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119 Report by Karsten Neuhoff, Mats Kröger, and Leon Stolle

A Renewable Energy Pool brings benefits of energy transition to consumers

- Despite the increasing importance of cost-effective renewable energy generation, electricity consumers are concerned about uncertain electricity prices
- A Renewable Energy Pool makes it possible for consumers to have predictable and affordable electricity prices
- Attractive conditions of long-term hedging contracts are passed on to consumers via an RE-Pool

LEGAL AND EDITORIAL DETAILS

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AT A GLANCE

A Renewable Energy Pool brings benefits of energy transition to consumers

By Karsten Neuhoff, Mats Kröger, and Leon Stolle

- Despite the rapid cost decline and increasing deployment of wind and solar power, uncertain and high electricity prices remain a concern for consumers
- A Renewable Energy Pool can ensure predictable and affordable electricity prices for consumers and facilitates low-cost financing of new wind and solar projects
- The attractive conditions of long-term hedging contracts are passed on to the consumers via the RE-Pool
- The pool hedges electricity consumers for consumption matching wind and solar production. Flexibility serves as hedge for any miss-match; this strengthens incentives to realize all flexibility
- An RE-Pool would replace the current support of renewable energy sources via the sliding market premium

"By passing on the advantages of renewable energy to the consumers, political support for the energy transition can be strengthened."

— Mats Kröger —

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Audio-Interview mit Mats Kröger (in German)
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A Renewable Energy Pool brings benefits of energy transition to consumers

By Karsten Neuhoff, Mats Kröger, and Leon Stolle

ABSTRACT

German companies view high and uncertain electricity prices a major challenge. A Renewable Energy Pool (RE-Pool), wherein the favorable conditions of competitive tenders for new wind and solar power projects are passed on to electricity consumers, could hedge such price risks. Consumers' electricity prices are thus hedged for the share of their consumption that corresponds to the RE-Pool's generation profile. This, in turn, strengthens the incentives to invest in flexibility, such as in heat storage systems or batteries, in order to adjust their demand to wind and solar electricity production in the pool. In addition, the RE-Pool profile can serve as a reference against which new products to hedge flexibility can be introduced in the futures and forward markets. The RE-Pool also addresses financing risks linked to regulatory uncertainties faced by renewable energy projects. This reduces financing costs and thus costs for consumers and enhances confidence in future renewable deployment and thus supports investments into the supply chain of project developers and manufacturers. The RE-Pool contributes to an even better use of renewable energy sources in the energy supply and prepares the electricity system for a future powered by a greater share of renewable energy.

The electricity generation costs[1] for renewable energy sources have decreased considerably over the past years. For example, costs declined by 89 percent for solar installations, by 69 percent for onshore wind installations, and by 59 percent for offshore wind installations from 2010 to 2022 (Figure 1).[2] Although over half of the electricity supply now comes from renewable energy sources,[3] their declining costs[4] could not protect electricity consumers against the price shocks on the gas and coal markets in the past years. This is due to the pricing mechanism on the electricity market, where the most expensive installation determines the power price in each hour. This means that the generation costs of gas and coal-fired power plants continue to determine the price of the electricity supply in most hours.

The geopolitical situation as well as the future development of energy and climate policy remain uncertain. Fossil fuel price shocks cannot be ruled out in the coming years, even if prices have declined recently. This uncertainty is also reflected in the expectations of companies as electricity consumers in the European Union. In a 2023 survey conducted by the European Investment Bank, 59 percent of companies expressed major concern about energy prices and 47 percent were worried about uncertainty regarding price development.[5]

In principle, companies and energy providers can insure themselves against fluctuating prices by concluding long-term bilateral power purchasing agreements (PPAs) with electricity producers through which prices and delivery

1 The generation costs, or the levelized cost of electricity (LCOE), is a common measure for comparing the costs of different electricity generation technologies. Both the installation costs and all variable costs are compared to the amount of electricity produced by a system over the entire operating period.

2 International Renewable Energy Agency (IRENA), *Renewable Power Generation Costs in 2022, International Renewable Energy Agency* (Abu Dhabi: 2023) (available online; accessed on March 20, 2024 (in German). This applies to all other online sources in this report unless stated otherwise).

3 Bundesnetzagentur, "Bundesnetzagentur veröffentlicht Daten zum Strommarkt 2023," press release, January 3, 2024 (in German; available online).

4 Bundesnetzagentur, "Bundesnetzagentur veröffentlicht Daten zum Strommarkt 2023."

5 European Investment Bank, *EIB Investment Survey – European Union Overview* (2024) (available online). The results are based on interviews with 12,030 companies in the European Union between April and July 2023.

DOI: https://doi.org/10.18723/diw_dwr:2024-15-1

amounts for the coming years are set. However, such bilateral contracts contain challenges for many companies, such as the default risk of the contract partner and collateral that must be submitted. In particular, it is risky for energy-intensive companies to hedge the price of a major share of their electricity demand via long-term PPAs if the prices of their final output are not insured for a comparable time period. Therefore, instruments that avoid the problems of such bilateral contracts and make the electricity market resilient to future price fluctuations are under discussion.

A Renewable Energy Pool allows electricity consumers and renewable energy project developers to mutually insure against price risks

The RE-Pool[6] consists of three elements (Figure 2). First, a publicly commissioned agency conducts an auction to tender long-term contracts for the output of new wind and solar projects. Second, these contracts are aggregated into a contract pool. The pool includes a diverse portfolio of plants with multiple technologies and at diverse locations that began operating at different times. Thus, long-term hedging contracts are aggregated in the RE-Pool, which reduce wind and solar project developers' investment risk. Third, electricity consumers receive a contract for a share of the electricity generated in the pool, thus hedging electricity price risks. In this concept, the conditions of the renewable energy projects are passed on to electricity consumers via the pool. The pool is budget-neutral for the federal government.

An RE-Pool guarantees financing for future wind and solar projects and addresses uncertainties that could otherwise endanger German expansion targets and increase the cost of the energy transition. At the same time, electricity consumers directly benefit from the cost reductions in renewable energy. Affordable and reliable electricity prices are a prerequisite for further electrification, which is an important component in many sectors in the transition towards a climate-neutral economy. Thereby, they contribute to the success of the industrial transition. By passing on the benefits of wind and solar energy directly to electricity consumers, the RE-Pool also increases political support for the energy transition.

Consumers can benefit from affordable renewable energy via an RE-Pool

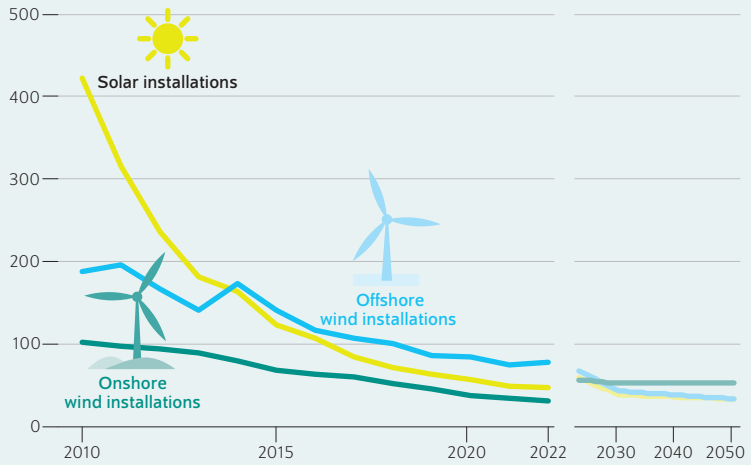
The elements of the RE-Pool build upon previously developed and well understood instruments. The long-term contracts are awarded to renewable energy plant operators in auctions by a publicly commissioned entity. The prices of successful bids define the contract price for the respective hedging of a project's electricity price risk, as was previously the case in the auctions according to the German Renewable Energy Act (EEG). If the market price is lower than this contract price during an hour in which the plant is producing electricity, the difference is paid to the operator. In addition to the current German system, the plant operator must reimburse the surplus revenue to the RE-Pool in hours in which the market price is higher than the contract price. Such symmetrical long-term contracts hedge electricity producers against price risks, allowing the projects to be realized at low financing costs.[7]

The previous one-sided hedging via the sliding market premium for new projects would come to an end with the introduction of the RE-Pool. This motivates developers of new wind and solar projects to participate in the pool. A further advantage of the RE-Pool is the ability to hedge against regulatory uncertainties, such as the introduction of price zones or local prices.

By switching to symmetric hedging, the benefits of the symmetrical contracts can be passed on to the consumers. All of the long-term contracts are aggregated in the RE Pool, which is defined by the sum of its generation and average contract price. Electricity generated from the RE-Pool is then proportionally allocated to the consumers. Under the previous support regime, consumers only incurred costs that were passed on via the EEG surcharge and have been paid from

Figure 1

Generation costs of renewable energy sources
In euros per megawatt hour



Notes: The assumed exchange rate is 0.95 euros per US dollar. The data until 2022 represent global values. Data from 2023 are linearly interpolated forecasts for the European Union.

Sources: International Renewable Energy Agency (IRENA), *Renewable Power Generation Costs in 2022;* IEA, *IEA World Energy Outlook* (2023).

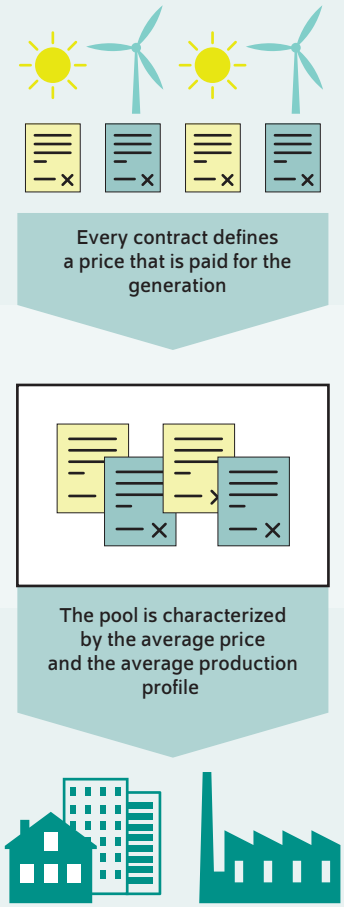
The average generation costs of renewable energy sources have continued to decline over the past years.

6 The concept of renewable energy pools as well as the calculations in this Weekly Report are based on Karsten Neuhoff et al., "Contracting Matters: Hedging Consumers and Producers with a Renewable Energy Pool," *DIW Diskussionspapier* no. 2035 (2023) (available online).

7 Cf. Mats Kröger, Karsten Neuhoff, and Jörn C. Richstein, "Contracts for Difference Support the Expansion of Renewable Energy Sources while Reducing Electricity Price Risks," *DIW Weekly Report* no. 35/36 (2022): 205-213 (available online).

Figure 2

Schematic depiction of a renewable energy pool (RE-Pool)



Sources: Karsten Neuhoff et al., "Contracting Matters: Hedging Consumers and Producers with a Renewable Energy Pool," *DIW Diskussionspaper*, no. 2035 (2023); authors' depiction.

An RE-Pool enables cost-effective financing of wind and solar energy projects, allowing the lower costs to be passed on to consumers.

the federal budget since July 2022. Following the introduction of symmetric hedging, however, consumers will benefit from payments during periods of high electricity prices. If symmetric contract structures had already been introduced in the past, it would have led to large payments and to a significant reduction in the burden on consumers during the energy price crisis.[8] The advantage of passing on the hedging contracts is that the payments in years with low electricity prices do not burden the federal budget as in the previous support regime, as the payments and reimbursements of pool consumers and electricity producers balance each other out each period.

As further auctions are held each year as part of Germany's renewable energy expansion targets, the RE-Pool volume would increase steadily over the years. If introduced for all new tenders starting from 2025 (Figure 3), the RE-Pool would consist of onshore wind and solar power installations in the first few years. Due to the longer project development times, offshore wind installations would be added beginning in 2029. In this case, over 100 TWh of generation could be hedged via the pool from 2028 if Germany's renewable targets are reached. The exact price of the RE-Pool depends on the generation costs of different renewable energy technologies and sites reflected in the bidding process. By weighting the forecasted technology-specific generation costs[9] with the respective pool volumes, suggests that pool prices in the range of 50 to 60 euros per megawatt hour.

An important question is what risks electricity consumers are assuming when participating in an RE-Pool, especially if electricity prices fall below the prices in the RE-Pool in the long term. Such a price drop could happen if renewable energy generation costs continue to fall or renewable electricity projects outside the pool would be subsidized. In principle, this could lead to a structural disadvantage for companies participating in the pool. This can be avoided if electricity consumers in the pool receive an exit option, for example with a five-year notice period. In case of an exit, the federal government, as guarantor of the RE-Pool, would have to cover the costs of the remaining contracts. This creates a de facto regulatory guarantee from the federal government to the companies in the RE-Pool, which protects them from disadvantages due to future regulatory measures like a subsidy for installations outside of the pool. On the other hand, a long notice period, for example five years, ensures that consumers remain in the pool and committed to the deal of a mutual insurance of producers and consumers also in periods of temporarily lower whole-sale prices.

RE-Pool access should prioritize consumer segments particularly affected by the transition

There are various options for allocating the electricity generated in the RE-Pool among the consumers: "pro-rata" allocation, auctions, or prioritization.

Under a "pro-rata" allocation, all electricity consumers are hedged according to their share of total electricity consumption. This would be the simplest and most plausible method in the long term. However, it would not provide sufficient hedging for groups of priority consumers who will be particularly affected in the coming years, as the RE-Pool volume must first be built up. A second option would be to allocate the RE-Pool via an auction. This would lead to the companies that are able to pay the most receiving access to the hedge. This would not necessarily benefit companies that require stable and competitive electricity prices in order to invest in transition processes.

8 Cf. Jörn Richstein, Frederik Lettow, and Karsten Neuhoff, "Marktprämie beschert Betreibern erneuerbarer Energien Zusatzgewinne – Differenzverträge würden VerbraucherInnen entlasten," *DIW aktuell* no. 77 (in German; available online).

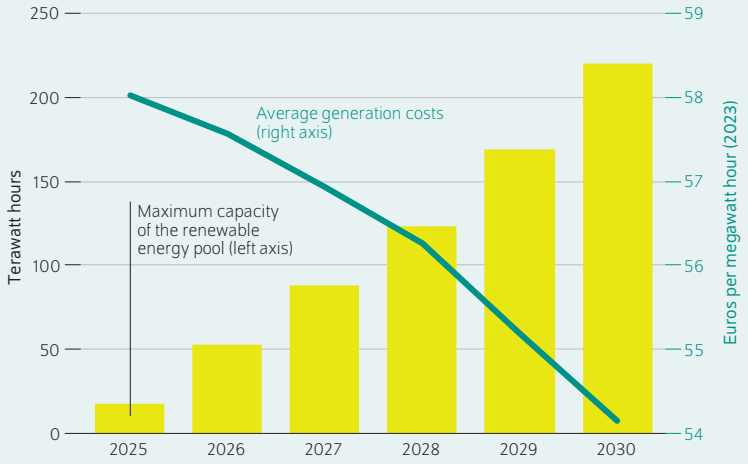
9 International Energy Agency, *World Energy Outlook 2023* (Paris: IEA, 2023) (available online).

A third possibility is prioritizing allocation to consumer segments that are especially affected by the energy transition. This includes companies who are investing in electrification processes and thus have a particular need for hedging their electricity costs as well as energy-intensive manufacturing companies that are under strong international competitive pressure. The uncertainty of the transition process could be reduced for these groups and the necessary investment security increased. A third group consists of the residents living close to new wind and solar parks. Allocation to this group could increase acceptance for the parks.[10] The public interest in the projects and their positive externalities would justify such prioritized allocation.

Discussions with stakeholders have revealed a significant interest from potential consumers for shares in an RE-Pool. Thus, it can be assumed that the demand for the pool shares would exceed supply in the short term and the setting of access criteria would likely be a subject to competing interests. However, a similar dynamic is to be expected even without an RE-Pool during times of high electricity prices and resulting possible government interventions. In any case, it must be noted that any decisions about prioritization must be discussed and decided upon in an open and transparent parliamentary process.

Figure 3

Volume and price development of an RE-Pool
In terawatt hours (left axis); euros per megawatt hour (2023, right axis)



Sources: Klaus Mindrup and Karsten Neuhoff, "Eneuerbare Energeien und Flexibilität – Optionen für reduzierte und verlässliche Stromkosten," *DIW Politikberatung kompakt*, no. 197 (2023); calculations based on the German federal government's expansion plans for renewable energy sources and predicted generation costs from the 2023 IEA World Energy Outlook.

The maximum volume of the RE-Pool will already be over 100 terawatt hours in 2028 if all new projects are aggregated into the pool beginning in 2025.

RE-Pool offers advantages due to electricity price security and low financing costs

For consumers, the RE-Pool offers the advantage of hedging their electricity costs. They are spared high bills in times of unexpectedly high energy prices, which decreases pressure on the federal government to take action in the market to lower prices via ad hoc measures or to use budgetary resources to relieve electricity consumers. During the 2022 energy price crisis, an RE-Pool would have led to considerably lower cost increases for participating consumers (Figure 4).[11] Moreover, hedging electricity price risk is associated with better plannability and investment security. For instance, private homeowners can better calculate the economics of installing a heat pump. For companies it lowers the risk of investing in electrification processes to reduce emissions.

Consumers could theoretically achieve the same effect using bilateral contracts with electricity suppliers. However, financing costs for wind and solar projects, and thus the electricity generation costs, would be ten percent higher under such bilateral contracts compared to the RE-Pool, as a DIW Berlin study shows.[12] This is the case because, in contrast to a state-guaranteed contract, the counterparty's default risk is greater. In addition, bilateral contracts have a negative impact on the creditworthiness of companies if they reach a large volume. This increases the financing costs and represents a further 20-percent cost increase for the renewable electricity that has been hedged. Furthermore, not all companies can conclude such bilateral electricity contracts in the amount of their actual electricity demand in practice. Thus, the RE-Pool increases the scope of consumers hedged against price fluctuations in the long term and reduces the cost of the energy transition.

Lastly, the RE-Pool has the advantage of a "flatter" generation profile compared to bilateral hedging of electricity consumers via individual projects. By aggregating all of the wind and solar installations in Germany—and in neighboring countries as well in the medium and long term—the generation volatility is reduced. This can be shown schematically for a pool comprised of equal shares of the current German solar and offshore wind installations compared to generation from only onshore wind installations (Figure 5).

RE-Pool creates incentives for flexible electricity demand

Another advantage of an RE-Pool would be that electricity consumers would be incentivized to invest in flexibility as well as to adjust their demand to short-term price signals during operation. These incentives arise because consumers are hedged by their share in the RE-Pool via the RE-Pool's generation profile. Therefore, they are only fully hedged against

10 Jakob Knauf, "Can't buy me acceptance? Financial benefits for wind energy projects in Germany," *Energy Policy* 165 (2022): 112924 (available online).

11 The calculations in Figure 4 assume that the average costs in both policy options are the same. The figure is thus less a prediction of the pool price and more an illustration of the reduced electricity price volatility.

12 Nils May and Karsten Neuhoff, "Financing Power: Impacts of Energy Policies in Changing Regulatory Environments," *The Energy Journal* 42, no. 4 (2021): 131-151 (available online).

Figure 4

Electricity costs with an RE-Pool compared to procurement without hedging
In euros per megawatt hour

Notes: Electricity costs without hedging calculated using price and demand data from 2015 to 2022; with pool also based on RE generation from 2015 to 2022; with flexibility based on a "spread product" that pays the difference between the four highest and lowest hours; same average costs in the scenarios.

Sources: Karsten Neuhoff et al., "Contracting Matters: Hedging Consumers and Producers with a Renewable Energy Pool," *DIW Diskussionspaper*, no. 2035 (2023); authors' depiction.

The RE-Pool stabilizes the electricity costs across the observation period.

the electricity price risk if their demand follows the profile of the pool's generation perfectly. This means that consumers with less flexible demand are exposed to the electricity price risks of the short-term markets for the share of their demand that deviates from the hedge provided by the RE-Pool. This creates incentives to tap into cost-effective flexibility potentials, which keeps costs low for electricity consumers and the entire system. For example, companies can invest in flexibilization of production, for example with storage of heat and industrial intermediate products.

The magnitude of costs incurred by electricity consumers with inflexible demand, and thus also the amount of incentives for investments in flexibility, can be illustrated with the help of market value defined as the revenue a plant would have obtained if it were to sell all production at the spot price of each hour (Figure 6). The green area depicts the 12-month moving average of the market value of an RE-Pool compared to the average of the wholesale spot prices. Generally, this value is below 100 percent because the electricity price tends to be below average when the supply of renewable electricity is high. The green line represents the electricity costs of flexible consumers who can perfectly adjust their demand to the RE-Pool's generation profile. Inflexible consumers, in contrast, incur costs, as they must procure electricity outside of the hedging via the RE-Pool. This would be the case primarily in hours of low production from renewable energy sources, in which the spot market price is higher than the average price of the pool. With the hypothetical RE-Pool assumed in this example, these costs (gray area) would currently be just under 20 percent of the electricity price for electricity customers with completely inflexible demand.

Hedging with the RE-Pool's generation profile does not only lead to incentives in increasing demand flexibility, but should also contribute to further developing the electricity derivatives market. Each company can decide to what extent it invests in its own flexibility or hedges through the forwards and futures market. In turn, this demand for forward products for flexibility allows flexibility providers to secure revenue from the flexible operation of batteries or heat storage systems and thus improves investment framework conditions.

Design of RE-Pool should be compatible with future electricity market reforms

When designing the tender procedures and long-term contracts between the RE-Pool and wind and solar projects, it must be ensured that installations are built and operated in a system-friendly manner and that plants do not produce in periods of negative electricity prices. There are various options for this: One is to hedge the hourly electricity price for producers but have clear regulations stipulating that plants do not receive any remuneration during hours of negative electricity prices. However, this would result in a loss of revenue that is difficult to predict. A further option for lowering producers' revenue risk would be to hedge the potential generation output during hours of negative electricity prices instead of the actual output of the plant. This

would restore incentives and maintain revenue security and low financing costs. Various research groups have made comparable proposals in recent months, all of which are based on decoupling the payments for symmetrical hedging from the actual production decisions of the plant operators.[13] An RE-Pool is also compatible with these proposals.

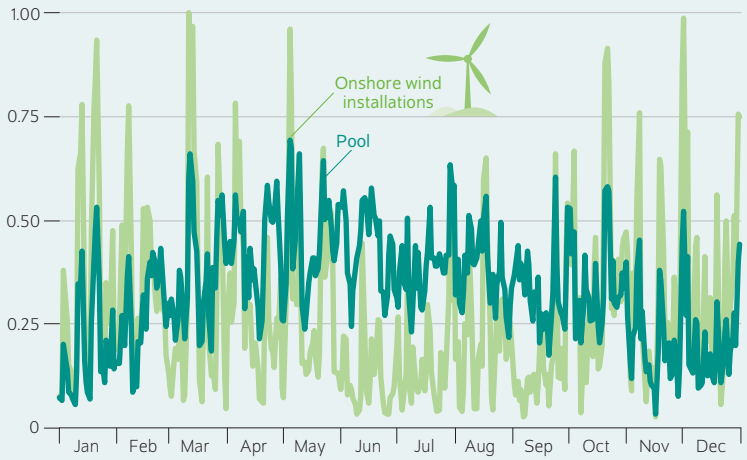
The design of the RE-Pool should be chosen in such a way that electricity consumers are hedged against regulatory uncertainties regarding possible future electricity market reforms. One example of this is the introduction of local prices or electricity price zones, which could replace the German single price zone to better align electricity demand and supply at a local level and thus avoid transmission constraints. The contracts in the RE-Pool should be specified in such a way that both electricity producers and consumers in the RE-Pool are directly hedged against the electricity price at their feed-in or purchase point. However, this could have the effect that the payments to and from the RE-Pool no longer balance each other out. The resulting revenues from introducing locational pricing should be used to eliminate these price differences.[14] This would secure budget neutrality of the RE-Pool.

Conclusion: An RE-Pool hedges both electricity producers and consumers against price risks

An RE-Pool is an attractive option for passing on the advantages of electricity producers' hedged electricity prices to the consumers. In an RE-Pool, long-term hedging contracts that lower the investment risk of wind and solar project developers are aggregated into a contract pool. In a second step, this advantage is passed on to the electricity consumers. By lowering the investment risk, the pool reduces the financing costs for renewable energy projects and thus costs for renewables to consumers. It makes it possible for electricity consumers to hedge themselves against future price shocks. Furthermore, it supports investments in flexibility and the development of financial hedging products compatible with renewable energy sources. The RE-Pool is an important part of an electricity market with increasing shares of renewable energy.

Figure 5

Production profile of a hypothetical pool compared to onshore wind installations in 2021
Index of the maximum generation

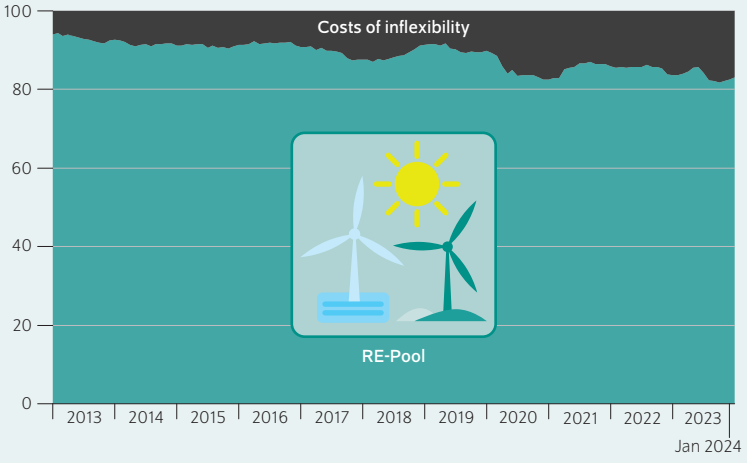


Sources: Karsten Neuhoff et al., "Contracting Matters: Hedging Consumers and Producers with a Renewable Energy Pool," *DIW Diskussionspaper*, no. 2035 (2023); authors' depiction.

An RE-Pool that contains half onshore wind installations and half solar installations significantly reduces production volatility.

Figure 6

Electricity costs for flexible demand
In percent compared to electricity costs for inflexible demand



Notes: Twelve-month moving average of the monthly market values of a hypothetical RE-Pool, weighted with the generation volumes of renewable energy sources from 2023, compared to the spot market price. The green area represents the twelve-month moving average, the dark gray area represents the additional costs for inflexible consumers.

Klaus Minrup and Karsten Neuhoff, "Eneuerbare Energeien und Flexibilität – Optionen für reduzierte und verlässliche Stromkosten," *DIW Politikberatung kompakt*, no. 197 (2023); calculations based on market values and spot market prices from netztransparenz.de.

A flexible consumer hedged by the RE-Pool reduces their electricity costs by nearly one fifth compared to an inflexible consumer.

13 Cf. Ingmar Schlecht, Christoph Maurer, and Lion Hirth, "Financial contracts for differences: The problems with conventional CfDs in electricity markets and how forward contracts can help solve them," *Energy Policy* 186 (2024): 113981 (available online); David Newbery, "Efficient renewable electricity support: Designing an incentive-compatible support scheme," *The Energy Journal* 44, no. 3 (2023): 1-22 (available online); Regulatory Assistance Project, The search for two-sided CfD design efficiency – a Shakespearean history (2023) (available online).

14 Redispatch measures currently implemented by transmission system operators to manage congestion in large pricing zones induce costs, e.g., 4.2 billion euros in 2022 in Germany. (Bundesnetzagentur, *Bericht Netzengpassmanagement* (2023) (in German; available online)). They are recovered through grid tariffs paid by consumers. A split of larger pricing zones or an introduction of locational pricing would reduce or eliminate these costs and instead result in congestion revenue that can be used for reducing grid tariffs and hedging locational price differences in an RE-pool.

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