Energy Policy 98 (2016) 199–209

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Is nuclear economical in comparison to renewables?

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HIGHLIGHTS

- State aids for new nuclear power is compared with incentives for renewables.
- Hinkley Point C in the UK is considered as example for new nuclear power.
- Comparison is conducted for the UK at a country level and for the EU 28 overall.
- Analysis shows that renewable energies are more economical than nuclear power.

ARTICLE INFO

Article history:
Received 18 February 2016
Received in revised form
18 July 2016
Accepted 21 August 2016

Keywords:
Hinkley Point C
Nuclear
Renewables
Modelling
Effectiveness
Economic efficiency

ABSTRACT

The European Union is divided on the issue of electricity production. While there is consensus that generation technologies need to be low on greenhouse gas emissions, the question of whether to use renewables or nuclear to meet this power demand is highly controversial. Both options still require financial support and this is not going to change in the near future. This raises the question of where public money should be invested in order to achieve greater economic efficiency: into support for renewable energies (RE) or support for nuclear power plants?

This paper sets out to answer this question. The detailed model-based prospective scenario assessment performed in this study provides the basis for estimating future cost developments. After discussing the existing support schemes for renewables, the paper compares these with a nuclear model. The comparison is conducted exemplarily for the United Kingdom (UK) at a country level and for the EU 28 overall. The recent state aid case for the construction of the Hinkley Point nuclear power plant (NPP) in the UK serves as the model for the nuclear option.

1. Introduction

In line with climate concerns, the European Commission (EC) has set short, mid and long-term targets to achieve a low carbon economy. In the long term the goal of the European Union (EU) is to cut its emissions substantially by 80–95% compared to 1990 levels (EC, 2015). The main binding target for 2030 is the reduction of EU domestic greenhouse gas (GHG) emissions by at least 40% below the 1990 level (EC, 2014a). Furthermore, EC says that to achieve these targets, renewables will play a key role and sets as target for an increase of the renewables share to at least 27% of the EU's energy consumption by 2030. Nevertheless, this target is binding at EU level and it has not been defined yet how the member states should contribute to that. Besides, the EC also leaves the individual member states free to use whatever technology they prefer to achieve emission reductions in the longer term.

When it comes to low-carbon electricity generation, renewable energy technologies and nuclear power plants are competing to design the future energy supply of EU member states. While Germany has decided to phase out nuclear power completely by the year 2022, many countries within the EU with existing nuclear power plants (NPPs) such as France, UK, Romania, Slovakia and Bulgaria (WNA, 2015) have disclosed plans to build new NPPs.

The economic dimensions of reducing GHG emissions is debated through the question whether nuclear or renewables should receive public subsidies, as both options still require financial support. The nuclear technology has also been subsidised since its beginning like fossil fuels (IEA, 2010) and renewables. The subsidies for nuclear come in different forms such as government-

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http://dx.doi.org/10.1016/j.enpol.2016.08.023
0301-4215/

funded loans, governmental liability in case of plant failure, industry dumping or tax relief (Biermayr and Haas, 2009; WNA, 2015b).

Subsidies for power generation technologies have been analysed in a number of studies; Badcock and Lenzen (2010) review the subsidies for coal-fired, nuclear and most common renewable technologies on a global level. A recent study commissioned by the EC, DG Energy quantifies monetarily the public interventions in energy markets in all 28 EU member states for all energy uses except transport (Ecofys, 2014). Zelenika-Zovko and Pearce (2011) compare the indirect nuclear insurance subsidies to the equivalent amounts of indirect subsidies (loan guaranties) for photovoltaic manufacturing.

Goldberg (2000) analyses the federal energy subsidies in the US to selected electricity generating technologies (nuclear, wind, photovoltaic, and solar thermal) for the period 1947–1999. His results for the first 15 years of observation show that commercial, fission-related nuclear power development received 15.30 $/kWh whereas between 1975 and 1989 subsidies for solar amounted to 7.19 $/kWh and to 46 ¢/kWh in the case of wind power. Furthermore, he adds that high early investment has led to a mature nuclear sector by achieving rapid growth. Koplow (2011) reviews the full range of subsidies for the nuclear power sector in the US and indicates that the most important subsidies to the industry are not the cash payments. In contrast, most relevant appear subsidies that shift the construction cost and operating risk (from cost overruns and defaults to accidents as well as nuclear waste management) from investors to the taxpayers.

A new milestone in state aid for NPPs will be the new NPP at Hinkley Point C in the UK as the planned state aid is a kind of feed-in-tariff (FIT), a system that is often referred to as a start-up mechanism for a newcomer technology like renewables (Morris, 2013). The authors of this work are not aware of any studies that compare the subsidies for nuclear and renewables by putting emphasis on the planned future supports for this new planned NPPs.

1.1. *Scope and structure of this paper*

Hence, this paper aims for a comparative assessment of necessary state aids for the construction of new nuclear capacity on the example of the planned NPP Hinkley Point C with necessary support incentives for renewable energies. A comparison is undertaken to indicate the effectiveness, that is the amount of electricity generation achieved, and the economic efficiency, that is the corresponding support required, of both options.

This paper is structured as follows: In Section 2 a closer look is taken at nuclear power in Europe, specifically at past (and future) cost developments and on future prospects, influenced by the UK approach on providing state aid for the built-up of new NPPs. Section 3 is dedicated to present the approach taken within our assessment of the effectiveness of financial support. The outcomes of our analysis are discussed in Section 4 and the paper concludes with key findings and recommendations (Section 5).

2. Background: a closer look at nuclear power in Europe

2.1. *Discussion on cost development of nuclear power*

For the economic comparison of technologies and for estimating their future role in energy supply, it is important to analyse their historical cost developments. Since these developments have been broadly assessed for renewable energy technologies, compare for example (Held et al., 2014) or (Ecofys, 2014), we shed light on a recently less prominently discussed electricity generation technology: nuclear power. Nuclear power is promoted as one of the most reliable and affordable options for power supply by its proponents. In literature, the cost development of nuclear power has been analysed mainly by considering France due to its long-standing nuclear based electricity supply system. Brook et al. (2014) argues the economic viability of nuclear energy by highlighting the low electricity price in France which is categorised among the lowest worldwide. However, the reactors are becoming older and the average age of reactors is about 30 years (in France and within EU) (Schneider et al., 2014). This means that most of the reactors have already been depreciated. The older reactors will need massive investment to increase safety or to extend lifetime as well as to replace them by building new reactors. A lifetime extension beyond 40 years probably cause, depending on the safety level, between € 1 billion and € 4 billion (US$ 1.4– 5.5 billion) per reactor (Marignac, 2014; Schneider et al., 2014).

While the cost of renewables has been decreasing due to learning effects, there is inconsistency with respect to development of nuclear energy costs over the years. Grubler (2010) indicates a negative learning effect in his analysis in the case of France, meaning that this technology has achieved a cost escalation of real-time contraction over the years. Boccard (2014) identifies the levelized cost of French nuclear power over the last four decades as 59 €/MWh (best case) and 83 €/MWh (worst case) and estimates the future costs as 76 €/MWh (best case) and 117 €/MWh (worst case).

By contrast, Escobar Rangel and Leveque (2015) revisited the French experience due to most recent public data and found positive learning effects when it comes to building the same size and type of reactors. However, these authors also state that the construction of bigger reactors leads to a change in technology (i.e. more complex reactors and longer lead-times) which will cause a cost increase (Escobar Rangel and Leveque, 2015). Besides, in case of large-scale infrastructure projects, the costs dramatically exceed the initial estimates (Grubler, 2010; Biermayr and Haas, 2009). Each delay in construction leads to higher costs. For example two NPPs under construction in the EU (Flamanville in France and Olkiluoto in Finland) are suffering from delays of several years each, and construction costs in Olkiluoto are now 280% over budget (Schneider et al., 2014).

Within the EU, the number of reactors is decreasing. Because of the large capital costs and high risks, in Western Europe, it took about 25 years where no new nuclear power plant was built outside France. Finland acted finally as frontrunner, where construction works for a new NPP at Olkiluoto in have started. This project could be launched through the large-scale industry dumping and a state subsidised loan from Bayerische Landesbank (Biermayr and Haas, 2009). The construction of Olkiluoto started in 2005 with the expectation to start (partial) operation in mid-2009 (Schneider et al., 2014). Nevertheless, at the date of this publication, this NPP is still under construction (Areva, 2015).

2.2. *Hinkley Point C: encouraging the built-up of new nuclear power plants in Europe*

Of special interest is a new political development, the launch of a state aid scheme for a new nuclear power plant at Hinkley Point C in the United Kingdom. The NNB Generation Company Limited (NNBG), part of EDF Energy, plans to construct and operate a new NPP, consisting of two units with an electrical capacity of in total around 3,260 MW, producing 26 TWh per year at the Hinkley Point NPP site (Hinkley Point C 1&2). If constructed, Hinkley Point C would be the UK's first new reactor since 1988.

The construction costs of Hinkley Point C were first estimated to be close to € 19 billion (EDF, 2013) but were corrected by the EC to € 31.2 billion, and overall capital costs are assumed to be € 43