

# Towards a 100% renewable energy future: WÄRTSILÄ Energy Solutions

Marco Golinelli, Director Energy Solutions

X Conferenza Nazionale per l'Efficienza Energetica



# THIS IS WÄRTSILÄ

A global leader in smart technologies and complete lifecycle solutions for the marine and energy markets

## CLEAN ENVIRONMENT

A future without emissions or pollution

## MARKET SHAPING & INNOVATION

A union of new technology and business models

## ENERGY INTELLIGENCE

An optimised way of producing and using energy

**WÄRTSILÄ'S PURPOSE**  
is to enable sustainable societies with smart technology.



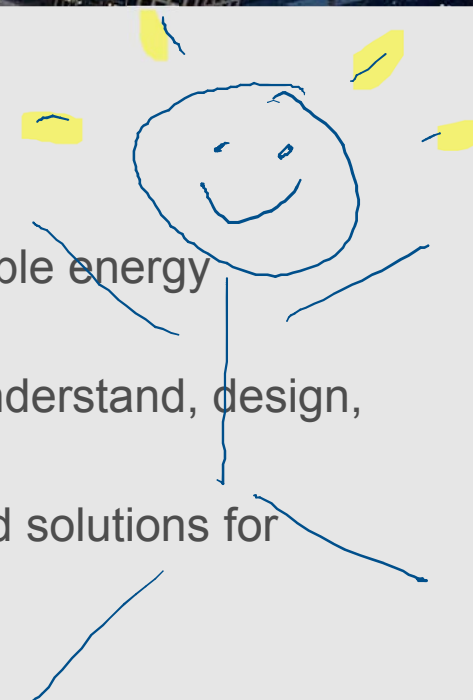


## Smart Energy Vision

The energy landscape is in transition towards more flexible and sustainable energy systems. **We envision a 100% renewable energy future.**

Wärtsilä is leading the transition as the **Energy System Integrator** – we understand, design, build and serve optimal power systems for future generations.

We provide all the essential technologies, lifecycle services and optimised solutions for future energy systems.



ECONOMIC  
GROWTH,  
ELECTRIFICATION  
AND IMPROVING  
STANDARD  
OF LIVING

RAPIDLY  
INCREASING  
**RENEWABLES**

DECLINING  
INFLEXIBLE  
**BASE LOAD**  
GENERATION

EMERGING  
DISRUPTIVE  
**STORAGE**  
TECHNOLOGY

THE ROLE  
OF **GAS** IS  
INCREASING

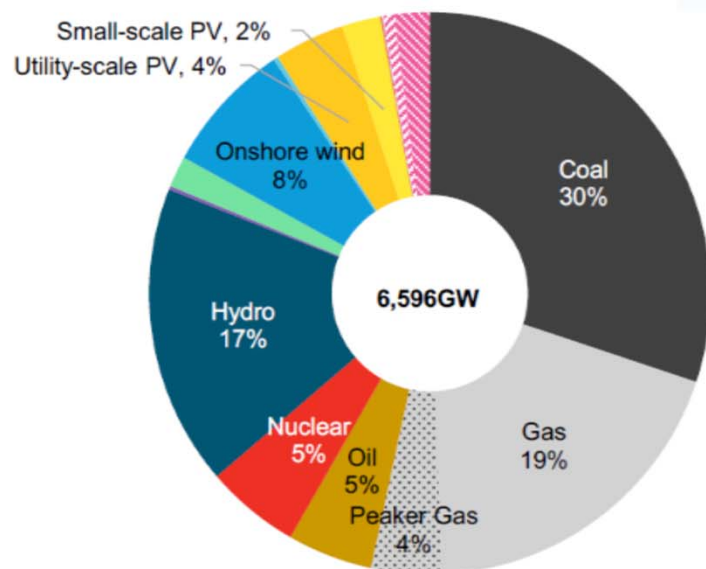


- Solar and wind dominate future electricity investment and capacity
- Solar and wind costs fall rapidly, due to fundamentally new technologies
- Coal-fired power collapses in Europe and the U.S., more mixed in Asia
- Gas plays a key role, but not as most people imagine
- Batteries and new sources of flexibility support reach of renewables

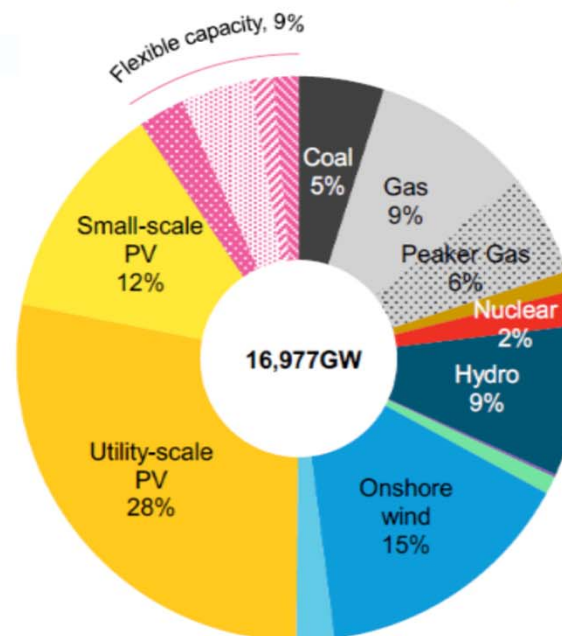
*Source: Bloomberg NEF.*



Global cumulative installed capacity: 2017



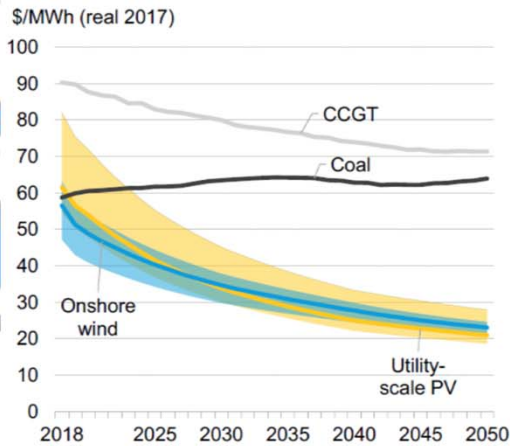
Global cumulative installed capacity: 2050



Source: Bloomberg NEF, New Energy Outlook 2018

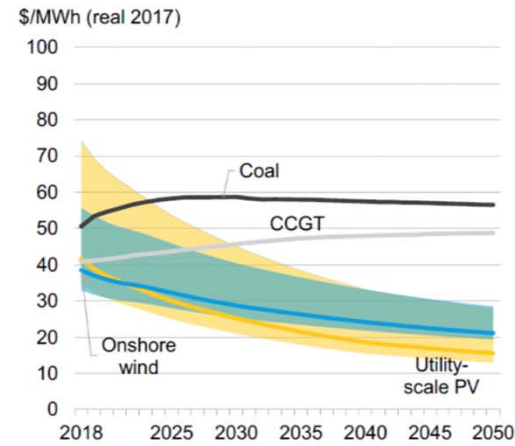
## VRE COST

### China



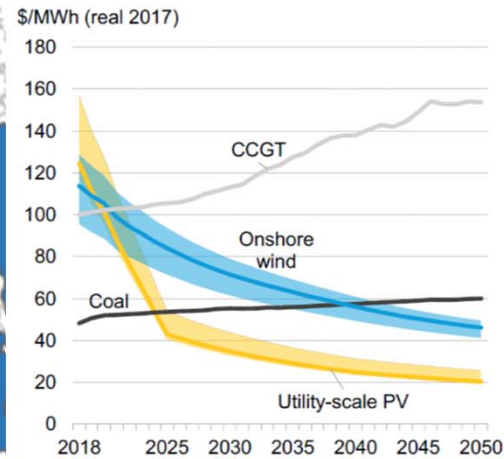
Source: Bloomberg NEF. Note: capacity factors: PV: 12%-18%, onshore wind: 23%-32%. Coal and gas plants capacity factors are a result of our NEO 2017 dispatch analysis. LCOEs are unsubsidized. The LCOE for thermal plants in China includes the carbon pricing.

### U.S.



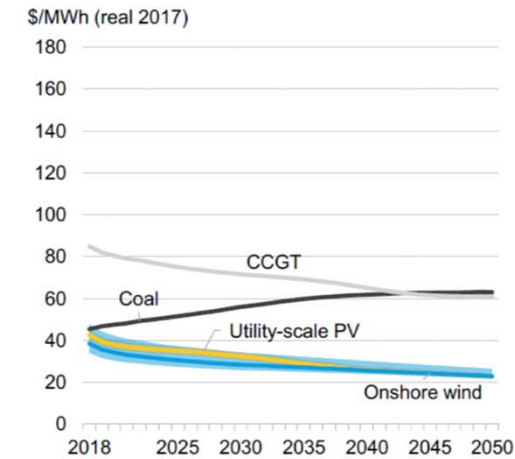
Source: Bloomberg NEF. Note: capacity factors: Tracking PV: 14%-30%, onshore wind: 29%-49%. Coal and gas plants capacity factors are a result of our NEO 2017 dispatch analysis. LCOEs are calculated on an unsubsidized basis.

### Japan



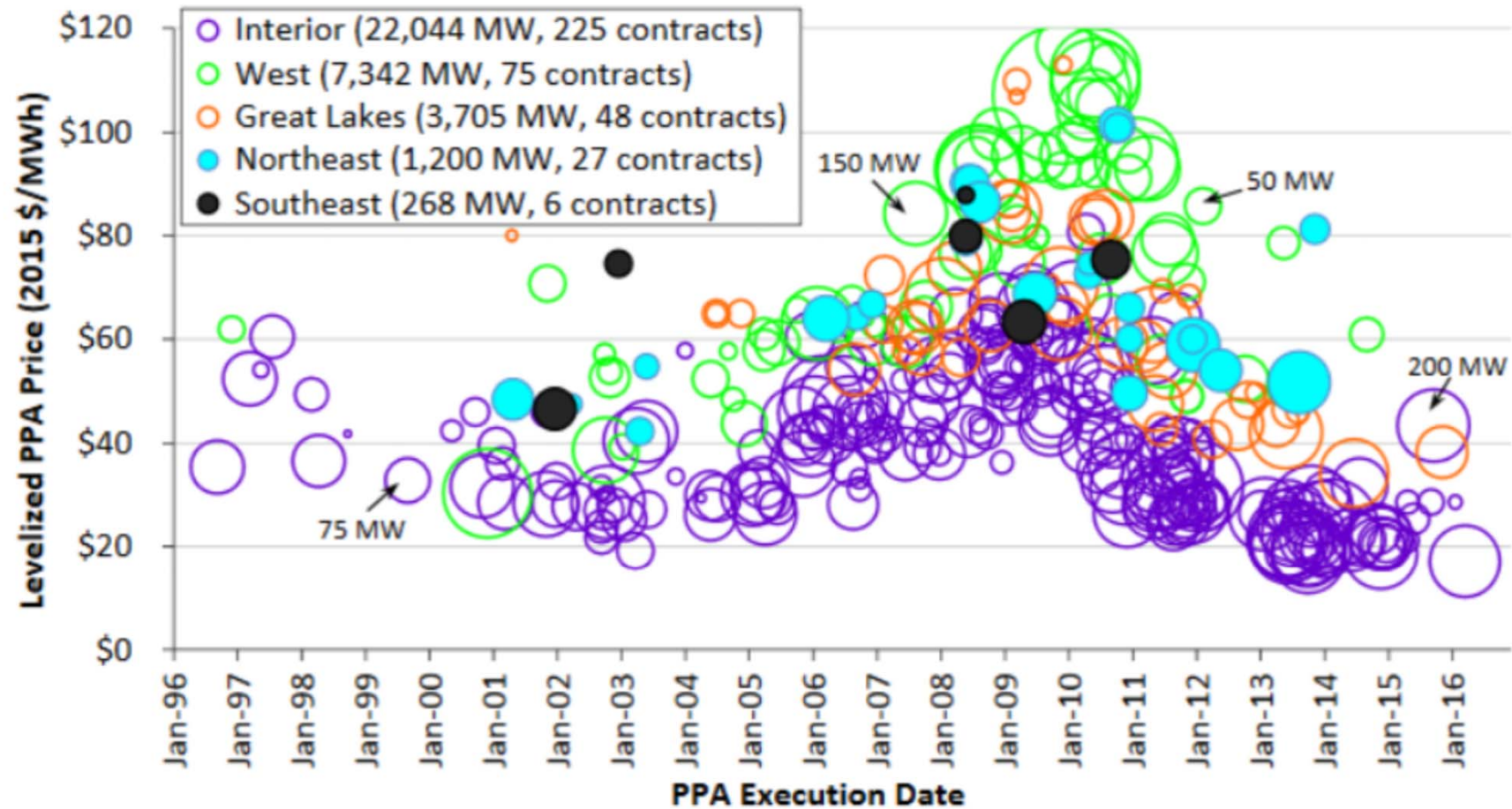
Source: Bloomberg NEF Note: capacity factors: PV: 12%-16%, onshore wind: 22%-30%. Coal and gas plants capacity factors are a result of our NEO 2017 dispatch analysis. LCOEs are calculated on an unsubsidized basis.

### India



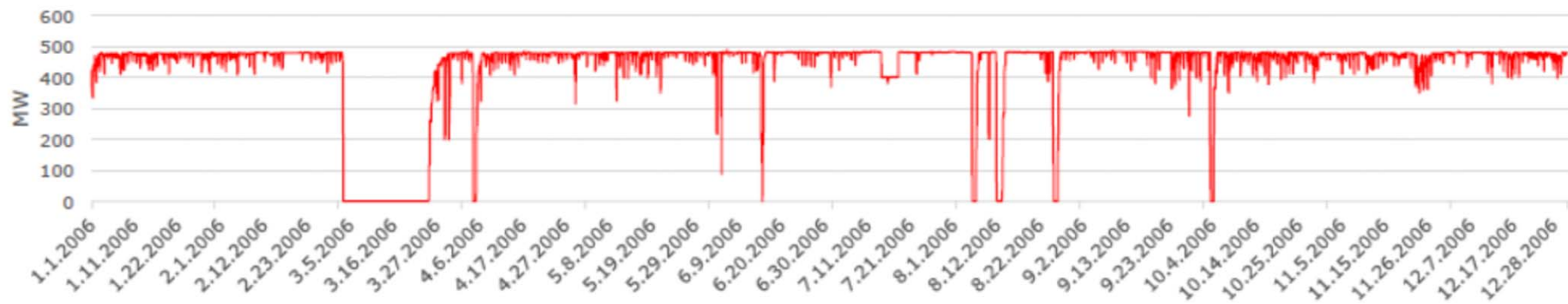
Source: Bloomberg NEF Note: capacity factors: PV: 19%-20%, onshore wind: 25%-35%. Coal and gas plants capacity factors are a result of our NEO 2017 dispatch analysis. LCOEs are calculated on an unsubsidized basis.

## WIND PPA PRICES: RECORD LOW

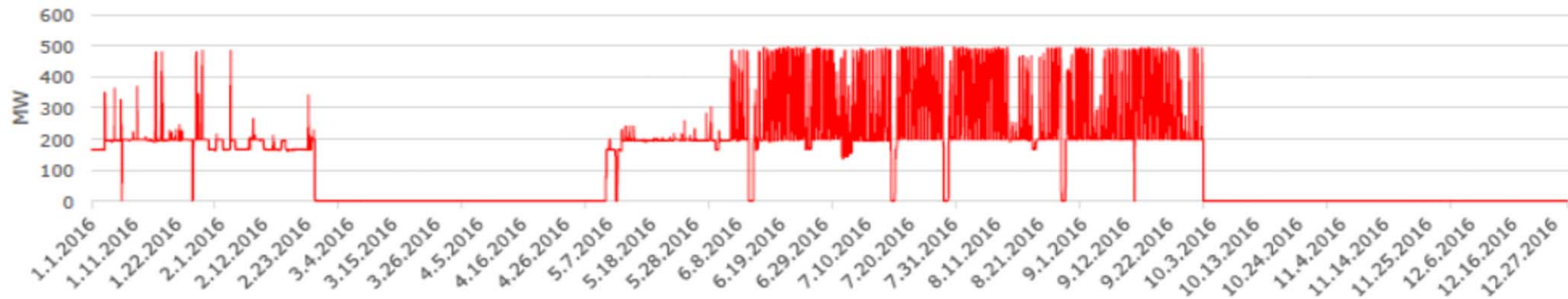


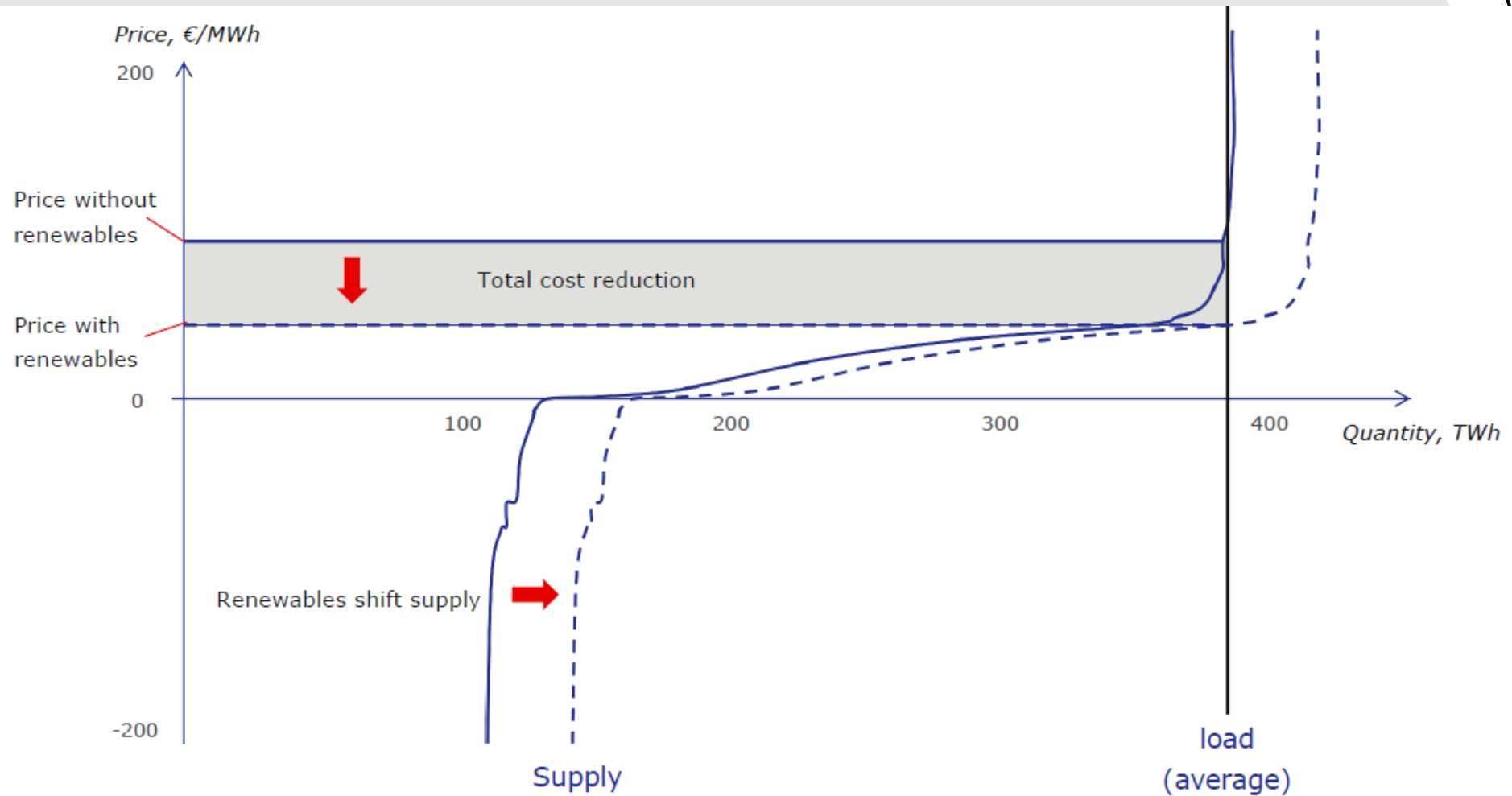


Gibbons Creek Coal plant in Texas in 2006

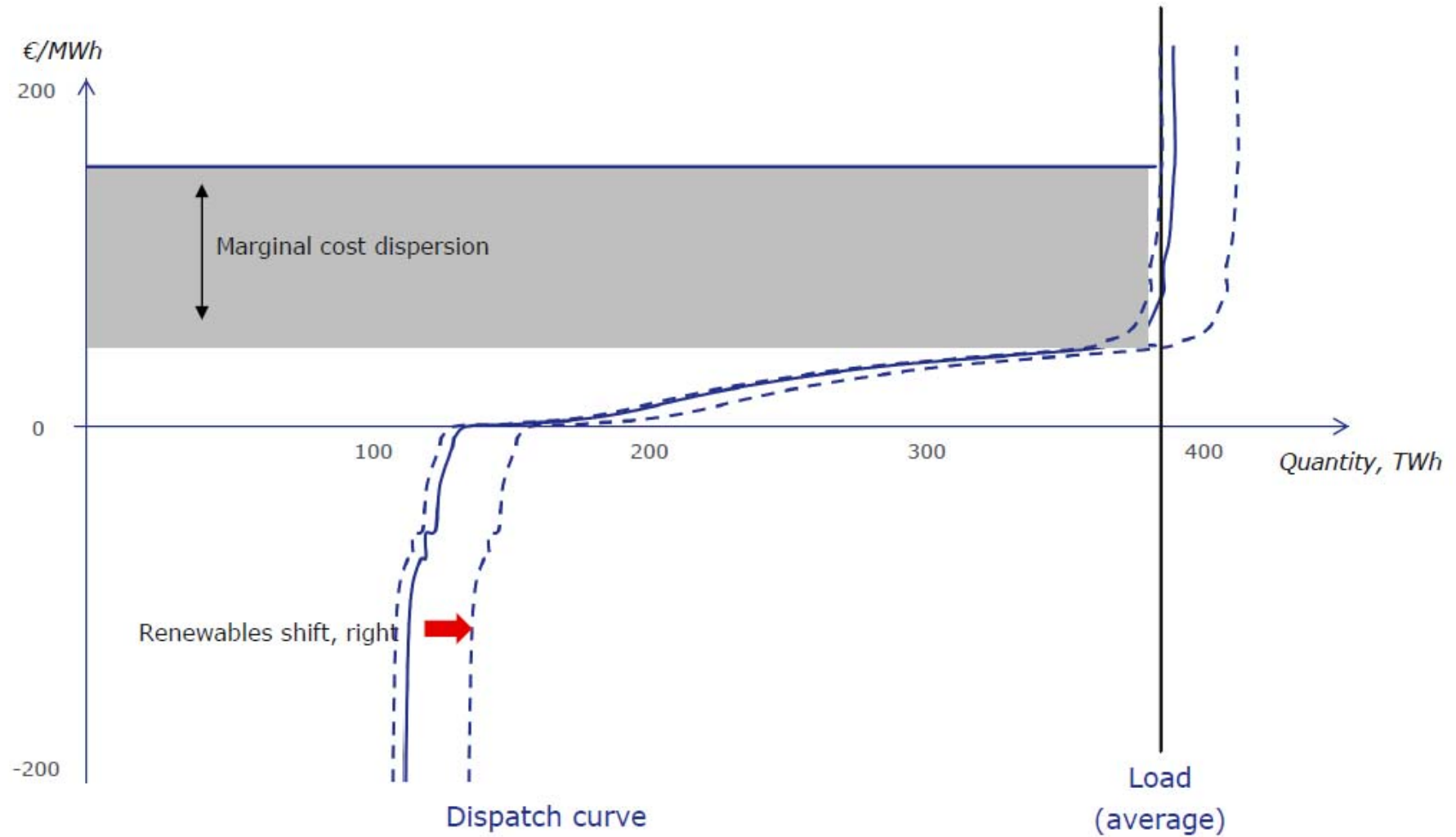


Gibbons Creek Coal plant in Texas in 2016









## Wind forecast error

Smart  
Energy

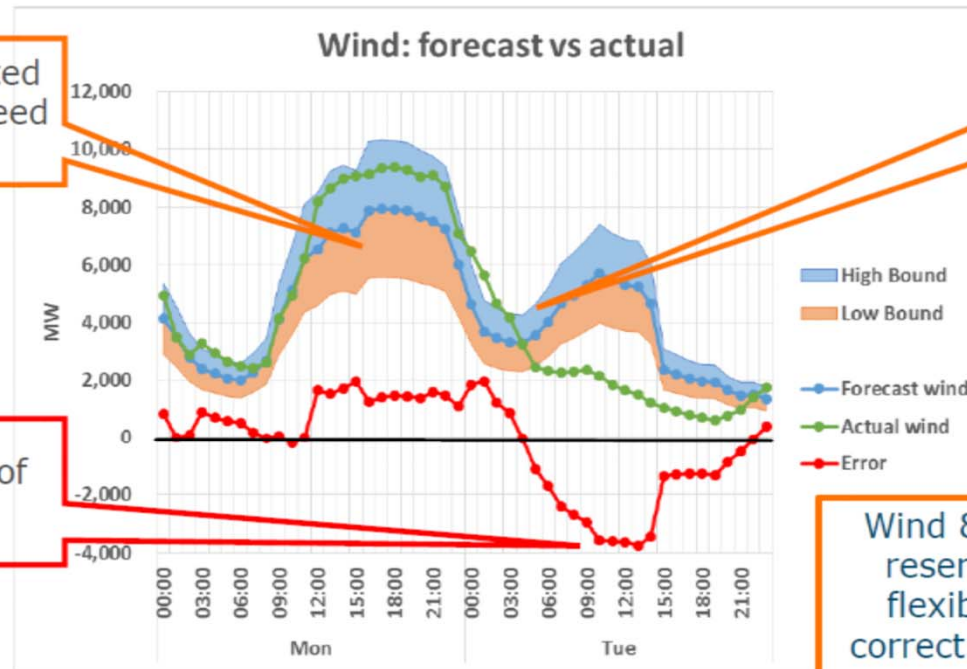
BY WÄRTSILÄ  
AND AACTO EE

Leaders  
Forum

Statistically calculated  
balancing reserve need  
up&down

How late can you  
react?

Need almost 4GW of  
balancing power!



Wind & solar forecast error  
reserve should be fast &  
flexible to come on-line,  
correct the error & go offline  
at any time!

Source: ERCOT, TX USA

7

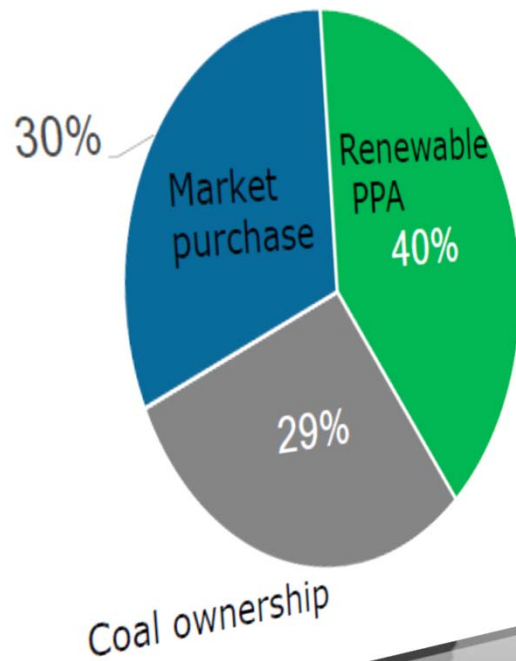


**1  
RENEWABLES  
PROVIDE  
MAJORITY OF  
ENERGY**

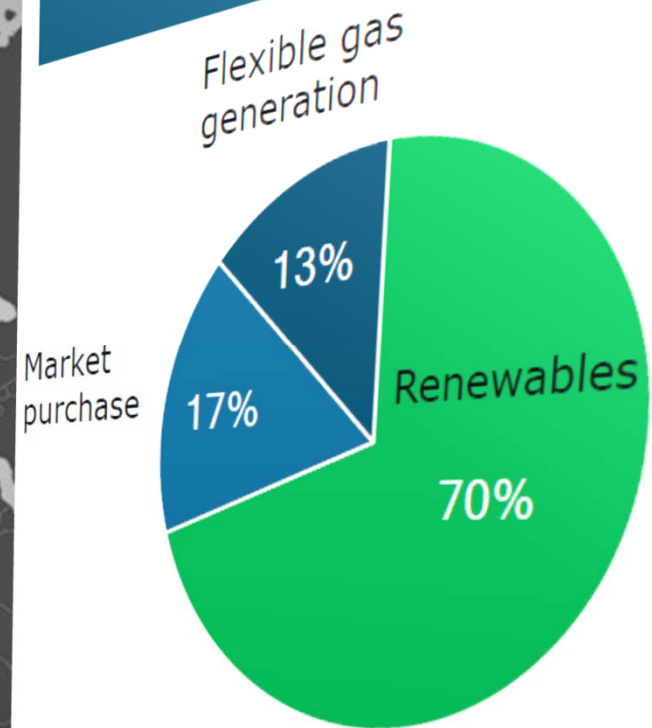
**2  
MARKET  
PROVIDES  
THE SOURCE  
FOR  
BALANCING**

**3  
FLEXIBILITY  
PROVIDES  
THE  
SECURITY**

Denton's energy mix 2016

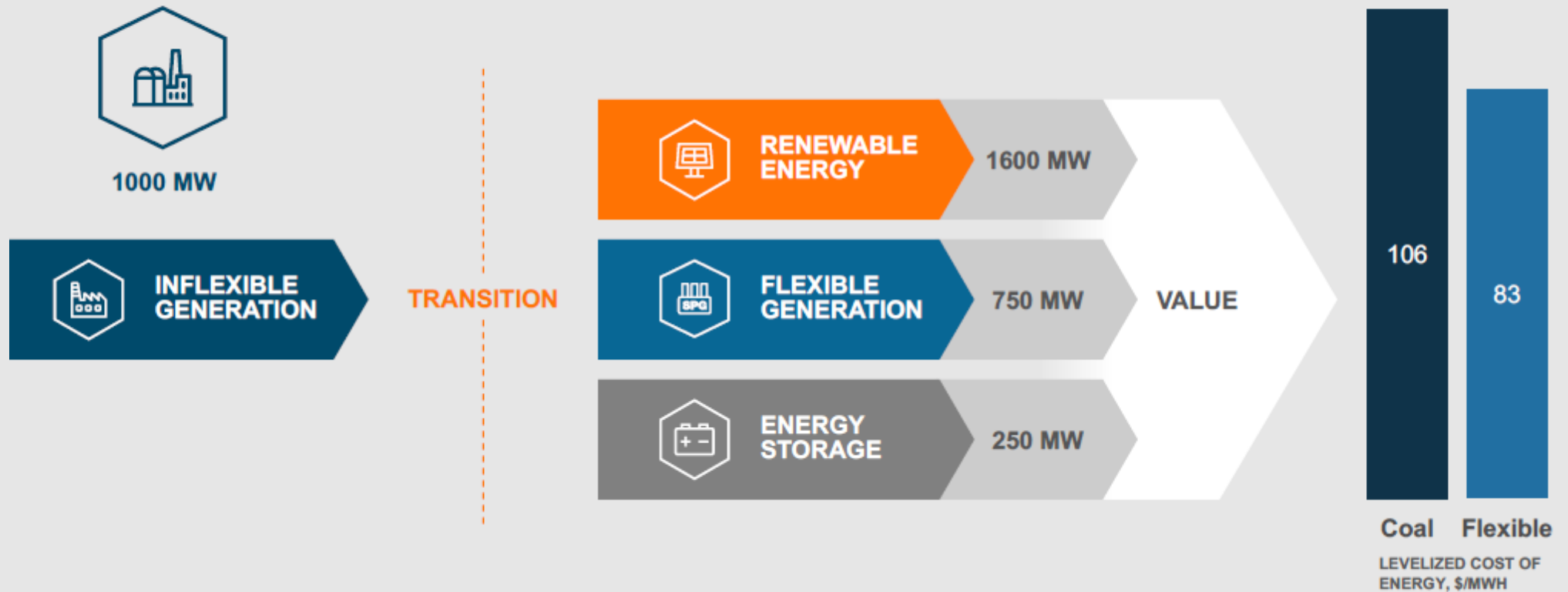


Denton's energy mix 2018





## AGL is planning to replace Liddell coal plant with renewables and additional 750 MW of flexible gas capacity



- Increased renewables

The UK government is committed to decarbonising the electricity network, as a key step towards decarbonising the wider economy. The UK is legally bound by emissions reduction targets of 34% by 2020 and 80% by 2050. Renewables will play a key role in this decarbonisation: the UK government has targeted that 30% of electricity generation will come from renewable sources by 2020, primarily wind turbines.

- Decreased conventional generation

Conventional thermal generation (coal, gas, oil) is set to reduce, primarily due to emissions regulations. Conventional plant currently provide some flexibility, and their reduction will lower system flexibility

- Increased nuclear by 2030

The government is committed to a new generation of nuclear generators to replacing the UK's ageing nuclear reactors. Nuclear generators are inflexible, and will not contribute to system flexibility





- System “flexibility” allows supply and demand to be balanced more easily than by conventional thermal power plant
- Sources of flexibility included:
  - Flexible generation
  - Demand Side Response (DSR)
  - Electricity storage
  - Interconnection
  - Smarter networks
- Different source of flexibility have different characteristics and constraints on operation. For example:
  - Storage and Demand Side Response shift demand that has to be recovered at another point in time
  - Interconnectors depend on adequate flexibility in interconnected markets
  - Flexible generation can be used at any time and does not rely on other forms of flexibility
- The different sources of flexibility operate over different time-frames, both in terms of response time and duration.

## CENTRICA COMPLETES TWO 50MW FAST-RESPONSE PLANTS IN BRIGG AND PETERBOROUGH



...Capable of producing enough power to meet the needs of 100,000 homes, the 50MW\* facilities have been designed to respond to peaks in demand within **two minutes**

The new plants have been built on land adjacent to Centrica's existing gas-fired power plants and each consist of five reciprocating gas engines that will typically run for a few hours a day...

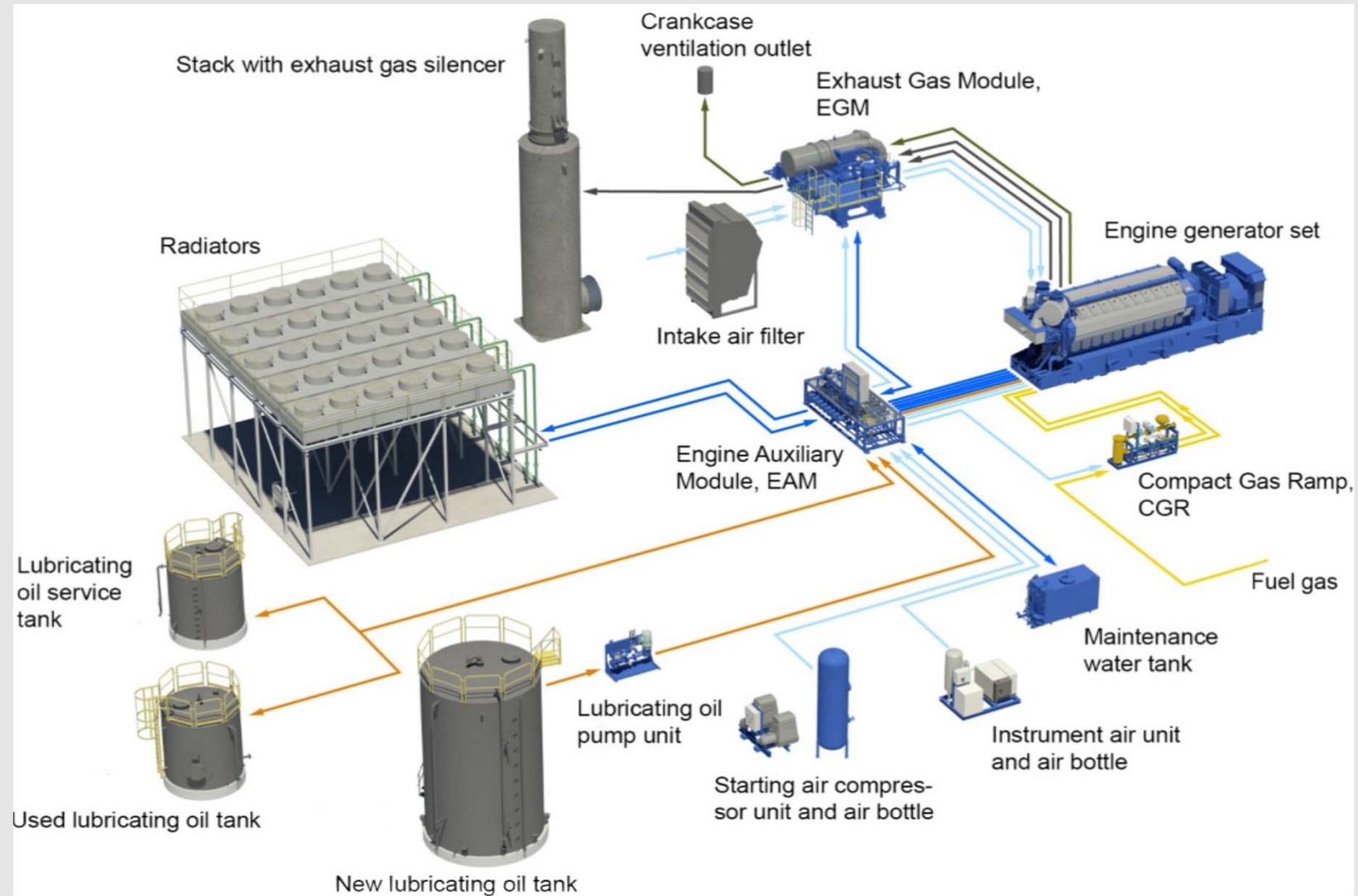
Mark Futyan, Distributed Power Systems Director at Centrica Business Solutions, said: **"We're pleased to open our first two peaking plants, which will help meet the UK's changing energy needs and ultimately support the transition to a low carbon future by providing an important back up to renewable generation."**

"We're seeing increasing demand for flexible power so this is an important demonstration of how we can help our customers to navigate the new energy landscape and deliver a variety of end-to-end solutions including onsite generation, demand side response and energy storage."

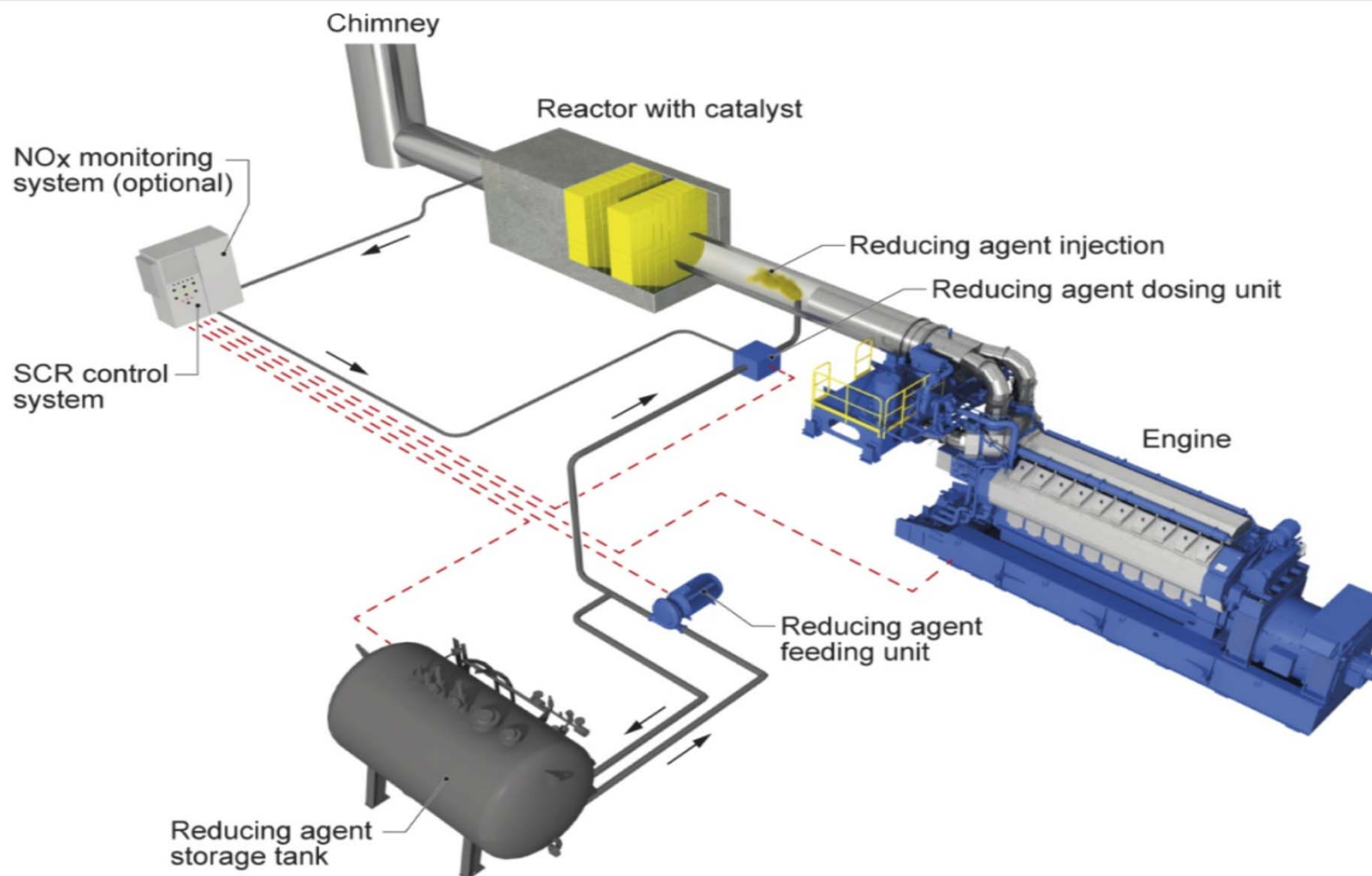
The engines have been supplied by Wärtsilä.

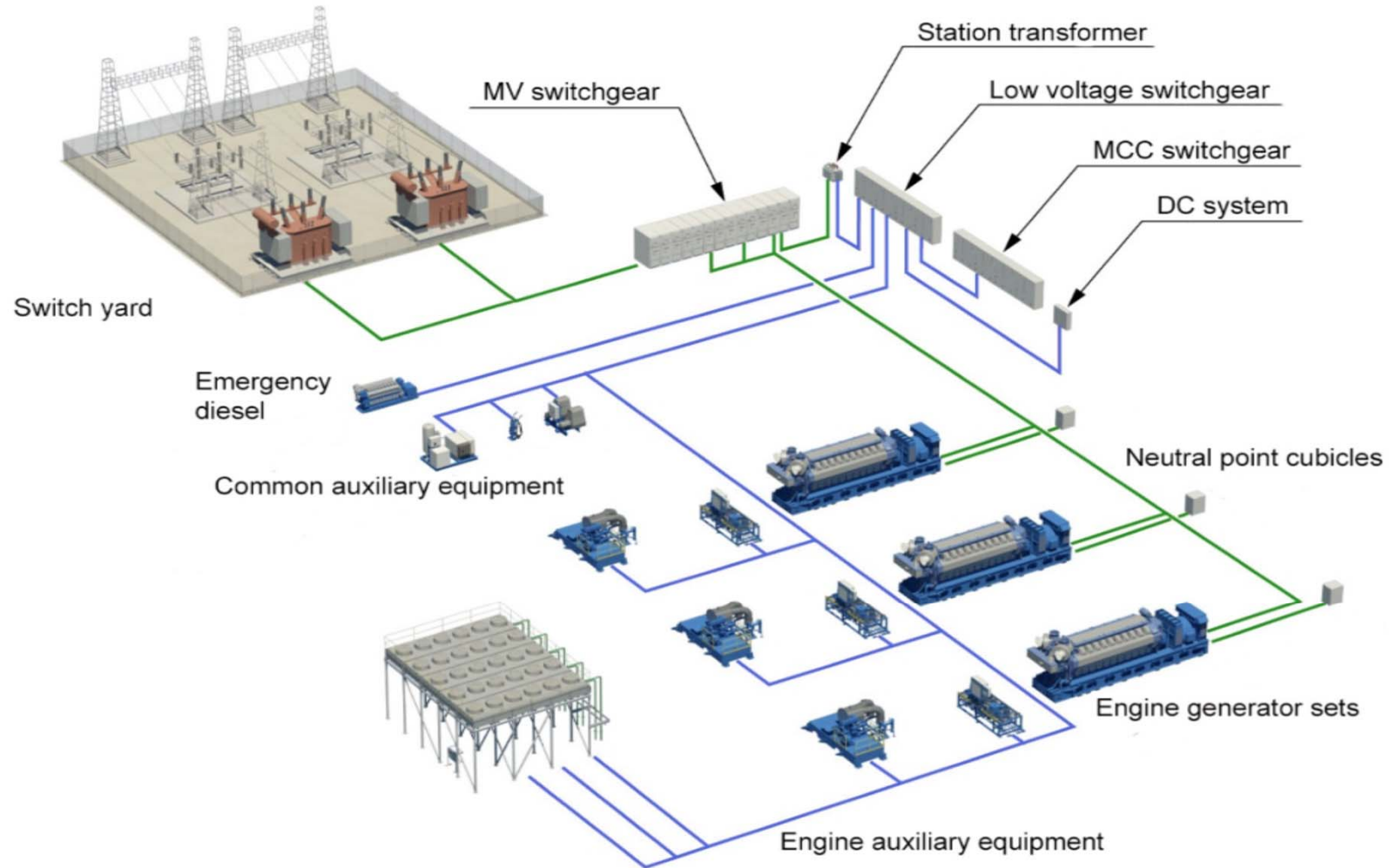
\*The plants each comprise 5 x 9.8MW engines, delivering a total capacity of 49MW.











## CENTRICA'S PLANT BRIGG





48

2

1

## 50 MW plant range

Under the scope:

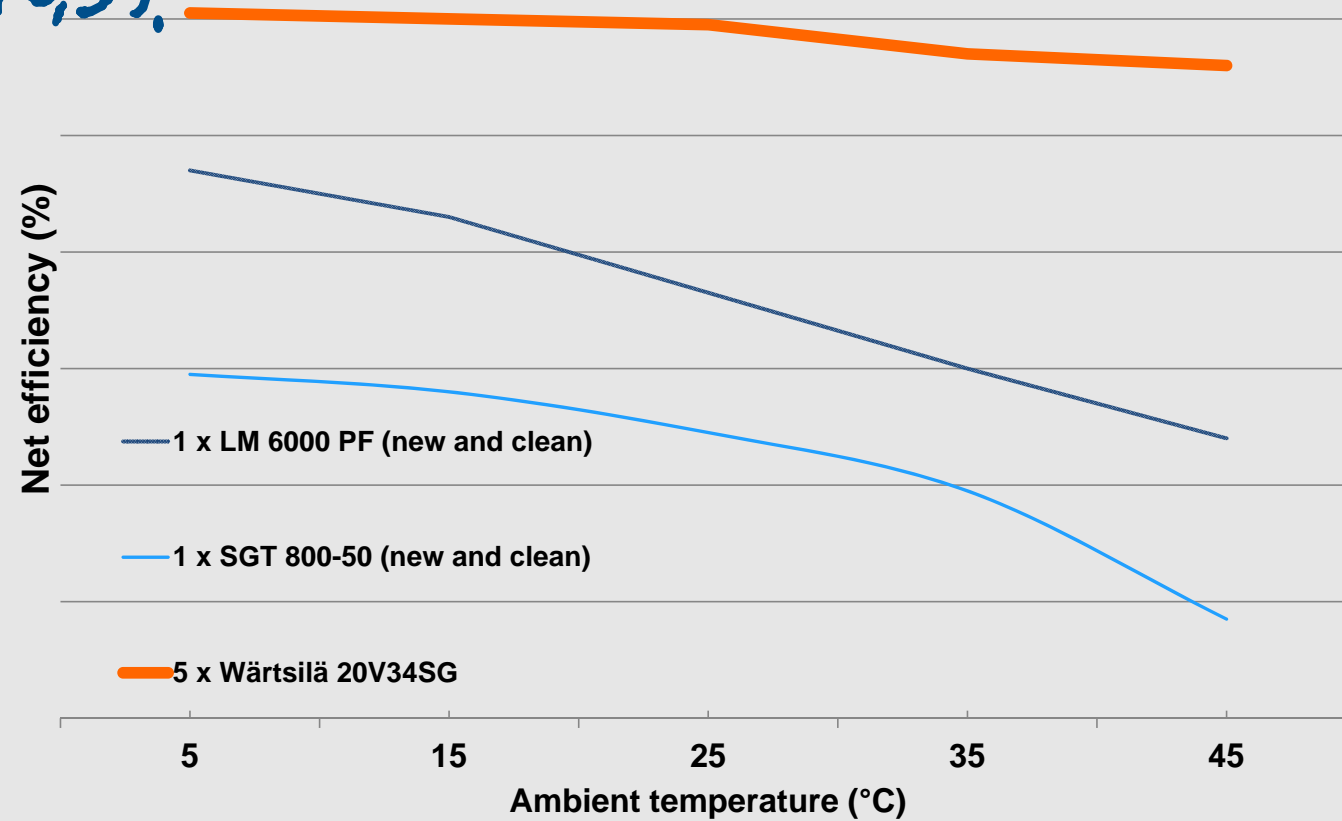
- GE LM6000 PF
- Siemens SGT 800-50
- 5x Wärtsilä 20V34SG

Comparison



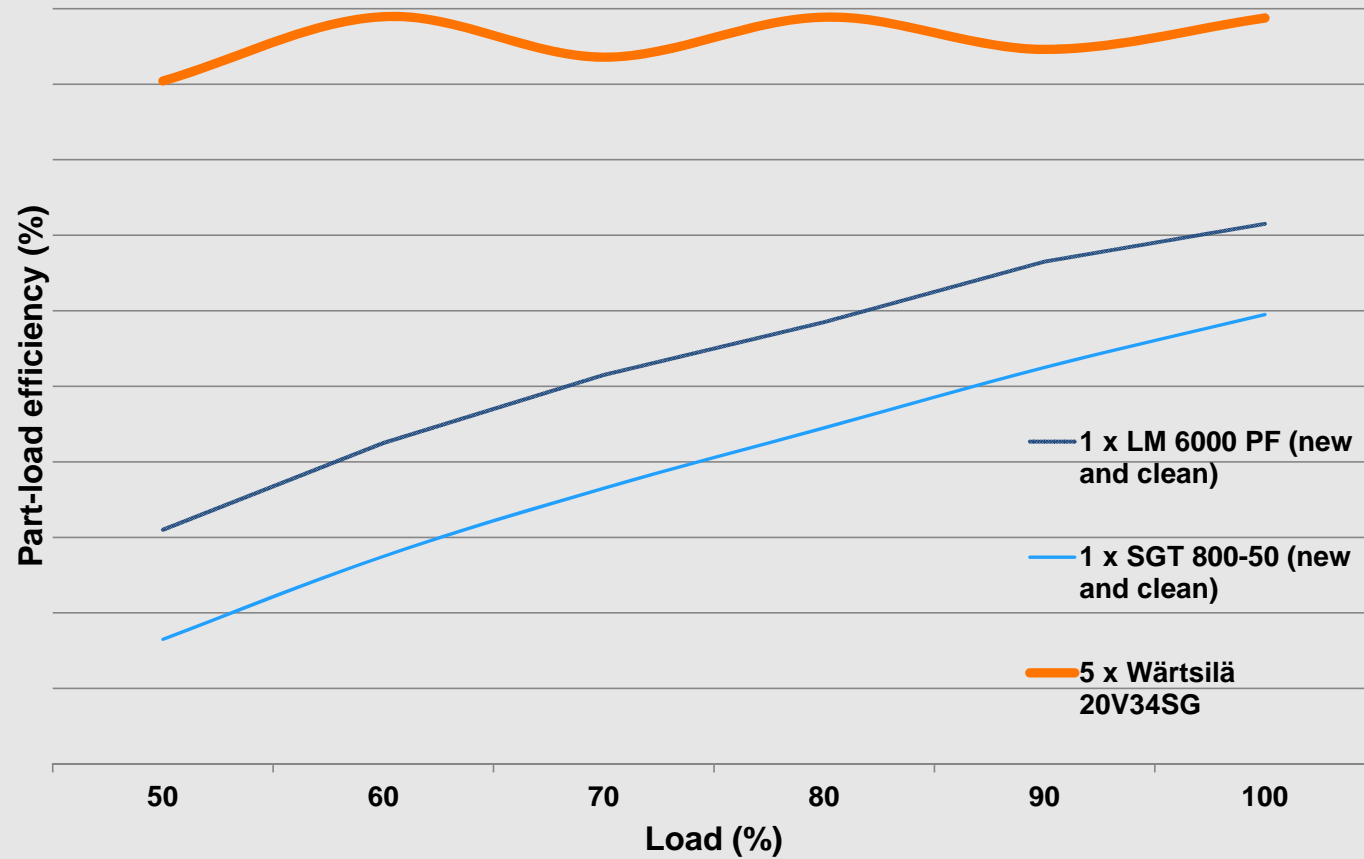
## EFFICIENCY VS. TEMPERATURE

48,5%

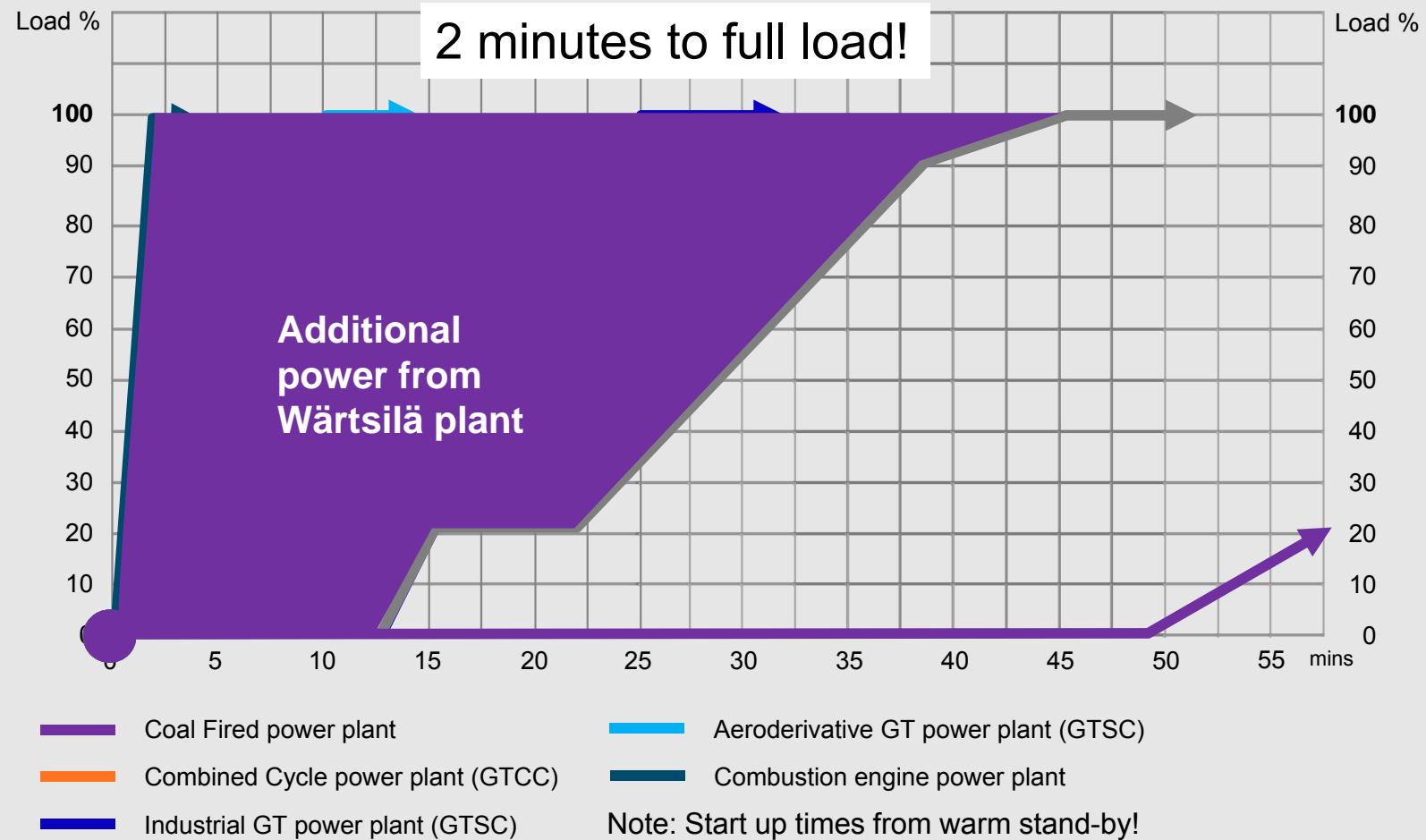




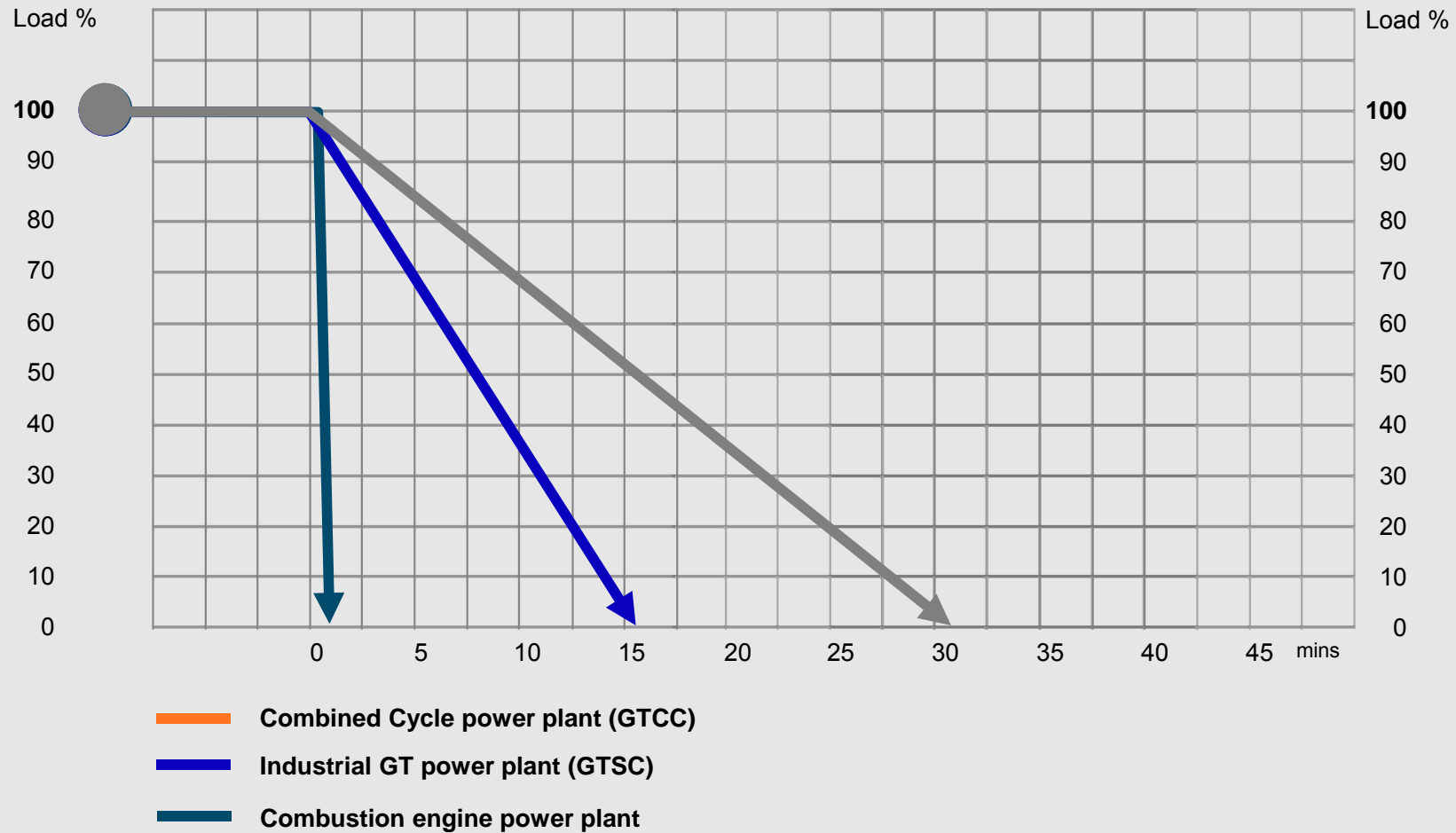
## PLANT NET EFFICIENCY VS. LOAD



## LOADING SEQUENCES FOR DIFFERENT POWER PLANTS

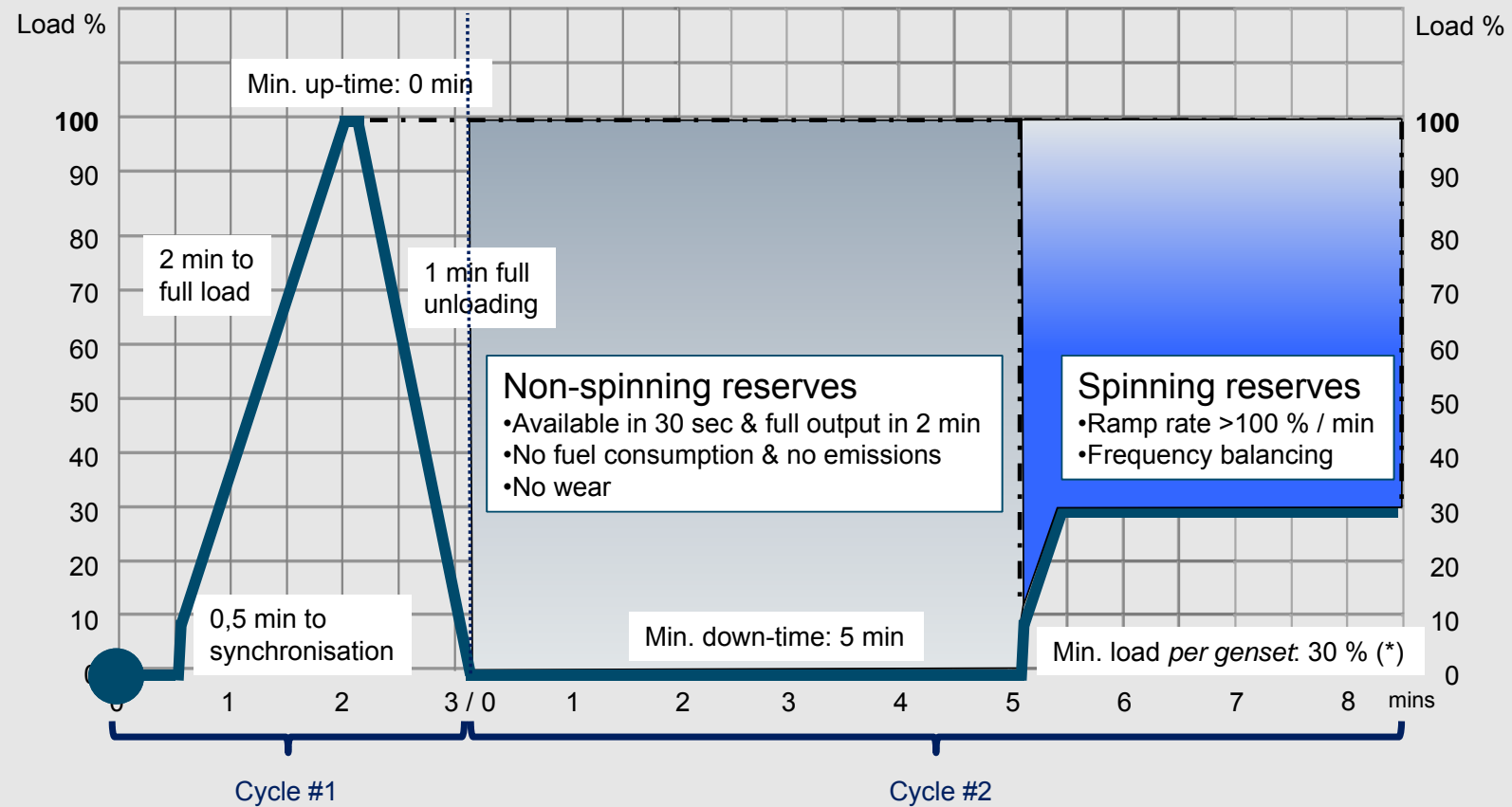


## UNLOADING SEQUENCES FOR DIFFERENT POWER PLANTS





## LOADING AND UNLOADING OF A WÄRTSILÄ 34 GAS POWER PLANT

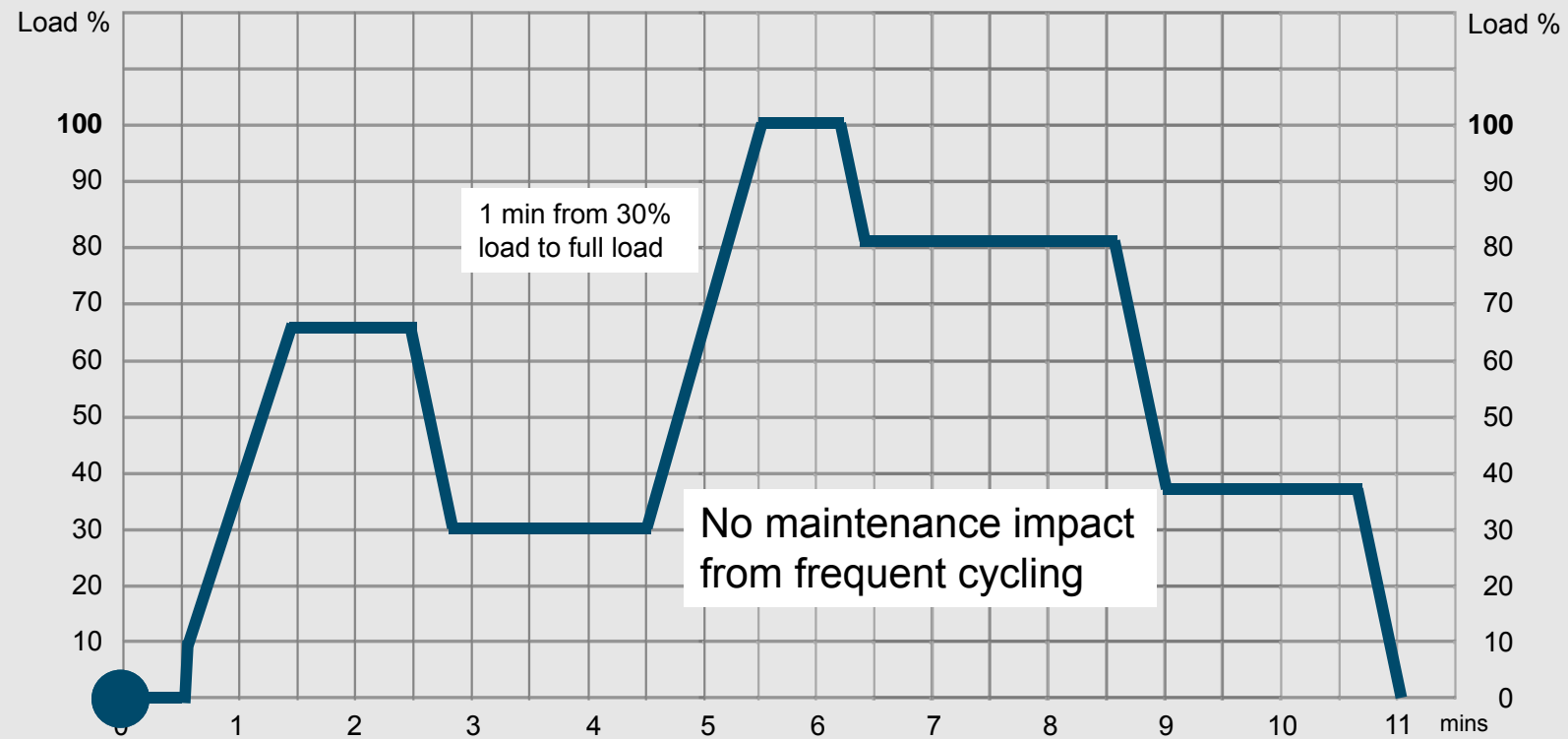


— Wärtsilä 34 gas power plant

(\*) A power plant with e.g. 10 gensets can correspondingly operate at 3 % of its total nominal output.

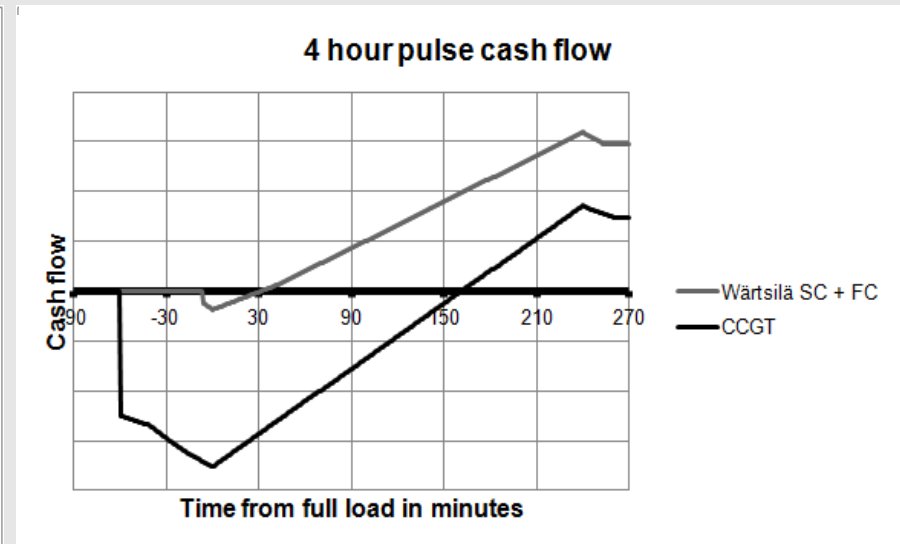
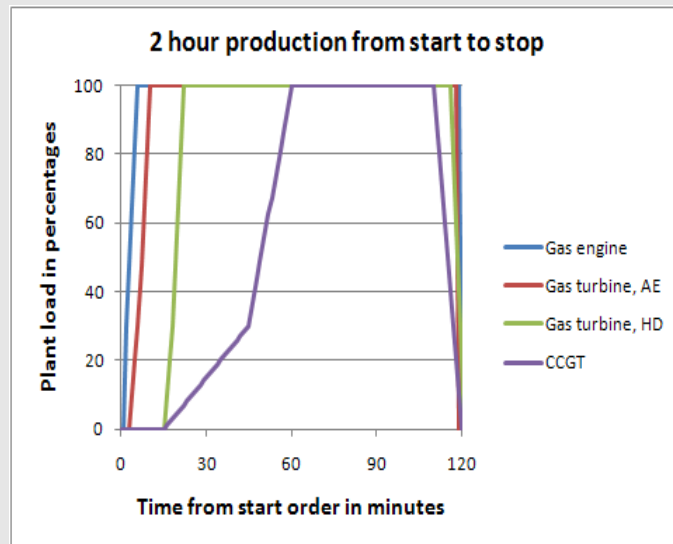
Note: Start-up times from hot stand-by!

## CYCLING OF A WÄRTSILÄ 34 GAS POWER PLANT



— Wärtsilä 34 gas power plant

Note: Start-up times from hot stand-by!



## The next generation of

- Efficiency
- Operational flexibility
- Reliability & Serviceability



The biggest internal  
combustion engine  
running on gas

49,4



The highest  
efficiency internal  
combustion engine

50,6



*W* + CHP



## ENGINE POWER PLANTS

Ultra-flexible internal combustion engine based power plants



## ENERGY STORAGE AND INTEGRATION

Utility-scale energy storage solutions and advanced software



## RENEWABLES

Utility-scale solar power plants, solar-engine, storage+ hybrid solutions



## LNG INFRASTRUCTURE

Small and medium scale liquefaction plants, terminals and distribution

**67 GW INSTALLED POWER PLANT CAPACITY IN 177 COUNTRIES**

**OVER 70+ GLOBAL ENERGY STORAGE SYSTEMS INSTALLED**

**WE HAVE BUILT THE LARGEST LNG TERMINAL IN THE NORDIC REGION**

**FIRST COMPANY IN THE WORLD TO OFFER UTILITY-SCALE HYBRID POWER PLANTS THAT UNITE LARGE FUEL-BASED POWER STATIONS WITH UTILITY-SCALE SOLAR PV POWER PLANTS**

**1**  
**RENEWABLES  
ARE THE NEW  
BASELOAD**

**2**  
**MARKET  
VOLATILITY  
WILL  
INCREASE**

**3**  
**FLEXIBILITY**  
**ENABLES  
THE SYSTEM  
FEASIBILITY**  
(and the winning  
strategy)



Italian target 2030 = renewable x2  
Flexibility support efficiency, security, environment  
Technology available (Italian technology!)  
Investors (theoretically) ready

SO WHAT?

- 1 Energy storage building
- 2 Engine hall
- 3 Electrical equipment building
- 4 Fuel treatment building
- 5 Administration building
- 6 Workshop and warehouse

Hybrid power plant configuration example

-Internal combustion engines: 60MW  
-Energy storage: 10MW / 2,5MWh  
-Hybrid output: -10MW...+70MW



THANK YOU



WÄRTSILÄ

**Marco A. G. Golinelli**

Director, Energy Solutions Italia

[Marco.golinelli@wartsila.com](mailto:Marco.golinelli@wartsila.com)

A white, handwritten signature in a cursive script, appearing to read 'Gm'.