

AN 80% CARBON-FREE EUROPE IN 2050, WHAT IMPACTS ON THE EUROPEAN ELECTRIC GENERATION TECHNOLOGIES USES?

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ABSTRACT

Overview

Climate change is the focal point of all attentions in Europe and the limit of a 2°C temperature increase above pre-industrial levels is a widely accepted target. In order to achieve that goal, the European Council confirmed the objective of reducing the greenhouse gases (GHG) emissions in Europe by at least 80% in 2050 compared to the levels of 1990 [1]. One of the most talked-about analyses of this subject is the European Climate Foundation's *Roadmap 2050, a practical guide to a prosperous, low-carbon Europe*. This report stipulates that the key to decarbonize Europe by 80% was to mitigate the emissions of the power generation sector by 95%, so it focuses on the elaboration of three scenarios dealing with different electric mixes. The scenarios are back-casted to prove their feasibility, so they are not cost-efficient [2].

What kind of electric mix could be cost-efficient to reach the 80% target and what does it imply for the emissions and the technology pathway of the power generation sector? The results in ECF's work are mainly aggregated at EU27 plus Switzerland and Norway scale and the role of each country or region and interconnections between them are tremendous. Estimating more precisely the implications of one of ECF's scenarios on a regional scale is necessary. As an example it could be done for France plus Germany. Such is the aim of this study.

Methods

This analysis is based on TIAM-FR, an ETSAP-TIMES family model. This is a bottom-up model so a wide range of present and future technologies are expressed to describe the sectors represented. The model is a geographically integrated one in 15 regions on the time horizon from 2005 to 2100. It includes GHG emissions (CO₂, CH₄ and N₂O) and allows assumptions made on those emissions [3]. For this study some scenarios have been tested to estimate the implication of the 80% mitigation in Europe on the electric sector, including:

- A 50% GHG mitigation in the world with a 80% mitigation in Europe from 1990 levels
- A 95% GHG mitigation on the European electric sector

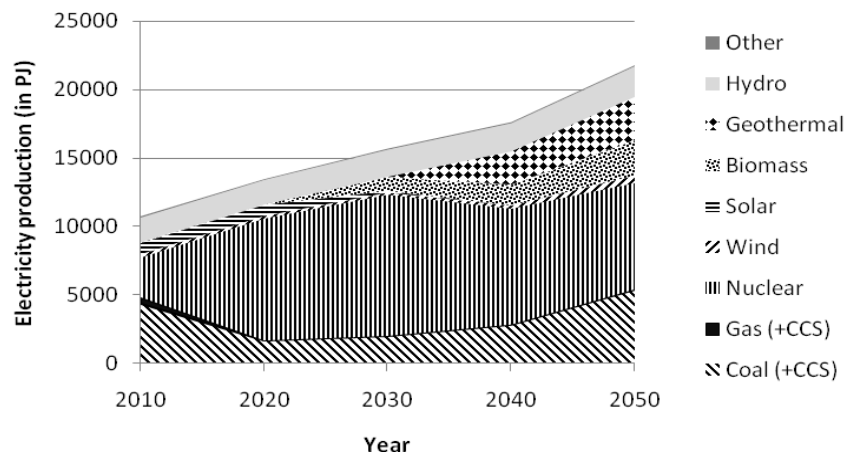
Other scenarios based on ECF's have been assumed to estimate the regional implications:

- A scenario with an imposed electric mix in Europe in 2050

Also, different technologies strategies have been tested, such as the availability of plants equipped with Carbon Capture and Storage (CCS) and different renewable potential in Europe.

Results

The first results deal with the implication of an 80% emissions mitigation of the economy on the electric sector. The most impacted sectors are the transport with an 85% reduction in GHG emissions compared to 1990 and the electricity with a reduction of 81%. Depending on the cost of emissions abatement accepted in other sectors, reducing the emissions by more than 90% in the power generation sector can be avoidable. The decarbonation of electricity helps the other sectors to reduce their emissions: if we compare energy sources in the baseline and in the scenario in 2050, there is an important fuel shift in the residential sector and in the industry. In the first one the main energy source was heavy fuel oil with 59% of the inputs in the baseline and in the scenario it becomes electricity with 73% of the inputs. Same thing in the industry with a share of electricity of 41% in the baseline and 54% in the scenario.



Power generation evolution in Europe aggregated by fuel type in the 80% reduction scenario

Mitigating 95% of GHG emissions in the electric sector results in a mix composed of 56% of nuclear energy in 2050. None of ECF's scenario has such a share of nuclear [2]. In the actual post-fukushima context it seems difficult to attain this share without Germany but it pins down a deeper question: What share of nuclear energy can we qualify as realistic after the recent Japanese events? More thought have to be made to answer this question, especially from an economic point of view.

At last, using the same electric mix as used in ECF's 40% renewable sources scenario helps Europe to mitigate their emissions by 80% in this sector. The use of coal plants as back-up and the CO₂ capture rate of 85% in the technologies used prevent this sector from being carbon free.

Conclusions

The role of CCS is critical to attain a low carbon electric sector and the development of interconnections between European countries is necessary to use the full potential of renewable sources. The regional implications of Europe decarbonation are key factors to implement the policies needed to reach such a goal.

References

- [1] European Commission, *A Roadmap for moving to a competitive low carbon economy in 2050*, Brussels (2011).
- [2] European Climate Foundation, *Roadmap 2050, a practical guide to a prosperous, low-carbon Europe* (2010).
- [3] Loulou R. and Labriet M., "ETSAP-TIAM: the TIMES integrated assessment model Part I: Model structure", *Computational Management Science* (2007), doi: 10.1007/s10287-007-0046-z.