OBSTACLES TO GREEN ELECTRICITY GENERATION BUSINESS

Arta Denina[1], Janis Zvanitajs[2]

Riga Technical University

Faculty of Engineering and Management

Meza str. 1/7, Riga, LV-1048, Latvia

E-mail: [1]arta.denina@gmail.com, [2]janis.zvanitajs@rtu.lv

Abstract. Investment in green electricity generation is normally associated with certain risk. There are several risks that have to be taken into account and seriously analyzed before the investment decision. Typically one can distinguish risks related to technology, risks related to electricity market, risks related to legislative and political frameworks. Many authors distinguish public support as an important risk category. Often risks transform into real obstacles to start-up and operation of green electricity generation business. The paper particularly looks into investment capital and electricity generation costs as key obstacles to competitiveness of green electricity generation business. Investment costs and operation costs of green technologies are compared against those of fossil fuel technologies. The paper concludes that only in certain cases green electricity generation can compete with electricity generation from the traditional energy sources such as gas, coal or nuclear power.

Keywords: renewable energy sources, investment and operation costs, competitiveness, risk

Introduction

Investment in electricity generation is associated with certain risk and uncertainty. Investment security is a concern for all investors. There are many factors that influence investment security and that have to be taken into account and seriously analyzed before the investment decision can be made (Kramina, 2012). The economic performance of a specific energy source determines its ability to establish market place (ECOFYS, 2010). Electricity generation from renewable energy sources (RES) is different from electricity generation in its traditional meaning. These sources represent variable output which makes it difficult to plan cash flow since producers cannot run their plants at maximum capacity. Nevertheless, today electricity generation landscape is undergoing significant change. Transformation from electricity generation based on fossil fuels such as gas and coal to electricity from renewable energy sources (RES-e) is evident (Ministry of Economy, 2010). Installed RES capacities are increasing (European Commission, 2010). Many,

including IEA, EWEA, EURELECTRIC and others believe that this trend will continue in the future. Technology learning curves and global energy policy change will support this development. There is an evident interest in investment in green electricity technologies due to economic, social and environmental gains (National Academy of Sciences, 2009). Despite the fact that it is often very difficult to compare electricity generation costs of different power technologies because of very complex financial structures of power projects, in general one can say that RES-e generation costs per unit of electricity are higher than those of a fossil or a nuclear power plant (Royal Academy of Engineering, 2008; National Academy of Sciences, 2009). There is no single set on electricity generation cost. Electricity generation costs differ from technology to technology on a global scale and are influenced by many factors, including operation mode, efficiency, fuel price, capacity factor, etc. However, there are not many

When looking at electricity generation costs, it is important to mention their structure, since the cost structure influence the cost of electricity. The cost structure of electricity generation is different from technology to technology. Investment and operation costs, on one hand, and revenues from selling the produced electricity, on the other, are key elements in the analysis of economic sustainability of a RES-e generation business project. Data on investment and operation costs help to calculate RES-e generation costs. In economic theory the concept of levelized costs of electricity is commonly used to assess competitiveness of different electricity generating technologies. Levelized cost of electricity shows the average cost to generate one unit of electricity during the life cycle of a power plant. It takes into account capital costs, fuel costs, O&M costs and CO2 costs. The concept of levelized cost of electricity helps an investor to calculate time to recover investment when there are no specific market or technology risks (IEA, 2010).

Literature Review

The number of publicly available sources on electricity generation cost is very limited. There are only few sources that provide comprehensive information on electricity generation cost data. This explains why only few authors have looked into this aspect in detail.

In order to compare electricity generation costs of different technologies, the authors have used the 2010 edition of the report *The projected costs of generating electricity* from the International Energy Agency and 2011 study from VGB Powertech *Investment and operation cost figures – generation portfolio* since they represent the most reliable information on electricity generation costs available. The IEA report is a global reference for electricity generation costs and features compiled data from the most recent publications of different organizations. Since the data presented in this report vary from country to country, the authors in this article provide ranges of

electricity generation costs of different technologies. The VGB study gives an overview about electricity generation costs from a point of view of engineering competence.

Methodological Approach

The objective of this paper is to identify the main risks to RES-e generation business and assess RES-e generation cost per unit as the major competitiveness risk. In order to achieve the objective the following tasks have been defined:

- To classify risks related to RES-e generation business;
- To present electricity generation cost structures for RES-e and fossil and nuclear power technologies;
- To compare electricity generation cost per unit of RES-e and fossil and nuclear power.

The paper has the following structure:

First, the risks related to RES-e generation business are presented. Then, electricity generation cost structures of different electricity generating technologies are looked at. Analysis of electricity generation costs of power technologies follows. Finally, conclusions of the discussed material are provided.

Electricity Generation Cost as the Major Competitiveness Risk

Risks to Electricity Generation

One can distinguish four groups of risks. These include risks related to technology, risks related to electricity market and risks related to legislative and policy frameworks. Technology related risks include investment and operation costs, construction time, efficiency, etc. Market risks include fuel costs, demand, competition, electricity price. Legislative risks deal with market organization, competition regulation, licensing, decommissioning, etc. Risks related to policy include environmental standards, CO2 emission limits, support framework, etc. (IEA, 2010). The authors believe that public support to green electricity projects is often the decisive factor and therefore should be considered as the fifth group in the risk classification.

Electricity Generation Cost structure

Risks often transform into real obstacles to start-up and operation of green electricity generation businesses. Investment and operation costs are two the most important cost aspects for

RES-e technologies, and only for few RES-e technologies, such as biomass, fuel cost is an issue. Compared to traditional electricity generating technologies and fuels, such as fossil fuels or nuclear power, fuel is not relevant since the resource is naturally available. The same applies for CO2 costs. Since RES-e technologies do not emit, there is no CO2 cost. In order to better understand competitiveness aspects of different electricity generating technologies it is important to look at the structures of generation costs. Figure 1 demonstrates structure of electricity generation costs of different electricity generating technologies at 5% (first bar) and 10% (second bar) discount rates. The total electricity generation cost is broken down into 5 groups: investment costs, operation and maintenance (O&M) costs, fuel and CO2 costs, and decommissioning costs.

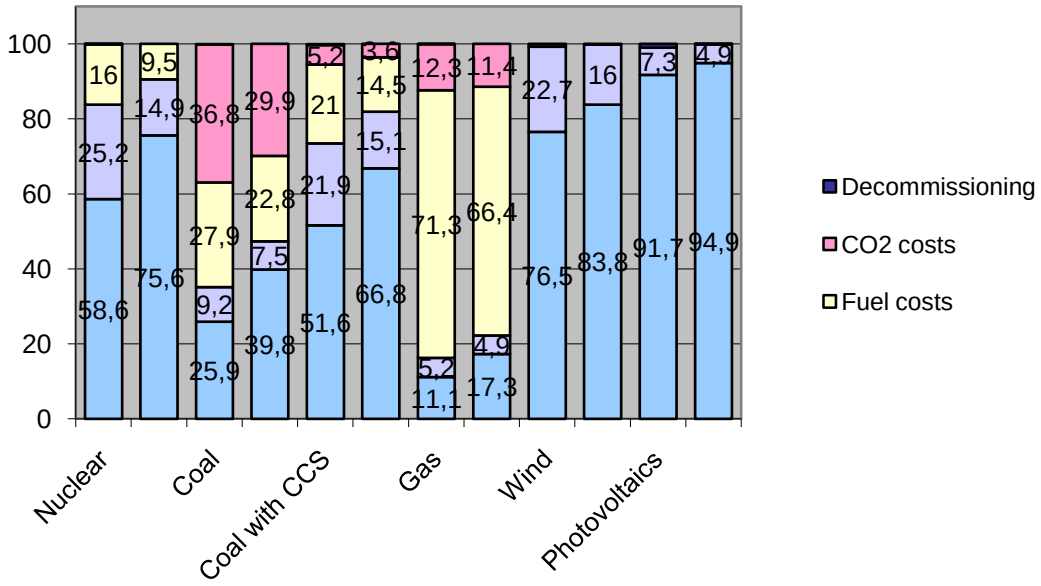

Figure 1. Structure of electricity generation costs, %

Source: Own construction based on IEA, Projected costs of generating electricity, p.112

In general investment cost of RES-e technologies accounts for the largest shares in the structure of electricity generation costs of different technologies. For example, in case of photovoltaics this share is even above 90%. O&M costs vary from 5-7% in case of photovoltaics to 16-23% for wind power plants. Traditional electricity generation technologies represent similar shares, varying from 5% for gas power plants to 25% for nuclear power. RES-e technologies have no fuel costs. In case of the fossil or nuclear power plants fuel costs vary from 10% for nuclear power to 71% for gas power plants. Coal power plants demonstrate the largest share of CO2 costs. In the future when carbon capture and storage (CCS) technology becomes commercial, this cost can drop to 4-5%.

Electricity Generation Costs

The IEA study on projected costs of generating electricity is a global reference for electricity generation costs. This study presents electricity generation cost data for different technologies in different countries. The authors have identified the cost ranges for different technologies. These ranges prove that conditions in which different power plants operate vary from country to country; however, this variation is clearly evident for RES-e technologies particularly.

The authors have used the data from IEA and VGB on levelized electricity generation costs to construct Figure 2.

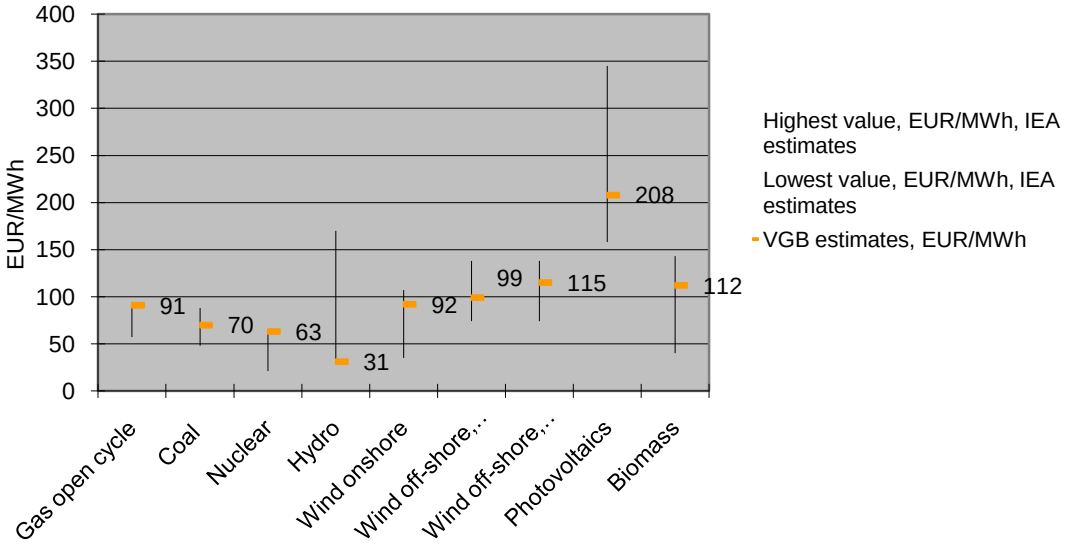

Figure 2. Levelized electricity generation costs of different power technologies

Source: Own construction based on IEA and VGB

For nuclear power the VGB estimates are given for nuclear technology EPR 1600 expected to come into the market after 2015. For wind onshore the cost estimates are given assuming that investment cost is 1100 EUR/kW. For wind off-shore close and wind off-shore far the cost estimates are made on assumption that investment cost is 2000 and 3000 EUR/kW accordingly.

In general RES-e generation costs are higher than electricity generation costs from the traditional power technologies. RES-e technologies represent large cost ranges as one can see in Figure 2. The large cost ranges indicate that RES-e technologies are yet not economically mature. Hydropower is the only RES-e technology that can be considered as mature. Great variation in electric capacity from several kW to several thousands of MW and in power potential explains the large cost ranges for hydropower. Besides weather conditions significantly influence hydropower production.

Solar photovoltaics have the highest electricity generation cost per unit. This technology represents the largest cost ranges from 158 EUR/MWh to 345 EUR/MWh. Electricity generation cost per unit at hydropower plants ranges from 36 EUR/MWh to 170 EUR/MWh. In general this cost range is larger than for nuclear power; however, in certain cases hydropower generation cost per electricity unit can compete with that of nuclear power. Electricity generation cost per unit of nuclear power is in the range from 21 EUR/MWh to 59 EUR/MWh. Also onshore wind power can be competitive with the traditional electricity generating technologies. Electricity generation cost per unit of onshore wind power is from 35 EUR/MWh to 107 EUR/MWh. Electricity generation cost per unit of off-shore wind power is significantly higher and is in the range from 74 EUR/MWh to 138 EUR/MWh. Electricity generation cost per unit of electricity produced in biomass power plants represents the third largest cost range among the RES-e technologies and is from 40 EUR/MWh to 143 EUR/MWh.

Conclusions

Financial structures of power generation projects are very complex and therefore it is difficult to compare electricity generation costs from various energy sources. The very limited number of available reliable sources is an important barrier to analysis of competitiveness risks of the green electricity technologies.

Investment cost and operation cost are key components of electricity generation cost which represent a competitiveness risk in electricity generation. For some technologies fuel cost and CO2 cost are also important cost factors. RES-e technologies demonstrate large share (up to 90%) of investment cost in the total generation cost structure. This is followed by O&M costs up to 23%. The traditional electricity generating technologies account for up to 75% of investment cost, 25% of O&M costs, 28% of fuel costs and 37% of CO2 costs.

In general RES-e generation costs per unit of electricity are higher than electricity generation costs from the traditional power technologies. The large cost ranges of RES-e technologies indicate that RES-e technologies are yet not economically mature and only in certain cases can be competitive with the traditional power technologies. In the future the learning curves of RES-e technologies and global energy policy change will enhance competitiveness of RES-e technologies.

References

1. ECOFYS (2010). Financing Renewable Energy in the European Energy Market. Retrieved (March 29, 2012) from http://ec.europa.eu/energy/renewables/studies/doc/renewables/2011_financing_renewable.pdf.

2. European Commission (2010). EU energy and transport figures. Retrieved (March 29, 2012) from http://ec.europa.eu/energy/publications/statistics/doc/2010_energy_transport_figures.pdf.
3. International Energy Agency (2010). The projected costs of generating electricity. Paris: OECD.
4. Kramina, I. (2012). Approved and planned amendments in the legislation – how will they influence investment security in renewable energy sector? Unpublished materials from Renewable Energy Conference 2012, Riga, Latvija, March 15 2012.
5. Ministry of Economy of Latvia (2010). National Renewable Energy Action Plan (in Latvian). Retrieved (March 20, 2012) from http://ec.europa.eu/energy/renewables/transparency_platform/doc/national_renewable_energy_action_plan_latvia_lv.pdf.
6. National Academy of Sciences (2009). Electricity from Renewable Sources. Status, Prospects and Impediments. Retrieved (March 20, 2012) from http://sites.nationalacademies.org/xpedio/groups/energysite/documents/webpage/energy_054518.pdf.
7. Royal Academy of Engineering (2008). The cost of generating electricity. A commentary. Retrieved (March 20, 2012) from http://www.raeng.org.uk/news/publications/list/reports/Cost_Generation_Commentary.pdf.
8. VGB Powertech (2011). Investment and operation cost figures – generation portfolio. Retrieved (February 21, 2012), from https://www.vgb.org/index.php?site=vgbmultimedia&id=5414z.