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FOUR RECOMMENDATIONS FOR A STABLE AND SUSTAINABLE ELECTRICITY MARKET

FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

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Four recommendations for a stable and sustainable electricity market

KEY FINDINGS

- The current electricity market design is the result of a decades-long process that has created a considerable amount of welfare.

- Four key pillars of the market design work well and need no improvement:
  1. Unbundling of generation, transmission and retail
  2. Marginal pricing
  3. The sequence of markets at different time scales
  4. Market coupling between regions

- We make four recommendations to improve the market design:
  1. Continue to implement the fourth energy package (2019)
  2. Improve price stability for consumers and producers using:
     i) Contracts for differences
     ii) Capacity payments
     iii) Power purchasing agreements
     iv) Long-term contracts for smaller consumers
     v) Citizen participation in renewable energy projects
     vi) Creation of a "long-term electricity contracts company"
  3. Make electricity demand more flexible through automation
  4. Improve the coordination of the energy transition

INTRODUCTION

The European Union is planning a thorough overhaul of the European electricity market this year. This "fifth energy package" should address weaknesses in the current market design, which were exposed by the energy and inflation crises. In support of this important reform, this *'Gents Economisch Inzicht'* presents four recommendations to make the electricity market more stable and sustainable.

THE GAS VOLUME CRISIS

The energy crisis is first and foremost a **gas volume crisis**. The chaotic price evolutions signal the possible shortage of gas and the rapidly changing (and sometimes speculative) expectations in this area. The energy crisis must therefore be addressed primarily in the gas market. This can be done by consuming less and switching to other energy sources. Also, the European gas price cap (at a substantially higher price than before the crisis) can help to mitigate speculative price-spikes and limit the unnecessary damage they inflect upon our social and economic fabric.

However, high gas prices also led to high electricity prices because gas plants are often the last generators activated to meet demand and thus determine the price of electricity. The fact that “cheaper” producers - such as solar, wind and nuclear – also receive this high marginal price is unacceptable to many. European Commission President Ursula von der Leyen said that "This market system does not work anymore. We have to reform it. We have to adapt it to the new realities of dominant renewables ".

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In this *Gents Economisch Inzicht*, we first discuss which parts of the current market design work well and therefore *should not* be changed. We then make four recommendations to improve the market design.

WHAT WORKS AND SHOULD THEREFORE NOT BE CHANGED?

Energy is the glue that holds Europe together and was central to the creation of the EU. The European electricity and gas market is the result of a decades-long process of iterative improvements, by thousands of committed people from diverse organizations, and is unprecedented on a global scale - nowhere is there such a large well-integrated and harmonized electricity market across numerous national borders.

Because supply and demand must be balanced at all times and because of the economic importance of electricity, the design of the market is different from most other markets for ordinary goods such as butter, beer or cars. It is a complex structure of markets, market participants, rules and responsibilities to ensure that trade is well organized. The four main pillars of market design are: (1) unbundling of production, transportation and retail, (2) marginal pricing, (3) a sequence of markets at different time scales, and (4) market coupling between regions.

UNBUNDLING OF PRODUCTION, TRANSPORTATION AND RETAIL

During the interwar period, the **first wave of electrification** began in Europe. During World War II, however, a lot of energy infrastructure was destroyed, and most European countries decided to nationalise it when reconstruction efforts began. The construction of power plants and networks to transport electricity to citizens and industry was seen as a new public service. Belgium was one of the exceptions to this. The electricity sector always remained in private hands, but **consolidated into a single monopoly**. In practice, therefore, the situation was similar to that in other countries.

The unification of the electricity sector initially accelerated electrification enormously. Not only did the size of the electricity network increase rapidly, but ambitious construction plans involving new technology such as nuclear power were also undertaken.

After two decades, however, the sector's voluntaristic ambition gave way to a complacent attitude. Electricity supply was considered a "problem solved ". As energy demand increased, additional power plants were simply built and the matter was settled. The cost was simply passed on to the consumer, who had no choice anyway. Unsatisfied customers, faced with a lacklustre quality of service, had nowhere else to go.

This monopolisation created an overcapacity of electricity production in many countries. Moreover, there was no need for **innovation**; in fact, this was often considered by electricity producers as a threat to their own position. The monopolists had an inherent interest in maintaining the status quo as much as possible.

The electricity sector thus became increasingly scrutinised by economically liberal European politicians. The Single European Act of 1986, which among other things harmonized the free movement of trade within the Union, served as a tool to break open the monopolies of energy companies. Two years later, the first vision paper on the unification of the European energy market was presented. Yet it took until 1996 to realise the **First Energy Directive** 96/92/EC. Central to this was the unbundling of the energy system.

Unbundling means separating electricity production from the power grid. Until now, these were in the hands of one and the same company. Europe wanted to free up the market for electricity production, privatizing existing energy producers and allowing new producers to enter the market. In this way it wanted to trigger competition, innovation and lower prices.

Unbundling did not go smoothly. The (former) monopolists fought tooth and nail against the erosion of their dominant position. In Belgium it took until 2005 before the unbundling was fully realised, at a considerable societal cost. New production technologies had to be subsidized in order to compete in a market saturated by the former monopolist and its depreciated power plants. The increased competition did lead to **decreasing wholesale prices**, but because the subsidies for new production technologies were added to the end-consumer's electricity bill, strong net-benefits were not felt initially.

Today, we are reaping the benefits of this long process. The quality of electricity supply has never been so high (households in Flanders are only affected – on average – by a small unplanned power outage once every 2.5 years), and a diverse range of energy supply companies has emerged. Energy cooperatives have also been able to grow and prosper thanks to unbundling.

Because unbundling was introduced in Europe, a comparison with the historical situation is difficult to make. Research in the US, however, where both systems still coexist, shows that unbundling has led to clear efficiency gains, although they hinge upon a well-designed regulatory framework[1][2]. In particular, regulators need to guarantee a level playing field between historical participants and new market entrants.

[1] https://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.97.4.1250

[2] https://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.20172034

MARGINAL PRICING

As with other commodities - such as grain, rice, minerals, metals, oil, coal and gas - electricity is traded in markets with **marginal pricing**. This means that the price is set by the last unit of production selected by the market to meet demand.

Since every MWh produced receives the same price, there is no reason for a producer to bid a price higher than the true marginal cost of production. As a result, marginal pricing ensures that the producers with the lowest marginal production costs are always chosen first to supply electricity. This is called **production efficiency**, since the cost of producing electricity is minimised (see Figure 1).

Production efficiency is not guaranteed in **pay-as-bid pricing mechanism**, where producers are paid only the price they bid for their own electricity generation. In such a system, producers are incentivised to bid a price higher than their marginal cost of production. This can result in more expensive generators, such as gas plants, to be selected while solar or wind farms are not allowed to produce – if they miscalculated and bid too high in the market (hoping for a higher return).

Marginal pricing also leads to **demand efficiency** for consumers who can respond to the market price of electricity. Consumers will lower their demand if the price exceeds the potential gains from their electricity consumption. Hence, a manufacturing plant may reduce its production during hours with a very high electricity price and increase it when the price is very low or even negative. Similarly, electric car charging may shift to hours with a lower price. This will reduce the need to turn on expensive gas plants and maximize the use of renewable generation. However, since the potential for **demand flexibility** is currently still limited, measures to increase it with the help of automation are listed further in this text (see "Recommendation 3").

If the electricity price was not determined by the marginal cost but the **average cost**, there would be no demand efficiency, since the marginal cost for each additional MWh is higher than the price consumers pay for it, leading to overconsumption. Intermezzo 1 provides more information on the history of marginal pricing.

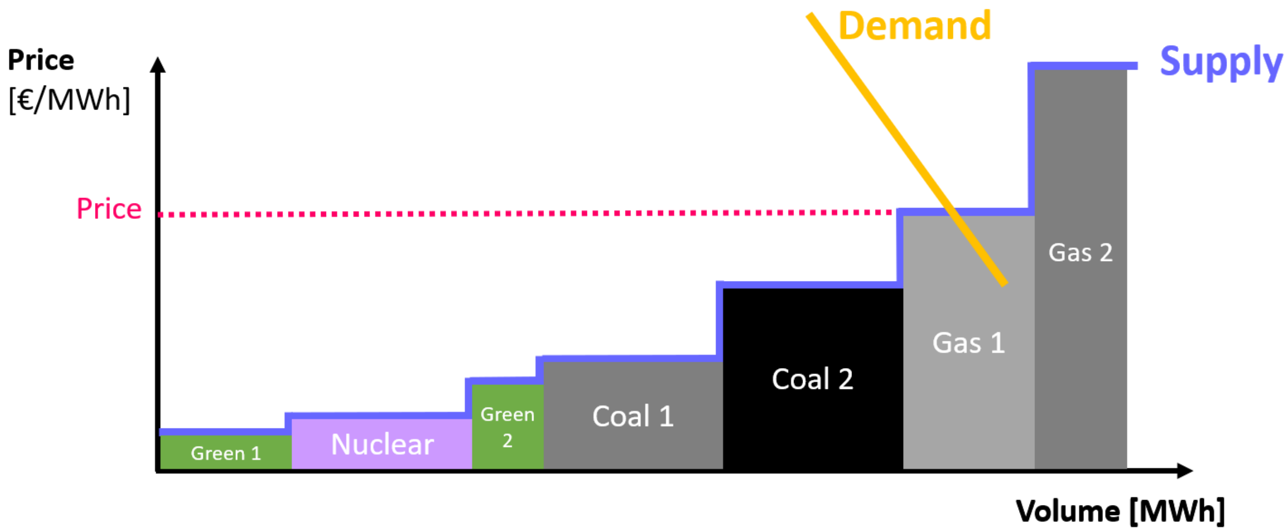

Figure 1 – Marginal pricing leads to efficient electricity production

SEQUENCE OF MARKETS AT DIFFERENT TIME SCALES

Like other commodities, electricity is traded on different time scales. On the **long-term market**, suppliers and industrial consumers can buy large volumes of electricity from producers, which will only be delivered in a few months or even years. This way, they can partially hedge their future electricity consumption at a fixed price, which offers major advantages in terms of risk management.

However, suppliers and large consumers can never perfectly predict how much electricity they will need from day to day - let alone hour to hour - in future months or years, so the long-term market is not sufficient. That is why there is also a need for a **short-term market**, where remaining shortages for a specific day can still be bought, right before delivery, when consumption turns out to be higher than the volume already bought long in advance on the long-term market. Conversely, surpluses can be sold when it appears that too much was purchased on the long-term market.

Volumes in the short-term market - also called **the spot market or day-ahead market (DAM)** - are thus smaller than what is traded in the long-term market, leading some to call it a ‘residual market’. However, this is not to say that the short-term market is of little importance, on the contrary. It is thé leading market that also co-determines prices in the long-term market. In fact, the short- and long-term markets are communicating vessels, resulting in prices that are always in line with each other at both timescales (see Figure 2). This is a logical consequence of the fact that market players maximise arbitrage opportunities between the short- and long-term markets. What could be bought cheaper on the long-term market can be sold at a profit on the short-term market and vice versa.

The result is prices that are always almost perfectly in line with each other. Therefore, prices on the long-term market are indirectly driven by the marginal pricing mechanism of the short-term market. Despite the fact that contracts on the long-term market are not explicitly determined by this mechanism. Contracts established through the long-term market are simply agreements between an individual buyer and seller of electricity, at a mutually agreed price.

In addition to the standard long- and short-term markets, there are some markets for electricity that are not used in the case of other commodities. These are necessary because of electricity's unique technical properties. There is the "very short term market", also known as the **intraday market**, where small surpluses or deficits that appear just hours before the effective delivery can still be sold or bought. There are also **balancing markets** where market participants compete with each other to keep the balance between supply and demand as cheaply as possible at any given moment in *real time*.

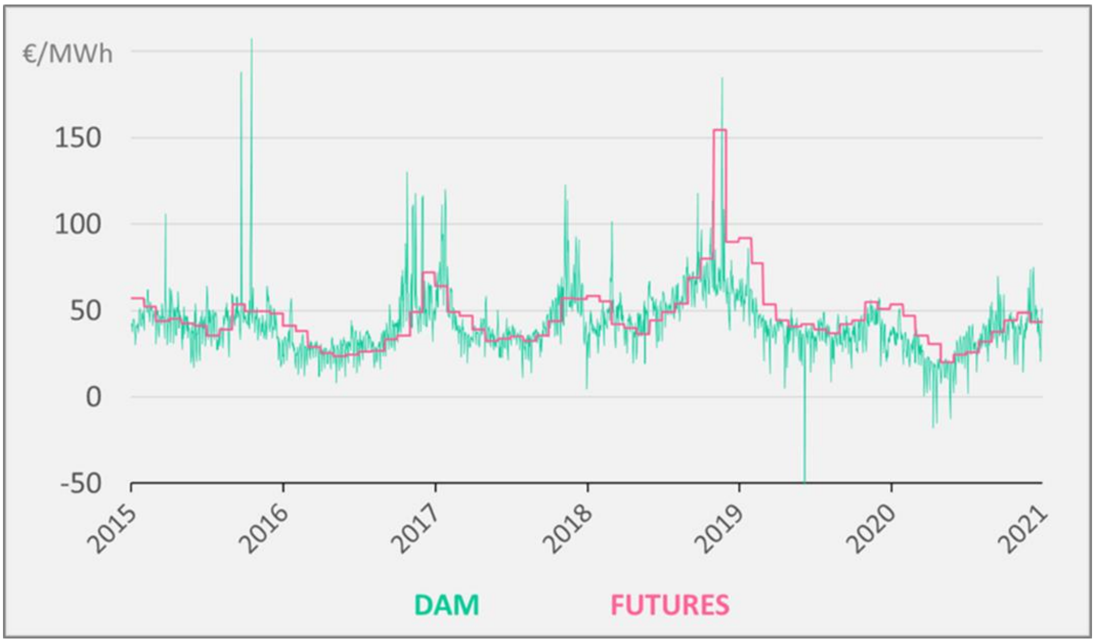

Figure 2 – Synchronicity of price evolutions on the short-term “day ahead” market (DAM) and the long-term “futures” market for electricity

MARKET COUPLING BETWEEN REGIONS

All of the abovementioned markets are increasingly integrated across the many national borders in Europe, generating large welfare gains for all Europeans, since cheaper production can be sold in more expensive regions. According to ACER[3], the welfare gains from market coupling have already amounted to approximately **€34 billion per year** over the past decade.

However, not all markets are *as* well-integrated already. In particular, much work remains to be done to better integrate the long-term market, to increase the number of market players and thereby increase liquidity. This could significantly smoothen the process of buying and selling electricity up to five years (or more) into the future, thereby strengthening and stabilising investment incentives in generation capacity (cf. next section).

In any case, the highly integrated European markets, across time scales, are already a **stabilising factor** in times of crisis such as today. The necessary solidarity between countries is arranged in a fully automated manner, through efficient market processes. This is a great advantage compared to the counterfactual situation in which explicit political decisions need to be agreed upon each time one country has to help out another.

Intermezzo 1: The history of marginal pricing

The current market design of marginal pricing has an interesting history that can be traced back to **Marcel Boiteux**'s paper "La vente au cout marginal" from ... 1949. Boiteux, a physicist by training, learned economics from Maurice Allais, who – decades later – would win the Nobel Prize for his research on efficient markets. However, Boiteux did not only receive economic insights from Allais, but also his concern for social justice with respect to the income distribution (Allais came from a family of simple dairy farmers).

When Gabriel Dessus, a director of EDF, attended a lecture by Boiteux and saw him apply the theory of efficient markets to the problem of social inequality, he promptly decided to recruit Boiteux. The economist was tasked with developing a **tariff structure** to allow the still-reconstructing French electricity sector to operate in the most socially efficient way possible. After all, the sector was publicly owned, and it was important that French taxpayers' money be spent in the best possible way and that every Frenchman received the best possible service in return.

The marginal pricing-based system that Boiteux designed attempted to match supply and demand. It ensured that the cheapest (most efficient) plants were used as much as possible to meet electricity demand, and that consumers felt a financial incentive to reduce their consumption, so the start-up of a more expensive plant could be avoided as often as possible. **Beginning in the 1960s, it became a fundamental aspect of electricity markets around the world**, which were still vertically integrated or publicly owned.

Like Boiteux himself, who was celebrating his 100th birthday in 2022, his work still lives on in today's market design. Indeed, during the liberalisation of energy markets, it was decided to retain the marginal pricing system precisely because it had proven its merits for several decades already. However, Boiteux was not entirely happy with the end result. **While his marginal pricing system arguably worked most efficiently, the redistribution of those efficiency gains - a political task - often failed to deliver**. When Boiteux retired in 1987, EDF, like other European state-owned or monopoly energy companies, was plagued by high labour costs, a rigid civil service mentality, government interference and declining worker productivity. Revitalising the energy companies was one of the things that gave rise to the liberalisation of the energy sector.

[3] https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER%26%23039%3Bs%20Final%20Assessment%20of%20the%20EU%20Wholesale%20Electricity%20Market%20Design.pdf

FOUR RECOMMENDATIONS TO IMPROVE MARKET DESIGN

The energy crisis has exposed some pain points in the current design of energy markets. We discuss four possible improvements with the goal of low and stable energy prices for European consumers and to accelerate the energy transition.

1. CONTINUING TO IMPLEMENT THE FOURTH ENERGY PACKAGE (2019)

Since the 1990s, many steps have been taken at the European level to provide consumers with cheap and stable energy prices, each time bundled in periodic "energy packages." This involved a host of measures and adjustments being negotiated and approved simultaneously by European member states and the European Parliament. The fourth and most recent package was approved in 2019 after years of negotiations and was named **"Clean Energy For All Europeans"**. Never before has a package contained so many legal texts, each consisting of hundreds of pages filled with the (often highly technical) details behind measures to further shape the integrated energy market.

Many of these measures have not been fully implemented to date, mainly with regard to the elements that must be transposed into national legislation by the member states. Before proposing any new measures, it is therefore important to emphasize that all measures that have already been designed and formally agreed upon should be fully implemented as soon as possible. We expect many of these measures to make a significant contribution to addressing the current energy crisis and to make energy affordable and sustainable in the long run.

In particular, there are a number of technical measures that need to be made to achieve the best possible functioning of the electricity market (across national borders). This includes, for example, the implementation of the **70% rule**, which encourages transmission system operators (such as Elia, in Belgium) to make a greater proportion of the technical capacity on cross-border cables commercially available for international trade. Together with other technical measures - such as expanding **flow-based coupling**, revising the **geographic boundaries of price zones**, and the further **integration of national balancing markets** – this aims to reduce European consumers' final electricity bills through increased competition and optimal market functioning.

"First and foremost, it is important that all the improvements to the European electricity market that were already decided in 2019 are implemented in practice."

It is also crucial to **accelerate the roll-out of digital meters** across Europe, allowing consumers to get a better insight into their gas and electricity consumption. In addition, the **mandatory offering of dynamic electricity contracts** (by energy suppliers) will ensure that consumers have opportunities to make use of the hours during which electricity is the cheapest.

2. IMPROVING PRICE STABILITY FOR PRODUCERS AND CONSUMERS

Suppliers or buyers of renewable energy face some risks caused by the intermittent nature of renewable generation and the interaction of renewable sources with the market:

- **Profile risk**: variable renewable power plants generate electricity under non-controllable conditions. **The profile of production (from hour to hour) does not necessarily correspond to the profile of demand**. For example, consider the early evening hours: often there is no sun or wind, while consumption reaches its peak. To cover demand at those times, an additional source of electricity needs to be activated.
- **Imbalance risk**: Injections of electricity onto and withdrawals from the grid should be balanced at all times, but the actual production may differ from the expected production due to **unexpected unavailability or forecasting errors**. When actual production differs from expected production, generators need to financially compensate the grid operator for the imbalances caused. The grid operator uses this income to pay for the mechanisms counteracting these imbalances in real time.
- **Price risk**: when energy from renewable sources is sold on a long-term basis at a fixed price, both contracting parties bear a price risk. After all, the agreed price may be higher or lower than the

market price throughout the contracted period. Conversely, both the generators of renewable energy and the consumers that buy it, bear the risk of unfavourable price evolutions (lower or higher than expected, respectively), when they *do not* step into long-term contracts with each other.

Each of these risks and uncertainties leads to **increased investment costs** for renewable energy because investors will demand a higher return due to uncertainty.

To encourage investment in renewable energy, we look at how to avoid risks for potential investors. Already today, there is a European patchwork of **possible support mechanisms** for investors[4]. We discuss some options that could improve price stability for producers and consumers:

1) **2-sided Contract for Difference**: price stability for producers.

A 2-sided Contract for Difference (2-CfD) is a contract between the government and renewable energy investors. The contract is awarded through an auction and provides the investor with a **price guarantee**. The investor receives payments or makes payments to the government according to whether a reference price is above or below the agreed-upon strike price. The strike price is the price the investor has bid in the auction, which he needs to make his investment profitable.

Before the auction begins, the reference price and a reference volume are agreed upon. The **reference price** is typically the average price in the day-ahead market, with the average calculated for each hour, day, month or year. The longer this period, the more a producer is incentivized to produce more efficiently. The generator usually sells the electricity generated under the 2-CfD in that same market to avoid a price risk. The volume of energy covered by the 2-CfD can vary - ranging from just the volume injected during the hours with positive market prices, to the total potential output of the generating unit (regardless of injection).

Contracts for differences are a good solution to reduce producers' price risk because they lead to more efficient dispatch decisions than previous support mechanisms (feed-in-tariffs, fixed feed-in-premiums, renewable obligation certifications) and can be better calibrated for different technologies through the choice of the reference price and volume[5].

2) **Capacity payments**: price stability for producers.

Under a **capacity remuneration mechanism**, producers receive a payment (€/MW) from the government for capacity that is kept available. Capacity payments aim to ensure that sufficient electricity capacity is available to meet supply needs. These payments allow the government to incentivize investors or operators to build or keep power plants in the market when expected revenues from the sale of electricity alone do not cover the costs of keeping the generation capacity operational and available to the system.

3) **Power purchase agreements**: price stability for generators and large consumers

A **power purchase agreement (PPA)** is a contract between an electricity producer and a customer of electricity that allows the customer to purchase electricity for a specified period of time at a pre-agreed price.

For the electricity producer, PPAs are a way to secure long-term financing (often 10-20 years). At the same time, it helps the electricity buyer secure a predictable and stable source of electricity. They often involve contracts with **large industrial customers**, who, with good creditworthiness and long-term commitment, play an important role in the development of renewable energy projects. In PPAs, the price risk is hedged but it needs to be mutually agreed upon (in the contract) which party bears the profile and imbalance risks.

4) **Long-term fixed price contracts**: price stability for consumers.

End customers with only a limited volume of consumption purchase their energy through suppliers. Since the energy crisis began, the supply of fixed-price contracts has almost disappeared. This can be explained by the high price volatility and the lack of protection for suppliers in case of contract breach by the consumer. Given the benefits that price stability can also provide to households, it is useful to work on standardized fixed price contracts for consumers. These contracts should

[4] See http://aures2project.eu/auction-database/ and http://www.res-legal.eu/

[5] Fabra, N. (2022). Electricity Markets in Transition: A Proposal for Reforming European Electricity Markets. Centre for Economic Policy Research

offer sufficient protection to contracting parties during the term of the contract, but also in the event of a contract termination. One element that can contribute to this is to agree on a **termination fee** that takes into account the remaining value of the contract and is paid by the party terminating the contract.

5) **Citizen participation in renewable energy projects**: price stability for small consumers

When citizens join together to become shareholders in an energy project and also purchase electricity from it, they thereby organize their own fixed price contract. They pay a price for their energy that reflects the **actual cost** to the producer. This eliminates the price risk, but similar to a PPA, there is still a profile and imbalance risk. Through ownership of the generating unit and through a (partial) price guarantee, citizens are incentivized to make a long-term commitment.

6) Create a **Long-term electricity contracts company (LECC):**

A disadvantage of a contract for difference is that the government bears the price risk. This allows the government to get a lot of revenue if market prices are structurally higher than the strike price, but also requires the government to pay large amounts if market prices are structurally lower. In addition, a CfD encourages producers to sell their output in the short-term market, which reduces consumers' ability to enter into long-term contracts from the renewable energy source.

One solution to both problems is for the intermediary [6]- referred to here as the Long-term electricity contracts company (LECC) - to offer long-term contracts (i.e., PPAs) with varying maturities to suppliers and large consumers. This reduces the government's long position and creates a liquid market of long-term contracts.

The LECC is responsible for efficiently managing long-term risks and does so on behalf of the government. The financial flows and production flows are illustrated in Figure 3.

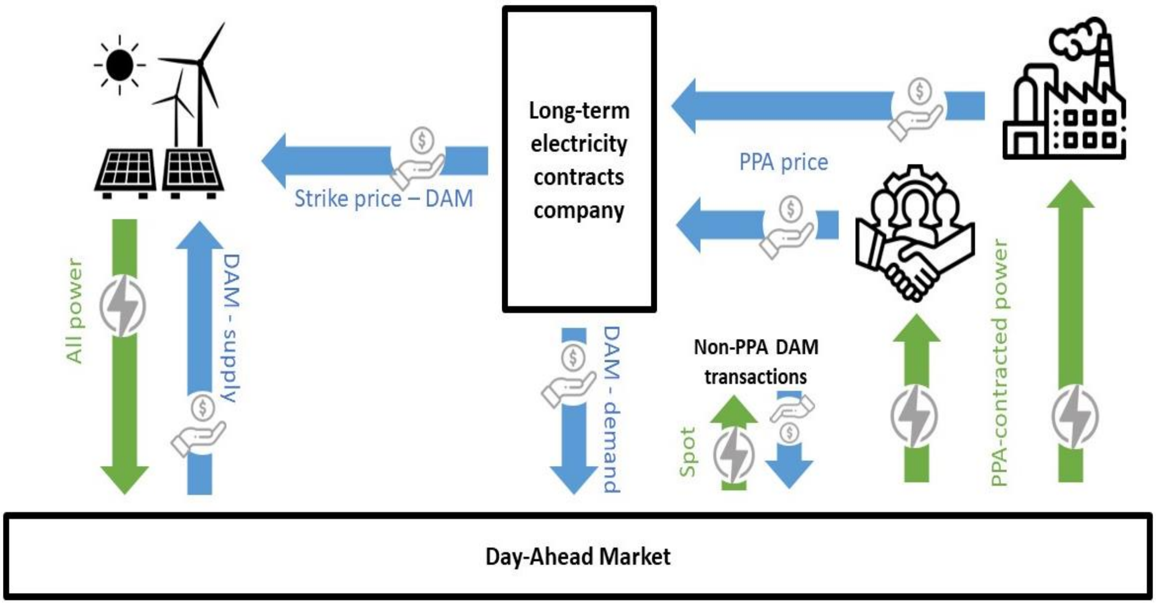

Figure 3 – The financial streams (blue) and production streams (green), when a long-term electricity contracts company (LECC) arranges CfD's with producers and PPRA's with energy suppliers and large-scale consumers.

[6] Analogous to the Low Carbon Contracts Company (LCCC) in the UK, see https://www.lowcarboncontracts.uk

3. MAKING ELECTRICITY DEMAND MORE FLEXIBLE THROUGH AUTOMATION

The design of our electricity market aims to match electricity supply and demand in the most efficient way possible, with price being the information signal (see section "Marginal Pricing"). On the generation side, this has always worked reasonably well. Energy producers have professional teams that closely monitor price evolutions on the markets. It is mainly the demand side that behaves more passively. The price signals that should stimulate (a reduction in) the consumption of electricity do not sufficiently reach small-scale consumers. This primarily has a technological cause. Historically, it was virtually impossible to link electricity consumption to the time when it was consumed, and thus to charge according to short-term evolutions in the market price. Classical electricity meters were only read quarterly or yearly, so one was forced to work with average prices. This made it impossible to react to short-term price signals.

Over the past decade, however, this has begun to change. **Large electricity consumers** were equipped with digital meters, which record consumption per quarter-hour and transmit it to the grid operator. With unbundling (see section "Unbundling of production, transmission and retail"), those consumers could now enter the electricity market directly or through an intermediary. More and more companies began to steer their electricity consumption, whenever possible, based on current electricity prices. During moments of overproduction, when negative prices arise, they can even be paid to consume electricity! On the other hand, by reducing their electricity consumption at times of peak demand at the system-level (i.e. when prices are high), they can help avoid the activation of the most expensive power plants.

This so-called "industrial flexibility" is already well established among Belgian energy-intensive companies, and is increasingly trickling down to smaller enterprises. For **residential consumers**, the households, electrical flexibility is still virtually non-existent. Yet households account for a quarter of our electricity consumption and, above all, they are responsible for the large consumption peaks in the evening.

Here too, technical barriers lie at the root of the problem. The rollout of the digital meter has only just reached cruising speed, while the amount and ability of appliances enabling consumers to control their energy consumption is still limited. However, this will change soon in the coming years. Just think of the increasing popularity of heat pumps and the wave of electric vehicles that is coming.

Whereas industrial flexibility has become well streamlined, "residential flexibility," the flexibility of household electricity demand, still has a Wild West feel to it: there is a lot of unexplored territory, but the terrain is also rough and unpredictable. Nevertheless, the potential is there: according to an estimate by system operator Elia, residential flexibility could account for a controllable capacity of up to 800 MW by 2030. This could avoid the deployment of one or two gas-fired power plants.

"The domestic demand for electricity can be made much more flexible through extensive automation, although work remains to be done to make it sufficiently simple and accessible."

Compared to industrial flexibility, residential flexibility has some additional barriers. First, there is the **variety of types and brands** of heat pumps and electric vehicles. The fact that manufacturers enable the "controllability" of their appliances in varying ways means that far-reaching customization is often required to make appliances interact with each other and with the energy market.

A second barrier is the **limited impact** of individual devices. To match the same electrical flexibility of a large industrial process, you need to run many thousands of heat pumps or electric vehicles simultaneously. The need for customization outlined above is incompatible with this scale that must be achieved with residential flexibility.

A third challenge is **the end consumers** themselves. An industrial process obeys the orders of the woman or man at the controls. With residential consumption, the consumer remains in charge of his consumption, and this varies greatly depending on lifestyle, the family situation and individual expectations. If an outside party were to *force* changes in a household's electricity profile, this could alienate consumers from the concept of flexibility, and even reduce support for the energy transition in general (see Intermezzo 2).

For the energy transition to succeed, it is essential that price signals also fully penetrate the consumption side. In addition to continuing to encourage industrial flexibility, this requires the following recommendations specifically for residential flexibility:

1. Flexibility must become **more understandable and transparent**. Capacity tariff, dynamic energy tariffs, self-consumption, etc. These are very complex issues for most end users. There is a need for more clear communication on this subject, which should also be much better coordinated between governments, regulators and grid operators.
2. Flexibility should be **simpler and cheaper**. Here is a big role for the manufacturers of appliances such as heat pumps or electric vehicles. The scheduling of energy consumption must become controllable in a simple and transparent way, and the devices must be able to cooperate with those of other brands. The legislator must avoid the creation of "walled gardens", where manufacturers make it difficult or impossible for devices of other brands to work together.
3. The "distance" between the energy market and the end customer who voluntarily wants to participate in a flexibility scheme should be reduced. The **current technical and legal regulations**, mainly focused on industrial flexibility, require a thorough review along several dimensions. A "**unified price signal**" could also be considered, which incorporates all aspects of flexibility (capacity tariff, energy tariff, etc.) as much as possible.
4. Services offering residential flexibility should be designed to be transparent and **user-friendly**, so that residential customers can easily understand how it works and which impact it may have on their families. This can address concerns about **"losing control"** of their devices and make the service more attractive to customers. This is where the designers and providers of these services have an important role to play.
5. The service must also be **flexible and customizable** so that private customers can choose the level of participation that is right for them. For example, they can opt in or out at any time, or they can specify the level of flexibility they are willing to provide to the grid.
6. There should be a **trade-off between efficiency and stability/peace of mind**. For example, flexibility contracts could place limits on how much and how often the flexibility potential of a heat pump or electric car is used, or there could be a limit on the average cost consumers pay per kWh under a dynamic contract. One can also apply dynamic tariffs *only* for suitable assets (electric cars, heat pumps, batteries, etc.) and keep fixed tariffs for traditional (base) consumption.

4. IMPROVING THE COORDINATION OF THE ENERGY TRANSITION

The energy transition requires such comprehensive changes that coordination is necessary. Markets are very good at coordinating short-term consumption and production decisions, but there is a need for long-term coordination at different levels.

At the **regional or national level**, there is a need for one central body that coordinates across policy areas and has final responsibility for all decisions related to the energy transition. There also needs to be more structural support for independent research and policy support, such as the Planning Bureau seen in the Netherlands.

At the **European level**, more coordination is needed on investments in wind, PV, storage, hydrogen production and the transmission grid.

- The optimal European **transmission grid** of the future, needed for a cost-efficient climate-neutral electricity system, will not simply ‘appear’ through the operation of pure market processes and the actions of profit-maximizing market players. There is a great need for more coordination at the EU level.
- Coordination is also needed for the cost-efficient distribution of **wind, PV, electrolysis and backup capacities** across European countries, as no individual country or market party has this overview when making investment decisions. To a certain extent, well-designed markets and price signals can contribute to this - especially if prices were more geographically differentiated (as with nodal pricing) - but we should not expect that therefore the need for European coordination would completely disappear.

CONCLUSIONS

The fifth energy package is a necessary step in the continuing development of the single European energy market, but the focus should not be on 2023. Any change to the market design must be in line with the long-term transition to a carbon-neutral electricity supply. The energy crisis has made it extra clear that this is the only way forward: **more renewable energy and more a flexible electricity demand**. The more we invest in this, the more we will "decouple" the price of electricity from the price of gas. As this process progresses the number of hours in which it is necessary to turn on a gas power plant will become decrease over time.

Today we can speak of an energy trinity, rather than an energy trilemma[7]. Historically, emphasis was often placed on the *trade-off* between sustainability, affordability and ensuring that there is always a sufficient amount of energy available. By now, however, it has become clear that policymakers who maximize the expansion of renewable energy - removing as many barriers as possible that delay its expansion - contribute to *all three* of these important societal goals. A system dominated by renewable energy not only achieves the necessary emissions reductions, but also makes Europe as a continent much more resilient to shocks in the price and availability of fossil fuels.

It has also become clear that the current focus on short-term markets is not good for anyone: neither producers nor consumers. Investors demand higher returns due to high uncertainty - leading to higher investment costs and lower investment - while households and businesses are exposed to significant price spikes leading to higher electricity bills. The solution lies in **coupling supply and demand over the long term, possibly with the government as an intermediary**. This can be done using contracts for difference, capacity payments, power purchasing agreements, more long-term contracts for smaller consumers, citizen participation in renewable energy projects and by creating a "long-term electricity

Intermezzo 2: An inclusive energy transition - do we sometimes think too much like economists, engineers and market specialists?

Changes in the energy landscape are coming faster and faster, and for some people it feels like it is being "forced upon us." The capacity tariff and dynamic tariffs, let alone a *dynamic capacity tariff*, add complexity to an already very complex life. It definitely benefits the efficient operation of our infrastructure, but this is of little use to citizens who already cannot make sense of their existing energy or telecom bills.

One should obviously *not be forced* to participate in dynamic tariffs. But citizens who do (because they want to **and** can) will capture the benefits in the form of financial savings.

In this context, technology could take away many burdens. Smart controls can ensure that one does not have to worry about dynamic rates to still benefit from them. A box in every household, a *black box* that measures and records how much energy we consume and when, and uses complex algorithms to control our appliances for us. It will prove necessary for those who want to benefit from the future energy system and not be left behind among the “losers”.

However, this may feel like a loss of control to many, in a world where many already feel increasingly out of control of their own lives when it comes to technology. Combined with the rapid changes in the energy landscape, this creates the risk of alienation or even opposition to the energy transition. For the energy transition to succeed, it is essential that the shift toward a low-carbon society is inclusive and broadly supported.

Perhaps some of the "efficiency thinking" could be replaced by "stability thinking"? For example by making certain complex aspects of the energy market *opt-in*, and ensuring that *opt-outers* are not necessarily worse off?

[7] Albrecht, J., Hamels, S., & Thomass, L. (2017). Energietrilemma. Een verkenning van het Belgische elektriciteitslandschap in 2030.

contracts company." Each of these solutions has advantages and disadvantages that should be studied in detail over the next few years before embedding them into the market design.

Improved price stability is essential for encouraging investment in renewable and firm capacity to achieve climate targets and guarantee security of supply. However, additional measures are needed, like reducing subsidies for fossil fuels, streamlining permitting, improving the training of technical personnel, improving access to raw materials, and strengthening the manufacturing supply chain of renewable production capacity.

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