Market integration

Coupling of the European electricity markets
TenneT’s view of market integration in Europe

Over the past few years the electricity market in Europe has changed dramatically. Many new power stations and wind farms have been built and energy companies and project developers have plans to build many more. TenneT has a crucial part to play in these developments. We are Europe’s first cross-border Transmission System Operator (TSO) moving electricity across national frontiers. So, in this exciting and challenging new European electricity market – what’s next for TenneT?

Market integration
As an international transmission system operator TenneT will continue to work on the further integration of the European electricity market, to assure reliable and sustainable electricity supply at competitive prices, now and in the future. To create this strong European market we need more integration between the TSOs like TenneT and the power exchanges (PXs) where electricity is bought and sold. This greater co-operation – this market integration – will improve the movement of electricity across national borders and make the buying and selling of capacity on this electricity highway more efficient, more effective and ultimately, more cost effective.

Role of TenneT
Seven years ago TenneT launched its ‘Strengthen and Build’ strategy. This strategy established the foundations for our robust transmission grid as we recognise it today. Here at TenneT we’re keen to take this even further – to make TenneT the power hub in the middle of the European electricity market. For this purpose, the company is investing more than ever in expanding the high voltage grid and in building new cross-border interconnections. We are doing this not only to guarantee security of supply now and in the years ahead, but also to make it easier for renewable energy suppliers such as wind farms to become part of this European grid. One significant step in this direction was in January 2010 when TenneT bought the German extra high voltage grid of transpower. This made TenneT Europe’s first cross-border TSO, putting us at the heart of the drive towards a single European electricity market.

Power hub
Various activities have been undertaken to strengthen and expand connections between the TenneT grid and the grids of other countries. The NorNed cable linking the Netherlands and Norway went into service in 2008 and is proving a great success in bringing surplus electricity from Scandinavia into northern Europe.
A strong and efficient electricity grid will increase security of supply, create opportunities for renewable energy and assure competition.

New interconnections with Germany and with the United Kingdom (through the BritNed cables under the North Sea) are currently being built. A connection to Denmark, the COBRA cable, and two more to Norway (NorNex2 and Nord.Link) are under consideration. TenneT is making major investments in the Netherlands and Germany both onshore and offshore. And there are plans for further interconnections between other TSO grids in Germany. Thanks to all these initiatives by TenneT we are now fully integrated in the European electricity market. TenneT is currently connected to seven other European countries and has cross-border interconnections in all directions, making it a true ‘power hub’.

Uncertainties due to sector dynamics

No-one can see into the future. But at TenneT we are already trying to plan for certain changes in the ways we produce – and the ways we all use – electricity. Who will be making our electricity and how? Wind farms, bio-mass production possibly even wave and tidal power are all part of the future. Which requirements will our grid have to meet twenty years from now, when everybody may be using solar panels to generate their own power? And what about new products requiring more electricity such as electric cars? TenneT is looking at all of these developments to maintain the balance in electricity supply and demand.

Where will we stand in 2030?

Many things will determine the shape of the future energy landscape. As the energy market in Europe opens up, the companies that generate electricity can look far beyond national borders for a market in which to sell their power. Gone are the days when a power station in Germany only went to light homes in Dusseldorf. And Europe is very much looking beyond coal, gas and nuclear as ways of generating electricity. We have all witnessed the growth of large scale wind farms. Energy storage is another important factor on the road to a sustainable society. Some developments will reduce our reliance on electricity – energy efficient household appliances, better home insulation – but others may well increase demand, such as electric cars. As we’ve said, no-one can see into the future. But at TenneT we have been analysing all of these trends to create our Vision 2030 document, our look into the future.

Developing a truly European electricity market

TenneT’s Vision 2030 document highlights the increasing importance of investing in the grid and especially in association with the other German TSOs. TenneT has already integrated the transpower extra high voltage grid and we are also working on further international integration with other TSOs to facilitate the creation of the European electricity market. It is an essential step towards assuring security of supply and enhancing the way the electricity market functions. Cross-border cooperation makes it possible to share scarce capacity efficiently with other countries and to work together to overcome any supply crises. If we can import more, relatively inexpensive, electricity from other countries, this may create more stable prices and step up competition in the electricity market to the benefit of customers. TenneT has taken a major step forward in developing a truly European electricity market. It has put us in a position to continue developing an effectively functioning electricity market in Europe.

But what is the rationale for having a strong and efficient electricity grid? It lies in having a highly versatile independent grid that will further increase security of supply, create opportunities for generating renewable energy and assure sufficient competition in the energy market to bring about greater price stability. The investments and grid expansions scheduled for the coming years will, besides assuring our security of supply, create Europe’s power hub.
The integration of electricity markets began in the Netherlands in the 1940s. At that time power stations and the electricity networks were owned by local municipal and provincial authorities. The cooperating electricity producers (united in an organisation called Sep) coordinated transmission and planned and built power plants. Several interconnections were created with Belgium and Germany to guarantee security of supply. The Electricity Act that came into force in 1998 liberalised the energy market. TenneT became grid operator for the Dutch high voltage lines - 220kV and 380kV. Although cables and interconnectors linked countries, the transmission capacity was not being used at its most efficient and the ability to sell electricity from one country to another didn’t really work either because electricity and capacity were traded separately. Something needed to be done.

The future of the integration of electricity markets

To make this new market – where power and the ability to move it across national borders were traded together – TenneT started the coupling of the electricity markets in 2006. At first this was in collaboration with the French and Belgian TSOs and PXs. Besides of that the coupling between Germany and Denmark was successfully launched in 2009. Germany, Luxembourg, a part of the Baltic countries and the Scandinavian countries (which had already coupled their markets starting in 1996 with a Norwegian and Swedish power exchange) followed in 2010. The United Kingdom will follow soon when the BritNed interconnector becomes operational.

With major investment in interconnections and the acquisition of transpower, TenneT transformed from a TSO on the periphery of Europe to a power hub with connections in all directions, both onshore and offshore.
Market coupling

Electricity transmission grids resemble motorways and railway lines crossing borders into other countries. TenneT has been working closely with other TSOs and PXs for several years on coupling Northwest Europe’s electricity markets to meet the growing demand for energy. The goal of interconnecting national markets is to establish one European market in place of the individual markets that currently exist. The objective is to establish a single European market that assures electricity consumers a reliable supply of electricity at competitive prices.

The reason for market coupling

The overall aim of market coupling is to maximise the total surplus of all participants and increase social welfare. Think of it this way: cheaper generation in one country can be matched with more valuable demand in another country. But market coupling is limited by the available cross-border capacity. When there is no congestion on the borders between coupled markets then you will have full price convergence in the region. When the demand is larger than the available interconnection capacity you get what we call congestion. Then there will be a price difference between the electricity exchanges. Market coupling optimises the use of the available transmission capacity and therefore enhances congestion management across interconnection borders by trading of the electricity and the transmission capacity as a single operation.

Market coupling has major benefits for all energy consumers in the coupled region: harmonised electricity prices in the coupled region, more efficient use of existing cross-border electricity interconnections; greater security of supply.

Power Exchange Europe

In October 2010 Elia and TenneT brought their respective stakes in the Belgian power exchange Belpex (60% for Elia and 10% for TenneT) into APX-ENDEX, which already operated the electricity spot market in the Netherlands and in the United Kingdom. APX-ENDEX ownership is now divided as follows: TenneT as a key shareholder (56%), Elia (20%), Fluxys (9%), Gasunie (11%). This operation is in line with TenneT’s European strategy and ties in with APX-ENDEX’s ambition to further improve the European electricity market.

Implicit capacity auction

Implicit capacity auctions take place not years or months in advance, but one day ahead. When these auctions take place we already know several things: how much spare transmission capacity there is and who owns it. We also know the day ahead what electricity has been bought in all the various markets. In other words we have a pretty clear idea about what amount of electricity needs to be transmitted from one part of Europe to another. And armed with all that knowledge deals can be done to include this transmission capacity directly (implicitly) into the electricity capacity trades for the next day. As a result, market participants only need to buy/sell the energy, instead of buying transmission capacity from the TSOs in addition to the buy/sell transaction of the energy. In implicit auctions the transmission capacity between bidding areas (price areas/control areas) is made available to the spot price mechanism in addition to bids/offers per price area, thus the resulting prices per area reflect both the cost of congestion in each internal bidding area (price area) and the cost of congestion. Implicit auctions ensure that electricity flows from the surplus areas (low price areas) towards the deficit areas (high price areas) thus also leading to price convergence.

There are different ways of coupling markets:

‘Loose volume coupling’ calculates the volume traded between two countries or regions. The prices are then calculated separately.

‘Tight volume coupling’ determines the volume traded between countries or regions before the individual PXs calculate their prices. ‘Tight’ means that the trading volume is calculated using all relevant information, i.e. the amount of cross-border capacity and the order books of all PXs and TSOs in the coupled region. An example is the Triborder Market Coupling (TMC) system that linked the Dutch, Belgian and French markets since 2006.

‘Flow-based coupling’ Flow-based coupling can be used with all three types of market coupling mentioned above. It refers to a specific type of transmission capacity determination by the TSOs. The total capacity is provided by the TSOs to the PXs via a more detailed grid model (flow-based model). This is an innovation compared with the less detailed method of making capacity available in the price coupling system based on available transfer capacities (ATCs). With flow-based coupling, transmission capacity can be made available to the market in a more reliable way. The transmission capacity can be used most efficiently and it also provides insight on the congestion.

Auctions and market coupling

Explicit capacity auction

An explicit auction is when the transmission capacity on an interconnector is auctioned to the market separately and independently from the market places where electricity is auctioned. Explicit auction is a way of handling the capacity on the international interconnections in Europe. This capacity is normally auctioned on three timescales through annual, monthly and daily auctions. Since the two commodities - transmission capacity and electricity - are traded at two separate auctions, this can result in an inefficient utilisation of interconnections. It can also mean less price-convergence. Buying capacity in the long term can have its drawbacks – you might end up with capacity that you can’t use. The drawback of explicit auction is compensated by a liquid and well functioning secondary market, where transmission capacity holders can trade their capacity amongst each other, or they can resell the capacity to the TSOs at a market price. In the short term however, there is no secondary market to mitigate the drawback of the explicit auctions. That’s why TenneT, together with other TSOs and PXs are designing and implementing the implicit allocation of cross-border capacity.
2006: Price coupling between the Netherlands, Belgium and France
An important step in Northwest Europe came in 2006 with the establishment of an implicit market coupling system between the Netherlands, Belgium and France (Tripartite Market Coupling, TMC). This innovative market mechanism linked the APX, Belpex and Powernext power exchanges and the national grid operators Elia (Belgium), RTE (France) and TenneT (the Netherlands). The price coupling system has stabilised prices in this region and has led to a better use of capacity.

2008: Joint year and monthly auctioning in CWE countries
At the end of 2008 the TSOs of the Central Western European (CWE) region jointly started a single auction platform for the region. CAS-CWE S.A. (Capacity Allocation Service Company - Central West Europe) was appointed as the joint auction office to operate activities for the explicit long-term auctions (by year and month).

2008/2009: Volume coupling between Germany and Denmark
In 2008 the European Market Coupling Company GmbH (EMCC) was founded in Hamburg. EMCC has been appointed to operate this market coupling. On 9 November 2008 the market coupling of the Nordic and the German spot market was launched. Thanks to the market coupling the average price difference between German spot prices and Danish spot prices decreased significantly.

2008-2010 Joint auctioning in CEE countries
In 2008 the Central Allocation Office GmbH (CAO) was established to develop and implement coordinated congestion management solutions in the Central Eastern Europe (CEE) region.

2010: Central Western European/Nordic market coupling
The next significant step was taken towards the end of 2010 by coupling the Central Western European (CWE) markets. At the same time the CWE region was coupled to the Scandinavian region (Nordic). Price coupling in the CWE region and tight volume coupling between the CWE and the Nordic region started in November 2010. Coupling the CWE and Nordic markets was an operation that included harmonising the closing times of the day-ahead markets of the PXs involved. The NorNed cable between the Netherlands and Norway was added to the CWE/Nordic region. A next step in market coupling is to create flow-based coupling, in addition to the price coupling of PXs.

2012: Further integration with day-ahead and intraday price coupling
In 2011 a partial coupling with the United Kingdom will be added, with the commissioning of the BritNed interconnector. Complete day-ahead price coupling for the CWE, Nordic and UK countries is planned for the end of 2012. Besides an integrated day-ahead market the intraday markets in CWE, Nordic and UK will also be integrated. After that, integration of balancing and ancillary services will follow. These are specialised services procured by the TSOs to manage system balance and grid security.

2020: One European integrated electricity market
This is the TenneT vision – a truly integrated European electricity market.

Steps towards coupled markets
The coupling of European markets is an intricate process that must be accomplished step by step. All the individual steps are important towards achieving the ultimate goal: a single European market.

Here’s a short summary:
1993: Coupling in Scandinavia
Since 1993 the Scandinavian market has an implicit auction.

1999: The first independent power exchange
APX Power NL started as the first independent internet-based power exchange in Continental Europe, operating a day-ahead auction.

2000: Start TSO auctioning
In spring 2000 TenneT and three of our fellow TSOs - Elia (Belgium) and E.ON Netz and FWE Netz (Germany) – decided to begin joint auctioning of cross-border electricity transfer capacity. TSO Auction is a wholly owned subsidiary of TenneT and now operates under the name of TSO Auction B.V.

Sustainable energy
Sustainable energy is growing in importance. Various initiatives are being undertaken, including solar, offshore and on-shore wind energy. Local electricity generation by households, for instance, is also increasing. With this kind of electricity generation, the supply is less predictable than before. In addition, the production of electricity (in the form of offshore wind energy, for example) will often take place at a greater distance from where it is needed and used. These developments call for new grid investments. There is also a need for new interconnections, especially with other countries bordering the North Sea. The additional interconnections that will be built will contribute to the establishment of an integrated European electricity market.
04
An insight into market coupling

Market coupling is more than just an agreement between PXs and the TSOs. Over 50 parties are involved in establishing market coupling. They include national regulators, European authorities, national governments, energy companies and producers.

05
Technique

When electricity markets are coupled the electricity bids are simultaneously matched with the available capacities determined by TSOs. This way of allocating capacities is called an implicit auction.

Before coupling existed the trading of capacity was always handled by TSOs and the electricity was traded by the PXs. These are exchanges that trade energy within a certain separate market.

The separate trading of capacity is called an explicit auction. But as the price of energy can differ from market to market there was a need to be able to trade across these separate markets. The TSOs and the PXs began coupling these separate markets to build an integrated market and use capacities more efficiently.

It’s a fact: a single European electricity market is becoming a reality. But how exactly does market coupling work from a technical point of view?
Steps in coupled electricity markets include:

1. Participating TSOs send information about available local capacities in their grid (local grid forecasts) to the joint TSO system. The local grid forecasts are based on expectations of congestion (i.e., where a shortage of transmission capacity can occur), the available connections and so on.

2. The common TSO system combines the received local grid forecasts and merges them into a joint model that shows the transmission capacities expected to be available to the market in the coupled region. There are a number of checks during this process to make an accurate grid forecast.

3. Before the opening of the day-ahead market the joint TSO system publishes the remaining transmission capacities available in the coupled region.

4. Based on the available transmission capacities and other factors relevant to the trade in electricity (such as weather forecasts and expected prices), the market parties determine their bids and offers on the local PX. The bids and offers consist of combinations of prices (in €) and volumes (in MWh). APX-ENDEX operates among others in the Netherlands whereas EPEX Spot operates in the German market. The individual PXs send their individual order books to the central market coupling system managed by the participating PX.

5. The central market coupling system uses the available transmission capacities obtained from the joint TSOs and the orders obtained from the PXs to calculate the prices and ‘net positions’ for the local markets. A local market’s net position corresponds with the net result of all matched local market orders. This may be a positive position if more supply than demand orders are matched in the local market at the calculated price. The local market will then export its surplus. But there may also be a negative position if matched local demand orders exceed matched local supply orders at the calculated price. The local market will then import the shortfall. The calculated prices and net positions represent the optimum prices and optimum distribution of electricity in the market coupling region. Maximum price harmonisation is achieved within the defined criteria, as electricity always flows in a direction that increases economic benefits.

6. After the market coupling system has calculated the prices and net positions, there are still some final steps:
   a. The common TSO system will translate the net positions of the PXs into actual electricity flows between the local markets;
   b. a clearing house makes sure that the required local market nominations are carried out correctly at the participating TSOs. This clearing house also collects congestion revenues;
   c. the PXs use the prices and net positions calculated by the market coupling system to determine the market results for local market parties. This involves determining the accepted and rejected supply and demand orders and volumes appropriate to each individual market player.
Facts & figures on market coupling

Economic assessment of the Central Western European and Nordic market coupling:
- 9 countries involved
- 12 TSO’s
- 3 PEx’s
- CWE-Nordic Market Coupling was successfully introduced. The first results show electricity prices on the day-ahead market were equal for over 86% of the time.
- Full price convergence between the CWE countries is expected during more than 50% of the time.
- Increase of social welfare estimated at EUR 42 million annually in the CWE region.
- Reduced price volatility.

Trilateral Market Coupling has produced positive results in the Netherlands, France and Belgium:
- Electricity prices on the day-ahead market were equal for over 70% of the time.
- The use of the interconnection capacity increased significantly.
- The daily allocated cross-border capacity at the Dutch - Belgian border increased from 347.4 MW to 544.1 MW and Belgian - French interconnection capacity showed a similar increase.
- Dutch import and export flows have both increased.

Investments
TenneT will invest billions in expanding and improving the high voltage grid in the Netherlands and Germany. We will also expand our grid with new connections for the large number of planned new production facilities, including all renewable initiatives such as offshore wind farms. In the next 5 to 7 years we will make major investments in both the Netherlands and Germany. And TenneT is investing more than ever in expanding the high voltage grid and in new cross-border interconnections, to make a major contribution to creating a single European electricity market and to facilitate the transition to sustainability through renewable energy supply.

Size:

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<tr>
<th>Size</th>
<th>Nordic Countries</th>
<th>CWE Countries</th>
<th>UK</th>
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<tr>
<td>Inhabitants</td>
<td>24.9 million</td>
<td>172.0 million</td>
<td>61.8 million</td>
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<td>Consumption</td>
<td>376 TWh</td>
<td>1,217 TWh</td>
<td>323 TWh</td>
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<tr>
<td>Production</td>
<td>370 TWh</td>
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<td>Installed capacity</td>
<td>97,500 MW</td>
<td>305,400 MW</td>
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1 Key figures ENTSO-C 2009 - Statistical Yearbook.
Explain the coupling of electricity markets isn’t always simple and sometimes relies on some complex words and phrases. They are explained below.

- ATC
  Available Transfer Capacity. This is defined daily by the TSOs prior to the matching of market coupling. An ATC is defined for each hour and each direction for each interconnection involved in the market coupling.

- Ancillary services
  Specialised services procured by the TSOs to manage system balance and grid security.

- CASC-CWE
  CASC-CWE (Capacity Allocation Service Company – Central West Europe) is a Joint Auction Office that runs activities associated with long-term explicit auctions.

- CWE market coupling
  This is the market coupling between France, Germany, Belgium, Luxembourg and the Netherlands (Central Western Europe).

- Congestion management
  Congestion management is a method of distributing scarce transmission capacity among parties requesting use of such capacity (a ban on the connection of new capacity is also a form of congestion management).

- Day-ahead pricing
  Market prices as result of day-ahead auctioning at the power exchange. Day-ahead prices (D-1) consist of 24 values of electricity prices, one price per individual hour on delivery date tomorrow (D=0). Day-ahead prices are determined once per day on D-1 within a defined, fixed time window for the day-ahead price auction process at the power exchange.

- CWE/Nordic market coupling
  This is the coupling between the CWE region, Scandinavia (Denmark, Finland, Norway and Sweden) and the Baltic counties (Estonia, Latvia and Lithuania).

- Explicit auction
  Traders buy capacity between areas and decide its daily use. The auctioning of power and capacity occur independently of each other. Traders buy capacity between areas and decide how it will be used each day. Separately from this they also buy electricity.

- Implicit auction
  The auctions of power and capacity are coordinated in a single activity.

- Intraday pricing
  Unlike in an auction, intra-day orders may be executed as soon as they are placed in the order book (continuous trading). The time window for intra-day pricing starts after finalisation of the day-ahead auction and ends a certain (short) period before actual delivery of the commodity (hour X on D=0).

- Market coupling
  Market coupling optimises the use of the available transmission capacity and therefore enhances congestion management across interconnection borders: trading of the commodity (electricity) and acquisition of the transmission capacity are coordinated and merged as a single operation.

- TLC (Trilateral Market Coupling)
  This was the first implicit market coupling system established between the Netherlands, Belgium and France, launched on 21 November 2006. This mechanism has worked successfully till the introduction of the CWE-Nordic coupling, in which TLC was incorporated.
TenneT is Europe’s first cross-border grid operator for electricity. With approximately 20,000 kilometres of (extra) high voltage lines and 35 million end users in the Netherlands and Germany we rank among the top five grid operators in Europe. Our focus is to develop a Northwest European energy market and to integrate renewable energy.

Taking power further