

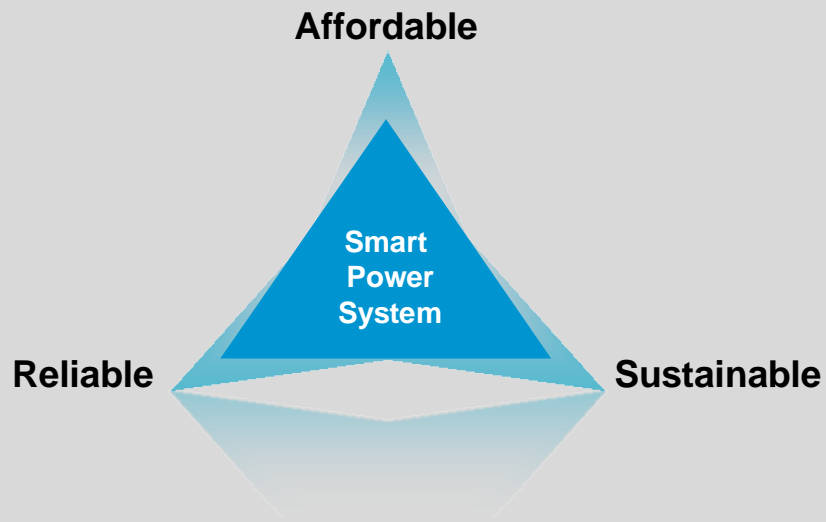
Wärtsilä Smart Power Generation

13 June 2012

**VESA RIIHIMÄKI
GROUP VICE PRESIDENT, POWER PLANTS**

The world demands

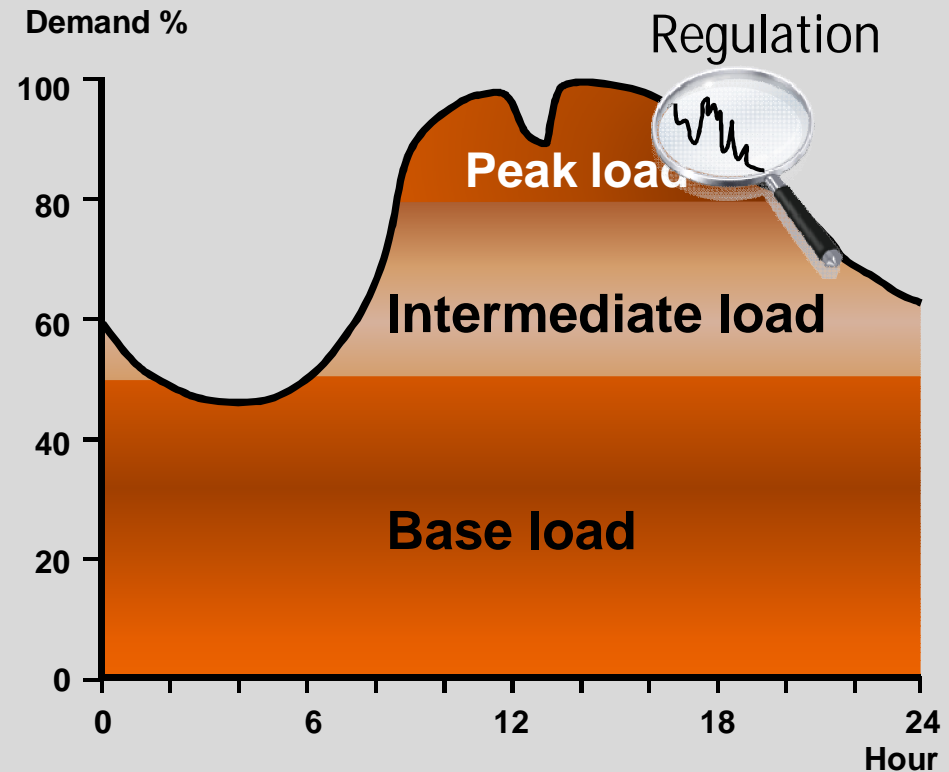
DESIRED FUTURE OF POWER SYSTEMS



Load variations in power systems

- **Base load**
 - Constant generation 24/7/365
 - Nuclear and coal plants
- **Intermediate load**
 - Normal daily load variations
 - Increase of wind and solar power introduce uncertainty which leads to large generation variations
- **Peak load**
 - Covering high demand hours
- **Regulation**
 - Balancing the system (frequency & voltage)
- **Reserves**
 - Contingency situations

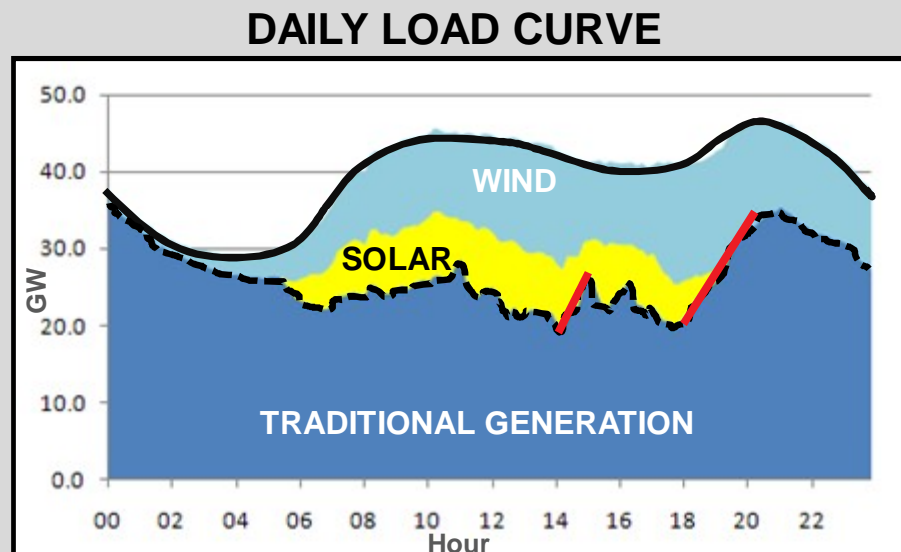
DAILY LOAD CURVE



Growing challenges for power systems

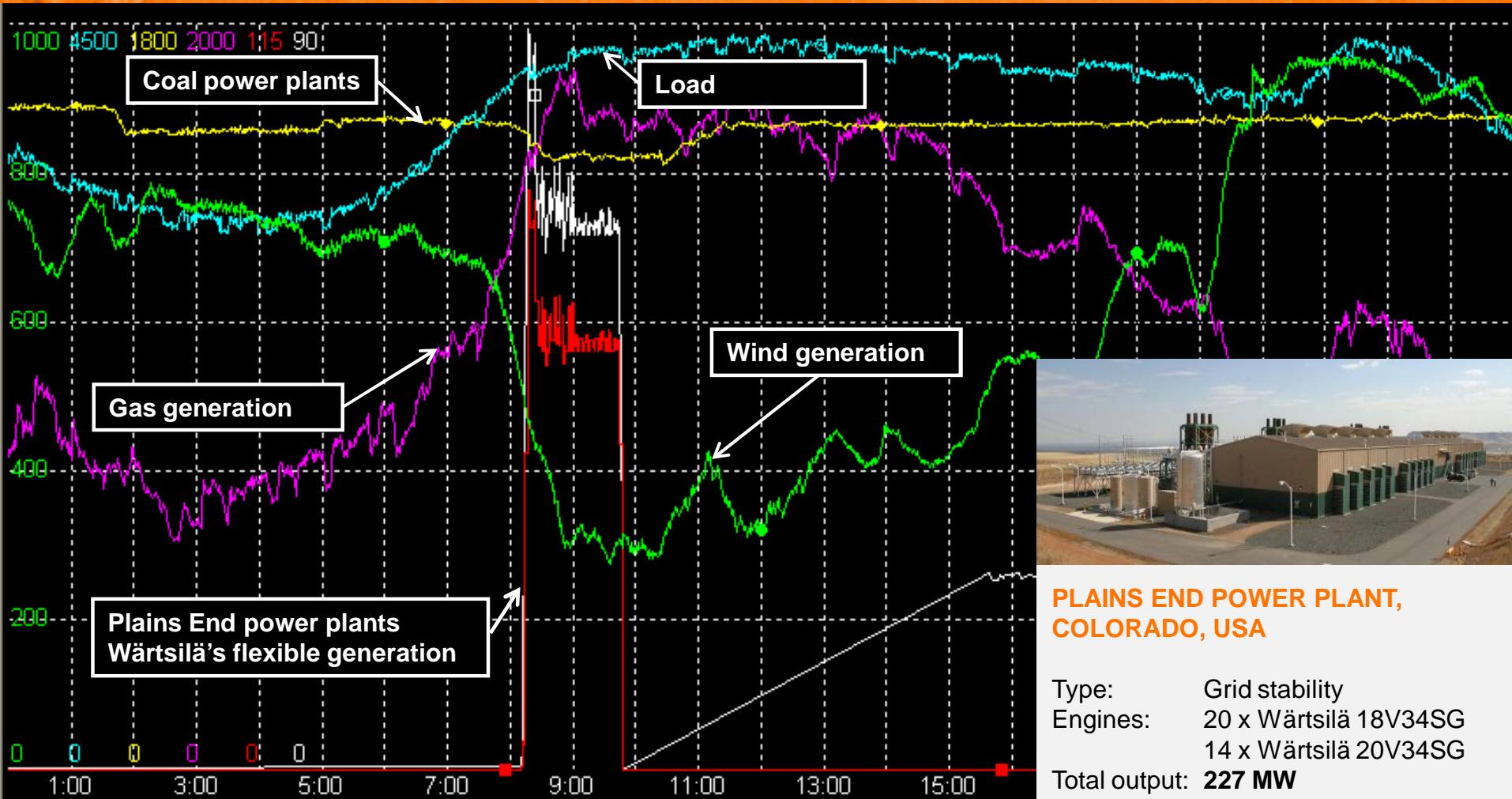
- **Variability of generation, intermittency**
 - Increasing wind and solar production
- **Forecasting error**
 - Intermittent generation
- **Increasing demand variations**
 - Electricity intensity and less industrial production
- **Power plant commitment**
 - Inflexible generation

**INCREASING DEMAND FOR
FLEXIBLE
POWER GENERATION**



The perfect match

Case study: Smart wind chasing in Colorado, US



**PLAINS END POWER PLANT,
COLORADO, USA**

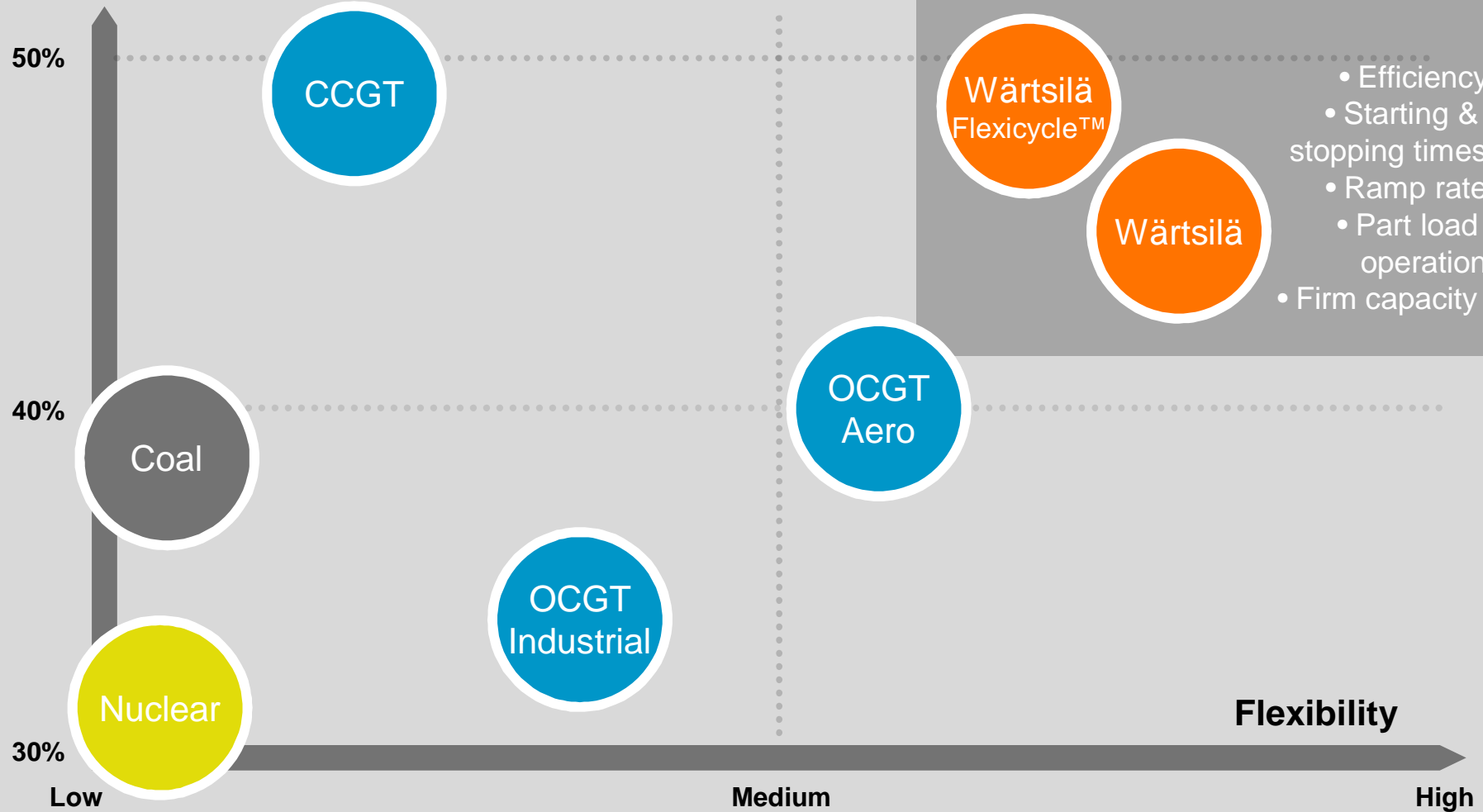
Type: Grid stability
Engines: 20 x Wärtsilä 18V34SG
14 x Wärtsilä 20V34SG
Total output: **227 MW**
Fuel: Natural gas
Installed: 2002 and 2008

Remote controlled from
Colorado Dispatch Center

**Screen shot from Colorado Dispatch
Center, Xcel Energy, USA
3 May 2008**

Operational flexibility AND electrical efficiency

Electrical efficiency



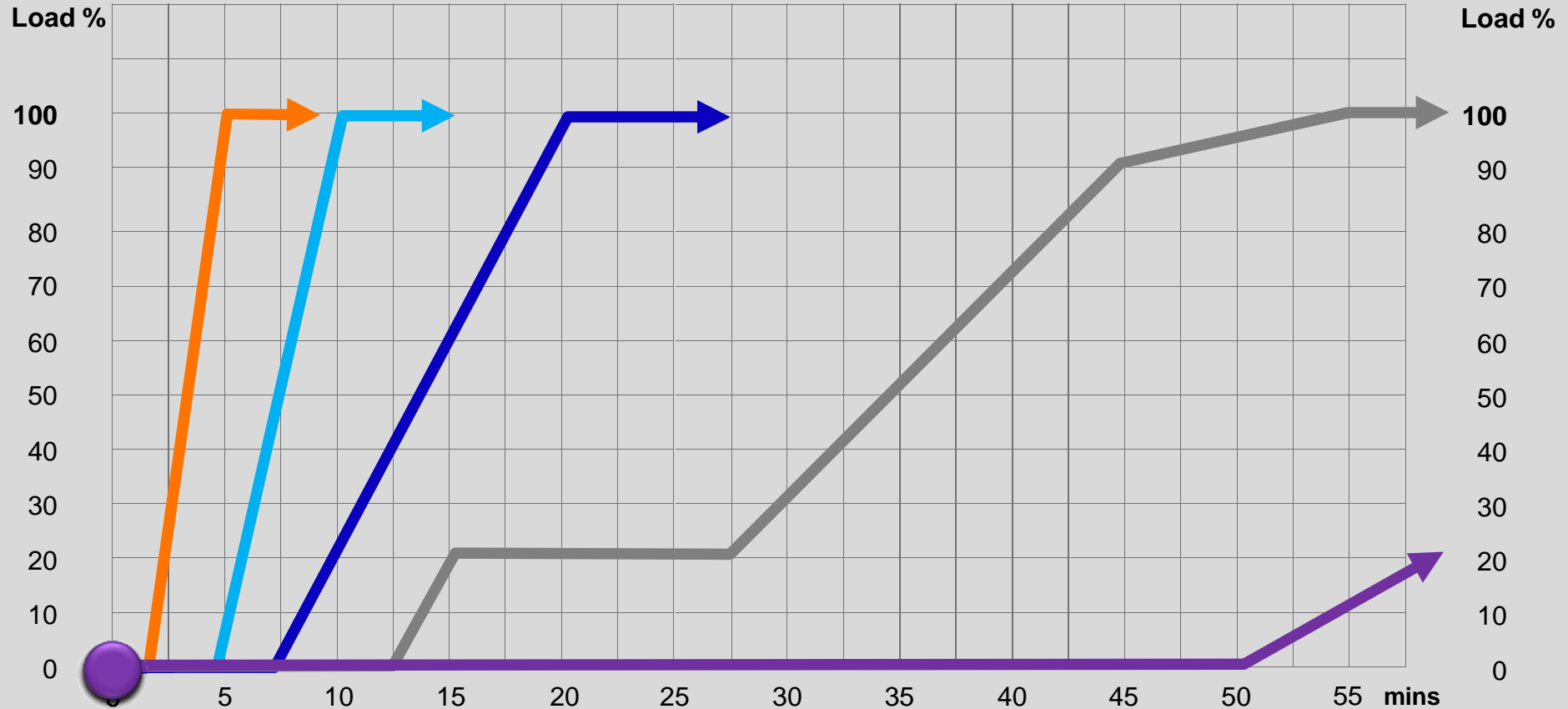
FUTURE POWER PLANTS:

- Efficiency
- Starting & stopping times
- Ramp rate
- Part load operation
- Firm capacity

- Nuclear Power Plants
- Steam Power Plants
- Gas Turbine Plants
Open Cycle (OC)
Combined Cycle (CC)
- Combustion Engine Plants



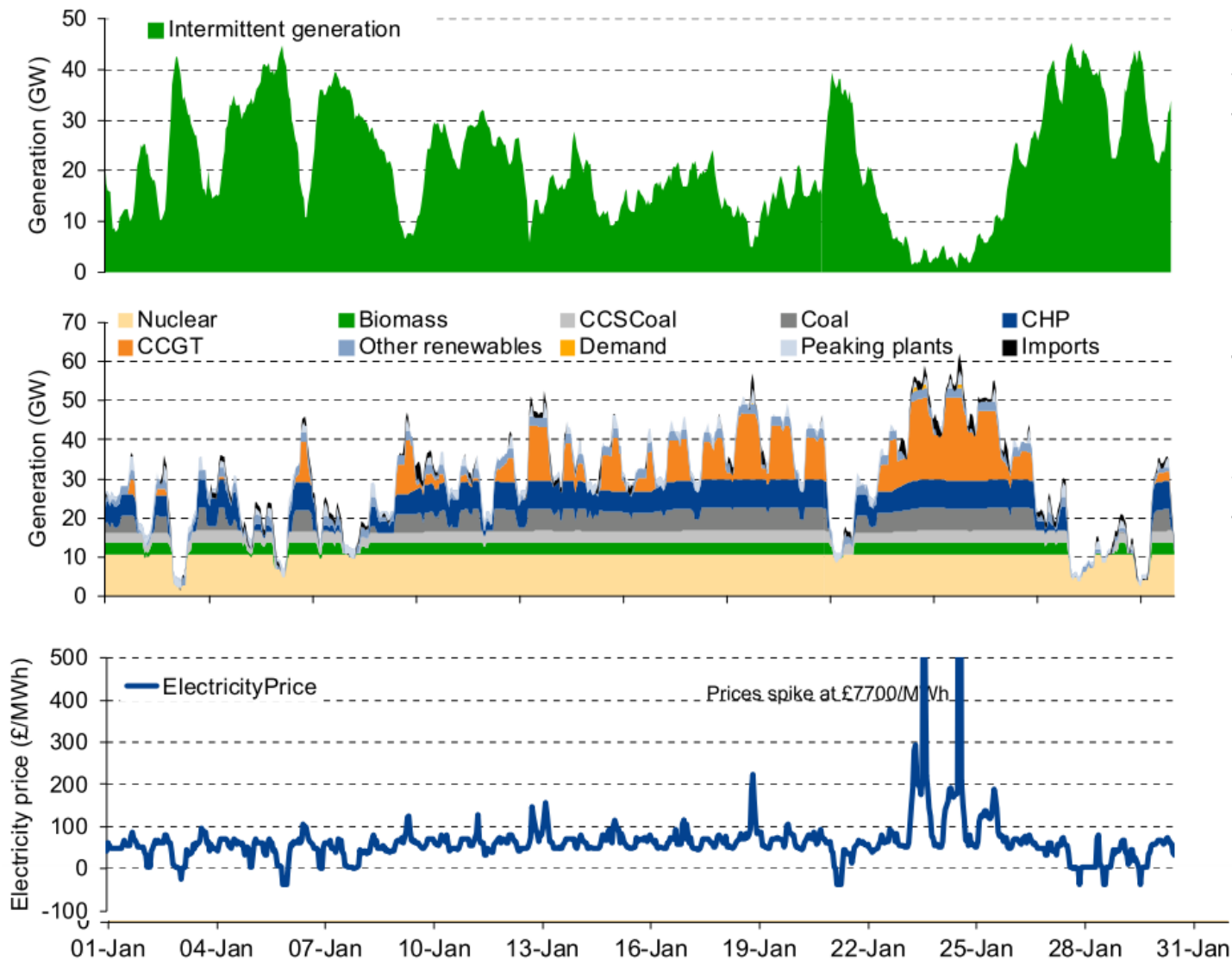
Fastest loading by Combustion Engine



POWER PLANTS:

- Wärtsilä Combustion Engine
- Open Cycle Gas Turbine (OCGT), aeroderivative
- Open Cycle Gas Turbine (OCGT), industrial
- Combined Cycle Gas Turbine (CCGT)
- Coal Fired

Wind will impact the whole system



Wind generation is very variable, leading to periods of very high generation and low periods of very low generation

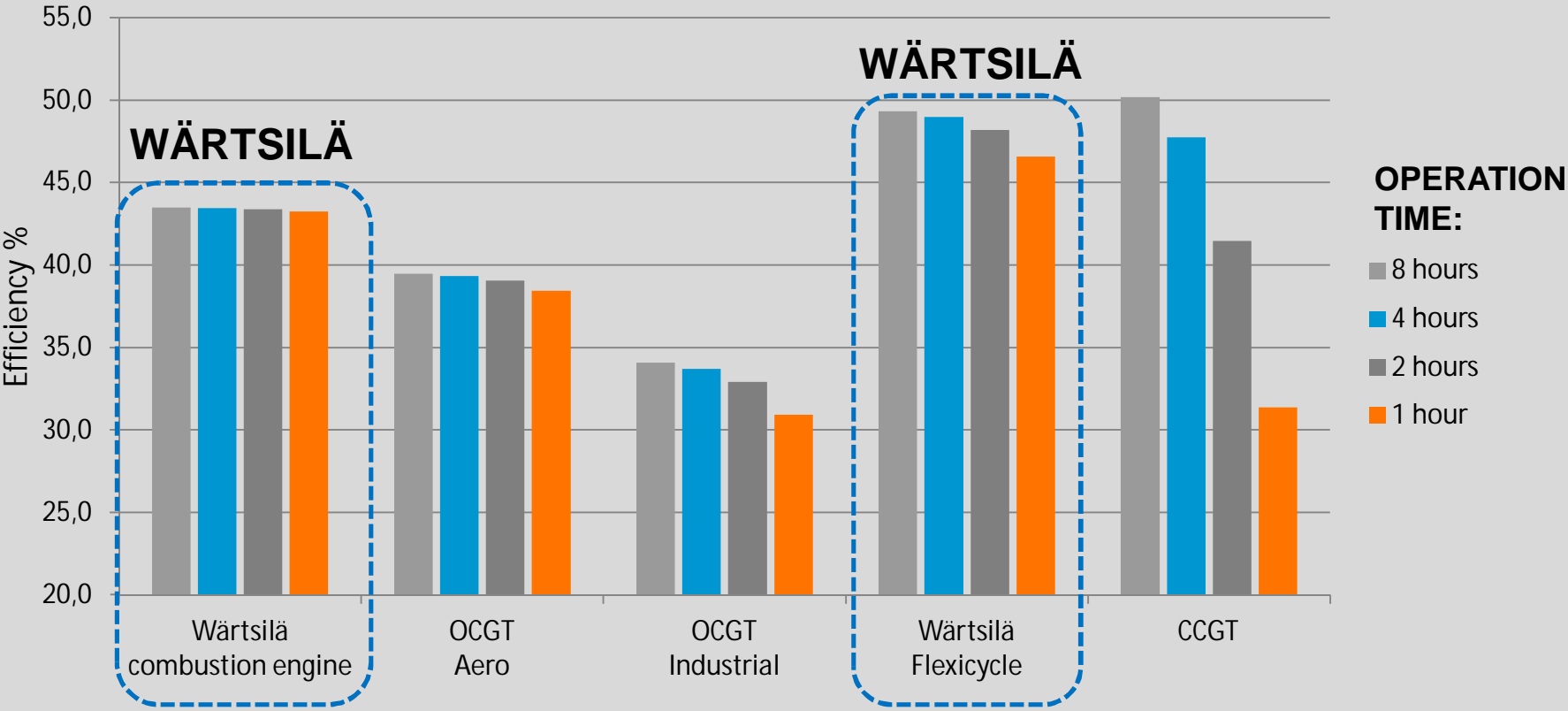
Thermal plants will have to operate in a different manner, with lower load factors and higher risk

Prices may become highly volatile and driven increasingly by wind generation

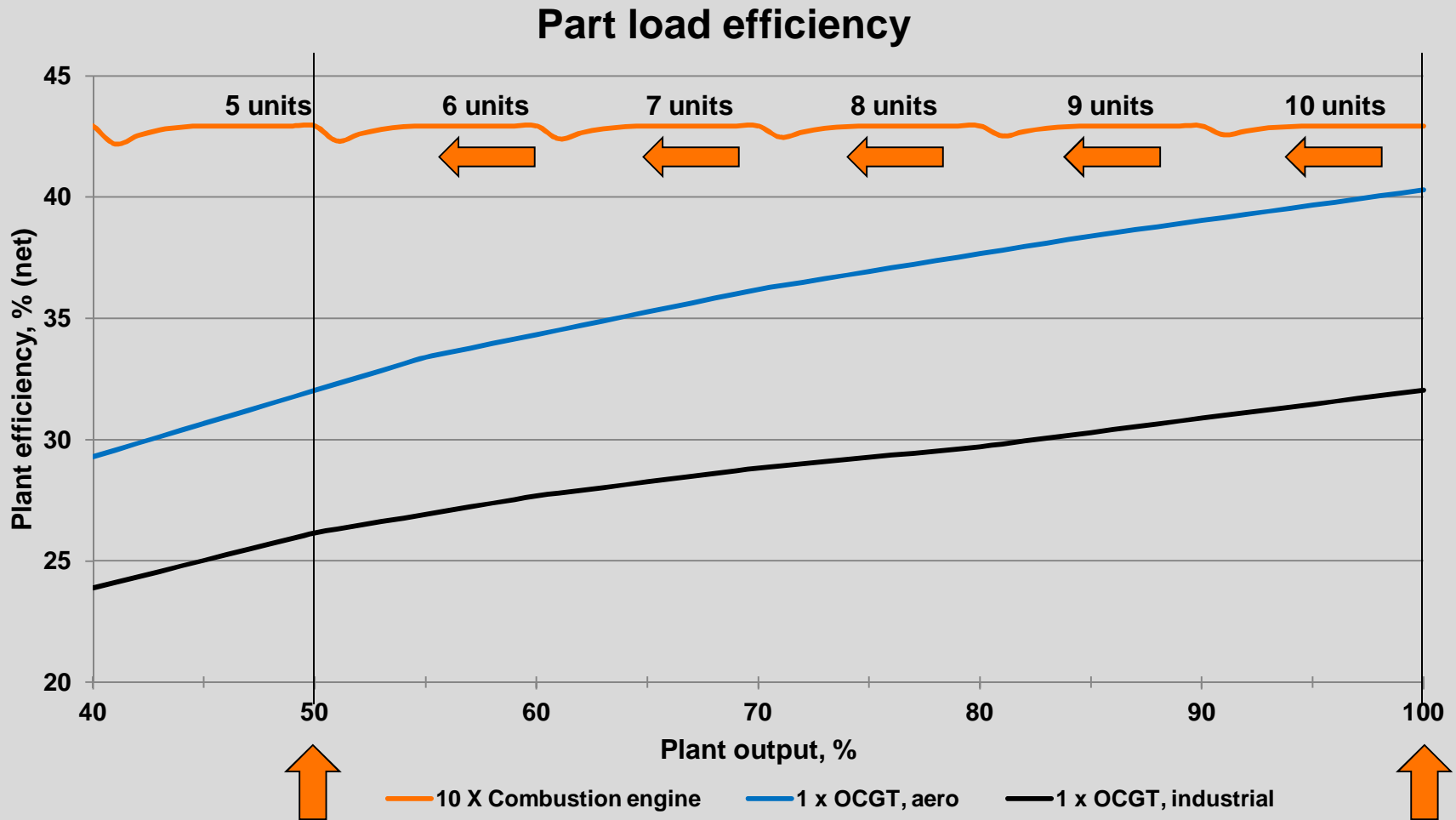
Source: *Impact of Intermittency: How wind variability could change the shape of the British and Irish electricity market, July 2009*

Engines are more efficient across the operation range

Average efficiency, start to stop

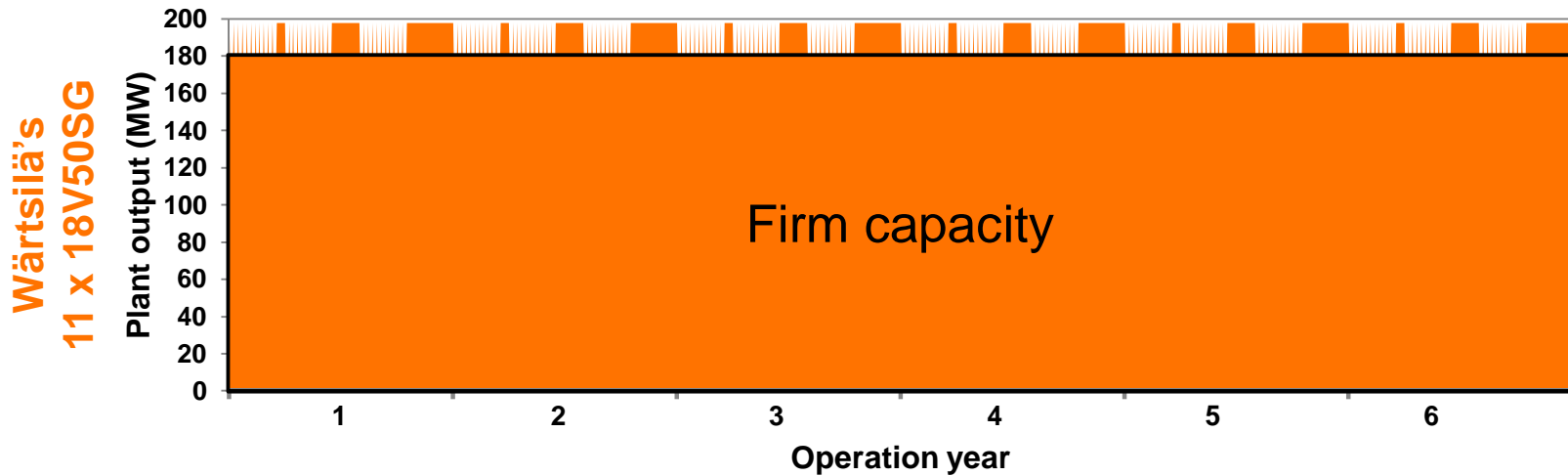
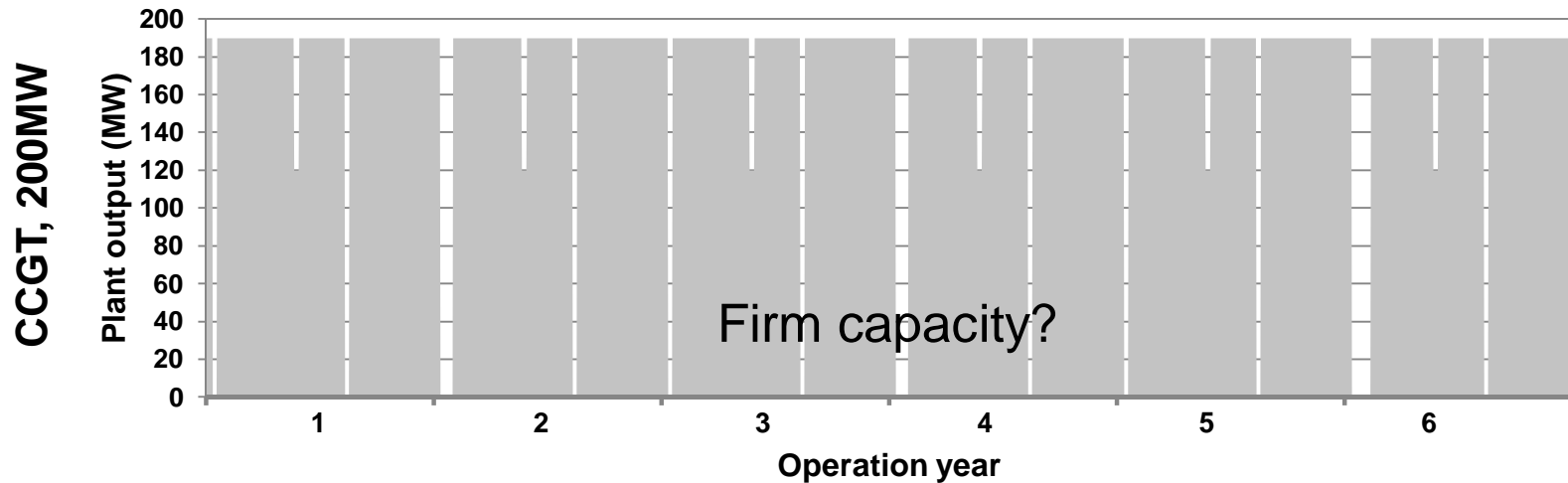


High efficiency due to multiple units



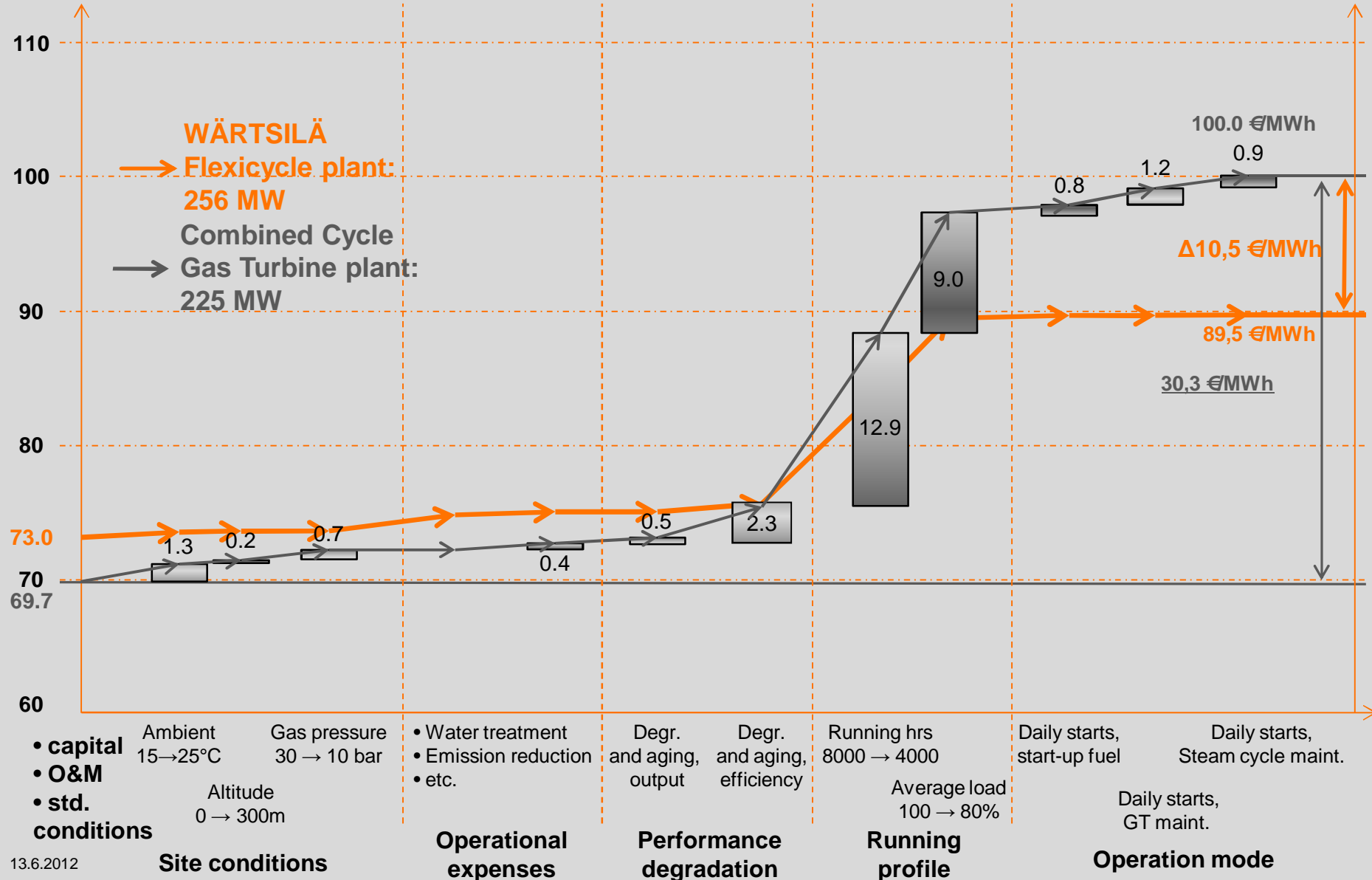
GT performances: GTPro by Thermoflow

High reliability due to multiple units



True and lower cost of generation

Electricity generation cost
€MWh



- capital
- O&M
- std. conditions

Ambient 15→25°C
 Gas pressure 30 → 10 bar
 Altitude 0 → 300m

Site conditions

- Water treatment
- Emission reduction
- etc.

Operational expenses

Degr. and aging, output
 Degr. and aging, efficiency

Performance degradation

Running hrs 8000 → 4000
 Average load 100 → 80%

Running profile

Daily starts, start-up fuel

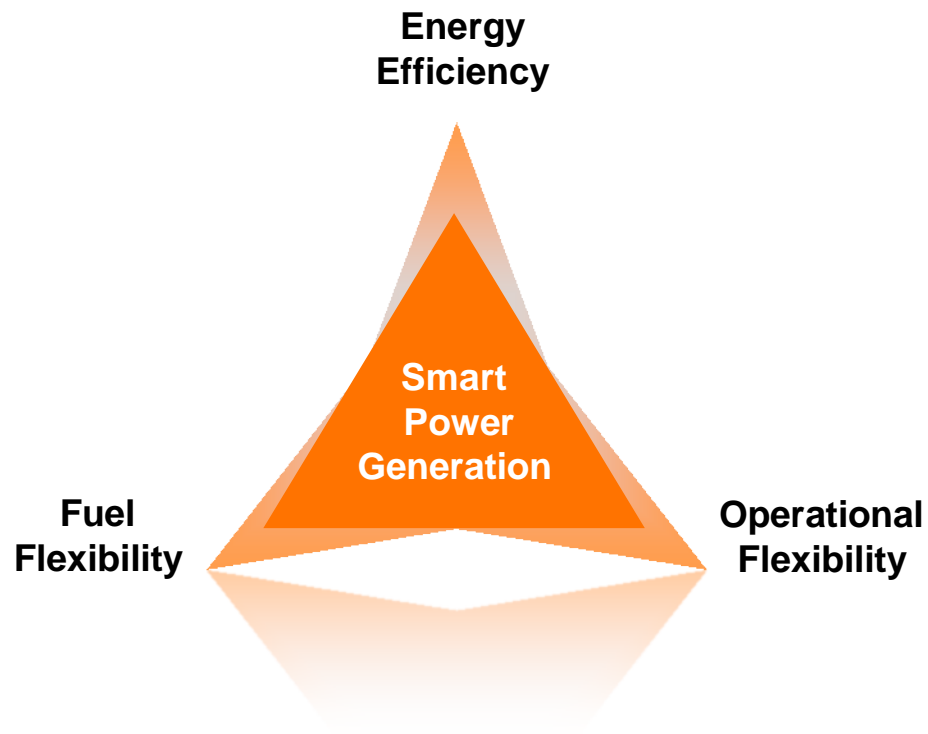
Daily starts, GT maint.

Operation mode

Daily starts, Steam cycle maint.

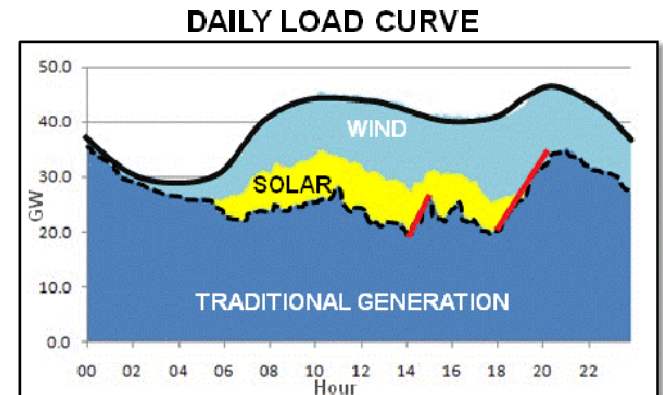
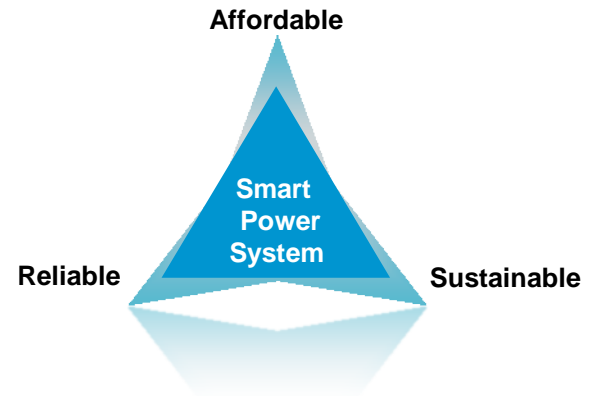
Benefits to power producers

- **Operation in different generation modes**
- **High efficiency**
- **Fuel flexibility**
- **Dependable and committable**
 - Multiple generating units
- **Operate on multiple markets**
 - Energy markets
 - Capacity markets
 - Ancillary services markets
- **Optimum plant location close to consumers**
- **Fast access to income through fast-track project delivery**
- **Competitive O&M costs**



Benefits to power systems

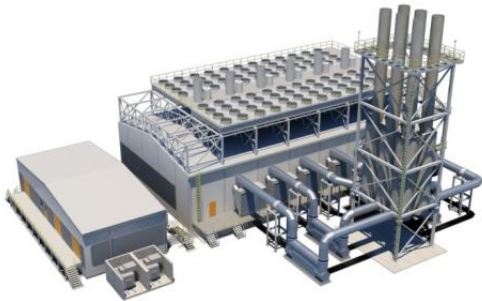
- **Secures the supply of affordable and sustainable power**
 - Enable highest penetration of wind and solar power capacity
 - Maximising the use of wind power capacity by minimising wind curtailment
 - Ensure system stability in wind variability and contingency situations
- **Ensures true optimisation of the total power system operation**
 - Remove the abusive starts and stops, and cyclic load from baseload plants that are not designed for it
 - Improves the total system efficiency



Smart Power Generation Solutions

Modularity and multi unit solution enable accurate plant size matching to the grid and the demand

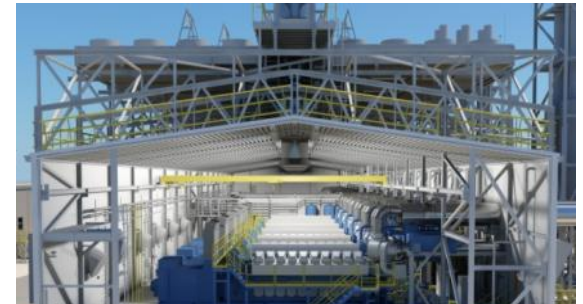
W34SG CMPP
10-100 MW



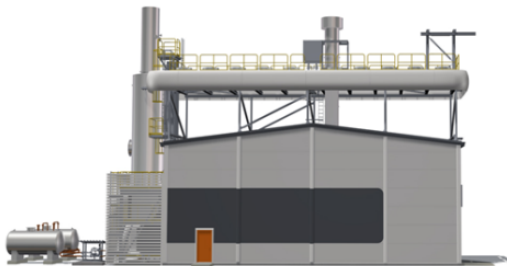
W34SG CMPP
100-300 MW



W50SG CMPP
20-500MW



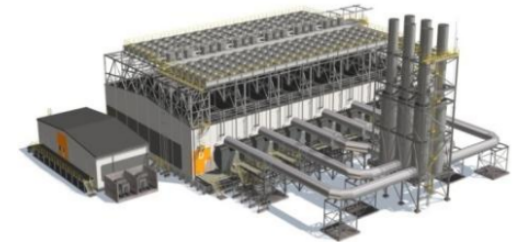
W34SG GAScube
8 - 30 MW



W34DF / W50DF CMPP



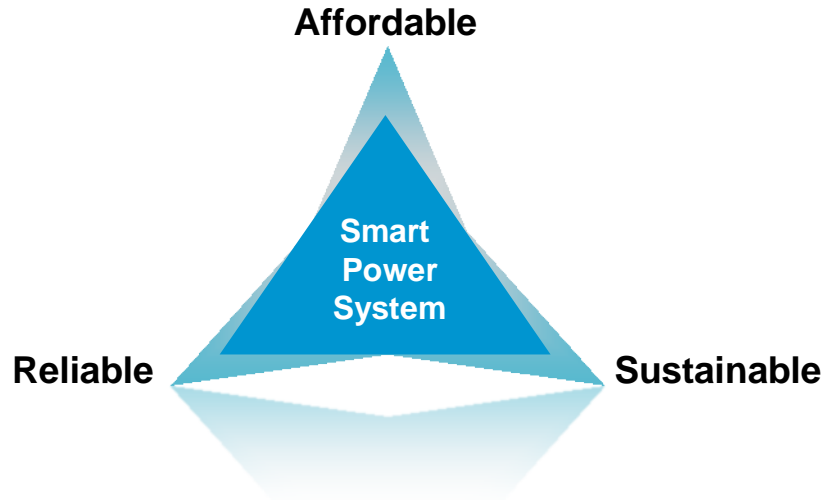
W32GD / W46GD CMPP



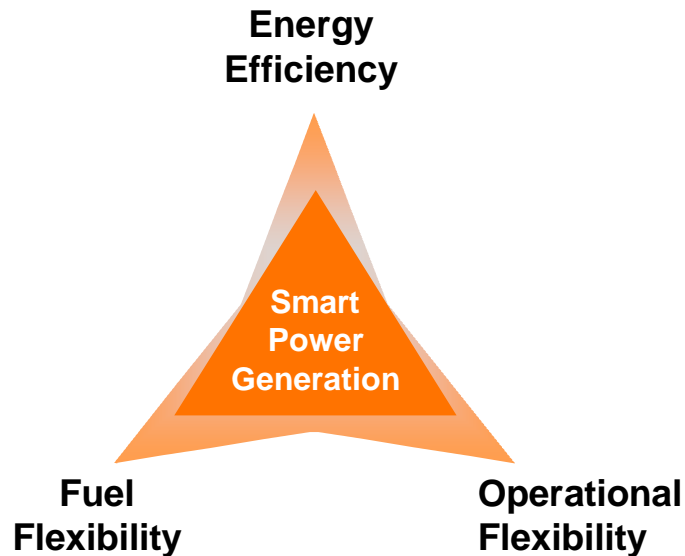
CMPP = Compact Modular Power Plant

Matching changing requirements

DESIRED FUTURE OF POWER SYSTEM



WÄRTSILÄ'S OFFER





WÄRTSILÄ