ETN's position on the SET Plan issue Paper 4 – "Energy Systems"

A holistic approach to support the future carbon free energy

The European Turbine Network (ETN) welcomes the European Commission's initiative to clarify and prioritise the actions and research needs within the updated SET-Plan and matching them to the pillars of the Energy Union. We appreciate the opportunity to participate in the dedicated stakeholder's consultation on the "Issue Paper No. 4: Energy Systems (Increase the resilience, security and smartness of the energy system)", where we would like to stress the importance of a holistic approach in the future energy systems.

The increasing share of intermittent Renewable Energy Sources (RES) in the energy system, such as wind and solar power, is changing the pattern of energy generation (intermittency + no inertia), requiring balancing power to maintain the grid's stability as well as new innovative solutions. Currently, the role of gas-fired power plants is shifting from providing base-load power to generating fluctuating back-up power & inertia to control and stabilise the electricity system grid. In such a scenario, Gas Turbine (GT) based back-up power plants will be required to stably perform loading and unloading phases quicker than the current ones while maintaining low emissions. The GT would also be required to be "parked" at its minimum environmental load (minimum load at which a power plant can still be run continuously within emission limits (NOx levels)) or even shut down when its power is not needed.

In order for GTs to properly provide this support in a cost efficient and optimised way and in the longer term develop low or zero emission hybrid systems, ETN foresees that a number of technical areas need to be further developed and optimised.

In the short term, GTs and Micro Gas Turbines (MGT) can help the integration of RES into the energy system by absorbing the fluctuations of the RES in the grid as well as by using low or CO_2 neutral fuels like natural gas, biogas, industry waste gas or landfill gas. In the long term, hybrid GT and MGT applications that can assure high utilisation of RES and ensure security of energy supply due to the fuel flexibility if needed. This will provide significant contributions to a decarbonisation of the energy system and to the full deployment of RES in the grid. ETN has identified R&I priorities for the optimisation of existing technologies and their hybridisation with the RES, according to the flexibility options mentioned in the issue paper 4.

Target

ETN agrees with the overall proposed target in the Issue Paper 4. As it is foreseen by the IEA[1] that conventional power generation will still be needed as backup power generation to the RES for many decades, ETN believes that an additional energy systems roadmap until 2050 should be proposed in order to incentivise the long-term investments needed.

[1] According to the International Energy Agency (Energy Technology Perspective 2DS, 2014) by 2050 the largely decarbonised electricity mix will still depend on fossil fuels for 20% of electricity generation

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Energy grids, systems and integration

ETN agrees on the topic's description but it deems necessary to specify a common strategy and requirements among all the actors of an energy system. Currently a high focus is on the power grids' modification in order to fulfil the integration of RES and to satisfy the customers' needs. However this approach doesn't ensure that power generation technologies can follow these requirements. The new technologies, systems and services to be developed should be able to manage integrated energy systems, considering the requirements of centralised power generation operators, RES operators, TSOs, DSOs, storage, etc., with the aim to minimise the cost of electricity based on the CAPEX and OPEX affecting the stakeholders. Opportunities for R&I activities on condition monitoring techniques and prognostic tools should be considered as it would optimise the whole European energy system.

The presence of "real time" monitoring devices allows the measurement and evaluation of all the main energy consumption entries within the power grid. This allows adopting strategic decisions to improve the efficiency of the energy system. IT solutions such as big data analysis and cloud computing could enable smart load sharing, reducing the differences between peaks and low load demand. The present network is already able to manage production optimum points, nevertheless it is not able to control and influence the demand. A particular focus should also be given to optimise the integration of hybrid technologies for centralised and decentralised power generation.

Flexible backup and generation

Energy grids, systems and integration should be based on system stability during transient operation, which means frequency control. Frequency drops (or increases) as consequence of different share of intermittent generation in the grid. Due to the shutdown of some of the conventional power plants, the time constant of existing inertia mass in the grid decreases, leading to greater growth in the initial rate of frequency. Therefore, it is expected that frequency deviation as well as oscillation will occur: with a fraction of 80% renewable energy in Germany and 60% in the other European countries by 2050, the frequency deviation after a 3GW disturbance will be increased from 390 MHz to 900 MHz, while the oscillation frequency will increase more than twice as much according to the simulation results[2]. There are different combinations of GT power plants that could contribute to the control and balancing issues.

For this purpose, **a detailed model of the European power system is required so that the load flow can be calculated and voltage and transmission limits can be analysed.** The following elements need to be considered:

- Up till now, grid services cannot be provided by intermittent renewable energy units;
- Frequency control (primary and secondary control), voltage control due to reduced power plants and therefor inertia in the grid;
- Increasing load flows can lead to increased voltage instability (losing reactive power). One of the contributions of the conventional power plants to the grid is voltage control, however their number is continuously reduced resulting in increased grid instability;

The main contribution to increased generation flexibility can be expected by upgrading existing plants and with innovative solutions.

[2] Source: System Stability Study VGB.

Innovative Solutions

GT hybrid systems with Concentrated Solar Power (CSP): CSP can be considered as one of the most viable source of renewable energy due to its dispatchable nature (if in combination with a heat storage system), a unique attribute among renewable energy technologies. However, the cost of electricity from contemporary CSP plants remains high, despite several decades of development. In order to drive down the costs, a step-change in the technology is needed. Hybrid solar gas-turbine power plants have been shown to be a promising alternative to conventional steam-cycle concentrating solar power plants The following key issues for future development of gas-turbine based solar power systems have been identified.

First, in order to maximize the degree of solar integration of GTs with CSP plants, the firing temperature of the GT should be kept close to the solar receiver temperature, resulting in low temperatures and low thermal efficiencies. As such, hybrid combined cycle systems are a viable solution since the trade-off between high solar shares and high efficiency is less pronounced than for simple cycles. This allows the firing temperature to be reduced with less of a penalty to the overall power plant heat rate, and thereby allow more economical operation at higher nominal solar shares.

Secondly, in order to simultaneously reduce carbon emissions and keep the cost of electricity low, it is necessary to integrate both thermal energy storage and a bottoming-cycle into the hybrid solar GT power plant. With optimally designed GT for this application, the performance of these power plants offer a significantly advantage over a simple combination of conventional power plant designs, demonstrating both lower emissions and a lower cost of electricity than any combination of conventional power plant designs.

Upgrading existing power plants

ETN welcomes the proposed system approach aiming at a greater flexibility and effective capacity of the electricity system in order to allow an increasing share of renewables. However, ETN believes that existing technologies, especially those used to back-up RES also need to be upgraded in order to accelerate the transition to a low economy. In line with the targets in the issue paper and the need of flexible power generation, R&I opportunities should be provided to optimise the flexibility of existing power plants.

The most valuable contribution to increase the flexibility of existing combined cycle plants can be expected from the bottoming cycle side. Given the fact the GT module of the combined cycle plants are developed for a certain operational profile, the source of flexibility in existing plants can be found in the bottoming cycle, which requires long time to reach required steam quality that can be used to operate the steam turbine. Changes to the heat recover steam generator (HRSG) can contribute to quicker start-up.

Others

ETN would like to highlight that decentralised power generation is not mentioned in the text of the Issue Paper 4. ETN believes that for decentralised power generation, there is a need to make innovative solutions regarding the hybridisation of existing technologies with RES, accessible to the consumers in order to enable power generation, heating and cooling production, aiming at the same time to increase the energy efficiency in the buildings. MGT with micro-CHP can play a substantial role in supporting renewables and meeting the challenges of the modern electricity grid. MGT technology is able to support renewables at the system level in Europe and can realise multiple benefits as a form of demand response.

ETN is fully supportive of the SET Plan approach and remains at your disposal for clarification and elaboration of these comments. We are available for any further questions and would appreciate an invitation to join the SET plan steering group meeting at which this issue paper will be discussed, in order to closely follow the discussion.