Territorial Reference Framework for Europe

Discussion Paper No. 2
Trends – ANEXES

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This Discussion Paper was prepared as part of the ESPON 2020 applied research activity 'European Territorial Reference Framework'. The views expressed herein do not necessarily reflect the opinion of the ESPON EGTC, the ESPON 2020 Monitoring Committee or the European Union.

1 Annex 1. European Roadmaps

During the early 2010s, the EC elaborated a prospective framework for European policies in relation to issues energy, transport, environment and sustainability, defining future pathways in a number of roadmaps, strategies and initiatives. Most representative initiatives are presented in a synthetic way next:

- The **Roadmap for Moving to a Competitive Low Carbon Economy 2050 (COM / 2011/0112 final)** established partial targets to meet 80% carbon emissions redution by 2050, namely 25% by 2020, 40% by 2030 and 60% by 2050. In practice, these targets implied increassed efficinecy of the European energy system, ie. consuming less, and transtion to 100% renewable energy production with full development of the electrification potential of each sector, ie. stoping emissions derived from energy consumption.
- The **Energy Efficiency Plan 2011 (COM / 2011/ 109 final)** defined energy efficiency as Europe's biggest energy resource, both meaning using less energy inputs for maintaining an equivalent level of economic activity and consuming less through behaviour change. To promote energy efficiency, five sectors were identified as strategic for action: the public sector namely through green procurement (public spending accounts for 17% of EU GDP) and refurbishment public buildings and dependencies (12% by area of the EU building stock); increassing efficiency of European buildings (they represent 40% of final energy consumption); efficient generation of heat and electricity, full exploitation cogeneration and district heating and cooling; energy efficiency in electricity and gas networks; and in the Industry Sector, energy audits and energy efficiency plans to pursue good track of the sector.
- The **Roadmap to a Single European Transport Area 2050 (COM / 2011/0144 final)** developped the transport dimension of the Low Carbon Economy Roadmap: 60% GHG emissions cut by 2050 while maintaining or even improving transport performance. To do so, proposals insisted on technology a key driver, eg. allowing for 40% of sustainable low carbon fuels in aviation in 2050, 40% shipping emissions cut by 2050, or ceassing conventionally-fuelled cars in cities by 2050. On another hand, the consolidation of the Single European Transport area plus the investments in the completition of missing links and the interconnection of transport networks (€ 1.500 billion) ought to favour seamless travel across borders and modes, and shift towards most efficient and environmentally friendly modes.
- The **Roadmap for Energy 2050 (COM / 2011/0885 final)** focussed on the strategy kinked to energy generation infrastructure. Although the roadmap did not provide targets on liked energy mixes, just recommendations for the future development of the energy sector, the roadmap elaborated on a number of prospective scenarios which all coincided in sharp long-term fall of oil consumption (20%) and solid fuels (between 10% and 15%), strong increase of renewable energy sources (between 40% and 60%), relative stability of natural gas, and diverse

alternatives for nuclear power downsizing (between 10 and 15%). Uncertainties in the sector were large, including the oil peak; the extent shale gas in Europe could prove viable, whether and when Carbon Capture & Storage (CCS) would become commercial, what role Member States would seek for nuclear power, how climate action across the globe would evolve

- The **2030 Energy Strategy (COM / 2014/015 final)** established in 2014 the policy framework for climate and energy in the period from 2020 to 2030. The post 2020 policy framework setup by the Energy Strategy established a binding targets including a 40% reduction of domestic EU emissions by 2030 relative to 1990, a 27% share of renewable energy sources by 2030 and an increased level of energy savings of approximately 25% in 2030.
- The **Roadmap to Resource Efficient Europe 2050 (COM / 2011/0571 final)** established a 2050 Vision where the EU's economy had grown in a way that respected resource constraints and planetary boundaries, thus contributing to global economic transformation. The economy would be competitive, inclusive and would provide a high standard of living with much lower environmental impacts. All resources would be sustainably managed, from raw materials to energy, water, air, land and soil. Climate change milestones would have been all reached, while biodiversity and the ecosystem services it underpins would have been protected, valued and substantially restored. The roadmap proposed a series of milestones, targets and monitoring indicators for recycling and reuse of resource, that were howweve not officially adopted.
- The **EU action plan for the circular economy (COM / 2015/614 final)** inherited the approach of the previous Ressource-efficiency roamap, providing strategies and milestones for increasing the levels of recycling and reutilisation of marterials in Europe, in the so-called circular loops. The transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised, is an essential contribution to the EU's efforts to develop a sustainable, low carbon, resource efficient and competitive economy. The EU action plan for the Circular Economy focussed on the areas of Product design, Production processes, Consumption, Waste management, and the market for secondary raw materials and water reuse. The action plan established priority action needed in dealing with Plastics, Food Waste, Critical Raw Materials, Construction and Demolition waste and Biomass and Bio-Based products.

Next, each of these Roadmaps, Strategies and Actions Plans are descrived in more detail, acompanyied with key tables and figures related to targets and milestones proposed.

A Roadmap for moving to a competitive low carbon economy in 2050
COM(2011) 112 final

Together with the White Paper on Transport (2011) and the Energy Efficiency Plan (2011), the Roadmap for moving to a competitive low carbon economy was elaborated as a key deliverable under the Resource Efficiency Flagship of the EU2020S.

The 2020 climate & energy package (2007)

The 2020 climate & energy package was a set of binding legislation to ensure the EU met its climate and energy targets for the year 2020. The targets were set by EU leaders in 2007 and enacted in legislation in 2009. They became headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth.

Three targets integrated the committment of EU Member States:

- reducing greenhouse gas emissions (GHG) by 20% compared to 1990
- increasing the share of renewable energy sources (RES) in the EU's energy mix to 20%
- increasing 20% the energy efficiency of Europe.

In 2011, it was aparent that targets related to CO2 and RES could be met pursuing undertaken committments, but energy efficiency targets would not be met unless further efforts were made[1].

The 2010-2050 Roadmap milestones

The transition towards a competitive low carbon economy meant according to the low carbon economy roadmap that the EU should prepare for reductions in its *domestic* GHG emissions by 80% by 2050 compared to 1990[2]. Reductions of the order of 40% and 60% below 1990 levels would be the cost-effective pathway by 2030 and 2040, respectively. In this context, it proposed reductions of 25% in 2020.

Such a pathway would result in annual reductions compared to 1990 of roughly 1% in the first decade until 2020, 1.5% in the second decade from 2020 until 2030, and 2% in the last two decades until 2050.

If the EU delivered on its current policies, including its commitment to reach 20% renewables, and achieve 20% energy efficiency by 2020, this would enable the EU to outperform the current 20% emission reduction target and achieve the propose 25% reduction by 2020.

A less ambitious pathway could lock in carbon intensive investments acording to the low carbon economy roadmap, resulting in higher carbon prices later on and significantly higher overall costs over the entire period.

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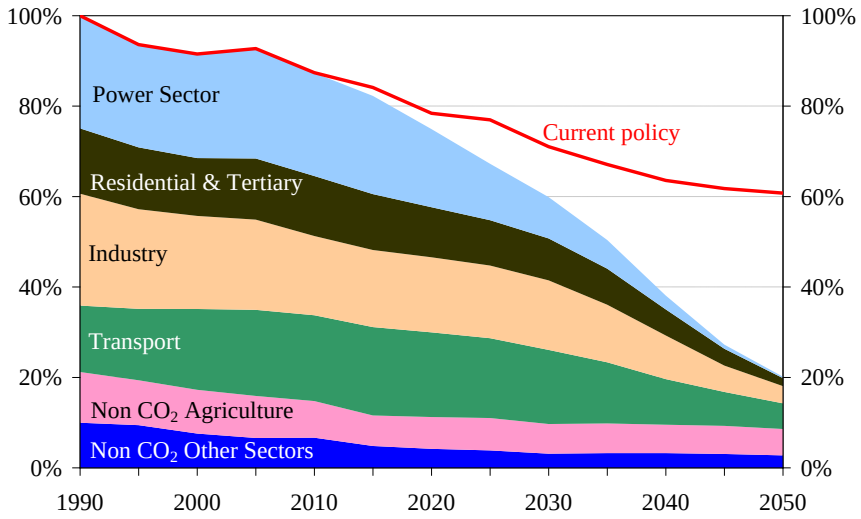
1 Energy Efficiency Plan - COM(2011) 109.

2 Domestic meaning real internal reductions of EU emissions and not offsetting through the carbon market.

Figure: EU GHG emissions roadmap and milestones towards an 80% domestic reduction towards 2050



Distribution of commitments among sectors

To fullfull the overall proposed targets, commitments were distributed among different sectors, considering the relative weight of each sector to the GHG abatement, and the relative feasability to reduce emissions in each particular sector. Most ambitious targets were foreseen for the Power industry and energy production sector (up to 99% reduction by 2050! Implying a fully RES based society by 2050), the Residential and Services sector (up to 91%, implying almost complete electrification of the sector), general Industry (up to 87% reduction), Transport (up to 67%) and Agriculture (up to 49%).

Table : CO2 Sector reductions 1990-2050

GHG reductions compared to 1990	**2005**	**2030**	**2050**
Total	-7%	-40 to -44%	-79 to -82%
Sectors			
Power (CO_2)	-7%	-54 to -68%	-93 to -99%
Industry (CO_2)	-20%	-34 to -40%	-83 to -87%
Transport (incl. CO2 aviation, excl. maritime)	+30%	+20 to -9%	-54 to -67%
Residential and services (CO_2)	-12%	-37 to -53%	-88 to-91%
Agriculture (non-CO_2)	-20%	-36 to -37%	-42 to -49%
Other non-CO_2 emissions	-30%	-72 to -73%	-70 to -78%

In practice, these targets implied full transtion of the European energy market to 100% RES production (and eventually consumption should energy imports decay in time as wanted), and full development of the electrification potential of each sector in order to take advantage of the clean electricity prodution (e.g. the electrification of transport).

Costs and savings

On average over the coming 40 years, the increase in public and private investment needed to fullfill proposed targets would amount around € 270 billion annually. This represents an additional investment

of around 1,5% of EU GDP per annum on top of the overall current investment representing 19% of GDP in 2009[3]. It would take Europe to the investment levels before the economic crisis. In this context, it is interesting to note the much larger shares of GDP allocated to investments in China (48%), India (35%), and Korea (26%) in 2009[4], showing emerging economies' need to build up infrastructure but also the potential in leapfrogging towards a competitive, low carbon economy.

Taken over the whole 40-year period, it is estimated that energy efficiency and the switch to domestically produced low carbon energy sources could impact as follows:

- In 2050, the EU's total primary energy consumption could be about 30% below 2005 levels. Average fuel costs by between € 175 billion and € 320 billion per year.
- In 2030, annual costs of controlling traditional air pollutants could be more than € 10 billion lower, and in 2050 close to € 50 billion could be saved every year.
- Reduced mortality would bring benefits estimated up to € 17 billion per year in 2030, and up to € 38 billion in 2050.

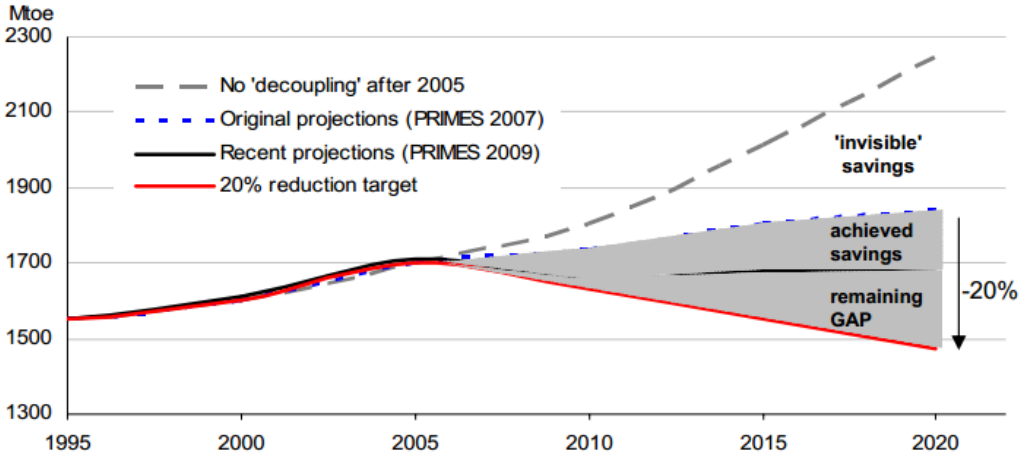
3 Eurostat, National accounts.

4 World Bank, Indicators.

ENERGY EFFICIENCY PLAN 2011
COM(2011) 109 final

Energy efficiency[5] was perceiced in 2011 (and it is still perceide) as one of the most cost effective ways to enhance security of energy supply, and to reduce emissions of greenhouse gases and other pollutants. Energy efficiency can be seen as Europe's biggest energy resource. In 2007 the Union set itself the target for 2020 of saving 20% of its primary energy consumption translating into a saving of 368 million tons of oil equivalent (Mtoe) of primary energy[6] by 2020 compared to projected consumption in that year of 1842 Mtoe.

Figure: Development and projection of primary energy use for the EU by 2020



The Energy Efficiency set up the following pillars and principles for action:

Public sector: leading by example. As public spending accounts for 17% of EU GDP and publicly owned or occupied buildings represent about 12% by area of the EU building stock, acting on the public sector could have considerable impact. Therefore, it would be promoted high standards of energy efficiency in goods purchase (e.g. ICT equipment), services (e.g. energy) and works (e.g. refurbishment of buildings); public authorities would be required to refurbish at least 3% of their buildings each year, by floor area (twice the currently prevailing rate for the European building stock); continuing support to the local approach to energy efficiency through the Covenant of Mayors.

Low energy consuming buildings. Nearly 40% of final energy consumption is in houses, public and private offices, shops and other buildings. In residential homes, 67% of this is for space heating. A

[5] Technically, 'energy efficiency' means using less energy inputs while maintaining an equivalent level of economic activity or service; 'energy saving' is a broader concept that also includes consumption reduction through behaviour change or decreased economic activity. In practice the two are difficult to disentangle and in the Energy Efficiency Plan the terms are often used interchangeably.

[6] Gross inland consumption minus non-energy uses

large energy saving potential remains untapped as energy efficincy of buldings is generally is low or even very across vast areas of Europe.

Efficient generation of heat and electricity. About 30% of the EU's primary energy consumption is consumed by the energy sector, mainly for transforming energy into electricity and heat and for distributing it. Therefore, priorities should focus on infrastructure update to replace ageing equipment, recovering heat losses from electricity and industrial production processes that could cover a significant part of Europe’s thermal energy needs, greater use of (high-efficiency) cogeneration, including from municipal waste treatment plants, and district heating and cooling.

Energy efficiency in electricity and gas networks. To strengthen the basis for national grid regulators to take energy efficiency into account in their decisions and in monitoring the management and operation of gas and electricity grids and markets.

European manufacturing industry. About 20% of the EU's primary energy consumption is accounted for by industry. While the sector had had already large progress in energy efficiency (over 30% improvement in 20 years) improving potential still existed. The Plan proposed a combination of mandatory regular energy audits for large companies, voluntary agreements on implementing energy efficiency processes and systems, and studying ecodesign protocols **that** could be suitable for industrial equipment like motors, pumps, compressed air, drying, melting, casting, distillation and furnaces.

Roadmap to a Single European Transport Area 2050
COM / 2011/0144 final

In 2011, the European Commission adopted the Single European Transport Area roadmap that included 40 concrete initiatives for 2011-2021 period to build a competitive transport system that would increase mobility, remove major barriers in key areas and fuel growth and employment. At the same time, the proposals ought to dramatically reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050.

To do so, by 2050, Europe should no more have conventionally-fuelled cars in cities, shift 50% of medium distance intercity passenger and freight journeys from road to rail and waterborne transport, use at least 40% of sustainable low carbon fuels in aviation and cut at least 40% in shipping emissions, and all in all, this would contribute to diminsh 60% European transport emissions by the middle of the century.

The key policy goals of the 2011 Transport White Paper are synthesized below.

Single European Transport Area. Elimination of remaining barriers between different modes and different national transport systems, in terms of regulation incompatibility, excess of bureaucracy, and investments for addressing technical compatibilities. Increasing the cohesion of transport network by establishing binding commitments of Member States towards implementation of TEN-T core network projects.

Safer and more interconnected infrastructure. Key priorities were set to address bottlenecks, cross-border links and network interconnections allowing the full development of the Single European Transport Area. The high efficient multi-modal TEN-T Core Network integrated global airports and ports connected to high performance rail for passengers and freight, and a cohesive network of roads balanced between western and central and eastern Member States. Enhanced and safer transport flows required increasingly segregated freight and passenger infrastructure.

Environmentally friendly transport. Internalisation of external costs of transport; EURO standards to seek further vehicle efficiency; visible links between the “polluter-pays” and “user-pays” principles and use of issued revenues. Transport should lower emission to 60% below 1990 levels in 2050.

Technology development. More technology development was claimed necessary, more focussed on key thematic elements like alternative fuels, smart vehicles, efficient traffic and infrastructure management to keep European industry’s leadership in the global market. This was a strong change respects to previous policy packages which relied more on modal shift from rail to road to achieve environmental targets for the transport sector.

Better transport management through technology, pricing and scheduling to enhance infrastructure management and increase effective capacity (ATM, ERTMS, ICT…). Real-time network information all over Europe, better access to information on real-time and centralised ticketing should allow seamless travel across the whole continent.

More diversified funding for transport. Increased use of PPP schemes; better coordination of funding sources to meet Common Transport Policy objectives and targets: ERDF, Cohesion Fund, TEN-T budget, EIB loans; bond issuing initiatives to fund major infrastructures; "user-pays" principle.

Increased efficiency of investment. Ex-ante project appraisal with cost benefit guidelines; competitive tendering, even when services of public interest may not operate under competition; clarification and uniform treatment of public funding; efficient corridor planning approach rather than project approach.

The table below synthesises transport targets and milestones set up to meet 2050 objectives.

Table : Synthesis of transport targets included in the 2011 Transport White Paper

Sector	Year	Target
Transport emissions and energy consumption	2050	Phasing out fuel powered cars by 2050
	2030	Transport emissions (including CO2 aviation, excl. maritime), 20% lower in 2030 in relation 2008
	2050	Transport emissions (including CO2 aviation, excl. maritime), 60% lower in 2050 in relation 1990's
Trans European Networks TEN-T	2030	Multi-modal TEN-T core network by 2030
	2050	All core network airports connected to rail network by 2050, preferably by high-speed rail
	2050	All core seaports sufficiently connected to the rail freight and, where possible, inland waterway system.
Urban transport	2030	Lower 50% the use of "conventionally-fueled" cars in urban transport
	2050	0% use of "conventionally-fueled" cars in urban transport
	2030	CO2 free logistics in cities by 2030
Road transport	2010	Reduction 50% the number of road fatalities by 2010 compared with 2001 levels
	2030// 2050	By 2020, 50% fatalities in road transport. Close to zero fatalities in road transport by 2050.
	2020	Car emissions: 95 g CO2/km target for 2020
	2030 // 2050	30% of road freight over 300km should shift to other modes such as rail or waterborne transport by 2030, and more than 50% by 2050 (facilitated by efficient and green freight corridors)..
Rail transport	2030	To triple the length of high-speed rail network by 2030.
	2050	To complete a European high-speed rail network by 2050.
	2050	By 2050, the majority of medium-distance passenger transport should go by rail.
Aviation	2050	Low-carbon sustainable fuels in aviation to reach 40% by 2050
	2020 // 2050	Stabilisation of air emissions by 2020 (carbon neutral growth) and 50% reduction in 2050 compared to 2005
Maritime	2050	CO2 emissions from maritime transport should be cut by 40% (if feasible 50%) by 2050, compared to 2005 levels
Freight Transport	2030	In freight transport, (rail + IWW) modal share of 30%
	2050	In freight transport, (rail + IWW) modal share of 50%
Transport management	2020	SESAR, Modernised air traffic management infrastructure.
	2020	To establish the framework for a European multi-modal transport information, management and payment system
	2050	Move towards full application of "user pays" and "polluter pays" principles

ENERGY ROADMAP 2050
COM(2011) 885 final

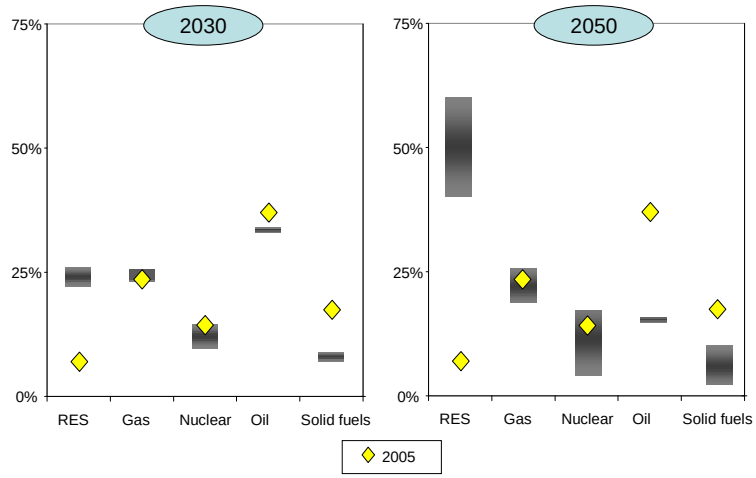
In the Energy Roadmap 2050 the Commission explored the challenges posed by delivering the EU's decarbonisation objective while at the same time ensuring security of energy supply and competitiveness.

The Commission had already analysed the implications of this in its "Roadmap for moving to a competitive low-carbon economy in 2050" for the energy-environmental dimensions, while the "Roadmap to a Single European Transport Area" focussed on solutions for the transport sector. The Energy Roadmap focussed on energy generation.

The roadmap recognized high uncertainty as a major barrier to investment in Europe. Uncertainties existed linked to the oil peak; to the extent shale gas in Europe could prove viable, whether and when Carbon Capture & Storage (CCS) would become commercial, what role Member States would seek for nuclear power, how climate action across the globe would evolve. Social, technological and behavioural changes would also have significant impact on the energy system.

To develop a long-term European technology-neutral framework in which these policies will be more effective, the roadmap elaborated on a number of scenarios. Each of the scenarios focussed on a different energy mix, all including long-term fall of oil consumption and other solid fuels, strong increase of renewable energy sources (between 40% and 60%), relative stability of natural gas consumption, and diverse alternatives for nuclear power decreasing.

Figure: EU Decarbonisation scenarios 2030 and 2050. Range of fuel shares in primary energy consumption compared with 2005 outcome (in %)



The Roadmap suggested the followng key-stones for action towards 2050 decarbonisation:

1. Full implementation of the EU's Energy 2020 strategy. All existing legislation had to be applied, and the proposals currently in discussion, notably on energy efficiency, infrastructure, safety and international cooperation, had to be adopted

2. Efficiency. The energy system and society as a whole had to be dramatically more energy efficient.

3. Renewable energies. Particular attention should continue to be given to the development of renewable energy sources. The EU's 20% renewable energy target has so far proven an efficient driver in development of the renewable energy in the EU and timely consideration should be given to options for 2030 milestones

4. Technology.Higher public and private investments in R & D and technological innovation are crucial in speeding-up the commercialisation of all low-carbon solutions.

5. Single energy market. The EU is committed to a fully integrated market by 2014.

6. Energy pricing. Energy prices need to better reflect costs, notably of the new investments needed throughout the energy system.

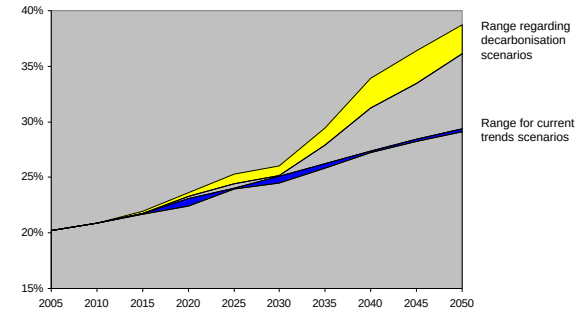
7. New infrastructure. A new sense of urgency and collective responsibility must be brought to bear on the development of new energy infrastructure and storage capacities across Europe and with neighbours.

8. Energy Security. There will be no compromise on safety and security for either traditional or new energy sources. The EU must continue to strengthen the safety and security framework and lead international efforts in this field

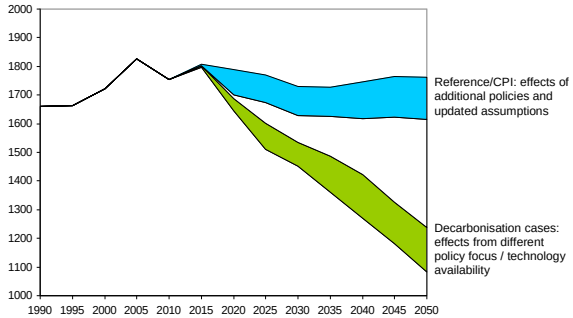
9. Governance. A broader and more coordinated EU approach to international energy relations

10. Milestones for 2030 needed. Member States and investors need concrete milestones. The 'Low-carbon economy roadmap' has already indicated greenhouse gas emission milestones. The next step is to define the 2030 policy framework, reasonably foreseeable and the focus of most current investors.

Graph 2: Share of electricity in current trend and decarbonisation scenarios (in % of final energy demand)



Graph 3: Gross energy consumption - range in current trend (REF/CPI) and decarbonisation scenarios (in Mtoe)



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2015's ENERGY STRATEGY 2030: A policy framework for climate and energy in the period from 2020 to 2030
COM(2014) 15 Final

In 2014, the EC perceived significant achievements since the EU adopted first policy packages of climate and energy measures in 2008:

- GHG in 2012 had decreased by 18% relative to 1990
- % of renewable energy sources had increased to 13% in 2012, the EU having installed about 44% of the world's renewable electricity (excluding hydro) at the end of 2012
- Energy intensity of the EU economy had been reduced by 24% between 1995 and 2011 whilst the improvement by industry was about 30%
- Carbon intensity of the EU economy had fallen by 28% between 1995 and 2010

Much had changed since 2008, being the most obvious the impact of the economic and financial crisis which has affected Member States' capacity to invest, and at the same time, there was further confirmation of the likely impact of human influence on climate change and of the need for substantial and sustained reductions of greenhouse gas emissions to limit further changes in the earth's climate.

The new policy package passed in 2014 aimed at reflecting on these developments and the policy framework the EU needed for 2030. The new 2030 policy framework was based on the full implementation of the 20/20/20 targets, now including following additional principles:

- Ambitious commitment to reduce greenhouse gas emissions in line with the 2050 roadmaps.
- Cost-efficient approaches responding to the challenges of affordability, competitiveness, security of supply and sustainability
- Simplification of the European policy framework while improving complementarity and coherence between objectives and instruments.
- Flexibility for Member States to define a low-carbon transition appropriate to their specific circumstances, preferred energy mix and needs in terms of energy security
- Further integration of the internal energy market and undistorted competition at its core.
- Ensuring competitiveness of business and affordability of energy for consumers
- Improving energy security, while delivering a low-carbon and competitive energy system
- Enhancing investor certainty by providing clear signals now on the long-term policy framework

The renewed targets set up in the 2030 Energy Strategy are presented next:

Greenhouse gas emissions target reduction for domestic EU emissions of 40% in 2030 relative to emissions in 1990. If fully implemented and fully effective, these measures are expected to deliver a 32% reduction relative to emissions in 1990. The ETS sector would have to deliver a reduction of 43% in GHG in 2030 and the non-ETS sector a reduction of 30% both compared to 2005. The collective effort for the non-ETS sector must also be allocated among the individual Member States

in an appropriate and timely way. The analysis underpinning the Commission's Impact Assessment provides the cost-effective allocation of effort between Member States. For example, the analysis indicates that countries with a GDP below 90% of the EU average would need to make investments in the period 2021-2030, at levels estimated to be some €3 billion per annum higher than the EU average increase in the period 2021-2030.

A Renewable energy target at EU level**.** The functioning of the ETS and the contribution to GHG reductions from renewables are closely interlinked and complementary. A greenhouse gas reduction target of 40% should by itself encourage a greater share of renewable energy in the EU of at least 27%. The Commission proposes, therefore, that this should be the EU's target for the share of renewable energy consumed in the EU. While binding on the EU, it would not be binding on the Member States individually but would be fulfilled through clear commitments decided by the Member States themselves which should be guided by the need to deliver collectively the EU-level target and build upon what each Member State should deliver in relation to their current targets for 2020.

Energy efficiency. The Commission's analysis shows that a greenhouse gas emissions reduction target of 40% would require an increased level of energy savings of approximately 25% in 2030. In some sectors, such as industry and passenger vehicles, the improvements observed in recent years will have to continue; while in sectors such as housing, other transport modes, and electrical equipment there will be a need for a significant acceleration of current efforts to tap the significant unexploited potential. The EU needs to continue to complement national efforts with ambitious EU-wide energy efficiency standards for appliances, equipment, buildings and CO_2 standards for vehicles. Making use of the economies of scale of the internal market, this can benefit EU manufacturers and help them to maintain technological leadership.

Reform of the Emissions Trading System (ETS). For the ETS to be effective in promoting low-carbon investments at the least cost for society an early decision is needed to restore the ETS as a more robust instrument. The Commission is of the view that the best way to achieve this is to establish a market stability reserve at the start of phase 4 trading in 2021. The market stability reserve would provide an automatic adjustment of the supply of auctioned allowances downwards or upwards based on a pre-defined set of rules and would improve resilience to market shocks and enhance market stability. There would be no element of discretionary supply management. The reserve would also provide a flexible tool to increase supply of allowances in case of sudden, temporary increases in demand thereby mitigating impacts on industry and sectors at risk of carbon leakage.

Systematic monitoring with key indicators is needed to assess progress over time and to inform any future policy intervention. These indicators would include:

- Energy price differentials between the EU and major trading partners, building on the report on energy prices and costs.

- Diversification of energy imports and the share of indigenous energy sources used in energy consumption over the period up to 2030 should also be monitored.
- Deployment of smart grids and interconnections between Member States, with particular urgency between those that are furthest away from meeting the already agreed objective for Member States to ensure a level of electricity interconnections equivalent to or beyond 10% of their installed production capacity.
- Intra-EU coupling of energy markets, building on the liberalisation of gas and electricity markets achieved already by EU legislation.
- Competition and market concentration on energy markets at the national level and in regions with functioning coupling at the wholesale level.
- Technological innovation (R&D expenditure, EU patents, competitive situation on technologies compared to third countries).

The Commission will come forward with periodic reporting and, where appropriate, accompanying measures, on these indicators.

ROADMAP TO RESOURCE EFFICIENT EUROPE
COM(2011) 571 Final

The Roamap to a Resource Efficient Europe established a 2050 Vision where the EU's economy had grown in a way that respected resource constraints and planetary boundaries, thus contributing to global economic transformation. The economy would be competitive, inclusive and would provide a high standard of living with much lower environmental impacts. All resources would be sustainably managed, from raw materials to energy, water, air, land and soil. Climate change milestones would have been all reached, while biodiversity and the ecosystem services it underpins would have been protected, valued and substantially restored.

Resource efficient development is the route to this vision.

It allows the economy to create more with less, delivering greater value with less input (efficiency), using resources in a sustainable way and minimising their impacts on the environment (environmentally friendly).

It will also require that residual waste is close to zero and that ecosystems have been restored, and systemic risks to the economy from the environment have been understood and avoided.

A new wave of innovation will be required.

In order to launch this process, two levels of indicators are provisionally formulated[7]:

a) A provisional lead indicator - "Resource Productivity" - to measure the principal objective of this Roadmap, of improving economic performance while reducing pressure on natural resources;

b) A series of complementary indicators on key natural resources such as water, land, materials and carbon, that will take account of the EU's global consumption of these resources.

Annex II to the Roadmap suggests for the following key indicators the following quantitative targets, which are not adopted in the Roadmap itself however.

- *Resource productivity*: Measured by the ratio of GDP to Domestic Material Consumption (expressed in Euro/tonne). The EU average was around 1.30 €/tonne in 2007, ranging from below 0.3 to around 2.5. Resource productivity in 2007 has increased with 7.4% in comparison with 2000. However, in order to achieve absolute decoupling of economic growth from resource use, resource productivity needs to grow equally to or faster than GDP, which has not been the case. GDP has grown with 16.2% over the same period while DMC has grown 7.9%. An absolute decoupling would mean that DMC should remain constant or decrease.
- *Land*: Artificial land has continued to expand; in the period 2000-2006 at a rate of 920 km² per year. To reach a state of no net land take by 2050 and assuming a linear reduction from now until then, the average annual land take needs to decease to maximum 800 km² per year in the period 2010-2020.

7 As set out in the accompanying COM(2011) 571.

- *Water*: Trends in EU average values of the water exploitation index (WEI) have been stagnating around 13% for the past 20 years. However WEI national values vary from 64% to less than 1% and decreases of WEI are rare. Values above 20% are considered unsustainable.
- *GHG emissions*: After an initial decline starting from the baseline in 1990, GHG emissions were for almost stable for a decade. Recently a further decline was observed, reaching 17.4% reduction (compared to 1990) in 2009 (the Kyoto Protocol requires the EU to reduce greenhouse gas emissions by 8% below 1990 levels by 2008-2012). The challenge will be to keep this trend also in the period of economic recovery as the EU target for 2020 is a 20% reduction (30% if the conditions are right).

TRANSFORMING THE ECONOMY : Strategies, milestones and targets

Transforming the economy onto a resource-efficient path will bring increased competitiveness and new sources of growth and jobs through cost savings from improved efficiency, commercialisation of innovations and better management of resources over their whole life cycle.

On Sustainable Consumption

- **Milestone**: By 2020, citizens and public authorities have the right incentives to choose the most resource efficient products and services, through appropriate price signals and clear environmental information. Their purchasing choices will stimulate companies to innovate and to supply more resource efficient goods and services. Minimum environmental performance standards are set to remove the least resource efficient and most polluting products from the market. Consumer demand is high for more sustainable products and services.
- **Milestone**: By 2020, market and policy incentives that reward business investments in efficiency are in place. These incentives have stimulated new innovations in resource efficient production methods that are widely used. All companies, and their investors, can measure and benchmark their lifecycle resource efficiency. Economic growth and wellbeing is decoupled from resource inputs and come primarily from increases in the value of products and associated services.
- **Milestone**: By 2020, waste is managed as a resource. Waste generated per capita is in absolute decline. Recycling and re-use of waste are economically attractive options for public and private actors due to widespread separate collection and the development of functional markets for secondary raw materials. More materials, including materials having a significant impact on the environment and critical raw materials, are recycled. Waste legislation is fully implemented. Illegal shipments of waste have been eradicated. Energy recovery is limited to non recyclable materials, landfilling is virtually eliminated and high quality recycling is ensured.

On Supporting research and innovation

- **Milestone**: By 2020, scientific breakthroughs and sustained innovation efforts have dramatically improved how we understand, manage, reduce the use, reuse, recycle, substitute and safeguard

and value resources. This has been made possible by substantial increases in investment, coherence in addressing the societal challenge of resource efficiency, climate change and resilience, and in gains from smart specialization and cooperation within the European research area.

On Environmentally harmful subsidies and getting the prices right

- **Milestone**: By 2020 EHS will be phased out, with due regard to the impact on people in need.
- **Milestone:** By 2020 a major shift from taxation of labour towards environmental taxation, including through regular adjustments in real rates, will lead to a substantial increase in the share of environmental taxes in public revenues, in line with the best practice of Member States.

Proposed Targets (non-officially adopted)

- % of the value, and number, of public procurement contracts that include Green Public Procurement (GPP) criteria → target to be defined
- Number and value of green products purchased by households→ target to be defined
- % companies within priority sectors which measure their environmental footprint → target to be defined by 2020
- Number of known 'substances of very high concern' (SVHC) included on the REACH Candidate list, from 53 in 2008 to 136 in 2012 and all relevant SVHC by 2020.
- Waste prevention → target to be defined
- Reuse and recycling – the existing targets of 50% of reuse/recycling of municipal waste and 70% of reuse/recycling/recovery of construction and demolition waste by 2020 will be reviewed and potentially raised to their maximum feasible level.
- Number and value of funding (€/year) of research and innovation projects promoting mainly resource efficiency and sustainable environmental management, allocated through European financial support programmes → target to be defined
- Environmentally Harmful Subsidies (EHS) phased out completely by 2020
- By 2020 the share of environmental taxation in public revenues (% of environmental taxes as share of total taxes and social contributions) will have been increased to an EU average of more than 10%.

NATURAL CAPITAL AND ECOSYSTEM SERVICES: Strategies, milestones and targets

Ecosystem services

- **Milestone:** By 2020 natural capital and ecosystem services will be properly valued and accounted for by public authorities and businesses.

Biodiversity

- **Milestone:** By 2020 the loss of biodiversity in the EU and the degradation of ecosystem services will be halted and, as far as feasible, biodiversity will be restored

Water

- **Milestone:** By 2020, all WFD River Basin Management Plans (RBMPs) have long been implemented. Good status – quality, quantity and use - of waters was attained in all EU river basins in 2015. The impacts of droughts and floods are minimised, with adapted crops, increased water retention in soils and efficient irrigation. Alternative water supply options are only relied upon when all cheaper savings opportunities are taken. Water abstraction should stay below 20% of available renewable water resources.

Air

- **Milestone:** By 2020, the EU's interim air quality standards will have been met, including in urban hot spots, and those standards will have been updated and additional measures defined to further close the gap to the ultimate goal of achieving levels of air quality that do not cause significant impacts on health and the environment.

Land and soils

- **Milestone:** By 2020, EU policies take into account their direct and indirect impact on land use in the EU and globally, and the rate of land take is on track with an aim to achieve no net land take by 2050; soil erosion is reduced and the soil organic matter increased, with remedial work on contaminated sites well underway.

Marine resources

- **Milestone:** By 2020, good environmental status of all EU marine waters is achieved, and by 2015 fishing is within maximum sustainable yields.

Proposed Targets (non-officially adopted)

- Map and assess the state of ecosystems and their services in Member States territory by 2014→ target to be defined
- Assess the economic value of such services, and integrate these values into accounting and reporting systems at EU and national level by 2020. → target to be defined
- Establishing sufficient functional green infrastructure in all MS for maintaining and enhancing ecosystems and their services
- At least 15% of degraded ecosystems restored by 2020
- Resource productivity of minerals and metals (GDP/DMC minerals+metals) → target to be defined
- good status of waters is attained in all EU river basins in 2015, and good quality and quantities of water will be ensured by 2020, as regards to Water Framework Directive
- River Basin Management Plans (RBMPs) implemented by 2012
- Concentrations of Particulate Matter (PM10) in ambient air, not exceeding 50µg/m3 per 24 hours more than 35 times a year
- Annual land take (i.e. the increase of artificial land) does not exceed 800 km² per year at the EU level by 2020.
- The area of land in the EU that is subject to soil erosion of more than 10 tonnes per hectare per year should be reduced by at least 25% by 2020
- By 2020 soil organic matter levels do not decrease overall and increase for soils currently with less than 3.5% organic matter

- Member States should have started undertaking remediation actions on identified contaminated sites by 2020
- At least 10% of the marine EU area is covered by a coherent network of (Marine Protected Areas) MPAs

KEY SECTORS: Strategies, milestones and targets

Addressing food

- **Milestone**: By 2020, incentives to healthier and more sustainable food production and consumption will be widespread and will have driven a 20% reduction in the food chain's resource inputs. Disposal of edible food waste should have been halved in the EU.

Improving buildings

- **Milestone:** By 2020 the renovation and construction of buildings and infrastructure will be made to high resource efficiency levels. The Life-cycle approach will be widely applied; all new buildings will be nearly zero-energy[8]and highly material efficient, and policies for renovating the existing building stock will be in place[9] so that it is cost-efficiently refurbished at a rate of 2% per year. 70% of non-hazardous construction and demolition waste will be recycled[10].

Ensuring efficient mobility

- **Milestone:** By 2020 overall efficiency in the transport sector will deliver greater value with optimal use of resources like raw materials, energy, and land, and reduced impacts on climate change, air pollution, noise, health, accidents, biodiversity and ecosystem degradation. Transport will use less and cleaner energy, better exploit a modern infrastructure and reduce its negative impact on the environment and key natural assets like water, land and ecosystems. There will be on average a 1% yearly reduction, beginning in 2012, in transport GHG emissions.

Proposed Targets (non-officially adopted)

- Amount of animal proteins (including meat and dairy products) consumed per person is in line with WHO recommendations
- Decrease of edible food waste in households, retailers and catering by 50% in the EU.
- Member States shall ensure that by 31 December 2020, all new buildings are nearly zero-energy buildings; and after 31 December 2018, new buildings occupied and owned by public authorities are near zero-energy buildings
- The Transport White Paper proposes a target to decrease GHG by 60% in transport sector by 2050

8 Directive 2010/31/EU.

9 In line with Art. 9 of Directive 2010/31/EU of 19 May 2010.

10 In line with Art 11 of Directive 2008/98/EC.

GOVERNANCE AND MONITORING: Strategies, milestones and targets

New pathways to action on resource efficiency

- **Milestone:** By 2020 stakeholders at all levels will be mobilised to ensure that policy, financing, investment, research and innovation are coherent and mutually reinforcing. Ambitious resource efficiency targets and robust, timely indicators will guide public and private decision-makers in the transformation of the economy towards greater resource efficiency.

Supporting resource efficiency internationally

- **Milestone:** By 2020 resource efficiency will be a shared objective of the international community, and progress will have been made towards it based on the approaches agreed in Rio.

Improving the delivery of benefits from EU environmental measures

- **Milestone:** By 2020 the benefits from EU environmental legislation will be fully delivered.

Proposed Targets (non-officially adopted)

- 30% of the EU Regional Budget (i.e. cohesion policy budget) allocated to environment related expenditure

Closing the loop - An EU action plan for the circular economy
COM / 2015/614 final

The transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised, is an essential contribution to the EU's efforts to develop a sustainable, low carbon, resource efficient and competitive economy. Such transition is the opportunity to transform our economy and generate new and sustainable competitive advantages for Europe.

The EU action plan for the Circular Economy focusses on the next domain areas:

Product design

- EC promotion of reparability, upgradability, durability, and recyclability of products by developing product requirements relevant to the circular economy in its future work under the Ecodesign Directive, as appropriate and taking into account the specificities of different product groups.
- The revised legislative proposals on waste creates economic incentives for better product design through provisions on extended producer responsibility.
- The EC will examine options and actions for a more coherent policy framework of the different strands of work of its product policy in their contribution to the circular economy

Production processes

- EC to provide guidance on best waste management and resource efficiency practices in industrial sectors in Best Available Techniques reference documents (BREFs) and to issue guidance and promote best practices on mining waste.
- Proposal in the revised legislative proposals on waste to clarify rules on by-products to facilitate industrial symbiosis and help create a level-playing field across the EU.

Consumption

- Proportionate requirements on durability and the availability of repair information and spare parts in its work on Ecodesign, as well as durability information in future Energy Labelling measures.
- New rules to encourage reuse activities in the revised waste proposals
- better enforcement of the guarantees on tangible products, examination of possible options for improvement, and tackle false green claims
- independent testing programme under Horizon 2020 to help the identification of issues related to possible planned obsolescence.
- Action on Green Public Procurement (GPP), by emphasising circular economy aspects in new or revised criteria, supporting higher uptake of GPP, and leading by example in its own procurement and in EU funding

Waste management

- Revised legislative proposals on waste and will step up its work with Member States to improve waste management on the ground, including to avoid overcapacities in residual waste treatment. In particular:

    - long-term recycling targets for municipal waste and packaging waste, and to reduce landfill

    - provisions to promote greater use of economic instruments

    - general requirements for extended producer responsibility schemes

    - simplification and harmonisation of definitions and calculation methods

- EC assistence to Member States and regions to ensure that Cohesion Policy investments in the waste sector contribute to supporting the objectives of the EU waste legislation and are guided by the EU waste hierarchy.

From waste to resources: boosting the market for secondary raw materials and water reuse

- quality standards for secondary raw materials where they are needed (in particular for plastics), and is proposing improvements to the rules on 'end-of-waste'.
- revised EU regulation on fertilisers, so as to facilitate recognition of organic and waste-based fertilisers in the single market and thus support the role of bio-nutrients in the circular economy.
- legislative proposal on minimum requirements for reused water, e.g. for irrigation and groundwater recharge, to promote water reuse.
- options on the interface between chemicals, products and waste legislation, including on how to reduce the presence and improve the tracking of chemicals of concern in products.
- further development of the recently launched Raw Materials Information System and support EU-wide research on raw materials flows.

Following up to these objectives, the communication sets up a series of Priority Areas to be addressed:

On **PLASTICS**, the Commission proposes to adopt a strategy for the circular economy, addressing issues such as recyclability, biodegradability, the presence of hazardous substances of concern in certain plastics, and marine litter. In the revised legislative proposals on waste, a more ambitious target for the recycling of plastic packaging will be proposed.

On **FOOD WASTE**, in order to support the achievement of the Sustainable Development Goal targets, it is proposed to develop a common EU methodology to measure food waste and define relevant indicators, to take measures to clarify EU legislation relating to waste, food and feed and facilitate food donation and the use of former foodstuff and by-products from the food chain in feed production without compromising food and feed safety; and to examine ways to improve the use of date marking by actors in the food chain and its understanding by consumers, in particular the "best before" label.

On **CRITICAL RAW MATERIALS**, the EC will take action to encourage recovery of critical raw materials, and prepare a report including best practices and options for further action, and will encourange action by Member States for revised proposals on waste.

On **CONSTRUCTION AND DEMOLITION** waste, the Commission states will take a series of actions to ensure recovery of valuable resources and adequate waste management in the construction and demolition sector, and to facilitate assessment of the environmental performance of buildings.

On **BIOMASS AND BIO-BASED** products, the EC will promote efficient use of bio-based resources through a series of measures including guidance and dissemination of best practices on the cascading use of biomass and support for innovation in the bioeconomy. The revised legislative proposals on waste contains a target for recycling wood packaging and a provision to ensure the separate collection of biowaste

ESPON 2020 – More information

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