D2.6
Synthesis

WP 2 - New concepts and paradigms for policies for resource efficiency

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This synthesis report covers all the different elements of POLFREE WP 2 – a vision, a new policy mix for the EU, new business models and global governance mechanisms – and draws conclusions based on an integrated perspective of these different view points. It will undertake a final reflection on how this addresses opportunities for an absolute decoupling of resource use from economic growth.

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1. Introduction

The main prevailing concepts and paradigms inspiring EU (environmental) law and policy are sustainable development and ecological (eco-)innovation, which have led to reliance on a combination of legally binding standards and market-based instruments. For some areas, a complex governance regime has been put in place (for example, EU ETS, Water Framework Directive, REACH). However, despite some successes, the Commission acknowledges that resource inefficiency and environmental degradation have not been addressed to the required extent.

Against this background the POLFREE vision of an adequate policy mix for resource efficiency was expected to find answers to the following main challenges:

- **What kind of policy framework is needed to boost resource efficiency in Europe and leads to total reduction of both primary resource use and global environmental burdens?**
- **How can such a policy framework be formulated and implemented?**

WP 2 aimed at the development of new policies, following visions, concepts and paradigms. Such policies shall have the potential to radically increase resource efficiency, to enhance prosperity while stimulating a total reduction of primary resource use without shifting problems to other regions. Our work however starts at a time when Europe is in a deep economic and political crisis, and getting support for radical environmental perspectives may not be easy.

The POLFREE approach of formulating new visions and analysing both the business dimension and the global perspective should help to formulate such new policies. We seek to develop a policy-mix that (a) optimises synergies and addresses trade-offs between different areas and policies and (b) stimulates pro-active approaches by business and in potential lead markets outside Europe, while keeping an eye on real developments elsewhere.

In line with transition management approaches, we believe that a policy-oriented analysis of existing new concepts and paradigms shall prepare the basis for an integrated vision for a resource-efficient economy for Europe, which is oriented towards and beyond key goals of the EU 2020 strategy and the Flagship Initiative on Resource Efficiency, with its associated Roadmap to a Resource-Efficient Europe. The whole process has been developed in collaboration with business, other stakeholders and both national and international policy makers.

The following describes key outcomes of the different sub-tasks in this work package and based on that draws conclusions with regard to the overall research questions outlined above.

2. Report about synthesis of new concepts

Task 2.1 synthesized a framework incorporating new concepts and paradigms, and related them to policy-relevant goals and measures. The project approached the synthesis of new concepts in four ways:

1. Review of existing goals that a resource-efficiency policy should strive for in terms of **planetary boundaries** and **key groups of resources** as targets of a resource policy;
2. Review of potential policy pathways to identify how resource-efficiency can be stimulated.
3. Comprehensive **inventory** of visions and concepts and development of a **classification** (e.g. by level in society, actors or type of activity);
4. Synthesized **strategic mapping of related operational strategies** to prepare the subsequent subtasks.

2.1. Goals of a resource-efficiency policy

In essence this chapter is an attempt at capturing sustainable development analytically through the use of principles, components and indicators. The goals that have to be set by sustainability and resource efficiency policies are far from unambiguous. Three perspectives have been discerned:

1. A 'weak sustainability' perspective that minimizes government intervention, emphasises the 'private goods' argument for resource-efficiency since it enhances profits and competitiveness of business, and has a very human centred view on sustainable development.
2. A 'strong sustainability' perspective that puts protection of the Earth's life support system upfront, which emphasises hence the 'public good' argument for resource-efficiency policies and provides a strong argument for government intervention,
3. Finally a 'paradigm change' perspective that simply stated argues we have to move away from an economic system that marries creative destruction with consumerism which will push the limits of the Earth's life support systems in pursuit of maximum growth and production.

The level of change underlying the first perspective is considered to be relatively incremental, whereas the last implies a complete overhaul of the current mode of action. At the same time, the choice between these different approaches is not entirely subjective. As Kuhn (1962) already remarked in his seminal work on scientific resolutions, some paradigms fit better with the 'real world' than others. Even in the 'weak sustainability' frame the argument that resource-efficiency helps competitiveness will fail when resources are cheap and abundant, let alone that the two other more stringent frames will have a chance to be a successful answer in such a situation. Conversely, in case of fundamental scarcity, an economic system that is too much based on throughput will not be viable on the long term, and will force an economic system based predominantly on the first perspective to move to one of the other perspectives. In that sense, an analysis of potential resource constraints is not too promising. There are no obvious resource limits for building materials, the most voluminous stream of materials used in society. For industrial minerals and metals the situation is far from clear – the much cited Rare Earth crisis that exists since around 2008 has its roots purely in market failures, short-sightedness of the West, and the use of power by its suddenly created monopoly by China, rather than scarcity as such. The calculation of a Factor 10 or more improvement of resource productivity for fossil energy materials is not based on potential scarcity, but the need to reduce CO_2 emissions – if no political agreement on drastic emission reduction is agreed upon globally, there is no driver for such reductions. Finally, with regard to biomass, water and land restrictions are likely to form a real limit that only can be solved by enhancing resource productivity with around a Factor 2 in this field.

2.2. Pathways of change

The theoretical framework of how particularly major societal change can come about particularly relies on transition theories that typically span 50-100 years, but also look at even longer time frames of historical change, as some conceptualizations of sustainability or resource-efficiency call for a change

that is similar to the Industrial revolution. Examples are e.g. McKinsey (2011) who claim there is a need for a 'Resource revolution' and Fischer-Kowalski and Haberl (2007) who link the sustainability challenge to the human transitions from hunter-gatherer societies to agricultural societies some 10,000-5,000 years ago, and the transition from agricultural to industrialized societies in the last 100 to 200 years.

There are four perspectives on how long-term change can be fostered via intervention of policy or by other means, summarized in the following table:

Table 1: Governance modes for Factor X transitions; Source: Tukker et al. 2013, p. 24

Fatalist **'Change will come upon us'** - Actors in stalemate over means and ends - No governance; wait for events creating windows of opportunity - If there is a transition, it is largely an 'unmanaged' one where structure dominated agency	**Hierarchist** **'Let's put a man on the moon!'** - Top-down central management - Government has power or legitimacy; means and ends clear - Main rationale is protecting public goods
Individualist **'Sustainability through the Market'** - Price and tax policy - Legitimacy for such policy; ends known; market can solve all remaining bottlenecks - Main rationale is realising economic efficiency by market parties	**Egalitarian** **'A good transition arena will do it'** - Multi-actor Arena process; learning-by-doing action research - Means and ends to be clarified; no dominant actor; actors tend to agree on rough direction of change - Intention is to have a 'managed' transition

In sum, when the problem and pathway of change is reasonably clear, and public goods are in danger, then authorities are legitimized to enforce the change, whereby either the hierarchist approach or regulation-induced technological change is most appropriate. Market-based instruments applied in the Individualist approach are useful if one knows which changes to the market incentive system will change the behaviour of actors in the direction of more sustainability. Regulatory instruments in combination with economic incentives are likely to be most appropriate for technology forcing. Resource-efficiency should be strived for since it ultimately lowers costs and enhances competitiveness. But if more complex, far reaching and paradigmatic change is at stake – means and ends uncertain, institutional change essential, fundamental failures in the market system – and there is no sufficient critical mass to embark on change, one may end up in the egalitarian or fatalist mode. In the egalitarian mode the situation is fluid enough to create change via a bottom-up and 'learning by doing' process. But in case of a stalemate about means and ends, one inevitably ends up in the fatalist mode, as seems currently the situation in international climate negotiations. In such situations there seems no option except to wait until 'system cracks' occur: a misfit between the existing way of doing things and dominant values, institutions, or physical boundary conditions (e.g. lack of resources or rising prices of resources).

2.3. Concepts, classification and mapping of strategies

Within the project, a long list of concepts has been developed by UCL and WI, which was complemented by the other project partners.

A 3 point scale was used to define positions on these dimensions:

Scope of change

The scope with regard to which system is covered plays a role in virtually all researched classification

systems, and seems also relevant given the long list of concepts mentioned above. Initiatives are classified in one of the following three categories:

- Scope is a specific industry sector (e.g. mining)
- Scope is a value chain
- Scope is societal (sub)-systems (e.g. food, energy, mobility)

Ambition with regard to the (paradigmatic) degree of change

Within the currently existing paradigm of utilitarian, economic rationality of use of nature there is a differentiation between objectives that emphasise predominantly the business opportunities and benefits for being sustainable and resource efficient – the role of authorities then simply is to remove market failures - and approaches that see also a threat to public goods – with authorities then having a role of protecting them. This leads to the following three categories:

- No paradigmatic change, focus on market-based solutions
- Intermediate paradigmatic change in the sense that there is a recognition of the 'public good' character of resource-related problems that need government intervention
- Fundamental paradigmatic change, the concept clearly calls for a revolution in our economic system, related values, institutions, etc.

Explicit attention for drivers and pathways of change

Factors that may help or hinder shaping a 'resource revolution' include real (physical or geopolitical) scarcity of resources; technological momentum, social momentum, and institutional momentum. The following three categories are proposed to classify concepts on this criterion:

- The concept ignores important factors that make the proposed change unnecessary;
- The concept only shows vaguely or conceptually why change is needed or could occur
- The concepts is clear in identifying pathways for change

The concepts are scored on the three main aspects discussed. A 'low' score is also presented with -1, a 'medium' score is presented as 0, and a 'high' scores is presented as + 1.

Table 2: Mapping of concepts; Source: Tukker et al. 2013, p. 29

No.		Scope of Change	Paradigmatic Degree	Plausibility of Paths
1	Industrial Ecology	1	-1	0
2	Industrial Symbiosis	0	-1	0
3	Waste Prevention	0	0	1
4	EPR	0	-1	1
5	Supply chain management	0	-1	1
6	Leasing society	1	1	-1
7	Ecological economics	1	1	0
8	Natural step	1	1	0

9	Weak	1	-1	1
10	Strong	1	0	1
11	Small is beautiful	1	1	0
12	Eco Innovation	1	0	1
13	Transition management	1	0	0
14	Green growth	1	-1	1
15	Green economy	1	0	1
16	Beyond GDP	1	-1	0
17	Cleaner production	0	-1	1
18	Eco-efficiency	0	-1	1
19	Resource efficiency	0	0	0
20	Pollution prevention pays	0	-1	1
21	SCP	1	0	0
22	PSS	1	1	0
23	Circular economy	1	-1	0
24	3R	1	-1	0
25	De-growth	1	1	0
26	Resilience, SOP	1	1	0
27	Hannover principles	-1	1	-1
28	BoP business models	0	-1	0
29	Leapfrogging	0	0	0
30	Slow food, transition towns	1	1	0

Mapping

Radical changes towards resource-efficiency must

a) Address societal sub-systems rather than single value chains or an individual industry; the volume of change otherwise simply will be too low;

b) Have a high level of paradigmatic degree of change; as Einstein reputedly remarked “We can't solve problems by using the same kind of thinking we used when we created them."

c) Must obviously also have a high plausibility of pathways of change, since otherwise change simply will not happen.

The following results stand out:

a) There is not **any** concept scoring +1 on all aspects. Or, in other words, there is not any concept that aims at changes at societal level, that are radical and paradigmatic, and that at the same time provides a clear and plausible pathway of change.
b) The most concepts that have a credible/plausible pathway of change in fact do not aim at a high level of paradigmatic change. Indeed, most concepts (extended producer responsibility, supply chain management, green growth, cleaner production, pollution prevention pays and eco-efficiency) simply assume that changes will be driven by win-win concepts, while it is well-known that changes based on such drivers tend to be incremental.
c) Conversely, concepts aiming at a high level of paradigmatic change at best have conceptual explanation of factors explaining change.

This overall finding is in fact very much in line with a message system innovation and transition scholars have conveyed for decades. Radical and paradigmatic change implies a shift away from existing socio-economic trajectories, the related infrastructure and sunk costs, routines, and hence also a shift to new parties dominating the system. Resistance to such change is hence significant, as exemplified by e.g. the almost continuous failure of sustainability summits like Rio+20 (2012), the COPs in Copenhagen (2009), Durban (2011), etc. 'New concepts' like Degrowth, Ecological economics and Small is beautiful hence may point at new ideas for organising society in a sustainable manner, but simply having an appealing idea – even if embraced by various groups in society – is far from sufficient to foster revolutions that can overcome the resisting powers mentioned before. The transition management concept hence indicates that the existing system and parties with power in it must already be under significant pressure before they 'crack' and a real revolution becomes possible. It seems hence that all the concepts we analysed in fact just managed to be convincing on one or two of the three aspects relevant for far-reaching change.

Unfortunately, the analysis of exogenous factors or autonomous developments that may force societal systems and dominant actors to move towards a 'resource revolution' seems to give little hope either. External pressures don't seem to be as strong as sustainability supporters would hope. Distinguishing the different resource categories, the picture is roughly as follows:

a) Energy materials. Given the climate challenge there is in principle a need for a radical reduction of their use, or better said: impacts of use, with around a factor 10 by 2050. This radical reduction however will only take place if enough political will materialises to really embark on strong and radical climate policies. There is no proof or sign this will happen at this moment. Carbon emissions are rising steadily, and authoritative scenario producers like IEA and Shell now put futures central in their work that have given up hope that the 2°C target will be met. It is further unlikely that absolute scarcity of fossil energy will become a bottleneck in the next decades, significant amounts of coal and (shale) gas being still available.

b) Biotic materials. Their extraction is mainly limited by water and land use constraints in relation to biodiversity impacts, which on the basis of scenario studies by e.g. the Water resources group (2009) and FAO (Nature, 2010) may require a Factor 2 improvement of resource-efficiency by 2050. While this certainly is a challenge, it is probably one that can be realised by incremental rather than radical innovations and changes.

c) Building and construction materials. Apart from materials that during their production create significant emissions of carbon (e.g. cement, steel, aluminium), there is no clear sign that resource or emission constraints will lead to a need to limit their use. They are abundant. Any pressure on the use of materials such as cement, steel and aluminium must come from climate policies, which already has been identified as a highly uncertain thing to happen.

d) Metal ores and industrial minerals. Here we encounter a very mixed situation, where some materials

may indeed see absolute scarcity in the next decades, but where in most cases supply disruptions are caused by geopolitical factors or market instabilities rather than real scarcity9. In such cases, simply learning better how to manage a market characterised by uncertainties in future demand, long lead times for opening mines, and dealing with geopolitical factors, can reduce many of the problems that exist today.

Overall, it is unlikely that scarcity problems by themselves will drive a broad, strong resource revolution in the next decades, apart from maybe a number of specific metal ores and industrial minerals, next to a need for incremental resource-efficiency improvements for particularly the extraction and use of biotic materials.

This all leaves uncontested that in the longer term humanity is probably better off when moving towards a resource-efficient and circular economy, as the Earth and its resources are finite. Continuing economic growth on a time span of over a century or more seems only viable by designing societal systems in such a way that resources are kept in in closed loops (without which significant energy or other resource input would be needed), or that they are based on massively abundant materials. However, to make this happen without immediate scarcity drivers, means that in the short term such change becomes a matter of societal and/or political will, which from experience is a very shallow basis to make radical change happen, and none of the concepts reviewed provided a convincing answer to this problem.

3. A Vision for a Resource Efficient Economy

3.1. Introduction

Within the POLFREE project, Task 2.2 aimed to establish a vision with clear and shared goals for a sustainable, resource-efficient economy in Europe that will provide the basis for deriving the scenarios within the POLFREE project (in Work Package 3). The vision should provide some metrics for evaluation as well as take into account the future of Europe, some likely changes at the international scale and normative issues such as human rights and equity as well as challenges of collective goods and collective action. Dimensions of the vision include scale, time, property rights and de-growth.

As a first step, a literature review and a selection of existing sustainability visions was carried out. More general "sustainability visions" from the last few decades, that were perceived as representative for the huge variety of existing sustainability visions have been identified and analysed, including both extremes of visions, such as conventional and unconventional ones. In a second step, the project team established a common analytical framework (in ANNEX 3 of Jäger et al. 2014) which establishes two major analytical pillars for assessing the existing visions in more detail, which are again divided into analytical sub-elements: Nature, and Wellbeing and Quality of Life. Those main elements of 10 selected visions that were thought to be relevant for the development of the POLFREE vision were then extracted and serve as a basis for the subsequent development of the vision presented.

3.2. Resource Efficiency within the Safe Operating Space

Targets regarding material flows can be discussed on the basis of two main entry points: the input side -- i.e. the environmental impacts of resource extraction -- and the output side, considering the limited absorption capacities of global ecosystems for waste and emissions arising from natural resource use. According to Bringezu (2014), sustainable resource use requires more than the control of negative environmental implications, and targets should be set at the input side. The EREP (2013)[1] also suggests that in addition to carbon (output side), targets should be set in the three key resource categories: materials, water and land (input side). POLFREE follows the dashboard approach of the EC to include relevant targets in the areas of materials, water, land and carbon and also distinguishes between targets related to the global and territorial perspective. Targets should either be directly derived from the safe operating space concept, or be tested against the safe operating space framework (e.g. to avoid problem shifting between environmental pressures). POLFREE grounds its targets on a global justice perspective to express the EU's fair share of environmental space (Weterings and Opschoor 1994). The vision is based on credible, scientifically-derived and measurable headline targets for the four resource categories: materials, land, water and carbon, which are solution-open and general.

To develop the POLFREE endpoints the project team identified existing visions, scenarios and targets with an explicit focus on resource use and resource efficiency, analysed the (in)consistencies contained with their targets and proposed a set of eight quantitative headline targets for 2050, including targets within and going beyond the scope of existing EU vision- and scenario- documents.

3.2.1. Objectives of Different Visions

The EU initiatives (EC 2011a, 2012) present resource efficient development as the only possible route to maintain a functioning economy, society and environment in the future. However, the European Commission's Roadmap towards a resource efficient Europe has been criticized for lacking the urgent measures to reduce Europe's overconsumption of resources, as its adoption of a traditional economic paradigm falls short of introducing innovative ideas and new policies for how to redefine the relationship

[1] European Commission (2013). European Resource Efficiency Platform. Action for a resource efficient Europe. Available at: http://ec.europa.eu/environment/resource_efficiency/documents/action_for_a_resource_efficient_europe_170613. pdf

between economic growth, material wealth and human well-being.

A vision released by the World Business Council for Sustainable Development (WBCSD) in 2010, 'Vision 2050: The new agenda for business report', sets its overall objective on the decoupling of economic growth from ecosystem destruction and material consumption, and provides very ambitious targets and innovative policy proposals in contrast to the Roadmap. However, the global vision is still quite focused on the production side with the key intervention related to price (carbon price, payment for ecosystem services, true value, etc.), while consumption is hardly addressed, nor the potential savings of increasing efficiency across supply chains.

By contrast, POLFREE stresses the importance of considering resource limits and focuses on the role the EU plays in light of global production and consumption trends.

3.2.2. POLFREE overall objective

For the POLFREE vision, absolute decoupling through resource efficiency is defined as a path where the European economy manages to maintain high levels of human well-being with lower resource use and environmental impacts. This requires not only technological innovations, but a combination of changes in business models, citizen behaviour, and governance that rely on social, organizational and systemic innovation. It also comprises the option of a stagnating or decreasing GDP as long as this does not affect human well-being.

3.3. Materials

Around 50 tonnes of resources are required per capita in the EU-27 (TMR), of which one-third is used directly, whereas around two-thirds consist of unused extraction and ecological rucksacks of imports. This means that the resource footprints of Europeans are more than double direct material inputs, and footprints are growing more rapidly than direct inputs (ETC/SCP 2011). Moreover, the EU is highly dependent on many material categories, and built-up stock is constantly increasing, posing pressures on the EU's limited land area and natural resource stocks in general.

Although the issue of unsustainable levels of resource use and waste generation is addressed as a major issue in all EU documents, quantitative reduction targets on the EU level have so far been formulated only for outputs (waste and emissions) of economic activities. The "Roadmap to a Resource Efficient Europe" focuses mainly on the topic of waste generation and waste legislation, while the European Innovation Partnership (EIP) (EC 2013) primarily aims at reducing the import dependency of the EU. The main target of the WBCSD is to improve the eco-efficiency of materials by closed-loop recycling as key strategy in terms of waste management, an increase of the co-combustion of renewable and waste to 50% of fuel needed for industrial production.

Other suggestions come from BIO IS (2012) in line with UNEP IRP (2011a), suggesting a demand reduction of industrialized countries in order to allow developing countries to grow, and Bringezu (2014), who proposes that in light of the drastic increase of global resource extraction in the last decade, the total resource consumption per capita (TMC/cap) should be reduced to that of the year 2000. In order to reach this target the resource productivity would have to be increased dramatically. Additionally, as a key strategy to reduce resource demand, BIO IS suggests that by 2050 built-up stocks in the EU should be stabilised.

According to POLFREE's overall objective by 2050, the limitations to the resource base should be respected and excessive acquirement of natural resources should have been reduced. Furthermore, the extraction of natural resources should be done in the most efficient way possible (BIO IS 2012).

As the DMC indicator shows only part of the picture of material consumption in the EU, it is essential to take into account the upstream resource requirements as well as the environmental impacts that are related to their consumption. The indicator covering these aspects is called raw material consumption

(RMC). Even more comprehensive is the total material consumption (TMC) indicator, which in addition to direct and indirect material flows, covers the unused extraction that occurs when materials are extracted from the earth's crust. While the TMC shows a more complete picture of material consumption in the EU, the RMC indicator is politically more accepted and thus the EU has already collected RMC data for all the 27 Member States (EUROSTAT). The POLFREE team therefore decided for the RMC indicator covering all four material categories (metal ores, industrial minerals, biomass, fossil fuels) when setting a target for Europe's future material consumption.

Table 3: POLFREE Materials Headline Target; Source: Jäger et al. 2014, p. 33f.

Perspective	Target 2050	Sources	Rationale	Calculations
Global (consumption)	5t RMC/cap.	BIO IS 2012 Bringezu 2013 Data: Eurostat	Returning to a level of global raw material extraction equivalent tot he year 2000 and distributing this level equally among the expected world population in 2050 (Bringezu et al. 2013)	17t RMC/cap in 2005 subtracted by 70%
EU supply	No net additions to stock	BIO IS 2012	European demand for primary resources is reduced tot he point that they can be nearly sourced within the built environment through e.g. urban mining. This also implies a reduced land take and much higher levels of renovation oft he existing building stock.	

3.3.1. Objectives on materials: specifying different material categories for possible sub-targets

Fossil Fuels

In the sector of oil, coal and gas the dependency of the EU on import is particularly high; over 53 % of all fuels are imported (EC 2011b). The use of fossil fuels further leads to CO2 emissions and therefore they are the greatest contributor to global warming, acidification, smog and toxicity.

POLFREE suggests that Europe in 2050 should be mostly fossil fuel free and thus potentially independent of foreign supply of energy sources. The Domestic Material Consumption of fossil fuels ($DMC_{fossil\ fuels}$) should be reduced by - 95 % from 2005 levels (BIO IS 2012).

Minerals and Metals

Due to the inherent properties and implications of minerals and metals in terms of mining and quarrying, a business-as-usual consumption of other minerals will be incompatible either with a continuous supply or with acceptable levels of accumulated resource extraction and related impacts in various regions. In addition, mineral waste constitutes the majority of waste in the EU (Arcadis et al. 2010) (62 %), while the global averages of many metal recycling rates are discouragingly low and less than a third of metals have a recycling rate of over 50 per cent (UNEP 2011b). Although there are clear indications to reduce the use of metals, a consistent framework is lacking that would allow defining a sustainable metal use rate. Given that many metals are used because of their unique characteristics and their supply is regarded as critical just because of their non-substitutionability, this would in many cases mean a more complete ban for the extraction of these metals. At the same time these metals are urgently required for a variety of environmental technologies with significant potentials to increase the total resource efficiency.

POLFREE suggests that in 2050 70% of the metal demand in the EU should be covered by

secondary resources (metric recycled content). The use of non-metallic minerals such as sand, gravel, limestone, clay which should be mainly used for construction activities building up infrastructure should be reduced by 85% by 2050 ($DMC_{minerals}$) in comparison to 2005 levels (BIO IS 2012).

3.4. Land

Land area is increasingly exposed to increasing demand by agriculture but also built - up land and at the same time increasing pressure due to intensification of land use. From an environmental point of view, unsustainable land management may lead to, for example, erosion, desertification, natural habitat loss and other threats to ecosystems (BIO IS 2012). Thus the challenges related to land can be characterized in two general categories: preventing undesirable land use change (e.g. conversion of forest to agriculture or urban sprawl at the cost of fertile cropland) and maintaining soil quality. As regards cropland, the EU currently uses around 0.31 ha/person for its overall consumption of agricultural goods. This is one-fourth more cropland than available within the EU, meaning that the EU is a net importer of land.

The Roadmap for a resource efficient Europe aims at the reduction of land take to an average of 800 km2 per year in the period 2000-2020 and at reducing soil erosion and increasing soil organic matter. The WBCSD vision focuses on a massive expansion of planted forests tremendous gains in productivity due to the application of biotechnology (including GMOs).

Modelling results have shown that to halt global biodiversity loss the expansion of agricultural land needs to, at least, stabilize form 2020 (van and Faber 2009). For this reason, a cautious global target of halting the expansion of global cropland into grasslands, savannahs and forests by 2020 is suggested. This would imply that business-as- usual could safely continue until 2020, at which time 1,640 Mha would be in use for agriculture (relating to a net expansion of around 100 Mha). On a per capita basis in 2030, 0.20 ha / person would be the target.

Table 4: POLFREE headline targets for land; Source: Jäger et al. 2014, p. 42f.

Perspective	Target 2050	Sources	Rationale	Calculations
Global (consumption)	Cropland reduced to 0.17 to 0.20 ha/person, or by 34 to 44% (compared to 2005)	- Low target: based on planetary boundary of Rockström et al. 2009 (15% of ice-free surface for cropland, or plus around 400 Mha from 2005) adjusted for population - High target: UNEP 2014 (+104 Mha net and nearly 200 Mha gross from 2005) and adjusted for 2050[2] - Per capita cropland area in 2007: Bringezu et al. 2012	Low target: planetary boundary for land use change to limit effects of climate change High Target: Halt the loss of biodiversity and keep land use change within the safe operating space	Resulting boundary in 2050 divided by expected population from UN 2012, medium variant (e.g. 0.20 to 0.17 ha per person in 2050) compared to use in 2007 (0.31 ha per person)
EU supply	No net loss of cropland	Combining targets from the RE Roadmap on non et land take and on soil fertility	No net land take (target from the Roadmap) due to expansion of built-up land and no soil degradation (implies long-term maintenance of soil fertility through good agricultural practices to ensure production over the years to come).	

[2] The study discusses targets for 2030, which have been recalculated here for 2050.

			Overarching rationale is to prevent the loss of fertile cropland in the EU.	

3.4.1. Objectives on land: specifying different biomass categories for possible sub-targets

Biomass for non food purposes

Biomass for non-food purpose can be described as material of recent biological origin that can be used as a source of energy or materials. This includes wood, crops, algae and other plants as well as agricultural and forest residues. Biomass can be used for a variety of end uses: heating, electricity generation or as fuel for transportation. The term 'bio energy' is used for biomass energy systems that produce heat and/or electricity and 'biofuels' for liquid fuels used in transport.

POLFREE suggests that in 2050 EU demand for food and non-food biomass from cropland should be within the safe operating space for cropland use. Food should be given first priority, followed by material use of biomass. Energy should be generated from biomass at the end of its life-cycle (e.g. organic waste).

Wood

POLFREE envisions a 2050 world in which the European demand for timber is within the safe operating space of global forest use. For demand levels, the flows of timber have to not only stem from sustainable production methods (e.g. sustainable harvest levels) but also that they are not contributing to an overuse of global land and forest resources (e.g. causing land use change). For consumption levels, three factors have to be considered for both the domestic and global perspectives: area available for timber supply, productivity on that area, and sustainable harvest levels in that forest.

Crops/Livestock

By 2050 share of biomass for human nutrition should be decreased due to a shift from animal- based food to higher share of plant-based food in European diets (BIO IS 2012). On the basis on the final report on Sustainability Scenarios for a Resource Efficient Europe prepared by Cambridge Econometrics for the European Commission in 2011(c) two additional sub targets are selected with regard to fish:

- By 2050 fish capture production [t] is below Total Allowable Catch (TAC)
- By 2050 fishing is within Maximum Sustainable Yields (MSY)

3.5. Water

The main challenge of water use is balancing the supply and consumption at a local level. In Europe the availability of freshwater has become increasingly problematic as water usage is increasing in households, industries, and agricultural sectors. The combined effect of reduced levels of water availability and increased ratios of water extraction to availability leads to a growing number of river basins becoming water – stressed (BIO IS 2012). Water stress is measured using the Water Exploitation Index (WEI), which is the ratio of water withdrawals to water availability on the river basin level(CESR 2011).

The Roadmap for a Resource Efficient Europe focuses on implementation of Water Framework Directive River Basin Management Plans to keep water abstraction below 20% of available renewable water resources. The WBCSD focuses on the agricultural uses of water with a radical reduction of water use per unit output and overall from agriculture. According to the resource efficiency roadmap, methodological gaps do not allow a target based on water abstraction to be formulated at the moment.

The Commission is currently developing appropriate indicators to set water efficiency targets. To complete the basket of indicators, the project team referred to the EEA recommendations that water abstraction should stay below 20% of available renewable freshwater resources (Water Exploitation Index). Following the discussions in the Roadmap and the EEA recommendations, the target of keeping water abstraction below 20% of available renewable freshwater resources can be taken as an endpoint for the POLFREE Vision. Following the recommendation of BIO IS and using the results of the OPEN EU project, a reduction of the water footprint of 30-50% from 2005 values is taken as the end-point for the POLFREE vision.

Table 5: POLFREE headline targets for water; Source: Jäger et al. 2014, p. 51

Perspective	Target 2050	Sources	Rationale
Global (consumption)	Mean water footprint per capita reduced 30-50% below 2004 levels*	Open EU project calculated EU water footprint for 4 scenarios. Range of results used here	The water footprint covers not only the demand consumption of water directly but also the water in imported goods
EU supply	Water exploitation index below 20% in all European Countries	EU Roadmap and EEA	At 20% a region is defined as being under „water stress“

3.6. Carbon

To prevent severe impacts of climate change, the international community has agreed that global warming should be kept below 2°C compared to the temperature in pre-industrial times. To meet this goal, the scientific evidence indicates that the world must stop the growth in global greenhouse gas emissions by 2020 at the latest, reduce them by at least half of 1990 levels by the middle of this century and continue cutting them thereafter. About 11% of the greenhouse gases emitted worldwide annually is from the European Union. For 2020, the EU has committed to cutting its emissions to 20% below 1990 levels. This commitment is one of the headline targets of the Europe 2020 growth strategy and is being implemented through a package of binding legislation. For 2050, EU leaders have endorsed the objective of reducing Europe's greenhouse gas emissions by 80-95% compared to 1990 levels as part of efforts by developed countries as a group to reduce their emissions by a similar degree.

For the headline targets in the POLFREE project, it is appropriate to take the EU greenhouse gas emission target of a reduction of 80 – 95%, since this is already adopted as an EU goal for 2050. In order to include consideration of Europe’s consumption within a global context, the results of the OPEN EU project are taken as a target for reduction of the EU carbon footprint.

Table 6: POLFREE headline Targets for carbon; Jäger et al. 2014, p. 53

Perspective	Target 2050	Sources	Rationale
Global (consumption)	Mean carbon footprint per capita reduced 60-80% below 2004 levels	Open EU project calculated EU carbon footprint for 4 scenarios. Range of results used here	Considers the impacts of goods and services imported into the EU
EU supply	GHG emissions reduced by 80 to 95% (compared to 1990)	Target from the Roadmap to a low carbon economy	To keep climate change below 2 degrees C. << target could be related to any base year, e.g. 2005, to make it comparable >>

3.7. An Example Vision for a Resource Efficient Economy

This vision for a Europe characterised by less resource use, respect of planetary boundaries and high

quality of life was developed by members of the POLFREE team based on a screening of other visions. In a participatory workshop, elements of other visions were clustered to create one vision to use as an example in the POLFREE project.

The three main elements of this vision are a safe and fair use of global resources; a sustainable society and a transformed economy. It describes what the resource efficient economy in 2050 looks like.

3.7.1. A Safe and Fair Use of Global Resources in 2050

European consumption of global resources is both within the safe operating space of planetary boundaries and fair. This means that consumption levels are (1) below environmental limits and (2) below limits of equal resource distribution—per capita use of global resources is below or equal to per capita world availability. Overall, resource efficiency is improved across the life-cycle of resource use with a multitude of benefits for nature and for people.

Materials

Mining is characterized by high levels of transparency and accountability, dedication to worker safety, and reduced environmental impacts. Materials are managed so that they do not become waste. Effective systems of material stewardship and global extended producer responsibility support the production and use of resource-light products. Information and Communication Technology devices and infrastructures have lead to massive increases in resource-efficiency of consumption patterns – and no longer rely on critical raw materials.

Energy

In 2050 Europe has an energy system that is low-carbon, resource-efficient, secure and competitive. Energy supply in 2050 is provided through a low-carbon energy system (emissions of CO2 have been reduced by 80% compared to 1990) that is based on a mix of predominantly renewables supplemented where necessary by natural gas. Primary energy demand is around 40% lower in 2050 than in 2005. Decentralisation of the power system and heat generation is higher due to more renewable generation.

Land

The global expansion of cropland, pastures, and fast-growing tree plantations into grasslands, savannahs and forests was halted in 2020. The EU has met both its target initiatives for no net loss of biodiversity and for reducing its level of global cropland use to sustainable levels.

Agriculture

Widespread application of the principles of agro-ecology enhance soil fertility, nutrient cycling and water cycling in both conventional and organic farming systems, and the use of fertilizers, pesticides and water are reduced overall. Livestock production is more climate-friendly in 2050, mostly due to a reduction in the demand for meat in the EU, enabling a combination of grassland-based production systems and sustainable intensification (especially in the tropics).

Forestry

The forest industry in the EU is characterized by its dedication to optimizing “cascades”, which means first producing the most value-added from virgin timber, optimizing reuse and recycling, and only using the raw material for energy at the end of its life-cycle.

Water

Water scarcity in Europe is reduced through highly efficient irrigation systems, closed loop water use systems and increased use of rain-fed crops. Most significant is the full implementation of integrated resource (water and land) governance and management at the water basin level. Ocean acidification has

been halted and pollution of the oceans (waste, oil, plastics etc.) is drastically reduced.

A Resource-Efficient Economy

In a resource-efficient economy citizens and public authorities have the right incentives to choose the most resource efficient products and services, through appropriate price signals and clear environmental information. Moreover, purchasing choices stimulate companies to innovate and to supply more resource efficient goods and services.

Labour, Industry and Technology

A working time reduction allows more free time for caring for the elderly or working for the community and also contributes to lowering resource use. The manufacturing industry has been transformed to respect the limits of non-renewable resources. In 2050 the leading companies are those that, through their core businesses, help society manage the world's major challenges.

Housing

The housing and building sector use a significantly lower amount of land, water and energy in 2050. Green buildings are the norm for all public buildings. The construction industry contributes to the resource efficient economy through renovation and refurbishment, increasingly sourcing recycled materials from urban mining, and employing ever-increasing resource-light innovations in (re)construction.

Mobility

Europe has a new understanding of mobility. It is not about travelling a lot and fast, but little and mainly for only short distances. This means that the transport system is low-carbon, resource-efficient, secure and competitive and uses clean technologies and transformed transport networks.

Values

All forms of diversity are important, not only the biological but also cultural diversity and diversity of social and economic systems. Human rights are upheld and people have equal access to opportunities and capabilities. Other leading principles for behaviour are peace, reaching social, cultural and environmental targets and allowing for personal development.

Governance

With a multi-level, polycentric governance system, cooperation rather than competition guides the approaches to dealing with resource efficiency. Long-term, iterative and structured participatory processes lead to increased trust.

Development

In 2050 the world population has stabilized at about 9 (at least 8) billion people. Basic needs (e.g., food, shelter, access to basic education and health care, sanitation and water) can be met all over the world and in addition it is possible to meet the human needs that go beyond the basic ones, such as security, identity, social interactions and freedom.

Open knowledge society

In 2050 Europe has an innovative, open knowledge system, which is based on the fact that there are multiple forms of knowledge and not just scientific knowledge. The general ambition is to protect, promote and whenever possible integrate the diversity of languages, concepts, models and forms of knowledge in ways that support transitions to sustainability.

4. A New Policy Mix for a Resource Efficient Economy in Europe

POLFREE WP 2.3 aimed to develop a policy mix that enables Europe to radically increase its resource efficiency, to overcome the web of constraints in WP 1 and to fulfil the goals developed in the POLFREE vision of a resource efficient economy in WP 2.2: a transformed economy, a safe and fair use of global resources and at the same time a sustainable society including aspects like governance, values and education.

This raises the question of the necessity for policy interventions: following Oates (1972) all environmental policies derive their legitimacy from existing market failures. As long as human activities directly and indirectly harm the environment with potentially disastrous outcomes, policies to counteract such failures are legitimate. Acknowledging the systemic character of many challenges, the more recent discussion has shifted towards system failures (OECD 2006) leading to more complex analyses on shared responsibilities between market participants and states.

4.1. What exactly is the failure?

In theory, free markets are able to deal with scarcities and to coordinate supply and demand in an efficient way. But especially in the case of raw materials these mechanisms show significant deficits when

- transforming geological or structural scarcity signals into anti-cyclic investments instead of following short term revenues,
- developing institutional arrangements for the reduction of price volatilities caused by supply bottlenecks and/ or social unrests,
- preventing price bubbles and the resulting risks for investments and planning procedures,
- internalizing environmental costs of access to and exploitation of natural resource deposits
- considering the use of secondary resources from recycling/ urban mining as alternative to the extraction of primary resources in the development of new infrastructures, legislation or product design.

4.2. Why would promising trends need additional incentives?

The need for a more ambitious resource efficiency policy that goes beyond the win-win rhetoric can clearly be derived from the need to counteract market and system failures by focusing on sustainable resource management. The sceptic economist however might raise the question about existing trends towards a decoupling, lowering energy- and resource-intensity, or about a ‘green Kuznets curve’, where a poorly designed policy could do more harm than good.

Fact is that

- Global resource use is rising; however, the EU shows a mixed picture: while some EU-15 countries experience a decline in resource use, some EU-12 countries show sharp increases (EEA 2012);
- The trend towards any decoupling is neither strong enough to cope with environmental challenges nor evenly distributed. Some countries even show decreases in resource productivity rather than efficiency increases; comparing aggregated indicators (like GDP and DMC/RMC) shows that countries are very heterogeneous with respect to economic structures and power, endowment with natural resources, performances in resource extraction and use (SERI 2012);
- Material leakage and problem shifting to developing countries lower the global improvements significantly;
- After any establishment of resource-intensive patterns, the need for maintenance (e.g. of transport infrastructures) requires additional inputs. Thus, there is an issue of path dependency that makes linear progress more unlikely;

- Rebound effects are estimated to occur in the range of 10-50%, depending on the specific instruments and resources (Gjoski 2011).

4.3. Developing a policy mix to radically increase resource efficiency in Europe

Against this background, this report identified elements of a new policy mix leading to an absolute decoupling of economic growth from unsustainable use of natural resources and environmental degradation. This was done in an integrative manner that incorporates existing research, WP1 and the visioning process. Based on new institutional economics and co-evolutionary analysis, we also applied elements of a regulatory impact analysis to analyse trade- offs and consistency. This includes

a) transparent assessment criteria,
b) a screening process for suitable options and a selection process of suitable instruments with key elements to be used in scenarios and modelling
c) ex ante analysis of such policy mix along the assessment criteria.

4.3.1. Theoretical framework for policy mixes

A series of innovative instruments (or innovative adaptations of existing instruments) was described in detail and analysed with regard to their potential impacts. The innovative aspect of POLFREE is to go beyond another long list of potential instruments or a mix of instruments, but to analyse them with regard to the coherence and consistency of such a mix. Synergies and contradictory effects between specific instruments, but also the consistency with regard to specific policy targets have been investigated.

Instrument specific design features

For the purpose of designing a policy mix, the single instruments have to be described by their essential characteristics. The policy mix concept developed by Rogge and Reichardt 2013 integrates the instruments characterized by their goals, type and design feature. The design features in particular are influential for innovation processes (Kemp and Pontoglio 2011, Vollebergh 2007), and therefore of particularly importance for analysing policy instruments and their relevance for innovation. The instrument design features *stringency, profitability, predictability, flexibility, differentiation* and *depth* are discussed, which are not only of particular relevance in order to analyse their innovation effect, but also an indication for the effectiveness as well as efficiency of instruments and the requirement for the analysis of instrument interactions (del Río González 2009, Rogge and Reichardt 2013).

Against this background we applied an analytical framework based on Rogge and Reichardt (2013) that brings together instrument specific design features and general characteristics of a policy mix. These policy mix characteristics can be applied both to the overarching policy mix, but also to distinct elements or processes. We will differentiate between consistency, coherence and credibility/ stability.

4.3.2. Identification of promising policy fields and instruments

Given the countless applications of resource usages and at the same time the variety of policy fields that influence the production, use and end-of-life phase of resources, a first step of a policy mix is the systematic identification of policy fields. Based on an intensive literature review on policy instruments applied in EU member states (EEA 2012) or described in the literature, nine policy fields have been selected. The following table show the selected policy fields and innovative instruments, which would allow to reach the targets described in the vision and to overcome the web of constraints:

Table 7: Selected policy fields and instruments – Instrument targets and intended effects; Source: Wilts et al. 2015

Phasing out environmental harmful subsidies	A comprehensive inventory of EHS in the EU	Instrument target: Member States are obligated to identify and assess EHS with a common approach to definitions and methods Intended effect: Inventory of EHS as starting point for

		reforms
	Environmental Subsidy Controlling: The „Environmental Check“ for Subsidies	Instrument target: Public authorities are obligated to do systematic, regular control of effect and success for all existing and new subsidies Intended effect: Create transparency and in this way to increase the pressure to reform
	Systematic phasing out of EHS	Instrument target: Implementing a degression scheme for an annual degression of subsidies identified as environmental harmful Intended effect: Reasonable environmental benefits support the diffusion of eco-innovations
Internalisation of external costs	European-wide harmonization and introduction of construction minerals taxes (incl. border tax adjustment) _ Construction Minerals Directive	Instrument target: Implementing a construction mineral taxation system Intended effect: incentive for cutting cost externalization through less demand and more material substitution through recycling
	TMR-based material input taxes	Instrument target: TMR based environmental taxation across all resources Intended effect: Creating incentives for a more efficient resource use , substitution by other (renewable) resources, more recycling, reuse and input of secondary resources
	LCA-based Value Added Taxes	Instrument target: VAT rates depending on the environmental product performance based on LCA indicators Intended effect: Set incentives to support consumer choices and producer action in favour of resource efficiency
Electricity production and distribution	Smart grids	Instrument target: Smart grids co-ordinate the needs and capabilities of all generators, grid operators, end-users and electricity market stakeholders. The real-time monitoring of network components of the energy distribution system permits to increase the transportation and distribution capacities of grids in a more flexible manner. Intended effect: Consumers are motivated for different purchasing patterns and behaviour, which result in more energy and cost efficiency. In addition, the instrument sets incentives for more decentralisation and small scale generation.
	Effective levels of carbon taxation through changes in the ETS and carbon border adjustments	Instrument target: Applying a “carbon price floor” mechanisms to counteract low price of carbon of the EU ETS. Border Tax Adjustment tariff to put in place to balance the divergence in national carbon prices Intended effect: The instrument encourages investments in low-carbon power generation
	Integrated micro-generating systems and through incentives and subsidies in industries and households accompanied with energy efficiency audits	Instrument target: Feed-in tariffs put an obligation on energy utilities and companies to buy electricity generated by renewable sources at a preferential price per unit. Intended effect: Policy to promote the deployment of renewable energy
Fuel efficient mobility	Strict CO_2 emission standards	Instrument target: CO_2 emission standard for vehicles, a pathway descending to about 50 gram/km (as company fleet average) by 2050 Intended effect: Reduce CO_2 emissions from transport 60% below 1990 levels in 2050
	Vehicle and road tax	Instrument target: Connecting taxes to the (absolute) CO2 label of the vehicle Intended effect: Car use is not cheaper than more resource-efficient alternatives
	Prioritizing urban non-car infrastructure	Instrument target: Local governments start spending most of their traffic & transport budget on improving non-car mobility Intended effect: Travel time and tariffs of car alternatives are more attractive than car mobility for most of the urban

		trips
Zero Energy and material efficient buildings	Landfill bans and landfill targets on C&D waste	Instrument target: Limiting the landfilling of C&D waste through bans and economic instruments Intended effect: Create incentives for the diversion of waste from landfill and the increase its reuse and recycling rates
	End of life of buildings and building passports	Instrument target: Including life cycle perspective in the management of building through a "extended producer responsibility" and "building passport" scheme Intended effect: Provide incentives to move C&D waste up the waste hierarchy and to promote the reuse and quality recycling of building components
	Promoting "co-housing alternatives" and living together through economic and planning instruments	Instrument target: Promoting co-housing developments using a combination of planning and tax incentives Intended effect: Lead to important reduce in material consumption linked to the sharing of resources
Minimization of food waste losses	Resource efficiency across the supply chain - Supporting cooperation, capacity building and innovation	Instrument target: Supporting cooperation, capacity building and innovation Intended effect: Reduce upstream food losses
	Green Public Procurement	Instrument target: Public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle Intended effect: GPP sets an example and creates a market for "sustainable" products and services to create economic incentives for innovation
	Courtauld commitment of food waste prevention	Instrument target: Agreement between major retailers, brand owners, manufacturers and suppliers alongside the food chain representing more than 90% of grocery supermarkets Intended effect: Reduce the amount of food the nation's householders throw away
Product Service Systems	Awareness raising campaign about existence and advantages of PSSs	Instrument target: Raising awareness about choices to consumers regarding functionality and service provision Intended effect: Contribution to dematerialize the economy without reducing human well-being
Circular Economy	Individual producer responsibility	Instrument target: Producers are responsible (bear the costs) of the end-of-life phase of their own products Intended effect: Design for durability, reuse and recycling
	Mandatory eco-design standards for reuse and repair-ability	Instrument target: Producers put only such products on the market which do not prevent the reuse of whole products or its components and their repair Intended effect: Longer product durability, more reuse and repair
	Waste targets for resource efficiency	Instrument target: Implementation of waste prevention targets, resource intensity targets and mandatory recycling content targets Intended effect: Focus on the production of high quality secondary resources instead of just ensuring an environmentally sound management of waste at the end of a products use span
Industrial symbiosis network	Landfill taxes, bans and end of waste criteria	Instrument target: Internalise landfill costs and reduce bureaucracy associated with exchange of materials Intended effect: Entail a more clear differentiation between waste and by-products that reduce the obstacles to the exchange of waste stream
	Pan-European network of industrial symbiosis programmes/ coordinating bodies	Instrument target: Coordinating industrial symbiosis programmes and ensuring exchange of good practice Intended effect: Stimulate efficient use of resources, resource efficient innovation, reduce the leakage of valuable resources
	Incorporating IS requirements in regional planning and activity	Instrument target: Provisions for material flow analysis of prospective industrial activities and identification of

	permits	potential IS opportunities in the environmental permit process Intended effect: Encouraging the clustering of activities and their distribution on space based on complementary resource needs

Case studies

In order to describe the often very different policy instruments with their characteristic design features, a common analytical framework has been developed that structures their analysis and allows to derive conclusions on their effectiveness in a resource efficiency policy mix. This structure differentiates between the policy context, the design features of the specific instruments and their implementation.

- *Context of the policy field* – why are innovative instruments needed in this field? What do vision and pathways say about it? What are relevant studies, literature etc.?
- *Instruments* – which innovative instruments would allow to reach the targets described in the vision and to overcome the web of constraints?
- *Implementation* – what are relevant barriers for implementation? Who would win, who would lose? Who are veto players? What could be "flanking instruments" in order to distribute the expected welfare benefits between the different actors?

For all policy fields three specific instruments have been described:

- The first instrument aims at the low hanging fruits of resource efficiency that could be described as win-win situation for all actors involved: increasing the efficiency of resource usage leads to cost savings (or quality improvements) so that very short amortisation periods can be achieved – sometimes even no additional investment are required at all. The basic rationale behind these instruments is often a reduction of transaction costs by improved framework conditions that make additional market activities economically viable without any additional external incentives (see OECD 2006).
- The second type of instruments requires severe market interventions by public actors that in particular force the supply side of raw materials and products to increase the resource efficiency of production processes. These instruments often follow the concept of technology forcing assuming the existence of technologies that are rationale to introduce from a social and long-term point of view, but not from the perspective of a single firm. In this specific case the regulator claims to be able assess their resource efficiency potentials: „Firms often have greater information about their own technological capabilities than regulators, and might be able to exploit this information asymmetry by hiding their true innovative capabilities, underinvesting in R&D, and claiming that the standards cannot be met. (Gerard/Lave 2003, p. 4) ".
- The third type of instrument aims at a systematic transformation of production and consumption patterns towards resource efficiency. In contrast to type 2 described above, these instruments also aim to directly influence consumption or consumer preferences. From the viewpoint of politics these instruments assume a high level of awareness for the urgent need to increase resource efficiency within the population (and thus amongst voters).

4.3.3. The step from innovative instruments to strategy development and an efficient policy mix

The detailed description of policy instruments clearly points out one of the key dilemmas of resource efficiency: There is no lack of innovative ideas for instruments that should be introduced from an overall, rationale point of view – nevertheless the implementation is often weak and scattered.

The results of the analysis of possibilities to go beyond single instruments but to integrate them into a consistent and coherent policy mix with relevant synergies between its single elements using the theoretical framework is presented below.

Consistency

The detailed description of policy instruments above clearly points out one of the key dilemmas of resource efficiency: There is no lack of innovative ideas for instruments that should be introduced from an overall, rationale point of view. However, the implementation is often weak and scattered. In the

following Section we will use the theoretical framework developed in chapter 2 to analyse the possibilities of going beyond single instruments but rather to integrate them into a consistent and coherent policy mix with relevant synergies between its individual elements.

A first step to design a policy mix is the assessment of the single instruments according to the instrument design features developed by Rogge et al. 2013. In order to provide direct comparability between the instruments, the following assessment is structured by the six design criteria. Every section starts with a short description of each design feature followed by the assessment for each instrument. A five-stage classification has been developed: (5) marks instruments, if its properties fulfil the considered feature – namely these instruments are stringent, profitable, predictable, flexible, differentiating or depth. (1) stands for instruments which do not fulfil the feature. The further differentiation - (4), (3), (2) - allows a more detailed assessment, since a clear judgement is not always possible.

Table 8: Synopsis of the valuation of 9 policy fields and 27 instruments (3 in each policy field) with respect to 6 design features; Source: Wilts et al. 2015, p. 166

		Stringency	Profitability	Predictability	Flexibility	Differentiation	Depth
Phasing out environmental harmful subsidies	A comprehensive inventory of EHS in the EU	4	3	5	1	1	-
	Environmental Subsidy Controlling: The „Environmental Check“ for Subsidies	5	4	3	1	1	-
	Systematic phasing out of EHS	3	1	4	5	5	4
Internalisation of external costs	European-wide harmonization and introduction of construction minerals taxes (incl. border tax adjustment) _ Construction Minerals Directive	1	3	3	4	3	4
	TMR-based material input taxes	5	3	1	5	1	5
	LCA-based Value Added Taxes	4	1	1	5	1	5
Resource efficient electricity production and distribution	Smart grids	5	4	1	5	5	5
	Effective levels of carbon taxation through changes in the ETS and carbon border adjustments	2	1	4	5	5	5
	Integrated micro-generating systems and through incentives and subsidies in industries and households accompanied with energy efficiency audits	4	3	3	5	5	5
Resource efficient mobility	Strict CO_2 emission standards	4	1	5	5	2	1
	Vehicle and road tax	4	1	5	5	1	5
	Prioritizing urban non-car infrastructure	4	2	5	5	1	3
Resource efficiency in the building sector	Landfill bans and landfill targets on C&D waste	4	1	4	4	5	1
	End of life of buildings and building passports	5	1	5	3	1	5
	Promoting “co-housing alternatives” and living together through economic and planning instruments	1	3	5	5	3	5
Minimization of food losses and waste	Resource efficiency across the supply chain - Supporting cooperation, capacity building and innovation	1	3	5	5	4	4
	Green Public Procurement	5	2	3	4	1	3
	Courtauld commitment of food waste prevention	1	5	5	5	5	5
Resource efficiency by product service systems	Awareness raising campaign about existence and advantages of PSSs	1	4	5	5	5	4
From waste disposal towards a resource-efficient circular economy	Individual producer responsibility	1	3	5	5	1	5
	Mandatory eco-design standards for reuse and repair-ability	2	1	1	1	5	1
	Waste targets for resource efficiency	5	1	5	4	2	1
Resource efficiency by industrial symbiosis	Landfill taxes, bans and end of waste criteria	3	3	4	4	5	3
	Pan-European network of industrial symbiosis programmes/ coordinating bodies	1	3	5	5	5	4

	Incorporating IS requirements in regional planning and activity permits	5	2	5	2	1	1

Coherency

The concept of policy coherency especially encompasses all policy processes across different governance levels – this specific aspect is of course of greatest relevance for the POLFREE policy mix which has to bring together and integrate in particular the different on-going activities on the EU and member state levels.

The following table shows the single instruments and the relevant initiation levels. The stronger the colour, the more important is the initiation role of the respective level. The bold coloured marks have the same importance; the lilac marking is used in addition, if an instrument can be initiated at one or at an other level.

Table 9: Distribution of responsibilities for resource efficiency instruments; Source: Wilts et al. 2015, p. 168

Leading role
Significant role
Supplementary role
Leading role

		Initiation Level					
		Sectoral	Global	EU	National	Regional	Local
Phasing out environmental harmful subsidies	A comprehensive inventory of EHS in the EU						
	Environmental Subsidy Controlling: The „Environmental Check“ for Subsidies						
	Systematic phasing out of EHS						
Internalisation of external costs	European-wide harmonization and introduction of construction minerals taxes (incl. border tax adjustment) _ Construction Minerals Directive						
	TMR-based material input taxes						
	LCA-based Value Added Taxes						
Electricity production and distribution	Smart grid						
	Effective levels of carbon taxation through changes in the ETS and carbon border adjustments						
	Integrated micro-generating systems and through incentives and subsidies in industries and households accompanied with energy efficiency audits						
Fuel efficient mobility	Strict CO2 emission standards						
	Vehicle and road tax						
	Prioritizing urban non-car infrastructure						
Zero Energy and material efficient buildings	Landfill bans and landfill targets on C&D waste						
	End of life of buildings and building passports						
	Promoting “co-housing alternatives” and living together through economic and planning instruments						

Minimization of food waste losses alongside the value chain/ Changing diets	Resource efficiency across the supply chain - Supporting cooperation, capacity building and innovation						
	Green Public Procurement						
	Courtauld commitment of food waste prevention						
Product Service Systems	Awareness raising campaign about existence and advantages of PSSs						
Circular Economy	Individual producer responsibility						
	Mandatory eco-design standards for reuse and repair-ability						
	Waste targets for resource efficiency						
Industrial symbiosis network	Landfill taxes, bans and end of waste criteria						
	Pan-European network of industrial symbiosis programmes/ coordinating bodies						
	Incorporating IS requirements in regional planning and activity permits						

4.4. Conclusions

Taking into account the aspects of consistency and coherency clearly underlines the challenge of establishing an integrated policy mix for resource efficiency – especially in contrast to traditional fields of environmental policy.

Firstly the character of resource efficiency as cross-cutting policy approach becomes evident: The more promising specific instruments seem, the more actors have to be involved in its development and implementation. This often requires complex coordination between different policy fields, e.g. in the field of food waste prevention between agriculture, industrial food processing, retailers and consumer policy. Despite the obvious potential environmental and economic benefits, high transaction costs of coordination are a powerful barrier. New platforms of coordination but also improved framework conditions for promising niche developments will be necessary in order to boost the uptake of existing technological and social innovations for resource efficiency alongside value chains – as addressed in several instruments of the POLFREE policy mix.

The need for cross cutting approaches also increases the potential number of veto players. The analysis of the instruments has shown that resource efficiency is often considered as a win-win strategy, but at the same time it produces a clear identifiable but powerful number of actors who currently generate income and influence from the wasteful patterns of resource consumption. For more or less all instruments the need for flanking instruments has been identified that aim to reallocate some of the cost savings or the revenues from new business models to those who potentially might hinder their diffusion. These elements can be seen as one of the key success factors for an effective policy mix.

The analysis has also clearly shown that despite the variety of existing long lists of instruments for resource efficiency, the actual implementation is often not really considered. This becomes especially obvious in terms of coordination between initiating actors on different spatial levels. Facing the complexity of resources and the complex web of constraints hindering their efficient use in production and consumption, there is definitely no common answer for who should be responsible. Several instruments (e.g. those focussing on the production phase like Eco design standards) seem to indicate the necessity of an at least European approach; on the other hand most instruments aiming at the consumption side highlighted the relevance of the regional or even local context. WP 1 described inconsistencies between the national approaches as one of the major elements of resource efficiency

policy failures. Based on the instrument analysis in this report a process is needed that goes beyond eliminating inconsistencies but aims at a systematic reallocation of responsibilities between international, national and subnational institutions – taking into account the characteristics of specific resources and at the same time the "resource nexus", the complex interdependencies between them.

5. New Business Models That Support Resource Efficiency

Businesses have proven to be both part of the problem as well as a part of the solution of the sustainability problem, and this may not be different for resource efficiency. More and more businesses face constraints between rising and less predictable prices in resource markets on the one hand and stagnating demand in many consumer markets on the other (Ellen MacArthur Foundation, 2013). It is commonly assumed that it is only in the last two decades that firms in extractive and transformation industries have adopted a more environmentally-friendly approach to manufacturing, including an efficient use of resources.

But the origins of the process of 'greening' industrial processes in resource-intensive industries can be tracked a long way back in history. Albeit it is fair to establish that leadership in this field has been typically a behaviour developed and adopted by proactive actors in search of new sources of value creation (Diaz Lopez & Montalvo 2012). At the heart of the production and consumption system there are web technologies, operations, user practices, products, etc. to be transformed, or 'greened'. An account of what 'greening' means is perhaps better understood at the intersection between business and the natural environment. Such interaction is of a systemic nature – constituting a complex, multi-directional, multi-actor, iterative process throughout the entire life cycle of products (Rosen 1997).

5.1. A conceptual model for business model change

Against this background WP 2.4 provided insights on business model changes, the barriers addressed when these changes were implemented and their policy dimension. The report builds on the results of the analysis of business barriers to the uptake of resource efficiency measures (POLFREE_D1.5, 2014). The analysis included an assessment of the type of resource efficiency measures, the associated business model changes and barriers addressed. In order to classify the various business model changes a conceptual framework was designed.

The distinctive elements of this conceptual model are as follows:

1. Business model change in the category value proposition (VP) consist of changes in the value embedded in the product/service offered to the customers. Examples are offering customers purchase biodegradable, decomposable and reusable products
2. Business model change in the category supply chain (SC) include changes in key activities and key resources and the structure and management of upstream relationships with suppliers (key partners).
3. Business model change in the category customer interface(CI) comprise changes in structure and management of downstream relationships with customers. Examples are leasing products to customers or services as add-ons to their existing products or providing product service systems.
4. Business model change in the category financial model (FM) contain changes in associated cost and revenue structures.

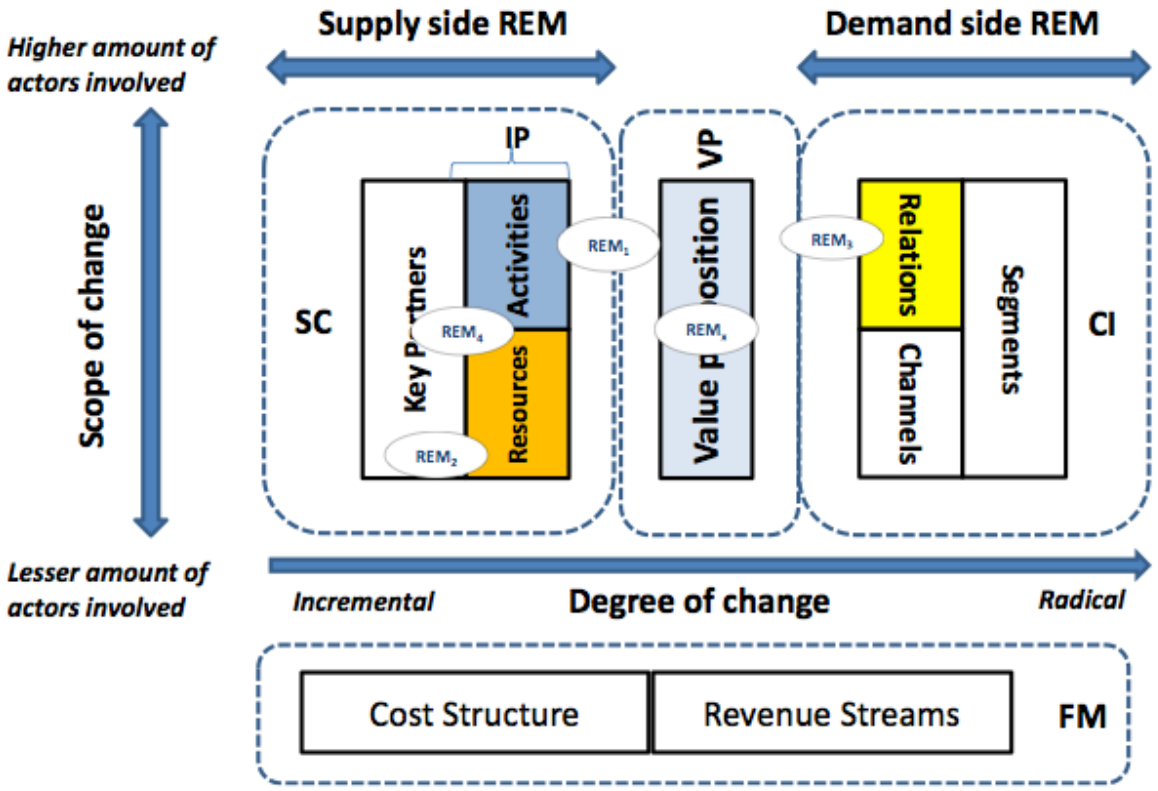

Figure 1: Conceptual model: Changes in business models supporting resource efficiency; Source: Diaz Lopez et al. 2014, p. 41, based on Osterwalder et al. 2005 AND O´Brien/ Miedzinski 2013

In order to analyse the empirical relevance of these elements, a content analysis was carried out of some 300 recent case studies reported in the literature in relation to business model change and resource efficiency (of which some 150 were studies in more detail). The results of the survey are shown in the tables below.

Table 10: Observations on business model change and barriers for product/service measures; Source: Diaz Lopez et al. 2014, p. 84f.

	REM	#		**Observation**
Product/Service	Green Products	30	REM	Relatively little combination with other types. No specific industry focus. *Clusters:* • Small-scale product changes; • New product introduction or other complete product overhauls.
			BM Δ	Mostly on the *value* proposition and some in *supply chain* and internal production.
			Barriers	Mainly *technological, behavioural* and *market* barriers, driven by the *value proposition* and the internal production changes.
	Green Services	32	REM	A very broad 'catch-all'- category. A promising number of combinations with *Industrial Symbiosis.* *Clusters:* • Services *to* Value Chains ('*X as a Service*'); • Services *in* Value Chain.

			BM Δ	Prevalence of *value proposition* changes.
			Barriers	Consequently confronted with *market* and *organisational* barriers, either when the service is in an existing market (competition) or when the service is in a new market.
	Service Substitutes	1	REM	A single case: Eco2Distrib.
			BM Δ	*Value proposition* and *customer interface.*
			Barriers	*Market, organisational* and *behavioural* barriers.
	Services instead of Products	13	REM	A focus on sharing and renting, sometimes extended with additional services such as insurance and *take-back management.*
			BM Δ	*Value proposition* and *financial model.*
			Barriers	*Behavioural* barriers due to the new way of offering and *market* barriers due to competition in traditional product market.
	Functional Sales	13	REM	*Clusters:* • Alternative for ownership focuses on material sharing: • Straightforward renting and leasing; • Added value services; Performance contracting allows for choices by the provider.
			BM Δ	This class typically needs changes in the *value proposition* to change both products to services to function and change incentives in usage. Therefore a change in the *financial model* is often occurring too. Sometimes with added value services such as TBM the *supply chain* is affected as well.
			Barriers	Because the class radically changes the proposition known to consumer concepts *market* barriers will have to be overcome. It also involves drastic changes within companies and a restructuring: therefore *behavioural and organisational* barriers are involved.

Green products (GP) is aimed at products which have smaller ecological footprint, like energy efficient machines and renewables. Green services (GS) when offered and consumed provide customers with green variants of usually existing services. These enable customers to reduce their footprint. Green services include advice/training/education, monitoring, data collecting, analysis and assessment on for example energy efficiency, CSR, green reporting, triple bottom-line services; eco-construction, eco-tourism, minimizing customer's utility (f. e. water) usage; cleaning up (oil spills), waste handling, recycling services. Service Substitutes (SS) are where companies offer services instead of products (dematerialisation) which have a smaller ecological footprint. An example is teleconferencing instead of having a physical meeting. Services instead of products (SP) results in more optimal use of services. Examples are sharing and renting of products. Functional Sales (FS) is a mix of both products and services, where the provider offers the customers an opportunity to pay for the functionality or performance of a product instead of buying the product itself.

Table 11: Observations on business model change and barriers operational measures; Source: Diaz Lopez et al. 2014, p. 85f.

	REM	**#**		**Observation**
Operations	Pollution Control	1	REM	Stena Metal Landfill Mining Project is the only case.
			BM Δ	A change in the *supply chain* and somewhat in the *internal processes.*

			Barriers	*Institutional* due to dealing with regulated landfill.
	Cleaner Production	7	REM	Cleaner production methods are often linked to other transformations, such as *supply chain management* or *pollution control.*
			BM Δ	Typical changes in the *supply chain* and *internal process*. If serviced then the *value proposition* is affected.
			Barriers	*Market* barriers due to power in the value chain and behavioural barriers if change is not in primary interest.
	Eco-efficiency	11	REM	Internally focused cases use less input materials or replace materials used. There are also service implementations, in these cases focused on training and behaviour.
			BM Δ	Surprisingly in many cases the *value proposition* was affected. In some cases actually a service was developed, in other cases *internal processes* were affected and in others the *supply chain.*
			Barriers	Dominantly *technological* barriers. If serviced also *market.*
	Green Supply Chain Management	26	REM	*Clusters:* • source green materials; • code of conduct; • co-operation between suppliers; • gain sharing.
			BM Δ	No surprise that this concept overall affects the *supply chain* component, although in different ways. Sometimes also the *value proposition* is affected as the service is advertised as green(er).
			Barriers	Coordination in the supply chain is considered an o*rganisationa*l barrier. Economical acceptance issues of chain partners represent a *market* barrier.
	Take-back management	23	REM	*Clusters:* • reusable packaging; • packaging and food waste for recycling through the retailer or a third party; • equipment for reuse or refurbishing.
			BM Δ	The *supply chain* is affected as in most cases the material taken back is fed into production. In some cases the relation with the customer, thus the customer interface is affected.
			Barriers	The *market* barrier is related to companies that need to change the way they deal with the customer. Achieving collaboration in the chain implies an *organisational* barrier.

Pollution control (PC) has emphasis on the own company and focuses on the transformation or adaption of processes to reduce negative externalities, pollution. Cleaner production (CP) are methods for cleaner production, for instance by substituting toxic chemicals with non-toxic. Eco-efficiency (EE) includes improving eco-efficiency in production, service and delivery. Examples are substituting old production capital with new energy efficient capital and training employees to act more resource efficient. Eco-efficiency focuses on processes within companies and finds its roots in production, service or delivery methods. Green Supply Chain Management (GSCM) is an integrated concept of greening activities in the supply chain focusing on upstream flow, cost reductions of and innovation in raw materials, components, products and services. Take-Back Management (TBM) extends the producers' responsibility of waste management through take-back mechanisms of down-stream use of the product.

Table 12: Observations on business model change and barriers for life-cycle measures; Source: Diaz Lopez et al. 2014, p. 86f.

	Cradle-to-cradle	24	REM	*Clusters:* • companies that produce components that can be used in C2C products or services, such as packaging; • services base on development of (bio-) (processing) technology; • C2C implementations that are driven by and scoped to a specific company.
			BM Δ	Achieving C2C starts with dealing with your inputs via the *supply chain* and *internal processes* and adopting technologies to do that. In cases also involves TBM (also Supply Chain). Some cases put C2C prominently in the *value proposition* and even service it. We term this class '*C2C as a service'.*
			Barriers	We observe *technological* barriers for the technologies required. Competing on either existing markets with a C2C enhanced product or a new type of service implies *market* barriers. The necessary collaboration in the supply chain implies *organisational* barriers.
	Industrial Symbiosis	26	REM	*Clusters:* • (Bio-) (processing) technologies that turn waste into valuable products; • platforms that connect supply and demand of residual streams; • effective collection of waste streams • implementations of eco-cities.
			BM Δ	Since IS typically relays a waste stream as an input this implies that the *supply chain* is affected. The cases where IS is being serviced, obviously affect the *value proposition*. This class is named '*IS as a service'*.
			Barriers	Due to the sensitive nature and consequently regulation of the waste streams that are treated in IS *institutional* barriers are apparent. The service concepts also face *market* barriers, because the demand for such concepts has to be found.

Cradle-to-cradle (C2C) designs innovative and essentially waste free products that can be integrated in fully recyclable loops or biodegradable processes. Cradle-to-Cradle has a focus both upstream and down-stream in the value chain. Industrial Symbiosis (IS) is a system approach to a more sustainable and integrated industrial economy which identifies business opportunities that leverage underutilised resources (materials, energy, water, capacity, expertise, assets, etc.).

5.2. Categorizing business model changes

Using the theoretical framework these business model changes are categorized along their size of business model change (i.e. vertical axis in scheme below: either simple internal change, or changes involving many stakeholders) and their impact on ether supply or demand side (horizontal axis).

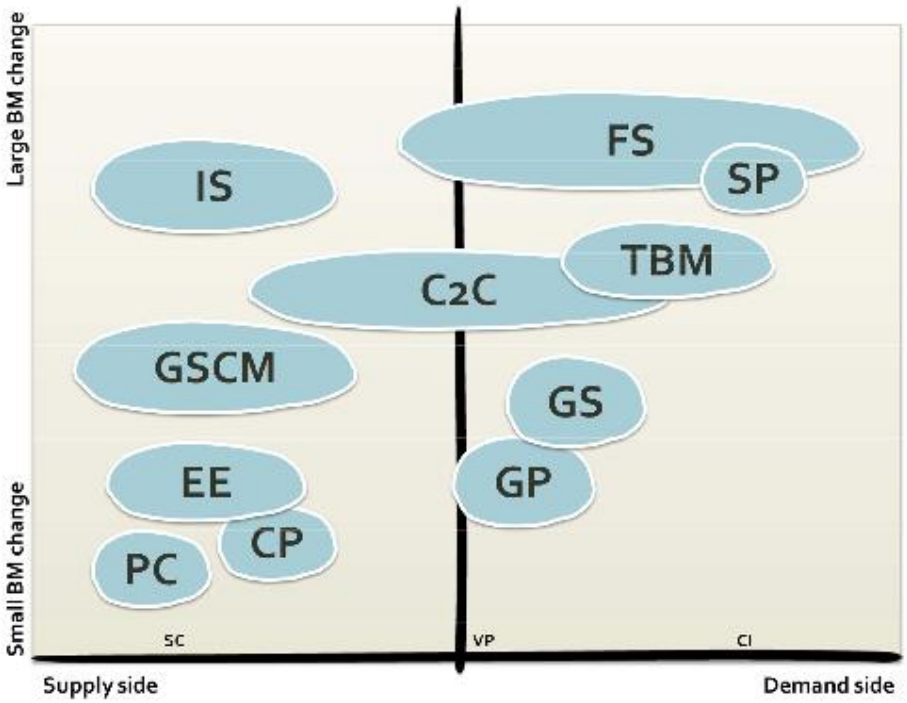

Figure 2: Results of cluster categories, supply and demand side and scope of change of resource efficiency measures and business model change; Source: Diaz Lopez et al. 2014, p. 90

Based on the observations a model is presented of service companies that will enable and facilitate a change to service models. Creating opportunities for service models is thought to play an important role in a transition towards radical shifts to resource efficiency. The nature of such companies is that they are able to serve multiple companies on the input (supply) side and multiple companies on the output (demand) side; they function as a platform that may create new and stable markets. The authors of this report identify and describe the potential benefits of such service constructions, which lie in a simpler interface (one company instead of a value network), the build-up of expertise, the potential for scaling-up and the focus on activities that for players in the value network may be out-of-focus. In other words, the authors suggest that such a platform enables the implementation of potentially high-impact RE measures without many of the organizational and market-barriers. Some relevant messages derived from the analysis of findings are summarised below:

- Demand side measures: A relatively large number of the studied cases are associated with green products or green services concepts, delivering products or services that contribute to resource efficiency. A relatively small number of the studied cases are associated with the functional sales concept, where the customer pays for the functionality or performance of the product instead of buying the product itself. This is possibly caused by the fact that it is more difficult to introduce this concept in the distinct markets or because of the relative newness of this concept. The services instead of products concept could be seen as the forerunner or a simplified version of functional sales.
- Supply chain measures: A second large group consists of cases related to green supply chain management and industrial symbiosis, focusing on resource efficiency in the supply chain in cooperation with partners or suppliers. Only a few of the studied cases are related to the pollution control and cleaner production concepts. This is most likely caused by the fact that these are rather specific concepts frequently related with the own production process that are linked with eco-efficiency and green supply chain management.
- Life cycle measures - design for radical change: The third dominant group of cases focusing on cradle-to-cradle or take-back management (also part of product-service systems), is oriented towards the product life-cycle and ultimately aims to close the recycling (or reuse / refurbishment)

loop. In terms of scope of change, life-cycle oriented resource efficiency measures like cradle-to-cradle involve business model changes on both supply and demand side. It is important to note the interaction with the services categories, as some types of green services enable the implementation of potentially high-impact resource efficiency measures like cradle-to-cradle and industrial symbiosis without less of the organisational and market barriers: C2C-as-a-service and IS-as-a-service.

- Supply side resource efficiency measures like pollution control, cleaner production and eco-efficiency can often be arranged within one company and entail none or a small business model change in the supply chain. Supply side resource efficiency measures like green supply chain management and industrial symbiosis often require considerable changes in components of the business model, because more parties or parties across the value chain have to be involved. Take-back management requires cooperation between different parties both upstream and downstream the value chain. It can lead to the creation of new companies and a green business plan, e.g. following a producer responsibility principle, requiring significant business model changes or the design of a new one.
- Demand side resource efficiency measures like green products and green (business) services can typically be realised by one company, resulting in no or a small change in the business model. Resource efficiency measures such as functional sales and services instead of products demand relatively large changes in the customer interface of the business model. Life-cycle oriented resource efficiency measures like cradle-to-cradle involve business model changes on both supply and demand side. For this type of resource efficiency measures normally more parties, including those that are further up- or downstream than the direct suppliers and customers, are required. As a consequence, the required business model changes are relatively large.

5.3. Overcoming the web of constraints

At first glance, the high number of cases demonstrates that improving resource efficiency is a driver for many companies for many reasons. On the supply side costs may be reduced and supply may be secured, on the demand side new customer niches (either through products or services) may be tapped or a new form of customer intimacy may be reached. But besides these obvious benefits, companies may also be active in this field to be seen as a reliable employer, that is attractive for new employees as well as for current employees, that may feel themselves more motivated.

Though policy measures have undoubtedly a stimulating effect on almost all business models discussed here, one should always keep in mind the web-of-constraints, that was introduced in an earlier report in this project (Deliverable report D1.5). Even in a perfect regulatory and fiscal environment, internal business barriers involving organisational or behavioural aspects may be insurmountable. And without deep insight in the quantitative nature of business processes and changes it is impossible to derive the effect of pricing instruments of raw materials and consumables. The current approach used in this report also has limitations. Reported cases rarely comment on the barriers that had to be overcome upon implementing the business model reported. In particular, the deeper barriers (internal behavioural barriers) are hard to extract from such literature evidence. Furthermore, business models attempts that failed do not reach the state of being reported at all. Valuable information about business barriers that had not been overcome are therefore unreported, and thus not discussed. Some reported cases may be cases in the framework of a larger movement within a company. The report of an individual case may even have less data on the barriers that were taken, since they might have been a result of a general management target that is of a more holistic nature than the individual case.

The number of cases and the variety in resource efficiency measures illustrates that businesses have a lot of options to become more resource efficient. The variety of business model changes reveals in its turn a great many variations to achieve business value from implementing a resource efficiency measure. However, the document sources gathered and presented in this report lacks information on the business value of these resource efficiency measures and business model changes (e.g. impact on return on investment, cost savings, etc.). It also lacks information on the environmental sustainability and

actual resource efficiency achieved. In general this information is hardly available and the authors of this report believe these are very much context dependent. Obviously the sector in which a company operates affects the potential implementation of the different measures. Also the (international) competition that companies face affects the effectiveness and even possibility of how to achieve business value from implementing a measure.

The consequence of the discussion above, is that from a business perspective the range of resource efficiency measures is broad but often with unknown quantified effects on business performance and value creation. This uncertainty does not lead to investment incentives nor enthusiasm from a business perspective. Likewise, informing policy remains a challenging and elusive task in terms of supporting critical choices of policy support to business models that both promote resource efficiency and business competitiveness alike. For example, should C2C or EE be preferred, or both, and how?

This could be termed an informational barrier, which not only has implications for the adoption of RE measures by individual companies but is also likely to hamper policy decisions to promote resource efficiency as it is unclear what measure to stimulate for whom? A holistic approach for evaluating RE measures and business model changes is missing. For this purpose additional primary research is required involving a combination of in-depth cases studies, quantitative analysis and econometric modelling and a subsequent wide dissemination and sharing of the findings thereof.

6. Report on Global Governance for Resource Efficient Economies

This report, forming deliverable 2.5 of the POLFREE project, moves the focus from resource efficiency in Europe to global governance of sustainable resource use. This is an important contribution for two reasons: (i) the recognition of a need to extend the focus of Europe's resource efficiency agenda to reflect on its reliance on imports for some commodities and the prevalence of global supply chains; and (ii) acknowledgement of the absence of an existing characterisation of the governance structure that covers resource issues across the environmental, trade, human rights, development and energy fields, and through the different layers of governance from international institutions to community level actions.

The report uses a broad characterisation of governance, leading from the UN International History Project definition, encompassing traditional state led institutions and actors, as well as those emerging from individuals, community, not for profit and business groups, with the full suite of formal and informal mechanisms. The definition of resources is also broad, covering all natural resources.

6.1. The Existing Governance Architecture

The research reveals a complex and interacting governance architecture when considered in the context of resources. Although the framing distinction of top-down and bottom-up governance is made to assist with the navigation through the subject matter, the strong interactions between the two and variability within are recognised.

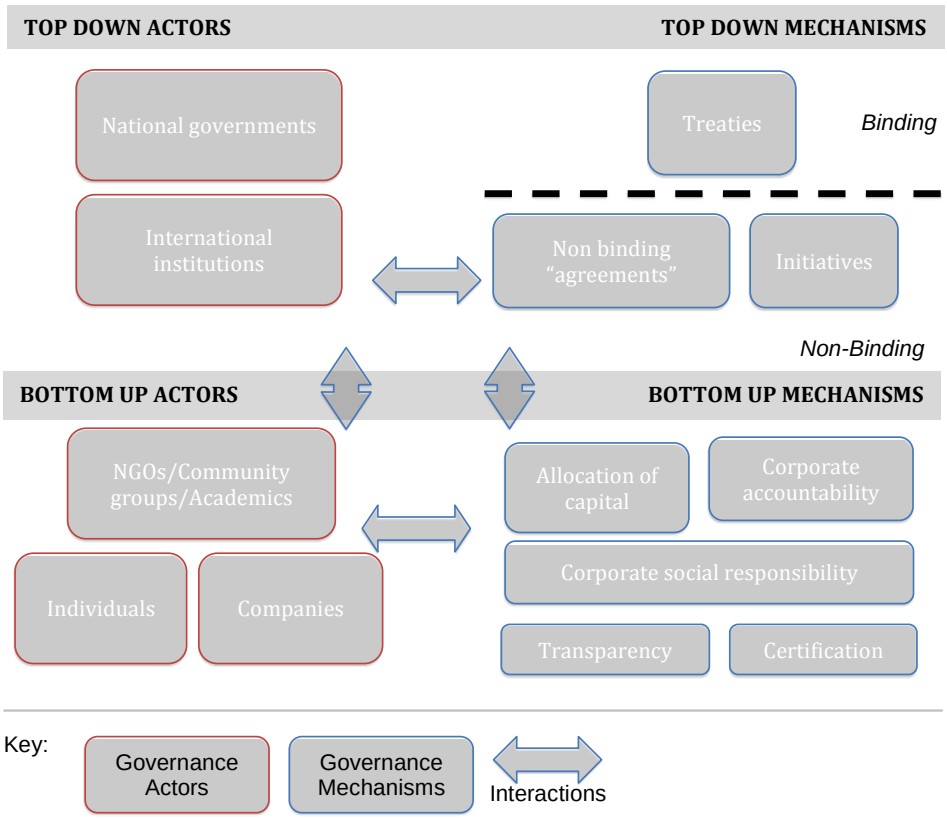

Figure 3: The existing governance architecture for resources; Source: O'Keeffe et al. 2014, p. 5

International institutions of relevance for resources include those established at the Bretton Woods conference that followed the end of World War Two, relevant UN institutions, programmes and specialised agencies, and other international institutions operating outside the UN system but with a global mandate. The UN Environment Programme (UNEP) has the closest mandate to the full spectrum

of resource issues, although in its environmental focus it does not cover all.

With regard to governance mechanisms, those considered as "top-down" are led by state actors, often co-ordinated through international institutions. Two distinct categories of top- down mechanisms can be identified. Hard law mechanisms are binding treaties, protocols and agreements which for resources can be derived from the fields of environmental, trade and human rights law as well as resource-specific areas of law (e.g. relating to global commons resources and similar). Soft law mechanisms are much more numerous and varied, and are non-binding, albeit powerful in the establishment of global norms and procedures. Those described in this work are primarily associated with the UN (directly or indirectly) and are grouped under five categories of scientific initiatives (such as the IPCC and IRP), enabling initiatives (such as the 10 YFP on SCP), business focussed initiatives (such as the UN Global Compact), green economy initiatives (such as the UN Green Economy Initiative) and international groupings of sub-national bodies (such as Resource Efficient Cities).

"Bottom-up" mechanisms originate from a myriad of sources from the not for profit, academic, business and community sectors. Non-binding but extremely effective at bringing in new partners to the governance system and at preparing the ground for development of norms and practices, the bottom-up mechanisms can operate on their own, or as precursors to more formal and traditionally top-down mechanisms. Key mechanisms are described including those relating to certification, transparency, corporate accountability, corporate social responsibility and allocation of capital.

The resulting picture is one of diversity. Whilst some are concerned about the large degree of fragmentation, others see an active patchwork of initiatives that have the potential to create new norms and practices, testing ideas and approaches that can eventually be adopted at scale. The evidence suggests that this national and international level adoption of bottom-up derived initiatives is already happening.

6.2. Understanding Global Governance for Sustainable Use of Resources

6.2.1. Establishing the context

The first stage is one of establishing the context for the assessment. Firstly there is a need to identify the issues that any governance system must address. These are:

- Physical supply and environmental degradation – are sufficient resources available geologically or biologically, and are they in a sufficient state of "health" to be able to support future populations and inter-related ecosystems?
- Access to supply and price volatility – can the resources available be accessed by those that need them in an equitable manner either physically or economically; are the methods of extraction supportive of sustainable long term resource use?
- Socio economic impacts – maximising positive impacts in resource rent capture and reducing negative impacts of competitive land and resource use and degradation of human rights
- Demand reduction – a way of relieving pressure on natural resources but with equity considerations regarding access and economic potential.

The second contextual aspect is the need for resource groupings with common attributes to be defined. For the purposes of this project these have been identified as:

- Internationally traded commodities – including metallic minerals, fossil fuels, timber and agricultural products
- Embedded resources – resources that do not have a direct economic value but are affected by extraction of commodities or relied upon as part of supply chains. They rarely end up in the product itself, and include freshwater, soils, land and air quality

- Global utility resources - embedded resources that have a greater perceived value at the global level due to an indirect global function, or through extended reach, including the atmosphere, forests and biodiversity.
- Commons resources – taking a broader than the strict legal interpretation of the commons, and including the high seas (and the fish and mammals that live within it), the seabed and Antarctica.

Thirdly, in this report we are only interested in the resource flows that operate globally. Therefore it is important to establish the pathways through which this occurs. Four pathways have been identified:

- International trade in commodities;
- Global supply chains and transnational companies;
- International concern; and
- Global commons

Two other aspects that are not considered in detail in the report but are key "threat multipliers" to the issues associated with resource use, and the pathways through which risks are escalated to the global level, are conflict and climate change. Conflict has the potential to arise from unsustainable patterns of resource use and also has the potential to exacerbate the potential negative aspects of the first three issues above, which can also be heightened through climate change.

6.2.2. Establishing the assessment criteria

The second stage is one of establishing assessment criteria, and uses two concepts: legitimacy and feasibility.

Legitimacy allows for the assessment of what each approach is able to govern and how appropriate the approach is with regard to its general governance characteristics. Three types of legitimacy are defined. Source-based legitimacy determines whether the governance approach utilises expertise and tradition and accords with the current discourse; process- based legitimacy determines how the approach engenders participation from government and non-governmental sources, and how it ensures accountability and transparency; and outcome legitimacy, or effectiveness, which evaluates whether the governance approaches address the issues of resource use sustainability and the resource groupings established above. In addition, three characteristics of good governance gleaned from the literature on environmental governance – flexibility, implementation and multidisciplinary – are considered.

The **feasibility** component recognises that to be successful, regardless of its attributes, a governance approach must be adopted, and in the context of this work adoption must be global. Furthermore, the POLFREE project is looking at resource efficiency in 2050 and therefore it is future feasibility that we are interested in. Therefore, potential governance futures must be envisioned to fully evaluate feasibility.

6.2.3. Envisioning a governance future

Three potential futures can be envisaged:

- A multilateral world
- A coalition driven world
- A world of unilateral action and bilateral agreements

A multilateral world

Here the one country one vote, fully multilateral approach is a successful one with all countries recognising the importance of coordinated action. This approach has characterised the later part of the 20th century with a proliferation of multilateral environmental agreements. Less commitment to these approaches is evident at present, however the potential for climate change impacts to galvanise global efforts should not be dismissed. Although the multilateral approach is seen as the outgoing paradigm, a

strong multilateral approach in 2050 does not necessarily mean that the same institutions prevail.

A coalition driven world

Here collaboration is occurring but it is in smaller coalitions rather than full multilateral processes. Progress is fragmented but is progress nonetheless, focusing potentially on key issues and maybe key regions. In this future it is important to also consider what Europe's role would be in such a fragmented governance system: is it a strong Europe acting as a driving force for the coalition-based leadership, or is Europe on the side lines with developing and emerging economies taking the lead? The fragmented, coalition based approach is characteristic of today's governance preferences, evident even within multilateral processes.

Unilateral action and bilateral agreements

In this final possible future, cooperation is at a minimum, with countries instead preferring to make unilateral decisions and enter into bilateral trade and resource sharing agreements where necessary. There is a wholesale rejection of the global governance institutions developed since world war two and the concepts of shared responsibilities are side lined.

6.3. Assessing The Legitimacy Of Global Governance For Sustainable Use Of Resources

The following institutions and mechanisms were assessed as part of the research, on aspects of both input legitimacy and output legitimacy. Whilst this list is not exhaustive, and in many cases groups institutions/mechanisms of similar characteristics together, it can be considered to be broadly representative of the key participants in the debate.

Table 13: Governance institutions and mechanisms analysed within the report; Source: O'Keeffe et al. 2014, p. 8

	Institution or Mechanism?
Trade in commodities pathway	
World Trade Organisation (WTO)	Institution
Coalitions of the powerful	Institution
Enhanced Sustainable Commodity Agreements	Mechanism
Global supply chains and transnational companies pathway	
Business-focused initiatives	Mechanism
Global extended producer responsibility	Mechanism
International concern pathway	
UN Environment Programme (UNEP)	Institution
UN Environment Organisation	Institution
Expanded UNEP	Institution
Coalitions of the powerful	Institution
Environmental court of justice	Institution

Integrated Resource Management Agency	Institution
Treaties	Mechanism
Sustainable Development Goals	Mechanism
Global commons pathway	
International Maritime Organisation (IMO)	Institution
International Seabed Authority (ISA)	Institution
Antarctic Treaty Consultative Meeting (ATCM)	Institution
Commission for the Conservation of Antarctic Marine Living Organisms	Institution
UN Convention on the law of the Seas (UNCLOS)	Mechanism

Input legitimacy

The analysis of input legitimacy builds a picture of the process of governance formation and operation. The assessment is performed on a range of institutions and mechanisms, including existing and proposed, across the four pathways.

Overall it can be seen that the institutions and mechanisms concerning resources (existing and proposed) have a strong tradition of incorporating appropriate expertise. The assessment indicates that the discourse promoted by these institutions/mechanisms is moderate or better, with the notable exception of the WTO which does not seem to have kept pace with changing attitudes to production and consumption and global relationships. A more mixed picture can be seen when looking at tradition, however this is to be expected from such a dynamic and expanding area of governance and from an assessment that includes both established and proposed governance approaches. It can be argued that an absence of tradition is not necessarily a weakness, particularly where the existing governance approach has been shown to be lacking.

The large number of institutions and mechanisms with a strong or moderate governmental participation demonstrates the continued prominence of nation states in governance approaches to resources in both the existing and proposed governance solutions, although not all provide for full global participation (coalitions of the powerful and the Antarctic governance institutions are examples). Non-governmental participation in top-down institutions and mechanisms has increased considerably over recent years but is still lacking in some areas, with the WTO, coalitions of the powerful and the environmental court of justice proposal assessed as weak in this regard (the latter two being dependent on final institutional proposals). Accountability is the component of legitimacy that the resource governance approaches perform worst in, with only extended Sustainable Commodity Agreements, global Extended Producer Responsibility and the Environmental Court of Justice being assessed as strong in this regard. All of these however are proposals and not established governance approaches and therefore it remains to be seen whether they can deliver on accountability. The final component, transparency, is again an area that has had much focus in recent years and subsequently most established and proposed governance approaches perform well. For the coalitions of the powerful it will remain to be seen whether they can deliver on transparency; the WTO is an existing approach that is again lacking.

Output legitimacy

Looking at the output legitimacy component, the focus is on how the institutions and mechanisms address the issues of sustainable resource use. From the analysis it appears that the physical supply

and environmental degradation issue is covered by a number of different governance approaches, reflecting a history of global cooperation in environmental issues, albeit one that is fragmented and with varying success. The institutions developed for environmental protection purposes have recently adopted a focus on demand reduction, which has enabled this issue to be brought into the international arena despite having relatively few dedicated governance institutions or mechanisms at the global level. Socio- economic issues and access to supply (in particular the price volatility component) appear to be much less of a focus in existing and proposed governance approaches and deserve more attention. Looking across the categories of resources adopted for this study, commodities and global commons show the strongest representation although all seem to be reasonably well catered for across the different governance approaches. A more nuanced view however may become evident if looking at individual resources as opposed to resource categories.

6.4. Assessing The Feasibility of Global Governance for Sustainable Use of Resources

The attitudes to governance in 2050 will be a key determinant of the success of proposed institutions and mechanisms. The key legitimacy attributes that differ depending on the position on the cooperation continuum are tradition and participation, as demonstrated below.

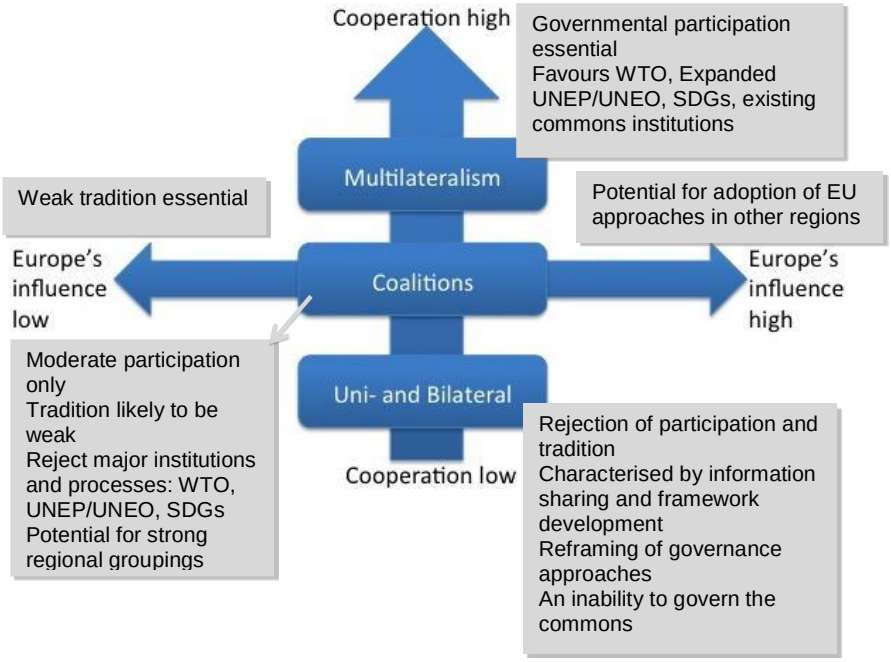

Figure 4: Summary of feasibility assessment; Source: O'Keeffe et al. 2014, p. 10

6.5. Key findings

This report has provided a basis from which to gain further understanding of the role and complexity of resources within the governance system. It is the first known attempt to collate the full governance framework from a resources perspective as opposed to an environmental or other lens, and reflecting the full range of governance layers. It has demonstrated the wide range of interconnecting resources, issues and pathways that call for a deeper level of understanding. Some key findings from the research are as follows:

- Resource efficiency and resource use sustainability can and should be tackled at an international scale.
- It must be recognised that the current international mood is one of scepticism regarding multilateralism, heightened by the failure to achieve a global consensus on climate change. This can be heightened by different national/continental attitudes towards international collaboration

as a whole.

- Despite the noted scepticism, there is evidence that the multilateral processes have stimulated activity in the more informal areas of governance to allow progress to still be achieved and creating a new pathway of adoption of norms and practices established at the bottom up level into more formal areas of governance. Key areas include transparency and accountability. It could also be argued that the strengthening of regional governance in many parts of the world could facilitate greater global governance.
- In the resource context, no clear and targeted governance structure has emerged yet that covers all the issues associated with sustainable resource use although the Integrated Resource Management Agency proposal has potential. Given the breadth of issues, fragmentation is likely to be a key feature in the near future and can in some cases be beneficial. Waiting for a perfect all-encompassing solution is not only overly optimistic but also ill advised.
- There are clear opportunities to address some of the issues of resource use sustainability through the international trade on commodities pathway, such as extended Sustainable Commodity Agreements, however such mechanisms are hampered by the need to operate within the WTO's framework.
- The proposed coalition of the powerful approach, whilst not meeting the academic understanding of good governance, is attracting a lot of attention and fits with current attitudes to multilateralism.
- Voluntary bottom-up measures have great potential to road test future international arrangements, and also to address issues of demand reduction. A significant breadth of approaches is in place at the moment and the field is extremely dynamic.
- Few of the international governance approaches address socio-economic issues associated with resource use and price volatility.
- Demand reduction has been incorporated into the global environmental agenda to some extent however it is important to ensure that the global implications of demand reduction at a national or regional level are understood.
- The business-focused initiatives have a lot of potential but need to address criticisms of ambition and accountability to be truly transformative.
- Transparency is also essential to allow for the full range of initiatives to flourish.
- Funding is key to regime success both in generating trust and in supporting capacity building for effective implementation.

Therefore some key actions for Europe to consider are:

Influence: As the world's largest importer, a member of the G8, home to three of the top ten largest stock exchanges in the world (by market capitalisation) and to four of the 10 largest companies globally (based on the Fortune 500), Europe is a significant player in global governance. Europe can use its influence in agenda setting at these important fora to ensure that resource use sustainability remains in focus. Where the appetite for action is not yet strong, transparency initiatives offer an opportunity to build the evidence base.

Support: Europe has demonstrated leadership in its adoption of a series of bottom up initiatives. These bottom-up mechanisms have shown an ability to build capacity, develop novel approaches that are transferable into national and regional top down governance. Supporting such initiatives can further capitalise on the potential for new approaches to governance to arise, with the support of a wide number of stakeholders.

Collaborate: It is important to keep multilateral dialogues open as future governance attitudes may be more conducive to such an approach. Potential solutions to address some of the issues of resource use sustainability are present within the range of initiatives already in operation, including the Natural Resources Charter, certification schemes, voluntary codes of practice and commodity agreements, however many will eventually require a full global commitment to reach their maximum potential. In the meantime it may be collaboration through coalitions that is the most successful, including with other

regional governance structures around the world.

Investigate: A number of areas have been identified for further investigation:

- The sheer volume and variety of measures that have some relevance to resources suggest the need for a body that orchestrates approaches on resource use sustainability. This is particularly important given the need to address impacts across the international trade system, as well as fields of environmental and human rights law. The Integrated Resource Panel is an assessment and advisory body and therefore does not fulfil this role, and there is no alternative coordinating institution with a remit that stretches this far. Further elaboration of the International Resource Management Agency proposal including evaluating the potential for a mineral based OPEC could therefore be informative.
- Considerations of conflict, security and climate change have not been fully explored within this work and represent significant areas of risk that warrant more detailed study.
- Looking in detail at interactions between international governance and national action on resource issues. Issues such as taxation, subsidies, governmental capacity and information gathering are essentially national issues but for which an international framework of support could be developed.
- In an attempt to cover multiple disciplines and layers of governance in the report, the importance of financial institutions (both multilateral development banks and private sector investment funds) has been neglected. This is something that should be remedied.
- It has not been the aim of this report to fully explore resource use from an ethical perspective in the context of a carbon constrained world and planetary boundary perspective, however this is clearly an area for consideration at the global level.
- More radical alterations in governance structure could yield a very different understanding of future governance mechanisms in the timeframe considered. More exploration in this area, and in particular of Europe's role in such a development, could provide an interesting extension to this work.

7. Conclusions: Successful Resource Policy Requires Core Strategies

Resource efficiency is a central answer to the shortages and price developments of important resources. In contrast to many areas of an ecological modernization policy (e.g. environmental and landscape protection), the intersection between economic and ecological objectives in resource politics in resource dependent regions such as Europe, which are also global suppliers of GreenTech, is relatively high. This is a decisive advantage for policy design and favours a cautious resource efficiency policy with endurance qualities and ambitious long-term goals for the reduction of resource use – even in times of decreasing resource prices.

It is now up to resource politics to awaken the „sleeping giant resource efficiency“. Energy efficiency only became a prioritised issue in politics and enterprises during the last years. Resource efficiency – with its essentially higher cost savings effect and comparably attractive savings options – is a major coming political and societal issue. Goal of resource efficiency politics has to be the promotion of the transition to a resource light and sustainable economic system with the corresponding production structures and products in the face of the challenges for an ecological modernization policy. In this process, it can learn from other policy areas and experiences from other countries. Reliability through political consensus and scientifically based reduction goals hereby serve orientation purposes for long-term effective investment decisions in production and infrastructures with long investment cycles (e.g. mobility and energy systems).

Integrative and international alignment of politics

Resource policy is a cross departmental task which has to be viewed in an international context and has to consider global aspects. Europe, as a resource-poor country, is a large resource importer as well as a significant exporter of resource efficiency solutions, products and services. The global aspects become visible also on a physical level through global impacts of raw material imports (e.g. through the shift of environmental impacts or „ecological backpacks“ to source countries) or the international waste and end-of-life product exports.

On a political level, the study of political approaches of other countries – e.g. from the Japanese 3R initiative (Initiative 3R 2010) or the EU resource strategy (European Commission 2005) – is just as significant as the transfer of technology and know-how or development partnerships “on eye-level” with emerging countries. In contrast to the international cooperation at business and association level in the field of renewable energies, international partnerships for resource efficiency are only at the beginning stage. Essential is the integration of national resource policy in the international and especially EU-wide context.

Ecological modernization especially requires a policy that is directionally safe. In order to be able to make a goal-oriented selection out of the multitude of possible instruments, it is of central significance for a policy to concentrate its aims in core strategies and clearly outline policy fields. Prioritised core strategies thereby also serve cross departmental orientation and public communication in a new emerging policy field.

The selection of core strategies and instruments for the entry into an accelerated resource politics is based on the following criteria:

- The core strategies are supposed to address central target groups and their field of action relevant to resource efficiency
- The budgetary financing of the deconstruction of obstacles and of a set of measures for the increase of ecological innovative capability, and the support of sustainable (real) investment activity are supposed to relieve budget pressure and support structural change towards an ecological modernization. Model analyses may help with specific policy design as they reveal in how far instruments finance themselves.
- In order to ensure a quick and rather effortless realization, the instruments assigned to the core strategies in the entry phase are supposed to build on already existing structures and

change processes. The aim here is to extend existing (administrative) infrastructures as far as they already address an aspect of resource efficiency, or to open them up to the topic.

- The number of selected instruments has to remain manageable. Furthermore, effective instruments are supposed to be applied which start at the central setscrews of ecological modernization.
- The instruments may be chosen in a way that enables a flexible adaptation to new developments and changing framework conditions or allows for a combination with other instruments which might become necessary at a later point.

The core strategies of resource policies altogether form a policy mix (set of instruments) of various instruments, as multiple barriers, various target groups and very different actors have to be addressed and involved. This requires tailor-made instruments. A single instrument is not able to fulfil these various demands all at once. The upcoming forced entry into a resource policy therefore requires instruments that facilitate dealing with the new topic for the central target groups, take the (operational and financial) legal capacity into consideration, find societal acceptance, lead to quick successes and show the importance and promising prospects of resource efficiency for economics, politics and society. In the coming years, when the topic of resources is widely established, the policy mix and political instruments have to be developed accordingly. Therefore it is important to choose a policy mix these days that excels with flexibility and future options and considers the necessity of further development.

Linking policies and business model changes

Reviewing the POLFREE attempts to develop an innovative policy mix for resource efficiency and at the same time supporting a business model change towards a radically improved efficiency of resource use, the key success factor seems to be the alignment of both elements. Many enterprises find themselves standing before crucial decisions when it comes to long-term investments into resource efficiency technologies, products and services: Many such measures are already taken and the environmental successes of such measures are clear. However, the low-hanging fruit in many areas has been harvested already and it may be questioned whether further intensifying such measures may have great benefits, especially in view of a level-playing-field discussion. Fiscal measures work as a generic tool to promote demand side, lifecycle and supply chain business models. One has to keep in mind however that the financial stimulus may be rather small. And even then, changes are not only governed by mere financial incentives. Especially in smaller companies, limited available effort may act as a behavioural barrier to pick up complex business model changes. Company management must have a clear view on the robust niche that can be captured by radically changing a business model, and the cultural, and competence shifts that are required. Policy measures may act as a push in a direction, but are certainly not the only factor. This also counts for the customer side in life-cycle business model changes or demand side changes. The customer (be it a citizen or a business-to-business customer) has many drivers for each decision, among which are perceived transaction costs (‘do I want to bother changing behaviour in view of the limited impact on my life and budget’), a feeling of freedom and choice (‘Do I want to share and lease goods that I always want at my disposition?’; ‘Can I always count on the supply of residual, secondary material as a feedstock?’). Policy influence in the uptake of product-service systems may therefore be rather limited.

Besides these ‘hard’ measures, governments have more tools to stimulate the business model changes discussed here. The role for strategic public procurement is one of them. It may act as a tipping point for new products and services so that they can create critical mass, and also shows that government is serious and acts as an example for society. It therefore adds to trustworthiness of government: act as you speak! The role of subsidies should also been seen in this light. Whereas on the one hand policies might be designed to create green business model innovations, companies may not be in favour of such policies. Whereas technological changes are protected by intellectual property rights, this does not count for most business model changes (such as product-service systems) making pioneers liable for speedy imitation thus loosing competitive advantage (and thus incentives to start in the first place).

Last but not least, the role of government may be to act as an information provider and keeper of data that are relevant for assessing opportunities and impacts of business model changes. This may stimulate and proliferate concepts such as the 'As-A-Service' business models. How can these be stimulated to come about and realise their potential? A way of promoting such concepts is by investigating currently implemented concepts and subsequently making the knowledge and capacities available to others (more open). This can be helped when information on potential demand is catered, e.g. by overviews on what companies take on what inputs so it will be a little bit easier to scale and increase returns.

8. Literature

Arcadis, VITO, Umweltbundesamt & BIO Intelligence Service (2010). Analysis of the evolution of waste reduction and the scope of waste prevention. Study for the European Commission, DG Environment, Brussels.

Bio Intelligence Service (2012). Assessment of resource efficiency indicators and targets. Final report. Study for European Commission - DG Environment, Brussels.

Bringezu, S. (2014). Targets for Global Resource Consumption. In: Angrick, M., Burger, A., Lehmann, H. Factor X - Policies, Strategies and Instruments for a Sustainable Resource Use. Eco-Efficiency in Industry and Science, Vol. 29., pp. 41-64.

Bringezu, S.; Schütz, H. (2013). Ziele und Indikatoren für die Umsetzung von ProgRess. PolRess-Policy Paper AS 1.2/1.3. Environmental Policy Research Centre (ffu), Berlin. URL: http://www.ressourcenpolitik.de/wp-content/uploads/2013/04/PolRess_ZB_AP1-1.2-3_Indikatoren-und-Ziele_final.pdf (accessed 30 January 15).

Diaz Lopez, F.J.; Becker, J.; Berkers, F.; Eris, B.;Koers, W.; Vliet, H. van; Bastein, T. (2014). New business models that support resource efficiency; D2.4 within WP2 New concepts and paradigms for policies for resource efficiency; Grant Agreement no. 308371 ENV.2012.6.3 Policy Options for a Resource Efficient Economy (POLFREE). University College, London.

Diaz-Lopez, F.J. · Montalvo-Corral, C. (2012). The Greening of the Chemical Industry: Past, Present and Challenges Ahead. In: Sanghi, R.; Singh, V. (2012). Green Chemistry for Environmental Remediation. Salem: John Wiley & Sons-Scrivener Publishing LLC. pp. 35-78. DOI: 10.1002/9781118287705.ch2

EEA (2011). Resource efficiency in Europe. Policies and approaches in 31 EEA member and cooperating countries. EEA-Report No. 5. European Environment Agency, Copenhagen.

EEA (2012). Material Resources and Waste — 2012 update. European Environment Agency, Copenhagen.

ETC/SCP (2011). Key messages on material resource use and efficiency in Europe. Insights from environmentally extended input-output analysis and material flow accounts. Assessment by D. Watson, M. Herczeg, J. Acosta, and D. Wittmer. European Topic Centre of Sustainable Consumption and Production, EEA, Copenhagen.

European Commission (2011a). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Roadmap to a Resource Efficient Europe. COM(2011) 571 final.

European Commission (2011b). COMMISSION STAFF WORKING PAPER. Analysis associated with the Roadmap to a Resource Efficient Europe Part II. SEC (2011) 1067 final. Brussels.

European Commission (2011c). Cambridge Econometrics. Sustainability Scenarios for a Resource Efficient Europe. Final Report prepared for European Commission, DG Environment.

European Commission (2012). Manifesto for a resource efficient Europe. Available at: http://europa.eu/rapid/press-release_MEMO-12-989_en.htm

European Commission (2013). Strategic Implementation Plan for the European Innovation Partnership on Raw materials. Available at: http://ec.europa.eu/enterprise/policies/raw-materials/innovation-partnership/targets/index_en.htm

Fischer-Kowalski, M., Haberl, H. (eds.) (2007). Socio-ecological Transitions and Global Change. Trajectories of Social Metabolism and Land Use. Edward Elgar, Cheltenham, UK and Northampton, USA

Gerard, D., Lave, L. B. (2003). Implementing Technology-Forcing Policies: The 1970 Clean Air Act Amendments and the Introduction of Advanced Automotive Emissions Control. http://www.cmu.edu/gdi/docs/implementing-technology.pdf

Gjoski, N. (2011). Rebound effects and the ecological rucksack in the light of resource policies. ESDN Case Study No. 7. European Sustainable Development Network.

Jäger, J. et al. (2014). A Vision for a Resource Efficient Economy; D2.2 within WP2 New concepts and paradigms for policies for resource efficiency; Grant Agreement no. 308371 ENV.2012.6.3 Policy Options for a Resource Efficient Economy (POLFREE). London, University College.

Kemp, R., Pontoglio,S. (2011). The innovation effects of environmental policy instruments — A typical case of the blind men and the elephant? Ecological Economics, 72:28-36.

Kuhn, T.S. (1962). The Structure of Scientific Revolutions. University of Chicago Press, Chicago, USA, 1962

McKinsey (2011). Resource Revolution: Meeting the world's energy, materials, food, and water needs. Available from: http://www.mckinsey.com/features/resource_revolution

Nature (2010). The Growing Problem. Vol. 466|Issue 7306, p546-547, 29 July 2010

Oates, W. E. (1972). Fiscal Federalism. *Journal of Economic Issues. Vol. 6*, No. 4 (Dec., 1972), pp. 225-227.

OECD (2006). Improving Recycling Markets, OECD, Paris.

O'Keeffe, M.; Jäger, J.; Hartwig, F.; Armeni, C.; Bleischwitz, R. (2014). Report on global governance for resource-efficient economies, D2.5 within WP2 New concepts and paradigms for policies for resource efficiency; Grant Agreement no. 308371 ENV.2012.6.3 Policy Options for a Resource Efficient Economy (POLFREE). London, University College.

Opschoor, J.B., Weterings, R. (1994). Environmental utilisation space. Netherlands Journal of Environmental Sciences 9(5), 198-205.

Osterwalder, A., Pigneur, Y., & Tucci, C. (2005). Clarifying business models: Origins, present, and future of the concept. Communications of the Association for Information Systems.

del Río González, P. (2009). Interactions between climate and energy policies: the case of Spain. *Climate Policy 9* (2), pp. 119-138.

Rogge, K., Reichardt, K. (2013). Towards a more comprehensive policy mix conceptualization for environmental technological change: a literature synthesis. Working Paper Sustainability and Innovation No. 3/2013. Fraunhofer ISI, Karlsruhe.

Rosen, C. M. (1997). Industrial ecology and the greening of business history. Business and Economic History, 123-137.

SERI (2012). Resource Use and Resource Efficiency in Emerging Economies - Trends Over the Past 20 Years. SERI Working Paper 12. Prepared by: Dittrich, M., Giljum, S., Polzin, C., Lutter, S., Bringezu, S. SERI, UCL, WI, MU-ICIS and PIK (2014). A Vision for a Resource Efficient Economy. ENV.2012.6.3-2 - Policy Options for a Resource-Efficient Economy, Deliverable 2.2. Online: http://www.ucl.ac.uk/polfree/publications/publications-2014/POLFREE_Del._2.2_28.03KSC_FormatMay2014.pdf (accessed 07/10/14).

Tukker, A.; Domenech, T.; Ekins, P.; Jäger, J.; Hartwig, F.; Kemp, R. (2013). Report about synthesis of new concepts; D2.1 within WP2 New concepts and paradigms for policies for resource efficiency; Grant Agreement no. 308371 ENV.2012.6.3 Policy Options for a Resource Efficient Economy (POLFREE). London, University College.

UNEP (2011a). Decoupling natural resource use and environmental impacts from economic growth, A Report of the Working Group on Decoupling to the International Resource Panel. United Nations Environment Programme.

UNEP (2011b). Recycling Rates of Metals. International Resource Panel. A Status Report. United Nations Environment Programme.

UNEP (2013). Environmental Risks and Challenges of Anthropogenic Metals Flows and Cycles, A Report of the Working Group on the Global Metal Flows to the International Resource Panel. van der Voet, E.; Salminen, R.; Eckelman, M.; Mudd, G.; Norgate, T.; Hischier, R. p. 23.

van Vuuren, D.P.; Faber, A. (2009). Growing within Limits. Netherlands Environmental Assessment Agency.

Vollebergh, H. (2007). Impacts of Environmental Policy Instruments on Technological Change. Report for Joint Meetings of Tax and Environment Experts. OECD Environment Directorate Working Paper COM/ENV/EPOC/CTPA/CFA(2006)36/FINAL. Paris: OECD.

Water Resources Group (2009). Charting Our Water Future. Economic frameworks to inform decision-making.

Weterings, R.; Opschoor, J.B. (1994). Towards Environmental Performance Indicators based on the Notion of Environmental Space. Report to the Advisory Council for Research on Nature and Environment , the Netherlands, Rijswijk.

Wilts, H.; Gries, N. von; Bahn-Walkowiak, B.; O'Brien, M.; Domenech, T.; Bleischwitz, R.; Dijk, M. (2015). Policy Mixes for Resource Efficiency; D2.3 within WP2 New concepts and paradigms for policies for resource efficiency; Grant Agreement no. 308371 ENV.2012.6.3 Policy Options for a Resource Efficient Economy (POLFREE). London, University College.

9. Annex: Case studies on industrial symbiosis

Alutrade Limited

CASE STUDY FOR BUSINESS CASE ANALYSIS BY INTERNATIONAL SYNERGIES LTD (NISP CASES)

Summary description of the case

The case illustrates how a business threat which arose from foreign competition was converted into a business opportunity by the application of industrial symbiosis principles, transforming what was a waste into a valuable input.

Alutrade Limited was set up in 1985 to supply aluminium extrudate bar to the manufacturers of window frames, security shutters, ladders etc. Alutrade also collected the scrap from its manufacturing customers, which formed their waste collection business (in addition to supplying bar). In its first 17 years, the company grew to £5.1m turnover and 45 employees. However by 2004 the business had begun to struggle because of competition from the Far East and the import of cheap finished products which diminished the UK market – that is, Alutrade's customers for bar were no longer manufacturing aluminium products like ladders and windows because the finished products were cheaper to import from China. In 2004 turnover declined by 10% and operating profit by almost 43% reflecting the decline in its manufacturing customer base.

The Alutrade directors realised that they needed to diversify the business and decided to move into the area of aluminium can recycling. This move required substantial new knowledge about supply chains and technology, and investment in new equipment and new facilities. In particular drinks cans are often a mixture of aluminium and steel, which requires specialist technology to separate. Working with NISP, the Alutrade directors were introduced to new partners, contact was facilitated with local and regional governments to access both sources of input (through domestic waste collections) and funding to grow the company. With the introduction of the Producer Responsibility Obligations (Packaging Waste) Regulations 2007 Alutrade sought help from NISP to become an accredited reprocessor and further expand its business. NISP also assisted Alutrade to access financing for capital investments.

The end result of the engagement was the creation and safeguarding of 24 jobs, £400,000 of private investment, and substantial revenue generation and cost savings. Environmental benefits include the avoidance of landfill virgin material use, and CO_2 emissions.

Motivation

The main incentive for the company to change its business model was the competitive threat to its business from low cost imports of manufactured goods from the Far East which diminished the market for aluminium raw material in the UK. When Alutrade chose to diversify its inputs, they also needed help navigating the new supply chain vis a vis accreditation, accessing the customer (local authorities) and understanding the technology. An additional challenge was obtaining finance for the necessary capital investment to access new products and markets. This relates to:

- Market threats from the Far East competition, which resulted in the cost of feedstock making innovation attractive
- Organisational, where knowledge was introduced about NEW value chains, specifically identifying and accessing new opportunities with local authorities to get the aluminium cans in the municipal waste stream, and understanding which waste streams contained aluminium cans versus which contained primarily steel cans.
- Institutional, where the introduction of the Producer Responsibility Obligations (Packaging Waste) Regulations 2007 created a revenue for the company in the new area of processing aluminium cans from domestic waste collections.

The main incentive to working with NISP was to locate funding to expand and adapt its premises and identify new sources of feedstock for its beverage can recycling process. NISP was able to use its network to build contacts with local authorities to identify additional sources of material through domestic waste collections.
The information provided has been obtained by interviewing a company representative, Don Larner (Director), NISP personnel, and background research.

Resource efficiency measures and changes inside the company
Life cycle focused: NISP drew on its relationships with local and regional government to enable Alutrade to begin processing aluminium cans from domestic waste collection, turning what was a waste into a valuable resource with concomitant economic and environmental benefits. 75% of all canned drinks sold in the UK are packaged in aluminium. In 2001 the UK consumed 5 billion aluminium drinks cans, of which 42% were recycled. Although this is a great improvement on the 2% recycled in 1989, there were still 3 billion cans that were landfilled. The company invested in equipment to recycle aluminium cans but did not realise at that stage that the majority of the cans in the particular waste stream which they were going to receive were steel and therefore they were not able to realise the full potential of their investment in recycling equipment at that stage. (Industrial symbiosis, circular economy).
Operations/product focused: Alutrade introduced new processing equipment and reorganised its site facilities to process aluminium beverage cans and recycle the high grade aluminium to remanufacturing processors. Substantial changes were needed to the size and shape of their facilities, as the factory was set up with the majority of the area dedicated to the production of extrudate bar and only a small area dedicated to can recycling. With NISP's assistance, Alutrade also acquired accreditation as a processor of aluminium packaging to trade PRNs, and began providing high quality aluminium for can production in addition to extrudate bar.
Product/Service focus: Alutrade began serving a new market, the local authorities, to capture and process aluminium cans from domestic waste collection – turning what was a waste into a valuable product.

Business model change:
Alutrade Limited was set up in 1985 to supply aluminium extrudate bar to the manufacturers of window frames, security shutters, ladders etc. When faced with intense competition from low cost producers in the Far East, the company recognized the need to diversify. Through the relationship with NISP over the last 8 years, Alutrade has been introduced to a range of private sector companies and local authorities that diversified the company's source of inputs, while maintaining its expertise in recovering aluminium. Alutrade Ltd is now recognised as a leader in the field of aluminium recycling in Europe, operating from a modern 100,000 sq.ft facility in the West Midlands region of England.
The company made contact with NISP in 2006. Working with the regional Development Agency, Advantage West Midlands, NISP was able to locate £5m of funding to allow Alutrade to modify its facilities to expand the part of the business which could be dedicated to beverage can recycling, and links to appropriate legal and regulatory advice to obtain the necessary planning and development approvals. NISP was also able to use its network to build contacts with local authorities to identify additional sources of material through domestic waste collections, allowing the business to expand rapidly so that by 2006/7 turnover had increased to £7.9m and the business was employing 70 people.

The company is able to sort and shred used beverage cans loose, baled, contaminated or mixed with other metals. They are able to offer a 24-hour service throughout the UK using a fleet of 17 vehicles. They still provide an extrusion scrap recycling service to over 500 end users in the building structures and tubing industries.
The company has now achieved accreditation as an exporter under the PRN scheme allowing them to export high quality recycled aluminium to beverage can manufacturers outside the UK.

The company has diversified its business into the manufacture of illuminated and non-illuminated aluminium signs, providing a range of specifications and are now looking at further diversification into tiles and seating structures. Initially set up to process extruded Aluminium from the automotive sector, the company was put in jeopardy when its primary source of input changed processes and competition developed. Through and IS approach to its

business, Alutrade was able to recognize material streams that had been waste as valuable input to their process, and continue providing Aluminium extrudate bar to its established markets.

Benefits in terms of sustainability value

Significant environmental impacts resulted from the NISP engagement, all of which were externally audited and verified, then signed off by the company. The reduction in primary aluminium production through recycling reduces energy use (and associated CO2 emissions). The end results are that the company has delivered significant economic impacts in terms of:

- an increase in sales of £18,048,000 (€22,845,570)
- an improvement in the value chain by saving £640,000 (€810,127) for Alutrade's clients,
- the generation of £400,000 of private investment, and
- increased turnover from £4m to £12.5m.

The company has also delivered significant direct environmental benefits of:

- a reduction in pollution by the avoidance of 24,000 tonnes of landfill,
- the avoidance of 1,316,800 tonnes of virgin materials and
- the generation of 212,040 tonnes of CO_2.

Positive social impacts are the creation of 24 jobs.

Role of policy

Previously lack of market opportunities discouraged the company from implementing resource efficiency measures however introduction of the landfill tax escalator created a market opportunity for the company to develop a business model based on recycling aluminium beverage cans into high quality aluminium for re-use.

The introduction of the Producer Responsibility Obligations (Packaging Waste) Regulations 2007 presented an opportunity for Alutrade. As an accredited reprocessor, ALutrade could enter the market for Packaging Recovery Notes (PRNs), worth at that time £150/tonne for aluminium. Alutrade sought help from NISP to become accredited, thus generating funding to develop their business. As a result, the company further expanded its business, increasing processing capacity to 20, 000 tonnes per annum, which is equivalent to 1,240,000,000 beverage cans per annum.

In June 2009 the UK Environment Secretary announced a wide-ranging review of the use of packaging materials and indicated that a ban on sending aluminium cans to landfill was being considered. International Synergies Ltd facilitated links between UK Government Department of Environment, Food and Rural Affairs (Defra) and Alutrade Ltd so that they were able to demonstrate that recycling capacity within the UK would not prove to be a barrier to a change in the regulatory regime.

Company overview

<table>
<tr><td colspan="3">Main product(s) : shredded used beverage cans</td><td colspan="4">Number of employees : 53</td></tr>
<tr><td colspan="3">Annual turnover (in EUR): 15,703,760</td><td colspan="4">% of turnover from new products: est 70%</td></tr>
<tr><td colspan="3">Annual production: 20, 000 tonnes per annum, equivalent to 1,320,000,000 beverage cans per annum.</td><td colspan="4" rowspan="2">Please indicate the main markets of the company, including the % of sales for each market
1. Local, Regional, National: 80% sales
2. International: 20% sales</td></tr>
<tr><td colspan="3">Type of manufacturing process: semi-continuous</td></tr>
<tr><td colspan="7">Main clients (include country, and % of sales) beverage can manufacturers, building structures and tubing industries</td></tr>
<tr><td colspan="3">Location of the company (country): UK</td><td colspan="4"></td></tr>
<tr><td>SECTOR:</td><td>SIC code 38320 — Recovery Of Sorted Materials.</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Additional Information
The registered and trading addresses are at Langley Forge House, Oldbury, West Midlands, B69 4NH. The website address is www.alutrade.co.uk.

Filled in by: Phil Johnson, Dr. Adrian Murphy, Dr. Rachel Lombardi – International Synergies Ltd
Contact information: Philip.johnson@international-synergies.com; adrian.murphy@international-synergies.com; rachel.lombardi@international-synergies.com
Date: 26 Sept 2014

Advantage Waste Brokers Ltd

CASE STUDY FOR BUSINESS CASE ANALYSIS BY INTERNATIONAL SYNERGIES LTD (NISP CASES)

Summary description of the case
The case illustrates the development of a micro company by the application of industrial symbiosis principles to take advantage of a market opportunity generated by changes in legislation.
Advantage Waste Brokers was set up in 2003. The owner had previously worked for a major waste company and thus was aware of the barriers to disposal of various types of waste and the market opportunities. In particular he was aware of the issues concerning the disposal of domestic refrigerators concerning processing capacity, the number of items being illegally disposed of and release to atmosphere of the residual CFCs contained in the insulating foam. It is estimated that up to 3 million domestic refrigeration (fridges, fridge-freezers and freezers) units are disposed of in the UK each year. Although there is less data available, it is believed that around a further half million commercial units are also replaced annually .One of the key strengths of the owner at this stage was his knowledge of waste logistics.
NISP introduced the owner to Business Link West Midlands, and supported and advised the company through the process of ISO9001 and subsequently ISO14001 accreditation with BSI. The next aim of the company was to identify sources of WEEE to develop the authorised treatment facility for white goods and small business to business trades, becoming a WEEE compliance scheme under the terms of the Waste Electrical and Electronic Equipment Regulations 2006, also facilitated by NISP.
The end result of the project was that Advantage Waste Brokers Ltd has grown and accessed new markets, increased its sales by £4.02m, 2 jobs have been created and 3 jobs safeguarded and £20,000 of private investment been facilitated. Additional impacts include landfill diversion with corresponding savings in the use of virgin materials and avoided CO_2 emissions.

Motivation
The owner set out to provide a service for end of life refrigerators to comply with the EU regulations concerning WEEE and ozone-depleting substances. The primary motivation for the start up was the identification of a market need to collect, process and safely dispose of end of life refrigeration equipment. This relates to:

- Institutional, where laws relating to the disposal of WEEE and ozone-depleting substances created a market opportunity
- Technological, where the knowledge of recovering CFCs from insulation foam enabled the process to take place
- Organizational – the owner's knowledge of the value chain enabled identification of new opportunities.

The main reason for approaching NISP for support was to gain accreditation to establish market credibility. The owner of the company had experience in the waste management industry but not in accreditation in quality and environmental systems. He also approached NISP to use the network to source raw materials for the process. NISP facilitated a number of introductions and links with local authorities which were collecting white goods, including refrigerators.

The information provided has been obtained by interviewing a company representative, Ian McQuaid (former owner and Managing Director), NISP personnel and through background research.

Resource efficiency measures and changes made inside the company

Offering a range of structural or tailored WEEE Producer Compliance Schemes, AWB provides WEEE collection and disposal services to many of the UK's best known companies. In its capacity as a producer compliance scheme the company works with producers of electrical and electronic equipment and handles all compliance requirements. This is achieved through the obtaining of electronic waste recycling evidence from AATF's (Approved Authorised Treatment Facilities). WEEE is initially sourced from local authority recycling points referred to as HWRCs (Household Waste Recycling Centres) or DCF's (Designated Collection Facilities). Advantage Waste Brokers tailors its service to the needs of each local authority ensuring that the WEEE collection and treatment services it provides are both suitable and compliant.

Life cycle focused: NISP drew on its partnership with local authorities to help Advantage Waste Brokers apply industrial symbiosis and identify a source of white goods from Household Waste Recycling Centres (HWRC).

Operations focused: by providing a guaranteed outlet for refrigerators the company was able to enact pollution control and reduce the number of fridges being flytipped.

Operations focused: management measures: the company gained ISO9001 accreditation facilitated by NISP's links with BSI.

Product- and service-focused: the provision of a compliance scheme for WEEE, specifically white goods.

Business Model Change

Advantage Waste Brokers' business model has been to develop the provision of new services to process refrigerators and other white goods and large WEEE. In order to establish the credibility of a small SME in a market dominated by larger solution providers he decided to develop Quality and Environmental Management Systems and have them externally accredited. AWB's Quality and Environmental Management Systems achieved external accreditation to ISO9001 and ISO14001 by BSI. AWB was further accredited as a Producer Compliance Scheme.

Benefits in terms of sustainability value

Significant environmental and social impacts resulted from the NISP engagement, all of which were externally audited and verified, then signed off by the company. The changes which the company has made have delivered significant economic impacts in terms of

- an increase in sales by €5.02m and
- an improvement in the value chain by saving €1.49m for Advantage Waste Brokers' clients.

They have also delivered significant direct environmental benefits of

- a reduction in pollution by the diversion of 105,678 tonnes of material from landfill with corresponding savings in the use of virgin materials,
- the avoidance of the generation of 319,000 tonnes of CO_2 and
- the avoidance of 1304 tonnes of hazardous waste.

Positive social impacts have been achieved by the creation of 2 jobs and the safeguarding of 3 jobs.

Role of policy

The European Council Regulation No. 2037/2000 on substances that deplete the ozone layer, came into effect in October 2001, requiring Member States to remove ozone depleting substances (ODS) (including CFCs and HCFCs) from refrigeration equipment before such appliances are scrapped. This provided a market opportunity for Advantage Waste Brokers to develop a process to collect and dispose of refrigeration equipment.

The Waste Electrical and Electronic Equipment Regulations 2006 which came into force in January 2007 and were fully implemented on 1 July 2007 provided Advantage Waste Brokers with the opportunity to become an accredited WEEE compliance scheme.

Company overview

Main product(s) : Producer Compliance Scheme : WEEE collection and disposal services				**Number of employees : 3**		
Annual turnover (in EUR): **1,694,552**				% of turnover from new products:		
Annual production: Type of manufacturing process: batch				Please indicate the main markets of the company, including the % of sales for each market 3. Local: % sales 4. Regional: % sales 5. National: % sales 6. International: % sales		
Main clients (include country, and % of sales)						
Location of the company (country): UK						
SECTOR:	82990 — Other Business Support Service Activities N.e.c					

ADDITIONAL INFORMATION.
Registered and trading addresses; 1A Essex Street, Preston, Lancashire, PR1 1QE
Website: www.advantagewastebrokers.co.uk

Filled in by: Phil Johnson, Dr. Adrian Murphy, Dr. Rachel Lombardi – International Synergies Ltd
Contact information: Philip.johnson@international-synergies.com; adrian.murphy@international-synergies.com; rachel.lombardi@international-synergies.com
Date: 26 Sept 2014

John Pointon & Sons

CASE STUDY FOR BUSINESS CASE ANALYSIS BY INTERNATIONAL SYNERGIES LTD (NISP CASES)

Summary description of the case

The case illustrates how changes in legislation were converted into business opportunities by a cross-sector application of industrial symbiosis principles.

John Pointon & Sons Ltd started processing animal by-products in 1977, and by 2003 had become a successful, single site animal renderer. In recent years, the facilities have evolved to offer cost-effective bespoke food waste disposal solutions which complement their core business and provide sustainable alternatives to landfill. A number of potential and actual changes in legislation created both risks and opportunities for the company, which NISP helped them to address. The end result was the diversification of the business into new markets, and new revenue streams deriving from what were once waste products, through industrial symbiosis.

The main drivers for change were compliance with the Animal By-Product Regulations (ABPR) (2003) and the UK Climate Change programme, specifically the Climate Change Levy (CCL). Following on the BSE outbreak in the 1990s, the European Commission started discussing a potential ban on sending animal by-products to landfill; this potential ban was identified as a business risk by John Pointon & Sons, who began exploring alternative options for dealing with meat and bonemeal residues from their rendering processes. At the same time the 2001 imposition of the Climate Change Levy (CCL) on major energy users in the UK led them to look for non-fossil fuel sources of energy. NISP introduced John Pointon & Sons Ltd to Castle Cement, resulting in a new market for the company, and an alternative fuel source for the cement kilns with high calorific value and significant quantities of calcium

salts, also suitable as a raw material replacement. John Pointon & Sons were also taking in packaged food in packets and tins for disposal. Working with NISP they identified routes to market for the waste metals and plastic and set up a depackaging plant to improve the efficiency of the operation.
The company then began carrying out a number of improvements at its animal rendering plant in Staffordshire to improve energy efficiency on the site. Discussions also led to water conservation measures being implemented, including rainwater collection, although plans for an anaerobic digester were abandoned after funds were raised, and other business opportunities pursued.
The main challenges to the company were legislative and economic (cost reductions). That engagement eventually led to a complete revamp of the business operating model – from animal renderer incinerating fallen livestock and landfilling the remains, to a clean energy company taking in fallen stock and waste packaged food, while serving markets as diverse as cement, pet food, and biofuels. The end result includes substantial cost savings, reduced waste to landfill, CO_2 emissions and water usage, and the creation of 10 jobs.

Motivation
Before the changes in policy, Pointon sent its by-products of bone and blood meal to landfill. The impending Animal By-Product Regulation (ABPR) was due to make that activity illegal once it came into effect, creating an incentive for the company to find an alternative. In addition, legislation affecting other industries (such as the Climate Change Levy impacting on the cement industry) was creating new market opportunities (new value chains) for the company.

- Institutional: implemented or upcoming legislation, including the Animal By-Product Regulation banning animal by-products from landfill; and the Climate Change Levy incentivising the use of non-fossil fuels.
- Organisational: knowledge about NEW value chains providing opportunities to generate value out of what was previously waste – specifically, learning about the cement and pet food industry opportunities for meat and bone meal (MBM).
- Behavioural: management commitment to maintaining the economic sustainability of the company through major changes in context.

John Pointon & Sons approached NISP for help identifying an alternative to landfilling when the Animal ByProduct Regulation was identified as a potential threat. In later stages of engagement, NISP provided the company with information and contacts to improve onsite production efficiency as well as enter new markets (including petfood and cement).

The information provided has been obtained by interviewing Martin Pointon, Director and Co-owner of John Pointon & Son Limited, NISP personnel and through background research.

Resource efficiency measures and changes made within the company
John Pointon & Sons Ltd converts a wide range of animal by-products into useful products, eliminating potential sources of pollution, contamination and disease. Through NISP, the company became aware of a number of avenues for diversification, resulting in the following resource efficiency measures:
Life-cycle focused, Circular Economy: inspired by the Animal Byproducts Regulation, John Pointon & Sons Ltd became aware of the value of its by-products including meat and bone meal (MBM) and blood meal, as inputs to the cement and pet food industries. MBM, a product previously sent to landfill, is ideal as a fuel source due to its high calorific value. In addition, the combustion of MBM generated significant quantities of calcium salts which can be used as a raw material replacement. By transforming the wastes into product, Pointon has kept valuable nutrients circulating in the economy.
Operations focused, cleaner production by the reduction in CO_2 emissions: Through NISP, John Pointon & Sons became aware of opportunities to provide inputs to the cement process, in response to an opportunity created by the Climate Change Levy (CCL). The industry had responded to the challenges posed by the CCL by substituting fossils fuels with alternative materials such as tyres. One particular company, Castle Cement, was looking for over 100,000 tonnes per year of alternative fuels. NISP introduced John Pointon & Sons Ltd to Castle Cement, to see whether the meat and bone meal (MBM) by-product could be used as an alternative fuel source for Castle Cement's

kiln operations. The trial found that MBM, a product previously sent to landfill, was ideal as a fuel source due to its high calorific value. In addition, the combustion of MBM generated significant quantities of calcium salts, also suitable as a raw material replacement. NISP helped to facilitate the delivery of commercial benefits and helped John Pointon & Sons to understand that the waste that they were sending to landfill could be considered as an asset rather than a problem

The rendering process involves a number of energy-intensive stages including grinding, cooking and centrifuging the material, with each being extremely energy intensive. Combined with the additional impact of transport required to move the material between stages, the company was using enormous amounts of energy in its everyday operations. During 2006 and 2007 John Pointon and Sons Ltd invested £400,000 to make on site improvements to its energy generation and energy efficiency. The company also successfully trialed a 1 MW engine burning tallow, a by-product. Additional engines were subsequently installed, allowing the company to provide energy to the grid.

Goods focused, new markets for by-products now products, resulting in diversification: as above.

Business model change

(Industrial symbiosis, new products and services, process improvement)

John Pointon & Sons Ltd (Pointon), based in Staffordshire, is the largest single site animal renderer in the UK. The company, a member of NISP, has the latest modern technologies on site to minimize the environmental impact of its operations. Pointon takes in fallen stock and other animal by-products (including food waste), and safely converts them into useful products. Initially, the process was limited to animal by-products which were incinerated and the outputs sent to landfill. Through engagement with NISP, and motivated by changes in legislation, Pointon transformed its business model to include new products and services extended to new sectors including pet food manufacture, cement, and energy sectors. Inputs have diversified to include waste packaged food.

John Pointon & Sons Ltd has adopted the industrial symbiosis approach throughout their business (processes and products). Water is a resource that is becoming scarce as the climate changes. Water is used in many processes throughout industry, and most often used only once before it is discharged as wastewater. This process can be expensive and places a burden on a precious resource. Pointon use over 500 m^3 of water per day in their industrial process. This water is used in a variety of essential processes such as wash down of equipment, boilers and odour abatement. The company installed a reverse osmosis treatment plant onsite that treats the wastewater before it is discharged to the river Churnet. Because the plant removes over 99% of any contaminants from the wastewater, the treated effluent can be reused. Of the 500 m^3 of water used per day, over 300 m^3 is reused, equating to over 60% reduction in the use of raw water by the site. This process improvement reduces both the amount of raw water used, and the associated cost.

John Pointon & Sons value proposition to the market is cost-effective bespoke food waste disposal solutions which complement our core business and provide sustainable alternatives to landfill. The company's mission is now:

- To be the number one Company in the UK offering professional waste management, recycling and environmental solutions to their customers.
- To become their customers most efficient and economical environmental champion by continuously offering the most qualitative and cost effective waste management service ensuring they meet changing legal requirements.
- To make a positive difference by continuously offering waste solutions that reduce customers carbon footprint thus reducing global warming.
- To work in partnership with their customers, totally focused on satisfying their needs and expectations thus allowing them to fully identify with their own company progress.
- To be totally committed to their employees and maximise their potential through personal development and intensive training.
- To meet members obligations and to help achieve the United Kingdom's Recovery and Recycling waste packaging target each year.

Benefits in terms of sustainability value

Significant environmental impacts resulted from the NISP engagement, all of which were externally audited and verified, then signed off by the company, including reduced disposal and raw fuel costs benefiting both companies and the environment:

- 100,000 tonnes of material diverted from landfill, increasing to 150,000 tonnes per annum;
- the avoidance of the generation of 104,635 tonnes of CO_2 based on an additional 30,000 tonnes animal by-product diverted to alternative fuel
- Water savings 140,000 tonnes per annum;
- 70,000 tonnes per annum waste fats recovered

Significant economic impacts:

- cost savings of £8m per annum;
- £140,000 per annum in water costs;
- 2M or more in additional revenue and avoided cost from biofuels.

Positive social impacts:

- the creation of 10 jobs
- Compliance with Animal By-Products Regulations

Role of policy

The EU Animal By-Products *Regulation 1774*/2002 created initial incentive for John Pointon & Sons Ltd to engage with NISP. The legislation divides animal-derived waste products into three categories depending upon their perceived risk to health and the environment, and prescribes suitable disposal routes for each of them. It effectively bans the landfilling of all animal by-products unless they have undergone some form of prior treatment, while specifically excluding some materials completely. The ABPR came into force on 1st May 2003, at which point it became illegal to send raw meat and fish; any product containing raw meat and fish; meat and fish processing wastes (such as blood, hides, feathers, bones); and raw eggs to landfill. The Regulation permits member states to substitute their own standards for the treatment of specific food waste streams, and these were set out in the UK Animal By-Product Regulations (ABPR) in 2003. This Statute replaced the Animal By-Products Order 1999 and its 2001 Amendment.

Implementation of the CCL under the Finance Act (2001) provided the incentive for the cement company to engage. The cement industry was subject to the climate change levy (CCL) which is a tax on energy delivered to non-domestic users in the United Kingdom. Its aim is to provide an incentive to increase energy efficiency and to reduce carbon emissions. Introduced on 1 April 2001 under the Finance Act 2000 it was forecast to cut annual emissions by 2.5 million tonnes by 2010, and forms part of the UK's Climate Change Programme. The levy applies to most energy users, with the notable exceptions of those in the domestic and transport sectors. Electricity generated from new renewables and approved cogeneration schemes is not taxed.

Company overview

<table>
<tr><td colspan="4">Main product(s) : Pet Food Ingredients Protein Meals & Bone Meal; High Quality Oil - Pet Food Industry; Oleochemicals</td><td colspan="4">Number of employees : 209</td></tr>
<tr><td colspan="4">Annual turnover (in EUR): 62,939,660</td><td colspan="4">% of turnover from new products:</td></tr>
<tr><td colspan="4">Annual production: 350,000 tonnes
Type of manufacturing process: semi-continuous</td><td colspan="4">Please indicate the main markets of the company, including the % of sales for each market
7. Local, Regional, National: 100% sales</td></tr>
<tr><td colspan="8">Main clients (include country, and % of sales): food industry supply chain from farmer to supermarket</td></tr>
<tr><td colspan="4">Location of the company (country): UK</td><td colspan="4"></td></tr>
<tr><td>SECTOR:</td><td>SIC 2007
01629 — Support Activities For Animal Production (Other Than Farm Animal Boarding And Care)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

	N.e.c.					

Additional Information.
Registered address: Bones Lane, Cheddleton, Leek, Staffordshire, ST13 7BT
Trading address: Felthouse Lane, Cheddleton, Leek, Staffordshire, ST13 7BT
Website: www.pointon.co.uk

Filled in by: Phil Johnson, Dr. Adrian Murphy, Dr. Rachel Lombardi – International Synergies Ltd
Contact information: *Philip.johnson@international-synergies.com; adrian.murphy@international-synergies.com; rachel.lombardi@international-synergies.com*
Date: 26 Sept 2014

Industrial Material Recycling Ltd

CASE STUDY FOR BUSINESS CASE ANALYSIS BY INTERNATIONAL SYNERGIES LTD (NISP CASES)

Summary description of the case

The case demonstrates the application of industrial symbiosis to the establishment and growth of a new business based on recovered resources.

Industrial Material Recycling Ltd (IMR) was founded in 2009 by two individuals who had previously worked for a plastics manufacturer and had a good understanding of the manufacturing and reprocessing of polymer materials (particularly nylon and PET), strong manufacturing experience and knowledge of environmental management systems. They identified a gap in the market for a hands-on approach to waste management and cost reduction initiatives. Their vision was to move into the recycling business, initially for plastics and then expanding the range to other materials, taking advantage of the market opportunity created by the UK landfill tax escalator. They approached NISP for assistance in the best way to do this without the need for excessive paperwork.

There are certain waste management activities, such as keeping, treating and recovering/recycling/disposing of controlled waste, which require an environmental permit under the regulations. It is also recognized, however, that certain operations involving waste present little risk to the environment, and that in such cases it is not in the public interest to require the operator to have a permit. NISP personnel used their knowledge of the legislation and links with the UK Government's Environment Agency to negotiate the necessary waste exemptions to allow IMR to quickly set up and start operating. NISP also facilitated introductions to new sources of input.

Having gained a reputation for success working with extruders and injection moulders the company looked to diversify into other industries such as automotive, construction, retail, and metals. IMR has now become a specialist industrial material recycling company offering a comprehensive material recycling service for material types including plastics, metals, chemicals, cardboard or paper. Their engineering expertise allows complex multi-component materials to be recycled.

The application of industrial symbiosis through NISP's involvement in the company's development achieved substantial landfill diversion, virgin materials savings, and avoided CO_2 emissions. Economic benefits include increase in sales, and cost savings for their value chain.

Motivation

The primary incentive for the company was the identification of a new market opportunity: to provide a tailored waste management service for companies in the plastics industry. The main drivers for change were the new market opportunities created by the landfill tax escalator and the need for companies to recognise the true cost of waste. This relates to:

- Market opportunities, where the income from a new product makes the activity attractive
- Institutional, where the landfill tax escalator created a market opportunity to provide a service that would reduce clients' disposal costs

- Organizational, knowledge of the value chain improved, identifying new opportunities; and
- Behavioural, the personal conviction of the directors to create a product deriving from material that used to be waste.

The primary incentive for approaching NISP for support was for help meeting the environmental regulations. The founders had previously worked in operations in the plastics industry and had little or no experience in compliance with environmental legislation arising from the Waste Framework Directive, the Environmental Protection Act and Duty of Care to enable them to process industrial wastes. The company became a member of NISP in 2009. IMR's directors have attended a number of NISP's Resource Matching Workshops and generated a significant number of potential business opportunities with over 100 companies including links with One3One Solutions, the business arm of the Ministry of Justice which has allowed IMR to develop innovative solutions for a range of complex waste streams.

The information provided has been obtained by interviewing a company representative Garry Warburton (Director) and NISP personnel, and through background research.

Resource efficiency measures and changes made within the company

The company started to offer new services to the plastics industry in the form of waste management and cost reduction support for the injection moulding and polymer processing industries. They rapidly diversified by the application of industrial symbiosis principles to providing services for construction companies for waste from block manufacture, for electrical component companies to divert urea-formaldehyde materials which contain usable nitrogen into beneficial uses for agriculture, and for companies in the metals industry to develop better revenue streams for scrap metals and use lead-containing wastes as carrier material for the processing of precious metals. The development of a partnership with the Ministry of Justice allowed them to offer innovative solutions for waste streams such as point of sale units from the retail sector. These contain a number of different materials bonded together which require separation before the value of the individual materials can be realized. The use of prison workshop labour provides a low cost solution for the separation of these materials and delivers One3One Solutions' objective of providing meaningful semi-skilled work for prisoners which can lead to transferrable skills and accredited qualifications. IMR have recently entered into a partnership with another NISP member to offer a service to the healthcare sector to process medical X-rays to achieve a revenue payment. The latest addition to their service is to work with Company Administrators to carry out site clearances and ensure that unused stock is recycled as far as possible.

Life cycle focused: NISP drew on its partnership with the UK Government's Environment Agency to help IMR Ltd. meet site permit regulations. As a result of the effectiveness of this relationship and an industrial symbiosis opportunity, the company was able to expand to a new site in the West Midlands and develop innovative processes to deal with a range of complex waste streams.

Life cycle focused: IMR Ltd. has become a key component in the circular economy by improving the life-cycle of plastic material used in a wide range of processing industries including automotive and electrical components.

Eco-innovation growth focused: NISP has continued to work with IMR Ltd. to support process changes by facilitating permit issues, sourcing alternative waste streams and developing additional new routes to market. Their personnel have attended a number of NISP's networking resource workshops and NISP's team of practitioners have visited IMR's site to discuss business opportunities on a number of occasions. NISP has provided IMR Ltd. with introductions to over 100 companies over the last 7 years.

Business Model Change

The business model was established based around industrial symbiosis to deliver a new service to the market (cost effective waste management). The relationship with NISP enabled IMR to further diversify inputs to include point-

of-sale (display) units from retail organizations, metallic wastes, and aluminium-based construction materials through new partnerships. NISP supported the company in its expansion and innovation activities to achieve more radical changes through new alliances with private companies to access new markets (x-rays) and partnership with the Ministry of Justice to process more complex waste streams by engaging with prison workshops for the labour needed.
IMR Ltd. also set up a sister company, Industrial Cost Reduction LLP (ICR), to assist clients with their complete waste management. By running an extensive waste process mapping exercise, ICR identifies and quantifies the company's waste costs and associated cost-reduction opportunities. The subsequent implementation of said cost-reduction projects is often self-funded through rapid cost reductions.

Benefits in terms of sustainability value
Significant benefits resulted from the NISP engagement, all of which were externally audited and verified, then signed off by the company. The changes which the company has made with the support of NISP have delivered significant economic impacts in terms of:

- an increase in sales of £122,824 (€155,473), and
- an improvement in the value chain by saving £22,923 (€29,016) for IMR's clients.

They have also delivered significant direct environmental benefits of:

- a reduction in pollution by the avoidance of 23,159 tonnes of landfill, and
- the avoidance of 4,656 tonnes of CO_2 emissions.

Role of policy
Previously lack of market opportunities discouraged IMR from implementing resource efficiency however the introduction of the landfill tax escalator in the UK created a market opportunity for the company to develop a business model based on a plastic waste management system so that polymer material can be returned to the supply chain in the form of raw material for other processes and their clients achieve a reduction in their cost base. The tax was first introduced in 1996 and in 2007 the Chancellor announced that the landfill tax would increase more quickly and to a higher level than previously planned. **Increases of £8 per tonne per year for active waste were announced from 2008-09 to at least 2013.**
The founders had previously worked in operations in the plastics industry and had little or no experience in compliance with environmental legislation arising from the Waste Framework Directive, the Environmental Protection Act and Duty of Care to enable them to process industrial wastes.

Company overview

<table>
<tr><td colspan="4">Main product(s) : The company's main products and services are granules of a range of waste management and cost reduction services and a secure destruction service for copyright and confidential materials.</td><td colspan="4">Number of employees : 10</td></tr>
<tr><td colspan="4">Annual turnover (in EUR): 1.52m</td><td colspan="4">% of turnover from new products:</td></tr>
<tr><td colspan="4">Annual production: not applicable</td><td colspan="4" rowspan="2">Please indicate the main markets of the company, including the % of sales for each market
8. Local, Regional, National: est 90% sales
9. International: est 10% sales</td></tr>
<tr><td colspan="4">Type of manufacturing process:
Batch</td></tr>
<tr><td colspan="8">Main clients (include country, and % of sales): Retail, NHS, Automotive, Construction</td></tr>
<tr><td colspan="4">Location of the company (country): UK</td><td colspan="4"></td></tr>
<tr><td>SECTOR:</td><td>38110 — Collection Of Non-Hazardous Waste</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Additional Information.
The company is registered and based in the UK and operates in the recycling industry with SIC code 38110 — Collection Of Non-Hazardous Waste. Its registered and trading addresses are at OCM House, St Peters Road, Droitwich, Worcestershire, WR9 7BJ.
The website address is www.industrialmr.co.uk.

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Recycled UK

CASE STUDY FOR BUSINESS CASE ANALYSIS BY INTERNATIONAL SYNERGIES LTD (NISP CASES)

Summary description of the case
The case demonstrates the application of industrial symbiosis to the establishment and growth of a new business based on recovered resources.
Recycled UK Limited was started in 2006 by two individuals who identified a market opportunity to process end-of-life vehicle (ELV) bumpers into a clean plastic feedstock. Car bumpers are made from polystyrene (PS), acrylonitrile-butadiene-styrene (ABS), and polycarbonate/ polybutylene terephthalate (PC/PBT). The average vehicle contains around 10kg of these materials and at this time almost all this material was destined for landfill with the associated loss of valuable material from the supply chain, lost opportunity for reuse, and potential damage to the environment as the material degrades over time. In 2006 over 995,000 vehicles reached end-of-life (EOL) in the UK representing 970,000 tonnes of material, 97,000 tonnes of plastics and 9,700 tonnes of scrap bumpers. Before the project started, the partners had no employees and no site, but a vision of what they wanted to do. The company was financed by personal savings and bank loans.

The company then started collecting used car bumpers from businesses throughout the West Midlands region of England, separating metal and segregating the different types of polymer, removing paint and shredding the plastic. Remaining small amounts of non-polymer materials were then removed from the shredded material producing a clean resource which could then be sold to a range of manufacturers to make new products for example wheelie bins and storage boxes.

The main drivers for change facing the company were the new market opportunities created by the ELV legislation, and the commitment of management to launch a product deriving from what used to be waste. Recycled UK set out to be one of the UK's most proactive companies in working towards the goal of national compliance with the Directive on End-of Life Vehicle 2000/53/EC, and engaged with NISP for assistance complying with environmental legislation.

By working with NISP to meet regulations, Recycled UK was able to begin processing material within just 5 months of starting out, saving a substantial amount of time and money. In the first few months of operation, the company was achieving an annualised rate of 1,200 tonnes of material diverted from landfill and saving 4,350 tonnes per annum of CO_2. A sales increase of £200,000 (€251,200) per annum and £150,000 (€188,415) of private investment led to the creation of 5 permanent jobs.

Motivation
The primary incentive for the company was the identification of a new market opportunity: to process PS, ABS and PC/PBT reclaimed from the End-of-Life Vehicle (ELV) waste stream and sell it into the market as a clean

feedstock. Recycled UK set out to be one of the UK's most proactive companies in working towards the goal of national compliance with the ELV Directive. This relates to:

- Market opportunities, where the income from a new product of reclaimed plastic makes the activity attractive
- Market opportunity to provide a greater service to clients by recovering ELV bumpers
- Institutional, where the new ELV Directive with the escalating landfill tax created a market opportunity
- Organizational, knowledge of the value chain and changing drivers allowed the identification of new opportunities; and
- Behavioural, the personal conviction of top management to create a product deriving from material that used to be waste.

The primary incentive for approaching NISP for support was for help meeting the environmental regulations. The founders had previously worked in the automotive and aerospace industries and had little or no experience in compliance with environmental legislation arising from the Waste Framework Directive, the Environmental Protection Act and Duty of Care to enable them to sell on and transport the reprocessed plastic to manufacturers. The company became a member of NISP in January 2006, following an introduction from Business Link Black Country.

The information provided has been obtained by interviewing a company representative (Paul Green, Managing Director of Recycled UK) and NISP personnel, and through background research.

Resource efficiency measures and changes made within the company

Life cycle focused: NISP drew on its partnership with the Environment Agency to help Recycled UK meet site permit and waste carrier regulations. As a result of the effectiveness of this relationship and an industrial symbiosis opportunity, the company was able to begin processing material within just 5 months of starting out, saving a substantial amount of time and money. In the first few months of operation, the company was achieving an annualised rate of 1,200 tonnes of material diverted from landfill and saving 4,350 tonnes per annum of CO_2. A sales increase of £200,000 (€251,200) per annum and £150,000 (€188,415) of private investment led to the creation of 5 permanent jobs.

Life cycle focused: Recycled UK Limited has become a key component in the circular economy by improving the life-cycle of plastic components used in automotive manufacture and the introduction of greener products. Processing ELV bumpers also allowed the company to provide a full waste management service to their clients in more than 10 different industries and sectors by recovering plastic that was going to landfill.

Eco-innovation growth focused: NISP has continued to work with Recycled UK Limited by facilitating planning and permit issues, sourcing alternative waste plastic streams and developing additional new routes to market. NISP facilitated links with the University of Birmingham so that Recycled UK could optimise their processes via the Innovation Programme for SMEs. Their personnel have attended a number of NISP's networking resource workshops and NISP's team of practitioners have visited Recycled UK's site to discuss business opportunities on 5 occasions. NISP has provided introductions to 52 companies over the last 7 years. Each time that changes in legislation or relocation to a new site have potentially impacted Recycled UK's operations, NISP has supported the company through NISP links with the EA and planning authorities to facilitate changes in permits.

Diversification: At the company level, the business model was established based around industrial symbiosis to deliver a new product to the market (recycled plastic polymer from ELV bumpers). The relationship with NISP enabled Recycled UK to further diversify inputs to include plastic pipes, waste bins, and construction materials through new partnerships. NISP supported the company in its expansion and innovation activities through new alliances to access new markets (x-rays).

Service Focus: The company started in a 2,000 ft^2 site, within 18 months moved to a 6,000ft^2 site, within a few years moved to 13,000ft^2 site and now occupies its third new site which is a 45,000ft^2 centre in the heart of the West Midlands. They currently have six shredding and granulating lines, 'Weima' and 'Untha' shredders, 'Rapid' and 'Cumberland' granulators along with 'eddy' current magnets plus twin bagging stations to ensure speed and accuracy of production. The capacity also includes 'Untha' single shaft shredders that can take everything from Polycarbonate CDs to HDPE 1100 litre wheelie bins and 'Rapid' granulators that turn material into 8mm chips to be used for re-manufacture. They have invested in a fully automatic baling machine to bale LDPE film/cardboard and the installation of a new shredding and granulating line to granulate various polymer types to customer specification.
Diversification: The company's ability to recycle 100 different grades of plastic, including PP, HDPE, PS, ABS, PET, PA, in a mix of batch and continuous production means they can offer a plastic waste management system to clients in more than ten different industries, recycling reject industrial parts, unwanted or unused plastic packaging, out of tolerance material, purged plastic, UPVC off cuts, bottles, PE pipes and boxes, hardware products, wheelie bins, film, CDs and even billboard posters.
Following demand for its secure destruction services, Recycled UK has invested £100,000 (€125,610) into a new 14,500ft^2 bonded warehouse. The unit includes 6 position picking stations and an automatic bailing machine, along with state-of-the-art CCTV systems so that customers can log in and watch their products being destroyed. CDs, DVDs and x-ray films are all catered for and the facility has already been audited, approved and accredited to FACT (Federation Against Copyright Theft).

Business Model Change
(Industrial symbiosis, new products and services)
Recycled UK's business model has evolved to include new products and services through industrial symbiosis. They aim to develop a bespoke recycling solution that fulfils the client's business needs and complies with legislation. Logistics is provided by a fleet of four branded vehicles – ranging from a transit van to 38 tonne articulated lorry – which complete more than 50 collections and deliveries every day, spanning the length and breadth of the UK. They also offer a toll granulation service, processing scrap/waste material and returning it to the client. This service includes polymer separation and keeping it in colour if required.
New business through Industrial Symbiosis:
The company has developed a new business through industrial symbiosis for disposing of time-expired x-ray films for the medical sector in partnership with another private company in the West Midlands. The technology, which has been developed with an industry-leading professional, can set specific parameters to filter the files, ensuring only the right ones are extracted and securely destroyed. It also takes a digital image of the label, including patient ID, so the hospitals not only receive an electronic record but one that can be searched to help with recovery of information. All work is carried out in compliance with hospital information governance and medical record policy and the first trial orders have already been successfully completed. Recycled UK believe the initial market place could be worth more than £1m per annum, with each National Health Service unit faced with disposal of thousands of time-expired x-ray films. The company provides collection, secure disposal and a certificate of destruction along with a rebate for the reclaimed silver. Recycled UK is turning its attention to other sectors that may require this service, including veterinary, dentistry and industrial.
Their latest innovation is the installation of a densification system for expanded polystyrene (EPS) which aims to meet the waste disposal needs for the large number of logistics companies in the West Midlands.

Benefits in terms of sustainability value
Significant environmental impacts resulted from the NISP engagement, all of which were externally audited and verified, then signed off by the company. The changes which the company has made with the support of NISP have delivered significant economic impacts in terms of:

- an increase in sales of £2,405,071 (€3,021,010), and
- an improvement in the value chain by saving £661,710 (€831,174) for Recycled UK's clients.

They have also delivered significant direct environmental benefits of a reduction in pollution by:

- the avoidance of 30,314 tonnes of landfill and
- the avoidance of 71,775 tonnes of CO_2.

Positive social impacts include:

- supporting the creation of 10 permanent jobs, and
- 33 employees who receive extensive in-house training and opportunities to gain recognised qualifications, such as NVQs and Apprenticeships.

Role of policy

Previously lack of market opportunities discouraged Recycled UK from implementing resource efficiency however implementation of the ELV Directive and the introduction of the landfill tax escalator in the UK created a market opportunity for the company to develop a business model based on a plastic waste management system. The result was that polymer material were returned to the supply chain in the form of raw material for other processes.

In 1997, the European Commission adopted a Proposal for a Directive which aims at making vehicle dismantling, reuse, recovery and recycling more environmentally friendly. EU Directive 2000/53/EC sets out clear quantified targets for reuse, recycling and recovery of vehicles and their components and also pushes producers to manufacture vehicles with a clear view to their recyclability. In 2006 over 995,000 vehicles reached end-of-life (EOL) in the UK representing 970,000 tonnes of material, 97,000 tonnes of plastics and 9,700 tonnes of scrap bumpers.

Recycled UK set out to be one of the UK's most proactive companies in working towards the goal of national compliance with the Directive on End-of Life Vehicle 2000/53/EC but was unsure as to how to tackle the issue of complying with environmental legislation arising from the Waste Framework Directive 2008/98/EC, the Environmental Protection Act (1990, amended 2010) and Duty of Care to enable them to sell on and transport the reprocessed plastic to manufacturers.

Company overview

<table>
<tr><td colspan="4">Main product(s) : The company's main products and services are granules of a range of different polymers, including PP, HDPE, PS, ABS, PET, PA; a toll granulation service; and a secure destruction service for copyright and confidential materials.</td><td colspan="4">Number of employees : 33</td></tr>
<tr><td colspan="4">Annual turnover (in EUR): 2.7m</td><td colspan="4">% of turnover from new products:</td></tr>
<tr><td colspan="4">Annual production: 840 tonnes</td><td colspan="4" rowspan="2">Please indicate the main markets of the company, including the % of sales for each market
10. Local, Regional, National: est 40% sales
11. International: est 60% sales</td></tr>
<tr><td colspan="4">Type of manufacturing process:
Semi-continuous</td></tr>
<tr><td colspan="8">Main clients (include country, and % of sales): Retail, NHS, Local Authorities, Automotive, Food</td></tr>
<tr><td colspan="4">Location of the company (country): UK</td><td colspan="4"></td></tr>
<tr><td>SECTOR:</td><td>Plastics recycling</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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ADDITIONAL INFORMATION.

The company's domestic throughput is 100 tonnes of material a month, with a further 150 tonnes of material not commercially suitable for domestic markets which is purchased by international buyers. This material is deemed to be commercially unsuitable for the domestic market, but is seen as a usable commodity in the overseas market place. They manage the logistics of the international delivery and are currently looking at developing more export markets.

The company is registered and based in the UK and operates in the recycling industry with SIC code 38320 — Recovery of Sorted Materials. Its registered and trading addresses are at Unit 22-24, Cannon Business Park, Gough Road, Coseley, Bilston, West Midlands, WV14 8XR. The website address is http://www.recycleduklimited.com.

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