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Low-carbon and Energy Strategies for the EU

The European Commission's Roadmaps: A Sound Agenda for Green Economy?

Renewable energy sources will play a prominent role in Europe's low-carbon economy and energy system in the future. But the European Commission holds reservations against a power sector completely based upon renewable energies because it underestimates their low-cost potential. Even more optimistic results could have been reached if several methodological biases had been avoided. And the potential for greening the economy in Europe could be far bigger. However, political and institutional factors might have influenced the assumptions and methodological choices.

Christian Hey

Low-carbon and Energy Strategies for the EU. The European Commission's Roadmaps: A Sound Agenda for Green Economy?
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Two communications by the European Commission, the *Roadmap for Moving to a Competitive Low-carbon Economy* (*Low-carbon Roadmap,* European Commission 2011 a) and the subsequent *Energy Roadmap 2050* (European Commission 2011 b), offer a framework for the transformation of Europe's energy economy. The *Low-carbon Roadmap* sets an overall mitigation target for 2050, a sectoral break-down of this target, and milestones to be achieved in the interim decades. Key targets are an overall 80 percent greenhouse gas (GHG) emissions reduction by 2050 and a 25 percent reduction by 2020. The *Energy Roadmap 2050* specifies how the energy sector, particularly the power sector, should contribute to meeting the reduction targets.

The approach of the European Commission must be seen in the context of the current green economy debate (OECD 2011), which discusses ways of decoupling resource consumption and economic growth. The green growth concept is based on the assumption that there is no fundamental contradiction between the objective of keeping human activity within safe boundaries (Rockström et al. 2009) and continued economic growth. But the green growth promise needs to answer critical questions: To what degree can economic growth and far-reaching GHG reductions be achieved simultaneously? Can this decoupling be accomplished without shifting problems from one environmental issue to another? Is a technology neutral approach to decarbonization appropriate?

Overall Assessment – the Economic Rationale

The green growth agenda is challenged from two sides: on the one side, neoclassical economists tend to perceive pollution abatement as a cost and see little economic rationale for unilateral action to protect the global commons (Sinn 2008, Wissenschaftlicher Beirat beim Bundesministerium der Finanzen 2010, SVR 2011, chapter 6). On the other side, the emerging de-growth literature raises doubts about the technological optimism of the green growth agenda with the arguments that backstop-technologies are not always available, that one-dimensional solutions might create new problems in other areas, and that the rebound effect will limit the success of resource efficiency strategies (Jackson 2009, Seidl and Zahrnt 2010, Sorrell 2010, Westley et al. 2011).

The *Low-carbon Roadmap* and the *Energy Roadmap 2050* provide arguments against both of these sceptical schools of thought. The economic modelling underlying the roadmaps suggests that in the case of GHG mitigation the green growth promise is realistic. The European Commission develops an interesting counterargument against claims that unilateral mitigation increases cost, but does little to save the climate. The key point is that cost differences between a European low-carbon economy and the rest of the world – and therefore potential negative effects on European competitiveness – are limited, both in the case of coordinated global action and in the case of unilateral action. Coordinated global action creates a level playing field among regions; hence higher mitigation costs will not lead to a competitive disadvantage. In the case of unilateral action for GHG mitigation, the European Commission works on the assumption that there will be a consid- >

Contact: *Dr. Christian Hey* | German Advisory Council on the Environment (SRU) | Luisenstr. 46 | 10117 Berlin | Germany | Tel.: +49 30 2636960 | E-Mail: christian.hey@umweltrat.de

erable increase in fossil fuel prices due to the continued growth of global energy demand. The resulting higher prices would lower the differential cost between a low-carbon and a business-as-usual economy (European Commission 2011 c). This justifies the claim by the European Commission that the *Low-carbon Roadmap* is in line with the *Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth* (European Commission 2010 b). This point is enhanced by the *Energy Roadmap:* in 2050, overall energy system costs will be similar in all scenarios including the reference scenario, which only assumes an overall reduction of GHG emissions of 40 percent (European Commission 2011 d). The key difference between a moderate and a low-carbon scenario is that – independent of technology choice – a low-carbon scenario requires a considerably higher level of capital investment during the transition period.

Positive Driver for Development

The European Commission does not interpret this investment purely as a cost – as mainstream economists would tend to do – but rather as a positive driver for the development of lead markets for low-carbon technologies, for technological innovation and, ultimately, for economic growth. It estimates that the transition to a low-carbon economy would need an additional investment of 1.5 percent of European gross domestic product, which would bring investment in the European economy back to pre-crisis levels (European Commission 2011 a). In effect, the *Low-carbon Roadmap* is considered as an instrument to avert the pending economic crisis. As additional benefits, the European Commission mentions lower vulnerability to energy price fluctuations and other environmental and health benefits. These broader co-benefits of investing in a low-carbon economy are not sufficiently taken into account by mainstream economists.

The 2050 target of a domestic 80 percent GHG emissions reduction is, however, only at the lower end of the range of required emissions reductions. It still leaves scope for economic optimization and burden sharing among different sectors' reduction efforts. A 95 percent target would require the full mobilization of all available options independent of costs (Öko-Institut and Prognos AG 2009).[1] It would, of course, be interesting to see if such a more ambitious target is also compatible with the green growth promise (Edenhofer et al. 2009, Hulme et al. 2009) or if it requires changes beyond the transformation of technological systems. Such an analysis would contribute to a better-informed discussion on the more recent new limits to growth debate (Jackson 2009, Sorrell 2010). Due to considerably higher costs, this target might risk coming into conflict with short-term economic growth objectives, but as unmitigated climate change will also have negative effects on the economy, this trade-off would merit more serious reflection.

A Long-term Transformation

A successful long-term transformation also needs an effective early start. The *Low-carbon Roadmap* fails to launch an initiative to achieve a more ambitious short-term reduction. The existing 20 percent GHG emissions reduction target for 2020 (adopted by the EU institutions in 2008) will be easy to achieve due to the drop in emissions caused by the current financial and economic crisis. Even though the European Commission and other study groups warn about delayed action (European Commission 2010 a, Jaeger et al. 2011), there is no winning majority in the Council of Member States for moving towards a 30 percent target. Many studies – and indeed the European Commission's own analysis – show that an overly slow reduction curve in this decade may increase the risk of getting locked-in technologies which deliver modest reductions today but are incompatible with the 2050 targets. Modest short-term reductions will require an even steeper reduction curve later. This could lead to stranded investments and/or a failure to meet the targets (Unruh 2000, SRU 2011 a, chapter 8). The problem of technological lock-in is especially persistent in the power and the transport sectors. If, for instance, modest targets do not discourage investments in new coal power plants, then this new generation capacity may dominate the sector for decades and make the transition to low-carbon sources more difficult. The same applies for long-lived infrastructures, which might become obsolete in a low-carbon economy. Overall, the *Low-carbon Roadmap* paints a fairly optimistic picture, but it leaves a number of key questions unanswered, namely on how to start the transition early and on the economics of a more ambitious GHG target.

Technology Choices: Technology Neutrality versus Priorities?

In the context of the climate mitigation debate the concept of technology neutrality plays a key role. Technology neutrality means that all low-carbon technologies – nuclear energy, coal and gas with carbon capture and storage (CCS), and renewable energy – are equally welcome as long as they deliver emissions reductions at competitive costs. Technology choice is usually considered to be market-driven and not policy-driven. An ideal-type technology-neutral transition towards a low-carbon economy is often presented as a "cap-and-trade" system in which mitigation costs and their relationship to the carbon price determine technology choice. However, the idea of technology neutrality has a number of prob-

1 Adopting the so-called budget approach proposed by the German Advisory Council on Global Change (WBGU 2009) would imply that industrialized countries need to achieve a reduction of more than 90 percent in order not to exceed their fair share of a global budget of 750 gigatons GHG emissions between 2010 and 2050. This global budget is calculated on the assumption that with this level of reduction it is with a high probability possible to avoid a temperature increase above two degrees Celsius. National carbon budgets are then determined on the basis of an equal per capita allocation.

lems being also related to the critical green economy discourse. The concept invites a shifting of problems – the solving of one problem at the expense of creating another. Measures to mitigate GHG emissions can often have negative effects on other environmental objectives, such as maintaining the life-supporting functions of ecosystems, respecting biodiversity targets and minimizing risks to future generations (SRU 2011 a, chapter 2). There are also more technical problems. Infrastructure needs, for instance, may in some cases be technology-specific. A massive deployment of off-shore wind energy in the North Sea would require strong north-south grid connections to bring the electricity from its source to consumers in the south (see figure). In contrast, a nuclear energy strategy is best served by east-west interconnectors that can make full use of France's nuclear energy.

Technology neutrality also assumes that all technologies can coexist in harmony. But traditional large-scale electricity generation is not easily compatible with high shares of intermittent renewable sources, as the latter would require more flexibility than the former can offer, both technically and economically. Finally there is a political dimension: not all low-carbon technologies are publicly accepted. This is especially the case for nuclear energy after the Fukushima nuclear disaster. Cost considerations, therefore, should not be the only decision criterion used when making a choice between low-carbon technologies.

FIGURE: What technologies will guarantee Europe's energy supply? The European Commission relies on renewables like off-shore wind turbines – however, other low-carbon technologies should play a certain role as well.

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Officially, the European Commission's approach towards the low-carbon economy is technologically neutral (European Commission 2011 b). The idea of technology neutrality reflects the institutional constraints of the EU (Calliess and Hey 2012, SRU 2011 a, chapter 6). Two of the EU's essentially constitutional characteristics – the internal market and the Lisbon Treaty – limit the competence of the EU to steer directly the choice of energy sources, as this would be inconsistent with the principles of a liberalized European energy market and with matters deemed to be of national sovereignty.

Low-carbon Energy Scenarios

Such arguments against technology neutrality are not reflected in the *Low-carbon Roadmap* and only to a very limited degree in the *Energy Roadmap 2050*. This can be illustrated with the example of the power sector. The suggested reduction pathway for the power sector is ambitious: the EU Commission proposes a close to complete GHG phase-out by 2050 (93 to 99 percent). This is based upon economic assessments that suggest that the power sector has the lowest long-term mitigation costs. The *Low-carbon Roadmap* assumes that in 2050 renewable sources will account for 50 to 55 percent of total electricity production, whereby a continued reliance on nuclear and coal and gas with CCS fill the gap (European Commission 2011 c).[2] But it has turned out in 2011 – after the Fukushima accident, when the German energy policy changed away from nuclear energy and considerable problems with the development of CCS became evident (Esken et al. 2010, Knopf et al. 2010) – that a decarbonization strategy mainly relying upon a nuclear renaissance and strong deployment of CCS is illusionary. Following this path will undermine the credibility of the low-carbon agenda.

This may explain the different approach of the *Energy Roadmap 2050* which is much more favorable for renewable energies. Its analysis uses the same data but adopts a different approach and compares the respective economic performance of different low-carbon technology mixes. Furthermore, it abstains from expressing a preference for any particular technology mix, but energy efficiency plays an important role in all scenarios. In the five different low-carbon scenarios, renewable sources achieve a share between 59 and 97 percent of total electricity generation. So even in a "nuclear scenario", the assumed growth of nuclear generation is minimal compared to the assumed growth of electricity from renewable sources. In sum, the European Commission outlines that the share of electricity generated from renewable sources will at least be able to quadruple between 2008 and 2050. In addition, the Commission concludes that overall ener- >

2 This is quite close to the scenarios commissioned by or written in close cooperation with the European power sector (EURELECTRIC 2011, ECF 2010).

gy system costs will not differ significantly between the scenarios and that they will reach levels of around 2 600 billion Euro annually between 2011 and 2050 (European Commission 2011 d, table 6). So while rhetorically advocating a technology-neutral approach and emphasizing the benefits of nuclear and CCS technology, the analysis of the European Commission effectively makes the case for a transition towards renewable energy as the dominant, yet not the only low-carbon source of electricity.

Interestingly, therefore, the high renewables scenario does not fare well in the Commission's opinion. There is a cost leap between a renewable share of about 60 percent and one of 97 percent: the high renewables scenario leads to the relatively highest electricity price increases of 82 percent – compared to ranges of 34 to 52 percent in the other scenarios (European Commission 2011 d, p. 31). The average price after tax, covering running, and investment cost per megawatt hour electricity, is assumed to amount to 199 Euro. This is between 35 and 52 Euro higher than in the other scenarios (European Commission 2011 d, table 10). The Commission identifies a number of reasons for this significant difference. The renewable scenario requires the highest infrastructure investments, which are 30 to 40 percent above the investment needs of the other scenarios running up to 2050, mainly for electricity storage and connecting off-shore wind energy to the grid. Further cost drivers are very high installed capacities compared to electricity generation. Due to a lack of assumed storage capacity, the scenario requires fossil fuel-based power plants with CCS with a capacity of 53 gigawatt to back up intermittent renewable power. Overall, the relatively weak performance of the renewable energy scenario is primarily due to a number of outdated cost-driving technology assumptions related to the high volatility of renewable energy sources, which do not appropriately reflect the state of knowledge in this field. For example, by far the cheapest available storage technology is pump storage in combination with existing hydropower generation. The German Advisory Council on the Environment (SRU) has identified considerable low-cost pump storage potential in Norway, which, if used, could scale down considerably renewable electricity generation overcapacities and reduce storage costs (SRU 2011 b).[3]

Conservative Assumptions

A further bias of the analysis underlying the *Energy Roadmap 2050* is that its assumptions on cost reductions as a function of market penetration are extremely conservative, especially with regard to wind power, which will dominate the renewable power mix. The argument put forward by the European Commission that no significant cost reductions for wind energy (maximum minus ten percent) can be expected by 2050, is not in line with current research. For example, the German Research Centre for Aeronautics and Space (DLR) quotes cost reductions of 75 percent for offshore wind energy over the same period (SRU 2011 a, p. 89). Also the more conservative *Technology Roadmap* by the International Energy Agency (IEA 2009, p. 17) assumes cost reductions of 23 to 38 percent for wind energy (see also IPCC 2011, p. 591).

There are also considerable doubts whether the assumed cost reductions for nuclear power and CCS technology hold up to close scrutiny. As the Commission itself argues, additional investment will be needed in order to minimize nuclear risk and to comply with an ambitious safety philosophy. Nevertheless, the scenario works with a drop in capital costs for the third generation of nuclear reactors by close to 20 percent between 2010 and 2050.

It is beyond the scope of this article to analyze whether the *PRIMES Model*, which is at the core of the energy system simulations for the European Commission, is accurately designed to calculate an optimized renewable power mix which addresses the issue of intermittency, energy storage, and grid investment. An alternative model which simulates a cost-optimized renewable power mix on an hourly basis is the *Remix Model* by the DLR. It has been used by the SRU to identify a low-cost, fully renewables-based power mix for Europe and North Africa. This model is part of a backcasting approach, starting from a defined situation in 2050: a 100 percent renewable electricity scenario that was calculated for 36 countries of the European and North-African region. Backcasting is structurally prone to provide more optimistic results for system transitions than forecasting approaches inherent in the *PRIMES Model* (Hertin et al. 2010). The result of the SRU-DLR scenario for the EU is in sharp contrast to that of the analysis carried out by the European Commission, as it puts the average cost of a fully-renewable power system at 65 Euro per megawatt hour (SRU 2011 b, annex I). Although the figures cannot be directly compared with the *Energy Roadmap 2050* scenarios due to methodological differences, they show that other long-term scenarios arrive at considerably lower costs than that of the European Commission.

Conclusion

The European Commission has undergone a notable change from a one-sided pro-nuclear agent in the early 1990s (Hey 1994) to an advocate of a balanced low-carbon energy mix and later to a moderate supporter of a system mainly relying on renewable electricity. However, it continues to hold reservations against a power sector completely based upon renewables. The arguments used to support these reservations are flawed. On the other hand, a fundamental system preference might be premature, considering the energy policy orientations of most member states, the limited competence of the EU to define the national power mix, and the influence of the power sector in the EU. If the current trends

3 The union of the electricity industry EURELECTRIC (2011) has also identified unused pump storage potential in Europe's mountainous regions, which would at least double existing storage capacity. Moreover, CAES technology (Compressed Adiabatic Air-Energy Storage), which has considerably higher conversion efficiency than hydrogen-based storage technologies (SRU 2011 b), has not been systematically analyzed by the Commission.

seen with the dynamic development of renewable electricity and the relative stagnation of conventional power continue, the current rather moderate pro-renewable position may still be reviewed and strengthened in later policy cycles.

The *Low-carbon Roadmap* and the *Energy Roadmap 2050* make impressive cases for the green growth agenda. The roadmaps and the extensive research presented in the impact assessments accompanying them show that deep cuts in GHG emissions and the required transformation of the energy system within a few decades are compatible with a growth agenda. The Commission shows that the necessary investments and the technological innovation associated with those investments can help stabilize the economy and improve competitiveness. There is a lead market advantage that can come from an early reduction of GHG emissions. It is also shifting over to the politically and institutionally difficult path of advocating for renewable energy sources as the dominant energy in the decades to come. Rhetorically, however, the Commission continues to insist on a technology-neutral approach of decarbonization as this is more compatible with the institutional and political realities of the EU than is a clear-cut technology system decision.

A thorough analysis of the required transformation suggests, however, that a successful and efficient political strategy for a low-carbon energy system should not be based on the concept of technology neutrality. The reason is that this might risk the creation of systemic inconsistencies between different technologies and a shifting of problems. Instead, the strategy should be driven by technology choices that make use of sustainability criteria. Energy efficiency and renewable energy development that occurs within a strong framework for protecting biodiversity should merit priority treatment.

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Christian Hey

Born 1961 in Saarlouis, Germany. Diploma in science of public administration and a PhD in political sciences. Doctoral thesis on sustainable mobility in Europe. Secretary General of the German Advisory Council on the Environment (SRU) and Chair of the Energy Working Group of the European Environment and Sustainable Development Advisory Councils (EEAC). Research interests: EU environment, transport, energy policy and governance.