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Opinion paper

A review of the IEA/NEA Projected Costs of Electricity – 2015 edition

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HIGHLIGHTS

- LCOE is a useful tool for economics of generation technologies.
- The IEA/NEA study did not cover fully the required criteria for assessment.
- It ignored interpretation of: the discount rate, carbon costing and subsidies.
- The world energy scene is changing, this requires reassessment of LCOE.

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ABSTRACT

The IEA/NEA recently issued their eighth edition of the Study on the "Projected Costs of Generating Electricity" – 2015 edition. The Study is mainly concerned with calculating the levelised cost of electricity (LCOE). The LCOE calculations are based on a levelised average life time cost approach using the discounted cash flow (DCF) method. The analysis was this year, and for the first time, performed using three discount rates (3%, 7%, and 10%). The LCOE can serve as a tool for calculating the cost of different generation technologies. However the Study's usefulness is affected by its narrow base of a limited set of countries that are not necessarily representative. It ignored the negative role of subsidies and did not provide a methodology for selective application of the discount rates and costing of carbon. The global power generation scene is changing. Generation growth in OECD countries has become very limited; simultaneously there is rapid growth of varying renewables (VRE) generation which needs special criteria for assessing its system cost. All this demands a rethinking of the application and usefulness of the LCOE in future generation planning.

1. Introduction

Every five years the International Energy Agency (IEA) and the Nuclear Energy Agency (NEA), both based in Paris, issue a joint study of the "Projected Costs of Generating Electricity" – the Study. The 2015 edition is the eighth report in this series (IEA/NEA, 2015). The Study is mainly concerned with calculating the levelised cost of electricity (LCOE). The LOCE calculations are based on a levelised average life time cost approach using the discounted cash flow (DCF) method. The analysis was this year, for the first time, performed using three discount rates (3%, 7%, and 10%), in contrast to earlier editions which employed only two discount rates – 5% and 10% (Khatib, 2010).

The Study is based on data from 181 plants in 22 countries, 19 are OECD countries, the other three are: China, Korea and South Africa. It is based on information and data provided by invited country representatives of OECD member countries and a select group of the three non-OECD countries. This is the first of the many shortcomings of this study in that it only deals with a very limited number of plants, which are not necessarily representative, in 22 countries out of many thousands of plants in over 180 countries in the world. It has to be realized that most of the electricity generation expansion during the coming years will be outside OECD as will be discussed below. The Study recognizes this. In its Conclusions it mentions that:

"This eighth edition of *Projected Costs of Generating Electricity* focuses on the cost of generation for a limited set of countries, and even within these countries only for a subset of technologies. Caution must therefore be taken when attempting to derive broad lessons from the analysis. Nevertheless, some conclusions can be drawn".

2. The levelised cost of electricity (LCOE)

The Study recognises that LCOE is a useful tool for comparing the discounted unit cost of different technologies over their operating life utilising an agreed at discount rate. It also recognises

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that LCOE is closer to the real cost of investment in electricity production in regulated monopoly electricity markets, with regulated prices, rather than to the real costs of generators in competitive markets with variable prices.

With annual discounting, the LCOE calculation begins with Eq. (1), which was wrongly printed in the Study but corrected later (IEA, 2015), expressing the equality between the present value of the sum of discounted revenues and the present value of the sum of discounted costs, including payments to capital providers. The subscript t denotes the year in which the sale of production or the cost disbursement takes place. The summation extends from the start of construction preparation to the end of dismantling, which includes the discounted value at that time of future waste management costs. All variables are real, i.e. net of inflation. On the left-hand side one finds the discounted sum of benefits and on the right-hand side the discounted sum of costs:

$$\Sigma P\,MWh{*}\mathrm{MWh}{*}(1+r)^{-t} = \Sigma(\mathrm{Capital}_t + \mathrm{O\ \&\ M}_t + \mathrm{Fuel}_t + \mathrm{Carbon}_t + D_t){*}(1+r)^{-t} \quad (1)$$

where the different variables indicate:

PMWh = the constant lifetime remuneration to the supplier for electricity;
MW h = the amount of electricity produced in MW h, assumed constant;
$(1+r)^{-t}$ = the discount factor for year t (reflecting payments to capital);
$\mathrm{Capital}_t$ = total capital construction costs in year t;
$\mathrm{O\&M}_t$ = operation and maintenance costs in year t;
Fuel_t = fuel costs in year t;
Carbon_t = carbon costs in year t;
D_t = decommissioning and waste management costs in year t.

Because PMWh is a constant over time, it can be brought out of the summation, and Eq. (1) can be transformed into

$$\mathrm{LCOE} = P\mathit{MWh} = \frac{\sum(\mathrm{Capital}_t + \mathrm{O\ \&\ M}_t + \mathrm{Fuel}_t + \mathrm{Carbon}_t + D_t){*}(1+r)^{-t}}{\sum \mathrm{MWh}(1+r)^{-t}} \quad (2)$$

where this constant, PMWh, is defined as the levelised cost of electricity (LCOE).

LCOE, as a useful tool, increasingly suffers from many weaknesses. It is blind to the when, where and how of power generation. It is also a measure of economic cost for a particular generation technology taken in isolation, for it ignores the interaction between the generation technology and the rest of the electricity system – system effect and system cost.

The results of the Study are briefly demonstrated in Fig. 1 for base load technologies, and in Fig. 2 for solar and wind technologies.

3. System effect and system cost

LCOE can be a tool in system design and comparing plants and technologies, but its use is limited and with the introduction of the varying renewables (VRE) this usefulness is decreasing and can be sometimes misleading. For instance, you cannot, in monetary terms, compare value of wind which is intermittent and unpredictable with dispatchable base load generation.

What is of prime importance is system cost. How does the introduction of a specific technology affect the security and cost of the system, over a defined time span, compared to other technology or technologies? The study recognises this for it states: "plant level costs imply that this report does not take into account system costs, i.e. the impact of a power plant on the electricity system as a whole. This is an issue that concerns all technologies, for instance in terms of location or grid connection".

It is system cost that concerns the planner and not LCOE. It is the long term implication of the introduction of the technology to the system in terms of system cost and system security and the timing and location which concerns the planner. This can only be obtained by sophisticated system simulation which is detailed in the literature.

Having explained the importance of the system cost there are many other concerns regarding the IEA/NEA Study. These are related to:

- the discount rate
- carbon costing
- the problem of subsidies
- the future of electricity demand.

4. The discount rate

Discounting is the most important aspect in project evaluation and choices of the least cost project (Khatib, 2014). The methodology adopted in the Study is based on three discount rates (3%, 7% or 10%), common to all forms of considered generation technologies. This is a controversial approach. As is well known, the discount rate is the opportunity cost of capital (as a percentage of the value of the capital). In turn the opportunity cost of capital is the return on investments foregone elsewhere by committing capital to the project under consideration.

It is also referred to as the marginal productivity of capital, i.e. the rate of return which would have been obtained by the last

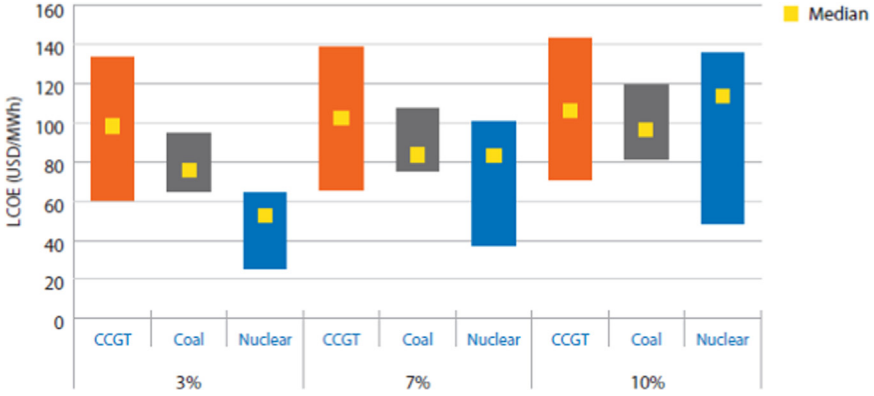

Fig. 1. LCOE ranges for base load technologies (at different discount rates).