Wärtsilä Energy Solutions

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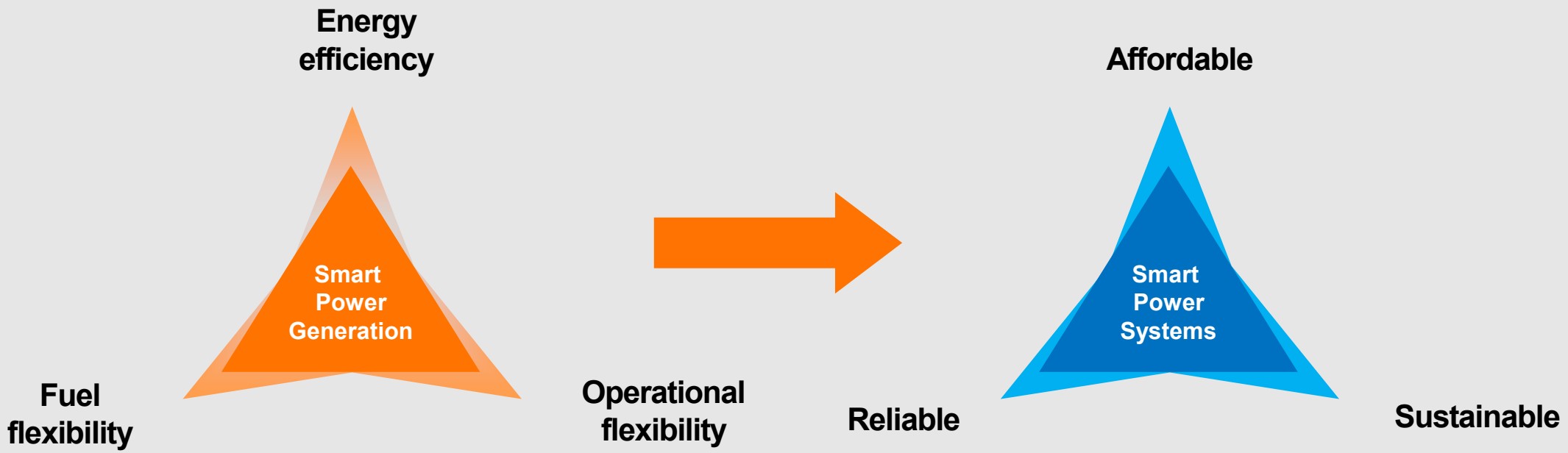
5th Energy Symposium, Nicosia, Cyprus

Market trends and drivers

- Economic growth and improving standard of living
- Growth in sustainable energy, reducing carbon emissions
- Rapid growth of intermittent renewable generation and escalating demand fluctuation
- Natural gas replacing other fossil fuels
- Ageing installed capacity driving investments in new technologies

The world needs clean, affordable, and reliable power generation

Smart Power Generation technology enables transition to a sustainable power system



Flexible baseload power plants

Wärtsilä is a major power plant contractor of liquid and gas fired flexible baseload power plants for utilities, IPPs and the industrial sector.

Selected references:

- Huinala, 139 MW, natural gas, Mexico, 2016
- Musandam, 120 MW, natural gas & LFO (back-up fuel), Oman, 2016
- PLTD Pesanggaran Bali, 205 MW, natural gas & HFO, Indonesia, 2015
- United Ashuganj, 195 MW, natural gas, Bangladesh, 2015
- IPP3, 573 MW, natural gas, HFO & LFO, Jordan, 2014
- Quisqueya I & II, 430 MW, natural gas & HFO, Dominican Republic, 2013

Dynamic peaking solutions

Wärtsilä multi-unit solutions provide unique, dynamic solutions for grid stability, reserve, peaking, load following and intermittent power generation.

Selected references:

- Arun, 184 MW, liquefied natural gas, Indonesia, 2015 – grid stability
- Port Westward Unit 2, 224 MW, natural gas, USA, 2014 – load following
- Kiisa I & II, 250 MW, natural gas & LFO, Estonia, 2013 & 2014 – grid stability
- Pernambuco III, 201 MW, HFO, Brazil, 2013 – grid stability
- Suape II, 380 MW, HFO, Brazil, 2012 – reserve for hydro power
- STEC, 203 MW, natural gas, Texas, USA, 2010 – wind power back-up

CHP applications

Wärtsilä offers combined heat and power (CHP) solutions for district heating and cooling applications.

Selected references:

- Kurgan, 23 MW_e & 20 MW_{th}, natural gas, Russia, 2015
- Tikhvin, 110 MW_e & 29 MW_{th}, natural gas, Russia, 2015
- Cheong Soo, 25 MW_e & 21 MW_{th}, natural gas, South Korea, 2010 & 2015
- Angstrem-T, 36 MW_e & 23 MW_{th}, natural gas and LFO, Russia, 2014
- Bolgiano, 20 MW_e & 9 MW_{th}, natural gas, Italy, 2014

Industrial self-generation

Wärtsilä supplies self-generation applications globally to industries.

Selected references:

- KazAzot, 40 MW, natural gas, Kazakhstan, 2016
- Umm al Qura Cement Captive Power Plant, 47 MW, HFO, Saudi Arabia, 2015
- McArthur River Mine, 53 MW, natural gas, Australia, 2014
- Grande Cote, 36 MW, natural gas, HFO & LFO, Senegal, 2013
- Barrick Gold, 118 MW, natural gas, USA, 2004

Floating power plants

Wärtsilä offers floating power plant solutions which integrate our expertise in marine technology with the benefits of flexible, decentralised power generation.

Selected references:

- Seaboard – Estrella Del Mar II, 106 MW, natural gas & HFO, Dominican Republic, 2012 – Flexicycle
- Lihir, 71 MW, HFO, Papua New Guinea, 2011

Wärtsilä developing LNG infrastructure

As a forerunner in gas and multi-fuel engines, fuel systems, technology and services, Wärtsilä participates in the global shift to gas also with LNG infrastructure projects.

- We provide our full range of project and lifecycle support to LNG liquefaction plants & terminals to deliver EPC projects worldwide.
- We have the capability to develop the entire LNG value chain in partnership with our customers.

Small and medium-scale terminals

INPUT

LNG transport

- Carriers
- Tanker trucks
- Containers
- Rail cars

TERMINAL

Tank capacity
100-160,000 m³
(26,400-42,000,000 gallons)

Jetty & marine facilities

Unloading systems

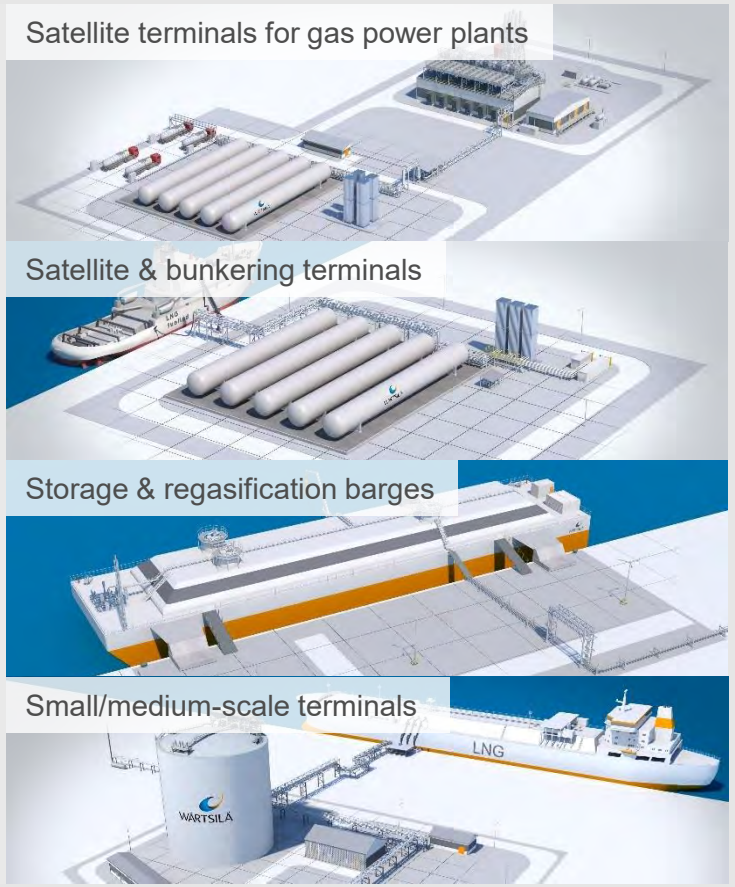
Storage tanks

Boil-off gas handling

Re-gasification

- Up to 1000 TPH (1000 MSCFD)

Export systems



OUTPUT

LNG transport

- Carriers
- Tanker trucks
- Containers
- Rail cars

Gas send-out

Ship bunkering

LNG solutions – how does Wärtsilä create value?

Reduce risk by guaranteed price, delivery and performance

We turn project ideas into reality

Increase revenues by shortening project development and EPC lead time

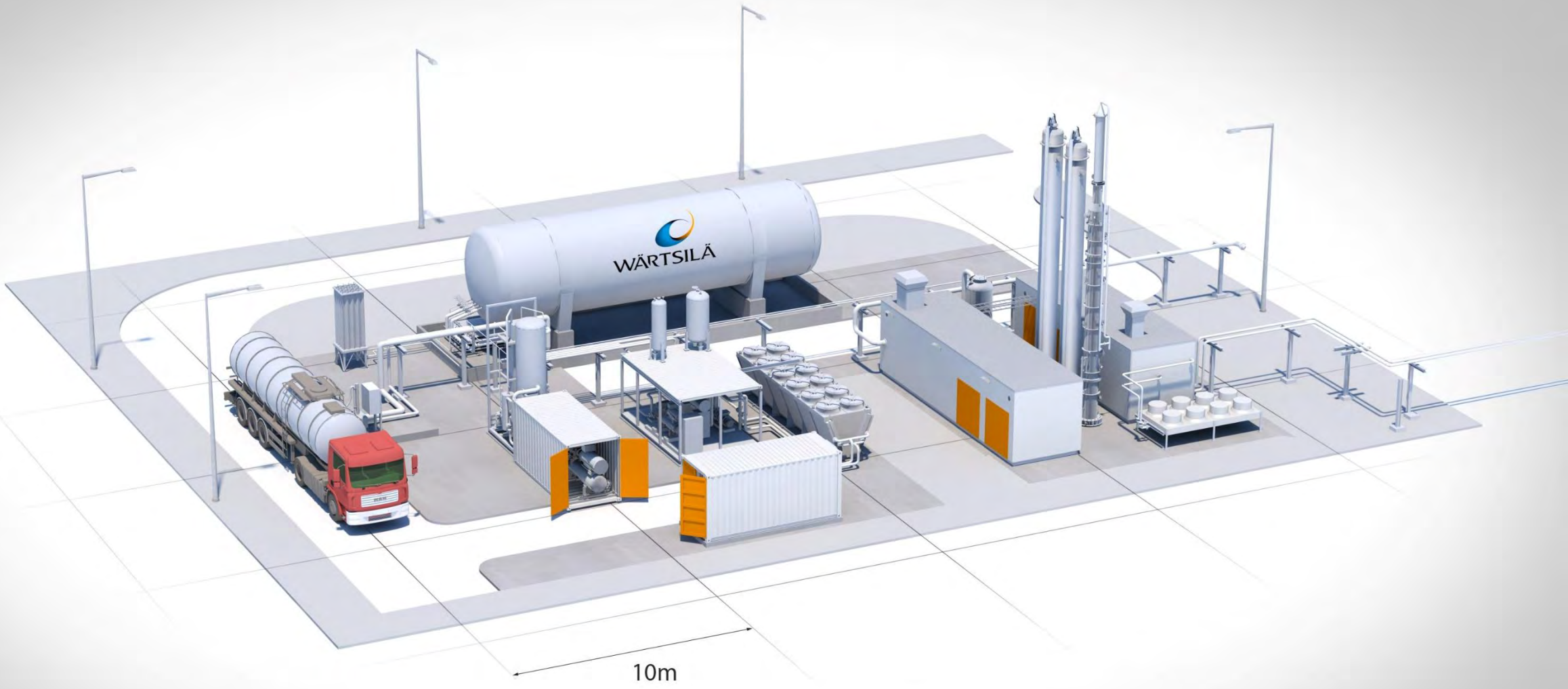
Reduce costs by adequate & standardized solutions

for power plants.

TORNIO MANGA LNG TERMINAL

In 2014 Wärtsilä signed an EPC contract to supply a 50,000 m^3 LNG terminal in Tornio, Finland. The construction of the terminal started in the beginning of 2015 and the terminal is planned to be ready for operations early 2018.

BIOKRAFT LBG PLANT

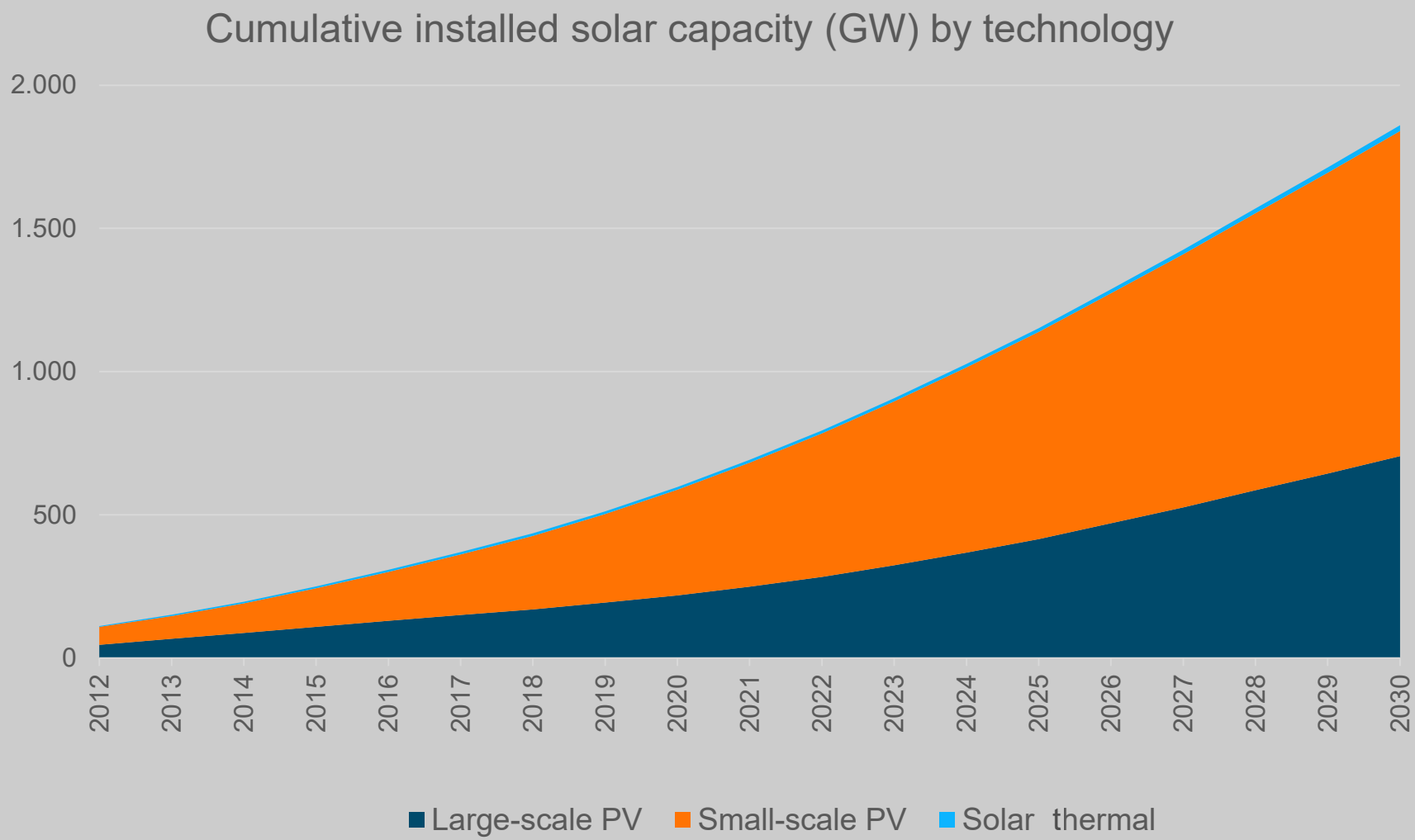


In 2016 Wärtsilä signed a contract to supply the world's largest biogas liquefaction plant in Skogn, Norway. The plant will transform biogas from fishery waste and residual paper mill slurry into liquid biogas (LBG) for buses. It is planned to be ready for operations in 2017.

Solar solutions

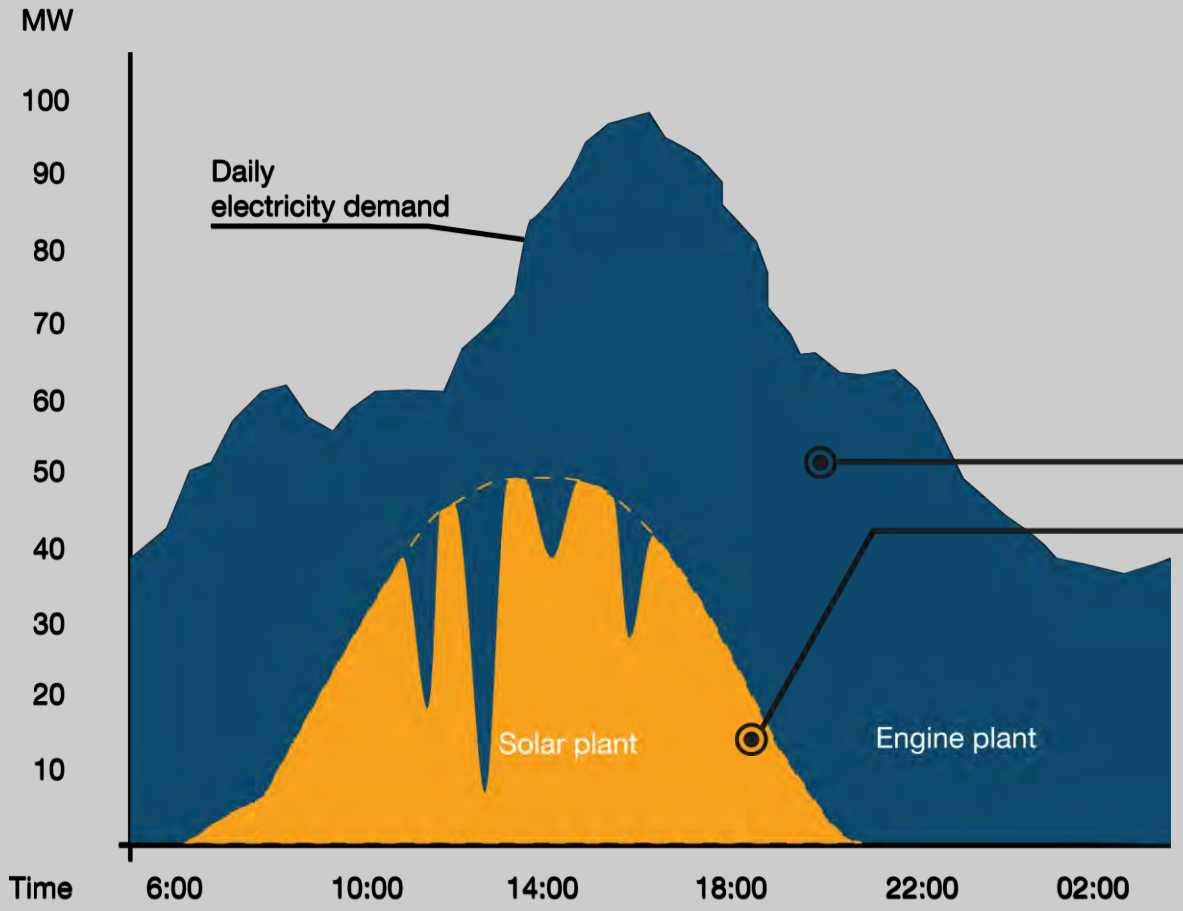
We offer utility-scale solar PV solutions with EPC delivery.

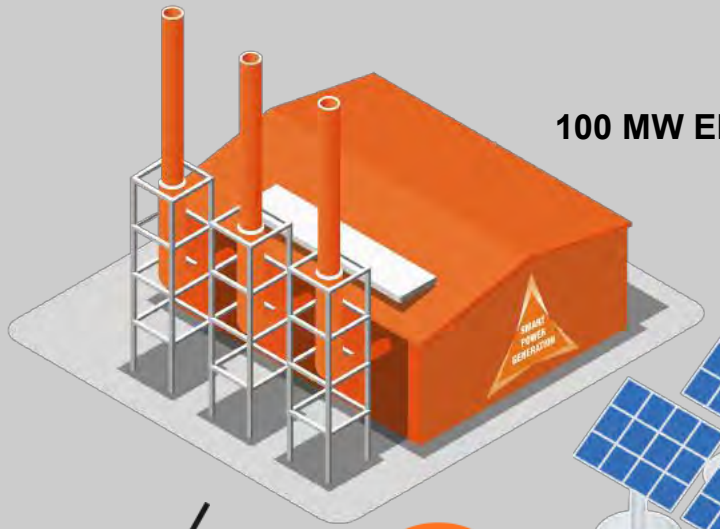
SOLAR GROWTH IS REMARKABLE



Source: Bloomberg New Energy Finance

SMART POWER GENERATION KEEPS THE LIGHTS ON





100 MW ENGINES

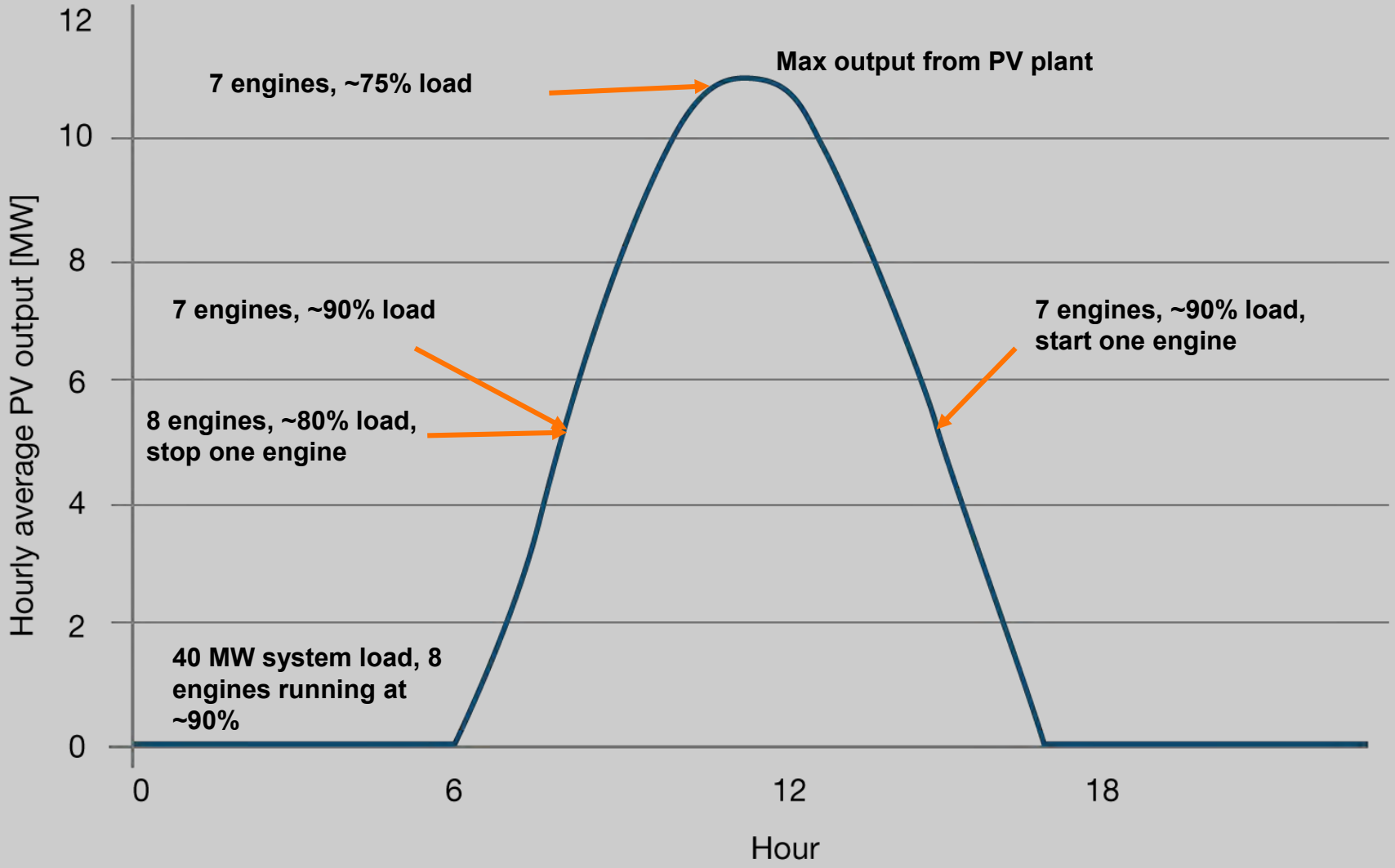
50 MW SOLAR PV

Smart Power Generation (SPG) engine power plants

- **Balance** fluctuations in **wind and solar** power
- **Ensure system stability** in contingency situations
- **Maximize the use of renewable capacity** by minimizing losses of excess wind and solar power
- **Improve *total* system efficiency**

Fast engine response to quick variations in solar PV output

TYPICAL HYBRID OPERATING PROFILE FOR INDUSTRIAL SELF-GENERATION



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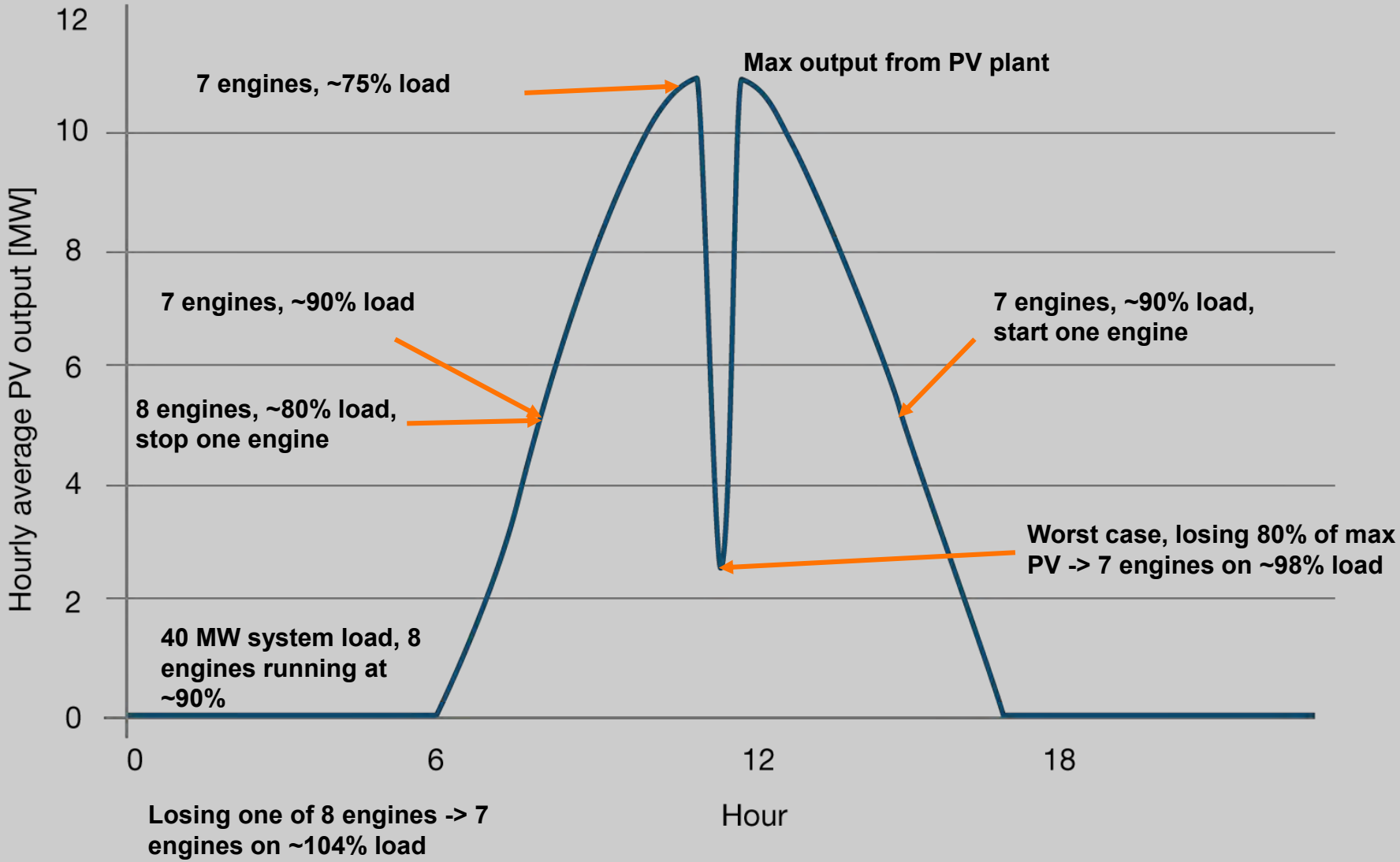

VALUE OF LARGE SCALE SOLAR PV

Key Word "I N T E G R A T I O N"

TAILORED SOLUTIONS FOR EACH PROJECT

- Maximise the value of solar PV given the land availability and cost
- Once the amount of solar reaches significant levels, it must be combined with adequate balancing:
  - Understand the system level costs and optimise the amount of PV and balancing power
  - Value of increased flexibility

→ Detailed analysis of the value is needed for each case

Wärtsilä has the inhouse knowledge for providing analysis for each project

VALUE OF HYBRID SOLUTIONS

Wärtsilä engine power plant

- Modular design
  - Reduced construction time
- Flexible capability
  - Maximal use of all energy provided by the solar plant
- Flexible use of different fuels at the same power plant
- High efficiency also on partial and low loads

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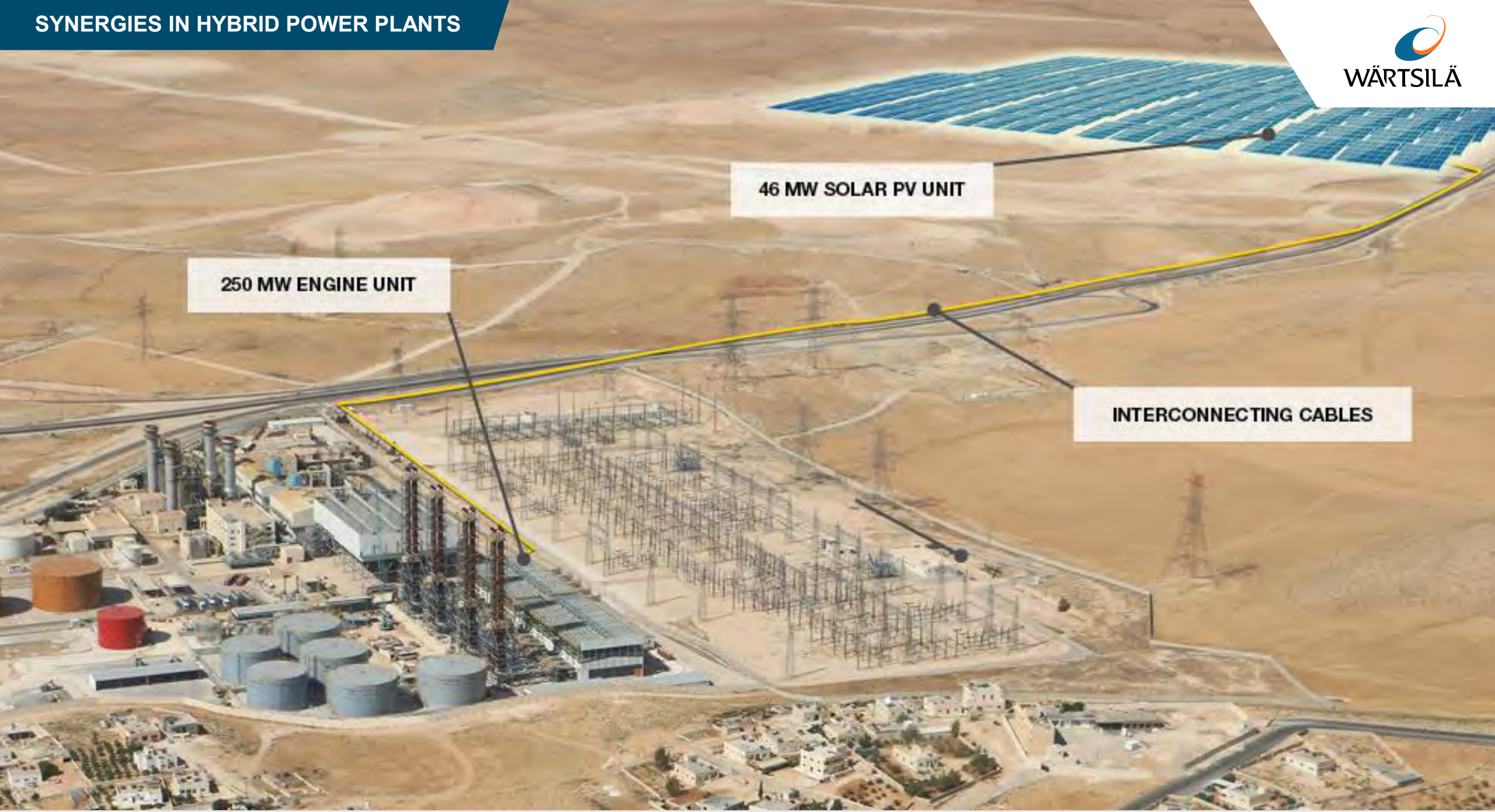
Wärtsilä solar plant

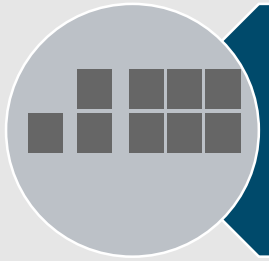
- Modular design
- No emissions
- No fuel consumption
- Lower land quality requirements than a conventional power plant
- Standardised and optimised to meet all individual needs

SYNERGIES IN HYBRID POWER PLANTS



THE VALUE OF A WÄRTSILÄ HYBRID

Save fuel: Hybrid saves fuel when solar is generating power



Highly scalable: Both engines and solar PV are scalable to needed capacity

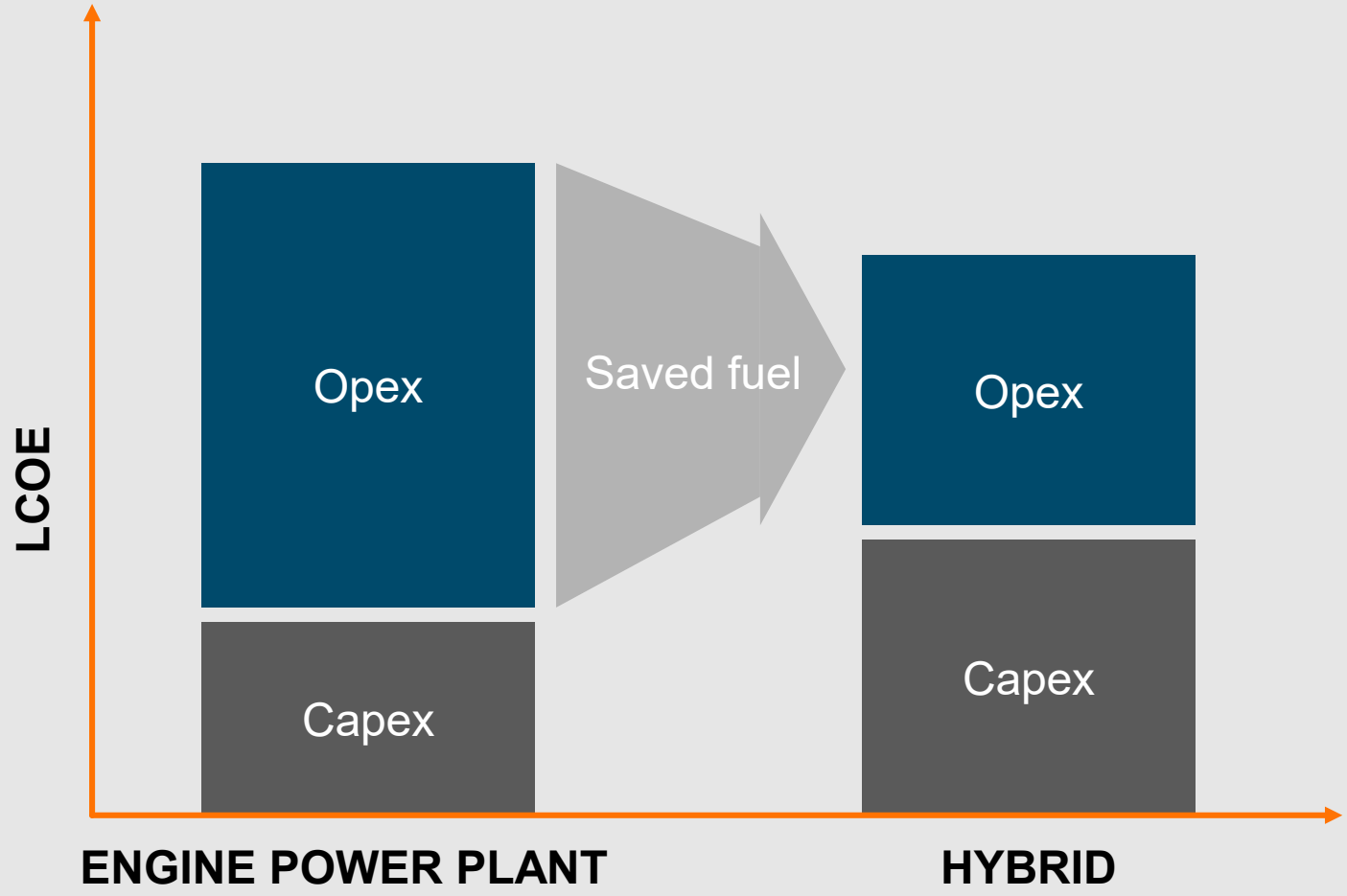
Reduce costs: Lower LCOE when the value of the fuel saved is greater than the solar costs. Optimization of CAPEX and OPEX for the power plant

High system efficiency: Optimized operations of overall fleet

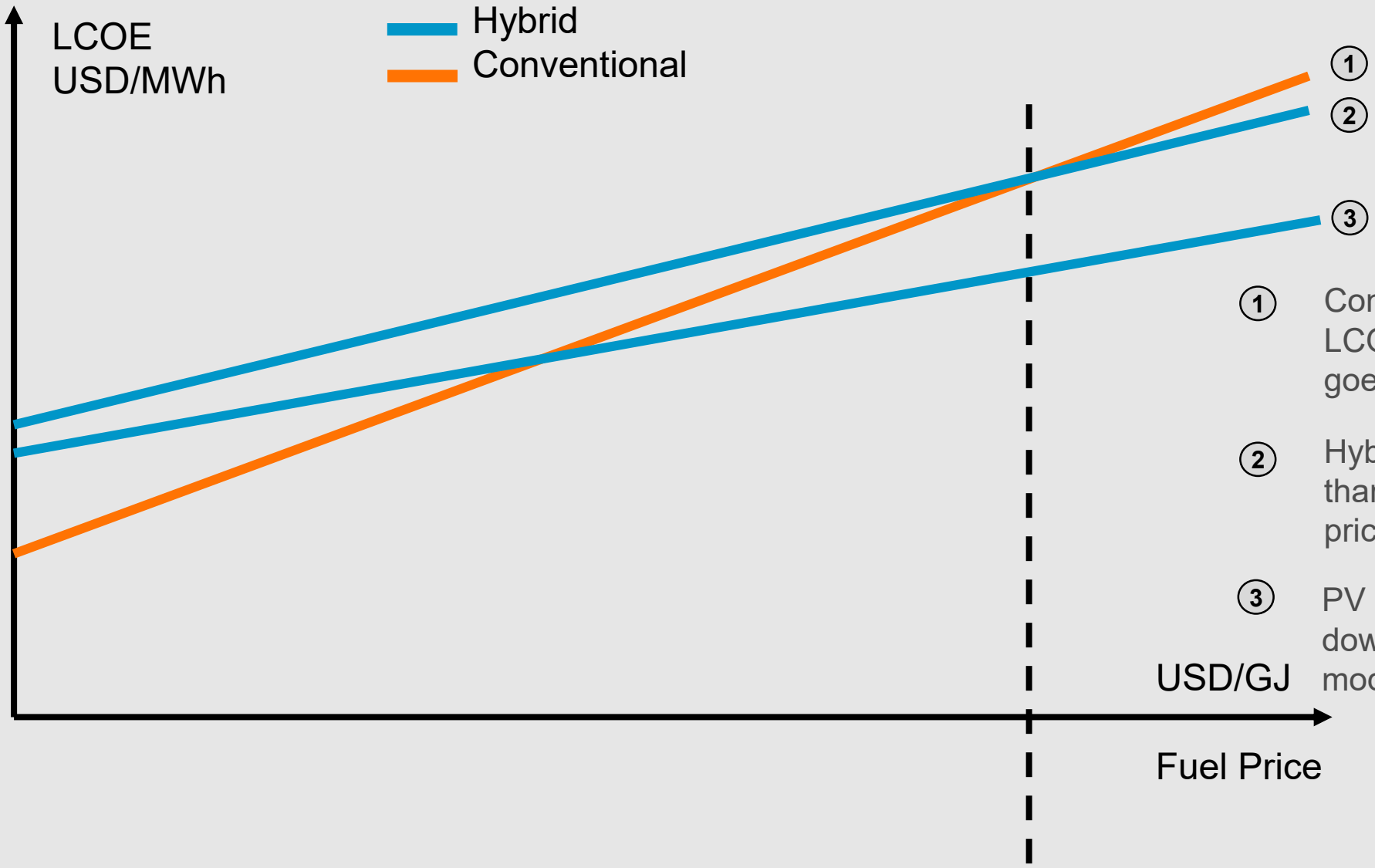
Reliability & flexibility: Engines flexibly dispatched according to changing demand – get electricity also when the sun doesn't shine

Environmental benefits: Reduced carbon emissions

FUEL SAVINGS DETERMINE HYBRID ECONOMIC FEASIBILITY



FUEL PRICE IMPACT ON HYBRID ECONOMICAL FEASIBILITY



1 Conventional power plant, LCOE increases as fuel price goes up

2 Hybrid LCOE increase less than for conventional as fuel price increase

3 PV module price trend downwards and increase in module efficiency

WÄRTSILÄ - A ONE STOP SHOP OF HYBRID SOLUTIONS

- Full EPC for the whole solar PV-engine hybrid solution under one single contract
- Lead on the complete development of a hybrid IPP and invest in these projects
- EPC and O&M contractor for the integrated PV-engine plant
- One stop shop providing hybrid solutions **from project initiation to full life-cycle services**


WÄRTSILÄ