Let's talk about risk: Why we need more than the EU Emissions Trading System to foster investment in wind and solar PV

Discussion paper

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Summary of key points

- As long as the EU Emissions Trading System generates prices below 60 EUR/tonne of CO_2, it is unlikely to provide for a stable growth of variable renewable energy technologies. This is due to the fact that those technologies face long-run revenue risks; given the merit order effect, they cannibalize the wholesale market prices from which they derive revenues.
- An approach to energy policy which relies exclusively on the ETS (*ETS-only*) will increase the risk premiums and capital costs of renewable energy deployment. Alternative policy frameworks that impose less risk on investors will reduce the cost of capital.
- If risks are kept sufficiently low through the choice of a suitable policy framework, onshore wind and utility-scale solar PV are cost-competitive with conventional electricity generation technologies in power markets assessing a CO_2 emissions price of 25 EUR/tonne.
- Renewable energy targets and national renewable support schemes will help to address risk barriers for deploying renewable technologies and will reduce the costs for those technologies, relative to an *ETS-only* support system.

Introduction

In October European Heads of State will chart the EU's climate and energy policy targets for 2030. As a basis for discussion, the European Commission has proposed a new reduction target for greenhouse gas emissions, namely, a 40% reduction of emissions against a 1990 baseline. This reduction target comes with an EU energy efficiency target of 30%, and a headline target at European level for renewable energy of at least 27% with flexibility for Member States.[1]

Whether or not renewables require a separate binding target at all is under debate.[2] Some argue that the EU's flagship carbon reduction instrument – the European Emissions Trading System (ETS) – is an effective tool for bringing more renewables into the power system (*ETS-only* approach). As such, the ETS would suffice as the single instrument for pulling renewable technologies into the market.

In this analysis, we argue that investments in capital-intensive, variable renewable energy sources, such as wind and solar PV, critically depend on access to competitive costs of capital. In turn, capital costs are substantially determined by the energy policy framework. We find that an *ETS-only* approach would likely raise financing costs enough to considerably slow the desired long-term fuel switch from conventional technologies to renewables. Therefore, an additional, separate target for renewable energy is indispensable if the overarching objective of reducing greenhouse gas emissions by 40% is to be met with meaningful contributions from renewable energy sources in the power sector.

The paper proceeds as follows: We first describe how the ETS can – at plausible CO_2 prices – induce fuel switching within the fleet of *existing* plants, but neither towards *new* combined cycle gas turbines (CCGT) or Carbon Capture and Storage (CCS) plants, nor towards new renewable energy sources. In fact, an ETS-induced switch towards variable renewables would require a very high CO_2 price that seems to be politically unfeasible.

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[1] COM (2014) 15. A policy framework for climate and energy in the period from 2020 to 2030, 22.01.2014;
COM (2014) 520. Energy efficiency and its contribution to energy security and the 2030 framework for climate and energy policy, 23.07.2014

[2] A similar debate is about the necessity of a separate binding target for energy efficiency.

Subsequently, we highlight the fact that variable renewables, such as wind and PV, tend to depress wholesale electricity prices – from which they derive revenues – because these resources have low or zero marginal generation costs.[3] Given these findings, we draw attention to the uncertainties and associated risk premiums to be paid for renewable energy investments in different policy support frameworks, such as feed-in premiums, quota obligations etc.[4] In particular, an *ETS-only* approach would increase risk premiums for renewable investments. As a consequence, it would be more expensive than all alternative policy frameworks. Finally, we demonstrate the cost-competitiveness of wind and PV relative to conventional generation and other low-carbon technology options. To begin, we look at the pace of change in the power sector overall.

Given infrastructure lifetimes, the existing fleet of power plants turns over slowly, even when considering the ETS' impacts

Understanding the ETS' effects on power generation requires a closer look at the project lifecycle of conventional power plants. Project development for new conventional power stations prior to final investment decisions typically takes five to seven years, and actual plant construction another three to five years. As a result, any impacts on new generation capacity from the ETS will occur with a time lag, perhaps up to a decade.

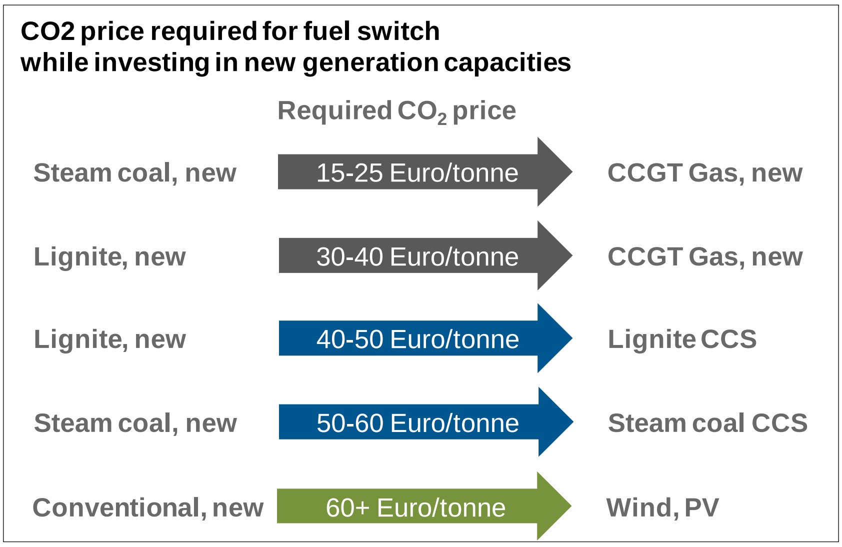
Moreover, once a plant is built, it remains in operation for 35 years or longer. Given this natural inertia in the power system, the existing fleet of power plants will likely produce more than 80 % of the CO_2 emissions of the European power sector until 2030.

An ETS price below 60 EUR/tonne of CO_2 will not sufficiently support renewable energy deployment

The basic functioning of the ETS is straightforward: CO_2 prices factor into a plant's marginal costs and influence how a given plant can position itself in the merit order of power plants. The more carbon-intensive a technology is, the more it will be affected by increasing CO_2 prices. That is, lignite and steam coal plants are more affected than gas plants, because CO_2 pricing increases the marginal costs of coal relative to gas plants, ultimately decreasing these plants' wholesale market earnings. If the ETS is supposed to induce a fuel switch towards gas, the price of CO_2 must be high enough to render gas plants more competitive than coal plants.

In the short-term, a price of 20 to 25 EUR/tonne of CO_2 can lead to fuel-switching from *old* steam coal plants to CCGT gas plants in the existing power fleet. Yet, this CO_2 price range is not enough to make CCGT gas plants more competitive than new steam coal or lignite plants. This would require CO_2 prices of 40 to 55 EUR/tonne.

Over the long-term, these CO_2 price levels may steer power system investors towards CCGT gas plants over other conventional technologies, or even spur investments into CCS plants, as illustrated below.



However, inducing a switch from conventional coal or gas plants to renewable energy sources, would require a price of about 60 EUR/tonne of CO_2.

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3 This effect is even more important within limited market areas in which those renewables generate electricity simultaneously.

4 The cost considerations presented here are derived from Prognos' power plant model. Based on fuel, variable operating and start-up costs, the model simulates the plant utilization (merit order) of the relevant European power plants.

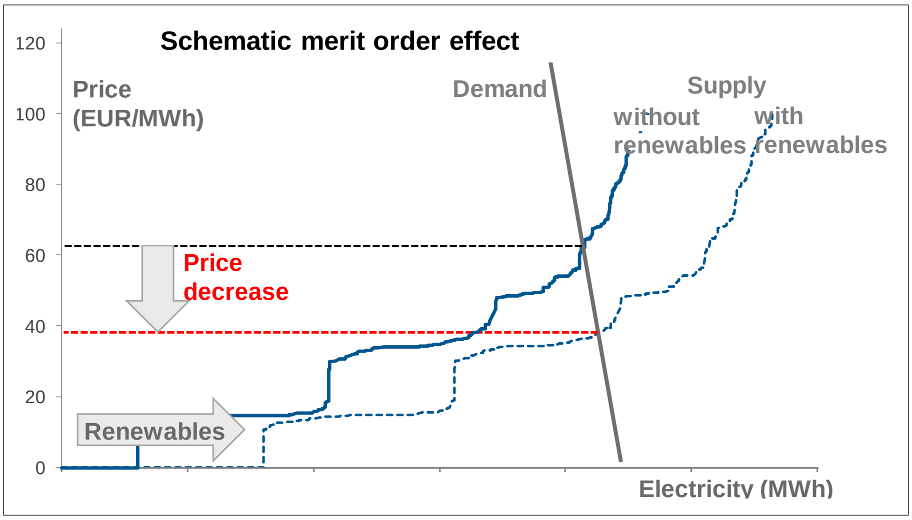
Overall, an ETS price signal that is below 60 EUR/tonne of CO_2 will have two impacts. First, it will cause shifts in profit margins between different power generation technologies in the existing fleet. Second, it will effectively influence investment decisions for conventional technologies towards less carbon-intensive technologies such as gas. However, the ETS will not induce the required fuel-switch to renewable technologies for reaching the long term goals of a sufficient renewable energy share in power generation and emission reduction.[5]

Variable renewables face considerable revenue risk due to the merit order effect, as they cannibalize the wholesale market prices from which they derive revenues.

Wind and solar PV struggle to receive sufficient revenues from an electricity-only market. Both technologies produce electricity dependent on weather conditions. With their marginal cost at or close to zero, wind and solar PV come first in the merit order of power plants and shift it to the right, thereby decreasing the wholesale price of electricity (often called the "merit order effect").

Thus, when wind and solar PV generate, they systematically cannibalize power market prices. As a result, wind and solar PV have a tendency to not earn sufficient revenues for refinancing themselves.[6]

Whether total revenues are sufficient in this regard depends on the specific assumptions that underlie an individual plant's expected profitability. In particular, the economic viability critically depends on the price of CO_2.



An *ETS-only* approach to energy policy will increase the risks of RES deployment and is unlikely to provide for a stable growth of variable renewable energy technologies in the EU

Renewable energy investors face various risks some of which are fundamentally influenced by the support scheme in place.[7] A key risk aspect is the exposure to electricity market prices, as illustrated in the table on the following page.

[5] This is not only true for solar PV and wind, but also for other renewable energy technologies which still need more innovation to get closer to market deployment.

[6] This effect gets stronger the higher the share of renewable technologies in the market. Also see Agora Energiewende (2013)

[7] For a broader discussion of risks see Rathmann et al. (2011).

Major risks for renewable energy investors associated with different policy frameworks

Policy framework / Risks	FIP with sliding premium/ CfD or cap & floor	FIP with fixed premium	FIT/FIP with tendering of support level	Quota obligation with tradable certificates	Emissions Trading System (ETS) only
Electricity market price risk	limited	full	none to full	full	full
Major additional risk	–	–	unclear frequency, pre-qualification, penalties	certificate market price risk	certificate market price risk; unambitious ETS cap with CO_2 prices too low for renewables

Note: FIP – Feed-in Premium; CfD – Contract for Difference; FIT – Feed-in Tariff;
Source: own elaboration, based on Held et. al. 2014; Klessmann 2014; de Jager et al. 2011

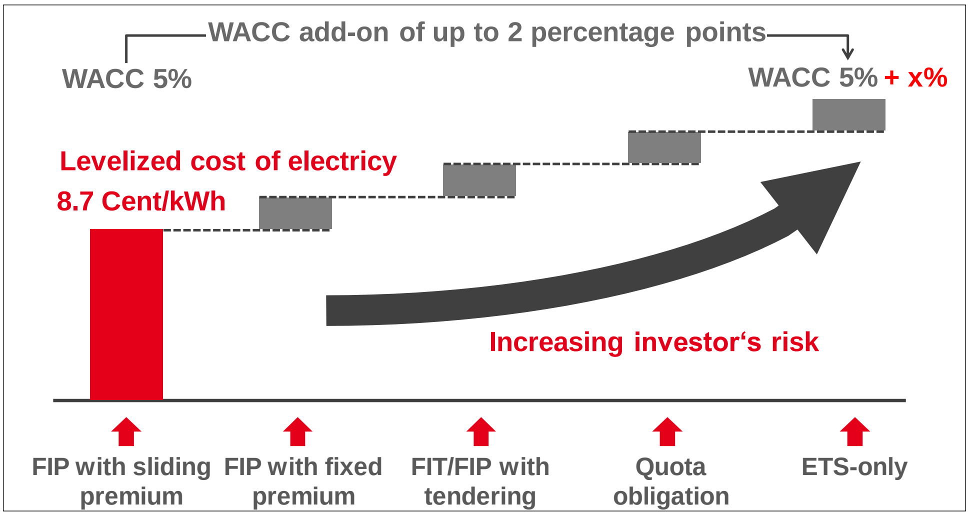
While feed-in premiums (FIP) with sliding premium in the left column represent only limited electricity market price risk, other FIP scheme variants are more risky. Major additional risks are associated with the tendering of the support level and quota systems.

The highest risk can be seen in an *ETS-only* approach without any additional renewable support, because an ETS cap will very likely result in CO_2 prices that are not sufficiently high.[8] As explained above, effectively promoting renewable energy deployment would require prices of around 60 EUR/tonne of CO_2 and above. Such price levels, however, seem politically to be very unrealistic in the medium term against the backdrop of industrial competitiveness considerations.

With elevated risks, renewable energy investors will need to pay higher risk premiums

Renewable energy sources are capital-intensive technologies, and thus their generation costs are strongly affected by the cost of capital. This cost is often expressed as the weighted average cost of capital (WACC), which represents the relative weight of return on equity and cost of debt with different risk profiles (see annex for details). When support schemes increase risks for investors, those increased risks will raise the WACC and consequently the levelized cost of electricity of renewables. This makes renewables more expensive and thus less competitive with other power technologies.

Even though the exact impacts of risk on capital cost are hard to evaluate – as market participants do not easily disclose such information – the available evidence is consistent: Support schemes with higher risks for investors increase their cost of capital[9]. This relationship is illustrated with an example of utility-scale PV in southern Germany in the following diagram[10]: A FIP with sliding premium (to the left) has the lowest WACC and lowest levelized cost of electricity of 8.7 Cent/kWh. All else being equal, an *ETS-only* approach leads to the highest risk add-on of up to 2 percentage points more and associated higher levelized cost of electricity.



8 Even when taking into account recent ETS reform ideas. For an overview see Edenhofer et al. (2014).

9 de Jager et al. (2011); Müller et al. (2011); Giebel et al. (2011); Grau (2014)

10 LCOE calculations for a utility-scale PV plant in southern Germany based on Peter et al. (2013). The estimates for WACC add-ons are based on experience from due diligence and renewable energy finance projects and expert interviews.

Managing risk efficiently is about finding the institution that can carry it at least cost

Renewable energy investment projects involve various types of risks. Some can be reduced; others are persistent. One has to ask which institution is best suited to bear the specific risk under consideration. Static efficiency in risk management can be reached if the actor who manages a given risk can achieve this purpose at least cost. Typically, certain technology and project risks are best understood and managed by the project developer.

For market revenue risks as described in the section above, however, the situation is less clear cut. Dynamic efficiency considerations may imply that project developers are intentionally exposed to certain "productive" risks so that they improve their risk management over time to reduce the associated costs.[11] One example is the requirement of decentralized direct marketing of electricity in feed-in premium systems, where competition in forecasts of variable renewable energy generation can be expected to increase forecast quality over time.

Yet, not all renewable energy investors are equal. Commercial investors and utilities with larger portfolios can carry higher project risks. In contrast, smaller private investors need some form of *de minimis* rule with reduced risk requirements to keep small-scale renewable energy investments sufficiently attractive for them. Only if a policy framework adequately reflects such different types of investors will it create an enabling environment for the whole spectrum of potential renewable energy technologies.

Overall, the appropriate allocation of certain renewable energy investment risks between society and individual market actors is up to debate, and there are various pros and cons. Finding a balance between the risk-carrying capacity of an actor and his risk responsibilities is of critical importance, on the one hand, to address the increasing importance of renewables for the energy system and, on the other hand, not to hamper a rising share of renewables.

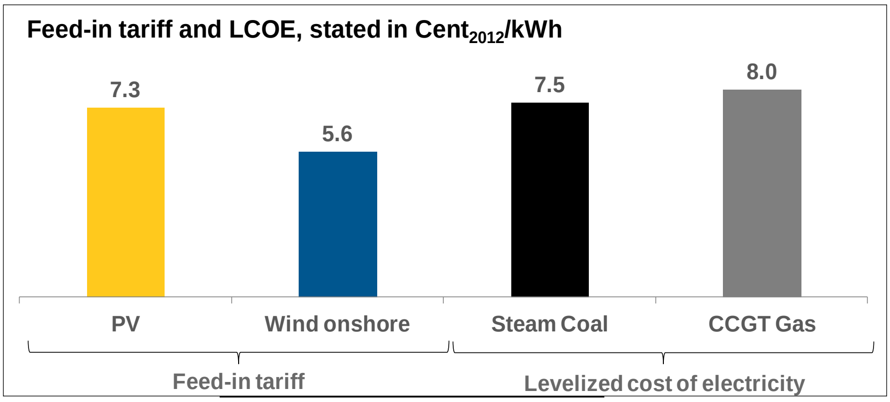
In the end, the crucial question is how the given bundle of risks imposed on different types of investors affects the risk premiums that have to be paid in relation to the overall costs of renewable energy technologies.

Risk allocation between public and private actors in the energy sector

The energy sector has a long history of distributing financial and environmental risks across the economy. Technologies such as coal and nuclear energy have received various forms of public support to increase their competitiveness. In the case of coal, society usually bears the long-term liabilities of coal mining. For nuclear energy, public support includes caps on financial liability for potentially catastrophic damages from nuclear disasters, as well as special financial arrangements for end-of-plant decommissioning and waste storage. A recent example for support of nuclear power generation is the Hinkley Point C agreement, in which the plant owners will receive a fixed price from the UK government to reduce market revenue risk.[12] By contrast, variable renewable energy sources demand much less public support.

If risks are kept sufficiently low through the choice of a suitable policy framework, renewables can compete with conventional electricity generation technologies at 25 EUR/tonne of CO_2

Utility-scale onshore wind and solar PV technologies are cost-competitive today with conventional electricity generation technologies in markets with favorable conditions at a CO_2 price of 25 Euros/tonne. At this CO_2 price, the levelized cost of electricity (LCOE) of new steam coal and CCGT gas plants exceed the 2013 feed-in-tariffs paid for utility-scale PV and onshore wind generation in Germany, as shown in the figure below.[13]



[11] Winkler et al. (2014); Rathmann et al. (2011); IEA (2014a)

[12] Deutsch et al (2014)

[13] see appendix for LCOE assumptions.

New PV and wind installations are even more competitive relative to other low-carbon electricity generation technologies. For example, the feed-in-tariff payments in Germany were considerably lower in 2013 than the approved remuneration for new nuclear power generation in the UK. Solar PV in Germany is up to 34% less expensive, and onshore wind up to 50% less expensive, than the nuclear power remuneration agreement between the UK government and operators for the Hinkley Point C power facility. CCS cost and support projections are similar to or even exceed those for nuclear power (see figure in the appendix).[14]

This means that renewable energy sources are among the most cost-effective low-carbon technologies at a price of 25 EUR/tonne of CO_2. Given their inherent revenue risks, however, renewables need sufficient risk-reducing support to tap their full potential. Clearly, additional renewable support needs coordination with the ETS to avoid negative interaction effects. Such coordination can be achieved by factoring renewable energy deployment into the ETS‘s CO_2 cap (del Rio et al. 2013; Mitchell et al. 2011). [15]

Summary

The EU ETS is designed to level the playing field across power generation technologies by incorporating the costs of carbon into energy markets. It is an effective mechanism to induce fuel switching between conventional power generation technologies, such as coal, gas and nuclear.

However, due to additional risk premiums and the merit order effect in the power market, an ETS scheme alone will not effectively induce the required long-term fuel switching towards renewable energies such as wind and PV.

A binding renewable target and national renewable support schemes help to address risk barriers for renewable technologies and will reduce the costs for those technologies.

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14 Peter et al. (2013); Note that the comparison presented here does not take into account the needed back-up capacity. For such a comparison – which still underscores renewables’ competitiveness in combination with gas backup versus nuclear power and gas – see Deutsch et al. (2014).

15 A wider discussion of parameterization issues between both policy instruments is beyond the scope of this paper. For a recent empirical analysis of interaction effects see Koch et al. (2014).

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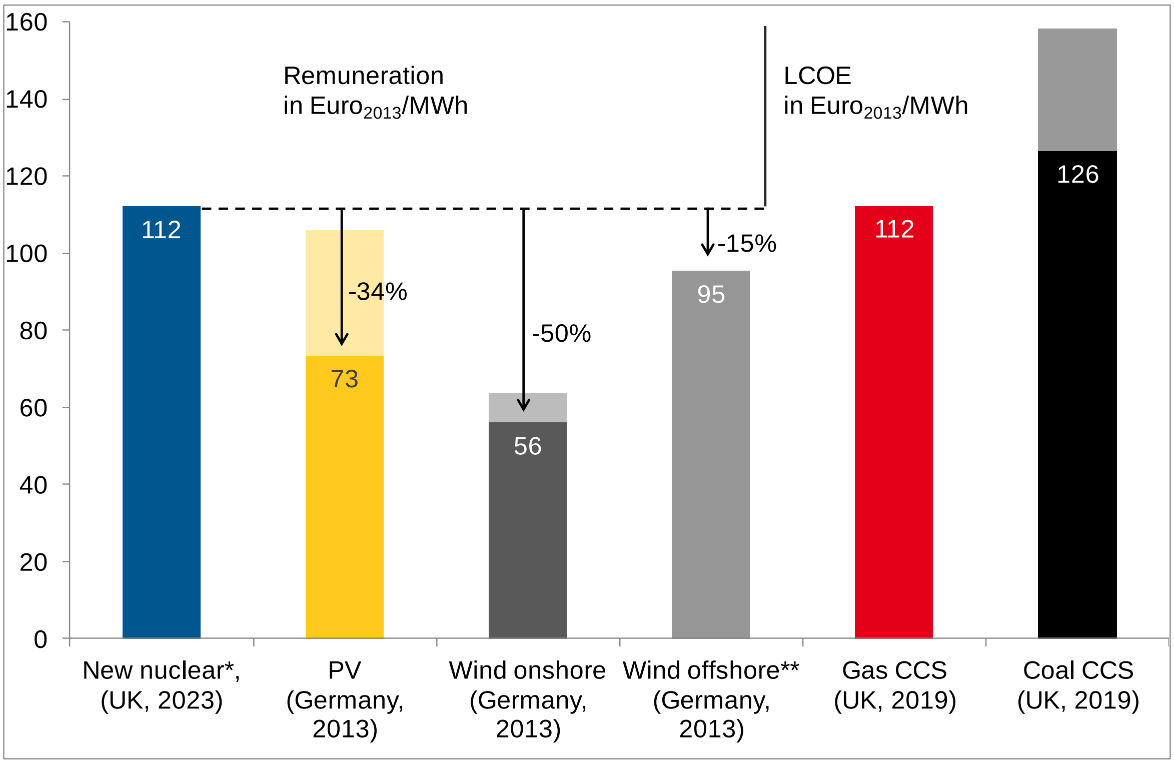
Appendix

Assumptions for calculating the levelized cost of electricity for steam coal and CCGT gas

	Steam Coal	CCGT Gas
Investment costs in EUR/kW	1,500	1,000
Power production in MWh/MW	5,500	4,500
ETA	0.37	0.58
Fuel in EUR/MWh	13	27
Emission specific in kg/MWh	0.33	0.202
CO_2 price in EUR/tonne	25	25
Variable O&M in EUR/MWh	1.5	3
WACC	6%	6%

Source: Peter et al. (2013)

Comparison of average remuneration for new nuclear power, PV, wind and the levelized cost of electricity (LCOE) for gas/coal CCS



Note: Payment ranges reflect different plant sizes (in the case of PV) and resource potentials within Germany (onshore wind).

Source: Deutsch et al. (2014).

Calculation of the levelised cost of electricity(LCOE)

Using the levelised cost of electricity (LCOE; (€/MWh) makes it possible to compare the costs of electricity generation for different generation technologies, but also for different projects with the same generation technology. (See IEA (2014) for a discussion of limitations of the LCOE metrics. The LCOE is the average cost over the lifetime of the generation plant. It is calculated as follows:

$$LCOE = \frac{I_0 + \sum_{t=1}^{n} \frac{A_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{M_{el}}{(1+i)^t}}$$

LCOE	Levelised cost of electricity in $Euro_{2012}$/MWh	i	Weighted average cost of capital in % (WACC)
I_0	Capital expenditure in Euro	n	Operating lifetime (20 years)
A_t	Annual operating costs in Euro in year t	t	Individual year of lifetime (1, 2, …n)
M_{el}	Produced electricity in the corresponding year in MWh		

The LCOE is calculated as the sum of the present values of annual operating costs and capital expenditure, divided by the present value of total electricity generation over a 20-year lifetime. Both costs and energy generation are discounted with the weighted average cost of capital (WACC). Therefore, the higher the WACC, the more the LCOE are rising.

Weighted average cost of capital (WACC

Particularly for capital-intensive technologies, the cost of capital strongly affects energy production costs. This paper refers to the weighted average cost of capital (WACC) that discounts annual operating costs and electricity generation in order to represent the real calculatory financing rate. The cost of capital over project duration represents the relative weight of return on equity (R_E) and cost of debt (C_D) with different risk profiles: