ALIGNING POLICIES FOR LOW-CARBON SYSTEMIC INNOVATION IN EUROPE

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INDUSTRIAL INNOVATION FOR COMPETITIVENESS

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CENTRE FOR EUROPEAN POLICY STUDIES

Aligning policies for low-carbon systemic innovation in Europe

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In view of the growing awareness that climate change is posing an existential threat to humankind, and that deep decarbonisation should therefore be put at the forefront of public policies, this report by Nicholas Ashford (MIT) and Andrea Renda (CEPS and Duke University) looks at EU policies and proposes ten steps to align EU rules with long-term objectives.

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i2-4C INDUSTRIAL INNOVATION FOR COMPETITIVENESS

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EXECUTIVE SUMMARY

In the age of *Anthropocene*, or massive human manipulation of the environment, there is much that we human beings have done to put our planet at risk. But there is also much that we can do today to bring it back to a sustainable path, provided that we act swiftly and effectively. Stabilising global carbon emissions in 2050 to no more than a 2°C (and possibly no more than 1.5°C) rise in the average global temperature above pre-industrial levels requires a reduction of at least 60% in the carbon intensity of global GDP (assuming a 2.5% annual GDP growth). This would necessitate a radical change in the mix of technologies used to produce and consume energy as part of an industrial transformation, and the relatively near-term deployment and rapid diffusion of innovative products, processes, and services. Not to mention behavioural changes in firms, consumers, and government. Such deployment and diffusion is considered to be the major determining factor in the overall cost of implementing a decarbonisation strategy.

This report considers potential policy options to promote 'systemic innovation' that foster decarbonisation, with a specific focus on the EU. By using the term 'systemic', we point to a variety of domains in which innovation can occur – not only technological, but also organisational innovation, (brought about by disruptive new business models); institutional (by revising both legal and economic incentives); and societal (requiring a change in consumption and behaviour), and emphasise how entire systems (e.g., energy, mobility, shelter) can be transformed through socio-economic change.

Compared to the growing literature in this field (which the report takes as a starting point), we perform what could be described as a 'double alignment' exercise, since we explore ways in which regulation and public policy can foster innovation, and discuss which aspects of the innovation process can in turn foster decarbonisation. It could also be described as a double backcast exercise, since we start from a vision of zero-carbon emissions by mid-century, describe possible socio-technical changes that could bring about this result, and then discuss policy alignment strategies that can make these changes possible. In doing so, the paper aims to create a framework that could enable EU institutions to identify and mitigate those EU policies that are either suboptimal or self-defeating, and take action by revising its policy mix to achieve what has been described as 'deep decarbonisation', or even better 'sustainable decarbonisation', since it will have to be reconciled with other important policy objectives, such as employment, financial stability, respect for fundamental rights, etc.

Nine myths that pervade the current debate

The international and EU debate is still characterised by a number of myths and misconceptions that must be dispelled if the right course of action is to be taken. We highlight nine myths in our report.

Myth #1 It is possible to realise mutual gains in industrial competitiveness, reduction of GHGs, and employment.

What may be possible are mutual gains in economic welfare, reduction of GHGs, and employment; yet significant gains in private-sector profit or even GDP may not necessarily be possible or desirable. At a minimum, socio-economic transitions would create winners and losers. It is important to depart from policies exclusively focused on GDP or market share and include societal measures of economic and social welfare, and adopt long-term societal well-being as the ultimate goal of EU policy.

Myth #2 Technological innovation in products and services is essential to achieving deep decarbonisation. Europe is suffering from an 'innovation deficit'

Many analysts argue that there are technologies already in existence that could be put to use, but which are hampered by a lack of appropriate market and regulatory signals, sufficient market demand, and/or lock-in. In many sectors, Europe has no idea or innovation deficits, but in many instances, a deployment [diffusion] deficit.

Myth #3 Innovation per se fuels the industrial state and creates jobs.

There is innovation in products and processes, which while fostering increases in GDP simply employs more material (natural and physical capital) and energy – and increasingly destroys jobs. A more nuanced innovation policy, taking into account the effects on employment and long-term societal well-being of invention, innovation, and diffusion, needs to be adopted. Innovation for whom? This question needs to be asked.

Myth #4 Governments cannot pick winners. Winners pick governments

The US experience with aircraft, computers, the internet, space technology, and pharmaceuticals (to name just a few examples) clearly demonstrates the power of government funding research. State-funded research and diffusion-oriented policies are among the most powerful tools to speed up decarbonisation.

Myth #5 Industrial policy is synonymous with innovation policy

An industrial policy not only encompasses invention, innovation and diffusion, it also envisions, i.a., the training – and re-education – of scientists, engineers, data and ICT specialists, etc., but also service and health-care providers, in addition to well-conceived employment and social policy.

Myth #6 Regulation inhibits beneficial innovation

There is overwhelming empirical evidence that properly designed regulation – especially stringent regulation and standards – have stimulated new products, processes, and work practices that would not otherwise have occurred. Often transformative, disruptive innovation comes from outside the incumbent producers or providers, which implies that care must be taken to prevent incumbents and special interests from unduly influencing both the industrial and the regulatory policy process.

Myth #7 Carbon leakage presents a practical disincentive and limits what regulation can achieve in terms of decarbonisation.

This problem will exist only if no international cooperation is sought on decarbonisation policy. If enough major economies could agree on a coordinated approach to carbon pricing/a uniform global price on carbon that spreads coverage broadly enough [which is not the case with nations acting independently], carbon leakage would become a less important issue. Trade scholars have uniformly called for a revision to the WTO trade rules, specifically the Subsidies Code. Otherwise, border adjustments on energy-intensive products and services consistent with revised WTO practices may need to be encouraged.

Myth #8 Trade in non-energy-related goods and services is a win-win proposition for all parties to trade

Trade does indeed primarily benefit the private-sector exporters and importers, contributing to wealth and income inequality, but not always with benefit to consumers and workers. EU trade initiatives (TTIP and other policies) need to be carefully assessed – and changed if necessary – for their potential to contribute to mitigating global climate change, as well as their adverse impact on employment. [1]

[1] See the important new study "The China Shock: Learning from Labor Market Adjustment to Large Changes in Trade" by Autor, Dorn and Hanson (2016): http://www.nber.org/papers/w21906.

Myth #9 Nations can 'go it alone'

It is clear that a multilateral effort is needed for significant, high-risk industrial development, combining skills, insight, and financial capital and joint risk taking – such as has been suggested for a 'Global Apollo Programme to Combat Climate Change'.

Mapping misalignments in the EU acquis

Specific EU policies/strategies/approaches receiving attention in this report are those focusing on innovation, better regulation, trade, and industrial policy/economic growth. The latter may well be in conflict with advancing sustainable development and an EU low-carbon system transformation. Indeed, concerns for industrial competitiveness as well as prospects for the future of employment routinely surface, coupled with the mounting concern that achieving the goals of COP21 may be far from sufficient to achieve deep decarbonisation. Short- to medium-term strategies need to be consistent with and reinforce longer-term strategies for deep decarbonisation.

Like all industrialised economies, the EU and its member states have adopted a vast array of policies that directly and indirectly, explicitly or implicitly exert a significant effect on the environment and the climate. The types of misalignments that we highlight are classified as follows:

Type 1 Inconsistent policies.

Cases in which the scope and direction of the policy is not in line with the goal of decarbonising the economy as officially set by the EU. Key examples are the persistence of fossil fuel subsidies in many EU countries and the absence of a real shift in taxation from labour to carbon in a number of member states, despite efforts in this direction by the European Commission.

Type 2 Incomplete or non-existent policies

Cases in which there was no policy action, or where there is legislation but it does not cover essential aspects that would be key for long-term decarbonisation. Here, very important examples include the lack of action in fields that represent substantial shares of carbon emissions such as aviation and maritime shipping, and the energy efficiency of buildings.

Cases in which policies lack stringency, and thus are unlikely to be incentivising behaviour that would fall in line with EU's decarbonisation goals. Here, one example is the EU Emissions Trading System, which seems unable to trigger the innovation investment

needed in a number of sectors to achieve decarbonization goals. In addition, air quality rules embedded in the LCPD (Large Combustion Plants Directive), the NEC (National Emission Ceilings) Directive, and the Industrial Emissions Directive (IED) are in need of more stringent standards.

Type 3 Lack of stringency.

Cases in which policies lack stringency, and thus are unlikely to be incentivising behaviour that would fall in line with EU's decarbonisation goals. Here, one example is the EU Emissions Trading System, which seems unable to trigger the innovation investment

Type 4 Lack of effectiveness due to problems of implementation, monitoring and enforcement.

Cases in which there are problems with time, since market players are given either too much or too little time to comply; compliance itself is taking too long; or policymaking occurs too slowly; or cases in which the scope of the policy is in line with overall decarbonisation objectives, but enforcement is too weak to secure compliance over time. The most straightforward example is certainly the legislation on car and light duty vehicles emissions, which was recently subject to ex post evaluation in mid-2015, right before the Volkswagen scandal emerged in all its magnitude. Other examples include energy labels and the Directive on the energy performance of buildings.

Misalignments in innovation policy and the better regulation agenda

In addition to these specific policies, misalignments are found also in innovation policy and in the EU better regulation agenda. Specifically, we argue that:

- **Innovation policy should be more systemic, simple and socially relevant (or, as often termed, 'challenge-led').** There is a need to consolidate the various communities and platforms offered by the EU. Many emerging societal challenges call on innovation policy to depart from sector-specific industrial policy, and take a more systemic and transformative approach that crosses sector boundaries. EU policy should enable experimentation and learning, and avoid creating biases in favour of incumbent business models. This requires policy instruments to test new business models and services that can benefit end-users and workers, yet without lowering protection levels for consumers. How to achieve this goal should be the main concern of EU policymakers in the coming years, starting from the revision of Horizon 2020 and the governance of EU innovation policy, from its R&D-centric 'innovation policy' today to an enabling and holistic understanding of 'policies for innovation'.

- **A disconnect between the needs of long-term strategies and the short-termism of the better regulation** agenda can be observed both in the methods used to perform ex ante impact assessment (typically, cost-benefit analysis), and even more evidently when it comes to the REFIT (i.e., ex post evaluations of entire policy areas) and Cumulative Cost Assessments, which constitute the two most comprehensive types of ex post evaluation carried out by the Commission. Recent initiatives such as the endorsement by the Dutch Presidency of the so-called 'innovation principle' and the recent call for 'innovation deals' appear to be of limited use in terms of aligning policies towards long-term goals, and even possibly prone to capture by incumbent interests. The situation only gets worse if one observes the current under-development of better regulation tools in other institutions, especially in the Council of the EU (where better regulation is still absent) and in the overwhelming majority of member states.
- **Beyond the better regulation system, long-term goals have gradually disappeared from the governance of the European Semester**, which came to represent the most prominent existing mechanism for the coordination of public policies enacted at the EU and member state level. This happened along with the gradual demise of the Europe 2020 strategy, which lost momentum in Europe first as a result of the financial crisis, later due to the Greek and eurozone crises, and finally due to the new course adopted by the Juncker Commission, more focused on the 'ten priorities' and less interested in sustainable development. A revised strategy would need to take into account the 2030 goals, but also longer-term goals to avoid falling into the medium-term target trap, and help Europe proceed towards deep decarbonisation.

A ten-step strategy for Europe

In the report we develop arguments for the EU to undertake ten crucial steps in order to put itself on the pathway to deep decarbonisation. Such steps are presented in logical order, from the input provided to policymakers to ongoing monitoring and evaluation of policies, with a constant reference to systemic innovation. The ten steps can also be implemented independently, although activating as many of these procedures would certainly improve the EU's ability to foster long-term societal well-being through more effective evidence-based policymaking. The proposed ten steps are outlined below.

Step 1 Set up mission-led platforms in charge of transferring state of the art information to policymakers.

Especially in view of the upcoming creation of a 'European Innovation Council' (EIC) and the mid-term review of Horizon 2020, there is need for challenge-led, streamlined platforms where research, development, and demonstration are tackled for specific societal challenges in a multi-stakeholder fashion, open to new entrants, new technologies, new business models workers and citizens, with a view to widespread deployment and scale. These platforms should also be entrusted with transmitting policy-relevant input to EU policymakers.

Step 2 Ask these platforms to produce options for deep decarbonisation pathways for the most relevant policy challenges.

Platforms would have to work towards the development of pathways towards long-term sustainable development, including of course deep decarbonisation. Challenges such as the energy transition, the future of mobility and shelter will have to be approached with a view to the long-term, and accordingly also through ad hoc pathways that also consider all the policy trade-offs that might emerge during the transition. Pathways would need to be designed and developed in cooperation with EU institutions.

Step 3 Set up the EIC with the right competences.

Rather than becoming yet another agency with a relatively narrow mandate (i.e., scale-ups), the EIC should become the key intermediary between the research and innovation world and the policy realm. The existence of a strong EIC could be seen as a precondition for smarter science-based, innovation-friendly policy at the EU level, especially if coupled with revised better regulation guidelines oriented towards long-term societal challenges, rather than evaluated in terms of short-term cost-benefit analysis.

Step 4 Modify the better regulation guidelines to capture the potential of regulation-induced innovation.

The current better regulation guidelines still place insufficient emphasis on issues such as policy coherence with other societal goals, long-term impacts, risk analysis, adaptive policymaking, systemic innovation and decarbonisation. Several changes are proposed in the definition of the baseline, in the method used to compare options, and in appraising impacts on innovation.

Step 5 Ensure that the European Parliament Research Service checks policy coherence

Even if the European Commission were not to change its better regulation guidelines to shift the focus from efficiency towards coherence with other long-term societal goals, the European Parliamentary Research Service would better focus on coherence rather than on stricto sensu cost-benefit analysis. This role of the EPRS would be more consistent with a situation in which long-term goals are embedded in the European Semester, and thus become more binding on EU member states; and would trigger a more meaningful debate between institutions on the extent to which proposed EU policy initiatives help the EU move in the direction of long-term sustainable development.

Step 6 Exert pressure on the Council to ensure it motivates amendments on the basis of long-term goals.

A similar emphasis on long-term policy impacts and sustainable development goals could be placed by the Council in discussing its proposed amendments to proposed new EU legislation. At the same time, the representatives of national governments in various Council formations could use long-term national sustainable development pathways when deciding their positions, possibly motivating their decisions also on that basis.

Step 7 Revise Europe 2020 in a more meaningful and long-term-oriented way, including a more nuanced industrial innovation strategy.

EU institutions should build a coherent vision for the next decade (2030) by joining all efforts currently being made on long-term policies, including i.a., those on decarbonisation, sustainable development, 'beyond GDP' and the future of policymaking. Most of these efforts are being coordinated by the European Commission. Such a vision should not be limited to 2030, but should also be checked for consistency with longer-term goals such as the zero carbon economy.

Step 8 Have countries develop their own decarbonisation pathways with adequate governance mechanisms, but join in a multilateral funding and technology-sharing effort.

Each member state should develop a decarbonisation pathway aiming at least at 2050. The most effective way would be to incorporate such pathways into the European Semester and to make their implementation an effective precondition for approval of national reform programmes and even the attribution of cohesion funds. Member states should then ensure cooperation, coordination and financial support to the multi-stakeholder, challenge-led platforms that we described above under step 1, in what would become single platforms for research and innovation, able to attract multilateral funding for the exploitation of available technologies and the piloting of new business models and technological solutions.

Step 9 Embed sustainable development goals in the European Semester.

Once the long-term EU sustainable development agenda has been formulated in terms of a Europe 2030 strategy with an eye to the longer term, member states should be motivated to jointly contribute to the agenda. The most logical way to achieve this result is to (further) mainstream the sustainable development dimension within the European Semester. First, in the Annual Growth Strategy and in the subsequent Country-Specific Recommendations the European Commission should devote at least equal attention to long-term reforms

oriented towards sustainable development compared to what it devotes to financial stability. Second, a specific conditionality linked to decarbonisation and more generally to sustainable development could be introduced for the attributions of cohesion funds. Third, national reform plans and proposed spending plans at the national and sub-national levels should be accompanied by an in-depth impact evaluation, which demonstrates that there are no better alternatives than the ones proposed, in order to reach Europe's sustainable development goals.

Step 10 Use EU trade agenda and climate diplomacy to ensure leverage of existing WTO rules, and their revision if necessary, to effectively place a price on carbon and minimise carbon leakage.

Leveraging EU trade policy in support of decarbonisation is an indispensable step, without which many of the other actions would be doomed to remain only partly effective. The EU trade agenda should increasingly focus on guiding the debate on the review, revision, and implementation of climate-friendly WTO rules, especially for what concerns the possibility to place a price on carbon through global mechanisms, or through the clarification of the legal treatment of domestic solutions such as border tax adjustments.

INTRODUCTION

Over the past few years, the global community has shown an unprecedented level of concern for the risks posed by climate change and the resulting need for strategies to drastically reduce carbon emissions, to the extent that the 'business as usual' scenario is considered to be the least affordable one. The global international agreement achieved in the COP21 in Paris in 2015 coalesced this concern into commitments on the part of most nations – both fully industrialised and developing – to reduce greenhouse gas (GHG) emissions. This agreement must now be translated into concrete policy actions to meet what many consider to be one of the greatest-ever challenges facing human beings, and one that they have to design and implement themselves so as not to compromise the planet. This is even more urgent and complex if one considers that, as will be explained in this report, the Paris accords represent an essential, yet insufficient condition to successfully address this challenge. Rather, there will be a need for systemic change, including radical changes to our production processes, modes of distribution and consumption behaviour, strengthened by the deployment and, crucially, the rapid diffusion of low-carbon technologies on a massive scale.

This report seeks potential policy options to improve the EU regulatory process and ensure that EU policies promote systemic innovation to foster decarbonisation. By using the term 'systemic', we point to a variety of domains in which innovation can occur [i.e. not only technological, but also organisational (brought about by disruptive new business models), institutional (by revising both legal and economic incentives), and societal (requiring a change in consumption and behaviour)] and emphasise how the entire systems (e.g., energy, mobility, shelter) can be transformed through socio-economic change. Compared to the growing literature in this field (which the report takes as a starting point), we perform what could be described as **a 'double alignment' exercise, coupled with a 'double backcast'**.[2] A double alignment because since we explore ways in which regulation and public policy can foster innovation, and discuss which aspects of the innovation process can in turn foster decarbonisation. And a double backcast because we start from a vision of zero-carbon emissions by mid-century, describe possible socio-technological changes that could bring about this result, and then discuss policy alignment strategies that can make these changes possible. In doing so, the paper aims to propose a new framework for decision-making that could help EU institutions to identify and mitigate the EU policies that are either suboptimal or self-defeating. It also aims to offer specific policy options for the European Commission to consider, in order to achieve what has been described as 'deep decarbonisation', or even better 'sustainable decarbonisation', i.e. compatible with the ultimate goal of long-term societal well-being.

The remainder of the report is structured as follows. Section 1 sets the stage for our analysis by uncovering prevailing myths related to innovation, sustainability and decarbonisation, and discussing the growing need for a new 'whole of government' policy

[2]Our reference is to the backcast exercise performed by Sachs et al. (2015).

approach based on both supply-side and demand-side measures, and actions in several policy areas, from industrial policy to trade. This section crucially sheds light on our next steps, which in many respects question the European status quo. Section 2 looks more specifically at existing EU policies in the sectors and policy domains considered to be most relevant for decarbonisation; at the EU better regulation agenda, and at innovation policy to discuss its alignment with long-term decarbonisation goals. Section 3 offers a number of recommendations for how to ensure a better alignment of EU policies with the decarbonisation goals. Section 4 concludes by summarising our main findings and outlining some avenues for future research.

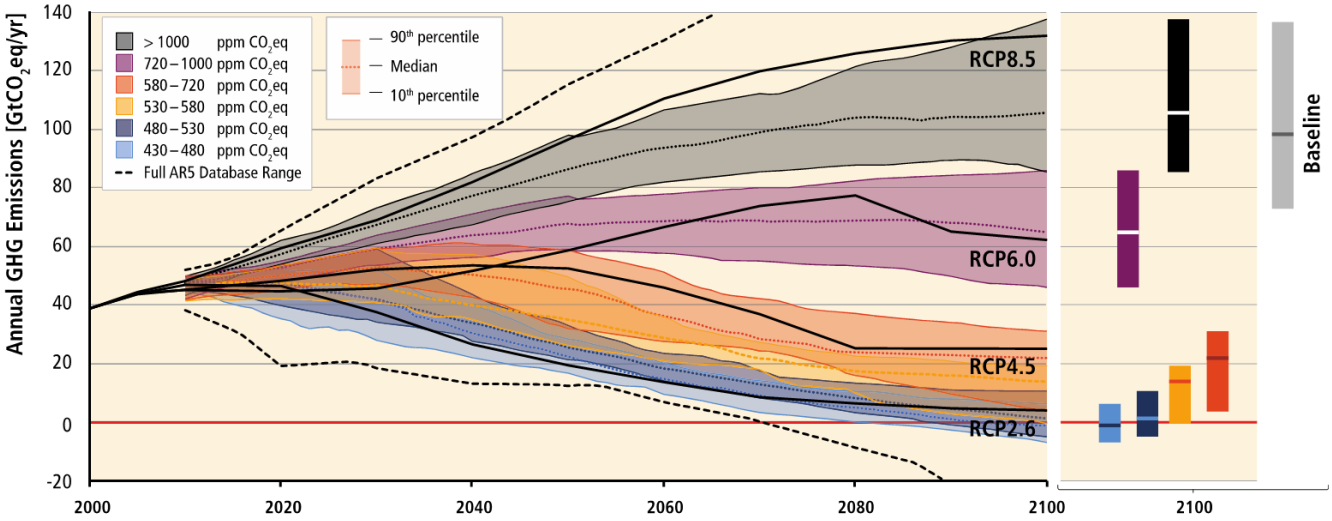
1. CONTEXT AND BACKGROUND

In the age of *Anthropocene*, or massive human manipulation of the environment, **there is much that we human beings have done to put our planet at risk** (Purdy, 2015). **But today, there is also much that we can do to bring it back to a sustainable path, provided we act swiftly and effectively**. Even without considering the preservation of natural capital and other species, decarbonisation is necessary also for humans, as climate change is already generating adverse effects in terms of health, life expectancy, systemic risks and the resilience of our production systems, and these effects are likely to worsen exponentially over the coming decades (ESRB, 2016). In other words, climate change has become an economic problem, capable of affecting global wealth and production. The publication, in 2014, of the fifth IPCC report on climate change has contributed to a growing awareness of the urgency of action in this domain (see Figure 1 for a graphic representation of pathways to achieve targets thought necessary to sufficiently minimise global warming). According to the IPCC report, stabilising global carbon emissions in 2050 to no more than a 2oC degree rise in the average global temperature above pre-industrial levels requires a 60% reduction in the carbon intensity of global GDP (assuming a 2.5% annual GDP growth), which requires **a radical change in the mix of technologies used to produce and consume energy as part of an industrial transformation. This, in turn, requires the near-term deployment and rapid diffusion of innovative products, processes, and services, as well as behavioural changes in firms, consumers, and government.** Such deployment and diffusion is considered to be the major determining factor in the overall cost of implementing a decarbonisation strategy. As such, it would also be a major determinant of the political feasibility and overall likelihood of uptake and success of that strategy.

As a result of the enhanced level of attention, international commitments are now emerging. Some 193 countries agreed to the new UN Sustainable Development Agenda in September 2015, and included Climate Action as one of the 17 new goals to be achieved by 2030 (as goal no. 13). The underlying targets include, among others, a commitment to integrate climate change measures into national policies, strategies and planning (renewable energy targets now exist in as many as 164 countries, see IRENA 2015); and a commitment to engage in mitigation of climate-adverse impacts, especially in developing and least developed countries. A few weeks later, 196 countries attended COP21 in Paris and reached an unprecedented agreement to limit global warming to less than 2 degrees Celsius compared to pre-industrial levels; to achieve zero net anthropogenic greenhouse gas (GHG) emissions during the second half of the current century; and to pursue efforts to limit the temperature increase to 1.5°C – a goal that, according to a number of scientists, is even more stringent in that it implies reaching zero emissions at some point in time between 2030 and 2050.[3]

[3]The Paris accord will become binding as soon as at least 55 member countries will ratify it.

Figure 1 – Emission pathways scenarios as illustrated by the IPCC fifth assessment report



Note: This figure presents all secenarios from the IPCC Fifth Assessment Report, including GHG representative concetrantration pathways (RCP). Scenarios in the lowest light-blue band correspond to concentration range of 430-480 ppm, likely to keep temperatures below 2°C by the end of the century; scenarios in the lowest dark blue band, correspond to the concentration ranges of 480-530 ppm are more likely than not and as likely as not to stay below 2°C. Emission levels for the year 2100 are indicated by blocks on the right.

Source: IPCC (2014)

These commitments, however resounding, have been hailed by authoritative commentators as insufficient to advance deep decarbonisation (Sachs, Schmidt-Traub & Williams 2015);[4] and by many as just a step towards what they consider to be a necessarily much more complicated implementation path. The Energy Transition Commission (2016) has also warned that meeting COP21 targets will not come close to achieving a 1.5°C rise to stem serious climate disruption. What is needed is a 3% improvement in energy productivity per year and a 1% decarbonisation per year. The current INDCs fall fairly short of achieving the necessary shifts. Further, the commitments made by the Paris signatories are unbalanced between the supply and demand levers, and are very limited in scope outside the power sector (RMI, 2016)[5]. In its policy recommendations the ETC divides the challenge into two

[4]Sachs et al. (2015) have drawn attention to the danger that policies implementing the means to achieve these emission targets may actually work to the detriment of the longer-term goals after 2050 and 2070 to more fully decarbonize industrial and industrializing states. Interestingly, Goldman Sachs experts argue, contrary to Jeffrey Sachs, that Coal-to-gas (C2G) switching or energy efficiency measures could deliver emission savings at relatively low cost and at significant scale. See http://www.goldmansachs.com/our-thinking/pages/new-energy-landscape-folder/report-the-low-carbon-economy/report.pdf

[5]The ETC Report states that "Decarbonizing the power sector is essential, and decarbonized power can be used in an increasing range of economic activities. However, we also need to decarbonize other sectors and value chains. This will require reshaping transport systems, building and urban design, industrial processes, and agricultural activities to enable either cost-effective zero-emissions electrification or a zero-carbon non-power energy supply. In both cases, radical improvements in energy productivity are also required. Achieving this will require the widespread use of new energy technologies, more circular production systems using recycled materials and more re-usable components, pervasive digitization to reduce energy waste, as well as more integrated strategies for land, energy, and water use. It will only be possible if technological and design change is complemented and enabled by changes in individual behavior, by new business and financing models, and by predictable policies and regulations which send a strong, clear signal to markets (ETC 2016, p.4).

parts: 1) reducing emissions stemming from the energy supply by increasing the share of zero-carbon energy in the supply mix and 2) moderating growth in the demand for energy. We would place the sources in three, rather than in two categories: 1) the energy/electricity industry that extracts, refines, produces and transmits energy and its precursors that power the system, 2) transportation/mobility, housing/shelter, and food/nutrition that use energy to function, and 3) the industrial system that supplies the materials and physical capital that are essential for the economic system to function successfully in transportation/mobility, housing/shelter, food/nutrition, and the provision of other consumer products. This expanded categorisation is more useful for policy redesign.

Complicating factors are numerous, however. First, global warming is not the only outstanding challenge faced by our societies, and it is important to address it in a way that does not compromise other equally urgent lines of action (e.g., the World Bank's Shared Prosperity agenda)[6]: a recent report by the European Systemic Risk Board highlighted the social and financial risks associated with a sudden, late action to curb emission levels.[7] Second, it is important to realise that this process is likely to create both winners and losers. While society as a whole will gain enormously from decarbonisation in the medium and long term, in the short term some industry players will exit the market; entire industries (mostly, the ones based on fossil fuels production or distribution or those who are displaced by firms using technologies with much lower GHG emissions) may be wiped away;[8] the global financial market will experience serious turbulence;[9] and some workers will see their jobs at risk if their training and skills are not updated to reflect new market needs. Third, some countries will be more affected than others, and this, too, can create collective action problems in a governance scenario that is still awaiting a clear definition, with commitments that are unlikely to be enforceable and will be left to an imperfect form of management-based governance framework (Coglianese, 2015). Fourth, the short-term outlook for decarbonisation-oriented policies might not be aligned with the electoral cycle,

[6]See i.a. Pichelmann for DG ECFIN, European Commission (2015): "over the medium-term a scenario might prevail by which the pace of productivity growth will be slower in the EU than in the emerging economies. Such a trend combined with demographic and climate change constraints in the EU would make agendas for structural reform, greater competition, trade opening, the transition to more knowledge-based economies, and deeper European integration and international cooperation even more necessary, while at the same time less socially acceptable if in this process too many people are left behind. The EU will have to develop a project integrating adequately fairness issues". And the OECD: "restoring robust economic growth, addressing systemic risk and instability in finance while ensuring investment in the real economy, slowing productivity, growing inequality in wealth distribution and persistent poverty, as well as ensuring the environmental sustainability of global economic development" (OECD, 2015).

[7]ESRB (2016). Sachs et al. (2015) warn that achieving the COP21 targets by "picking the low hanging fruit" would make it difficult to embark on a goal of deep decarbonization because of the deployment of suboptimal technology-based solutions and changes to infrastructure. In contrast, the ESRB Report (executive summary), states: "[b]elated awareness about the importance of controlling emissions could result in an abrupt implementation of quantity constraints on the use of carbon-intensive energy sources…[A] sudden transition away from fossil-fuel energy could harm GDP, as alternative sources of energy would be restricted in supply and more expensive at the margin…[and] there could be a sudden repricing of carbon-intensive assets, which are financed in large part by debt. According to this view, this would lead to a "hard landing" exacerbated by a lack of technological progress. Inasmuch, as discussed below, we are not convinced that an innovation deficit is at the root of these dire predictions, preparing for preparing for changes through the deployment of already-developed technologies may not lead to the massive disruptions the report anticipates. See also Fagerberg (2015) who argues that the needed innovation is achievable with the adoption of specific policies and initiatives.

[8]Suffice it to consider that, as estimated by McGlade and Ekins (2015), if the rise in average global temperatures is to be kept below 2°C, then approximately 35% of current oil reserves. 50% of gas reserves and nearly 90% of coal reserves should be seen as unusable. It is interesting to couple this observation with Weyzig et al. (2014), who estimates the exposure of European financial institutions to fossil-fuel firms as exceeding one trillion Euros.

[9]HSBC (2013) estimated that a sudden transition away from fossil fuels might lead to up to 50% decrease in market capitalization for oil and gas companies, including both the risk of stranded assets and reduced demand.

which might create even weaker incentives for policy-makers to embrace the long(er)-term challenge. Fifth, as we explain below, there is no way that long-term decarbonisation goals can be achieved without a concrete, proactive and collaborative participation of national governments and private players. This is a public-private endeavour that requires trust and significant mutual commitment, and might even entail sacrificing short-term profit for some of the parties, in the face of likely unequal longer-term gains.

Should this not suffice, the decarbonisation task is made even more Herculean by the inadequacy of the existing legal and financial framework. Both at the international and domestic level, legal rules and public policies are often providing the wrong incentives, facilitating transactions that do not achieve the underlying long-term goal of pursuing decarbonisation (or any other sustainability-related goal). GDP still catalyses most of the attention (including that of global financial markets) when it comes to measuring countries' performance; international donors often link their fund allocations to variables that have nothing to do with sustainability (e.g., the ease of doing business); and trade rules up to now are still largely carbon-insensitive, and end up encouraging low-cost, high-carbon products over more sustainable ones (but see the discussion below on carbon leakage in Myth #7). National governments often decide on their agendas and assess and monitor the impacts of their rules in a way that has nothing to do with decarbonisation; in many countries, governments regulate markets and develop industrial policies in an uncoordinated way, especially from the point of view of the transition towards a low- or (zero-) carbon economy. Many policies, from taxation to public procurement, provide incentives and trigger market behaviour that is not conducive to long-term decarbonisation goals. And indeed, organisations such as the OECD (2015) have highlighted the urgency of policy alignment and coherence as a necessary, though not sufficient, condition for advancing towards a zero carbon economy.

Faced with such complexity and coordination, many commentators and policy-makers have reverted to innovation as the 'ultimate solution' (or the last resort) for tackling global warming (see, for example, Fagerberg, 2015). In Paris during COP21, innovation was given the same prominence as energy, and a "mission innovation" was launched by 20 governments with the aim to promote the development and diffusion of new technologies. This announcement was immediately echoed by the creation of a Breakthrough Energy Coalition, a private initiative that involves an international group of 28 investors to bring companies that have the potential to deliver affordable, reliable and carbon-free power from the research lab to the market.[10] **Invoking innovation is easier said than done, however, and is per se not sufficient.** On the one hand, R&D investment in renewable energy seems to be still dwarfed by investment in technologies related to fossil fuels (which still account for 70% of new energy investment according to the IEA[11]), to the extent that the OECD estimated the need for an additional R&D investment of as much as 1 trillion dollars per year to decarbonise the economy while maintaining a sufficient level of energy supply.[12] On the other hand, additional investment seems to chiefly depend on major policy and regulatory effort to achieve a sufficient level of regulatory stability and certainty, and promote those types of systemic, transformative innovations that can provide the decisive contribution to decarbonisation in the long term (see the discussion of systemic innovation in section 1.2.2). This in turn means that many

traditional innovation policy tools, typically based on technological innovation and R&D support, are to be thoroughly revisited and brought in line with current needs.

Against this background, **the situation of the European Union is perhaps even more complicated**, even if some EU member states appear more advanced than most other world economies in their path towards environmental sustainability (Sachs et al., 2015). After being a pioneer in its climate mitigation efforts, over time the EU has set more ambitious goals in its climate action strategy, and today it aims to cut emissions to 80% below 1990 levels by 2050, with intermediate milestones in 2030 (40%) and 2040 (60%). Climate action appears to have only marginally affected the EU policy process, however, and in particular its better regulation agenda. Moreover, the decarbonisation debate has gradually been 'decoupled' from the more prominent debate on growth and jobs. As a result, and perhaps not surprisingly, Europe (as well as the US) appears to have become a living portrait of the policy misalignment that could jeopardise the achievement of much-needed sustainability goals, as denounced by commentators and international organisations.

The most telling example in this respect, as explained below in more detail, is the still uncertain fate of the Europe 2020 strategy for "smart, sustainable and inclusive growth", which – however imperfect – represented an early, pioneering attempt to create links between related, but often separate, concepts such as innovation, the environment, and sustainable growth and employment (EEB 2015; Renda 2014). Europe 2020, however imperfect in its governance and uncertain in its positioning within the broader context of the European Semester, marked an important milestone since it set a vision for Europe's priorities and evolution in the medium term; and was potentially an important step towards the alignment of policies (including innovation policy and industrial policy) in support of long-term goals (Renda, 2014). But the strategy has been gradually eroded and made less meaningful by the economic downturn and by the 'perfect storm' that hit Europe since the end of the last decade, and is now leading towards a deflationary spiral, notwithstanding the efforts of the ECB to pump liquidity into the system through quantitative easing (Sinn, 2016), not to mention the possible negative effects of the recent UK vote for Brexit. As it became clear that the 2020 targets were unattainable (ironically, with the exception of environmental ones, due to a serious fall in industrial production as a result of the 2008 financial/economic crisis)[13] and short-term emergency measures dominated the scene, the Europe 2020 strategy was gradually abandoned. Its expected review, originally scheduled for the second half of 2014, was never completed by the European Commission, and hence a concrete proposal on how to re-launch Europe's strategy for smart, sustainable and inclusive growth was never brought to the attention of the European Parliament and the Council. The absence of a comprehensive framework in which to address the links between EU policies, innovation, sustainable development and decarbonisation deprived Europe of the instruments it needed to navigate its way out of the perfect storm – what

[10]http://newsroom.unfccc.int/clean-energy/mission-innovation-clean-energy/
[11]IEA 2015.
[12]Kaminker and Stewart (2012).
[13]Note that based on Eurostat data industrial production in the EU28 never went back to pre-crisis levels. It reached the highest value in April 2008 and then fell continuously for one year until in April 2009 when it was more than 22% points below its former peak. Afterwards the indicator steadily increased again and regained over 90% of its pre-crisis value by May 2011, and has had highs and lows since then. http://ec.europa.eu/eurostat/statistics-explained/index.php/File:EU-28_Industrial_production_total_and_MIGs_monthly_data_seasonally_adjusted_2005-2015.png

we would call an industrial policy for achieving sustainability. As things stand, Europe risks going from leader to laggard in sustainable development, and to end up invoking innovation for the sake of it, as an end rather than as a means (EEB, 2015).

Much has been said and written about decarbonisation. Countless reports and scholarly articles have shaped this debate, sometimes taking a more balanced and enlightened view, and sometimes taking more partisan positions. Accordingly, several years of discussion have led to the emergence of a number of myths, which must be dispelled before we proceed towards what we consider to be a balanced, carefully designed policy strategy to face the decarbonisation challenge and all the constraints and opportunities that come with it. This is why this section tries to briefly describe nine myths related to this crucial debate. See also a complementary compilation of myths by Aiginger (2016).

1.1 Nine myths on innovation, sustainable development and the low-carbon economy

Myth #1 It is possible to realise mutual gains in industrial competitiveness, GHGs reduction, and employment

Why is this untrue?
This formulation is derived from the goals of the Lisbon Strategy and its successor Europe 2020, and is now being questioned.[14] What may be possible are mutual gains in economic welfare, a reduction of GHGs, and employment; however, significant gains in private-sector profit or even GDP may not necessarily be possible or desirable, and policies will increasingly create both winners and losers, with consequent distributional effects. The limitations of both GDP and productivity as adequate metrics for economic welfare and predictors of employment are now well recognised (see Ashford & Hall, 2011a).[15] This will require a reformulation and re-articulation of EU goals for 2030, 2050, and beyond.

The distinction between policies directed towards increasing traditionally-defined competitiveness and those directed towards enhancing economic welfare is that the former are profit-driven and best informed by GDP, while the latter are human-needs (or end-use functions) driven – including employment – and described by other and broader metrics [see (i24c 2016)]. Because the term 'competitiveness' is now so often used in policy discussions, an alternative is to be clear that the term is not restricted to profit or increases in GDP or market share – derived from the usual private-sector-dominated metrics -- but rather also includes societal measures of economic and social welfare, including employment. See especially Aiginger et al. (2013), who argue for a more comprehensive definition of competitiveness.

Why is this untrue?
(See the box on the diffusion/innovation debate) The technology innovation process consists of invention, innovation, and diffusion. There are many analysts [e.g., Amory Lovins (2011) and Robert Ayers (2016)] who argue that there are many technologies already in existence that could be put to use, but which suffer from the inadequacies of appropriate market and regulatory signals, in sufficient market demand, and/or lock-in due to inappropriate policies, not to mention influence and agency capture by incumbent technology providers (see Bhattacharjee and McCoy 2012 for an extensive incentives analysis influencing the diffusion of energy technologies). For earlier work focusing on options for achieving reductions in GHGs, see Pacala and Socolow (2004) and Blok et al. (2012). Further, more than technological innovation is needed. Institutional, organisational, and societal/social innovation is also essential and should always be kept in mind by policy-makers as part of the bigger picture of what innovation can do for long-term societal well-being.[16]

BOX - THE DIFFUSION/INNOVATION DEBATE

The sources of greenhouse gas emissions

In order to sensibly discuss the diffusion/innovation debate, it is useful to consider the sources of greenhouse gas emissions. It is acknowledged that transportation/mobility, housing/shelter, and food/nutrition are not only 80% of Europe's resource use and 60% of its household expenditures (i24c 2016), but also they are the areas of economic activity that consume energy and materials, and provide services, that lead to significant greenhouse gas (GHG) emissions and environmental contamination. More upstream, the energy/electricity industry extracts, refines, produces and transmits energy and its precursors that power the system, and the industrial system supplies the materials and physical capital that is essential for the economic system to function successfully in transportation/mobility, housing/shelter, food/nutrition, and the provision of other consumer products.

By design, the world is driven by what Daly (2008) calls a "throughput mentality", rarely or insufficiently internalising the externalities that accompany the production and consumption of goods and services. On the contrary, both production and consumption are encouraged and subsidised, creating a pseudo-equilibrium, which occasionally collapses as a result of a financial bubble (Ayers, 2015; Stiglitz, 2010). The rules under which industrial economics

[14]See ESPAS (2015) "Global Trends to 2030: Can the EU Meet the Challenges Ahead?"
[15]There is good GDP and bad GDP. All GDP measures reflect expenditures related to transactions which are as different as selling cars and treating lung disease caused by air pollution from those cars. See i.a., Philipsen, D. (2015), The Little Big Number: How GDP Came to Rule the World and What to Do about It, Princeton University Press.

operate do not favour conservation, energy efficiency, or the essential determinants of growth (for a provocative report addressing the necessity of a new approach, see Stiglitz (2015) and also Dernbach (2011). Not only is there a serious absence of rules dealing with the various compromises to sustainability, there is a deficit of monitoring, enforcement, and compliance of the rules that do exist.

Beyond improvements addressing the externalities contributing to GHGs emissions and pollution (what comprises an overarching environmental policy approach), the policies are not directed towards the transformation of the industrial system involving 1) a very low carbon system, 2) low-waste value chains associated with the economic activities mentioned above, and 3) a circular economy related to enhancing dematerialisation and de-energizing the production of goods and services (see Ekins et al., 2015). These could comprise a re-designed industrial policy approach. Together they constitute an integrated sustainable industrial policy for the environment, a kind of industrial ecosystem, as some have called it. While both innovation and diffusion might be important for improving both the environment and economic welfare, existing challenges to governance do not imply that they are magic bullets, and the optimal balance among them is not likely to be the same for addressing the different sources of GHG emissions. Both supply-side and demand-side policies are in need of re-examination and re-design.

A number of reports and studies address the goal of decarbonisation, but one stands out for its conciseness and focus on manufacturing (Ahman and Nilson 2015).

The debate in the literature

Despite considerable evidence that a diffusion deficit, rather than an innovation deficit characterises the need to deploy existing technological approaches, articles and reports continue to reinforce the latter. Especially revealing is the recent article in Foreign Affairs by Sivaram and Norris (2016). The emphasis is to support R&D on the power grid, citing the importance of the Breakthrough Energy Coalition, involving 28 investors from 10 countries, unveiled by Bill Gates and President Obama's announcement of the formation of Mission Innovation involving a 20-country commitment focusing on power generation and transmission, and arguing for future public-private partnerships to advance the needed innovation.

Romm (2016) offers a convincing debunking of this perspective, arguing that "[t]he truth is that we have dawdled so long on serious climate action that we must rapidly slash CO_2 emissions, which requires over a 100 times more money spent on deployment [diffusion] than R&D." Further, based on the history of successful innovation, the author argues that we should not expect that breakthrough technologies can be developed in time. Looking closer at the debate, when the term R&D is used, sometimes advocates are arguing for basic R&D, and sometimes moving technologies from bench or lab up to practical scale are intended by that term, such as what is reflected in the US ARPA-E endeavour. The difference is important, and semantics should not obscure key differences in what is being advocated or planned. Clarity and focus in the details of specific projects, and what is being specifically recommended, would help the policy planning process. In this regard, the reader is referred to a recent report by i24c (2016) in which it is stated; "[t]he energy sector, Europe has no ideas deficit, but in many instances, a deployment [diffusion] deficit."

[16]For example, Sachs et al. (2015) examine DDPs without modelling new technologies, only looking at the ones being commercially available or currently being tested.

Myth #3 Innovation per se fuels the industrial state and creates jobs

Why is this untrue?
Much innovation in products and processes simply employs more material (natural and physical capital) and energy. While fostering increased GDP it increasingly destroys jobs, as the labour content of production decreases and contributes to a heavy non-energy-related environmental footprint and un- or under-employment in both blue- and white collar professions (Brynjolfsson and McAfee 2014). As discussed under Myth#2 above: Europe, like the United States, may be suffering more from a 'diffusion deficit'. A more nuanced innovation policy, taking into account the effects on employment of invention, innovation, and diffusion needs to be adopted so that interventions in the appropriate part of the innovation cycle, e.g., deployment rather than basic R&D, can be used to achieve positive consequences for employment.[17]

Myth #4 Governments cannot pick winners - winners pick governments

Why is this untrue?
The US experience with aircraft, computers, the internet, space technology, and pharmaceuticals (to name but a few examples) clearly demonstrates the power of government research funding, e.g., see the US examples of DARPA and ARPA (Mazzucato, 2014; Bonvillian & Van Atta, 2011). In a recent contribution, Mariana Mazzucato convincingly argued that state-funded research (e.g., the ARPA-E in the US) is achieving major breakthroughs in at least one of the key technologies that will provide a contribution to decarbonisation, i.e., batteries for energy storage. In addition, what is important for the purposes of this report is that while private sector efforts such as Elon Musk's Tesla have taken important steps towards the production of "an existing, pretty powerful battery technology", ARPA-E has been pursuing technological innovation in the purest sense, by "creating new ways of doing" things that "have the potential to be significantly better."[18] Bill Gates himself acknowledged that only the state, in the form of public institutions like ARPA-E, can lead the way to an energy breakthrough.[19]

Myth #5 Industrial policy is synonymous with innovation policy

Why is this untrue?
An industrial policy not only encompasses invention, innovation and diffusion, it also envisions, i.a., the training – and re-education – of scientists, engineers, data and ICT specialists, etc., but also service and healthcare providers, in addition to well-conceived employment and social policy options (Ashford and Hall 2011). Trickle-down theory – often accompanied by the mantra 'a rising tide raises all boats' – embodying the belief that

[17]See Goldman Sachs on lack of scale of some techs http://www.goldmansachs.com/our-thinking/pages/new-energy-landscape-folder/report-the-low-carbon-economy/report.pdf. And http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/01/Dechezlepretre-et-al-policy-brief-Jan-2016.pdf.
[18]See Mazzucato (2014).
[19]Gates (2012)

economic advance in the private sector benefits society and workers as well has been basically discredited. The economic crisis of 2008 stands out as a stark reminder. In a recent commentary on the relationship between industrial policy and innovation policy, aiming to establish an 'industrial compact' focusing on system changes envisioning techno-economic and socio-technical transformations, Steward (2015) argues that the industrial compact should be "broad in scope, have purposive directionality, deliver system transformation and rely on network capabilities"[20] and not expect that enhancing industry profit alone will benefit others in the society.

Myth #6 Regulation inhibits beneficial innovation

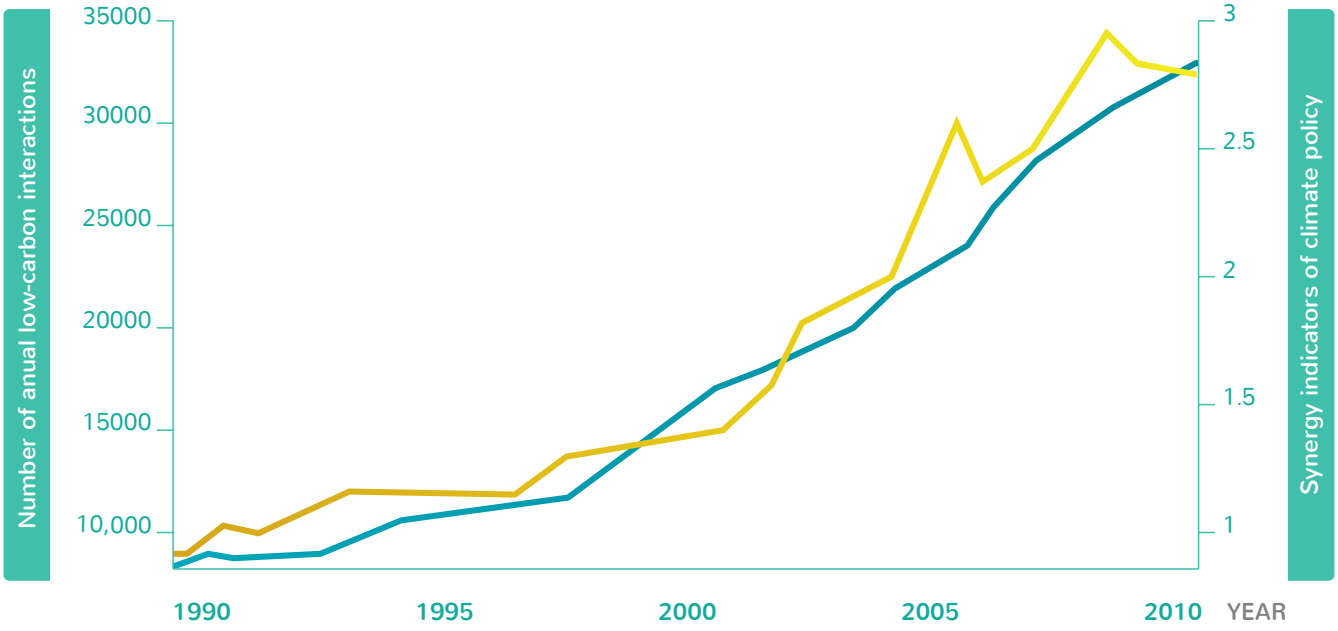
Why is this untrue?

There is overwhelming empirical evidence that regulation, especially stringent regulation and standards, properly designed, have stimulated new products, processes, and work practices that would not otherwise have occurred (Ashford et al., 1985; Porter & van der Linde, 1992; Pelkmans & Renda 2014; see also OECD, 2016b for a recent comparison of stringency). However, often transformative, disruptive innovation comes from outside the incumbent producers or providers, which implies that care must be taken in order to prevent incumbents and special interests from unduly influencing both the industrial and the regulatory policy process. Negotiated agreements and self-regulation need to be viewed with appropriate scrutiny [Ashford & Caldart (1999); Coglianese (2015)]. For what concerns more specifically decarbonisation, Dechezleprêtre et al. (2016) map the relationship between the number of low-carbon inventions for which patent protection has been sought by inventors located in OECD countries between 1990 and 2012, along with an indicator of the stringency of climate change policy developed by the OECD (Botta & Kozluk, 2016). The graph is shown below and shows a correlation between innovation efforts and the stringency of policy.[21]

[20]See Steward (2015) "Building an EU Industrial Policy Focused on Innovation" presented at the i24c Workshop on Innovation for Industrial Competitiveness, 9 September 2015. Professor Steward. See also: vivideconomics (2015) "Understanding European Industrial Competitiveness and Drivers of Innovation in the New Global Economy" prepared for i24c.

[21]Quote i.a., Lanjouw and Mody (1996), Jaffe and Palmer (1997), Brunnermeier and Cohen (2003), Johnstone et al. (2010), Dechezleprêtre and Glachant (2014).

Figure 2 - Innovation and stringency of climate change policies



Source: Dechezleprêtre et al. 2016. Data from the PATSTAT database and OECD Climate policy stringency indicator (2014). Individual countries are weighted by their GDP in order to calculate the average policy stringency across the OECD.

Myth #7 Carbon leakage presents a practical disincentive and limits what regulation can achieve in terms of decarbonisation

Why is this untrue?

'Emissions leakage' is generally defined as the increase in foreign emissions that is the consequence of domestic actions to reduce emissions that encourages the export of manufacturing abroad [Fischer (2015) p. 298]. Not only may foreign producers use cheaper (and dirtier) energy sources, they may also be generally less efficient than first-world domestic firms in their manufacturing operations. The consequence is usually that global energy prices go down as other [exporting] countries consume more fossil fuels. The implications for competitiveness can be significant, as can the impacts on world trade activities (Carbon Trust, 2009; Fischer, 2015; Mavroidis & de Melo, 2015; Wu & Salzman, 2014). "China's exports are eight times as carbon-intensive as those of the EU and three times as those of the US" [Atkinson et al. (2011), as quoted in Fischer (2015) p. 305].

In fact, the export of manufacturing (e.g., from the EU and the US to China) and services (e.g., to India) has been accelerated and intensified by the absence of enforceable or

enforced regulations in those locations, allowing domestic importers in developed countries to "trade on the externalities" and thereby increase their profits, with negligible reduction of prices to consumers – as well as a reduction of jobs at home. Trade rules should allow discrimination between products and services that are attended by undesirable side effects like adverse health, safety, environmental or climate change effects (WTO asbestos decision), as well as adverse employment effects [see Capaldo (2014) on the development on the TTIP]. In a recent publication, also the World Economic Forum (2015) acknowledged that sustainable and effective trade policy, including most notably the prominent role of decarbonisation in regional and bilateral trade agreements, is one of the enabling factors of long-term decarbonisation.[22]

If enough major economies could agree on a coordinated approach to carbon pricing/a uniform global price on carbon that spreads coverage broadly enough [which is not the case with nations acting independently], carbon leakage would become less of an issue [Fischer (2015) p. 298].

Barring the adoption of a global price for carbon in the near future, the concerns of especially developed countries wanting to curtail global GHG emissions may well turn to options affecting international trade to address their concerns for adverse effects on their international competitiveness, namely 1) subsidies for the development and deployment of cleaner technologies, so-called 'green subsidies' (Charnovitz, 2014) and 2) border carbon adjustments (BCAs) (Condon & Ignaciuk, 2013). While countervailing duties may well be allowed under Section XX of the GATT to prevent the import of goods produced with inappropriately high energy (disadvantaging developing countries), subsidies for environmental improvements are no longer exempt from 'actionable subsidies' prohibited by the WTO. Trade scholars have uniformly called for a revision to the WTO trade rules, specifically the Subsidies Code (Charnovitz, 2014; Condon & Ignaciuk, 2013; Fischer, 2015; Mavroidis & de Melo, 2015; Wu & Salzman, 2014; ETC, 2016).

Myth #8 Trade in non-energy-related goods and services is a win-win proposition for all parties to trade

Why is this untrue?

Both the experience with NAFTA and the WTO have clearly demonstrated not only a loss of health, safety, and environmental protection, but also a worsening of wages, working conditions, and human and working rights in one or both parties to trade (Greider; Scott). Money flows from the developing world to the developed world where returns on investment are the highest. Trade does indeed primarily benefit the private-sector exporters and importers, contributing to wealth and income inequality, but does not always benefit consumers and workers. EU trade initiatives (TTIP and other policies) need to be carefully assessed – and changed if necessary – for their potential to contribute to mitigating global climate change, as well as their adverse impact on employment.[23]

[22]WEF "Scaling technologies to Decarbonize Energy", October 2015.
[23]See the important new study "The China Shock: Learning from Labor Market Adjustment to Large Changes in Trade" by Autor, Dorn, and Hanson (2016): http://www.nber.org/papers/w21906.

Why is this untrue?
It is clear that a multilateral effort is needed for significant, high-risk industrial development, combining skills, insight, and financial capital and joint risk taking – such as has been suggested for a 'Global Apollo Programme to Combat Climate Change' (King et al., undated). With real and uncertain costs in transitioning to different energy futures, collaborative efforts should be pursued wherever possible so that long-term goals not be undercut by short-term competitive advantage and free-riding.[24] In illustrating the global nature of clean energy technology and the importance of technology transfer (diffusion), Gallagher (2014) argues that 1) clean energy technology innovation has globalised; it is no longer a national process, 2) the most important barriers are cost, lack of policy, and insufficient access to finance, and 3) the best incentives are market-formation policies and the provision of affordable finance.

1.2 From the throughput mentality to a new policy mix

Taking decarbonisation seriously is such a daunting and urgent task that it requires the mobilisation of all existing resources and policy levers that governments can use. This includes focusing on the core policies that can exert a direct impact on the transition towards a low-carbon economy, and coupling them with a consistent overall government approach to innovation and better regulation to ensure that all aspects of public policy reflect the growing importance of reaching decarbonisation goals. This will require a major effort, with a level of ambition that surpasses that of the resounding Paris accord; and major changes in the methods and approaches followed by governments in the definition, implementation, monitoring and evaluation of policies.

More specifically, changing the policy mix will be dramatic since it will require re-engineering the current mainstream approach to policymaking. As a matter of fact, by design, modern capitalism is driven by a 'throughput mentality', rarely or insufficiently internalising the externalities that accompany the production and consumption of goods and services.[25] On the contrary, many current policies encourage and subsidise production and consumption, creating a pseudo-equilibrium that ends up occasionally collapsing in the creation of financial bubbles, such as occurred in 2008 [see Ayres (2014) The Bubble Economy and Stiglitz (2010) FreeFall]. **The rules under which industrial economics operate do not favour conservation, energy efficiency, or the essential determinants of growth**.[26] Not only is there a serious absence of rules dealing with the various compromises to sustainability; there is a deficit of monitoring, enforcement, and compliance of the rules

[24]See K. S. Gallagher (2014) The Globalization of Clean Energy Technology: Lessons from China. MIT Press.
[25]Herman Daly (2008)
[26]For a provocative report addressing the necessity of a new approach, see Stiglitz (2015) "Rewriting the Rules for the American Economy: An Agenda for Growth and Shared Prosperity"; see also Dernbach (2011), "Creating the Law of Environmentally Sustainable Development."

that do exist, calling into question regulatory governance arrangements. This is especially the case with the financial architecture of the eurozone, but also extends to the entire system of financial flows.

Beyond improvements addressing the externalities contributing to GHGs emissions and pollution (which comprises an overarching environmental policy approach), many existing policies are not directed towards transformation of the industrial system involving 1) a very low or zero carbon system, 2) low-waste value chains associated with the economic activities mentioned above, and 3) a circular economy related to enhancing dematerialisation and de-energising the production of goods and services (Allwood and Cullen 2012; Ekins et al. 2015). These could comprise a re-designed industrial policy approach. Together they constitute an integrated sustainable industrial policy for the environment, a kind of industrial ecosystem or energy innovation ecosystem as some have called it.[27] Both innovation and diffusion are important for improving the environment and economic welfare, but existing challenges to governance imply that they are far from being magic bullets. Regulation and regulatory governance are essential in many respects:

- Establishing a greater degree of **regulatory certainty and predictability** that currently otherwise hampers investment in, and the diffusion of, new low-carbon technologies. This includes affecting expectations, in particular for financial intermediaries, of the technologies that are likely to receive regulatory scrutiny in the medium and long term.

- Setting **targets and outcomes** that, if adequately stringent, would incentivise the deployment of new technologies that are compatible with long-term decarbonisation and standards that facilitate the exit of the most inefficient products and firms off the market.

- Creating **incentives for consumers** to switch to more sustainable patterns of consumption **and for existing or new market players** to challenge existing business models and create innovative products and processes that could lead to a smoother transition towards a low- or zero-carbon economy.

In this respect, the core policy framework that affects long-term decarbonisation includes the following elements:

- **'Core' policies** (including both supply-side and demand-side policies) that directly affect decarbonisation. These include, in line with what was observed by the OECD (2015), the removal of fossil fuel subsidies, fuel taxation, carbon pricing, cap-and-trade and direct regulation and various forms of renewable energy promotion. Those policy strategies include putting a price on carbon emissions; adopting policies targeting carbon intensity measures; resource planning strategies; appropriate subsidies; establishing emissions standards for contracts or supply portfolios; and regulation of environmental impacts other than GHGs. Their aim is, i.a., to send a robust and credible price signal to internalise the cost of emissions; and to trigger behavioural and production changes through regulatory measures whenever pricing is not effective. They can take the form of both supply-side and demand-side policies, and can try to influence the energy

[27] I24c (2016b).

extraction and production phases, restrict the market for specific materials considered as unsustainable, expand the market for sustainable ones, or address final uses (e.g., transportation, agriculture) or even final users to exert an impact on the overall level of emissions generated by specific value chains.

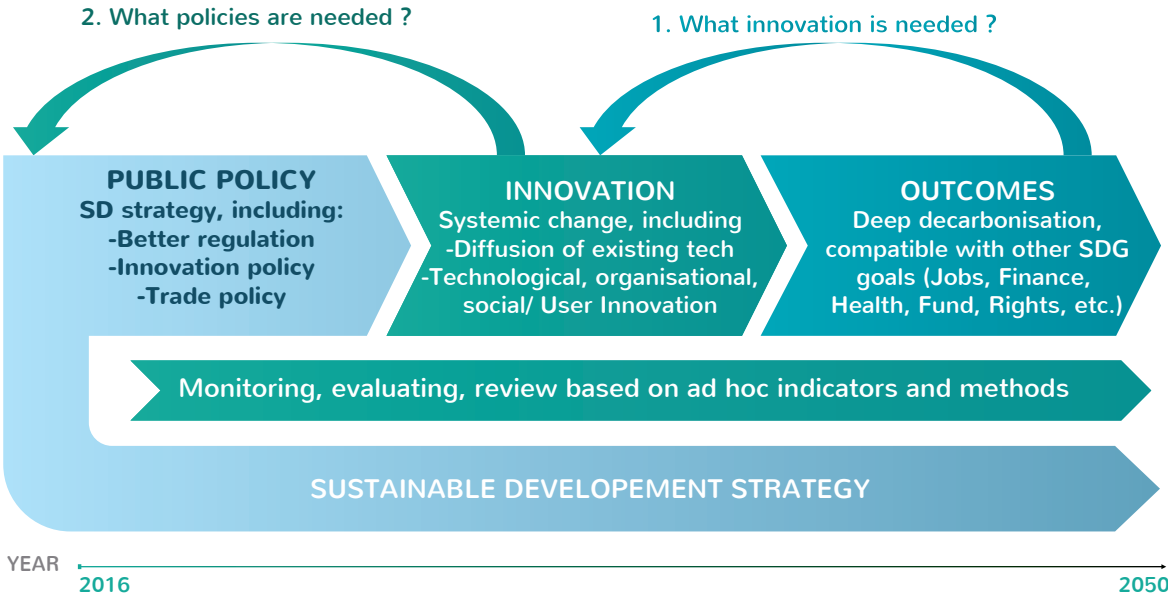
- **Horizontal policies**, which include several policy domains, including i.a., public procurement and trade policy. Both these policy areas affect the extent to which governments 'demand' low-carbon products, thus creating a market for them. If one considers that public procurement represents a relatively large share of the domestic market (close to one-fifth of GDP in Europe), it becomes clear that a robust commitment towards purchasing only sustainable products (and where appropriate, innovative and sustainable products) can help governments pave the way towards decarbonisation. Similarly, harnessing trade policy can become an important enabler of the future decarbonised economy.

- **Innovation policy** encompasses several supply-side and demand-side measures, including expenditure measures (public R&D, support for private R&D, funding schemes for entrepreneurs, equity and debt capital provision, etc.); regulatory measures (e.g., intellectual property rights, technology transfer regulations, etc.); demand-side policies (strategic use of public procurement, pre-commercial procurement, etc.); and orchestration activities oriented towards societal challenges (e.g., mission-led multi-stakeholder platforms, overall government incentive programmes etc.).

- **Better regulation** entails the adoption of specific tools, procedures and metrics, which must be interpreted as broadly leading to more transparent, accountable, evidence-based policymaking. The most widely mentioned better regulation tools include adequate and transparent legislative and regulatory planning, widespread stakeholder consultation, the use of ex ante impact assessments, adequate monitoring arrangements, ex post evaluations of individual pieces of legislation/regulation or groups thereof, dedicated programmes aimed at streamlining and improving the condition of specific industry players, ad hoc reviews of legislation, etc. As widely acknowledged (e.g., at the OECD level), better regulation produces its most effective outcomes when accompanied by a suitable governance framework, which typically includes the appointment of one or more regulatory oversight bodies, and the creation of appropriate skills in administration.

- **A sustainable development strategy** is essential to steer government initiatives towards decarbonisation. We believe that a meaningful strategy for sustainable development is to be preferred to a strategy restricted to the goal of decarbonisation per se: as a matter of fact, an all-encompassing strategy that analyses alternative decarbonisation pathways in terms of their possible impacts on other, equally important societal goals such as i.a., employment, financial stability and the protection of fundamental rights, is the first best for governments wishing to take decarbonisation seriously. Such a long-term strategy (which should extend to almost the end of the century) must then lead to the identification and deployment of adequate indicators and assessment methods, to be used in the daily activity of policymakers when using better regulation tools.

Figure 2 - Innovation and stringency of climate change policies



Source: Authors' elaboration.

As shown in the graph above, we contend that governments should start from the latter point (defining a sustainable development strategy) to then move towards a whole-of-government better regulation agenda that places sustainable development and in particular decarbonisation front and centre when considering any relevant regulatory and legislative action in the future, including retrospective reviews of the existing stock of legislation and regulation. As we explain below, we believe that such actions should be informed by open, inclusive, consolidated multi-stakeholder platforms that act as interlocutors of the government by preparing state-of-the-art technology and business roadmaps and helping the administration devise suitable strategies to avoid technology lock-in, regulatory capture, incumbency problems and other suboptimal outcomes. Only then can governments identify the best possible approaches to both horizontal policies and sector-specific regulation.

Below, we reflect in more detail on changes needed in core policies, in innovation policy, and in better regulation systems.

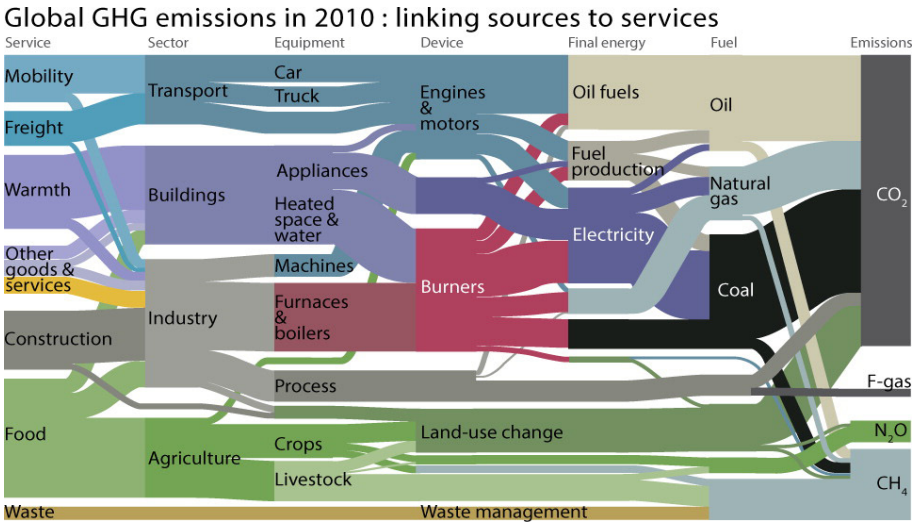
1.2.1 Core policies

For what concerns core policies that exert a significant impact on decarbonisation, there is an emerging consensus that both supply-side and demand-side policies are in need of re-examination and re-design. And regulation, which governs both the supply- and the demand-side, should be used extensively to manage incentives and steer outcomes.

A prominent role should certainly be attached to **policies aimed at reducing fossil fuel consumption**, since the latter is responsible for the bulk of global GHG emissions.

Some 42% of emissions from the consumption of fossil fuel in 2013 was destined to **electricity supply** (IEA, 2015), which makes the electricity sector particularly important for any strategy hoping to reach meaningful results in terms of decarbonisation. Energy efficiency, reducing the consumption of electricity necessary to provide energy services such as heating, cooling, lighting, and the operation of appliances, is widely regarded as the most promising approach to reducing GHG emissions associated with the electricity sector. But even with aggressive energy efficiency, it will be necessary to change the emissions profile of the electricity sector as part of efforts to achieve scientifically based GHG emissions reduction targets.

Figure 3 – World GHG Emissions Flow Chart, 2010



Global GHG Emissions in 2010: Linking Sources to Services. Bojana Bajželj, Julian M. Allwood, and Jonathan M. Cullen (2013) Designing Climate Change Mitigation Plans That Add Up, Environ Sci Technol. 2013 Jul 16; 47(14): 8062-8069.

More specifically:

- **Supply-side policies** have become preponderant in industrial and innovation policy over the past decade. They include i.a., direct subsidies, support schemes, old-fashioned industry-specific plans, R&D support and tax schemes. Today, these are affected by significant problems, especially since they are path-dependent and thus unable to adapt to systemic innovation. They are often trapped in regulatory frameworks designed for one specific type of production process, and reflect a through-put production system that is dominated by incumbents locked into suboptimal specific technologies and modes of service provision. They are also reinforced by both subsidies and commitments/arrangements within their supply chains. As a result of this latter condition, even when better technologies already exist, they rarely enjoy the advantages

of subsidised alternatives and are not encouraged by captured regulatory systems/ agencies that maintain the status quo. This is problematic as disruptive innovations are needed in many sectors to reach important goals, but they are not only unlikely to be favoured by incumbents; in some markets, incumbents are unlikely to be the sources of those innovations.[28] A striking example is provided by the inefficient construction of residential homes that occurs on-site, creates unnecessary material waste, pollution and worker accidents, produces uneven seasonal employment, reflects the interests of construction unions, is reinforced by existing housing regulations, and is more expensive than flexible modular construction (see Ashford, Hafkamp, Prakke, Vergragt 2001). Additional, abundant legendary examples can be found in food production and transportation.[29] Apart from specific wasteful inefficiencies, another problem faced by the growth-driven economy is that it encourages turnover and consumption, which can directly conflict with deep decarbonisation goals. Producer-created demand is generated from the supply-side actors, for example people are encouraged to buy larger automobiles by car manufacturers because the profit margins are greater than with smaller cars (see J. K. Galbraith, 1958). Further, the tax treatment of investment and profits, and the numerous key factors of production (natural and physical capital, labour, energy, and ICT), greatly influence what is produced and provided by supply-side actors. Herman Daly has long posed the question: if society wants more employment and less pollution, why are we taxing labour and not pollution? Under concerns for global climate change, why are we shying away from a carbon tax?[30] As discussed, as long as GDP dominates our ranking of firms, industries, and countries – reflecting our preoccupation with policies that encourage competitiveness in the traditional sense, growth-driven strategies will prevail.

- **Demand-side policies** are not only relevant, they can sometimes be more important than supply-side policies. Existing alternatives to products and services that could contribute to decarbonisation are often unknown to economic consumers – be they firms or individuals. Government and industry often bemoan an 'innovation deficit' while better solutions might well address a 'diffusion deficit' when it comes to advances in energy generation, transmission, and utilization.[31] In the context of encouraging a circular economy and acknowledging the "invisible energy embodied in our industrial economy" – particularly in the use of steel and aluminium – see Allwood and Cullen (2012) where both supply-side and demand-side policies are required to meet energy-use reduction goals. Sorrell (2015), however, cautions that optimism regarding the effectiveness or likelihood of the adoption of demand-side policies needs greater scrutiny.[32] He observes that reducing energy demand may prove more difficult than is commonly assumed, in particular since mainstream economics "is likely to have underestimated the dependence of ... growth upon increased energy consumption"; as well as the likelihood of often neglected "rebound effects" (i.e., energy demand

[28](Ashford and Hall 2011a and 2011b; Christensen 1997)
[29]In the context of encouraging a circular economy and acknowledging the 'invisible energy embodied in our industrial economy' -- particularly in the use of steel and aluminium -- see Allwood and Cullen (2012)
[30]Daly (2008), which criticises the "Growth Commission" report.
[31]See Lovins (2011) and Ayers (2015).
[32]"Reducing Energy Demand: A Review of the Issues, Challenges and Approaches" Renewable and Sustainable Energy Reviews 47-82, at page 81.

increases, or does not decrease as expected as a result of improved energy efficiency, thus frustrating policy actions towards lower demand). Sorrell (2015) also observes that price signals must be accompanied by additional policies triggering more sustainable behaviour (see below), which are currently "underrepresented in the current policy mix which remains largely focused upon energy supply and incremental changes within existing systems". Finally, the same author argues that unprecedented attention towards large-scale transformations in the 'sociotechnical' systems that provide energy services such as thermal comfort and personal mobility are required: this, in turn, calls on governments to provide 'direction' in a meaningful and viable way, and "to do so in a way that overcomes the inertia of sunk investment and delivers the speed of change required to avoid dangerous climate change". Within demand-side policies, behavioural approaches are considered increasingly important to trigger changes in consumption patterns that would either trigger reductions in energy use, or open up new market opportunities for more sustainable products and services. The lack of visible metrics to inform the consumer in a meaningful way also contributes to inappropriate consumption. For example, the advertised price of purchasing an automobile is not usually accompanied by its total life cycle cost including upkeep, repair, disposal, and resale value. Critics of the growth-driven model of consumption uniformly call for a reining in of advertising that continues and serves to expand the current basis for consumption.[33] By contrast, government 'counter-advertising,' procurement, targeted subsidies, and tax system changes could facilitate a shift towards greener products and services. Similarly, the creative implementation of properly designed trade policies could favour the export and import of more desirable products and services.

- Importantly, it must be recognised that **regulation** of products, materials, energy content, efficiency and use, as well as advertising to encourage or discourage consumption can create a market for innovation (Ashford, et al. 1985; Ashford and Hall, 2011b; Porter 1999; Pelkmans and Renda, 2014). Regulation is one of the few areas of intervention that can simultaneously create both demand and supply side changes. In light of the weaknesses of pure demand-side policies articulated by Sorrell above, regulation may be particularly important for its impact on demand by constraining or defining the nature, kind, and extent of permitted demand, e.g., by requiring stringent fuel efficiency standards. The recent recommendation formulated by the Dutch presidency, that the EU should promote an "innovation principle" needs to be understood as encompassing both changes in innovation and changes in diffusion (see the discussion in the next section). Both supply-side and demand-side interventions are needed. Furthermore, it is not only technological innovation, but also organisational, institutional, and societal innovation that should receive attention.

[33]See Jackson (2012) and Schor (2005).

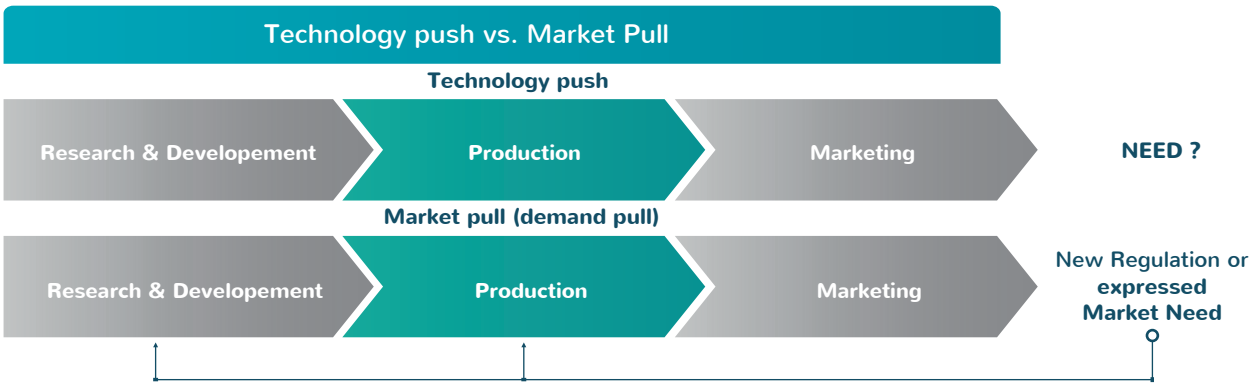
1.2.2 Innovation policy: systemic and mission-oriented

Much faith and hope in transforming industrial systems has been placed on the concept of innovation. After all, the root of the word implies change. The innovation process is acknowledged to encompass three related and interactively connected activities: invention, innovation, and diffusion. Invention is the first working prototype of a technology; it can involve a product, a process or a manufacturing/services system. Innovation is the first or new market application, while diffusion refers to proliferation of the innovation throughout an industry. When the innovation is then used in other industries, applications, or national contexts, we often also use the term technology transfer to describe diffusion. Finally, if significant adaptation is required in a new context, it is sometimes referred to as a separate innovation. Intellectual property protections – a temporary monopoly -- are considered important to secure adequate returns for the inventor and developer.

While governments, as well as the private sector, generally devote significant resources to create innovations, especially in saleable products, although process innovations also receive attention, it is important for our purposes to distinguish what motivates a particular innovation and who provides the financial capital to spur both innovation and diffusion.

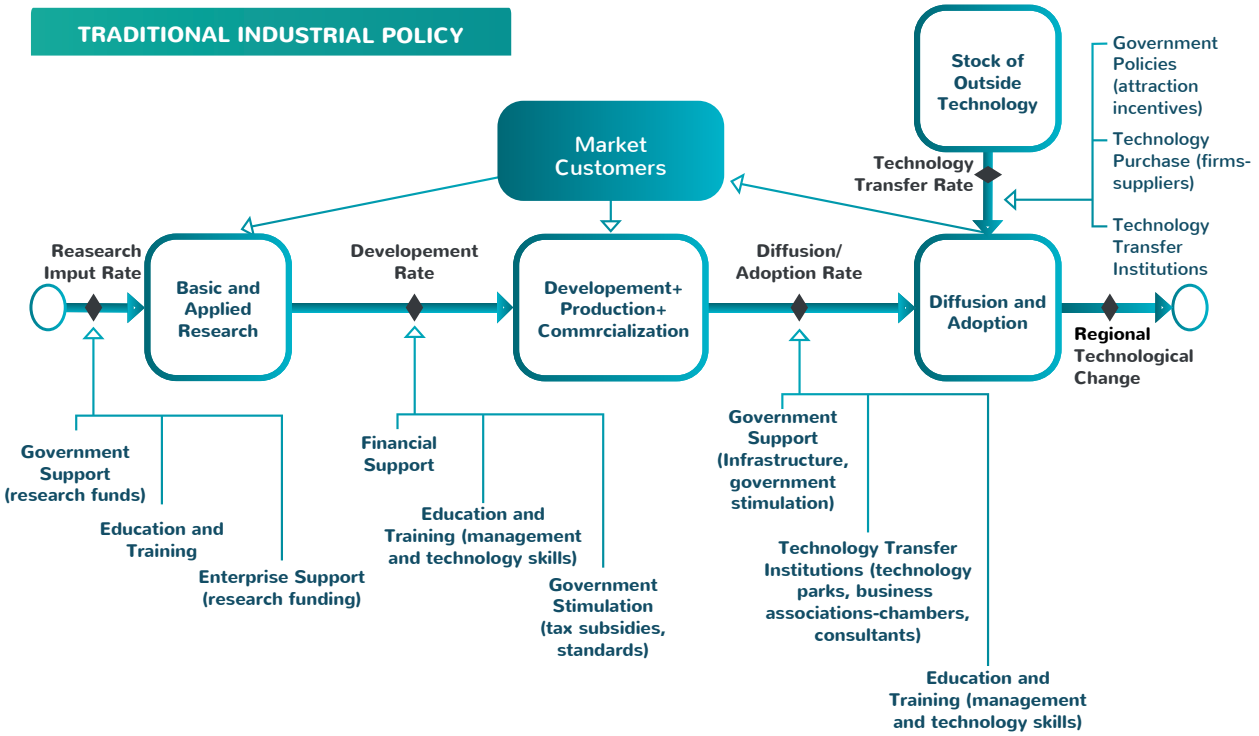
Innovation may occur driven by technology push forces, or by market pull (see Figure 5). Industrial sectors routinely engage in the R&D necessary to develop saleable technologies with the hope that the market will absorb them, even in the absence of nascent market demand. This occurs naturally (as an evolutionary process) and can take decades, and traditional industrial policy providing government assistance is often said to 'oil the wheels of innovation' in hopes of the nation enjoying financial rewards (see the discussion below).

Figure 5 – Technology push v. Market pull



The role of the government in promoting innovation is presented in Figure 6, indicating all the traditional ways in which innovation might be stimulated (Ashford and Hall, 2011b).

Figure 6 – Traditional industrial policy



Source: Ashford and Hall (2011b)

The interventions depicted in the figure are of course familiar to those involved with traditional industrial policy that focuses on singular product or process changes. System innovations, discussed below, such as the transportation system or the agricultural system necessarily involve multiple economic actors interacting in larger venues and this model does not adequately represent the complexity involved in system transformations. Technology push innovations are pursued by profit-seeking firms and by countries seeking to enhance domestic and trade revenues (capital supplied by firms and subsidised through R&D innovation programs and cost-sharing through business tax deductions – and in the case of trade and aid, Export Credit Agencies, Sovereign Wealth Funds and Overseas Development Grants).

By contrast, there are often nascent or expressed market needs demanding to be satisfied. Market pull innovations can also be pioneered (Jänicke & Jacob) by firms recognising an unmet societal or market need and direct their innovative efforts towards that end. Often the demand is difficult to assess and can wane over time. An example is the need for a better chemotherapeutic approach to cancer, or greater impetus to find a cure for Alzheimer's disease. Often, the R&D need is cutting-edge and financially risky. Government often supports the initial forays into research, as exemplified by the development of computers, aircraft, and the internet (Mazzucato, 2014).

When it comes to stimulating innovation (and diffusion) of system transformations – or technologies that have remained unchanged for decades -- there seems little doubt that government setting of specific medium- to long-term mandatory targets, plus economic support, is indispensable for achieving transformations within a reasonable period of time (Ashford et al, 1985; Ashford & Hall, 2011b; Pelkmans & Renda, 2014). Regulation and mandated targets essentially collectivise public demand or needs through the setting of standards and requirements [See Reinaud et al (2016), p. 27) for a discussion of the importance of market-pull instruments for energy technologies such as feed-in-tariffs, green certificates, etc.]. Costs are imposed on the private sector with cost-sharing achieved through business and R&D deductions. Sometimes subsidies are provided.

Governments need to understand the different forces giving rise to innovation and diffusion, and not succumb to traditional industrial policy if serious transformations – especially involving the displacement of incumbents or system changes – is what is needed. The regulatory initiatives such as Better Regulation and REFIT (as discussed in section 2.3) do not seem to focus on the change processes that are needed.

Over the past two decades, the concept of co-evolutionary innovation has been introduced by Dutch researchers injecting government and stakeholder guidance into the selection process entailing strategic niche management and transition management (Grin et al., 2010). This co-evolutionary process is advocated for system innovation, but its promoters admit the transformations can also take decades to achieve. A criticism of depending on these co-evolutionary processes to achieve systemic sustainable transformations can be found in Ashford & Hall (2015).

A hallmark of system innovation influenced by the 'Dutch School' is that it involves – in a multi-stakeholder negotiation otherwise known as the 'Polder Process' -- the stakeholders, government, and especially incumbents which are likely to be limited in their capacity to go beyond incremental innovation. Indeed, in a recent document (OECD 2016a, p, 10), in which a key Dutch School advocate of system innovation provided the basis for the report on System Innovation, it is stated: "[c]hanges in large socio-technical systems take time, sometimes twenty to thirty years". The global climate change process cannot wait that long for significant transformations to take effect. We certainly believe that system transformations are key to achieving change and innovation involving technogical, organisational, institutional, and economic actors, but a much more directive role is needed for government to meet the challenges through an integrated approach utilising regulations, targets, and appropriate economic signals. What is recommended in the System Innovation Report sounds good, but it is wrong-headed, takes too long, and is very likely to be overly influenced by incumbents and limited by their technological capacity. The government must take on the role of trustee for the needed transformations – and trustee of the technologies and firms of the future, often not yet represented at the negotiation table – not of referee, teacher, or generator of consensus. Our view is seriously at odds with the essence of the System Innovation Report, even though the report recognises the danger of incumbent influence, which is absent from earlier writings of the Dutch school. The actual thrusts of the recommedations do not cure its fundamental flaws.
Finally, one of the bottlenecks in commercialisation of useful technologies may come late

in the innovation cycle. The innovation literature emphasises the importance of deployment – the step in which a technology moves from bench-top, lab, or small scale use to actual commercial use in practice. Semantic preferences differ as to whether this is described as the last step in the innovation activity or the first step in diffusion. Semantics aside, what is important is that the R&D to accomplish this transition is not basic research, but truly applied research, a distinction often glossed over in discussions of innovation policy. Barriers to deployment are often influenced by incumbents whose technologies compete with the new technology and seek to delay or prevent its entry.

Using data on the diffusion of renewable energies from 15 European countries from 1990 to 2012, Aflaki et al. (2015) give important empirical support to demand-pull diffusion driven by government policies that promote the growth of renewables. While they did not study the role of regulation as a demand-pull strategy, they did identify other demand-side government policies that support the notion that "government support should be directed at stimulating aggregate demand rather than at establishing niche markets (reflecting the Dutch school's emphasis on evolutionary/co-evolutionary innovation). Variability and uncertainty in these policies were found to dampen diffusion, supporting our recommendation that establishing clear and stringent future performance targets for the development of non-carbon energy technologies is crucial for accelerating their deployment and adoption.

1.2.2.1 Systemic innovation and the role of technology

There is growing agreement among experts that long-term decarbonisation goals can be achieved only with the help of systemic innovation. This, as already explained, does not necessarily mean that innovation has not already occurred. For example, in an influential study Amory Lovins estimated in 2011 "a 2.6-fold-bigger US economy by 2050 with no oil, coal, or nuclear energy, one-third less natural gas, a $5 trillion dollar net savings, 82-86 percent lower carbon emissions, and no new inventions" solely through profit-motivated business activity. Lovins also argued that the "twin transition to efficiency and renewables" "requires no new federal taxes, subsidies, mandates, or laws. The policy innovations needed to unlock and speed it need no Act of Congress." In the same vein, Sachs et al. (2015), in exploring their deep decarbonisation pathways, assume no major technological disruptions over the coming decades, and only base their assumptions on technologies that are either commercially available or expected to become so in the near future.

The World Economic Forum (2015) observed that some of the key technologies that can contribute to the decarbonisation of energy are already at a mature stage, attracting high levels of investment, although they still have significant potential for growth and further cost reduction; whereas others are at the stage where more basic research, applied R&D or pilot testing are needed to take them to maturity and reach the 'market tipping point' where investments will unlock larger potential. The European Parliament also acknowledged in 2015 that

there are many potential technologies already in use or being developed ranging from forestation to bio-energy with carbon capture and storage to enhanced weathering and mineral carbonation to name just a few. However announcements of revolutionary breakthroughs should be taken with a grain of salt, keeping in mind that the new technologies might not scale up from laboratory experiments to industrial scale deployment, and that costs may be high and hard to reduce.

As indicated by the same World Economic Forum Report (2015), **short-term technologies** (which will take up to five years for acceleration) include solar-PV, wind power, and third generation nuclear energy; energy efficiency in buildings; energy efficiency in transportation; and efficient industry processes. On the other hand, **medium-term technologies** (which will take up to 15 years for acceleration) include advanced power storage; carbon scrubbing technologies (CCS and CCU); advanced nuclear reactors; next generation power electronics; next generation biofuels; hydrogen technology; advanced geothermal and ocean energy.

Against this background, it is not at all clear that Europe or any other industrialised country faces a serious innovation deficit. Rather, the problem may be diffusion or deployment of far-developed technologies, or – put more simply – ensuring that the most promising existing technologies have a place in the market. But how can deployment, diffusion, and technology transfer be fully promoted? Here too, policy measures include both supply-side and demand-side interventions.

1.2.2.2 Beyond R&D: tackling diffusion

Besides R&D focused on innovation, however, there is growing awareness of the need for a number of additional measures that increasingly belong to the innovation policy domain. These measures look at the potential uptake and diffusion of existing technologies in the marketplace – an essential precondition for their expected virtuous environmental impacts to materialise.

First, while picking winners has been successful by governments promoting big science innovation (Mazzucato, 2014), **institutions may often lack adequate knowledge of 'which winners to pick',** and as such would not necessarily be able to choose the right technology to focus on to accelerate deployment. For this reason, multi-stakeholder involvement should supplement governmental intervention. As reported by the OECD (2015), "the kinds of breakthrough innovations that can generate significant environmental benefits can come from fields as diverse as ICT, materials sciences and biotechnology"; and within these areas, several options exist. Innovation policy can contribute to this challenge if governments invest in the skills possessed by civil servants, and most importantly if the institutional framework for innovation includes transparent multi-stakeholder, mission-oriented R&I platforms that can convey technical information and technology forecasts to policymakers.

Second, **even if R&D were successfully promoted on a given technology, the market**

conditions for its uptake might not necessarily exist: in particular, not all innovative technologies are produced by incumbent players, and in most cases they imply a reshuffling of the status quo in a given sector. For example, many new business models in the energy or financial sector are not being adopted by incumbent players, who are typically less agile and more affected by sunk costs compared to new entrants; and in other cases, e.g., for smart grids, the need to cooperate with other players (e.g., telecoms, IT companies) could end up threatening the market position of the incumbent electricity companies, leaving them with little urge to move forward. In contrast, see Reinaud et al. (2016) for documentation of incumbents that have become innovators/players in this innovation space.

Third, **lack of skills, collective action problems and path-dependency in consumption habits** are often major obstacles to the uptake [deployment] of disruptive technologies and business models. Lack of skills can emerge both along the value chain (for example, repairers may lack the skills needed to work on electric vehicles); collective action problems can emerge whenever technological uptake is favoured by interoperable standards (e.g., recharging stations for electric vehicles or hydrogen-powered cars). Finally, path dependency can emerge whenever the technological breakthrough requires changing long-term contracts and switching providers; changing the way in which a given service or product is used by residential customers; changing equipment; etc. All these conditions have to be part of an overall assessment of the measures that would be needed in order to facilitate the smooth, swift penetration of more sustainable technologies into the market, with consequent benefits in terms of transition towards a low-carbon economy.

All these problems deserve careful scrutiny, also for what concerns the role of the public sector, which is typically invoked whenever markets fail (as in the case of collective action problems). As observed, i.a., by Mariana Mazzucato (2014), governments play a fundamental role in changing economic direction by creating and shaping markets, taking on risks at research and development stages, and at stages of technological diffusion by supporting manufacturing and commercialisation. Governments influence the direction of innovation when they manage training and educational institutions, produce information, set regulations, supply funds (with conditions attached), purchase goods and services, and sets targets. The case of decarbonisation is no exception. There seems to be growing consensus on the need for strong public presence and direction, not just through regulation, but also through systemic innovation policy, to lead the world back onto a sustainable path towards decarbonisation.

1.2.3 A circular policy process for the circular economy age

Our analysis of the need for constant consideration of policy trade-offs and long-term goals in the policy process leads to a relatively new way to approach government activity, and in particular the so-called "policy cycle" (Renda 2015; European Commission 2010). While approaching long-term goals, governments should ensure that they consider all short-term and long-term impacts, as well as all available data, before they lay down the baseline

scenario, prospective counterfactual analysis and assessment of alternative policy options that typically form the ex ante impact assessment phase. This exercise should potentially be carried out both for primary and secondary legislation:[34] the former, especially, should be tabled and discussed on the basis of solid (technology) foresight and adequate consideration of long-term policy priorities. This creates the **first challenge for governments that want to align their policies with long-term sustainable development goals: ensure adequate input into the ex ante impact assessment for consistency with possible pathways towards a low-carbon economy.** For example, in the United States this can be very challenging for government since a structured ex ante impact analysis system only exists for secondary legislation, whereas the policy process for primary legislation seems to be less oriented towards a systematic assessment of prospective impacts. In the EU and in other jurisdictions the situation is different, since primary legislation (or in the case of the EU, major new legislative initiatives of the European Commission) is subject to ex ante impact assessment, and there is (in principle) an obligation for the European Parliament and the Council to update the impact assessment document throughout the ordinary legislative process.

Ensuring consistency with long-term policy goals such as decarbonisation already in the ex ante phase of legislation might require a number of changes in the policy process. These include the following:

- **Introducing a whole-of-government approach to the analysis of long-term policy impacts.** For example, the government might work on the basis of a common economic, social and environmental baseline scenario when crafting policies. In the case of decarbonisation, it would be important to formulate a whole-of-government "decarbonisation pathway" (Sachs et al. 2015) that would then inform government action in all relevant policy domains. Economic studies that project the economy in the long term might be translated into concrete general economic models for estimating long-term impacts, which should then be used as a reference by administrations wishing to propose new rules (e.g., the EU JRC has worked on a common baseline for the whole EU, but this has remained at the stage of a research study).

- **Ensuring the collection of all available data even before a regulatory intervention is fully shaped.** One of the most recurrent critiques of the better regulation system of many OECD countries is that stakeholders do not get a chance to intervene by proposing new actions at a very early stage of policymaking (Noveck, 2015). Adopting an open government strategy at the early phases of the policy process can be very helpful for government wishing to gather and use data and results from various prior initiatives in the policy assessment: recent initiatives to gather and collect data such as 'hackathons' or 'datapaloozas', coupled with a strategy to open up to stakeholders information held by government can be used to make the most of the available information.

- **Set objectives that are consistent with long-term goals.** In some jurisdictions, defining objectives is a key part of the ex ante impact analysis process. In the EU, for example,

[34]In the case of the EU policy process, this distinction is less easily drawn compared to the case of domestic policy. We refer here to primary legislation as denoting major new policy initiatives of the European Commission, with far-reaching expected economic, social and environmental impacts. Secondary legislation includes narrower initiatives within already established legislative frameworks, and implementing and delegated acts.

officials in charge of ex ante impact analysis have to specify general, specific and operational objectives, but the link between general objectives and long-term goals is not always explicit, let alone clear; and the difference between specific and operational objectives is often difficult to grasp. Ideally, governments should couple the definition of a comprehensive long-term agenda with the definition of targets and indicators, and methodologies to keep track of those indicators. These methodologies would then become the DNA of policy appraisal from an ex ante and ex post perspective.

- **Ensure that alternative options considered for a given policy intervention include all feasible options, set up a data collection system, and adequately consider flexibility and adaptation to possible technological and systemic changes.** Policy alternatives typically considered in ex ante impact assessment are often selected from a menu of recommended options, and range from light-touch options (e.g., awareness raising campaigns) to behavioural approaches (e.g., nudging individual behaviour, using social peer-pressure); the use of market instruments (e.g., cap and trade systems); management-based regulation; and more prescriptive forms of regulation. Yet little guidance is available in many countries as regards the possible risks and long-term consequences of adopting any of those regulatory approaches. In addition, a long-term perspective might require that under uncertainty, more reversible choices are made: but this need for a more sequential approach to regulatory solutions has so far never fully permeated the better regulation debate.

- **Adapt the methodology used to compare options.** Most international organisations and national governments recommend the use of cost-benefit analysis as the most reliable and effective criterion for choosing among policy alternatives. And indeed, this method has a number of virtues, including the fact that it can be used by economists regardless of the geographical location and the sector involved, and can also be used by the centre of government as a control tool to ensure that the incentives of administrations at the periphery of government are aligned with those of the centre, within a typical principal-agent framework (Posner, 1999). The use of mainstream (neoclassical) cost-benefit analysis largely disregards distributional impacts, however, and assumes that income can be used as a good proxy for happiness and well-being. When using this type of cost-benefit analysis, administrations attach monetary values to saved or improved human lives and heavily discount future regulatory benefits, sometimes minimising the value associated with goals such as decarbonisation. Furthermore, they assume that an individual's happiness or well-being only depends on what (income) that individual possesses, and not by what others have, or whether income is evenly distributed (so-called "methodological individualism", see Renda 2011). They assume that what makes a policy 'desirable' is the sum of individual willingness to pay for a given future state of the world, and as such incorporate all behavioural biases such as short-sightedness, short-termism, over-optimism biases and mere lack of inter-generational altruism into their calculations. All these assumptions have proven shaky when tested empirically; and they are far from morally neutral. What is even more worrying is that some jurisdictions around the world (including the European Commission) also use CBA to assess the impact of primary legislation, whereas in the US no specific tool is being used. In order to fully take into account decarbonisation, there are a number of alternative methods

that could be used: they include weighted cost-benefit analysis (Adler, 2012); 'Rawlsian' approaches that set specific priorities that take precedence over other impacts (so-called lexicographic order); trade-off analysis that explicitly accounts for distributional impacts and technology evolution (Ashford, 2007); or multi-criteria analysis linked to a number of specified impacts, coupled with transparently set indicators (possibly included in a country's long-term strategy), which could include a decarbonisation pathway. The latter seems to be the most preferable and viable for many jurisdictions, especially those that scrutinise primary legislation through ex ante impact assessment.

- **Consider interactive and cumulative impacts.** Assessing the impact of legislation on decarbonisation entails that administrations take into account both the stock and the flow of rules. This means that the impact of an individual rule often depends on how the rule interacts (or clashes) with other international, national, regional, public or private rules and standards that a given entity (company, individual, civil society organisation) is exposed to. Accordingly, the so-called cumulative costs and benefits of legislation should be adequately considered, together with the interactive benefits (or co-benefits). The latter occur when a specific type of policy intervention creates benefits also in terms of other policy impacts. For example, environmental policy normally brings health benefits. A study by Bollen et al. (2009) for the Dutch Environmental Agency showed that a stringent air quality policy can lead to a reduction in emissions of greenhouse gases. The authors estimated that if China pursued a stringent air policy to reduce the number of premature deaths from chronic exposure to outdoor air pollution by 70%, by 2050 (compared with a baseline trend without policy), this policy would lower GDP in 2050 by 7%; but air quality benefits would be equivalent to 7.5% of GDP, while greenhouse gas emissions would be 40% lower. Christian Friis Bach (Under Secretary-General of the United Nations, Executive Secretary of the United Nations Economic Commission for Europe) recently observed that taking into account co-benefits, "it is estimated that up to 90% of the reductions in GHG emissions required to prevent temperatures rising above 2°C could be achieved through measures that are in the direct interest of the countries undertaking them"[35].

- **Monitor the impacts of legal rules and evaluate them periodically through retrospective reviews.** Monitoring has emerged as perhaps the most important phase in policy appraisal, since policymakers often have problems assessing all risks and possible challenges that can emerge, especially in the implementation and enforcement phases of the life of a rule. Many features of legal rules are, borrowing from the language of marketing, 'experience goods', i.e., their impact and effectiveness can only be judged after a period of practical implementation. Accordingly, smart governments lay down the preconditions for adequate monitoring already during the ex ante phase, by answering the question "how am I going to monitor the impact of this rule?" In many cases, this requires the setting of ad hoc mechanisms for generating and processing data in the forms of performance indicators or, at least proxies for effectiveness of the rule. Obviously, this again brings up the question of what the appropriate metrics are and whether they exist. In addition, as shown in the latest OECD regulatory policy

[35]http://www.euractiv.com/section/climate-environment/opinion/assessing-co-benefits-could-accelerate-action-on-climate-change/

outlook (November 2015), a growing number of governments use a variety of forms of ex post evaluation of legislation, which can take the form of an appraisal of an individual rule, or of a group of rules; or the partial appraisal of specific impacts (e.g., administrative burdens; environmental impacts; impacts on SMEs, etc.). In this respect, and in line with our previous point, we argue that the most appropriate way to evaluate the stock of existing rules is to analyse a group of homogeneous rules (e.g., climate change legislation; energy and environmental regulation) to capture their cumulative and interactive impacts. For primary legislation especially, the scope of the evaluation should focus on the effectiveness and coherence of the rules, i.e., on whether they are helping the country progress towards its many long-term goals. If a decarbonisation pathway has been defined, the evaluation of the stock of existing legislation should indeed lead to an assessment of whether the implementation of existing legislation is putting the country on track towards the achievement of its decarbonisation goals. If problems or risks emerge, or new risks emerge in the future, administrations should then proceed towards an ex ante impact analysis of possible alternatives to mitigate those risks or further improve the effectiveness of the rules at hand.

All these phases represent a full policy cycle, which goes from the initial ex ante assessment phase to ex post evaluation, and then again ex ante assessment of possible reforms. International experience shows that this policy cycle approach offers significant opportunities for governments willing to learn how to regulate in a more effective way (OECD 2015). At the same time, international practice shows that this process becomes even more effective if a strong, adequately skilled and cleverly positioned regulatory oversight body is established, with a mandate to ensure coherence of legislation with long-term goals, rather than the reduction of red tape.

A policy cycle approach can, of course, prove more complex in practice than the one outlined above. Typical complicating factors are the horizontal coordination between institutions within the same jurisdiction (e.g., government with parliament; independent agency with government); and multi-level governance setting in which implementation is dealt with by institutions at a different level of government than the one where the rules was enacted (e.g., regional governments or local authorities in charge of implementation). As we will discuss below, both problems arise in the case of the EU, requiring adequate mitigation strategies.

2. DECARBONISATION AND THE EU: GETTING READY FOR THE NEW PARADIGM

The European Commission recently observed that "the transition to a low carbon, resource-efficient economy demands a fundamental shift in technology, energy, economics, finance and ultimately society as a whole"; that the Paris agreement "provides important opportunities, notably for jobs and growth"; and that "the transition will stimulate investment and innovation in renewable energy, thereby contributing to the EU's ambition of becoming the world leader in renewable energy, and increase the growth in markets for EU produced goods and services, for instance in the field of energy efficiency".[36] Altogether, these resounding statements demonstrate a strong ambition to lead the world by example and aim towards decarbonisation by means of a whole-of-government, all-encompassing, far-reaching strategy touching upon industrial policy, trade policy, innovation and investment.

In this section, we take this ambitious statement very seriously, and focus on the way in which the EU can promote systemic innovation and diffusion that will provide a decisive contribution towards climate change goals. Our view of innovation policy, as explained in the previous sections, is broad, since innovation can be affected, in both its intensity and direction, by incentives and stimuli generated both by market forces and by legal rules. The latter, in turn, can be inspired by long-term needs to a larger extent than happens today.

This chapter of the report is therefore divided into three main sections. Section 2.1 maps some of the most important misalignments currently existing in EU policy, including cases in which the misalignment is caused by divergences between EU member states. Section 2.2 looks at EU innovation policy stricto sensu, and discusses ways to increase the diffusion of existing innovations that are key to decarbonisation. Finally, Section 2.3 discusses EU better regulation, and the misalignments between methods and procedures currently adopted in the EU policy process, and the ones that would be most useful to guide Europe towards its ambitious long-term decarbonisation goals in a timely and effective manner.

[36]See Communication From the European Commission to the European Parliament and the Council, "The Road from Paris: assessing the implications of the Paris Agreement" and accompanying the proposal for a Council decision on the signing, on behalf of the European Union, of the Paris agreement adopted under the United Nations Framework Convention on Climate Change. COM/2016/0110 final.

2.1 Mapping misalignments in key EU policy areas

Like all industrialised economies, the EU and its member states have adopted a vast array of policies that directly and indirectly, explicitly or implicitly exert a significant effect on the environment and the climate. Within these policies, along with remarkable results, a number of inconsistencies and misalignments have also emerged, sometimes due to the need to face concomitant social and economic emergencies (e.g., the financial and economic crisis that still partly rages in Europe), and sometimes due to more political factors that hamper the transition towards a more sustainable economy. Without claiming to be exhaustive, below we illustrate some of the most evident examples, distinguishing between types of misalignments. We do this with reference to several areas of policymaking, which we consider to be the most relevant for the purpose of our report. These include the following:

- **Fossil fuel subsidies** as existing at the EU or member state level. These can (or will) be potentially addressed at the EU level, either under the common EU Energy Policy, or under State Aids rules where appropriate.

- **The EU Emission Trading System** (ETS),including its first three phases and the future, post-2020 phase. Directive 2003/87/EC of the European Parliament and the Council Establishing a scheme for GHG emission allowance trading within the Community (hereinafter the ETS Directive) and its amendments.

- **Air quality rules** ssuch as the LCPD (Large Combustion Plants Directive); the NEC (National Emission Ceilings) Directive and the Industrial Emissions Directive (IED).

- **EU legislation on energy efficiency**, including the Energy Performance of Buildings Directive (2010/31/UE) recast, the Construction Products Regulation (305/2011), the Energy Efficiency Directive (2012/27/UE), products regulation such as the Eco-Design Directive (2009/125/EC) and the Energy Labelling Directive (2010/30/EU).

- **Legislation on transport**, including rules on emissions generated by light duty and heavy duty vehicles, non-road mobile machinery, and environmental rules in aviation and shipping.

- The EU acquis related to the **common agricultural policy.**

- Legislation on the **circular economy**, in particular related to waste.

- **A variety of demand-side policies,** including green public procurement, taxation on carbon-intensive products, and various forms of behavioural incentives.

Key aspects of regulation that affect innovation include stringency, time, flexibility and certainty (Ashford, 1985; Pelkmans and Renda, 2014). Stringency relates to how difficult and/or costly it is for firms to comply with new regulatory requirements using existing ideas, technologies, processes and business models. The amount of time that a regulation gives to the targeted stakeholders for compliance with the regulatory requirements is essential to stimulate innovation, but timing is a double-edged sword: too little time might discourage innovation and determine an unsustainable increase of compliance burdens, too much time might crystallise innovation efforts due to the lack of pressure to meet the requirements.[37] **Flexible, performance- or outcome-based regulation** stimulates innovation more than purely prescriptive regulation, provided that it is coupled with adequate monitoring and enforcement (see i.a., Coglianese, 2015). Uncertainty has also been found to act as a driver and an inhibitor of innovation depending on the circumstances.[38] Against this background, the types of misalignments that we will highlight are classified as follows:

Type 1. Inconsistent policies
Cases in which the scope and direction of the policy is not in line with the goal of decarbonising the economy as officially set by the EU.

Type 2. Incomplete or non-existent policies.
Cases in which there was no policy action, or where there is legislation but it does not cover essential aspects that would be key for long-term decarbonisation.

Type 3. Lack of stringency.
Cases in which policies lack stringency, and thus are unlikely to be incentivising behaviour that would fall in line with EU's decarbonisation goals.

Type 4. Lack of effectiveness due to problems of implementation, monitoring and enforcement.

Cases in which there are problems with time, since market players are given either too much or too little time to comply; compliance itself is taking too long; or policymaking occurs too slowly; or cases in which the scope of the policy is in line with overall decarbonisation objectives, but enforcement is too weak to secure compliance over time.

[37]BERR (2008) and Centre for International Economics (2006) specifically discuss the timing of standardisation: here too, the message is that standardisation should neither occur too early or not too late to stimulate and encourage innovation. An early standard can kill alternatives (e.g., the GSM standard for mobile communications), creating more intra-standard competition. If the standard is imposed too early, it can generate an undesirable lock-in effect, which leaves society trapped in a suboptimal standard. Similarly, the selection of a rigid, non-scalable standard can inhibit both incremental and disruptive innovation, and as such is highly damaging to social welfare and progress.
[38]Ashford et al. (1985) claim that "although excessive regulatory uncertainty may cause industry inaction on the part of the industry too much certainty will stimulate only minimum compliance technology. Similarly too frequent change of regulatory requirements may frustrate technological development." More generally, it is fair to state that whenever innovation requires large investment in R&D, the absence of reasonable stability or certainty in the regulatory framework can significantly hinder innovation. Our case study of competition rules applied in the e-communications sector below can contribute to shedding some light on this aspect of uncertainty.

2.1.1 Type 1. Inconsistent policies

This type of misalignment is one of the most serious and normally self-evident. We would say it is uncommon in the case of the EU, which adopted several pieces of legislation in view of a transition towards a low-carbon economy. However, cases of actual misalignment between specific policies and overarching long-term decarbonisation goals can present themselves, most often due to one of the following factors: existence of other, conflicting policy goals such as protecting existing jobs; responding to incumbents or other vested interests representing the status quo; the need to reduce prices (e.g., of energy) in the short term; following a specific, high-carbon smart specialisation strategy in regional policy; etc. The most evident examples are provided by the persistence of various forms of subsidies to fossil fuels in Europe,[39] and by the excessive weight of taxation on labour relative to carbon. Below, we analyse these two examples.

2.1.1.1 Example 1: Persistence of fossil fuel subsidies

While the use of renewables is increasing in most of EU member states, it is equally true that there is no sign of a concrete reduction in the use of fossil fuels, which should in principle be phased out over the coming years, with most of the reserves (especially for coal) remaining buried in the ground. But a recent European Commission document still reported a figure of €26 billion as the total level of support received by fossil fuels.[40] This figure largely relied on government documents and heterogeneous methodologies used by different countries, however. In June 2015, the International Monetary Fund published a report indicating post-tax fossil fuel subsidies projections for 2015, and attributed a much higher figure to EU Member States (202 billion dollars for 2015).[41] In addition, the study reported that in the EU alone coal companies received 10 billion euros annually (in the years 1970-2007) in the form of pre-tax subsidies. Figure 7 below, which uses OECD data, shows that Germany, the UK, France, Belgium and Italy are the countries providing the highest support for fossil fuels.

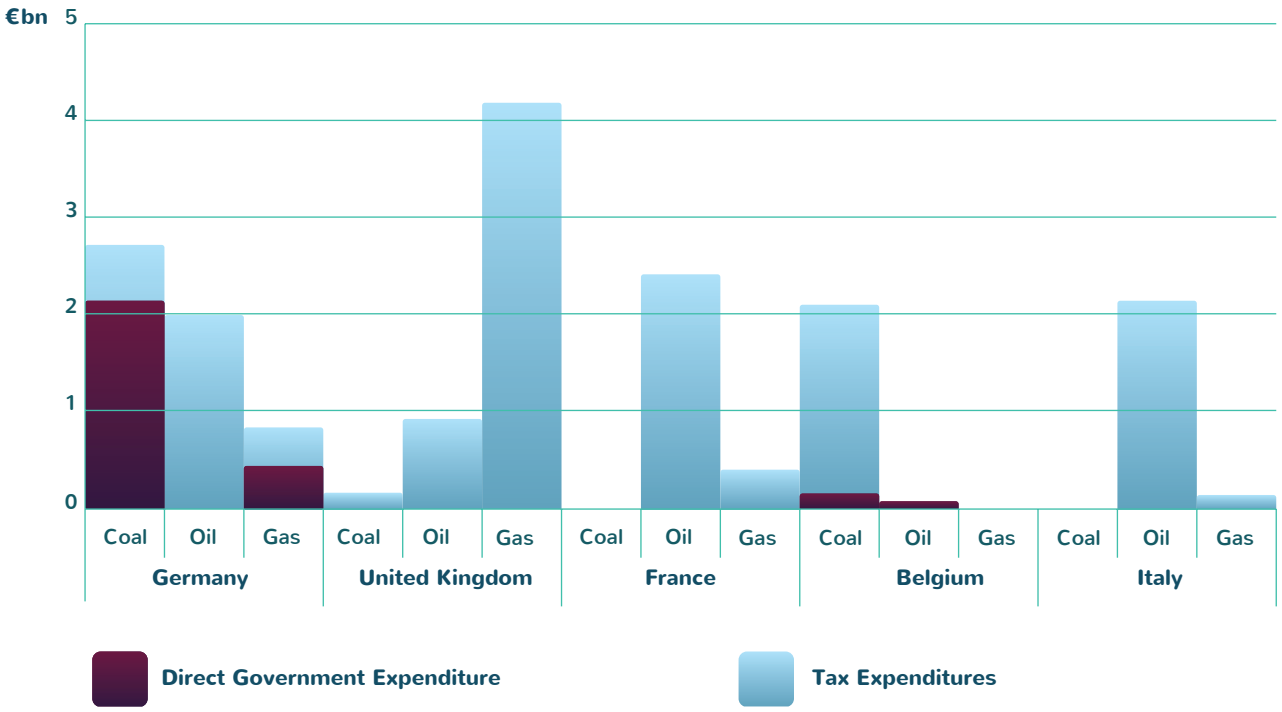
[39]Support to fossil fuels can be classified in the following categories: i) Producer subsidies – reducing the cost of production (for mining and burning coal), i.e. with cash hand-outs, by building public energy infrastructure, or giving funds for research and development purposes; ii) Consumer subsidies – governments pay the difference between the market price of energy and the price for companies and households. For instance, they do this by fixing the energy prices; iii) Tax cuts – subsidising high energy users by lowering their energy tax rates by giving mining companies free access to public land (no payments of royalties), by giving water rights for free; iv) Capacity payments – paying coal companies to keep their plants operational, in case there is peak demand so they can quickly turn the coal units on; v) Export credits – providing international (development) finance for coal projects abroad; and vi) Transition – giving money to regions and mining operators to rehabilitate former mining areas, pay for early retirement of ex-coal workers etc.

[40]European Commission (2013), "European Commission Guidance for the Design of Renewables Support Schemes". NERA (2014) correctly criticises the methodology used to arrive at this figure, since it relies on the OECD inventory of fossil fuel subsidies, which explicitly reports figures per country built with different methods and classifications of what constitutes a subsidy. Accordingly, summing up the figure to reach 26 billion Euros is not a correct approach.

[41]The IMF provides the following definitions:

- Pre-tax subsidies are based on a comparison of pre-tax end-user prices with a benchmark price. For traded products, the benchmark price is based on an international benchmark price adjusted for distribution and transportation costs. The IMF assumes margins for distribution and transportation are similar across all countries. For non- traded products – mainly electricity – the benchmark price is "is the cost recovery price for the domestic producer, including a normal

Figure 7 - OECD Inventory: Five Countries Providing Highest "Support" in 2011



Source: NERA (2014) on OECD data.

Calculations based on data by the IEA suggest that European coal power emissions must fall by at least 8% on average every year until 2040, and this is not happening fast enough. In 2015, 22 EU countries were still burning coal in a total of 280 coal power plants. Only six countries are coal power free: Cyprus, Estonia, Latvia, Lithuania, Luxembourg and Malta. These 280 coal power stations produced 18% of total European greenhouse gas (GHG) emissions in 2014. In five countries, the contribution of coal power stations to total national GHG emissions was over a quarter or more, with 44% of GHG emissions produced by coal power stations in Bulgaria, followed by 34% in Greece, 33% in the Czech Republic, 33% in Poland and 28% in Germany[42]. From the standpoint of economic theory, that of fossil fuel subsidy is a textbook case of market failure, aggravated by government support. More precisely, the negative externalities generated by fossil fuel extraction are not internalised by the producing companies, or by the downstream players that make use of electricity generated with fossil fuels. All these support schemes hamper the development of renewable energy both by maintaining artificially low prices for electricity

return to capital and distribution costs".

- Post-tax subsidies compare end-user prices inclusive of all taxes with a benchmark price that reflects assumptions about a "reference rate" of VAT (or GST) and allowances for the externalities of greenhouse gas (GHG) emissions, local air pollutants, and some traffic externalities (e.g., congestion). For VAT, the IMF develops assumptions about what constitutes a reference rate of VAT: for example, in countries where no VAT is paid on the consumption of any product, it nonetheless assumes that the reference VAT is the same as in countries with similar incomes. The adjustment for GHG emissions in the benchmark price is based on an assumed carbon price of 34 USD/tCO_2e, which is taken from the United States Environmental Protection Agency. Finally, for local air pollutants, the IMF assumes that countries have similar characteristics to the US and uses estimates from the US to quantify this externality.

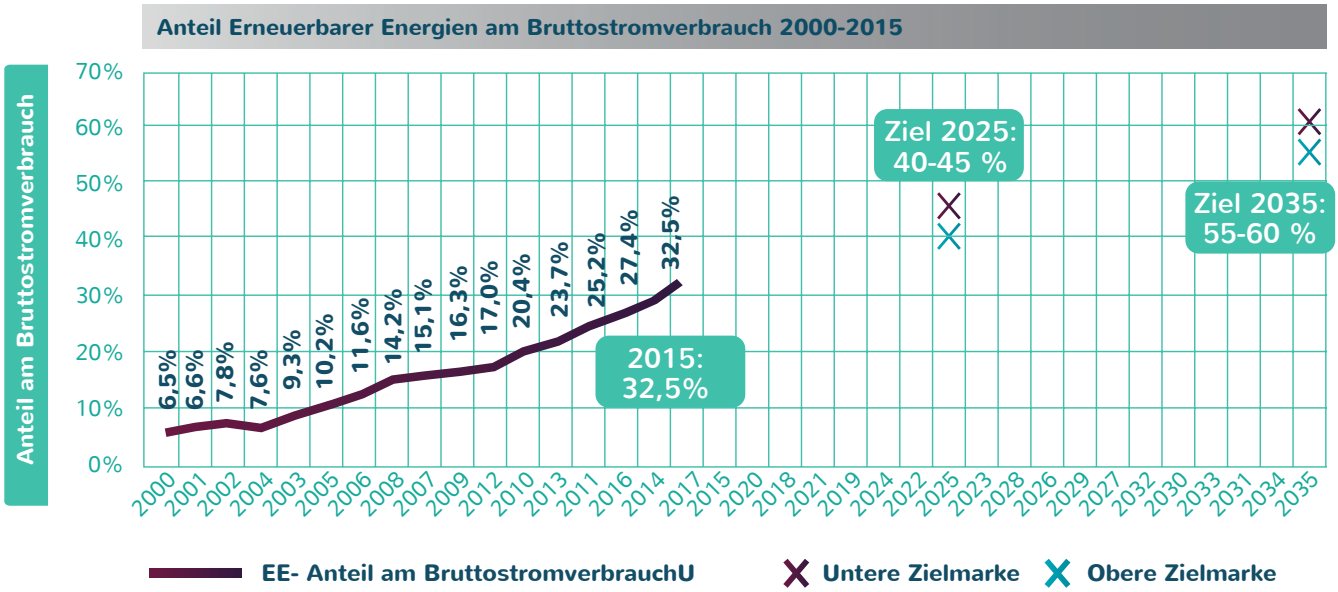
generated by fossil fuels, and by distorting investment away from renewable energies. The distributional impacts of this imbalance are also significant, as testified by a recent IMF report that suggests that the benefits of subsidised energy prices are mostly captured by the wealthiest parts of the population.[43]

Why are fossil fuel subsidies not being fully phased out in EU member states? There are several concurring reasons, which include direct involvement of governments in coal production, the need to maintain employment in energy- and carbon-intensive industries, and trade policy reasons (export credits allow European countries to export coal technologies also outside the EU). The two most telling examples are provided by Germany and Poland.

While Germany has decommissioned nuclear plants (after the Fukushima-daichi disaster in Japan) and gradually moved towards an increase in the use of renewables, including wind and solar, there has been no parallel reduction in fossil fuels consumption. The government still contributes approximately three billion euros a year to the industry, mainly to keep German coal competitive to imported coal. This support will be phased out by 2018 because of EU regulations. Germany also gives energy tax relief for energy-intensive processes, does not require mining companies to pay a royalty fee, rehabilitates lignite mining sites in East Germany and pays for early retirement for miners. The current government plans to spend hundreds of millions of euros in capacity payments for lignite power plants – a plan which has sparked controversy and could be challenged by the European Commission. A recent report by Mark Lewis for Barclays concluded that the 46,000MW of black and brown coal fired generation currently in service in Germany will be worthless in little more than a decade if the country adopts the targets embraced at the Paris climate change conference. Coal fired power generation (without carbon capture and storage, but which in any event is considered problematic by many analysts) would have to be almost completely eliminated by 2030 in a scenario that would require a substantial carbon price (€45/t) and the end to the current energy market design. Importantly, this analysis also implicitly points to possible short-termism in deciding how to approach the energy transition path: in Germany, under current policies, total generation will reduce by 15% under energy efficiency measures and its target for 50% renewables; to meet the emissions goals, however, that remaining fossil fuel generation will have to come nearly exclusively from gas-fired generation, exactly the risk that Sachs (2015) denounced after Paris, which could jeopardise what he calls "Deep decarbonisation" after 2030.

[42]See http://ec.europa.eu/economy_finance/publications/economic_briefs/2015/pdf/eb40_en.pdf
[43]See IMF (2013), Energy Subsidies Reforms: Lessons and Implications, at https://www.imf.org/external/np/pp/eng/2013/012813.pdf

Figure 8 - The renewables share in German consumption (goals for 2025 and 2035)[44]



Source: Agora Energiewende (2016): Die Energiewende im Stromsektor: Stand der Dinge 2015. Rückblick auf die wesentlichen Entwicklungen sowie Ausblick auf 2016.

As argued in a recent report (Kucera, 2016), one explanation for Germany's continued support for coal is its record exports of coal surpluses to other countries, including most notably Austria, the Netherlands, France and Switzerland. In overall economic terms, the German commercial surplus, also for coal exports, seems to have become too big to be ignored. And if countries like Austria keep closing fossil fuel plants and shift to renewable energy, it is equally true that they import high-carbon, low-price electricity from Germany, which puts the sustainability of domestic plants (including, most notably, gas-fuelled plants) at risk.[44]

In Poland, the government is heavily involved in the coal industry in terms of co-ownership. Indeed, the Silesia region – partly in Poland, partly in the Czech Republic – has more working coal miners than the rest of the EU combined. From 1990 to 2012, the Polish government handed out about 16.8 billion euros in subsidies for the coal energy sector. The lion's share of coal subsidies go to state-owned firms like PGE, Tauron, Energa and Enea. All these utilities receive free emission allowances under the EU's Emission Trading Scheme. Poland uses all types of subsidies to boost the coal sector. Plants are being kept open in case there is peak demand. There is also generous support for plants that co-fire coal with small shares of biomass.

There is no apparent lack of will by the European Commission to accelerate the phasing out of fossil fuels, and in particular coal. As a matter of fact, coal emissions rose 6% from 2010-13, despite massive investment in renewables and electricity demand falling. In 2013, coal emissions alone contributed to 18% of total EU CO_2 emissions, which is as much as the road transport sector alone[45]. The problem seems even more circumscribed,

[44]http://www.energypost.eu/german-conundrum-renewables-break-records-coal-refuses-go-away/
[45]Ibid.

since Germany, UK and Poland are responsible for 66% of coal based emissions, and also responsible for the entire 6% EU increase since 2010. However, and relatedly, the past few years have shown that this endeavour is an uphill battle due to the reluctance of large Member States that, heavily affected by the crisis, are in no position to accept what they consider to be further reductions in employment and increases in energy prices.

In February 2015, EU member states committed to provide "biennial reports on energy prices, with an in-depth analysis of the role of taxes, levies and subsidies, in order to create more transparency on energy costs and prices". But the subsidies element has since been dropped. Governments are now just committed to "greater transparency in the composition of energy costs and prices by means of appropriate monitoring".[46] During the same period, the European Commission has taken steps to actively encourage member states to phase out fossil fuel subsidies and even tried to use the European Semester's recommendations to mandate that 11 member states be asked to tackle their fossil fuel subsidies. Yet all 11 draft recommendations were dropped from the final text issued by the Commission itself. The stated reason was that the issue of fossil fuel subsidies would not be tackled by the Energy Union package.
The OECD has been seeking a compromise on coal export credits for more than a year and has described the phase-out of fossil fuel subsidies as "alarmingly slow".[47] Without a clear shift of gear, the EU will be responsible (together with other countries, such as Australia, Canada, Japan, the US) for the failure of this crucial goal.

2.1.1.2 Example 2: Why tax labour and not carbon?

In order to incentivise the maintenance of high levels of employment, we need to stop taxing labour and start taxing the carbon footprint and pollution, as long advocated by Herman Daly and other ecological economists (Lawn 2004a, 2004b, 2006; see also Ashford, Hall and Ashford, 2012). The practice of exacting transfer payments on a per worker basis is a disincentive to increase employment. Alternatives such as taxes on sales, profits, dividends, or retained earnings etc. should be considered. Taxing carbon in lieu of taxing labour would be revenue neutral (see Ashford et al. 2012). See two recent reports focusing on shifting the tax basis from labour to environment and energy: Wijkman and Skanberg (undated); Farid et al., (2016).

An IMF staff discussion note (Farid et al., 2016, p.23) reports:

> in 2012, out of €5 trillion in tax revenue in the EU member states, over 50% was derived from labour taxes and social contributions, almost 30% in consumption taxes and the remaining 20% was based on capital. Only 6% of tax revenues consisted of environmental taxes, mainly on energy and transport as part of consumption taxes.

[46]See Jones, D. and B. Worthington (2014), Europe's Failure to Tackle Coal, Sandbag.
[47]https://euobserver.com/opinion/129036

2.1.2 Type 2. Incomplete or non-existent policies

In other cases, the misalignment between EU policy and long-term decarbonisation goals could be attributed to inaction, rather than to inconsistent action. Such inaction can be related either to the complete lack of policy initiatives with respect to a specific policy issue; or to the absence of individual rules addressing a specific problem within an existing policy framework.

2.1.2.1 Example 1: Exempting aviation and shipping from ETS emissions limits

According to a scientific study published recently by the European Parliament Research Service, if left unaddressed, aviation and shipping could account for almost 40% of the world's CO_2 emissions in 2050. Such growth will render the Paris goal of limiting temperature increases to 1.5/2°C unachievable. Also, a letter sent to the Commission by the heads of seven political groups of the European Parliament's environment committee demanded greater climate ambition at both ICAO and IMO, the UN bodies charged with regulating emissions from aircraft and ships respectively. The letter states that "there is no reasonable excuse to continue exempting aviation and shipping from the international and EU climate policies."[49] Aviation accounts for about 5% of global warming, and CO_2 from shipping is some 3% of the global total. These sectors have CO_2 impacts on a par with the UK and Germany, respectively, and are continuing to grow rapidly.

The European Commission has so far simply referred to the evolution of the international debate. Likewise, documents circulated by the Dutch Presidency of the EU to Ministers in advance of the meeting appear to delegate to international governmental organisations (UN bodies) the solution to the problem of international transport emissions. This is possibly too optimistic, since both ICAO and IMO have not been very active in this field since Kyoto, and there is no evidence that they plan to take more leadership and responsibility, even after the Paris accords. As regards aviation covered by ETS and international emissions outside the EU 2030 targets, for aviation International Civil Aviation Organization (ICAO) is developing a global market-based measure to address emissions from aviation, including an approach to assess lifecycle emissions from alternative fuels. It will decide on its implementation at the 39th Session of the ICAO Assembly in September 2016. In addition, the ICAO is working on a CO_2 standard for aircraft, due to be adopted in 2016. For shipping the EU has put in place a monitoring, reporting and verification regime. The development of a global monitoring, reporting and verification system under the International Maritime Organisation is being pursued, with the expectation that it could be adopted in 2016. In such a case, as specified in the EU Regulation, a revision would need to be considered.

[48]OECD (2015), OECD Companion to the Inventory of Support Measures for Fossil Fuels 2015, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264239616-en

2.1.2.2 Example 2: Energy efficiency of existing buildings

One key example of incomplete legislation is provided by rules on the **energy efficiency of buildings**. The European Commission acknowledged that the potential contribution of this policy area is huge: **households are responsible for 32% of greenhouse gas emissions and 42% of energy consumption in Europe.** In the Staff Working Document on "Better regulation for innovation-driven investment" the European Commission observes that "improved efficiency in buildings could cut Europe's total energy use by over 20%, reduce energy bills by EURO 70 billion and reduce CO_2 emissions by 460 million tonnes a year". In this area, the most relevant pieces of legislation are the Energy Performance of Buildings Directive (2010/31/UE) recast, the Construction Products Regulation (305/2011), the Energy Efficiency Directive (2012/27/UE), products regulation such as the Eco-Design Directive (2009/125/EC) and the Energy Labelling Directive (2010/30/EU). All these pieces of legislation are under review with different timeframes; the construction products regulation review being was due before the summer of 2016.

Europe's stock of buildings seems to be renovated at a very slow (insufficient) pace, however, and experts predict that already-existing buildings will account for as much as 70% of the building stock in 2050. Accordingly, while there is much to do on new buildings (also since the Energy Performance of Buildings Directive and the Energy Efficiency Directives appear to be too flexible and insufficiently oriented towards use of new materials, let alone insufficiently enforced and monitored),[50] the biggest challenge is how to improve the energy performance of the existing building stock. Ad hoc policy intervention aimed at stimulating 'deep renovations' might thus be needed to achieve the potential of this sector to contribute to decarbonisation goals. A recent BPIE report (2015) for the German market argues that over half of the potential for energy savings and investments is currently untapped, and that a combination of (mostly supply-side) instruments (feed-in tariffs for saved energy, conditional on achieving an ambitious level of energy saving; tax incentives; carbon pricing leading to higher energy prices; higher taxation of energy used in buildings, e.g., for heating oil;[51] financial support; etc.) could contribute to unleashing that potential.[52] In addition, specific technologies such as 'deep energy retrofits' seem to hold a great

[49]See https://www.transportenvironment.org/sites/te/files/2016_04_Coordinators_letter_Dutch_presidency_shipping_aviation.pdf.

[50]Zgajewski (2015). Member States' unwillingness to timely and properly transpose and implement the Directives continues despite the high degree of flexibility permitted. The decentralized approach chosen for some specific aspects and the differentiation in the application of EPBD standards between Member States do not appear optimal either. Adequate financial schemes remain rare. The permanent deficit of qualified and trained personnel and the inertia of public authorities to make the public understand the stakes in this domain remain problematic. Hence the need to take new initiatives to reap the benefits that the building sector is meant to bring" See http://www.egmontinstitute.be/wp-content/uploads/2015/04/ep78.pdf

[51]For example, the six cent/litre tax rate on heating oil in Germany is considerably below the EU average of 18 cents/litre. Indeed, seven Member States have a rate that is over 30 cents/litre

[52]http://bpie.eu/wp-content/uploads/2016/02/BPIE_Renovating-Germany-s-Building-Stock-_EN_09.pdf

[53]http://iet.jrc.ec.europa.eu/energyefficiency/node/9096; Read more: http://www.youris.com/Energy/Ecodesign/Building-Retrofits-Critical-To-EuropeS-Low-Carbon-Pathway.kl#ixzz45pGKS3PN

[54]Horizon 2020 and Intelligent Energy Europe projects are backing the new heating and cooling strategy of the European Commission by providing support for market uptake of energy efficient and renewable heating and cooling. A newly published review provides an overview of the projects supported by the EASME in these areas. https://ec.europa.eu/easme/sites/easme-site/files/heating_and_cooling_projects_market_uptake_activities.pdf

potential for speeding up the energy efficiency of European buildings, leading to near-zero emissions in the coming decades.[53] These instruments, coupled with demand-side policies aimed at reducing consumption of energy and incentivising the purchase of highly energy-efficient products, appear to be decisive, despite the significant number of other research and innovation projects already launched at the EU level to boost the uptake of new energy efficient technologies.[54] Other technologies that might prove important, if adequately supported by policy measures, include bio-based materials (a cheaper and more energy-efficient alternative to traditional insulations).[55] The launch, on 5 April 2016, of the European Commission Joint Research Centre's European Energy Efficiency Platform is a good starting point for scaling up efforts and synergies between technologies and policy instruments.[56] Once again, regulation can play a key role in ensuring the diffusion of these important innovations.

2.1.3 Type 3. Insufficient stringency

A third type of misalignment that deserves attention at the EU level refers to all those policies that, although potentially in line with decarbonisation goals, are insufficiently stringent, i.e., do not provide, for lack of adequate implementation of badly selected targets, proper incentives to regulated stakeholders to adopt the necessary changes within a reasonable timeframe. We offer here two examples of insufficiently stringent rules, corresponding to different underlying reasons: the ETS appears to lack stringency due to its inability to send credible price signals that drive low-carbon technologies that will enable the deep decarbonisation of the EU economy to the market; air quality rules appear insufficiently stringent in that they set targets that are not ambitious enough to be considered in line with long-term decarbonisation goals.

[51]For example, the six cent/litre tax rate on heating oil in Germany is considerably below the EU average of 18 cents/litre. Indeed, seven Member States have a rate that is over 30 cents/litre

[52]http://bpie.eu/wp-content/uploads/2016/02/BPIE_Renovating-Germany-s-Building-Stock-_EN_09.pdf

[53]http://iet.jrc.ec.europa.eu/energyefficiency/node/9096; Read more: http://www.youris.com/Energy/Ecodesign/Building-Retrofits-Critical-To-EuropeS-Low-Carbon-Pathway.kl#ixzz45pGKS3PN

[54]Horizon 2020 and Intelligent Energy Europe projects are backing the new heating and cooling strategy of the European Commission by providing support for market uptake of energy efficient and renewable heating and cooling. A newly published review provides an overview of the projects supported by the EASME in these areas. https://ec.europa.eu/easme/sites/easme-site/files/heating_and_cooling_projects_market_uptake_activities.pdf

[55]Researchers in the ISOBIO project are developing a new approach to insulating materials, through the combination of existing bio-derived aggregates with low embodied carbon and innovative binders to produce durable composite construction materials. With these novel composites, the aim is to cut embodied energy and carbon dioxide at component level by 50%, and to improve insulation properties by 20% compared to conventional material. The study will also seek to demonstrate a reduction in total costs by 15% and in the total energy spent over the life time of a building by 5%.

[56]The core features of the E3P are four mutually reinforcing collaborative tools: the Data Hub, the wikEE, the Community and the Calls. The information collected in the E3P is organised around six thematic areas, including Buildings; addressing policies, technologies, and financing for deep renovation, Near Zero Energy Buildings and districts. Users are invited to provide content on such items at their earliest convenience and by December 2016.

2.1.3.1 Example 1: The EU Emissions Trading System

The EU ETS is a cap-and-trade system first implemented in 2005 to provide a cost-effective tool to reach the greenhouse gas (GHG) targets the EU had committed to. The legislation setting up the ETS is Directive 2003/87/EC of the European Parliament and the Council establishing a scheme for GHG emission allowance trading within the Community (hereinafter the ETS Directive) and its amendments.[57] The EU ETS was extended to the non-EU members of the European Economic Area (Liechtenstein, Norway and Iceland) in 2007. The EU ETS compliance is managed at the installation level. More than 11,000 installations are covered by the scheme. Each year, each installation must surrender a number of emission permits equal to its emissions during the past year. European Union Allowances (EUAs) are compliance units that represent one tonne of CO_2-equivalent emissions. Other units that can be used to comply with this provision are Emissions Reduction Units (ERUs) from Joint Implementation projects and Certified Emission Reductions (CERs) from Clean Development Mechanism projects.

The total cap for emissions is equal to the total amount of EUAs made available each year through free allocation or auctioning. Underneath that cap, market participants, including covered installations, are free to trade. The total cap for installations covered by the EU ETS was set to decrease every year by 1.74%, now increased to 2.2% for the post-2020 phase.

The EU ETS is now in its third phase. The characteristics of these different phases are discussed below. Given their different characteristics, each phase has different impacts on the EU economy. During the first phase (2005-07), which was a pilot phase, caps were set at the national level through the National Allocation Plans (NAPs), which had to be approved by the European Commission. A maximum of 5% of the allowances could be auctioned; the rest was allocated free of charge on the basis of estimates of historical emissions. Due to a lack of good quality data and no banking provisions between phases,[58] this resulted in a sizable over-supply of EUAs, driving prices close to zero at the end of the phase. Despite being a pilot phase, phase 1 resulted in significant outcomes. A price for carbon was established. It also helped create the necessary infrastructure for future phases: at the installation level this included monitoring, reporting and verification (MRV); while in the marketplace National Registries, the Community Independent Transaction Log and carbon exchanges were founded.

In phase 2 (2008-12), allocation was granted on the basis of the reported emissions in the first phase. This grandfathering process was considered fit to solve the problem of over-supply observed in phase 1. But the economic crisis had a clear impact and substantially decreased emissions in phase 2. The European Commission estimates that between 1.5 and 2 billion EUAs were carried over to phase 3.[59] The amount of allowances that could be auctioned was also increased, to a maximum of 10% of the total.

[57]Amending acts were as follows: i) Directive 2004/101/EC of the European Parliament and of the Council; ii) Directive 2008/101/EC of the European Parliament and of the Council; iii) Regulation (EC) No 219/2009 of the European Parliament and of the Council; and iv) Directive 2009/29/EC of the European Parliament and of the Council. The latter act is the most relevant, as it introduces the third phase of the emissions trading scheme.
[58]Meaning that EUAs from Phase 1 could not be carried over to Phase 2.
[59]Report from the Commission, The state of the European carbon market in 2012, 14.11.2012, COM (2012)652.

The functioning of the ETS saw some significant changes at the start of the third phase (2013-20). Auctioning was increased, and more than 40% of all allowances can be auctioned (including full auctioning for the power sector). Energy-intensive industries continued to receive a large part of their needed allowances for free, and have to buy any shortfall at auctions or in the market (as was the case during phases 1 and 2). Allocation to energy-intensive industries is largely determined by using benchmarks,[60] established per product, according to Decision 2011/27/EU.[61] The average carbon-intensity of the 10% best performers represents the benchmark for allocating free emissions. Those installations that meet the benchmark receive a greater percentage of free allowances than those that do not. The latter are thereby incentivised to catch up to their best-performing peers. This approach also rewards early action by industry towards reducing emissions. Free allocation is granted at the 80% level of the benchmark, a share which is set to decrease to 30% in 2020 for sectors not deemed exposed to the risk of carbon leakage, and which are listed in the carbon leakage Decision.[62] These installations received free allowances at 100% of their benchmarks.

As a result of the lessons learned in phases 1 and 2, several important EU ETS functions have been centralised in phase 3. Member states' registries were incorporated in the EU registry, and allocation is harmonised at EU level. Electric utilities now have to effectively buy all their allowances linked to electricity production; additional measures have been included to compensate energy-intensive industries, especially those exposed to international competition. This is based on ETS Directive Art. 10a.6, which allows member states to compensate for the indirect costs of emissions passed through electricity prices. Not all countries can afford it, however, so indirect costs are not always compensated.

The ETS legislation is a fundamental cornerstone of the EU decarbonisation strategy. By placing a price on carbon, it is expected to deliver those price signals that would reorient the market towards renewable energies. But its main problems today include the excessively low price it generated for EUAs, and the still-too-long list of exemptions granted to carbon-intensive, energy-hungry industries.[63]

- **The price of allowances is far too low**. For what concerns the price of emission allowances, the current levels are as low as 4 euros per tonne. This is interesting if one considers that a recent impact assessment by the European Commission reported that the main driver for a 40% CO_2 emissions cut will be a €40 a tonne carbon price by 2030, which will rise to €264 a tonne by 2050. It is unclear how these prices will be achieved.[64] The rapporteur for the ETS reform for the European Parliament, Ian Duncan MEP, recently observed that "clearly, something has to change, if the ETS is to be a driver of low carbon innovation within the industries that emit carbon".[65] He also

[59]Report from the Commission, The state of the European carbon market in 2012, 14.11.2012, COM (2012)652.
[60]The setting of benchmarks for industry is discussed in Methodology for the free allocation of emission allowances in the EU ETS post 2012. The full study commissioned by the European Commission to Ecofys (project leader); Fraunhofer Institute for Systems and Innovation Research; and Öko-Institut is available at http://ec.europa.eu/clima/policies/ets/allowances/docs/bm_study-project_approach_and_general_issues_en.pdf
[61]Commission Decision determining transitional Union-wide rules for harmonised free allocation of emission allowances pursuant to Article 10a of Directive 2003/87/EC of the European Parliament and of the Council (2011/278/EU)
[62]Commission Decision determining, pursuant to Directive 2003/87/EC a list of sectors and subsectors which are deemed to be exposed to a significant risk of carbon leakage (2010/2/EU).
[63]See Andrei Marcu, Milan Elkerbout and Wijnand Stoefs, "The State of the EU ETS - 2016", Report of the CEPS Carbon Market Forum, February 2016 (www.ceps-ech.eu/publication/2016-state-eu-ets-report).
[64]See http://www.euractiv.com/section/energy/news/building-efficiency-sector-the-2030-debate-was-a-set-up/
[65]http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2015/swd_2015_0135_en.pdf

highlighted that the European Commission ultimately decided not to incorporate the targets set in the Paris accords in the ETS reform, despite explicit requests by countries like the UK, Germany, and France, and triggering a vibrant protest by Germany, Austria, Portugal and Luxembourg among others, whereas countries like Hungary, Lithuania and Italy opposed the adoption of more ambitious targets.[66]

- **ETS seems to have led to emissions reduction mostly determined by operational changes such as fuel switching, which is of limited use for long-term decarbonisation.** Delarue et al. (2008) estimate that fuel switching has the potential to reduce emissions by up to 300 million tonnes annually, which is no more than one-tenth of what is needed to meet the EU target to cut emissions by 80% by 2050 against 1990 levels. (see Calel and Dechezleprêtre, 2016) In addition to the evidence on fuel switching, a growing literature of case studies and expert interviews indicates that rather than developing new technologies, firms have been introducing well-known technological solutions that had simply not been economically viable without the EU ETS carbon price (Petsonk & Cozijnsen, 2007; Tomás et al., 2010).[67] Calel and Dechezleprêtre (2016) estimate, by using difference-in-difference analysis on a sample of ETS-regulated and control group of non-regulated firms, that only 2% of the observable post-2005 surge in low-carbon patenting can be attributed to the EU ETS, and that the latter so far "has had at best a very limited impact on the overall pace and direction of technological change". The authors conclude that "in its current form, the EU ETS may not be providing incentives for low-carbon technological change on a large scale".[68]

- **The impact of ETS reform could be targeted more effectively.** A 'tiered approach' to the carbon list was proposed by both France and the UK with a view to better focusing allowances among industry. France also proposed a 'price floor', and a 'corridor', which outlines a minimum price below which the carbon price cannot fall. The UK already adopted a carbon price floor in its domestic legislation. On the process of allocation, there is widespread acknowledgement that better alignment of allowances to actual production would reward innovators and help keep us within our carbon budget.[69]

- **Need to make the most out of the innovation fund.** Consisting of 450 million allowances, the innovation fund is open to industry to help new and first of a kind technology come to fruition. But a recent CEPS report that evaluates the ETS (Marcu, Elkerbout & Stoef, 2016) warns that "at current EUA price levels, the Innovation Fund of 450 million tons will have at its disposal significantly fewer resources than anticipated", and that "under these circumstances the direct impact of the EU ETS, and its power to drive change, is marginal at best".[70]

[66]http://www.climatechangenews.com/2016/03/04/germany-austria-call-for-higher-eu-2030-climate-ambition/
[67]Martin et al. (2011) conducted interviews with nearly 800 European manufacturing firms, of which almost 450 fell under EU ETS regulations. Using their interview-based measure of innovation, they find a positive effect of the expected future stringency of EU ETS.
[68]Calel and Dechezleprêtre 2016, at 174.
[69]At the same time, proportionality is of the essence. As Duncan recalls, "Nearly three-quarters of the 11,500 individual installations covered by the ETS collectively emit only five per cent of the total emissions. Subjecting these small installations - which include hospitals, distilleries and brickworks - to the same rules and the same costs as large emitters is disproportionate. Serious consideration needs to be given to the exclusion clause for small emitters".
[70]Andrei Marcu, Milan Elkerbout and Wijnand Stoefs, "The State of the EU ETS - 2016", Report of the CEPS Carbon Market Forum, February 2016 (www.ceps-ech.eu/publication/2016-state-eu-ets-report).

In terms of timing, during 2016 the Commission will present the key remaining legislative proposals to implement the agreed 2030 regulatory framework; to set up a reliable and transparent governance mechanism and streamline the planning and reporting requirements related to climate and energy for the post-2020 period. The Parliament will work on the proposed revision of the ETS between April and December 2016, with the aim to vote by 8 December in the environment committee.

All in all, the overall impression is that **the ETS, alone and under current conditions, will not trigger the innovation investment needed in a number of sectors to achieve decarbonisation goals.** Even if the ETS were perfectly finetuned to present a credible carbon price signal in the industries affected, the high risk and uncertainties related to the investment needed, and the resistance of incumbents and specific national governments potentially create almost insurmountable obstacles, especially if complementary policies are not put in place.

2.1.3.2 Example 2: Air quality rules

Within air quality rules, the three most important pieces of EU legislation for the purposes of our report are the LCPD (Large Combustion Plants Directive); the NEC (National Emission Ceilings) Directive; and the Industrial Emissions Directive (IED). This legislation could benefit from more stringent standards, for the following reasons:

- The **LCPD** gave power stations a choice to a) comply by installing flue gas desulphurisation, or b) opt-out and limit generation 2008-15, closing by Dec-2015. This led to about 35GW of power station closures across Europe, but much of this was low-load factor plant, and often back-up oil plant. A recent report by Sandbag estimates that opted-out LCPD power stations reduced their total emissions by 5% from 2008 to 2013. However, total coal emission from 2008-13 fell by only 3%, meaning that remaining coal power stations increased their emissions. LCPD opted-out power stations continued to contribute 3% of coal emissions in 2013. They must stop generating by 2016, but there is no certainty that this necessarily ensures a drop in total EU coal emissions.
- The long-awaited revision of the **National Emission Ceilings (NEC)** comes with very weak targets for 2020. The EEB (2015) claims that emission levels proposed are even less ambitious than those under a business-as-usual scenario, i.e., levels that EU member states will achieve anyway merely by implementing their obligations under existing EU and national legislation. For 2025, no legally binding targets are proposed, which will result in further delays to cut air pollution. The 2030 targets are not only too late they are also far from sufficient to achieve the EU's air quality objectives as set out in the 7th Environment Action Programmes (EAP). Moreover, the Commission missed the opportunity to include NEC emission reduction commitments for mercury, despite the recent Minamata Convention.

- The introduction of EU-wide standards for **medium scale combustion plants** was also criticised for setting too weak standards. The emission limit values (ELVs) proposed by the European Commission are extremely weak compared to levels that could be achieved by the use of best available techniques (BAT) and also compared to some member states' existing national legislation. The compliance deadlines are also way too late if member states are to meet air quality standards and targets in the shortest timeframe possible. Not to mention the number of derogations proposed by some member states (e.g., upfront exclusion of MCPs located on islands, exemptions for refineries, crematoria, district heating plants bigger than 5MWth or plants with a limited remaining life time).

- The impact of the revision of the **Industrial Emissions Directive** in 2016 is also under the spotlight.[71] The new Industrial Emissions Directive (IED), as originally proposed by the European Commission, and largely endorsed by the European Parliament, sought to tighten further the emission limit values for SO2 and to remove some of the flexibilities for achieving NOx reduction by reduced running and by trading emissions permits. This would certainly have forced further power station closures from 2016, and it raised serious security of supply concerns in the UK, Poland and several other countries in Eastern Europe. But no coal power stations have announced closure due to IED, and the IED allows many coal plants to stay open if they comply with cheaper compliance techniques. Expectations are that many coal power stations will invest to stay open, which creates a high-carbon lock-in into the 2030s.[72] This situation is made more serious by the relative lack of stringency of the limit imposed on NOx emissions (200mg/Ncm): the European Commission is trying to reduce the limit to 80mg, but it is unclear whether this will occur. Moreover, concerns have been raised that the scheme put in place to gradually update the BAT reference documents (BREFs), the so-called 'Seville process', is incorporating in the decision-making process incumbency interests, due to the large presence of industry players in the Technical Working Group.[73] In a recent report, Greenpeace observed that seven delegations (Poland, the Czech Republic, Greece, Germany, France, the UK and Spain) are responsible for the vast majority of comments seeking to further weaken the limits.

[71]The IED is a recast of 7 previous directives (Integrated Pollution Prevention and Control Directive 2008/1/EC – Large Combustion Plants Directive 2001/80/EC – Waste Incineration Directive 2000/76/EC – etc.) and regulates different industrial activities in the EU with the aim of preventing/reducing "emissions into air, water and land and to prevent the generation of waste, in order to achieve a high level of protection of the environment as a whole" (IED, art.1)

[72]The intention of IED was to require all power stations to install selective catalytic reduction (SCR) on all coal power stations by 2016, which reduces NOx levels by about 90%. Power stations that chose not to do this had to run limited hours and close by 2023. However, two things suggest this won't happen as envisaged: First, many flexibilities were negotiated by industry and implementation has effectively been delayed by 4½ years. The EC introduced the concept of a "transition plan" for key countries, where full compliance is delayed until mid-2020. Second, cheaper NOx abatement techniques have since become available, allowing a wide range of compliance options. These do not abate NOx by the same levels, but they enable power stations to comply more cheaply and still operate high load factors. The IED limit imposed on NOx emissions is relatively high – a limit of 200mg/Ncm, when 80mg is possible if SCR is fitted. The EC is currently trying to reduce the limit to 80mg for a future date, but this decision is subject to aggressive lobbying by utilities and may not be introduced for many years. The net effect of how the IED is now being complied with means more coal power stations will be able to remain open at relatively high load factors. Far fewer coal stations are likely to close than might have been first anticipated.

[73]See page 28 at http://www.greenpeace.org/eu-unit/Global/eu-unit/reports-briefings/2015/Smoke%20and%20Mirror%20final%20report.pdf

2.1.4 Type 4. Lack of effectiveness due to problems of implementation, monitoring and enforcement

Some rules can also be imperfectly aligned with long-term goals because, however stringent and potentially oriented towards such goals, they either adopt a suboptimal timeframe for compliance, or fail to generate a timely reaction by market forces. In addition, some pieces of legislation, however well designed, fall short of being monitored and implemented effectively. Lack of effective monitoring and implementation can jeopardise the effectiveness of existing policies, just as bad regulatory design or misalignment between the direction of a policy intervention and the overarching policy goals.

The most straightforward example is certainly the legislation on car and light duty vehicles emissions, which was recently subject to ex post evaluation in mid-2015, right before the Volkswagen scandal erupted. The ex post evaluation of the Regulations 443/2009 and 510/2011 on CO_2 emissions from light-duty vehicles, however formally elegant, did not include a thorough on-field analysis of the actual compliance behaviour, and ended up only briefly mentioning that there could potentially be a difference between test results and actual emission levels on the road. That divergence ended up being huge, mostly due to the easy manipulation of the test results based on the NEDC model. In a typical NEDC test, cars would go through two test cycles, urban and extra-urban, which together would take around 20 min (11 km). There is no simulation of prolonged motorway driving, the top speed achieved is between 90 and 120kph, and car manufacturers often use optimal settings to improve performance, such as a bare minimum of fuel and switching off air conditioning, removing side-mirrors, taping over any crevices (such as car doors) to reduce drag, top-charging batteries, or driving on unrealistically smooth roads. In addition, manufacturers are allowed to reduce 4% of measured consumption. The weakness of this test was apparently reinforced by the lack of third-party supervision and the cooperation of corrupted authorities. As a result, the credibility of CO_2 emission reductions achieved in the car sector is very limited today. According to recent studies, in 2002 cars performed 10% better under laboratory tests measuring CO_2 emissions than in the real world. By 2010, the gap had reached 24% and rose again to 35% in 2014. The widening gap can be attributed to car-makers improving their skills at cheating the system more than focusing on improving car engines. A T&E report found that on average two-thirds of the claimed gains in CO_2 emissions and fuel consumption since 2008 have been delivered through test manipulations.

Other examples from the same area include energy labels and the Directive on the energy performance of buildings:

- When it comes to energy labels the current solutions adopted at the EU level appear at once outdated (leading to a concentration of products in the higher classes, and empty bottom classes) and ineffective (leading to low consumer willingness to pay for higher energy classes.[74]
- Moreover, the **Directive on the energy performance of buildings** requires member states to establish a system for certification of the energy performance of buildings. However, only buildings owned by public authorities and those frequently visited by the public and with a floor area exceeding 500m^2 are required to actually display the certificate. For non-domestic buildings, the Directive requires that a common, voluntary scheme of certification be established.[75] One European project, IDEAL-EPBD (2013), looked into the effectiveness of energy performance certificates (EPCs) in influencing homeowners' decisions with regard to energy efficiency. The final report indicated that homeowners are generally not aware of the EPC and its recommendations, but that if they were, they would be likely to undertake energy efficiency measures compared to homeowners that do not have an EPC.[76]

2.2 Innovation policy in the EU: towards a more systemic, simple and socially relevant agenda

Needless to say, research and innovation policies in the European Union can play a very important role in generating technological breakthroughs and contributing to the long-term decarbonisation agenda. And as a matter of fact, there has been no shortage of initiatives in this respect at the EU level: to the contrary, the EU's anxiety when it comes to the so-called 'innovation emergency' has led to a proliferation of initiatives that today portrays a rather confusing picture of where most important research efforts are.[77] Today, there is a need for consolidation of the various communities and spaces offered by the EU: Research Infrastructures, Knowledge and Innovation Communities (KICs), European Innovation Partnerships (EIPs), Joint Technology Initiatives (JTIs), and many more. Likewise, the governance of innovation policy at the institutional level should be simplified to enable seamless communication between the research and innovation community and the policy community. Within this context, a recent CEPS Task Force on Innovation and Entrepreneurship (2016) proposed a '3S' framework for EU innovation policy, aimed at making it:

[74]https://ec.europa.eu/energy/sites/ener/files/documents/Impact%20of%20energy%20labels%20on%20consumer%20behaviour.pdf and http://www.energylabelevaluation.eu/tmce/Background_document_IV_-_first_findings_comments.pdf

[75]Currently, certification schemes of buildings around Europe are examining a wider range of issues than just energy performance. Examples are the BRE Environmental Assessment Method (BREEAM) (United Kingdom), the Deutsches Gütesiegel Nachhaltiges Bauen (DGNB) (Germany), the Haute Qualité Environnementale (HQE) (France), VERDE (Spain) and others.

[76]C Tigchelaar, J., C. Backhaus, M. de Best-Waldhober (2011),

[77]In contrast, the U.S. innovation strategy appears more consistent and focused on a limited number of societal challenges See Renda (2016), forthcoming report for DG R&I, RISE Group.

- **Socially relevant.** Since entrepreneurship and innovation are means, not ultimate policy goals, innovation and entrepreneurship policy should seek to incentivise those entrepreneurial ventures and innovation efforts that help address the outstanding societal challenges that Europe faces, including most notably decarbonisation. In this respect, socially relevant can be understood also as 'challenge-led'.

- **Systemic.** As previously stated, innovation is broader than industrial R&D, and includes other forms, such as social and user innovation, and new business models are just as important when it comes to addressing Europe's thirst for new solutions to outstanding challenges. This variety should also be reflected in the choice of innovation policy tools and entrepreneurial support schemes.

- **Simple.** Entrepreneurs and innovators do not often have the time and resources to dedicate to complex procedures and administrative requirements; the governance of EU and national innovation and entrepreneurship policies does not often offer the single points of contact and multi-stakeholder platforms that entrepreneurs need to test their ideas and apply for funding, mentoring and support.

In summary, **many emerging societal challenges call on innovation policy to depart form sector-specific industrial policy, and take a more systemic and transformative approach** that crosses sector boundaries. Herein, EU policy should enable experimentation and learning, and avoid creating biases in favour of incumbent business models: this requires the creation of policy instruments for testing new business models and services that can benefit end-users and workers, without lowering protection levels for consumers.

How to achieve this goal should be the main concern of EU policymakers in the coming years, starting from the revision of Horizon 2020 and the governance of EU innovation policy, from its R&D-centric 'innovation policy' today to an enabling and holistic understanding of 'policies for innovation'. In March 2016, the European Commission launched a call for ideas to shape the powers and functions of a prospective European Innovation Council. Commissioner Moedas observed that "Europe lags behind in disruptive innovation and in scaling start-ups into world-beating businesses", and that "a European Innovation Council [EIC] could contribute to solving this problem".[78] Our opinion in this respect is that another EU agency is unlikely to solve the problem of systemic innovation in Europe, unless the overall governance of innovation policy at the EU level is simplified.

A recent CEPS Task Force report on innovation and entrepreneurship (2016) proposed to embed the EIC in a new, simplified governance structure for EU innovation policy, in which two councils (ERC and EIC) would create an interface between science, innovation and policymaking, critically contributing to the shaping of roadmaps and pathways to be integrated into future impact analysis, and highlighting emerging policy problems such as the need to amend legislation to incorporate new technological developments, or encourage efforts in basic or applied research to address long term societal challenges. These two councils would then be complemented by a limited number of agencies (e.g., the EIB

[78]https://ec.europa.eu/research/eic/index.cfm
[79]http://www.vinnova.se/upload/EPiStorePDF/va_15_07_T.pdf

and the EIT), which would be called to launch and orchestrate challenge-led, streamlined platforms where research, development, demonstration are tackled for specific societal challenges in a multi-stakeholder fashion, open to new entrants, new technologies, new business models, and citizens. There would be only one such platform for every emerging societal challenge, with cooperation across platforms in case of overlapping issues. And within this simplified framework, as argued also in a recent report on the role of national research and innovation councils as an instrument of innovation governance (Serger et al., 2015), the added value of the EIC could rest in its ability to orchestrate "systemic action across policy domains": provided that the powers and functions of the EIC are adequately shaped to reach this result.[79]

Last, but not least, the upcoming review of the Horizon 2020 programme will be an important milestone, and an opportunity to strengthen efforts towards sustainable solutions to the deep decarbonisation challenge. The proposed new governance would enable a more coherent and high quality debate on how to achieve this result. This is important, also for the effectiveness of EU innovation policy in and of itself, if one considers that a recent study found that the EU Framework programmes have not directly contributed to major radical innovations (JIIP, 2015), which makes a compelling case for a sea change, and the adoption of more effective, mission-oriented programmes. After so many years and seven editions of the Framework programme, it is also time to embrace a truly EU dimension in national programmes, which still today account for the bulk of the public investment in R&D and is thus fundamental to achieve a higher level of policy coordination beyond collaborative projects. Rather than adding more and more instruments (JPIs, for instance), member states should become more integrated with the pan-European innovation framework in the setting up of their programmes, giving actual preference to networks like COST and Eureka that can then orchestrate coordination and pull together available national means.

2.3 Tapping the potential of the EU Better Regulation agenda

The EU Better Regulation agenda was largely reformed and relaunched in 2002, when the Commission adopted its first better regulation package (Renda 2006, 2011, 2015). That package already introduced a commitment to assess the prospective economic, social and environmental impacts of major new policy initiatives included in the European Commission's yearly legislative work programme, as well as new, more ambitious standards in terms of stakeholder consultation. The main milestones in the evolution of the better regulation system were the Itern-Institutional Agreement on Better Lawmaking, signed by the Commission with the Parliament and the Council in 2003 and later reinforced as the 'Common Approach to Impact Assessment'; the relaunch of the system with stronger emphasis on economic impacts and competitiveness and new, more structured guidelines in 2005; the creation, in 2007, of an Impact Assessment Board in charge of quality assurance within the Commissions' Secretariat General; the launch, during the same year, of the first

pan-European measurement of administrative burdens and the subsequent creation of an ad hoc High Level Group (dismantled by the Juncker Commission); the launch of ex post evaluations and the "evaluate first principle" in October 2010 with the Communication on Smart Regulation; the creation of the European Parliament's IMPA Directorate (later integrated into the EPRS) in 2012; the launch of comprehensive REFIT (regulatory fitness) exercises and cumulative cost assessments in various industry sectors since 2012; and the new better regulation package of May 2015, which marked important changes in the overall organisation of the system.

Within the new package, it is important to mention the creation of a Regulatory Scrutiny Board, which replaced the Impact Assessment Board and is characterised by the presence of three independent members; the expansion of impact assessments into the domain of implementing and delegated acts; the introduction of new forms of consultation (in particular a 12-week consultation on "inception Impact Assessments" for major new proposals, an 8-week consultation after the Commission proposal is finalised and a 4-week consultation for impact assessments on implementing and delegated acts); and a proposed new inter-institutional agreement on better regulation (IIBR), which is being negotiated with the European Parliament and the Council.

The Better Regulation agenda of the EU aims to improve the overall quality of EU legislation, but has so far met with significant obstacles and constraints. These include the lack of clarity on the overall methodology to be adopted in impact assessments (cost-benefit analysis, or multi-criteria analysis); the relatively poor quality of some impact assessments, also due to weak oversight; the lack of compliance, especially on the side of the European Parliament and the Council, with the commitments of the (recently re-launched) Inter-Institutional Agreement on Better Lawmaking; and the widespread lack of familiarity with better regulation in EU member states (see Renda, 2015). In addition, a number of features of the Better Regulation agenda make it less likely to secure coherence with long-term goals such as decarbonisation than might have been the case. Below, we briefly outline these features and constraints. These will be subject to specific policy recommendations in Section 3 below.

2.3.1 Misalignments with decarbonisation in better regulation tools and methods used at EU level

A peculiar feature of the EU better regulation agenda, compared to many other countries and most notably the US, is that impact assessments and ex post evaluations are performed with respect to a variety of instruments, both binding and non-binding, featuring also primary legislation such as cross-cutting, far-reaching EU directives and regulations.[80] This means that, compared to other systems that gauge through policy appraisal the most efficient way to implement existing pieces of legislation adopted by their parliaments,

[80]In the US, only secondary legislation (i.e., federal regulation) is subject to ex ante RIA, limited to economically significant rules.

the European Commission actually uses better regulation to compare alternative policy agendas, and then also their implementation. This is a very important but often neglected feature of the EU system (Renda, 2011).
The feature becomes even more important if one considers that ex ante Impact Assessments typically require the use of cost-benefit analysis. As explained above, in section 1.2.3, the use of cost-benefit analysis does not constitute a perfect match for policies aimed at triggering transformational change and long-term impacts. And if its use for secondary legislation is already controversial, for primary legislation some of the limitations of this methodological approach become too evident to be overlooked. We refer to distributional impacts, long-term impacts, problems related to measuring well-being and sustainability, and general problems related to methodological individualism (Renda, 2011). In many respects, the debate on CBA mirrors, at the macroeconomic level, the debate on GDP as opposed to other measures of prosperity and well-being. Use of CBA is linked, especially for benefit assessment, to measurement of the willingness to pay (wtp) of individuals, and as such takes consumption (especially in the case of revealed preferences) as well as wtp (which often is indeed ability to pay) as an indication of intensity of preferences. This 'bottom-up', often distortionary proxy for social welfare cannot take into account longer-term impacts, especially during times of economic crisis, in which individuals typically have less propensity to focus on the long term, or on future generations. The problem of selecting an appropriate discount rate, especially for benefits, is pervasive and remains unresolved: and indeed there have been cases in which the choice of the discount rate has led to a major battle inside the Commission and among stakeholders, as was the case for the energy efficiency directive.[81] Likewise, the collective action problems that intervention to foster decarbonisation addresses would inevitably be reflected in the limited willingness to pay of individuals to contribute to the low- or zero-carbon economy.

Looking more specifically inside the methods used by the European Commission, the issue becomes even more tangible. The new better regulation guidelines do not even dedicate a section of the toolbox to assessing environmental impacts, while several other impacts (administrative burdens, competitiveness, culture, fundamental rights, SMEs) are specifically addressed. The Commission still recommends a relatively low discount rate of 4% in CBA, but also shows awareness that "discounting at even modest rates (i.e.,4%) reduces the value of costs and benefits effectively to zero over very long time periods" (IA Toolbox, at 377).[82]

All in all, and despite the relative sophistication reached by DG CLIMA in the modelling of impacts, there seems to be little attention to long-term decarbonisation goals in the current EU IA framework. This is also due to the fact that cost-benefit analysis (or 'net benefits' calculation) transforms the ex ante impact assessment into an exercise aimed at identifying the option that maximises neoclassical economic efficiency. When assessing the impacts of primary legislation, however, which typically entail much larger distributional, as well as more long-term impacts, we contend that the focus should rather be placed on the coherence and effectiveness of the proposed alternative options in achieving the EU's medium- and long-term goals. As one of us already wrote on several occasions (Renda

[81]See the ECEEE report "Evaluating our future", 2015, at http://www.eceee.org/policy-areas/discount-rates/evaluating-our-future-report.
[82]See http://www.euractiv.com/section/energy/news/building-efficiency-sector-the-2030-debate-was-a-set-up/

2011, 2014, 2015), linking the better regulation agenda with the Europe 2020 agenda for smart, sustainable and inclusive growth would probably have led to a win-win strategy for both, marking an improvement in the usefulness of ex ante impact assessments (and in their usability by the European Parliament, the Council and national governments), as well as embedding more effectively Europe 2020 within the EU policy process.

Finally, the European Commission often compares alternative policy options on the basis of benefit/cost ratios (or cost-effectiveness analysis), rather than net benefits calculations. These two techniques, normally considered as substitute methods by impact assessment guidelines (including the EU ones), in reality yield very different results. While the technique of cost-effectiveness analysis can be considered preferable to the calculation of net benefits since it avoids the substantial problems created by the monetisation of benefits, the Commission actually uses it to compare monetised costs with monetised benefits, actually defeating its advantages. This can lead the Commission to express preference for more conservative policy options, which entail very small compliance costs compared to the baseline. Suffice it to recall two recent examples: the impact assessment of the Directive on periodic roadworthiness tests (2012), and the impact assessment on the Proposal for a Regulation on Requirements relating to Emission limits and Type-approval for Internal Combustion Engines for Non-road Mobile Machinery (2014). In both cases, the Commission ended up choosing, on the basis of CEA (benefits/costs), an option that would have been discarded under CBA (benefits – costs), with negative consequences for the stringency of the resulting rules. More generally, while using these alternative techniques can provide some flexibility in accepting policies otherwise rejected under a strict net benefits approach, they suffer from several problems including monetising conventions of questionable validity and time discounting practices, which biases choices against far-future outcomes.

The framework for ex post evaluation is, however, different from the ex ante one. Typically ex post evaluations of individual rules focus on criteria such as effectiveness, efficiency, relevance and coherence. And apart from more minor remarks (i.e., the relevance of the rules should probably be assessed before the effectiveness, whereas the opposite usually occurs; and the enforcement and compliance phases should taken seriously),[83] this framework appears far more suitable for the incorporation of long-term goals. But here too, badly formulated objectives or time horizons that are too short to realise benefits might lead to distortions in the appraisal of criteria such as effectiveness and relevance; whereas linking the evaluation effort to medium- and long-term decarbonisation goals, on the basis of a well-defined deep decarbonisation pathway for the EU, would certainly provide a more accurate perspective to the evaluators.

The disconnect between the needs of long-term strategies and the short-termism of the better regulation agenda becomes more evident when it comes to the REFIT and

[83]See the evaluation of the CO_2 emissions of cars and LDVs, formally very elegant, but completely overlooking the VW scandal.
[84]For example, on the web page dedicated to the Natura 2000 Fitness Check, the Commission explains that "Fitness checks provide an evidence-based critical analysis of whether EU actions are proportionate to their objectives and delivering as expected. They cover environmental, economic and social aspects, and concern all EU policy areas". See http://ec.europa.eu/environment/nature/legislation/fitness_check/index_en.htm

Cumulative Cost Assessments, which constitute the two most comprehensive types of ex post evaluation carried out by the Commission. More specifically:

- REFIT exercises are methodologically the most complete forms of evaluation, potentially incorporating also cumulative costs and benefits, and to some extent also co-benefits.[84] However, they end up being almost always focused on cost reduction and are conducted mostly by means of stakeholder consultation, which inevitably embeds incumbents' interests into the analysis. Future generations, unfortunately but not surprisingly, are under-represented in today's stakeholder consultations. Recent examples include the consultation on financial regulation, in which the European Commission is asking stakeholders to identify and locate the burdens, and the interactive costs, of financial rules. The simplification-oriented nature of REFIT is confirmed by its slogan ("making EU law lighter, simpler and less costly") and the description given by the European Commission on the dedicated website ("action is taken to make EU law simpler and to reduce regulatory costs, thus contributing to a clear, stable and predictable regulatory framework supporting growth and jobs").[85]

- Cumulative cost assessments, led by DG GROW, typically differ from fitness checks carried out under the REFIT programme since they focus on a specific industry sector, rather than on a specific policy area. So far, they have been carried out for important industry sectors that are also very relevant for the purposes of decarbonisation, such as steel, aluminium, chemicals, furniture, glass and ceramics. These actions are typically undertaken in close cooperation with existing trade associations and companies, with a view to lighten the burden of various pieces of EU legislation on their accounts to improve their cost competitiveness. Even when the analysis reveals the use of different technologies with different levels of efficiency and performance (as was the case for steel), no action is taken by the European Commission to promote energy efficiency. The exercise is mere fact finding, which entails the collection of data at the plant level, but entails neither the formulation of a technology roadmap, nor a comparative analysis of the (energy efficiency of) technologies used in the EU and in main competing countries, nor any strategic outlook of how the industry could reasonably migrate to higher levels of competitiveness, or of energy efficiency.

All in all, the difference between the policy cycle described in section 1.2.3 above and the current EU better regulation agenda is remarkable. Recently, the issue of how to use better regulation in support of growth and innovation has been under the spotlight in Brussels, with a number of new proposals and orientations being formulated in the European Commission and among industry stakeholders. We briefly comment on those recent developments below.

[85] http://ec.europa.eu/smart-regulation/refit/index_en.htm

2.3.2 Fostering innovation through better regulation: recent developments

Four main trends can be observed with respect to the use of better regulation tools to foster innovation: the adoption of an 'innovation principle' in the ex ante impact assessment process; the proposed creation of a European Innovation Council (EIC); the consideration of possible ways to foster 'innovation-driven investment' through better regulation; and within this framework, the introduction of a non-legislative approach termed 'innovation deals', to tackle regulatory obstacles to innovation. Below, we briefly describe these three new proposed arrangements.

2.3.2.1 The Innovation Principle

The innovation principle was proposed in 2013 by a group of industry representations, think tanks and large companies' CEOs, and was vibrantly advocated as a necessary change in the EU policy process.[86] Its aim is to ensure that "whenever policy or regulatory decisions are under consideration the impact on innovation as a driver for jobs and growth should be assessed and addressed".[87] One of the key concerns voiced by the signatories is the negative effect that increasingly risk-averse legislation is having on European innovation; that said, the innovation principle is said to be complementary to the precautionary principle. The innovation principle is also said to be open to "anyone who is interested in promoting an 'innovation friendly' and environmentally responsible regulatory environment in Europe", which potentially makes it consistent with long-term decarbonisation objectives, which appear to be the only responsible way to tackle environmental issues today.

The innovation principle was articulated in a more comprehensive way over the past year, as exemplified in a recent monograph.[88] In addition, it was recently endorsed by the Competitiveness Council conclusions of the Dutch presidency, and described in some more detail by a new note of the European Political Strategy Center.[89] That said, the methodology behind the innovation principle is still not very detailed, whereas methodological quality would be a decisive factor for the usefulness of adding yet another test to the already quite complex ex ante impact assessment process.

At first sight, our reaction would be that impacts on innovation, as all economic, social and environmental impacts, would not need a dedicated test in the impact assessment process. At the same time, however having a dedicated screen for innovation could 'force' administrations to address innovation impacts when appraising new policies or evaluating existing ones. We consider that a 'sustainable development test' – aimed at assessing

[86] Initially 13 CEPS in 2013, then became 22. The 22 CEOs sent a letter to President Juncker upon his election.
[87] http://www.riskforum.eu/uploads/2/5/7/1/25710097/innovation_principle_one_pager_5_march_2015.pdf
[88] http://www.riskforum.eu/uploads/2/5/7/1/25710097/monograph_innovation_principle.pdf
[89] See EPSC (2016), Towards an Innovation Principle Endorsed by Better Regulation, Strategic Notes, Issue 14, June 2016. At http://ec.europa.eu/epsc/pdf/publications/strategic_note_issue_14.pdf.

the impact of proposed regulatory interventions in terms of progress along indicators of sustainable development, and thus through multi-criteria analysis – would probably be more useful than an innovation principle for the simple reason that innovation is a means, not an end, for policymakers. In addition, any innovation-related test that is relevant for sustainable development and decarbonisation should avoid any incumbency constraint and be open to systemic, disruptive innovation. But we share a number of the concerns voiced by the proponents of the innovation principle: in particular, the lack of a focus on coherence in the current better regulation agenda (in particular with respect to Europe 2020 goals; and the lack of a framework for using scientific and technological inputs in policymaking.

Finally, it may well be that the EU suffers equally or more so from a diffusion deficit, rather than from an innovation deficit.

2.3.2.2 Better regulation for innovation-driven investment

At the end of 2015, the European Commission published a Staff Working Document that outlines a relatively new approach to better regulation, more oriented towards innovation.[90] The document, initiated by DG Research and Innovation and endorsed by Commissioner Moedas, goes a long way towards acknowledging the potential role of better regulation as a driver of innovation. In addition, the document acknowledges the systemic nature of innovation and its role in addressing societal challenges.

Among the problems highlighted by the document (which widely quotes a previous CEPS report by Pelkmans and Renda (2014) with respect to the existing regulatory framework, some are particularly relevant for the purposes of this report. First, the Commission services highlight cases in which the regulatory framework i) is de jure or de facto prescriptive in technology choice and discourages different solutions and new entrants; ii) establishes a level of stringency which is inconsistent with available cost-efficient technology, hence delaying investment and deployment of solutions or iii) allows too-frequent changes in standards that may also limit the incentive for investment if a technology is relatively recent. Driverless cars are among the examples mentioned.

Second, the Commission cites cases in which the regulatory framework is not sufficiently innovation-friendly due to i) lack of interoperability (sic) of the regulation across sectors and cases in which rules block cooperation and the development of open innovation based on multi-technology sourcing; ii) cases in which regulations that are technology specific are not adapted in a timely way to technological progress or iii) cases of inconsistencies between regulations, which give rise to legal uncertainties and unnecessary additional compliance costs. Among the examples mentioned in the document, the most relevant for the purpose of this paper is related to energy-efficient buildings. There, the document identifies a number of pieces of EU legislation that would have to be reviewed to boost innovation in the sector, including a recast of the Energy Performance of Buildings Directive

[90]https://ec.europa.eu/research/innovation-union/pdf/innovrefit_staff_working_document.pdf

(2010/31/UE), a review of the Construction Products Regulation (305/2011) and of the Energy Efficiency Directive (2012/27/UE), plus the evaluation and review of the Eco-Design Directive and the Energy Labelling Directive.

Third, the Commission identified cases in which the implementation of innovation-friendly regulations can also discourage investment and limit the marketing of innovative products, when: i) legislation is not uniformly or not appropriately implemented across member states; or ii) European and national legislation duplicates, overlaps or is not fully consistent or repetitive controls and authorisation procedures are maintained. Here too, examples include relevant areas for decarbonisation such as eco-design for resource efficiency, again energy-efficient buildings, and electrified vehicles.

Finally, the Commission document identifies some areas in which there are regulatory gaps that might affect innovation, especially by creating fragmentation that could hamper the emergence of innovative products. Examples include again road vehicle automation, and also low carbon hydrogen in transport.
This document is, in our opinion, a Commission initiative that offers a promising perspective on the policy alignment initiatives that could be achieved at EU level. We strongly endorse the overall approach adopted by the document, and further encourage the Commission to pursue its efforts with a view to promoting systemic innovation, not simply by listening to incumbent stakeholders but to permanent, multi-stakeholder platforms that would engage in backcast (or double backcast) exercises to offer policymakers input on what set of measures would be needed to stimulate systemic innovation to the benefit of long-term decarbonisation. The problem remains, however, that incumbents may not adequately represent future disrupting innovation more likely to be generated by new entrant displacing incumbents' technologies.

2.3.2.3 The Innovation Principle

In the same Staff Working Document on "Better Regulation for Innovation-driven Investment", the European Commission also announces that it would pilot so-called "innovation deals", and indeed a first pilot was launched through an open call for expressions of interest in June 2016.[91] The Commission has clarified that these deals would be a new way to address EU regulatory obstacles to innovation in an open and transparent manner, in the form of voluntary cooperation between innovators, national/regional/local authorities and Commission services to better achieve EU policy objectives. In addition, Innovation Deals are being piloted as one of the actions under the Circular Economy Action Plan. An important feature of Innovation Deals is that they seem to be destined for specific cases in which legislation must be clarified, or interpreted, not amended. They are, in this respect, presented as a tool for addressing cases in which legislation is difficult to interpret for new players, but never as a way to change EU or national law.[92]

[91] https://ec.europa.eu/research/innovation-deals/index.cfm?pg=home.
[92] "To offer a pragmatic, flexible and transparent approach to timely address innovation obstacles to trigger growth and jobs whilst fully respecting EU law, without derogating from the existing legislative framework".

In a companion paper for the European Commission, DG Research and Innovation, Renda (2016, forthcoming) analyses more closely the virtues and possible challenges of such an instrument, by looking also for equivalent experience in the US (in particular, in so-called negotiated rulemaking, negotiated implementation and negotiated compliance; see Ashford and Caldart, 1999). Based on this past experience, while Innovation Deals might end up becoming an important tool for the clarification of EU legislation and the removal of 'perceived obstacles' to innovative product and service offerings, there are greater concerns about the suitability of innovation deals for systemic innovation addressing long-term decarbonisation. To mitigate such concerns, it is essential that Innovation Deals are not underpinned by a belief that 'less is more", and that 'clarification' of regulation should always mean red tape reduction and slashing of regulatory requirements in the name of innovation. On the contrary, as we have amply demonstrated in earlier research, regulation often has a positive impact on innovation, and certainly a clearer regulation, other things being equal, is better than an obscure one. But this does not mean that less regulation should be the objective in innovation deals. Similarly, the red tape rhetoric, also originated in the Netherlands (according to which reducing admin burdens by 25% would lead to remarkable GDP increases) was not confirmed empirically after years of experimenting with the Standard Cost Model.

Second, the likely nature of innovation deals makes them potentially ill-suited for more disruptive, systemic innovation. Due to their negotiated nature innovation deals might suffer from an 'incumbency' problem, and as such would lend themselves more easily to incremental innovation rather than substantial market reshuffling. Adequate control and monitoring by EU institutions would thus be essential to ensure that incumbency problems do not exert a disproportionate influence on the way Innovation Deals are handled.

Third, and relatedly, the governance of Innovation Deals should be clarified in a number of aspects: how will Innovation Deals be selected; where would the applications originate (REFIT stakeholder platform), would there be multi-stakeholder advisory boards to avoid incumbency problems, would the Regulatory Scrutiny Board advise on their implementation and compatibility with existing regulatory frameworks; how would trust be built and nurtured, and what arrangements will be in place to sufficiently avoid adverse selection problems (offering an easy way out to firms that cannot comply with legislation for reasons related to their own inadequacies)? In addition, there are important questions over how to offer legal certainty (guidelines on selection, due process, time horizon, monitoring of compliance, evaluation); how to ensure technology neutrality and avoid the incumbency problem; and how to deal with multi-level governance, especially for what concerns the powers of the European Commission to request clarifications in national and local legislation? Since it seems clear that it will be member state authorities that will have to report on their implementation and results, it is still unclear how Innovation Deals are going to work, in a context in which communication between the EU and national level is not always effective and rapid. The involvement of all levels of government should also be accompanied by the involvement of all relevant stakeholders. And also, a weak rule of law in specific member states should be taken into account.

Overall, it is important to offer more certainty as regards the scope of the instrument. If

the Innovation Deals are only related to possible "clarification, enhanced guidance, existing flexibility and/or demonstration of the innovative solution" (see the SWD of 15 December 2015), then it is also important to clarify that their use is not going to be a 'magic bullet' solution that will bring Europe back to growth, let alone sustainable development. If anything, it would be a sign of greater attention given to possible obstacles to innovation disseminated throughout the 'downstream phase of EU legislation, i.e., the delivery and enforcement phases. The reasonable expectation is that most of these obstacles will be found in national legislation: that said, it is not clear whether the Commission's attempt to clarify or streamline national legislation will be well received by member states, or if it will be seen as a wild card for the Commission, which will lead it to go ultra virus and bypass other EU institutions to recommend and de facto impose regulatory changes on member states.

All in all, Innovation Deals might prove useful in specific circumstances, but will have to be accompanied by a much more ambitious, whole-of-government effort to promote systemic innovation through policies that have in mind swift action for shorter goals, consistently with a longer-term view of societal well-being.

2.3.3 Misalignments in better regulation: beyond the European Commission

Better regulation, of course, does not end with the work of the European Commission, and indeed it would be unfair to expect the Commission to shoulder all the responsibility for the alignment of EU policies with long-term goals such as deep decarbonisation. And as a matter of fact, other EU institutions are still much less advanced than the European Commission in the use of better regulation tools. More specifically:

- The **European Parliament** only recently developed specific capacity to perform policy evaluation, thanks to the creation of a dedicated Directorate for Impact Assessment and European Added Value in 2012. The Directorate, now moved to the new European Parliamentary Research Service (EPRS), routinely summarises and appraises the strengths and weaknesses of Commission IAs accompanying legislative proposals and is available to provide, upon request from the relevant EP committee, more in-depth IA-related services, such as complementary or substitute impact assessments, in cases where certain aspects have been dealt with inadequately or not at all in the original Commission IA, and impact assessments of substantive amendments.[93] The EPRS now also includes dedicated units for ex post evaluation, European Added Value, and a scientific foresight unit (STOA). The methodology used by the EPRS is still not entirely sharpened, however, and the methodological approach (typically oriented towards use of cost-benefit analysis) does not entirely match the type of scrutiny that MEPs want

[93]Evidence backing proposed amendments may help support the institution's position in trialogue negotiations, as well as improve advance knowledge of likely effects. Guidance for committees in using these EP impact assessment services are set out in the Parliament's internal 'Impact Assessment Handbook', adopted by the Parliament's Conference of Committee Chairs, and most recently updated in November 2013. http://www.europarl.europa.eu/EPRS/impact_assesement_handbook_en.pdf

to carry out on Commission proposals. Indeed, one possibility for the future of the EU better regulation system would be for the EPRS to play the role of 'guardian of long-term goals' by performing a coherence check between Commission proposals and long-term sustainable development goals, including decarbonisation goals. We would very much advocate this change, to ensure that EU legislation is subject to this double testing, and amended on the basis of policy coherence, rather than on alleged efficiency grounds.

- The **Council** has initially run a limited number of pilot impact assessment on some of its own major amendments shortly after signing the Inter-Institutional Agreement on Better Lawmaking, but soon abandoned the project. Since then, for more than a decade very little has been done, with the exception of a growing use of Commission IAs in Council working parties at an early stage of the debate on specific legislative proposals. In the past years, at least a third of the EU Member States have exerted pressure on the Council to set up at least a small IA unit, but so far no concrete step has been made in that direction. In the future, it would be good if, either through an upgraded Inter-Institutional Agreement or through a stand-alone initiative of the institution itself, the Council could start motivating its amendments on the basis of their potential impact on decarbonization and other important medium- and long-term goals of EU policy.

- For **member states**, it is fair to say that the landscape is very uneven. While countries like the UK (now exiting the Union) have a very consolidated experience in the field of better regulation, and even of ex post cumulative analysis (e.g., in DEFRA on environmental issues), the remaining member states either have a better regulation system almost exclusively focused on regulatory costs (Germany), compliance costs (the Netherlands) or administrative burdens (France, Sweden, Belgium, the Czech Republic); or still make very sparse and occasional use of better regulation tools, despite official commitments towards ex ante impact assessment.[94] As a result, when legislation is adopted at EU level, its transposition and implementation are most often not subject to a comprehensive appraisal and monitoring at the member state level, which leaves EU policy incomplete even where a relatively complete analysis has been carried out at EU level. And Brexit will only exacerbate this problem by depriving the EU of its most advanced member state in the domain of better regulation.

2.3.4 Coordinating policies: the absence of better regulation and sustainable development in the European Semester

Beyond the better regulation system, long-term goals have gradually become less visible and salient in the governance of the European Semester, which came to represent the most prominent existing mechanism for the coordination of public policies enacted at the EU and member state level. This happened along with the gradual demise of the Europe 2020 strategy, which gradually lost momentum in Europe first as a result of the financial crisis, later due to the Greek and eurozone crises, and finally due to the new course adopted by the

[94]Possible exceptions are Sweden, Poland and Estonia. But even in these countries the situation is far from optimal.

Juncker Commission, more focused on the "ten priorities" and less interested in sustainable development. As a result, the proposed review of the Europe 2020 strategy never took place. Two years ago, in view of the announced mid-term review, one of us proposed to relaunch the strategy and place it at the core of the European Semester (see Renda, 2014).

Within the Europe 2020 strategy, originally the so-called 20/20/20 by 2020 goal had been formulated (20% CO_2 emissions reduction, 20% renewable energy, and 20% improvement in energy efficiency). In the meantime, the October 2014 European Council adopted new targets, to be fulfilled by 2030: at least 40% CO_2 emissions reduction; at least 27% renewable energy "binding at EU level" and at least 27% improvement in energy efficiency. A revised strategy would need to take into account the 2030 goals (EPSC 2015), but also longer-term goals to avoid falling into the medium-term target trap denounced by Sachs et al., (2015) and help Europe proceed towards deep decarbonisation.In trying to achieve this goal, a number of changes in the current European Semester would be needed, and this will be far from easy:

- The Europe 2020 strategy should be reviewed and updated to 2030 (and where appropriate 2050) to reflect also the SDGs;
- The National Reform Programmes sent by Member States to the European Commission within the European Semester should include reforms aimed at reaching the new 2030/2050 goals. These should reflect deep decarbonisation pathways agreed upon at the pan-European level (possibly as part of a broader national sustainable development plan), and made specific for each Member State.
- The Country-Specific recommendations issued by the European Commission should comment on the alignment between the proposed national reforms and each individual Member State's decarbonisation plan.
- The Annual Growth Survey should become an Annual Sustainable Development Survey, or at least contain sections dedicated to sustainable development targets and goals.

We are aware that political opposition to this proposal would be harsh, although we believe that supporters will be numerous. At the same time, we believe that there will be little prospects for decarbonisation in Europe absent a real coordination of reform programmes between different levels of government. A recent publication by the EPSC, the Commission's in-house think tank, confirmed this view by observing that Europe 2020 never featured prominently in the European Semester, "not the least because it has no legislative 'teeth'. Therefore, in addition to the limitations of the Open Method of Coordination, member states did not fear sanctions for not being on the planned trajectory towards their self-proclaimed goals. This also explains why several National Reform Programmes become a mere list of actions undertaken by governments, in response to the Commission's Country-Specific Recommendations. Rather than an instrument for peer learning and a driver of change, reporting on the targets has been interpreted as a 'check-box' exercise to be completed not for the sake of the member state itself but to satisfy 'Brussels'.[95]

The EPSC also proposed moving from static to dynamic, internationally benchmarked indicators and selecting a limited number of "working themes", which could correspond to what we defined grand societal challenges in the previous chapters of this report. This would be a way to bring the Europe 2030 strategy closer to the idea of a mission-oriented, multi-level medium-term strategy that can bring Europe back on a trajectory of sustainable development.

[95]See EPSC (2015) "Europe 2020. From Indicators and Targets to Performance and Delivery", EPSC Strategic Notes Issue 6, September 2015. At http://ec.europa.eu/epsc/pdf/publications/strategic_note_issue_6.pdf.

3. RECOMMENDATIONS FOR NEXT-GENERATION EU POLICY: TEN STEPS TO SOLVE TRADE-OFFS AND EMBED SUSTAINABLE INNOVATION IN THE EU POLICY PROCESS

This section discusses possible ways to align EU policy to the long-term decarbonisation objectives, in a way that triggers systemic innovation and preserves consistency with overall sustainable development goals. We propose alignment in ten steps, which involve changes in the governance of innovation policy, in the better regulation agenda and its associated toolkit, and also in EU's trade agenda. At the same time, none of the proposed steps requires Treaty changes, which makes our proposal more viable in the short and medium term.

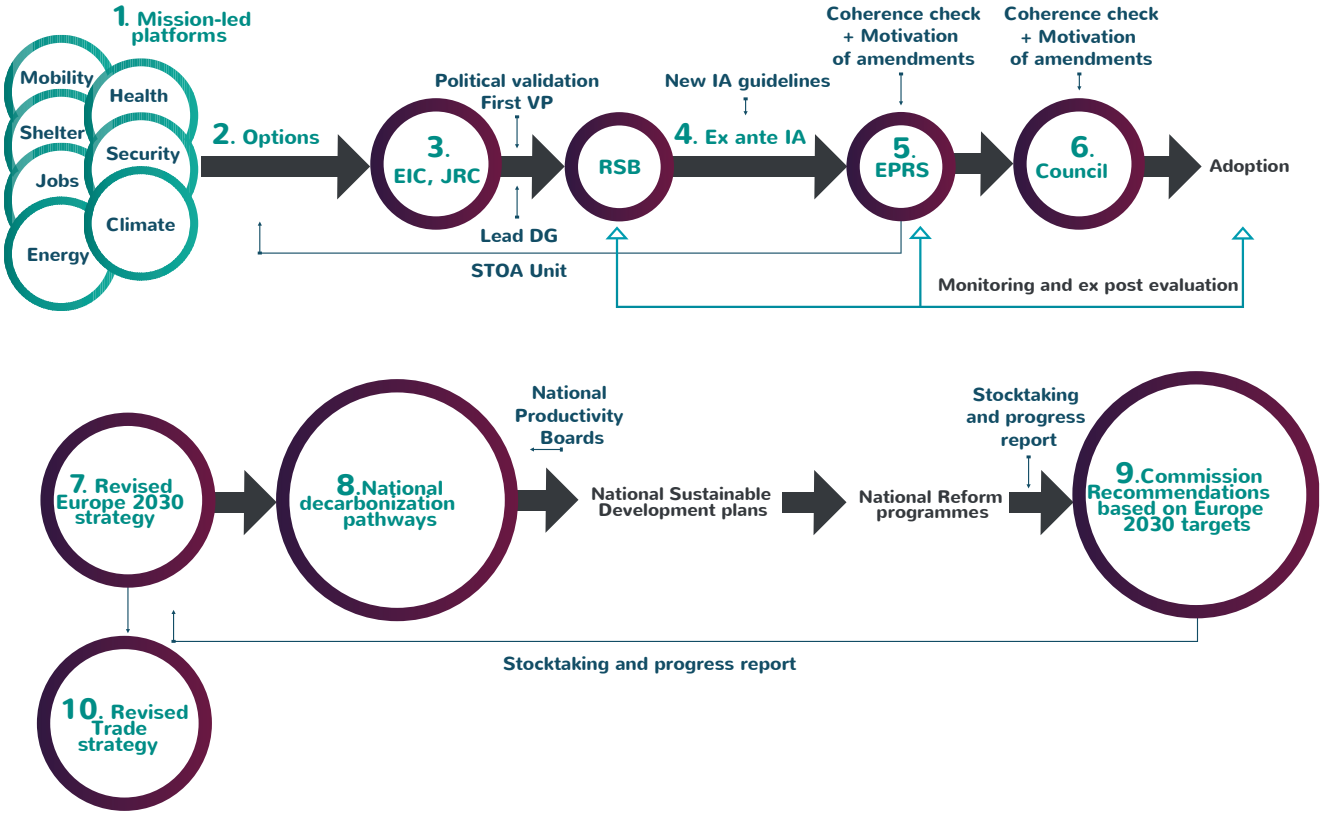
The ten steps are a natural consequence of our previous sections. In particular, as will be shown in the next pages, strengthening the evidence base and the informational input to policymakers should help avoiding being caught by the myths discussed in Section 1.1 above. Reorienting the whole better regulation agenda towards coherence implies the detection of existing misalignments in EU policies. Improving foresight should help reducing problems of short-termism, and increase the consistency of individual policies with long-term goals. Consolidating existing platforms for research and innovation and establishing a more structured channel for the translation of existing knowledge into actionable policies aim at improving at once the effectiveness of innovation policy and policies for innovation. Involving the Parliament, Council and Member States in the development and implementation of policies for low-carbon systemic innovation towards long term decarbonisation also responds to existing problems in the EU policy cycle, as well as weaknesses in the EU Semester and inconsistencies between national policies and EU goals. And finally, making an active use of the EU trade agenda in the array of policies is the only way to face the problem of carbon leakage and establish a global cooperation on decarbonisation.

Moreover, it is important to clarify, already at the outset, that while implementing all ten steps would be in our opinion ideal, each of the ten steps can also be implemented in isolation, and would already improve on the status quo by contributing either to a more effective innovation policy, a better scientific input into policymaking, a more effective and coherent inter-institutional cooperation on better regulation, a stronger and more future-proof multi-level governance in the EU, or a more effective trade policy for the long term. Figure 7 below shows the logical sequence in which the ten steps have been imagined and

developed. As shown in the picture:

- Steps 1, 2 and 3 deal with the provision of a more structured, informative, and competent input by mission-led research and innovation platforms to policymakers, with the help of key institutions such as the EIC and the JRC.
- Steps 4, 5 and 6 refer to the transition of the existing better regulation agenda towards a more coherent inter-institutional framework, in which individual policies are linked to long-term sustainable development goals.
- Steps 7, 8 and 9 deal with the future of the European Semester, and aim at improving the multi-level governance of the EU, at the same time re-orienting it towards long-term sustainable development.
- Step 10 looks at Europe's role in the global context and advocates a stronger commitment towards climate diplomacy and international cooperation towards long-term decarbonisation goals.

Figure 9 – Steps 1-9: reforming the EU policy process



Step 1: Set up mission-led platforms to transfer state of the art information to policymakers

Even before looking at how to improve the EU better regulation agenda and toolbox, it is important to discuss how to improve the way in which competent input is provided to policymakers in the form of evidence and technology/business forecasts. This could be achieved by slightly reorganising and re-orienting innovation policy, both at EU and member state level. As recently argued in a CEPS report on innovation and entrepreneurship in the EU (CEPS 2016), there is a strong need for consolidation of the various communities and spaces offered by the EU on research and innovation, such as KICs, EIPs, EIIs, JTIs, etc., which were created at various points in time, mostly to respond to the perceived 'innovation emergency' (which we earlier argued was equally or more of a 'diffusion emergency'). The proliferation of platforms and communities, often on partly or wholly overlapping themes, multiply transaction costs and reduce opportunities for entrepreneurs.

In view of the upcoming creation of a 'European Innovation Council' (EIC) and the mid-term review of Horizon 2020, it would be preferable to create an overarching institutional framework in which agencies such as the European Institute for Innovation and Technology (EIT) launch and orchestrate challenge-led, streamlined platforms where research, development, and demonstration are tackled for specific societal challenges in a multi-stakeholder fashion, open to new entrants, new technologies, new business models, and citizens. Ideally, these platforms would merge previous instruments such as the Research Infrastructures, the European Innovation Partnerships, the Joint Technology Initiatives, and obviously the KICs. There should be only one such platform for every emerging societal challenge, with cooperation across platforms in case of overlapping issues. KICs, in this respect, are already contributing to the coordination of programmes following a 'business logic', resulting in a significant leverage factor of coordination (one euro of EIT funding leverages up to three euros of national and regional funding); they have the potential to become 'professional brokering' structures for the coordination of 'societal challenges'.

In addition to consolidation, these platforms should also be entrusted with an additional function, i.e., that of translating their work into policy-relevant input to be transmitted (with the help of the EIC, see step 3 below) to EU institutions and in particular to the European Commission when considering new policy initiatives. As recalled by Mariana Mazzucato (2016) "with a mission-oriented approach and the freedom to experiment – with failure understood to be an unavoidable, and even welcome, feature of the learning process – the state is better able to attract top talent and pursue radical innovation" by leveraging multi-stakeholder platforms and offering industry and academic knowledge as inputs to a more evidence and science-based policy, EU institutions can really change the way in which they approach systemic innovation for sustainable development, and thus also for decarbonisation.

Step 2: Ask these platforms to produce options for deep decarbonisation pathways for the most relevant policy challenges

Upon their creation, mission-led, multi-stakeholder platforms would have to work towards the development of pathways towards long-term sustainable development, including of course deep decarbonisation. Challenges such as the energy transition, the future of mobility and shelter will have to be approached with a view to the long term, and accordingly also through ad hoc pathways that consider all the policy trade-offs that might emerge during the transition. In this respect, we consider that the work being done by researchers on long-term deep decarbonisation pathways can provide a crucial benchmark to assess policy progress and identify policy inconsistencies (IDDRI 2015; Waisman and Virdis, 2016).

These deep decarbonisation pathways would have to be developed with attention to due process (and thus, openness, transparency, accountability), and in a way that makes them possible and actionable at the EU and member state level. Sustainable and smart management of the platforms and the inclusion of national research centres would make this goal easier to achieve. Also, pathways would need to be designed and developed in cooperation with EU institutions, and in particular the European Research Council, the European Innovation Council (see below, step 3), the European Commission Regulatory Scrutiny Board, the Joint Research Centre and the European Parliamentary Research Service (especially the STOA unit, on scientific foresight).

Step 3: Set up the EIC with the right competences

The European Innovation Council would play a key role in this new framework for providing scientific and technological input to the decision-making process of the European Union. In our opinion, rather than becoming yet another agency with a relatively narrow mandate (i.e., scale-ups), the EIC should become the key intermediary between the research and innovation world and the policy realm. While the Joint Research Centre should contribute to the work of individual platforms, and the EIT should define and orchestrate the management of the platforms, the EIC should primarily be in charge of defining methods and instruments for the mainstreaming of systemic innovation into the EU policy process. Otherwise, another EU agency dedicated to innovation would probably add to the current confusion and complexity without fostering smart policymaking to any significant extent.

More generally, the existence of a strong EIC could be seen as a precondition for smarter science-based, innovation-friendly policy at the EU level, especially if coupled with revised better regulation guidelines oriented towards long-term societal challenges, rather than evaluated in terms of short-term cost-benefit analysis (see step 4 below). At a time when

public decision-making faces growing difficulties given the complexity and fast-changing nature of many policy issues, constant but evolving input from the research and innovation field, incorporating emerging business models and socio-technical transitions, is going to be perceived as an increasingly inevitable solution to maintain the relevance of policy initiatives. This is even more true for the EU level, in which policy interventions are often started too early for fear of the long time needed to get to approval at the EU level and implementation by member states. And yet, they are often implemented too late.

Step 4: Modify the better regulation guidelines to capture the potential of regulation-induced innovation

The current better regulation guidelines, as revised in May 2015, are among the best examples of integrated guidelines for evidence-based policymaking worldwide. At the same time, they still place insufficient emphasis on issues such as policy coherence, long-term impacts, risk analysis, adaptive policymaking, systemic innovation and decarbonisation. In this respect, the following changes could be contemplated to improve the extent to which better regulation can become more conducive to policy alignment for the long term.

- The baseline option adopted as a basis for major new policy initiatives could be inspired by long-term decarbonisation pathways, possibly in a way that is made consistent across policy areas. A first attempt in the direction of common baseline options across different Directorate General of the European Commission was made by the Joint Research Centre, but so far this idea has not been fully translated into the practice of impact assessment in the Commission.[96]

- The overall **methodology for the selection of the preferred policy option(s)** for major new initiatives (corresponding to so-called 'primary legislation' in national legal systems) should make use of multi-criteria analysis, where criteria should reflect long-term societal challenges and should be measured by means of dedicated indicators. Such indicators could extensively borrow from the existing well-established literature on indicators of sustainable development, and should be refined and made more EU-specific with the help of mission-led platforms and the EIC (see above, steps 1 to 3).

- The **role of innovation** should be subject to more careful analysis in the better regulation guidelines, as recently evoked also by the Council conclusions of the Dutch presidency. However, accounting for systemic innovation does not mean leading Europe on a deregulatory path. On the contrary, the guidelines could devote more attention to the role of policy learning and experimentation by offering guidance on so-called adaptive policymaking, or "planned adaptation";[97] and to the consistency

[96]See http://publications.jrc.ec.europa.eu/repository/bitstream/JRC94069/lb-na-27019-en-n%20.pdf.
[97]See e.g., McCray, L.E:, K.A. Oye and A.C. Petersen (2010), Planned adaptation in risk regulation: An initial survey of US environmental, health, and safety regulation, Technological Forecasting & Social Change 77 (2010) 951–959. And more recently, IRGC (2015), A short introduction to "planned adaptive regulation", at https://www.irgc.org/wp-content/uploads/2015/12/A_short_introdution_to_Planned_Adaptive_Risk_Regulation-19Nov15.pdf.

of prospective policy impacts with long-term sustainable development (including, of course, decarbonisation). Moreover, the input offered by mission-led platforms (step 1, above) and by the EIC (step 3, above) should be put to use in impact assessment, in a way that would automatically incorporate a vision for systemic innovation into the EU policy process, and would also minimise the risk that incumbent interests dominate the policy process.

- When attributing monetary values to regulatory costs and benefits, the discount rate chosen should be consistent with long-term policy goals. Choosing too high a discount rate could lead to systematically downplaying long-term goals, which would rather be kept on the radar at every step of the policy process. Specifically identifying the time framework over which investments and results occur, rather than using any discount rate, could be a preferable approach, as recommended by the use of 'tradeoff analysis,' an alternative to cost-benefit analysis (Ashford 2007; 2008).

Step 5: Ensure that the European Parliament Research Service checks policy coherence

Even if the European Commission were not to change its better regulation guidelines to shift the focus from efficiency towards coherence, the European Parliamentary Research Service would better focus on coherence rather than on stricto sensu cost-benefit analysis. While this would contradict the spirit (but not necessarily the actual implementation) of the 2003 Inter-Institutional Agreement on Better Lawmaking, as confirmed later by the 2005 "Common Approach to Impact Assessment" and also by the recent Inter-Institutional Agreement on Better Regulation, this would be an improvement in many respects. First, since its creation in 2012 the EPRS has struggled with the performance of high-quality economic analysis of EU legislation, be that in response to a Commission proposal or on an own initiative of the Parliament. Second, and perhaps relatedly, the EPRS seems to be facing difficulties in organising a meaningful dialogue with MEPs, who tend to focus on actual coherence and specific policy impacts rather than on overall evaluations of net benefits. Unsurprisingly, practically no country in the world has been able to successfully mainstream cost-benefit analysis in parliament, and the country that has led the way in this field, the US, never even tried to launch impact analysis in Congress. Third, this role of the EPRS would be more consistent with a situation in which long-term goals are embedded in the European Semester (step 8, below), and thus become more binding on EU member states. Finally, and importantly, this EPRS role would trigger a more meaningful debate between institutions, and in particular between MEPs and the European Commission services, on the extent to which proposed EU policy initiatives would help the EU move in the direction of long-term sustainable development.

Step 6: Exert pressure on the Council to ensure it motivates amendments on the basis of long-term goals

A similar emphasis on long-term policy impacts and sustainable development goals could be placed by the Council in discussing its proposed amendments to proposed new EU legislation. At the same time, the representatives of national governments in various Council formations could use long-term national sustainable development pathways (including decarbonisation pathways) when deciding their positions, possibly also motivating their decisions on that basis. This could avoid, or at least make less likely, that the Council adopts decisions that do not promote the well-being of European citizens, without having to offer any justification, especially since the most ambitious proposals advanced by the European Commission in its draft Inter-Institutional Agreement on better regulation back in May 2015 (Renda, 2015), (aiming to ensure that final legislative texts were accompanied by an updated impact assessment) were not agreed upon by other institutions and never made it to the final text.

What we are proposing here is that the Inter-Institutional Agreement be gradually relaunched with less emphasis on the convergence of methodologies initially foreseen, and never achieved by the three participating EU institutions; and that it rather focuses on the coherence, accountability and transparency of the decision-making process in all three institutions, with the Parliament and the Council focusing more on the consistency between individual legislative texts and the overall vision of EU sustainable development in the long term.

Step 7: Revise Europe 2020 in a more meaningful and long-term-oriented way, including a more nuanced industrial innovation strategy

Needless to say, a focus on sustainable development would be much easier to achieve if the EU managed to revise and re-launch its sustainable development strategy. Unfortunately, as already mentioned, the Europe 2020 strategy for smart, sustainable and inclusive growth is to be considered in all respects as defunct. More specifically, Europe 2020 was an incomplete strategy from the beginning, but was at least an attempt to bring sustainable development, rather than pure GDP growth, into the big picture of EU policymaking by introducing a balanced, sustainable, multi-level, decade-long vision for Europe to be considered as a reference for all policies to be launched or evaluated by EU institutions (Renda, 2014; EPSC, 2015). Its incompleteness rapidly also became obsolescence, as the economic crisis made most of the targets set by Europe 2020 meaningless and not easily actionable. Paradoxically, as acknowledged also by the European Commission, the environment-related and energy efficiency targets are today the only ones really achievable

(together with the education ones, which were probably not ambitious enough), but for the 'wrong' reason: the economic crisis has led to such a reduction of production levels, especially in industries such as construction, that emission levels have also slowed down. Today, Europe 2020 has been gradually marginalised by the Juncker Commission, and it seems very unlikely that any of the future presidencies will work on a revision that would no longer be mid-term, but closer to an ex post evaluation. The Juncker 'ten priorities' do not have the same similar breadth, even if elements of sustainability are present in a relatively scattered way across initiatives.

Against this background, EU institutions should build a coherent vision for the next decade (2030) by bringing together all efforts currently being made on long-term policies, including i.a., those on decarbonisation, sustainable development, "beyond GDP" and the future of policymaking. Most of these efforts are being coordinated by the European Commission. This vision should not be limited to 2030, but also be checked for consistency with longer-term goals such as the zero carbon economy.

The development of a new EU sustainable development strategy should be accompanied by meaningful indicators, and methodologies for progress-tracking, and should echo the SDG framework being built and developed under the UN umbrella, and the shared prosperity framework being led by the World Bank. The centrality of the Europe 2030 agenda should then be ensured by providing incentives to member states to promulgate reforms that are in line with their SDG potential for the end of next decade (see step 9, below).

Step 8: Have countries develop their own decarbonisation pathways with adequate governance mechanisms, but join in a multilateral funding and technology-sharing effort

Each member state should develop a decarbonisation pathway, in line with what is happening under the initiative of the SDSN and IDDRI (2014, 2015). The approach of the deep decarbonisation pathways is to have country research teams develop national-scale pathway analysis for deep decarbonisation by 2050, consistent with the 2°C (or even better, 1.5°C) limit and development objectives. Currently, the DDPP comprises 15 Country Research Teams of leading researchers and research institutions from countries representing 70% of global GHG emissions and at very different stages of development.[98] But other European countries are already following a similar methodology to develop decarbonisation pathways.[99]

[98]Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Japan, Mexico, Russia, South Africa, South Korea, the UK, and the US.
[99]See "Deep decarbonization Pathways (DDPs): A catalyst for the climate change debate", by H. Waisman and M. Virdis, Energia, Ambiente, Innovazione, 1/2016. ENEA. At http://www.enea.it/it/pubblicazioni/pdf-eai/n-1-gennaio-marzo-2016/17-deep-decarbonization-pathways.pdf.

The most difficult issue is, of course, not the design and development of decarbonisation pathways; rather, it is the translation of such pathways into concrete, actionable and implemented policy initiatives. In this respect, the most effective way would be to incorporate such pathways into the European Semester and to make their implementation an effective precondition for approval of national reform programmes, and even the attribution of cohesion funds. In addition, given the ongoing creation of national productivity boards at member state level (mandatory only in the eurozone), and with the hope that such boards adopt a broad definition of productivity, it would be natural to expect that such boards take the lead in the development of national pathways.[100] Ongoing research for the OECD (Renda, forthcoming) is showing that even the most established productivity commissions (e.g., in Australia and New Zealand, and also Singapore, Denmark and Norway) and recently created bodies such as France Stratégie adopt a very broad approach to productivity, which incorporates long-term well-being. These boards are being created as possible interlocutors of the Commission in the European Semester, and would then be essential actors in our re-designed European Semester (see step 9, below).

That said, the development and implementation of national deep decarbonisation pathways should not imply that all research and innovation efforts are confined within national borders. On the contrary, member states should ensure cooperation, coordination and financial support to the multi-stakeholder, challenge-led platforms that we described above under step 1, in what would become single platforms for research and innovation, able to attract multilateral funding for the exploitation of available technologies and the piloting of new business models and technological solutions.

Step 9: Embed sustainable development goals in the European Semester

Once the long-term EU sustainable development agenda has been formulated in terms of a Europe 2030 strategy, member states should be motivated to jointly contribute to the agenda. The most logical way to achieve this result is to (further) mainstream the sustainable development dimension into the European Semester.

First, in the Annual Growth Strategy and in the subsequent Country-Specific Recommendations the European Commission should devote at least equal attention to long-term reforms oriented towards sustainable development compared to what it devotes to financial stability. Currently, the opposite trend seems to be in place, with the Commission appearing more inclined to minimise the presence of environmental reforms

[100]In June 2015, the Five Presidents' Report on Completing Europe's Economic and Monetary Union set up a roadmap towards a deep, genuine and fair Economic and Monetary Union (EMU). According to the report, during the first stage (1 July 2015 - 30 June 2017) concrete progress towards an Economic Union of convergence, growth and jobs should rest on four pillars, one of which was the creation of a euro area system of Competitiveness Authorities. In October 2015 the European Commission presented a Recommendation for a Council Recommendation on the establishment of National Competitiveness Boards within the Euro Area. Final adoption is expected in September 2016. See http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0601&from=EN.

in national reform programmes. Likewise, the Competitiveness Council (possibly renamed, or explicitly adopting a very broad notion of competitiveness) could also be strengthened and placed at the same level of the ECOFIN, with both working under the coordination of a stronger General Affairs Council.

Second, a 'micro-conditionality' linked to decarbonisation and more generally to sustainable development could be introduced for the attributions of cohesion funds. Currently, the macro-economic conditionality ensures that the effectiveness of the five European structural and investment funds is not undermined by unsound macroeconomic policies, in line with the European Council conclusions of 8 February 2013. Such conditionality has both a preventive and a corrective arm. At the same time, cohesion funds have been increasingly tied to the Europe 2020 objectives especially after 2014, but the current system does not seem to be triggering sufficient coherence between member states' national reform plans and their decisions on how to spend funds from EU and national resources.

Third, national reform plans and proposed spending plans at the national and sub-national levels should be accompanied by an in-depth impact evaluation, which demonstrates that there are no better alternatives than the ones proposed, in order to reach Europe's sustainable development goals. The National Productivity Boards should be in charge of policy evaluation, as mentioned in the European Commission Recommendation on the matter.[101] This impact evaluation would have to be particularly detailed if the reforms proposed entail a derogation from the constraints envisaged by the fiscal treaty: in this case, national government would have to demonstrate that no available alternatives would at once be consistent with the fiscal treaty and achieve sustainable development goals. And all proposed reforms, besides the ex ante impact evaluations, should be accompanied by a plan to implement the identified reforms, a monitoring plan based on clear sustainable development indicators, and a time horizon for the mid-term and the ex post evaluation of the proposed reforms. The European Commission should then validate the plan by applying further conditionalities – e.g., only a country on its way to reducing the number of infringement proceedings, with a good track record in cohesion funds spending and exhibiting good progress on the (new) good governance indicators would be able to apply for flexibility.

Step 10: Use EU trade agenda and climate diplomacy to ensure leverage of existing WTO rules, and their revision if necessary, to effectively place a price on carbon and minimise carbon leakage

Leveraging EU trade policy in support of decarbonisation is an indispensable step, without which many of the other actions would be doomed to remain only partly effective. The ETC (2016, p. 9) recently observed that:

[101] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0601&from=EN.

> the shift in energy-intensive manufacturing to China and other middle-income countries has enabled high-income countries to offshore a significant percentage of their domestic emissions to offshore a significant percentage of their domestic emissions [up to 48% according to some estimates (Xu et al., 2011)].

This implies not only that redesigning the WTO (and TPP) trade rules needs to be undertaken, but also that trade policy has to be an integral and important part of the overall strategy to achieve deep decarbonisation. The reader is reminded that differences among producing nations in the cost of mitigating global climate impacts encourages the export of manufacturing abroad [Fischer (2015) p. 298]. Not only may foreign producers use cheaper (and dirtier) energy sources, they may also be generally less efficient than first-world domestic firms in their manufacturing operations. The consequence is usually that the global prices for energy go down as other [exporting] countries consume more fossil fuels. The competitiveness implications can be significant, as can the impacts on world trade activities (Carbon Trust 2009; Fischer 2015; Mavroidis and de Melo 2015; Wu and Salzman 2014).[102]

As observed by Flannery (2016), "Negotiators, economists, and policy analysts have long recognized that climate and trade policies appear to be on a collision course, without the means to reconcile differences".[103] These concerns were partly addressed by the UNFCCC with the insertion of provisions aimed at avoiding undesirable consequences (particularly Section 3.5 and 4.10). However, experts tend to agree that domestic measures such as border tax adjustments still face potential problems in terms of their compatibility with WTO obligations (Flannery, 2016; Trachtman, 2016), especially when they result in subsidies or free allowances provided to energy intensive, trade-exposed industries (Maruyama, 2011, Hillman, 2013). Trachtman (2016) observes that while border tax adjustments to emissions inherent in a product and its use seem to potentially comply with WTO rules, the same does not occur for emissions associated with the production process (e.g., from electricity use). In addition, he argues that differential treatment of WTO member states aimed at reflecting differing carbon intensities could end up violating the Most Favoured Nation obligation; and that in any case, to qualify for an exemption might entail a burdensome process of demonstrating that there were no alternatives available that would be less restrictive for trade.

The EU trade agenda should increasingly focus on guiding the debate on the review, revision, and implementation of climate-friendly WTO rules, especially for what concerns the possibility to place a price on carbon through global mechanisms, or through the clarification of the legal treatment of domestic solutions such as border tax adjustments.

[102]China's exports are eight times as carbon-intensive as those of the EU and three times as those of the US" [Atkinson et al. 2011 quoted in Fischer (2015) p. 305].
[103]Flannery, B. E. (2016), Carbon Taxes, Trade, and Border Tax Adjustments, RFF policy Brief 16-02, at http://www.rff.org/files/document/file/RFF-PB-16-02.pdf.

4. CONCLUDING REMARKS

This report has sought to show, among other things, that what is needed in order to achieve an EU low-carbon system transformation is an integrated approach that addresses a wider set of sustainable development goals. These goals are reflected in the UN's Sustainable Development Goals and necessarily include economic welfare (competitiveness), environment, and employment. The goal of an EU low-carbon system transformation is thus embedded in the EU's sustainable development strategy. This EU strategy is in turn nested within a global sustainable development strategy. Since a low-carbon system transformation ultimately requires coordination, if not integration into the global system, trade policies and strategies take on special importance.

Specific EU policies/strategies/approaches receiving attention in this report are those that focus on innovation, better regulation, trade, and industrial policy/economic growth. The latter may well conflict with advancing sustainable development and an EU low-carbon system transformation. Indeed, concerns for industrial competitiveness as well as prospects for the future of employment routinely surface, as well as the expectation that achieving the goals of COP21 may be quite different from achieving deep decarbonisation. Short- to medium-term strategies need to be consistent with and reinforcing of longer-term strategies of deep decarbonisation.

The report serves to clarify important distinctions in this regard. If further notes that different levels of governance (Member States/regions/cities) may have advantages over approaches at the EU-level. A somewhat related point is that while some initiatives need to address sectoral changes, more universal structural changes that transcend a sectoral focus are needed. This is especially true in fashioning better regulation, focusing on the appropriate level of regulatory stringency as a motivator for change. The energy extraction, generation and transmission sector(s) differ from the intensive energy-using sectors (manufacturing, housing, agriculture, and transportation), and further differ from general energy use by consumers, citizens, government and industry reflecting concern for the circular economy. Finally, the limits of heuristics such as cost-benefit analysis, policies that fail to distinguish achieving energy efficiency from energy utilisation and consumption, failure to distinguish static from dynamic efficiency – and diffusion from innovation, and theoretical versus practical advantages of prices versus regulation versus mixed instruments such as cap-and-trade are all the subject of discussion throughout the report.

Finally, this report is intended to provide guidance to stimulate change in the process of policy design and implementation by the EU. While implementing all the ten proposed steps would be ideal from our perspective, the individual implementation of many of them would already add value to the current policy process at EU level. It is our hope that our proposal serves as impetus to the EU to think in a broader and more integrated way about these as yet intractable problems.

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There is a growing awareness that climate change is posing an existential threat to humankind, and that deep decarbonisation should therefore be placed at the forefront of public policies. This requires that existing policies be aligned with this crucial long-term objective, and that existing regulation promote the systemic innovations that can lead to decarbonisation.

In this accessible and timely report, Nicholas Ashford (MIT) and Andrea Renda (CEPS and Duke University) look at EU policies and propose ten steps to align EU rules with long-term objectives. As such, this endeavour bears important consequences for the EU's better regulation strategy, innovation policy and sectoral policies in many fields.

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