COSTS AND SUBSIDIES

European Commission study on energy costs and subsidies in the EU

Report for EDF*

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FTI-CL Energy
Section 1

Executive summary

1.1 The European Commission (EC) has launched a study (hereafter “EC study”) on energy subsidies and costs in the European Union in January 2014. The objectives of the EC study, as defined by the original ITT of the EC is to provide “a complete and consistent set of data on energy generation (electricity and heating) and system costs and the historical and current state of externalities and subsidies in each Member State of the EU and for the EU overall. The transport sector is not included in the scope of the study.”

1.2 The overarching aim of the study, according to the recent EC presentation, is to provide input for policy making on public interventions by measuring in a comparable way across countries and industries, and by using a uniform methodology of the following elements:

- Energy costs;
- External costs; and
- Subsidies.

1.3 In this report, we provide a critical review of the methodology developed to date for the EC study in the inception report and the accompanying slides. We consider, in particular, the following three dimensions:

- Categorise of the different types of costs and taxes, and provide a robust economic definition of subsidies associated with electricity generation;
- Review the LCOE methodology used to calculate generation costs of various technologies and identify caveats in this methodology; and

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2 Brussels Electricity Club (2014) “Study on energy costs and subsidies in the EU.”
- Provide a review of the different costs, as well as taxes and levies associated with nuclear generation.

**Definition of costs and subsidies associated with electricity generation**

1.4 The social cost of power generation can be characterised as a sum of the internal costs, subsidies, and external costs. Defining the cost components relevant to the former is relatively straightforward (although some computational issues are not, as we discuss in Section 4), while subsidies and external costs deserve more attention. For the purposes of the EC study, it is important to ensure that the considered cost components correctly represent the social cost of electricity and have no overlaps or gaps.

1.5 Direct subsidies that use public finances are considered state aid and are generally subject to European regulation on state aid. In addition, there is a range of public interventions in the energy sector that do not imply the use of public finances. For example, these include priority scheduling for renewable generation.

1.6 Direct subsidies are subject to the European regulation on state aid. The overarching economic framework for legally granting state aid is the balancing test that weighs the possible negative effects of the subsidies on trade and competition with its positive effects in terms of achieving objectives of common interest.

1.7 Recent EC Environment and Energy Aid Guidelines (EEAG) provide guidance for subsidies, specifically in the energy sector. One of important criteria for the aid proposed by the EEAG is the appropriateness. It suggests to prioritise policy instruments other than aid, if this is possible to achieve the same objective.

1.8 We compare the EC study methodology as presented in the interim report of 7 July 2014 with our own literature review. We summarise the main gaps in the methodology and quantify potential cost evaluation bias that these gaps could induce.

**Subsidies**

1.9 The EC study methodology appears to take into account most public interventions in energy generation mentioned in the literature and map thoroughly recent interventions.

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1.10 However, it is important to consider some interventions with caution, in particular when they intend to compensate for market failures. For example, Capacity Remuneration Mechanisms (CRM) are introduced to compensate for the “missing money problem” that originates in various markets or regulatory failures preventing generators from earning sufficient scarcity rents during the peak hours. Whether a CRM involves a subsidy or not depends on the design of the mechanism (e.g. whether it is a market based approach or a capacity payment fixed independently of the system need for capacity).

1.11 Taking CRMs into account as subsidies would tend to over-estimate the overall value of interventions, especially for fossil fuel and nuclear plants in countries where such capacity support schemes use market based approaches. The magnitude of the likely over-estimation can be significant in markets where the missing money is important. For example, the capacity prices in the UK are estimated to be in the range between 20 and 30 GBP/kW.\(^5\) At a plant utilisation level of 85% (technical full load assumed in the EC study methodology for fossil fuel technologies) and a 2012 exchange rate GBP/EUR of 0.81, this corresponds to 3-5€/MWh of levelised cost.

Externalities

1.12 When addressing the external costs associated with the environmental impact, the EC study appears to be based on a thorough review of the literature (albeit sometimes using higher rather than lower bounds of the estimates).

1.13 In addition to the environmental external costs that are generally considered in the literature, the EC study methodology introduces a category of external cost associated with the resource scarcity (fossil and water depletion costs). According to the EC study, these costs may represent up to 10€/MWh for nuclear generation (water depletion cost) and 40-50€/MWh for fossil fuel generation (fossil depletion cost).

1.14 Our analysis suggests that assumptions used by EC study methodology to quantify technology-related resource scarcity costs are questionable, in that these costs may represent an overestimation of the external cost.

System costs

1.15 The interim report of the EC study does not provide guidance on whether and how the system costs of generating technologies will be addressed. Nevertheless, the system costs

of the integration of various technologies in the power system can be a significant element of the external cost.

1.16 According to several studies addressing the cost of integration of variable renewable technologies, the system costs for these technologies may represent up to about 30€/MWh for significant penetration rates. Therefore, failure to account for these costs represents an underestimation of the external costs of these technologies.

**The methodology of calculating the levelised cost of electricity (LCOE)**

1.17 The LCOE inherited from the pre-liberalisation times has been a useful tool for investors and energy planners because it provides a simple comparison metric to evaluate generation costs of different technologies. The LCOE is the constant unit cost (per MWh) of a payment stream that has the same present value as the total cost of building and operating a generating plant over its life.

1.18 However, the LCOE provides only a partial picture of alternative generation technologies valuations and is of limited use to evaluate investment decisions in liberalised power markets. In particular, the LCOE is limited in its ability to capture the impact of a number of critical differences between generation technologies, which should be accounted, to avoid a biased comparison of generation costs. We identify the following areas where LCOE approach should be treated with caution.

**Taking into account the electricity system impact on utilisation rates of different technologies**

1.19 The LCOE approach typically assumes a theoretical utilisation rate for different technologies, without contextualising the electricity system a given technology will operate, which determines this utilisation rate. The LCOE of thermal plants depends critically on the assumed utilisation rates, which are distorted in the current EU markets by out of market policies supporting specific technologies.

1.20 Therefore, a useful approach is to compare utilisation rates in a scenario with and without out-of-market support for renewables. This breaks down the generation costs into an intrinsic cost component and an extrinsic cost component associated with the policy mandated deployment of renewables.

**Accounting for the difference between controllable and non-dispatchable generation**

1.21 The LCOE is a flawed metric for comparing the economic attractiveness of variable technologies with conventional dispatchable generating technologies because it fails to account for the variability of the value (wholesale market price) of electricity over the course of a typical year.
1.22 The EC study could expand the LCOE approach to take into account the system costs associated with the deployment of the variable technologies, which include the “profile costs” (capturing the effect of variability), the effect of uncertainty “balancing costs” and the effect of locations “grid-related costs”. These system costs are significant (between 10€/MWh and 30€/MWh) for wind and solar technologies for penetration rates on the order of 15%, and increase with the penetration of variable renewables.

**Comparing technologies with different cost structures and lifetimes**

1.23 In practice, the economic life of a plant can be shorter or longer than the anticipated technical project life. Where possible, the EC study should run sensitivity analyses on the project lifetime to identify the potential impact of early closure and/or plant upgrades and life extensions.

**Cost of capital of different generating technologies**

1.24 The EC study proposes to differentiate the Weighted Average Cost of Capital (WACC) and risk premiums by technology and by market. One important methodological issue is the potentially double counting of the effect of subsidies, in the sense that risk adjusted discount rates by technology reflects investors’ perception of the riskiness of investing in such technology given the support schemes and subsidies in place.

1.25 The assumptions made by the EC study for renewables seem to be lower for some renewables technologies compared to other sources. This might be due to the double counting of the policy risk associated with subsidies for renewables technologies, through both a negative policy premium and a lower technology premium than other technologies.

1.26 Instead, a simpler and sound approach is to rely on identical discount rates across technologies, and to use sensitivity analysis to explore the impact of some of the issues, which are external to the technology such as the impact of policy and market risk.

**Failure to capture the investors’ approaches to choose among technologies**

1.27 The LCOE generation costs should be interpreted with care, particularly when using results to make policy decisions, as these can only explain investment choices to a limited extend in the current liberalised markets.

1.28 The EC study should therefore consider alternative valuation methods and financial indicators to complement the LCOE. Simple metrics such as the payback time or the value at risk give useful additional dimensions to assess the relative competitiveness of different technologies, and to assess the impact and efficiency of policies and subsidies.
Assessment of the full cost of nuclear power

1.29 This section aims to assess more precisely the costs linked to nuclear generation, and also to highlight the positive contribution of nuclear generation to the economy, for instance through taxes. This allows estimating the complete cost of nuclear generation using the methodology of LCOE (and keeping in mind the potential caveats of this methodology presented in Section 4).

1.30 We compare the main findings of the literature review on the external and internal costs of nuclear generation with the proposed methodology of the EC study.

External costs

1.31 The main external effects of nuclear generation we identify are associated with radioactive waste and nuclear accidents. The costs of externalities specific to nuclear energy are limited. Even though a major nuclear accident would bear heavy consequences, given the low probability of occurrences and compared to nuclear output, the order of magnitude of the economic valuation of accident costs is around 1 €/MWh. The economic valuation of externalities related to radioactivity (mainly waste) is close to zero as soon as a non-zero discount rate is used.

1.32 According to the interim report, the EC study methodology will be relying on similar sources to quantify these costs as the ones we consider in our review (D’haeseleer 2013 and NEEDS 2009). Therefore, one should not expect a major discrepancy in the estimation of the nuclear external costs.

Interventions

1.33 There is no direct support for nuclear generation in Europe at the present stage. However, certain mechanisms intended to accompany the development of nuclear generation (e.g. Contract for Differences) and to address specific market or regulatory failures may appear in the future.

1.34 A substantial portion of public expenditures in energy have been invested in R&D in nuclear technology. Between 2002 and 2011, R&D expenditures have represented 0.72 €/MWh for nuclear fission (1.06 €/MWh if we also include R&D in fusion nuclear technologies).

1.35 When accounting for R&D cost allocation, several elements are important to consider:

- R&D on nuclear fusion (mainly) should not be attributed to nuclear generation (which is currently based on fission). Inclusion of fusion R&D in the public interventions on nuclear energy would increase the estimate of this cost by 0.34€/MWh.
• One should be careful that R&D costs may be (at least partly) already included in the operators’ costs, which directly perform or finance R&D through specific funds or taxes.

**Liability**

1.36 The difference between the limit of liability for nuclear accidents and the cost of nuclear accidents may be considered as a subsidy for nuclear generation. We provide an overview of the liability limits applied in different European countries. Some US sources also provide an estimate of the effective subsidy obtained by nuclear plants to be about $600,000 per reactor per year. This is about 0.05€/MWh assuming reactor capacity of 1500MW and a utilisation factor of 75%.

1.37 The interim EC study methodology provides a wide range of the estimation of the nuclear liability subsidy between 0.0031 and 0.46€/MWh. The high range is explained by a high uncertainty of the risk and the cost of a nuclear accident.

1.38 We note that to avoid double counting, the nuclear liability costs already integrated in the internal costs (e.g. through insurance) should be subtracted from the external cost of nuclear generation associated with nuclear accidents.

**Tax revenues**

1.39 To account for the net value of government interventions one should take into account the taxes applied to electricity generation in addition to subsidies. In a recent study, NERA proposed a methodology to estimate the full range of financial flows both to and from different sources of energy as a result of government policy, including direct subsidies, other transfers of funds, and major taxes. This study compared the taxation and subsidy regimes applying to oil, gas, coal, wind, and solar power in the EU28 and Norway during the period 2007-2011. We applied the NERA study methodology to nuclear generation in Europe.

1.40 Nuclear is taxed directly on the generation side: this includes both specific taxes imposed to nuclear generators, as well as taxes that are imposed on all generation sources, including nuclear, e.g. local taxes or professional taxes. In addition to that, electricity is also taxed on the consumption side, through different taxes such as VAT but also taxes to finance renewable support schemes for instance. These are not specific to nuclear, but they apply to the consumed electricity that was produced by nuclear generators among others. We

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6 NERA (2014) “Energy Taxation and Subsidies in Europe: a report on government revenues, subsidies and support measures for fossil fuels and renewables in the EU and Norway” for the International Association of Oil and Gas Producers
analyse taxes applied both on the generation and consumption sides, to have a full picture of taxes applied to the whole value chain, and to draw a comparison with figures calculated by NERA using this approach.

1.41 Expanding the approach used by NERA in its study to evaluate both the costs and benefits associated with various forms of energy, and based on the example of France for which disaggregated data is available, we estimate that:

- Taxes specific to nuclear generation in Europe represent a fiscal revenue of more than 3 b€ per year. These nuclear-specific taxes represent an average tax of 3.8 €/MWh applied to each MWh of electricity produced by nuclear power plant in Europe;

- General taxes applied to electricity generation (including nuclear) were estimated at around 2 €/MWh based on the French case study; and

- Taxes paid on the consumption side for each MWh consumed (including produced by nuclear generation), represent another 40 €/MWh.

1.42 When considering the taxes on the generation side alone, these taxes (~5.8 €/MWh) are of the same order of magnitude as costs of externalities induced by nuclear generation (1.3 and 7 €/MWh in D’haeseleer (2013)). 65% of these taxes are specific to nuclear generation.

1.43 When considering the whole value chain and applying NERA’s approach to also take into account taxes paid on the consumption side, the total taxes applied to nuclear generation, both on the generation and the consumption sides (around 45 €/MWh), represent a very substantial fiscal revenue (~39 b€) and largely exceed nuclear externalities (1.3 to 7 €/MWh) and subsidies (1 to 2 €/MWh).

Internal costs

1.44 Estimates of the internal cost of nuclear energy expressed in terms of the levelised cost range from 83 to 133€/MWh for NOAK and from 101€/MWh to 147€/MWh for FOAK. This range is higher than the range of the LCOE estimates for nuclear generation provided in the interim EC study report. According to the EC study, the LCOE of nuclear generation in France lies within the range of 60€/MWh to 90€/MWh with a mid-point at about 75€/MWh. The EC study interim report provides similar ranges of LCOE for nuclear energy for other European countries.