Who can absorb the investment risks of the Energiewende

PPAs as a tool to allocate risk to the most suitable parties

November 2018
PPA negotiations try to strike a deal between the technology cost and the fair market value perspective.

Developers take the perspective of technology cost during PPA negotiations...

...while off-takers should focus on the perspective of fair market value of power.

<table>
<thead>
<tr>
<th>Levelized cost of electricity (LCOE), EUR/MWh</th>
<th>Fair value of PPA contract cash flows, EUR/MWh</th>
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</thead>
<tbody>
<tr>
<td>10%</td>
<td>Wholesale price</td>
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<tr>
<td>8%</td>
<td>Asset profile</td>
</tr>
<tr>
<td>6%</td>
<td>Annual var.</td>
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<td></td>
<td>Short term var.</td>
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<td></td>
<td>GoO</td>
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<td></td>
<td>Capital at risk cost</td>
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<td></td>
<td>Fair value of contract</td>
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PPAs can create value for both parties if the right trade-off between fixed cash flow for asset to reduce financing cost and value-at-risk for off-taker is struck and priced according to market value.

Source: Aurora Energy Research
Fair market value of an onshore wind fixed price 4-year post-subsidy PPA is 35.0 EUR/MWh for volume as-produced

Contract: Duration: 2020 for 4 years // Price: fixed price\(^1\) // Volume: as-produced & no economic curtailment

Fair price calculation for onshore wind fixed price PPA, EUR/MWh

- **Expected energy value of onshore profile over next 4 years is 9 EUR/MWh below baseload**
- **Price effect of high/low wind year increases expected value**
- **Forecast uncertainty Day-ahead to final delivery decreases value**
- **Assuming today's GoO price**
- **The cost of holding capital to cover a P90 loss is 1.1 EUR/MWh**
- **Off-taker holds downside risk if market price falls below contract value**

1. **Wholesale price**
2. **Asset profile**
3. **Interannual variability**
4. **Short-term forecasting cost**
5. **Value of energy**
6. **GoO**
7. **Capital at risk cost**
8. **Admin cost**
9. **Fair value of contract**

\(^1\) Prices expressed in real 2017. Fixed price always refers to an inflation-linked rate in this study.

Source: Aurora Energy Research
Risk of declining market value of contract needs to be covered with underlying capital

Key contract indicators:

- **Value at Risk (VaR):** Average EUR/MWh contract value risk between P50 and P90 forecast
- **Cost of risk capital:** Cost of holding capital to cover expected cumulative value-at-risk

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Onshore wind delivered energy value (energy and GoO) EUR/MWh

Capital is held to cover P90 risk, reducing the fair value of the contract

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1) Contract price before accounting for risk

Source: Aurora Energy Research
For long-term contracts which could enable green-field developments VaR rises to 11 EUR/MWh

Value of delivered energy in a offshore wind PPA\(^1\), EUR/MWh

Depending on off-taker's exposure to power prices, value of hedge can represent up to 5.2 EUR/MWh value add

Cost of value at risk applied to price to give fair value in case where no hedge benefit to off-taker

1) Capture prices shown for a representative asset, with 2 EUR/MWh GoO value added, and intraday and interannual terms totaling 0.87 EUR/MWh subtracted

Source: Aurora Energy Research
**Fair market value of an offshore wind fixed price 12-year PPA is 44.4 EUR/MWh for volume as-produced**

**Contract clause:** Duration: 12 years starting 2023 // Price: fixed price // Volume: as-produced & no economic curtailment

Fair price calculation for offshore wind with fixed price PPA, EUR/MWh

<table>
<thead>
<tr>
<th>Value at risk (EUR/MWh)</th>
<th>11.2</th>
<th>Off-taker holds downside risk if market price falls below contract value</th>
</tr>
</thead>
</table>

**Expected energy value of onshore profile over next 12 years is 7.4 EUR/MWh below baseload**

**Price effect of high/low wind year increases expected value**

**Forecast uncertainty Day-ahead to final delivery decrease value**

**Assuming today's GoO price**

**The cost of holding capital to cover a P90 loss is 5.9 EUR/MWh**

**Wholesale price** | **Asset profile** | **Interannual variability** | **Short-term forecasting cost** | **Value of energy** | **GoO** | **Capital at risk cost** | **Admin cost** | **Fair value of contract** |
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<tr>
<td>5.9</td>
<td>11.2</td>
<td>44.4</td>
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To a certain level a rising price floor improves project economics

Impact of price floors on equity IRRs

<table>
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<tr>
<th>Price floor in EUR/MWh</th>
<th>Typical IRR range for equity investors in infrastructure¹</th>
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<tbody>
<tr>
<td></td>
<td>Fixed price most profitable as off-taker is accepting all risk and discount is lowered by foregone upside</td>
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<tr>
<td></td>
<td>Raising floor returns little value</td>
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<td></td>
<td>Benefit of higher price floor outweighs bigger value discount</td>
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</tbody>
</table>

CAPEX assumptions: Aggressive(-25%)  Returns for fixed price

Equity IRR² in %

Debt/Equity ratio

1) EDHEC Infrastructure Institute (2017). 2) Nominal IRR for fully leveraged equity

Source: Aurora Energy Research
Increasing floor beyond 35 EUR/MWh has marginal return for equity but adds significant VaR for off-taker

CAPEX assumptions:

Returns for fixed price
Aggressive(-25%)

Impact of price floors on equity IRRs

Impact of price floors on Value-at-Risk

Typical IRR for equity investor

Who is best able to manage long-term value at risk?

Source: Aurora Energy Research
C&I ability to take power price risk is exacted to be limited to ~62 TWh/a or 1 bn EUR value at risk

Estimate of C&I PPA market potential, TWh/a

Short duration PPA potential: Ability to absorb power price risk depends on share of power on total cost & level of competition¹

Long duration PPA potential: PPAs are only bankable if off-taker have sufficient credit-rating²

1) We defined a hurdle rate per industry as maximum EBIT impact of P90 risk realisation between 0.5 – 1.5% depending on level of competition. 2) Assumed discount based on fragmentation of industry

= 1 bn EUR value at risk p.a. or 12 bn of investment payback time

= ~ 14 GW offshore

Source: Aurora Energy Research
Until 2030 Energiewende requires investments with 24 – 33 bn EUR in value at risk, ca. twice C&I absorbability

Cumulative value at risk over investment payback time vs. ability to absorb risk, bn EUR

Cumulative value at risk of RES investments with CoD 2020 until 2025/30

65% RE target
- Solar
- Offshore
- Onshore

-41% -62%
Food for thought

Industry

- Large off-taker who are able to absorb power price risk are a scarce resource and thus have a strong negotiation power
- Building up strong relationship with C&I player can be a key success factor for RES developer

Utilities

- To transition to a “subsidy free” Energiewende the market needs large risk accumulators who are able to manage long-term power price risks
- This favours a strengthening of the classic utility model.

Regulation

- If the aim is to transition away from subsidies regulator should focus on reducing downside risks e.g.: Carbon price floor, fixed long-term build out targets etc.
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