Assessment of resource efficiency indicators and targets

Final report – Executive summary

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Executive summary

Our successful economic development over the past century is based on the ever increasing use of natural resources over time. Nonetheless, if we continue with our current patterns of consumption, it would be inevitable to avoid irreversible damage to the planet's natural environment and jeopardise its very ability to provide these resources and the ecosystem services that we are so dependent upon. Resource efficiency is seen as the path where economic development and human well-being can progress with lower resource use and environmental impacts. To know whether we are on the path of resource efficiency, we need good indicators - and possibly also specific targets - to guide us on the way. This study investigates how indicators and targets of resource use can be used to increase resource efficiency in the EU as part of the European Commission's Flagship Initiative for a Resource Efficient Europe.

The study analysed several existing indicators that track the different types of resource flows in the economy, such as materials (abiotic and biotic), energy, water and land use. The selected indicators were then evaluated for their appropriateness for target setting at the EU policy level. The outcome of the study is a framework for a set (or basket) of indicators for resource use and their associated environmental impacts. This basket of indicators was used as a basis for proposing a corresponding set of targets for the EU in 2020 and 2050. The implications of setting resource use targets were evaluated to provide the Commission with possible ideas on how to concentrate their efforts towards setting medium and long-term resource efficiency targets.

Existing indicators and targets related to resource use

Although hundreds of indicators for tracking resource use exist, not many of them are used to set concrete and quantitative targets. A review was performed of resource use and resource efficiency related targets in EU Member States and third countries such as Australia, Canada, China, Japan, Switzerland, and USA. This revealed that the strategic objectives for resource use in environmental policy tend to be general in nature, with the exception of GHG emissions and renewable energy. Such objectives are often defined in sustainable development strategies or climate action plans. The typical areas covered by targets are related to materials, waste, energy, water and land. In the EU Member States, most of the climate change, energy and waste (recycling) targets are driven by the EU legislation.

In general, there is little political consensus among national governments for setting targets both nationally and globally. This could partly be due to the lack of scientific evidence and a clear understanding of the planet's sustainability thresholds. Non-governmental organisations and some academics are pushing for more targets to be set and have even proposed specific targets to be integrated into policy. However, most countries are hesitant. Governments often formulate sustainable development strategies without any time-bound quantitative targets on resource use.

Framework for resource efficiency indicators

The proposed framework covers four key categories of resource use that can be directly related to the economy: materials, energy (and climate), water and land use (Table 1). It provides a structure to track the progress of resource use in the EU from two perspectives: domestic (territorial) use, and global (life-cycle) demand. The framework also allows both the quantities of resource use as well as their environmental impacts to be monitored. All these perspectives are essential for developing a successful resource policy.

Table 1: The basket of resource use relevant indicators

	Resource use-oriented		Environmental impact-oriented	
	Domestic resource use *(resources directly used for domestic production and consumption)*	***Global resource demand*** *(domestic resource use plus resource use embodied in trade)*	***Environmental impacts related to domestic resource use***	***Environmental impacts related to global resource demand***
Material use	Domestic material use **Domestic Material Consumption**	Global material demand **Raw Material Consumption**	***Territorial part of*** **Life-Cycle Resource Indicator** (of *Environmentally-weighted Material Consumption*)*	**Life-Cycle Resource Indicator** (*Environmentally-weighted Material Consumption*)*
Energy use and climate change	Domestic energy use **Gross Inland Energy Consumption**	Global energy demand **Energy Footprint**	Domestic GHG emissions **Territorial GHG Emissions**	Global GHG emissions **Carbon Footprint**
Water use	Domestic water use **Water consumption** *(Water abstraction)**	Global water demand **Water Footprint**	Domestic water exploit. **Water Exploitation Index**	Global water exploit. **Global Water Consumption Index**
Land use	Domestic land use **Domestic Land Demand**	Global land demand **Actual Land Demand (Land Footprint)**	Domestic LU intensity **Human Appropriation of Net Primary Production**	Global LU intensity ***eHANPP, LEAC and other indicators on ecosystem quality***

Note: * … short-term proxy indicator for the medium-term desired indicator

A set of currently available aggregated headline indicators were selected to represent each resource category and perspective in the most comprehensive manner possible. A second level of indicators addressing specific questions within each resource category (e.g. fisheries in the category of materials, built-up land in the category of land use) were also presented, but not analysed in detail during the study. An evaluation of the individual headline indicators and the basket as a whole suggests that:

- the proposed basket of indicators provides comprehensive information on EU's use of natural resource and its corresponding environmental impacts.
- there is a need to further harmonise the methodologies that calculate indicators, in particular related to the consideration of resources embodied in internationally-traded products.

- the indicators suggested for the basket are consistent in terms of boundary setting and accounting principles.
- all indicators suggested for the basket can be linked to economic data to establish indicators on resource efficiency.
- the basket of resource use indicators would need to be complemented by other indicators on natural stocks (e.g. availability of freshwater, resource depletion) and environmental risks (e.g. consequences of nuclear energy and genetically modified organisms (GMOs)).

Setting targets related to resource use

A target sets a clear orientation, it provides concrete guidance and helps prioritise actions to achieve a policy objective. If properly enforced and supported by an appropriate mix of policy measures to ensure fair global market conditions and a level playing field, it can be a powerful approach to addressing environmental issues. Long-term objectives provide actors in society, e.g. governmental organisations and companies, certainty, stability and time to achieve the target in the most efficient manner.

Scientific knowledge about environmental thresholds and carrying capacity can serve as a starting point for defining acceptable levels of risk and environmental impact on which a target could be set. For resources such as fossil fuels, land, water and fish stocks, there is some understanding of the limits to when long-term depletion and degradation occurs. For other energy and material resources, the limitation of the resource base is less clear. Instead, the knowledge of the absorption capacities of nature's ecosystems could be used for target setting. A clear example of this is the limit of a maximum 2°C rise in global mean temperature, or 350 ppm CO_2 in the atmosphere, which is used to define EU's GHG emissions targets.

An important aspect when proposing targets is determining the most appropriate level to set the target. The majority of indicators in the proposed basket of indicators have strong links to socio-economic activities and entities, e.g. material consumption and GHG emissions. Some of the indicators are however more relevant on a specific ecosystem scale rather than a national/ economy-wide level, e.g. river basins are more suitable for water indicators, human harvest or HANPP (Human Appropriation of Net Primary Production) is more relevant for agro-ecological zones. Another important consideration is how EU-wide targets could be disaggregated to Member State level or across different sectors of the economy. Some possible approaches include disaggregation according to equity of effort sharing, relative ease/difficulty to achieve the target, demographic characteristics, economic structure and features of the ecosystems including climate.

The cost-effectiveness of setting a target is an important aspect of any target-setting exercise. Although the Flagship Initiative recommends a clear vision and objectives to guide resource efficiency policy in the EU, target oriented policy may not always be the best approach. Depending on how a target and its associated indicator are defined, the mix of supporting policy instruments, and how they are implemented, target setting could lead to unintended consequences. This is of particular importance when considering how the use of resources is interlinked. For example, the targets set for biofuels in transport can have significant consequences for global land use.

Whatever the approach chosen to set targets for resource use and efficiency, it is advisable that the targets are based on relevant existing indicators, and that the knowledge of resource use and its environmental impacts is well developed. The figure below shows an example of how targets in one area are linked to other resource use targets.

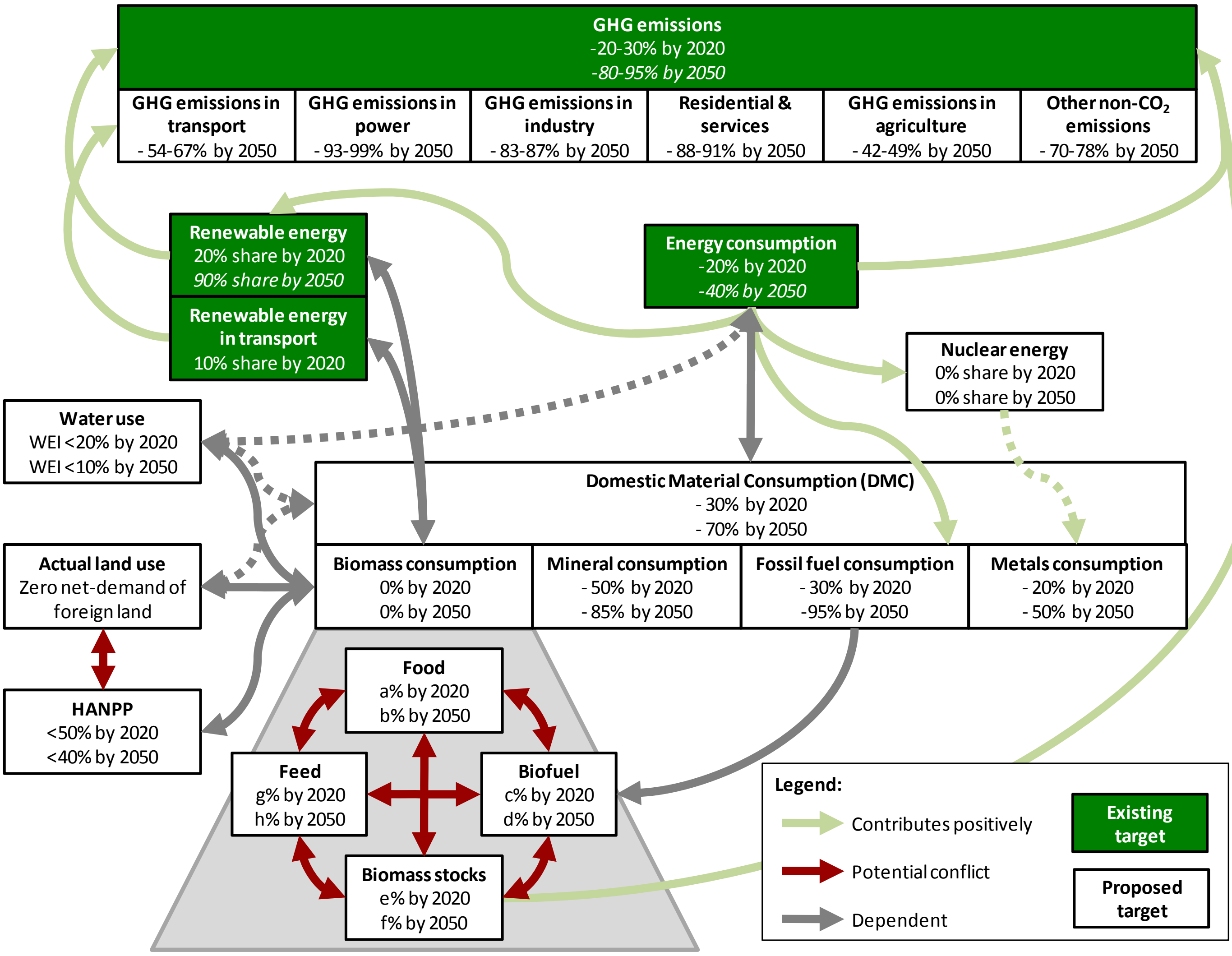

Figure 1: The proposed resource use targets and their links

Analysis of the proposed targets

The fact that the use of natural resources is closely interlinked was obvious in the process of defining resource use related targets. For example, biomass is directly dependent on land and water. Furthermore biomass serves four main purposes for society: (1) feeding humans, (2) feeding livestock, (3) providing energy (e.g. biofuels, wood fuel), and (4) building biomass stocks (in vegetation and soils), which provide vital ecosystem services, e.g. climate regulation such as carbon sinks.

Starting from the existing targets related to GHG emissions and energy use, and based on knowledge about links and plausibility, a set of aggregated headline targets were proposed to match the basket of resource use related indicators (Figure 1). The latest trends show that the EU is on track in meeting its 2020 target for GHG emissions. It is now considering extending this to a more ambitious target for 2050. Following are the key findings:

- **GHG emissions**

The Commission has already assessed the impacts of an 80% reduction of GHG emissions by 2050 compared to 1990. It showed that this target could be achieved by maintaining (and in some cases even increasing) activity levels. Depending on early investment in different (known) technology assumptions and global action, this could be cost-effective and lead to lowering fuel costs. High investments are required, but this offers opportunities for economic growth and job creation. A reduction of domestic GHG emissions would encourage the diffusion of renewable energy and thereby increase security of energy supply. Furthermore, a reduction of GHG emissions would also reduce SO_2, NO_x and PM emissions that would benefit the environment and human health.

A less ambitious target would increase fuel costs and supply risk, besides aggravating the effects of climate change. A more ambitious target (e.g. 95% reduction of GHG emissions by 2050 compared to 1990) is technically and economically feasible, but would require greater infrastructure investments and a lower demand and modal shift in the transport sector.

- **Energy consumption**

A target for GHG emissions would also drive energy efficient technologies and thereby lead to a reduction in energy consumption. The 80% GHG emission reduction target by 2050, would lead to a 30% reduction in (gross inland) energy consumption in 2050 (compared to 2000). This GHG emission target will also require the EU to abandon fossil fuels and instead rely on renewable energy sources. Biomass would provide about two thirds of the renewable energy until the other renewable energy technologies establish themselves over the next two decades. The share of biomass energy will then decrease but remain the principal renewable energy source well into the future.

- **Material consumption**

Reductions in fossil fuel energy consumption would be proportional to reductions in domestic material consumption (DMC) and imports. Due to the increase in demand for bioenergy, it would be difficult to reduce DMC of biomass. However, due to favourable biogeographical conditions (climate and soils) and a high availability of productive land per capita, the EU has the potential of being self-sustaining with regard to food and other uses of biomass. There is evidence that Europe has sufficient sources of domestic 'environmentally compatible' bioenergy to cover its demand. Without adequate policies in place, this would undoubtedly compete against food production and put pressure on global land use change resulting in unintended negative environmental and social consequences. A possible response to decreasing the demand of biomass production is to lower the amount of animal based products in the EU average diet and thus lower demand for animal fodder.

Although metals only constitute a small share (under 4%) of overall DMC, they contribute significantly to the EU economy and global environmental impacts. Setting ambitious targets to encourage more efficient use of metals would be cost-effective, environmental beneficial and limit dependence on foreign imports (particularly for the critical raw materials). It is possible to reduce the DMC of metals, but only to a certain extent as they are required for the construction and production of energy efficient products and infrastructure. Many of the rare earths which have been identified as critical raw materials for the EU are needed for many low carbon technologies.

Construction minerals (even excluding sand and gravel) constitute the greatest share of non-metallic mineral DMC. At present it seems difficult to set very ambitious targets to reduce DMC as the majority of construction materials are needed to maintain the existing building stock and infrastructure. The shares of the input flows needed for replacement at end-of-life are estimated at about 63-90% for the transportation network and 88% for buildings - much larger than the ones related to infrastructure expansion. Even when applying the full (theoretical) potential of construction and demolition waste recycling, only 25% of current construction minerals DMC would be reduced. Given the known technologies and level of (economic) activity, further reductions of DMC might not be cost effective.

Land use

It is evident that without greater yields, it will not be possible to increase biomass production without increasing land use. There is evidence to support that it is possible to increase yields in the EU without putting more pressure on the environment (e.g. without increasing water abstraction, mineral fertiliser use and nutrient loss). As mentioned, the EU is capable of being self-sufficient in biomass, but the target for zero net demand of global land should not compromise the competitive trade advantage of growing crops in the biogeographic regions that are most productive and best suited. The proposal to halt the (net) increase of artificial land is feasible and would support the other resource use targets. Densification of existing built-up land can increase energy efficiency and reduces the demand for construction metals and minerals. It would further reduce the negative impacts on the environment such as soil sealing and fragmentation of natural habitats.

Human harvest

HANPP (Human Appropriation of Net Primary Production) – a measure for the amount of biomass removed from the land - varies across different land use categories. Cropland is typically characterised by high HANPP levels at or above 85%, whereas forests have low HANPP values below 30%. Depending on land cover patterns and the intensity of land use, domestic HANPP across European countries differs widely. The overall target for the EU-27 of stabilising average HANPP at 50% or reducing it to 40% should not be applied equally to individual Member States. Countries with less favourable conditions for intensive land use (e.g. Sweden, Finland and Slovenia) should maintain low levels of HANPP, whereas countries with productive land suitable for agricultural production (e.g. the Netherlands, Hungary, Denmark and the Czech Republic) should still engage in agriculture – and thus can have levels above the target level. However, HANPP in regions with high suitability for intensive cropland agriculture should not exceed 75% in order to stay within sustainable limits. In other words, stabilising or reducing average HANPP in Europe may require a stabilisation or increase in extensive land use types, and a sustainable intensification on the best agricultural land. Although targets for HANPP need to take the specific agro-ecologic areas into consideration, it can lead the way to more sustainable agriculture practices by improving soil quality and determining environmental thresholds.

Water use

Major methodological gaps do not allow a target based on water abstraction to be formulated at the moment. The Commission is currently developing appropriate indicators to set water efficiency targets. To complete the basket of indicators, the project team referred to the EEA recommendations that water abstraction should stay below 20% of available renewable freshwater resources (Water Exploitation index). There are many existing solutions and best practices that would allow this target to be achieved without compromising agricultural yields and fulfilling the needs of the economy. But due to a lack of data and understanding of water use at a river basin level, it is not clear how cost effective such a target would be.

Table 2: Overview of the assessment of the economic and technical feasibility of achieving the proposed range of targets

	Ambitious	Moderate	Conservative
GHG emissions (baseline 1990)	-30% by 2020 -95% by 2050	-20% by 2020 -80% by 2050	-20% by 2020 -50% by 2050
Energy consumption (GIEC) (baseline 2005)	-20% by 2020 -40% by 2050	-15% by 2020 -30% by 2050	-10% by 2020 -20% by 2050
Material use (DMC) (baseline 2005)	-30% by 2020 -70% by 2050	-10% by 2020 -30% by 2050	-5% by 2020 -20% by 2050
Land use	Zero net demand of foreign land by 2020	Zero net take of artificial land by 2020	Limit annual net increase of artificial land to 200 km^2 by 2020
Water use **Water Exploitation Index (WEI)**	<20% WEI by 2020 <10% WEI by 2050	<25% WEI by 2020 <20% WEI by 2050	<30% WEI by 2020 <25% WEI by 2050

Legend for feasibility:	Possibility to achieve targets with significant changes in levels of activity and significant advancement from known and future technologies	Possibility to achieve targets with slight changes in levels of activity and greater investments in known technologies	Possibility to achieve targets while maintaining current levels of activity and cost effective investments in known technologies

Multi-return strategies

During the analysis of the targets, strong links between the use of different resources prompted an alternative approach to setting resource efficiency targets. These so-called 'multi-return' strategies address multiple resource categories and several issues related to resource efficiency by identifying the one key driver behind them all. This approach aligns various resource use targets and captures them through one focussed policy intervention. The following multi-return strategies were identified in this study:

- **Changing the human diet towards a lower share of animal-based food**. Tackling this will have several effects:

- Positive effects on human health; less livestock lowers the pressure on land and water resources; it also reduces GHG emissions from ruminants; less demand for cooling and transportation of meat will reduce energy consumption.

- **Steady stocks of built-up infrastructure and densification of settlements, reducing urban sprawl** will have following effects:

  - Decreasing material consumption; facilitating a continuous recycling of construction materials; decreasing energy use for the construction of infrastructure, in transport and in the use phase; decreasing use of land area and sealing of land.

- **Product re-design for longevity and recycling.** This is not really one strategy, but a bundle of strategies, to be developed for groups of products. Tackling this will have several effects:

  - Reducing the use of toxic materials; increasing the use of bio-degradable materials; increasing longevity, repair-friendliness and re-use of products; increasing recyclability by design; improving energy efficiency in production and use of products.

Multi-return strategies could be an approach for target based policy that would require less action, but would have broader effects.

Recommendations

The European Commission has made it clear in its Europe 2020 strategy the direction in which the EU should be moving. Indicators and targets are important tools to guide, coordinate and encourage progress in the right direction. Although the study has demonstrated that many of the available indicators desperately need to be improved or developed further, this should not deter the Commission in continuing their work by discussing and considering possible resource use and resource efficiency targets. There is too much at stake to wait for a perfect set of indicators. Many of proposed indicators can already be adopted for use in resource policy development. In the case of limitations, other supporting indicators and experts should be consulted.

The project team identified the following areas where the Commission would benefit from further development:

- **Continue improving and developing resource related indicators**

  - *Indicators and data on resource use embodied in trade* - further develop and harmonise different data and methodological approaches to calculate resource use embodied in international trade of the EU-27 and EU Member States.

  - *Indicators and data on the environmental impacts of resource use* - further strengthen and test currently developed methodologies and improve the underlying databases for their calculation.

- *Indicators on the impacts on ecosystems and biodiversity* – support the development of approaches to link land cover and land use change to indicators on ecosystem quality and biodiversity.
- *Indicators on the natural capital stock* – support the development of approaches for indicators and databases that can monitor scarcity and overexploitation of resources.
- *Level 2 indicators* - refine the understanding of the interlinkages between level 1 (headline indicators) and level 2 (supporting indicators addressing specific questions within a resource category) indicators, as well as support the further development of specific level 2 indicators that are not yet available.

- **Develop the knowledge base in order to better assess the impacts of resource efficiency targets**

  - *Multi-return strategies* – investigate how improving resource efficiency for several resources at the same time can be achieved through focused policy interventions.
  - *Methodologies to better assess the impacts of (policy) responses* (e.g. environmental taxes, R&D spending in eco-innovation areas and subsidies for resource-efficient technologies) on resource quantities and related environmental impacts, in order to prioritise policy and business action, e.g. marginal abatement curves for resource use.
  - *Build-up the policy "business case"* – find socio-economic evidence to justify setting a target, when the scientific evidence on the environmental rational is missing, e.g. emphasise the benefits of securing supply and competitiveness.

- **Involve external actors and stakeholders in the process of target setting**

  - *Communication of indicators* - rethink how the indicators could be better communicated and more easily understood by everybody. Many of the current resource related indicators use unclear language and terminology, e.g. embodied water, actual land demand and virtual footprint. Consider renaming or harmonising the terminology.
  - *Establish open multi-party debates* - extensive consultation allows all viewpoints to be heard on an equal level and is a good starting point for building consensus.