Exchanges:

At the Core of the Future Energy Market

Our Vision for an Evolving Energy Sector

Europ/ex

GUIDE TO THE READER

To facilitate focused reading, Section 1 starts with a short summary of the main points and Section 2 provides an overview of our recommendations for successful regulation.

Sections 1.1 to 1.4 and the Annex provide more detail. They give the fact base and describe the current trends in the energy sector, deriving positions and recommendations.

PREFACE

Dear reader,

Over the last two decades, the European energy sector has been faced with fundamental changes and continues to do so at a steadily increasing pace. Starting with the energy market liberalisation in the 1990s, we have seen major shifts in the energy mix, the corporate set-up and the legislative and regulatory framework of the energy industry.

Times of change present opportunities and challenges alike. Founded in the early days of the liberalisation process and celebrating its 15th anniversary this year, Europex aims to contribute to the debate on the further development of the European energy system, its design and functioning. Market liberalisation has been a major success, and we are convinced that continuing on the path of market-based solutions is the best way forward to facilitate the implementation of the EU's climate and energy targets.

Representing 27 energy exchanges and market operators, we strongly believe that the existence of well-functioning, liquid and transparent energy markets is decisive in meeting today's and tomorrow's challenges. Efficient wholesale markets facilitate innovation and the development of new business opportunities and are essential for achieving a successful energy transition.

The highly complex energy sector with its constantly increasing number of different actors needs to work towards one common goal: delivering energy to European citizens in a reliable, affordable and climate-friendly way. Exchanges serve as an important facilitator in this multifaceted environment by organising liquid and efficient wholesale markets. Through the resulting price signals, exchanges orchestrate the market. Reliable price signals constitute the most effective means to steer investment decisions and to ensure the most efficient use of resources.

We wish you an enjoyable and interesting read!

Pieter Schuurs
Chairman

Christian Baer
Secretary General

ENERGY EXCHANGES: AN INDISPENSABLE PART OF THE PRESENT AND FUTURE ENERGY SECTOR

Exchanges contributed strongly to today's liberalised common energy market

The European Union and its Member States successfully unbundled and liberalised their energy markets. Power and gas retail, gas wholesale and power generation have been opened to competition between utilities and for new competitors. Open and non-discriminatory access to grids has proven to be a cornerstone of the successful liberalisation.

Wholesale markets make unbundling possible and allow new competitors to enter the market. Retailers, gas wholesalers and power producers can buy or sell power and gas, market their assets and secure themselves against risks. Consumers can now choose between competing suppliers and profit from better offers, facilitated by a regulation that guarantees a transparent and simple process for switching suppliers.

Exchanges orchestrate the liberalised common energy market: they contribute significantly to the interconnected, efficient, transparent and non-discriminatory market across the continent, which has led to significant welfare gains. Transparent prices are the glue that holds a diverse energy sector together beyond borders and individual companies.

Exchanges are a catalyst for innovation and competition in the evolving energy sector

The transition to a decarbonised energy sector poses new challenges and opens up opportunities, and innovation is a key element of a successful transition. The energy landscape is changing, and technology and new business models are evolving quickly.

Energy companies and investors need stability to be able to invest in innovation and infrastructure. A reliable market is able to provide this stability, where it is supported by a solid regulatory framework and given enough room for entrepreneurship. Market prices take the role of a transparent guiding signal to steer and incentivise innovation and investments. The success of market liberalisation has shown that competition and access to markets ultimately leads to lower prices for consumers.

Exchanges are an anchor point in energy markets and are needed to tackle challenges and seize new opportunities. Exchanges and independent market operators provide and facilitate neutral market access. They are the binding force of an increasingly diverse and heterogeneous market landscape. They provide price transparency – fuelling innovation, investment and competition.

With this paper, Europex and its members want to contribute to the debate on the energy sector's future and provide expertise and advice.

Europex 15 years

EUROPEX – THE ASSOCIATION OF EUROPEAN ENERGY EXCHANGES

Europex, the Association of European Energy Exchanges, represents the interests of exchange-based wholesale electricity, gas and environmental markets. It supports the development of the European regulatory framework and provides a discussion platform at the European level.

Europex aims to increase the welfare of all Europeans through an efficient and effective energy system based on solid markets and strong price signals. Along with its members, it has been accompanying and supporting energy market liberalisation almost from the beginning.

Europex was founded on 12 April 2002 as a Brussels-based not-for-profit association under Belgian law. Starting with seven members in 2002, it currently represents 27 energy exchanges across Europe.

Members comprise both classical energy exchanges and other market operators such as imbalance settlement administrators.

Europex has grown and transformed significantly over the past 15 years – along with the development of the liberalising European energy markets. It constitutes the central voice of European energy exchanges vis-à-vis the European institutions and many other stakeholders.

Europex members helped to achieve today's common energy market. To give one example, as early as 2003, Europex members had a major role in establishing decentralised market coupling as a measure to optimise electricity flows across Europe, directly optimising available cross-border capacity. Europex has been strongly promoting and actively supporting this ambitious project from the beginning and has served as the central coordination point of the participating exchanges at policy level.

Europex was also closely involved in discussions on energy commodity derivative markets, financial regulation at large, environmental markets and measures to improve the transparency and integrity of the energy wholesale markets, to only name a few.

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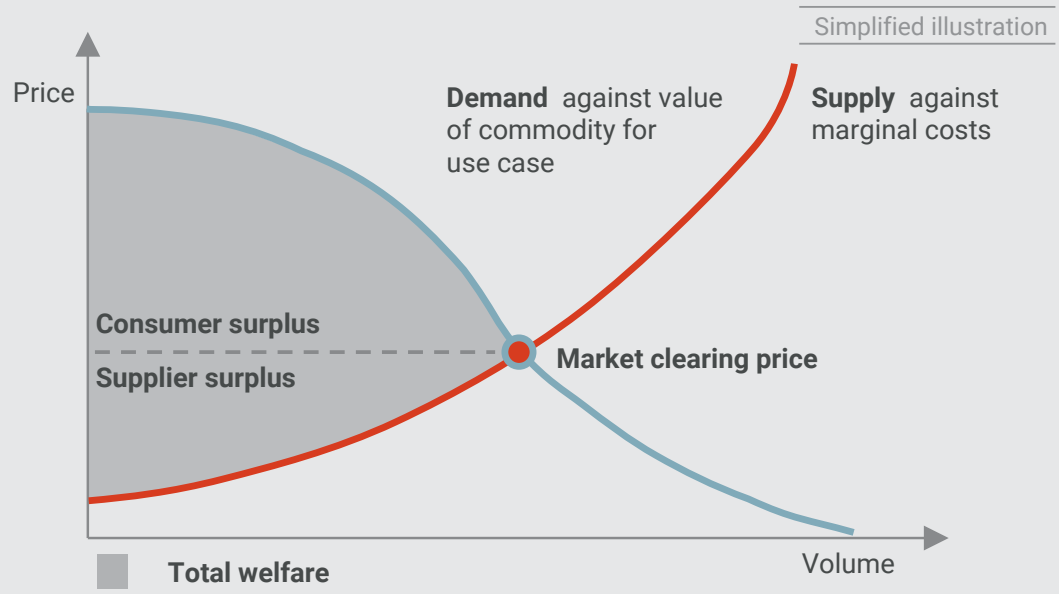
HOW EXCHANGES INCREASE SOCIAL WELFARE – EXAMPLE OF DAY-AHEAD POWER AUCTIONS

Figure 1:



Create transparency: Exchanges bring together demand and supply from retailers, consumers, suppliers and traders. As the exchange is a trusted and anonymous trading venue, all market participants can reveal their true willingness to pay or their production costs in the process. This creates a level playing field for all.

Determine an efficient price: Exchanges match supply and demand ("bids and offers") to determine an efficient price. The same price is then paid to or by all market participants and communicated openly.

Create and couple liquid markets: Exchanges connect markets through power market coupling or virtual trading points for gas. As they pool liquidity, they increase the markets' reliability and decrease costs. By coupling markets, they maximise the efficiency in using transmission capacity and assets across borders.

Maximise social welfare: The process exchanges manage is designed to maximise overall welfare. Supply at lowest cost is used first – until the costs for additional volume exceed its value for consumers.

1. OUR VISION FOR AN EVOLVING ENERGY SECTOR

The energy sector is experiencing significant changes and it is not clear yet how the future energy sector will look in detail. However, we believe that it is essential to build a vision of the future success factors to serve as guidance in designing the market and setting the rules. We build our vision by analysing the success factors of the past years and challenging them against the major trends that are visible today.

The energy sector increasingly relies on close interplay between physical and financial markets – they provide competitive access to power and gas, needed for a more diverse market landscape

Europe's liberalised markets strongly rely on wholesale markets for open and competitive access to power and gas. Wholesale markets cover two major needs: financial risk mitigation and physical optimisation.

Liquid futures and forward markets provide cost-efficient tools for securing prices and reducing risks. Independent retailers are enabled to competitively cover their demand in advance, gas companies or power generators to market their assets. Spot markets are efficient tools for balancing supply and demand across competitors and national borders.

For power markets, large and zonal market areas are required to ensure demand and production can be pooled effectively and to ensure high levels of liquidity.

In mature and efficient commodity markets, financial instruments are used as efficient tools for risk management. Financial regulation therefore influences energy markets.

Exchanges play an important role in both developing and mature markets. In developing markets they help pool liquidity and find a consensus on price benchmarks. In mature markets they provide highly liquid, standardised and neutral trading platforms and determine reliable benchmark prices.

The energy landscape is changing rapidly – particularly exchanges help to orchestrate a heterogeneous and decentralised energy landscape

Digital technologies, the increasing share of renewables and decentralisation are the main trends in the European power sector today. Innovation and new solutions will be required to successfully implement the challenging target to decarbonise the sector.

Competition will be essential to foster innovation, and ensure low prices and choice for consumers. At the same time, regulatory stability is required to encourage investment.

Since renewables have a significant and increasing share in power generation, they must contribute to system stability. This is most efficiently achieved by exposing them to market prices and balancing responsibility. The growing share of renewables increases the need for exchanges to determine transparent prices and to leverage the efficient interregional balancing of production and consumption across Europe.

Security of supply and resilient energy infrastructure continue to be important aspects of policy because Europe will continue to import a significant proportion of its energy. Exchanges secure access to global markets and help to optimise sourcing opportunities.

Exchanges are the binding force for the new, heterogeneous and decentralised energy landscape. They provide efficient trading platforms, clearing and settlement solutions and establish transparent prices that serve as a reliable benchmark for all market participants.

Digitalisation has already profoundly shaped wholesale markets – and they will support an increasingly automated and digital energy sector

Exchanges are neutral and reliable facilitators that offer non-discriminatory trading venues needed in an automated, digitalised and increas-

ingly decentralised market. They are able to develop new products as market needs change.

Moreover, in a decentralised energy market, non-discriminatory access to grids and liquid wholesale markets are key elements in guaranteeing competition between suppliers and freedom of choice for consumers. If ways to exchange energy locally are created, for instance in power distribution grids, non-discriminatory access must be maintained. Local networks need to remain part of a large and liquid market.

New data processing concepts such as blockchain offer the opportunity to change the way markets are operated. In any trading platform, however, central oversight under regulatory control is required to ensure fairness and customer protection.

Competition delivers the best solutions – regulation needs to provide a stable level playing field

Today's common market across national borders has increased the efficiency of how assets and transmission capacities are being utilised. Overall this has led to lower prices for consumers and greater security of supply, as power and gas are made available wherever needed. Regulation should continue to further these achievements.

Market mechanisms such as Emission Trading Schemes or Guarantees of Origin have proven effective means of achieving political targets. The design of the EU ETS has room for improvement, but generally provides the right incentives to reduce emissions – at the lowest cost to consumers.

In power markets, for example, Member States may deem capacity mechanisms necessary as a last resort. However, their design needs to avoid distortions to the power market and to neighbouring regions to preserve the achievements of the common energy market.

Good regulation should give businesses the freedom to operate and innovate, and create a level playing field. All market participants need be exposed to the incentives of market prices – including renewables and consumers.

Recent reforms in financial regulation aimed at increasing the overall stability of financial markets. These changes also had a significant impact on power and gas markets as they increased regulatory complexity significantly. Complexity should be reduced where possible. Small players in particular may face disadvantages if compliance with complex regulation hinders competition.

1.1 The energy sector increasingly relies on close interplay between physical and financial markets – they provide competitive access to power and gas, needed for a more diverse market landscape

Wholesale markets consist of several elements that can be distinguished across two dimensions: the settlement method (physical and financial markets) and the time to maturity (futures/forward and spot markets). These elements complement each other to meet the needs of market participants.

Wholesale markets rely on the interplay between several complementary elements: spot, futures and forward markets

The energy wholesale market consists of spot, futures and forward markets. They complement each other and serve energy companies' and consumers' different use cases (see Figure 2). For details on typical roles and responsibilities in the power and gas value chain, please refer to Section 3.1. Independent market operators, for example, have an important role in balancing and settlement.

Spot markets, such as day-ahead auctions and intraday or within-day markets are leveraged to balance supply and demand across companies. Consumers and retailers adjust their demand based on their latest forecasts and suppliers adjust their offers based on the latest information on asset availabilities and costs. Assets are managed optimally across the market as individual companies optimise their portfolios against the market price as a benchmark. See Figure 1 for an illustration based on the day-ahead power auction.

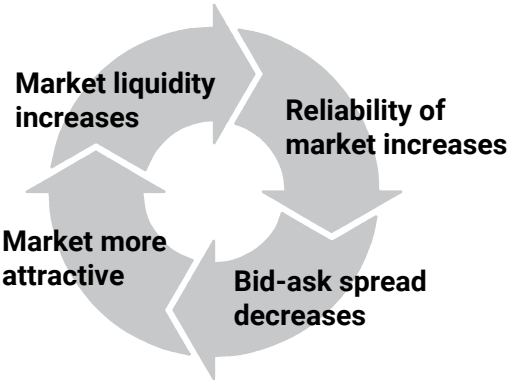
Demand for power and gas is volatile and has pronounced temporal patterns. Spot markets are therefore important tools for balancing

supply and demand based on the latest forecasts. Gas demand, for example, is influenced by ambient temperature, as it drives demand for heating. Volatile power generation from wind or solar PV[1] production, for example, depends on wind and sunshine and has a strong influence on demand for conventional generation and ultimately power prices. Prices are determined in spot markets by balancing supply and demand.

Futures and forwards are contracts that allow energy companies to buy or sell, or to secure the price of a commodity at a specific time in the future. They are needed to hedge against price risks, particularly as businesses are unbundled. For example, independent retailers cannot rely on an integrated value chain and need wholesale markets to buy or sell energy at competitive prices.

As market participants hedge their positions ahead of time, they typically enter spot markets with relatively balanced positions. They can thus utilise spot markets to re-optimise their portfolios without being subject to risks from their volatility.

The virtuous circle of market liquidity: Liquidity is an important factor for reliable and cost-effective risk management. Reliability is driven by the ability to find offers or bids at sufficient volumes, securely closing positions. Costs for risk management are driven by the "bid-offer spread", in other words, the difference between prices for bids and offers. The bid-offer spread decreases with increasing liquidity[2]. Financial institutions play an important role in increasing liquidity in futures/forward markets.



Liquidity follows a virtuous circle: Activity concentrates on liquid markets where companies find reliable and cheap access to the market. This, in turn, increases liquidity. Financial regulation, as discussed in Section 2, may have adverse effects on liquidity.

Figure 2: Main elements of energy markets: forward, futures and spots markets

	Forward/futures markets	Spot markets
Products traded	**Delivery in the future** ▪ Contracts with a future physical delivery ▪ Financial settlement: Derivatives secure underlying prices at a future point in time	**Direct settlement** ▪ Commodities traded "on the spot", i.e., orders are settled directly ▪ Power and gas are delivered physically
Main use case	**Manage risks and secure prices** ▪ Buy or sell a commodity in advance ▪ Secure against price changes and high spot market volatility	**Buy or sell physical quantities** ▪ Example: Day ahead auctions and intraday markets ▪ Balance production, sales, supply and demand ▪ Optimise transmission capacity
	Hedge against risks and secure prices	Short-term optimisation and benchmark for futures or forward markets

Financial regulation is increasingly affecting the energy sector

Commodities such as power and gas are traded in spot and futures or forward markets, trades being settled physically or financially. Financially settled products are indispensable for energy wholesale markets in facilitating cost-efficient risk management, among other purposes. As suppliers of power and gas are active in financial commodity markets, they may be subject to financial regulation in addition to energy-specific regulation.

Europe's liberalised markets strongly rely on wholesale markets for open and competitive access to power and gas. Wholesale markets cover two major needs: financial risk mitigation and physical optimisation.

Liquid futures and forward markets provide cost-efficient tools for securing prices and reducing risks. Independent retailers are enabled to competitively cover their demand in advance, gas companies or power generators to market their assets. Spot markets are efficient tools for balancing supply and demand across competitors and national borders.

For power markets, large and zonal market areas are required to ensure demand and production can be pooled effectively and to ensure high levels of liquidity.

In mature and efficient commodity markets, financial instruments are used as efficient tools for risk management. Financial regulation therefore influences energy markets.

Exchanges are increasingly important as markets mature

Commodities can generally be traded over the counter (OTC) or via exchanges. Particularly in less mature and less liquid markets, market participants rely on bespoke contracts. Long-term gas contracts, for example, are bespoke contracts between gas wholesalers and producers.

As commodities are traded more actively by a growing number of companies, contracts are increasingly standardised. This makes them more comparable, and benchmark prices can be derived. Brokers play an important role in this phase in bringing counterparties together.

Direct contracts between market participants come with the risk of counterparty default. Clearinghouses serve as a central counterparty and deposits mitigate counterparty risks, in all market timeframes, including balancing and post-event imbalance settlement. Clearing requires a highly standardised and liquid market as operated by exchanges, so positions can be closed in case of counterparty failure.

Exchanges are organised trading platforms for standardised and cleared contracts. As products are standardised and major risks are eliminated, they open up wholesale markets also to risk-averse players, or those with limited trading experience.

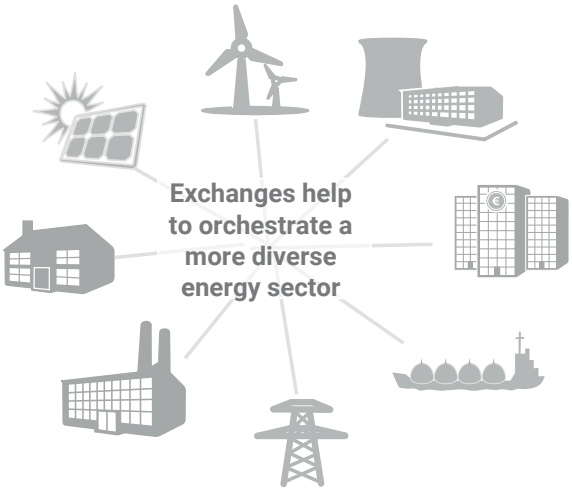
Exchanges play an important role in both developing and mature markets. In developing markets they help pool liquidity and find a consensus on price benchmarks. In mature markets they provide highly liquid, standardised and neutral trading platforms and determine reliable benchmark prices.

1.2 The energy landscape is changing rapidly – particularly exchanges help to orchestrate a heterogeneous and decentralised energy landscape

Recent years have witnessed significant change in the energy sector – from changes in global oil and gas markets to the rapid development of renewable technologies. Gas and electricity remain important for consumers, with access to competitive prices as important as ever.

It will be a key challenge in the coming years to build a resilient energy sector that is able to deal with uncertainties. As past years have shown, fair competition in open markets drives innovation and produces the best solutions.

Gas and electricity remain important for consumers – access and competitive prices are as significant as ever



Overall energy demand is projected to decrease across Europe (see Figure 4[3]). The main energy source for consumption remains oil, which is primarily used for transportation.

Gas and further electrification are seen as important aspects for meeting Europe's emissions targets. Gas is projected to retain a stable share in final energy demand for the coming decades. Electricity is projected to strongly increase its share.

Since the share of renewables is increasing, sector coupling is increasingly important. It opens the possibility of utilising cheap electricity during hours of abundant renewable production for new use cases such as power-to-heat or power-to-gas. Electric vehicles will play an important role in shifting the transportation sector to renewable energy, replacing oil. Electricity storage also has considerable potential in the power system itself.

Technology is developing quickly. Open markets with a stable regulatory framework are best in dealing with the uncertainty

Projections reflect political targets and a view on what is currently seen as technologically feasible. Looking back at the developments in recent years, it is clear that projections cannot be more than today's view on what the future may look like.

Forecasts on solar PV installations, for example, were significantly different year after year (Figure 10). The same is happening in offshore wind, where tenders in past years have revealed rapidly falling costs for new installations (Figure 11). Costs for battery storage have been reduced by a factor of approximately three since 2010 (Figure 12).

An open market quickly reveals progress and makes cost improvements accessible to consumers. It rewards companies' efforts to innovate. The right market design utilises the force of competition. Market-based policies for support systems such as tenders could quickly reveal progress and translate it into lower costs for consumers. Regulated tariffs would not have been able to achieve this.

Digital technologies, the increasing share of renewables and decentralisation are the main trends in the European power sector today. Innovation and new solutions will be required to successfully implement the challenging target to decarbonise the sector.

Competition will be essential to foster innovation, and ensure low prices and choice for consumers. At the same time, regulatory stability is required to encourage investment.

Renewables are gaining in importance in the power sector – their contribution to system stability will be indispensable

The share of renewables is increasing. According to the EC reference scenario, renewables will grow by 2.3% per year up to a share of 67% of the installed capacity in 2050. At the same time, conventional technologies are projected to shrink by 0.9% annually but will still play an important role, with a share of 33% in 2050 (see Figure 5).

Renewables growth is gradually becoming independent of subsidies. Investments in renewables have been driven by subsidies so far, but as the technology matures, they become increasingly competitive with conventional technologies. This means that future growth has the potential to become largely independent of subsidies.

The importance of gas is increasing. As a low-carbon fuel, gas helps Europe to meet its emission targets and can fuel flexible plants, needed as backup for volatile renewable generation in some European regions. Seasonal power storage large enough to cover longer

periods of low solar PV and wind production will not be available across Europe in the coming decade.

An increasing share of solar PV and wind in power generation will come with great challenges for the power sector:

Solar PV and wind generate power when the sun is shining and the wind is blowing, replacing conventional power plants. Backup plants, storage and optimisation through demand response will be needed.

Balancing supply and demand becomes more important, as volatile renewable generation gains importance. Other technical difficulties arise with a growing share of renewables, particularly in the area of power system balancing and stability.

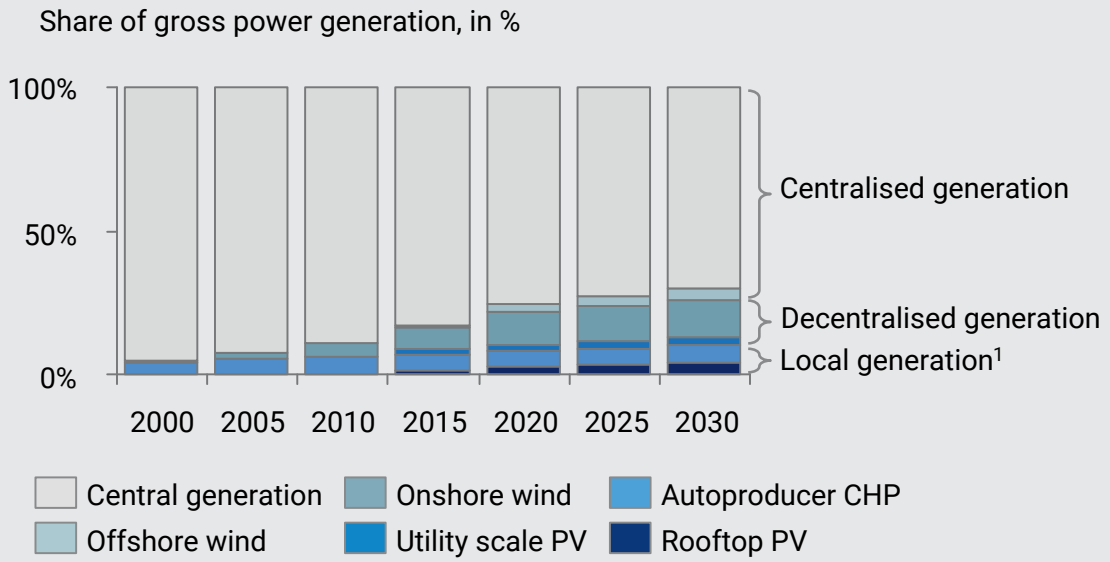
Electricity transmission grids are put under strain, as renewable generation is not always set up where it replaces conventional power plants. Electricity distribution grids need to be upgraded. For the most part, they were originally designed to distribute power from central power plants to end customers, but they now need to integrate increasingly decentralised and renewable generation capacity. They will also need to cope with higher demand flexibility and changing peak and off-peak load patterns.

As renewables gain a significant share of the market, their contribution to system stability becomes indispensable. This includes balancing responsibility (in other words, balancing the amount of electricity that is produced and sold), being able to actively steer production and to provide grid services such as frequency control.

Exchanges and optimisation across large bidding zones will gain importance with more renewables and other decentralised sources

Renewable power generation assets are decentralised in the sense of typically being smaller than conventional power plants and being largely connected to distribution grids. However, they are largely not "local" in the sense of being suitable for production for a single household. They are usually not located on the consumer site (for example, wind or utility-scale solar PV) and do not necessarily produce power when it is needed. See Figure 3

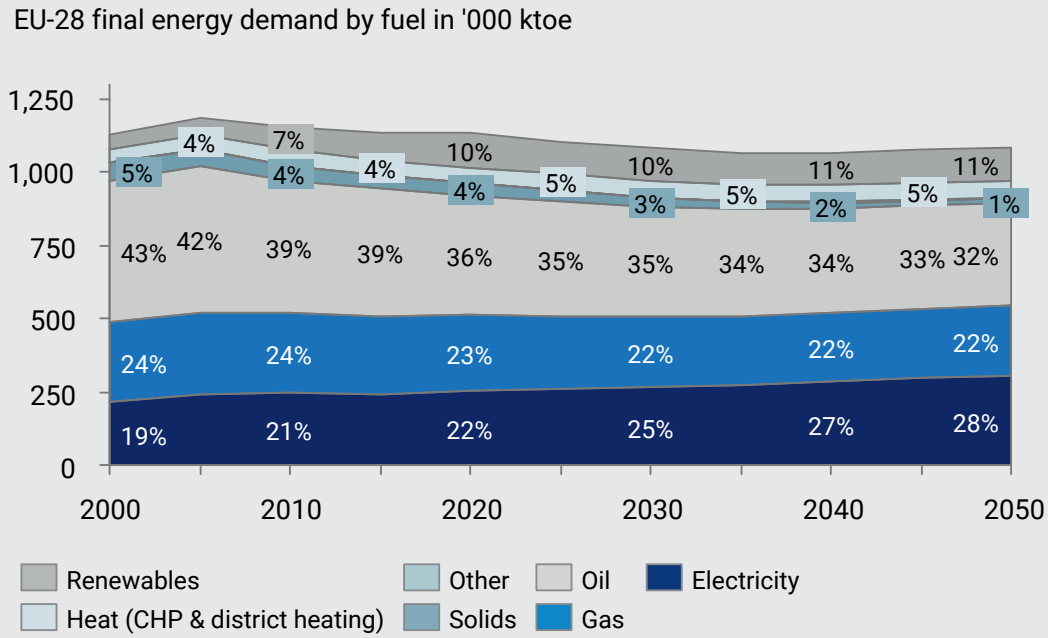
Figure 3: Decentralised generation – small assets that are largely connected to distribution grids – is projected to reach a significant share in the power market by 2030. However, local generation on consumer sites will be limited and consumers will largely stay dependent on competitive supply.



[1] Local generation defined as rooftop PV and autoproducer CHP
Source: European Commission, reference scenario 2016; Eurostat; IHS; BCG analysis

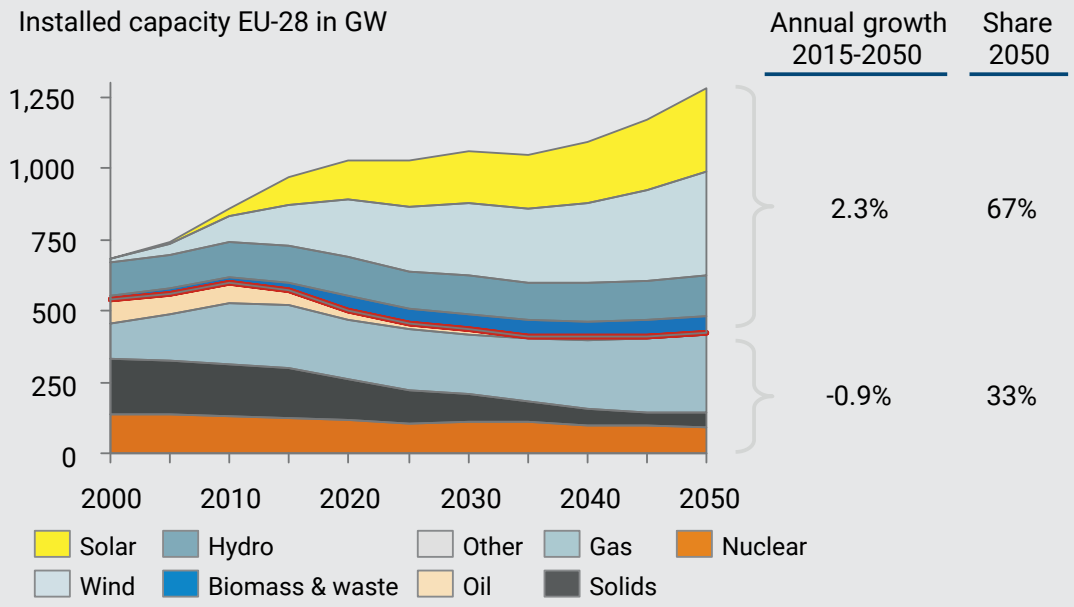
ENERGY DEMAND AND POWER GENERATION CAPACITIES

Figure 4: Gas is projected to have a stable and electricity an increasing share in energy consumption according to the European Commission's reference scenario



Source: EU-28 reference scenario 2016

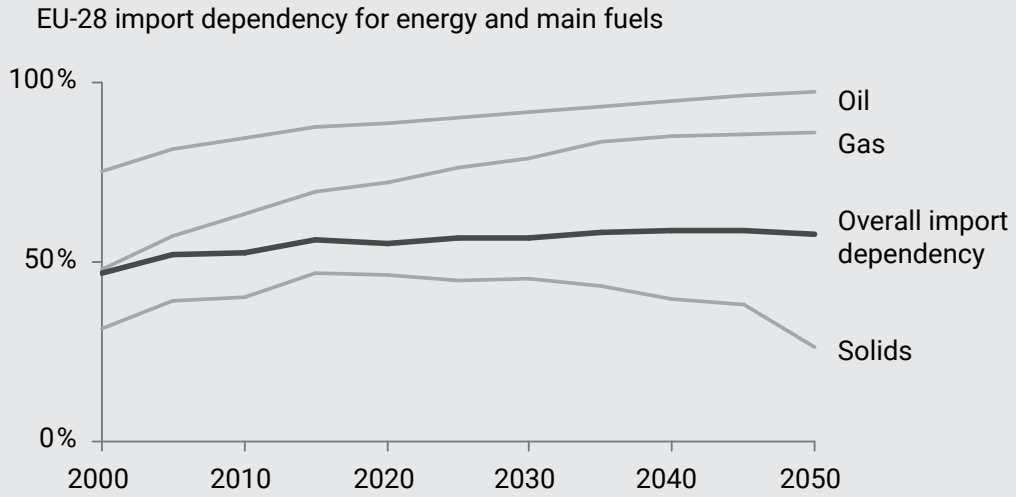
Figure 5: Installed power generation capacity along the EU-28 reference scenario



Source: EU-28 reference scenario 2016

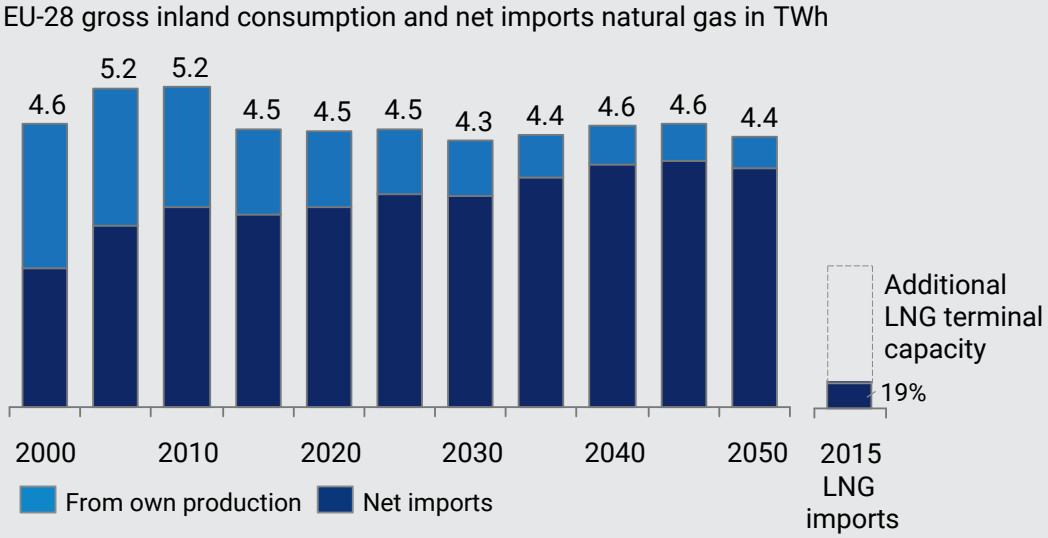
EUROPEAN ENERGY IMPORTS

Figure 6: European energy imports are increasing despite high investment in renewables



Source: EU-28 reference scenario 2016

Figure 7: EU gas supply relies on imports. LNG terminal capacity provides significant additional spare capacity and diversification options



Source: EU-28 reference scenario 2016; ACER/CEER Annual Report on the Results of Monitoring the Internal Natural Gas Markets in 2015; GLE; BCG analysis

for a view on the share of decentralised, local and central generation.

Therefore, exchanges will gain importance as the share of decentralised and renewable generation increases – as platforms for exchanging electricity between producers and consumers and efficiently steering an increasing number of assets.

Battery storage is quickly becoming cheaper, and it may prove to be an important factor in the electrification of transport and as part of the power system (for example, via home storage to back-up rooftop PV or large-scale installations to stabilise the grid). Large-scale installations that can cover longer periods and completely replace conventional power plants, however, will not be available in the coming decades.

Since renewables have a significant and increasing share in power generation, they must contribute to system stability. This is most efficiently achieved by exposing them to market prices and balancing responsibility. The growing share of renewables increases the need for exchanges to determine transparent prices and to leverage the efficient interregional balancing of production and consumption across Europe.

Europe depends on global markets to fuel its energy consumption. Access to global markets is required to secure and diversify sourcing

Europe relies on international energy markets to meet its energy demand. Current discussions surrounding energy in Europe are focused on high growth rates of renewables such as solar PV and wind. However, despite high growth rates, fossil fuel imports will still be an important energy source for the coming decades (see Figure 4). For oil and gas, import dependency is increasing, while domestic production is decreasing (Figure 6).

The major hydrocarbon sources – oil, coal and gas (LNG) – are traded globally. Prices are influenced by several factors such as growth in developing countries and the global economic environment (see Figure 8). Since Europe is importing energy, for example gas, coal and oil, its markets are also driven by factors that are determined outside of Europe.

International commodity markets have been subject to great changes and progress in recent years. Notably, the large-scale development of shale oil and gas resources, and the emergence of a global LNG market have had strong effects on global commodity markets.

The possibility to import LNG plays a significant role in the security of supply. While LNG imports today only amount to around 10% of European gas supply, LNG terminals already offer significant potential for increasing this share if needed (see Figure 7). Power prices, in turn, are influenced by fuel prices via the production costs of gas and coal power plants (see Figure 9).

Ample LNG regasification capacity, bi-directional flow capacity (for example, bringing LNG from terminals in Spain to Central Europe) and new pipeline routes will help to guarantee security of supply in Europe.

Security of supply and resilient energy infrastructure continue to be important aspects of policy because Europe will continue to import a significant proportion of its energy. Exchanges secure access to global markets and help to optimise sourcing opportunities.

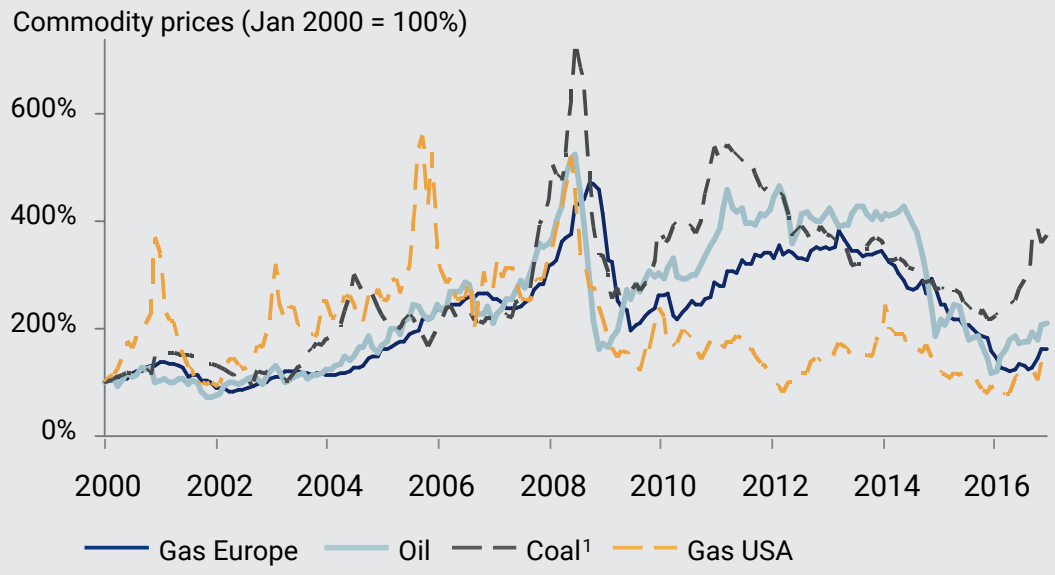
Exchanges have helped navigation through tumultuous years and will continue to do so

The energy sector has faced significant changes in recent years, driven by various developments.

The gas sector has been driven strongly by the developing global LNG market. It provides an alternative source and gives price signals via the maturing gas market. Consumers are no longer forced into expensive and long-term supply contracts (LTCs) that used to dominate the market, tying gas to oil prices and fixed minimum volumes. The decoupling of gas prices from oil was enabled by the growing independence and maturity of the global gas markets. Figure 8 shows how gas prices have been decoupled from oil prices.

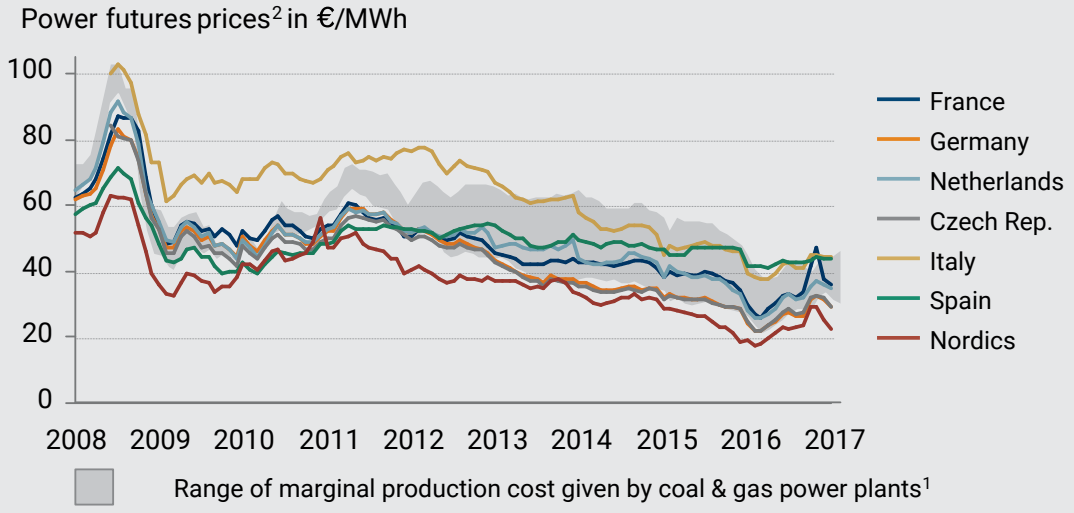
GLOBAL COMMODITY PRICE DEVELOPMENTS

Figure 8: Global commodity prices are volatile and linked to global developments



[1] South Africa; Source: World Bank

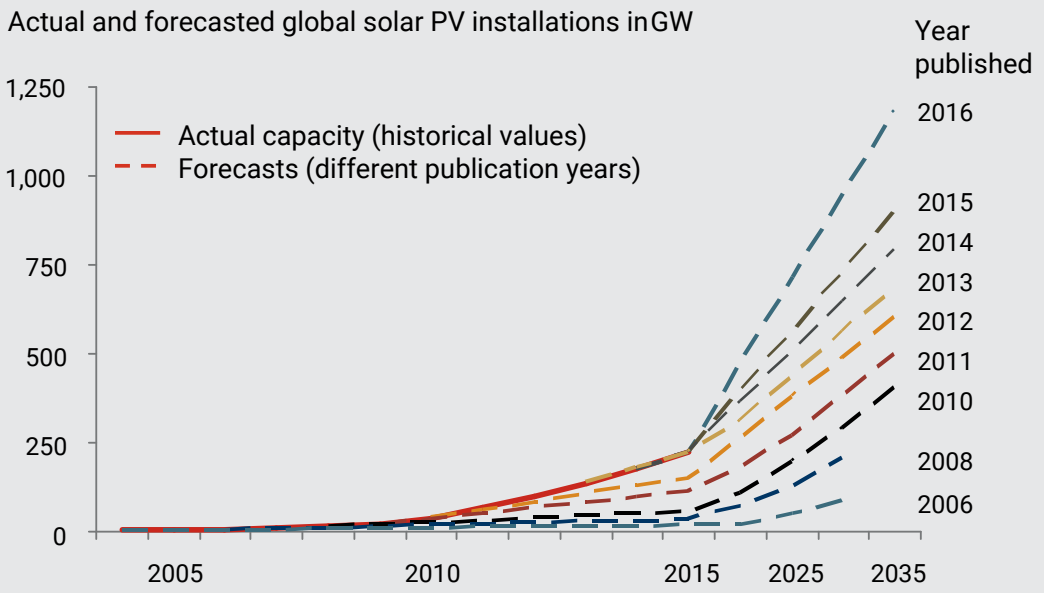
Figure 9: Power prices are closely related across Europe and correlated to coal and gas prices



[1] Marginal fuel costs of a typical coal power plant and CCGT at Central European fuel and CO2 prices. Coal efficiency 40%, CCGT 50%
[2] YR1; prices traded for following year
Source: Prices from Bloomberg

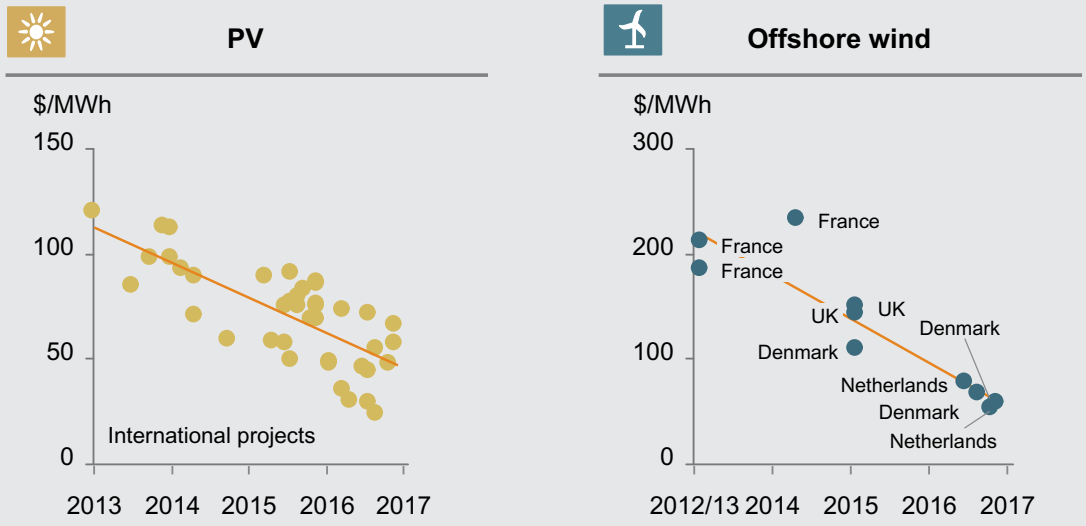
RAPID DEVELOPMENT OF RENEWABLE TECHNOLOGIES

Figure 10: Development of forecasts on global solar PV installations. Forecasts needed to be adjusted significantly year by year



Source: IRENA; IEA World Energy Outlook; BCG analysis

Figure 11: International tender results for solar PV and offshore wind revealed significant cost decrease in little time



Note: Reported prices comprise a selection of recently announced long-term remuneration contract prices (e.g., auctions) for renewable power by date of announcement. Commissioning dates later
Source: Press research; BCG

Liquid futures markets helped to mitigate risks from volatile commodity prices. Consumers and energy companies can apply suitable hedging strategies to secure prices or smooth out volatility. As many players in the energy and financial sectors trade actively, liquidity is high and bid-offer spreads are small. This reduces costs for hedging.

The power sector has been driven by both fuel prices and the increasing share of renewables (see Figure 9).

The hourly profiles of renewable generation and residual load are increasingly volatile, as illustrated in Figure 13. Power prices effectively steer demand and production. While high peak prices used to be an incentive for customers to avoid consumption during "peak" times, prices now guide them towards times of abundant renewable production. Industrial customers can, largely, already profit from this optimisation, while smart meters and flexible retail contracts have yet to be rolled out to households across Europe.

Prices will continue to play an important role in the coming years, supporting innovation in the energy sector. Price formation will continue to work at a high share of renewables. Their ability to efficiently steer a more decentralised system will gain importance (see Section 3.2 for an introduction to price formation and the concept of the merit order).

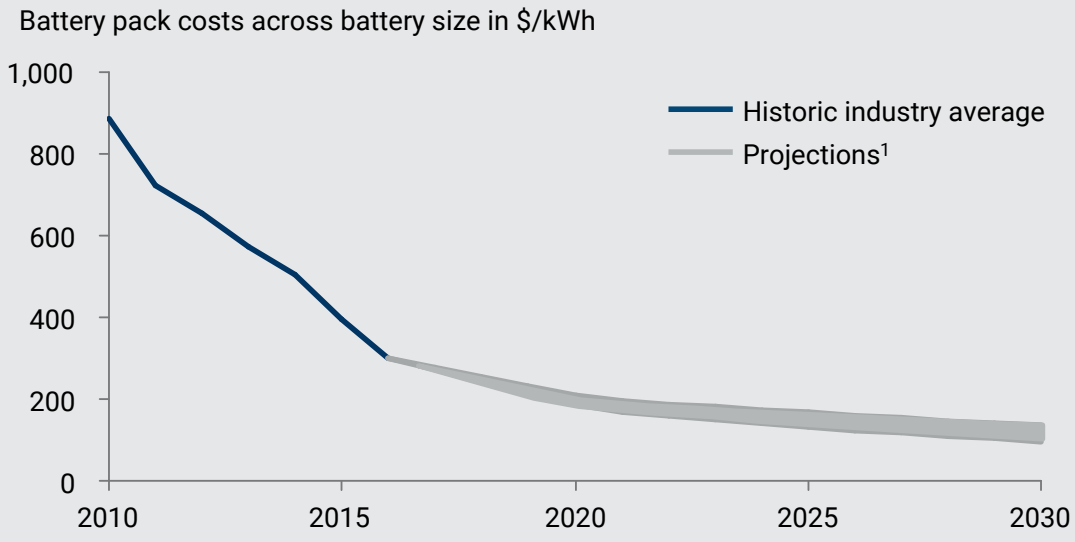
Exchanges create transparent prices that are an important signal to help market participants optimise strategies and portfolios. Prices effectively summarise all available information in one signal that is easy to understand and available for all – consumers, small and large energy companies – levelling out information advantages.

New business models are evolving and new players entering the market. The past decades have shown that open markets are a prerequisite for fair competition

Market liberalisation and unbundling have been drivers for change: As the market opened up for competition, consumers became able to switch suppliers. Power generators and gas wholesalers were enabled to compete in supplying retailers. As we outlined in Section 1, exchanges have played an integral role in the liberalisation.

The value chain is experiencing further diversification and new business models are emerging (see Figure 14). The following are current examples:

Figure 12: Historical and projected evolution of battery pack costs. Battery costs dropped by a factor of three since 2010



[1] Forecasts based on several sources
Source: GTM Research; BTM Navigant; Bloomberg New Energy Finance; press research; Nykvist and Nilsson (2015): Rapidly falling costs of battery packs for electric vehicles, in: Nature Climate Change 5: 329–332; BCG analysis

- Renewable production needs to be actively managed and committed volumes need to be balanced against actual production. New service providers pool capacities to efficiently manage them in larger portfolios.

- Specialised retailers, which do not own assets and fully depend on wholesale markets to procure power and gas and to hedge their risks, are gaining importance.

- Aggregators collect flexibilities of consumers and small generation units to market them as virtual power plants for ancillary service or on wholesale markets (for instance through exchanges). Their services play a significant role in leveraging demand flexibility for system stability.

- Energy efficiency is offered as a service, actively managing and optimising consumption and production for own use.

- Big and medium-sized consumers become active participants in energy markets, directly procuring energy, hedging risks or selling their flexibility.

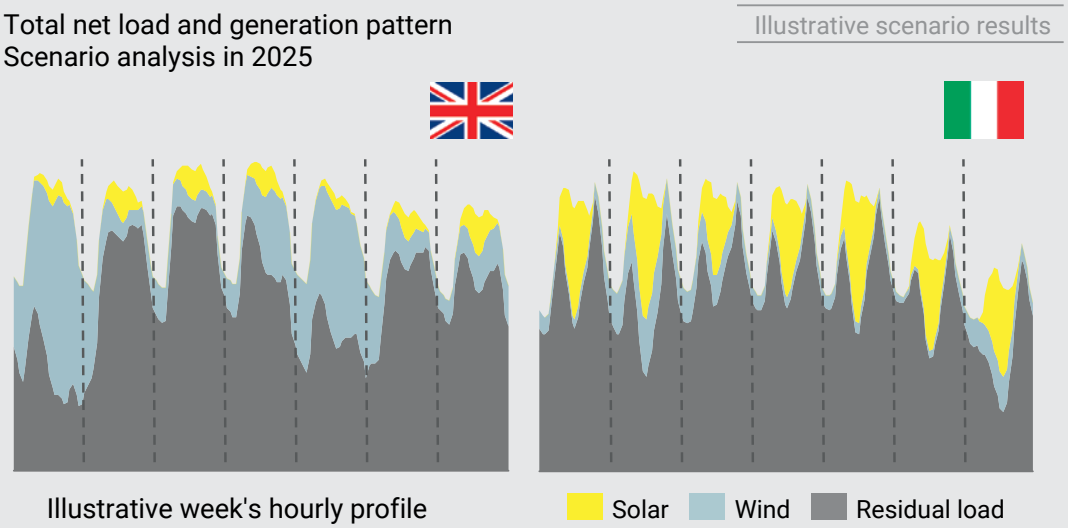
Business models are diverse, and the rapid development is likely to give rise to new models that do not yet exist. Nevertheless, there is an apparent trend towards smaller players and the specialised optimisation of energy consumption, generation assets or optimisation of storage or flexibility.

Integrating flexibility on the demand side will be a key ingredient of the future power market, as it is increasingly dependent on more volatile availability of renewable generation. Reliable wholesale price signals provided by exchanges exhibit an efficient signal to steer activity. In hours where sun and wind are abundant, prices are low and consumers can make generous use of electricity (for example, for new applications such as power-to-gas or power-to-heat). At times with limited renewable generation, prices are high and incentivise reducing consumption (for instance, reducing the power of cooling applications).

Exchanges are the binding force and a main facilitator in a diversified energy value chain. They bring together supply and demand and have a central role across the value chain. See Section 3.1 for a simplified illustration on the main use cases of wholesale markets and the typical roles of exchanges.

- In futures markets, market participants buy or sell commodities or related financial products several years in advance to manage risks and secure prices. This allows

Figure 13: Volatile generation from wind and solar has an increasing impact on the power system. The need for conventional power varies greatly with wind production and high solar production creating two short peaks in which flexible technologies are needed



Source: Following ENTSO-E scenario "Expected Progress"; BCG analysis

independent retailers to compete with integrated utilities that also own assets.

- Wholesale markets facilitate investments, as they allow asset owners to smooth returns and as they provide independent price signals.

- Day-ahead power auctions facilitate an optimisation of portfolios across players. All players bid their demand and supply capacities into a central day-ahead auction. This way, assets are utilised in the most effective way, reflecting the latest forecasts. The auction determines an efficient market price to be paid per zone in a transparent and reliable manner.

- Power market coupling as well as the gas market model with entry-exit zones and hub trading allow for holistic optimisation across Europe, making efficient use of assets and transmission lines or pipelines.

- Intraday markets allow market participants to continuously refine their commitments, helping them to react to new information (for example, updated renewable generation forecasts).

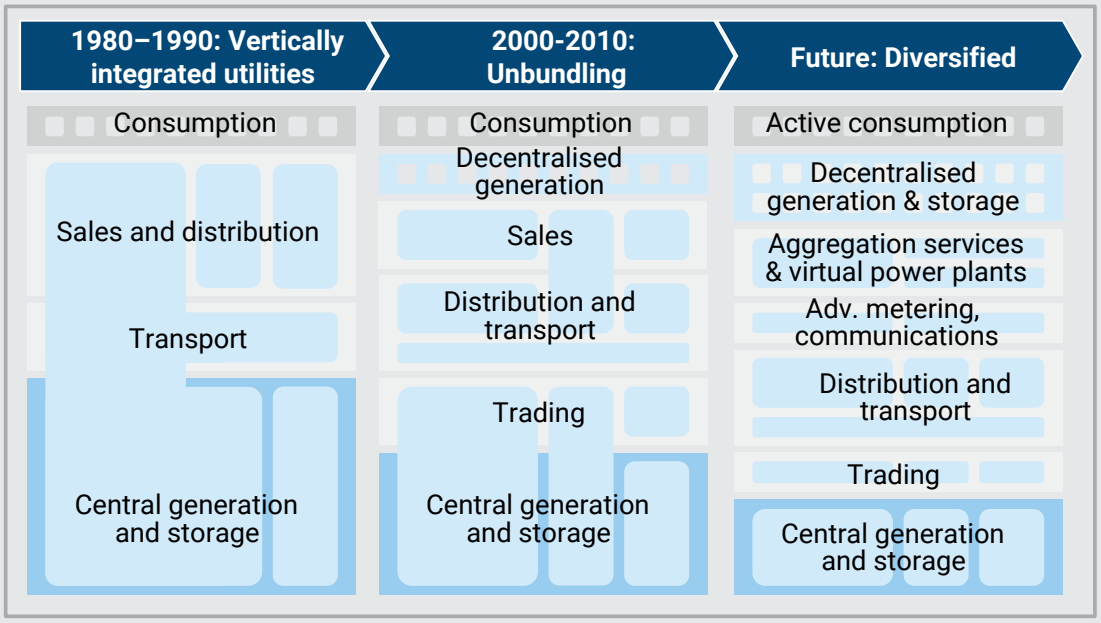
The requirements of wholesale markets evolve with the energy sector: There is a growing need to integrate renewables and the demand side into the market. Assets are increasingly steered automatically, particularly as smart production and small capacities, for instance from the demand side, are developed and optimised. This directly translates into the requirement to be able to automate corresponding wholesale activities.

Balancing renewables and leveraging demand-side flexibility requires bringing markets closer to real time. As gate closure, after which market participants cannot optimise their positions on intraday markets, is extended towards time of delivery, more accurate information and forecasts can be taken into account.

As gas-fired power plants are needed as a backup in significant parts of Europe, the corresponding gas capacity needs to be available. Requirements for the flexibility of gas grids and markets are following. As lead times in gas markets are significantly reduced, they facilitate gas-to-power as an option to balance renewables.

Exchanges are the binding force for the new, heterogeneous and decentralised energy landscape. They provide efficient trading platforms, clearing and settlement solutions and establish transparent prices that serve as a reliable benchmark for all market participants.

Figure 14: The evolution of the energy value chain towards a more diversified landscape



1.3 Digitalisation has already profoundly shaped wholesale markets – and will support an increasingly automated and digital energy sector

The energy sector has witnessed significant change in recent years, which has had a significant impact on wholesale markets – and wholesale markets themselves have facilitated the change. Technology is moving quickly and digital technologies are the driving factor.

The fundamental function of exchanges – bringing together supply and demand, and determining efficient prices – will persist, even as players and technology develop.

New products are developed and traded as the energy sector changes. They allow companies to reduce risks and finance investments in the new environment

Products that are traded on commodity markets are diverse. Spot markets trade power and gas delivered physically at a specified location and time. Derivatives that are traded in futures markets directly refer to an underlying spot index or more complex products such as options.

Traded products allow businesses to market their assets or hedge against risks, and new products are developed as the energy sector changes. Large players may offer specific new services to smaller businesses, or exchanges may develop new products for the broader market. As in other sectors, the actual demand for products determines whether they are accepted by the market and are able to gain market share.

As an example, "wind futures" were developed for renewable production. They replicate the production of wind generation and allow owners of wind farms to hedge against risks[4].

Digitalisation and automation profoundly change the market. Automation makes it possible to steer a landscape of small and decentralised assets

Wholesale markets themselves are highly impacted by new digital technologies. They are increasingly automated and require less and less manual intervention. This holds true for back-office processes such as the verification and settlement of deals as well as deal closing and capture. That makes it possible to implement fully automated management of assets, from operation to marketing, which is required to flexibly steer a large fleet of small assets.

New business models such as algorithmic and high-frequency trading are increasingly implemented also for commodity markets such as oil, but also power and gas, which is a signal that these markets are maturing and gaining in liquidity.

Digital capabilities and automation enable the development of a more decentralised energy sector. They provide an efficient way to steer the developing complex infrastructure with assets of different sizes and nature across many players. Digital capabilities are now a key success driver for all participants in energy markets. Requirements for trading IT platforms are increasing. Non-discriminatory access to information and digital networks is increasingly important.

Exchanges are neutral and reliable facilitators that offer non-discriminatory trading venues needed in an automated, digitalised and an increasingly decentralised market. They are able to develop new products as market needs change.

Local electricity trading can help to manage bottlenecks, as long as they remain part of large and liquid bidding zones

The share of decentralised generation is increasing. In line with this trend, it is often argued that power markets also need to be decentralised. This would reverse the positive trend of increasing interconnectivity and competition across the European power system (see Figure 16).

Decentralised generation is typically defined as generation or storage assets being connected to distribution grids in contrast to transmission grids. However, generation is still not necessarily collocated with consumption or produced by consumers themselves. As discussed in the previous section, local genera-

tion with the potential for local self-supply will have a minor share in the coming decades.

Exchanges play an important role in balancing supply and demand between regions in an optimal manner. To ensure that markets can fulfil this important role, local networks need to remain part of large bidding zones and the interconnected European market.

Some consumers may wish to be part of local electricity trading even at higher costs. However, few consumers have the means (be it capital or rooftop) to become self-sufficient and be independent of energy supplies. The rationale of the successful liberalisation of Europe's energy sector still holds true.

In a decentralised energy market, non-discriminatory access to grids and liquid wholesale markets are key elements in guaranteeing competition between suppliers and freedom of choice for consumers. If ways to exchange energy locally are created, for instance in power distribution grids, non-discriminatory access must be maintained. Local networks need to remain part of a large and liquid market.

Blockchain as a new IT technology opens new possibilities, but regulation and customer protection remain important

Blockchain is a new IT technology: Enthusiasts believe that the technology has the potential to turn the financial sector upside down by using decentralised networks instead of trusted central intermediaries to manage transactions and guarantee data security.

Blockchains store data in many copies across a network. Encryption technology guarantees data integrity, as each step between blocks in the chain is validated by the network.

The network could be designed to work without any manager or owner of the network. In its pure form, this removes any institutions as intermediaries from the system. Lack of oversight may be perceived as an advantage, but also comes with risks:

Pilots in local energy networks: Blockchains as decentralised networks are often interpreted as a complementary technology for decentralised power generation and local networks. They have been tested in several pilot projects such as Solar Change or Brooklyn Microgrid[5].

In contrast to trading on exchanges, participants directly trade with each other and do not rely on a supplier or other intermediary. Besides technology, regulatory questions, physical grid balancing and risk management are important aspects, particularly to protect inexperienced consumers.

Central oversight is a key element of energy markets to protect customers and to manage risks. Inexperienced customers also need to be protected in peer-to-peer networks. Here, they effectively conclude contracts that may come with risks that they are unable to fully understand. A central operator is therefore needed that is subject to regulatory oversight, as has been implemented in the case of exchange trading today. Clearing is a major function to mitigate the risk of counterparty failure that exchanges cover today, with their clearing houses serving as a central counterparty. Clearing by definition cannot be implemented in a purely decentralised network.

New data processing concepts such as blockchain offer the opportunity to change the way markets are operated. In any trading platform, however, central oversight under regulatory control is required to ensure fairness and customer protection.

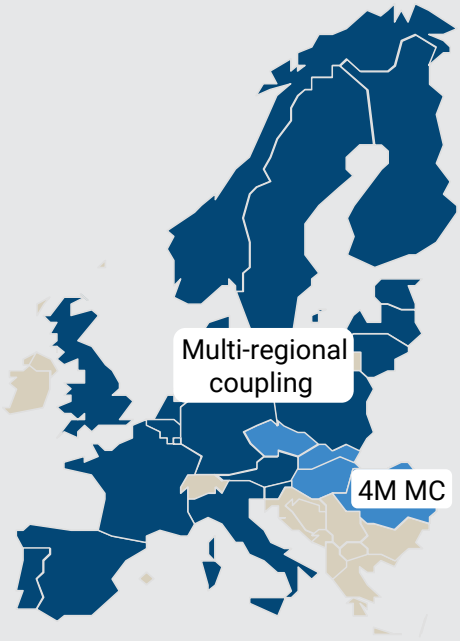
1.4 Competition delivers the best solutions – regulation needs to provide a stable level playing field

The effort to liberalise the energy sector has successfully developed gas and power markets, now providing cheaper energy bills for customers across Europe. Market-based approaches have proven to be the most efficient way to implement political targets.

Trading schemes help to achieve emission targets in the most efficient manner and energy markets are the most efficient vehicle to guarantee security of supply.

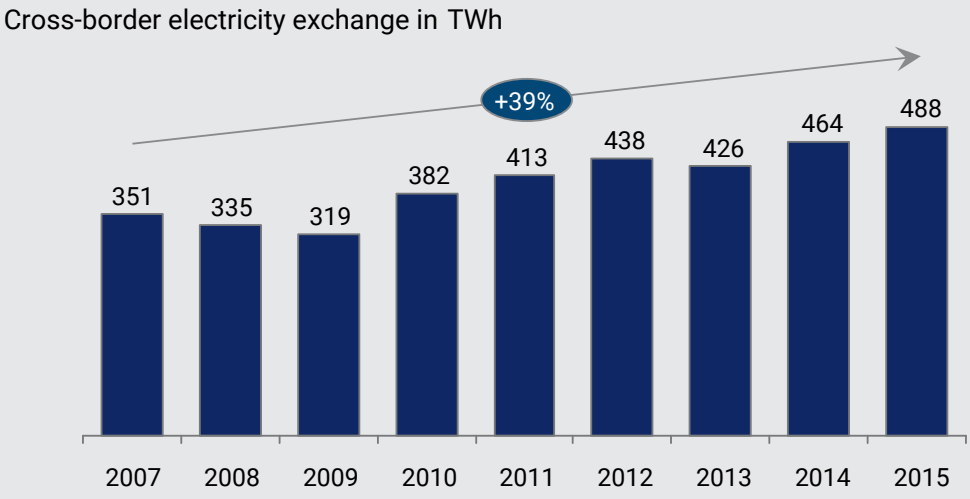
POWER MARKETS INCREASINGLY COUPLED ACROSS EUROPE

Figure 15: Main steps towards a coupled European power market



1996	Nord Pool: world's first international power market with common Nordic system price
2006	Day-ahead market coupling of France, Belgium and the Netherlands
2007	MIBEL couples Spain and Portugal
2010	Coupling of Central Western Europe (CWE), incl. coupling with the Nordics, Poland and the Baltics
2014	Coupling of CWE , GB, the Nordics and Baltics and MIBEL . 4M market coupling integrates CEE from Hungary to Romania
2015	Italian Borders Market Coupling launched, multi-regional coupling covering 19 countries

Figure 16: Cross-border electricity exchange with significant increase since 2010, as market coupling was intensified



Source: ENTSO-E

The liberalised energy sector now provides cheaper energy bills for customers across Europe

European gas markets are organised in virtual trading points like the National Balancing Point (NBP) in the UK, Title Transfer Facility (TTF) in the Netherlands, Punto di Scambio Virtuale (PSV) in Italy or CEGH in Austria. Gas bought or sold at a virtual trading point can be withdrawn or injected at any entry or exit point in the market area that is associated with the trading point.

Virtual trading points across the EU allow standardisation of gas products and foster the development of trading at wholesale markets with transparent prices. Unified network codes facilitate trading across the EU, since gas can be shipped easily. Market participants can utilise liquid futures/forward markets to secure prices and hedge risks or optimise their positions in spot markets.

As shown in Figure 17, gas wholesale markets have helped to tightly link gas prices across Europe in recent years.

Power market coupling across Europe helped to connect power markets across Europe (see Figure 15 and Figure 16). Starting with Scandinavia as the first international power market, the market coupling now covers 19 countries and 85% of Europe's power consumption in the Multi-Regional Coupling plus four countries in the 4M area.

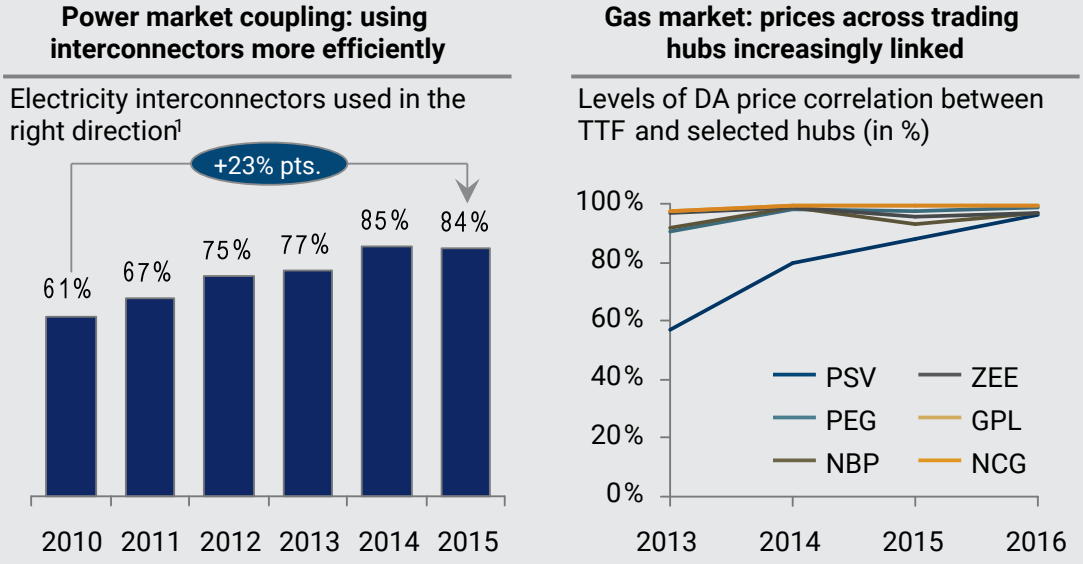
Market coupling links supply and demand across regions in simultaneous auctions, implicitly optimising the utilisation of interconnectors. Figure 17 shows that the efficiency of interconnector usage has increased by 23 percentage points from 2010 to 2015, as electricity flows in the right direction. At the same time, electricity exchange volumes between countries have significantly increased.

The maximum possible transmission capacity, of course, needs to be made available for market-based optimisation.

Market coupling and bi-directional gas flow are excellent examples of market-based initiative and innovation. Europex members had a substantial role in driving power market coupling in cooperation with TSOs. In particular, the first phase of coupling between 1996 and 2010 relied on private initiative without regulatory push. Regulation picked it up as a successful model.

Market coupling started with day-ahead auctions and is now being extended to intraday

Figure 17: European power and gas markets are increasingly connected, interconnectors being used more efficiently and prices converging



[1] Available tradable capacity used in the direction of a significant price differential in all EU interconnectors price differential in all EU interconnectors **Source:** ACER/CEER

Correlation of daily prices TTF vs. other hubs.
Source: Prices Bloomberg; methodology ACER/CEER

markets and balancing, promising similar efficiency gains.

Today's common market across national borders has increased the efficiency of how assets and transmission capacities are being utilised. Overall this has led to lower prices for consumers and greater security of supply, as power and gas are made available wherever needed. Regulation should continue to further these achievements.

Market mechanisms such as emission trading schemes help to achieve policy targets in the most efficient manner

While politics must define targets and the regulatory framework, markets have proven an effective means to achieve these targets. Provided market participants are exposed to the right incentives, markets are able to drive innovation and uncover the most efficient implementation, often not known beforehand.

Institutions need to continuously monitor targets, but stability is important to support investments with long pay-off periods.

Emission trading schemes (ETS) are being implemented globally to limit emissions by putting a price on them. They follow the principle that the polluter pays. As policy defines targets for emission reduction and introduces a trading scheme, market participants are free to find the most efficient ways to develop detailed measures to achieve the targets. As a result, emission trading schemes achieve an environmental objective at the lowest cost to society.

The price for emission rights will reflect the actual costs to achieve the given targets and incentivise the most efficient measures. Measures can vary from increasing energy efficiency, using low-emission fuels such as gas or investing in renewable energy sources. In principle, no further interventions are necessary to achieve the targets.

The success of an emission trading scheme is directly linked to the underlying targets and stability of the framework. They might require adjustments over time, as experience with the EU ETS has shown. Successful emission trading schemes require large scale, wide coverage of sectors and a uniform policy framework even across countries.

Emission trading schemes are today implemented across the globe, including in China, and market schemes are widely recognised as a suitable tool to implement emission targets. The global spread of emission trading schemes opens up opportunities for increased cooperation between these systems, enhancing effectiveness and reducing costs.

Guarantees of origin (GOs) can be used to link sources of production to consumption. GOs are today mainly used to inform consumers regarding the source mix of the electricity they consume as well as to empower them to deliberately choose to procure a particular mix of electricity (usually "green"). It can be readily extended to other network-based energy systems, such as gas or heating.

They could also be used to balance national renewable targets and support sources that are preferable according to policy targets.

The main prerequisite to fully leverage the potential of GOs is to implement a system that covers all sources and advance standardisation[6].

Market mechanisms such as white certificates provide useful incentives for energy-efficiency targets. They provide a way to finance actions for those with savings potential (even beyond their target), as well as enable lower-cost compliance for those subjects, where direct action would result in unreasonable costs – thereby achieving overall efficiency.

Market mechanisms such as Emission Trading Schemes or Guarantees of Origin have proven effective means of achieving political targets. The design of the EU ETS has room for improvement, but generally provides the right incentives to reduce emissions – at the lowest cost to consumers.

Market design is a regulatory decision. Market-based approaches have proven to be the most efficient way to approach system design and implementation

The EU system of virtual trading points for gas and zonal pricing for power has proven to be very successful at reducing costs and increasing freedom of choice for consumers. They were developed in the course of the liberalisation effort (see Section 1.4).

Holistic optimisation across regions and national borders is essential. Stability of zones is an important feature for representative prices. Where persistent power transmission bottlenecks exist, they need to be reflected in the definition of price zones or be removed by expanding transmission capacity. Price differentials between zones efficiently guide investments in grid infrastructure to increase welfare.

Fair competition will remain essential as most consumers will need still to buy their power or gas in the decades to come. In a fragmented market, competition will be severely obstructed, forcing consumers to buy from a limited number of players active in a constrained and localised market area.

Markets support secure and diversified gas supply: With the LNG market, European gas imports have become more diversified and security of supply increased. While LNG currently constitutes a minor source for gas in Europe, existing LNG terminals already offer high additional capacities to import gas. New projects such as Nord Stream II and Turkish Stream extend pipeline capacities.

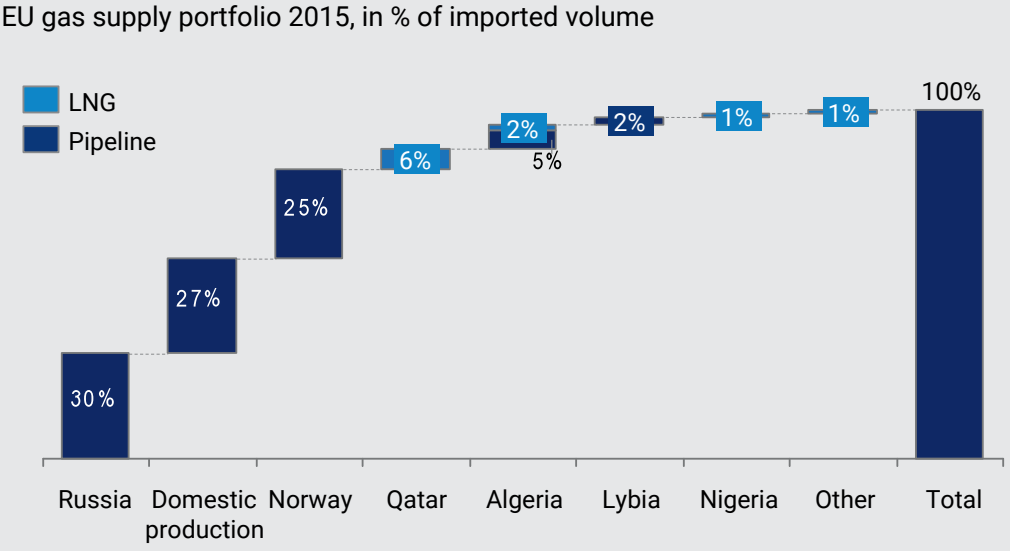
As shown in Figure 18, LNG imports accounted for only about 10% of the European gas supply portfolio in 2015, but free LNG terminal capacities would allow for a significant increase (see Figure 7). Supply from the global LNG market could be ramped-up significantly within a short time frame if it would support cheaper gas. Bi-directional gas transmission capacity could distribute the gas across Europe.

EU gas storage capacity covers around 18% of the yearly gas supply[7] and is able to bridge potential supply gaps. Wholesale markets provide revenue for storage owners through seasonal price differences.

Power markets support secure supply, also at high penetration of renewables: The need for capacity remuneration in the power market has been discussed widely in recent years and national regulators have found different answers across Europe.

An energy-only market without capacity payments can deliver investment signals and efficient utilisation of assets even in a market dominated by volatile and low-marginal-cost renewables. They are able to ensure reliability

Figure 18: The EU gas supply portfolio. LNG had a total share of 10%, with significant additional capacity of LNG terminals



Source: ACER/ CEER annual report on the results of monitoring the internal natural gas markets in 2015

at least cost to consumers (see Section 3.2 for an introduction to the discussion)[8].

The consequences of an energy-only market, however, may prove politically unacceptable, as peaker plants (such as gas-fired power plants) or investments in demand-response technology are financed through few hours with high power prices.

Prescriptive rules require flexibility: Detailed regulation comes with the danger of inhibiting innovation and the ability to react to new circumstances. As Network Codes and Guidelines, for example, prescribe detailed operational rules, a quick and flexible change process needs to be in place.

In power markets, for example, Member States may deem capacity mechanisms necessary as a last resort. However, their design needs to avoid distortions to the power market and to neighbouring regions to preserve the achievements of the common energy market.

2. RECOMMENDATIONS FOR SUCCESSFUL REGULATION OF THE ENERGY SECTOR

Energy markets are strongly driven by energy regulation and financial regulation. We believe that the following challenges are most critical for a successful and stable regulatory framework.

The most critical challenges for energy regulation

Provide a stable regulatory framework: Markets are able to innovate and adapt flexibly to new situations. Because these developments take time, regulation needs to provide a stable framework, avoiding detailed prescriptions and frequent changes. Particularly where investments are required, trust in a stable framework is indispensable.

Avoid regulatory complexity: Regulatory requirements can be a driver for costs and complexity, creating hurdles particularly for smaller companies. Detailed and complex requirements may have the negative side effect of reducing competition.

Regulation typically moves slower than technical developments. Regulation that covers detailed technical requirements may become a handicap for innovation.

Ensure the consistent application of rules across Europe: EU regulation is targeting common rules across Europe. However, national legislation may inhibit their consistent application. EU regulation should ensure that regional markets do not drift apart.

National support schemes for renewables, CO2 taxes or capacity mechanisms may severely distort the market, including neighbouring markets. National rules on licensing may constitute hurdles for competition from other EU members.

Keep market prices relevant: Market prices are the most efficient incentives for long-term investments and optimal short-term behaviour. Levies, e.g. to cover renewable subsidies, grid fees, and taxes constitute an increasing share of the energy bill for consumers and the incentives from actual wholesale market prices for energy are not as strong as they need to be. At the same time, demand flexibility is required to stabilise the power system as the share of renewables increases. Only if market prices are allowed to work properly, demand response will pay off for consumers and they will be willing to participate in the demand flexibility market.

Energy prices should not be regulated ("tariffs"). Consumers need to be enabled to opt for flexible contracts and smart meters must be available where economically viable. This will reduce the overall system costs.

Minimise market distortions from interventions or subsidies: Subsidies and interventions should be avoided as much as possible, as they lead to market distortion and higher costs for consumers.

Where politically desired, e.g. to support low-emission technologies, subsidies should be designed in a way that they minimise market distortion. They also need to consider potential negative effects on neighbouring regions. The EU Emissions Trading Scheme, Guarantees of Origin or White Certificates are examples of efficient mechanisms.

Expose renewables to market prices: Renewables support schemes were initially designed with the aim of kick-starting the industry. As the share of renewables has already reached a significant level and continues to increase, their systemic relevance becomes more important. As an example, feed-in tariffs shield renewables from any incentive to respond to market price signals. Hence, in the short-term, they need to be replaced by less distortive mechanisms, and in the long-term they must be completely phased-out.

Good regulation should give businesses freedom to operate and innovate, creating a level playing field. All market participants need be exposed to the incentives of market prices, including renewables and consumers.

Financial regulation: Adherence to global standards is key to ensuring international consistency when implementing financial reforms

Global financial regulation was revised following the financial crisis in 2007/2008, as leaders of the G20 agreed at the Pittsburgh summit '*To make sure our regulatory system for banks and other financial firms reins in the excesses that led to the crisis*'[9]. Financial regulation was subsequently implemented internationally to increase transparency and reduce systemic risk in financial and commodity markets.

Implementation in Europe: The European Market Infrastructure Regulation (EMIR) and the Markets in Financial Instruments Directive (MiFID) are the main regulatory initiatives implementing international agreements in the European Union. Furthermore, the Capital Requirements Directive IV (CRD IV) and Capital Requirements Regulation (CRR) implement Basel III requirements. It includes the Regulation on Wholesale Energy Market Integrity and Transparency (REMIT).

Ensure international compatibility: Europe needs to ensure that its regulation is compatible to the implementation chosen internationally to retain competitiveness and access to global markets.

Drive global regulatory cooperation: The EU should be a driving force in enhancing global regulatory cooperation as a basis for agreements and standards to underpin mutual equivalence. EU member states participate in many international forums, including the G20, the Financial Stability Board, the Basel Committee on Banking Supervision and CPMI/IOSCO. The EU concept of equivalence recognises that not all regulatory regimes are the same in every detail but that they seek the same kinds of outcomes. Equivalence is determined based on outcomes and informed by adherence to internationally-agreed global standards.

Recent reforms in financial regulation aimed at increasing the overall stability of financial markets. These changes also had a significant impact on power and gas markets as they increased regulatory complexity significantly. Complexity should be reduced where possible. Small players in particular may face disadvantages if compliance with complex regulation hinders competition.

Figure 19: The value chain of power and gas markets. Simplified illustration

	Futures and forwards	Day-ahead auction	Intraday	Balancing
Time frame	Up to several years ahead	Day before delivery	Last hours before delivery	Last minutes before delivery
Main use case	Buy and sell in advance to secure business against price fluctuations	Optimise and balance portfolio Nominate volumes to be fed into the grid	Adjust for short-term changes	Deliver committed volumes Balance the grid to match supply and demand
Exchanges	Match bids and offers and determine prices for standard products Provide clearing service Support transparency obligations	Manage auctions and cross-border price coupling, determine prices Manage nomination of volumes towards TSO	Match bids and offers and provide, determine price Manage changed nominations	Partly provide balancing services to TSOs
Brokers	Bring counterparties together and offer expert insight Connect to clearinghouses			
TSOs	TSOs manage shipping licences (gas)	Determine available cross-border capacities Procure balancing capacities (e.g., up to a week before delivery)	Allocate intraday cross-border capacities	Dispatch required balancing capacities Determine and invoice imbalances (after delivery)

3. ANNEX: MAIN ELEMENTS OF EUROPEAN COMMODITY TRADING

3.1 Exchanges with central role in energy wholesale markets

The value chain of power and gas wholesale markets

In Figure 19 we illustrate the value chain of energy wholesale markets by going through the main use cases for energy companies or consumers and outlining the typical role of facilitators in the market, notably exchanges, brokers and TSOs. Exchanges have a central role throughout the process:

Manage risks. Margins in power and gas retail are typically small and retailers need to secure prices as they commit to fixed prices for their customers. In power generation, spreads, the price difference between power prices and the costs for fuel and emission rights, highly depend on fuel prices and weather conditions, for example. The same holds true for operators of other power or gas assets such as storage.

Futures and forwards are contracts to buy or sell a commodity. The contract defines at which point in time and to which location the commodity is delivered.

- **Forwards are over-the-counter (OTC)** contracts and are concluded directly between two counterparties. Standard contract terms, such as those provided by the European Federation of Energy Traders (EFET) or the International Swaps and Derivatives Association (ISDA) or the exchange contracts, are often used. However, contracting parties may agree on specific terms.

- **Futures** are standardised contracts that are traded on exchanges, where the exchange's clearinghouse serves as a central counterparty to minimise the risk of counterparty failure. They are settled day by day (marked-to-market).

Clearing: Clearinghouses act as central counterparties to mitigate the risk of counterparty default. Clearing is generally done in exchange trading, but also OTC trades are often transferred to clearing houses.

Exchanges collect bids and asks, and centrally match overall supply and demand. Standardised products are used to make all offers comparable. All deals that can be matched become effective with the central clearinghouse as a central counterparty. Standardisation is a key prerequisite for exchange trading and facilitates the formation of transparent prices, as the product is made comparable in terms of delivery location, time and contract terms. Brokers bring counterparties together that directly conclude contracts with each other.

Balance the portfolio. Day-ahead power markets offer energy companies the possibility to balance their portfolios. For renewables, the electricity sold is matched with the latest production forecast. For retailers, this means matching energy to be delivered to customers with energy bought on the wholesale market.

Day-ahead markets are organised by exchanges in central auctions. This pools supply and demand and provides a highly liquid market also on a granular level, for instance hourly for power. Prices derived in day-ahead markets serve as an important benchmark, for futures markets, for example.

Market coupling is currently implemented mainly for power day-ahead markets: Exchanges across regions match supply and demand jointly across borders to optimally allocate transmission capacity.

Re-optimise power portfolio in intraday markets. Production or demand forecasts change until delivery and intraday markets allow energy companies to adjust for short-term changes. As they do, imbalances in the grid are reduced.

Exchanges operate continuous intraday power markets until close to delivery. They determine intraday prices, that serve as an important signal for consumers or asset owners that may have the flexibility to balance the system. Demand response aggregators, for example,

may sell extra energy from their virtual power plant when prices are high by reducing the consumption of their clients.

Balancing: Power and gas fed into and taken out of the grid need to be in balance. Day-ahead and intraday markets allow energy companies and consumers to balance their own portfolios to a large extent. Power grid operators procure additional reserve capacity to correct remaining imbalances. Gas TSOs are residual balancers, subject to market-based balancing, such as on an exchange.

Terminology

If the contract specifies **physical delivery**, the supplier delivers the commodity physically to the buyer at the fixed price at the defined delivery time and location.

With **financial settlement**, the commodity is not actually delivered. Instead, the difference between the contracted and actual underlying price is paid out.

Virtual trading points (VTP) are used to define the delivery location of a transaction for gas quantity. Transport through the grid from an entry to an exit location in the relevant market area is assured by transmission grid operators (TSOs). Brokers aid in bringing OTC counterparties together, for example via trading platforms. They may also provide additional services and connection to clearinghouses.

3.2 The merit order: A key concept for understanding how markets work

The merit order is a well-known concept for understanding prices in competitive markets. Its use is well established in commodity markets, and early example employing it to analyse cyclic prices for pork in 1927[10].

Illustration power generation (Figure 20): Assume a given demand for electricity and a given production of wind and solar PV, depending on the weather. The residual demand needs to be covered by conventional power plants and may vary from hour to hour.

When optimising the production for the next day, investments and fixed costs are not relevant for the decision of which existing asset to use. The relevant costs are “marginal”, mainly consisting of fuel and emission costs.

The cost-efficient way to meet residual demand is to use assets in the order of their marginal costs until the residual demand is met. The marginal cost of the most expensive power plant that is still needed sets the power price[11].

Price formation in power and gas spot markets is more complex in reality; for example, as transmission bottlenecks and technical constraints of power plants need to be taken into account. The basic principle, however, still holds.

Power markets will still work, even as the share of renewables with very low marginal costs increases. Figure 21 illustrates the merit order of a system with high penetration of renewables and small-scale storage.

In this example, renewables and storage can cover the load in many hours. Prices are low and electricity is available for extensive use, such as to charge electric vehicles and for power-to-gas or power-to-heat applications.

When load is high and renewable production is low, flexible demand will be reduced and conventional backup plants may kick in. In tight situations, demand needs to be reduced further, for example by reducing energy-intensive production. In those hours prices may be very high, reflecting the opportunity costs of reduced power usage in production.

Investment signals lead to an optimal fuel mix in the long run. Technologies that are able to produce in hours of limited supply and high prices are rewarded. This includes storage and demand flexibility in particular. Technologies that only produce when supply is high, in turn, may not be replaced. At the same time, demand is steered towards hours where supply is abundant and demand flexibility is rewarded.

Spot prices may be more volatile than today. Therefore, futures markets will be required to allow consumers to secure themselves against high prices and to allow producers to stabilise their income.

THE MERIT ORDER CONCEPT FOR UNDERSTANDING PRICE FORMATION IN POWER MARKETS

Figure 20: Price formation explained with the merit order concept. Power generation as an example

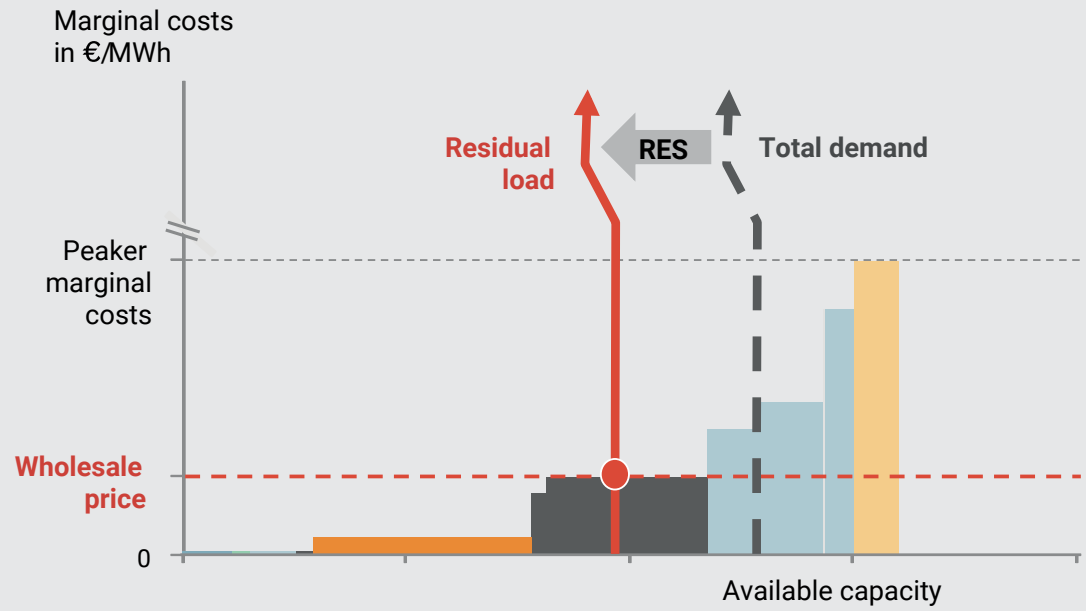
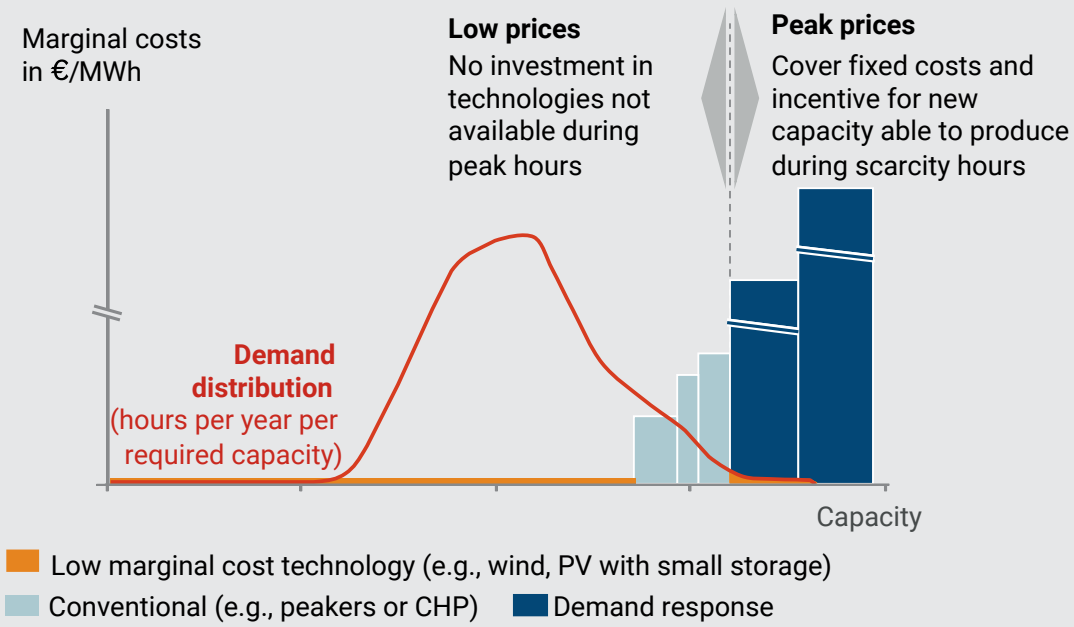


Figure 21: Price formation still works at high shares of renewables



NOTES:

[1] PV: photovoltaics.

[2] Refer to analyses and explanations in the ACER/CEER Annual Report on the Results of Monitoring the Internal Natural Gas Markets in 2015.

[3] Projection from the European Commission's reference scenario. The reference is used throughout our paper for illustration. Projections vary widely across sources, as the sector is developing quickly.

[4] Wind futures: Their purpose is mainly to allow asset owners to hedge against volume risks. The futures are based on the production of wind farms in relation to their installed capacity and effectively let asset owners sell their production in advance, independently of changing wind conditions.

[5] See company websites for more information: http://www.solarchange.co and http://brooklynmicrogrid.com.

[6] Please refer to "Eleven recommendations for improving the Guarantees of Origin system under REDII" for details (http://www.europex.org/position-papers/eleven-recommendations-for-improving-the-guarantees-of-origin-system-under-redii/).

[7] Calculated based on 2015 EU gas supply and storage capacity in ACER/CEER Annual Report on the Results of Monitoring the Internal Natural Gas Markets in 2015.

[8] Also refer to M. Hogan, Hitting the Mark on Missing Money: How to Ensure Reliability at Least Cost to Consumers.

[9] See G20 Pittsburgh Summit Leaders' Statement item 16: (http://ec.europa.eu/archives/commission_2010-2014/president/pdf/statement_20090826_en_2.pdf).

[10] A. Hanau, 1927.

[11] Illustration based on the "uniform pricing mechanism". "Pay-as-bid" would be another solution in which all bidders that are considered receive their bidding price. Both will give the same results if all bidders have the same information. Uniform pricing can be seen as a more efficient implementation in many use cases. See A.E. Kahn et al (2001): Uniform Pricing or Pay-as-Bid Pricing.

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