March 2024
Summary of the Position Paper

Creating Investment Incentives, Providing Reserve Capacity

Options for the market integration of renewable energy

German National Academy of Sciences Leopoldina
acatech – National Academy of Science and Engineering
Union of the German Academies of Sciences and Humanities

The expansion of renewable energy in Germany due to the energy transition has profoundly transformed the electricity system and the associated electricity market. Although the electricity market has demonstrated its fundamental ability to function effectively in recent years, the energy transition nonetheless poses a number of challenges. The nature of renewable energy gives rise to investment problems, not least in the following two areas of the electricity market:

- A future climate-neutral energy supply will require a massive expansion of renewable energy, especially wind and solar installations, which will generate most of our electricity. In view of the ambitious expansion targets and high financing requirements, the goal should be to establish a market system based on a cross-sectoral **carbon price by 2030**. In the interim, the **carbon price** should be steadily increased alongside **market premium models** that are gradually phased out.
- The transition to more decentralised, renewable energy generation poses new challenges for ensuring security of supply in the overall system. From an economic perspective, there is also an externality problem, since under the current system it is not possible to attribute individual responsibility for security of supply in accordance with the “polluter/user pays” principle. It is thus doubtful whether the current **energy-only market** will be able to guarantee an adequate level of security of supply in the medium term. Even today, Germany already needs an additional strategic reserve. Consequently, the establishment of **central** or **decentralised** capacity markets should be investigated as a means of providing long-term security of supply.
- It will be essential for implementation of the above policy options to be accompanied by complementary measures geared towards leveraging the flexibility potential of the current electricity system.

The need for a new electricity market design and the key challenges

The massive expansion of renewable energy is a fundamental part of the energy transition. Renewables are expected to account for eighty percent of electricity generation by 2030 and one hundred percent of electricity generation in the G7 countries by 2035. However, the nature of renewable energy means that its increasing integration into the market will give rise to two key investment risks:

Investment risks of renewable energy:

1. **Merit order effect**: Wind and solar installations have virtually no variable costs. Their very low marginal costs put them at the 'top' of the merit order, above other types of power plant. Since spot prices are determined by the last power plant used, if wind and solar installations account for a high percentage of electricity generation, a general reduction in spot prices ensues.

2. **Cannibalisation effect**: At any given time, the amount of electricity fed into the grid by a weather-dependent renewable source such as a wind installation is strongly correlated with the amount fed in by other installations of the same technology. The more electricity these installations feed in, the more they are affected by the merit order effect.

The challenge for investments in providing security of supply:

1. **Providing flexibility in a system with a high percentage of renewables**: The growing proportion of weather-dependent wind and solar installations is making electricity generation increasingly inflexible. To compensate for this, it is necessary to provide incentives for storage systems, more flexible demand and flexible additional capacity so that curtailments and temporary power cut-offs can be avoided.

2. **Changes in Germany's electricity supply**: With the phase-out of nuclear power and its long-term plans to end coal-fired power generation, Germany will lack the capacity to cover the base load in the medium term. As a result, the role of natural gas is becoming increasingly important. To achieve full decarbonisation, other means of providing flexibility such as storage systems will also be necessary to replace the missing base load.

3. **Responsibility for security of supply**: From an economic perspective, the current electricity market has an externality problem: the cost of providing security of supply is borne by individual parties, whereas the benefits are collective. The electricity market's competitive design offers little incentive for the individual actors to contribute to security of supply. This means that there is a danger of systematic underinvestment in flexible technologies or reserve capacity.

Market support versus grid support: The future market structure will combine the supply of renewable energy through the European grid system with large numbers of individual and decentralised structures. This will cause conflicts between the overall market's need for flexibility (market support) and the reduction of grid load and grid expansion requirements (grid support).

Options for a new electricity market design

Key Question 1: What are the most effective and efficient ways of **supporting renewable energy installations** and how can the electricity market design help renewable energy to prevail in the market **without financial support** and a government safety net?

At a glance: Four policy options for an efficient and effective model to support renewable energy

Policy option 1A: Fixed market premiums

- **In brief:** Fixed payment in addition to proceeds from selling on the power exchange.
- **Pros:** Incentive to act in a manner that supports the market and respond to price signals, reduces investment risk, can be flexibly adjusted to regional circumstances and specific technologies, can be combined with Power Purchase Agreements (PPAs), no legal obstacles to approval of properly designed market premiums.
- **Cons:** Direct marketing investment risk remains, danger of installations receiving too much/too little financial support, danger of windfall profits, limited incentive for curtailment in the event of negative market prices.

Policy option 1B: Sliding market premiums (current model)

- **In brief:** Premium prevents price from getting too low: 'guaranteed minimum selling price'.
- **Pros:** Confidence regarding minimum selling price, reduces investment risk, incentive to act in a manner that supports the market, prevailing model for supporting renewable energy in Germany (no need for major regulatory changes).
- **Cons:** Little incentive to respond to market price changes, limited incentive for curtailment in the event of negative market prices.

Policy option 1C: Contracts for Difference (CfDs)

- **In brief:** Premium offsets high and low prices: 'guaranteed selling price'.
- **Pros:** Highest investment security compared to other premium models, no direct risk of windfall profits.
- **Cons:** No incentive to act in a manner that supports the market, no incentive to invest in more flexible technologies or technologies that support the market, danger of inefficiencies and additional costs to businesses and the economy as a whole.

Policy option 1D: Focus on carbon pricing

- **In brief:** Instead of a premium, provides 'indirect support' through internalisation of carbon-intensive generation.
- **Pros:** Very cost-efficient, highly effective means of meeting climate targets, technology- and location-neutral, stronger market-based incentives than market premiums.
- **Cons:** Higher investment risk due to lack of direct financial support, danger of prices falling if there is a high proportion of renewable energy.

Key Question 2: Is the current market design **(energy-only market)** able to guarantee a **high level of security** of supply in the long term or are **additional investment incentives** required?

At a glance: Four policy options for guaranteeing a high level of security of supply

---

Policy option 2A: Energy-only market

- **In brief:** The necessary flexibility is provided implicitly via price signals.
- **Pros:** Simple and cheap to implement, market-based incentives, cost-efficient, no need for structural changes or establishment of an additional capacity market.
- **Cons:** Externality problem remains (no responsibility for overall system), danger of supply shortages due to lack of investment, danger of political intervention counteracting flexibility potential if spot prices are very high.

Policy option 2B: Energy-only market with strategic reserve (current model)

- **In brief:** Payment of power plants that do not participate in the regular electricity market to provide reserve capacity during supply shortages.
- **Pros:** Guarantees and increases security of supply, which can in principle be as high as desired; keeping this model only requires refinements rather than structural changes.
- **Cons:** Externality problem remains (no responsibility for overall system), comparatively poor cost efficiency, danger of politically motivated interventions if market prices are high, danger of free riding by neighbouring countries

Policy option 2C: Establishment of a central capacity market

- **In brief:** A second market is established to pay for (guaranteed) capacity.
- **Pros:** Guarantees high level of security of supply, incentive to maintain flexibility, cheaper and more efficient than current strategic reserve.
- **Cons:** Higher costs than energy-only market and decentralised capacity markets, danger of inc-dec gaming, less cost-efficient, susceptible to lobbying, flexibility potential of micro-consumers may not be leveraged.

Policy option 2D: Decentralised capacity markets with individual responsibility for security of supply

- **In brief:** Trading of certificates for flexible generation, providers have capacity obligation at peak demand times, security of supply level forms part of supply contracts.
- **Pros:** Resolves externality problem (transfers supply risk to providers), overcapacity less likely, better regional distribution, cost-efficient, promotes demand-side flexibility.
- **Cons:** Extensive technical and legal preparations required prior to implementation, lower-income households could suffer if badly designed.

Next steps

There is no fundamental question about the effective functioning of the current electricity market design. However, the current model will need to be reformed to ensure that the future electricity market design helps to meet the climate targets and reflects the fact that a high proportion of electricity will be generated from renewable sources. Regardless of which policy options are implemented, it will be essential to simultaneously leverage the **flexibility potential** in the current electricity system.

1. From both a climate effectiveness and a cost efficiency perspective, the long-term goal should be to move away from direct financial support of renewable energy and **focus** instead **on (cross-sectoral) carbon pricing**. This model should be implemented by 2030. During the transition period, the carbon price should increase gradually within a predictable **price corridor**. After weighing up the respective pros and cons, it will also be necessary to simultaneously implement an **appropriate market premium model** in order to achieve the massive expansion of renewables required by 2030. In the longer term, this market premium model should be phased out in favour of a focus on carbon pricing.

2. In view of the transition to a renewable electricity supply, it will be necessary to establish whether, in the future, a pure **energy-only market** will be able to guarantee the necessary **security of supply** and **flexibility**. Even today, it is necessary to maintain an additional strategic reserve outside of the market in order to guarantee the required capacity. By the same token, it will also be necessary to determine whether the establishment of a central or **decentralised capacity market** would be a better way of ensuring security of supply and increasing supply- and demand-side flexibility. If, after weighing up the pros and cons, the decision is taken to implement one of the capacity market models, extensive **technical and legal preparations** will be necessary, especially if the decentralised capacity market model is chosen. The design will also need to address the **social justice dimension**.

The Academies' Project "Energy Systems of the Future"

The Position Paper *Creating Investment Incentives, Providing Reserve Capacity. Options for the market integration of renewable energy* evolved within the framework of the Academies' Project "Energy Systems of the Future". In interdisciplinary working groups, about 160 experts are working on different courses of action for the pathway to an environmentally sustainable, safe and affordable energy supply.

Participants in the working group "Electricity Market of the Future"

Members: Prof. Dr. Jürgen Kühling (co-chair, University of Regensburg), Prof. Dr. Justus Haucap (co-chair, Heinrich Heine University Düsseldorf), Dr. Munib Amin (E.ON Group Innovation GmbH), Prof. Dr. Gert Brunekreeft (Jacobs University Bremen), Dr. Dörte Fouquet (Becker Büttner Held), Prof. Dr. Veronika Grimm (FAU Erlangen-Nürnberg), Prof. Dr. Jörg Gundel (University of Bayreuth), Prof. Dr. Wolfgang Ketter (University of Cologne, Prof. Dr. Martin Kment (University of Augsburg), Prof. Dr. Jochen Kreusel (Hitachi Energy), Prof. Dr. Charlotte Kreuter-Kirchhof (Heinrich Heine University Düsseldorf), Prof. Dr. Mario Liebensteiner (FAU Erlangen-Nürnberg), Prof. Dr. Albert Moser (RWTH Aachen University), Dr. Marion Ott (ZEW), Prof. Dr. Christian Rehtanz (TU Dortmund University), Prof. Dr. Heike Wetzel (University of Kassel)

Scientific coordinators: Miriam Borgmann (acatech), Jonathan Meinhof (Heinrich Heine University Düsseldorf), Dr. Cyril Stephanos (acatech), Marlene Wagner (University of Regensburg)

Contact:

Dr. Cyril Stephanos
Head of Project Office "Energy Systems of the Future"
Georgenstraße 25, 10117 Berlin, Germany
phone: +49 30 2 06 79 57 - 0 I e-mail: stephanos@acatech.de
web: energiesysteme-zukunft.de/en

The German National Academy of Sciences Leopoldina, acatech – National Academy of Science and Engineering, and the Union of the German Academies of Sciences and Humanities provide policymakers and society with independent, science-based advice on issues of crucial importance for our future. The Academies' members and other experts are outstanding researchers from Germany and abroad. Working in interdisciplinary working groups, they draft statements that are published in the series of papers *Schriftenreihe zur wissenschaftsbasierten Politikberatung* (Series on Science-Based Policy Advice) after being externally reviewed and subsequently approved by the Standing Committee of the German National Academy of Sciences Leopoldina.

German National Academy of Sciences Leopoldina
Jägerberg 1
06108 Halle (Saale)
phone: 0345 47239-867
Fax: 0345 47239-839
Email: leopoldina@leopoldina.org

Berlin Office:
Reinhardtstraße 14
10117 Berlin

acatech – National Academy of Science and Engineering
Karolinenplatz 4
80333 München
phone: 089 520309-0
Fax: 089 520309-9
Email: info@acatech.de

Berlin Office:
Georgenstraße 25
10117 Berlin

Union of the German Academies of Sciences and Humanities
Geschwister-Scholl-Straße 2
55131 Mainz
phone: 06131 218528-10
Fax: 06131 218528-11
Email: info@akademienunion.de

Berlin Office:
Jägerstraße 22/23
10117 Berlin