Flexible Integration

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Introduction

The growing share of renewable energy like wind and solar in the electricity market are already posing new challenges for the European grid. Strong fluctuations of the power output from renewables will increasingly require all types of thermal power plants and especially the combined cycle turbine plants to operate cyclically.

GT plants, especially combined cycle plants, are typically designed for base load operation with best efficiency at 90% - 100% load and constant power output. Any cyclic operation will immediately affect the operating and maintenance costs of the plant. Various parameters have an influence on the direct and indirect costs so that a complex system of interacting variables has to be taken into account. The effect of cycling operation on the gas turbine typically is expressed in 'equivalent operating hours' (EOH). Every start with an industrial gas turbine costs a certain amount of EOH which means that such an event equals several hours of nominal operation. Currently available "equation" for calculation of EOH and life time consumption, developed for base load operation, is out dated and need to be redefined taking these facts into account.

It becomes obvious that any kind of cyclic operation will shorten the maintenance intervals and increase the costs. Also the other plant components are affected by such an operating scheme. It will also cause damages in the steam cycle (HRSG, steam turbine etc.) [1].

In addition the plant operation at conditions away from the nominal level has a significant impact on the efficiency. Thus the fuel consumption as well as the emissions per unit of produced electricity will be much higher than for base load operation. Engine start and stop as well as load changes influence the emission characteristics due to changed combustion conditions.

That means that with increasing share of cycling operation of a power plant these effects get an significant influence on the total emission characteristic.

The issues addressed above show that the O&M costs are mainly influenced by the operation mode and will increase by cycling operation. Existing approaches for decision support are not capable of handling this new situation, so a tool that includes all these aspects is needed to provide plant operators with decision support concerning economical and environmentally friendly operation of their plants. Therefore this project is aiming at developing such a supporting tool which considers the complex interaction between economical, technical and environmental issues. This will enable the operators to operate their plants in a cost effective manner.

The new operational patterns leads to stronger interaction between various stake holders, e.g. producers, grid operators, policy makers/authorities, end users. To address the upcoming challenges, direct interaction between stake holders as well as inter-disciplinary approaches is necessary to cover the whole value chain. At the same time it will enable endusers to actively participate in energy market and profit of optimal price conditions, and make the grid more efficient and contribute to integration of renewable energy sources.

Project rationale

The main objective of this project is to deliver a methodology and software framework for a cost efficient operation of energy supply systems exposed to highly fluctuating demand and supply patterns dominated by renewable energy sources. This will cover the technical aspect of energy efficiency as well as the important aspects of technical and economic risks, via techno-economic evaluation.

As secondary objective, application of this optimization tool will enable the end-users to design new plants adapted to these complex and continuously changing operational conditions and will also cover the long-term operation (upgrading and regular review of existing installations) and short-term operation scheduling of existing installations with respect to

- minimisation of fuel and resource consumption

- minimisation of emissions and environmental impact
- optimization of cash return
- minimization of operational risk

Expected Outcome

- The final product of this research work will provide the users with a tool that applies the LCA1 and LCCA2 to firstly optimise operating of existing power plants and secondly to optimize design of new plants for a give operational scenario.
- The resulting methodology and software frame work will be capable of analysing and optimizing the short-term operation of existing plant installations by minimizing the operational cost or other relevant objective functions (e.g., minimum energy consumption, minimum CO2 emissions) while taking into account the part-load performance maps of the single equipment units and the technologic limitations (e.g., maximum load ramp rate of gas turbines and HRSGs, minimum downtime period, maximum number of start-ups, warm-up operation mode, minimum and maximum loads).
- The resulting methodology and software frame work can be extended to both the design of new installations and the review and upgrading of existing plants in a way that the equipment design and sizing accounts for the expected long-term operation scheduling and part-load performance.
- The resulting methodology and software frame work will have the capability of handling different set-ups of power plant installations.
- Techno-economic aspects as well as practical industrial experience will be considered during the project and included in the resulting methodology and software frame work.
- As a result the application of the above software frame work will lead to reduced operating costs. The concepts and tools can be applied to minimize the following objectives (or any combination of them):
    - Lower energy costs
    - Lower NOx emissions
    - Reduced costs for applying changes and modifications
    - Risk reduction (minimise loss of production) in case of component failure
    - Optimised life cycle costs of the plant

Contact and Expressions of Interest

Please submit expressions of interest for participation in a first consortium-building meeting to:

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