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- Collaborative project -

# D3.5 Report on Scenario Formulation

WP 3 - Scenarios and modelling of policy implementation for resource efficiency

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### **Key word list**

Resource efficiency, scenarios, pathways

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## 1 Introduction

This Deliverable reports on the activities of Task 3.2 of the POLFREE project.

As described in the Description of Work (DoW), the aim of this task is to use the results of WP2 and transform the objectives and targets of the overall vision for a resource efficient Europe and the policy mix into concrete scenarios, i.e. policy packages for achieving a resource efficient economy under different assumptions of driving forces. The task was designed to define at least three alternative, plausible, future socio-economic development pathways. In addition, a “business as usual” (BAU) scenario will be established as a basis for comparison.

As outlined in the DoW, elements of the scenarios should reflect those identified in the vision developed in Work Package 2 (e.g. the most resource intensive sectors, such as agriculture, transport and construction and related activities at the individual level, such as food consumption, mobility and housing and work patterns) and cover policies that address the macro-, meso- and micro-level (i.e. the global, European and local levels). These policy options will be modelled in different combinations (regulations, economic instruments to support behavioural changes, etc.) to see whether they achieve the resource-efficiency targets for 2050 described in detail in POLFREE Deliverable 2.2.

The scenarios should describe possible future developments until 2050 and specify at what time different policy measures will be introduced or enhanced. Short, medium and long-term options should be introduced in order to incorporate measures that are easy to implement and also measures that are more difficult to realize. As the vision and scenarios have to be formulated in a way that provides the basis for modelling, it is of special relevance that the underlying assumptions are described properly and that the process of scenario development is clear, logical and reasonable.

Concerning the driving forces of the scenarios it is important to distinguish between those factors that are the same for all scenarios (basic conditions such as population development) and those determinants that influence the changes in the scenarios in different ways. That means that the same indicators and themes should be dealt with in each scenario, but vary in the extent and intensity of behavioural changes and the policy measures that induce these changes.

## 2 Pathways and scenarios

### 2.1 What are scenarios?

In the literature on scenario development there is a broad range of different definitions of scenarios and also a range of methods are available for producing scenarios. Thinking about the future can be classified according to three different perspectives (Dunn, 1994; Borjeson et al, 2006; Linstone, 1999):

- **Probable futures:** *What will happen?* This category includes **forecasting studies** that are characterized by a predictive nature and are mainly focused on current trends and conditions and historical data.
- **Possible futures:** *What might/could happen?* **Scenario studies** are included in this group and can be categorised as descriptions of possible future states and their developments. Influential scenarios include the IPCC scenarios<sup>1</sup> and the Global Environmental Outlook (GEO) scenarios created by UNEP<sup>2</sup>. The functions of those scenarios are manifold: most often they stimulate creative (“out of the box”) thinking; and they try to anticipate the unforeseeable. Moreover, these scenarios intend to raise political awareness of what happens if certain measures are introduced and do not aim at selecting and pursuing the most desirable scenario.
- **Preferable futures:** *What should happen?* **Visions /scenarios** of this type focus on normative or desirable futures. They start with an image of the future or a vision and aim to find plausible development pathways for getting there.

In the POLFREE project, the scenario development is based on the backcasting approach from the vision developed in Task 2.2 of the project. This approach is preferable due to its normative and problem-solving character and because this approach is typically applied to complex long-term problems and long-term sustainability solutions involving various aspects of society and its environment (Dreborg, 1996). In the following the backcasting approach is explained in more detail.

### 2.2 Backcasting

Backcasting emerged in the 1970s with first applications in energy backcasting and soft energy paths in the USA (by Amory Lovins<sup>3</sup>), Canada (by John Robinson<sup>4</sup>) and Sweden and focused on developing and comparing the feasibility of different normative future options and their policy implications. Backcasting has gradually become more popular and more widely applied over the last decade. As the normative concept of sustainability has gained increasing importance throughout the world, backcasting, as a normative approach with distinctive features, has been used as an important tool to tackle sustainability issues.

Backcasting is recognised as an alternative to traditional forecasting. It is a method in which the future desired conditions are envisioned and the policies, strategies and pathways are defined to reach those, rather than take steps that are merely a continuum of present methods extrapolated into the future.

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<sup>1</sup> IPCC, Intergovernmental Panel on Climate Change, [http://www.ipcc-data.org/ar4/gcm\\_data.html](http://www.ipcc-data.org/ar4/gcm_data.html).

<sup>2</sup> Global Environmental Outlook <http://www.unep.org/geo/geo4.asp>.

<sup>3</sup> A.B. Lovins, *Soft Energy Paths: Toward a Durable Peace*, Friends of the Earth International/Ballinger Publishing Company, Cambridge MA, 1977.

<sup>4</sup> J.B. Robinson, *Energy backcasting: a proposed method of policy analysis*, *Energy Policy* 10 (1982) 337–344.

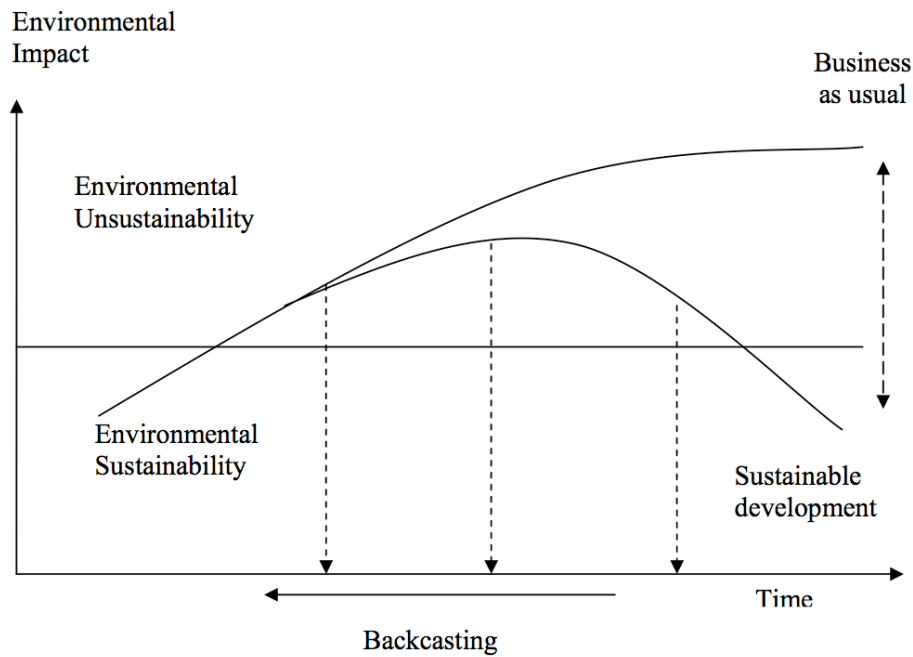
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The term backcasting was coined mainly by John Robinson in the description of a method of policy analysis. Robinson defines the backcasting as a normative and design-oriented method which works “backwards from a particular desired end point to the present in order to determine the feasibility of that future and what policy measures would be required to reach that point” (Robinson, 1990 p.823).

Therefore, the backcasting process moves from a definition of future goals and objectives to the development of various future scenarios. End points are usually chosen for a time far into the future, around 25-100 years.

The figure below summarizes the backcasting approach in comparison with the “Business as usual” (BAU) approach in a sustainability framework.

**Figure 1: Backcasting and forecasting approaches in a sustainability framework.** (Source: Banister, 2006 )



### 3 Process of Scenario Design

The creation of alternative futures scenarios involves eight steps, each of which is described in more detail below.

- (1) Determining the objectives
- (2) Defining the scenario framework
- (3) Designing four scenario landscapes
- (4) Exploring the pathways
- (5) Qualifying and quantifying the pathways
- (6) Finalising the pathways and visualisation
- (7) Review of pathways by stakeholders
- (8) Modelling the pathways and analysing the results

#### 3.1 Determining the objectives

The development of the three Transition Scenarios for a Resource Efficient Europe 2050 builds on all previous work in the project. The vision for the EU for resource efficiency together with the resulting headline targets (see also Deliverable 2.2) is the starting point for the development of the pathways for the specific scenarios. This vision describes a resource efficient economy in 2050. In particular it defines **eight headline targets for 2050**. These targets (Table 1) cover both the supply of resources (materials, carbon, land and biomass and water) in Europe as well as the consumption of resources. The vision specifies in concrete terms which resource- targets (objectives) have to be achieved and which problems the pathways intend to address.

**Table 1: Headline Targets for the POLFREE Visions (Source: POLFREE Deliverable 2.2)**

Resource	Perspective	Target 2050
<b>Materials</b>	Global (consumption)	5t RMC/cap.
	EU (supply)	No net additions to built-up stock
<b>Land</b>	Global (consumption)	Cropland reduced to 0.17 to 0.20 ha/person, or by 34 to 44% (compared to 2005)
	EU (supply)	No net loss of cropland in EU
<b>Water</b>	Global (consumption)	Mean water footprint per capita reduced 30-50% below 2004 levels
	EU (supply)	Water exploitation index below 20% in all European Countries
<b>Carbon</b>	Global (consumption)	Mean carbon footprint per capita reduced 60-80% below 2004 levels
	EU (supply)	GHG emissions reduced by 80 to 95% (compared to 1990)



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### 3.2 Defining the scenario framework

At an internal project meeting held in Vienna in November 2013, the draft vision developed in WP 2 (see Deliverable 2.2) was presented and discussed. At the same internal meeting, the preliminary results from Task 2.5 (Global Governance) were presented. The discussion of these results led to a discussion of their implications for possible pathways to achieve the vision developed in Work Package 2. It was immediately clear that three plausible pathways could be defined:

- (1) a pathway in which cooperation at the global level would lead to implementation of resource efficiency measures;
- (2) a pathway in which Europe proceeds with implementing strong goals and measures for resource efficiency but with weak or uncoordinated responses to the resource efficiency challenge in the Rest of the World; and
- (3) a pathway in which Europe pursues the goals of increasing resource efficiency with a strong emphasis on sustainable consumption and production and more bottom-up processes.

### 3.3 Designing four scenario landscapes

Based on the three possible pathways we defined two critical variables or uncertainties that we combined to produce three future landscapes and one business as usual scenario (BAU). The two critical uncertainties are governance and the spatial scope. We further divided governance into conventional or unconventional global governance and spatial scope in Europe and Global. Based on these uncertainties we created the scenario quadrant (Figure 2) that forms the basis for the further work on the scenarios.

**Figure 2: Scenario Framework**



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### 3.4 Exploring the pathways

The next step was to identify ‘predetermined’ and ‘underdetermined’ elements for the scenarios by GWS. The predetermined elements are the same in each scenario; the underdetermined elements are elaborated in several ways, depending on the three different possible future developments.

**For the modelling of all scenarios, three general assumptions are made:**

- **population: UN medium variant;**
- **real interest rates;**
- **restrictions on public debt.**

After this, several key assumptions for the different pathways were specified to further define each alternative scenario. These underdetermined assumptions underlying each scenario, outlined in Chapter 4 (Table 3), have been further developed through e-mail discussions with the project consortium.

### 3.5 Qualifying and quantifying the scenarios and pathways

Subsequently three separate tables (one for each scenario) were prepared to define firstly the sub-targets for the most resource intensive sectors (Food, Housing, Mobility and Industry) and secondly the policy measures and instruments relevant for each pathway in order to get policy mixes that reach the targets proposed in the vision. Based on a literature review, the following categories (see Table 2) were used to design the policy mixes:

- **Economic Instruments:** e.g. taxes, subsidies, prices
- **Regulation:** e.g. quotas, standards, bans, binding targets...
- **Cooperation Instruments:** e.g. international agreements incl. trade agreements...
- **Information-based:** e.g. eco-labelling, awareness-raising, education...
- **R&D&I:** e.g. research for new technologies and innovation
- **Self-Committing:** e.g. values and behavioural change. These are not “policies” but changes based on personal or group decisions to do something. They could be stimulated by policy programmes to support such self-commitment, though, e.g. public pledges, neighbourhood/city competitions.

**Table 2: Framework for the elaboration of policy pathways**

Resources	Sectors	Sub-targets	Economic Instruments	Regulation	Cooperation Instruments	Information -based	R&D&I	Self Committing
<b>Air</b>	Food							
	Mobility							
	Housing							
	Industry							
	Energy							
<b>Materials</b>	Food							
	Mobility							
	Housing							
	Industry							

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	Energy							
<b>Land/ Biomass</b>	Food							
	Mobility							
	Housing							
	Industry							
	Energy							
<b>Water</b>	Food							
	Mobility							
	Housing							
	Industry							
	Energy							

This stage is the most complex and time-consuming part of the scenario development, but in terms of the backcasting the most interesting. A comprehensive review of the full range of policy measures is carried out. Apart from the measures, information is being gathered on their effectiveness, and the time scale necessary for their implementation. These policy measures are being assembled into policy mixes that are mutually supporting.

Finally, on the basis of the elaborated sub-targets and the measures and instruments, the Partners involved in this Task are deriving pathways: What would have to have happened by 2020 and in subsequent decades in order to reach the different sub-targets and consequently the headline targets of the vision?

### 3.6 Finalising the pathways and visualisation

For this deliverable, narrative storylines (see Chapter 4) with both qualitative and quantitative elements have been developed. These narratives will be developed iteratively with the further specification of policy measures and when the modelling results are available. The narratives also clearly illustrate people's lifestyles (how they work, live, eat and consume) in the three scenarios in 2050. Once the timelines are completed and checked for consistency, the timeline for each scenario with the selected policy mixes and the milestones will be visualised by Robert Horn and presented at a stakeholder workshop in June 2014.

### 3.7 Review of pathways by stakeholders

A stakeholder workshop will be held in Brussels (June, 2014). A first workshop was held in December 2013 (see Deliverable 2.2), in which the stakeholders commented on the vision produced in the POLFREE project. In the second workshop the stakeholders will have the opportunity to comment on the three pathways and the draft visualization. We anticipate that they would provide further input on possible policies for inclusion and on the timing of their introduction and / or when the measures are strengthened.

### 3.8 Modelling the scenarios and analyzing the results

The pathways with sub-targets and policies will be quantified and then modelled using the suite of models developed in Work Package 3 of the POLFREE project.

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### 3.9 Assumptions for the Reference (Business as Usual) Scenario

The Reference Scenario reflects a future of the economy and the environment under the following conditions for the EU and Rest of the World (ROW):

- business as usual
  - in climate policy (6 degree scenario)
  - in resource policy
- no additional **autonomous** change in
  - preferences
  - technology
- real basic prices for fossil fuels will be taken from the IEA 6- degree scenario
- real basic prices for minerals will be forecasted by trends.
- A 6 degree climate scenario has to be taken with the regional variant of a hot and dry Europe for the biomass and water modelling.

## 4 Three Transition Scenarios for a Resource Efficient Europe

As discussed in the previous section, three transition scenarios to achieve the “Vision for a resource efficient Europe” have been developed:

**Strong Cooperation:** Strong global cooperation to achieve sustainability goals between now and 2050;

**Strong Europe:** Europe takes the lead in pursuing its ambitious targets for strong, sustainable and inclusive growth;

**Strong Civil Society:** Europe takes a different governance model (strong participation) and a different economic model (beyond growth) and achieves resource efficiency goals through efficiency improvements and reduced resource use.

The three scenarios are outlined in Table 3. This outline is complemented by three narrative storylines of the main elements of the scenarios presented in the following chapters.

**Table 3: An outline of the three POLFREE scenarios**

Scenarios Key assumptions	Strong Cooperation	Strong Europe	Strong Civil Society
<b>International context</b>	Multilateralism	Regional Clubs	Bottom-up
Global Governance	Global governance Strong global cooperation and agreements	Coalitions and regional governance Selective international cooperation	New forms of governance based on participatory processes Relationships and networks operating at the local level and extending outside of nation-state boundaries
Resource efficiency	Binding standards and targets on resource efficiency for the main world players Increasing international trade with resource-efficient goods	Plurilateral and regional agreements Europe leads and sets an example Coordination with resource efficiency activities in emerging economies	Bilateral agreements Strong emphasis on services rather than products, increased demand for resource efficient products and services and voluntary demand reductions in absolute terms
Availability and Accessibility of resources	Good	Limited, as resource nationalism prevails	Fairly limited but balanced through less demand in the EU
World trade	Globalisation efficient to boost the world economy and trade	Regional trade clubs National/EU restrictions to globalisation	Local and regional fair trade of products and services, global exchange of concepts and ideas for resource-efficient lifestyles
World finance	<ul style="list-style-type: none"> <li>▪ High levels of international trade</li> <li>▪ Extended sustainable commodity agreements</li> </ul>	<ul style="list-style-type: none"> <li>▪ Regional and bilateral trade agreements</li> <li>▪ International consumer demand</li> </ul>	Local/alternative currencies co-exist with conventional currencies
Climate Change	Representative Concentration Pathway (RCP) 2.6	RCP 4.5 Regional clubs, EU sticks to	RCP 4.5 Climate cities, community climate clubs

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	Strong binding agreements at the global level	new 2030 targets	and energy cooperatives are addressing climate change at local and regional levels
<b>EU and member countries</b>	Medium/high GDP and high competition	Medium/high GDP and high competition	Low GDP and high sustainability (GDP less important, other indicators in use)
Economic model	Green Growth	Green Growth with industrial policy	Beyond Growth
Macro-economic objective	Green Economy	Smart, sustainable and inclusive growth	Well-being maximization
Environmental Policies and instruments	International agreements and international voluntary schemes	Taxation, subsidies and pricing	<ul style="list-style-type: none"> <li>Information provision on product/service/lifestyle footprints (rucksacks)</li> </ul>
Social equality	Lower than today	Similar to today	Higher than today
<b>Technology and resource efficiency</b>	“Green tech revolution” Supply-side technologies, Centralized technologies	De-centralized and centralized technologies, Eco-innovations “Green tech revolution”	De-centralized technologies, systemic and social innovations
Housing	<ul style="list-style-type: none"> <li>Rapid replacements of old buildings</li> <li>Zero-energy and highly material-efficient construction of new buildings</li> <li>Industrial production in housing (more large-scale companies operating at a global level)</li> <li>Sustainable Mega-Cities</li> <li>Prices in urban areas high (‘London model’ – elites from abroad purchasing posh apartments)</li> </ul>	<ul style="list-style-type: none"> <li>Highly resource-efficient renovation of existing buildings</li> <li>Zero-energy and highly material-efficient construction of new buildings</li> <li>Recycling of non-hazardous construction materials and demolition waste</li> <li>Greater technology integration (e.g. building-integrated photovoltaics (BIPV))</li> </ul>	<ul style="list-style-type: none"> <li>Renovation and refurbishment of existing buildings sourced by high rates of recycled materials from urban mining</li> <li>Modular construction enabling easier repair, rebuilding and rearranging of the building</li> <li>Efficient heating and cooling with the natural advantages of earthen walls, rooftop gardens, and indoor vegetation</li> </ul>
Food	<ul style="list-style-type: none"> <li>Food chains shifted towards the remit of government, with new integrated partnership food enterprises.</li> <li>EU cooperation increases and leads to specialization of intensive farming. Niche products can be marketed on a global basis.</li> <li>Self-sufficiency reduced at national level</li> </ul>	<ul style="list-style-type: none"> <li>Advances and efficiency improvements through new technologies in industrial agriculture.</li> <li>Increase in organic agriculture in the EU to 75% by 2050, compared to 4.1% in 2010</li> </ul>	<ul style="list-style-type: none"> <li>Local food production by smaller businesses</li> <li>95% of farms are organic</li> <li>Specialized and niche products</li> <li>Fertilisers and pesticides have been substantially reduced</li> <li>Food supply chains are generally short</li> <li>High self-sufficiency at national level</li> </ul>
Mobility	<ul style="list-style-type: none"> <li>High-speed international trains</li> <li>Seamless transportation infrastructures</li> <li>Intelligent traffic management (ICT)</li> <li>International shipping and aircraft multiplies, fuelled by new low-carbon engines</li> <li>Large-scale deployment of hydrogen, electric vehicles and other new engines fuelling resource-efficient cars</li> <li>International tourism boosted</li> </ul>	<ul style="list-style-type: none"> <li>Fuel efficiency</li> <li>New engines, materials and design</li> <li>Cleaner energy use through new fuels and propulsion systems</li> <li>Better use of network through information and communication systems</li> <li>New technologies for vehicles and traffic management</li> <li>Optimised performance of multimodal logistic chains</li> </ul>	<ul style="list-style-type: none"> <li>High-efficiency intermodal transportation options combining public transport, biking and walking</li> <li>variable sharing concepts of cars and bikes</li> <li>Biking, walking etc. preferred</li> <li>Integrated, system spatial planning reduces travel needs</li> <li>People work close to where they live</li> <li>International travel reduced</li> </ul>

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Energy	<ul style="list-style-type: none"> <li>Large scale international grids, with more efficient direct current systems, to enable power sharing between the solar resources of North Africa, hydropower and biomass resources of Scandinavia and so on</li> <li>A diversity of supply strategies (REN, unconventional fuels, nuclear) but strong treaties on quality and risks as well as on non-proliferation</li> </ul>	<ul style="list-style-type: none"> <li>Energy prices split between world regions. The EU adopts border tax adjustments or similar measures</li> <li>EU energy partnership with Russia and neighbourhood policy with Northern Africa brings new gas supply</li> <li>Cooperation within Europe (e.g. grids)</li> </ul>	<ul style="list-style-type: none"> <li>Energy infrastructure is largely decentralised, flexible and collaborative.</li> <li>Centralized large-scale systems and decentralised systems work together and depend on each other.</li> <li>Micro-generation and more localized renewable sources.</li> </ul>
Industry	<ul style="list-style-type: none"> <li>Increased recycling rates</li> <li>(Eco)-Innovations</li> <li>Industrial Symbiosis</li> <li>Global product agreements</li> <li>High levels of technology transfer</li> </ul>	<ul style="list-style-type: none"> <li>Increased recycling rates</li> <li>(Eco)-Innovations</li> <li>Industrial Symbiosis</li> </ul>	<ul style="list-style-type: none"> <li>Waste prevention (reuse)</li> <li>New Business models (Product-services, Sharing, Pooling)</li> <li>Eco-Innovations</li> <li>Industrial Symbiosis</li> </ul>
<b>Lifestyles and Preferences</b>	Autonomous change of preferences of consumers by intrinsic motivation to a certain extent.	Autonomous change of preferences of consumers mainly by extrinsic motivation and to a certain extent by intrinsic motivation.	Autonomous change of preferences of consumers by intrinsic motivation concerning structure and level of consumption and labour supply.
How people work	Work hard to earn more Large-scale communing the new norm	<ul style="list-style-type: none"> <li>Working more to earn more</li> <li>More education and training</li> </ul>	<ul style="list-style-type: none"> <li>Reduced (paid) working hours</li> <li>Expansion of teleworking and the application of new ICTs</li> </ul>
How people live	High-tech accommodations in posh neighbourhoods Gentrification and stratification	<ul style="list-style-type: none"> <li>High-tech accommodations located in close proximity to work and personal, social and community services</li> <li>Funding for social and sustainable housing</li> </ul>	<ul style="list-style-type: none"> <li>Innovative forms of energy, water and resource-efficient housing e.g. Cohousing</li> <li>Private spaces are reduced and common services and spaces emerge with their multifunction qualities</li> <li>Succession of dense lodges with zero density green/leisure areas</li> </ul>
How people eat	More food services (excellent deliveries, international food chains, etc.)	As usual, but with somewhat more conscious diets Reduced food waste	<ul style="list-style-type: none"> <li>Diets based on local, regional, seasonal and organic food</li> <li>Less meat-consumption</li> <li>No food waste</li> </ul>
How people move	Mobile societies worldwide Mobility and Pro-Migration policies adopted	<ul style="list-style-type: none"> <li>The use of cars remains high</li> <li>Conventionally fuelled cars are replaced by new fuels (e.g. electric cars, biofuels)</li> <li>European high speed rail network</li> </ul>	<ul style="list-style-type: none"> <li>Lifestyle change, an extreme shift in transport modes towards combining public transport, biking and walking</li> <li>variable sharing concepts (car &amp; bike sharing schedules and car &amp; van-pooling) walking and cycling.</li> <li>Less air traffic</li> </ul>

## **4.1 Scenario Narrative: Strong Cooperation**

### **4.1.1 International context**

Under this scenario the commitment to global cooperation is strong with all countries recognising the importance of coordinated action

#### ***Global governance***

In some areas global cooperation is expressed through fully multilateral processes with all countries represented on a one country one vote basis. This is complemented by strong international coalitions striving forward to develop new norms and practices. This strong multilateral approach in 2050 does not necessarily mean that the same institutions prevail as existed in 2014. The Leadership Council of the Sustainable Development Solutions Network (2013) notes that: “Global problems require global institutions that are representative of the world they seek to govern. The voting rights and shares in many international institutions reflect the world as it was after the Second World War and not as it is today”. A strong organisation for the environment exists at the UN level and drives forward the multilateral process and accountability.

#### ***Resource efficiency***

Greater awareness of and progress in resource efficiency is supported by an Integrated Resource Management Agency (IRMA). The IRMA supports global information gathering and sharing, coordinates activities on resources between environmental, human rights and trade law, and supports the development of global voluntary and binding agreements regarding resources. The Sustainable Development Goals are agreed by all nations and contain a strong commitment to resource efficiency. Binding standards and targets for resource efficiency are adopted for the major world players in the early stages of a multilateral agreement on resources. At the corporate level, methods are developed to adopt a global approach to Extended Producer Responsibility to increase levels of recycling and reuse of materials and water.

#### ***Availability and accessibility of resources***

Resource extraction and consumption occurs at a global scale with high level of trade in resources. This is supported by international agreements on the transparency and governance surrounding resource rents and on anti-corruption practices.

#### ***World trade***

The international trade system is strong and blockages at the World Trade Organisation (WTO) have been overcome to support the development of extended sustainable trade agreements to allow for distinguishing between products on the basis of production methods. This has arisen from an early proliferation of voluntary measures at the corporate level surrounding labelling and certification that have been adopted at the international level.

#### ***World finance***

The financial system remains as in 2014, highly integrated and supporting high volumes of trade in major financial markets. International financial institutions such as the World Bank and the Regional Development Banks play a key role in supporting sustainable development with high environmental performance and high levels of governance and transparency.



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### *Climate change*

A global agreement on climate change forms the backbone of the renewed commitment to multilateral processes and imposes strong binding targets at the global level accompanied by commitments to technology transfer and funding in developing countries. With regard to CO<sub>2</sub> concentrations, this pathway assumes Representative Concentration Pathway (RCP) 2.6.

### *G20*

The G20 plays an active role in driving forward international politics as a coalition of the willing. It uses its economic and political strength to make progress on issues of international importance whilst recognizing and accommodating the needs and rights of other countries who do not have a formal seat at the table.

### **4.1.2 EU and Member Countries**

The EU plays an active role in the multilateral and coalition-based processes, collaborating with partners from across the world. Global targets and commitments are reflected in regional and national approaches and reflect the impact of Europe's actions internationally as well as within the Union. GDP continues to be the main measure of progress and continues to grow through the green economy.

### *Economic model*

The economy is based on the principle of green growth, resulting in a medium to high level of GDP and high levels of competition.

### *Environmental policies and instruments*

The defining instruments of scenario 1 are those developed in the international arena. From international voluntary schemes for reporting, transparency, certification and labelling, international agreements and formalised procedures develop and are applied throughout global supply chains. International agreements on key issues such as climate change set targets and standards, which are achieved through a variety of EU and national measures. Research and development is strong and is sought through international collaborations, and technology transfer plays a key role.

### **4.1.3 Technology and Innovation**

The same as for Scenario 2, with the addition that international requirements for technology transfer are another characteristic.

### **Housing**

As in Scenario 2.

### **Food**

Essentially the same as Scenario 2 but additionally growth in confidence in the sustainability of international agricultural supply chains is achieved through international programmes of labelling, certification and sustainable commodity agreements. Europe contributes to a global agricultural market with niche products and specialised intensive farming.

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### **Mobility**

As scenario 2 but additionally all international transport conforms to common fuel efficiency standards and the European high-speed rail network extends outside of the Union where geography permits, creating extensive options for land-based international travel.

### **Energy**

International agreements on climate change provide big incentives for the decarbonisation of the energy sector and significant diversification of supply strategies in Europe and across the world. International treaty systems provide the standards for quality and risks as well as non-proliferation. Whilst the opportunities for large-scale international grids are considered, practical limitations lead to an energy system that resembles that of Scenario 2.

### **Industry**

Two key drivers lead to improvements in the resource efficiency of industrial processes. Firstly, technology transfer is a key aspect of the global agreement on climate change and this stimulates a growth in innovative technologies and commitments to investment in research and development within Europe. Secondly, the growth of global product agreements (either through sustainable commodity agreements or through certification or labelling mechanisms) drives the industrial sector to compete not for compliance but to outperform their competitors on resource efficiency. In this scenario such competitiveness is on a global scale, which in the early years is an advantage for Europe given their tradition in eco-design legislation, but others soon catch up and hence effective eco-innovation is paramount to success on the global market.

#### **4.1.4 Lifestyles and Preferences**

Lifestyles and preferences are largely shaped by the top down structures and systems, and are largely led by extrinsic motivations. High levels of technological advancement in resource efficiency driven by international standards allow for more consistent standards of living and ease the pressure of resource use despite continued consumerism. International standards on products ensure that the price of goods reflect their cost in environmental, humanitarian and resource terms.

#### **How people work**

As for scenario 2

#### **How people live**

As for scenario 2

#### **How people eat**

As for scenario 2 but additionally efficient and standardised international rules on food labelling, certification and sustainable commodity agreements mean that consumers are more equipped to take into account the global impact of the food they buy, and respond accordingly.

#### **How people move**

As for scenario 2

## **4.2 Scenario Narrative: Strong Europe**

### **4.2.1 International context**

In Scenario 2, multilateral approaches are less important and whilst there is some international cooperation it is fragmented and more commonly characterised by pluri-lateral agreements and regionally based responses.

#### ***Global governance***

The multilateral treaty processes of the UNFCCC and the World Trade Organisation are stalled. However progress on the international stage continues through pluri-lateral agreements and coalitions of the willing, many of which exist between regional groupings such as the EU, African Union, Mercosur, Arab League of Nations, OECD, etc. The extensions to UNEP's power as agreed post-Rio 2012 are still in place but the main function of UNEP is one of information gathering and sharing, rather than treaty brokering and administration. Many of the coalitions are issue-focused and therefore progress is fragmented and stilted.

#### ***Resource efficiency***

The Sustainable Development Goals have been agreed with resource-related goals included but implementation and enforcement remain an issue. Bottom-up initiatives derived from the corporate and NGO sectors continue to improve standards and transparency and although they do not gain the full backing of international agreements do achieve widespread voluntary adoption and assist in the development of new higher standard norms and practices. The EU is an important driving force in this regard, cascading improved standards throughout global supply chains through the opportunities for sustainability requirements within the applicable confines of the World Trade Organisation's rules.

#### ***Availability and accessibility of resources***

Although a global commodity market is in place, availability and accessibility of resources is reduced at times due to instances of resource nationalism. This is in response to a failure to set appropriate international rules on resource rent capture, transparency and human rights, despite improvements arising from voluntary measures, and the WTO has not been able to agree an approach to counter export restrictions.

#### ***World trade***

Regional and bi-lateral agreements are more common for this scenario compared with scenario 1. The EU's demands for higher standards of sustainability that are not supported by a global agreement lead to preferences for more regionalised supply chains. That said, consumer demand is still high and so supports international movement of goods.

#### ***World finance***

As for scenario 1.

#### ***Climate change***

A global agreement on binding targets has not been achieved. The EU pursues its own targets, but at a lower rate of reduction than would be achieved should global cooperation have been reached. Other countries make commitments but it is in a unilateral manner, with the level of commitment varied and the accountability limited. As such, the Representative Concentration Pathway (RCP) is 4.5.

## Policy Options for a Resource-Efficient Economy

### **G20**

The G20 fail to make a strong contribution to global governance of resource efficiency due to differing national positions and priorities. Some progress on technological collaboration is made but the organisation is not able to engender support from other nations.

### **4.2.2 EU and member countries**

#### **Economic model**

As for scenario 1.

#### **Environmental Policies**

The main policy instruments used by EU and national governments in the scenario “Strong Europe” are taxation, subsidies and pricing. Huge investments and incentives are placed to boost R&D and innovation in the key areas for resource efficiency and to orient consumers’ decisions towards targeted technologies and services. Stronger policy is required to drive further changes in behaviour due to the higher growth and demand in this scenario compared with Scenario “Strong Civil Society”.

The key measures taken by Governments in this scenario, are: energy and resource taxes, subsidizing resource and energy efficiency, phase out environmentally harmful subsidies by 2020 and information tools to strengthen the market for sustainable products (e.g. product labels indicating resource use). By 2020 there was a major shift from taxation of labour towards environmental taxation, including through regular adjustments in real rates and an increase in the share of environmental taxes in public revenues.

Binding regulations and standards (e.g. fuel efficiency, water-efficiency at the river basin level, eco-design, compulsory resource accounting and reporting) are imposed on all big emitters (industry, transport and energy sector...). Regulations and norms on energy and GHG performances are generalized to existing and new buildings and road vehicles existing or new devices.

### **4.2.3 Technology and Innovation**

"Strong Europe" is highly technology-oriented. The common belief among decision makers and common people is that technology will "save the World": it is mostly a matter of getting the appropriate technologies at the right time. The transition to a green and low-carbon economy is triggered by significant innovations, from small incremental changes to major technological breakthroughs. Incentives are in place so that the private sector invests more in research and innovation on resource efficiency. Demand-side measures create incentives for green innovation by building markets.

By 2020, smart and specialized R&D efforts resulting from 'Innovation Partnerships', Joint Technology Initiatives, private-public partnerships and EU research projects (EU Horizon 2020) dramatically improved the management, reuse, recycling and substitution of resources.

## Policy Options for a Resource-Efficient Economy

### Housing

By 2050, Europe is densely populated and around 80 % of its citizens live in or near a city. By 2020, most cities in the EU implemented policies for sustainable urban planning and design. Disincentives were provided for further urban sprawl through active spatial planning and revitalising urban centres.

Due to stricter energy performance standards for new buildings, houses and offices, all new buildings became climate neutral by 2020 and the existing building stock became climate neutral by 2050.

Passive houses became mandatory in construction in all EU countries in this scenario. The energy performance of buildings improved drastically; 'passive' housing technology became mainstream for new buildings and old buildings were retrofitted at a rate of 2% per year until 2050. Standards for new buildings with a maximum total material requirement per m<sup>2</sup> were introduced before 2020.

Through new innovations in high-quality recycling techniques, 70% of non-hazardous construction and demolition waste is recycled. A tax relief for builders using reclaimed construction materials was established by 2020.

The combined effect of price incentives (in particular carbon tax) , "white certificates" and innovation in retrofitting techniques, resulted in a drastic reduction of energy consumption for space heating in all kinds of dwellings and a dramatic decline in material consumption in the housing sector, everywhere in Europe.

By 2020, 80% of domestic properties were fitted with smart meters and smart water meters, 90% by 2025, and 100% by 2030.

### Food/Agriculture

A growing global population and a strong focus on income, growth and consumption in this scenario put intense pressures on land for food production. Along with growing global demands for food, the scenario "Strong Europe" aspires to further increase the efficiency and productivity of industrial agriculture in all Member States through technological knowledge and innovation (including genetically modified crops and the use of nanotechnology). Furthermore, there is a focus on bridging the gap between science and practice via the Farm Advisory System, as well as special support on farmer training programmes. These instruments are aimed at helping the farm sector to adapt to new trends and technologies, thus becoming more resource-efficient and cost-effective. Other instruments, which enhance competitiveness at farm level, include restructuring and modernisation measures as well as start-up aid for young farmers and small-scale farms (but not as strong as in the scenario "Strong Civil Society").

Furthermore, there is a strong focus on introducing practices that are beneficial for the environment and climate on the utilised agricultural area. Farmers are rewarded for the services they deliver to the wider public, such as landscapes, farmland biodiversity, climate stability even though they have no market value. Therefore, from 2015 onwards, the CAP introduced a new policy instrument, the Green Direct Payment. This mandatory "greening" component of direct payments rewards farmers for respecting three obligatory agricultural practices, namely maintenance of permanent grassland, ecological focus areas and crop diversification. Additional voluntary measures provide support to organic farming, water conservation and soil protection from erosion. Efficiencies gained through industrial agriculture have also enabled an increase in organic agriculture in the EU to 75% by 2050.

Measures to facilitate producer cooperation boost the competitiveness of farming by reducing costs, improving access to credit and adding value to the primary sector. This includes support for setting up producer groups as well as short supply chains and cooperation. Together these instruments encourage producer cooperation and improve the functioning of the food chain.

## Policy Options for a Resource-Efficient Economy

By 2025, avoidable food waste in households, retailers and catering has declined by 50%. This occurred mostly by initiating taxes or fees on food wasted in production and in the retail system and the introduction of pay-as-you-throw (PAYT) schemes for households as well as through large scale information campaigns before 2020 and National community engagement & support.

### Mobility

While emissions from transport were still increasing in 2014, they are reduced by 60% below 1990 levels in 2050.

Improvements in the fuel efficiency were achieved by 2025 through new engines, improved materials and designs of conventional vehicles, combined with the development and deployment of sustainable fuels and propulsion systems of cars, urban buses, taxis and delivery vans.

Road pricing, access restriction schemes and the removal of distortions in taxation encourage the use of public transport, the gradual introduction of alternative propulsion and lead to the gradual phasing out of 'conventionally-fuelled' vehicles in cities. The use of 'conventionally-fuelled' cars in urban transport was halved by 2030 and phased out in cities by 2050. The 'conventionally-fuelled' vehicles use and the associated CO<sub>2</sub> emissions were further reduced by several other measures, which include:

- A revised motor fuel taxation with clear identification of the energy and CO<sub>2</sub> component in conjunction with road vehicle charging schemes (by 2016),
- Full and mandatory internalisation of external costs (including noise, local pollution and congestion on top of the mandatory recovery of wear and tear costs) for road and rail transport (by 2020),
- Vehicle labelling Directive for CO<sub>2</sub> emissions and fuel efficiency,
- Appropriate standards for CO<sub>2</sub> emissions of vehicles,
- Promotion of eco-driving and fuel saving techniques are promoted in other modes – for example continuous descent for aircrafts,
- Maximum speed limits of light commercial road vehicles.

After 2025, public procurement strategies as well as research and innovation efforts, particularly on batteries, fuel cells and hydrogen together with smart grids ensure rapid development and deployment of the key technologies for a shift to plug-in hybrid cars and electric cars cut CO<sub>2</sub> emissions very notably. In 2050, electricity provides around 65% of energy demand by passenger cars and light duty vehicles.

Planes have been redesigned to become lighter, are powered largely by 2<sup>nd</sup> generation biofuels and low-carbon sustainable fuels in aviation reach 40% by 2050. Airport capacity is increased to face the growing demand of a doubling of EU air transport activities by 2050.

Heavy duty vehicles (lorries) rely both on biofuels and electro mobility. Airports, ports, railway, metro and bus stations are linked and transformed into multimodal connection platforms for passengers. By 2020, online information and electronic booking and payment systems integrating all means of transport to facilitate multimodal travel were established.

Considerable investment is placed to expand or to upgrade the capacity of the rail network. By 2050, a dense European high-speed rail network is established in all Member States and the majority of medium-distance passenger transport goes by rail.

**Policy Options for a Resource-Efficient Economy****Energy**

In the scenario “Strong Europe”, electricity is extraordinarily important (almost doubling its share in final energy demand to 36-39% in 2050) and mainly contributes to the decarbonisation of transport sector and for heating and cooling of buildings.

The share of low carbon technologies in the electricity mix increased to around 60% in 2020, to 75 to 80% in 2030, and nearly 100% in 2050. Encouraged by growing investments in renewable technologies, such as ocean energy and concentrated solar power and 2<sup>nd</sup> and 3<sup>rd</sup> generation biofuels have resulted in growing shares of renewables of around 30% in gross final energy consumption by 2030. Existing technologies, such as offshore wind turbines and blades are increased in size to capture more wind and photovoltaic panels are improved to harvest more solar power.

Wind and solar power from the Mediterranean deliver substantial quantities of electricity, with Scandinavian and other mountainous member states providing energy storage via pumped hydro. Imports of electricity produced from renewable sources from neighbouring regions are complemented by strategies to use the comparative advantage of Member States e.g. such as in Greece where large-scale solar projects are in place. Similarly, the EU imports renewable sources provided by countries like Russia and Ukraine (notably biomass) and gas provided through energy partnerships with countries like Russia and North Africa. Nuclear energy is still needed to provide a significant contribution in the energy transformation process in those Member States where it is pursued. It remains a key source of electricity generation.

For heat generation, gas is critical for the substitution of coal (and oil) with gas in the short to medium term and helps to reduce emissions with existing technologies until at least 2030 or 2035. Carbon Capture and Storage (CCS) is commercialised and contributes significantly to power generation. Centralized large-scale systems dominate in this scenario continue to play a greater role than in the “Strong Civil Society” scenario where centralized and decentralised systems work together and depend on each other.

Single European markets for gas and electricity were established by 2025, following an extensive programme of expanding Member State interconnection. This facilitates the addition of ever more substantial stochastic renewables across Europe, improving Member State as well as EU-wide energy security.

The starting point for the “Strong Europe” policy path was a strong carbon price signal followed by EU-wide targets for RES and national energy targets. In this scenario, the carbon price reached a higher level than in the scenario “Strong Civil Society” driven by the stronger demand for energy. The high carbon price is the major driver of innovation and provides an incentive for deployment of efficient, low-carbon technologies across Europe.

**Industry**

The key features of the Scenario “Strong Europe” regarding the industry sector are strong policy measures, which above all enhanced recycling amounts and support the development of eco-efficient innovations.

By 2020, “green tax reforms” led to an increasing share of environmental taxes. Businesses increasingly faced an urgent need to adjust in order to preserve their competitiveness. As firms sought to maximise their economic performance and raise their competitiveness, there was an increasing need for all

## Policy Options for a Resource-Efficient Economy

enterprises to step up efforts to implement a wider use of diverse strategies such as recycling, eco-design, eco-labelling and zero-waste production processes throughout Europe.

More stringent environmental regulation included market-based instruments (payment schemes, charges and taxes) and targeted bans. Extended Producer Responsibility schemes were expanded and improved. Policy incentives that reward business investments in efficiency were introduced by 2015. These incentives have stimulated new eco-innovations in resource efficient production methods. Supplemental investments for private-public partnerships, innovation partnerships and Union research funding (such as EU Horizon 2020) further enhanced scientific breakthroughs and sustainable innovation efforts in high-quality waste management and recycling techniques. Moreover, increasing consumer demand triggered the production of sustainable goods and services. By 2020, minimum environmental performance standards were set to remove the least resource-efficient and most polluting products from the market.

A more rigid Ecodesign directive that extended its scope to include any kind of product (i.e. not just those considered energy-related) was introduced by 2020 and has boosted the material resource efficiency of products (e.g. reusability/recoverability/recyclability, recycled content, durability) and waste prevention. This has led to implementation of measures also taking into account the material productivity of products through design principles such as design for recyclability, lighter products and design for longevity. To increase recycling rates and the use of secondary raw materials incentives were spread to stimulate secondary materials market and demand for recycled materials. Minimum recycled material rates, durability targets and reusability criteria were set by 2015. Thus, raw materials extraction has become increasingly uneconomical compared with the recycling option.

At the same time, Ecolabel criteria became mandatory for all products sold in the EU. Although waste prevention is a priority in this Scenario, recycling is by far the preferred waste treatment option. Other waste prevention strategies as, for example, reuse, are promoted in the Scenario „Strong Civil Society“.

### 4.2.4 Lifestyles and Preferences

In the “Strong Europe” scenario, resource efficiency is achieved by technological solutions. Appropriate price signals and clear environmental information (Eco-labelling) show citizens the most resource-efficient products and services. Consumers value products and services based on their resource efficiency, as social status is now linked to sustainable living. Thus, consumer demand is high for more sustainable high-quality and long-lasting products and services. This growing demand for greener products spurs new innovations in resource efficient production methods. Consumers are active market actors and take responsibility to buy green or more sustainable products. As citizens work and earn more, they have more, which in turn has led to a steadily increasing consumption of more but greener products.

#### How people work

In 2050, people work more than in 2014. Most Europeans voluntarily spend more time working in order to enable additional consumption.

#### How people live

Europe is densely populated and 80 % of its citizens lived in or near a city by 2020. Initiatives that support innovation and best practice sharing in cities together with policies for sustainable urban planning and design led to smart waste and water management systems, better air quality and strikingly decreased



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greenhouse gas emissions. About 70-80% of Europeans live in high-tech zero-energy accommodations located in close proximity to work and personal, social and community services.

### **How people eat**

Europeans demand high quality and a wide choice of food products. They slightly shifted their diets to less meat in favour of more vegetables (in line with WHO recommendations). As Europeans have less time, they prefer fast dishes and meals. Advanced labelling of products guides consumers to purchasing more environmentally friendly products and services.

### **How people move**

Public transport choices are more widely available than in 2014. Also the options for walking and cycling are improved. More people drive electric/hybrid cars or electric bikes than in 2014.

### 4.3 Scenario Narrative: Strong Civil Society

#### 4.3.1 International context

##### *Global Governance*

The global governance characteristics for scenario 3 are the same as those for scenario 2. Whilst global governmental processes are weak, global non-governmental networks and partnerships remain, although they are aligned strongly along ideological lines rather than necessarily along traditional governmental allegiances as they are in scenario 2.

##### *Resource Efficiency*

Again, a similar situation is seen as for scenario 2. The only difference is that where in scenario 2 the EU was a driving force for supporting the greater adoption of bottom-up initiatives globally and cascading standards through global supply chains, it is now less dominant in this regard.

##### *Availability and accessibility of resources*

This is the same as for scenario 2.

##### *World trade*

As for scenario 2 except that consumerism is much reduced in scenario 3 and therefore the demand driver of global trade is not as strong.

##### *World finance*

Whilst a global financial system exists, as for scenarios 1 and 2, in scenario 3 this co-exists with local and alternative currencies that stimulate locally based consumption and trading of goods and services within communities, thereby reducing resource demand.

##### *Climate change*

Whilst climate change mitigation is being addressed in Europe at a local and regional level, the lack of a global agreement means that actions across the world are not consistent and not of the scale required and therefore the emissions trajectory remains high, with a Representative Concentration Pathway of 4.5.

##### *G20*

As for scenario 2.

#### 4.3.2 EU and member states

##### **Economic model**

"Strong Civil Society" is a scenario in which the transition is a bottom-up process. This means that the role of EU and member states is not so much to lead the transition, but to create the appropriate conditions for this bottom-up process to develop.

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This means first a change in the balance of power and financial means between central governments and local/regional ones, in favour of the latter. Laws are adopted to encourage and protect decentralized initiatives that increase resource efficiency and sufficiency, while subsidizing mechanisms are systematically implemented by EU and national governments to support these initiatives.

The role of central governments is also to create the appropriate economic conditions for resource efficiency technologies and behaviours to develop on a wide scale. This implies in particular a radical reform of resource pricing (increasing prices with consumption) and taxation. The economic and financial context of this scenario is not so favourable for capital-intensive technologies and infrastructures to develop on a large scale, and there is no clear policy support for this except for ICT and high-speed train networks (where geographically possible).

The EU's economy is reflective of its values and has become famous for its Beyond GDP approach. GDP is replaced by more adequate indicators for tracking social development and progress in sustainability. Health, happiness and an individual's ecological rucksack are among the aspects measured. Quality of life (e.g. health, holistic education, social interactions, comfort) is prized over economic growth and increasing output (GDP). It is a scenario in which growing concerns about other aspects of wellbeing, including time-use, quality of goods and environmental friendliness are hugely important.

Targets for economic, social and environmental developments are clearly formulated and guiding every policy decision on local, regional, national and EU levels. Eco-labelling based on "real" facts and criteria is mandatory.

The initiatives for a reindustrialization in many European countries are successful. The focus of education policy, which for a long time was on the support of general education and academic education (theoretical skills), has shifted strongly towards practical, artistic and career education (practical skills, implicit knowledge and vocational training). The tax, economic and research policy frameworks provide a disadvantage for companies with liability exclusions and strengthen companies that have partners with personal liability. Through reforms of inheritance laws and trademark laws and further protection SME-structures and added value in regions are strengthened. The EU reduces the regulation of SMEs and the subsidiarity principle is strongly applied.

### **Environmental policies**

Strong Civil Society describes a strong bottom-up transition scenario in which social innovation and community building as well as changes in values through information and education play an important role both in raising the awareness of societal actors in terms of resources and climate, and in designing and implementing local, decentralized solutions to these problems.

Prices reflect the environmental and social costs. Labour taxes are very low, while resources (including material, water, land, energy...) as well as capital and consumption are taxed at high rates so that a high proportion of tax revenues come from "environmental taxes", which makes services (including repair and maintenance of products), recycling and labour intensive products relatively cheap. The monetary system primarily supports the real economy which is mainly based on owner-lead SMEs while only a few large companies financed by the financial markets are left. Only national banks are allowed to "create money".

Social policies are based on the principles of "flexicurity", which allows for flexible labour markets and support for those not participating in the labour market at the same time. Social and distribution policies create a strong incentive to take up paid work (at all levels of skills and education) while securing those not at work over their whole life-span.

**Policy Options for a Resource-Efficient Economy****4.3.3 Technology and Innovation**

Both social and technical innovations are important drivers for change. Technological innovation creates opportunities for sustainable lifestyles through eco-efficient products (such as household appliances, food, or hybrid/electric cars) and services (smart metering of individual consumption). The emphasis in this scenario is on user-centred designs of innovation that produce locally based smart and creative products. They are based on regional, national and global technological and scientific knowledge. However, it is social innovation that stimulates lifestyle changes through, for example, new online or offline communities or networks that share knowledge, ideas, tools, solutions and experiences. At the technological level, further proliferation of web and mobile technologies continues to play a critical role in building sharing communities. Strong and cooperative research and innovation activities take place on a local and regional level and a large number of scientific and social entrepreneurs throughout the EU are important change agents in the search for sustainable lifestyles. New technologies enable local manufactures to produce and “print” products or parts of them.

New business models support the transition from a linear to a circular economy with an increasing adoption of the product service system model of leasing rather than selling and with a focus on redesign, refurbishment, and reuse.

This re-industrialisation is based on common pools of innovative technologies, co-developed in a spirit of open source and open innovation covering a whole range of application from vertical farming in cities via micro-manufacturing of processed food (take high quality micro-breweries as an example) to products that some decades ago were more and more monopolized, such as mobility or pharmacy. This has also brought (back) small- and medium-sized factories and hence qualified jobs to formerly rural areas. This new equilibrium of globalized and regional production and consumption technologies ranges from traditional craftsmanship (e.g. in food production) to high-tech (e.g. 3D printers).

Most products: from mobile phones to buildings are of high quality, made from renewable resources, can easily be repaired and upgraded and provide a large amount of service to their users and can be recycled at the end of their life span.

**Housing**

In this scenario, zero-energy and material-efficient buildings became mandatory in construction before 2020 in all EU countries. Construction uses locally and regionally sourced building materials and compostable materials.

For existing buildings, targets for thermal retrofitting, renovation and refurbishment are established, with subsidizing procedures. Renovation and refurbishment is sourced by recycled materials from urban mining. Increased urban mining finds new ways to recycle concrete (including upcycling), and lower Europe’s demand for minerals like sand. New buildings are built both with high technology aspects like smart grids, and with efficient heating and cooling mechanisms using, for example, the natural advantages of earthen walls, rooftop gardens, vertical gardens and indoor vegetation. Moreover, modular construction enables easier and more flexible repair, rebuilding and rearranging of the building.

There is a strong local and regional movement in favour of retrofitting buildings, with ambitious targets, partially subsidized, but constrained by financial limitations due to the low economic growth. Subsidies for energy and water efficiency and distributed renewables are also part of the local / regional policy instruments in this scenario.

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There is a large movement of collective multi-stakeholder and participatory approaches to urban planning and the design of transport and other infrastructure that support compact, complex and efficient cities with strong social cohesion to promote sustainability and well-being. Reorganisation of the structure of urban development and especially of public space in core cities, gives more space to pedestrians, bicycles and public transport on the one hand and shared public space e.g. for urban farming on the other.

Reconstruction of existing buildings also aims at increasing the average density of resident population and providing a smaller housing floor area per person compared to 2014, but with more common space areas (both in form of common public space in buildings, e.g. shared kitchens and laundry rooms, and in form of more common public space in cities, e.g. parks and green urban areas). Innovative forms of housing e.g. co-housing reflect greater societal value for community living. Infills from urban sprawl are dedicated to collective urban farming and parking lots are turned into places for food production.

### Food/Agriculture

On the production side, widespread investment into R&D has resulted in improvement in diversified land production systems like organic farming, permaculture and agro-ecologic farming. Inputs of fertilisers and pesticides have been substantially reduced. The integration of scientific and local knowledge has advanced agricultural practices on both small and large-scale farms. Specialized and niche products are widespread and this helps to repopulate the countryside and preserve local culture. The focus in this scenario is put on rural development and setting the framework conditions to empower people in local areas, strengthen capacity building and improve local conditions (e.g. employment).

A radical reform of the Common Agricultural Policy led to a move away from direct payments and all market measures (CAP export subsidies, import tariffs, quotas), and a main focus on environmental and climate change objectives by 2018. The income lost through a progressive phase out of direct payments is in a large part compensated by the progressive phase in of Payment for Ecosystem Service (PES) schemes underpinned by EU CAP payments, favouring small and medium sized farms of large agricultural holdings. Strong financial support is given to small farms and young farmers to create additional job opportunities.

A strong connection between farmers and consumer ensures that food is supplied by community-supported agriculture and much food is distributed through co-operatives and farmers' markets. In addition to production, high importance is also placed on food quality, and distribution. Food supply chains are predominantly short, except for regions with a lower share of agricultural land. The decreasing need for transportation of food products over long distances cuts the associated carbon emissions. Growing food in urban farming circles meets local food demand and becomes a part of everyday life. Schools and other institutions grow fresh food on collective farms in the urban fringe and empty urban sites are converted into allotments.

Livestock production is more climate-friendly in 2050, mostly due to a reduction in the demand for meat in the EU.

Avoidable food waste has been halved by 2025. Key actions in support of this include a consumer food waste prevention campaign (e.g. Love Food Hate Waste campaign) which is underpinned by an interactive website giving practical advice on taking action (more than one million visits per year).

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### Mobility

In the “Strong Civil Society” scenario all major cities are almost car-free. This target is achieved by several soft policy measures. Firstly, by reducing the need for motorized transport, due to improved land use policies and integrated spatial planning policies to reduce urban sprawl and to shorten the distances to various services (e.g. workplace, supermarket...) Land use patterns reduce the per capita vehicle travel and /or average travel distance that residents must travel for some services.

“Enhancing modal shift” policies are introduced to make people to use alternative transport modes instead of a private car. In this category there are two groups of measures: the so-called “push measures”, that aim at making driving a car less attractive, and “pull measures” that aim at offering alternative mobility options. “Pull measures” include measures to internalize external costs of private cars, namely pricing measures such as: congestion charges; city centre pricing in Limited Traffic Zones. In addition, limiting parking places and expanding pedestrian zones create the conditions to continuously reduce car use until 2050. Furthermore there is a particular focus on “pull measures”. These include campaigns and initiatives that support cycling, walking and using cost-free public transportation. Together with well-developed bicycle lanes, safe and well-designed footpaths and a well-planned, secure and subsidised public transport network including public bike sharing, public renting services for shared electric vehicles and transport on demand for disabled people, cities offer variable multimodal transportation options.

Furthermore, measures (e.g. taxation policy and pricing incentives to use cleaner technologies) are introduced that regulate those mobility activities that cannot be avoided or shifted to alternative modes, thus are realized by low emissions vehicles. However, this change in technology plays a marginal role compared to the other soft measures. Finally, fuel-efficient driving initiatives are introduced to promote fuel-efficient driving, particularly through training programmes.

Investment in new motorways and airport infrastructures is strongly reduced. In contrast, a European high-speed train network for passengers and freight connecting European core cities continues to be developed.

At local and regional levels, there is a strong public support for the fast development of public transport using road and rail as well as promotion and information campaigns on sharing concepts. For education, commerce, health and services to the public (post, banks, police), new rules are established for the location of new premises, based on the concept of accessibility.

Goods and freight transport in cities is now carried out on the one hand by cargo bikes (for small to medium sized goods), and on the other hand by zero-emission lorries and trucks. International and bilateral goods and freights transportation is done mainly by railways and low-emission ships.

### Energy

The EU follows the principle of “food first” for using global cropland. While biomass does contribute to energy supply, this biomass is mainly sourced from residues (after accounting for soil fertility needs) and organic waste. The EU has played a role in aiding the establishment of energy crops abroad—on degraded soils—which have been instrumental in building local energy networks (e.g. combined heat and power units). The import of energy crops is very low.

Decentralised individual and community owned renewable power generation compliments large-scale centralised plant (particularly nuclear and remaining fossil fuel, along with offshore wind). A significant

## Policy Options for a Resource-Efficient Economy

number of power grids are bought under community or local government ownership. Electrification forms an even higher percentage of final energy demand than the previous scenario, as reliance on imported gas and other fossil fuels for non-electricity generation purposes decreases (e.g. cooking and space and water heating). Fracking takes place in some regions, with significant community ownership/benefit-sharing. Heat pumps are extensively used in buildings from 2025 onwards, along with greater use of district heating in new builds. Rapid expansion of electric car charging infrastructure also occurs from 2020 onwards.

### Industry

As in Scenario “Strong Europe”, but with a stronger focus on waste prevention strategies and new business models. By 2020, zero-VAT policies were introduced for waste prevention strategies which include production processes like lean production, circular economy and industrial symbiosis as well as reuse strategies (e.g. refurbishment, repair, remanufacturing, servicing, communal use). New business models include approaches that seek to prolong and/or optimise product life by increasing the sharing/renting/leasing/pooling of products.

#### 4.3.4 Lifestyles and Preferences

Europe’s population eschews consumerism and many have adopted lifestyles of voluntary simplicity, contentment and modesty but none the less of high quality of life. As a result energy and resource use has declined significantly despite somewhat low technological advancements.

There has been a major shift from ownership of many low quality cheap and short-lived products to shared access to robust and durable high-quality goods or services by exercising collaborative consumption or sharing systems. This reduces the need for new products and satisfies consumer needs for products without the need for absolute ownership. Sharing-systems are established by users directly through peer-to-peer networks or by businesses. The growth of such schemes is facilitated by the emergence of new technologies that connect suppliers and users.

Changing practices (such as no longer wasting food or washing clothes at high temperatures), or upgrading, reusing, repairing or recycling products are encouraged through information provision and awareness-raising campaigns. Fiscal reform (see above) contributes to the reduction of resource exploitation and harmful emissions to air, water and soil. Consumers choose to upgrade products by, for example, improving the performance of their computer through software or hardware upgrades, or by “restyling” clothing. To give products a second life, goods like clothing, leisure equipment, books and DVDs are reused by other people by passing them to second-hand or charity shops. And finally, the many valuable materials in products are reused and recycled.

People are also increasingly satisfied by services and experiences rather than simply purchasing goods. This shift in spending in favour of areas with a low environmental impact, such as education, communication, or recreation and culture (barring activities that involve intensive use of transport) reduces the environmental pressures of consumption.

Lifestyle changes in the Scenario “Strong Civil Society” did not just happen towards more environmentally efficient solutions, but also towards sufficiency.

## Policy Options for a Resource-Efficient Economy

### How people work

Developments described in this Scenario result in a lower growth of GDP compared with the second half of the 20th century. Expected demographic changes and the wish of more people to "downshift" (reduce their working hours/week) also reduced labour supply and growth of labour productivity has followed the trend of slowing GDP growth. Labour productivity has still grown faster than GDP, so social partners and governments have installed further incentives to reduce working hours so that full employment has been achieved. This trend was supported by measures that led to a more equal distribution of income and wealth and more years of work (along with the ongoing trend of increased life expectancy) to relieve the pension system.

### How people live

Most Europeans live in cities in socially innovative and resource, water and energy efficient modes of housing such as co-housing communities, urban co-ops and communes. Co-housing is essentially a combination of private dwellings, each with its own privacy and autonomy, but with the added advantage of shared facilities such as living rooms, laundry facilities and gardens, which offer resource-efficient social, environmental and economic benefits to the community.

Small-scale settlement structures and living close to work and amenities induced by systemic planning, reduced a lot of unnecessary movement from one place to another. Urban sprawl has thus declined. Some self-sufficient communities have moved back to the countryside, and many people have developed the green areas of the cities for cultivation. Fish, salads, mushrooms and some vegetables are normally grown in very productive urban farming initiatives.

### How people eat

The 2050 diet in the scenario "Strong Civil Society" is guided by conscious and "slow food" practices that lead to a healthier way of life of EU citizens and to an overall reduction of food overconsumption and decreasing amounts of food waste. By developing awareness and collective supporting networks people understand the impact of food choices on the surrounding environment and their health and choose to adopt vegetarian and low animal product consumption.

Demand for local, organic, seasonal and self-grown foods as well as Fair Trade markets are growing, and an increasing number of consumers are seeking information on the conditions under which the products they purchase are produced and transported. Urban farms are popping up around Europe, using un-used urban spaces and roofs to grow food. Online social networks connect people who need land to grow food with those who have land to spare, and also connects growers so that they can share advice, find land, create groups, and swap surplus seeds and crops.

### How people move

The preferred way to move in cities is biking and walking. Local mobility is emphasized and less road space is devoted for private vehicles. Old and new infrastructure is adapted to cycling and walking. Car-sharing systems dominate the use of vehicles when public transportation is not used while shared offices enable people to work closer to their homes. Digital social networking enables different forms of lift sharing.



## Policy Options for a Resource-Efficient Economy

The huge share of work-related mobility and commuting is decreased by the expansion of teleworking and by reorganization and reduction of working hours. The application of new ICT's (Information and Communication Technologies) reduces the need for business travel. Hence, business trips are reduced to a minimum.

New options and ideas for holidays diminish travel needs related to vacationing. Travel agencies promote low-carbon travel routes, which emphasise the advantages of local travel destinations. Distant travel destinations can be reached using slower forms of transportation, since people have more time.

### 4.4 Policies that affect multiple resources/sectors

As the work on defining the policy mixes for each of the scenarios has progressed, it has become clear that some policies or measures that would be implemented are not specific to one resource type (e.g. water or metals) or to one particular sector (e.g. agriculture or industry). For example, an ecological tax reform in which taxes on resources are increased while taxes on labour are decreased would affect all resources. Similarly, removing environmentally harmful subsidies would affect both agriculture and energy. On the other hand, the strength of these measures might differ across scenarios. This is illustrated in Table 4, which provides a list of measures to be considered in the scenarios that are not resource- or sector-specific. The number of “+” signs shows the estimated strength of the policy/measure in each scenario. This table is preliminary and will be refined as the scenarios are further developed.

**Table 4: Policies that affect multiple resources/sectors for each scenario**

	Scenario 1	Scenario 2	Scenario 3
Ecological Tax Reform	+	+++	++
Labelling eco-efficient products	+	++	+++
Participatory governance		++	+++
Remove environmentally harmful subsidies	+	++	+++
Beyond GDP approaches			+++
Training and skills (cooking vegetarian, driving skills, repair, renovate, recycle...)	+	++	+++
Educational reform (->integrative, problem-solving)		+	+++
EU Sustainable Spatial Planning Directive			+++
Information Campaigns (co-housing, mobility, food waste, water effic)	+	++	+++
Green Public Procurement	+	+++	++
Use of ICT (e.g. trip sharing, shopping)		+	+++
R&D&I	++	++	+++
Reduction of working hours			+++

### 4.5 An Example of a Timeline for Water

To illustrate the development of a timeline for the scenarios, an illustration is provided here of a preliminary timeline for Water for scenario 2 (Strong Europe). As discussed in the previous sector, it is divided into two parts – policies that affect all sectors (agriculture, housing, energy and industry) and then specific measures to improve water efficiency in each decade.

#### Scenario 2 (Strong Europe)

##### **Policies that affect all sectors (primary policy tools)**

<b>Moderate Ecological Tax Reform introduced in 2020. Taxes on resources increased by x%, taxes on labour decreased by y%</b>
<b>Labelling on water-efficient products introduced in 2020. By 2030 75% products are labelled. By 2040 100% products are labelled.</b>
<b>All environmentally harmful subsidies removed by 2020.</b>
<b>Training and skills development for water efficiency introduced in 2025.</b>
<b>Information Campaigns on water efficiency introduced in 2018</b>
<b>Green Public Procurement for water-efficient products and buildings. By 2030 all products and buildings publicly procured meet highest water efficiency standards.</b>
<b>Investments in Research, Development and Innovation in water efficiency increase by x% by 2020 and y% by 2030</b>
<b>Eco-Design Directive expanded in 2025 to include water efficient products</b>

##### Timelines:

Food/agriculture	Until 2020	European Innovation Partnership on Agricultural Sustainability and Productivity established Directive on Water Pricing (level of water pricing decided nationally – xx)
	Until 2030	Irrigation efficiency increased by x% Transparency Standards introduced* Full compliance with the Water Framework Directive by 2025 Water Efficiency Targets at River Basin Level introduced
	Until 2040	Health Standards and Information Campaigns lead to a x% reduction in the consumption of meat Net imports of embodied water reduced by 50%

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	Until 2050	Net imports of embodied water reduced to zero
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Housing	Until 2020	Directive on Water Pricing (level of water pricing decided nationally – xx)
	Until 2030	Transparency Standards introduced* Mandatory labelling for all Water-using Products introduced in 2025 Water metering introduced Awareness raising campaigns on water efficiency
	Until 2040	Voluntary rating of water performance of residential buildings (x% households comply by 2040) Mandatory rating of water performance of non-residential buildings
	Until 2050	Certification schemes for reuse of water and rainwater harvesting introduced

Energy	Until 2020	Directive on Water Pricing (level of water pricing decided nationally – xx)
	Until 2030	Transparency Standards introduced* Smart grids expanded (reduces energy use in households) Full implementation of the Water Framework Directive by 2025
	Until 2040	Net imports of biomass reduced to zero by 2030
	Until 2050	Share of renewables in energy mix 80% in 2050 (lowers demand for cooling water)

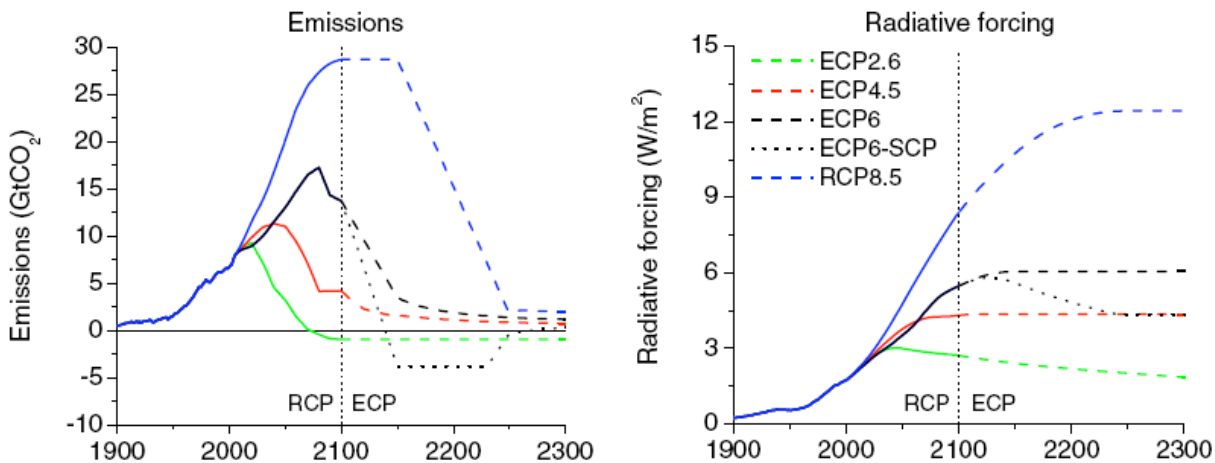
\*Biggest companies in food, construction, ICT, manufacturing and car industries agree on transparency standards on data concerning energy and natural resource efficiency (Source: SPREAD project)

**5 Climate Scenarios**

**CLIMATE SCENARIOS FOR THE POLFREE PATHWAYS**

A major assumption for the work in the POLFREE project regards the climate in Europe in 2050. As indicated in the Scenario Outline Table, the POLFREE team assumes that Scenario I (Strong Cooperation) would have the Representative Concentration Pathway (RCP)2.6 (van Vuuren et al. 2011). RCP 2.6 is the pathway with the most rapid and earliest reduction of greenhouse gas emissions, consistent with the global agreement on climate change in POLFREE Scenario 1. For the POLFREE Scenarios 2 and 3, it is assumed that RCP 4.5 applies.

The figure below illustrates the emissions of these two pathways (RCP 2.6 green line; RCP 4.5 red line). The diagram on the right hand side shows the radiative forcing<sup>5</sup> of these two scenarios and shows that the forcing is the same for both until shortly before 2050. For the purposes of the POLFREE project, we assume that the amount of climate change in 2050 is the same for each scenario. The significant differences in climate, depending on different levels of emissions emerge after 2050.



**Figure 3:**

**Representative Concentration Pathways: Emissions and Radiative Forcing (van Vuuren et al. 2011). RCP 2.6 = green line. RCP 4.5 = red line.**

Since the results of climate models simulating the effects of these RCPs are not yet published, the POLFREE project has looked at the results of climate models that have simulated the effects of the earlier set of IPCC scenarios. Rogelj et al. (2012) concluded that the RCP 4.5 has similar temperature effects to the B1 scenario used in the IPCC reports.

Information on the climate in Europe in 2050 using the B1 scenario has been obtained from the web-site of the FP7 project CLIMSAVE (www.climsave.eu). The CLIMSAVE project looked at the results of 16

<sup>5</sup> Radiative forcing is a measure of the energy absorbed and retained in the lower atmosphere – effectively a measure of the amount that the Earth’s energy budget is out of balance.

## Policy Options for a Resource-Efficient Economy

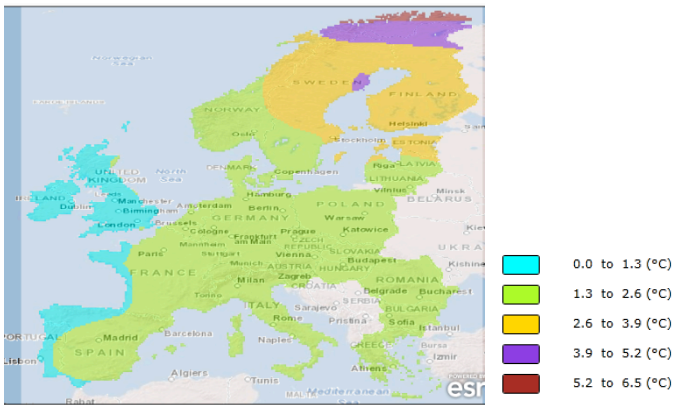
climate models and selected 5 models to illustrate the range of possible climate futures in 2050. From these 5 models, the results of two models are used here. The CSMK3 model was found by the CLIMSAVE project (Harrison et al. 2013) to be the climate model whose climate change scenario is the closest to the mean scenario over the 16 available models (i.e. “central”). The GFCM21 climate model simulates a strong summer drying in Europe.

The maps below show the relative changes compared to a baseline for the B1 Scenario, using a medium climate sensitivity, for annual temperature, summer temperature, winter temperature, annual precipitation, summer precipitation and winter precipitation. The broad results are also summarized in the table below, which shows that depending on the climate model used the climate scenario for 2050 differs. To reflect this uncertainty, it is therefore better to use the results of more than one climate model when discussing the possible climate in Europe in 2050.

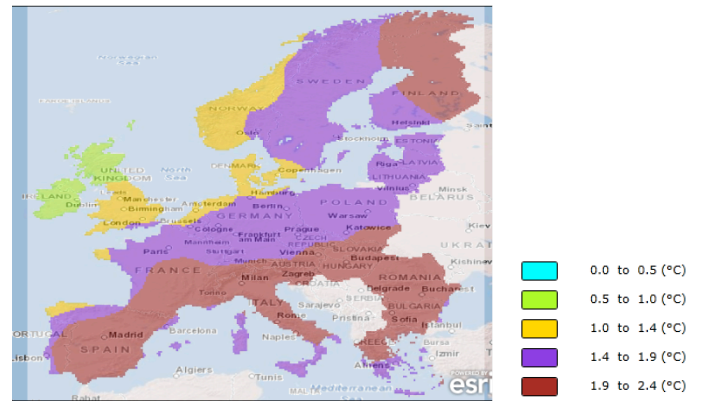
	Climate Model CSMK3	Climate Model GFCM21
Change in annual mean temperature	Maximum in Arctic (6.5C). Little change in western Europe	Maximum change 2.4C in Arctic and Southern Europe
Change in mean summer temperature	Mediterranean warming less than 3C	Maximum change >4C in Mediterranean region
Change in mean winter temperature	Maximum warming >10C in Arctic	Maximum warming 3.8C in Finland
Change in annual precipitation	Wetter in North, drier in South	Drier over most of Europe
Change in summer precipitation	Wetter in North, drier in South	Drier over much of Europe
Change in winter precipitation	Drier in South and Central	Wetter in North and Central

**The maps on the following two pages are derived from the CLIMSAVE project ([www.climsave.eu](http://www.climsave.eu)). They show the changes between baseline and the year 2050 of annual mean temperature, summer mean temperature, winter mean temperature, annual precipitation, summer precipitation and winter precipitation calculated by two climate models (CMSK3 and GFCM21) using the B1 scenario of the Intergovernmental Panel on Climate Change.**

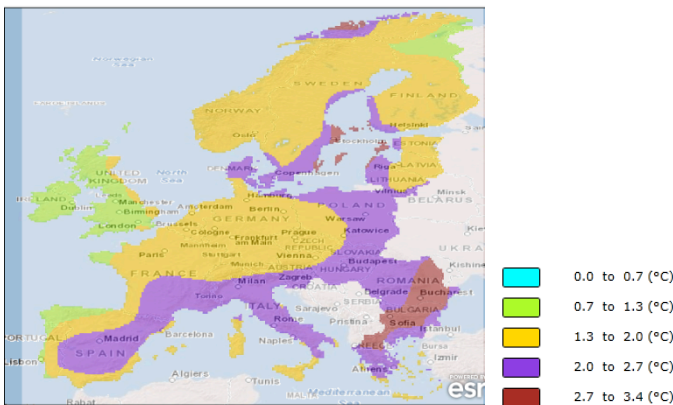
## Policy Options for a Resource-Efficient Economy



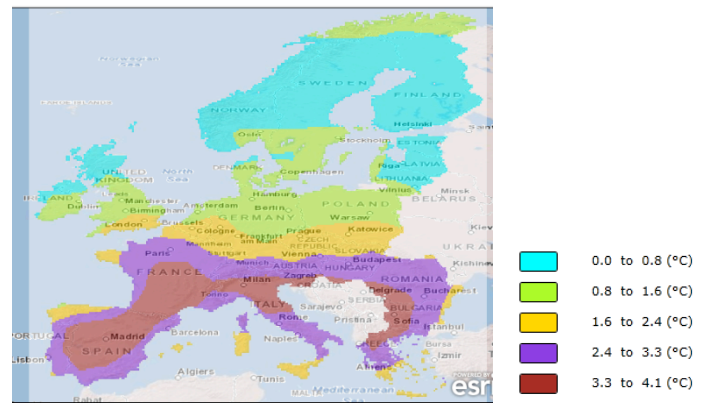
CSMK3 Annual Temperature



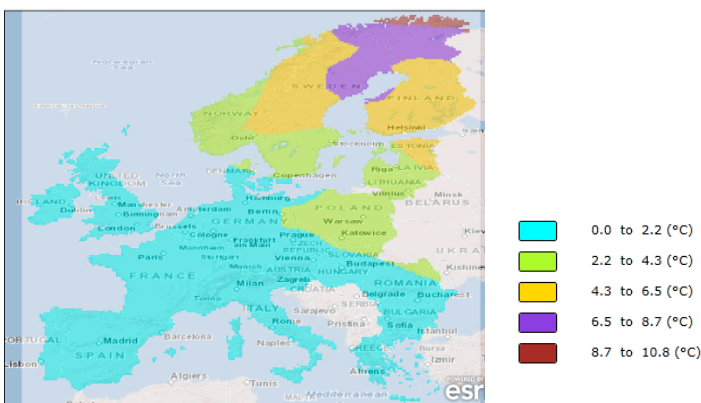
GFCM21 Annual Temperature



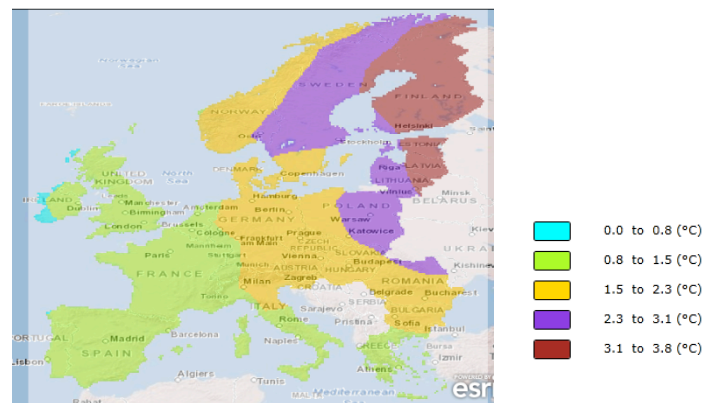
CSMK3 Summer Temperature



GFCM21 Summer Temperature

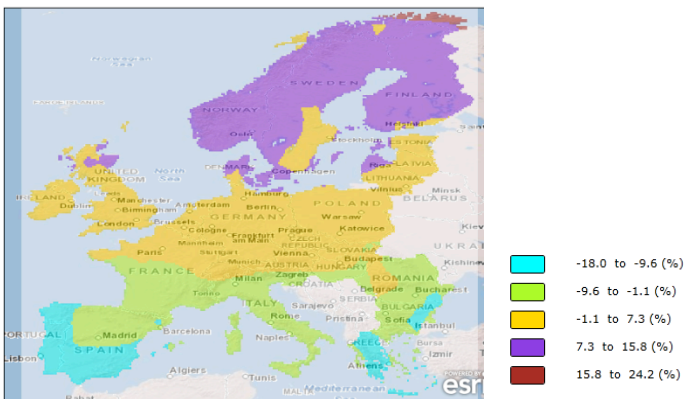


CSMK3 Winter Temperature

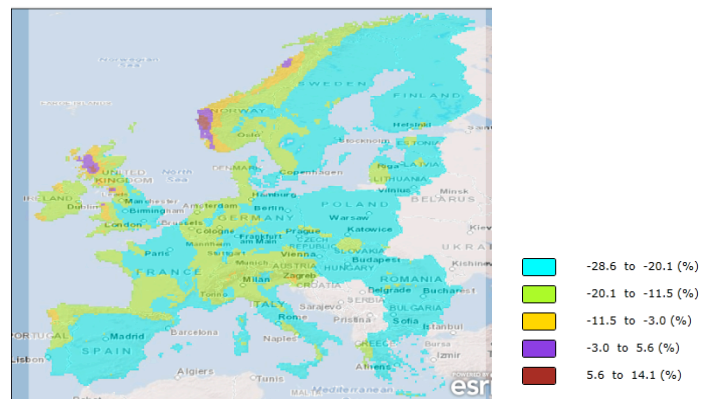


GFCM21 Winter Temperature

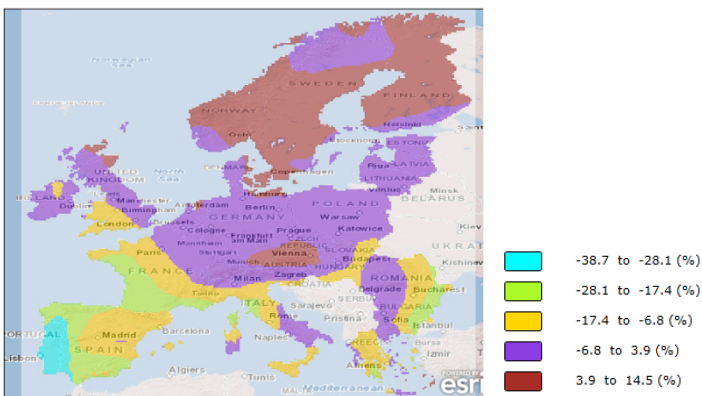
## Policy Options for a Resource-Efficient Economy



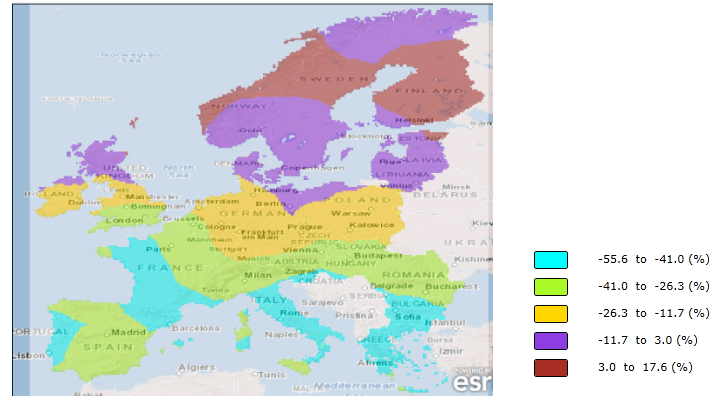
CSMK3 Annual Precipitation



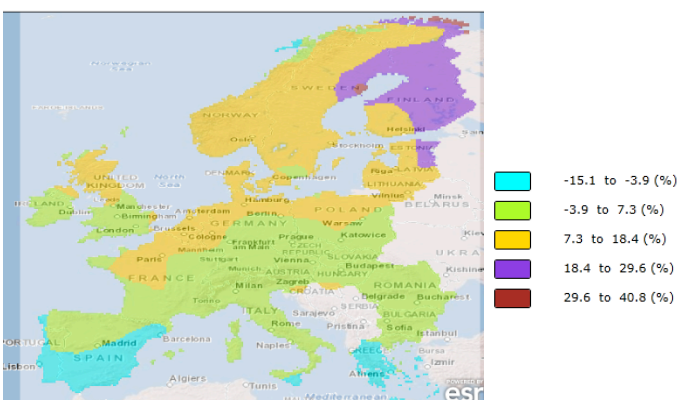
GFCM21 Annual Precipitation



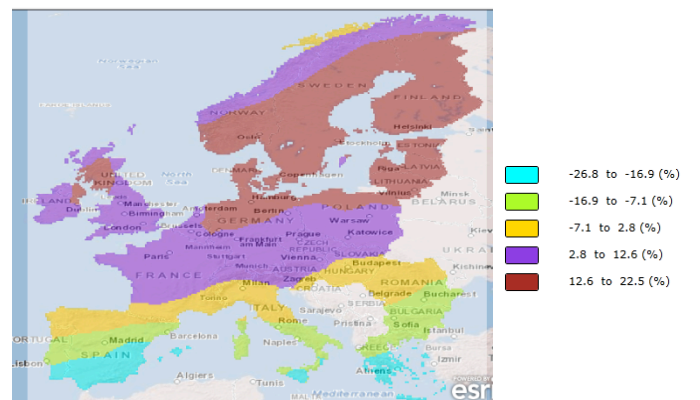
CSMK3 Summer Precipitation



GFCM21 Summer Precipitation



CSMK3 Winter Precipitation



GFCM21 Winter Precipitation



## 6 Conclusions and Outlook

The work on defining pathways for the POLFREE project has identified three pathways to achieve the vision outlined in POLFREE Deliverable 2.2: first a pathway (Strong Cooperation) in which there is strong global cooperation to achieve sustainability goals between now and 2050; second a pathway (Strong Europe) in which there is weaker global cooperation but in which Europe takes the lead in pursuing its ambitious targets for strong, sustainable and inclusive growth; and third a pathway (Strong Civil Society) in which Europe takes a different governance model (strong participation) and a different economic model (beyond growth) and achieves resource efficiency goals through efficiency improvements and reduced resource use.

These three scenarios plus a reference scenario (business as usual) will be modelled during the second half of the POLFREE project. A comparison of the results of scenario modelling will show:

- Comparing Strong Cooperation with the Reference Scenario gives the global environmental gains and differences in economic performance that an international cooperation can achieve;
- Comparing Strong Cooperation with Strong Europe shows the economic and social costs/benefits of international cooperation for Europe;
- Comparing Strong Europe with Strong Civil Society shows the impacts of different pathways to sustainability on welfare in Europe;
- Comparing Strong Europe and Strong Civil Society with the Reference Scenario shows the welfare gains that can be achieved in Europe, if all other countries do not cooperate.

In order to carry out the modelling, it is necessary to carry out a detailed analysis of the different policies that would be implemented in each scenario. This work has begun by filling out a matrix for each scenario, with the addition of sub-targets and consideration of the main resource-use sectors: food, mobility, housing, manufacturing and energy.

Once the final set of policies for each scenario is available, the next step is to decide when each of the policies will be introduced and/or strengthened. This will be done for each decade: until 2020, 2030, 2040 and 2050. The timelines will then be converted into quantitative input for the modelling.

As outlined in the POLFREE Description of Work, a stakeholder consultation workshop will be organized (scheduled for June 10<sup>th</sup> 2014). The three scenarios will be visualized by Robert Horn and the draft visualization will be discussed at the workshop. The stakeholder inputs on the three scenarios will be taken into account in the final formulation of the scenario input for modelling.

In summary, the work in Task 3.2 has proceeded according to the plans in the description of work, starting with the formulation of a vision and headline targets in Task 2.2. Using inputs from Task 2.5, three scenarios have been defined and described. The work is proceeding on defining policy mixes for each scenario in preparation for the quantification and modelling as well as for the production of murals to visualize the scenarios and support the discussion with stakeholders.

## 7 References

- Banister, D., Hickman, R. and Stead, D. (2006): Looking over the Horizon: Visioning and Backcasting, in Perrels, A. , Himanen, V. and Lee-Gosselin, M. (eds): Building Blocks for sustainable Transport – Dealing with Land Use, Environment, Health, Safety, Security, Congestion and Equity, Amsterdam: Springer.
- Börjeson, L., Höjer, M., Dreborg, K.-H., Ekvall, T., Finnveden, G. (2006): Scenario types and techniques: towards a user's guide, *Futures* 38, 723–739.
- Dreborg, K. H. (1996): Essence of Backcasting, “Futures”, vol.28, n.9, pp.813-828;
- Dunn, W.N. (1994): Public Policy Analysis: an Introduction, Prentice Hall, Englewood Cliffs NJ.
- Linstone, H. A. (1999): Decision Making of Technology Executives: Using Multiple Perspectives to Improve Performance, ArtechHouse, BostonMA/LondonUK, 1999.
- Robinson, J. (1990): Futures under glass: a recipe for people who hate to predict. “Futures”, October, pp.820-842.
- Rogelj, J., M. Meinshausen & R. Knutti (2012) Global warming under old and new scenarios using IPCC climate sensitivity range estimates. *Nature Climate Change*, 2, 248-253, DOI:10.1038/nclimate1385.
- van Vuuren, D.P., Edmonds, J., Kainuma, M. et al. (2011) The representative concentration pathways:an overview. *Climatic Change* 109, 5 – 31.