DYNAMIX

Decoupling growth from resource use and environmental impacts

Comparative analysis of policy mixes addressing natural resources

Learning from real world experiences

Deliverable D.3.2

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This document is available on the Internet at: http://dynamix-project.eu/results.

Other documents of relevance to this report are also available at the same address:

- Full case study reports on individual policy mixes evaluated
- A summary report of the 15 policy mixes evaluated
- The comprehensive ex-post evaluation template used for the case studies

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DYNAMIX PROJECT PARTNERS

Key messages

The EU aims at decoupling the economy from resource use and environmental impacts. This report has compared 15 case studies of past and existing policy mixes in different sectors and assessed how effective they have been in spurring decoupling. Key results are:

Relative decoupling is being achieved in Europe, though at different rates across countries and resource issues. Examples include fossil fuels use in Sweden and Denmark; local municipal waste in Slovakia; and land take in England and Germany.

Evidence of absolute decoupling is less frequent and related to specific resources and countries. Examples include Denmark's fertiliser use, the UK's use of aggregates, Ireland's plastic bag use and Japan's 'sound material cycle society'. In Iceland, absolute decoupling within resource limits has been achieved for some fish species.

Our review suggests that effective policy mixes…

- …focus on a specific resource or sector.
- …achieve transformation because they match the type and level of 'lock-in' in the sector.
- …are informed by a clear understanding of limits and thresholds.
- …address global impacts of resource use, particularly imports from overseas.
- …have clear targets and address all phases of the policy cycle, including built-in monitoring, review and response mechanisms.
- …struck the right balance between effectiveness and acceptance.
- …have predictable effect, thereby increasing efficiency.
- …include information instruments to increase awareness, but do not use them in isolation, because information alone fails to deliver the scale of change required for decoupling.

There is no obvious trend between the absolute number of instruments in a policy mix and its effectiveness. Rather, **instruments can play different roles**:

- Regulation is often the driving instrument and has proven fundamental for meeting critical environmental objectives, particularly by driving innovation.
- Market-based instruments (MBIs) as core instruments have led to both relative and absolute decoupling.
- Voluntary instruments are weaker, but can be useful as a bridge to more ambitious instruments.

Main shortcomings in policy design include:

- A lack of policy coherence or conflicting policy objectives.
- Gaps and loopholes, for example through exemptions.
- Rebound effects are not taken into account.
- Targets and objectives not fit for purpose (e.g. not defined in achievable terms).
- International impacts are often not fully integrated, risking leakage.

Executive Summary

Decoupling the economy from resource use and environmental impacts is an objective that is increasingly committed to at EU level (e.g. the Europe 2020 Strategy, the 7th Environment Action Programme) and internationally (e.g. the OECD's 2011 Environmental Strategy). It is also an essential need for societies and economies, given resource and ecosystem limits. The ambition levels for decoupling are related to policy objectives of resource efficiency, green growth and green economy as well as ambitions for a circular economy.

Relative decoupling – i.e. lower resource input or impacts per unit of GDP – is generally being achieved in Europe, though at different rates across countries and issues. Progress on absolute decoupling and absolute decoupling within resource or ecosystem limits is very specific to resource issue and country. See Table 1 for examples of issues and policy mixes.

The impact of policy mixes on decoupling is very time dependent because in most cases the policies need to be implemented over many years to achieve their effects. This is due to the time needed for substitutions of resource, processes and products, for innovation, demand changes and the evolution of social norms, infrastructure investments and to overcome technological lock-in.

Absolute decoupling represents a major transformative challenge for the economy, society and policy governance. Systems change is needed, to address technological lock-in and needs for changes to habits and social norms. This will require multi-level governance across stakeholders in society and the economy. Dynamic mixes of policy instruments with specific designs to address different issues and objectives, and reflecting a diversity of country contexts are needed to decouple the economy. Table 1 presents examples of policy mixes and their contributions to decoupling to date.

Table 1: DYNAMIX case study policy mixes and contributions to decoupling to date

Type of decoupling achieved to date	Case studies
Absolute decoupling within resource limits	**Sustainable levels of fish catch in Iceland:** A mix of setting total allowable catches, and introducing individual tradable quotas and a resource tax has allowed fish stocks to recover and be at more sustainable levels. Herring recovered from a 1960s collapse and Icelandic cod increased from 500,000 t in 1992 to 1.2 mt in 2012.
Absolute decoupling	**Reducing fertiliser use in Denmark:** Excessive fertiliser use causes serious negative environmental impacts especially in water ecosystems. A range of instruments, with regulatory ones at the core were implemented. Nitrogen fertiliser use has reduced by almost 50 % from 394,000 t N in 1990 to 203,900 t N in 2011. **More efficient use of aggregates in the UK:** Due to the variety of negative environmental impacts of the use of aggregates, an aggregates levy and a sustainability fund were introduced, complemented by an existing landfill tax. This policy mix managed to achieve a decrease in primary use of aggregates while achieving an increase of the construction output.

	Reducing plastic bag use in Ireland and the UK: Through a mix of taxes, voluntary initiatives and awareness-raising campaigns Ireland reduced plastic bags use by 90 % within five months after introduction of the policy mix. **A sound material cycle society in Japan:** Expected increasing dependency on raw materials and critical metals imports motivated Japan to introduce a policy creating a 'sound material cycle society', using national targets, R&D and subsidies but also awareness-raising campaigns to promote mainly recycling.
Relative decoupling	**Reducing fossil fuel use in Sweden:** Through long-standing taxation instruments, a tradable certificate system and various political strategies and regulation, Sweden has reduced CO_2 emissions (0.5 % per year) but the picture is less clear on total energy consumption. Different instruments were used to address various sectors. **A fossil fuel-free energy system by 2050 in Denmark:** Denmark's extensive use of taxation of energy and CO_2 is built upon by more recent political strategies aiming to end fossil fuel dependence by 2050. CO_2 emissions have decreased, while energy consumption shows a slight decreasing trend. Although difficult to quantify robustly, a transition from relative to absolute decoupling appears to be occurring. Support across political parties features heavily in Danish policy, with very positive effect. **Reducing municipal waste at the local level in Slovakia:** Palárikovo municipality adopted a "Zero Waste" strategy, based initially on an awareness-raising campaign and recycling infrastructure introduction. The pay-as-you-throw scheme introduced had a strong reinforcing effect. Landfilled waste decreased by 64 % from 1999-2011. **Conserving rural land in England:** Use of planning acts, identification of land that should not go to development and areas that are available to development, combined with incentives have helped reduce net land take to around 5,000 hectares per year. **Reducing land sealing in Germany:** A national 2020 goal of taking no more than 30 hectares per day was set to limit additional land take. Modest progress has been made, particularly given lack of unity in tools used and contradictory instruments.
No decoupling	**Sustainable use of forests and wood in Finland:** Use of regulation, voluntary schemes and forest certification has helped reduce use of domestic forestry products and increase forest stock/standing forest biomass. However, increased imports of wood products are offsetting domestic progress. Overall decoupling had not been achieved. **Reducing transport CO_2 emissions in Spain:** Although there was a decrease in CO_2 emissions in the final year of the policy mix (2007), this is more likely due to the global economic and financial crisis and due to how GDP time series is constructed. The policy mix focuses on information instruments. **Increasing industrial energy efficiency in Portugal:** The policy mix used a mixture of regulatory and economic instruments. However, industry energy consumption is still coupled with economic growth, despite GHG emissions having decreased.
Not clear	**Reducing phthalate and PVC use in Denmark:** Through instruments such as bans and taxes, Denmark succeeded in reducing consumption of phthalates and PVC by around 50 %. These two substances have significant negative human health impacts. **Preventing food waste in the UK:** In efforts to decrease methane emissions, this policy mix used the existing landfill tax and information campaigns targeted at consumers. 1.1 mt of food waste were prevented.

Source: DYNAMIX case study summary report *Evaluating existing policy mixes to identify solutions for EU resource efficiency – Summary report of 15 real world policy mix evaluations*. http://dynamix-project.eu/results.

Key factors of success

Policy mixes focused on a specific resource or sector are more likely to achieve absolute decoupling. Examples include: Iceland's fisheries management; the UK's aggregates consumption; Denmark's fertiliser use; and Ireland and the UK's plastic bags use.

The complexity of the resource through the economy is an overriding factor in the level of complexity of the policy mix - there is no obvious trend between the absolute number of instruments in a policy mix and its effectiveness. Addressing resources used in various sectors and potentially for different uses in an economy needs policy mixes using a number of different types of instruments. One policy instrument per aspect of policy target and per market failure has been found most beneficial in designing effective policy mixes.

Policy mixes need to be designed in relation to the level and type of 'lock-in' to achieve transformation. The ease or not of transformation is dependent upon the level of (inter)dependency or 'lock-in' of economic and social systems in relation to a resource or product in question. Systems thinking is required, to understand the range of inter-linkages, to identify where there are issues of particular lock-in or market failures that need addressing.

A clear understanding of limits and thresholds encourages more effective moves towards absolute decoupling. Examples include:

- Fisheries in Iceland, where the setting of total allowable catches on how much fish can be caught were a key element in the policy mix, which also underlines the importance of defining the limits with reference to the appropriate geographic scope.
- Restrictions on fertiliser use in Denmark, where clear targets were set and the estimated contribution of the various initiatives was also provided; regular policy review also ensured that revisions to strategies were more effective.

Internationally traded resources require policy mixes addressing global impacts of resource use, particularly imports. Shifting of burdens from the EU to the rest of the world is already a recognised reality, falsely presenting some EU Member States as having increased resource efficiency. The Finnish wood example illustrates how domestic improvements can come at the expense of international imports with sometimes dramatically more negative impacts.

Policy mixes addressing all phases of the policy cycle are more likely to be effective in the long term – especially having targets and built-in monitoring, review and response mechanisms. Examples include:

- Denmark's fertiliser use: a good illustration of how continued monitoring can serve as a trigger for progressive tightening of the policy mix in light of trends showing that additional policies and measures were needed if set targets were to be achieved.
- Given the scarcity of water resources in Australia, a system of water accounts has been recording annual water consumption per sector of final use (e.g. agricultural, households) since 2000-2001. This has enabled monitoring of the water trading system, which has reduced and shifted water use across sectors.

Effective policy mixes struck the right balance between effectiveness and acceptance. Examples include:

- The UK aggregates levy: the recycling of parts of the levy revenues generated and targeting them to the Aggregates Levy Sustainability Fund is thought to have made the introduction of the levy more acceptable to the extraction industry affected and helped the sector further reduce its environmental impacts.
- Carbon and energy taxation experience has shown that some form of exemptions and/or tax reductions are often a necessary component of environmental tax reform (ETR) and are relied on as a politically expedient measure. However such practices often impair the effectiveness of ETR as the cheapest emission reduction potential is not exploited.

The efficiency of policy mixes increased with the degree of predictability of their effects. Predictability provides incentives for targeted sectors to make the investments required for increased resource productivity or phasing-out certain types of products or materials. An example of this is Denmark's policy on use of phthalates and PVC: the Danish government and the industry adopted an agreement on the use of PVC in 1991 with the objectives of reducing incineration of PVC, increasing recycling and limiting the use of additives in PVC. A 1999 national strategy on PVC set the goal of reducing the use of 17 phthalates by 50 % by 2010. Subsequently, the consumption of phthalates in Denmark was almost halved from 1999 - 2011 and phthalates consumption achieved relative decoupling to GDP.

Information instruments are key in development of natural resources policies. However, used in isolation, they will usually fail to deliver the scale of change required for decoupling. Company transparency and accountability can be improved through information-based instruments such as labels. Nonetheless, heavy dependence on information-based tools needs to be handled with care. In product policy, a long held perception persists that providing the public with more information through labels can help them make more informed (and sustainable) purchasing decisions. Habits, social norms, choice, social status, amongst other factors, also play significant roles in decision-making. General evidence has shown that consumer information could only bring about significant behavioural change if accompanied by other measures as part of a strategic approach. However, such information-based activities can help raise awareness of key issues and act as a *precursor* to more ambitious activities. For resources about which relatively less is known, the role of information plays a vital role in setting the scene for future activities, for example in the area of critical metals.

Observed shortcomings in the policy mixes and challenges for future policy design

Lack of policy coherence or conflicting policy objectives

Examples include:

- Fossil fuel subsidies, which undermine decoupling of growth from fossil fuel consumption and CO_2 emissions.
- The existence of home ownership subsidies and a commuter subsidy encourage urban sprawl and undermine efforts to reduce land take and sealing in Germany.

Gaps and loopholes in the policy mixes

These undermine the effectiveness of a policy mix. Incomplete policy mixes can fail to comprehensively target all sectors or products responsible for the overuse of a specific

resource, or can focus too narrowly on impacts of resource use accruing domestically thereby failing to address resource extraction and use impacts across the global value chain. Examples include:

- The sustainable forestry policy mix in Finland, where domestic wood production appeared to have stayed within limits while imports of potentially unsustainably (and illegally) harvested wood increased importantly.
- The Japanese policy mix for a sound material cycle society case, where a substantial part of Japanese production requiring critical metals as inputs is exported to countries which do not have the same environmental standards as Japan and where recovery and recycling is not the rule.

Rebound effects insufficiently taken into account in most of the policy mixes

- Rebound effects were not addressed in the policy mixes analysed, despite being relevant to a wide range of them.

Targets and objectives that are not fit for purpose undermine progress towards decoupling

- Of those policy mixes having achieved absolute decoupling two thirds were developed with clearly defined quantitative targets to be met within a set period of time (Denmark's fertiliser use and phthalates/PVC, Japan's raw materials, Ireland and UK's plastic bags).
- Of those not yet achieving decoupling, half of the policy mixes did not have measurable targets (e.g. wood in Finland and food waste in the UK).

Conclusions

Given the diversity in the conception, design, implementation and revision of the policy mixes analysed, it is difficult to draw conclusions or trends. However, as the points above illustrate, existing policy mixes provide interesting insights of relevance to the EU's path towards a resource-efficient, low carbon economy.

EU resource use policy is already building upon existing policies in a wide range of areas such as agriculture, air quality, biodiversity, chemicals, climate, energy, fish, waste and wood. In most cases, effective policy demands setting clear targets, using regulatory instruments supported by economic incentives and voluntary measures, and a built-in consistent monitoring system for the policy to be successful.

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List of Abbreviations

AGL	Aggregates Levy
ALC	Agricultural Land Classification
ARCE	Rationalisation Agreement for Energy
BMW	Biodegradable Municipal Waste
CFP	Common Fisheries Policy
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DKK	Danish krone
EEA	European Environment Agency
EHS	Environmental Harmful Subsidies
ETR	Environmental Tax Reform
ETS	Emissions Trading System
EU	European Union
EUR	Euro
FLEGT	Forest Law Enforcement, Governance and Trade
FSC	Forest Stewardship Council
GBP	UK pound sterling
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GNP	Gross National Product
GPP	Green Public Procurement
IEEP	Institute for European Environmental Policy
IMR	Impact Mitigation Regulation
ITQ	Individual Tradable Quotas
LATS	Landfill Allowance Trading Scheme
LCA	Life Cycle Assessment
MSC	Marine Stewardship Council
MT	Megatonne
mt	Million tonnes
NGO	Non-governmental organisation
NO_x	Nitrogen Oxide
OECD	Organisation for Economic Co-operation and Development
PAYT	Pay-as-you-throw
PEFC	Programme for the Endorsement of
PETRA	Strategic Goods Transport Plan
PLATA	Bus Transport Action Plan
PO4e	Phosphate equivalent
PPP	Purchasing Power Parity
PREn	Energy Consumption Rationalisation Plans
PSO	Public Service Obligation
PV	Photovoltaic
PVC	Polyvinyl chloride
SMC	Sound Material Cycle
SME	Small and Medium Enterprise
SO_x	Sulphur Oxide
TAC	Total Allowable Catch
TFP	Total Factor Productivity
TGEC	Total Gross Energy Consumption
UK	United Kingdom
VAT	Value Added Tax
VITO	Flemish Institute for Technological Research
VPA	Voluntary Partnership Agreements
WEEE	Waste Electrical and Electronic Equipment
WING	Materials Innovations for Industry and Society
WISE	Water Information System for Europe
WRAP	Waste and Resources Action Programme

1 Introduction

This report provides a comparative analysis of 15 policy mixes addressing different natural resources on which ex-post evaluations have been delivered in the context of the DYNAMIX research project. It also includes lighter analysis of other examples of policy mixes, to supplement the 15 case studies, as a means of drawing on wider real-world experience and thus allowing a wider set of thematic areas to be covered and lessons from broader set of instrument mixes to feed into the comparative analysis. The report has been prepared by IEEP and partners as part of a European Commission funded research project – DYNAMIX, DYNAmic policy MIXes for absolute decoupling of environmental impact of EU resource use from economic growth – that aims to develop policy mixes to help the EU to reduce substantially its resource use and their environmental impacts while ensuring the prosperity and well-being of its citizens.

The 15 case studies and this comparative analysis report serve to provide the evidence base from existing policy mixes, to feed into the development of a set of policy mixes to be evaluated ex-ante.

1.1 Aims and objectives

Through the delivery of the 15 case study ex-post evaluations of existing policy mixes and this resulting comparative analysis, IEEP and its project partners aimed to:

- Provide a clear framework to study the performance of policy mixes – a comprehensive ex-post evaluation template was prepared for case study authors to use in their evaluation of policy mixes
- Analyse examples of current use, impacts and success conditions of a range of policy mixes set to achieve (or contribute to) absolute decoupling, based on selected case studies in EU Member States and other countries.
- Apply innovative ex-post modelling on a small number of selected cases using selected models, to test and improve assumptions about the success conditions of policy instruments and mixes.
- Draw lessons and conclusions to identify why policies and policy mixes work and if there are instrument mixes that are commonly and usefully applied and hence lend themselves to policy replication and transfer. Also to draw lessons on common solutions and diversity of solutions, and issues of scale and connectivity within a multi-level governance context (local, national, EU, global).

1.2 Approach

Fifteen ex-post case studies were delivered to allow the identification of uses of policy instruments to achieve decoupling that could inform the development of different scenarios and associated policy mixes aiming to achieve EU absolute decoupling of resource use (see Table 2 for selection of cases and wider issues). These were selected after a broader screening and the project partners' decision to focus case study work in particular on resources used to produce products with considerable environmental impacts (UNEP 2010),

namely agricultural goods and biotic materials, fossil fuels, metals and construction minerals. The selection was based on a mix of the following criteria:

- Type of resources (inputs/outputs)
- Objective of policy mix (absolute/relative reduction of use of resource use, reduce outputs (wastes/emissions) or impacts (historically impacts on environmental media)
- Orientation of instruments (mix led by regulatory, economic or info instrument/approach)
- Level of focus– economy wide, sectoral, specific products
- Geographic coverage (N-S, E-W EU, and non-EU countries)
- Successes and failures
- Timeline/age of policy mixes
- Data availability
- Potential replicability / transferability to EU level/other EU countries/region
- Competition; dealing with scarcity and importance for other systems
- Cost effectiveness if information is available

An evaluation template was developed for the ex-post evaluation of the selected policy mixes, to better ensure harmonised evaluation across all the case studies. In particular, this included the collection of information on:

a. how the concept of 'decoupling', as defined in the DYNAMIX Common Approach (Umpfenbach 2013) could be interpreted and applied in the context of the specific policy mix and the resource targeted (and implications for measurement and choice of decoupling indicators);
b. institutional and governance arrangements, political economy and the role of different actors in the establishment of the policy mix (striking features, role of geographic scope, etc.);
c. an assessment of the extent to which policy mixes achieved decoupling;
d. identification of the instruments that appeared to have made particular contributions in achieving decoupling.

1.3 Structure of the report

Chapter 2 briefly sets the overall context of the comparative analysis within the DYNAMIX project, highlights key issues and provides insights into methodological aspects of the ex-post analysis delivered. **Chapter 3** provides results from the comparative analysis of the case studies, and conclusions across the different resource categories as regards the impacts of the policy mixes on decoupling in general. It also highlights which instruments appear to have been applied in most cases of decoupling, what instruments appear to be more specific to certain types of decoupling and the instruments that seem essential for absolute decoupling. **Chapter 4** provides results of a quantitative analysis of a short list of the 15 case studies. **Chapter 5** provides conclusions in the form of insights and lessons from the application of policy mixes, identifying in particular key factors of success, main shortcomings and inadequacies and lessons for the development of instruments mixes. It also includes conclusions on drivers of decoupling, taking into account the extent to which approaches can be replicated across the EU.

Table 2: Overview of the 15 case studies

Country	Type of resource	Decoupling Achieved	Year introduced	Objective
Iceland	Fish stocks	Absolute within limits	1975	Sustainable management of fisheries resources
Finland	Wood production	No decoupling	1997	To implement sustainable forestry management by reducing deforestation and forest degradation
Denmark	Fertiliser use	Absolute	1985	Improving the quality of the aquatic environment, reducing nitrogen leaching and phosphorus and nitrogen discharges
Denmark	Phthalates/PVC consumption	Absolute	1996	Restricting use of phthalates and support the development of substitutes in products
Japan	Natural resource Use	Absolute	1991	Prevention of waste, promotion of recycling and ensuring appropriate disposal of waste that cannot be recycled, with emphasis on critical metals
UK	Aggregates consumption	Absolute	1996	Internalisation of externalities associated with the supply of aggregates and the disposal of waste in landfills, and to encourage the use of alternative materials
Ireland and UK	Plastic bag use	Absolute	1999	Reduction of plastic bag use to avoid litter
Sweden	Energy consumption	Relative	1924	Reduction in greenhouse gas emissions and energy intensity for specific sectors, and increase the share of renewable energy sources.
Denmark	Energy consumption	Relative	2005	Independency from fossil fuels and drastic curbing of energy sector CO_2 emissions
Germany	Land take	Relative	1960	Reduction in additional land take
UK	Land take	Relative	1955	Containment of urban development to preserve fertile land for agricultural production, secure quality of life in urban areas (green belt)
Slovakia	Waste generation reduction	Relative	1992	Reduction of waste landfilled and introduction of separate collection scheme for recyclable/compostable materials
UK	Food waste reduction	No decoupling	1996	Reduction of food and drink waste produced, and sent to landfill
Portugal	Energy consumption	No decoupling	2006	Increase in industrial energy efficiency.
Spain	Energy consumption	No decoupling	1992	Reduction of energy consumption growth rates and energy intensity in the transport sector

2 Background to the comparative analysis

The DYNAMIX project aims to develop and assess EU policy mixes that would achieve increases in economic output (and/or well-being) while remaining within resource limits, regenerative capacities of ecosystems, local to global ecological thresholds and other planetary boundaries. The development of promising future policy mixes is partly based on ex-post evaluations of a number of existing policy mixes, selected in part due to the transferability of approaches and/or successes to the EU level. As we will see, these ex-post evaluations are based on an agreed understanding of what is meant by decoupling, as well as a conceptual understanding of ex-post evaluation of policy mixes.

This report focuses on the ex post evaluation of cases of sector- or resource specific policy mixes and complements the wider macro-economic approach of other project tasks.

2.1 Decoupling

As the extent of humanity's over-consumption of natural resources becomes better scientifically understood and proven, as well as impacts on ecosystems, the wider environment and health become more evident, the recognition of the need to change our production and consumption behaviour has grown. The term 'decoupling' has increasingly been used to talk of (progress in) separating economic performance from resource use and its related environmental impacts.

Decoupling can be divided according to extent of decoupling and to what is being decoupled A detailed discussion of different understandings of the 'decoupling' term and the challenges of operationalising it can be found in the DYNAMIX Common Approach (Umpfenbach 2013, p. 5–11) and the definitions developed for the project are provided in Box1. As a minimum, absolute decoupling would result in stabilising environmental impacts at the level of the chosen base year. The concept does, however, not give any indication as to the extent to which resource consumption in the EU needs to decrease – e.g. to stay within local to planetary limits (Rockström et al. 2009). Dynamix therefore extends the concept of decoupling to include decoupling within limits based on a set of five key targets for 2050 (see Graph 26).

Box 1: Types and definitions of decoupling

The DYNAMIX Common Approach (Umpfenbach 2013) distinguishes the following types of decoupling:

Absolute decoupling requires that resource use or environmental impacts stay stable or decline in relation to a base year level while the economy continues to grow or stagnates, but societal well-being continues to increase.

Relative decoupling means that the growth rate of the environmentally relevant parameter (resources used and/or some measure of environmental impact) is lower than the growth rate of a relevant economic indicator (for example GDP).

Resource decoupling means reducing the amount of primary resources used per unit of economic activity (including hidden flows).

Impact decoupling reduces negative environmental impacts per unit of economic output.

Double decoupling is achieved when economic growth is delinked from both resource use and environmental impacts.

By limits, we mean:

- Resource limits when it relates to the availability of non-renewable resources – these can be global limits in terms of technically available resource or national and regional limits to take into account practical accessibility to the resource.
- Resource limits that relate to ecological limits such as the generative capacity of ecosystems (e.g. provision of fish or clean water) – i.e. resource limits associated with ecosystem service provision (see ten Brink et al. 2012)
- Other ecological limits in the sense of ecological thresholds – e.g. avoiding changes of the state and functioning of ecosystems through pollution pressure (see ten Brink et al. 2008)Environmental limits – such as state of air quality or water quality – which can lead to, inter alia, health impacts.

Together these create 'safe operating spaces' at local, national or global level depending at what scale decoupling is being sought.

Within the DYNAMIX project, decoupling is assessed in terms of relative decoupling, absolute decoupling and decoupling within limits, with a view to assessing the role of policy mixes in driving decoupling (the prime research question) as well as exploring whether certain policy mixes are more appropriate for different types of decoupling in different resources and impact areas (second research question).

As illustrated by Figure 1 and 2, the decoupling story does not end at absolute decoupling, particularly where resource consumption levels are unsustainable. This unsustainability can be because use of renewable resources (trees, water) occurs more quickly than the resource can be renewed, because non-renewable resources are being depleted so quickly that future availability of stocks and/or reserves becomes questionable, or because resource use impacts still lead to serious environmental degradation.

The concept of decoupling has become increasingly used in policy documents (see Box 2), but means different things to different people. Similarly, terms such as

Box 2: The use of the term 'decoupling' in policy documents

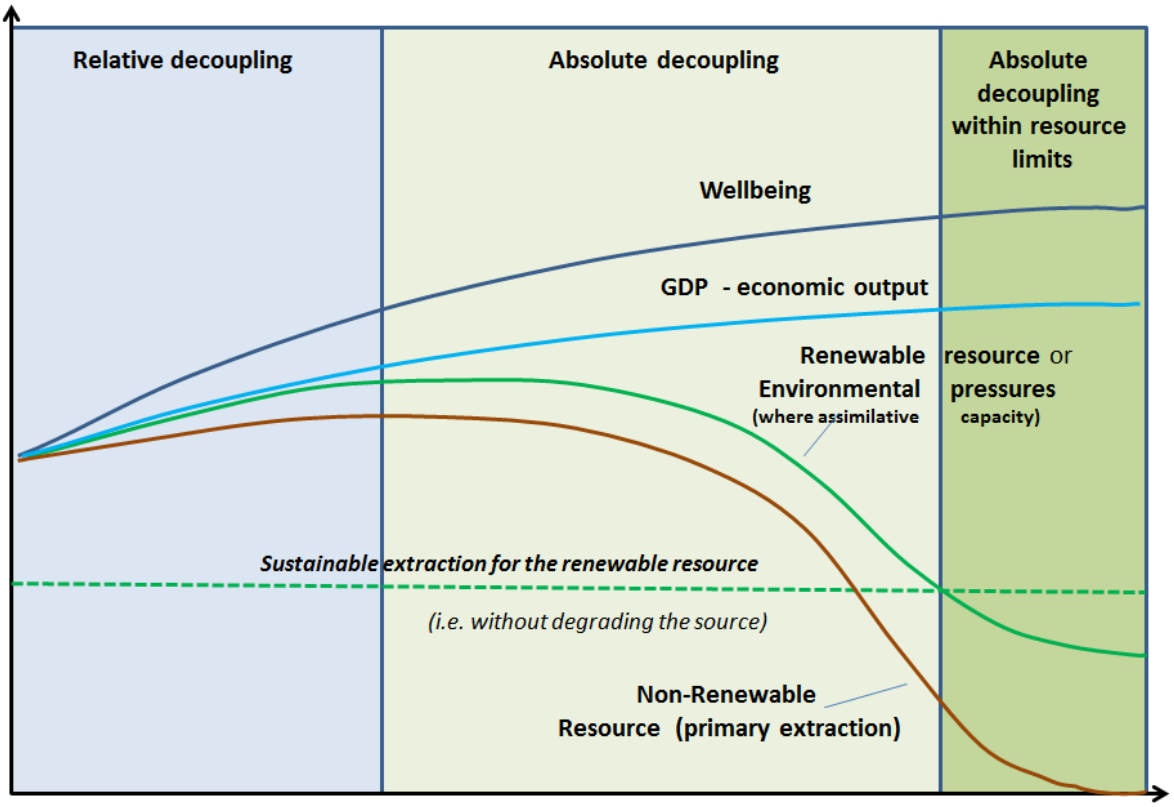
The term 'decoupling' begins to be used in some international institution reports, namely the EU, from the late 1990s. The 1999 Directive on the Fifth Framework Programme on research was the first legal document mentioning decoupling (of economic growth and environmental pressures) (Directive 1999/167/EC). The 2002 6th Environment Action Programme also referred specifically to decoupling environmental pressures from economic growth, as well as specifying decoupling of economic growth from the use of resources and waste generation, aiming "to ensure that the consumption of renewable and non-renewable resources does not exceed the carrying capacity of the environment" (Decision No 1600/2002/EC).

More recently, 'decoupling' enters economic policy through the Europe 2020 strategic document (European Commission 2010), aiming to "decouple economic growth from the use of resources…" (European Commission 2010, p. 6). The 2012 7th Environment Action Programme also mentions decoupling, echoing the above objective in the Europe 2020 strategy, but also mentioning "an absolute decoupling of economic growth and environmental degradation" (European Commission 2012, p. 6). Interestingly, the Action Programme has been given a reader friendly title: "Living well, within the limits of our planet", setting out decoupling – absolute decoupling within limits - from the outset.

Beyond the EU, the OECD's 2011 Environmental Strategy includes an objective of "decoupling environmental pressures from economic growth" (OECD 2011), recognising that particular attention is needed in the areas of agriculture, transport and energy.

green growth, green economy, and resource efficiency are all linked to decoupling either explicitly or implicitly (i.e. as a means of measuring and talking about progress) (for a discussion of those links see *Nature and the Green Economy* by ten Brink et al. 2012). It is important to note that decoupling is usually talked about at the national, EU or global levels, though it can also be used when talking of regions, cities and even down to the installation or citizen levels.

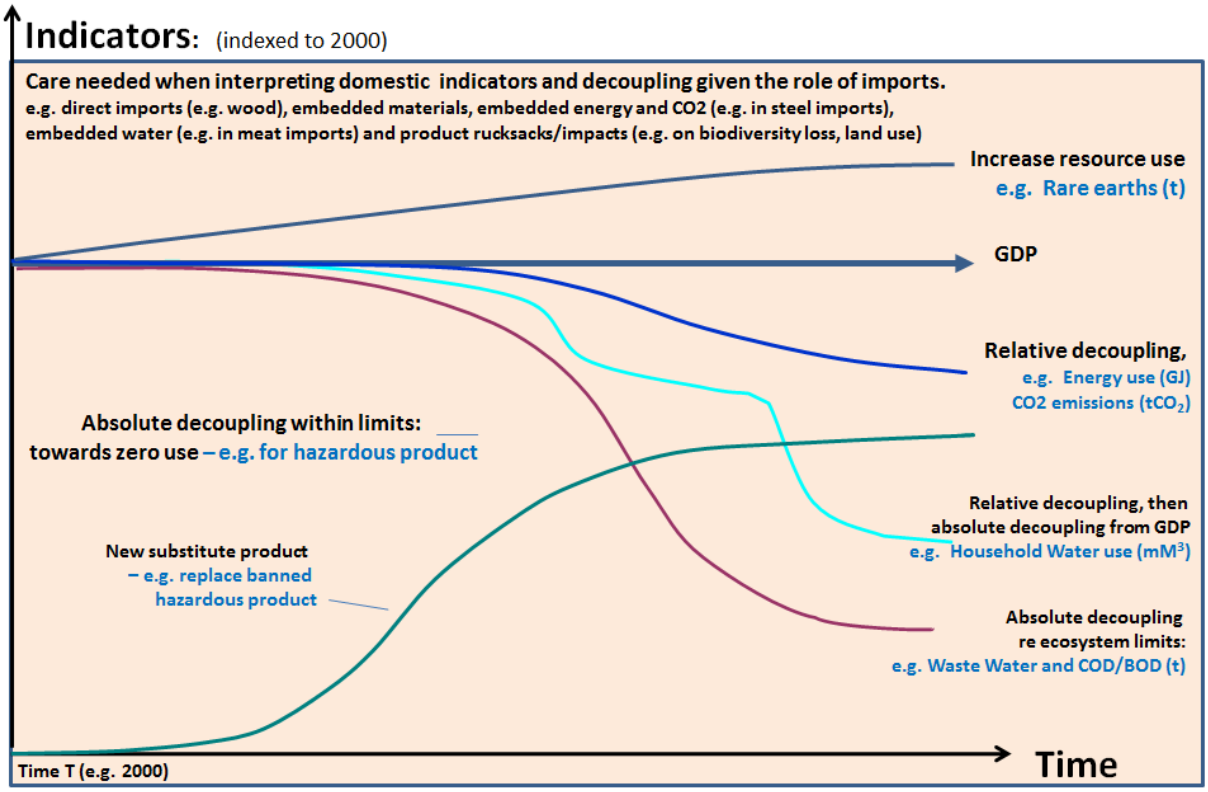
Figure 1: Decoupling concepts



Source: Own representation, IEEP.

Decoupling at higher levels (national, EU, international) is necessarily an aggregate of activities at lower levels, which can hide varying levels of decoupling at individual (company, region, installation) levels. For example, decoupling can be due to a combination of efficiency gains at installations and use of more efficient products (relative decoupling at lower scales), of more innovation in processes (leading to relative or absolute decoupling, depending on the nature of the innovation) and of demand changes (leading to relative or absolute decoupling, depending on the changes). Examples of demand change are using a personal vehicle less (relative decoupling) vs. trading in the car for public transport (absolute decoupling). Progress is therefore rarely smooth and any aggregate line hides behind it a complexity of different resource use and consumption choices of actors across the economy.

Figure 2: Decoupling over time: types of decoupling and indicators



Source: Own representation, IEEP.

A further issue of importance is that the decoupling of one resource or impact may not necessarily represent progress as it may be substituted by another resource or product that may be more polluting, or by imports which may entail environmental impacts abroad. Figure 2 illustrates these issues and they are acknowledged where relevant in the case studies (e.g. Finnish wood case and imports). Care is therefore needed when interpreting results and concluding on the extent to which progress was achieved. For example, while there is clear progress at EU level as regards decoupling the economy from EU CO_2 emissions, the picture of progress is less clear when the embedded carbon in imports is factored in.

Section 3 addresses what decoupling means for different categories of resources, as a means of analysing what kind of decoupling occurred in the case study policy mixes.

2.2 Ex-post evaluation

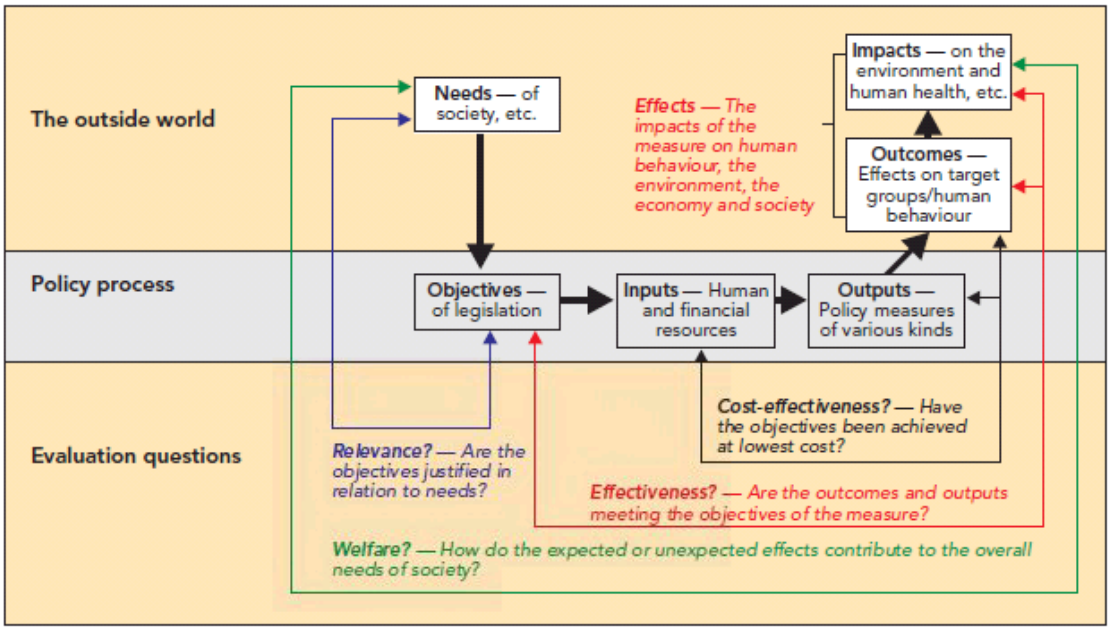
Once the case studies for evaluation were selected, an in-depth evaluation was undertaken based on a common template taking the DYNAMIX Common Approach document as a starting point (the template is available on the project website). The evaluation of the 15 policy mixes aimed to distinguish between the ***effect*** of the policy mix, i.e. the results of a measure that can be attributed to its implementation (which implies a causal link between the policy action and its intended impacts on human behaviour and the environment) and its ***effectiveness***, i.e. whether or not the intended objectives and targets were achieved (EEA, 2001). In addition, the ***efficiency*** and ***(social) sustainability*** of the policy mixes was

evaluated. Efficiency of the policy mixes was assessed comparing the achieved level of resource and impact decoupling with the monetary (or other) resources applied to achieve the outcome. Sustainability of the policy mixes was assessed by evaluating the social effects and environmental effects not covered in the key targets (e.g. local effects, toxicity, marine issues). To reduce complexity, social effects were only assessed for EU countries, contrary to the environmental effects which were also assessed globally (as much as data allow).

Figure 3 below provides an illustration of a policy evaluation framework and includes a number of broader evaluation questions including those related to the 'effect' and 'effectiveness' of a policy or a policy mix. The figure distinguishes between inputs (resources dedicated to the design and implementation of the measure, e.g. staff, financial resources, administrative structures), outputs (tangible results of the measure), outcomes (the response of target groups to the outputs) and impacts (effect of the changes in behaviour on the environment, human health etc.).

The insights from DYNAMIX cases were then complemented by insights from existing and parallel work on policy mixes in other areas to obtain a fuller assessment of the roles and effects of policy mixes on decoupling.

Figure 3: Policy evaluation framework



Source: EEA. 2001, p. 20.

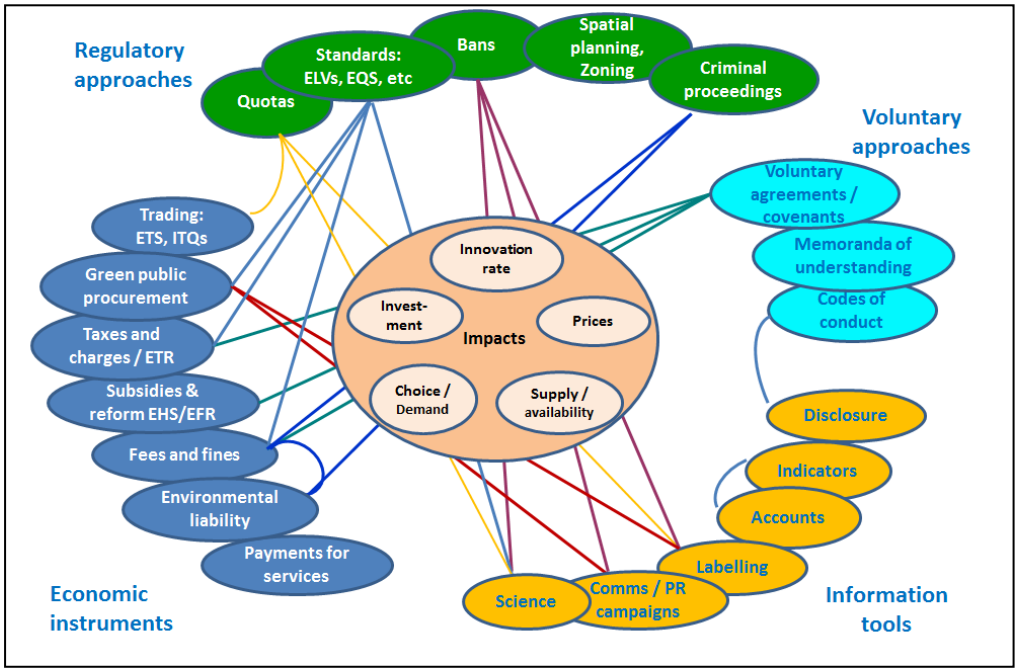
2.3 Typology of policy mixes

The portfolio of policy instruments can be broadly categorised as containing: regulation (including planning-based instruments), market-based and economic instruments, information tools and voluntary measures (including cooperation or collaborative instruments) – see Figure 4 (and also later discussion in section 3.7). There are also direct investment instruments (e.g. direct expenditure from general budgets, or from specific programmes and

funds), though these are often linked to market-based instruments that help raise the funds to be subsequently disbursed directly (if earmarked) or indirectly (e.g. via government budgets).

In any policy mix a range of different tools interact and together determine the effect, cost-effectiveness, efficiency and hence suitability of the mix in achieving absolute decoupling. Some of these links are typically used to make the instrument mix work – e.g. bans, science and labelling; fisheries quotas, science and monitoring; voluntary agreements, subsidies and ETR. Which choice is made as regards instrument mixes is very country specific as some have a greater tendency towards market-based solutions, others more regulatory-based.

Figure 4: Potential policy landscape: instrument classification and interlinkages



Source: Own representation, IEEP.

Instruments have different functions within a policy mix and can play different roles as the policy-mix evolves. Some instruments can be seen as the 'core' instruments to a policy mix – i.e. ones that are seen as the main or driving instrument. Others play a 'supporting' or 'enabling' role. Voluntary agreements have proven to be useful, arguably essential 'enabling instruments' for fiscal reform packages, where new taxes are introduced. As regards supporting instruments, information provision can be critically important (e.g. to support consumer choice in some areas and inform bans or quotas in others). There can also be instruments that limit or undermine the effectiveness of a mix (e.g. subsidies that have outlived their purpose or are not proportional to their objective).

While this nomenclature is useful, it also has its limits due to the changing role of a given instrument at different times in a policy mix life – e.g. a subsidy may begin as an enabling instrument that becomes a limiting instrument if and where it proves to be no longer necessary or appropriate. Similarly instruments can play supporting roles at certain times, and leading or enabling roles in others - e.g. scientific knowledge on sustainable fish stocks can

drive change if policy-makers take the information seriously and focus on long term sustainability; the same knowledge in other contexts may simply play an enabling or supporting role (or even no role), depending on who is engaged in the policy deliberations and what time perspective is taken.

What instrument mix is chosen, how it is designed and implemented and how it develops (and their effect) is generally very context specific – firstly how it fits within wider government policies, objectives and plans (precedent in approach in existing policies, coherence, familiarity etc.). It also depends on the institutions in place (e.g. ability to monitor, check compliance and enforce non-compliance). The economic context is equally important (structure of the economy, of a sector; openness to trade; concerns about competitiveness) as of course is the social context (health impacts, affordability to pay) and the environmental context (availability of resources, quality of the environment, ecosystem capacities).

2.4 Challenges for practical application in the work

A number of challenges are faced when trying to undertake an evaluation of a policy mix containing a number of individual policy instruments. Most importantly to the DYNAMIX project was the need to balance between having enough data available on analysis already undertaken on a specific policy mix, and avoiding focusing on well-studied policy mixes. In the specific case research within Dynamix the project team tried to put more focus on policy mixes addressing specific physical resources while trying to avoid an over-focus on previously studied resources such as fossil fuels or water.

The challenges in evaluating policy mixes can start with the **identification of the policy instruments within the mix**. In reality, what often happens is that policy instruments are added over time, sometimes designed to be directly and fully incorporated into the policy mix, but often at least partly contributing to a policy mix's objectives although not explicitly presented as an instrument within that policy mix. The identification of the instruments within the policy mix can then become subject to interpretation. In the DYNAMIX project, it was left to the case study authors to decide which instruments were part of the policy mix and subject to assessment, so long as this was made explicit in the case study report. In some cases, for example the German and English land and the Japanese critical metals case studies, a policy mix was identified that is a subset of a wider range of instruments contributing to decoupling.

One of the most important difficulties in evaluating a policy mix is in being able to allocate **causality between any given policy instrument in the mix and its contribution to effects/outcomes**. This depends on the complexity of the policy mix – the number of instruments used, how often new ones are added and/or amended and whether these additions/amendments occur at the same time – and very few of the 15 case studies evaluated had a very small number of instruments.

In any case, there is likely to always be an element of **subjectivity** in evaluating a policy mix, ex-post or ex-ante. It is important that **assumptions and interpretations be made explicit**, to allow readers and other analysts to better understand the reasoning behind the results.

It is also difficult to assess whether changes in outcomes would have happened even if a particular policy mix or instrument did not exist. In other words, would resource productivity have increased and/or environmental impacts decreased due to other pressures, such as resource prices or technological innovation? We have not been able to provide such

analysis in the case studies and light analysis delivered for this report. Nonetheless, it could be assumed that policy mixes inherently will be a driver amongst a set of forces shaping effects, given their more comprehensive influence and stronger market signal on a given sector or part of society.

Finally, as the DYNAMIX project could not be designed to deliver primary research analysis in the case study evaluation, the team was dependent on analysis already undertaken and made publicly available. Hence, the ability to evaluate the cost-effectiveness and the efficiency of policy mixes in achieving objectives was extremely limited.

3 What have different policy mixes achieved?

3.1 Introduction

The extent to which the policy mixes studied have achieved decoupling were variable and indeed were sometimes rather difficult to assess. This is due to the challenge of defining a scope and limits within which decoupling is considered to be both measurable and necessary in order to achieve decoupling. Thus, while Table 3 below attempts to broadly attribute policy mixes studied to different levels of decoupling, it is also clear that the distribution below is directly dependent on the scope defined for the analysis both in the project's Common Approach (Umpfenbach 2013) as well as in each of the individual case study reports.

Table 3: Distribution of the case studies across the different levels of decoupling

Type of decoupling achieved	Case studies
Absolute decoupling within resource limits	1. Sustainable levels of fish catch in Iceland
Absolute decoupling	2. Reducing fertiliser use in Denmark 3. More efficient use of aggregates in the UK 4. Reducing plastic bag use in the UK and Ireland 5. A sound material cycle society in Japan
Relative decoupling	6. Reducing fossil fuels use in Sweden 7. A fossil fuel-free energy system by 2050 in Denmark 8. Reducing municipal waste at the local level in Slovakia 9. Conserving rural land in England 10. Reducing land sealing in Germany
No decoupling	11. Sustainable use of forests and wood in Finland 12. Reducing transport CO2 emissions in Spain 13. Increasing industrial energy efficiency in Portugal
Not clear	14. Reducing phthalate and PVC use in Denmark 15. Preventing food waste in the UK

More information on the case studies themselves as well as references for the information gathered can be found in a case study summary report and the individual case studies are available on the DYNAMIX project website 'results' section.

3.2 Policy mixes targeted at renewable resources

Amongst the 15 policy mixes for decoupling studied in this project, two targeted renewable natural resources. These were on the sustainable use of forests and wood in Finland and on the sustainable levels of fish catch in Iceland**.** For the Finnish case study, the boundaries around the policy mix were identified in relation to DYNAMIX project objectives (rather than taking a clearly defined existing policy mix), which meant looking also at relevant EU and international policies.

3.2.1 Applying 'decoupling' to renewable resources

Meaning

Managing renewable natural resources sustainably means ensuring that the rate of extraction does not exceed renewal limits, therefore limits to extraction need to be identified and extraction levels need to stay within these limits. In the fisheries case, this limit corresponds to the 'maximum sustainable yield' and, in the forestry case, this implies that the fellings from forests are not greater than their rate of growth (i.e. increment) and that forest exploitation does not result in unacceptable levels of ecosystem services and biodiversity loss.

Measurement: implications for measurement: scope and indicators

In the case of wood in Finland, the decoupling to be achieved was defined as decoupling the growth in the economic output of wood product industries from "deforestation and forest degradation". As wood is an internationally traded commodity, it was decided that the case study evaluation would include analysis of trends in forest management within Finnish borders as well as the sustainability of wood imported into the country (in order to ensure that Finnish wood consumption does not lead to deforestation, degradation of ecosystem and loss of biodiversity outside of Finland).

Iceland's definition of decoupling was achieving growth in the economic output of the fisheries sector while at the same time avoiding overexploitation of the stocks, i.e. that the stocks are kept at a level that allows to obtain the maximum yield whilst still maintaining the population size at the point of maximum growth rate, allowing the population to continue to reproduce indefinitely.

3.2.2 Recurrent instruments in the policy mixes

Ensuring that exploitation of the resource stays within sustainable limits appears to have been an integral part of the policy mixes that targeted these resources. The renewable nature of the resource seems to have determined, to a certain extent, the policy mix applied to these resources: the instruments are tailored to the resource and its specific characteristics.

As regards Iceland's policy mix to address overexploitation and decline of fisheries resources, the policy mix was considered to have contained three key instruments:

- Total allowable catches (TACs) for all commercially exploited species;
- Individual Tradable Quotas (ITQs) for the same species (with some minor exceptions);

- A resource tax levied on all species and all catches (calculated so that it depends both on the amount of quota held by the fishing firm as well as its economic).

TACs and quotas, i.e. limits on how much fish can be caught, can be employed as a fisheries management tool on their own. ITQs, on the other hand, are an instrument that intrinsically requires TACs and quotas to be established. ITQs are a cap-and-trade mechanism, and the TAC constitutes the cap on fishing opportunities. Therefore it could be stated that TACs are the primary instrument, and ITQs are an enhancing instrument.

Finland's policy mix to address unsustainable use of the country's forests was considered to include the following elements that combine instruments at national level with elements at European and international levels:

- EU Forest Law Enforcement, Governance and Trade (FLEGT), and Voluntary Partnership Agreements;
- EU Timber Regulation;
- Forest Stewardship Council (FSC) certification;
- Programme for the Endorsement of Forest Certification (PEFC) schemes;
- Finland's Forest Act;
- Finland's Act for Financing of Sustainable Forestry;
- Finland's Strategic Programme for the Forest Sector (MSO 2009-2011);
- National Forest Programme 2010; and
- National Forest Programme 2015.

Thus, this policy mix is composed of a combination of a range of regulatory, voluntary, information and market-based instruments (including subsidies for more sustainable practices and funding for innovation projects via the Strategic Programmes). As stated earlier, it was decided to focus this case study on policies targeted at both Finland's forests and wood imports (hence supranational policies) to avoid achieving sustainable use of forests in Finland while contributing to deforestation, degradation of ecosystems and loss of biodiversity outside of Finland (in the EU and globally), thereby displacing the problem elsewhere.

Atypical instruments

While atypical and specific to fisheries resources at first sight, the definition of "total allowable catches" is being frequently applied to other populations of wild animal (e.g. game) and to water management (e.g. limits on water extraction in Australia). Indeed, identifying limits and thresholds and distributing quotas to users is not specific to the use of renewable resources. Such instruments have also frequently been used for emissions of pollutants, e.g. the Dutch nutrient quota system (Wossink 2003) and the EU Emissions Trading System for CO_2 emissions. The wood case study suggests that the two instruments would merit from being applied more systematically and widely if genuine decoupling is to be achieved. It is quite clear that if national wood production is being maintained at sustainable levels but compensated by the import of unsustainably harvested wood abroad, the observed trend towards national decoupling cannot be considered "sustainable". Hence, the importance of two instruments that may ensure that the import of raw materials such as wood does not undermine the objective of truly decoupling the productivity of the wood product industries (pulp and paper, wood products, bioenergy) from adverse environmental impacts. The case study suggests that a combination of Voluntary Partnership Agreements as well as the

different certification and labelling schemes (FSC, PEFC) could play a key role here, but would need to be strengthened with policy instruments setting clearer limits on harvest levels, and setting 'product' or forest management requirements for domestic sources, as well as import requirements (see next section).

3.2.3 Links between renewable resources and institutional and governance arrangements

Role of geographic scope

While the 1997 Finnish Forest Act can be categorised as a state-led instrument establishing mandatory requirements for sustainable forest management, it was accompanied by an Act for Financing of Sustainable Forestry allowing forest owners to comply with the regulations and be eligible for subsidies based on Forest Management Plans developed at a local level .

Finland's wood policy mix also serves to illustrate that as it addresses an internationally traded commodity special care needs to be taken not to achieve sustainable levels of resource use domestically at the expense of unsustainable management of resources abroad. Although the policies to address this problem are not yet in place there appears to be a recognition that this needs to be made an integral part of the policy mix and that, in the case of EU Member States this might involve pushing for legislation as well as the negotiation of Voluntary Partnership Agreements (VPAs) between the European Union and wood exporting countries in which wood is harvested unsustainably.[1]

For Iceland's fish policy mix, a decentralised structure was developed to ensure a better tailored implementation of the policy mix, involving for example the establishment of regional fisheries management organisations that, amongst other things, set the total allowable catches. The national quotas are however assigned to individual vessels rather than to the management organisations.

Common issues and diversity

The role of non-governmental organisations in the sustainable management of renewable resources is of particular importance, especially as regards information to consumers. An instrument in Finland's policy mix is the international FSC certification that was created in 1993 by a number of environmental groups and companies – a private initiative designed to promote voluntary sustainable forest management. Additional certification programmes followed including the Programme for the Endorsement of Forestry Certification (PEFC) - PEFC caters more for small private, non-industrial forest owners and is set up as an endorsement process to assess independent national forestry management schemes against internationally recognised criteria for sustainable forest management. FSC sets global standards for sustainable forest management and then adjusts it to different national needs

[1] Voluntary partnership agreements are bilateral agreements between the EU and tropical wood exporting countries, which aim to improve forest governance and guarantee that the wood imported into the EU is from legal sources.

for sustainability (PEFC 2011). Today, 95% of Finland's forests are certified under the PEFC system (Metla 2011).

In Iceland's case, labels were not included in the policy mix. While it appears likely that the more sustainable management of the stocks may make Icelandic fisheries eligible for labels and thus open up new market opportunities, this type of tool has not been considered to drive the decoupling process in this specific example.

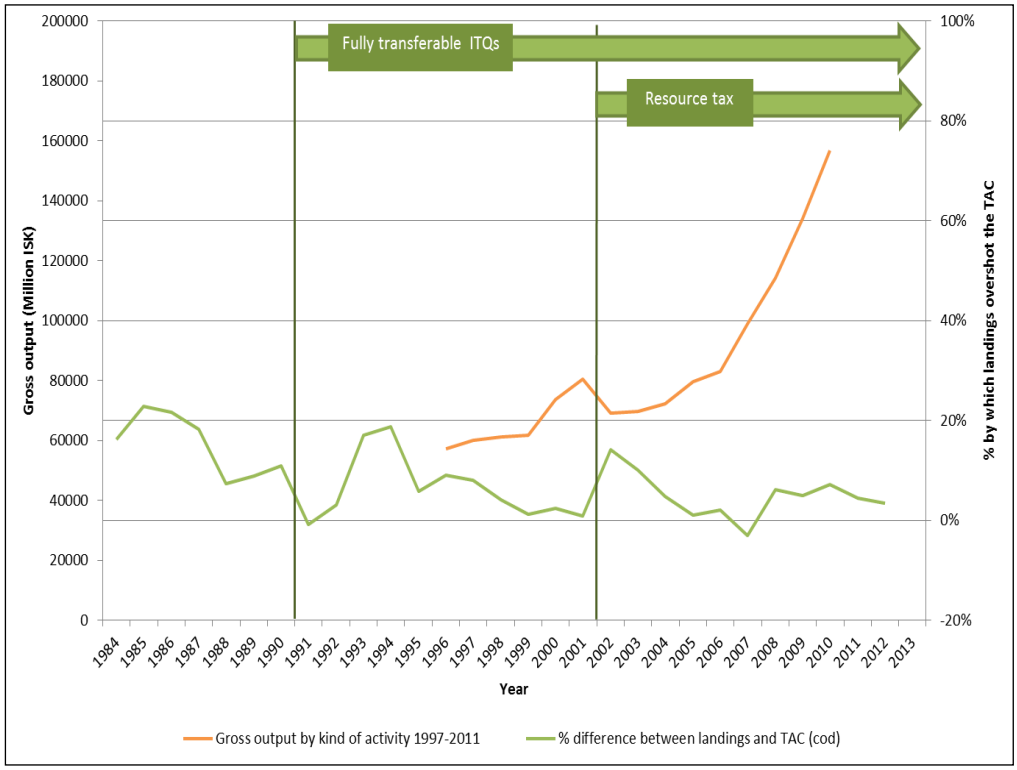
3.2.4 Extent to which policy mixes achieved decoupling

In the case of the Icelandic policy mix meant to "promote exploitable marine fish stocks conservation and efficient utilisation", the policy mix achieved **absolute decoupling within resource limits** (or sustainable exploitation of fisheries resources while at the same time enabling the fishing sector to become highly profitable). Before the introduction of **the ITQ system**, profitability of the fisheries sector was poor (see section 5) (Arnason 2008, Gissurarson 2000). It is fair to say that ITQs turned around the sector, increasing its efficiency by reducing fishing effort and fishing capital, rebuilding fish stocks, raising the quality of the landed catch and improving coordination between supply of landings and market demand (Arnason 2008).

The data on stocks shows that since the introduction of the **ITQ system** there has been steady improvements in their state. **The herring stock has rebuilt steadily since the collapse in the late 1960s, and cod stocks have had a steady increase in the fishable biomass from 1992-2012** (from 1992's 550 thousand tonnes to around 1.2 million tonnes in 2012) – see Figure 5. 2013 International Council for the Exploration of the Sea advice states that the spawning stock of Icelandic cod is increasing and "is higher than has been observed over the last five decades". In addition, the percentage of the fish stock removed each year by fishing (i.e. fishing mortality) has declined significantly since the early 2000's and is presently at a historical low.

For Finland's forestry policy mix, it appears to have ensured that domestic wood removals stay below sustainable resource limits. In Finland wood removals have been far below the annual growth since the mid-1970s (Metla 2011). Even though domestic wood production has increased, it still remains well under the annual increment in growing stock and has not affected the total forest area in the period 1990 - 2010. In terms of quantities, wood production was already within sustainable limits when the policy mix was introduced in the 1990s. The annual increment of Finnish forest growing stock (and also the net carbon sink) has been greater than the removals for almost 40 years. Although Finland's forestry policy mix has achieved ***domestic* absolute decoupling within *resource* limits, *impacts* are still unsustainable** such as habitat degradation and in particular biodiversity loss.

Figure 5: Performance of Icelandic fish policy compared to output of fishing activity



Source: Author's compilation based on Statistics Iceland for economic data and from Icelandic Marine Resources Institute for cod stocks, IEEP.

On other indicators of sustainability, particularly forest biodiversity, the policy mix has not achieved its objectives. The 2008 Red List of habitat types revealed that nearly half of Finnish forests (nearly 70 % of the types of forest habitats) were threatened, i.e. either vulnerable, endangered or critically endangered (OECD 2009). This is thought to be due to intensive forestry practices which have resulted in an increase in the share of young and middle-aged forests with reduced ecological integrity and quality of habitats (e.g. related to the characteristics of living and dead trees). Forest policies have however had some effect as the rate of decline of certain forest species has slowed down in Finland, or in some cases even stopped since the 1990s (Metla 2011).

In addition, it must however be pointed out that **economic performance of wood-dependent industries seems to be coupled with wood removals**. Thus, productivity and profitability of the forest and wood product industries do not seem to have increased over the period (although it is difficult to distinguish whether the Finnish wood-dependent industries were not able to increase productivity or whether lower global wood commodity prices were the reason for decreased profitability). While forest area and wood production in Finland seems to be stable in the past two decades, until the economic crisis in 2008 domestic consumption of wood was increasing – in particular wood fuel (FAOSTAT 2013). **Additional consumption has come from a significant increase of imports** (50 % increase from 1990 - 2007) **and in particular imports of wood fuel** (over 400 % increase from 1990 to 2007). This is mainly due to lower wood prices in relation to domestic production, but also to availability on the domestic market of certain timber grades (Finnish Ministry of Agriculture and Forestry 2007).

Much of the wood was imported from Russia, where it is suspected that a large share has been illegally logged (WWF 2008).

In order to ensure that all wood used in Finland (domestic production and imported) is sourced sustainably and that a level playing field is created for companies, imported wood should live up to the same ecological requirements as domestic wood production. To achieve this, sustainable forest management certification of all imported wood and wood products would need to be mandatory. Arguably, only once a country's wood-based industries achieve a higher per unit output (i.e. continue to increase their productivity) and it can demonstrate that it meets all its needs relying on wood from sustainably harvested sources (whether domestic or imported) there is a chance that decoupling will be achieved.

3.2.5 Striking features of the most effective policy mixes

Out of the two examples falling into this category that have been discussed, the case study on the fisheries sector in Iceland is the one that is closest to 'absolute decoupling within limits'. The striking feature is that policy makers identified the **sustainability thresholds** within which resource use can take place and created an incentive for the quota holder (fishermen) to exploit the resources within their limits.

3.3 Policy mixes targeted at mineral/metal resources

Two of the policy mixes studied in this project targeted mineral resources/metals: more efficient use of aggregates in the UK, and a 'sound material cycle society' (SMC) in Japan. For the Japanese case study, the boundaries around the policy mix were identified in relation to DYNAMIX project objectives (rather than taking a clearly defined existing policy mix), which meant looking at both SMCS and critical metals policy instruments.

3.3.1 Applying decoupling to mineral and metal resources

Meaning

The definition of 'decoupling' is relatively straightforward for the UK aggregates policy mix. Given aggregates are mostly used in construction, decoupling can here be defined as a stabilisation or increase in construction output with a decrease in primary aggregates consumption.

Japan's 'sound material cycle (SMC) society' policy mix sought decoupling between economic growth within the economy as a whole and 'domestic material use'.

Measurement: implications for measurement: scope and indicators

Data available for the UK aggregates policy mix allows an easy monitoring of the trend towards decoupling. Indicators used are construction output (economic) and primary aggregates consumption (resource use). In addition, an increase of secondary and recycled aggregates consumption in the construction sector suggests that a substitution of the primary aggregates with secondary and recycled aggregates has indeed taken place (which was also one of the objectives of the policy mix) (see Figure 7 in case study summary report).

The evaluation of the Japanese policy mix raises the question how “domestic material use” is to be measured. The Japanese SMC Plan usefully identifies indicators to monitor progress in achieving the results of the policy mix objectives. Targets and indicators were introduced in the 2008 revised Plan following review of the original 2003 Plan, specifically resource productivity (GDP/Direct Material Input) a material cyclical use rate (recycling rate), and final waste disposal (municipal solid waste and industrial waste levels). Hence, the policy mix can be considered effective in contributing toward decoupling if there is an increase in resource productivity (ten thousand yen/tonne) and the recycling rate (%) and a fall in the final disposal volume (million tonnes). Whether these are the optimal indicators to capture all dimensions is subject to debate but they certainly provide insights into the extent to which decoupling is been achieved and whether the trends are heading in the right direction.

3.3.2 Recurrent instruments in the policy mixes

Recurrent instruments

In the UK, the introduction of taxes (a combination of the aggregates levy and an earlier landfill tax applying to construction and demolition waste) are the key instruments in the policy mix that allowed a noticeable reduction in the extraction of primary aggregates within a rather short period of time. For a period of time (2002–2011), revenue from the aggregates levy was ‘recycled’ to a national Aggregates Levy Sustainability Fund to support development of use of secondary aggregates materials. These three instruments form the UK aggregates policy mix.

The Japanese SMC policy mix has primarily focused on setting standards for reusability and recyclability that companies must respect (e.g. Effective Utilisation of Resources in 1991). Subsidies seem to also have played a key role – these were in particular provided to businesses that invested in R&D to develop cost-efficient technologies to recycle materials and recover critical metals (for more detail on the instruments introduced please see Figure 9 in the case study summary report).

Elements of diversity or atypical instruments

Comparing these two case studies, there are fundamental differences in scope (UK aggregates versus Japanese materials). This in part explains a different emphasis in the instruments in the policy mixes. While the key instruments in the UK case are taxation, the instrument that appears to have driven change in the Japanese case is a mix of information tools (e.g. awareness campaigns) and subsidies to finance R&D activities. The UK policy mix also initially encouraged R&D, financed through the tax revenues, but this appears to have happened on a far smaller scale than the system put in place in Japan.

3.3.3 Links between minerals and metals and institutional and governance arrangements

Role of geographic scope

The **specific nature of the resource targeted** by the UK policy mix made it quite straightforward to introduce a tax and assess compliance as a means of creating the right incentives, especially since a uniform rate was chosen. It is indeed quite easy to identify who should be subject to the tax (anyone commercially exploiting aggregate in the UK or anyone

importing aggregate into the UK). The policy mix was introduced through budgetary decisions. The landfill tax, which was to contribute to the aggregates levy (AGL) success, became effective on 1st October 1996. The new budget tabled in 2002 (after general elections) included the aggregates levy, applying to all extraction and imports to the UK, but excluding exports. Section 16(2) of the Act, as amended, states that the charge to the AGL is to arise whenever a quantity of taxable aggregate is subjected, on or after the commencement date under the Act, to commercial exploitation within the United Kingdom. It therefore applies to imported aggregates in the same way as to aggregates extracted in the United Kingdom. As a result of the policy mix's sector specific focus, government initially liaised with the sector's representatives to explore alternative ways to tackle the issue without introducing a tax, including possible voluntary schemes.

The Japanese policy mix takes an **economy-wide, multi-sectoral approach**. Rather than focusing particularly on specific sectors, it encourages an economy-wide move towards a 'sound material cycle society'. This involves both reducing the amount of waste and using resources that are imported more effectively. This holistic approach also explains that the government's strategy has been to engage all of society (consumers, businesses, other public authorities) in the transition towards an SMC society. Early on, a vision was developed and responsibilities of consumers, businesses and governments were singled out, enabling targeted projects to be carried out.

Common issues and diversity

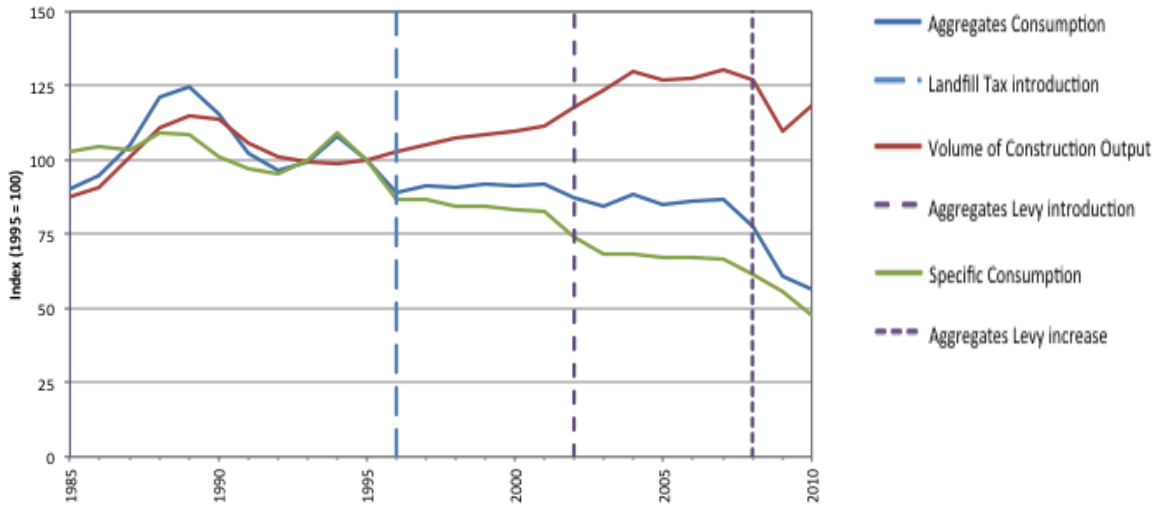
Both policy mixes rely on **market-based instruments** (taxes, subsidies) that make recycling more commercially viable options. In the UK policy mix, the landfill tax makes recycling the materials more attractive. In the Japanese case, the subsidies to R&D to recover and recycle materials made it easier for industry to explore possibilities without enduring heavy costs.

3.3.1 Extent to which policy mixes achieved decoupling

For UK aggregates, the close correlation between aggregates consumption and construction output before 1995 started to weaken with the introduction in 1996 of the landfill tax, and decoupling progressed over time with the introduction of the aggregates levy and its increase. Hence, from 1996-2010 a clear trend towards decoupling between construction output and primary aggregates consumption can be observed (see Figure 6 below).

In the case of the Japanese policy mix, efforts appear to have decoupled the performance of the Japanese economy from material use. The amount of household waste generated per person/per day has for example decreased by 10 % from 2000-2005. As the population did not increase over this period this suggests that absolute decoupling was achieved, at least in this area. Assessing the extent to which absolute decoupling was achieved for material use is more difficult. While there seems to have been an important increase in resource productivity (as measured by GDP per unit of direct material input, this indicator increased by 10,000 yen/tonne over the 2001-2008 period), it is not entirely clear whether this was enough to achieve absolute decoupling – be it only because the indicators established do not take into account the indirect flows associated with material imports, which are much higher than direct material input. If considered, the progress of decoupling of material use is in reality more modest in Japan and other OECD countries.

Figure 6: UK aggregates consumption and construction output against a 1995 baseline



Source: Idoine, Bide and Brown 2012.

3.3.2 Striking features of the most effective policy mixes

Of the two cases, the UK aggregates policy mix has achieved **absolute decoupling**. The more direct effects of the landfill tax and aggregates levy, which have had noticeable effects on prices, mean that, at least in the years following their introduction, a sharp decline in primary aggregates extraction was observed despite a continued increase in construction. However, this is not to say that the decline will necessarily continue at the same rate in the future as it is possible that there is a non-compressible demand for primary aggregates that is less price sensitive.

A striking feature of the Japanese policy mix is the **instruments that clearly encourage industry to invest in R&D** – either through direct financial support to R&D in the form of subsidies or through the setting of standards for reusability and recyclability that companies have to adhere to.

3.4 Policy mixes targeted at land

Two of the policy mixes studied in this project were primarily targeted at land: conserving rural land in England (as opposed to the UK), and reducing land take in Germany. For both of these case studies, the boundaries around the policy mix were identified in relation to DYNAMIX project objectives (rather than taking a clearly defined existing policy mix).

3.4.1 Applying ‘decoupling’ to land

Meaning

While a range of countries have land-related policy mixes, especially in the area of land-use planning, the objectives explicitly or implicitly pursued are variable. As a resource, land has

two important characteristics: it is finite and may be used in a multitude of, sometimes mutually exclusive, ways. This is particularly the case for the provision of ecosystem services. Hence using land as a resource implies delivering an increasing amount of services from a given land surface in order to ensure that the increased delivery from certain services does not need to come at the expense of the delivery of other services.

Usually, policy mixes targeted at land as a resource aim to protect or set aside specific land in order to prevent its conversion to other land uses.

The UK policy mix tries to prevent the loss of productive agricultural land as well as land that has a high recreational value (i.e. green belt around cities), while the German policy mix has a primary objective that is focused on reducing the rate at which land is sealed, inter alia in order to prevent the loss of the multiple ecosystem services delivered by unsealed land. The slightly different aims of the policy mixes lead to different definitions of decoupling.

Measurement: implications for measurement: scope and indicators

For the UK case study, the report author selected decoupling indicators of provision of housing, number of new dwellings and rural land take. These are not official indicators, and they were chosen to be able to evaluate the policy mix based on available data that can serve as a proxy to assess the extent to which the policy instruments have been successful.

The indicator chosen for the Germany case study was decoupling of land-take, understood as the increase in settlements and traffic areas in hectares (ha) per day (given that related targets are formulated in these terms) from economic activity as expressed by GDP growth. This assumes that economic growth is a key benefit from land use but suggests that the ambition in terms of decoupling is that such growth continues using a decreasing amount of land for each percentage point of growth. While such a macro-level approach to decoupling appeared most pragmatic in the context of such a case study, it is also clear that, to be meaningfully measured and effectively monitored, decoupling would have to take place at the sectoral level, starting with the sectors that contribute most to land sealing, e.g. housing, transport, logistics, agriculture, etc.). It is probably at the sectoral level that decoupling of value creation from land take could most meaningfully be measured.

3.4.2 Recurrent instruments in the policy mixes

Recurrent instruments

In both policy mixes, **land-use planning** plays an important role. For example, both countries have introduced **legislation establishing natural parks, and areas of outstanding natural beauty and heritage**. Some legislation is however more specific to each of the countries.

Another common element is **land-use planning legislation.**

Land-use planning in England has evolved taking a **containment approach** to protect the countryside and its respective resources and services from urban sprawl and built development. Until recently, the UK had a relatively mature and effective system in place, centred on mainly three main instruments:

(a) Town and Country Planning Act introduced in 1947
(b) 1995 green belt system

(c) 1996 'Best and most versatile land' distinction (to inform land use planning decisions)

In Germany there are four planning levels: the municipal, the regional, the state ("Bundesländer") and the federal level. The Federal Spatial Planning Act provides the framework for spatial order and planning which the states make operational through state planning. Each state consists of several planning regions, which work out regional plans with guidelines on the regional planning structure. These guidelines are to be taken into consideration at the municipal level. In parallel to the overall spatial planning process, landscape planning comprehensively addresses environmental issues. Landscape planning has been established as a central planning instrument of prevention oriented nature conservation since 1976. Its core objectives and tasks are described in the Federal Nature Conservation Act.

In addition to this overall framework, a range of land-take reduction related measures in the policy mix are relatively recent and not fully implemented, aspirational or of a non-binding nature (see below). In general, the German policy mix appears to be a rather complex package of inter-related instruments targeting reduction of land take (but to variable degrees) rather than a clear and coherently-designed policy mix.

Elements of diversity or atypical instruments

Beyond the instruments noted above, England's policy mix has two **regulatory instruments** that stand out:

(1) The Agricultural Land Classification (ALC) system introduced in 1996, with guidelines to determine which land is most fertile and capable of producing high yields compared to very poor quality agricultural land.

(2) Focus on previously developed land and brownfield sites with targets to encourage development on them: regenerate urban areas with an initial target that over 60 % of the development between 1998 and 2008 is on previously developed areas (brownfield areas).

Specific to the German case is its more general 2002 **non-binding target** to reduce land take to 30 ha/day by 2020. While the Federal Sustainable Development Strategy in which this target was introduced also refers to the spatial planning concept, the target seems to have had less of a binding character than the UK's focus on the re-development of brownfield sites. An atypical instrument in Germany's policy mix is its Impact Mitigation Regulation (IMR), an instrument adopted via the 1976 Federal Nature Conservation Act, which deals with the **mitigation and compensation of impacts on nature and landscape**, including those outside protected areas. The IMR is consistent with the 'polluter-pays principle' and introduces a number of duties on developers to avoid avoidable impacts on nature and the landscape and to offset any residual impacts in view of preserving at least the status quo as regards ecosystem functions and landscape features.

In addition, there are a wealth of commitments and initiatives at regional and local levels, most of which are too early in their lives to have made obvious effects. As far as targets are concerned, they include a vision of '**zero net growth**' to be achieved in the long term in the Land of Baden-Württemberg or the ambition to achieve "**no net land take**" by 2020 in the Land of Thüringen. Information instruments include building area cadastres which provide an overview of land that is available for building, helping to avoid greenfield sites being

designated for development before available brownfield sites have been developed. The creation of “land alliances” or “land management platforms” at regional level that serve to share best practice in reducing land take and help municipalities communicate on their land saving efforts through the establishment of certificates or awards for land-saving municipalities. Research has looked into using economic instruments to overcome the problem, including the use of tradable planning permits (land certificates), and pilot projects in this area are on the way.

3.4.3 Links between land and institutional and governance arrangements

Role of geographic scope

With land being very diffuse as a resource, the policy mixes developed to address them are very cross-cutting and rarely sector-specific although in practice it might make sense to develop policy at the sectoral level that aims at reducing land take. What is also striking is that, although at Federal level, targets are set, these no longer seem to be consistently considered and applied at the level at which most land use planning decisions are taken, i.e. at the local and regional levels.

Common issues and diversity

Both England and Germany have identified uncontrolled urban sprawl, the associated sealing of valuable land and loss of ecosystem services as problems needing to be addressed. Both countries feature continued pressure to build on rural land or in the fringes of urban areas, and slowing down the loss of greenfield sites remains challenging.

Contrary to the German case, in England, there has been **clear identification** of both land that should be kept open, i.e. free from building development, and land that is suited for (re)development. The instruments that have been put in place take into account the overall objective of channelling development away from rural land, in particular the most productive land, and to encourage developments on brownfield sides. In addition, green belts around cities have been quite successfully maintained.

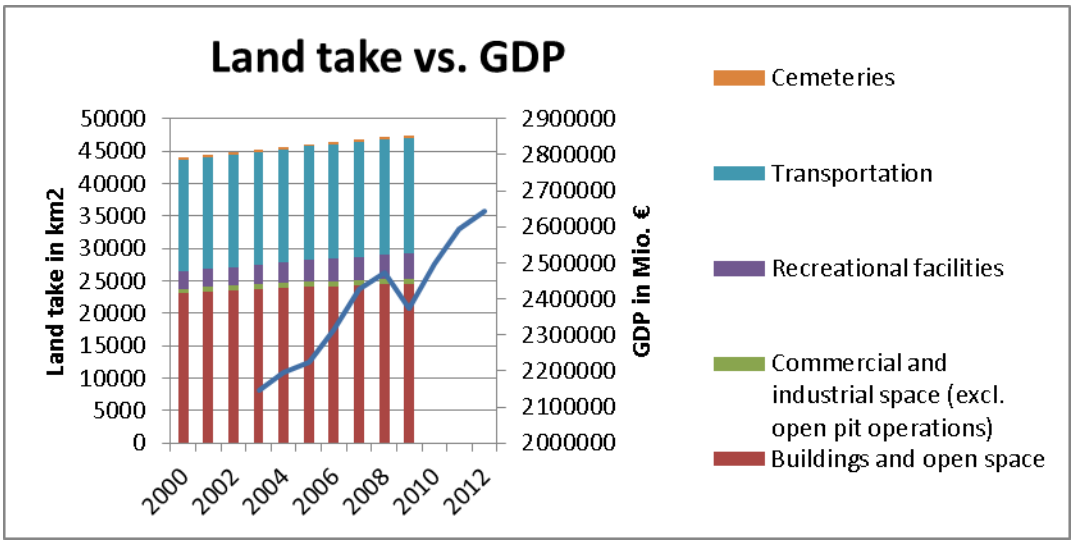
While Germany has a 2020 target to reduce the rate at which new land is taken, its approach to achieving this objective seems to be less coherent than the UK policy mix. This may be because a wealth of approaches is implemented at the regional level and the **national policy framework only seems to provide relatively broad guidelines and does not appear to have fully integrated the national target**. Contributing even further to incoherence, a **wide range of contradictory incentives** that encourage inefficient land-use exist, especially in the area of taxation. Experts in Germany consider that subsidies to building on previously developed land could compensate for the incentives that current (tax) instruments give to build on previously unbuilt land.

3.4.1 Extent to which policy mixes achieved decoupling

In England, the share of land allocated to different land uses has remained relatively stable over the last 50 years. This has been the case despite a growing population, changing household composition (increasing housing demand) and rising incomes. The average annual rate of rural land take for built development between 1927–1939 was approximately 25,000 ha which declined to 15,700 ha for the period between 1945–1975 and further still to 5,000 ha in 2009 (Bibby 2009). Although the rate of decline has slowed, rural land continues to be taken for built development. For example, even with a slower rate of conversion, the area designated as green belt land is in decline and, based on historical trends, is likely to continue doing so.

In Germany, as shown in Figure 7 below, decoupling achieved is relative at best and one could argue that economic development and land take are still coupled to a certain extent. While additional land take per day has been slowing down (from more than 120 ha per day in 1993 to 81 ha a day in 2011) it remains on a high level and overall land take increases every year.

Figure 7: Trends in land take and GDP in Germany, 2000-2009



Source: Statistisches Bundesamt, 2010.

3.4.2 Striking features of the most effective policy mixes

While the trends in new land take suggest that the German 30 ha/day target will be missed (in 2011, 81 ha/day were lost to settlement and traffic areas, which corresponds to approximately 30,000 ha/year), England seems to have been rather successful in reducing the average annual rate of rural land take for built development from 15,700 ha/year between 1945–1975 to around 5,000 ha/year in 2009.

The most striking features of the English policy mix are the clear identification of the land that should not undergo development (e.g. green belt system, identification of best and most versatile land) and of land that is suited for re-development, as well as a set of policy instruments that create incentives to channel development to those areas where the loss of

valuable greenfield sites and associated ecosystem services is least likely (e.g. targets for the reuse of brownfield sites).

3.5 Policy mixes primarily targeted at environmental media (air, water and soil)

Six policy mixes studied in this project have been primarily targeted at environmental media. There are on reducing fossil fuels use in Sweden, fossil fuel-free energy by 2050 in Denmark, increased industrial energy efficiency in Portugal, reducing transport CO_2 emissions in Spain, restricting use of phthalates/PVC in Denmark, and restricting fertiliser use in Denmark. In the Danish fertilisers case study, the boundary of the policy mix was limited to policy instruments addressing fertiliser use, as the full policy mix addresses water quality more broadly.

3.5.1 Applying 'decoupling' to environmental media

Applying decoupling to efforts to reduce emissions to environmental media – whether to air, water or land – implies setting targets on limits of such emissions, ideally compared to a baseline year and by a given date. This also implies that a maximum sustainable limit of such emissions is identifiable and known, based on robust scientific knowledge. Given the transboundary nature of certain emissions, efforts are usually needed beyond national level to achieve overall decoupling.

Measurement: implications for measurement: scope and indicators

For these six policy mixes, the sole example of a policy mix with targets that are difficult to measure is the Danish PVC/phthalates example. A report estimating PVC consumption across a number of years was commissioned by the government, requiring data analysis beyond national statistics provided on products. Indeed it is difficult to identify (without producer/importer declaration requirements) what specific phthalates and amounts are imported into the country, making measurement impossible. Instead, the case study has used extrapolated proxy data to try to measure the performance of the policy mix.

Greenhouse gas emissions, energy production and consumption, energy intensity (unit of energy used per added value unit) and transportation levels are all more easily measured, and form part of the measurements for the four case studies relating to fossil fuels.

For fertiliser use, a number of indicators can be used: fertiliser imports and sales, and aquatic status indicators such as "nitrate in groundwater" that makes up part of the Water Information System for Europe (WISE) data collection. WISE is a partnership between the European Commission (DG Environment, Joint Research Centre and Eurostat) and the European Environment Agency, and is a gateway to information on European water issues. Such EU-wide information collection and analysis is potentially invaluable in monitoring Member State performance against policy targets, to evaluate targets themselves (are they set within natural limits), and evaluation exercises to help identify how improvements can be made.

3.5.2 Recurrent instruments in the policy mixes

All six policy mixes use an interesting range of instruments, with a particular emphasis on **regulatory and market-based instruments** (particularly **taxes and subsidies/public funding and investment**).

All of the case studies include **strategic documents** – national policies, action plans at different levels of governance and in companies – to set out national policy objectives and to structure instruments introduced, and for stakeholders to provide structured contribution to meeting the objectives. Denmark's *Action plan for reducing and eliminating the use of phthalates in soft plastics* (Danish Environment and Energy Ministry, 1999a) and the *Strategy for the PVC Area* (Danish Environment and Energy Ministry, 1999b) provided the political position and objectives of the policy mix and the instruments used. Spain's policy mix on reducing CO_2 emissions from transport is based primarily on strategic documents (plans) that apply to **national, local and enterprise level**, thereby requiring key actors (municipalities, companies) to draw up strategies for reducing CO_2 emissions in their area and business. At national level, key plans include the 2001 Strategic Goods Transport Plan (PETRA) outlining actions to modernise the goods transport sector, and the 2004 Bus Transport Action Plan (PLATA) establishing actions to modernise bus transport through network integration, market competition, sustainable practice, and corporate responsibility. Examples of plans required from key actors include urban mobility plans for local authorities and greater share of collective transport and increased use of rail transport for regional authorities. Company-focused plans include transport plans, road transport and aircraft fleet management, efficient driving of lorries and buses and of aircraft.

Denmark's policy mix aiming to reduce fertiliser use has evolved over the years (since the first national policy document published in 1985), and has a strong focus on strategic documents that set out clearly detailed policy objectives (targets to be met by a certain date) and announcing policy instruments to meet these objectives (see Figure 8 below). Both Denmark's and Sweden's most recent climate/energy policies set out policy objectives to 2050 and 2020, respectively, and they both build upon a long history of national policies in these areas.

Portugal uses a series of strategic documents to ensure increased industrial energy efficiency. These include **binding energy audits** (every 6 or 8 years depending on amount of energy used) for facilities consuming more than 500 tonnes of oil equivalent per year (toe/y), and voluntary audits for facilities using less than 500 toe/y. Obligated companies are required to establish '**energy consumption rationalisation plans**' (PREn), including individual targets for energy and specific energy consumption (and setting rationalisation measures). These plans are to be submitted to the government, as well as biennial execution and progress reports. At the end of each PREn period (6 or 8 years), facility operators must reduce their target indicators by 4 % if consumption is above 500 toe/y and by 6% if it is higher than 1000 toe/y. With time, the PREn becomes a **Rationalisation Agreement for Energy Consumption** (ARCE), which is then communicated to the Customs and Excise Ministry in order to be applicable for exemption from excise duties. Some exemptions have been allowed from the excise duty on different energy products.

EU Directives also encourage national-level efforts. Both Spain and Portugal's policies to reduce CO_2 emissions are based on the then Energy Services Directive (Directive 2006/32/EC). Denmark's fertiliser use reduction policy mix was supplemented by various EU

Directives, notably the EU Nitrates Directive (Directive 1991/676/EEC) and the EU Water Framework Directive (Directive 2000/60/EC). The Nitrates Directive aims to protect European water quality by preventing the pollution of ground and surface waters from nitrates from agricultural sources and by promoting the use of good farming practices. It sets limits on rates of nitrogen use. The Water Framework Directive sets a political target of 2015 for all of Europe's water to be in "good ecological status", with various requirements for achieving this objective. Both of these EU Directives have been transposed into national legislation, adding to the regulatory instruments in this policy mix.

Market-based instruments form a key element of the majority of the environmental media policy mixes. **Taxes** have most widely been used amongst these case studies. In relation to PVC/phthalates, Denmark introduced in 1999 a tax of 2 DKK/kg PVC on all PVC products (with the exception of construction goods) and a tax of 12 DKK/kg on all PVC foils for food products. In 2000, it also introduced a tax on phthalates of 7 DKK/kg. The results of a mid-term review of Denmark's Second Action Plan for the Aquatic Environment included the introduction of a tax on mineral phosphorous added to feed, to encourage reduced fertiliser use. Although not studied in the case studies on the Danish and Swedish fossil fuels policy mixes, both countries have long histories in progressive and ambitious climate and energy policies, and both are notably known for their successful use of taxation in these areas. Sweden's first energy tax dates back to 1924, on petrol and diesel, and over the decades such taxes have been charged against more types of energy products (coal, liquid petroleum gas, natural gas, etc.) as well on electricity and heating. A carbon tax was introduced in 1991, complementing existing energy taxes initially, and applied to different energy products over the years and to uses (heating also). Vehicle taxes have also been introduced, as has an electricity certificate scheme to encourage efficiency in use. Denmark's history of the use of taxation mirrors roughly that of Sweden, in terms of application of taxes to a wide range of energy products, on heating, and on carbon dioxide (Larsen 2011).

Bans have been used particularly by Denmark in its PVC/phthalates and fertiliser use policy mixes. Indeed, in relation to PVC/phthalates, bans and taxes form the main policy instruments in this policy mix, with the objective of stimulating and incentivising the use of substitute substances and eliminating PVC/phthalates from products. However, bans of widely used products or substances has been proven to be difficult, as in an abandoned ban proposed in 2012 on products for indoor use containing four phthalates (Danish Environment Ministry 2013). Bans were also introduced on fertiliser use (such as application of manure on frozen ground, on bare fields in autumn and winter).

Public funding and investment is often used as a supporting instrument. For Denmark's PVC/phthalates efforts, the key complementary instruments used to help develop and spread alternatives in the market have been **R&D funding, green public procurement (GPP)** and industry agreements (see more on these agreements in the section that follows). Portugal introduced **subsidies** for energy audits and investments in energy management and monitoring equipment; and an **Energy Efficiency Fund** set up in 2010. The Fund allocated EUR 1.5 million to encourage behavioural change, raise awareness and support energy efficiency projects (although this funds not just industrial users, but also, citizens). Denmark also offered farmers **financial incentives** to reduce fertiliser use, linking agro-environmental

payments to reduction targets or providing compensation for production losses for farmers voluntarily converting to organic farming or re-establishing former wetlands.

Another **financial instrument** introduced in two case studies was **non-compliance penalties.** Portugal introduced penalties to companies for non-compliance with CO_2 reduction requirements agreed in their plans and agreements. In Denmark, farmers can face a non-compliance fine for nitrogen use beyond the amount allowed by the fertiliser account (up to DKK 20 (EUR 2.70) /kg nitrogen).

Regulatory instruments used include **standardisation**, and **criteria and requirements in ecolabelling and green public procurement** (GPP), such as is the case for Denmark's PVC/phthalates efforts. Denmark also included **requirements** in its fertiliser use reduction efforts (such as on storage of manure, minimum green cover on farmland, crop rotation, limits on livestock density, using nitrogen in manure) and **standards** (mandatory regulations for nitrogen standards for crops and fertiliser accounts). The results of a mid-term review of the Second Action Plan for the Aquatic Environment included the introduction of **regulations** (changed rules for the establishment of wetlands, stricter standards for various crops and green cover). Portugal has introduced **specific legislation** to **regulate the training of recognised auditors**, PREns and execution and progress reports.

Information instruments feature in a small number of the case studies. As mentioned earlier in this section, both Portugal and Spain use **plans** and **agreements** to ensure that key actors (companies for both countries, as well as local/regional authorities for Spain) develop a strategic approach to their contribution to meeting national policy objectives. For Portuguese industry, the plans include reduction targets that need to be reported to the Ministry of Customs and Excise in relation to tax exemptions. In Denmark, **farm-based fertiliser accounts** (mentioned previously under regulatory instruments, thus having multiple uses) require farmers to submit a plan for nitrogen use to the Danish Plant Directorate, with a request for a nitrogen fertiliser quota as well as a report on compliance with the previous fertiliser account (the quotas are subsequently adjusted depending on weather conditions). The plan must contain a map of the crops and a soil classification. If the farmer buys fertilisers or produces manure, which in total represents too much fertiliser, he or she must store, sell, or give away the surplus to another registered business. Fertiliser sellers control whether the buyer is registered as a "user of manure and fertilisers" and report the sale to the Danish Plant Directorate.

Very few examples of **voluntary measures** were identified. Denmark's initial voluntary information instrument (farm-based fertiliser accounts) became mandatory following the review of its Second Action Plan for the Aquatic Environment (alongside the introduction of other mandatory instruments, some of which have been mentioned earlier in this section). Denmark has also used a voluntary instrument in the form of a **negotiated agreement** with industry in its PVC/phthalates policy mix. More detail is provided on this in the section that follows.

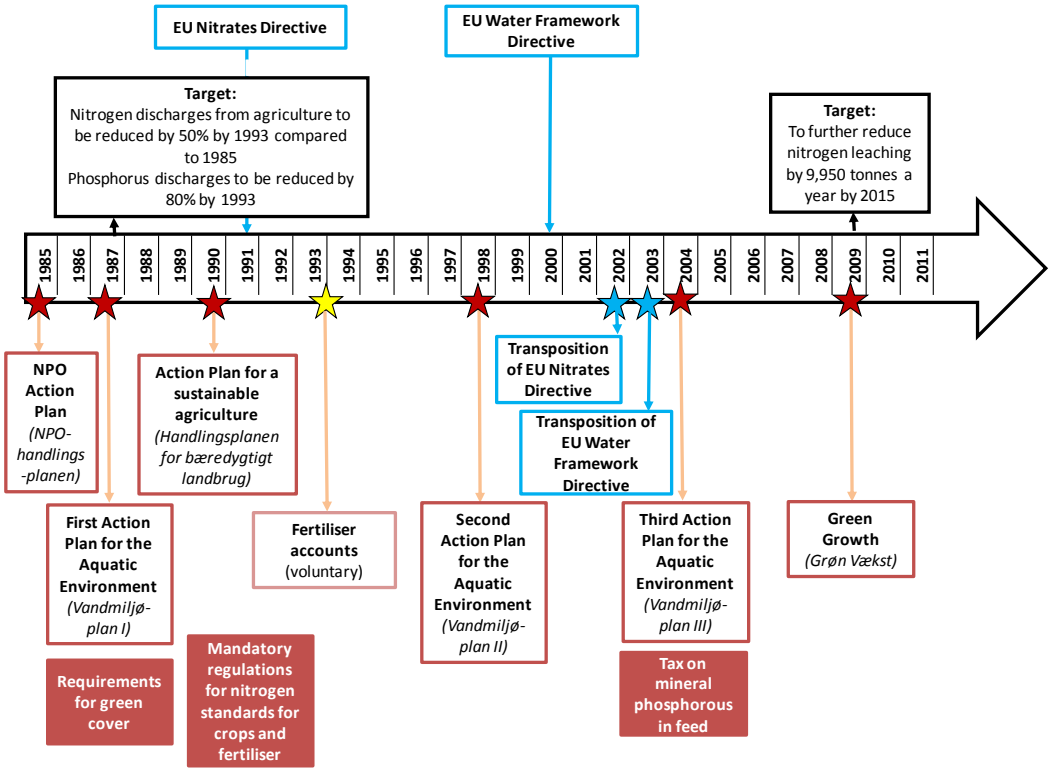
Elements of diversity or atypical instruments

Denmark particularly provides a range of examples of unusual instruments and actions in developing their policy mixes. Most notably in the area of governance, Denmark's use of **political consensus through agreements** appears to ensure more political certainty even with changes of government. An example of this is the change in government that occurred in

2011, which saw the outgoing government's February 2011 energy strategy replaced by the incoming government's November 2011 energy strategy. The latter was broadly based on the former, but had more ambition. The 2012 Energy Agreement also continues such a collaborative approach, including industry, and is based on a long tradition of the use of these stabilising instruments in its development of energy policy (Notenboom et al. 2012).

The use of agreements as part of Denmark's collaborative or participative approach to policy development can also be seen in the case study on PVC/phthalates, where the government entered into an agreement with the PVC industry two years after the 1999 publication of its two key strategic documents. The objectives of the agreement were to reduce incineration of PVC, increase recycling and limit the use of additives such as lead and chlorinated paraffin. Since the agreement, some positive results were reached (e.g. restriction of use of heavy metals, reduced use of PVC packaging, etc.) but some other issues were not solved (e.g. financing of the collection system for PVC construction products; incineration of PVC building products, increasing consumption of PVC products and increased PVC waste generation). Denmark's engagement with industry while developing its strategies, its use of agreements and its persistence in arguing for EU-level action (on phthalates) has more recently resulted in industry agreeing to support Denmark's proposal for an EU-wide ban of four phthalates, to prepare guidelines to help consumers to better avoid products containing phthalates, and to develop options for labelling of products not containing the phthalates.

Figure 8: Denmark's policy mix to reduce fertiliser use: timeline for introduction of policies



Source: Own compilation based on Blicher-Mathiesen et al. 2012, BIOIS.

Finally, Denmark's 2012 Energy Agreement addresses the **financing requirements** of achieving its 2020 targets. It sets out three elements to be used to meet the financing requirement: first, energy companies' tariffs are to finance energy saving initiatives by energy companies (consumers' energy bills); second, Public Service Obligation (PSO) schemes will be used to finance expansion of renewables in electricity production; and third, a security of supply tax was introduced on all space heating fuels. These measures were put in place in anticipation of a reduced consumption of fossil fuels, and the subsequent reduced state revenues from taxes on coal, oil and gas.

3.5.3 Links between environmental media and institutional and governance arrangements

Role of geographic scope

For the four climate and energy case studies, most measures are at national level (regulatory, economic instruments, standards, information), while there are some sub-national applications of instruments. This is notably the case for Denmark's Wind Turbine Secretariat, which is a national agency working with local authorities to identify potential sites where on-shore wind turbines could be installed, as well as Spain's local and regional authority requirements to prepare plans on urban mobility (for local authorities) and plans on increasing the share of collective transport and increased use of rail transport (for regional authorities). Such geographic scale instruments are important in ensuring that local planning and management adequately addresses key relevant issues when seeking to contribute to a national political target. It is also a good means of ensuring ownership and engagement in policy implementation from key actors.

Denmark's implementation of its policy mix on reducing fertiliser use includes farm-level requirements. Since 1993/94 (OECD 2007a) accounts to track fertiliser use have existed, and these are used to regulate fertiliser use and management. The fertiliser account is based on the soil types and crops grown on each individual farm, and a fertiliser application standard for each crop and soil is estimated as the economically optimal dosage minus 10 %. The previous crop on the field and precipitation is also taken into consideration.

A similar site-specific approach was taken by both Portugal and Spain in efforts to reduce GHG emissions. Portugal's mandatory reporting instruments for companies (with stringency of requirements based on levels of a facility's energy consumption) include 'energy consumption rationalisation plans' (PREn) in which individual targets for energy and specific energy consumption (and setting out rationalisation measures) must be detailed. The plans are submitted to the government, as well as biennial execution and progress reports. The PREn becomes a Rationalisation Agreement for Energy Consumption (ARCE), and is submitted to the Customs and Excise Ministry in order to be applicable for exemption from excise duties.

Spain's use of strategic plans in reducing transport-related CO_2 emissions includes the elaboration of plans at the company level. This is the case for companies with a certain number of employees, which were required to establish transport plans; fleet owners required to produce plans on the management of road transport fleets; contract hauliers and fleet owners required to produce management of aircraft fleet plans; and transport companies required to product plans on efficient driving of lorries and buses and on aircraft (as appropriate). Additionally, the co-management system between the central government

ministry and the 19 Autonomous Communities, which managed the Action Plan and its public funds, was considered to be highly efficient and successful.

In using such 'site'-specific (whether a public authority geographical area – local and regional, corporate level, or farm level) instruments, this better ensures the elaboration of management plans required at this lower (administrative) level of activity. It also helps to ensure more active engagement with the policy objectives and therefore in theory is more likely to result in the required behaviour change.

Common issues and diversity

For most of the environmental media case studies, apart from that of Denmark's PVC/phthalates policy mix, there has been a mix of instruments addressing issues at national level as well as sub-national level, whether local or regional. The inclusion of locally/regionally applied instruments gives more refinement to responses to national objectives, helping to identify solutions and actions according to the local/regional situation. This is also the case for company-level instruments, which could have been applied at the sectoral level in principle to be in line with efforts to reduce administrative burdens. However, the company-level instrument better ensures engagement and action resulting in behaviour change from the entity actually creating the environmental impact (emitting CO_2, in this case).

3.5.1 Extent to which policy mixes achieved decoupling

A range of 'decoupling' results was achieved, with varying levels of success although not necessarily attributable to the specific policy mixes that have been evaluated.

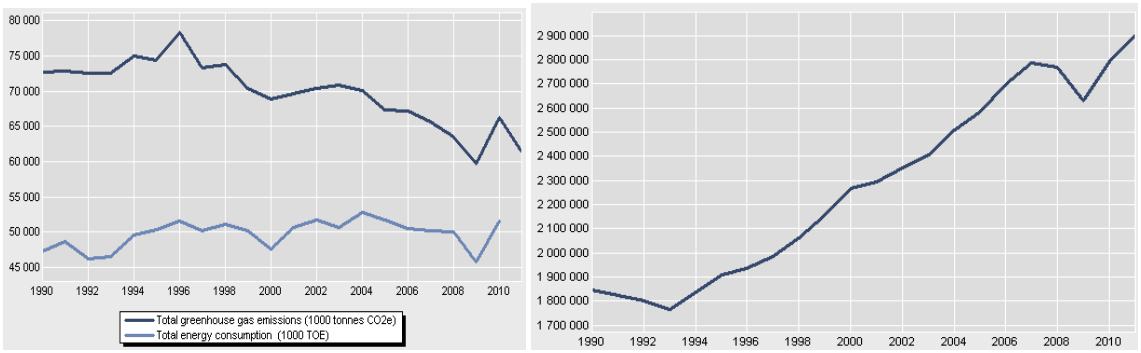
Portugal and Spain appear to have achieved **no decoupling**. From 2000–2010, although Portuguese industrial final energy consumption dropped by 14 % (the evaluated policy mix was introduced in 2008), industrial energy use per unit of value added slightly increased over the same period. Thus, energy use has not been decoupled, rather reduction in energy use is explained by a drop in industrial production. However, electricity consumed in the production of 1 Euro of added value decreased by 28 % on average for the manufacturing industry as a whole from 2000–2011. This reduction indicates that electricity use has been decoupled from production in the manufacturing industry.

Spain's transport-related CO_2 emissions prior to the introduction of the 2005 - 2007 Action Plan were already growing at the same rate as GDP, and in 2008 there was a sharp decline in emissions while GDP continued to rise, with a corresponding reduction in emissions intensity. Both the availability of data and the difficulty of disentangling the impacts of the Action Plan from other existing polices prior to, during and since, are significant. Nonetheless, there was a reduction in CO_2 emissions from the transport sector, amounting to around 8.5 - 9.0 Mt CO_2 in the final year of the Action Plan, although this is most likely explained by the construction of GDP time series as well as the global financial and economic crisis.

Climate and/or energy policy had already existed for decades in both Denmark and Sweden, explaining the strong focus on and widely applied economic instruments. Hence, analysis of the effects of their more recent strategies (2009 for Sweden and 2011 for Denmark) is not possible, and certainly difficult to disentangle from these previous efforts. Nonetheless, both of these countries have achieved only **relative decoupling** following their efforts.

From 1990-2007, Sweden had achieved relative decoupling, as its GNP rose annually at a rate of 2.3 – 3 %, while its per capita emissions of GHGs diminished from 8.4 t/capita to 7.1 t/capita (EEA 2010). Figure 9 below illustrates GDP (graph on the right) versus GHG emissions and total energy consumption (graph on the left) from 1990–2011. It shows still **erratic performance in energy consumption, and a clear falling trend in GHG emissions**. The energy efficiency electricity certificate scheme was introduced in 1993, and appears to have had a reduction effect on total energy consumption, but it is most likely that the extreme drop in energy consumption of 2009 is due to the global financial and economic crisis. Hence, it is difficult to assess the effectiveness of the policy mix.

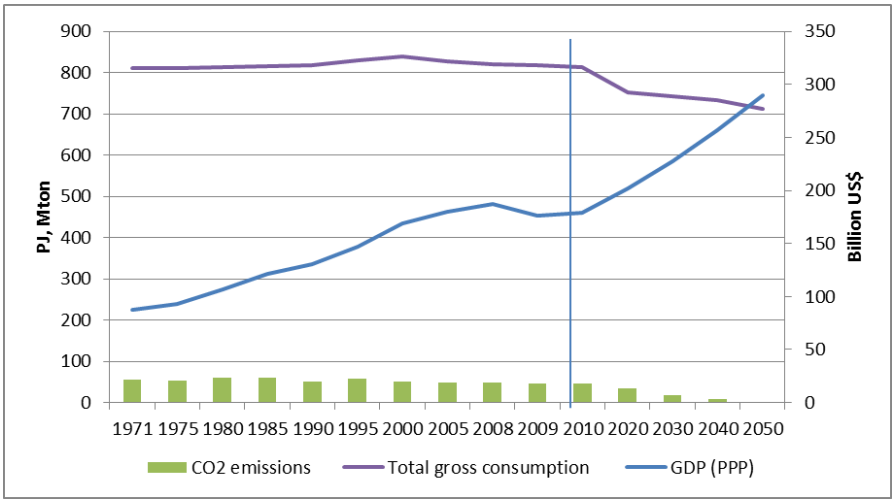
Figure 9: Sweden's GHG emissions, energy consumption and GDP, 1990-2011



Source: Nordic Council website, Indicators of Sustainable Development page: http://www.norden.org/en/nordic-council-of-ministers/ministers-for-co-operation-mr-sam/sustainable-development/indicators-for-sustainable-development

Denmark has achieved relative decoupling since the 1970s, with stronger relative decoupling in latter years. From 2000 to 2010, both CO_2 emissions and total gross energy consumption (TGEC) reduced slightly while GDP increased (with a dip since 2008, presumably due to the global financial and economic crisis). It has been difficult to assess robustly, but **Denmark appears to be transitioning from relative to absolute decoupling** (of CO_2 emissions as well as total energy consumption). To 2050, CO_2 emissions are forecasted to reduce to nil and TGEC will reduce more considerably than previously, while GDP will continue to rise (see Figure 10).

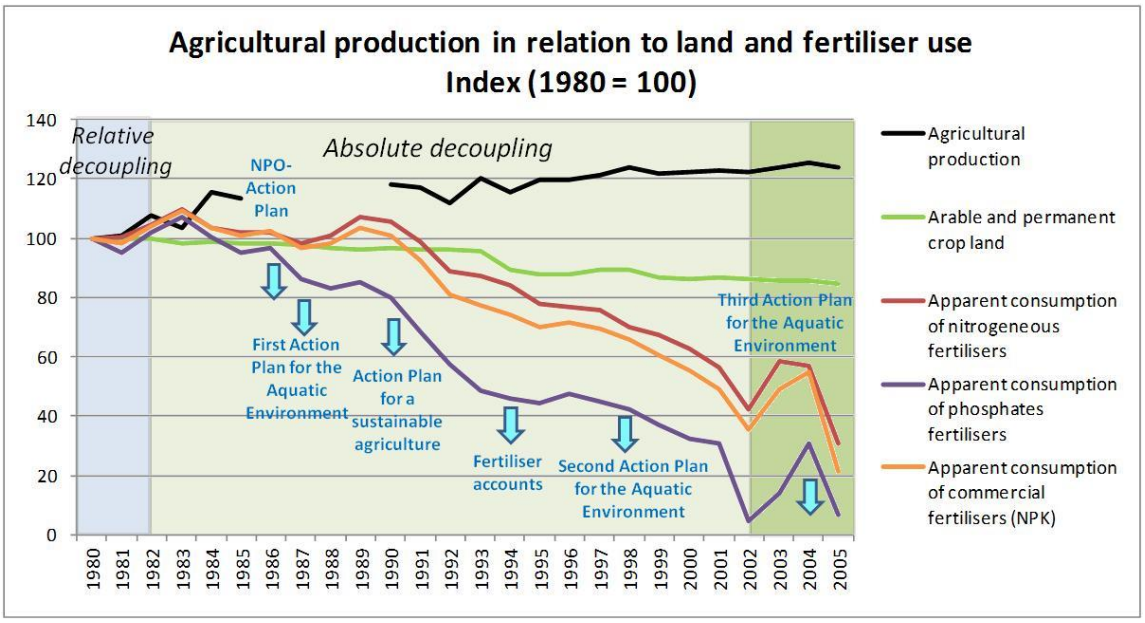
Figure 10: Denmark's GDP, CO_2 emissions and total gross energy consumption, historical performance and projection to 2050



Source: from IEA (2012); Statistics Denmark; FEEM computation on data by the Danish Energy Agency. GDP growth based on OECD Economic Outlook average rate for the period 2010-2014, taking into account the 2020 targets set in the 2012 Energy Agreement.

Denmark's efforts at reducing fertiliser use has achieved **absolute decoupling** between agricultural production and the apparent consumption of nitrogen- and phosphorus-based as well as other commercial fertilisers since 1991 (see Figure 11). However, despite this absolute decoupling, **fertiliser use has not yet achieved a sustainable level**. Not only are average nitrogen surpluses in Denmark above the EU average (76 kg N/ha in Denmark in 2009 compared to 49 kg N/ha in the EU as an average in 2008), while phosphorous surpluses are now closer to EU averages, oxygen conditions in Danish waters have not improved (DMU 2009). This is thought to be due to still relatively high intensity of nutrients used per hectare in Danish agriculture compared with other OECD countries (OECD 2008), but also due to increasing temperatures caused by climate change. With temperatures set to increase further, the state of Danish waters will continue to degrade if the flow of nutrients is not further reduced. Hence absolute decoupling has occurred but not within limits.

Figure 11: Decoupling trends in agricultural use of fertilisers in Denmark



Source: OECD Environmental Data. Compendium 2008. Agriculture.

In its efforts to reduce phthalates and PVC use, Denmark's policy mix has been very difficult to evaluate in terms of decoupling performance as there does not appear to have been any official analysis undertaken, and national statistics cannot distinguish all PVC- or phthalate-containing products.

3.5.2 Striking features of the most effective policy mixes

The only policy mix to have achieved absolute decoupling (although not yet within limits) is the Danish fertiliser use one. The most striking features have been the **use of multiple instruments**, many of which have been amended over time (increases in taxes, lowering application thresholds, changing failing voluntary measures into mandatory ones). Another striking feature is the use of **official reviews of strategies**, to assess the extent of success or failure of existing instruments, before setting out new strategies. In this way, policy evolves according to independent analysis, learning from experience, and building on previous successes.

3.6 Policy mixes for waste prevention

Waste generation is a clear example of poor use of resources, as it may represent a waste of resources (e.g. raw materials, land, greenhouse gas emissions) from the initial manufacturing phase of the materials used as intermediate goods to the emissions along their lifecycle to when they are introduced in the production process of the final product. It also brings about potential environmental harmful impacts from both the waste itself and its management. Policy mixes for waste prevention are therefore a fairly straightforward example of policies that aim to promote a more intelligent and sustainable resource use. Such policy mixes aim to implement the waste management hierarchy as defined in the EU Waste Framework Directive, which prioritises the options for waste management as follows: prevention (top priority) > re-use > recycling > recovery (incineration with energy recovery) > disposal (e.g. incineration without energy recovery or landfilling).

Three of the policy mixes for decoupling studied in this project can be regarded as aimed at preventing waste: reducing municipal waste at the local level in Slovakia; preventing food waste in the UK; and reducing plastic bag use in Ireland and the UK.

3.6.1 Applying 'decoupling' to waste prevention

Meaning

The generation of waste is often assumed to be linked to economic growth; as wealth increases, the amount of waste produced can have a tendency to increase. However, there is an increasing number of policy mixes that aim to prevent or at least reduce waste generation, meaning that there are attempts to decouple waste generation from economic growth.

Applying the decoupling concept to waste is relatively simple. Resource decoupling applied to waste can be defined as breaking the link between economic growth and the generation of waste. For relative decoupling to be claimed, evidence is needed of a lower rate of increase in waste generation than the rate of economic growth. Absolute decoupling can only be claimed if the generation of waste actually falls whilst economic growth is stable or increases.

Impact decoupling applied to waste can be defined as reducing the negative environmental impacts of waste, for example a reduction in landfilling (and associated reduction in greenhouse gas emissions/leachate), incineration (and associated reduction in greenhouse gas and other emissions/residues) and increased recycling (and associated reduction in virgin raw material use).

Measurement: implications for measurement: scope and indicators

Measurement of decoupling in terms of waste is usually based on the definition of a baseline situation, measuring the new situation after a certain amount of time and comparing the two measurements to quantify the change. The indicators used are usually the quantity of waste generated, landfilled or recycled, and in terms of environmental impacts can include the amount of greenhouse gas emissions generated or estimates of the amount of raw material use avoided due to recycling. Economic growth is usually measured in terms of GDP. The measurement of actual waste prevention, however, is by definition not straightforward, as it is difficult to measure something that has not been created.

3.6.2 Recurrent instruments in the policy mixes

There are a number of recurrent instruments used in these policy mixes. All three case studies feature **regulatory instruments** of one type or another. All three include **targets, standards or limits**, e.g. on reducing the amount of biodegradable municipal waste (BMW) sent to landfill (relevant to both the UK food waste and Slovakian waste management case studies) and on recycling of certain materials (in the Slovakian waste management case study). It should also be noted that there is EU legislation that sets targets on both landfilling and recycling, which therefore acts as at least a partial driver for national level action. **Bans** are included in two cases: on the use of plastic bags in certain UK towns, and a forthcoming ban in Scotland on sending biodegradable municipal waste (BMW) to landfill (to be introduced in January 2021).

In terms of **market-based instruments**, taxes or charges are used in all three of the case studies, albeit of different types. The landfill tax and Landfill Allowance Trading Scheme (LATS) in the UK are both relevant for food waste, as they aim to divert biodegradable waste away from landfill by imposing charges for its disposal. In Ireland and the UK, there are charges/taxes applied to plastic bags. In Palárikovo, a pay-as-you-throw (PAYT) scheme was introduced to charge households according to the quantity of waste they generate.

Public investments have been used in two of the case studies, with **infrastructure investments** in food waste collection services to households in the UK (in 2011, around 47% of UK local authorities provided such a service) and the creation of waste management infrastructure (a collection centre, door-to-door collections, composting centres) in Palárikovo in Slovakia.

In terms of **cooperation-based instruments** voluntary commitments are a feature of two of the case studies, including the Courtauld Commitment[2] (which began in 2005) through which leading retailers and brands have voluntarily committed to reduce food waste; the Hospitality and Food Service Agreement, whose signatories aim to reduce food and associated packaging waste arising by 5 % by the end of 2015 (compared to 2012, and measured in terms of CO_2e emissions), and to increase the rate of food and packaging waste being recycled, anaerobically digested or composted to at least 70 % by the end of 2015, and numerous initiatives by individual retailers in the UK to reduce the use of plastic bags by customers.

Information-based instruments feature prominently in all three policy mixes. They include: the 'Love Food, Hate Waste' public campaign on food waste, information campaigns run by retailers on both food waste and plastic bags, food waste prevention campaigns that were run by over 50 % of local waste collection authorities in the UK between 2008 and 2010, and extensive (and ongoing) information on recycling and composting provided to inhabitants of Palárikovo in Slovakia.

[2] The Courtauld Commitment is a voluntary agreement to improve resource efficiency and reduce waste in the UK grocery sector. It was launched in 2005, is funded by the UK national governments, delivered by WRAP, and is now in its third phase. The targets for 2015 are to: reduce household food and drink waste by 5%; reduce ingredient, product and packaging waste in the grocery supply chain by 3%; and improve packaging design to maximise recycled content, improve recyclability and deliver product protection to reduce food waste, whilst ensuring no increase in the carbon impact of packaging. No baseline year for the above reductions has been identified.

Elements of diversity or atypical instruments

There are also a handful of interesting atypical instruments used in only one of the policy mixes.

With regards to **market-based/economic instruments**, the Landfill Allowance Trading Scheme (LATS) in the UK aims to reduce the amount of biodegradable municipal waste landfilled by local authorities by requiring them to possess sufficient LATS allowances for the biodegradable portion of BMW landfilled. All waste disposal authorities could trade, bank and borrow allowances, therefore making the LATS a trading system. (It should be noted that the scheme has now ended; it ran from 2005 to 2013, with trades concluding on 30 September 2013.) There is only one major **subsidy** mentioned in the case studies, namely the National Recycling Fund in Slovakia which pays municipalities that meet targets for the collection of certain materials for recycling. The case study notes that this may have the harmful perverse effect of encouraging a municipality to create those waste materials to ensure that the quotas are met and funding received. With regards to **public investments**, only the case study on food waste in the UK indicates the existence of green procurement measures in government, with the introduction of Government Buying Standards for Food[3] which include the goal of minimising food waste.

Unique **cooperation-based instruments** are also indicated, including **capacity-building** with the creation of the Waste and Resources Action Programme[4] (WRAP) in the UK to research and support policy development on food waste; and the creation of **networks** in the Palárikovo waste management case study, namely the Slovakian citizens' NGO and an association of municipalities that work together on waste management. A unique **information-based instrument** mentioned in the UK food waste case study is the introduction of guidance and initiatives on food date labelling.

3.6.3 Links between resource type and institutional and governance arrangements

Role of geographic scope

As waste tends to be generated at a localised level, several elements of the policy mixes in the three waste prevention case studies are focussed at a local level. This is particularly true when it comes to information-based instruments, which often target households (in the case of the Palárikovo waste management case study) or customers (in the case of the Ireland/UK plastic bags case study) and are therefore conducted by local municipalities or individual retailers. The PAYT scheme and investments in waste management infrastructure in

[3] Defra website, *Food and catering services*, accessed 18 November 2013 at http://sd.defra.gov.uk/advice/public/buying/products/food/

[4] WRAP was created in 2000 to support recycling and markets for recycled materials in the UK; through its expertise, research and practical advice, WRAP helps governments to devise strategies in areas such as waste prevention, carbon reduction and resource efficiency. More information available at http://www.wrap.org.uk/

Palárikovo were also implemented at the local level, although they were then used as a model to extend to many municipalities nationwide. However, many market-based instruments (e.g. taxes or charges on plastic bags, landfill taxes) tend to be decided and applied nationally. Many regulatory instruments such as regulation, targets/standards/limits also tend to be applied at the national level.

3.6.4 Extent to which policy mixes achieved decoupling

Palárikovo in Slovakia has achieved some impressive waste management results since 2000, whilst GDP has shown a positive trend (with an expected stagnation in 2008 during the global financial and economic crisis). The amount of waste landfilled fell by around 64 % and recycling and composting increased from 0 % to around 64 % over the same timeframe. On the other hand, total waste generation in 2012 was around the same as it was in 2000, so absolute decoupling cannot be claimed; this is rather a case of **relative resource decoupling**, and also likely **impact decoupling** as the environmental impacts of waste will have reduced as a result of waste management moving up the waste hierarchy.

Data in the case study on food waste in the UK suggests that the quantity of food waste generated in the UK actually increased between 2006 and 2009 whilst GDP was falling. As one would assume that people would be less inclined to waste food when their relative wealth is decreasing, this seems rather counterintuitive. For the period 2009–2011, however, GDP was increasing and food waste generation was falling. The 'Love Food, Hate Waste' campaign is cited as having led to an overall reduction of 137,000 tonnes of food waste between 2008 and 2010, and a 35 % reduction in food waste among UK schools in the same time period (Bio Intelligence Service, 2010). WRAP (2013) estimates that from 2006/7 to 2010, 1.1 m t of food waste was prevented in the UK. Over the same time period, an 18 % reduction in the quantity of food waste collected by local authorities was observed (from 4.65 m t to 3.82 million tonnes), in spite of a 4.2 % growth in household numbers (WRAP, 2011c).

The Landfill Allowance Trading Scheme (LATS) does appear to have contributed to a reduction in landfilling of BMW, with 52 % less sent to landfill in England after seven years of the scheme. However, it is worth pointing out the performance of individual waste disposal authorities (WDAs) varies considerably: in 2011/12, for example, whilst 87 WDAs landfilled less BMW than their initial LATS allocation (indicating that they either sold, or could have sold, allowances), 36 WDAs landfilled more BMW than their initial LATS allocation (meaning they had to buy extra allowances) (Environment Agency, 2013). Given the inconsistency in the trends observed in this case study, it is only with some caution that **relative decoupling** can be assumed, and absolute decoupling cannot be claimed.

In Ireland, after introduction of the EUR 0.15 tax per plastic bag in 2002, a very steep drop in plastic bag use was rapidly observed, from 328 bags per person and year in 2002 to only 21 in 2003. This then gradually increased again to 30 bags per person and year in 2006; the level of the tax was raised to EUR 0.22 in 2007 in response to this increase, and bag use decreased again to 26 per person in 2008 and 18 in 2010. 2010 survey data shows that plastic bags constitute 0.24 % of litter pollution compared to an estimated 5 % prior to the introduction of the tax. **Absolute decoupling has been achieved, but not with a steady downward trend** in bag use, and it is interesting to note that per capita use of plastic bags dropped even as the economy grew robustly until 2007 (with an annual average growth rate of 5.7 % between 2000 and 2007).

In the UK, a voluntary agreement between the Environment Ministry and large retailers led to a reduction from 870m thin bags being used in participating supermarkets in 2006, to 452m in May 2009 and 475m in May 2010. In Wales, the introduction of a GBP 0.05 charge per single-use carrier bag appeared to lead to a reduction of between 35 and 96 % in the number of bags used in 13 retailers. In the UK, only **relative decoupling** has been achieved.

3.6.5 Striking features of the most effective policy mixes

A couple of features in the composition of the policy mixes appear to have been particularly effective in moving towards decoupling. Interestingly, all of the **taxes/charges have been increased at least once** in their lifetime (the Palárikovo PAYT scheme, the Irish plastic bag tax and the UK landfill tax). This appears to have helped to maintain their impact, especially in the case of the Irish plastic bag tax which appeared to diminish in impact after the initial introduction of the tax. In addition, in all three of the policy mixes, the **importance of public information/awareness** is stressed. This may be due to the nature of the resource in question; local authorities are responsible for the safe management of waste generated by citizens and therefore it is important to effectively target the public to drive reductions in waste. In the plastic bag and food waste case studies, it seems to have been important to ensure that retailers are engaged in efforts to reduce waste, as has been done through **voluntary agreements**; again, this is due to their important role in both the generation and potential prevention of these specific types of waste.

3.7 Synthesis: impacts of policy mixes on decoupling

3.7.1 What instruments are more specific to what decoupling?

A brief look at the categories of policy instruments used provides helpful insights into what policy mix approaches were more effective in reducing resource use and/or its related environmental impacts. Building on the instrument typology detailed in the DYNAMIX Common Approach document, Table 4 below lists the categories of policy instruments and examples of instruments found across all the case studies.

There is much overlap between the types of instruments used in the case study policy mixes, so it is not possible to pinpoint specific instruments for different types of decoupling. This is especially the case as there will be other factors that were particularly relevant or important for the level of decoupling achieved by the policy mix as well as the instruments chosen. Nonetheless, it is worth looking for trends in instruments used.

Absolute decoupling was achieved in five of the policy mixes, most of which included **strategic documents providing national policy objectives**, a strong element of **regulatory instruments** and **taxes or charges**. **Key regulatory instruments used were limits, requirements and bans.** These policy mixes are also among the longer living ones, with introduction of the policy mixes in 1985 and 1999 for Denmark's fertiliser use and phthalates/PVC respectively, and 1975 for Iceland's fish. Ireland's considerable success on plastic bags occurred very quickly, after introduction of the policy mix in 2002, and Japan's Sound Material Cycle Society policy mix was begun in 2000 (but building on a piece of legislation from 1991).

Table 4: Policy instrument typology for DYNAMIX case study evaluations

Instrument type	Examples
Regulatory instruments	Regulation, bans, standards, quotas, criminal proceedings
Planning instruments	Regional/urban planning, spatial planning
Market-based or economic instruments	Revenue-generating instruments (taxes, charges) Subsidies (direct payments, tax allowances) Property rights (licenses, tradable permits) Discouraging instruments (fees, fines) Others (user benefits, environmental liability, payments for ecosystem services, green procurement)
Public investments	Infrastructure investments, R&D spending
Cooperation-based instruments	Agreements, memoranda of understanding, codes of conduct
Information-based instruments	Communication/information campaigns, capacity building, labelling, accounts, indicators, disclosure (reporting), science/R&D

Source: Umpfenbach 2013.

Limits took various forms, from Iceland's use of **total allowable catches** providing a national cap on fish take for different species, to Denmark's **limits** (on manure spreading, and livestock density) and **requirements** (on provision of farm-level fertiliser accounts, storage of manure, use of manure in organic farming, use of nitrogen in manure, green cover minimums, low nitrogen feed and buffer zones). Denmark's phthalates/PVC policy mix also included **product criteria in standardisation and ecolabelling**. Denmark's fertiliser use case study is also a very good example of the use of **national targets** on nitrogen and phosphorus discharges (acting as limits and providing the context for other limits and requirements) and **strategic documents**.

Bans were especially used in two Danish policy mixes, on reducing fertiliser use and on reducing phthalates/PVC use. The phthalates/PVC policy mix included a ban on **phthalates for childcare products**, and a further ban was proposed in 2012 on **all products containing certain phthalates and intended for indoor use** (although it was not possible to put in place this latter ban due to the ubiquitous use of the phthalates in the products in question). On fertiliser use, bans of **direct discharges from manure** were accompanied with government **subsidies** for investments in animal manure storage capacity. Although neither Ireland nor the UK introduced bans on **plastic bags** in their efforts to reduce their use, several towns and cities in the UK have introduced such a ban.

Taxes and charges also play a significant role in most of these case studies (5 out of 6). These instruments play a central role in the UK aggregates, the Danish PVC/phthalates, and the Irish/UK plastic bags case studies, all 'discreet' resources which can generally be managed with a **sectoral approach**. The UK aggregates policy mix includes the **Aggregates Levy** and the Landfill Tax. **Revenue recycling** of the Levy has helped to fund research and information provision to businesses. On fertiliser use, Denmark also introduced a tax on **mineral phosphorus added to feed**, and Iceland introduced a **resource tax on fish**.

Subsidies are the only instrument used across all case studies that achieve absolute decoupling, except the Iceland fish policy mix that was the only one to have achieved absolute decoupling within limits. Moreover, **promoting of R&D** is a part of the policy mix in half of the case studies. The Japanese case includes and combines these two elements: subsidies (another market based instrument) to increase R&D to meet its recycling targets, since it is a key sector to its economy.

A number of other instruments have played important roles in helping to achieve absolute decoupling, including Denmark's **farm-level fertiliser accounts**, which are sent to a national agency in order to establish future account levels and payment levels on fertiliser use. The instrument is both an **information and accounting instrument**, allowing closer monitoring of performance. Denmark's phthalates/PVC policy mix included an **industry agreement**, which helped ensure more structured efforts at phthalate use reduction and substitution. On plastic bags, Ireland ran a public **awareness-raising campaign** at the same time as the launch of the tax, and the UK has also used awareness campaigns, **voluntary agreements** (with individual retailers).

Relative decoupling was achieved by 5 policy mixes: on German and UK (England) land use, on Sweden and Denmark's fossil fuels, and on waste in Slovakia. The instruments most frequently used were **voluntary agreements, communication campaigns and investment** (in 80 % of the case studies).

The two land-use policy mixes (for Germany and England) featured key **regulatory and planning instruments** – particularly **spatial planning**, local planning, and planning guidance. England's more national approach also included very supportive **information instruments**, such as on what areas were considered 'best and most versatile land', brownfield and green belt, thereby ensuring that everyone was working to the same 'rules of the game'. Germany's **Impact Mitigation Regulation** aims to avoid and minimise environmental impacts and to compensate those which are not avoidable (residual impacts).

Unfortunately, the Swedish and Danish case studies focused on recent policy mixes; hence they could not provide analysis of existing (long standing) instruments. Both countries are renowned for their use of **taxation** in the areas of climate and energy, and they have also produced important **strategic documents** providing the national impetus for many actions. Slovakia's municipal waste policy mix began with an **awareness-raising campaign** to effect behavioural change (from disposal to recycling and composting), alongside the introduction of separate collection of recyclables and composting. A number of years later, a **fixed charge for waste collection** was introduced, and this became a **variable charge** in a later amendment.

For these policy mixes achieving relative decoupling, their lifetimes vary considerably and enough so to not show a trend relating specifically to time. England's land-use policy instruments began to be introduced in 1947 and through to the 1960s, then again from the 1980s onwards; Germany's instruments were introduced in the 1960s and 1970s, and with most developments taking place since the 1990s; and Slovakia's policy mix was introduced in 1999. Sweden introduced its first energy-related tax in 1924, and further taxes were introduced in the 1970s at the same time that Denmark started introducing similar taxes.

For the 4 policy mixes for which **no decoupling** has yet been identified, one trend can be identified: **a too strong reliance on information-based and voluntary instruments**. This

was the case for Finland's wood, Spain's transport, the UK's food waste and Portugal's industrial energy efficiency policy mixes, although the latter involved formal plans which then became agreements with the national government and linked to excise duty exemptions. **Indicators** were used across all these case studies, and this could suggest that there is a need to gather information before further policy objectives are developed. This could especially be the case for wood and food waste, as EU policy did not (and for food waste still does not) provide clearer requirements at the time of introduction of the policy mix. Other instruments used in these policy mixes include **regulatory**, **planning** and **market-based and fiscal instruments** for Finnish wood; **strategic documents** (at national, regional and urban, as well as company levels) for Spanish transport; **green taxes** (for the purchase of energy efficient equipment) and **government funding** (to encourage behavioural change, raise awareness and support projects); and **voluntary agreements**, **market-based and fiscal instruments**, and **regulation** for UK food waste.

3.7.2 What instruments seem essential for absolute decoupling?

Interestingly, **the six policy mixes that achieved absolute decoupling addressed resources with very different characteristics**, from renewable (fish) and non-renewable (aggregates and materials/critical metals) but abundant and locally produced and used (aggregates) or scarce and internationally traded (critical metals), to individual products (plastic bags), ubiquitous substances (phthalates/PVC), and having a significant negative environmental impact (fertilisers).

The diversity in the subject of these policy mixes illustrates how all types of resources can be managed through policy mixes, with political will.

The evidence from the case studies reveals a number of key elements that play important roles in the development, design and implementation of policy mixes that ensure prosperity and well-being while reducing resource use and its environmental impacts. These include:

- **Scientific information and analysis:** to help assess the environmental problem(s) to be addressed by the policy mix, to provide evidence to affected stakeholders, to give context to the policy instruments to be included in the mix at the outset and for future modifications, and to assess performance of the mix at regular intervals as part of monitoring and review exercises.
- **Strategic documents**: to provide clearly set-out reasoning for specific actions to be taken through policy instruments, to provide details of national objectives and targets and contributions to be made by relevant sectors and actors, to give guidance to all stakeholders (including other national government ministries) so that policy coherence at all levels (including corporate) can be better ensured.
- **Review and monitoring**: this should be built-in to any significant overarching strategic documents, to be undertaken at regular intervals, to allow assessment of the effectiveness and efficiency of the policy mix, and to identify further modifications needed (whether revising existing instruments or introducing new ones).
- **Quotas, limits and bans**: the use of instruments that set clear limits, requirements, and 'no-go activities' (e.g. bans), so that all actors understand what actions are acceptable, everyone plays to the same rules, and rights and responsibilities are clearly defined.
- **Allocation of rights and responsibilities**: instruments that allocate responsibilities, preferably individually (to a company, a farmer, a fisherman, a level of government etc.)

ensure better management of natural resources, and these need to be monitored officially and closely at least by a national government ministry or agency. These need to be carefully designed, to ensure equitable sharing of resources between users.

- **Market-based and fiscal instruments**: a key element to effective and efficient mixes, but, at least in the case studies analysed, they do not prove strong enough drivers for the level of change needed to achieve reductions in resource use. Ideally, they act as a further incentive, enhancing regulatory requirements and stimulating broader innovative responses.
- **Compensatory measures**: The introduction of responsibilities especially in relation to limits or requirements can evoke negative reactions from affected parties, so compensatory measures (such as tax exemptions, availability of R&D funding or other government funding to ease the transition) can help reduce this negative reaction and provide stimulus for change that goes beyond set objectives. Such measures need to be treated carefully, as compensation levels can be difficult to identify to avoid their having a negative effect on the desired change or other unexpected side-effects. Ideally, compensation should be set at a level that offsets any damage caused by a policy (e.g. displaced economic activities caused by a policy supporting renewable energy sources and resulting in wind farms or hydro plants) as they would correct a negative externality.
- **Engagement with key sectors**: Structured contact with key sectors can be very helpful in getting actors on board should there be resistance to new policy measures. It can also provide opportunity for collective reflection, to identify the best instruments to affect the desired change. Voluntary agreements can be a further enhancing instrument in the policy mix, rather than playing a central role; nevertheless, these agreements should have clear, measurable objectives.
- **Public information**: beyond awareness-raising campaigns, the role of publicly available information is central to ensuring better transparency between actors, and evidence of performance against targets which can then be communicated publicly to better understand performance to date. Public discourse allows for a ‘story’ to continue to develop and be told to all actors. However, these types of instruments, even if used for accounting and knowledge addition, will not achieve absolute decoupling in a central role in a policy mix.

4 Quantitative analysis: case study modelling

4.1 Introduction

This chapter presents the key findings of quantitative analysis of four of the policy mix case studies. Estimates of the effects of policies for the four case studies were attempted, but convincing results through quantitative analysis was possible for only three. Policies proved to be successful in reducing aggregates use in the UK, fertiliser use in Denmark and rebuilding fish populations (especially cod) in Iceland. As the Japanese policy mix on material use and critical metals specifically was 'created' for the DYNAMIX project, the effects of the policy instruments is not visible in data.

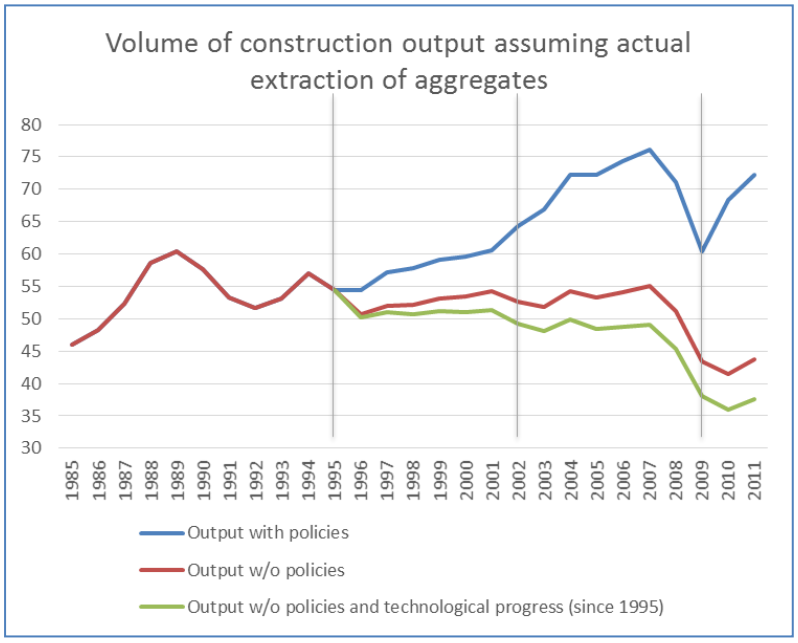
4.2 Aggregates use in the UK: policy mix impacts

The UK aggregates case study was the easiest to model, due to the fact that aggregates use in construction is to a large extent dependent on construction output and vice versa. In contrary to e.g. fertilisers, aggregates cannot be replaced by other production factors. Moreover, they are quite easy to extract and more difficult to recycle than metals, which makes their recycling unprofitable without special incentives from the government. Furthermore, as the policy mix was introduced in particular years as specific regulation, it was possible to single out the specific moment when the structural change took place. Econometric analysis based on the simple production function allowed the identification of the impact of policies from the actual data on aggregates use in the construction sector.

Figures 12 and 13 present the results of such estimations. Technical progress is responsible only for a small improvement of efficiency of aggregates extraction and without the introduction of the aggregates levy and the landfill tax, their use would be almost twice as high as it is now. The largest effect on aggregates consumption can be attributed to the introduction of the second policy instrument (the aggregates levy) in 2002, however all three components – the landfill tax, the aggregates levy, and the aggregates levy sustainability fund - of the policy mix proved to be successful. Moreover, it must be underlined that technological progress in the construction sector would allow for only a small change in the use of such materials – technological progress in this sector does not influence 'aggregates efficiency' much, so the only way to reduce its extraction is to force recycling via smart policy instruments, such as those introduced in the UK.

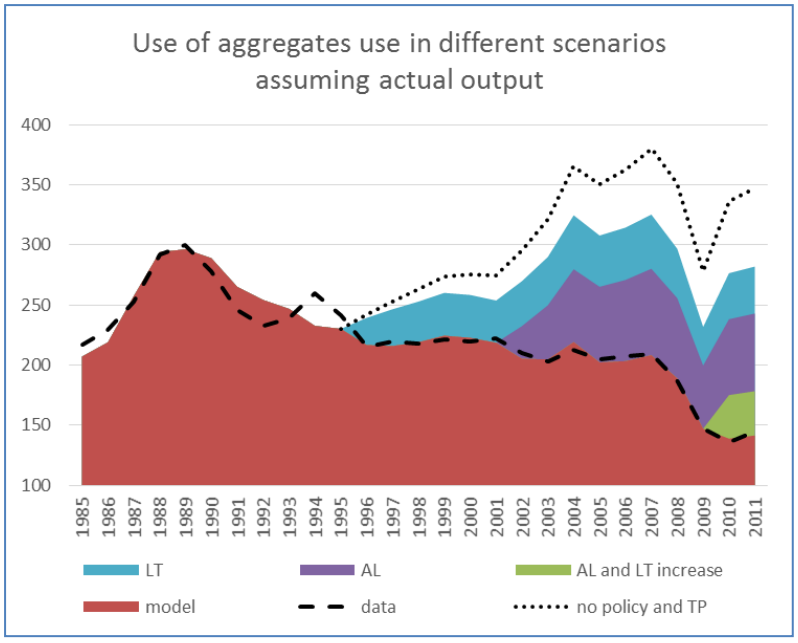
The environmental assessment includes primary, recycled and secondary aggregates. It would not be representative to only consider primary aggregates since the purpose of the policy is to increase the utilisation of secondary and recycled aggregates, which also impact the environment through processing and transportation. A lifecycle approach is therefore used to take into account all consequences of the use of production of primary aggregates, alternative materials and transport. It was deemed unnecessary to consider the construction phase as this is considered the same for both scenarios. Primary aggregates were broken down into land-won sand and gravel, marine sand and gravel and crushed rock.

Figure 12: Volume of construction output with and without policies and technological progress assuming actual extraction of aggregates



Source: Own calculations, WISE Institute.

Figure 13: Aggregates extraction assuming actual volume of construction output with and without different policies



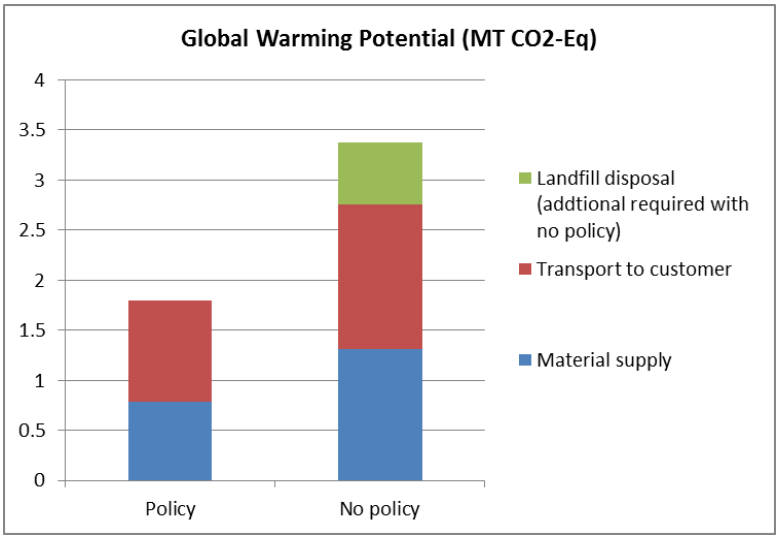
Source: Own calculations, WISE Institute.

The environmental impact assessment shows that there has been a significant reduction in environmental impact due to the introduction of the policies. Lifecycle global warming

potential (not including the construction or use phase, hence a partial 'cradle to gate' approach) has been reduced from 3.38 mt CO_2e to 1.80 mt CO_2e per year, a reduction of 46.7 %. This is highlighted in Figure 14, which shows that there is a reduction of impact for both the supply of materials and transport, as well as from the reduced landfill disposal of aggregates[5]. For each of the 63.7m UK citizens, the reduction in annual global warming potential is approximately 25 kg CO_2e per year.

Figure 15 shows the reduction of environmental impacts across nine impact categories, based on lifecycle analysis software and further studies[6]. Generally the policy has reduced impacts by at least 30 % across all categories, with some reduced by up to 90 %. It can be seen that eco-toxicity has particularly been reduced due to the reduction in landfill disposal.

Figure 14: Global warming potential of policy and no policy scenarios

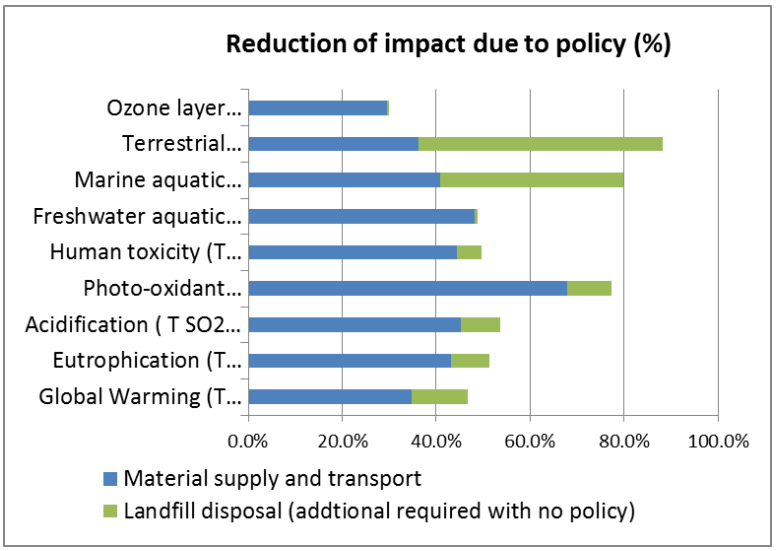


Source: Own calculations, IVL.

[5] It should be noted that this only accounts for the difference in the two scenarios, i.e. the savings in landfill from the increased use of recycled aggregates. The policy scenario also has a landfill component that is not included, whilst disposal under the 'no policy' scenario would also be higher.

[6] The calculations were performed using GaBi lifecycle assessment software, with various input data particularly from Korre and Durucan 2009. Life Cycle Assessment of Aggregates. Report for WRAP, UK. EVA 025 – Final Report: Aggregates Industry Life Cycle Assessment Model: Modelling Tools and Case Studies.

Figure 15: Reduction of impact due to policy for each of the impact categories



Source: Own calculations, IVL

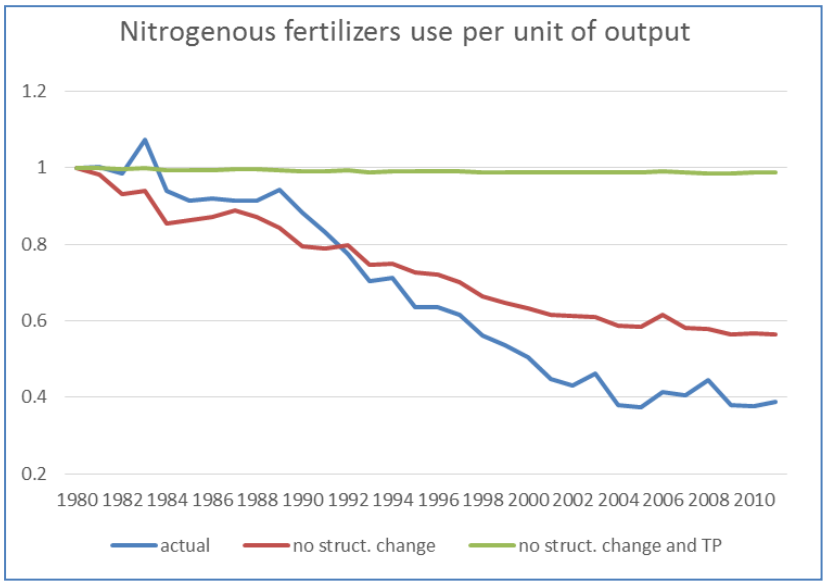
4.3 Denmark's fertiliser use – structural change or policy effect

The Danish fertiliser use case is quite difficult to analyse quantitatively for several reasons. Firstly, the policies were introduced gradually and often with many changes taking place at the same time so it is impossible to precisely indicate specific years after which changes took place. Secondly, agriculture is a specific sector in which production declined in highly developed countries rather than increased, at least in monetary terms. Thirdly, fertilisers are not the most important production factor for the agriculture sector and they can be easily substituted to a certain extent by land, capital or other methods of cultivation. Therefore, some important structural changes may be observed and described in Scandinavian agriculture in the last twenty years, but it is not possible to link these to particular policy measures in a compelling way, although they can be attributed to policies in general.

To assess the impact of policy on agriculture in Denmark, a comparative approach was taken, comparing Denmark with a similar country - Sweden. These two particular countries were compared for several reasons. First, they are next to each other and their climate and natural resources are quite similar. Second, they are both well developed countries and have access to the same technologies. Third, the internal structure of agriculture in both countries is similar with a large share of dairy farming and pork production. Consequently, the difference between them should be the effects of their policies; the similarities can be presumed to be the effect of global processes, changing world prices of production factors, climate change and other phenomena affecting both countries to the same extent. Changes in utilisation of five production factors were decomposed into structural change and rise in their overall productivity (total factor productivity, TFP), reflecting the impact of technical progress on efficiency. An assumption was made that, in general, policies influence the relative prices of production factors and thus they will change their use – they will foster substitution of fertilisers by other production factors such as capital or labour. This basic assumption led to

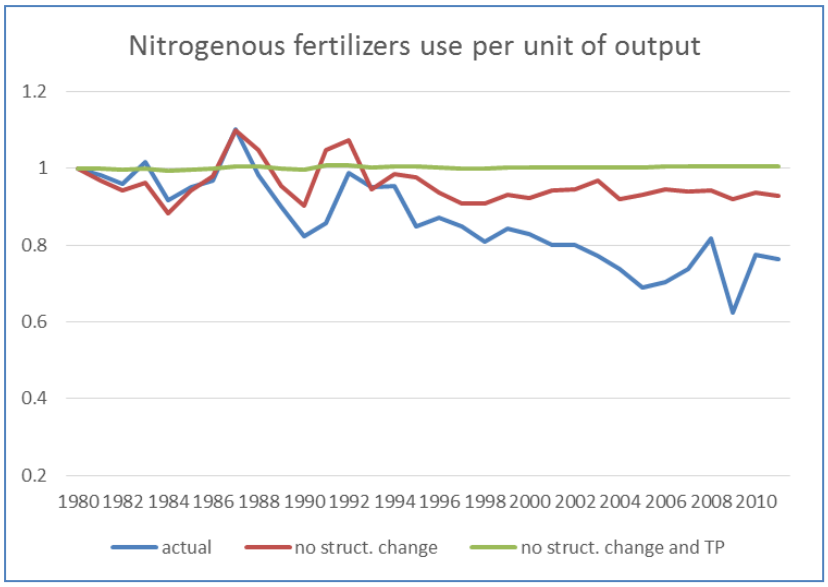
estimating the impact of policy on fertilisers us (in particular potash, nitrogenous, and phosphorus).

Figure 16: Nitrogenous fertilisers used per unit of output – Denmark, (1980=1)



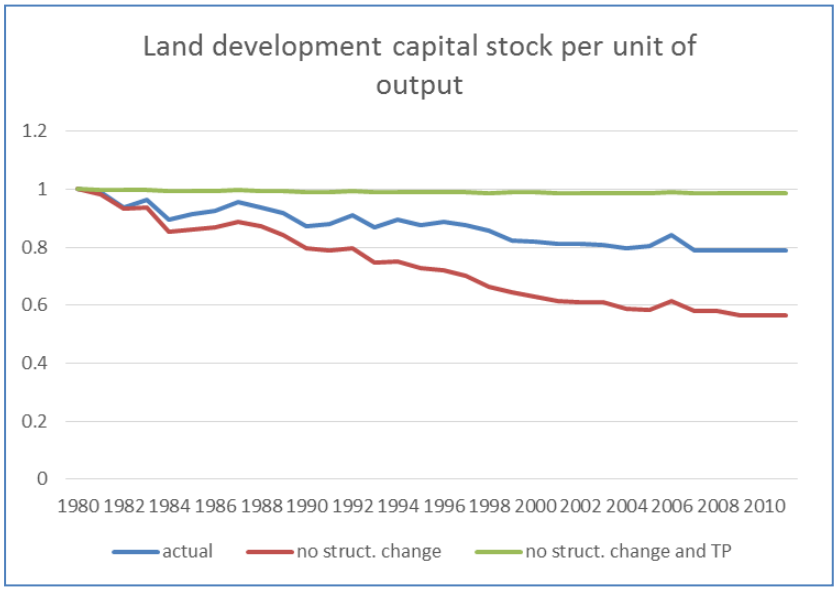
Source: Own calculations, WISE Institute.

Figure 17: Nitrogenous fertilisers per unit of output – Sweden, (1980=1)



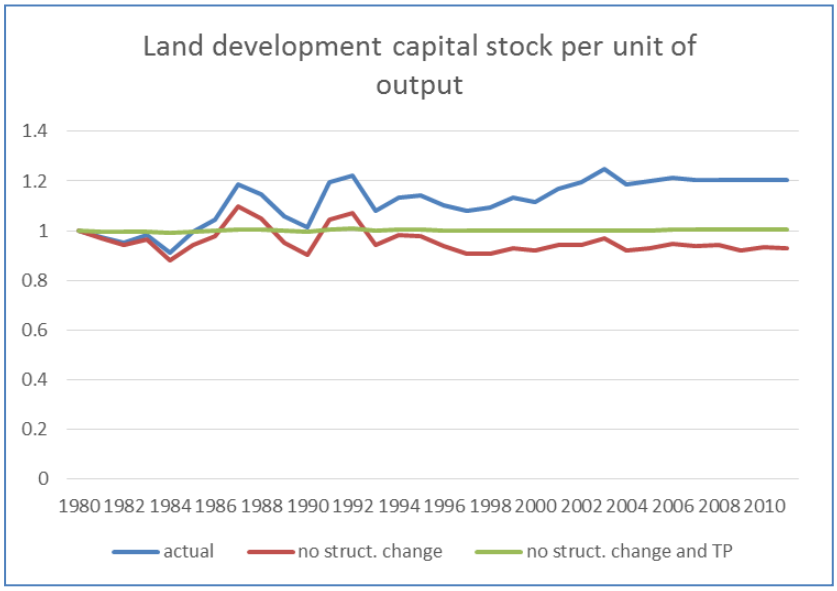
Source: Own calculations, WISE Institute.

Figure 18: Land development capital stock per unit of output – Denmark, (1980=1)



Source: Own calculations, WISE Institute.

Figure 19: Land development capital stock per unit of output – Sweden, (1980=1)



Source: Own calculations, WISE Institute.

Figures 16-19 show fertiliser and capital use in Danish and Swedish agriculture. In the hypothetical “no policy” scenario the use of the former would be bigger and of the latter would be smaller, suggesting that policies to some extent induced substitution of fertilisers by development of capital stock. However, the scale of substitution is greater in Denmark than in Sweden. Moreover, a smaller impact of technological change was observed in Sweden, which might be to some extent an effect of differences in policies.

The main environmental areas of concern with regard to agricultural fertiliser use are the leaching of nutrients to waters, causing eutrophication and emissions of greenhouse gases. The leaching of nitrogen originating from manure and nitrogen fertilisers also results in substantial emissions of nitrous oxide (N_2O), a greenhouse gas 310 times more potent than CO_2, through bacterial processes. Although methane emissions are not the direct result of the application of fertilisers, they are considered here because they are intricately bound up in the management of manure. Methane emissions are mainly due to livestock and enteric fermentation; manure management is responsible for about 30 % of total methane emissions.

Due to the complexities of modelling the farming system and data limitations, a combination of approaches was required for different parts of the lifecycle. Lifecycle assessment (LCA) software was used for the start of the supply chain, which includes raw material extraction, fertiliser production and transport to the farm (manure management was calculated using another method, see below). Standard data was used within the LCA programme that gave generic environmental data for European production and transport of nitrogen, phosphorus and potassium fertilisers.

Table 5: Summary of GHG emissions from agriculture with and without policies

Fertiliser production	2,860	1,780	37.8 %
Emissions of N_2O from agricultural soils	6,786	5,118	24.6 %
Manure management (CH_4 and N_2O)	1,669	1,711	-2 %
Total	**11,315**	**8,609**	**23.9 %**

Source: Own calculations, IVL.

Table 6: Comparison of eutrophication potential of production and after use stages

Production of fertiliser	9.26	5.37	42.0 %
From on farm use			
N to groundwater	96.31	62.70	34.9 %
N to rivers	42.62	29.92	29.8 %
N to sea	37.29	24.18	35.2 %
P to sea	11.35	6.29	44.6 %

Source: Own calculations, IVL.

Table 6 shows a comparison of the eutrophication potential resulting from the production and on-farm use phases. The reduction in fertiliser use has resulted in a 42 % reduction of eutrophication potential for production. Similarly, there has been a reduction of 34–45 % in eutrophication potential for the leaching quantities from the on-farm use of fertilisers.

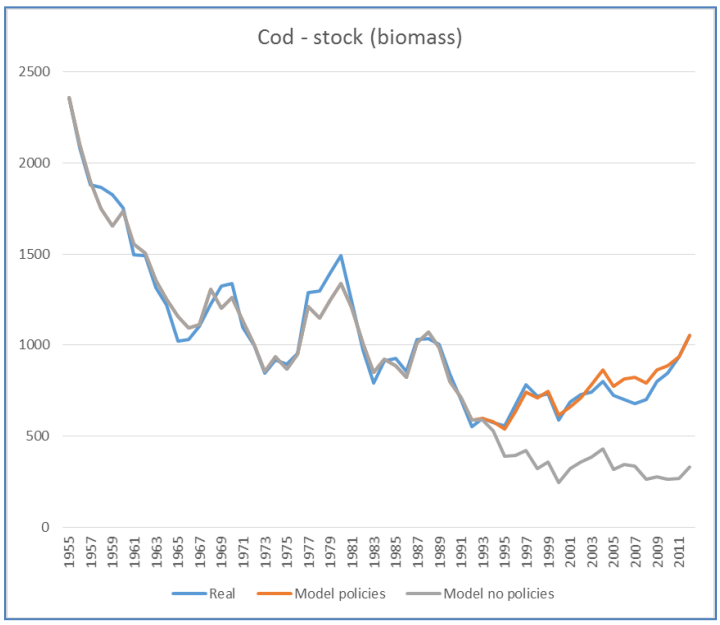
4.4 Fish stock and catch in Iceland – are quotas efficient?

To model fish quotas, a simple fish population model was developed based on the Gordon-Schaeffer approach. This model employs a simple differential equation approach to depict the evolution of fish population over time. As fishermen aim to maximise their profits, the optimal harvest rate, measuring effort that is put into fishing activities, can be estimated econometrically, taking into account current fish populations and the efficiency of fishing processes. As can be expected, a harvesting rate that is optimal from a fisherman's profits point of view is far beyond the level that ensures the sustainability of fish stocks.

Assuming that in the absence of policy, fish catch will follow the optimal pattern derived from the model, we can present the effects of introduction of policies on fish stock, fish catch and harvest rate. We estimated the impacts for four species – cod, saithe, herring and capelin. Here we present only the highlights for cod. Details and methodology can be found in the background report (Bukowski and Gąska 2013).

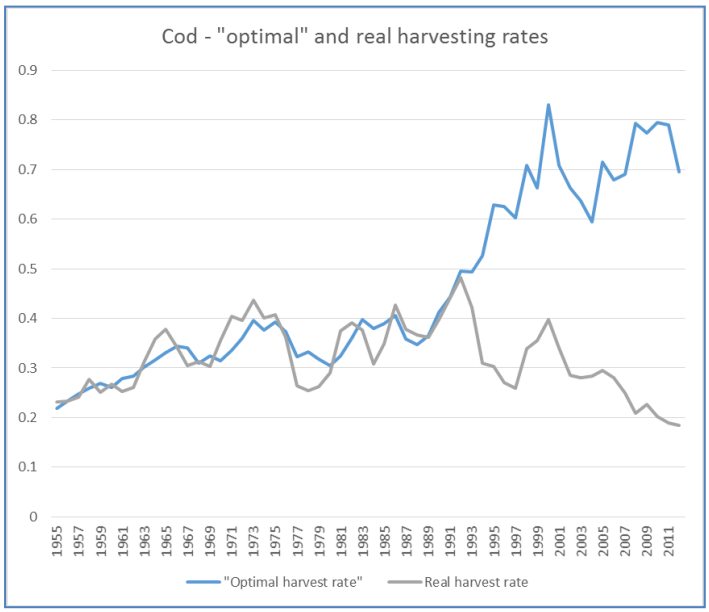
Figure 20 and Figure 21 show the evolution of biomass of cod over the last 30 years, their real and 'optimal' harvesting rates and the effects of the policy mix studied. Cod was chosen to highlight because for that specimen, the time series for harvesting rate and fish stock generated by the model were very similar to those observed in reality. Therefore, we can assume that the model reflects the real world quite well, and that factors not considered in the instrument are of relatively low importance. However results were similar for all other species, but as the impact of factors that are not reflected in the modelling approach was more important, the results are less robust. Details can be found in background report (Bukowski and Gąska 2013). Quotas were introduced in the early 1990s and had an impact of reversing the increasing trend in harvesting rates. Due to the policy instrument, gradual decline in fish population could be reversed and decline in harvesting rates allowed the fish stock to recover.

Figure 20: Evolution of biomass of cod – real and predicted by the model in 'policy' and hypothetical 'no policy' scenarios



Source: Own calculations, WISE Institute.

Figure 21: Real and 'optimal' harvesting rates of cod



Source: Own calculations, WISE Institute.

4.5 Metals in Japan

The aim of the Japanese *Sound Material Cycle Society Plan* was to reduce material use in general and critical metals in particular. However, the effect of policies on rare earth imports to Japan is barely visible.

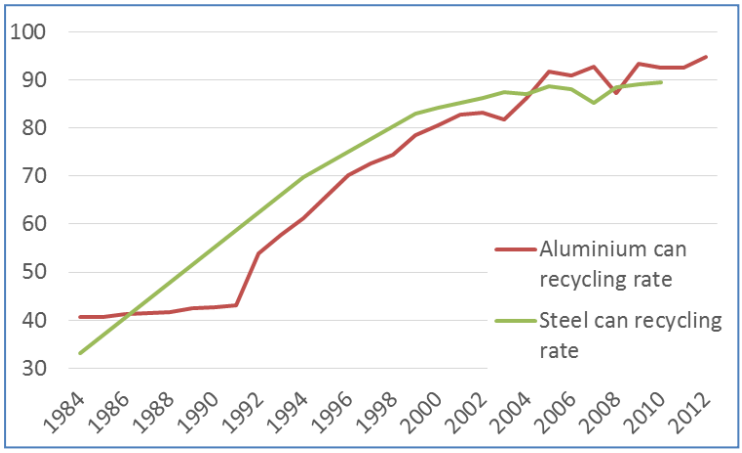
Metals are quite easy to recycle, and their recycling can be profitable from a purely economic point of view. They retain their utility value during the lifecycle of a product. Moreover, they can be easily restored to their initial quality and as they are quite expensive to extract, many producers have developed technologies that allow them to use primary and secondary metal compounds interchangeably. Furthermore, most non-ferrous metals are extracted from ores that contain only a small percentage of material in the long and energy intensive production process, therefore it is easier and cheaper to acquire them from used products.

As a consequence of these characteristics, recycling of steel, iron and non-ferrous metal became common even before 2000, when the *Sound Material Cycle Society Plan* was introduced. Figure 22 shows recycling rates for aluminium and steel cans, but similar figures are also valid for other metal products. However, recycling of rare earth metals is quite difficult, because they are used in very small quantities, and techniques of extracting them from scrap are still quite uncommon and expensive. Hence, as shown in Figure 23, rare earth metals imports to Japan is strongly correlated with the value added in the machinery and equipment sector. Moreover, econometric analysis proved that changes in rare earths imports to Japan can be entirely explained by variations in prices of those resources, technological trends and changes in the value added in the machinery and equipment sector. Therefore, recycling rates of such metals are still very low and policies have not yet been successful in overcoming technological difficulties with rare earth metals recycling.

In summary, quantitative analysis brought two important conclusions. First, recycling of steel, iron and non-ferrous metals - abundant resources widely used in industry - is very profitable

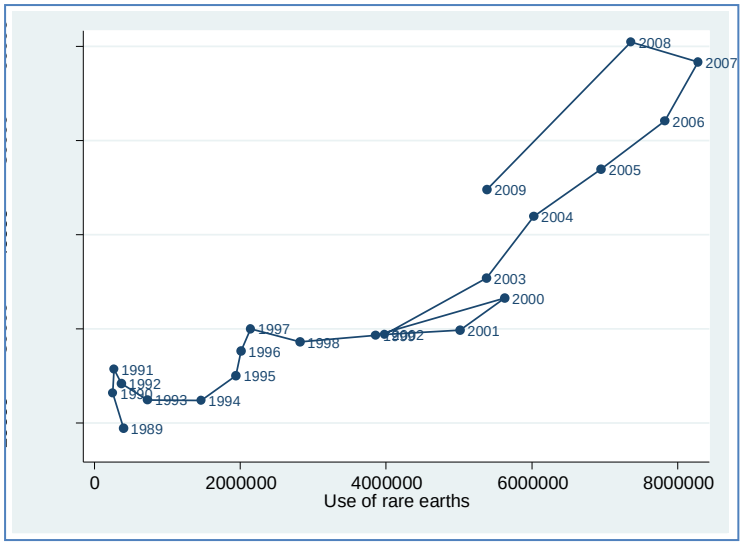
due to specific properties of these resources and policy plays a minor role in improving recycling rates of these metals. The main culprit is the economy and profitability of use of secondary materials. Second, the methods of extracting rare earth metals from scrap for recycling are still not mature enough to be widely used. Consequently, policies aiming at improving recycling rates of materials should be directed towards fostering technological progress in the area of rare-earth recycling. The improvement is already visible in 'the real world', but not yet in statistical data.

Figure 22: Aluminium and steel can recycling rates in Japan, 1984-2012



Source: USGS, Japan Steel Can Recycling Association, Japan Aluminium Association.

Figure 23: Value added in machinery and equipment sector and rare earth 'use'



Source: USGS, Japan Steel Can Recycling Association, Japan Aluminium Association.

4.6 Conclusions

The level of difficulty of analysis of different policy mixes aiming at material efficiency is highly dependent on characteristics of the sectors targeted and their material use and, therefore, so are the effects of the policy mixes. The most appealing numbers were obtained for aggregates in the UK. There are several reasons for that: recycling of aggregates is in general more expensive than extraction, moreover they are not substitutable by other resources. The Danish fertiliser policy mix also proved to be successful: it fostered the replacement of commercial fertilisers by use of capital. Nevertheless, as structural change that occurred in Danish agriculture across the last three decades can be to a large extent attributed to the changes in global environment, it is difficult to extract the pure effect of the policy instruments. Introduction of quotas helped to rebuild fish populations in Iceland, especially for cod. The Japanese *Sound Material Cycle Society Plan* has not yet shown efficiency in reducing metal imports to Japan, largely due to the fact that metals that are abundant are quite easy and profitable to recycle and government intervention is not necessary in that case. On the other hand, it might foster technological progress in rare earths recycling technology, but the results are not yet visible in statistics.

5 Conclusions

5.1 Introduction

Given the diversity in the conception, design, implementation and revision of the policy mixes analysed in this report, it is difficult to draw conclusions or trends. Such comparison is further complicated by the diversity of the resources addressed, and therefore the different needs of an effective and efficient policy mix. Therefore, we limit ourselves to providing some interesting insights into various aspects of the policy mixes, with a particular focus on issues of potential relevance to the EU's path towards a resource-efficient, low carbon economy.

The 15 policy mix case studies and complementary analysis provide a good evidence base on which to draw lessons to help improve existing policy mixes and to better design new ones on a range of natural resources and environmental impacts. As we have seen, the policy mixes evaluated in this comparative analysis have been applied to renewable and non-renewable resources, to abundant and scarce resources, to locally produced and used and to globally traded resources, to specific products or environmental and health impacts.

As the EU continues to develop its policy framework to build a resource-efficient, low-carbon economy, insights and lessons from the real world can shed useful light on some less easily developed areas.

The insights and lessons detailed below are based on all of the policy mixes looked at through the DYNAMIX project, not simply those that have managed to achieve reduced resource use and/or environmental impact.

Natural resource use, as for many environmental problems, is complex by nature. Therefore, the responsible and sustainable management of resources requires policy mixes rather than individual policy instruments. Indeed, the synergetic effect of multiple instruments if often greater than the sum of their parts, effecting greater change overall due to the instruments' reinforcing nature. **Effective management of policy mixes is heavily dependent on policy coherence**, both within the same field such as environmental policy and most importantly across different policy fields (OECD 2007b). This then requires shared objectives across policy fields. For example, the EU's 2010 economic strategy "Europe 2020" begins to marry economic and environmental policies, particularly with its objective of creating a resource-efficient, low-carbon economy. Despite this, the continuing financial and economic crisis since 2008 has put considerable pressure on EU and national governments (and also sub-national levels) to focus on more immediate public concerns, the duo of 'jobs and growth'. Such an approach tends to marginalise environmental (and many social) aspects as they are considered a threat to growth and competitiveness. Such an approach is also resistant to the change needed in a resource-constrained, increasingly populated planet with increasing demand for all resources, whether renewable or not.

Various drivers encouraged governments (at national and local levels) to introduce the policy mixes evaluated and analysed in this report: from environmental disaster and awareness of negative public health impacts, to ideological belief and EU legislation, to industry pressure and geo-political realities. The EU is on the road to building a resource-efficient, low-carbon economy, and the question is whether it constructs a path that is intentioned and quick to

address difficult issues, or whether it waits for outside pressures to force it to react often too late. The DYNAMIX project was created, and funded, to assist the EU in the former option. Some insights follow to help contribute to that construction.

5.2 Key factors of success

Evaluating the responses of different governments to a range of issues relating to resource use has provided insights across an interesting breadth of factors that have helped or hindered success. Below we explore strengths and weaknesses identified in a policy mix's ability to achieve decoupling – this of course depends on the aims and objectives of the policy mix, but also on the instruments included in the mix. This builds on the 15 case examples studied in depth and complemented by insights from wider literature. These strengths and weaknesses are presented in terms of factors of success or weaknesses and insufficiencies.

Policy mixes focused on a specific resource or sector are more likely to achieve absolute decoupling

The analysis suggests that the most effective policy mixes in terms of decoupling value creation from resource use have been those that could be tailored to a very specific sector given the strong reliance of that specific sector on the resource at stake or a given sector's responsibility for the overuse of a specific resource (or emissions to an environmental media). Amongst the case studies which have achieved absolute decoupling are Iceland's fisheries management, the UK's primary aggregates consumption, Denmark's fertiliser use, and plastic bag use in Ireland. Three of these case studies focused on specific sectors or resources/products: Iceland's fisheries, the UK's aggregates, and Ireland/UK's plastic bags. Denmark's fertiliser use has been absolutely decoupled from agricultural production, but the large number of sources of fertiliser use (farmers) and the various types of activities affecting fertiliser levels in run-off have required a complex policy mix over a long period of time (first policy instruments were introduced in 1985).

Where pressures emanate from a wide range of disparate sectors or actors and/or the resource targeted is an internationally traded commodity, designing an effective policy mix is much more challenging. This potentially explains the moderate success of policy mixes to reduce land take (in Germany and the UK) – for which only relative decoupling was achieved – and sustainable forest management in Finland, reduction of food waste (UK), increasing energy efficiency in industry (in Portugal) – where no decoupling was achieved.

The complexity of the resource through the economy is an overriding factor in the level of complexity needed in the policy mix - there is no obvious trend between the absolute number of instruments in a policy mix and its effectiveness

In addressing resources used in various sectors and potentially for different uses in an economy, policy mixes will need to reflect this complexity. The Tinbergen Rule[7] states that for

[7] The Tinbergen Rule was named after the Dutch economist, Jan Tinbergen. His Rule the states that for each and every policy target there must be at least one policy instrument. If there are fewer instruments than targets, then some policy goals will not be achieved. However, public policy is more complicated than this, as some policy instruments help achieve more than one target, some policy

each policy target there must be at least one policy instrument, although this is also seen as too simplified an interpretation and has been elaborated to one policy instrument per *aspect* of a policy target. OECD work has also highlighted the need for one policy instrument per *market failure*, to correct this failure effectively (OECD 2007a).

The 15 case study policy mixes tended to rely on a great variety of instruments usually including a combination of regulatory, market-based, voluntary and information-based instruments. The evidence suggests that successful policy mixes relied on a combination of different instruments types in the pursuit of a clearly defined policy objective. However, there was no obvious trend between the absolute number of instruments or instrument types in a policy mix and the mix's effectiveness.

Some of the most effective policy mixes have for example relied on a very limited number of instruments from across a limited range of instrument types. This is reflected in the relatively simple structure of policy mix cases such as UK aggregates, Iceland's fish, and Ireland/UK's plastic bags, all of which featured no more than 3 policy instruments and which had more or less immediate effect in moving towards absolute decoupling. For resources with complex use through the economy, policy mixes have needed to be more complex and long-lived. For example, the Swedish and Danish fossil fuels and the Danish fertiliser use case studies, despite decades of policy development and use of various instruments, have resulted in relative decoupling (for fossil fuels) and absolute decoupling but not within limits (for fertiliser use). It is not possible to generalise based on this narrow an evidence base, but an assumption can be made that more complex resources, with many users in an economy and therefore many market failures needing addressing individually, will require fuller use of a range of policy instruments, and such an intricate policy mix ideally needs regular review to assess effectiveness and efficiency of policy instrument design.

Policy mixes need to be designed in relation to the level and type of 'lock-in' to achieve transformation

The ease or not of change and transformation is dependent upon the level of (inter)dependency or 'lock-in' of economic and social systems in relation to the resource or product in question. Systems thinking is required, to understand the range of inter-linkages, and to identify where there are issues of particular lock-in, or market failures that need addressing. This will help identify what instruments are most appropriate to effectively and efficiently meet political targets. An important factor in 'lock-in' is the ease of substitutability of a resource or product that relates to the existence of alternative products (e.g, from plastic bags to cloth bags) or processes (e.g. from fossil fuel-fired energy generation to renewables), or means of supplying a service (e.g. private transport and public transport). Where decoupling is sought through substitutability it must be recognised that such substitutability can be very different across areas. Examples include the immediate substitutability is possible in the context of the plastic bag; both immediate and longer term in the energy choice (immediate for output at a given time, and longer term for building of new power plants); and short and longer term in transport decisions (short term for social norm changes, as it is seen

instruments affect more than one target, and some policy instruments may meet one target but in so doing make the meeting of other targets more difficult.

as more socially appropriate to use public transport rather than the car, and longer term for public transport infrastructure introduction and extension). In short, demand for certain products are highly inelastic in the short term; and can become more elastic over time – the level of elasticity depends on the existence of substitutes/alternatives, incentives and social norms.

A clear understanding of limits and thresholds encourages more effective moves towards absolute decoupling

Some of the most effective policy mixes explicitly identified limits or ecological thresholds and were designed to achieve resource use reduction in order to stay within these limits. The scientific work underpinning the identification of the instruments for those policy mixes contributes to increasing the legitimacy of the policy mixes introduced. Examples include fisheries in Iceland, where the setting of total allowable catches on how much fish can be caught were a key element in the policy mix. This also underlines the importance of defining the limits with reference to the appropriate geographic scale.

Denmark's case on fertiliser use is another example: clear targets were set and the estimated contribution of the various initiatives was also provided. Where impacts of the policy mix on resource stocks and environmental media can be effectively measured and monitored, the policy mix can be more adaptive and responsive to changes. Although in theory, sustainability limits can be identified in forestry and wood removal targets set according to these, the fact that wood is an internationally traded commodity makes it difficult for national policy makers to ensure that value creation in the wood industry decouples from the adverse environmental impacts of wood production (e.g. deforestation, biodiversity loss, etc.).

Internationally traded resources require policy mixes addressing global impacts of resource use, particularly imports

Apparent decoupling of a domestically-supplied resource use and/or its related environmental impacts and an economic variable can falsely present a more sustainable picture than is truly the case if there is an increase in imports of the resource. As was seen in the Finland wood case study, sustainable harvest levels of domestic forests was partly explained by an increase in imported wood and wood products, most likely from unsustainably (illegal) managed sources. The same can be said for any policy mixes addressing environmental media, as air is a transboundary media, and both water and land (pollution) can be. To focus too narrowly on domestic resource use and domestic impacts and not taking account of the global impacts of internationally traded resources is to ignore the 'burden-shifting' that can often come with greater negative environmental impacts if resources are sourced from outside the EU.

Policy mixes addressing all phases of the policy cycle are more likely to be effective in the long term – especially having targets and built-in monitoring, review and response mechanisms

Policy development can be seen as an iterative process: the development of a policy moves through a cycle of stages, from issue identification (e.g. of a problem that needs to be addressed through policy) through to evaluation (e.g. of a policy's effectiveness). The cycle

can be divided into different intermediate stages such as planning, implementation, monitoring and revision. Figure 24 below depicts a cycle with 9 stages.

Figure 24: Example of a policy cycle

Source: taken from Bassi et al., 2011, based on TEEB 2010.

More regular provision of harmonised data can be expected from ongoing efforts at data collection, for example through the strengthening of environmental economic accounts that should lead to the development of more robust or new indicators and the setting of more relevant targets. The identification of targets contributes to the effectiveness of the policy mix and, as a policy mix is being designed, targets are key elements at the stages of selection and design of policy options (Bassi et al. 2011).

Denmark's fertiliser use policy mix is a good illustration of how continued monitoring can serve as a trigger for progressive tightening of the policy mix in light of trends showing that additional policies and measures were needed if set targets are to be achieved. A particularly important instrument with respect to monitoring was the introduction of fertiliser accounts: since 1993/94 farmers have been required to produce accounts to track fertiliser use as a means of regulating fertiliser use and management. When the accounts requirements were introduced, they were originally voluntary, but after a review of the performance against targets, the government made the accounts mandatory, to ensure stricter adherence to fertiliser use limits. This created the data for the development of an effective policy response.

Other policy areas have also seen successful policy mixes relying on the introduction of instruments to facilitate monitoring. Given the scarcity of water resources in Australia, a system of water accounts has been recording annual water consumption per sector of final use (e.g. agricultural, households) since 2000-2001 (with more frequent data from 2008). This has enabled monitoring of the water trading system, which has reduced and shifted water use across sectors (see Box).

It is therefore not surprising that difficulty in monitoring trends seems to be one of the factors that undermines progress towards decoupling, as illustrated by the UK food waste case.

Box 3: Water accounts in Australia

Water management in Australia is an important issue due to frequent droughts and water shortages (aggravated by climate change) that result in economic, environmental and social costs. In the 1990s, Australia introduced a policy mix with the objective of ensuring a productive and efficient water use and returning water extraction to sustainable levels. This policy mix resulted in absolute decoupling over the period 2001 to 2011.

The policy mix began in 1994 with the Council of Australian government's Water Reform Framework that envisioned a variety of instruments that came into force with subsequent legislation. This included a water trading system (the primary instrument that efficiently allocates water resources to users that value it most, so that it is optimally allocated). To monitor the evolution of water consumption, the Australian Bureau of Statistics developed a series of water accounts published annually, which distinguish between different sectors as regards water use that allow to assess the progress of the water pricing initiative (by analysing the shift of water use per sector).

Sources: Australian Governmen. 2004, Mudgal et al. 2010.

Effective policy mixes struck the right balance between effectiveness and acceptance

Correctly framing the resource use problem at stake and clearly identifying the actors and sectors that should be targeted by the policy mix are central to designing an effective mix. Once those sectors required to increase their resource productivity have been identified, care needs to be taken in designing the policy mix in a way that allows different sectors to adapt in different ways and occasionally over different timeframes. These differences need potentially to acknowledge differences in investment cycles in different industries. Nonetheless, effective policy mixes require strong political leadership, particularly in effective, transformative change in sectoral practices.

In the case of the UK aggregates, the recycling of parts of the aggregates levy revenues generated (via the Aggregates Levy Sustainability Fund) is thought to have made the introduction of the levy more acceptable to the extraction industry affected and helped the sector further reduce its environmental impacts. Also, work between the government and the industry sector began a few years prior to the levy's introduction, particularly on reflection on different instruments which could achieve the levy's objectives. Despite the revenue recycling element of the levy, and its effectiveness in achieving sectoral absolute decoupling, the extractive minerals industry continues to resist the existence of the levy. Therefore, a balance between effectiveness and acceptance should be sought as much as possible, but full acceptance cannot be guaranteed.

Beyond the DYNAMIX case studies, policy mixes in the area of carbon and energy taxation in a range of countries have shown that some form of exemptions and/or tax reductions are often a necessary component of environmental tax reform (ETR) and are relied on as a politically expedient measure. However such practices often impair the effectiveness of the ETR as the cheapest emission reduction potential is not exploited. Thus, such provisions need to be designed carefully. (Withana et al. 2013).

The efficiency of policy mixes increased with the predictability of their effects

Successful policy mixes usually result in relatively predictable outcomes (e.g. effects on prices and costs to business, stopping certain unwanted behaviour). Predictability thereby provides the incentive for targeted sectors to make the investments required for increased resource productivity or the phasing-out of certain types of products or materials.

In the Danish phthalates/PVC policy mix, the Danish government and the industry adopted an agreement on the use of PVC in 1991 with the objectives of reducing incineration of PVC, increasing recycling and limiting the use of certain additives in PVC. A 1999 national strategy set a goal of halving the use of 17 phthalates by 2010, while also introducing R&D support and product restrictions (through GPP and ecolabelling). Hence, the Danish government was clear on its intentions to ensure the phthalate/PVC reduction, with clear support to industry to adapt through identification of acceptable substitutes. `

Information instruments can play several roles in policy mixes, and is key in development of natural resources policies. However, used in isolation, they will usually fail to deliver the scale of change required for decoupling.

Transparency is a key instrument for most instrument mixes and can contribute to both relative and absolute decoupling. Various groups of actors have to be provided with information for a successful transition to a resource efficient economy. A range of policy mixes relied on information to consumers by helping credible labels emerge and spread, most notably for wood (e.g. FSC and PEFC) but also for various environmental aspects of products (e.g. the EU Ecolabel, the EU Energy Label, and the EU organic label), and fisheries (e.g. MSC).

Transparency and information on the environmental characteristics of a product may also support GPP (as seen in the Danish phthalates/PVC case), one of the most straightforward ways in which governments can help increase market demand for environmentally friendly/resource efficient products, making them less costly to produce and less expensive for the public (through economies of scale achieved by producers).

In the area of waste policy, information campaigns have also played an important role in the policy mixes, for example in the cases on Slovakia's waste and the UK's food waste. Some policy mixes aiming primarily at changing consumer behaviour even rely primarily on information instruments. This is the case for the Veggie Day in the Belgian city of Ghent (see Box).

Box 4: Veggie day in Ghent

The "Thursday Veggie Day" (*Donderdag Veggiedag*) campaign introduced in 2008 in the Belgian region of Flanders, was officially backed by the city of Ghent in 2009 (Leenaert 2011). It was launched by EVA (Ethisch Vegetarisch Alternatief), a non-profit organisation promoting vegetarianism in Belgium. The aim of the campaign is to promote the adoption of one vegetarian/vegan day a week in schools, canteens, restaurants etc., as well as in private households (EVA 2010a). It also aims to support vegetarian products, but has no further quantitative targets or timetables. Information and voluntary cooperation instruments are of major importance. Voluntary instruments include cooperation with schools and hospitals, and

structural cooperation with European vegetarian organisations and intercultural projects. Information mechanisms include training courses, conferences and meetings, and a focus on education. Financial support from Ghent municipality allowed the introduction of Veggie Days in schools, canteens and hospitals, and to develop and distribute campaign materials. Surveys for Flanders and for Ghent (Leenaert 2011) showed high adoption and popularity of the campaign. The initiative is well integrated into Flemish lives, and a large part of the Flemish population is aware of the campaign and the majority of people take part. 60% of the Flemish population agreed that livestock has a big impact on the climate (70% in Ghent), and half of respondents intended to decrease their meat consumption (EVA 2011b). However, relatively few people consider that their meat consumption has decreased due to the campaign (Debourdeau 2012, Leenaert 2011). While the campaign has high visibility within Ghent and successfully reaches a high number of people, the campaign is too small to identify measurable impacts with regards to decoupling of resource use in relation to the economic performance or well-being. This local initiative has spread to cities worldwide, including San Francisco, Cape Town, Sao Paolo, Zagreb and Washington DC (Debourdeau 2012), and the German cities of Wiesbaden, Bremen, Karlsruhe, Paderborn and Schweinfurt.

Sources: Debourdeau 2012, EVA 2011b, EVA 2010a, Leenaert 2011.

Heavy dependence on information-based tools needs to be handled with care. In product policy, there is a long held perception is that providing the public with more information through labels can help them make more informed (and sustainable) purchasing decisions. Although this may be the case for some elements of the public (informed, interested, curious), and on some issues or products (e.g. wood, coffee, large electronic products, cars), information is only one element of complex purchasing decision-making. Habits, social norms, choice, social status, amongst other factors, also play significant roles.

There is still lack of evidence of the effectiveness of labelling in stimulating behavioural change (Tzilivakis et al. 2010), and evidence from the UK's Defra[8] to a Parliamentary Committee enquiry on environmental labelling identified that "research on consumer choice and behavioural change had demonstrated that consumer information could only bring about significant behavioural change if accompanied by other measures as part of a strategic approach. Commitment is needed throughout the supply chain." (UK Environmental Audit Committee 2009, p. 16).

Policy mixes relying on information instruments as the primary instrument or without more effective instruments (such as regulation or fiscal instruments) in the policy mix, have usually not led to high levels of decoupling (e.g. food waste in the UK, Veggie day in Ghent) as they have usually not delivered the scale of change required to achieve relative or absolute decoupling. In addition, these mixes only seem to have influenced the behaviour of a selected number of consumers but not achieved important and durable shifts in consumer behaviour at large scales. Recent results from Dutch food waste reduction efforts have also identified that information campaigns have failed to meet a 2009 target of reducing food waste by 20 % by 2015, achieving no change in household food waste levels from 2010 - 2012 (CREM 2013).

[8] The UK's Department for Environment, Food and Rural Affairs, providing evidence to the House of Commons' Environmental Audit Committee 2008/9 enquiry on environmental labelling.

However, on a positive note, such information-based activities can help to raise awareness of key issues (e.g. the negative environmental impacts of meat production and consumption) and act as a *precursor* to more ambitious activities in future, for example, the introduction of a meat tax. Therefore, the use of information instruments needs to be considered throughout the future evolution of a policy mix. Another recent example from food waste experience can be found in new efforts by the 4 major UK supermarkets to publicly disclose levels of food waste in their stores, with the first data to be published in early 2015. These group efforts come after one of the retailers admitted in 2013 that it generated 28,500 tonnes of food waste in the first half of the year, with two-thirds of bagged salad being thrown out (in-store or by shoppers) and 40 % of apples wasted. Such public disclosure has helped green campaigners to call for changes to buying and marketing practices. An industry federation response was that the new public reporting initiative would help drive change within the sector (The Guardian 2014).

Similarly, for resources about which relatively less is known, the role of information plays a vital role in setting the scene for future activities. An example of this is a number of existing policy mixes addressing critical metals. Information plays a central role in various activities aiming to improve use of these important metals.

Table 7 provides a summary of four policy mixes – from Germany, Flanders (Belgium), Japan and the EU – which have taken sometimes different trajectories, yet all of which include information tools. It remains to be seen which of these (or other such policy mixes) will be revised in coming years following the provision of key information, and therefore which will be most effective in achieving absolute decoupling in the medium-long term.

In the German case, decoupling of impacts on the environment is not likely to be achieved because the bilateral partnership agreements do not include an environmental dimension and are primarily focused on ensuring stable supplies of metals and rare earths – there is only limited emphasis on recycling and any environmental benefits that would be achieved through recycling are likely to be offset by the lack of standards in primary metals extraction in the partnership countries.

Table 7: Approaches to decouple the economy from the use of critical metals

		Germany (Resource Efficiency Programme)	Flanders (Sustainable Materials Management Programme)	Japan (Policy mix on critical metals)	EU (Raw Materials Initiative)
Purpose	Substitution	Minimising environmental impacts (e.g. research and environment ministries researching phosphate substitution potential)	Substitution, and innovative technologies enabling a minimal use of (critical) materials having a trade-off with the recycling potential	Finding alternative materials (e.g. palladium alternatives have been found)	**Finding substitutes for 3 applications of critical metals looking at the value chain (e.g. funding available for rare earths and platinum group metals)**
	Recycling	Some initiatives (e.g. building stock recycling and pilot plant for lithium-ion traction batteries)	**Promoting research on easier separation of components for particular materials (recycling efficiency) and promoting eco-design**	**Improving existing recycling technologies and their profitability (e.g. magnets, batteries and electronic scrap)**	85% of the WEEE collection stream should be available for the recovery of valuable raw materials, instead of being lost due to improper treatment
	Metals Efficiency	**Programmes such as WING (Materials Innovations for Industry and Society) and in the steel and PV sectors**	Researching nanomaterials with a view to decrease the use of critical metals	Initiatives such as the "Development Project on Rare Metals Substitution" until 2011	Context of EU waste legislation (Waste Framework Directive) and supporting pilot actions
Funding		Subsidies	Research grants	Subsidies	Loans (European Investment Bank and others)
Engaged Sectors		Public sector funded associations (e.g. Federal Institute for Geosciences and Natural Resources)	Researchers from all Flemish universities and an environmental consultancy	Mostly the business sector (78% of R&D is funded and carried out by the business sector)	European Innovation Partnership on raw materials includes industry, national governments, research/academia

* The bolded text corresponds to the major focus of **R&D investment**.

Sources:

http://ec.europa.eu/enterprise/policies/raw-materials/documents/index_en.htm

http://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/progress_en_bf.pdf

http://www.vlaamsmaterialenprogramma.be/documents/19/92b7f316-c069-4377-b4b1-35aa5f4ab55e

5.3 Main shortcomings/inadequacies

Lack of policy coherence or conflicting policy objectives

In a range of cases badly designed policies with unintended corollary effects undermined the original policy mix objectives. This can be seen in the German land-take case where the existence of home ownership subsidies and a commuter subsidy ('Pendlerpauschale) encourages urban sprawl and undermines efforts to reduce land take and sealing. Similarly, fossil fuel subsidies undermine decoupling of growth from fossil fuel consumption and CO_2 emissions, and these continue to grow globally despite international efforts to phase them out.

Gaps and loopholes in the policy mixes

One of the most frequent factors undermining the effectiveness of a policy mix is limited scope. The policy mix can be incomplete for a number of reasons: it fails to comprehensively target all sectors responsible for the overuse of a specific resource, it focuses too narrowly on impacts of resource use accruing domestically but fails to address resource extraction and use impacts across the (global) value chain. The latter can lead to more sustainable *domestic* use of a resource at the expense of the same resource *abroad*. This has arguably been the case in the policy mix for sustainable forestry in Finland, where domestic wood production appeared to have stayed within limits while imports of potentially unsustainably harvested (and illegal) wood increased importantly. Similarly, one might consider that the UK's land-use policy mix to contain urban encroachment on fertile agricultural land was a success, but this success might in part be explained by the shifting of industrial production to other countries and significant imports of food products. Hence, the land use impacts are now embedded in the higher number of products imported into the UK.

Another type of loophole potentially undermining decoupling was identified in Japan's Sound Material Cycle Society policy mix: a substantial part of Japanese production requiring critical metals as inputs is exported to countries which do not have the same environmental standards as Japan and where recovery and recycling is not the rule. Were these international flows and the disposal of products produced in Japan fully accounted for, the extent to which Japan's production has decoupled from environmental impacts might have to be called into question. It should be noted that (illegal) exports of toxic waste, including and especially electronic waste, has been identified as a 'major global threat' (BBC 2013), with such exports coming from most industrialised nations (Blacksmith Institute and Green Cross Switzerland, 2013).

Rebound effects insufficiently taken into account in most of the policy mixes

In addition, rebound effects[9] tend not to be addressed in the policy mixes analysed, despite being relevant to a whole range of them, in particular those relating to fossil fuels use. Various studies provide insights based on evidence of the rebound effect in relation to household energy efficiency for space heating/ cooling; (Maxwell et al. 2011); to personal transport, white goods and lighting (Greening et al 2000, Schipper and Grubb 2000, Sorrell 2007, Small

[9] The rebound effect has been defined as "increases in consumption due to environmental efficiency interventions that can occur through a price reduction (i.e. an efficient product being cheaper and hence more is consumed) or other behavioural responses." (Maxwell et al., 2011)

and van Dender 2007); to commercial road transport (Gately 1990, Graham and Glaister 2002, Anson and Turner 2009); and to industry sectors (4CMR 2006).

Targets and objectives that are not fit for purpose undermine progress towards decoupling

Amongst the 15 case studies, there was a strong relationship between policy mixes having clearly defined targets and the extent to which decoupling was achieved. Clearly defined and ambitious targets in policy mixes were more likely to achieve absolute decoupling than those with no clear target or objective. Amongst the policy mixes having achieved absolute decoupling two thirds were developed with clearly defined quantitative targets to be met within a set period of time (Denmark's fertiliser use and phthalates/PVC, Japan's raw materials, Ireland/UK's plastic bags) (See Box for an update on plastic bags). Amongst those that had not achieved decoupling, half of the policy mixes had not been developed in order to meet a clearly defined measurable target (e.g. Finland's wood and the UK's food waste). In addition, the absence of clearly defined ambitions may lead to less effort going into assessing the cumulative effects from the different instruments in the policy mix and ensuring that the policy mix as a whole delivers the scale of change required (as was done in the Danish fertiliser use case). Finally, in most of the cases studied, it appears that the policy mixes were developed with limited evidence on the impacts of resource use over the whole lifecycle (from extraction to disposal), suggesting that a range of the policy mixes were not specifically tailored in order to achieve decoupling across all impact categories over the entire lifecycle.

Box 5: EU policy action on reducing plastic bag use

In November 2013, the Commission issued a proposal to reduce consumption of lightweight plastic carrier bags. Given cross-border impacts on marine environments, the proposal requires Member States to reduce carrier bag consumption through any instruments they may deem necessary, for example economic instruments. Also in its proposal, the Commission states that the establishment of EU-wide targets would be difficult to design and implement, so setting of targets at Member State level is suggested but not mandatory.

In January 2014, European Parliament approved a resolution on the Commission's public consultation on plastic waste, and went beyond its original ambition by proposing that lightweight plastic bags should be banned by 2020. Parliament stressed that plastic waste continues to damage the environment as there is weak enforcement of EU waste legislation and there are no specific EU laws on plastic waste, despite their unusual properties.

According to Parliament's rapporteur on the plastic bag file, Vittorio Prodi: "We … want to change bad habits and account for our products, from production through to final disposal. By putting these products to good use and recycling them as much as possible, we close the loop and give effect to the concept of a 'circular' economy. This will also help to clean up our seas and land, while creating more job opportunities". Another MEP, Margrete Auken, said that the absence of targets in the proposal "will clearly undermine the prospect of ensuring a reduction across the EU", to prevent that "only those Member States that want to act will do so".

Sources: European Commission. 2013. European Parliament website 2013.

5.4 What has driven decoupling

Environmental catastrophe and resource scarcity concerns have acted as an impressive driver for change

We do not want to suggest that the EU should await such events before putting in place a policy framework addressing natural resources, rather we provide examples of the level of action that is possible when catastrophic events occur. Iceland's fish policy mix was inspired by the **collapse of herring fish stocks** in the late 1960s, and **mass fish deaths** in Denmark in the 1980s resulted in significant action to improve water quality (including fertiliser use reduction). Interestingly, both of these policy mixes achieved absolute decoupling (but only Iceland's reductions are within planetary limits), so both of these are explored in more detail further in this section when looking at policy mixes that achieved absolute decoupling.

The 1970s oil shocks spurred activity in a number of countries around the world. These activities were driven forward in the 1990s by the **rise of scientific knowledge and evidence of climate change and an international political agreement to cut greenhouse gases** (the Kyoto Protocol). More recently, **energy security** has also driven policy action. From the cases studied, Denmark introduced energy taxes in the 1970s on various energy products and on heating, followed by a CO_2 tax on household and industry energy consumption in 1992. There are also taxes on fuels for internal combustion engine vehicles. In terms of political strategy, Denmark's strategic documents have for a long time included objectives on security of supply, environmental impact and competitiveness, pushing also for more use of renewables.

In contrast, Sweden's first energy tax was introduced in 1924 on petrol and diesel, followed in the 1950s by taxes on electricity, oils and coal, and eventually on liquid petroleum gas and natural gas. A carbon tax was also introduced in 1991, followed by a CO_2-based vehicle tax. Hence taxation of energy use **did not require environmental shocks**.

For both Sweden and Denmark, despite these long-standing and comprehensive policy instruments and mixes, 'only' relative decoupling has been achieved (although Denmark appears to be transitioning to absolute decoupling). This is not to say that the policy mixes or approach are failures, rather it is meant to illustrate **how strongly these economies are coupled with energy use** (as is the case for most, if not all, other countries). **Transformation of key sectors**, in energy production as well as significant energy consumers, makes up their latest climate and energy strategies to achieve ambitious GHG reductions (and for Denmark total fossil fuel-independence) by 2020 and 2050 for Sweden and Denmark, respectively.

Some products or resources are selected due to their 'totemic' image in society

Examples of these include Finland's **wood** (in a society with a strong relationship with nature/forests and an economy dependent on wood-based products), the UK's **food waste** (a sign of wasteful lifestyles), and the Ireland/UK **plastic bags** (as a proxy for (over)consumption) policy mixes. Notably, only the plastic bags policy mix has achieved absolute decoupling amongst these three. Plastic bags have been taxed or banned in a number of countries globally, due to the environmental damage caused to the wider environment and especially water ways (littering, ocean contamination, other environmental pollution, health hazards, etc.). These bags are widespread, often free, visually intrusive,

persistent once littered, and often excluded from recycling schemes. As a symbol of disposable consumerism, policies to address them also have a role in raising environmental awareness more generally.

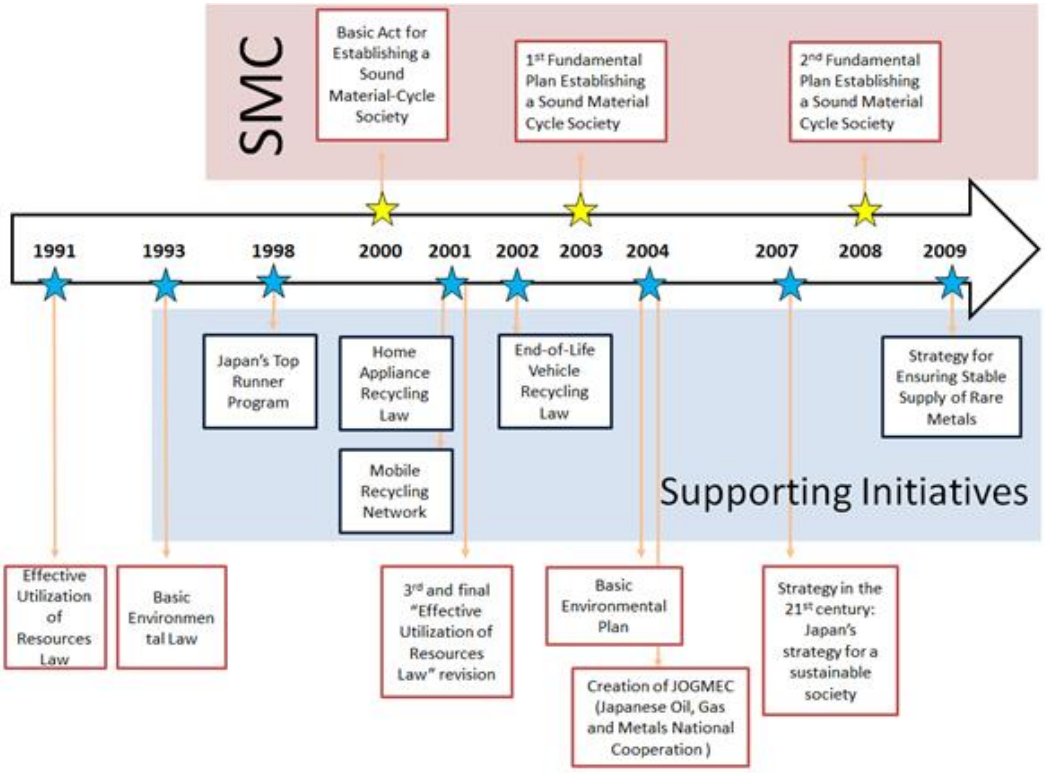
Effective policies are designed to evolve over time according to changing priorities

With the exception of discreet resources used by a clearly defined and small-sized industry sector (as per the aggregates sector), or products providing simple uses (and which can be easily substituted – as per the plastic bags case), most policy mixes take a longer time (one to more decades) to achieve objectives. This is particularly the case for resources that run through the economy in a more complex way (as per fertilisers), or where there is a very close relationship between resource use and economic performance (as per fossil fuels).

Japan's Sound Material Cycle Society (SMC) is an example of a policy mix that has **evolved over time according to different needs**. Japan has few domestic natural resources, and is well-known for its high resource productivity levels. An expected increasing dependency of high-tech industries (the major exporters of Japan) on imports of raw materials, including critical metals, in Japan and in the rest of the world encouraged the Japanese government to take initiatives in order to foster its SMC approach. An initial law in 1991 on the Promotion of Effective Utilisation of Resources was introduced, and re-enforced in 2000 with the Law for Creation of the SMC Society. Subsequent Plans for Creation of the SMC Society have included instruments to implement these laws. The second Plan was Japan's first policy to recognise the importance of critical metals and address management of their waste. It also **introduced overarching targets after a policy review identified their absence as a weakness in the policy**. As a result of the full SMC policy, efforts on appliance recycling and security of supply of these critical metals emerged. A number of pieces of waste management legislation contribute to the SMC society, although we have added these to the policy mix based on our own subjective judgement (see Figure 25).

As we saw in Table 7, providing an excerpt of policies addressing critical metals developed in a number of countries globally, much focus is on strengthening existing waste legislation (ensuring higher levels of recycling of products containing critical metals) while also addressing R&D and innovation, including substitution of resources. Notably, however, there is more focus on supply (through recycling) than on exploring how to set clearer eco-design requirements for electronic products. This could be explained in the initial focus on substitution and R&D. As most of the policies are very recent, these are still early days to be able to expect visible results.

Figure 25: Japanese Sound Material Cycle Society policy instruments



Source: Own compilation, IEEP.

5.5 Applying real world experience to the EU

Although some of the policy mixes evaluated included elements of EU legislation, for the most part the policy mixes evaluated were created independently (although not in isolation) of EU legislation, addressing a national need. In particular, climate change, energy, water and waste policy formed the basis for some of the policy mixes, or added to them considerably.

Admittedly, EU policy is more complex and difficult to develop, given a number of key factors including limitations set out in the EU Treaty, the balance of competencies between EU institutions, Member States and regions, the changing roles and willingness of the different EU institutions (European Parliament, European Commission and European Council) to agree ambitious policy instruments and their levels, and Member States' subsequent willingness (or ability) to implement and enforce agreed legislation. Also, there continues to be strong resistance by some key sectors and stakeholders, lobbying EU institutions against ambitious policies.

We analyse briefly here some key highlights from the case studies, drawing conclusions on what can be applied at the EU level and what more will be needed.

There is an important need to address global impacts of EU production and consumption. The EU Resource Efficient Europe Roadmap already includes such consideration of global impacts. However, this is not a guarantee that policy developments will occur or will respect what has been set out. For example, it is not expected that the land communication anticipated in 2014 will address such global impacts. As was seen, especially

from the Finnish wood case study, this is essential if burdens are not to be shifted outside the EU, where often greater burdens are created due to the less stringent environmental and social policies in place. **Integration of global impacts aspects into EU policy will likely be a gradual process as most policies have not yet addressed these.**

Clearly defined political targets are needed to ensure effective and significant reduction in resource use: Of the policy mixes evaluated, those that achieved absolute decoupling for more complex resources – fertilisers and materials - included clearly stated political targets. EU legislation is inherently complex in design, ambition levels and implementation requirements, given that it needs to be most easily adoptable by almost 30 countries having different environmental, social and economic situations. **Targets are necessary at EU level, to ensure that the diverse countries implementing the policy work towards meeting the same objective.** Analysis from the case studies illustrates that long term targets would also be needed when developing policies to achieve decoupling for wood (extra to strategic documents and information instruments). Both Sweden and Denmark have developed much **tougher targets than those set at EU level** on climate and energy, to help achieve reduced GHG emissions. This is also the case for Denmark's phthalates/PVC policy mix, which included clearly stated bans. There is also scope for the EU to take up certain **indicators and targets** beyond those already proposed and under development through the Resource Efficient Europe Roadmap. In particular, targets and indicators on **cyclical material use** and on **final waste disposal volume** (which were already proposed in the 5th Environmental Action Programme but deleted), would be interesting to explore.

Clear requirements and monitoring are needed to ensure that targets are met: Good practice examples from the case studies include Finland's wood policy mix featuring **forest management plans**, Denmark's fertiliser use policy mix provided **clear requirements to a sector** (through national targets, regulated limits and requirements) **and to individual farmers** specifically (through fertiliser accounts, and requirements to receive agricultural funds). Portugal's requirements on company **energy audits and energy consumption rationalisation plans** helped companies identify their energy use 'hotspots' with the aim of better ensuring improvements in these areas. The German and English land use case studies both feature **controlled land planning**. Germany's policy mix also included a progressive instrument on **impact mitigation regulation**. In contrast, England has undertaken a very recent and worrying revision to its planning policies, relaxing restrictions and reducing and eliminating planning laws and guidance.

Market-based instruments, especially taxation, will need to play a stronger role in EU policy. This is likely to be a slow process given EU rules (unanimity voting on taxation), competencies, lack of political will and significant vested interests. A serious break on more effective achievement of Europe 2020's objective of making the EU a low-carbon, resource-efficient economy is the EU Treaty design in relation to taxation. The requirement of Council unanimity to introduce EU-wide taxes looks increasingly outdated in light of the recent creation of various harmonising economic processes and structures. This situation is made worse by the laissez-faire attitude of both the European Commission and a large number of EU Member States in acting on their capacity to introduce identical taxes where governments are willing. Nonetheless, fiscal reform pressure on Member States is beginning to bear fruit

through the European Semester process, the monitoring and review element of Europe 2020. Recommendations from the European Commission to specific Member States has focused on fiscal reform, particularly calling for new environmental taxes (ENDS 2013). Examples of case study resources where taxation and other market-based instruments have played key roles include: Iceland's fish, UK's aggregates, Denmark's fertiliser use, Ireland's plastic bags, Sweden and Denmark's fossil fuels, and Slovakia's waste. An example of recent rejection by Member States of progressive use of market-based instruments is that of the recent review of the Common Fisheries Policy (CFP). The CFP already includes total allowable catches for a large number of fish species, and in principle a system of transferable quotas could be applied at the EU level. In 2013, the European Commission's proposed introduction of **ITQs for all Member States was very unpopular and rejected early on in negotiations.** In Iceland's case, the ITQs also proved unpopular at the beginning, but these eventually yielded excellent results. In any case, Member States are free to establish tradable quotas, as some do, including Denmark and the UK, and resource taxes also.

Tools for transformation are increasingly needed to support radical change in corporate, public administration and public behaviour: Japan's practice of **high investments, R&D** and **working with industry** to develop better methods is an element the EU and its Member States should consider in their policy design. Japan also considered how best to **target instruments at key economic sectors** when concentrating efforts on R&D. Another example of a highly transformational policy mix is Denmark's most recent energy strategy, aiming to achieve a fossil fuel-free energy system by 2050. Denmark has a record of successful energy policies that have already put its economy on an absolute decoupling path. It already has a flexible international electricity transmission network that can accommodate peaks in renewable electricity generation, and it has a strong commitment to R&D and innovation in energy technology that has already placed it at the frontier of the renewable energy sector. Nonetheless, some ideas, if backed by sustained political will can be transferred to other countries: **support for renewables, the shift away from fossil fuels in the transport sector, and energy efficiency in buildings** are a few examples of transferable policy initiatives.

In summary, EU resource use policy is already building upon existing policies in a wide range of areas such as agriculture, air quality, biodiversity, chemicals, climate, energy, fish, waste and wood. In most cases, **effective policy demands setting clear targets, using regulatory instruments supported by economic incentives and voluntary measures, and a built-in consistent monitoring system for the policy to be successful.**

5.6 Next steps for Dynamix

The DYNAMIX project features reflection on reasons for resource inefficiency and ex-post evaluations of existing policy mixes, to have a better understanding of underlying factors driving over-use of resources and to learn from real world experiences in trying to reduce resource use. This comparative analysis, along with the separate reports on the case study summary and the full case study evaluation reports, provide the ex-post analysis element.

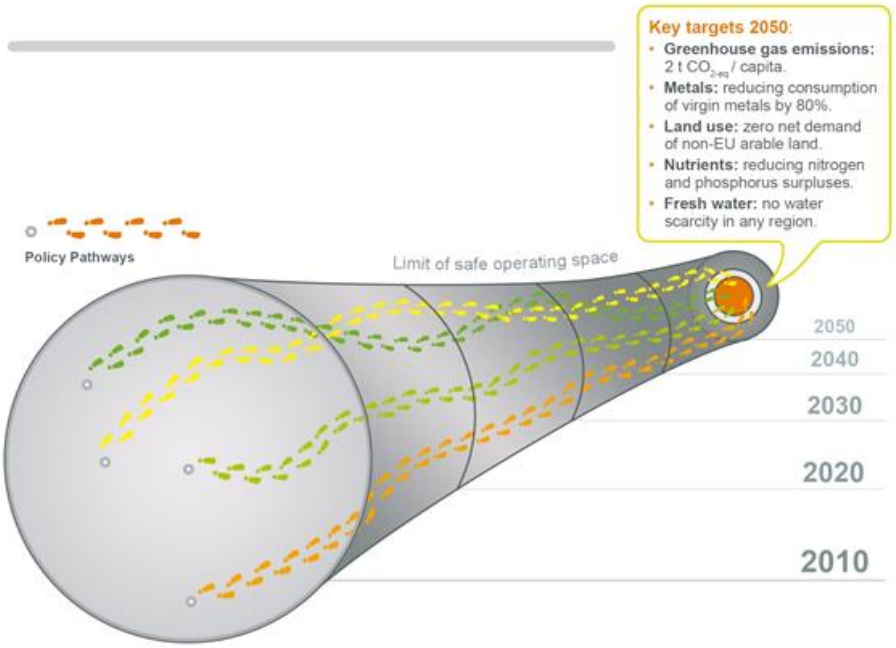
Next steps in the project are to develop between 3-5 policy mixes that could achieve absolute decoupling of resource use and its related environmental impacts from improvements in wealth and well-being. Figure 26 below provides a visual representation of the policy mix

pathways to absolute decoupling by 2050, as well as the elaborated 2050 targets developed in the DYNAMIX project.

These will then be evaluated ex-ante against environmental and social impacts. The evaluation will also address qualitative issues that a separate modelling exercise cannot address, public acceptability and behavioural policy enhancements, governance aspects, and a legal assessment.

Both the policy mix development and the ex-ante assessments will be delivered throughout 2014 and into early 2015.

Figure 26: DYNAMIX 2050 targets



Source: Umpfenbach 2013, p. 19.

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