Can German renewables become competitive within 5 years?
June 2018
Political ambitions for renewables to become competitive in the near term are high, but significant questions remain:

The Minister for the Economy and Energy, Peter Altmaier, expects renewables to become competitive before 2023:

“I assume that renewables will become fully competitive within the next four to five years, and that will be able to finance renewables without subsidies by then”

However, it is questionable if RES can become competitive this early in the current market design:

- Will technology costs of renewables continue to decline fast enough?
- How does the 65% coalition target impact revenues of subsidy-free renewables?
- How will financing costs change for higher-risk merchant renewables and how are total project cost affected?
- What role can policy play in facilitating subsidy-free buildout?
The EEG 2017 has been a success in reducing costs for renewables...

Source: Aurora Energy Research, BNetzA

After initial decline, price resurgence resumed after:
- privileges for “citizens’ projects” (longer construction limits and no permit required) were suspended
- 65% RES target was introduced
However, actual subsidies are higher than published results suggesting current projects are far from being competitive

Power price
Nominal Euro/MWh

ILLUSTRATIVE

Regional location factor
- Auction bids are given for a reference location (standardised windspeed)
- Actual guaranteed prices are corrected by a location-specific factor to incentivise more distributed buildout

Location trend
- Average wind farm location at around 75% of reference yield
- With increasing market saturation, quality of available location is likely to decrease further

<table>
<thead>
<tr>
<th>Latest onshore wind bids</th>
<th>Average correction factor</th>
<th>Resulting price</th>
<th>Difference subsidised by current system</th>
<th>Annualised capture price for wind farm built in 2020</th>
</tr>
</thead>
</table>

1) Average price of successful bids (weighted by capacity) in May 2018 auction
2) Approximated based on locations of wind farm locations in 2012-14
3) 20 year nominal average capture price, (inflation projection 1.5% p.a.) Aurora Central Scenario

Source: Aurora Energy Research, BMWi
The 65% coalition target cannibalises market revenues of renewable plants

Onshore wind capture price, EUR/MWh real 2017, levelised average 2023

Capture price

- Government target increase by 15pp depresses capture price by 33%
- This makes competitive RES before 2040 very unlikely

1) Levelized capture price in 2023 2) market price achievable by wind onshore farm

Source: Aurora Energy Research
A carbon price floor significantly increases certainty on 25-30% of revenues of a merchant asset and decreases capital costs.

- Carbon price floor increases the cash flow certainty for >25% of revenues.
- Secured cash flow can increase debt-equity ratio.
- This results in lower financing costs for overall project.

Capture price wind onshore, EUR/MWh, real 2017

- Aurora Central Scenario
- Without CO2 price

Share of CO₂ price of total price

~25-30%
Subsidy-free renewables face significantly higher cost of capital than current supported investments under EEG

<table>
<thead>
<tr>
<th>WACC, In % (nominal)</th>
</tr>
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<tbody>
<tr>
<td>16</td>
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<tr>
<td>14</td>
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<tr>
<td>12</td>
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<tr>
<td>10</td>
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<td>8</td>
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<td>6</td>
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<tr>
<td>4</td>
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<tr>
<td>2</td>
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<tr>
<td>0</td>
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</tbody>
</table>

- Battery UK
- CCGT USA
- Onshore Wind Spain
- Onshore Wind Sweden
- Solar PV Australia

Notes: 1) Supported by low price floor covering some downside risk 2) Benefiting from additional priority via green certificates in the market 3) Benefiting from additional support via mandated renewable shares in generation portfolios

Source: Grant Thornton, Agora Energiewende, Castalia Strategy
PPAs increase revenue certainty and lower cost of capital by up to 4 percentage points

PPA impact on cost of capital

- PPAs increase certainty of project’s revenues and assure availability of cash flow for debt service
- Increased availability of cash flow to cover debt services enables higher debt share
- Higher (debt) leverage decreases cost of capital for the sponsor
- Reduced project risk decreases cost of equity and further lowers WACC

- Only with PPAs widely applied can they make a relevant impact on RES WACC and competitiveness
- System with higher liquidity and lower transaction cost (i.e. time and legal resources) for PPAs important for application throughout different sectors and scales

<table>
<thead>
<tr>
<th>Capital structure</th>
<th>Share (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debt</td>
<td>6 - 7%</td>
</tr>
<tr>
<td>Equity</td>
<td>10 - 11%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in financing cost under PPA contracting</th>
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<tbody>
<tr>
<td>Merchant conditions</td>
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<tr>
<td>PPA contracted</td>
</tr>
</tbody>
</table>

Sources: Aurora Energy Research
We assessed three policy options quantitively: status quo, PPAs and a carbon price floor under three market scenarios.

<table>
<thead>
<tr>
<th>Policy options</th>
<th>Status quo</th>
<th>PPAs</th>
<th>Carbon price floor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Continuation of current EEG system</td>
<td>• No EEG build-out past 2022</td>
<td>• No EEG build-out past 2022</td>
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<tr>
<td></td>
<td>• Merchant RES at 10.5% WACC when exceeding EEG build-out path</td>
<td>• Policy framework to create favourable conditions for PPA</td>
<td>• Carbon price floor at 45 EUR/t to incentivise RES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• WACC of 7.5%</td>
<td>• 9% WACC due to lower uncertainty</td>
</tr>
<tr>
<td>Market scenarios</td>
<td>Central</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>As in Aurora Central in particular</td>
<td>As in Aurora Central except</td>
<td>As in Aurora Central except</td>
</tr>
<tr>
<td></td>
<td>• Carbon price of 31 EUR/t in 2030</td>
<td>• Carbon price of 52 EUR/t in 2030$^1$</td>
<td>• Carbon price of 8 EUR/t in 2030$^1$</td>
</tr>
<tr>
<td></td>
<td>• Gas price of 27 EUR/MWh in 2030</td>
<td>• Gas price of 46 EUR/MWh in 2030</td>
<td>• Gas price of 15 EUR/MWh in 2030</td>
</tr>
</tbody>
</table>

$^1$ In carbon price floor scenario, minimum carbon price of 45 EUR/t CO$_2$

Sources: Aurora Energy Research
Carbon price floor is most resilient against change in market conditions, other policies are comparably more cost effective.

**Status Quo**

**Power sector CO2 emissions 2030, million tCO\(_2\)**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Central</th>
<th>High</th>
<th>Low</th>
<th>Avg</th>
</tr>
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<td>Status Quo</td>
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<td>184</td>
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<td>192</td>
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</table>

**PPA**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Central</th>
<th>High</th>
<th>Low</th>
<th>Avg</th>
</tr>
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<tr>
<td>PPA</td>
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**Carbon Price Floor**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Central</th>
<th>High</th>
<th>Low</th>
<th>Avg</th>
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<tbody>
<tr>
<td>Carbon Price Floor</td>
<td>185</td>
<td>183</td>
<td>185</td>
<td>184</td>
</tr>
</tbody>
</table>

**Impact on electricity cost, % of central price projection**

- Remaining price components
- Central
- High commodities
- Low commodities

- **Status Quo**: Ø 101
- **PPA**: Ø 98
- **Carbon Price Floor**: Ø 119

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1) Remaining price components – e.g. grid charges & taxes - remain constant over scenarios. Legacy subsidies only change marginally.

Source: Aurora Energy Research
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- Analyst support

Power Market Forecast Reports
- Power market forecast reports
- Forecast data in Excel
- Global energy market forecast reports
- Analyst support

Bespoke forecasts
- Aurora can provide power market forecasts upon request

Source: Aurora Energy Research
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