Reflections on the Eurelectric Study "Power Choices - Pathways to Carbon-Neutral Electricity in Europe by 2050"

Working Paper for the EEAC Energy Working Group Seminar

"Scenarios and Policies for Decarbonisation"

Brussels, March 22nd 2010

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Introduction

The full decarbonisation of the power sector is on the EU Agenda. Commission President Barroso addressed this in his "Political Guidelines for the next Commission" (BARROSO 2009) and the European Council in principle confirmed its commitment to the idea in October 2009. Energy scenarios are being prepared or have been published on how to achieve this transformation of the power sector. One of the politically most prominent scenarios is the "Power Choices" scenario prepared for the European umbrella organisation of the national federations of the power industry, Eurelectric.

The overall commitment to decarbonisation in the Power Choices scenario has a number of problematic assumptions and claims, which basically would preclude a transition to a truly sustainable power sector with renewable energy becoming the energy source for the EU. The following analysis highlights some of the most problematic aspects.

Short summary of the "Power Choices" Scenario Study

The "Power Choices" study (EURELECTRIC 2009) uses a computer model to simulate an annual reduction of the emission allowances by 1,74% up-to 2050 under the European Emissions Trading System (ETS) and the extension of the ETS to all sectors, gradually phasing out support schemes for renewables after 2020. The standard scenario takes as its starting point the political situation in early 2009 on nuclear phase out decisions in Germany

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and Belgium. The cross sectoral carbon price is expected to increase to 100€ /t CO2 by 2050. The scenario is simulated using the Primes Model, which is a state of the art “partial equilibrium” model of the energy sector widely used by the European Commission for scenario analysis and impact assessment. The ETS-driven energy mix is considered optimal from an economic efficiency point of view.

The result of this European scenario is “target achievement”, i.e. a 75% reduction of CO2 emissions over the period 1990 to 2050. The scenario assumes a considerable increase in electricity demand from 3,100 TWh in 2005 to 4,800 TWh in 2050, mainly due to the electrification of the transport sector and a growth of renewable power by factor 4 to 1800 TWh. Renewables are to reach a share of 38% of the total electricity supply. This is not, however, a very ambitious vision. The 38% share igoes little beyond what will be achieved by 2020 as a consequence of the targets of the directive for renewable energies. Some of the 95% carbon-intensity improvements and much of the growth in renewables are eaten up in the scenario by the expected electricity growth. The power mix envisioned consists of renewables, nuclear and CCS. The average electricity cost is calculated to reach 77 €/MWh after peaking in 2025 at a level of 89 €/MWh.

Seven propositions on the “Power Choices” study:

1) Long-term scenarios are analytical tools, not prognoses

Scenarios are tools for reflection. They highlight choices, opportunities and trade-offs, but they do not predict the future, nor can they claim to provide definitive answers about the optimal energy mix. Any scenario for a long-term future has to deal with a wide range of uncertainties which must be reduced by making assumptions, for example on fuel costs or dynamics of technology development. Diverging assumptions and methodology choices mirror this uncertainty about the future and perhaps also the preferences of the authors. In that sense it has to be appreciated that Eurelectric expresses a commitment for considerable emissions reductions. On the other hand, other scenarios are available which show the plausibility of more fundamental transformations. One key difference between different scenarios is whether they adopt a backcasting approach that takes as its starting point the end goal of a a future where the energy system is decarbonised, sustainable, secure and affordable and then identifies a road-map for reaching this goal or a forecasting approach, which starts from the current infrastructure and models the reactions of the economy and the energy system to policy interventions (for example through the Emissions Trading System). The latter approach systematically comes to more conservative conclusions.

The German Advisory Council on the Environment is working on a modelling-based study which shows that EU and German electricity demand can be fully met through renewable energy by 2050 at cost levels similar to or lower than the Power Choices scenario while ensuring security of supply (SRU 2009). The full report will be published in October 2010, however first results may be publicly available earlier. A large share of base load-oriented coal and nuclear power stations - as suggested by the Eurelectric study - is, however, incompatible with a largely renewables-based electricity system which requires quick-start generating capacity to balance intermittent renewable supply (SRU 2009; EEAC 2009).

2) The "Power Choices" Scenario does not meet the new EU mitigation target

The reduction path established by the 2009 ETS directive is not anymore in line with the October 2009 European Council conclusions, indicating an 80 – 95 % reduction of greenhouse gas emissions in order stay within the 2°C temperature increase ceiling. Therefore, the mitigation target implicit in the study is too low, especially given that there is a consensus that the electricity sector will have to make a larger contribution to the overall mitigation target than other sectors where decarbonisation is more difficult to achieve (e.g. agriculture). There is also some doubt whether the specific mitigation effects of CCS (in the range of 90% compared to a conventional plant) will be sufficient to meet the new level of ambition. Therefore, an additional reduction of emissions by up to 20 percentage points has a serious impact on the EU power mix.

3) Power Choices appears to make overly optimistic assumptions on CCS

The basic assumptions of the Power Choices scenario on economic development and electricity demand are in the medium range when compared to a selection of other major modelling scenarios that cover the EU (INTERNATIONAL ENERGY AGENCY 2009; JOCHEM und SCHADE 2009; HULME et al. 2009; MATTHES et al. 2006; EUROPEAN RENEWABLE ENERGY COUNCIL (EREC) und GREENPEACE INTERNATIONAL 2008; EDENHOFER et al. 2009). The average annual rate of GDP growth (1.7% for 2005-2030 and 1.6% for 2031-2050) is comparable to that used in the ADAM study (1.6%) (JOCHEM und SCHADE 2009) and the WEO-EU scenario (1.5% up to 2030) (INTERNATIONAL ENERGY AGENCY 2009). The net electricity demand modelled in "Power Choices" (4763 TWh in 2050) represents a slight rise in comparison with the reference scenario used in the study (4533 TWh) and a considerable increase when compared to current electricity demand in Europe which stands at about 3,325 TWh (INTERNATIONAL ENERGY AGENCY 2009). The increase of electricity demand is, however, partly due to the increased use of power in the transport sector, an assumption that is plausible and made by many other modelling studies. The different modelling studies vary considerably in relation to the electricity demand they project for 2050, ranging from 2750 TWh in one of the ADAM 400ppm scenarios to more than 6500 TWh in several of the RECIPE and ADAM scenarios (JOCHEM und SCHADE 2009; EDENHOFER et al. 2009).

With 1812 TWh and 38% of net electricity demand, both the absolute and the relative amount of electricity from renewable sources modelled in the “Power Choices” study are at the lower end of the spectrum provided by analysed studies. In the WEO policy scenario, renewables already reach a share of 44% in 2030 (INTERNATIONAL ENERGY AGENCY 2009), in the analysed ADAM and RECIPE scenarios, the share varies between 34 and 75% (JOCHEM und SCHADE 2009; EDENHOFER et al. 2009). EREC/Greenpeace have the highest share with 86% (EUROPEAN RENEWABLE ENERGY COUNCIL (EREC) und GREENPEACE INTERNATIONAL 2008). The analysis of the reasons for this low share of renewables would require a detailed review of the methodology of the study and the assumptions behind the “Policy Choices” scenario, particularly the available technologies, relative costs and potentials, the development of oil price, and so forth. This analysis cannot be done at the current time because Eurelectric has so far only released a short summary of the full report. It is notable, however, that in comparison to other studies, the power mix is not as dominated by nuclear power, but rather characterised by a high share of fossil fuels. Only one of the RECIPE scenarios has an even higher share of power from fossil sources than the 35% put forward by “Power Choices” (EDENHOFER et al. 2009). In the WEO policy scenario the share drops to 26% already in 2030; even the WEO 2030 *reference* scenario (which is estimated to lead to 1000ppm in atmospheric concentrations and 6°C warming) has only a modest 48% share of fossil-based power (INTERNATIONAL ENERGY AGENCY 2009). This power mix suggests that the “Power Choices” study’s assumptions on the availability and cost of CCS technology and on storage capacities in Europe are more optimistic than those adopted by other studies.

4) The ETS does not necessarily achieve portfolio optimum

The “Power Choices” scenario assumes that a single market based instrument, the ETS, will deliver an “optimum energy portfolio”. The concept of an “optimal portfolio”, however, raises a number of questions. EU energy policy always has to achieve multiple, interlinked objectives, but “optimization” only determines what is best from an economic perspective. Therefore, while an “optimum energy portfolio” achieves the mitigation target at minimum abatement costs, other policy objectives are neglected. The “optimum portfolio” is consequently not necessarily the politically most desirable power mix.

Furthermore, even assuming a single purpose policy, the idea of an “optimal portfolio” has serious flaws. First, what is optimal in the presence or in the near future (static efficiency), does not need to be optimal in the long-term (dynamic efficiency). For example, it might be cost-efficient to invest in more efficient conventional energy in the portfolio in the short run, but if a longer-term perspective is taken, the energy system might be locked into a power supply structure, which is not able to meet Europe´s decarbonisation needs. An early shift towards renewable energy appears more favourable. Full decarbonisation in the power sector will only be met with great certainty, if renewable energy becomes the main energy source. In addition, the cost for renewable technology can be expected to decrease drastically. Calculations by the German Aerospace Center (DLR) for 2050 made for the SRU will show that renewable technology will be (more) competitive than conventional resources. Second, while an ETS may deliver a portfolio optimum in a perfect market, such an assumption is unrealistic for the energy sector. Market imperfections, such as oligopolistic supply, the need for the regulation of natural monopolies, massive state intervention with open and hidden subsidies (coal subsidies or nuclear waste policy), and market rigidities as well as path dependency, real-life loopholes and distortions of the ETS raise doubts about the ability of one single instrument to deliver an "optimal portfolio". If such "real world properties" are incorporated in models such as "Primes", the results can differ considerably from a hypothetical optimum.

Problems with the "optimal portfolio" concept can best be illustrated by the "lock-in effect" (UNRUH 2000). Neoclassical economic theory assumes perfect markets and fully informed, optimizing agents who make optimal technology choices. The reality is, however, that the power sector can be locked into a centralized, capital-intensive supply sector consisting of large-scale coal or nuclear based plants. Path-dependency, as result of long economic life-cycles, earmarked infrastructure or specialized technological competence therefore can hinder market-driven innovative transitions towards a different energy system. Investments in the energy sector have high fixed costs which take decades to be amortised. As a result, firms are reluctant to invest in more sustainable alternatives until earlier investments are recouped. In free electricity markets without special support for renewable electricity (e.g. priority grid access and adequate remuneration of invested capital) financing renewable energy projects become unprofitable because investors are not adequately compensated for their invested capital (BODE und GROSCURTH 2008).

A further barrier to only market driven transition is the reality of electricity markets. Electricity prices follow the merit order curve and are set equal to the marginal cost of the last provided unit. As renewable energy sources have low variable cost (almost zero), greater shares of renewables than today can be expected to decrease the electricity price (SENSFUß und RAGWITZ 2007). Because of the very slow start-up times of conventional power plants, it is economically sensible for these plants to keep producing electricity even at times when this is more expensive than their variable production costs, that is at times when renewable energy supply is high (e.g. when the wind blows). An oversupply of electricity can result and this in turn may result in very low or even negative prices. The higher the share of renewable energy, the more often this situation will occur, and the more difficult it will be for investments to be recovered. Power plants that are already written off will have a comparative advantage and new investments in renewable sources will as a result not be profitable. Renewable energy support schemes must therefore continue in the future (although not necessarily in their current form) in order that investors will continue to provide monetary support for renewable projects.

Furthermore, increasing returns to scale of existing technologies encourage energy companies to increase production volume (and not to search for alternatives) so that unit production costs decline. Firms have greater incentives to improve and continuously specialise on existing technologies in order to increase their market power than to structurally change a system that could make their current products obsolete (UNRUH 2000). Instead of developing a sustainable system, a technological lock-in of existing technologies and infrastructures is created.

This lock-in is further intensified by a network of systemic inter- and intraindustry as well as private and public institutional relations (UNRUH 2000). These actors share a common interest in a continuation of the status quo and will coordinate their efforts. Even public institutions add to the effect as their interventions through fossil fuel and nuclear subsidies create perverse incentives to stick to current structures.

A single policy instrument in the form of the ETS is unlikely to overcome the carbon lock-in. A political framework is needed, which encourages new actors to enter the market and break through barriers to structural change. Also, investments in renewable energy need greater planning reliability than the ETS alone can provide in its current form. Historically, the carbon price has been too low and fluctuating to encourage fundamental innovation.

In short, “Power Choices” simply tells the reader, what – on the basis of a state of the art model - might happen to the energy sector if you assume a carbon price associated with a given carbon cap. The result is a choice but it is far from an “optimum” choice and from sustainability.

5) Some questions to the economics of the power mix

The power mix derived by the Primes model for “Power Choices” scenario for 2030 consists of 38% renewables, 27% nuclear power and 35% fossil fuels.

This assumes considerable investment in new nuclear and CCS technology after 2025. As those investments are model driven, some questions about the model arise:

- How does the model incorporate evidence that by 2030 renewable energy might become more competitive than CCS?
- Does the model incorporate the recent and unexpected rise in the construction cost for the new generation of European pressurized reactors?
- To what extent does the model anticipate conflicts between intermitting and traditional baseload power energy (according to the PRIMES authors it does not)? Intermittent

energy requires flexible dispatch and storage capacities; yet,the degree of flexibility especially of new nuclear and CCS based power plants is limited. Such conflicts can be expected already at the levels of renewable energy assumed in the study (SRU, 2009, IWES 2009, ….).

In total, the "optimal power mix" as assumed in the "Power Choices" Study tends to ignore new technology trends as well as the technical properties of conflicting power sources. This leads to the paradox that a renaissance of nuclear and coal with CCS is foreseen exactly at the point in time when a broad renewables portfolio is expected to become competitive. This may lead to a slow down or even barriers to renewables growth, as investment for grid extension and other infrastructures for renewables and conventional power compete and the priority grid access for renewables might be endangered due to economic and technical arguments in favour of full baseload energy capacity utilization.

6) The resulting power mix cannot be considered "sustainable". Nuclear energy still faces the unresolved problems of safe nuclear waste storage, limited uranium resources, proliferation risks of fuel recovery and nuclear safety. Due to these risks, nuclear energy faces acceptance problems in many Member States. Coal with CCS technology is not yet proven on a large scale, involves the risk of leakage and is associated with considerable efficiency loss which leads to additional coal demand and price risks and environmental consequences. Similar to nuclear power, it also faces large acceptance problems among local populations. Furthermore safe storage capacities are a limited resource and face serious use conflicts either with other uses for renewable energy (geothermal energy, energy storage) or with other processes which require CCS as the only decarbonisation option (e.g. industrial use).

Renewable energy, on the other hand, is land-use intensive. This implies considerable potential conflict with biodiversity and climate sensitive land-use changes. This implies that renewable energy is not per se "sustainable", but studies indicate, that renewables potentials by far exceed demand forecasts even if areas with potential land-use conflicts are excluded (EEA 2009).

Overall, it is not sustainable to rely on such unsustainable energy sources longer than needed for security of supply reasons.

7) Conclusion: Backcasting is more suitable for the analysis of sustainable solutions than forecasting

The outcome of economic models such as Primes and a socially desirable outcome will always differ, as long as studies do not fully incorporate

1) a comparative analysis of all external costs of all energy sources (e.g. limited liability for risk of nuclear accidents) ,
2) electricity market properties, such as the link between plant utilisation and costs,
3) or the need to cover total costs at prices set by variable costs, and
4) dynamic efficiency.

The “Power choices” scenario study does not meet these requirements. The projected emissions reductions are not in line with necessary mitigation levels to achieve the 2°C target. The study also does not account for the problem that conventional power plants need to run on constant, high power to be economically viable. Furthermore, it also neglects the problems new plants face to cover their total costs. Lastly, a single instrument approach as envisioned in the study does not meet dynamic efficiency criteria.

For these reasons, the German Advisory Council on the Environment (SRU) favours a backcasting approach which starts with a vision for a desirable future and designs a road-map backwards to the present. The need to fully decarbonise the electricity sector by 2050 is more and more widely accepted. Only an extensive development of renewable energy can ensure that this aim will be met. Based upon the work of DLR and analyses done by EEA, EWEA, EREC, Stockholm Environment Institute and Greenpeace, the EU has sufficient potential to achieve 80 - 100% renewables based electricity by 2050 at competitive overall cost to other decarbonisation options. As we have the choice, there are compelling arguments for keeping the pathway towards the most sustainable option open and to take adequate decisions now.

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