Solutions from the European Power Plant Suppliers' Perspective

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Abstract

The EU has committed itself to ambitious long-term climate goals, which include increasing integration of renewable energy sources (RES) in the system. This will be a significant challenge for security of supply and grid stability, and thermal power plants will be needed to provide flexible back-up, involving inter alia fewer running hours (and at part-load) and operation beyond their design limits. The most efficient power plants in existence were optimised for maximum efficiency at full load and do not reach their full potential in their new backup role. Meeting increasing future demands for flexibility will also require the continued development of new technologies.

Today's back-up and balancing needs can largely be met by existing state-of-the-art flexible and efficient technologies. However, the support schemes that promote the integration of intermittent RES also impact the energy-only market so that deployment of existing state-of-the-art flexible technologies is not appropriately remunerated, leading to the 'missing money' problem. In many aspects, energy policy is resulting in unintended consequences which undermine its initial objectives of sustainability, competitiveness, and security of supply. As all these issues are arising at a time when the EU's generation fleet is aging and new plants are not fully exploited, the lack of investment also risks the loss of technological leadership and engineering skills.

To overcome all these issues, many EU Member States are implementing or considering new market mechanisms to provide a revenue stream which will support decisions for new investments that meet the needs of the evolving energy system, today and tomorrow. However, to achieve this, new market mechanisms must be designed and implemented carefully in order to ensure that they incentivise the correct technologies. In EPPSA's view, a new market mechanism must be designed to incentivise new flexible and part-load efficient power plants with added value for grid stabilisation, and supporting diversification of Europe's energy generation mix, thus ensuring an affordable, clean, and secured electricity supply.

1. Introduction

1.1 EPPSA Statement

The European Power Plant Suppliers Association (EPPSA) is the voice, at European level, of companies supplying power plants, components and services. EPPSA members, located throughout Europe, represent a leading sector of technology with more than 100,000 employees and annual revenue of over 30 billion euro.

Virtually all existing Power Plants in the EU have either components from or were built by EPPSA Members.

1.2 Elements of Grid Stability

EPPSA believes that any accurate view of the requirements for grid stability has to take note of all essential elements of grid stability, which are highlighted in Figure 1 below:

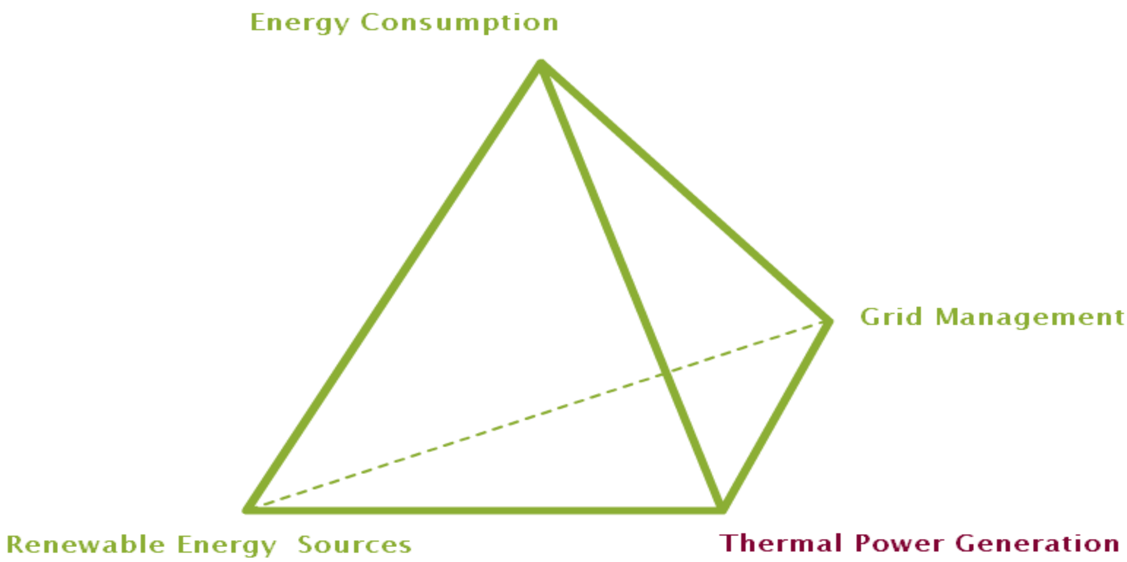

Figure 1 - Elements of Grid Stability (EPPSA, 2013)

Essentially, a stable grid requires all four elements of grid stability, as increasing energy consumption and renewables integration is enabled through thermal power generation and supported by grid management (e.g. demand-side management and storage).

2. The European Energy Market

2.1 Situation in the European Energy Market

2.1.1 ...Even more complicated in the Future

The EU has set itself ambitious decarbonisation goals for 2050, the transition towards which will lead to the energy system becoming increasingly complex. Thus, as electricity is expected to increasingly being supplied by RES, its intermittent character requires a complex system of flexible back-up and balancing measures in order to ensure that the grid and the electricity supply remains stable and uninterrupted.

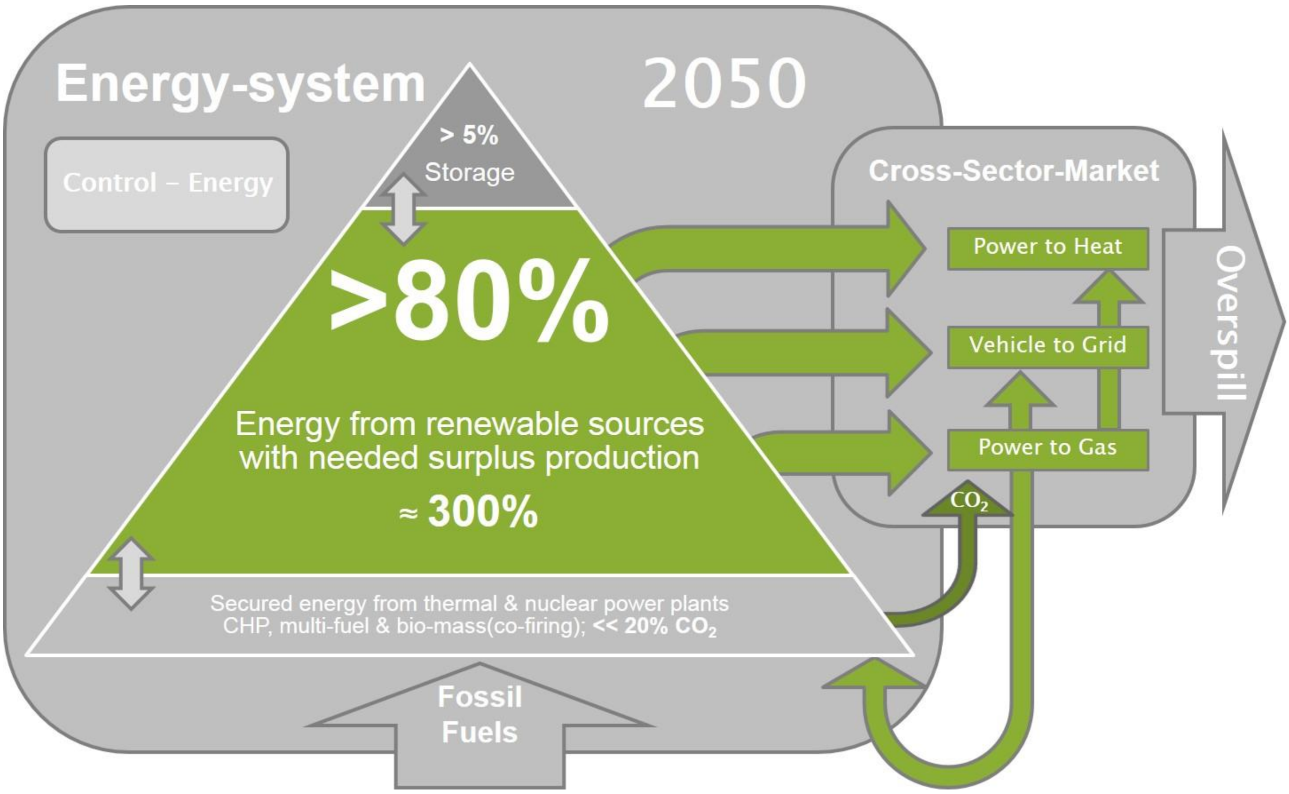

Figure 2 - Future Energy System (EPPSA, 2013)

Figure 2 above highlights the fact that although energy storage and cross market measures will play key roles in this transition, the contribution of thermal power generation to keeping power flowing in such a system is absolutely crucial and indispensable. It is building the base of a secured power supply. For example, the intermittent nature of RES makes it a reasonable assumption that a system with 80% RES supply may require approximately 300% surplus installed RES capacity. In turn this may lead to only 15-25% of supply being secure, and while energy storage can be expected to provide an additional 5% contribution to the secured short term supply, the bulk of secured supply – in the form of availability for flexible back-up and balancing – will still consist of thermal power, while the cross sector technologies take the role of the over supply regulation. This will make it possible to avoid carbon emissions in other industry sectors as mobility or else.

Thermal power generation may therefore be required to be available with an installed capacity of 70-80% of total peak capacity, even in an 80% RES world. For this reason, in the transition towards decarbonisation, it is crucial therefore, for thermal power to move from its so-called 'conventional' role towards the role of flexible back-up and balancing. While more research and development is needed to fully optimise thermal power generation to be capable of meeting the needs of the far more complicated energy system of the future (i.e. 2050), current technology is capable of meeting current and near-future flexible back-up and balancing needs. However, the current situation in the European energy market is far from conducive towards actual deployment thereof.

2.1.2 The Current Situation

2.1.2.1 Integration of Renewable Energy Sources in the System

The increasing integration of RES in the energy system, as a result of EU climate & energy policy, is proving to be a significant challenge from the perspective of security of supply and grid stability as experience so far shows that even a small share of intermittent renewable energy sources can have large effects on the electricity grid. Integration of renewable energy sources into the grid is therefore a key infrastructure challenge. In times without sun or wind, thermal power must step in as flexible back-up generation to provide power when it is needed. This alters their existing mode of operation, which has led to suppliers increasingly receiving orders for 'off-design' operation.

More specifically, increasing integration of intermittent RES into the system requires thermal power plants to increasingly provide flexible back-up and balancing, which involves low running hours (often at part-load), more frequent start-up and shut-down, and operation beyond the design limits for cycling modes. This means that the most efficient, state-of-the-art thermal power plants are not being operated to their full potential; for example, the efficiency of CCPP has been raised over the last decade, but the operation hours dropped dramatically.

Thus, in contrast to maximum efficiency as the current best available techniques' standard in EU legislation, the facts of daily operation and management of the European power supply underline the increasing need for maximum flexibility and minimum must-run capacity. In this sense, modernisation of the system is crucial to enable the transition towards decarbonisation, and there are several technological solutions which could enable and promote this.

2.1.2.2 Technological Solutions

As explained above, today's state-of-the-art efficient power plants do not operate to their full potential, as the evolving needs of the system increasingly require flexible and efficient thermal power plants, thus modernisation of the fleet is needed.

With regard to achieving this necessary modernisation of the fleet, it must be noted that a 100% rebuilding of power plants is not the only option, although there are several examples of existing technologies for flexible and efficient operation. In addition to new-builds utilising existing technologies for flexible and efficient operation, existing technologies already in operation can also be modified for flexible and efficient operation. Furthermore, different existing technologies can be combined to achieve overall more flexible and efficient operation.

The main conclusion from the above is that the evolving needs of the system as they are today and will be in the near future can be met by deployment of today's state-of-the-art flexible and efficient technologies. However, the transition towards decarbonisation and increasing integration of intermittent RES will put further demands on the system for flexible back-up and balancing. Thus, in order to meet the evolving needs of the system in the longer term (i.e. towards the 2050 horizon), further research, development and demonstration (R, D & D) is required to improve the flexible and efficient performance of thermal power generation. Examples of R, D & D that is necessary include, but are not limited to, reduction of minimum load limits, materials with improved fatigue behaviour, and boiler adaptation for lower steam throughput.

However, the current situation in the European energy market does not incentivise either deployment of existing state-of-the-art flexible and efficient technologies, nor does it incentivise R, D & D in further improvement of such technologies, and this is largely the result of support schemes for RES and their effects on the energy-only market, which can best be summarised by the 'missing money' problem.

2.1.2.3 The 'Missing Money' Problem

In the energy-only market, electricity is traded wholesale and the interaction of supply and demand should determine the price at any given moment. Due to the merit order effect, a crucial component of the price is the variable cost which is largely a reflection of fuel costs. As wind and sun are 'free', so to speak, intermittent RES have a variable cost of essentially zero, and therefore they displace energy sources with non-zero variable costs.

In addition to fuel costs, operation and the initial capital investment are also reflected in the cost of each specific energy source as these fixed costs must be recovered during the operating lifetime of each power plant and/or installation. However, this is only true for thermal power generation, as the fixed costs of intermittent RES are remunerated through a number of diverse support schemes (for example, feed-in tariffs are set at cents per kWh, suggesting remuneration for power produced, but are in fact set high enough to compensate for initial capital costs as well). Therefore, just as the variable costs of intermittent RES are essentially zero, from the perspective of the energy-only market, the fixed costs of intermittent RES are virtually zero (as they are entirely remunerated in parallel through support schemes).

Finally, the energy-only market was designed for trading electricity as if it were any other commodity (i.e. easily transportable and storable), and so power quality and security of supply are not considered in the pricing of electricity. However, electricity must be delivered as it is demanded and (aside from pumped storage) cannot be easily stored, suggesting that part of the price determined in the energy-only market should also reflect the costs of ensuring a stable, on-demand electricity supply. However, this is not the case, and the overall effect of increasing integration of intermittent RES on the energy-only market is downward pressure on wholesale prices, which leads to the 'missing money' problem, which essentially means that the money needed to remunerate and secure electricity supplies, to a degree that is required to ensure overall system and grid stability, is simply not available.

Figure 3 (see Annex) explains the 'missing money' problem; the general principle is that the integration of zero-variable cost RES (with parallel remuneration through support schemes) exerts downward pressure on electricity prices and pushes the merit order to the right, essentially destroying the business case for generation sources which have costs that should be remunerated for several reasons (the supply of stable, dispatchable electricity being one of these) but are not. Yet these generation sources are (precisely due to their stability and dispatchability) absolutely necessary for the system. To illustrate the general nature of the 'missing money' problem, it can be seen from Figure 3 that not only some thermal power generation types are pushed far enough right so that their operation no longer makes commercial sense; the business case for pumped storage, which is at the moment the only technologically mature form of energy storage, is also being destroyed.

At the same time, since intermittent RES support schemes are generally funded by top-up charges on the final end-user electricity bill, consumers – both households and industry – are faced with the situation that although the wholesale price of electricity traded in the energy-only market is decreasing, the final price for consumers not exempt from top-up charges is in fact increasing. In some support schemes, this is in fact a direct result of feed-in tariffs, which are meant to ensure a stable return regardless of market prices – so if market prices decrease as a direct result of increasing integration of RES, itself a direct result of feed-in tariffs, it becomes increasingly the case that feed-in tariffs are, through their effects on the energy-only market, justifying their own existence by perpetuating a situation they were intended to help to overcome. Essentially, this is a completely counterproductive result, and is one of the many unintended consequences of current energy policy.

2.2 Unintended Consequences of Energy Policy

The aims of energy policy in general but in particular of EU energy policy and consequently Member State energy policy are to overcome the so-called 'energy trilemma' and deliver an energy supply that is sustainable (in terms of environmental impact), secure (in terms of a secure supply both from a fuel perspective as well as an electricity supply and grid stability perspective), and affordable (in terms of enabling households to purchase enough energy to support a certain standard of living, and to enable industry to operate in a way which does not undermine its (international) competitiveness.

However, at present, the actual effects of energy policy are leading to numerous unintended consequences which in fact undermine all three initial objectives. Thus, as power plants not optimised for flexible operation have low part-load efficiencies, running such plants in such a way leads to increasing emissions and resource consumption, which are contrary to the sustainability objective; decreasing the capacity of thermal power generation plants (which is stable and dispatchable) is endangering the secured energy supply, which is not acceptable in an industry-based society like the European Union and is contrary to the security of supply objective; and last but certainly not least, all effects of energy policy but in particular the rising end-use electricity prices are weakening European economies and are jeopardising (international) competitiveness as well as leading to rising energy poverty among households in some member states, which is contrary to the affordability objective.

2.3 Time for Investment Decisions

All of the issues explained above are arising at a critical moment, as the EU's generation fleet is aging and will need replacement or refurbishment in the very near future. However, as explained above, the effects of increasing integration of intermittent RES on the energy-only market are leading to a missing money problem, which does not incentivise any new investments either in new or refurbished capacity and therefore prevents steps which are critical for the continuing functioning of European industry and society from being taken, precisely at the moment when they should be taken.

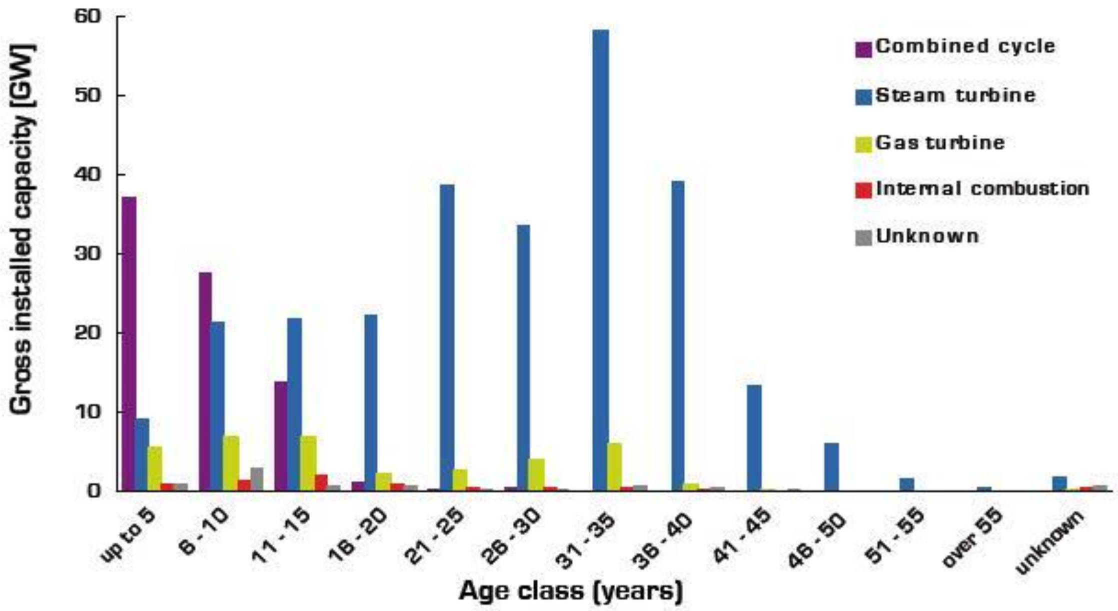

Figure 4 - Age Class of Thermal Power Capacity (JRC, 2009)

Figure 4 above highlights the issue on a generation-type basis; except for combined cycle plants, which are relatively new but due to the missing money problem do not operate as often as they were designed to, the majority of plants are more than 10 years old and for steam turbine plants, the majority of plants are in the age range of 20 to 40 years. This is an age where replacement or refurbishment with state-of-the-art technologies starts to make sense and towards the upper range becomes more and more crucial.

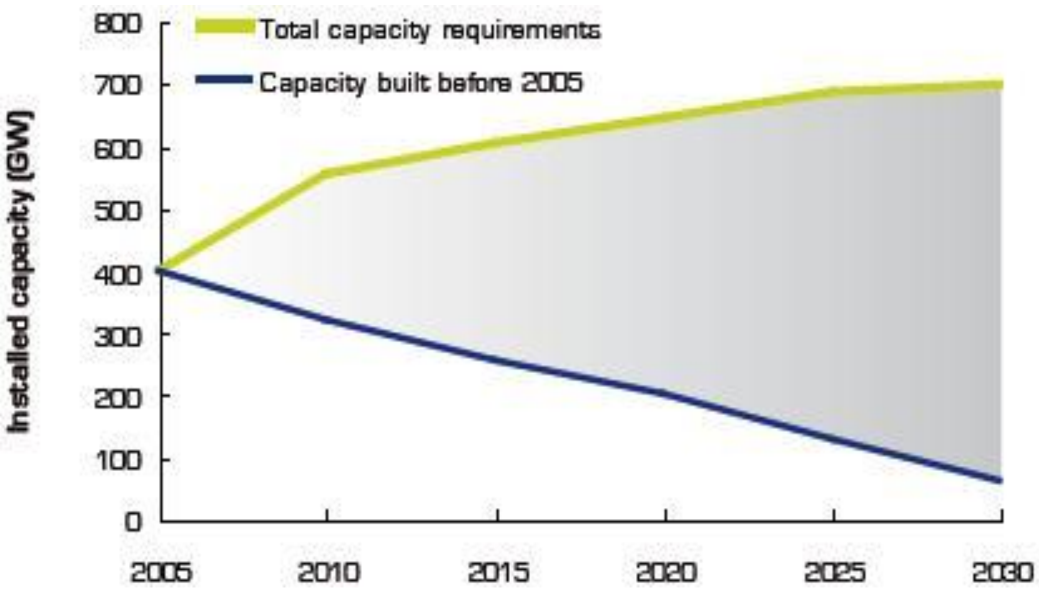

Figure 5 - Upcoming Generation Gap (JRC, 2009)

Figure 5 above presents an even more clear-cut picture, highlighting the difference between future capacity requirements and future trends of older (i.e. built before 2005) capacity installed; the generation gap steadily widens over the coming two decades.

This is not only problematic from a security of supply perspective, but also risks loss of technological leadership and engineering skills. A parallel can be drawn to the situation that arose in the late 1990s, where a cyclical low for new-builds resulted in little to no investments made; a consequence of this was skill loss due to the lack of projects, as well as brain drain to other industries. When orders and investment began increasing again in the early 2000s, challenges arose for suppliers to meet the high number of orders with less manpower and experience due to the aforementioned losses. All signs are pointing towards a similar situation being increasingly likely to arise again – yet it should be obvious that past mistakes should not be repeated.

3. Two Issues – One Solution

3.1 The Need for a New Market Mechanism

At present, it is clear that the energy-only market is not able to secure the performance of recent investments, nor is it able to support decisions for new investments. These two issues have one solution - a new market mechanism. Such a new market mechanism should ensure the adequate incentivation and remuneration of flexible and efficient thermal power generation as a vital component of a stable grid and a secure and affordable energy supply.

Of course, a first-best solution would be to remove the initial distortion of RES support schemes fragmented across EU Member States, but for a variety of reasons this is unlikely to happen to the degree necessary and at a point in time appropriate enough to overcome the current situation.

In a number of Member States, the situation is being recognised as the risk that it presents, and measures have been, or are being, taken to correct some of the issues explained above. Essentially, the solution(s) currently being implemented consists of different varieties of capacity remuneration mechanisms (or simply capacity mechanisms), ranging from strategic reserve requirements to capacity payments and/or auctions.

3.2 Reasons for New Market Mechanisms in Principle

The reasons for new market mechanisms in principle, and regardless of their implementation, are broadly the following:

- to ensure adequacy of capacity in a market with several stakeholders whose mission is no longer ensuring the overall balancing of the system
- to solve the 'missing-money' problem
- to manage intermittent RES generation which benefits from support policies
- to manage specific consumption patterns

Essentially, the aim of a new market mechanism is to overcome the generation gap by ensuring enough capacity is available – either through preventing retirement of existing plants, by promoting new-builds, or a mixture of both.

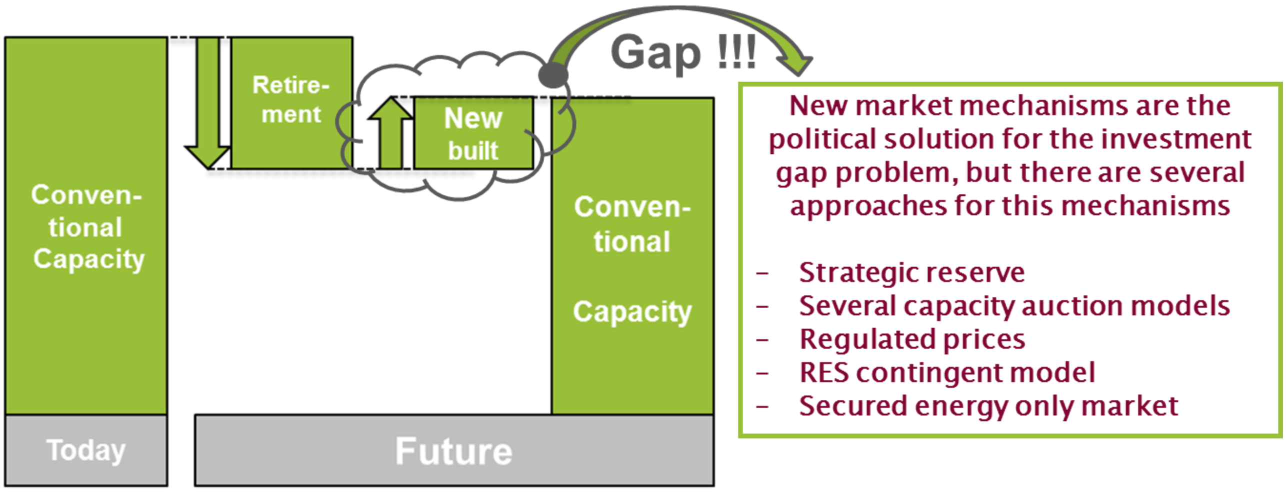

Figure 7 - Aim of a new market Mechanisms (EPPSA, 2013)

Figure 7 above shows the general aim behind a new market mechanism as ensuring that the balance between plants retiring and new-built plants entering operation is such that overall capacity demand is met. For this several mechanisms have been introduced over the last years

However, a new market mechanism is the only political solution for the investment gap problem and its impact must be analysed not only from the perspective of overcoming the generation gap but from the perspective of the electricity market and energy system as a whole.

3.3 Analysis of the Electricity market

The electricity market in EU Member States today is increasingly characterised by multiple and varying national capacity mechanisms on top of a variety of different support schemes for RES. The main result thereof is that today's increasingly integrated European energy market – i.e. what will eventually become the EU's 'Internal Energy Market' – is full of competitive (dis)advantages and market distortions, as mechanisms are not optimally designed, there is a lack of incentives for thermal power generation, and a level playing field between technologies is missing. Thus, the deregulation of the European Energy Market, which is a main goal of the EU's energy policy, is a myth.

Policy fragmentation on Member State level with varying incentives – sometimes preventing plants from retirement, sometimes only supporting new capacity without considering possibilities of refurbishment with state-of-the-art technologies – is counterproductive to the EU's objective of an Internal Energy Market and will not fully overcome the unintended consequences of energy policy outlined above.

Instead, what is needed is a smart market mechanism which incentivises state-of-the-art, flexible and part-load efficient thermal power generation with added value for grid stabilisation, based on all fuels to support diversification of Europe's energy supply. Paying for capacity as such, without considering the capability of the capacity for the role it is asked to play (i.e. flexibility and part-load efficiency), and by discriminating against either new builds (via strategic reserves) or refurbishment (via capacity auctions for strictly defined 'new' capacity only) prevents the application of state-of-the-art technologies to the extent that is necessary in the face of the requirement for an energy supply that is sustainable, secure, and affordable. In turn, this lack of application and deployment does not provide sufficient incentive for further R, D & D, and altogether risks the loss of European technological leadership on top of jeopardising the sustainability, security, and affordability of the European energy supply.

The 10 Commandments to be recognised for a "New market Mechanism" in Europe are:

1. **Market Conditions** have to be respected
2. **Secured Power Supply** must be safeguarded
3. **RES** have to be integrated in the market
4. **Ancillary Service** must be supplied with reasonable costs
5. **Power Quality** has to be ensured on a high level

6. **Energy Storage** must generate arbitrage
7. **Demand Side Management** must be promoted
8. **Non Discrimination** of fuel or technology must be respected
9. **Cross Sector Technologies** must be integrated
10. **Uniformity over Europe** must be reached

To reach this simply to implement a capacity market is reaching too short. A fundamental analysis has to be done all over the European Union and an uncomplicated regulative mechanism has to be introduced, which is serving the entire system.

4. Conclusions

The current situation in the European energy market is such that support schemes for intermittent RES are jeopardising the business case for the flexible and efficient back-up and balancing provided by thermal power generation which makes the integration of intermittent RES possible in the first place. Although removing initial distortions is a first-best solution, it is unlikely to happen, and a new market mechanism is needed. Such a market mechanism should secure the performance of recent investments, support new investment decisions, and consequently incentivise R, D & D to prevent the loss of European engineering skills and technological leadership.

The solution to the current situation appears to lie in the different varieties of capacity mechanisms implemented or being considered in several EU Member States. However, if a return to deregulation, aided by the temporary implementation of strategic reserves, is not an option, and if capacity mechanisms are indeed the solution(s) that will be applied, then care must be taken that they are designed and applied appropriately and, if possible, at the EU rather than Member State level. Capacity mechanisms should incentivise deployment of, or refurbishment with, state-of-the-art technologies to meet the flexible back-up and balancing needs of today, but they should also incentivise R, D & D to further improve flexibility and part-load performance of thermal power generation technologies to meet the flexible back-up and balancing needs of the future.

In EPPSA's view, a new market mechanism must therefore be designed in a way that incentivises new flexible and part-load efficient power plants with added value for grid stabilisation. Such properly designed capacity mechanisms would enable and incentivise investments in higher flexibility and higher efficiency at part-load in thermal power plants, which in turn would reduce unnecessary emissions, enhance resource efficiency, and secure grid stability as well as ensure security of supply. In addition, such properly designed capacity mechanisms would also avoid brain drain, create sustainable jobs, and perpetuate the EU's technological leadership.

Annex

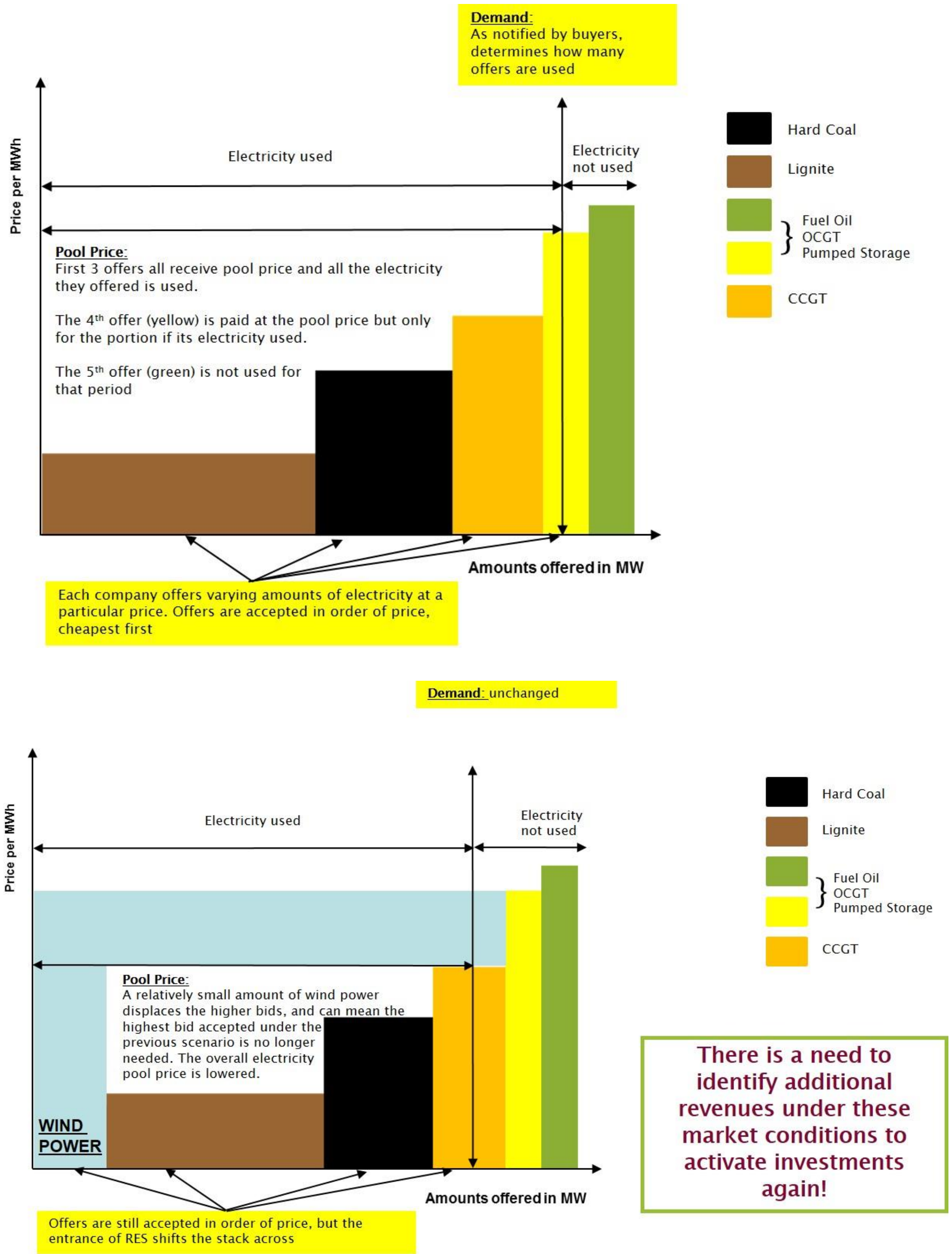

Figure 3 - The Missing Money Problem (B. Courtice, 2011)