Thermal Power Plants – a vital asset in a new energy world

A EURELECTRIC paper

March 2015

EURELECTRIC is the voice of the electricity industry in Europe.

We speak for more than 3,500 companies in power generation, distribution, and supply.

We Stand For:

***Carbon-neutral electricity** by 2050*

We have committed to making Europe's electricity cleaner. To deliver, we need to make use of **all low-carbon technologies**: more renewables, but also clean coal and gas, and nuclear. Efficient electric technologies in **transport and buildings**, combined with the development of smart grids and a major push in **energy efficiency** play a key role in reducing fossil fuel consumption and making our electricity more sustainable.

***Competitive** electricity for our customers*

We support well-functioning, distortion-free **energy and carbon markets as** the best way to produce electricity and reduce emissions cost-efficiently. Integrated EU-wide electricity and gas markets are also crucial to offer our customers the **full benefits of liberalisation**: they ensure the best use of generation resources, improve **security of supply**, allow full EU-wide competition, and increase **customer choice**.

***Continent-wide** electricity through a coherent European approach*

Europe's energy and climate challenges can only be solved by **European – or even global – policies,** not incoherent national measures. Such policies should complement, not contradict each other: coherent and integrated approaches reduce costs. This will encourage **effective investment to** ensure a sustainable and reliable electricity supply for Europe's businesses and consumers.

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Dépôt légal: D/2015/12.105/4

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KEY MESSAGES

Thermal generation keeps the lights on as electricity becomes increasingly CO_2 free

The role of conventional thermal power generation technologies is changing as the share of variable renewable generation from wind or sun continues to grow. Thermal generation can readily be turned on or off and can flexibly adjust power output to demand. It is therefore now increasingly **guaranteeing security of supply** by providing **flexible back-up capacity** to generate electricity when the sun does not shine and wind does not blow. Thermal generation is also needed to **maintain system stability.**

Modern, more efficient thermal plants help to reduce emissions across Europe

Technological advancements have resulted in **more efficient thermal units**, which can substantially reduce emissions of CO_2 and atmospheric pollutants. So does the development of **combined heat and power (CHP)** in areas with sufficient demand for industrial steam or district heating and cooling. **Biomass or biogas fired thermal plants** can bring more renewable electricity to power systems. Moreover, with carbon capture and storage (CCS), thermal generation can become increasingly CO_2 emission free. Thermal plants can also be **upgraded to flexibly adapt to the structural changes the power system is witnessing today.**

Policies must allow thermal generation to deliver in its new role

Properly functioning interconnected electricity markets and fair access to competitive fuel sources are crucial for thermal generation to support the EU's energy policy objectives of competitiveness, sustainability, and security of supply. To allow electricity markets to operate effectively, the **EU Emissions Trading System,** not subsidies, **should be the main driver for emission reductions**. In addition, the electricity market should **value energy, capacity and flexibility**, reflecting the changing circumstances of the electricity market.

Europe should foster RD&D activities to push forward improvement and **innovation in flexible thermal generation** and **facilitate large-scale demonstration and early deployment of carbon capture and storage**. **Environmental regulation should be coherent with other policy goals** and should take the changing role of thermal generation into account.

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Summary and recommendations

1. The future role for thermal generation

The European power sector is undergoing radical change. The decades-old architecture of large generators located in relatively few locations and mainly run on fossil fuels, nuclear and hydro is being transformed as renewable power generation (RES), distributed generation and demand response come to play an increasing role. Electricity customers are becoming prosumers, and the emerging value pools further down the electricity value chain – that is, closer to the end customer – are becoming increasingly central to the business.[1] In the meantime, reduced demand due to the economic crisis, together with a rapid increase in supported RES with low variable cost, has seriously affected the business case for power generation. Wholesale prices have fallen and running hours of thermal generation have decreased.

What is the role of thermal generation in this picture?

Thermal generation is necessary to complement variable renewable power generation and ensure security of supply. In most European countries, wind and solar are the main drivers for the increasing share of RES in electricity generation. In windy and sunny hours, a major share of electricity will be produced from such renewable energy sources. However, the total need for dispatchable generating plants (thermal generation, hydropower and nuclear power) that can adjust their power output on demand is not expected to decrease significantly in the near future. While smart grids, demand response and storage are expected to play a growing role in ensuring a balance between electricity demand and supply, these sources cannot completely replace thermal generation as a provider of firm capacity. For economic and technical reasons, thermal generation will remain a key asset.

At the same time, the volatility of the demand **that has to be met by capacity other than solar or wind power** will increase and thermal generation will need to adapt to this. The relevant new capabilities include faster start-ups and shut-downs, lower minimum generation, higher ramping rates, and more frequent changes in generation.

Thermal generation is also needed to maintain system stability, a key element of security of power supply**.** The stability of the transmission system is at risk particularly in times of sudden and unexpected generation loss or network fault. In these situations thermal generation is crucial: thermal plants provide vital system services (inertial response, fast frequency power recovery) that help stabilise the power network.

The projected increase of renewable energies and distributed generation will vary considerably in the different EU member states, since starting points, potential for deployment of RES or other low carbon technologies such as nuclear power, as well as the very configuration of the power systems reflect national characteristics. Furthermore, some member states have considerable potential for reducing emissions by using bioenergy in thermal generation and deploying CHP technologies. In short, some member states will rely upon thermal generation more heavily than others, and thus thermal generation will also continue to provide part of the base load capacity in Europe well into the future. Thermal generation also has a specific role to play on islands where the small size of the system and

[1] EURELECTRIC, *Utilities: Powerhouses of Innovation*, May 2013, http://www.eurelectric.org/innovation/

increasing share of variable RES sets very high demands on flexibility of power generation capacity.

2. Adapting to the "new rules of the game": Environmentally sound, flexible thermal generation

It is obvious that thermal power generation has entered a period of fundamental change in which a "do nothing strategy" could be damaging for the sector and indeed for the power system as a whole. Thermal generators must adjust to the "new rules of the game" by **improving their environmental performance, efficiency, flexibility and competitiveness and by providing new services**.

There are a variety of opportunities for thermal generation to make the most of its potential as a key pillar of the future energy system. Technological advancements have resulted in **more efficient thermal units,** which can substantially reduce emissions of CO_2 and atmospheric pollutants, as does the development of **combined heat and power (CHP)**[2] in areas with sufficient demand for industrial steam or district heating and cooling. **Biomass or biogas fired thermal plants** can bring more renewable electricity to power systems. Moreover, with **carbon capture and storage (CCS)** thermal generation can become increasingly CO_2 emission free. CCS is a proven technology, but the whole CCS chain from capture to storage needs to be demonstrated in Europe on an industrial scale to validate it technically and financially and facilitate early deployment.

EURELECTRIC sees the following mission and vision for thermal generation in the evolving power systems:

Mission of Thermal Generation

Competitive, reliable, flexible, diverse and environmentally friendly electricity production, based on best available technologies, highest industry standards, and valuable experience.

Vision for Thermal Generation

Thermal generation retains its competitiveness in the challenging market and political environment by transforming and adapting to the new rules of the game, shifting away from base load generation towards flexible/back-up generation and system service provision.

[2] EURELECTRIC, *CHP as a part of the energy transition* October 2013

As a consequence of its changing role, the critical performance requirements of conventional power generation are shifting. Previously, thermal plant requirements were focused on high conversion efficiencies to minimise marginal operating costs. The new role requires above all high flexibility and reliability, as well as low CAPEX to minimise fixed costs. Thermal power plants must be capable of operating in cycling modes with a large number of start-ups and shut-downs and frequent load changes. However, such operating modes are associated with additional costs and may damage equipment. The availability and reliability of conventional power plants need to be enhanced to make them suitable for such new operating modes. In addition, highly flexible thermal technologies are needed.

The existing thermal capacity requires special attention to ensure that it can contribute to decarbonisation and security of supply under rather challenging operating conditions that differ from the original design criteria.

A variety of opportunities exist for improving the operational performance of thermal generation:

- converting Combined Cycle Gas Turbines (CCGT) and gas turbines to operate as **flexible and back up capacity**;
- **providing ancillary services** such as frequency and voltage control support, black start, increased load ramps, etc.;
- sharing reserves, optimising thermal plants;
- optimising planning and maintenance to **improve availability and reliability,** making thermal plants fit for new operational patterns;
- installing **equipment for emission (NO_x,SO_2 and dust) reduction** to satisfy new and more stringent requirements in those power plants that could require flue gas treatment;
- boosting the **flexibility of CHP plants** by retrofitting heat storage and power-to-heat installations.

At the same time it is important to note that thermal generation, especially gas fired plant, is facing severe economic difficulties in many European countries. Thermal plants today face lower running hours than expected, combined with increasing costs due to new environmental regulation, new EU network codes as well as new, more demanding operating patterns that raise technical challenges and increase emissions per unit of electricity produced. Rebuilding a business case in this context will not be easy.

Globally, fossil and biomass generation, together with nuclear power and hydropower, will continue to play an important role. In China, India, USA, Russia and Australia these technologies will remain the dominant sources of electricity even as the role of solar and wind power continues to increase.

3. Regulatory framework: Enabling the New Role for Thermal Generation?

In addition to the power sector's ability to evolve and innovate, energy policies and regulation will largely determine the extent to which thermal generation will be able to play its role in this new environment.

The policy framework for decarbonising power generation will have major consequences for the power market and the operation of the power system. In this respect, a swift

strengthening of the EU Emissions Trading System (ETS) [3] combined with the gradual phase out of energy subsidies is crucial. The EU ETS is European wide and technology neutral, and thus the suitable instrument for driving emission reductions across technologies. Within thermal generation, responses to a strong carbon price signal include modernisation to improve energy efficiency and the deployment of CHP technology. A strong carbon price signal is also needed to improve the investment climate for nuclear power and provide a stronger long-term signal for the development of CCS. At current emission allowance price levels, the influence of the EU ETS as a driver for decarbonisation is very limited. Change is urgently needed.

EURELECTRIC's recent work[4] outlines solutions that reconcile the transition in the power sector with increasing shares of variable RES, while ensuring security of supply. Given the pace of change and increasing market uncertainty, current power markets are not likely to successfully take up the challenges posed by growing shares of variable generation without any specific adaptations. For this reason, the development of the EU internal electricity market should be accelerated and the market model adapted to ensure that it values energy, flexibility and capacity. Proper electricity market design is a key enabler for a cost-effective power sector transition and security of supply.

Pricing of flexibility should be done through improved day-ahead, intraday, balancing and ancillary services markets. All different sources of flexibility such as generation, storage, demand response and cross-border participation should be used to deliver flexibility in the most cost-efficient way. The choice of the best compatible technology should be left to the market, and thermal generation should compete on a level playing field with other providers of flexibility.

Energy-only-markets remain the reference for the completion of the internal energy market. However, in many markets the introduction of a capacity element has become increasingly important. EURELECTRIC recognises that properly designed technology neutral capacity markets, whether centralised or decentralised, will probably be an integral part of a future market design. Market participants who optimise their performance across these competitive markets will be the most successful while delivering the most cost-efficient market outcome. The lifetime of power generation capacity is generally several decades, and investments ensuring long-term system adequacy would benefit from long term and stable investment signals.

In addition to the development of the power market, investments in network infrastructure will be necessary. Grid extension is needed to integrate renewable electricity, increase competition, optimise system dimensioning, and connect different balancing areas. This will facilitate the sharing of flexibility resources provided by thermal generation and other technologies.

Stricter requirements on thermal generation to ensure security of supply and system stability are likely to be a necessity in the future power systems with an increasing share of variable generation. The European network codes currently being developed take this as a starting

[3] For the full position of EURELECTRIC and its members on the EU ETS, please see *EURELECTRIC's Manifesto*

[4] EURELECTRIC 2014 *Renewable energy and security of supply: Finding market solutions*

point. Thermal generation is expected to operate reliably in both normal and abnormal situations, support secure system operation (load-frequency control, voltage control, etc.) and provide black start capacity in case of electricity system blackouts.

To reduce costs for end consumers, the Network Code on Requirements for Generators, network codes on system operation and the Network Code on Emergency and Restoration should ensure that the most cost-efficient solutions are applied. The network codes should take into account that in some cases grids can provide services to ensure system stability with lower costs than power generation. EURELECTRIC remains concerned especially regarding the Network Code on Requirements for Generators: the draft code includes requirements (e.g. on frequency and voltage) that can lead to significant costs or negatively affect security of supply – either directly or indirectly if operators find the required investments too costly. To avoid this, the generators network code should apply to new capacity only. The network codes should ensure that provision of ancillary services is based on a commercial agreement between the plant owner and the system operator. The procurement of ancillary services must be transparent and non-discriminatory. After the codes are published, stakeholders including generators should be closely involved in their implementation.

Combustion plants have significantly reduced their emissions of NO_x, SO_2 and particulates over the past 25 years. Further emissions reductions can be expected from the implementation of the Industrial Emissions Directive, the proposed Medium Combustion Plant Directive and the mandatory cyclic emissions improvement process based on Best Available Technique (BAT). At the same time, emissions will be influenced by the changing operational regimes of thermal plants, and this needs to be taken into consideration when deciding on BAT in the context of reference documents used as the basis for legally binding emission levels. Environmental regulation supports power generators in improving their environmental performance, but it is also a cost factor and should be aligned with other policy goals such as security of supply and competitiveness.

There are also trade-offs between different aspects of environmental performance. Moreover, the integration of energy and environmental policies, in particular the water policies and low-carbon agenda, should be improved. Like many other technical choices in power plants, the choice of cooling system for power generation has other environmental and wider socio-economic consequences, for instance regarding thermal efficiency, greenhouse gas emissions and air quality. This is not sufficiently recognised in the EU's water policy and might result in unwarranted restrictions on existing or future water-cooled plant, based on water considerations alone. These could in turn be detrimental to security of supply and to progress in improving thermal conversion efficiency and the deployment of crucial low carbon technologies, including nuclear power and CCS.

4. Recommended policy measures

EURELECTRIC calls for an energy, climate and environment policy that takes a holistic approach to the energy transition and allows thermal generation to play a vital role in this process. Thermal generation is needed to ensure a secure, cost-effective supply of electricity to Europe's energy customers. We recommend the following legislative and policy measures:

1. **Ensure that the transition to a low carbon power system does not compromise the functioning of the market. Properly functioning electricity markets support the achievement of the EU's energy policy objectives of competitiveness, sustainability, and security of supply.**

- Ensure in the implementation of the Energy and Climate Package endorsed by the European Council on 24 October 2014 that the EU ETS is the main driver for decarbonisation and that other policy initiatives support this goal. EU targets on renewables and energy efficiency should be primarily conceived as instruments to achieve the overarching emissions reduction target. Defining appropriate governance for the 2030 climate and energy framework will be key.
- Strengthen the EU ETS by increasing the annual linear reduction factor in line with the European Council's decision and implementing a market stability reserve[5].
- Ensure that RES support schemes maximise market orientation and integrate renewable generation into the market and grid. This means that all generators should be responsible for selling in the market, nominating and scheduling and costs of imbalances. In addition, all generators should be subject to the same rules regarding grid connection and usage as well as dispatch and grid access.
- Progressively phase out all energy sector subsidies to ensure that all technologies can compete on a level playing field and that decarbonisation is accomplished as cost-effectively as possible.
- Reach a global climate agreement and in the long run link up global carbon markets under the right conditions to maintain a level playing field and avoid carbon leakage.

2. **Move towards an internal electricity market that properly values energy, capacity and flexibility**

- Fully implement a European energy market through integrated forward, intraday, day-ahead and balancing and ancillary services markets that ensure incentives for flexibility. The design of the current balancing and intraday markets must be improved, introducing for instance a possibility to trade balancing forward and more sophisticated products and timeframes that better fit the flexibility requirements (ramp up and down rates etc.).
- Energy only markets by themselves are not likely to deliver the necessary level of firm capacity. EURELECTRIC recognises that properly designed capacity markets are an integral part of a future market design. Capacity markets should be technology neutral and a regional approach to the implementation of market-based capacity market models should be followed. Cross-border participation in capacity markets is a crucial stepping stone to the establishment of a European approach to system adequacy. Moreover, ensuring the availability of longer term signals would improve

[5] For EURELECTRIC and its member's full position on the Market Stability Reserve, please see *Proposed Decision of the European Parliament and of the Council concerning the establishment and operation of an EU ETS Market Stability Reserve (MSR), A EURELECTRIC position, July 2014.*

investors' confidence in order to successfully implement the transition to decarbonisation.

- The network codes are critical to enhance cross-border trade and foster EU-wide competition in the energy sector. They must be based on cost-efficient solutions, and the assessment of costs and benefits should take into account both generator capabilities and solutions in the grid. Provision of ancillary services should be based on a commercial agreement between the owner of the plant and the system operator.

3. Promote the development of diverse technologies and energy sources to reduce emissions and ensure security of supply

- Foster research, demonstration and development (RD&D) activities to push forward innovation in flexible thermal generation.
- Facilitate demonstration and early deployment of CCS, which is proven but needs to be scaled up to large integrated projects. Aid that enables projects while minimising energy market price risk with volume control should be selected. Both the member states and the EU have a role in incentivising CCS.
- The EU needs a CCS Roadmap to ensure long-term planning and progress in CCS at member state, regional and EU level. If CCS is to play a role in the coming decades, the process to enable the investments must begin today. Maintain the current directive on the geological storage of CO_2: changes before 2020 would be premature given the lack of operating experience with CCS and would lead to uncertainty for project developers.

4. Achieve environmental objectives in a cost-effective way

- The power sector has already achieved major reductions in emissions of SO_2, NO_x and other pollutants. Further regulation should take into account the relatively high cost of further improvements and the fact that future investment will have to be amortised over a relatively small number of operating hours. Policy instruments must be coordinated and a predictable regulatory environment ensured.
- The Best Available Technique Reference documents (BREF) that are the main reference documents to be used by national authorities when issuing operating permits for industrial installations should take the changing operational characteristics of thermal plants into consideration. This applies especially to the Large Combustion Plant BREF that is currently under review.
- Energy and environmental policies should be better integrated, not least in the area of water policy and the EU's low-carbon agenda.
- The benefits of electricity in heating, cooling and transport should be fully considered in the EU's air quality legislation.

5. Ensure well-functioning and interconnected gas markets to increase security of supply and competitively priced fuel

- Promote competitive and flexible gas markets allowing gas fired generation to act more flexibly and help ensure the smooth integration of RES into the electricity system.
- Promote diversification of gas supply routes

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