



Flexibility options – from power plant technology to latest storage solutions

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Adopting Flexibility and Addressing Challenges for New Emission Norms | Hamburg | 27 September 2016

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Revenue € 167 million

(consolidated)

Employees 1,615

(consolidated)

as of Dec. 31st, 2015



STEAG Energy Services

Energy Technologies



Design, site supervision and commissioning of power plants

Plant Services



Operation & Maintenance, catalyst management and -regeneration, personnel services

Nuclear Technologies



Decommissioning and dismantling of nuclear plants, safety, radiation protection and realization of final disposal sites

System Technologies



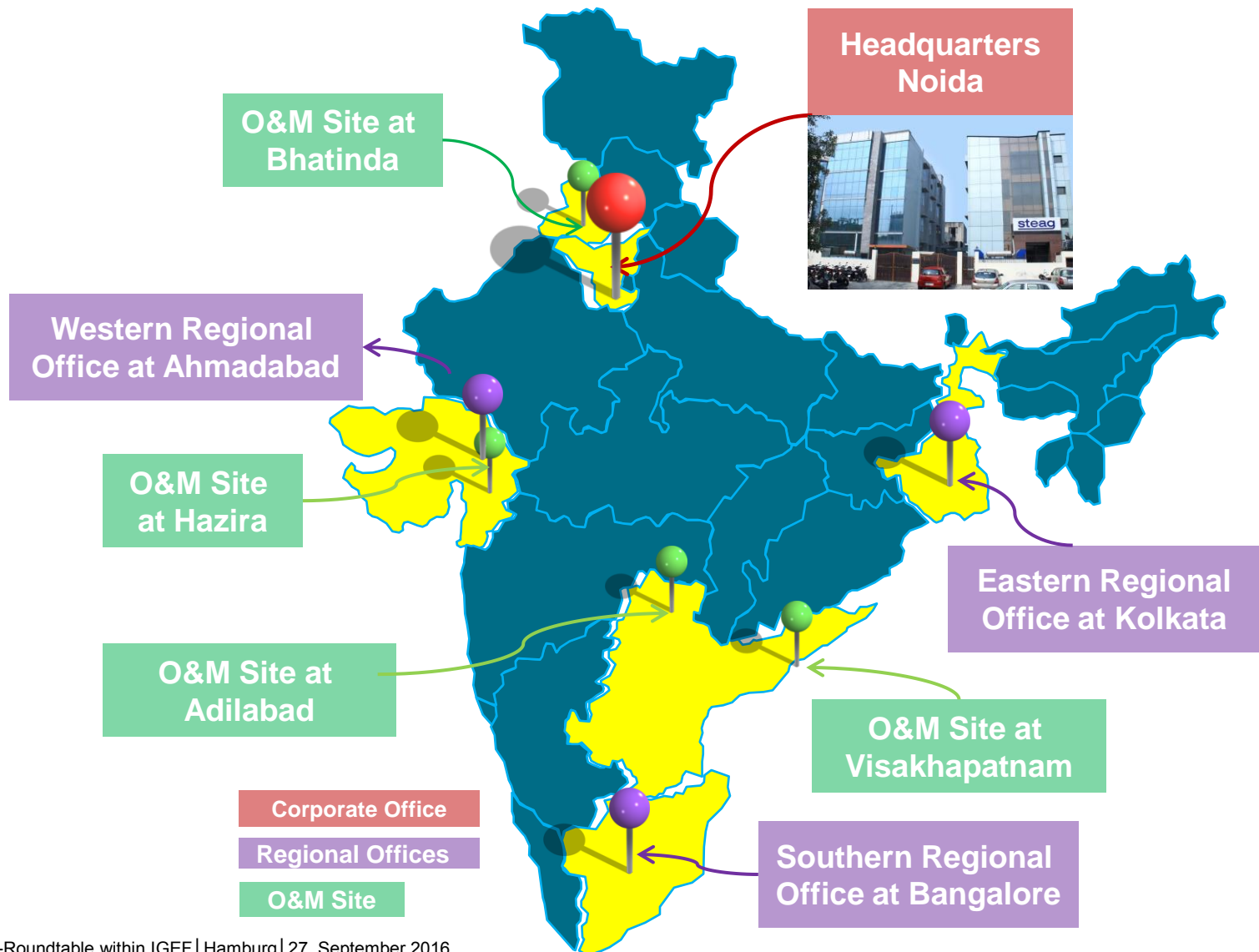
Energy Management Systems, process optimization by sensor-based solutions, user trainings

Information Technologies



Operation Management Systems, Communication Technologies, Site IT

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Electricity Mix (Installed Capacity) 2012-2047

Source	Year %			
	2012	2022	2030	2047
Coal	55	51	47	43
Gas/ Oil	12	09	07	05
Nuclear	03	03	03	02
Hydro	21	15	11	07
Renewable	09	22	32	43

- Increased share of Energy from renewables from 9% (year 2012) to 43% (year 2047)
- Increased addition of infirm power into Grid requires flexible operation of Thermal Power Plants

Source: A Report On Energy Efficiency And Energy Mix In The Indian Energy System (2030), Using India Energy Security Scenarios, 2047 by Niti Aayog, GOI, - April 2015

Need for flexible operation

- **Increased utilization of renewable energy**
- **Increased supply of fluctuating energy into the grid**
- **Coal-fired power plants are required to balance power grids**
 - **by compensating for the variable electricity supply from**
 - **renewable energy sources**
- **Fluctuations in consumption between day and night, workdays**
 - **and weekends, and seasonal variations**
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- **Absence of sufficient large-scale electricity storage capability**
 - **requiring coal fired units to deliver greatly varying output**

Challenges of Flexibilization

- **Cyclic Operation may lead to:**
- **Mechanical failure due to Creep and fatigue.**
- **Stress related failures in thick-walled components of boilers.**
- **Mechanical fatigue related failures in turbine rotors when it passes through a series of critical speed while starting.**
- **Thermal shocking of economizer headers /super heater headers.**
- **Carry over of oxide scales from boiler to turbine, causing erosion of turbine blades.**
- **Infiltration of dissolved gases leading to increased corrosion.**
- **Fatigue related failure of copper components of electrical equipments.**

- **Loss of fuel efficiency due to increased plant start-ups and part-load operation (and therefore, reduced efficiency)**
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- **Increased Operations and Maintenance(O&M) costs due to increased wear-and-tear to plant components & component failures**
- **Increased environmental costs resulting from increased specific emissions**
- **Loss of income due to:**
 - ❖ **More forced outages**
 - ❖ **Increase in fuel oil consumption & APC percentage**
 - ❖ **Increase in water consumption and water treatment costs**

Flexible Operation - Operational Challenges

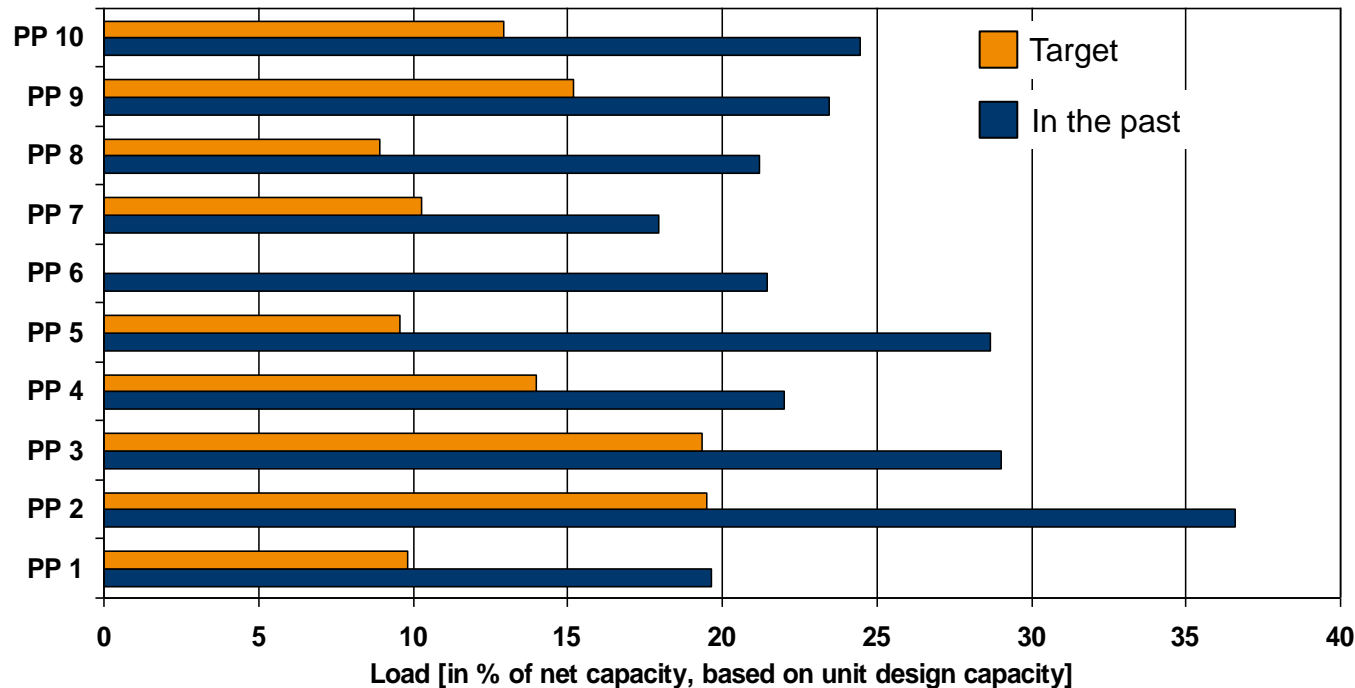
- **Forecasting of Renewable Generation**
- **Sliding Pressure operation for part load optimisation**
- **Maintenance Scheduling**
- **Specification for future plants modified to suit two shift**
- **operation**

Flexible Operation – Areas of Attention

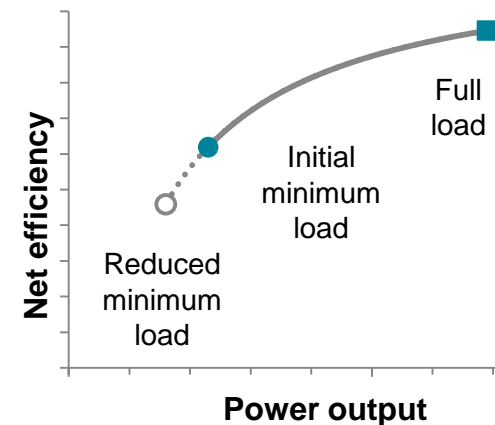
- **Boiler pressure parts with thinner piping (with advanced material)**
 - **Varying number of mills**
 - **Optimisation of combustion process**
 - **Turbine and water systems retrofits for faster ramp up/rampdown**
 - **Electrical systems- Generator windings**
 - **Modified chemical regime**
 - **Particulate removal system and FGD**
 - **Advanced process controllers for better flexibility**
 - **Plant control with self-learning predictive systems.**
 - **Centralized fleet wide monitoring**

Flexibility Optimisation of low load and start-up

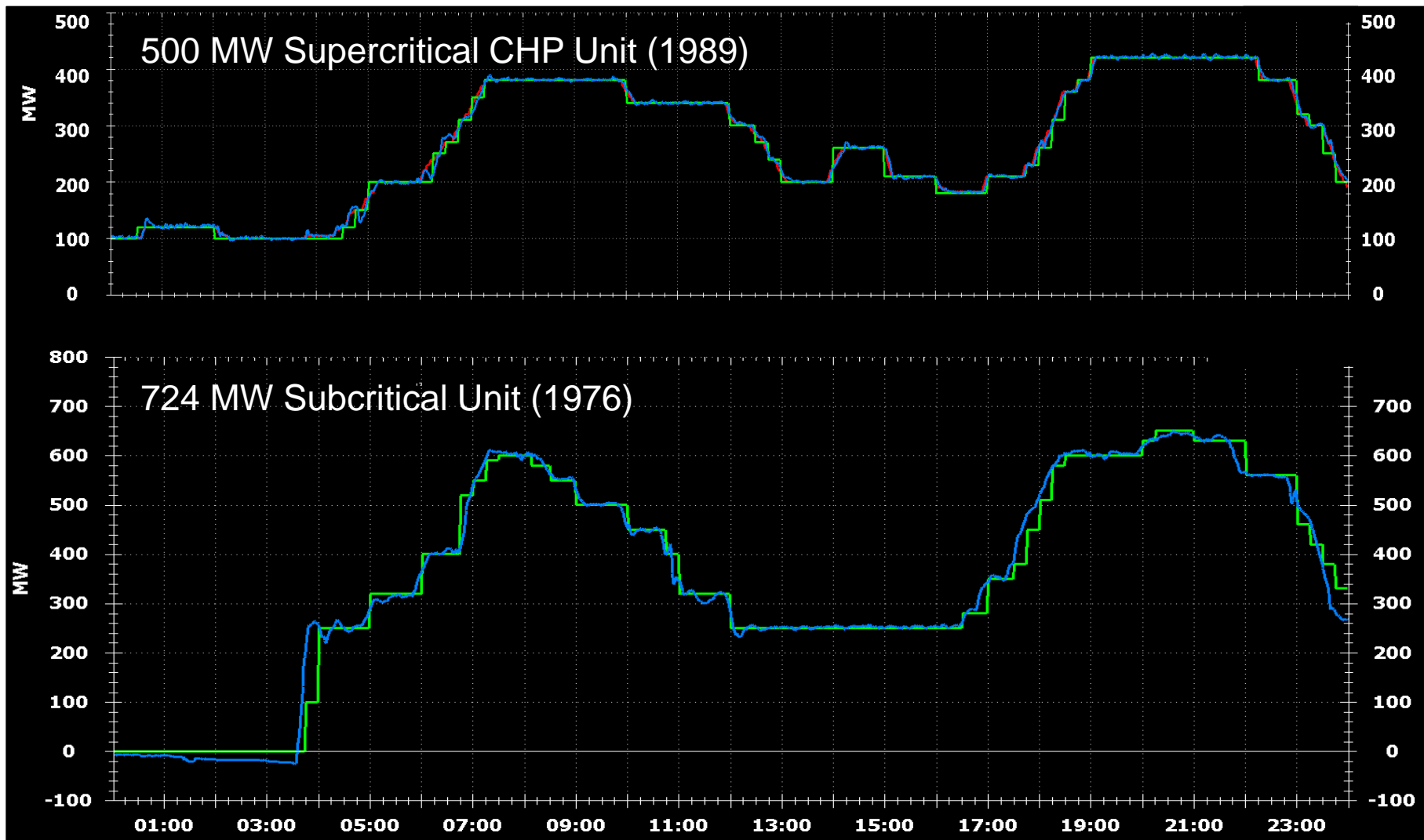
- Big potential beyond the initial design



- Reference plants in Germany built between 1970 – 1990
- But reduction of load will decrease efficiency



Flexibility Optimisation of low load and start-up



Plant performance

- Increase of level of automation
- Empowerment and skills transfer to operating staff
- Implementation and use of energy and operation management systems

Improvement of processes

- Evaluation of best-practice procedure, e.g. for start-up, shut-down, overhauls etc.
- Harmonization of organizations and processes within the fleet

Central administration and asset management

- Streamlined and effective reporting
- Reduction of overhead costs

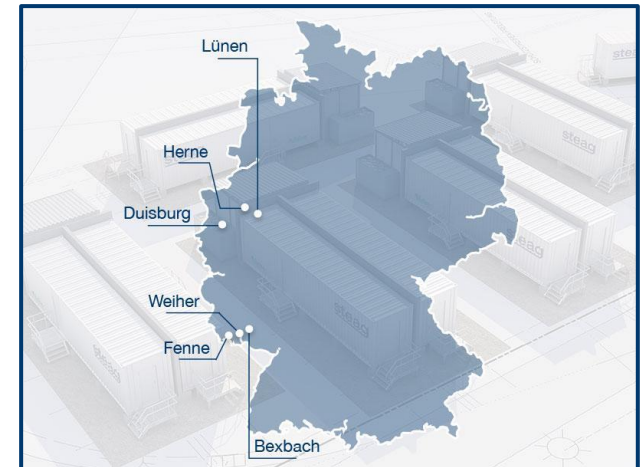


Investment in large battery systems to provide 90 MWeI PC in total:

- Project costs in total: about 100 Mio. €
- No subsidies
- Erection at 6 STEAG sites in Germany using existing grid connections
- Containerized solution to have the option of relocation

Fast realization

- Start of erection April 2016
- Commercial operation of all units end of 2016



Conclusion

Market and environment require flexibility, i.e.

- able to change to cope with variable circumstances,
- capable of being changed or adjusted to meet varied needs.

Coal fired power plants

- are not rigid dinosaurs,
- can be adapted to new market,
- can be operated as flexible partner to secure growth of the renewables and must secure the stability of electrical grids.

Battery systems

- offer interesting solutions for grid stabilization and renewable feed-in,
- but have limits concerning mass storage of energy.



STEAG is adopting and facilitating the change towards flexibility.!

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