Key Trade-offs Within a Policy Mix for Resource Efficiency

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Abstract. The European Commission states that "continuing our current patterns of resource use is not an option". Against the background of an often wasteful use of natural resources, the European Union has named resource efficiency as one out of seven flagship projects to pursue its so-called Europe 2020 strategy considering resource efficiency a top policy priority. But so far neither the business tools of integrated environmental management nor classic environmentally policy tools are able to deliver such strategic changes and any policy formulation for resource efficiency is still at a very early stage. Based on an on-going research project called "Policy options for a resource efficient Europe" (Polfree) this paper analyses potential policy instruments and their interdependencies in a policy mix for resource efficiency. It focuses on fundamental trade-offs in such a mix and identifies three generic challenges based on an empirical analysis of 27 specific instruments.

1 Introduction

The European Commission states that "continuing our current patterns of resource use is not an option (European Commission 2011a)". Against the background of an often wasteful use of natural resources, the European Union has named resource efficiency as one out of seven flagship projects to pursue its so-called Europe 2020 strategy, which means that the EU considers resource efficiency a top policy priority. But so far neither the business tools of integrated environmental management nor classic environmentally policy tools are able to deliver such strategic changes and any policy formulation for resource efficiency is still at a very early stage. Based on an on-going research project called "Policy options for a resource efficient Europe" (Polfree) this paper analyses potential policy instruments and their interdependencies in a policy mix for resource efficiency. It focuses on fundamental trade-offs in such a mix and identifies three generic challenges based on an empirical analysis of 27 specific instruments.

The paper is structured as follows: Chapter 2 describes the thematic background of resource efficiency policies and, based on that, develops the guiding research questions. Chapter 3 deals with the methodological approach applied to operationalize generic criteria that make policy mixes efficient in terms of consistency, coherence and credibility. Chapter 4 then analyses selected innovative policy instruments outlined within Polfree. The final chapter draws conclusions on the three key trade-offs of resource efficiency policy mixes and describes further needs for research.

2 The challenge of resource efficiency policy mixes

The Polfree project is based on the assumption that the current utilization of resources, especially non-renewable ones, is not sustainable. In line with such statements, the European Union has named resource efficiency as one out of seven flagship projects to pursue its so-called Europe 2020 strategy, which means that the EU considers resource efficiency a top policy priority. The economics of resource efficiency have made compelling arguments about the relevance of material purchasing costs to manufacturing businesses (Bleischwitz 2012; EIO 2011, 2012). On average, the estimation is that the share of resources in gross production value is in the order of 40 % – usually higher than net costs of personnel (EIO 2013). However, any policy formulation for resource efficiency is still at a very early stage. The European Commission has released a "Roadmap for a Resource Efficient Europe" in 2011 and started to run activities aiming at better communication and awareness (European Commission 2011b). The EU member states consider a number of existent environmental policies as able to trigger resource efficiency, according to a recent report initiated by the European Environment Agency (EEA 2011). However this report also states that only a certain number of these policy instruments and initiatives were developed with the primary aim of improving resource efficiency (EEA 2011, p. 51), with EU countries such as Germany and UK probably being at the forefront of a newly emerging policy field. A quest for resource efficiency policies can also be observed in a number of other countries (China, Japan, new EU Member States such as Bulgaria, Newly Independent States such as Azerbaijan, some South East European States such as Croatia and others, see EEA 2011).

The legitimacy of such RE policies seems to be based on two pillars: firstly to enable markets in their strive towards allocation efficiency and secondly to minimize environmental, social, and economic risks stemming from a lack of information, information asymmetries, and adaptation deficits. The existing early policies for resource efficiency put clear emphasis on the enabling function of policies. With programs such as KTN in the UK, DEMEA in Germany, or the resource efficiency platform in the EU, policies have started to do capacity building as well as to demonstrate the business case of material efficiency. At the same time, stakeholders are getting engaged and expectations are mutually managed. It is less clear however whether and to what extent those approaches deliver the full information about resource constraints and risks, and how they could trigger radical product eco-innovations and system eco-innovations.

Theories of policy formulation usually underline the importance of removing existing failures and barriers and of attracting potential new beneficiaries (Bleischwitz et al. 2009). The long history of introducing crosscutting new themes in existing policy fields also suggests being explicit about additional potential benefits that might arise if such new policies are being formulated and implemented.

Against this background this paper seeks to develop criteria for an ambitious resource efficiency policy along the following research questions:

- Given that many countries manage a relative decoupling of using natural resources from GDP, what policies are currently hindering a stronger decoupling, what structures and barriers should be addressed for removal, and how could countries accomplish an absolute decoupling – i.e. an absolute reduction in the use of primary materials and other resources?
- Given that such mission should ideally be pursued worldwide and in a most responsible manner, what policies would acknowledge the international life cycle of resources and minimize leakage effects and risks of burden shifting?
- Given that countries have strategic interests in resources beyond the efficiency issue such as ensuring access to critical resources, or maintaining a competitive position as exporter and manufacturer of commodities, how could resource policies become more consistent and contribute to shared visions and better international relations?
- Assuming that one instrument is likely to be used in combination with others: What are the additional impacts and side-effects (in terms of environmental effectiveness and economic efficiency), which types of policy mixes are likely to radically increase resource efficiency, optimize synergies and minimize trade-offs between instruments and policy fields?
- How could policies stimulate pro-active behaviour beyond "win-win" options to support system eco-innovation able to radically transform the resource use patterns on a global scale?

3 Methodological approach

3.1 Necessity of a policy mix

The starting point of every policy mix of should be an inventory of which instruments are available or already in place. In contrary to neo-classical textbooks there is a much more differentiated variety of instruments than just “carrots, sticks, and sermons” (Sterner & Coria 2011, p. 58). A fundamental aspect for every policy mix development should be the question if a mix is really needed: “A key question at the outset is whether the environmental issue at hand is a “single-aspect” or a “multi-aspect” one.” Single-aspect environmental problems can be characterized by only one relevant dimension or characteristic – for example, the total amount of a certain type of emission. “To fall into this category, it should be of no importance where the emissions take place, when they take place, etc. Emissions of ozone-depleting chemicals and greenhouse gases are (at least close to) examples of such issues.” (Sterner & Coria 2011, p. 254)

“If we are facing a “single-aspect” environmental issue that can be addressed directly, a “first-best optimum” can theoretically be reached through the use of a single instrument – under certain frequently-made assumptions regarding the functioning of relevant markets” (OECD 2007, p. 7). Of course, these assumptions include the existence of completely defined property rights, full information and perfect foresight among all actors, and that no buyer or seller is sufficiently large to be able to hold market-power. If these assumptions are reasonably valid for the case at hand, the use of only a single instrument – rather than a mix of instruments – could be preferable. Facing the reality of resources

- as partially private goods, partially club goods and like in the case of global climate public goods,
- extremely limited information about for example the interplay between the socio-industrial metabolism and ecosystems
- and often irrational behaviour

we cannot assume effective functioning of the relevant markets. Based on the concept of “second-best” theory, Lipsey and Lancaster (1956) already emphasized that in such situations, one instrument per market failure will be needed: “For example, if the assumption about full information is invalid (while all the other assumptions hold), one instrument would be needed to address the environmental externality per se, and another instrument would be needed to address the information failure.” Thus - according to the “Tinbergen Rule” and considering the multi layer issues of the resource challenge as “multi-aspect” environmental problems, a first-best optimum cannot be reached by applying only one instrument and a combination of several instruments – an “instrument mix” – will be needed (OECD 2007). This is especially true for the topic of resource efficiency when taking into account the crosscutting dimension of resources being part of many other policies. There is no single policy tool that would be equally suited for all problem structures, goals, actor types, kinds of resources, etc. Instead, a policy-mix is required that overcomes a variety of barriers, is mindful of separate innovation stages, and effectively addresses future global challenges.

3.2 Polfree approach

Against this background the Polfree project aims to develop a policy mix that enables Europe to radically increase its resource efficiency and to overcome the existing web of constraints for resource efficiency (Kemp et al. 2013). The innovative aspect of Polfree is to go beyond another long list of potential instruments or a mix of instruments, but to analyse based on a common set of indicators. Based on an analytical framework developed by Rogge/Reichardt (2013) Polfree differentiates between the generic criteria of a) consistency, b) coherence and c) credibility/ stability.

Consistency refers „to the state of a policy mix that is characterized in its weak form by the absence of contradictions and in its strong form by the existence of synergies within and between the elements of the policy mix, thereby enabling the achievement of policy objectives.“ This kind of integrated analysis of instruments is rarely addressed in the literature (del Río González, 2009, del Río González, 2010, IEA, 2011b, Sorrell et al., 2003), especially not for resource efficiency with its significant interactions and interdependencies between specific natural resources.

The second key characteristic of an efficient and successful policy mix is the **coherence of the policy process** that aims to develop, implement and monitor the specific instruments. In contrast to consistency with a focus on contents, the term coherence focuses on the process dimension (Den Hertog and Stroß, 2011a, Jones, 2002, OECD, 2001, OECD, 2003a, OECD, 2003b). Rogge et al. (2013, p. 25) suggest defining "policy coherence as referring to the processes of policy making and implementation, ensuring that the elements of the policy mix are not in contradiction with one another or may even reinforce one another".

A third analytical dimension relevant for describing the nature of a policy mix includes the perception of the addressed actors: **credibility and stability** (Foxon and Pearson, 2008, Majone, 1997, Matthes, 2010). The credibility of a policy mix refers to the extent to which the policy mix is believable and reliable (Newell and Goldsmith, 2001). Credibility may be influenced by a range of factors, such as the commitment from political leadership, the operationalization of targets by a consistent instrument mix and the delegation of competencies to independent agencies. Given the fact that radically increasing resource efficiency in Europe will require significant long-term investments, credibility of a policy mix is a necessary precondition – in this way it is also linked to the two dimensions described above because inconsistent and incoherent policy mixes of course send out mixed or wrong signals.

In order to operationalize these criteria - considering the purpose to design a policy mix – specific innovative policy instruments have to be described by their essential characteristics. The policy mix concept developed by

Rogge/Reichardt 2013 integrates the instruments characterized by their goals, type and design feature. Especially the design features are influential for innovation processes (Kemp and Pontoglio 2011, Vollebergh 2007), and therefore of particular importance for analysing policy instruments and their relevance for innovation.

In the following 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/Reichardt 2013).

1. ***Stringency*** measures the extent of how ambitious the target is in relation to a "baseline" trajectory (Hascic et al. 2009) and how well target actors can adapt to the external pressure (Bernauer et al. 2006, Kammerer 2008). The economic unit covers public authorities, private households and companies (private/public). According to Hascic et al. 2009 "a stringent policy is more likely to induce innovation than a lax policy since it will increase the opportunity cost of polluting relatively more".

2. Profitability is in the nature of things - firms are more likely to do investments or engage in environmental behaviour the higher and more obvious profitability is. According to Rogge/Reichardt 2013 profitability "captures an instruments effect on the return of an investment".

3. Predictability in terms of expected probability of implementing a specific policy instrument as well as its future development, such as the overall direction, the detailed rules and the timing, of an instrument is captured by the predictability as design feature (Rogge et al. 2011). Especially if the desired effect of the instrument is linked to high necessary investments, this feature is of particular importance (ibid.). Bernauer et al. 2006 mentioned that an instrument seem to be predictable, if its characteristics are foreseeable.

4. Flexibility of an instrument describes if it allows testing new technologies when they become available and thus hamper that technological potential stays unused (Kivimaa et al. 2006). According to Johnstone et al. 2009 an instrument is flexible, if the innovator finds out how to meet the goal, no matter what goal it is. Such instruments provide for every firm the flexibility to decide in which way they want to meet goals (Norberg et al. 1999). The point is that these instruments are "technology-neutral" (Johnstone et al. 2009).

5. ***Differentiation*** as design feature also has a high relevance for the impact of an instrument on innovation. Differentiation of an instrument is characterized by distinguishing by properties of the target actors or the object of regulation. For instance, Kemp and Pontoglio 2011 describe differentiation of an instrument as a "differentiation with regard to industrial sector or size of

the plant". Rogge/Reichardt 2013 mentioned the geographical location as a further exemplary relevant aspect.

6. The ***Depth*** of an instrument measures whether the instrument addresses incentives "all the way down to potential solutions with zero emissions" (Rogge/Reichardt 2013). Hascic et al. 2009, for instance, mentioned that in principle standards have a low depth, because standards set no incentives beyond the standard level.

The integrated analysis of these six key design features was taken as starting point for the systematic development of a policy mix for resource efficiency. Another important input to this task was the analysis of barriers and missing targets within Polfree that highlighted especially the aspect of uncertainties related to resource consumption and environmental burdens. This aspect is so far empirically widely neglected and undertheorized. Only a careful differentiation of uncertainties, asymmetric information and their specific relevance for specific instruments allows identifying strengths and weaknesses of policy instruments. The analysis highlights that a policy mix is way more complex than just picking the right instruments: "Practical policymaking is an art of timing, combining, and sequencing instruments to meet multiple goals amidst changing circumstances" (Sterner & Coria 2011, p. 262).

4 Analysis of policy instruments

Based on the theoretical framework outlined above, the empirical part of the project describes the development process for innovative policy instruments that would enable to achieve a radical increase in resource efficiency in Europe. The selected instruments address the most relevant fields of action with regard to resource consumption and at the same time resource efficiency potentials:

1) Minimization of food waste losses alongside the value chain/ Changing diets
2) Zero Energy and material efficient buildings
3) Fuel efficient mobility
4) Electricity production and distribution
5) Industrial symbiosis network
6) Product Service Systems
7) Ecodesign Product Standards for a Circular Economy
8) Phasing out EHS
9) Internalization of costs

Case study: From waste disposal towards a resource-efficient circular economy

Turning waste into a resource is one of the key strategies to increase resource efficiency in Europe – thus waste management is undergoing a fundamental transition process: Historically waste infrastructures have been established in order to ensure the disposal of waste in a cheap, reliable and – starting in the 1970s - also environmentally friendly way. Traditionally waste has been seen as a potential threat for the human health and it was regarded as a public task to take care of it – by landfilling it outside of the city walls or in later times by burning it in waste incineration plants (the first ones established in Germany and the UK after the last outbreaks of cholera in urban agglomerations). This socio-technical regime of waste disposal with all its technical infrastructures, governance structures and behaviour patterns was and still is focussed on this purpose: To avoid that the society is drowning in waste. In the public opinion, large-scale systems based on municipal waste collection schemes and end-of-pipe technologies like waste incineration, shredding or other volume reducing waste treatment procedures seemed to literally have minimized these sorrows – in most developed countries and especially in the EU waste seemed to be a „solved problem".

Only recently this perception has been contested and the idea of a circular economy raised increasing interest in the public debate, e.g. in the European Commission´s Communication on Zero Waste: „Since the industrial revolution, our economies have developed a 'take-make-consume and dispose' pattern of growth — a linear model based on the assumption that resources are abundant, available, easy to source and cheap to dispose of. It is increasingly being understood that this threatens the competitiveness of Europe. Moving towards a more circular economy is essential to deliver the resource efficiency agenda established under the Europe 2020 Strategy for smart, sustainable and inclusive growth. (European Commission 2014)".

Although the roots of the circular economy go back to the 1970s and are based on the principles put forward by many thinkers and business innovators including Walter Stahel and his conceptualisation of the performance economy (Stahel and Reday 1976), John Lyle and his work on regenerative design (John T. Lyle), cradle to cradle models of Michael Braungart, bio-mimicry popularised by Janine Benuys or the blue economy concept developed by Gunter Pauli. In the current debate, the most prominent proponent of the model is the Ellen MacArthur Foundation (2012). The narrative is increasingly gaining the support of businesses and enjoys increasing recognition by the European Commission: „Transition to a more circular economy requires changes throughout value chains, from product design to new business and market models, from new ways of turning waste into a resource to new modes of consumer behaviour. This implies full systemic change, and innovation not only in technologies, but also in organisation, society, finance methods and policies. (European Commission 2014)".

Despite the ongoing initiatives to transform Europe into a "recycling society", reality still shows a clearly different picture. In 2011, total waste production in the EU amounted to approximately 2.5 billion tons. But only a limited share (40%) of the municipal waste generated in the Union was recycled, with the rest being landfilled (37%) or incinerated (23%) of which around 500 million tons could have been otherwise recycled or reused. Right now the European Union continuously loses a significant amount of potential secondary raw materials contained in waste streams which are not fed into the optimal treatment options: "The Union thus misses out on significant opportunities to improve resource efficiency and create a more circular economy leading to economic growth and jobs which in turn would reduce greenhouse gas emissions and its dependency on imported raw materials" (European Commission 2014, p. 10).

4.1 Need for better policies

Against this background the Roadmap for a Resource Efficient Europe has set a clear milestone: „By 2020, waste is managed as a resource. Waste generated per capita is in absolute decline. Recycling and re-use of waste are economically attractive options for public and private actors due to widespread separate collection and the development of functional markets for secondary raw materials. More materials, including materials having a significant impact on the environment and critical raw materials, are recycled. Waste legislation is fully implemented. Illegal shipments of waste have been eradicated. Energy recovery is limited to non-recyclable materials, landfilling is virtually eliminated and high quality recycling is ensured" (European Commission 2011b).

Given that especially high quality management of waste depends on an ambitious and consistent regulatory framework, there is a clear need for innovative policy instruments that help to transform waste management into a circular economy: "If waste is to become a resource to be fed back into the economy as a raw material, then much higher priority needs to be given to re-use and recycling. A combination of policies would help create a full recycling economy, such as product design integrating a life-cycle approach, better cooperation along all market actors along the value chain, better collection processes, an appropriate regulatory framework, incentives for waste prevention and recycling, as well as public investments in modern facilities for waste treatment and high quality recycling." Against this background especially the establishment of ***waste targets that 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 is most important.

Waste management as a policy field has always been mainly driven by framework conditions like regulations for collection and treatment of waste and especially targets play a crucial role for the emergence and diffusion of innovations – as stated in the Zero Waste Communication: „Strong policy signals are needed to create longer-term predictability for investment and change so that materials, such as plastics, glass, metals, paper, wood, rubber and other recyclables, re-enter the economy as secondary raw materials at competitive prices." POLFREE WP 1.3 highlighted as a specific barrier for resource efficiency that concreteness and ambition of targets and policy signals differ significantly alongside the waste hierarchy: recycling and disposal are regulated by binding and quantitative targets, reuse and waste prevention lack such targets. From a resource efficiency perspective the targets in place show three fundamental weaknesses that fail to steer innovations in the right directions:

1. Recycling targets refer to the weight of waste and neglect the ecological rucksacks related to them alongside their life cycle. This perspective makes sense from the perspective of securing disposal capacities, but it leads to a focus of recycling heavy stuff instead of the relevant waste streams from a resource efficiency perspective[1].
2. The current recycling targets focus on the input to waste treatment procedures and do not take into account quality aspects for the secondary raw materials coming out of it. Based on the legal definitions set out in the Waste Framework Directive, a product or waste stream is „recycled" when it enters a specific waste treatment operation like shredding, incineration etc. Again this makes sense following the purpose of reducing waste volume – but it doesn´t give any indication how much of the raw materials contained in the waste stream are actually recovered and can be fed again into production processes.
3. The comparison of targets and their consequences for waste treatment and waste generation clearly shows that waste policy has an impact on recycling but so far fails to influence the generation or

[1] This problem becomes obvious in the regulation for waste electronic products: The current WEEE-Directive obligates all member states to collect 4 kg per year and capita; naturally the municipalities or other responsible institutions focus on heavy products like freezers or washing machines in order to fulfil these targets. Without any doubt resource conservation potentials – and also recovery potentials for critical raw materials – would be much higher if 200 mobile phones would be recycled instead of a single washing machine. But without any incentives to collect light – although „resource-heavy" products, the collection rate for mobile phones e.g. in Germany is estimated at less than 5%.

composition of waste – although this should be the top priority of all waste policy and infrastructure planning according to the Waste Framework Directive.

Against this background also the Roadmap for a Resource Efficient Europe (European Commission 2011b, p. 8) describes the need for innovative targets as a specific regulative policy instrument: “Member States should ensure full implementation of the EU waste acquis including minimum targets through their national waste prevention and management strategies (continuous) (and) assess the introduction of minimum recycled material rates. The European Commission should recommend amending the Waste Framework Directive with the following three targets: A resource intensity based recycling target and a mandatory recycled content target.

4.1.1 Resource intensity based recycling target

Current recycling targets don't give any indication how much of the raw materials contained in the waste stream are actually recovered and can be fed again into production processes. The decision if a specific waste treatment is appropriate in order to close material loops is completely left to the economic considerations of the actors in the waste management sector – leading to a situation e.g. for plastics that low quality recycling pays off a little better than high quality recycling with the consequence of an actual use of recycled plastics in production processes of close to zero in most application fields (Consultic 2012). Hence, high percentage of municipal solid waste (MSW) fractions collected for potential recycling cannot translate into maximum sustainable resource efficiency (Velis and Brunner 2013).

The European Commission has been aware of this inconsistency of the recycling definition and wanted to shift the focus on output qualities. As a minimal consensus the Circular Economy Package proposes „for the purpose of calculating whether the targets (...) have been achieved, the weight of the waste prepared for re-use and recycled shall be understood as the weight of the waste which was put into a final preparing for re-use or recycling process less the weight of any materials which were discarded in the course of that process due to presence of impurities and which need to be disposed of or undergo other recovery operations. However, where the discarded materials constitute 2% or less of the weight of the waste put into that process, the weight of the waste prepared for re-use and recycled shall be understood as the weight of the waste which was put into a final preparing for re-use or recycling process.“ Obviously this is still far away from securing output qualities but given the on-going difficulties e.g. to define necessary end-of-waste criteria (when does waste stop being waste and becomes a raw material again), this can be seen as a first starting point.

4.1.2 Mandatory recycled content target

The classic approach towards waste management activities has always been the establishment of mandatory recycling quotas – regulating the treatment of waste and avoiding environmentally harmful disposal. A recycling and reuse rate of at least 50 per cent by mass is currently implemented in the Waste Framework Directive for paper, metal, plastic and glass for the year 2010. For construction and demolition waste, a rate of 70% by 2020 will have to be achieved. Although mass-based product-specific or waste stream-specific quotas ensure material recycling of these two categories, they do not allow a targeted control of materials contained in the product. Against this background a mandatory recycled content target could be introduced especially for plastics. This would be an essential prerequisite for the recovery of for instance secondary plastics, which is at least since the publication of the Green Book on plastic waste by the European Commission a waste stream that has been in the focus of many waste and recycling related discussions. The favourable initial conditions for plastic incineration over plastic recycling result in extremely low recycling quotas, for example in the case of electrical goods: plastic contained in electrical or electronic equipment (devices) is currently almost entirely incinerated (Consultic 2012).

With the specification of minimum recycled content quotas for plastic-containing products, the demand would rise significantly for high-quality secondary raw materials and thus provide incentives to capture a greater share of separated plastic wastes (i.e. in the sense of high-quality recycling) which will be recycled and not utilized for thermal recovery.

Experiences with minimum recycling quotas have already been made in particular for the case of packaging in the 1980’s as it became clear that the recycling sector needs to be supported. After the emergence of different scandals concerning the disposal of waste in California, Oregon and Wisconsin, different regulations on recycled content had been introduced in the U.S., while each of these instruments had a different result (Napcor 2011a). In Oregon the recycling law does only apply if the recycling quota for plastics drops below 25%. In fact, the recycling rate has always exceeded this value through mandatory deposit-refund schemes, meaning that the law was never actually applied. In Wisconsin, the inclusion of plastic waste from production was allowed by law. According to general assessments, this has undermined any effect on the actual management of plastic waste.

The by far most stringent regulation has been applied in California and has received a lot of criticism for its bureaucratic burdens and the associated administrative costs and monitoring problems. The adoption of this law however has led to a significant stabilization, especially in the market for HDPE product waste (Napcor 2011b). The Rigid Plastic Packaging Container Law (RPPC) was fundamentally revised in 2012, manufacturers or marketers of plastic packaging must confirm complying with a minimum recycling quota that is being controlled by a sample system (CAW 2012). The scope has been expanded significantly beyond beverage packaging. Simultaneously, manufacturers may comply with the law via design changes (-10% material input or minimum use of 5 times), a 45% recycling rate, or through a 25% share of secondary resources. Similar regulations are, for example, currently planned in Europe under Guidance of the European Packaging Directive (European Commission 2009).

Within the research project "Material Efficiency and Resource Conservation", the instrument of minimum recycling quotas has been examined for ICT products and in particular contained critical metals. It has been proven that the Ecodesign Directive could provide the legal foundation for such an instrument, and for resources such as gold or palladium, relevant environmental potentials exist without impeding the quality.

At the same time, however, several problems in the implementation of this instrument have been found: In particular, the access of manufacturers to secondary raw materials, the inclusion of non-European recyclers to the certification system, traceability of material flows (e.g. by a proof of origin) and the prevention of fraud along the entire certification chain (e.g. illusive lowest quality recycling activities) were identified as challenges (Werland 2010). Against this background, also experiences abroad should be considered, in which the introduction of such quotas has failed. For example, in Australia the uncertain ecological effects of unspecific product quotas and high costs have been mentioned (PCA n.d.).

4.2 Implementation

The following paragraph discusses the implementation of the instruments described above, taking into account related barriers. The aim is to provide increased transparency on how these instruments could fit into the existing policy framework, what would be the instrument's inherent barriers and which barriers can be eliminated with the introduction of flanking instruments or measures.

4.2.1 Resource intensity based recycling target

Measuring resource-intensity of a product based on its resource footprint enables a sustainable assessment base to set a resource- rather than a mass-oriented target. It is proposed that recycling should generate resource benefits of at least 50% in terms of secondary raw materials that fulfil end of waste criteria. However, with the implementation of this quota some difficulties arise.

A resource-oriented recycling target depends on a high level of information. The example of electrical and electronic equipment, which is one of the most complex waste fractions, illustrates the problem of uncertainties about product compositions: the rapid changes of technology and product design result in continuous changing material composition. Due to complex supply chains often the product- or component-producers themselves have insufficient information on content and location of materials. In the global network material compositions of products can change on a daily basis, depending on changes in raw material prices. Keeping of product information (competitors could derive insights into technical innovations) are a further reason for the deficient data situation.

To secure output qualities the proposed recycling target is accompanied by imposing the obligation that the outputs fulfil end of waste criteria. Since legal uncertainty about when waste ceases to be waste and becomes secondary raw material affects the development of the recycling sector, the fulfilment of end of waste criteria is a requirement to make a resource intensity based recycling target fully effective.

The Commission is establishing end-of-waste criteria for a number of specific recyclables. Since 2008, the Joint Research Centre (JRC/IPTS) has prepared a series of technical studies proposing end-of-waste criteria on these materials[2]. The studies are the result of intense consultations with experts in a technical working group, and consist of thorough techno-economic-environmental assessments that help verify when a recyclable waste material is safe for the environment and has a sufficient quality to merit being released from the waste regime. These flanking developments are an adequate starting point for the implementation of a recycling target focusing on output qualities.

Monitoring of the output instead of the input would be practically challenging in many respects. An output-based calculation of the recycling targets has to refer to actual output qualities, otherwise it can lead to negative environmental effects: a simple sorting with a small impurity rate would be preferable against a highly technical sorting with a high impurity rate (BDE 2013). Against the background of often multi-stage recycling processes and plants in which municipal waste as well as commercial and industrial waste is accepted, the identification and precise assignment of input to output flows would be impossible. In addition, the question arises how the output in case of exports will be determined (ibid.). The application of estimations and extrapolations would be a possible solution, but in view of errors in the calculation of the recycling rate, the efficiency of the instrument is questionable.

4.2.2 Mandatory recycled content target

The introduction of minimum recycled content quotas would allow direct control of the use of secondary raw materials and thus mechanical recycling. Instead of defining technological standards, this approach would be based on

[2] see http://susproc.jrc.ec.europa.eu/activities/waste/index.html

market consideration how these standards can be met at the lowest cost level. Especially the construction sector offers good conditions for the introduction of a secondary plastic quota because many of the employed products are used in the „non-visible range“ meaning that the frequently cited problems of colour fidelity of secondary plastics only play a minor role (i.e. DSD 2012). Although take-back systems for PVC-windows, doors and shutters exist since 2002 in Germany (Rewindo 2012), the construction sector features only a below-average share of mechanical recycling for plastic waste. There is therefore a need for action in the construction sector since the components used in principle have a very long expected lifecycle but are now increasingly moving towards their end of the lifecycle. Thus, they are increasingly becoming a challenge from a recycling and demolition perspective. Based on experiences of the construction sector, electronic products could be tackled in the next step. On the one hand this sector is an increasing important field of application for plastics, on the other hand electric/ electronic products are characterized by significantly shorter innovation cycles and higher degrees of specialization, so that higher requirements are assumed for a certification system on the use of secondary plastics.

A generally perceived problem of quotas is determining their specific rate. On the one hand, the rate must be set sufficiently high to trigger actual effects on product design and the management plastic waste. On the other hand, it must be technically achievable without impeding the final quality of the products. The proof of the utilization of secondary plastics for certain products without the cooperation of all relevant actors will hardly be realized. This would require a comprehensive monitoring of complex international material flows and the certification of recycling processes. It is also obvious that the proposed changes in production processes require not only a national but also an EU-wide approach. The implementation should be carried out through a voluntary commitment that needs to be developed by the construction sector, the confederation of the plastics processing industry, Rewindo as a stakeholder for Germany’s leading plastic profile manufacturers and the Umweltbundesamt/ Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Given the importance of PVC for the construction sector, experiences of the European commitment VinylPlus should also be taken into account (VinylPlus 2012). The commitment should also provide a regular, randomized monitoring system similar to the case of California in which manufacturers should prove their compliance with the minimum recycling quota.

The development of an appropriate certification system should be carried out in a joint effort between all relevant parties. Experiences show that the success of such commitments depends on clear and verifiable implementation controls but also on an agreed system of sanctions. The instrument should be accompanied by public participation in research and development projects to optimize manufacturing of secondary resources for the participating organizations. In case of a persistent and widespread failure to comply with the minimum recycling quota, a process for the development of proper legally binding market access restrictions (for example through the Eco-design directive) should also be introduced.

Moreover, this instrument supports a reliable demand for high quality secondary plastics and thus promotes additional investments in the needed infrastructures; it may also be employed on a temporary basis. The underlying consideration is that secondary plastics should have gained higher market shares after the initial phase of capital-intensive investments against primary plastics, making a further intervention in the market unnecessary. A self-agreement should therefore provide an appropriate evaluation, for example after 5 years.

Also the actual market definition for which a minimum quota would have to be realized appears to be challenging: In an ideal world, plastic type-specific minimum recycled content quotas could take the respective economic and ecological aspects of PE, PS or PVC recycling into account. However, this option would require excessive monitoring if evidence of the realization of the quota would have to be provided. The industry would then have incentives to circumvent the quota by substituting between the different types of plastics. If the quota were assigned to each product, than the benefits of static efficiency (minimum recycling quotas would allow manufacturers to choose which waste streams to use to fulfil the required quotas[3]) would be diminished because manufacturers cannot use secondary plastics for the most cost-effective purposes. A quota calculated on the level of manufacturers would also be difficult in the sense that quotas would lead to different efforts depending on product portfolios – some producers might have more products for which it´s easier to use secondary plastics. If the quota was aligned to whole sectors, then a regulatory approach would become virtually impossible because manufacturers would not be assigned with individual, enforceable responsibilities.

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[3] Of course for manufacturers it would be beneficial to utilize only waste streams coming from production processes (“new scrap”) since these are generally viewed as more predictable and occur in higher homogeneity. The incentive to improve collection and recycling of waste products could therefore be undermined. But a sole focus on process wastes in the plastics sector seems rather unlikely, since these are already recycled mechanically to a rather high degree. If additional amounts of plastics waste would have to be recycled in order fulfil the quota, product waste would also have to be taken into account. A correspondingly high minimum recycling quota would therefore provide incentives along the entire recycling chain to compile with a high quality recycling.

5 Conclusions

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 – nevertheless the implementation is often weak and scattered. The paper uses the above outlined methodology in order to explore possibilities to go beyond single instruments but to integrate them into a consistent and coherent policy mix with relevant synergies between its single elements.

The following table gives an overview of the assessment based on a classification scheme from 1 to 5 in which higher number indicate higher suitability for a policy mix.

Table 1: Assessment of policy instruments with regard to their key design features

		Stringency	**Profitability**	**Predictability**
Minimization of food waste losses	Resource efficiency across the supply chain - Supporting cooperation, capacity building and innovation	1	3	5
	Green Public Procurement	5	2	3
	Courtauld commitment of food waste prevention	1	5	5
Zero Energy and material efficient buildings	Landfill bans and landfill targets on C&D waste	4	1	4
	End of life of buildings and building passports	5	1	5
	Promoting “co-housing alternatives” and living together through economic and planning instruments	1	3	5
Fuel efficient mobility	Strict CO_2 emission standards	4	1	5
	Vehicle and road tax	4	1	5
	Prioritizing urban non-car infrastructure	4	2	5

Electricity production and distribution	Smart grids	5	4	1
	Effective levels of carbon taxation through changes in the ETS and carbon border adjustments	2	1	4
	Integrated micro-generating systems and through incentives and subsidies in industries and households accompanied with energy efficiency audits	4	3	3
Industrial symbiosis network	Landfill taxes, bans and end of waste criteria	3	3	4
	Pan-European network of industrial symbiosis programmes/ coordinating bodies	1	3	5
	Incorporating IS requirements in regional planning and activity permits	5	2	5
Product Service Systems	Awareness raising campaign about existence and advantages of PSSs	1	4	5
Circular Economy	Individual producer responsibility	1	3	5
	Mandatory eco-design standards for reuse and repair-ability	2	1	1
	Waste targets for resource efficiency	5	1	5
Phasing out environmental harmful subsidies	A comprehensive inventory of EHS in the EU	4	3	5
	Environmental Subsidy Controlling: The „Environmental Check“ for Subsidies	5	4	3
	Systematic phasing out of EHS	3	1	4
Internalisation of external costs	European-wide harmonization and introduction of construction minerals taxes (incl. border tax adjustment) _ Construction Minerals Directive	1	3	3
	TMR-based material input taxes	5	3	1
	LCA-based Value Added Taxes	4	1	1

The detailed analysis of the six design features underlines the complexity of designing integrated and efficient policy mixes for resource efficiency. Three main conclusions can be drawn:

Intuitively plausible, but clearly backed up by the analysis of the instruments described above: The more ambitious an instrument (stringency), the lower the immediate profitability for the actors involved. There is a clear trade-off between those instruments that offer the highest potential increases for resource efficiency and those that could be easily implemented due to market incentives. This point also relates to the different Polfree pathways that describe differences with regard to the political acceptance of instruments and specific measures: The process of designing policies for resource efficiency cannot be based on the instrument as such, but needs to take into account the political economy aspects: The higher the general acceptance for resource efficiency policies, the more stringent instruments can be implemented. This is especially the case if the instruments aim at influencing or even regulating the consumer side.

In many cases there is a clear trade-off between the predictability of an instrument and on the other hand its flexibility. Instruments are often considered as more efficient and acceptable if the evolvement of tax rates, recycling rates etc. is clearly foreseeable so that all actors can adapt especially their investment decisions to upcoming changes of prices etc. At the same time this self-binding character of an instrument negatively influences the flexibility of an instrument that would allow policy makers to react on external factors like technology or market developments. The analysis has also shown that are approaches to successfully deal with this trade-off: Specific measures can already include a clear and transparent mechanism of revising the elements of an instrument and in this way not reduce the risks of mis-investments but at least make the costs related to such events more predictable.

A third trade-off can be seen between the level of specificity of an instrument (differentiation) and its depth, the level of inclusion of up- and down stream actors. Obviously policy instruments benefit from a design that enables to take into account external circumstances like specific economic, cultural, social etc. regional aspects. At the same this specific focus makes it more challenging to include actors outside of this specific situation. The case studies show that for example technical regulations or permitting procedures allow to very systematically take into account plant-, region- or sector-specific aspects. On the other hand market-based instruments show clear strengths not only to address specific links of the value chain but to set incentives that can be passed on (e.g. in the case of material extraction taxes).

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