Les **matières plastiques** peuvent avoir une large gamme d'applications, notamment dans les emballages et les produits alimentaires, ainsi que des applications de construction légère comme les automobiles. Les matières plastiques représentent aussi un exemple important pour explorer la gamme des « *cascading options* » (options en cascade) associée aux matériaux et pour une transition vers une économie axée sur la bioéconomie.

L'analyse de ces études de cas indique clairement que la **relation entre les acteurs de la chaîne de valeur** peut être une limite importante à la saisie des bénéfices liés à l'économie circulaire,

en particulier lorsque l'innovation (liée aux produits, à la structure organisationnelle, aux connaissances ou relations de la chaîne de valeur) est requise. Tout particulièrement, ceci est un obstacle supplémentaire à la transition vers une économie circulaire au-delà des barrières souvent mises en évidence dans la littérature, et qui peut nécessiter une intervention politique pour être surmonté.

Options politiques pour soutenir une économie circulaire dans l'UE

Il existe un **éventail de politiques et mesures déjà en place** aux niveaux communautaire, national, régional et local, et une série d'initiatives en cours lancées par des acteurs privés et autres parties prenantes, qui s'occupent d'une partie de la transition vers une économie circulaire. Ces efforts sont étroitement liées à des discussions politiques parallèles, y compris:

- L'adoption d'un **Paquet Économie Circulaire** en juillet 2014, qui comprend une communication globale (COM(2014) 398), une proposition législative visant à modifier certains aspects de six directives de l'UE sur les déchets (COM (2014)397), et les renseignements connexes sur les bâtiments durables (COM (2014) 445), l'emploi vert (COM (2014) 446) et des actions écologiques pour les PME (COM (2014) 440) ;
- La mise en œuvre d'une **Feuille de route pour une Europe efficace dans l'utilisation des ressources** (COM (2011) 571), le 7e Programme d'Action Environnementale - 7e PAE (décision n ° 1386/2013 / UE) et les recommandations de la plateforme européenne pour une utilisation efficace des ressources (EREP) ;
- L'atteinte des objectifs sur la promotion de l'**économie verte à l'intérieur et au-delà de l'UE** (y compris les travaux sur l'agenda cadre de développement post-2015 et l'élaboration des nouveaux Objectifs de Développement Durable) ;
- La volonté de faire progresser la **Bioéconomie** dans l'UE s'appuyant entre autres, sur la Stratégie bioéconomique pour l'Europe (COM (2012) 60) et sur les travaux en cours entrepris au sein des DG ENTR, DG AGRI, DG RTD et DG ENV pour identifier de nouvelles chaînes de valeur et des marchés dans ce domaine ;
- La mise en œuvre de la **Stratégie Europe 2020**, notamment les feuilles de route correspondantes et les initiatives phares au-delà de l'efficacité des ressources (par exemple L'Union de l'innovation, la Politique industrielle, les Compétences et l'emploi) ; et aussi
- Le processus du **Semestre Européen** (y compris l'adoption de recommandations spécifiques à chaque pays).

Ces engagements et initiatives offrent une bonne base sur laquelle construire et vont générer des idées intéressantes pour encourager de nouvelles mesures. Cependant, tout en étant utiles, ces mesures ne suffisent pas à elles seules à garantir le progrès vers l'économie circulaire, car elles se concentrent sur certaines parties de la transition et posent l'accent sur des secteurs, produits et politiques individuelles ou « policy silos » (des cloisonnements politiques). La transition vers une économie circulaire exige un **changement systémique et une approche plus holistique et intégrée**, qui prend en compte la myriade d'interdépendances au sein et entre les secteurs, à l'intérieur et aussi à travers les chaînes de valeur et entre les acteurs. Une telle approche permettrait de prendre en compte les différentes interactions en jeu, la distribution des récompenses économiques et les impacts des mesures spécifiques tout au long de la chaîne de valeur, dans les différents secteurs et domaines politiques.

Cette transition nécessite un **ensemble d'instruments et d'approches complémentaires** qui peuvent être mises en œuvre par des acteurs à des différents niveaux, du secteur privé, des particuliers et des acteurs publics à tous les niveaux, du local à l'UE. Les actions politiques possibles comprennent des mesures réglementaires, des incitations économiques, des financements ciblés et plus larges, des efforts pour engager et créer des liens entre les acteurs de la chaîne de valeur et aussi des campagnes de sensibilisation sur les avantages de l'économie circulaire et les solutions disponibles. Il existe un fort besoin de politiques pour **soutenir les opportunités et les efforts en place** (par la révision des politiques existantes et la suppression des obstacles existants) ; en s'appuyant sur les efforts actuels en matière de gestion et de recyclage des déchets, à l'appui **d'autres boucles de l'économie circulaire** (c'est-à-dire la réutilisation élargie, la remise à neuf et la rénovation), en apportant un soutien **aux initiatives bottom-up**, **en développant des compétences**, **en soutenant les incitation à l'innovation** et en rapprochant les acteurs dans la **chaîne de valeur**.

Les possibilités d'accroître la circularité varient considérablement entre les différentes entreprises, secteurs, produits et chaînes de valeur. En outre, la nécessité d'une intervention politique au-delà des initiatives privées (le cas échéant) et le type d'intervention nécessaire varient en fonction de la question considérée. Dans certaines régions, la transition vers une économie circulaire pourrait se concrétiser sans intervention (en particulier lorsque les produits ont une concentration élevée en matières incorporées, pour lesquels les incitations dans le secteur privé permettent des mutations individuelles vers des modèles plus circulaires et/ou à des modèles orientés vers les services) ; alors que, dans d'autres domaines, un soutien fondé sur le financement et l'intervention publique ciblée est nécessaire pour encourager la transition. Il est donc cruciale que la structure de la **chaîne de valeur et la rentabilité** de la circularité pour les différents acteurs soit comprise dans les détails et prise en compte dans le processus d'élaboration des politiques.

Compte tenu de son rôle clé dans une série de domaines politiques connexes, y compris inter alia, l'efficacité des ressources, le recyclage et la gestion des déchets, la politique produit, la politique commerciale, la politique industrielle, la bio-économie, la recherche et développement, il est aussi important d'inclure dans chaque catalogue de mesures **une dimension communautaire appropriée** pour faire avancer l'économie circulaire. Le but de cette étude a été de fournir une première évaluation des **options possibles pour une prise en considération au niveau de l'UE dans une série de domaines**, options qui pourraient être mises en œuvre, chacune ayant différentes forces et faiblesses. L'étude a également identifié un certain nombre de domaines sur lesquels l'UE pourrait se concentrer de manière plus productive (à court et moyen terme) pour soutenir la transition vers une économie circulaire à l'échelle européenne. Cette étude n'a pas été conçue pour explorer ces options en détail, mais le document fournit plutôt une **évaluation initiale des domaines d'intérêts potentiels qui pourraient être explorés à l'avenir**. Ces options peuvent être regroupées en trois grands domaines tels que décrits brièvement ci-dessous (et détaillés dans la section 6 du rapport):

- **Des instruments réglementaires**, notamment une ***meilleure exécution et mise en œuvre de la législation existante en la matière*** (par ex. sur les déchets, la politique produit, etc.) ; ***des révisions de la législation pertinente***, notamment celles qui constitue un obstacle à l'économie circulaire (par ex., les définitions de la législation européenne sur les déchets) et celles qui peuvent mieux intégrer les concepts circulaires (par ex. l'écoconception, la législation liée à la responsabilité élargie des producteurs (REP), les exigences relatives aux emballages et au conditionnement des déchets, l'étiquetage, l'in-

formation et la gestion, la législation REACH ; et de ***nouvelles mesures ou réglementations*** à l'instar de nouveaux objectifs (par ex. sur les déchet alimentaires comme proposé dans (COM (2014) 397)), des restrictions ou interdictions sélectives (par ex. sur la mise en décharge de matières plastiques ou des matières recyclable comme proposé dans COM (2014) 397)), les exigences en matière de produits on procédés obligatoires (par ex., la récupération de phosphore obligatoire à partir de boues d'épuration), les mesures possibles pour répondre au problème de l'obsolescence programmée (par ex. les objectifs politiques généraux, des périodes de garantie prolongées).

- **Les autres instruments et approches** pour soutenir les mesures législatives comprennent des ***accords volontaires*** (par ex. entre les distributeurs et le gouvernement et entre les acteurs de la chaîne d'approvisionnement) ; ***des incitations fiscales au niveau des impôts, taxes et prélèvements*** au niveau local ou national (par exemple taxes/impôts sur les agrégats ou sur les matériaux de construction, certains produits (par exemple, le phosphore dans les fertilisants minéraux), la pollution (CO_2, par exemple), l'élimination des déchets (par exemple, les taxes de mise en décharge et les plans *Pay-As-You-Throw*) et encouragées au niveau européen (par exemple à travers le Semestre européen et l'adoption des recommandations spécifiques dans ce domaine) ; ***les services d'information et de conseils ciblés*** (par exemple pour les entreprises sur d'autres utilisations possibles de leurs sous-produits) ; des ***campagnes de sensibilisation*** (par ex. à destination des consommateurs, des producteurs et des autorités locales sur les moyens de réduire les déchets alimentaires).

- **L'investissement public** pourrait jouer un rôle d'appui utile aux côtés d'importants fonds privés pour soutenir des activités pertinentes comme la ***R&D et l'innovation*** (par exemple à travers les programmes Horizon 2020 et COSME), en s'appuyant à la fois sur un financement public et privé et aussi grâce aux renforcement des efforts existants, tels que l'European Innovation Partnership (EIP), pour ***développer de nouvelles compétences*** et aider à la formation de la population active actuelle (à la rénovation, reconditionnement, des compétences du personnel de la chaîne alimentaire) et de la future main-d'oeuvre (par exemple avec la création des spécifiques « Prix pour jeunes créateurs », etc.). Le Fonds Social Européen pourrait représenter une opportunité pour financer le développement de ces compétences. En même temps, les Fonds de Cohésion et les Fonds Structurels européens pourraient ***soutenir le développement des nouvelles infrastructures, y compris des infrastructures spécifiques*** (tels que des points de collecte centralisés) et une meilleure utilisation des infrastructures et services déjà en place (comme par exemple le service postal pour la collecte de certaine objets). Les investissements publics pourraient également soutenir les ***clustering***, les projets de ***symbiose industrielle*** et la diffusion des « ***bonnes pratiques*** » (dans ce cadre le Fonds de Cohésion pourrait être utilisé pour créer des « facilitateurs » au niveau national ou régional dans les régions européennes qui connectent entreprises, municipalités et autres acteurs). D'autres mesures visant à encourager les ***Marchés Publics écologiques*** (MPE) pourraient également s'avérer utiles pour inciter des pratiques d'approvisionnement plus circulaires au sein des autorités publiques. Entre autre, la possibilité d'utiliser ***d'autres instruments de financement de l'UE tels que LIFE +, le Fonds européen pour la pêche, et la PAC*** pour supporter la transition vers une véritable économie circulaire devrait être explorée d'une manière systématique (par exemple, avec l'utilisation « en cascade » des matériaux biologiques), ainsi d'éviter ou de minimiser le financement européen des in-

vestissements/projets qui vont à l'encontre du concept d'économie circulaire (comme l'investissement dans la valorisation énergétique des déchets non traités).

Les discussions politiques sur l'économie circulaire doivent se focaliser non seulement sur les **ressources techniques et biologiques** mais aussi sur l'interaction entre ces deux types de ressources (c'est-à-dire passer à une solution fondée sur la bio-économie et la nature). En outre, les **interactions, synergies et possibles compromis** entre l'économie circulaire et les autres initiatives en matière d'efficacité des ressources, bioéconomie, économie verte, dématérialisation, etc., doivent être analysées pour assurer une cohérence d'ensemble entre les différentes initiatives politiques. Le Paquet sur l'économie circulaire récemment publié par la Commission européenne peut être un cadre utile pour faire avancer les initiatives de l'UE qui soutiennent la transition vers l'économie circulaire, pour réunir l'ensemble des parties prenantes des différents secteurs, les chaînes de valeurs et les pays membres ou non de l'UE.

List of Acronyms

Acronym	Meaning
ACR+	The Association of Cities and Regions for Recycling and Sustainable Resource Management
AD	Anaerobic Digestion
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CEE	Central and Eastern European
CFP	Common Fisheries Policy
COSME	Competitiveness of enterprises and SMEs
CSR	Corporate Social Responsibility
DG	Directorate-General
DG AGRI	Directorate-General for Agriculture and Rural Development
DG ENTR	Directorate-General for Enterprise and Industry
DG ENV	Directorate-General for the Environment
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DG RTD	Directorate-General for Research & Innovation
DIFTAR	DiFferentiated TARification
DSME	Korean shipyard
DYNAMIX	DYNAmic policy MIXes for Absolute Decoupling of Environmental Impact of EU Resource Use from Economic Growth
EAP	Environment Action Programme
EC	European Commission
EHS	Environmentally Harmful Subsidies
ELV Directive	End-of-Life Vehicles Directive
EP&L	Environmental Profit and Loss Accounts
EPR	Extended Producer Responsibility
ERDF	European Regional Development Fund
EU	European Union
G20	The Group of Twenty Finance Ministers and Central Bank Governors
GHG	Greenhouse Gas
GPP	Green Public Procurement
MS	Member States
NISP	National Industrial Symbiosis Programme
NL	Netherlands
OEF	Organisation Environmental Footprint
OMC	Open Method of Coordination
PAYT	Pay as you throw
PE	Polyethylene
PEF	Polyethylene Furanoate or Product Environmental Footprint
PET	Polyethylene Terephthalate
PP	Polypropylene
PPWD	Packaging and Packaging Waste Directive
PRO	Producer Responsibility Organisation
PSI	Policy Studies Institute
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RED	Renewable Energy Directive
RFID	Radio-Frequency IDentification

RTO AVT	Research and Technology Organisation Applied Vehicle Technology Research and Development
R&D	
SME	Small and Medium-sized Enterprises
SMM	Sustainable Materials Management
UK	United Kingdom
UN SEEA	United Nations System of Environmental-Economic Accounting
URL	Uniform Resource Locator
VAT	Value Added Tax
VHS	Video Home System
VOC	Volatile Organic Compounds
WFD	Waste Framework Directive
WLC	Whole Life Costing
WRAP	Waste & Resources Action Programme

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1 Introduction

This is the final report of a '*Scoping study to identify potential circular economy actions, priority sectors, material flows & value chains*' launched by the European Commission (DG Environment). The study was carried out by the Policy Studies Institute (PSI), Institute for European Environmental Policy (IEEP), BIO and Ecologic Institute between November 2013 and July 2014. The aim of the study was to provide an initial scoping assessment of potential priorities and policy options to support the transition to a circular economy in the EU. In particular the study aimed to:

- Identify barriers to the deployment of the circular economy in the EU.
- Identify existing EU policies that could help to enable the circular economy as well as any gaps in the current EU policy framework relating to the circular economy.
- Identify priority value chains, material flows and sectors/products where accelerating the circular economy would be particularly beneficial and where appropriate EU policy would have important leverage.

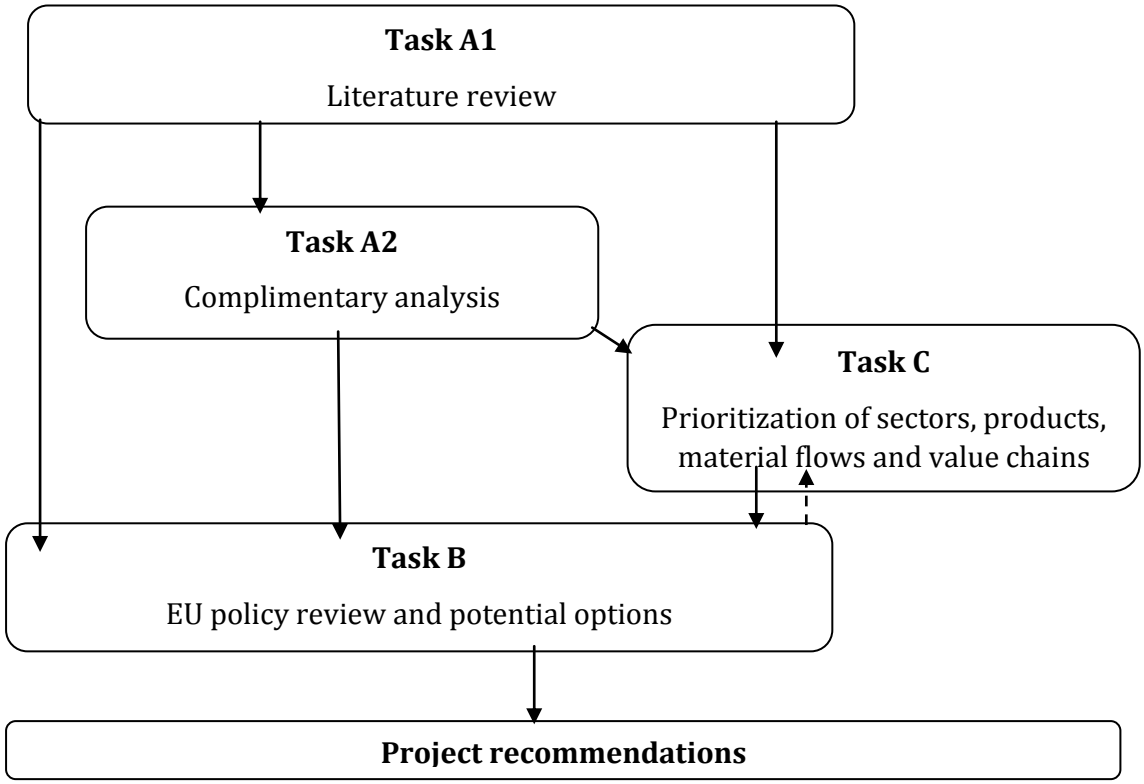
The study is intended to feed into on-going policy processes including follow-up to the Roadmap to a Resource Efficient Europe (European Commission 2011) and the recently published Circular Economy package (European Commission 2014c).

This study takes a transition or systems change perspective to explore the drivers and barriers towards greater economic circularity in the EU. The study is based on an analysis of relevant studies and literature and input from discussions at an experts' workshop in Brussels in May 2014. The study was structured around the following tasks:

- **A literature review** (Task A1) which identified and reviewed relevant literature related to the circular economy in the EU including existing evidence on: environmental and economic issues; key obstacles to the implementation of a circular economy – with special attention to SMEs; and pre-existing prioritisation exercises.
- This was complemented by **additional analysis** (Task A2) on barriers and favourable conditions for successful innovation in value chains
- **Identification of priority value chains, material flows and sectors/ products** (Task C) where accelerating the circular economy would be beneficial and where EU policy has a particular role to play. This prioritisation exercise is extended to a selected number of priority areas to analyse how sectoral structures, winners and losers can shape the applicability of policy in these areas. **Identify and assess key EU policies and instruments of relevance to the circular economy** and develop **potential policy options for consideration in the EU** (Task B).

The relationship between these tasks and the overall project recommendations are shown in **Figure 1** below.

Figure 1: Relationship between project tasks and the overall project recommendations



1.1 Structure of report

This is the final report of the study. The remainder of this report is structured as follows:

- Section 2 introduces our understanding of the circular economy concept including a definition of the circular economy, strategies deployed to date as well as the concept of 'circular economy loops'.
- Section 3 explores the barriers to a circular economy and how they can be overcome.
- Section 4 summarises the results of the study's prioritisation exercise of different sectors, products, material flows and value chains in the EU.
- Section 5 maps the current EU policy landscape including the current EU policies which both support and (may) act as barriers to the circular economy and the extent to which additional EU action is needed.
- Section 6 summarises case studies in four prioritised areas, setting out how an understanding of sectoral structures, winners and losers is important in developing detailed policy responses.
- Section 7 proposes policy options to support a circular economy in the EU including a mix of general approaches and policies which are applicable to different areas, structured across different actors, levels and timeframes.

2 Understanding the circular economy

2.1 A circular economy versus a linear economy

In contrast to a traditional 'take-make-use-dispose' linear economy, a circular economy represents a development strategy that enables economic growth while **optimising the consumption of natural resources**, deeply **transforming production chains and consumption patterns** and **re-designing industrial systems**. A circular economy is 'restorative or regenerative by intention and design' (Ellen MacArthur Foundation, 2012), considering the potential across entire value chains and cross-value chains, and closing 'resource loops' in all economic activities (Hislop & Hill, 2011). A circular economy goes beyond the pursuit of waste prevention and waste reduction to inspire **technological, organisational, and social innovation throughout the value chain** in order to 'design-out' (Ellen MacArthur Foundation, 2013) waste from the beginning, rather than relying solely on waste recycling at the end of the chain.

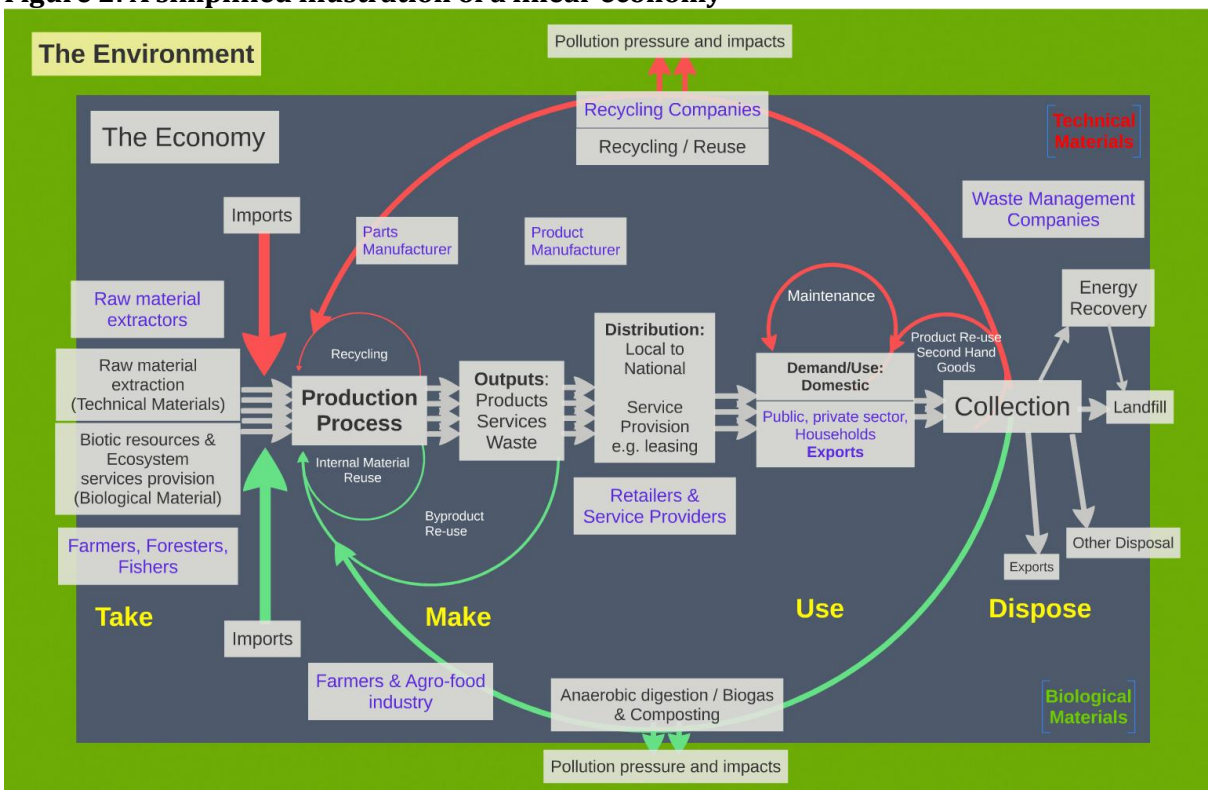
Simplified illustrations of the linear and the circular economy concept are provided in Figure 2 and Figure 3. The figures show the shift from a linear economy (of take, make, use and dispose) to a circular economy in terms of lifecycle, material flows, impacts, actors and instruments. It is important to note that today's **linear economy** includes some circular aspects such as recycling, maintenance, composting etc., but requires action to increase circularity at all levels and take advantage of untapped opportunities. It is evident from the figures that a circular economy can be taken forward with different approaches including *inter alia:* **product design** for durability, disassembly, refurbishment and reuse; **cascading components, materials and resources** through different uses; **material recycling**; **biochemical extraction, composting and anaerobic digestion; circular/regenerative forms of consumption;** and **industrial symbiosis**. Different approaches can be distinguished for **technical materials** (i.e. minerals, metals, polymers, alloys, hydrocarbon derivatives which are not biodegradable and based on finite resources) and **biological materials** (i.e. materials from biological origin such as agricultural and forestry goods/commodities, bio-based wastes and residues, which are generally non-toxic and renewable to an extent as they are limited by the availability of land, water and nutrients).

There are numerous potential **benefits** from the transition to a circular economy including material cost savings, reduced price volatility, improved security of supply, potential employment benefits, as well as reduced environmental pressures and impacts. For example in the **UK**, it is has been estimated that a circular economy could help generate 50,000 new jobs and €12 billion of investment (ESA, 2013), while in the **Netherlands** the potential benefits of the circular economy have been estimated to amount to €7.3 billion a year in market values, leading to 54,000 jobs and numerous environmental benefits (TNO, 2013). These figures are considered a conservative and prudent estimate, and reflect the fact that there is already some circular economy action taking place in the Netherlands (Expert input, 2014). However, there will be **both winners and losers from the transition -** as more goods are reused and repaired, fewer new goods will be bought, which implies a loss of income for certain product manufacturers, transporters and dealers, and opportunities for others (e.g. service providers, recycling companies etc.).

Moreover, one needs to keep in mind the **wider EU and global dimension** as circularity does not necessarily have to occur within the boundaries of a specific country, but should be conceived within the wider EU and global context at the same time. For example, certain elements in the

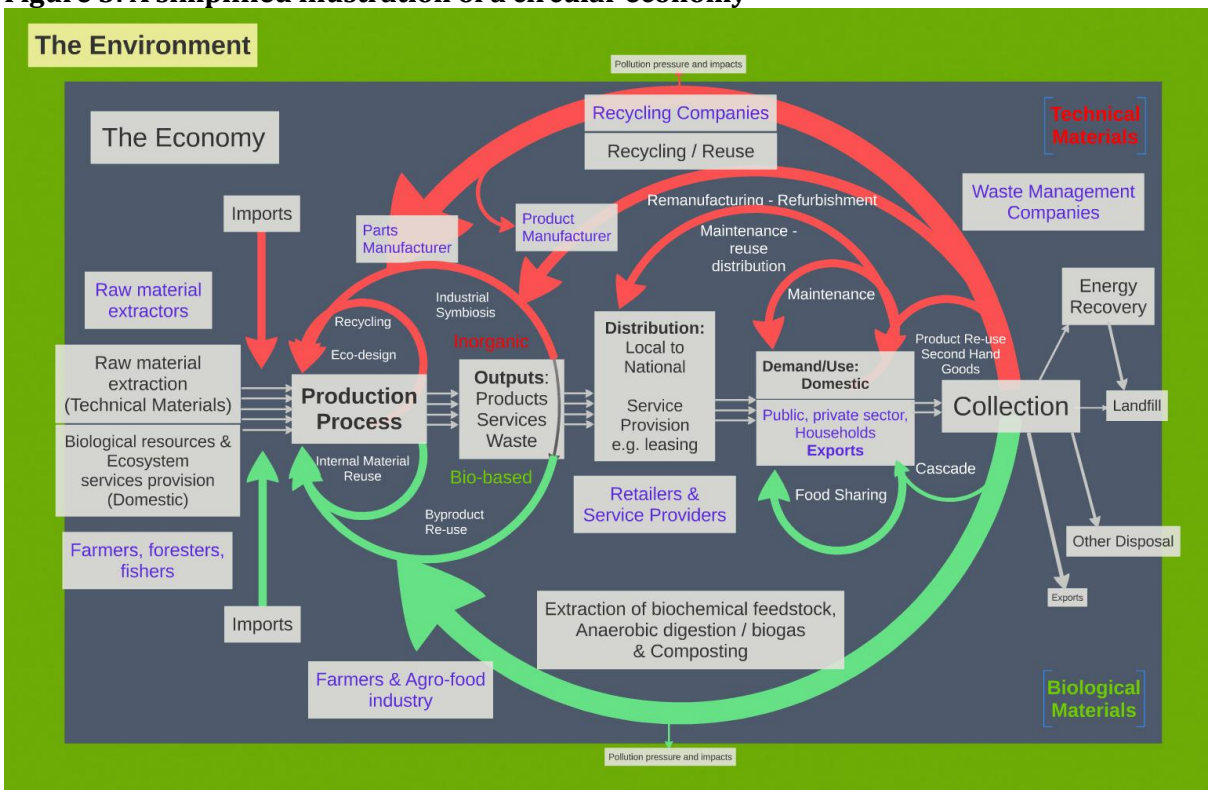
chain of circularity (e.g. refurbishment, remanufacturing and reuse) could take place outside a particular country or the EU, where practical and appropriate, in a sustainable, responsible way. This has implications in terms of trade and governance which need to be taken into account.

Figure 2: A simplified illustration of a linear economy



Source: Own representation, P. ten Brink, P. Razzini, S. Withana and E. van Dijl (IEEPa), 2014

Figure 3: A simplified illustration of a circular economy



Source: Own representation, P. ten Brink, P. Razzini, S. Withana and E. van Dijl (IEEPa), 2014

2.2 Circular economy strategies

Circular economy strategies are schemes ensuring that upstream decisions in the value chain are coordinated with downstream activities and actors. They connect producers, distributors, consumers and recyclers, link incentives for each of these actors, with an equal distribution of costs and benefits. If circular economy aims to "design out" waste, it goes beyond the approach of waste prevention and waste reduction (Schulte, 2013). It aims to inspire innovation throughout the *whole* value chain, rather than relying solely on waste recycling at the end of value chains.

The studies which go the farthest in defining the circular economy concept (and not those which limit its definition to waste reduction and prevention) state that it is based on **two pillars**:

- **The 'cradle to cradle' principle** (McDonough & Braungart, 2002), which is twofold:
  - **Product design for durability, disassembly and refurbishment**: businesses should apply the principles of eco-design to all their products, i.e. use as little non-renewable resources, eliminate as many toxic elements and hazardous materials as possible, use renewable resources (at or below their rates of regeneration), increase the life and reuse potential of products, and facilitate, at the conception stage, the sorting and final recovery of products (IAU, 2013).
  - **"Modern circular and regenerative forms of consumption,** from anaerobic digestion of household waste to product recovery." Furthermore, models of consumption should change **from buyer to user**.
- **Industrial symbiosis :**
  - A **cross-sector approach** and **cooperation between actors** unaccustomed to cooperate (e.g. between product designers and recyclers), **along the whole supply chain of a product**, in order to optimise its life-cycle. It is the sharing of services (e.g., transport) (Ellen MacArthur Foundation, 2013), utility, and by-product resources among industries **in a territory**, creating synergies between businesses for economies of scale. The **spatial clustering** of collaborating companies is highly important as it makes the interconnecting of links in the supply chain and the exchange of residuals between links easier (TNO, 2013). However, in some cases exchanges are possible also at a geographical distance (e.g. implementation of the National Industrial Symbiosis Programme in the UK).

When applying circular economy concepts, resources in general can be distinguished into two categories:

1. **Technical materials** like minerals, metals, polymers, alloys and hydrocarbon derivatives (e.g. plastics), which are not biodegradable and are based on finite resources.
2. **Biological materials** from biological origin such as agricultural and forestry goods/commodities, bio-based wastes and residues, which are generally non-toxic and renewable to an extent as they are limited by the availability of land, water and nutrients and can be returned to the biosphere, where they act as nutrients.

The distinction between technical and biological materials as defined in the literature, is not always clear (e.g. biodegradable plastics). Furthermore, although **circularity** typically brings to mind the capture of such material flows, **a few studies equally apply the concept to the management of energy and water resources** within a closed loop economy. However the management of water has not been discussed further in this synthesis, and only limited focus has been placed on the management of energy**.** This is because most of the literature on circular economy focuses on technical and biological nutrients.

One of the founding principles of a circular economy is that waste should be minimized or virtually eliminated as it is "designed out" (Ellen MacArthur Foundation, 2013), of economic activities. In other words, the biological and technical components of a product are "designed by intention to fit within a materials cycle, designed for disassembly and re-purposing" (Ellen MacArthur Foundation, 2012).

2.3 Circular economy "loops"

This section presents the conceivable material loops a circular economy aims at creating. It presents technical nutrients and biological nutrients in turn.

2.3.1 Circular economy loops for technical nutrients (EMF, 2012; EMF, 2013)

According to the literature, there are four means (Ellen MacArthur Foundation, 2012) of achieving a circular economy for technical nutrients which are set out below in descending order of the value of the outcome:

i. **Reuse of goods**:
   a. A product (whether intermediate or final) is used again ("as-good-as-new"), for the same purpose as in its original form or with little enhancement or change (e.g. refillable milk bottles being reused for the same purpose).
   b. A product (whether intermediate or final) is used again for a different purpose than its original form with few or negligible improvements (e.g. using tires as boat fenders).

ii. **Product refurbishment or component remanufacturing:**
   a. *Product refurbishment*: A process of returning a product to good working condition by **replacing or repairing** major components that are faulty or close to failure, and making 'cosmetic' changes to update the appearance of a product, such as cleaning, changing fabric, painting or refinishing. Any subsequent warranty is often less than issued for a new or a remanufactured product, but the warranty is likely to cover the whole product (unlike repair).

b. *Component remanufacturing:* A "process of disassembly and recovery at the subassembly or component level. Functioning, reusable parts are taken out of a used product and rebuilt into a new product (Ellen MacArthur Foundation, 2012). In other words, remanufacturing means restoring used, discarded or traded-in product to "*like-new* condition". "The key term in this definition is like-new. From the viewpoint of the producers this represents the manufacturers' intent, their claim for the product and their ability to live up to that claim." (Lund, 1998) The remanufacturing process "includes quality assurance and potential enhancements or changes to the components" (Ellen MacArthur Foundation, 2012).

iii. **Cascading of components and materials:** Successive uses of a material across different value streams. It involves user-friendly, cost-effective, and quality-preserving collection systems; as well as treatment/extraction technologies that optimise volume and quality. For instance, in the textile sector, clothing can become furniture and then insulation material. Cascading use keeps materials in circulation for a longer period of time.

iv. **Material recycling:** "Any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations". Ellen MacArthur Foundation reports distinguish:
   a. *Upcycling*: converting materials into new materials of higher quality and increased functionality.
   b. *Functional recycling*: recovering materials for the original purpose or for other purposes, excluding energy recovery.
   c. *Downcycling*: converting materials into new materials of lesser quality and reduced functionality.

A circular economy approach for technical nutrients focuses either on the life cycle of a product across its value chain, or on industrial symbiosis, i.e. it can be cross sector (e.g., by-products of a company become the raw material of another producer: waste is a resource).

Eleven of the fourteen studies analysed in-depth for this literature review provide case studies on initiatives which create closed loops for technical nutrients. These case studies have been analysed in part.

2.3.2 Circular Economy loops for biological nutrients

In addition to cascading and industrial symbiosis approaches as identified as possible for technical nutrients, the literature review highlights the following means available to create a more circular economy in the field of biological nutrients:

i. **Cascading of components and materials:** As with cascading use of technical materials, this entails looking for other, higher value uses for constituent materials than material recycling of raw materials. It involves user-friendly, cost-effective, and quality-preserving collection systems; as well as treatment/extraction technologies that optimise volume and quality. For instance, in the paper sector. Cascading use keeps materials in circulation for a longer period of time.

ii. **Extraction of biochemicals**: "applying biomass conversion processes and equipment to produce low-volume but high-value chemical products, or low-value high-volume liquid transport fuel—and thereby generating electricity and process heat fuels, power, and chemicals from biomass. In a 'biorefinery' such processes are combined to produce more than one product or type of energy". (Ellen MacArthur Foundation, 2012)

iii. **Anaerobic digestion**: "process in which microorganisms break down organic materials, such as food scraps, manure, and sewage sludge, in the absence of oxygen (EMF, 2013)". This process generates biogas (methane and carbon dioxide) and a solid residual. The solid residual can be applied on the land or composted and used as a soil amendment, while biogas can be used as a source of energy similar to natural gas.

iv. **Composting**: "biological process during which naturally occurring microorganisms (e.g., bacteria and fungi), insects, snails, and earthworms, break down organic materials (such as leaves, grass clippings, garden debris, and certain food wastes) into a soil-like material called compost. Composting is a form of recycling, a natural way of returning biological nutrients to the soil" (Ellen MacArthur Foundation, 2012). Compost can be used as a non-toxic ingredient in agricultural fertilizers.

2.3.3 Energy recovery and landfilling

After options with cost and resource savings have been exhausted or can no longer be chosen by economic actors due to the quality degradation constrains, the final *loop* for products would consist of energy recovery. Energy recovery can be defined as a process in which "waste materials can be converted into useable heat, electricity or fuel" (Ellen MacArthur Foundation, 2012), through combustion, gasification, pyrolysis, combustion of biogas from anaerobic digestion, or landfill gas recovery.

Finally, landfilling (i.e. disposing of waste in a site used for the controlled deposit of solid waste, onto or into land[1]) is considered as the last end-of-life solution for non-recyclable waste. The Ellen MacArthur Foundation states that a circular economy would avoid it and "would try to extract the maximum value from used products and materials", because landfilling creates negative externalities such as "its impact on land use—including the societal burden associated with siting choices—and greenhouse gas emissions (Ellen MacArthur Foundation, 2012)." Previously, some[2] have envisioned landfills as having the potential to become the "mines of the future" and thus grow to be part of the circular economy loop. However, whilst extraction from historical landfills may be part of a future vision of a circular economy, this does not logically support the case for unnecessary landfilling within a future circular economy.

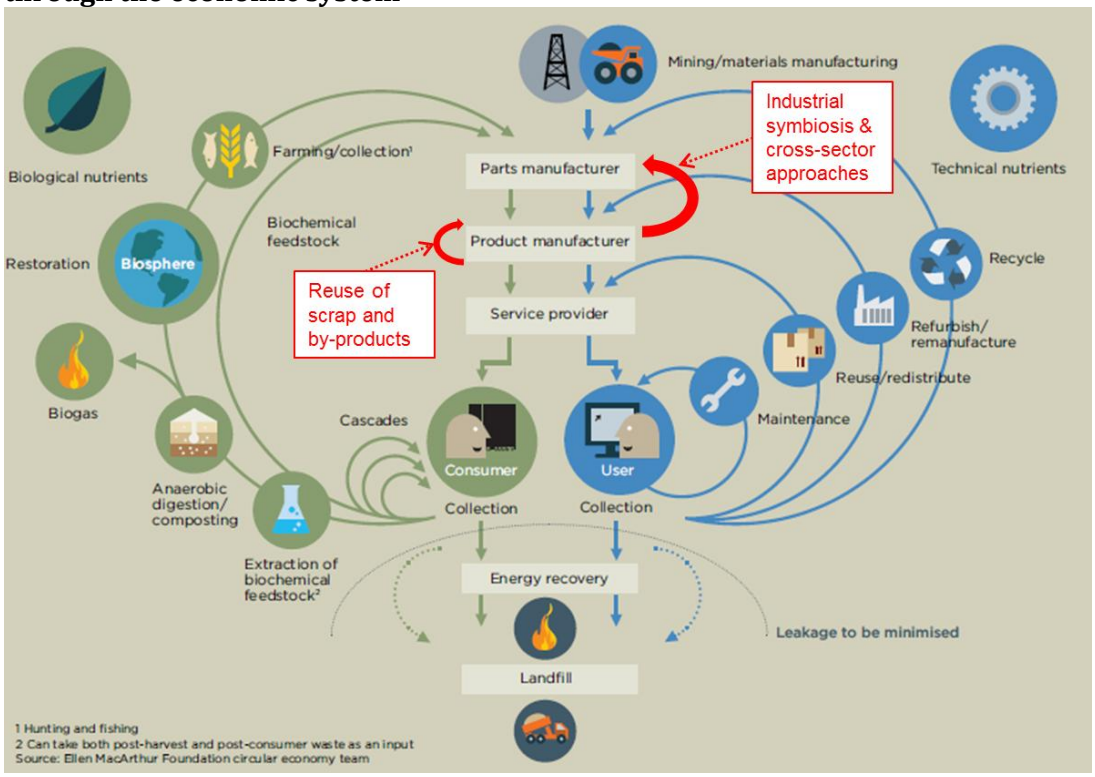
The figure below, taken from the second report of the Ellen MacArthur Foundation (2012), illustrates how technological and biological nutrient-based products or materials can cycle through the economic system. The project team has added to this figure the red arrows and the comments in red, to show that some strategies such as industrial symbiosis can create circular

[1] Landfill definition of the Council directive 1999/31/EC

[2] such as the 'e-Waste Academy', co-organized by the United Nations University and the Global e-Sustainability Initiative (GeSI)

economy "loops" among manufacturing companies, without necessarily involving end users of a product.

Figure 4: Means by which technical and biological -based products or materials can cycle through the economic system



Source: Adapted from second 2nd report of the Ellen MacArthur Foundation (2012)

3 Barriers to a circular economy and how they can be overcome

Drivers and barriers have first been described and analysed for the **general framework conditions** necessary to move towards a circular economy, before being examined for each major stage of value chains/ supply chains: **Design and production; Consumption;** and **Recycling and recovery.** Lastly, as the transition to a circular economy has implications for logistics flows at all scales, drivers of a circular economy and associated barriers have been considered in the field of logistics. Logistical issues and solutions are cross-cutting, i.e. relevant at any stage of a value chain.

Whether drivers and obstacles are stemming from policy, regulation or the legal framework, or linked to social, cultural, economic, technological or infrastructural contexts, there is rarely only one driver in one sector or value chain. Typically several factors are in play and often the factors influence each other. For instance, the infrastructure to support the efficient collection of products after use, i.e. "reverse cycles" (Ellen MacArthur Foundation, 2012) or "reverse logistics" (Hawks, 2006), which is an essential component for a circular economy, can be heavily influenced by various levers: policy instruments (such as landfill tax), extended producer responsibility (EPR), new business models and take-back schemes. The list of examples below is non-exhaustive but primarily targets policy-oriented drivers. It is shown in Annex 1**.**

Actions towards a circular economy to date have mainly been driven by value maximization along the value chain and the interest in continually reintroducing assets to markets. Once a material is seen as an investment and customers as users, it makes business-sense to maintain the customer relationship during multiple cycles. The policies which enable business models and value chains to be more circular, in every sector and along any value chain, are the ones which:

- Encourage manufacturers to design products with asset recovery in mind and to take into account the true cost of materials;
- Encourage the development of product lines that meet demand without wasting assets;
- Incentivise businesses to source material from within regenerative loops, rather than from linear flows;
- Enable businesses to develop a revenue model that generates value at all parts of the value chain; and
- Get customers/ consumers to change their consumption and ownership patterns.

This literature review has identified the following gaps which currently act as barriers to the development of a circular economy, and therefore where further consideration of policy action may be beneficial in promoting the circular economy:

- The **lack of internalisation of externalities** through policy or other measures and the **lack of resource pricing** (cost recovery and pricing for the resource itself), which lead to economic signals that do not encourage the efficient use of resources (i.e. as there are greater incentives to use materials more effectively) or a transition to a circular economy (i.e as resources become more costly there are increased incentives to reuse/recycle materials);
- The **lack of skills and investment** in circular product design and production;

- The **lack of enablers** to improve cross-cycle and cross-sector performance due inter alia to non-alignment of power and incentives for transformation between actors within and across value chains;
- The **lack of consumer and business acceptance** regarding consumer-as user, and performance-based payment models;
- The **lack of know-how and economic incentives** including for repair and reuse;
- The **lack of consumer information** on origins and perishability of products;
- The **lack of waste separation at source** (especially for food waste and packaging);
- The **lack of sustainable procurement incentives** for public authorities;
- The **lack of investment and innovation** in recycling and recovery infrastructure and technologies, (related to this is the lock-in of existing technologies and infrastructure);
- The **lack of harmonisation of transport flows systems** between municipalities, which leads to confusion among shippers and transporters.
- Weaknesses in **policy coherence** (e.g. bioenergy and waste policies);
- Widespread **planned obsolescence** within product chains**.**

This list is non-exhaustive but covers the main barriers to the development of a circular economy.

From a policy standpoint, addressing these barriers means:

- **Encouraging economic players to take into account the economic value of their environmental externalities** through for example:
    - ***Regulatory requirements*** such as the ones posed by the Extended Producer Responsibility (EPR) principle. EPR promotes the integration of environmental costs associated with goods throughout their life cycles into the market price of the products, and, thanks to financial incentives, encourages manufacturers to design eco-friendly products by holding producers responsible for the costs of managing their products at end of life. This policy approach differs from Product stewardship (where responsibility is shared across the value chain of a product), and attempts to relieve local governments of the costs of managing certain priority products by requiring manufacturers to internalize the recycling cost within the product price. Other relevant regulatory requirements include those related to product design and standards.
    - ***Economic incentives and tax measures*** strong enough to change business behaviour, and to encourage the recovery of more secondary raw materials, such as the phosphate levy which fosters the recovery of phosphate from sewage and the use of high quality, secondary sources of phosphate in agriculture.
- **Encouraging the development of skills, awareness and investment in circular product design and production, as well enabling to improve cross-cycle and cross-sector performance**, through for example:
    - Support programmes for ***investment in R&D and eco-innovation*** (e.g. support investment in 3D printing technology and determine which components are most suitable to it).
    - Support integration of circular design concepts and reusable parts through investment support (e.g. Framework Programme Renewable Resources Germany, € 800m fund).
    - The development of an extensive raw materials ***information*** service, providing – *inter alia* - data on primary and secondary raw material production, prices, and

supply risks, and increase the dissemination of knowledge about the development of new materials.
    - The promotion of ***cleaner production (CP) methods,*** in particularly in SMEs, by offering a production-integrated environment protection tool (e.g. a guidance manual or electronic tool) where the relevant material flows and current level of production technology are analysed, and where recommendations are made. CP methods emphasize on *prevention* rather than control of pollution, waste, etc.

- **Encouraging the improvement of cross-cycle and cross-sector performance,** through for example:
    - The development of a free-to-business ***advice and networking*** programme at a regional level to identify resource exchanges between companies for sustainable resource management solutions – e.g. National Industrial Symbiosis Programme (NISP) (UK).
    - The development of local networking for ***industrial symbiosis*** opportunities, perhaps via an internet application.
    - The availability of (public or private) ***planning agencies*** who would perform, in a given territory and for the industries of this territory, every function required to turn the industries' by-products into feedstocks, including finding appropriate uses, dealing with regulatory agencies, brokering necessary agreements, and even transporting the materials from the waste/ by-product generator to the user.

- **Encouraging a change in consumption patterns,** through for example:
    - The support and promotion of innovative ***leasing and rental contracts*** (pay-per-use instead of ownership). When goods vendors embrace the idea of themselves as service providers, this can lead not only to an effective hedge against cost volatility but also strengthens the customer relationship and increases the upsell, such as in Vodafone's Red-Hot plan[3] (customers can rent the latest phone for a year and keep on exchanging it for a newer version; while Vodafone is engaged in collecting the old phone, which enables material collection and pooling and creates deeper customer relationships).
    - The support and protection of the ***'peer economy'*** (collaborative consumption) and of initiatives promoting repair and reuse, such as the creation of 'repair cafés' (see table below for further detail).
    - The development of ***consumer knowledge/ awareness*** on perishability of products (e.g. GS1 DataBar, informational barcode about the shelf life of a product) and on origins of products (certification, labelling).
    - The development of ***incentives*** such as PAYT (Pay as you throw) or DIFTAR, a system of differentiated tariffs where citizens are charged according to the amount and type of waste they generate.
    - Regulation to ***separate food and packaging waste collection*** at source.
    - The development of ***obligations for public-sector agencies and government*** departments to purchase resource-efficient and cradle-to-cradle products.

- **Encouraging investment and innovation in recycling and recovery infrastructure and technologies** through for example:

[3] See Vodafone website: https://www.vodafone.co.uk/shop/pay-monthly/vodafone-red-hot/

- Investment support in regional ***infrastructure and*** for companies seeking to develop innovative recycling and recovery ***technologies*** (e.g. Starbucks actually aims to turn thousands of tons of its waste coffee grounds and food into everyday products by using bacteria to generate succinic acid which can then be used in products such as detergents, bio-plastics and medicines[4]).
- The set-up of Business parks, Business Improvement Districts and other ***clusters*** of SMEs to facilitate collective long term contracts for recyclable waste collections. This will make it cheaper to invest in collection and recycling infrastructure.
- The ***harmonisation of the quality criteria*** of the end-of-waste status across the whole of the EU. Furthermore, progress remains to be made regarding the status of a 'by-product' or the concept of 'reuse', to comply with the waste management hierarchy, which emphasizes reuse before recycling.
- The ***removal of a number of regulatory obstacles*** to the use of biotic waste streams, such as in the Dutch Environmental Management Act (chapter 10).
- ***Developing understanding of the feedstock base***, ***competing uses and consequences for upcycling***, e.g. using straw for the bio-economy removes it from fields where it acts as a soil improved. A key question is to understand when wastes are truly waste with no other competing uses. .
- Incentives for suppliers and retailers to establish ***mandatory take-back arrangements*** if a product remains unsold (magazines, bread, etc.)

- **Encouraging the harmonisation of transport flows systems between municipalities, which currently often leads to confusion among shippers and transporters** through for example:
  - ***Streamline transport flows and urban distribution*** through business-to-business concepts such as Green City Distribution, Binnenstadservice, Cargohopper (in the Netherlands); business-to-consumer concepts such as DHL; system solutions (partnership between retailers on the same street or by sector/product; cooperation between transport companies). Digitisation is one of the tools available to shape partnerships.[5]
  - Inviting shippers to develop ***concepts for city logistics through innovative tendering*** (i.e. flexible and incentivising) ***and supply chain-transcending cooperation***. Tenders would formulate clear end goals, including noise and air emissions, maximum number of transport movements, and load factor for both inbound and outbound flows, service logistics, and involvement of all stakeholders.

[4] See Starbucks website
[5] *Dutch Logistics 2040*, *Designed to last* , Council for the Environment and Infrastructure study (2013)

4 Priority sectors, products, material flows and value chains

4.1 Background

This scoping study explores which materials, products and sectors constitute policy priorities for increasing circularity in the EU. Priority areas are those which have a potential for greater circularity and EU policy intervention can play a role in achieving these opportunities.

This section presents the prioritisation process and the priority areas identified in this scoping study. The findings are further complemented by an analysis of the winners and losers in four selected case studies, presented in section 6.

The prioritisation process is broken down in this section into the following three stages:

1. We first explore which **materials** might be considered priorities to reflect the cross-sectoral nature of materials and resources.
2. We map the **overlap between materials and key product sectors**.
3. This material-products mapping is then used to identify further **priorities amongst product sectors**.

This process has been done using a positive selection process whereby areas have been prioritised, rather than any area being rejected as not relevant to the circular economy. The prioritisation has been subject to comment and review from within the project team and Commission staff in the first instance, and then from input from the project's expert workshop. The outcome therefore represents a scoping level prioritisation and should be subject to review as further information becomes available, particularly about new circular economy opportunities in non-prioritised areas.

4.1.1 Sources and factors

A number of key existing studies explore the opportunities, challenges and scale of benefits of actions to enhance circularity in various resource areas and product sectors. They highlight and draw conclusions about the priority resources that ought to be targeted, and recommend the key changes to practices, products and infrastructure seen to be necessary. An important finding from reviewing this literature is that previous prioritisation exercises have not always provided a clear methodology of how they proposed the prioritisation that they have. The prioritisations will have been made from a particular perspective and will have weighted particular factors more heavily than others.

For example, the Ellen MacArthur Foundation in its second volume report analyses the consumer goods sector to identify the priority goods where the most substantial and underexploited opportunities for circularity lie. Comparing the areas with the highest potential for circularity with the degree of opportunities already captured today, the study highlights products such as furniture and washing machines as priorities within this sector (EMF, 2013).

A study by Green Alliance, on the other hand, takes the priority materials metals, water and phosphorus as a starting point due to their role as key inputs to the economy and the large quantities of these currently lost. The study then explores the barriers and proposes potential policy solutions to improve circularity in each of the three areas (Green Alliance, 2011).

The priorities identified in this study attempt to draw together the collective understanding from these different studies and approaches, and combine and contrast them for the first time across an integrated spectrum of both materials and sectors, incorporating expert input and judgement.

Priorities are assessed against a core set of key relevant factors from the literature and on the basis of available comparable information. These include: scarcity and economic dependence (materials only); environmental impact; potential savings (material, environmental and/or economic); feasibility; potential for job creation (sectors only) and overlap with priority materials and other sectors (sectors only).[6]

4.1.2 Caveats

The priority areas for increasing circularity in the EU proposed by this study are not definitive. While the analysis draws on and unites a wide range of existing literature and data to synthesise a list of priorities, the variety of methods, scales and scopes adopted by these various studies give rise to data availability and comparability issues in the analysis. Furthermore, the resulting proposed priorities are sensitive to the weighting assigned to the various assessment factors (e.g.: the relative importance of degree of environmental impact versus resource scarcity and economic dependence issues), which is largely subjective. Finally, considering the potential gains from greater circularity requires that assumptions be made about the specific circular economy transformation for each given material or sector; in reality, these may differ depending on technological developments, for example. This exercise has therefore needed to incorporate expert judgement; identification of detailed circular economy actions has been an occurring challenge throughout this scoping study and the purpose of the case study analyses as summarised in section 5. The tables used in the analysis and which are presented here may further serve as templates for future development as and when new information emerges.

[6] Other factors raised by participants in the Experts' Workshop for consideration included: social fairness; biodiversity; geographical scale; and revolutionary new technologies. Where relevant data was available, biodiversity considerations are included in the 'environmental impact' factor.

4.2 Priority materials

Table 1 shows the priority materials identified in this scoping study, alongside, where available, their outcomes against each of the core assessment factors. The key opportunities and challenges column explores sub-priorities along with feasibility issues for each of the materials tabulated. Water and land were additionally identified as priority resources by McKinsey Global Institute (water and land) and Green Alliance (water); these are not included in the table, but considered where relevant in the environmental impact factor. A more detailed table is included in Annex 2.

Based on the analysis of existing literature, the following emerge as priority materials:

- **Agricultural products and waste** – Prioritised by TNO (2013), The World Economic Forum and Ellen MacArthur Foundation (2014) and McKinsey Global Institute (2011), agricultural products are highly critical both globally and in the EU due to the rising levels of demand and food price volatility anticipated. Food waste in particular is highlighted as a sub-priority due to the extent of unexploited opportunities such as compost and energy, which promise savings in the billions. Emerging technologies have the potential to displace virgin material consumption (WEF & EMF 2014), and in the area of large-scale farm yields, a proportion of resource productivity opportunities are considered readily achievable (McKinsey Global Institute, 2011). Improving the resource productivity of agricultural products and waste face some feasibility issues, warranting policy intervention.
- **Wood and paper** – While high collection rates have already been achieved, there is both need and scope to improve the purity of recovered and recycled materials, with significant savings to be made if ink contamination and quality can be addressed in the reverse cycle for paper and cardboard.
- **Plastics** – Plastics are a priority material flow due to the long-term durability of waste plastic and the costs of petroleum, from which most plastics are derived. As with paper, collection rates for PET are already high, and instead the priority focus is on improving the purity of recovered and recycled materials in order to best retain value and minimise the environmental and economic costs of production and at end-of-life. The quality and purity of polymers PP and PE similarly need improving, as well as collection rates.
- **Metals** – Metals are identified by multiple studies as a priority area for circularity, such as McKinsey Global Institute (2011), TNO (2013), and World Economic Forum and Ellen MacArthur Foundation (2014). Metals have a high environmental impact (the iron and steel sector is the largest industrial emitter of CO_2 (BIO, 2010)), and are economically critical, with twelve metals reaching the top 20 non-energy, non-food raw materials identified by the European Commission as critical because of their economic importance and risk of scarcity (DG ENTR, 2014). There are already high collection rates for steel, but there is scope for and a need to improve purity for and in the reverse cycle. Iron and steel energy efficiency and end-use steel efficiency are key sub-priorities where opportunities are readily achievable (McKinsey Global Institute, 2011). There is a policy need to address those metals identified as economically critical, as well as the possible lost value of metals which leave the EU.
- **Phosphorus** – Also identified as a critical raw material (DG ENTR, 2014), phosphorus use in agriculture (more than 90% of phosphorus extracted annually) has undergone some substantial reductions already, and may be largely optimised. However, phosphorus might be further reduced by substituting phosphorus used for fertiliser (85-90% of phosphate rock extracted) with alternative nutrient sources such as sewage, animal and food waste.

In particular, **metals** and **agricultural products and waste** are the most commonly identified priorities by existing studies.

Chemicals and compounds are particularly notable for their cross-linkages and connection with purity issues for several of the other materials categories, such as paper and plastics. These are not proposed as a priority material on their own as such, but rather embedded within each of the priority materials and sectors identified in this study, e.g. in issues such as production practices and material purity.

The following materials were not taken as priorities by this scoping study:

- **Textiles** – Although collection rates are fairly low across Europe (25% of clothing for example is currently collected at end-of-use), and there remain some opportunities (e.g. encouraging clothing donations, 'clothing libraries, clothing repair services, leasing of clothes, use in other sectors, e.g. as insulation), textiles were identified as having lower potential for circular business practices (product design, reverse logistics and feasibility) (Ellen MacArthur Foundation, 2012). For example, textiles may have only a short usage period, and over time, recycling options are no longer possible due to the quality of the fibre, so the final loop for textiles would consist of energy recovery in various possible forms.
- **Rock, glass and ceramics** – Policy priorities include improving the purity of glass for recycling and further promoting the recovery and reuse of secondary (recycled) aggregates. However, these materials do not rival the environmental impact nor the economic risk of the materials prioritised above.
- **Fossil fuels** – Fossil fuels have both high significance for the economy and high environmental impact, but also substantial existing policy coverage, regulation, and policy feasibility issues.

Table 1: Priority materials identified in this scoping study

	Material	Prioritised by	Scarcity and dependence	Environmental impact	Potential savings	Key opportunities and challenges	Identified as a priority?
Forestry & agricultural products	**Agricultural products & waste**	• TNO 2013 • WEF & EMF 2014 • McKinsey Global Institute 2011	High	High	High	Need and some scope for improvement - some feasibility issues	Priority
	Wood & paper	• WEF & EMF 2014	Medium	High	Medium	Need and scope for improvement	Priority
	Textiles	*None*[*]	Low	Medium	Medium	Some scope for improvement: collection rates	-
Minerals, chemicals and compounds	**Plastics**	• Arcadis 2010 • WEF & EMF 2014	Medium	High	*No info*[†]	Need and scope for improvement: purity (PET and polymers) and collection rates (polymers)	Priority
	Metals	• Arcadis 2010 • EMF 2012 • Green Alliance 2011 • TNO 2013 • McKinsey Global Institute 2011 • WEF & EMF 2014	High	High	High	Need and scope for improvement: purity, material efficiency and value recovery	Priority
	Phosphorus	• Green Alliance 2011	High	High	*No info*[†]	Need and scope for improvement: substitution and improved practices	Priority
	Rock	• WEF & EMF 2014	Low	Medium	*No info*[†]	Scope for improvement: reuse and recycling	-
	Glass & ceramics	• WEF & EMF 2014	Low	*No info*[†]	*No info*[†]	Scope for improvement: purity of recycled material	-
	Fossil fuels	• Arcadis 2010 • McKinsey Global Institute 2011	High	High	*No info*[†]	Substantial existing policy coverage; feasibility issues	-
	Other chemicals & compounds	• RLI 2013 • Arcadis 2010	Some high	High	Embedded in savings from improved recycled quality of other materials	Need for improvement: contamination and material purity repercussions for other materials and products (e.g. paper and plastics)	-

KEY - Based on available information, outcome warrants priority consideration

[*] *Not identified as a key priority amongst sources reviewed.*

[†] *Not addressed in sources reviewed; or due to lack of availability of comparable information.*

4.3 Priority products and sectors

Table 2 illustrates the overlap and linkages between materials and a selection of key products and sectors. Plastics, metals and other chemicals and compounds are pervasive across multiple sectors and products.

Table 2: Overlap and key linkages between material flows, products and sectors

Material ↓	Priority?	**Packaging** incl. bottles	**Food** incl. production, distribution, consumption & waste	**Electronic & electrical equipment** incl. phones, home appliances, electrical tools, office equipment	**Transport** incl. automotive	**Furniture**	**Buildings & construction** incl. materials, production & design	**Apparel & fabrics**	**Cleaning & cosmetics** incl. soaps, detergents, makeup, etc.
← Cross-linkages		*Food, electronic & electrical, transport, furniture, apparel, cleaning & cosmetics*	*Packaging, transport, apparel & fabrics, cleaning & cosmetics*	*Construction, packaging, transport*	*Packaging, food, electronic & electrical, furniture, construction, apparel*	*Packaging, transport, fabrics*	*Electronic & electrical (machinery & tools, long-term lighting & energy-use design), transport*	*Packaging, transport, food*	*Packaging, transport, food*
Agricultural products & waste	✓		Food		Biofuels			Some animal products	Some animal products
Wood & paper	✓	Paper & cardboard			Some wood in boats etc.	Wood & paper	Wood		
Textiles						Textiles		Textiles	
Plastics	✓	Plastics		Plastics	Plastics used in automotives	Plastics	Plastics	Polyester	
Metals	✓	Metals used: aluminium, steel		Metals used: Steel, copper, aluminium, rare earths	Metals used in automotives: Steel, aluminium	Metals used: aluminium, steel	Metals used: aluminium, steel		
Phosphorus	✓		Phosphorus used as fertiliser in agriculture						Phosphorus
Rock							Rock used: Aggregates, limestone, gypsum, cement		
Glass & ceramics		Glass		Some glass	Glass		Glass		
Fossil fuels			Energy used in supply + unrecovered energy from waste	Energy	Energy & fossil fuels				
Other chemicals & compounds		Chemicals used in production	Chemicals used in production and preparation	Chemicals used in production	Coatings, adhesives, paints	Flame retardants, dyes	Paints, etc.	Flame retardants. dyes	Chemicals

← Product / sector

KEY	
	- Material has a non-negligible input to the product sector
	- Material has a small, non-negligible input to the product sector
	- Material input to this product sector is comparatively negligible
	- Identified as a priority material in **Table *1***

Table 3 presents the priority products and sectors identified in this scoping study. Using the outcomes from Table 2, the various sectors are correlated against their associated priority material flows and, together with available data for each of the assessment factors, priority sectors are established.

Based on analysis in the study and consultation with the European Commission, the following **products and sectors** are identified as priorities in this study:

- **Packaging**
- **Food**
- **Electronic and electrical equipment**
- **Transport**
- **Furniture**
- **Buildings and construction**

These sectors each comprise multiple priority material groups, and have some need and scope for greater circularity. Other potential priorities identified by participants at the experts' work-shop include:

- Fish and seafood products was highlighted as an area where there is potential for greater circularity in relation to consumption, energy, material use, which also links to the area of oil, fats and lubricants. It was noted that DG MARE is currently developing a strategy on sustainable fisheries, which includes energy-related aspects.
- Photocopiers and other office equipment were noted as another area which could yield important opportunities for pro- active design for remanufacturing. This is an area which is highlighted in the literature, however in some sectors opportunities for greater circularity have already been (or are being) explored and exploited by several manufacturers.
- Heating and cooling equipment.
- Professional power tools.

The following sectors were not taken as priorities by this scoping study:

- **Apparel and fabrics** – Apparel and fabrics were not prioritised as they were identified as a lower priority within the Ellen MacArthur study.
- **Cleaning and cosmetics** – This product sector does not share cross-linkages with as many priority material groups as the sectors prioritised above. Less than 10% of phosphorus is used for non-agriculture uses.

Table 3: Priority product sectors identified in this scoping study

Packaging incl. bottles	**Food** incl. production, distribution, consumption & waste	**Electronic & electrical equipment** incl. phones, home appliances, electrical tools, office equipment	**Transport** incl. automotive	**Furniture**	**Buildings & construction** incl. materials, production & design	**Apparel & fabrics**	**Cleaning & cosmetics** incl. soaps, detergents, makeup, etc.	← Sector/product
Food, electronic & electrical, transport, furniture, apparel, cleaning & cosmetics	Packaging, transport, apparel & fabrics, cleaning & cosmetics	Construction, packaging, transport	Packaging, food, electronic & electrical, furniture, construction, apparel	Packaging, transport, fabrics	Electronic & electrical (machinery & tools, long-term lighting & energy-use design), transport	Packaging, transport, food	Packaging, transport, food	← Cross-linkages with other sectors and products
• Arcadis 2010 • EMF 2013	• COWI 2011 • EMF 2013	• COWI 2011 • TNO 2013 • Arcadis 2010 • EMF 2012	• COWI 2011 • EMF 2012 • McKinsey Global Institute 2011	• EMF 2012	• COWI 2011	• EMF 2013	*None*[*]	← Prioritised by…
High	High	High	High	High	High	High	High	← Environmental impact (current)
High	High	Medium	Medium	*No info*[†]	Medium	Medium	*No info*[†]	← Potential savings
Already some instruments tackling this issue	Scope to limit waste, at end-user and through handling and transport	Both need and scope to improve collection rates, and design for disassembly and refurbishment	Scope to increase refurbishing levels, improve efficiency, and create jobs. Some feasibility challenges.	*No info*[†]	Need and scope to improve building energy efficiency, with measures considered highly feasible.	*No info*[†]	*No info*[†]	← Key opportunities and challenges
Paper & cardboard Plastics Metals (aluminium, steel)	Food Phosphorus	Plastics Metals (steel, copper, aluminium, rare earths)	Plastics Metals (steel, aluminium)	Wood Plastics Metals (aluminium, steel)	Wood Metals (aluminium, steel)	*No info*[†]	Phosphorus	← Associated priority material flows

[*] *Not identified as a key priority amongst sources reviewed.*

[†] *Not addressed in sources reviewed; or due to lack of availability of comparable information.*

Priority	Priority	Priority	Priority	Priority	Priority	*No info*[†]	*No info*[†]	**← Identified by this study as a priority?**

KEY - Based on available information, outcome warrants priority consideration

Table 4 explores further reasoning for selecting the sectors prioritised, along with the circular economy transformation envisaged. A preliminary mapping of the identified priority areas against their coverage by existing EU policies and scope for further measures is presented in section 5.3.

Table 4: Justification for prioritised sectors and products

Priority products and sectors	Key materials (priorities in **bold**)	Why is it a priority?	Envisaged circular economy transformation
Product packaging (incl. beverages)	**Plastics**; Wood; Paper & cardboard; Glass; Aluminium; **Steel**	- Resource efficiency - Waste reduction - Energy use	- Alternative delivery schemes with leasing arrangements - Coordinated deposit return schemes - Increased collection, reuse and recycling
Food and Food Waste	**Phosphorus**; Energy; biomass	- Food scarcity & security - Land use requirements for food provision and impacts on biodiversity - GHGs emitted & pesticides applied in production of food, especially that which is wasted - Competing uses for materials (e.g. energy) - Potential resource efficiency gains - Raw material security (phosphorus) - Environmental impact of food waste - GHG emissions from landfill	- Improve agriculture & land management methods (e.g. use natural fertilisers, reduce water use) - Substitute high impact products - Implement waste hierarchy (prevention, food banks, processing for food applications, feed, industrial resource, AD, composting, renewable energy, incineration, landfill) - Reduce waste throughout supply chain (e.g. reduce supply-side losses, encourage surplus-sharing among farmers)
Telecommunications (incl. mobile & smart phones)	Rare earths; Gold; Copper	- Environmental impact of production & disposal - Toxicity of heavy metals & materials - Energy saving requirements - Value of materials recovery - Scarcity of rare earth minerals - Concern for social impacts of disposal (e.g. in third countries)	- Design for increased recycling and materials extraction - Leasing models - Greater capture & refurbishment of old models - Modulation of components (consumer driven repair, refurbishment) - Bring back, take back and increased repair , recycling and materials extraction
Home appliances	**Fossil fuels**; Rubber; **Steel**; Aluminium; Copper	- Resource use: energy, water, detergents (phosphorus) - Environmental impact of end of life disposal/waste - Scale: applicable to several households - Pioneer economic actor towards greater circularity elsewhere	- Improved design to facilitate repair, reuse, refurbishment, & recycling - Leasing contracts & extended take-back-requirements linked to replacement - Sharing of long life, high performance products

		- Potential for action - sufficient scale, existing retail distribution network, limited number of suppliers	
Personal motor vehicles, trucks and motorcycles	**Fossil Fuels**; **Steel**; Aluminium; Rare earths; **Plastics**	- Scale: dominant transport mode for short-medium distances - Environmental impact of emissions - Energy use - Stricter CO_2 emission reduction requirements	- Improved design for repair, refurbishment and recyclability & end-of life material management - Longer product durability whilst maintaining the opportunity to exploit the environmental benefits of new developments and innovation (e.g. through modularity and remanufacturing) - Shift towards leasing & vehicle sharing - Innovation for improved performance & design - Increased fuel efficiency of vehicles
Industrial motor vehicles, ships, trains and airplanes	**Fossil fuels**; Rubber; Metals (**Steel**, Aluminium, Copper); **Plastics**	- Scale: dominant goods and passenger mode on long distances - Environmental impact of emissions - Energy use - Increasing price of resources & commodities - Increasing competition from emerging markets	- Shift towards leasing & vehicle sharing - Improved durability & remanufacturing possibilities - Improved management of end-of life material management - GPP
Furniture	Wood (timber) including forestry residues; Textiles; Aluminium; **Steel**; **Plastics**	- Resource efficiency - Waste product contamination (flame retardants) - Pressure on resources - Competing uses for materials	- Design for disassembly, repair, reuse, refurbishment & recycling - Improved collection rate - Increase in leasing
Buildings & public infrastructure	Wood (timber); Concrete; Aluminium; **Steel**; **Plastics**	- Resource and energy use - Rising commodities price - Resource constraints (esp. wood & timber) - Stricter landfill requirements - Higher energy efficiency targets/standards for buildings - Competing uses for materials	- Sustainable building practices (combined with service contracts) - Deconstruction design requirements - Higher resource efficiency of infrastructure (energy, water)

5 Mapping the current EU policy landscape

The transition to a circular economy requires a **systemic, multi-level governance approach** which takes into account the myriad of inter-linkages within and between sectors, along value chains and between actors (i.e. going beyond traditional sector / policy 'silos'). It includes policies and approaches which stimulate behaviour change among producers, consumers and public authorities. A range of policies and measures are already in place at EU, national, regional and local levels that address part of the transition to a circular economy. Several efforts are also underway by private actors and other stakeholders in this area.

These efforts are closely related to parallel discussions including the recently published **Commission package on the circular economy** (European Commission, 2014c) , which includes: a legislative proposal to review recycling and other waste-related targets, a green action plan for SMEs, a green employment initiative, and a communication on resource efficiency opportunities in the building sector). Other parallel discussions include the forthcoming **implementation of the Roadmap for a Resource Efficient Europe** (European Commission, 2011), implementation of the **7th Environmental Action Programme (7th EAP)**(Decision No 1386/2013/EU) , taking forward ambitions on the **green economy** (including work on the post-2015 development framework and the drafting of Sustainable Development Goals (SDGs), the **bio-economy** (European Commission, 2012a) where DG ENTR, DG AGRI, DG RTD and DG ENV are currently working to identify new value chains and markets, implementation of the **Europe 2020 Strategy** (including the mid-term review) and the on-going **European Semester process** (including country-specific recommendations). One of the main objectives of this study has been to **identify and assess key EU policies and instruments of relevance to the circular economy.** This mapping exercise aims to provide an overview of the current EU policy landscape to help identify the extent to which current policies (both environmental and non-environmental) already support the circular economy, the extent to which current policies may act as barriers to the circular economy, and the extent to which additional action is needed either in the form of new policies or revised/strengthened EU policies to fulfil their potential (i.e. broader scale, expanded scope, better implementation, more coherence). As this is a scoping study, the assessment remains at a more general level, building on the analysis in the study and insights from discussions at the experts' workshop organised for the study in Brussels on 8 May, it focuses in particular on the priorities identified in the study (and discussed in section 4 of this report), while also offering insights in other relevant areas.

To put EU efforts into a wider context, it is useful to note that policies to support the circular economy are being implemented in **countries across the globe** – see Box 1**.**

Box 1: Some examples of international approaches to supporting a circular economy

China: A law on the promotion of the circular economy was adopted in 2009 which focuses on the 3Rs (reduce, reuse and recycle) and a number of resources (water, energy, raw minerals etc.). A Circular Economy Development Strategy and Action Plan (2010-2015) has also been adopted and a system of 'Circular Economy Evaluation Indicators' set up to assess progress at provincial, municipalities and business level on energy consumption, recycling and reuse of resources, pollution and social development. Circular Economy Offices have been set up at the local level to provide advice to businesses and citizens. Several fiscal measures have also been introduced to foster the use of recycled products and the development of industrial symbiosis (CGDD, 2014). Efforts at different levels (business, industrial parks, regions/townships/urban systems) seek to support the transition through *inter alia* resource recovery, cleaner production methods and public facilities (Swiss Academy of Arts and Sciences, 2014).

Japan is considered a front-runner in supporting the development of a circular economy. Its approach is underpinned by several pieces of legislation including on the circular economy, resource efficiency, waste and several sectoral pieces of legislation. These policies set objectives and targets and have been complemented by a number of supporting policies, measures and approaches (e.g. top-runner programme, eco-towns, 3R awards, green public procurement etc.). Furthermore, there is an emphasis on 'eco-conception' (whereby products are designed so as to reduce the use of resources in production, repair and maintenance), a focus on substituting non-renewable resources with renewable resources, preference for local consumption, cyclical reuse of biomass and revitalization of local communities. Cooperation between stakeholders such as local communities, NGOs and companies is also emphasised (CGDD, 2014).

South Korea: The Government has adopted a Food Waste Reduction Policy which contains different food waste reduction programmes, such as campaigns for changing table settings, food waste-to-energy policy, use of food waste for fodder and compost and a ban on direct landfill of food waste – all of which aim to reduce the amount of food waste (COWI, 2011). The programme also has pay-by-weight food waste management system where rubbish receptacles are updated to contain RFID scanners with disposal fees billed based on the weight of the food waste a family generates (Legislative Council Secretariat, 2012).

United States: While there is currently no formal policy objective on the circular economy at the federal level, several actions have been taken at the State and local levels in this area. For example, in Madison (Wisconsin) the 'Construction Recycling Ordinance' requires new constructions and remodelling above a certain cost to reduce the amount of waste sent to landfill and has a 70% target for recycling concrete and steel debris. Chicago has a 'Construction and Demolition (C&D) Debris Recycling Ordinance' which sets a recycling target of 50% for all C&D waste (with an exception for wastes containing lead, asbestos and other hazardous materials). Contractors are also required to control and track the total amount of C&D debris produced and submit a 'recycling compliance form'. In Boulder (Colorado), the 'Green Building and Green Points Program' requires at least 50% of construction waste to be recycled and for at least 65% of total 'material by weight' generated from demolition to be diverted from landfill. San Jose (California) has a 'Construction, Demolition, Debris Deposit Program' which refunds fees paid by contractors/remodelers where they can show appropriate documentation of avoided landfilling of construction materials (The Delta Institute, 2011). Moreover, in November 2013, the New York City Council approved local law 2013/142, which banned the use single plastic-foam food and drink containers (styrofoam) from restaurants and food stores in the city. (NNC, 2013)

Sources:

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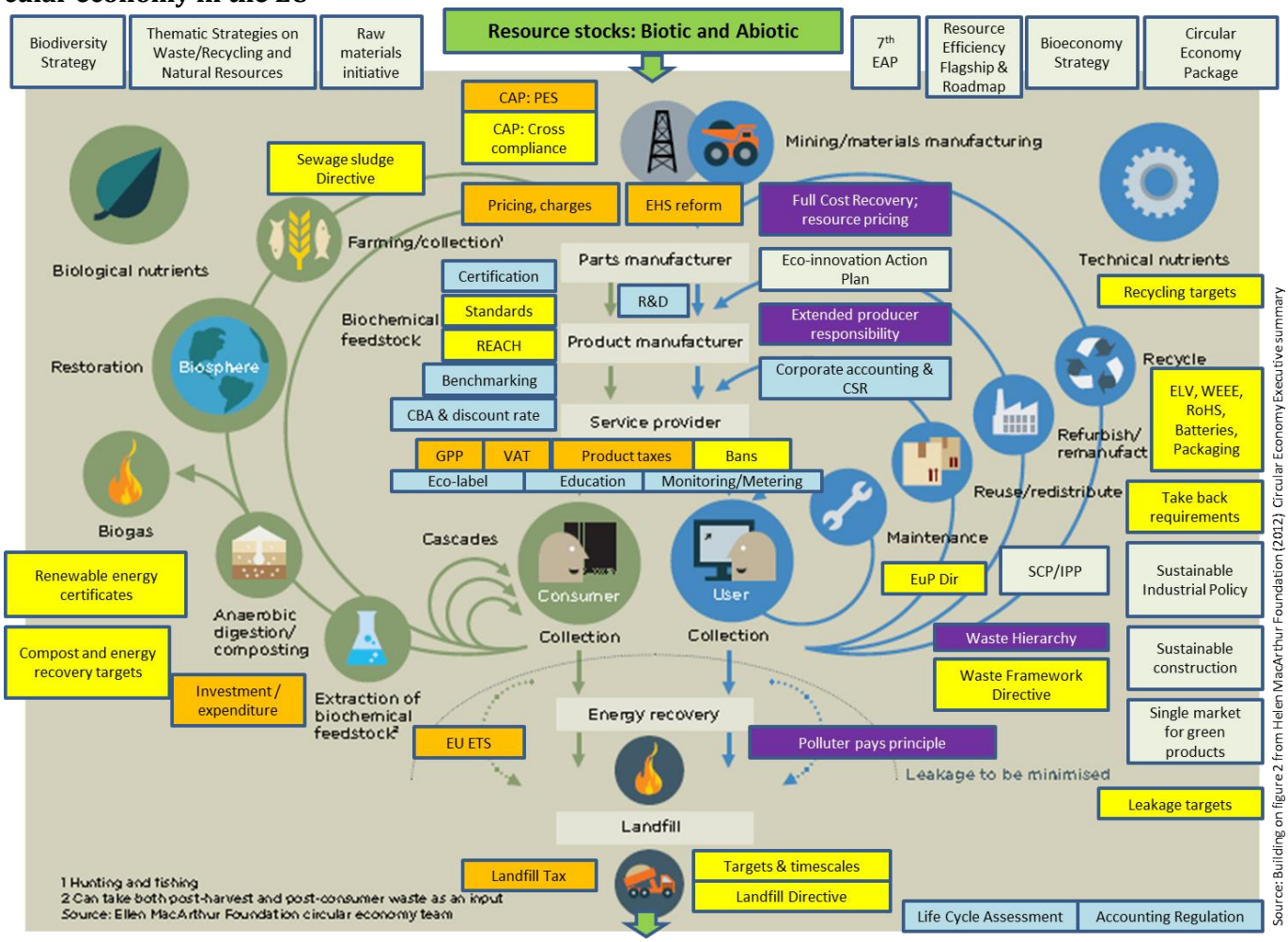
5.1 Current EU policies which support the circular economy

A **range of policies and measures are already in place** in the EU that support (or have the potential to support) the transition to a circular economy. This starting point implies that in a number of areas, the transition to a circular economy has an existing policy base and range of activities already underway on which it can usefully build. Figure **5** provides an **illustrative overview of the range of policies and approaches** at EU, national, regional and local levels that already play a role in different parts of the circular economy. This figure builds on the work in the 2012 report by the Ellen MacArthur Foundation. It does not aim to be comprehensive, but rather serves as an illustration of the myriad of interlinked policies and measures which support the circular economy in the EU.

Figure 5: Illustrative overview of existing instruments and approaches supporting a circular economy in the EU



Source: IEEP, building on Figure 2 from Ellen MacArthur Foundation (2012)

Key:

Regulation- yellow

Market based instruments - orange

Information tools – blue

Principles – purple

Strategies - light green

Existing policies support different stages in the circular economy.

Table ***5*** provides an overview of the different stages in the circular economy (distinguishing between technical and biological materials) and sets out some generic examples of supporting EU policies at each stage. The table includes some policies which are already driving the circular economy and those which have potential to support the circular economy, but have not yet reached their capacity for various reasons (e.g. inadequate implementation and/or limited scope).

Table 5: Illustrative overview of EU policies which support different stages in a circular economy

Stage	Some examples of supporting EU policies
Technical materials	
Extraction	Environmental Impact Assessment Directive (2001/42/EC); Mining Waste Directive (2006/21/EC); Raw Materials Initiative (COM(2008)699); Water Framework Directive (2000/60/EC)
Manufacturing	Construction Products Regulation (305/2011); Take-back requirements; Eco-design Directive (2009/125/EC); Waste electrical and electronic equipment Directive (WEEE) (2012/19/EU); Restriction of Hazardous Substances in Electrical and Electronic equipment Directive (RoHS) (2011/65/EU); Batteries Directive (2006/66/EC and 2013/56/EU); End-of-Life Vehicles Directive (ELV) (2000/53/EC); Type-approval of motor vehicles Directive (2005/64/EC); Packaging and Packaging Waste Directive (2004/12/EC); Directive on Industrial Emissions (2010/75/EU); Water Framework Directive (2000/60/EC); VOC Solvents Emissions Directive (1999/13/EC); REACH Regulation (1907/2006); Illegal Timber Regulation (995/2010); Ecolabel Regulation (No 66/2010); Energy labelling Directive (2010/30/EU), Product environmental footprinting (PEF).
Collection	Waste Framework Directive (2008/98/EC) requirements for setting up separate collection schemes for certain recyclables; Packaging and Packaging Waste Directive (2004/12/EC); Waste Electrical and Electronic Equipment Directive (2002/96/EC); Batteries Directive (2006/66/EC); Waste Shipment Regulation (EC/1013/2006). Investment in waste collection infrastructures supported by the EU Structural and Cohesion Funds.
Maintenance / Repair	Directive on the sale of consumer goods and associated guarantees (1999/44/EC)
Consumption	Funding awareness raising campaigns; voluntary commitments; product environmental footprinting (PEF), Eco-design Directive (2009/125/EC), Ecolabel Regulation (No 66/2010); Energy labelling Directive (2010/30/EU); PAYT systems for municipal waste; mandatory take-back requirements; Green Public Procurement Practices.
Reuse	Funding for R&D and innovation, investment in collection infrastructure, awareness raising campaigns, industrial symbiosis; Waste Framework Directive (2008/98/EC); Urban waste water treatment Directive (91/271/EEC); ELV Directive (2000/53/EC) targets on reuse; Packaging and Packaging Waste Directive (2004/12/EC) provisions on reuse and reusability; WEEE Directive (2012/19/EU) targets and provisions on reuse.
Refurbish / Remanufacture	Funding for R&D and innovation, investment in collection infrastructure, awareness raising campaigns
Recycle	Waste Framework Directive (2008/98/EC); End-of-Life vehicle Directive (2000/53/EC); Packaging and Packaging Waste Directive (2004/12/EC); WEEE Directive (2012/19/EU); Batteries Directive (2006/66/EC and 2013/56/EU); Funding for R&D, innovation and infrastructure; PAYT systems for municipal waste
Biological materials	
Cultivation / collection	Fertiliser Regulation (2003/2003); Pesticides legislation (including Directive 2009/128/EC); Raw Materials Initiative (COM(2008)699); Nitrates Directive (91/676/EEC); Sewage Sludge Directive (86/278/EEC); proposed Soil Directive; CAP; CFP; product quality and marketing standards Regulation (1221/2008); Renewable Energy Directive (RED) (2009/28/EC); Biomass Action Plan (COM(2005)628); Forest Action Plan (COM(2006)302); Water Framework Directive (2000/60/EC)
Extraction/ harvesting of biological resources	CAP; Landfill Directive; Eco-labels; Packaging and packaging waste Directive; RED (2009/28/EC); proposal on Indirect Land Use Change (ILUC)
Storage/ processing/ transport	Packaging and Packaging Waste Directive (2004/12/EC); Extended Producer Responsibility schemes; Investment in infrastructure, R&D, innovative business practices, clustering for industrial symbiosis
Consumption	Funding awareness raising campaigns; voluntary commitments; product environmental

Stage	Some examples of supporting EU policies
	footprinting (PEF), Ecolabel Regulation (No 66/2010); Energy labelling Directive (2010/30/EU);; PAYT systems for municipal waste; mandatory take-back requirements; Green Public Procurement Practices
Anaerobic digestion (AD)	Renewables obligations, incentives and feed-in tariffs; investment in R&D and infrastructure; Animal by-products Regulations; CAP; Renewable Energy Directive (RED)
Composting	Waste Framework Directive; standards for compost and digestate; proposed Soil Framework Directive; Landfill Directive; REACH Regulation; Classification, Labelling and Packaging Regulation; Communication on future steps in biowaste management in EU (COM(2010)235)

This overview illustrates that **current efforts are focused on certain stages** of the circular economy, notably manufacturing, collection and recycling (technical materials) and cultivation/collection (biological materials), with varying coverage, implementation and effectiveness across different measures (e.g. collection rates, infrastructure etc.). Policies to date have **focused primarily on recycling,** while various '**inner circles' or loops such as reuse, repair, refurbishment, remanufacturing and upgrading** have received limited policy attention. Some efforts in these inner circles or loops have been initiated by the private sector, civil society and citizens – see Box 2. These 'inner circles' have significant untapped opportunities, and could be supported through targeted action to ensure they are not neglected or overlooked (Expert input, April 2014). However these 'inner circles' are also more difficult for policy-makers to address and would require new approaches which involve more collaborative support and engagement of actors within and across value chains.

Box 2: Some examples of private sector and civil society initiatives supporting a circular economy

Leasing tyre scheme by Michelin: In the 1920s, Michelin pioneered leasing tyres under a pay-per-kilometre programme. As of 2011, Michelin Fleet Solutions had 290,000 vehicles under contract in 23 countries, offering tyre management (upgrades, maintenance, and replacement) to optimise the performance of large truck fleets. Currently in Europe, 50% of large truck fleets externalise their tyre management. By maintaining control over tyres throughout their usage period, Michelin is also able to collect them at the end of the leases and extend their technical life (e.g. by re-treading) and ensure a proper reintegration into the material cascade at their end-of-life (Ellen MacArthur Foundation 2013, p. 28; Stahel 2010, pp.122-123).

A food-business incubator in Chicago: The plant is an energy efficient, local-centric food business incubator which features a brewery, a commercial kitchen, an anaerobic digester, and research/education space. The waste produced by the micro-brewery are used to grow mushrooms, turned into compost for farming, or turned into briquettes and burned in the masonry oven used by bakeries in the building. Spent grains from the brewery are also fed to tilapia fish, while solids from the tilapia waste are fed to the mushrooms. The waste from one part of the farm thus serves as raw material for another part in order to create a net-zero energy system (Madden, 2013).

Recyclable cargo ships by Maersk: In 2013, Maersk Line together with the Korean shipyard DSME introduced the Triple-E class cargo ship which is engineered with the intent to be almost completely recyclable. The ship features a "Cradle-to-Cradle" passport which documents almost 95% of materials used during the construction of the vessel (MAERSK Line 2012; pp. 8-9).

'Power-by the-hour' contracts for Rolls-Royce: In 1962**,** Rolls-Royce introduced 'power-by-the-hour' contracts under which engine operators are charged accordingly to flying hours while the manufacturer operates maintenance of single engines (Bagnall, Shaw and Mason-Flucke, 1999).

Remanufacturing at Caterpillar: A remanufacturing division was set up in 1972. The company now has a remanufacturing portfolio of hundreds of parts which handled more than 70,000 tonnes of remanufactured products in 2010 (an increase from 45,000 tonnes in 2005) (Ellen MacArthur Foundation 2012; p. 28).

Reuse at Desso: The Dutch carpet manufacturer Desso was one of the first companies to actively implement a circular economy model and a "reverse supply chain". A polyolefin introduced in the manufacturing process enables carpets to be reused several times. All toxic chemicals within its carpets have been eliminated. Desso managed to increase its market share (from 15% in 2007 to 23%) and at the same time increase its profit margin per carpet from 1% to 7% (Ellen MacArthur Foundation 2012; p. 28).

WorldLoop is an international non-profit organisation which provides high-quality used computers donated by companies, after making them ready for use, to education, medical and social projects in developing countries. This is combined with collection and recycling systems that reduce the negative impact of electronic waste in developing countries (WorldLoop, 2014).

Sources:

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5.2 Current policies that (may) act as barriers to the circular economy

The analysis undertaken for the study and input from discussions at the experts' workshop has also identified some EU policies which can act as barriers to the transition to a circular economy. Some examples of such barriers and their implications for the circular economy are briefly set out below. This is an **initial identification** of barriers which merit further, detailed assessment to determine the precise nature of the barrier posed and relevant action to overcome this.

- **Definitions in EU waste legislation** currently leave room for some uncertainty over when materials should be classified as waste, a product/secondary material (often based on specific end-of-waste criteria) or a by-product. There is at least anecdotal evidence that this lack of clarity can cause difficulties with regard to the reuse of certain materials, hampering their re-injection into the value chain/production cycle (Expert input, 2014). This may, for example, take the form of legal restrictions e.g. export restrictions, or the classification of usable secondary raw materials as waste, resulting in reduced market value. In addition, although there is a definition of recycling provided in the Waste Framework Directive, there can still sometimes be a lack of transparency on recycling processes used or the recycled content present in products. This could perhaps be addressed through enhanced provisions in eco-design criteria to improve the visibility of recycled content in products, or to encourage the use of recycled and/or recyclable materials. Definitions in EU waste legislation could also be revised, or further guidance provided, to increase clarity and coherence across different pieces of legislation, e.g. to further clarify when materials should be classified as waste, a product/secondary material or a by-product; what constitutes recycling and recycled content.

- There is also, to some extent, a **lack of clarity in the application of the waste hierarchy** to specific types of waste, despite the Waste Framework Directive's call for Member States to 'support the use of recyclates […] in line with the waste hierarchy [and] not support the landfilling or incineration of such recyclates whenever possible'. The lack of methodical application of the waste hierarchy can result in some waste materials being used in a way that is sub-optimal in terms of environmental impacts/benefits. On this

point, further research into the **'cascading use'**[7] of certain types of waste may be beneficial as well as improved understanding of when wastes are truly waste with no other competing uses, e.g. using straw for the bio-economy removes it from fields where it acts as a soil improved.

- The **Renewable Energy Directive (RED)** (2009/28/EC) contains targets to deliver 20% of the overall share of energy from renewable sources by 2020 and within this 10% of energy from renewable sources in transport. The Fuel Quality Directive (30/2009/EC) also requires a 6% reduction in the greenhouse gas intensity of fuels by 2020. Most Member States have primarily sought to meet their volume based targets through biofuels as opposed to other options (e.g. energy efficiency, electrification, hydrogen etc.), opting for conventional biofuels (from food and feed crops) rather than more advanced conversion techniques that utilise wastes and biomass which, depending on the feedstock have already been through a cascade[8]. While the drive towards renewable energy is critical for a low carbon Europe, current policies combined with market readiness and lower costs associated with the use of biomass for energy have in some cases been incentivising the use of biological resources (including forest products and agricultural crops) as biofuels and solid biomass for heat and electricity, over their 'cascading use' (Keegan, Kretschmer et al. 2013). To adopt the 'cascading use' concept to deliver a more efficient management of biological resources requires a common or at least coordinated policy approach to ensure decisions on use and prioritisation of use are based on the collective whole and the added value delivered to society. This would require a more comprehensive approach to biomass and biowaste (e.g. through a framework directive on biomass or biological resources or a roadmap) which ensures coherence with other policies and goes beyond the current focus on energy to explore other opportunities for cascading use (IEEP 2014c, forthcoming). This could be complemented by a revision to the RED which requires Member States to consider the most effective use of resources to generate energy when drafting their National Renewable Energy Action Plans.

- The **VAT Directive** (2006/112/EC) provides an EU-wide common system of VAT on goods and services bought and sold for consumption within the EU. Reduced rates of VAT may be applied to supplies of certain goods and services which include for example foodstuffs or drinking water. In some cases, the application of reduced VAT rates can be seen as going against circularity and resource efficiency related objectives, e.g. by encouraging greater levels of food and water consumption (Withana et al., 2012). This is for example recognised in a 2012 consultation paper by the European Commission which questions whether a reduced VAT rate on water is compatible with resource efficiency objectives and whether social objectives could be better achieved by other means (European Commission 2012). In some cases the application of reduced VAT rates can support the circular economy – for example, 13 Member States interpret previsions under the Directive which allow VAT rates to be fairly low, or close to zero, for donated

[7] i.e. that activities are prioritised based on the level of added value they provide to society and the ability to 'reuse' the biomass after the original use (e.g. combined digestion, composting) (Keegan, Kretchmer et al. 2013)

[8] Some biological resources have already been down the cascade and are used for energy (municipal waste incineration, AD from manure etc.), whereas others have not. In some cases certain sources of biomass may not have a cascade route, e.g. dedicated energy crops.

food close to its 'best before/use by' date, Belgium applies reduced VAT rates on reused clothes etc. Given preferences for a single VAT rate with as little exceptions as possible and concerns about the actual benefits of reduced VAT rates, the scope for action in this area may be limited. However one option could be to review the scope of reduced rates allowed under the VAT Directive and develop further clarification and guidance on what is and is not allowed within the scope of the Directive.

- Lack of knowledge on relevant **EU Food Hygiene Legislation** (including Regulation (EC) 852/2004 and Directive 2004/41/EC) and concerns about the unclear legal liability that might arise from food donations (EC, 2013c) may discourage the donation of surplus food to food banks. EU Food Donation Guidelines for food donors and food banks on how to comply with EU Food Hygiene legislation (types of food suitable for donation, conditions for transport and traceability, legal liability, etc.) could improve this situation, as for example is already provided in German legislation[9] (European Commission, 2013b). The Good Samaritan Law is a legal framework originally adopted in the US which limits the liability exposure of food companies for products donated to charities. Italy is the only European country to date to have passed similar legislation ('Legge del Buon Samaritano', 155/2003) in 2003. The Law only covers companies that make good-faith donations of products they know to be fit for consumption at the time of the donation. For example, the Law allowed Italian food banks to recover surplus meals from mass catering and surplus food from retailers. Such approaches are, however, controversial and there have been warnings of potential perverse consequences, e.g. providing a disincentive to reduce food waste, could be considered a 'solution looking for a problem' (House of Lords, 2014).

- **EU Animal By-products Regulation** (EC 142/2011) prohibits the feeding of animals with catering waste that contains or has been in contact with animal by-products. As most food waste at the retail stage is mixed, it is difficult to separate out food that has come into contact with animal by-products and food which has not. However, it has been said that restrictions could be removed, as long as robust systems are in place for the safe and centralised collection and processing of such waste in order to protect animal and human health. For example, a UK organisation The Pig Idea[10] is advocating reform of the EU Regulation on animal by-products to allow food waste, including catering waste, to be diverted for use as pig and chicken feed; introduce a robust legal framework to ensure that it is processed safely and that outbreaks of animal diseases are prevented. Some countries, such as Japan and South Korea, operate such a robust system, however, opponents argue that concerns over exotic animal diseases are currently too sensitive to relax existing measures. The discussion would benefit from a review of the applicable legislation (House of Lords, 2014).

- Legislation on the provision of information to consumers on **labelling, presentation and advertising of foodstuffs** (Regulation 1169/2011) requires use-by and best-before dates

[9] Bundesministerium für Ernährung und Landwirtschaft (2012), 'Leitfaden für die Weitergabe von Lebensmitteln an soziale Einrichtungen – Rechtliche Aspekte', URL: http://www.bmelv.de/SharedDocs/Downloads/Broschueren/LeifadenWeitergabeLMSozEinrichtungen.pdf?__blob=publicationFile [07/07/14]

[10] The Pig Idea (2014). URL: thepigidea.org/the-solution.html [14/07/14]

and instructions on special conditions of storage and use of packaging. Best before dates provide a stock management and food quality function within the food supply chain. Consumer confusion regarding durability of food based on information provided in these labels, and particularly best before dates, is considered an important cause of food waste (European Parliament, 2011). Targeted information campaigns could help increase consumers understanding of these labels. While food producers are cautious in determining minimum durability dates, the European Commission could explore possibilities to extend the list of foods which do not require best-before dates (e.g. those which currently only have them for quality rather than safety reasons). This action could be supported by promoting an alternative stock management practice within the food supply chain.

- **Directive on the sale of consumer goods and associated guarantees** (1999/44/EC) sets out a framework for the sale of consumer goods in the EU which seeks to guarantee a uniform minimum level of consumer protection, in particular, with regard to the event of goods not conforming to contract. The Directive requires that the total duration of the limitation period provided for by national law not be shorter than two years while consumers should have at least two months in which to inform the seller that a lack of conformity exists. This sets certain minimum time frames which could serve as default periods and/or limit consideration of longer periods. Alternatively it could form a basis to move to extended guarantees and warrantees, differentiated by the technical lifetime of the product. There is also a lack of awareness of the minimum two year guarantees as well as on the rights of consumers to take back products and sellers to take back products which could be addressed through better information and awareness raising activities.

In addition there are a number of other EU policies which may act as barriers to the transition to a circular economy for example, **consumer protection** legislation (e.g. misleading green claims could undermine efforts to inform consumers on more circular consumption practices), legislation on **product safety** (e.g. which require specific standards and rules on the safety of products sold in the single market could affect approaches to the more circular design of certain products), **transport safety and logistics** (e.g. which set specific criteria for the transport of certain products and/or components such as car batteries could have cost, infrastructure or administrative implications for reuse/remanufacture/refurbishment/recycling). These areas together with those briefly outlined above merit further, detailed assessment to determine the precise nature of the barrier posed and relevant action to overcome this.

The role of **international trade** in the circular economy is a contentious issue. On the one hand, international trade can be seen as a **driver** to a circular economy as certain elements in the chain of circularity (e.g. refurbishment, remanufacturing and reuse) could take place outside a particular country or the EU, where practical and appropriate, respecting relevant standards in processing and recycling and supported by due investments in these countries which can also contribute to broader goals of sustainable development. On the other hand, international trade can be seen as a **barrier** to further circularity, for example where trade leads to increased export of cars and other products such as electronic waste which may lead to a loss of important materials (i.e. catalytic converters) and reduced efficiency in extraction processes where these take place in countries with less stringent requirements and may le ad or contribute to problems of overcapacity in the EU, e.g. in the recycling sector (Expert input, 2014). In some cases, international value and supply chains can also complicate efforts to increase **transparency and**

labelling (for example given difficulties in certifying sustainability of processes in third-countries). Some observers suggest that the '**proximity principle'** could be applied to encourage 'inner circles' of repair, upgrade, remanufacture etc., at the local level (Expert input, 2014). This is, however, a complicated issue and needs further assessment (which goes beyond the scope of this study).

5.3 Scoping the extent to which additional action is needed

Building on an understanding of the different stages of the circular economy and the types of policy instruments which can be used to support them or act as barriers to them, the study has sought to scope the **extent to which current policies already support the circular economy and the extent to which additional action is needed** in the identified priority areas (see section 3). A synthesis of this scoping exercise is set out in Table 6 below which maps the priorities identified by the study team, their coverage by existing EU policies and opportunities for the further development of policies in these areas.

Table 6: Mapping coverage by existing EU policies and scope for further measures in identified priority areas

Identified priority areas	Coverage by existing policies, instruments & approaches	Potential policies, instruments and approaches
Sectors		
Transport – personal motor vehicles, trucks and motorcycles	- ELV Directive target to reuse and recover vehicles and components - Environmental Liability Directive (2004/35/EC) - Eurovignette Directive (2011/76/EU) - Directive on industrial emissions (2010/75/EU) - VOC Solvents Emissions Directive (1999/13/EC) - Renewable Energy Directive (RED) (2009/28/EC) and current proposal for revision - Fuel Quality Directive (30/2009/EC) and current proposal for revision	- **Improve product design requirements**: e.g. eco-design criteria, use recycled/recyclable materials, stricter CO_2 emission requirements - **Extended producer responsibility**: e.g. take-back requirements (e.g. on vehicles and/or specific components such as batteries), improve coverage of schemes; extended warrantees, expand scope of ELV to additional types of vehicles - **Fiscal incentives**: e.g. revise vehicle registration and annual circulation taxes (e.g. link to CO_2, pollution standards; recyclability); increase fuel taxes, bonus-malus schemes - **Improve implementation**: e.g. ELV Directive and WEEE Directive targets to reuse and recover - **Investment**: e.g. R&D and innovation, infrastructure in alternative transport modes, skills - **Information**: e.g. product passports detailing embodied emissions, impacts etc., encourage car sharing through development of online platforms etc., increase public awareness, design awards
Transport - industrial motor vehicles, ships, trains and airplanes	- Environmental Liability Directive (2004/35/EC) - Ship Recycling Regulation (1257/2013) - Green public procurement (GPP) - Directive on industrial emissions (2010/75/EU) - VOC Solvents Emissions Directive (1999/13/EC) - Renewable Energy Directive (RED) (2009/28/EC) and current proposal for revision - Fuel Quality Directive (30/2009/EC) and current proposal for revision	- **Improve design requirements:** e.g. extend eco-design criteria, use recycled/recyclable materials, CO_2 emission requirements - **Extend producer responsibility:** e.g. expand scope of ELV to other transport modes, e.g. 'End-of-Life Trains, Planes and Ships' Directive(s), extended warrantees, take-back requirements - **Improve implementation:** e.g. EU Ship Recycling Regulation - **Targets/bans:** e.g. recycling targets, landfill bans - **Fiscal incentives**: e.g. increase fuel taxes, reduce kerosene exemptions - **GPP:** e.g. criteria for materials, environmental performance, recyclability, warrantee lengths - **Investment**: e.g. R&D and innovation, infrastructure, skills, education - **Information**: e.g. increase public awareness and design awards
Construction – buildings and public infrastructure	- Construction Products Regulation (305/2011) standards for materials in construction - Waste Framework Directive (2008/98/EC) target for 70% of non-hazardous construction & demolition waste to be recycled by 2020 - Extraction charges in some MS - Mining Waste Directive requirement for environmentally sound treatment of extractive	- **Regulation:** e.g. design to integrate recycling requirements in construction products regulation, integrate disassembly / recycling requirements in building legislation, extended warrantees - **Targets/bans:** e.g. landfill ban on certain construction materials: e.g. clay, timber - **Fiscal incentives**: e.g. materials taxes/charges on aggregates or construction materials, increased landfill charges on demolition waste, refundable compliance bonds for contractors if certain criteria met - **Information:** e.g. labelling on the environmental performance of buildings, material use, recyclability and recycled content in construction materials, etc.,

Identified priority areas	Coverage by existing policies, instruments & approaches	Potential policies, instruments and approaches
	wastes, including minimising disposal, prioritising recovery and recycling. - Energy performance of buildings Directive (2010/31/EU) - Communication on Resource Efficiency Opportunities in the Building Sector (COM(2014)445)	- **Improve implementation**: e.g. Waste Framework Directive, Mining Waste Directive - **GPP:** e.g. as in Netherlands and Japan where public authorities are encouraged to use recycled materials in construction practices - **Investment**: e.g. R&D and innovation, infrastructure, skills of construction workers and architects
Products		
Home appliances	- Eco-design Directive (2009/125/EC) and implementing measures (Regulations by product group) - Waste electrical and electronic equipment Directive (WEEE) (2012/19/EU) - Restriction of Hazardous Substances Directive substances in electrical and electronic equipment (RoHS) (2011/65/EU) - Directive on industrial emissions (2010/75/EU) - VOC Solvents Emissions Directive (1999/13/EC) - Waste Framework Directive (2008/98/EC) - Directive on sale of consumer goods and associated guarantees (1999/44/EC)	- **Improve product design requirements:** e.g. revise eco-design Directive to integrate reparability requirements, use of recycled/recyclable materials, information on expected lifetime etc. - **Extend producer responsibility:** e.g. improve coverage of schemes/access of consumers/businesses, extend warranty periods for certain products - **Information:** e.g. awareness raising campaigns on how/where to recycle - **Targets/bans:** e.g. tougher targets in WEEE Directive, landfill ban - **Fiscal incentives:** e.g. primary materials taxes/product taxes [MS action], incentives for leased goods/goods with extended manufacturer guarantees, higher recyclability and other key environmental performance – e.g. vouchers, tax credits, reduced VAT rates - **Investment:** e.g. innovation, improved collection/recycling infrastructure, skills and education -
Smart phones and mobile phones	- Waste Electrical and Electronic Equipment Directive (2012/19/EU) target for collecting electronic waste - Restriction of Hazardous Substances Directive substances in electrical and electronic equipment (RoHS) (2011/65/EU - Directive on industrial emissions (2010/75/EU) - VOC Solvents Emissions Directive (1999/13/EC)	- **Improve product design requirements**: e.g. revise eco-design Directive to include use of recycled/recyclable materials, require provision of instructions for repair, increase availability of spare parts, information on expected lifetime, etc. - **R&D funding for innovation:** e.g. to allow modulation of components, to provide tools that safely delete personal data from devices such as smartphones, etc. - **Extend producer responsibility**: e.g. take-back requirements, improve coverage, extend warrantees - **Standardisation of certain elements:** e.g. screws, bolts, batteries and connectors

Identified priority areas	Coverage by existing policies, instruments & approaches	Potential policies, instruments and approaches
	- Waste Framework Directive (2008/98/EC);	- **Information:** e.g. awareness raising campaigns on how/where to recycle, design awards and software to delete sensitive information from devices such as smartphones. - **Targets/bans**: e.g. strengthen targets in WEEE Directive, landfill ban - **Fiscal incentives:** e.g. primary materials taxes/product taxes on use of rare earth materials, incentives for leased goods/goods with extended manufacturer guarantees, higher recyclability etc. e.g. with vouchers, tax credits, reduced VAT - **Investment**: e.g. innovation, centralised collection points, skills, education
Furniture	- Directive on Industrial Emissions (2010/75/EU) - VOC Solvents Emissions Directive (1999/13/EC) - Waste Framework Directive (2008/98/EC);	- **Improve product design requirements:** e.g. eco-design criteria, use recycled/recyclable materials and or reduction in use of flame retardants, modularity - **Extend producer responsibility:** e.g. establish take-back schemes for furniture, building on existing experiences e.g. in France - **Investment:** e.g. in improved collection/recycling infrastructure, skills and education - **Information:** e.g. eco-label for furniture - **Targets/bans:** e.g. landfill ban for waste wood, ban/restrict use of certain hazardous chemicals - **Fiscal incentives:** e.g. taxes/charges on material extraction, incentives for leased goods/goods with extended manufacturer guarantees, higher recyclability etc.
Material flows		
Plastics	- Packaging and Packaging Waste Directive (PPWD) set target of 25.5% recycling of plastic packaging by weight by 2008.[11] - Waste Framework Directive includes plastic in target to recycle 50% of household waste by 2020.[12]	- **Improve product design requirements**: e.g. revise eco-design directive, strengthen requirements in PPWD - **Extend producer responsibility**: e.g. extend coverage & scope, coordinate schemes for packaging with other product/waste streams - revise Waste Framework Directive / new Directives to address specific waste streams / amend existing producer responsibility Directives. - **Targets and bans**: e.g. tougher targets in PPWD for recycling plastic packaging, ban plastics in

[11] NB The recent proposal to amend existing EU waste legislation (COM(2014)397) would introduce a 45% recycling target for plastic packaging for 2020 and a 60% target for 2025.

[12] NB The recent proposal to amend existing EU waste legislation (COM(2014)397) would amend this to be a 50% by weight recycling and preparation for re-use target for all municipal waste, and introduce a new target for 1 January 2030 of 70% by weight recycling and preparation for re-use.

Identified priority areas	Coverage by existing policies, instruments & approaches	Potential policies, instruments and approaches
	- Proposal to revise the PPWD to reduce the consumption of lightweight plastic carrier bags (COM(2013)761), and proposal to ban landfilling of recyclable plastics by 2025 (COM(2014)397) - Some MS have introduced charges on plastic bags while others have introduced bans. -	landfill - **Fiscal instruments**: e.g. expand use of charges/bans on plastic bags, deposit refund schemes - **Increase investment in infrastructure**: e.g. centralised collection points, home/office pick-up - **Improve implementation:** e.g. of waste hierarchy, PPWD, Waste Framework Directive - **Investment in R&D and innovation:** e.g. multiple re-use bags, enhance plastics recyclability, biodegradable and/or compostable plastics.
Metals and steel	- ELV Directive for car components, - European Innovation Partnership on Raw Materials (RARE) - Packaging and Packaging Waste Directive target for 50% of metal packaging by weight to be recycled by 2008.[13] - Waste Framework Directive includes metallic waste in target to recycle 50% of household waste by 2020.[14] - Environmental Liability Directive	- **Improve implementation:** Strengthen Shipment of Waste Regulation (1013/2006/EC), ELV Directive - **Targets and bans**: e.g. tougher targets in PPWD for recycling metal packaging, tougher targets in Waste Framework Directive for recycling household metallic waste - **Improve product design requirements** Extend scope of Eco-design Directive (2009/125/EC) - **Extend producer responsibility**: e.g. extend coverage & scope, take-back requirements - **Increase investment in infrastructure**: e.g. centralised collection points, home/office pick-up - **Investment in R&D and innovation**: e.g. development of new technologies for substitution of critical raw materials
Phosphorus	- Fertiliser Regulation Raw Materials Initiative (COM (2011)25) and (COM(2014)297) - European Innovation Partnership on Raw Materials (RARE) - Nitrates Directive (91/676/EEC)	- **Fiscal incentives:** e.g. levy on primary phosphate consumption (or primary phosphorus extraction), tax on phosphorus in mineral fertilizers (e.g. DK) - **Regulation and targets:** e.g. Phosphorus recycling target (e.g. SE), mandatory phosphorus recovery from sewage sludge (e.g. DK), revise existing legislation (fertiliser Regulation, water) - **Subsidies:** e.g. subsidy for optimisation of sewage sludge treatment (e.g. in FR)

[13] NB The recent proposal to amend existing EU waste legislation (COM(2014)397) would introduce a 70% recycling target for metal packaging by 2020, an 80% target for 2025 and a 90% target for 2030.

[14] NB The recent proposal to amend EU waste legislation (COM(2014)397) would amend this to be a 50% by weight recycling and preparation for re-use target for all municipal waste, and introduce a new target for 1 January 2030 of 70% by weight recycling and preparation for re-use.

Identified priority areas	Coverage by existing policies, instruments & approaches	Potential policies, instruments and approaches
	- Water Framework Directive - Targets for phosphorus recovery - Phosphate levies in some MS - Organic production regulation - Regulation (EU) No 259/2012 amending Regulation (EC) No 648/2004 as regards the use of phosphates and other phosphorus compounds in consumer laundry detergents and consumer automatic dishwasher detergents - Communication on the sustainable use of phosphorus COM(2013) 517	- **Revise product standards:** e.g. to reduce/fix maximum amount of phosphorus per kg/tonne of a certain product. (e.g. soaps, fertilizers) - **Investment in innovation:** e.g. use of more efficient technologies to reduce waste during extraction, increase phosphorus recovery from sewage sludge at farm level (e.g. using 'manure injection' technologies)
Food and food waste	- Landfill Directive - Food waste target in Resource Efficiency Roadmap - Voluntary commitments in some MS (e.g. existing/forthcoming bans on landfilling of biowaste) - Awareness raising campaigns in some MS - Renewable Energy Directive (RED) - Forthcoming communication on sustainable food, and a new target in proposal to amend EU waste legislation (COM(2014)397) to reduce food waste by 30% between 2017 and 2025	- **Regulation, targets and bans**: e.g. ban landfill of bio-waste, mandate separate collection of bio-waste, target, revise legislation on **l**abelling, presentation and advertising of foodstuffs (use-by and best-before dates), standards for compost and digestate, clear definitions of wastes & residues eligible for support under RED, clarify status of by-products, encourage donations by addressing liability issues e.g. Good Samaritan laws - **Better implementation:** e.g. of waste hierarchy - **Fiscal incentives:** e.g. tax/pay-as-you-throw charges on biowaste disposal, tax breaks to encourage donations of edible unsold food. - **Encourage food waste as fodder policy:** e.g. lift ban on feeding (heated) catering waste to animals - **Voluntary commitments and supply chain cooperation:** e.g. between retail sector & government (e.g. UK), between retail chains and suppliers (e.g. NL). - **Labelling**: e.g. on product footprints (embedded carbon, water), sustainability (e.g. for social and environmental criteria) to encourage more conscious purchases - **Awareness raising campaigns**: e.g. public (on food storage, low meat diets etc.), retailers - **Investment:** e.g. technology upgrades, post-harvest technologies, skills of food chain personnel, infrastructure such as centralised collection points, clustering activities.

6 Case study analysis of prioritised circular economy areas

Four case studies were developed by the study team to provide a more detailed understanding of circular economy opportunities that exist within different prioritised areas identified in section 4, the structure and power relationships between relevant actors and potential winners and losers if the transition to a circular economy occurred. The rationale for this approach is that it is necessary to combine these three factors in some detail before effective and practical policy options can be developed. The following case studies were selected in consultation with the European Commission and were intended to ensure that a range of aspects of the circular economy are explored in more depth in the study. The case studies include:

1. **Mobile and smart phones** which are an illustration of high-tech products which shows signs of growing consumer interest and participation within the circular economy, and therefore potentially a pioneer product which exhibit many of the issues faced by other electronic product areas.
2. **Food supply chains** are central to many biological materials and represent an area subject to significant levels of waste, associated environmental impact and therefore merit policy attention to support more circular action.
3. The optimal use of **steel** explores the use of high-strength steels and de-materialisation within products chains. This case study illustrates the systems level link between a prioritised material and a number of prioritised product supply chains, including construction and transport.
4. **Plastics** focusing on **the packaging and automobile sectors** explores the greater use of bio-plastics in food packaging and the greater use of plastics in automobiles as a means of further decreasing weight and therefore fuel efficiency.

The structure of each of these supply chains was explored, alongside the points of power and influence within them, and the various winner and losers within the system in the case that transition or intervention were to occur. A summary of key points from the case studies is outlined in the below section, with full details provided in Annex 6.

6.1 Case Study #1: Mobile phones and smart phones

This case study suggests that there are a large range of opportunities for actions which improve environmental performance and promote greater circularity in mobile phone and smart phone value chains. One way to look at the opportunities for greater circularity is to look at the value of the handset at different phases in its usable life, and the potential for capturing value which is currently lost . For instance, the value of a phone with a failing battery is low, however when that battery can be replaced, the value of the whole phone increases once more. This conceptual approach was used as a foundation for identifying actions which are more specifically focused on product circularity in a way that engages consumers. The following opportunities for greater circularity have been identified in the area of mobile and smart phones:

1. ***Better capture of end-of-use handsets.***
2. ***Cross-manufacturer standardisation of peripheries.***

3. Replaceability of all durable items including batteries and covers.
4. Better design for refurbishment and reparability and recyclability of all main components. This could include:

a. End-of-life refurbishment or recyclability.
b. In-use and user-led refurbishment.

The implications for winners and losers within the mobile and smart phone supply chain for each of the above actions is described in detail in Annex 6, as well as an overview of the structure and points of power within the mobile and smart phone supply chain.

The mobile and smart phone supply chains displays many of the features which would allow it to innovate for the circular economy: the balance of power exists among a relatively small sub-set of actors within the much longer value chain, and those actors have high innovative ability; actors within the value chain frequently work with each other to plan and co-ordinate innovations, to create whole innovative products; the number of actors within the value chain is small and there are ongoing relationships between the market players, which facilitates trust and pay-back on innovation.

The established and dominant manufacturers were identified as both in a position of power to initiate change and as potential losers from these action and may resist certain regulatory interventions. Introducing these actions would likely reduce their profitability from sales of new handsets, peripheries and manufacturer-led replacement of durables. The unit sales issue can be mitigated if manufacturers participate in the capture of end-of-use handsets to ensure that refurbished phones are diverted from their high value consumers. The analysis also suggests that less dominant and emergent manufacturers have less to lose from greater reparability and may well have more to gain by gaining market position. The identified extended warranty is a potential key to transformational innovations in which the sector moves towards a service rather than product provider.

This analysis suggests that, if the correct economic incentives were in place, for at least some of the economic actors, the mobile and smart phone value chain could innovate towards greater circularity. The position of some established and dominant manufacturers would need to be addressed in order to avoid obstacles to policy efforts to encourage greater circularity through economic incentives. There is also a need to consider the role of consumers, both in purchasing and in end-use behaviour, and it may be argued that policy has a role to play to exert influence within the value chain to coordinate sensible and cost effective measures on the consumer's behalf which promote greater circularity.

6.2 Case Study #2: Metals and the transition to optimal use of steel

This case study focuses on the optimal use of steel within value chains. Optimising use of steel in value chains is relevant to a number of areas identified as priority circular economy areas in the study, including the construction sector and automotive industry. The construction sector currently accounts for nearly half of global steel consumption, and the

automotive industry is the world's largest single manufacturing activity, using approximately 15% of the world's steel. Whilst there has already been significant and ongoing effort within the upstream sector to reduce energy use in the production of iron and steel, there are two key strategies reported in the literature for achieving optimal use of steel and greater circularity in value chains:

1. ***Better design of products to use less steel.***
2. ***Greater use of high strength steel.***

The full case study analysis in Annex 6 details the rationale behind these two strategies, as well as the barriers that may exist in pursuing/achieving them.

The steel value chain is made up of a small number of large steel producers who produce a number of intermediary products (e.g. sheet or rod steel) in a way that avoids the need for those later on in the value chains to re-melt the steel. These steel products are sold-on as commodities to a large number of value chains, which further process and fabricate the steel and use them in a very wide range of applications and products. The steel makers sometime face fierce price competition as a result of over-capacity within the sector, and appear responsive to customer demand. The same seems likely to be true of commodity product makers (metal formers). So, on the supply side, there appears to be little economic resistance to innovation.

In addition, the analysis suggests that it is not usually the end-user of steel which has influence over the use of steel in final products(such as buildings). Rather, in the construction sector, it is the designers, architects and value chain managers who exert the greatest reach and influence over product design and so the use of steel in various value chains. For final users, the amount of steel is usually neither reflected in the value or the cost of the product. The incentives for these design actors to reduce the amount of steel are often low, compared to the perceived costs and risks of change.

For example, an architect has very little incentive to reduce steel in the design of a building, particularly as their fee may be based on a percentage of construction cost. Potential actions to reduce the use of steel without changing the nature of the steel used are limited by issues related to designers and architects. Moreover potential changes to design to reduce the use of steel can also, sometimes be held back by mismatches between the steel being offered, and the alternative use it is put to. These actions are hampered by issues of interactions along the whole value chain. There are also incentives to over-specify loads, to make up for potential calculation errors (which would bring significant liability costs).

In the automotive industry, there is an established incentive for fuel efficiency and performance by reducing weight and thus an incentive to reduce the use of steel in the manufacture process. For many other products, product performance is not hindered by excess steel, and where steel costs form a small part of total machinery sale value, there is limited incentive among architects & designers to resist the optimal use of steel.

Generally though, it is the manufacturers and builders who represent the capital investors and are therefore the actors best placed to ensure that innovation occurs so that they can benefit from reduced costs. It is therefore in the interest of manufacturers and builders to ensure that architects & designers pursue innovation. In doing so, the first movers will capture some of the value whilst their competitors catch up.

6.3 Case Study #3: Food supply

A significant proportion of the food produced for consumption ends up as food waste. Globally about a third of the food for human consumption is wasted (European Commission, 2014b). Although the greatest source of food waste with the greatest potential cost saving lies with the consumer (in developed countries), circular economy attention and intervention is also justified before the point of sale. This case study identifies three key areas for circular economy action: retailer initiated actions; policy enabled contractual reforms; and policy initiated actions aimed at consumers and SME caterers.

- ***Retailer initiated circular economy actions***: Large retailers have a high level of control over the food sector generally and over producers in particular. Retail decisions can lead to wastage at producer level, due to a range of interlinked factors including: contractual requirements; product standards; and poor demand forecasting. Thus retailers are in a position to influence the behaviour of producers, manufacturers and consumers. The main source of preventable waste in retailing is perishable or fresh produce. Actions in this area therefore focus on stocking the precise quantities demanded and maximising shelf life. Both solutions typically require large retailers to initiate optimisation of the supply chain back to the manufacturer and growers. Other examples of retailer actions to deal with food waste include for example phasing out 'buy-one-get-one-free' offers for food, selling misshaped fruit and vegetables, restaurants offering smaller portions and 'take-home' bags for leftovers, donating food close to expiry dates, etc.

- ***Policy enabled contractual reforms*****:** Contractual arrangements of large retailers in particular have the potential to reduce food waste. The following opportunities are available to reform contractual arrangements between large retailers and their producers: long-term contracts between retailers and producers to establish a more frequent or better understood ordering pattern; longer notice periods for retailers to alter their volume orders; and whole-crop contracts where large retailers seek to negotiate contracts based on taking the entire crop from an individual producer.

- ***Policy initiated actions aimed at consumers and SME caterers***: There are a number of policy initiated actions aimed at consumers and SME caterers that could also be pursued. Examples of these types of action might include: development of food waste campaigns; review of eat-by labelling; use of a levy/tax on all retail food unaccounted for in sales or used as feed-stock; development of schemes for door-step collection of food waste and treatment in anaerobic digestion; and increasing landfill tax for food waste disposal on a weight basis.

A breakdown of the potential winners and losers from these potential actions is provided in a table in Annex 6.

6.4 Case Study #4: Plastics

There are a number of factors in the way that plastics are used within the economy which present a particular context for this case study:

1. Plastics offer a light-weight and de-materialised material option. Around half of all Europe's goods are now packaged in plastics, and yet plastics account for only 20% of packaging by weight. Furthermore, the increasing use of plastics in automobiles represents a major part of making vehicles lighter, and therefore more fuel efficient.
2. Most plastics are produced from non-renewables sources and if not properly managed at the end-of-life, can pollute the world oceans with plastic debris, which is emerging as a significant global concern[15].
3. The innovative use of plastics can sometimes lead to other material savings not possible in other materials. So for example, innovations in food packaging can increase the shelf life of foods and therefore reduce food wastes.
4. The range of different plastic resins and innovations in how they are put together means that in many cases, even when plastics are recovered, they end up being cascaded toward lower value applications or disposed of.

These issues present a trade-off between the advantages of greater diversity of plastic products, environmental concerns and the opportunity to create material loops. Whilst it might be desired to tackle all of these issues within a particular material loop, there may remain cases where the advantages of producing plastic products which do not readily form a renewable or material loop, out-weigh benefits from repeated use.

In 2011 in the EU, 25.1 tonnes of plastic arose as post-consumer waste requiring management. Of this, 14.9Mtonnes or 59.1% was recovered (6.3 recycled & 8.6Mtonnes through energy recovery) and 10.2Mtonnes or 40.9% was disposed of in landfill. Recycling and recovery rates for plastics packaging is higher at 66%. This reflects focused efforts over a longer period to develop recycling and recovery options particularly in Norway, the Netherlands, Belgium, Austria, Denmark, Sweden, Germany, Switzerland and Luxembourg where total recovery rates are approaching 100%. In all of these countries, recycling makes up more than half of this rate of recovery. Two winners & losers cases were explored to investigate the issues in depth:

[15] http://ec.europa.eu/environment/waste/plastic_waste.htm

- The assessment of the **greater use of bio-plastics in food packaging** suggests that all key players are potentially both winners and losers. The players who are best positioned to require the introduction of bio-plastic packaging, the retailers and consumers, are set to gain from co-disposal of food and packaging, and therefore potentially cheaper and easier waste disposal costs. This needs to be weighed against the additional cost of bio-plastic in packaging. In the event that policy proposed the introduction of bio-plastic food packaging, other players would be in a position to influence the process. The quality of recycled plastic could be reduced and therefore the revenue that municipalities who manage wastes will receive from the recovered plastics from households. This would need to be weighed against the possible improvement in value of recovered food waste from households where this was collected separately and less contaminated by plastic wastes.
- The assessment of the **greater use of plastics in automobiles** suggests that the interests of key players in the automobile supply chain are incentivised to further innovate and incorporate plastics into automobiles. Some consumers may be cautious of the extensive and visible use of plastics in vehicles. However, this process is already very much a reality in modern automobiles and manufactures will need to continue to be conscious of how the product is presented. Overall, the incentive and requirement for fuel savings will very likely ensure that further innovation will be implemented in this sector.

6.5 Factors supporting the realisation of circular economy opportunities

Successful realisation of the opportunities of the circular economy depends on the motivation of actors in the value chain (or cycle). For example, businesses motivation usually depends on the ability to realise added value, typically increased profits (either from increased profit margin, or increased volume of sales).

Many of the **possibilities of realising value require action by more than one actor** (for example, the purchaser's change in demand, and what the supplier is prepared to offer). This is particularly the case where some product or organisational innovation is required, as it is for much of the non-incremental opportunities in the circular economy. For example, some claim that 80% of the environmental impact of products is determined at the design stage (German Federal Environment Agency, 2000). It is also the case where the circularity requires a significant change by whomever is 'closing the loop' (perhaps a waste collector) and the actor receiving the looped material. Thus both the **capabilities of actors in the value chain** (or circle) (like their **capacity to innovate**) and their **relationships** can limit realisation of value from the circular economy.

Barriers to value chain collaboration arise when there is a perception that any innovative investment is not likely to pay back. This is often the case where:

- There is a ***lack of trust*** in the other partners' commitment to a continuing relationship.

- There is an ***absence of complementarity in strategic approach*** between partners, or ***dissimilarity of management culture and corporate goals*** would prevent co-operation.
- ***Power relationships*** in the value chain can mean that some actors who are required to invest in the innovation would not benefit from the innovation; or
- There are no actors in the value chain which have the ***ability to co-ordinate co-operation*** along the value chain.

These come on top of barriers caused by the lack of sufficient innovative capacity in a value chain, or insufficient market incentives for value chain actors to be motivated to move towards a circular economy. Policy is likely to be more successful where it takes these constraints into account when choosing and designing interventions. The issues are described in more detail in Annex 5 which describes the key role that power structures play in facilitating and blocking value chain collaboration for the circular economy.

7 Policy options to support a circular economy in the EU

As noted in the introduction to this report, the aim of this study is to provide a **first scoping assessment of potential options for consideration across a range of areas** rather than focus on sector or product specific policy recommendations that only address a fraction of the challenge. The proposed policy options build on the assessment undertaken in the study and related work such as the recommendations of the European Resource Efficiency Platform (EREP, 2014) – see Box 3.

Box 3: Policy recommendations of the European Resource Efficiency Platform (EREP)

At the end of March 2014, the European Resource Efficiency Platform (EREP) adopted a set of policy recommendations entitled 'Towards a resource efficient and circular economy' which are summarised below:

1. ***Promoting new, resource efficient business models*** for resource efficient production and end-of-life management, and support service-based business models, e.g. through sector-specific good practice, adapted accounting frameworks, information and incentives. Public authorities should take environmental criteria into account and move to performance-based public procurement contracts.
2. ***Boosting Extended Producer Responsibility*** for producers to improve waste management beyond end-of-life of products, promote better product design, remanufacturing and recycling. Schemes need to become more transparent, operate according to certain minimum principles, better monitoring and enforcement, improved data collection and reporting.
3. ***Enabling consumers to make more sustainable choices*** through fiscal, financial and pricing policies, marketing campaigns, education, counselling and labelling, and actions such as take-back schemes. There is a need for product standards on resource use and reparability, EU principles and methods for measuring environmental impacts, extended warranty periods for some products, and policies, surveillance and enforcement to remove the most unsustainable products from the market.
4. ***Developing employment and skills*** through an EU strategy for greening jobs, skills and education which *inter alia* mobilises EU funding, supports exchange of good practice, promotes awareness raising, and ensures follow-up in the European Semester.
5. ***Financing to enable the transition*** including green investment and resource-efficiency R&D, greater company reporting on resource use, a review of accounting rules and investors' responsibilities, and the potential of the bonds market further explored.
6. ***Speeding up the development and use of indicators*** that show progress towards a resource-efficient economy, distinguishing between efficient and sustainable use of materials.

Source: EREP (2014) European Resource Efficiency Platform, Towards a resource efficient and circular economy, 31 March 2014, http://ec.europa.eu/environment/resource_efficiency/documents/erep_manifesto_and_policy_recommendations_31-03-2014.pdf [accessed 30/5/2014]

The options developed by the study team include a **mix of general approaches and policies** which are applicable to different areas and policies including regulation; information tools; market-based instruments; research and innovation policy including support for market take-up of developed technologies; voluntary approaches etc. The transition to a circular economy requires a systemic approach which makes use of a wide toolkit of policies and measures, across different points of value changes and affecting the full set of private and public stakeholders. Given the multi-level governance approach needed, options can be **structured across different actors** (e.g. EU, Member State, regional and local authorities, private sector, civil society, citizens), **levels and timeframes**, keeping in mind that in some areas circular economy benefits will materialise as a result of own initiatives by the private sector, while in other areas support (including public intervention) will be needed to encourage transitions.

For ease of presentation, the study has clustered potential policy options into **three broad areas or clusters**:

- regulatory instruments (including better implementation);
- other instruments (fiscal instruments, voluntary agreements, information); and
- public investment.

These areas cover a number of different types of instruments and approaches, which can be taken forward by actors at different levels and over different timescales. There are also overlaps between these areas and the clusters should not be seen as mutually exclusive but rather complementary and part of a wider policy mix that is needed to support the transition to a circular economy. These broad areas are discussed in further detail below, bringing together insights from the analysis and input from experts at the workshop organised in the context of this study.

7.1 The role of regulatory instruments and approaches in encouraging circularity

Better implementation and enforcement of existing regulation

There are a number of regulatory instruments and approaches in place at EU, national, regional and local level which already support (or could support) a circular economy. Thus, **an important part of the transition to a circular economy could be facilitated by better implementation and enforcement of existing policies** (e.g. Waste Framework Directive, Packaging Waste Directive, ELV Directive, Ship Recycling Regulation, Waste Shipment etc.). Implementation varies across Directives (e.g. Landfill Directive, producer responsibility under WEEE, ELV, Packaging and Packaging Waste and Batteries Directives, application of waste hierarchy etc.), not only at Member State level (e.g. southern and CEE countries where there is a need to improve implementation of basic waste legislation), but also within countries at the regional level (e.g. Catalonia versus Andalucía in Spain or Trentino-Alto Adige/Südtirol versus Campania in Italy) (Expert input 2014). The reasons for this poor implementation record relate *inter alia* to costs (of compliance, administration), administrative burdens, complexity, transposition (delays, interpretation), lack of information, data and awareness,

poor enforcement checks, different cultural/political contexts, corruption, lack of political will etc. (IEEP, 2014).

Improving implementation of the environmental *acquis* continues to be a key strategic objective of the EU which is reiterated in the 7th Environment Action Programme (7th EAP). It requires a range of different actions at different stages of the policy cycle and across governance levels. Although the better implementation agenda is not necessarily something new, there is a need for **systemic change and the involvement of different partners** across the value chain to be able to better address this challenge, particularly as it relates to the circular economy transition. For example, local authorities could support better implementation by introducing supporting instruments such as bans or restrictions on certain waste streams at the local level as a way of improving recycling rates.

It should also be noted that **existing legislation has been designed to meet certain objectives** (e.g. encourage waste-to-energy, increase recycling), and that this is not always fully compatible with various other stages in a circular economy such as reuse, refurbishment, cascading use, up-cycling etc. Thus, there is a need for **reviews of existing measures** to assess whether they are 'fit for purpose' and relevant to current and future priorities. These reviews can be used as an opportunity to revise legislation in line with current policy priorities, keeping in mind technological developments, the availability of alternatives (e.g. to incineration) and wider impacts across the value chain and between sectors or areas (Expert input, 2014). The current programme of 'fitness checks' could include reflections on how existing legislation could be improved to encourage the transition to a resource efficient, circular economy.

Revising existing regulation

In some areas there is a need for **revisions to current regulation so that it can better support the circular economy.** An example of a recent revision to EU non-environmental legislation which supports a circular economy was the phasing-out of minimum marketing or cosmetic standards for 26 types of fruits and vegetables (e.g. the notorious "Cucumber Regulation" EEC No 1677/88 and the "Carrot Regulation" EEC No 730/1999), which allows less aesthetically perfect vegetables to be sold, preventing the unnecessary discard of various types of produce. As discussed in section 4.3, there is also a need to **revise legislation which acts as barriers** to a circular economy (e.g. definitions in EU waste legislation, RED, etc.) Indeed, some action has already been seen at the EU level, with a proposal to amend aspects of six EU waste Directives (2008/98/EC on waste, 94/62/EC on packaging and packaging waste, 1999/31/EC on the landfill of waste, 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment) (COM(2014)397) included in the circular economy package published by the European Commission in July 2014.

Looking ahead, other areas where revisions to existing EU legislation could be considered include for example, **extended producer responsibility** (EPR) **related legislation,** which could for example include an expansion in the coverage and scope of existing schemes such as **take-**

back requirements (e.g. to white goods and furniture), **deposit-return schemes** (see Box 4) and **extended warrantees** for certain product categories (taking into account the technical lifetime of a product). Another area could be in relation to **packaging and packaging waste**, where for example provisions in the Packaging and Packaging Waste Directive (PPWD) could be strengthened (e.g. increased targets for recycling, expanded scope as conceived in the current proposal to revise the Directive to better address issue of plastic bags). The Commission has also recently proposed '**minimum requirements' for EPR schemes**, included as an annex in the proposal to amend existing EU waste legislation (COM(2014)397).

Box 4: Extended producer responsibility in Germany

German packaging waste recycling rates are among the highest in the EU-27 with 72.7% in 2010, and total recovery rates of 97% in 2011 (GVM, 2013). These rates have been achieved by regulation based schemes, adopted under the Closed Substance Cycle Act ('Kreislaufwirtschaftsgesetz' since amendment in June 2012), which use Producer Responsibility Organisations (PROs) to recover and recycle metals, glass, paper and plastics. These schemes have created incentives and the institutional framework for high rates of recycling and recovery of consumer packaging in Germany.

The success of the schemes arise from their attention to incentives for all actors involved in the material cycle; as well as the creation and support of market structures that provide cost-effective recycling and recovery. The schemes incentivise consumers to sort and collect waste, through a combination of cost savings for households and information campaigns. They also allocate full responsibility for the cost related to packaging recovery to industry and the retail sector, which has led to packaging recovery being viewed as a business activity.

While the use of extended producer responsibility (EPR), involving PROs, is widespread in the EU and is mandated under EPR related legislation; deposit return schemes for beverage containers are less common. There are key lessons to be learned from the German experience in successfully setting up PROs which could help improve implementation of similar schemes elsewhere. In particular costs can be reduced through competitive tendering in a well-developed waste-treatment market; provision of adequate collection and treatment infrastructure; explanatory information campaigns to assist consumer behavioural change; and provision of adequate price incentives (i.e. high deposit fees) to motivate action.

Sources:
Gesellschaft für Verpackungsmarktforschung (GVM) (2013). Verwertung von Verkaufsverpackungen - Private Endverbraucher.
http://www.umweltbundesamt.de/daten/abfall-kreislaufwirtschaft/entsorgung-verwertung-ausgewaehlter-abfallarten/verpackungsabfaelle [accessed [10/01/2014]
See detailed case study in Annex 4 for related sources and further information on this case.

Another area where there is scope for action relates to **product design including related standards and requirements** where relevant product policies can be revised to encourage

greater circularity from the start. This is an area where the EU's role is particularly important given links to the single market. Furthermore there is an existing base of legislation on which to build. In this regard, the forthcoming review of the EU eco-design and the energy labelling Directives (expected to be launched in November 2014) could be considered a potential window of opportunity to extend existing legislation beyond the area of energy. The **Eco-design Directive** has the potential to deal with modularity, recyclability, reusability and durability if its scope is expanded beyond the current focus on energy. Revised eco-design requirements or principles for certain products which take into consideration 'end-of-life' and integrate requirements on defined recycled content could encourage more circular practices (from the start) and support greater transparency throughout the value chain. However, this would require a robust approach including appropriate standards and technical specifications for relevant concepts such as product durability, reparability, reusability, recyclability, recycled content, product lifespan etc. One option could be to start off with reporting obligations and gradually move towards a system with minimum requirements (e.g. a minimum percentage of defined recycling content of products according to the sector/product characteristics). Issues of cross-brand standardization, e.g. with phone chargers, could also be taken into consideration in the review of the Directive (Expert input, 2014).

There is also a need to strengthen requirements on **reporting, labelling and accounting** to increase information and transparency. For example, **revised energy labelling and eco-labelling** legislation, further development of methodologies to measure the environmental footprint of products (PEF) as part of the Single Market for Green Products Initiative (European Commission, 2013) could play a role in fostering the circularity of products. In addition there could be measures to **improve or encourage repair** such as requiring the provision of product repair manuals and easy access to them (e.g. online), **increased information on recyclability**, e.g. through product passports to be used in Business-to-Business (B2B) transactions or through enhanced recycling logos that also indicate the recycling destination of materials (e.g. plastics) could be useful measures to **increase transparency** on the origin of products, resources and materials and thus support greater circularity, e.g. by increasing purity of cycles. Provisions could also be introduced which require manufacturers to provide information on the **expected or intended lifetime of a product** (e.g. as already done for light bulbs, recharging potential for batteries, etc.) and on **product durability** as a means of addressing issues related to planned obsolescence. Such information could then be collected by consumer associations, which could in turn inform and communicate this to consumers (Expert input, 2014). Some work has been done which could provide insights on this issue, e.g. 'products that last' work by CE Delft together with industry as well an on-going study for the European Commission on product durability[16].

[16] For more information about the on-going project, please see project website: http://www.productdurability.eu/

On **accounting**, national environmental-economic accounts such as material flow accounts, accounts on taxes (as currently required under the on European environmental economic accounts Regulation (No 691/2011) as well as accounts for subsidies (not yet required) and natural capital accounting (part of UN SEEA experimental accounts[17]) could form an important evidence base and regular window of opportunity for policy change. Similarly, there are needs for greater **corporate disclosure, wider use of organisational environmental footprints (OEFs) and of environmental profit and loss accounts** (EP&L), e.g. as piloted by Puma, to support greater transparency, ensure internal visibility of key issues for company management and hence facilitate the transition to different business models that take resource use and impacts into account. This will also support the **information available to the finance sector** when making investment decisions (e.g. pension funds and ethical investment funds), and over time could support increased funding for circular economy vanguard companies.

There could also be potential scope for revision in the context of the **REACH Regulation** which for example could be expanded to cover a wider range of toxic chemicals which when used in products and materials may prevent greater circularity, i.e. by limiting reuse, recycling etc. Furthermore, it has been noted that current cut-off thresholds for the provision of information under REACH could be reviewed which although simplifying administrative burdens, exclude a range of products containing chemical substances which has implications for business-to-business communication and assessments of compliance at later stages (e.g. recycling) (Expert input, 2014).

New measures and regulation

In some cases there may be a **need for new regulation** such as **new targets** (e.g. new targets on food waste as proposed in (COM(2014)397) to reduce food waste by 30% between 2017 and 2025 as part of new circular economy package), **restrictions or bans** (e.g. on landfilling of plastics or recyclable materials as proposed in (COM(2014)397) that after 1 January 2025, a maximum of 25% of the quantity of waste generated in the previous year to be landfilled; by 1 January 2030, only residual waste to be accepted in landfills, so that the total waste going to landfill does not exceed 5% of total municipal waste generated in the previous year, on the use of certain toxic chemicals, coupled with strong legislation on energy recovery to avoid incineration). Another option could be to introduce **mandatory requirements** (e.g. mandatory phosphorous recovery from sewage sludge, qualitative requirements on recycling, development of action programmes to tackle food waste, mandatory requirements for the separation of waste).

Explore potential measures to address issue of **intentional obsolescence** (Expert input, 2014).Creating new regulation on intentional obsolescence would likely prove challenging to

[17] The System of Environmental-Economic Accounting (SEEA) is the main guidance on environmental economic accounting developed by the United Nations Statistics Division.

implement in practice given the difficulty in proving intentional obsolescence, even if the burden of proof is placed with product manufacturers. Nevertheless, it could be useful to enshrine the principle of non-intentional obsolescence into a broad policy objective (e.g. within product design legislation) to help provide due signals to the market and explore other potential instruments such as increased warrantee or guarantee periods.

There is also a need to develop adequate **indicators** (as reiterated in the 7th EAP and the EREP recommendations – EREP 2014) that show progress towards a resource-efficient economy. As noted in the Circular Economy Communication (COM(2014)398), the Resource Efficiency Scoreboard used to monitor indicators of the use of resources other than carbon and materials (in particular, land and water) will be developed further and national statistical offices are to work to establish a commonly accepted methodology within the European Statistical System to calculate raw material consumption at national level. Such information can be used to provide insights on progress, raise public awareness and build support for relevant measures. These indicators could be monitored and reviewed through the European Semester processes and feed into discussions on the review of the Europe 2020 Strategy.

7.2 Other instruments to incentivise action towards a circular economy

Legislative measures will need to be supported by other instruments and approaches. A number of **voluntary agreements** are already in place and include for example agreements between retailers and government, between actors along a supply chain such as retailers and suppliers such as those supported through WRAP – see Box 5 below, the World Business Forum, certain purchasing agreements, etc. These approaches have been rather selective and ad hoc to date, driven by internal factors (e.g. CSR and branding purposes) and external developments (e.g. rising resource prices, awareness raising activities by actors such as the Ellen MacArthur Foundation and the World Economic Forum) (Expert input, 2014).

Box 5: Waste & Resources Action Programme in the UK

WRAP was setup in 2000 to support recycling and create a market for recycled materials. WRAP's work focuses on overcoming barriers to waste reduction and recycling. Today, WRAP emphasises the circular economy. In doing so, WRAP works with a wide range of partners, from major UK businesses, trade bodies and local authorities through to individuals looking for practical advice.

WRAP has launched a number of campaigns including the successful 'Love Food Hate Waste' campaign, 'Recycle Now' and 'Love Your Clothes'. WRAP's research and funding helped create the first food-grade and mixed plastics recycling facilities in the UK. More than a million people each year view WRAP's websites recyclenow.com and Lovefoodhatewaste.com. WRAP also manages voluntary agreements with various business sectors including:

- The Courtauld Commitment working with the grocery sector
- The Home Improvement Sector Commitment worked with retailers to reduce packaging and help consumers to recycle more.
- The Hospitality and Food Service Agreement, which is a voluntary agreement to support

the sector in reducing waste and recycling more.
- The Voluntary reduction in Carrier Bag Agreement with seven major supermarket chains.
- The Federation House Commitment, a voluntary agreement which aims to help reduce overall water usage across UK Food and Drink industry by 20% by 2020.
- The Business Recycling and Waste Services Commitment intended to boost recycling rates.

A key driver behind WRAP's activities has been government policies to reduce waste and to increase recycling including producer responsibility for packaging waste, the Landfill Tax and targets set in the Waste Strategy. This shows the complementary and interacting role between different types of instruments.

Germany and the Netherlands have been in discussions with WRAP about replicating similar initiatives. An important element of WRAP's successes lays in the institutional setup behind WRAP as not-for-profit-company with the freedom to recruit and achieve its remit in each particular sectoral cultural context that it faces. This approach would need to be translated into any new cultural setting, rather than necessarily replicated.

Sources:
See detailed case study in Annex 4 for related sources and further information on this case

.**Fiscal incentives including taxes, charges and levies** are other important instruments which can be introduced at the national or local level (and encouraged at EU level) to increase the value/prices of materials and incentivise action towards more circularity. Such incentives can be particularly useful in cases where the value of the product or material does not initiate a spontaneous effort to encourage circularity. These can combine increased resource pricing (e.g. on aggregates or construction materials) upstream to influence production choices as well as taxes and charges downstream on products (e.g. phosphorous in mineral fertilizers), pollution (e.g. CO_2) and waste disposal (e.g. PAYT schemes, landfill taxes) (see Withana et al., 2014a; 2014b). Due exemptions and reductions can also be considered for high-performing sectors/products (e.g. vouchers or tax credits for leased goods or for goods with extended manufacturer guarantees/ higher recyclability).

Such instruments can be effective in **changing incentives of different actors**, e.g. municipalities, producers and consumers. Box 6 provides an example from experience in France where economic and fiscal incentives can be seen as encouraging greater circularity. Given the unanimity requirement in relation to fiscal instruments at EU level, this is an area where the scope of EU action is more limited, and where national, regional and local level action has an important role to play.

Box 6: Economic and fiscal incentives in France

France has both economic and fiscal incentives in place that support the transition to a circular economy. An important economic incentive is provided through modulated fees under many EPR schemes where fees paid by producers to PROs for managing waste from their products is varied

according to different eco-design related criteria. In addition to weight and number of items collected, criteria currently applied include: amount of recycled material used in the product, whether certain materials used interfere with the recycling process and other eco-design criteria such as the absence of universal chargers for mobile phones. In some cases (e.g. packaging), a bonus can be given if actions to raise awareness about separate waste collection are undertaken. A draft law is currently being discussed which reflects on the possibility of extending the criteria to product lifetime guarantee and the availability of spare parts.

Other fiscal tools in place include the 'Taxe Générale sur les activités polluantes' (General Tax on Polluting Activities) which is levied on polluting activities in proportion to the level of pollution generated and a tax reduction for food donations of 60% of the given sum which is limited to 0.5% of pre-tax turnover. A number of proposals are also being discussed including an upstream tax for products that are not currently covered by EPR systems (and therefore not recycled) to discourage consumers from buying them and further encourage eco-design and an incentive-based pricing policy for waste collection (PAYT scheme) as is already implemented in a number of other European countries.

Sources:
See detailed case study in Annex 4 for related sources and further information on this case.

Other important supporting instruments are targeted **information and advisory services** for companies (e.g. on alternative uses for by-products), **awareness raising campaigns** among both consumers (e.g. on ways to reduce food waste) and producers (e.g. major UK supermarket Tesco has various internal policies which seek to raise awareness among employees), local authorities as well as **labels** (e.g. on building performance and car CO_2 emissions and recyclability including real life performance, eco-labels for furniture and foods). Such tools can play a critical role in supporting the transition and engaging consumers and producers – see Box 5 **Fehler! Verweisquelle konnte nicht gefunden werden.**. Increased information and transparency can be useful between different actors, for example between producers and end users (e.g. feedback from recyclers to consumers on how much waste has been collected in their region and what it has been used for can also help encourage greater separation of waste) and between actors along the supply chain (e.g. through harmonised reporting tools such as on bill of materials, disassembly schemes, the use of hazardous materials, etc.) (Expert input, 2014).

In some cases despite the availability of information, it remains **difficult to engage certain actors,** e.g. SMEs, end users. Thus there is a need to reflect on how to ensure greater interest and engagement through more **effective training, education, new targeted messaging** (e.g. focusing on related aspects that are important and can appeal to a wider audience such as business logic, cost savings, consumer demand for healthy products, etc., avoiding over complex concepts to ensure messaging is understandable and does not risk confusion) and **continuous repetitive communication** which is supported by governments, civil society and industry to ensure a **coherent and strong message**. Depending on the nature of the

information and awareness raising tools, this could for example be an area where local and regional authorities have an important role to play (Expert input, 2014).

7.3 The role of public investment in encouraging circularity

Increased public investment is another key element in the transition to a circular economy which could play a useful supporting role alongside substantial private financing of relevant activities. Public investment could for example be used to support further **R&D and innovation** to ensure greater circularity (e.g. to allow modulation of phone components, to support innovative initiatives such as Phonebloks[18], to encourage connections within and between value chains to enhance circularity, reduce marginal costs and ensure a fair allocation of costs between different actors along the value chain); together with investment in **pilot projects** to prove things work and encourage market up-take. In this area, EU funding including through for example the **Horizon 2020 and COSME programmes** could be used to support circular economy activities, leveraging both public and private financing. It could also build on existing efforts such as the **European Innovation Partnerships (EIPs)** which are considered a different and effective way of bringing together different stakeholders, strengthening dialogue between policy-makers and innovators, and providing an EU-wide platform of practice to encourage innovation and systemic change. Such efforts can be further supported and improved, taking into account identified shortcomings in the process to date (DG Research and Innovation, 2014).

Public investment could also be used to support the **development of the knowledge base** to support better policy making. This could include support for example through the Horizon 2020 Programme for improved information and data on the existing use and pathways of different resources, particularly those of biological origin, support for the development of robust indicators to monitor progress towards the circular economy etc.

Public funds could also be used to raise awareness of circular economy opportunities for example with support for information and awareness raising campaigns as elaborated above as well as wider public information campaigns, e.g. TV documentaries, design awards etc. (Expert input, 2014).

In some cases, public action could be structured around a more **strategic approach** to the circular economy, aligning public funding and other activities towards an overarching goal and vision on the circular economy– see Box 7.

[18] Phonebloks is an independent organisation which aims to encourage the development and production of products that generate less electronic waste. See https://phonebloks.com.

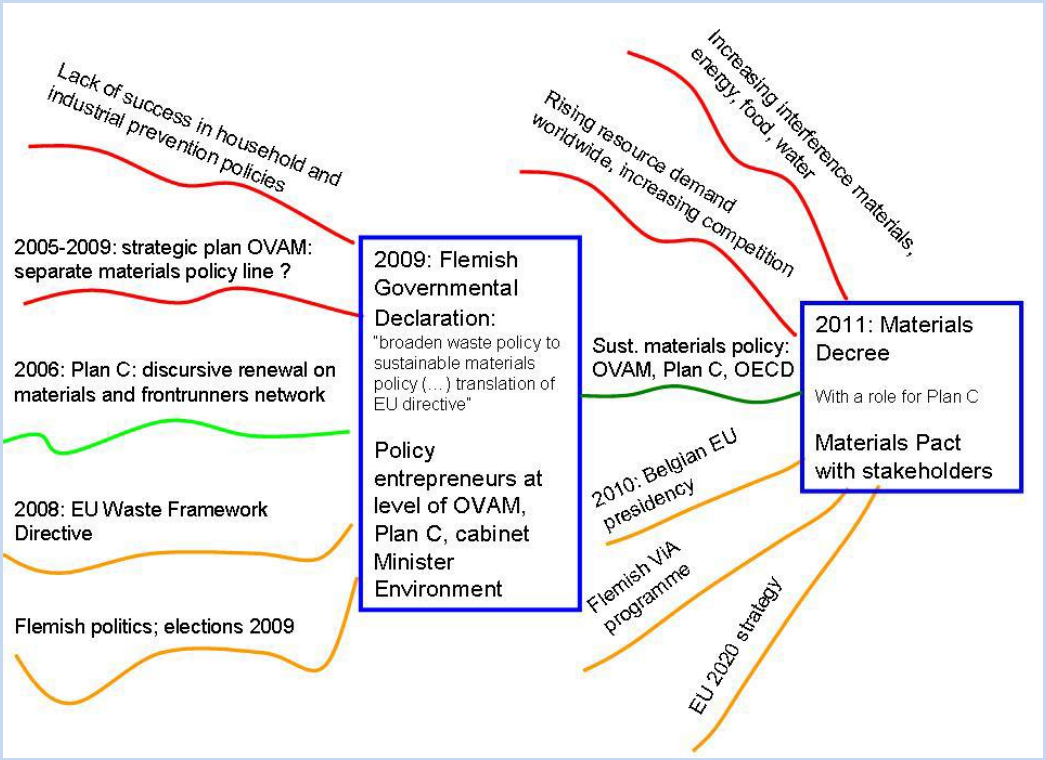
Box 7: A regional approach to the circular economy: Materials Programme in Flanders (Belgium)

The Flanders' Materials Programme was launched in June 2012, bringing together different stakeholders, to develop long-term visions and experiments, policy-relevant research and concrete actions. The Programme is taken forward through a transition network Plan C, Policy Research Centre for Sustainable Materials Management (SuMMa), and Agenda 2020 - an operational action plan with nine levers and 45 actions.

The Programme aims to establish a basis for a green circular economy with the lowest possible use of raw materials, energy and space, and the smallest possible impact on the environment in Flanders and elsewhere (Vlaamse Regering, 2012). As the Materials Programme was launched only two years ago it is not yet possible to identify any specific impacts. Nonetheless, the Programme can be considered an interesting case of a regional approach to supporting the circular economy, through a strategic, overarching plan which has managed to engage 33 parties in the transition towards a circular economy including research institutes, industry, environmental NGOs, and public authorities. Moreover, it uses an integrated approach across a number of different areas, involving concrete agreements with different parties, set objectives and indicative timeframes for action (Ibid.).

Several factors have driven or enabled the development of the Flemish Materials Programme – See Figure 6: Drivers of the Flanders' Materials Programme. The programme has increased cooperation, created a new discourse in Flanders about sustainable materials management (SMM) and started a network of frontrunners (Paredis and Block, 2013). Similar initiatives are also being discussed in some other regions, notably Catalonia and Denmark, thus there may be scope for further regional approaches in the future, with the success of implementing a similar programme elsewhere dependent on knowledge available, experience, waste management practices, and previous collaboration between stakeholders (Expert input, 2014).

Figure 6: Drivers of the Flanders' Materials Programme



Source: Paredis and Block (2013)

Sources:
See detailed case study in Annex 4 for related sources and further information on this case

Public funds could also be used to **develop skills and training in the current workforce** (e.g. on refurbishment or remanufacturing, skills of food chain personnel) **as well as in the future workforce** (e.g. through young designer awards etc.). In this area, EU funding through the **European Social Fund** could for example be explored.

Public funding for **clustering and industrial symbiosis, as well as for relevant platforms** that bring together different actors and stakeholders across the value chain (e.g. the EPR Club which is an ACR+ initiative[19]) could also be useful – see Box 8. Such support could be particularly helpful in identifying appropriate partners at regional and national level, improving communication and aligning incentives of different actors in the value chain through multi-stakeholder partnerships (Swiss Academy of Arts and Sciences, 2014). EU funding can play a role in this context, for example as seen in the case of the Frisian province in the Netherlands which developed a 'cradle-to-cradle island with support from European

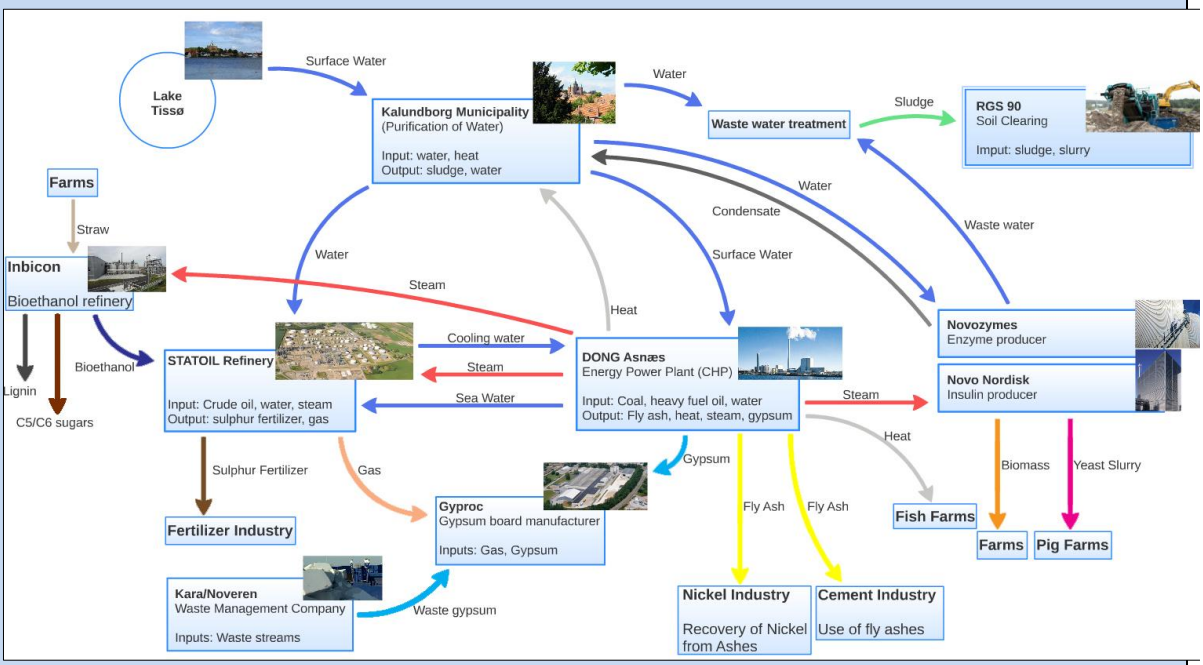
[19] ACR+ EPR Club, URL: http://www.eprclub.eu/about_epr_Club [08/07/2014]

funding under the INTEREG programme (CGDD, 2014). **EU Cohesion Policy** funding (ERDF and INTERREG) could be used to set up a **node of catalysts or 'facilitators' at regional/national level** across European regions which connect companies and other actors including municipalities etc. to discuss how to move towards a circular economy, identify perceived barriers and how they can be overcome and practical steps to be taken (Expert input, 2014). Public funding could also be used to set up a platform to share best practices between policy makers, businesses including SMEs and consumers across different sectors.

Box 8: Industrial symbiosis at the municipal and national level

Industrial symbiosis in Kalundborg (Denmark) is considered as one of the first and most successful cases of industrial symbiosis implemented to date. Since its beginnings as a form of cooperation between a local power plant and oil refinery in the 1960s, the number of companies involved as well as the network of exchanges between the companies has increased – see Figure 7. This has led to substantial reductions in the consumption of virgin materials, reduced GHG emissions, cascading use of energy, reduced environmental impact of companies and the exchange and re-use of several types of waste streams (Domenech & Davies 2011, p.81). The programme has also led to important economic savings for the actors involved. It has been facilitated by a number of factors including contractual obligations between the companies involved, the enforcement of environmental regulations and a continuous negotiation process between public authorities and companies (Jacobsen & Anderberg 2004, pp. 322-323).

Figure 7: Graphical representation of the Kalundborg industrial symbiosis project



Source: Author's own elaboration based on Domenech & Davies (2011), Jacobsen (2006), Kalundborg Symbiosis (2014a)

The example provided by the Kalundborg symbiosis has inspired initiatives in other parts of the

world including for example Barceloneta/Guayama (Puerto Rico), Kwinana (Australia) and Rotterdam (the Netherlands) (Chertow 2007, p.22). Therefore, there may be opportunities to implement similar initiatives in other areas and could lead to substantial benefits. For example, it has been estimated that replicating a similar programme at EU level to the National Industrial Symbiosis Programme (NISP) in the UK could yield up to €1.4 trillion savings and more than €1.5 trillion additional turnover, with a public expenditure of €250 million (COWI 2011).

Sources:
See detailed case study in Annex 4 for related sources and further information on this case.

Further action to encourage **Green Public Procurement** (GPP) can also be useful in incentivising more circular procurement practices among public authorities. While current EU public procurement directives (2004/18/EC and 2004/17/EC) contain specific reference to the possibility of including environmental considerations in the contract award process these could be further revised to better support circularity for example through revised criteria to include 'recyclability requirements' for public procurement practices and tenders (Expert input, 2014) and a systematic implementation of whole lifecycle costing (WLC) criteria which could also be a useful means to encourage product and investment choices that take lifecycle impacts into account (Hjerp et al., 2012). There are a number of GPP initiatives already underway which support the circular economy and could serve as good practice examples to stimulate action among other public authorities – see Box 9.

Box 9: GPP in Ferrara (Italy)

The LOWaste (Local Waste Market for Second Life products) programme was launched in the city of Ferrara, in the Emilia-Romagna Region of Northern Italy in 2011. The programme aims to increase recycling of municipal waste by 70%, decrease CO_2 emissions (through the diversion of material from landfills) and increase recovery of raw materials. It targets four waste streams: hospital textiles, street furniture (e.g. public benches), food waste, demolition and construction waste. It also establishes specific GPP criteria to be integrated into purchases by the municipality.

Between 2011-2014, the LOWaste programme has supported the diversion of 90 tonnes of hospital textiles annually from landfill and 2,159 tonnes of avoided CO_2 emissions, at least 11,200 tonnes of recycled construction and demolition waste materials used in the construction of roads and cycling lanes resulting in up to 593 tonnes of avoided CO_2 emissions; the refurbishment of old street furniture has helped save 90 tonnes of virgin raw materials and realized savings equivalent to 67 tonnes of CO_2; and oil and food waste used for the production of compost, biodiesel and glycerine has led to an annual saving of 30 tonnes of food waste and the production of 4,500 kg of compost material (LOWaste 2014).

This case illustrates how circular economy activity can be driven through initiatives at the local level and the role of municipalities through the adoption of GPP practices and specific programmes. The adoption of legislation at both the regional and national levels has also supported efforts at the local level. The LOWaste has benefitted from EU funding under the LIFE+

programme. The case also highlights some opportunities for revising legislation, particularly at the national level to better support local action, e.g. clarifying 'end of waste' criteria, promoting reuse centres, clarification of definitions of 'special waste' and product labelling (especially of food products).

Sources:
See detailed case study in Annex 4 for related sources and further information on this case

Public funding could also be used to **support citizen-led platforms encouraging greater circularity** e.g. platforms on how to repair / reuse products, car/house sharing networks, local, non-profit swap networks. It could also be used to support bottom-up financing sources for these activities such as **Crowdfunding** which pools the time, cooperation and money of individuals to support initiatives by individuals, communities, organisations or companies [20]. For example, DG Internal Market is exploring how to raise awareness and increase transparency in this relatively new and growing area(European Commission, 2014).

In certain cases, there may also be a need for **investment in specific infrastructure** (e.g. centralised collection points, pick-up-at-door services) as well as better use of **existing infrastructure and services** which can for example be used to improve collection, e.g. using the postal service to collect CDs, DVDs and VHS tapes (e.g. as is being trialled in Portugal and France) and offer new spaces for community initiatives (e.g. reinventing public libraries as community centres to encourage greater reuse and repair) (Expert input, 2014). Such investments can be supported through **EU Structural and Cohesion Funds** and can for example help support greater velocity of cycles so products come back faster, people hoard less, transport times are reduced, and circles are made more efficient.

While there is a need to increase public funding towards activities that support the circular economy, there is also a need to avoid or minimise public funding of investments that go against the circular economy, e.g. investment in energy recovery from untreated waste, fossil fuels etc. (Expert input, 2014). This links to the need to **reform ineffective or harmful public subsidies** which has long been recognised and has been a contentious point of discussion for several years (Oosterhuis and ten Brink, 2014). The EU has a long-standing commitment to removing or phasing out environmentally harmful subsidies (EHS) which was reiterated in the Resource Efficiency Roadmap and the 7th EAP. Commitments to reform such subsidies have also been adopted at the global level (e.g. in the context of the Convention on Biological Diversity (CBD) and the G20) as well as at the national, local and regional level (Withana et al., 2013). These discussions are also linked to efforts to modernise and strengthen the result-orientation of the **EU budget.**

[20] European Crowd Funding Network, URL: http://www.europecrowdfunding.org/ [accessed 19/3/2013]

7.4 Synthesis

It is evident from the analysis undertaken for this study and discussions at the experts' workshop that there is a need for **systemic change** and a more holistic, integrated approach which takes a whole **value chain perspective** rather than a purely sector and/or product focused approach**.** Such an approach will take into account the **different incentives** faced by actors along the value chain as some stages may not be profitable (e.g. battery dismantling), while others are extremely profitable (e.g. extraction of metals); the **distribution of economic rewards** (costs and benefits) along the value chain and impacts of a particular measure **along the whole value chain** (e.g. a ban on the landfilling of plastics could lead to an increase in incineration) and **across different sectors and policy areas** (e.g. increasing the energy efficiency of certain products may lead to an increase in the amount of iron, gold and copper in electronic devices, increasing the quality of recycling could require additional energy) .

This implies a need for a **mix of complementary instruments and approaches** across different parts of the circular economy (e.g. regulatory measures complemented by economic incentives to ensure pricing of a related product or resource, funding for innovation etc.) and **efforts to engage and link actors along the value chain** (to ensure circular thinking and identification of opportunities for greater circularity across the entire chain). Opportunities for increased circularity vary considerably within different firms, sectors, products and value chains. Moreover, the need for policy intervention (if any) and the type of intervention needed will vary according to the issue at hand. In some areas, the transition to a circular economy might materialise without intervention (i.e. where products have high embedded material values, where the private sector moves towards more circular and/or service-based models independently as it seek opportunities), while in other areas support including public intervention is needed to encourage the transition.

As set out in section 4, there are a range of policies and measures in place which support the circular economy and a lot of activity already underway, albeit often in an ad hoc way. There is a need for policies which can support existing efforts and opportunities (revising existing policies, removing barriers, supporting bottom-up initiatives); moving beyond the current focus on recycling to support other loops in the circular economy; developing skills and providing incentives for innovation and closer collaboration between different actors along the value chain. It is important that the **value chain structure and the business case for circularity** for the different actors is understood in detail when considering policy intervention. Based on this, a case for policy supporting the circular economy can be made where analysis indicates that there are either gaps in what the private sector are incentivised to do, or that the most influential actors are not set to realise the value from the transition. In doing so, policy may take on any of the following roles:

- **Ensuring the right incentives** by for example fiscal reforms, removal of legislative barriers, better implementation, action on marketing or green public procurement.

- **Removing market structure barriers** such as tackling market distortions and unhelpful power concentrations, changing existing legislation, creating extended producer responsibility type markets.
- **Reducing transition costs** of the shift to a circular economy by providing necessary infrastructure, promoting technical and structural innovations and GPP practices.
- **Encouraging value chain collaboration**, knowledge provision and brokering.
- Supporting **citizen or community-led initiatives–** e.g. social investing, repair cafes, etc.

This study has identified some concrete areas where 'low-hanging fruit' have yet to be explored and can be used to support transition in the EU. Some key areas for more specific action in short-medium term include:

- **Better implementation and coherence** – in particular implementation of waste related legislation (e.g. landfilling, recycling), definitions in waste legislation, coherence between waste and bioenergy legislation; but also improved implementation across environmental and wider product legislation as well as horizontal legislation and policies (e.g. on product policy, procurement, VAT). Integration of wider circular economy considerations in policy review processes (e.g. 'fitness checks' and other planned legislative reviews) and in impact assessment procedures could support the transition to a circular economy as well as smart regulation principles and improve the added value of EU legislation.
- **Revise key legislation,** particularly in the area of product design to set minimum requirements for products (e.g. eco-design, labelling) so as to provide a useful starting point to move forward by integrating circular concepts in the design phase to ensure detoxification, modularity, upgradability, disassembly, durability, recyclability in subsequent phases. In addition, increased use could be made of take-back requirements and extended producer responsibility (e.g. via product end of life requirements). Furthermore, a review of the minimum warrantee period could be merited for certain products (i.e. review Directive on the sale of consumer goods and associated guarantees, 1999/44/EC).
- In some cases there may be a **need for new regulation** such as **strengthened or new targets** (e.g. new targets on food waste), **restrictions or bans** (e.g. on landfilling of plastics or recyclable materials, on the use of certain toxic chemicals, coupled with strong legislation on energy recovery to avoid incineration). Another option could be to introduce **mandatory requirements** (e.g. mandatory phosphorous recovery from sewage sludge, development of action programmes to tackle food waste, mandatory requirements for the separation of waste). There is also a need to develop adequate **indicators** that show progress towards a resource-efficient economy, thus providing insights, raising public awareness and support for relevant measures.
- **Increase/leverage funding** to support industrial symbiosis, clustering, and citizens initiatives (e.g. Cohesion Policy, link to smart specialisation strategies) as well as investment in skills, training and education (e.g. through European Social Fund). There is also a need to leverage private funding (e.g. through innovative financial

instruments, disclosure, accounting and transparency) and public funding (e.g. through GPP and whole life costing) for investment in R&D and innovation and/or procurement of products or services that support the transition to the circular economy. There is also a need for funding to support research to understand opportunities and needs for systemic eco-innovation, how to overcome current lock-in to the linear economy, the existing use and pathways of different resources, particularly those of biological origin (e.g. through use of COSME and Horizon 2020).Furthermore, the potential to use other EU funding instruments such as LIFE+, European Fisheries Fund, and the CAP to support the transition to the circular economy should be systematically explored (e.g. to support cascading use of biological materials).

- **Fiscal reform** to change incentives at different points in the value chain – i.e. upstream for materials inputs (e.g. resource pricing, cost recovery), product charging (e.g. deposit-refund schemes), waste charging (e.g. greater use of PAYT for household waste). Such efforts will need to be take forward at the national or local level, however EU levers could be used to support this where available, e.g. implementing cost recovery principles of the Water Framework Directive, using open method of coordination (OMC) approaches such as encouraging progress through the European Semester, sharing lessons and best practices.
- **Improved understanding, awareness and transparency** to encourage greater innovation (e.g. research funding for product and materials innovation), citizen action (e.g. bring back products), and inform purchasing and procurement decisions (e.g. via labelling and information). Furthermore, there is a need to support greater transparency (including through reporting on subsidies, and increased use of environmental economic accounting at both national and corporate level. Greater non-financial reporting and disclosure on corporate resource use and pollution impacts can help leverage additional funding to support circular economy activities (e.g. from ethical investment funds and pension funds). There is also a need to develop and use relevant indicators to help raise public awareness and support for relevant measures. Finally, better understanding the global impacts of EU consumption and waste (e.g. from resource extraction, to waste treatment and disposal) can usefully inform policies, investment decisions and purchasing choices.
- **Multi-stakeholder engagement** across the value chain which takes into account geographic aspects (proximity principle, global value chains and impacts) is needed. The EU could usefully support and engage with such a wider group of actors, for example establishing catalysts or 'facilitators' at regional/national level across European regions which can connect companies and other actors to discuss how to move towards a circular economy, identify perceived barriers and how they can be overcome and practical steps to be taken; setting up platforms to share best practices between policy makers, businesses including SMEs and consumers across different sectors; and projects to work together to create the enabling conditions for progress in the transition to a circular economy.

Discussions and action on the circular economy should reflect both **technical and biological resources** as well as the interplay between them (i.e. move to bio-economy solutions as well as nature based solutions). Furthermore the **interactions, synergies and potential trade-offs** between the circular economy and related initiatives on, bio-economy, dematerialisation etc., need consideration to ensure overall coherence of policy initiatives. For example:

- The ***bio-economy*** seeks to make greater use of biological resources including residues and wastes in place of fossil based resources (e.g. bio-plastics, bio-refineries, biofuels). This could deliver environmental and economic gains and support the circular economy and resource efficiency agendas. Nature based solutions (e.g. biomimicry for products and materials, water and waste regulation, adaptation to climate change) can also reduce the need for technological solutions and impact on the flow of materials and availability of waste for recycling. However, care is needed to ensure hierarchies are respected (i.e. use of biomass for energy and fuels) and that biological resources are managed and used within their sustainable limits (IEEPc, 2014 forthcoming).
- ***Dematerialisation*** can support a move toward greater reliance on functions or services rather than on the purchase of products, and on concepts of 'sharing rather than owning' elements within a circular economy. As with resource efficiency, dematerialisation can have negative implications for certain circles or loops within the circular economy, i.e. the viability of certain types of recycling or the generation of energy from waste.

These issues are not problems per se, but it is important that policies and investment decisions take into account these **synergies and interconnections** and encourage appropriate hierarchies of activities, i.e. not supporting investment in incineration and energy recovery that then becomes dependent on certain waste streams and creates contracts that reduce the availability of the waste resource for more societally beneficial solutions within the circular economy.

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9 Annexes

Annex 1: Results of literature review
Annex 2: Prioritisation matrices
Annex 3: Summary of discussions from experts' workshop
Annex 4: Best practice case studies
Annex 5: Complementary analysis: Why going it alone can be ineffective, why collaboration can be tricky, and why this gives policy makers another role
Annex 6: Case study analyses of four prioritised circular economy areas

(See separate document)