



WÄRTSILÄ Flexible Power Generation

ENGINES+LNG+STORAGE

Alejandro Mc Donough
Business Development

This is Wärtsilä

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

THIS IS WÄRTSILÄ



Our business areas



ENERGY SOLUTIONS

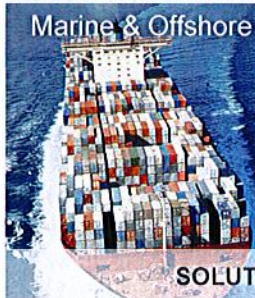


MARINE SOLUTIONS

SERVICES



THIS IS WÄRTSILÄ



Marine & Offshore



Power Generation

18,000 Professionals / 200 locations / 70 countries

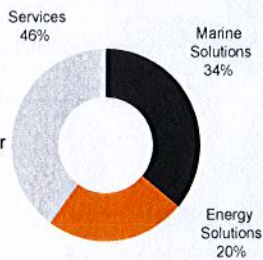


SOLUTIONS FOR



Net sales by business 2016

Listed in Helsinki
4.9 billion € turnover
Solid financial standing



LEADER IN

EFFICIENCY

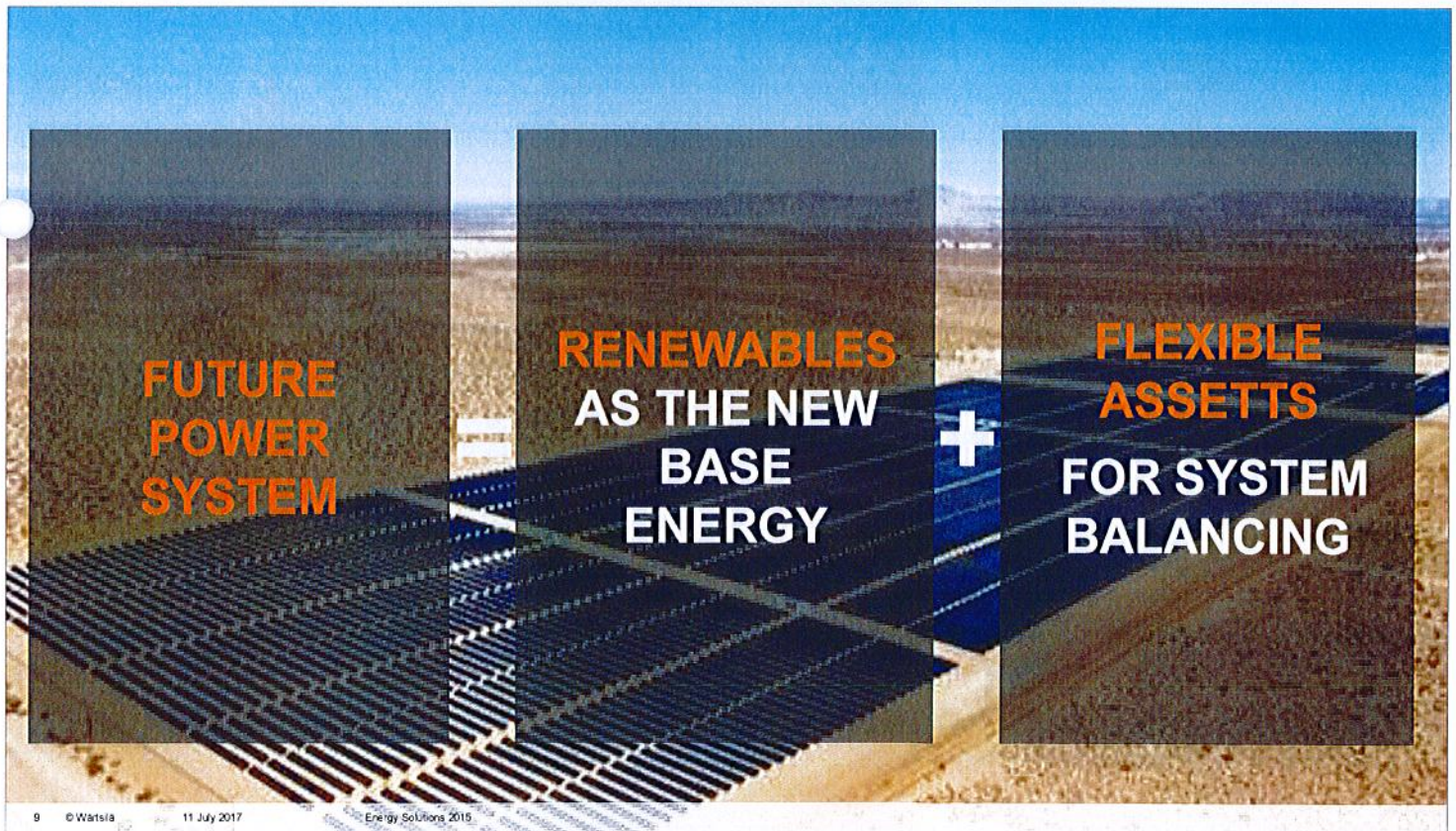
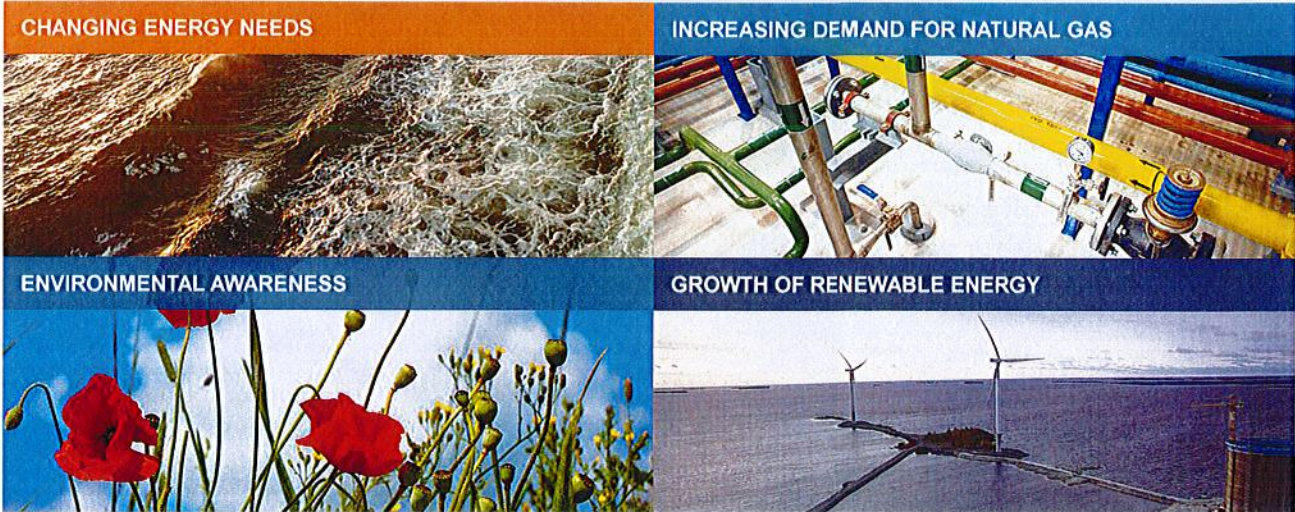


FLEXIBILITY



ENVIRONMENTAL SOLUTIONS

Climate change and scarcity of natural resources are affecting our operating environment



A GLOBAL SYSTEM INTEGRATOR FOR GREENER AND MORE EFFICIENT ENERGY SYSTEMS



Energy Efficiency

Smart Power Generation

Fuel Flexibility

Operational Flexibility



SMART POWER GENERATION FEATURES



Agility of dispatch

- Megawatts to grid in 1 minute from start, 5 minutes to full load
- Fast shut down in 1 minute
- Fast ramp rates up & down
- Unrestricted up/down times

High plant reliability and availability

- Multiple units enable firm power
- Typical unit availability > 95%
- Typical unit reliability ~ 99%
- Typical unit starting reliability > 99 %

Low generation costs

- High efficiency (>48% in simple cycle and >50% in combined cycle)
- Wide economic load range with multiple units
- Total efficiency in CHP up to 90%

Optimum plant location and size

- Location inside load pockets i.e. cities
- Typical size range 50–500 MW
- Flexible, expandable plant size enables step by step investments
- Low gas pressure requirement (5 bar)
- Low/no water consumption

Clasificación por tamaño

20V34SG
(9.7 MW* / unit)

10 to 200+ MW

Efficiency 47%** , 5 min start

18V50SG
(18.3 MW* / unit)

50 to 400+ MW

Efficiency 48.6%** ,
10 min start

18V50SG
(Flexicycle™)
20 MW*/unit

50 to 500+ MW

Efficiency 52.6%** ,
10/45 min start

PLANT SIZE

* Generator Terminals, sea level, radiator cooled, 25C(77F)

** Generator Terminals, 5% tolerance, LHV , sea level, radiator cooled, 25C(77F)



Principios de funcionamiento



LIQUID ONLY:
 - Petróleo crudo, fuel oil pesado (HFO), light fuel oil (LFO), LBF's

- 4 tiempos
- Principio de operación Diesel
- Inyección unitaria

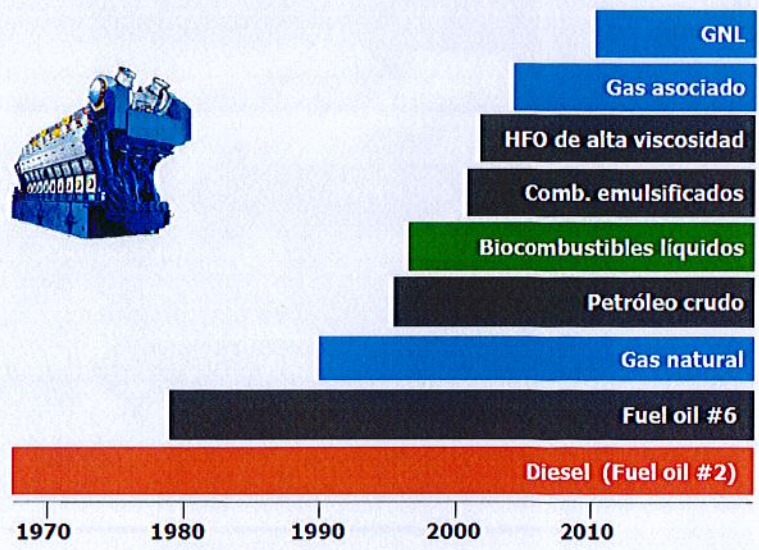
GAS ONLY
 - Motores operando sólo en gas de baja presión (5 bar)

- 4 tiempos
- Principio de operación Otto / chispa
- Lean burn / baja presión

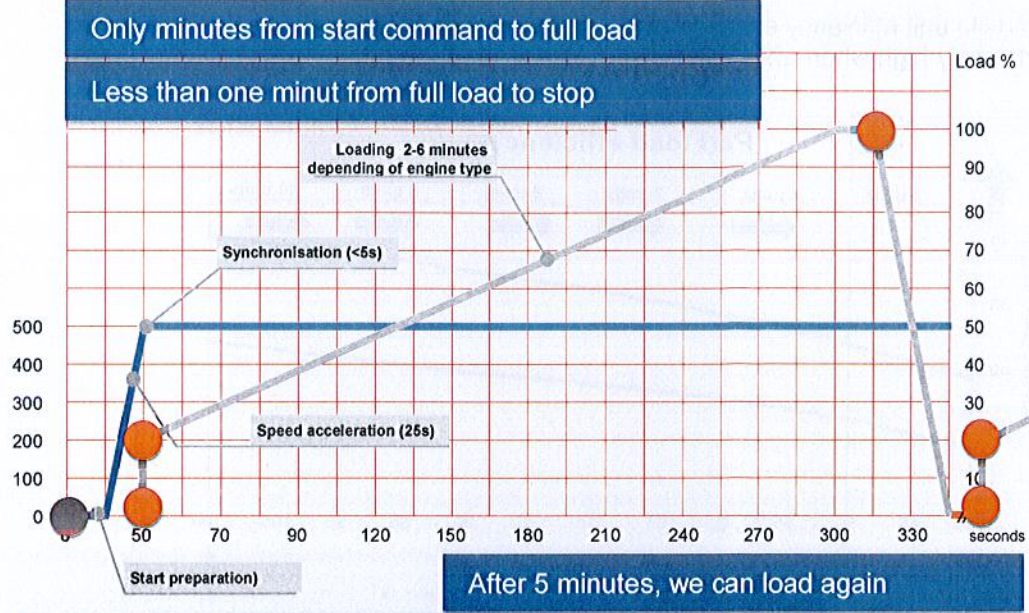
DUAL FUEL:
 - Pueden operar con gas y líquidos.
 - Fuel mix (30-100% load)

- 4 tiempos Dual Fuel
 - Principio de operación Otto / piloto
 - Lean burn / baja presión
- Wärtsilä DF
-
- 4 tiempos Dual Fuel
 - Principio de operación Diesel
 - Alta presión
- Wärtsilä GD

Flexibilidad en combustible

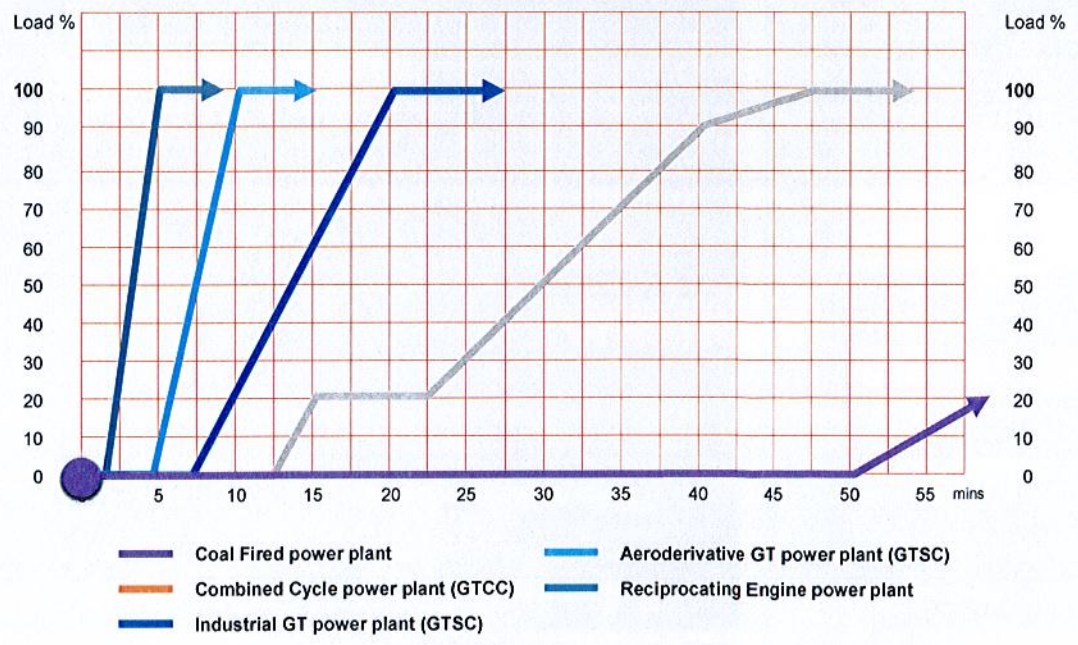


REALLY FAST STARTING, STOPPING AND RESTARTING



No impact on maintenance schedule !

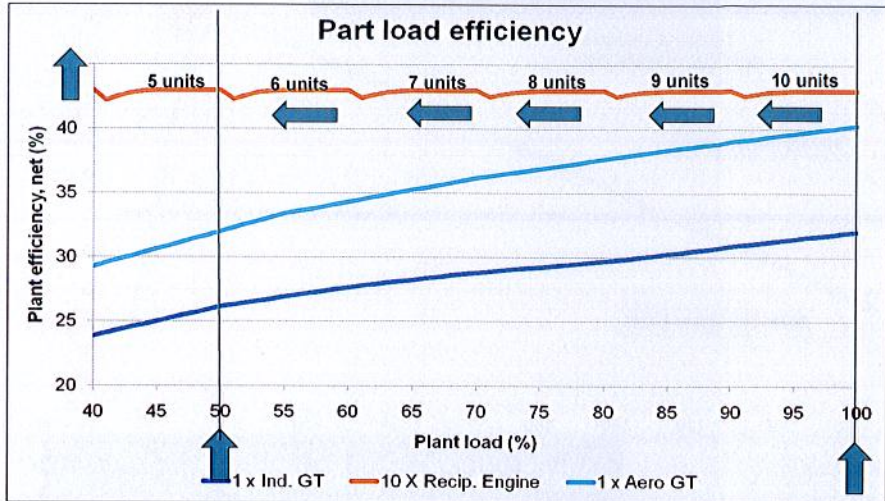
RELATIVE LOADING CAPABILITY FOR DIFFERENT TECHNOLOGIES



PERFORMANCE ON PARTIAL LOAD

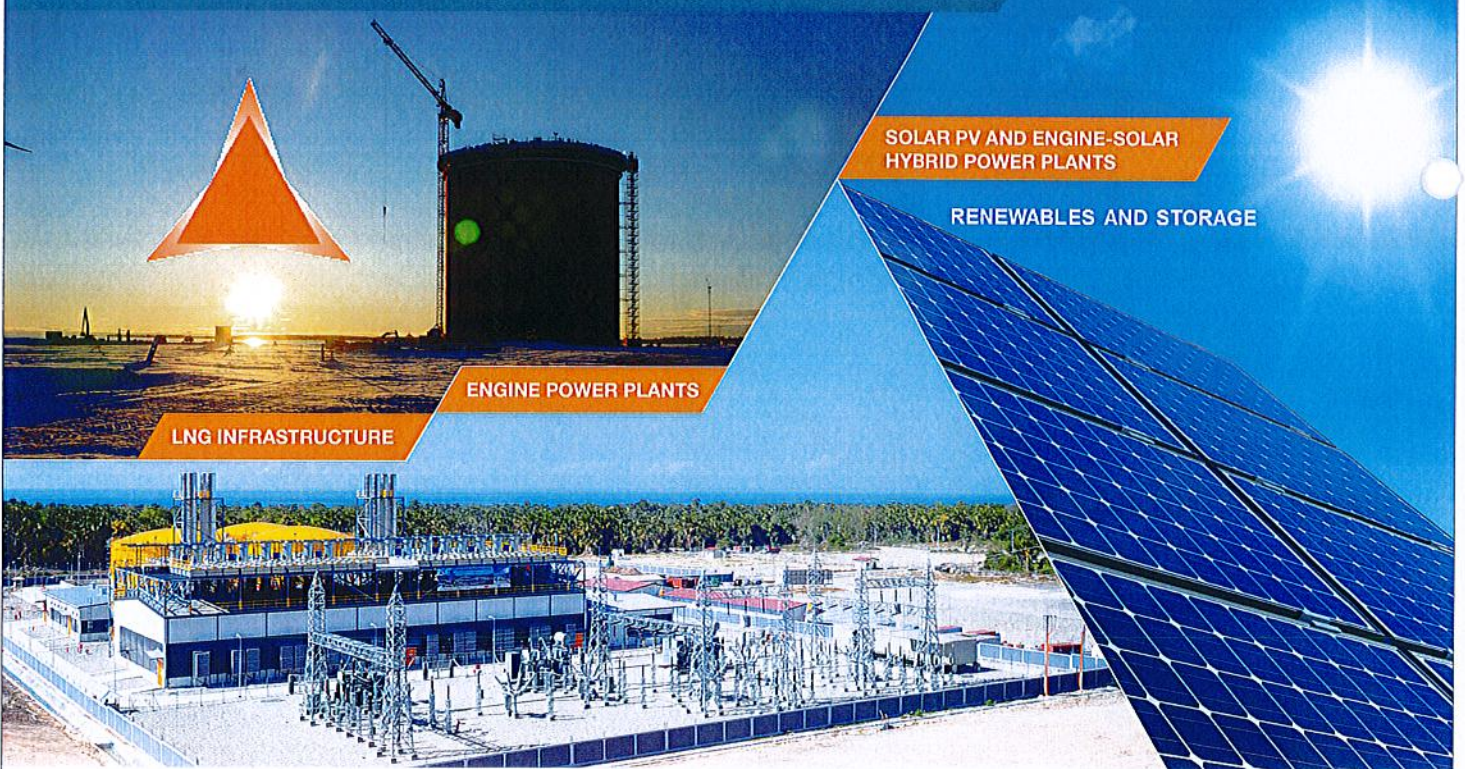


Wartsila unit efficiency exceeds 48%_{el} @ ISO and part load efficiency also extremely high when units can be started and stopped one by one



GT performances by GTPro
15 °C, 10 bar NG

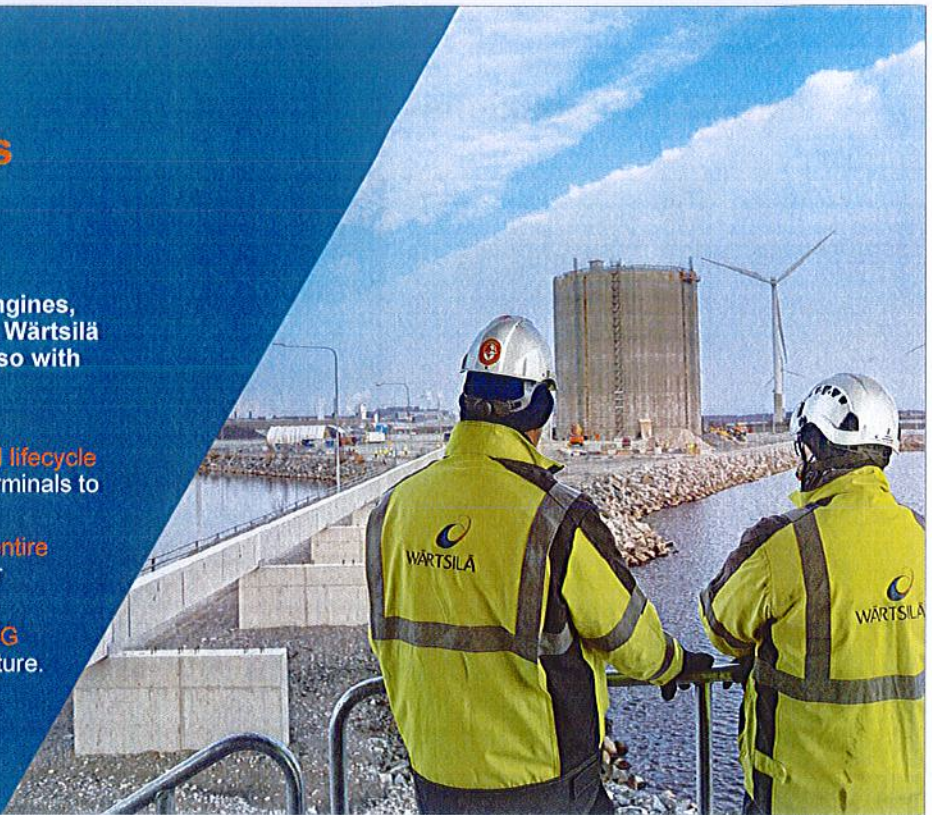
A GLOBAL SYSTEM INTEGRATOR FOR GREENER AND MORE EFFICIENT ENERGY SYSTEMS



Wärtsilä LNG solutions

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

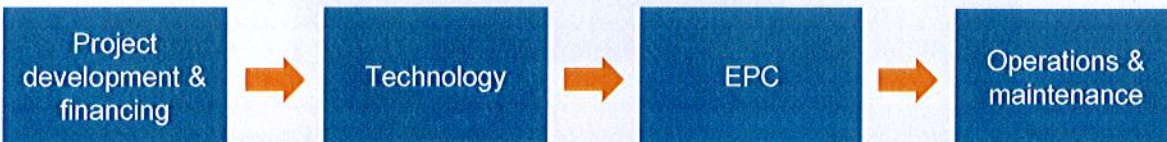
- We provide our full range of **project and lifecycle support** to LNG liquefaction plants & terminals to deliver EPC projects worldwide.
- We have the capability to **develop the entire LNG value chain** in partnership with our customers.
- Also, we provide similar services for **LEG (ethane) and LPG (propane)** infrastructure.



ENERGY SOLUTIONS



Complete solutions that bring value to customers

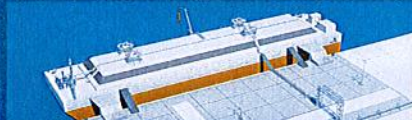


Small and medium-scale terminals (tank capacity 100-160,000 m³)

Satellite terminals for gas power plants



Floating Storage and Regasification Barges (FSRB)



Small satellite terminals



Medium-scale terminals



Mini and small-scale liquefaction plants (2000-300,000 TPA)



Gas and dual-fuel power plants



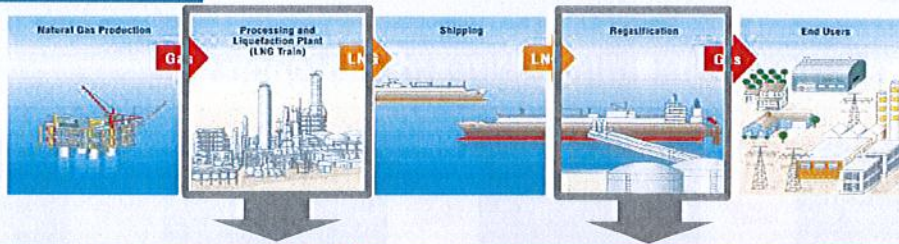
LNG OFFERING



Wärtsilä LNG solutions

ONSHORE						
	Small LNG liquefaction plants	Mini LNG liquefaction plants	Small/Medium LNG terminals	LNG satellite & bunkering terminals	LNG storage & regasification barge	
	OFFSHORE					
		LNG regasification	BOG reliquefaction	Cargo Handling System Gas and LNG Carriers	Fuel gas handling system	Ship and Cargo Tank design
		LIFECYCLE				
Lifecycle services	Start-up support		Product and technical support	Spares		

LNG SOLUTIONS - PRODUCT PORTFOLIO



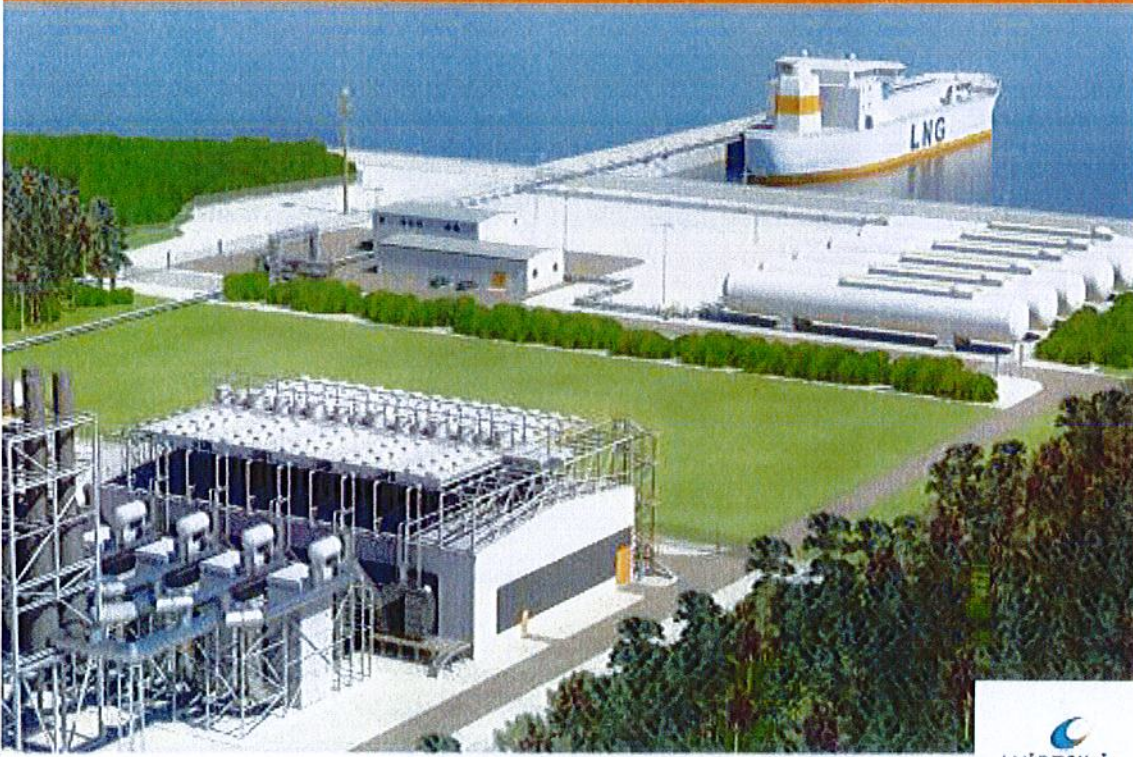
(L) Liquefaction Plants

(T) Terminals

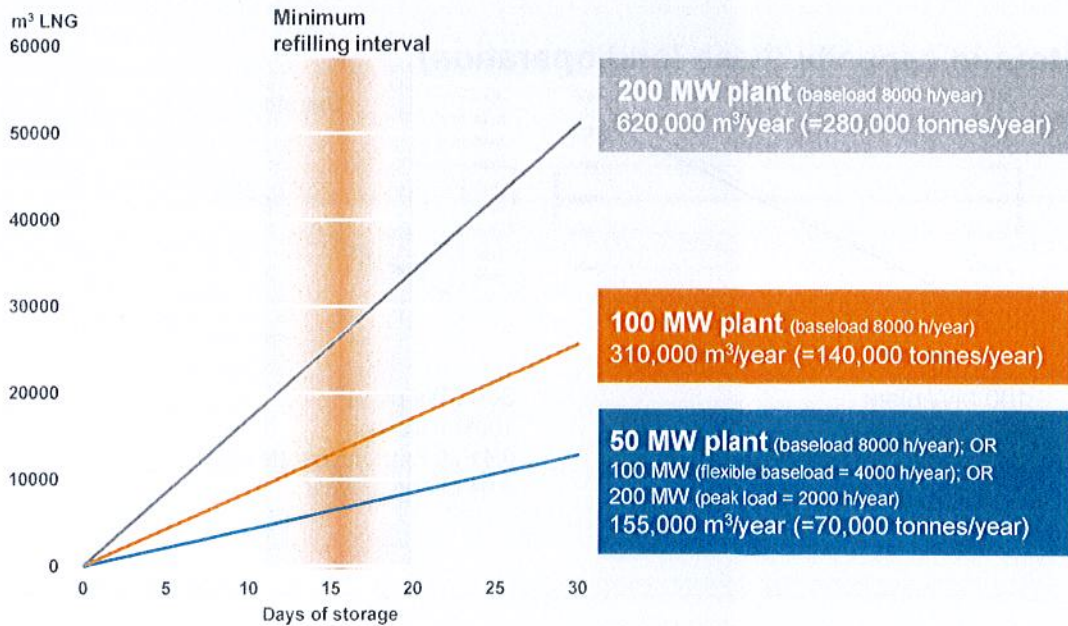
Mini L1	Small L2
Peak shaving / Storage L3	Medium/Large L3 Equipment only Power Plant

Satellite terminals for gas power plants T1	Small satellite terminals T2a	Storage & Re-gasification barges T2b
Medium-scale terminals T3	Large-scale terminals Equipment only Re-liq unit & Power Plants	Floating Storage & Re-gasification Units (FSRU) Equipment only Regas unit

Smart Power Generation meets LNG



LNG CONSUMPTION IN A POWER PLANT

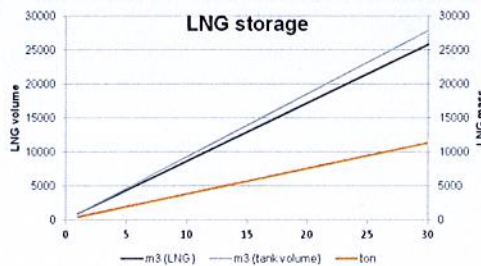


LNG storage alternatives offered by Wärtsilä

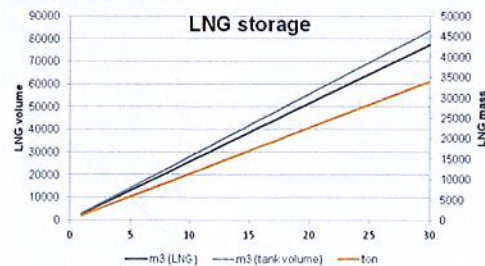


Tank type	Bullet tank (Double shell steel tanks)	Flat bottom tank (Single, double or full containment)
Capacity	Single tank 100 – 1200 m ³ Multiple tanks 100 – 20,000 m ³	15,000 – 160,000 m ³
Boil-off gas (holding mode)	0.05-0.15 % per day, but the tank is capable of handling the increased pressure for up to 1 month	0.05 % per day
Operating pressure	0.5 – 8 barg	Atmospheric
Rollover monitoring needed	No	Yes
Manufacturing method	Pre-fabricated in factory	On site
Installation time on site	Days to weeks	24 – 36 months

LNG storage capacity (base load operation)

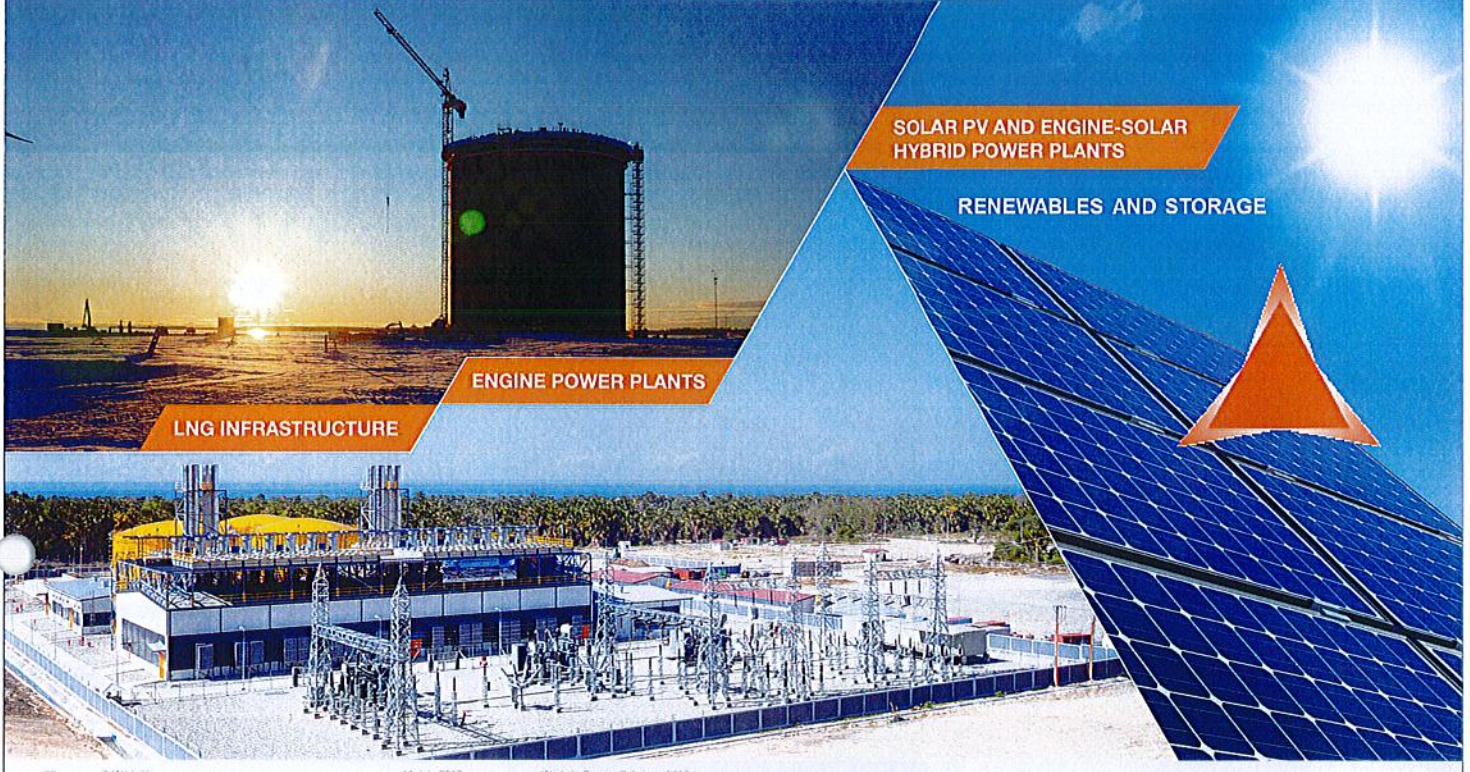


100 MW plant
100% utilization
0.14 Million Ton/year (MTPA)
0.31 Million m³/year



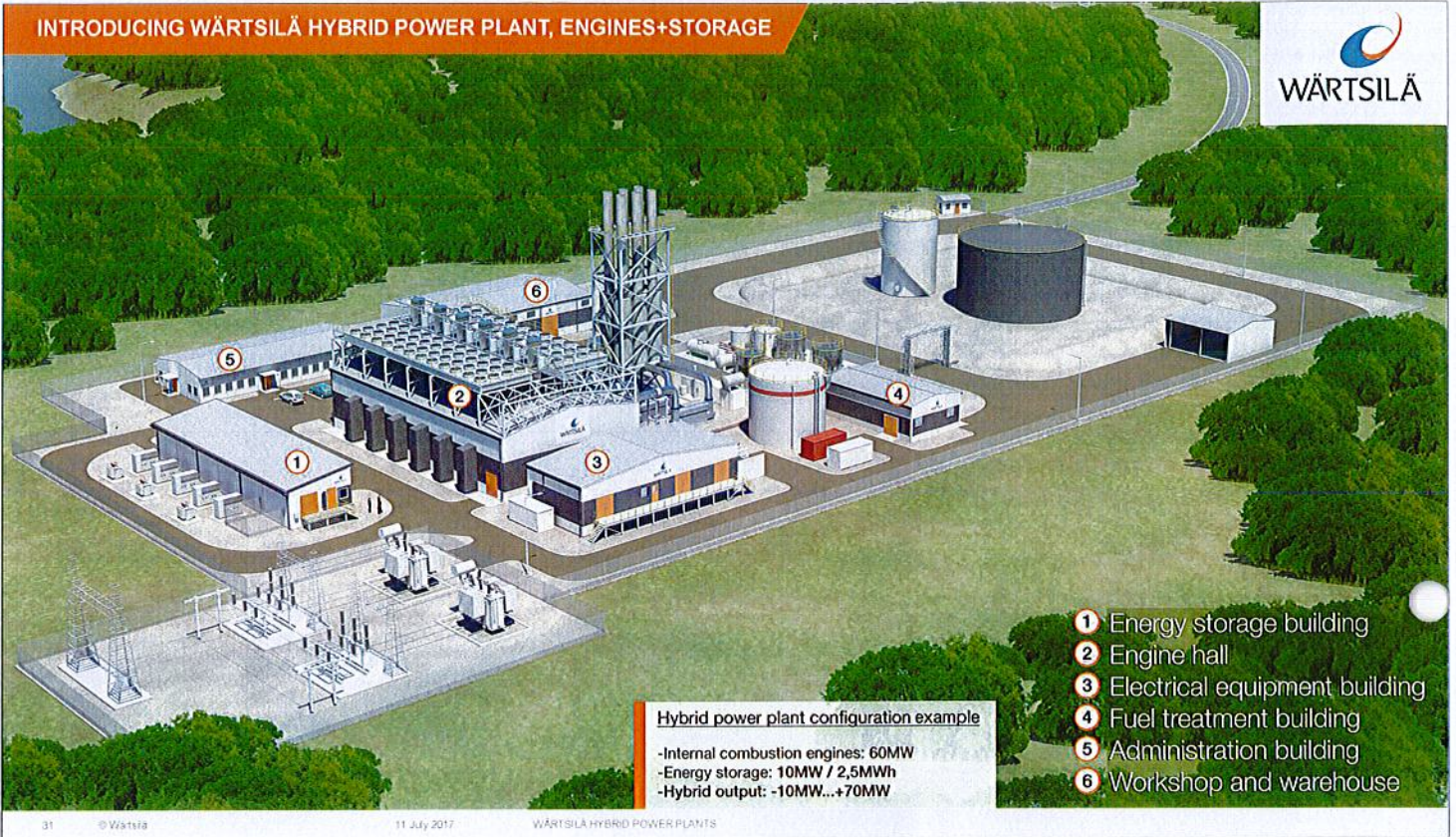
300 MW plant
100% utilization
0.41 Million Ton/year (MTPA)
0.94 Million m³/year

A GLOBAL SYSTEM INTEGRATOR FOR GREENER AND MORE EFFICIENT ENERGY SYSTEMS



WÄRTSILÄ ENERGY STORAGE POWER PLANTS ENGINES+STORAGE

INTRODUCING WÄRTSILÄ HYBRID POWER PLANT, ENGINES+STORAGE



- 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

HYBRID SOLUTION DESCRIPTION 3 X 18V50DF (51 MW) + 20MW/10 MWH STORAGE LI-ION



Engine	3 x 18V50DF
Power	51 MW*
Time to synch	~ 30s
Energy	Unlimited
Time to full load	300s
Ramp capability	0,5 MW/s*
Min load	10%*
Initial delay	1s
Reactive power run / condenser mode	+38 to -19 / +54 to -26 MVAR***
Efficiency full load	~45%

Hybrid Plant	71 MW Hybrid
Power	- 20 ... +71 MW
Time to synch	Synchronized
Energy	51 MW Unlimited + 10 MWh
Time to full load (71 MW)	300s
Ramp capability	40,5 MW/s *
Min load	-20 MW
Initial delay	0,2s
Reactive power P / Q (Cond.) mode	+40 to -21 / + 66 to -38 MVAR
Efficiency full load	~45% / 85%

Storage System	20 MW / 10 MWh
Power	+/- 20* MW
Time to synch	Synchronized
Energy	10 MWh**
Time to full load	0.3s
Ramp capability	40 MW/s
Min load	- 100%
Initial delay	0,2s
Reactive power P / Q mode	+/- 2 / 12 MVAR***
Efficiency round trip	85%

Possible storage guarantees:

- Availability
- Round trip efficiency
- Battery capacity

*) At generator and inverter terminals and within operation range.
 **) Pending duty cycles and life time
 ***) Theoretical at generator and inverter terminals

STORAGE + ENGINE: MAIN FEATURES & CUSTOMER VALUE



**ENGINES+STORAGE HYBRID
MAIN FEATURES**

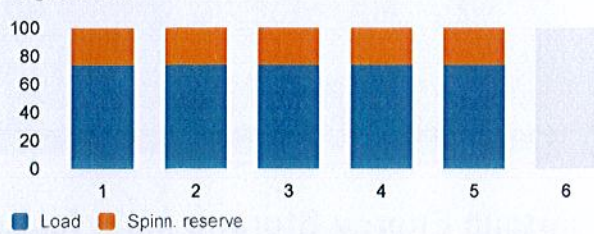
- Spinning reserve replacement
- Power quality
 - Frequency control
 - Voltage control
- Ancillary services
- Instant power

MAXIMIZING CUSTOMER VALUE

- Optimized plant operation
- Fuel savings
- O&M optimization and savings
- Regulation compliance
- Enhanced dispatchability
- Reduced emissions

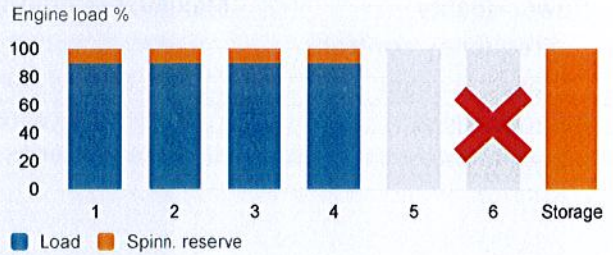
Average load 74%, Average efficiency 42,2%

SPINNING RESERVE BY ENGINES

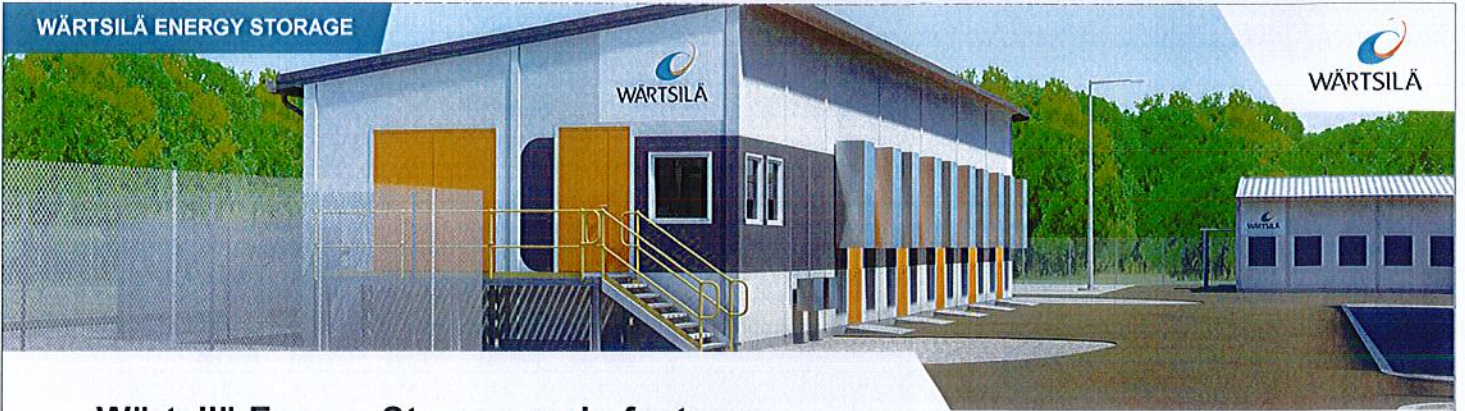


Average load 90%, Average efficiency 43,0%

SPINNING RESERVE BY STORAGE



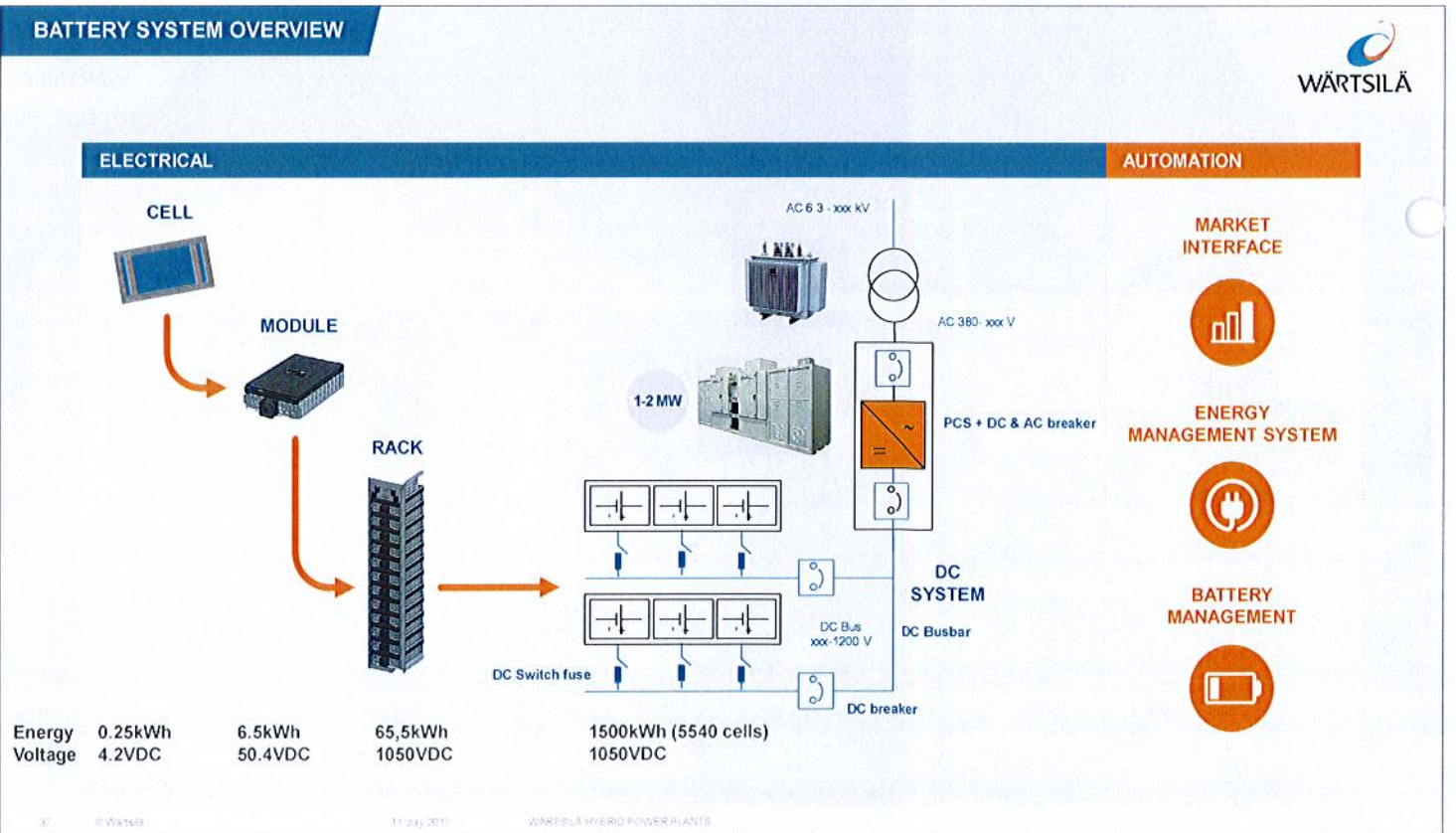
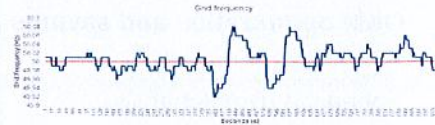
Introducing
**WÄRTSILÄ
ENERGY STORAGE**



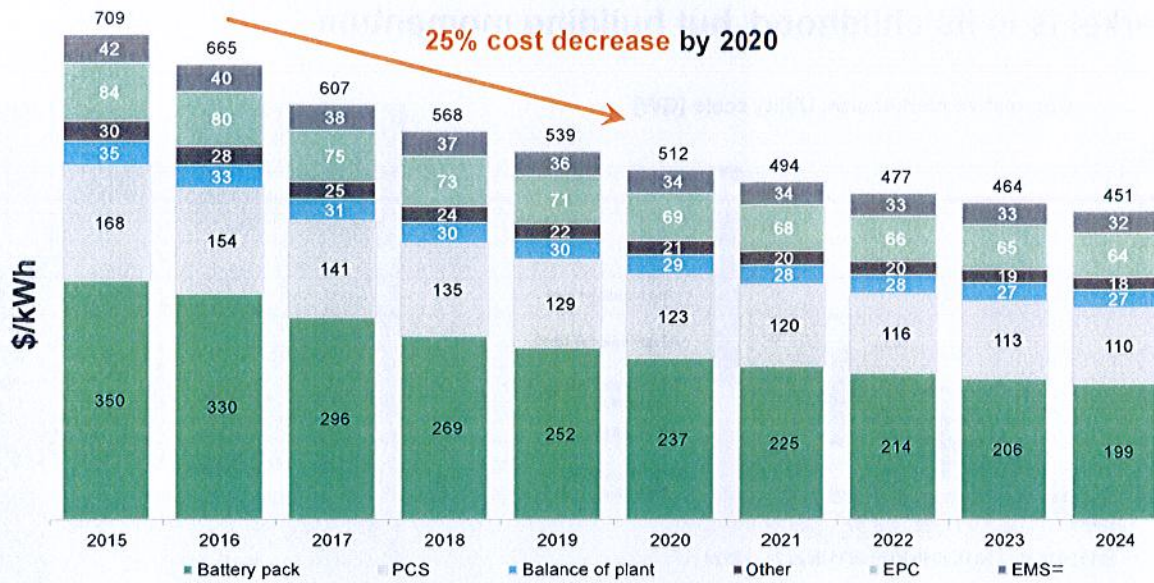
Wäartsilä Energy Storage main features

- Power quality
 - Frequency control
 - Voltage control
 - Energy shifting
 - Instant power
- Maximizing customer value**
 - Electricity market(s) opportunities
 - Peak demand management
 - Demand charge reduction (C&I)
 - Back-up capacity

Grid frequency control with energy storage.

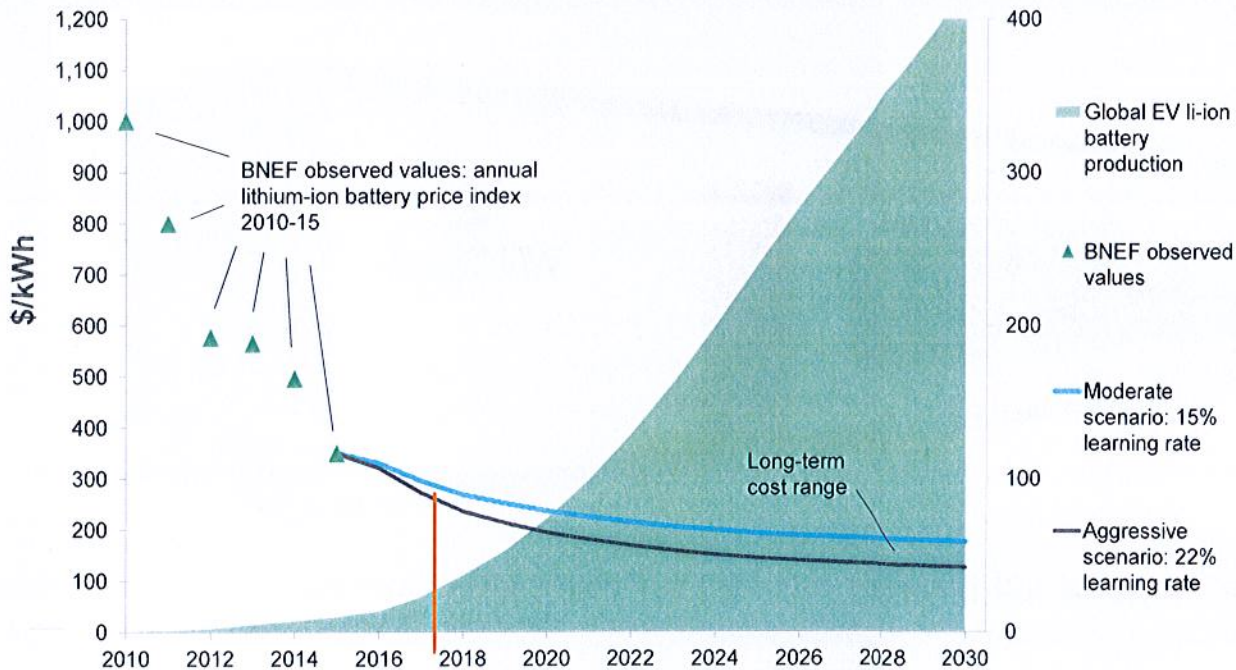


GRID SCALE STORE PRICE FORECAST



Note: The ratio of the inverter kW output to energy storage nameplate capacity was set at 1kW:1kWh. Energy storage costs may vary by geography, application and region.

LI-ION BATTERY PRICE & EV VOLUMES

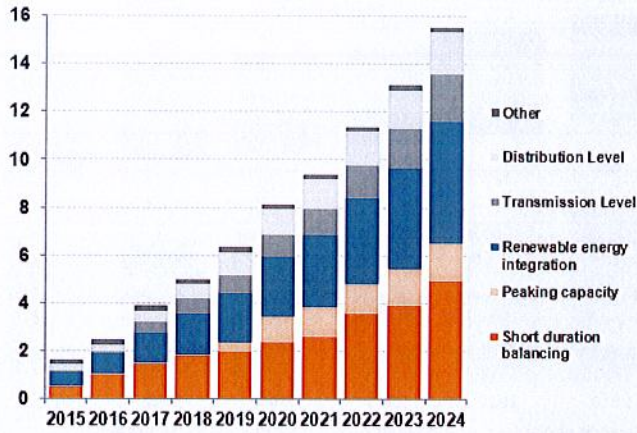


FLEXIBILITY FROM STORAGE?

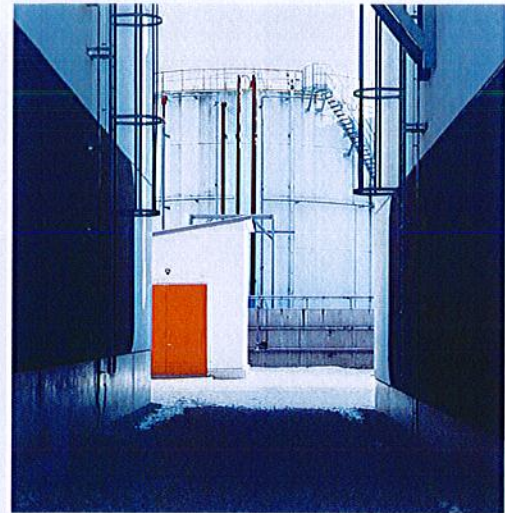


Market is in its childhood, but building momentum

Cumulative market size, Utility scale [GW]



Source: Bloomberg New Energy Finance

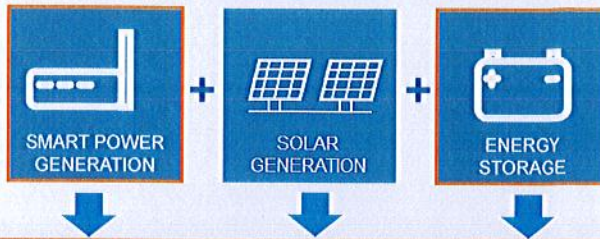


LARGE SCALE ENERGY STORAGE



Containerized solutions:
1,5...5MWh

GLOBAL SYSTEM INTEGRATION



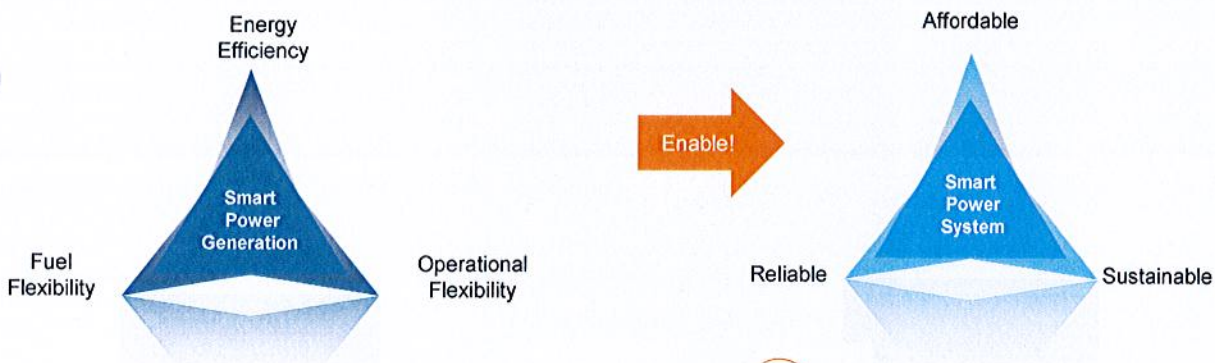
SYSTEM INTEGRATION
 optimizes different energy sources, storage and demand
 in sustainable, reliable and affordable way



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Conclusion



Making Power Generation Smarter!

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THANK YOU



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