WÄRTSILÄ

Flexible Power Generation

Northwest Power and Conservation Council

February 27, 2014

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Wärtsilä in short

Business Areas

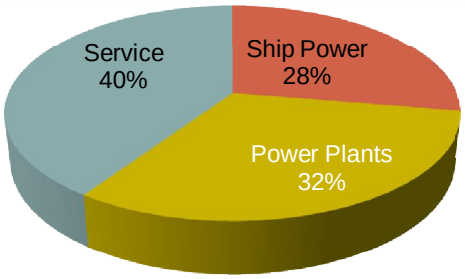
POWER PLANTS	SHIP POWER	SERVICES

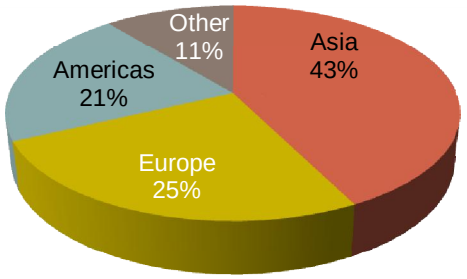
- Founded in 1834
- Headquarters in Helsinki Finland
- Net Sales € 4.7 billion (2012)
- Presence in 170 locations in 70 countries

What we bring to the market

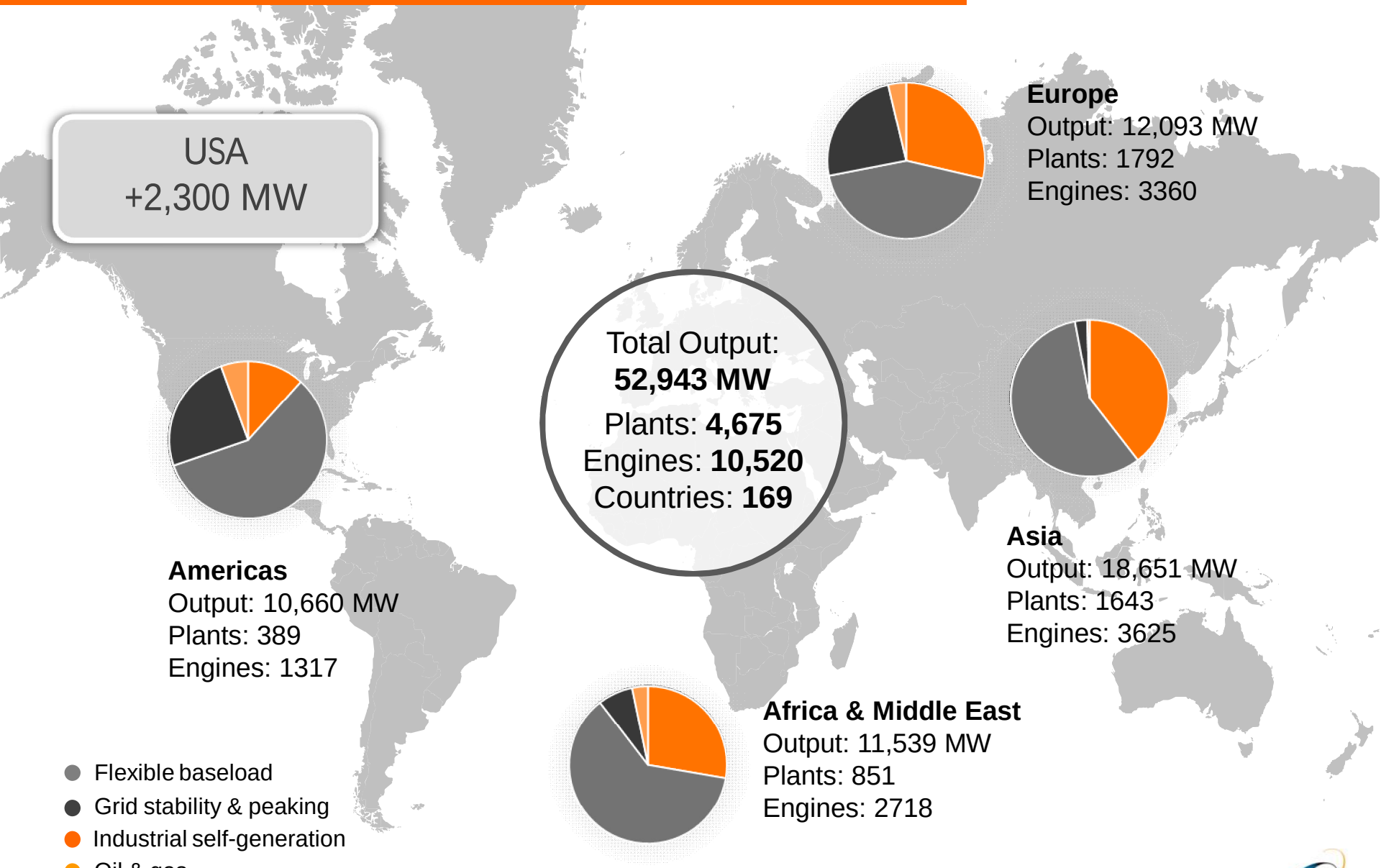
Efficiency	Environmental Solutions	Fuel Flexibility

- We have 2 plants, Trieste(IT) & Vaasa (FI)
- Over 4300 MW production capacity
- 3,98% of Net Sales = R&D Budget (2012)
- Personnel 18,887





Wärtsilä Power Plants Worldwide *



* Includes plants on order and in construction

Wärtsilä Lifecycle support around the world

→ 70 countries → 160 locations → 11,000 people → 7,500 field service forces

We are the only player in the market able to offer our clients 24/7 support, globally, in the fields of logistics, technical support and field service from a single source.

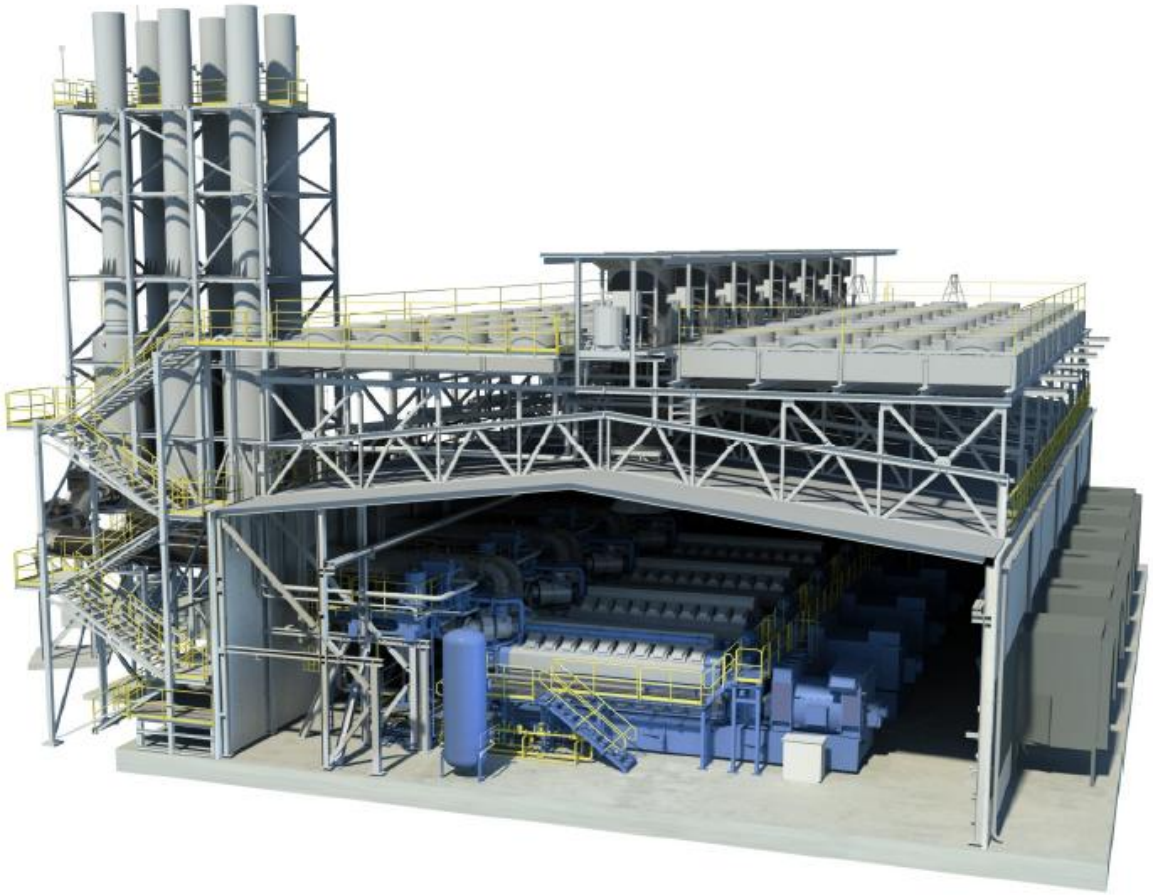
About Wärtsilä in North America

Wärtsilä USA since 1979.
Currently 650 employees
in North America

Wärtsilä Gas Engines

SMART POWER GENERATION

- 20V34SG*- 9.3 MW / unit
  45% efficiency
- 18V50SG*- 18.8 MW / unit
  46% efficiency
- + Combined Cycle (Flexicycle™)
  50.4% efficiency
- Arranged in parallel
  to configure any
  size plant in the
  ~10 to 500+ MW size range
- Required project MW capacity
  met by multi-unit solution



* Similar Engines in DF configuration on gas/liquid fuel

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Wärtsilä Gas Engines

	20V34SG-D	18V50SG
Output	9,341 kWe	18,759 kWe
Heat Rate* (LHV) (HHV)	7,461 Btu/kWh 8,271 Btu/kWh	7,375 Btu/kWh 8,176 Btu/kWh
Speed	720 rpm	514 rpm
Dimensions (L/WH)	42’ x 11’ x 15’ 143 US tons	63’ x 18’ x 21’ 391 US tons

* *At generator terminals (pf 0.8, 0% tolerance)*

Wärtsilä Duel Fuel Engines

	20V34DF	18V50DF
Output	9,341 kWe	17,076 kWe
Heat Rate* (LHV) (HHV)	7,525 Btu/kWh 8,341 Btu/kWh	7,460 Btu/kWh 8,271 Btu/kWh
Speed	720 rpm	514 rpm
Start Time (min)	2 / 5 / 10	7 / 10

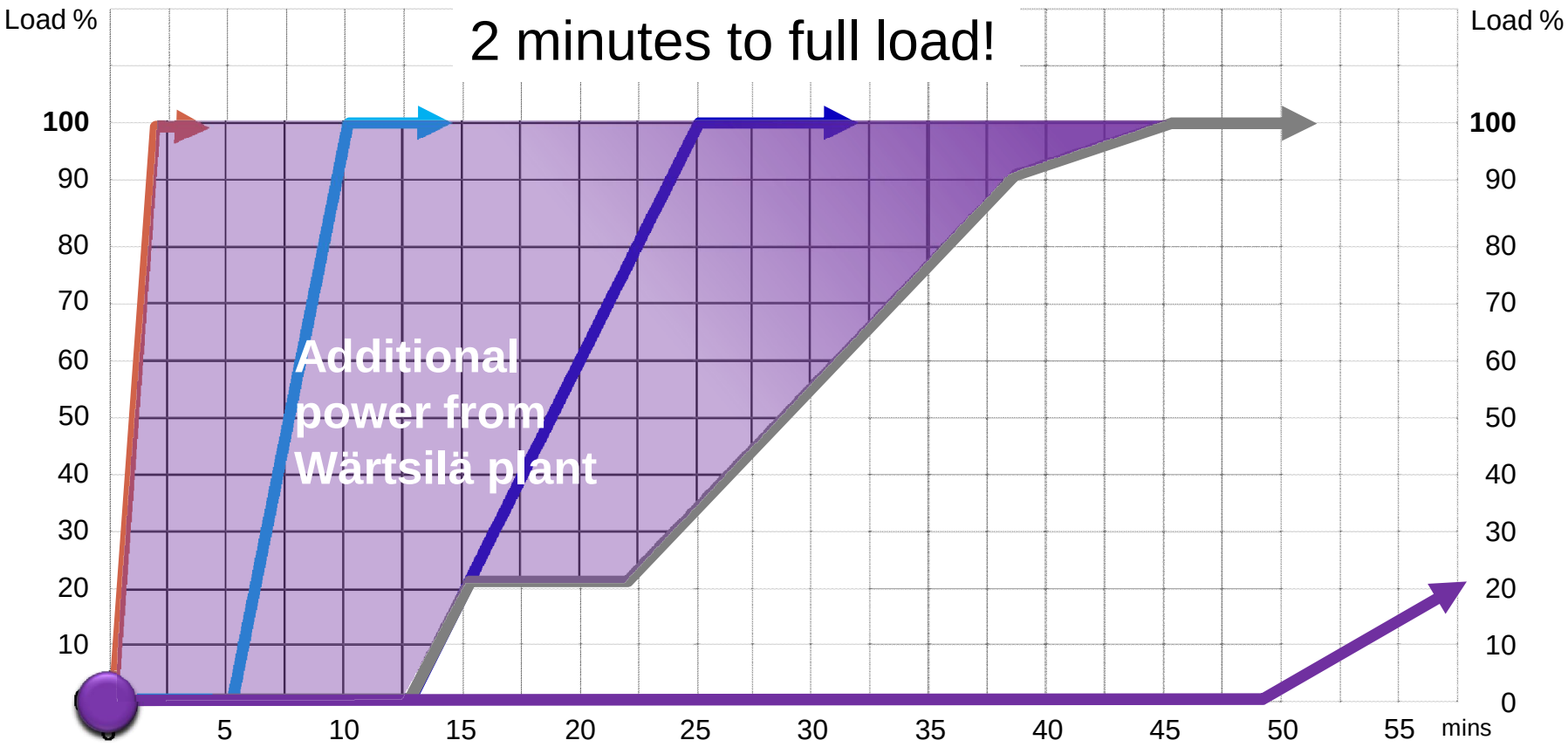
* *At generator terminals (pf 0.8, 0% tolerance) when operating on natural gas with 1% liquid pilot fuel*

Best simple cycle efficiency

We offer the best simple cycle efficiency available in the market at >46%. Typical net plant heat rate of <8400 Btu/kWh HHV at 95 °F

Our power plants achieve high efficiency in a wide range of ambient conditions

Loading sequences for power plants



Coal Fired power plant

Aeroderivative GT power plant (GTSC)

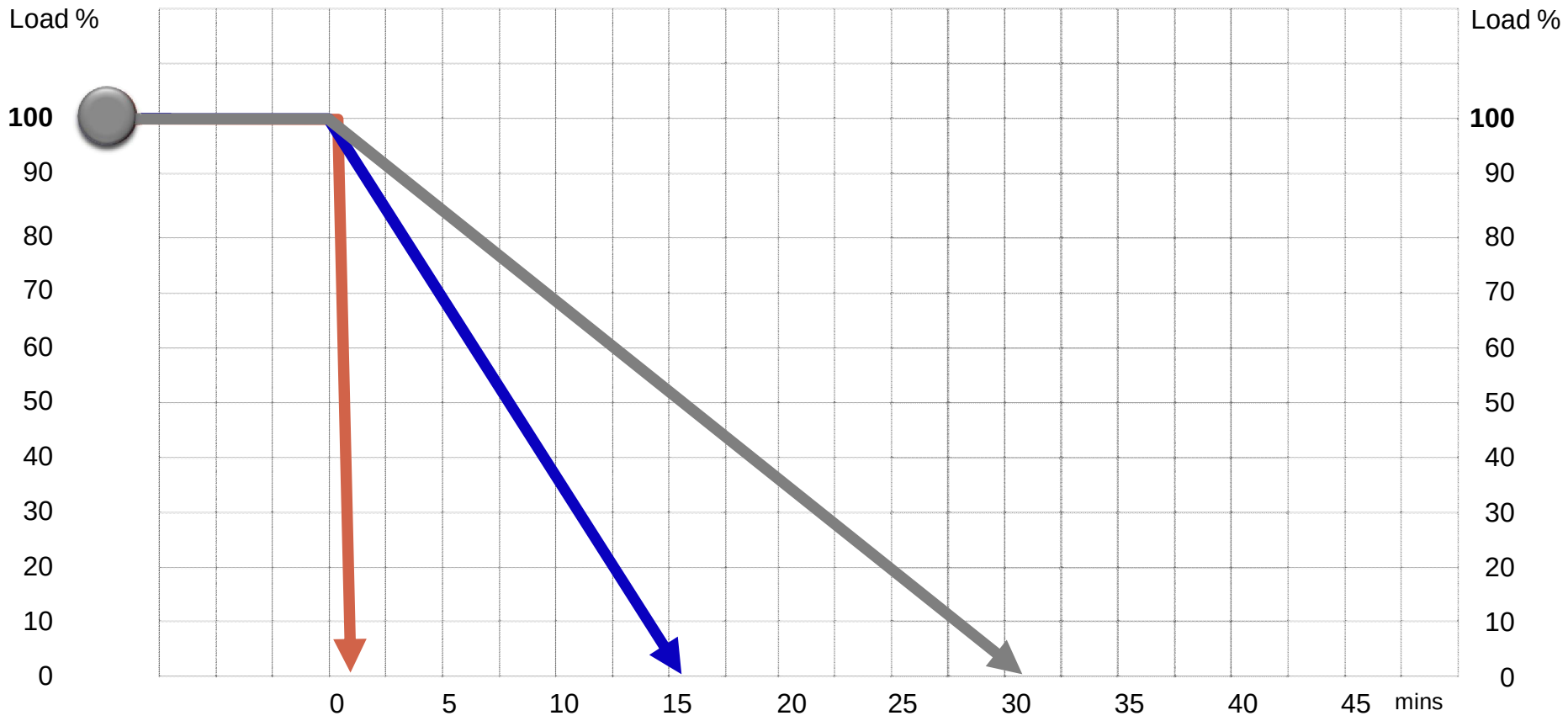
Combined Cycle power plant (GTCC)

Combustion Engine power plant (W34SG)

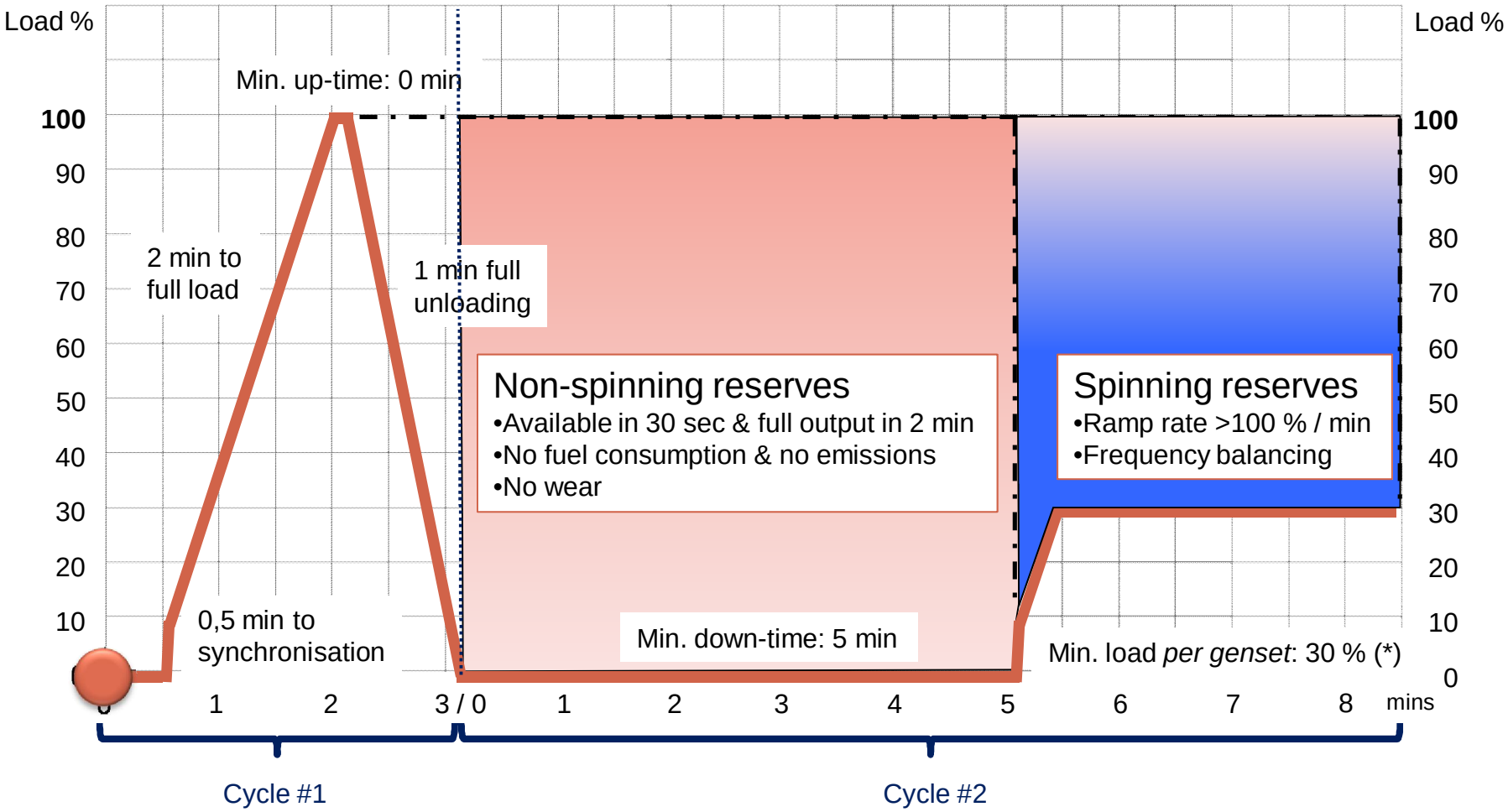
Industrial GT power plant (GTSC)

Note: Start up times from warm stand-by!

Unloading sequences for power plants



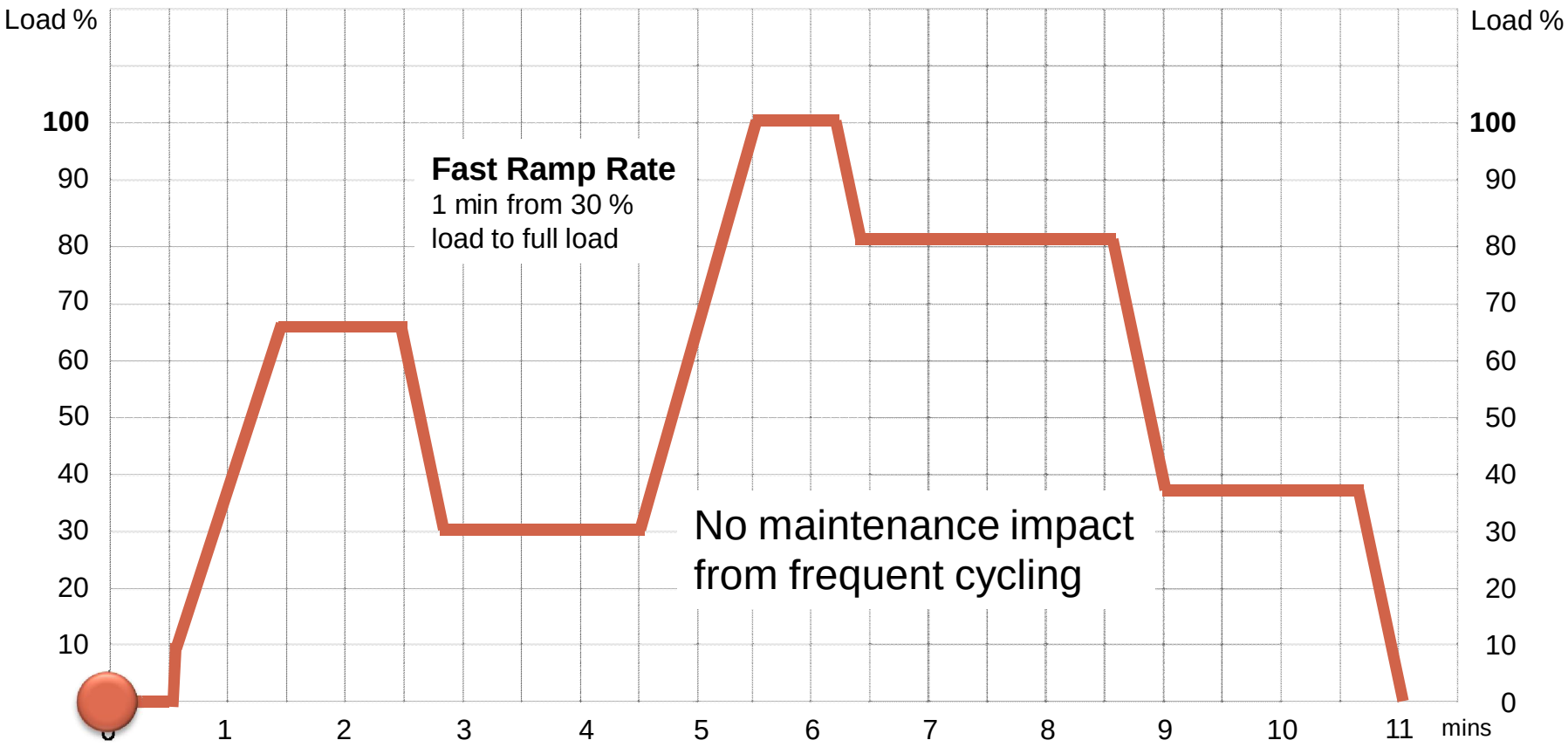
Loading and unloading of a W34SG plant



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

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

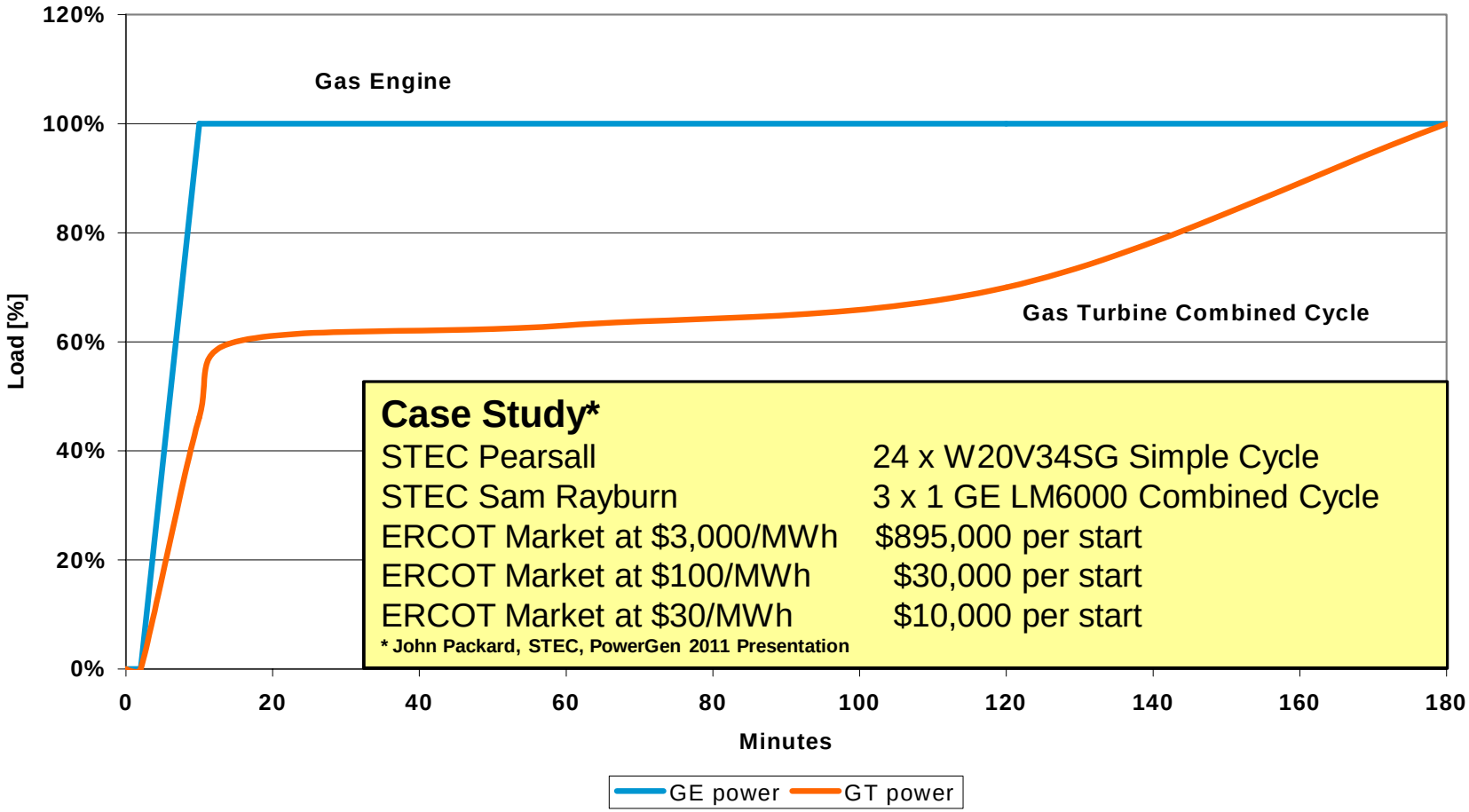
Cycling of a W34SG plant



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

Quick Start

Start up and loading of a Gas Engine power plant compared to a GTCC

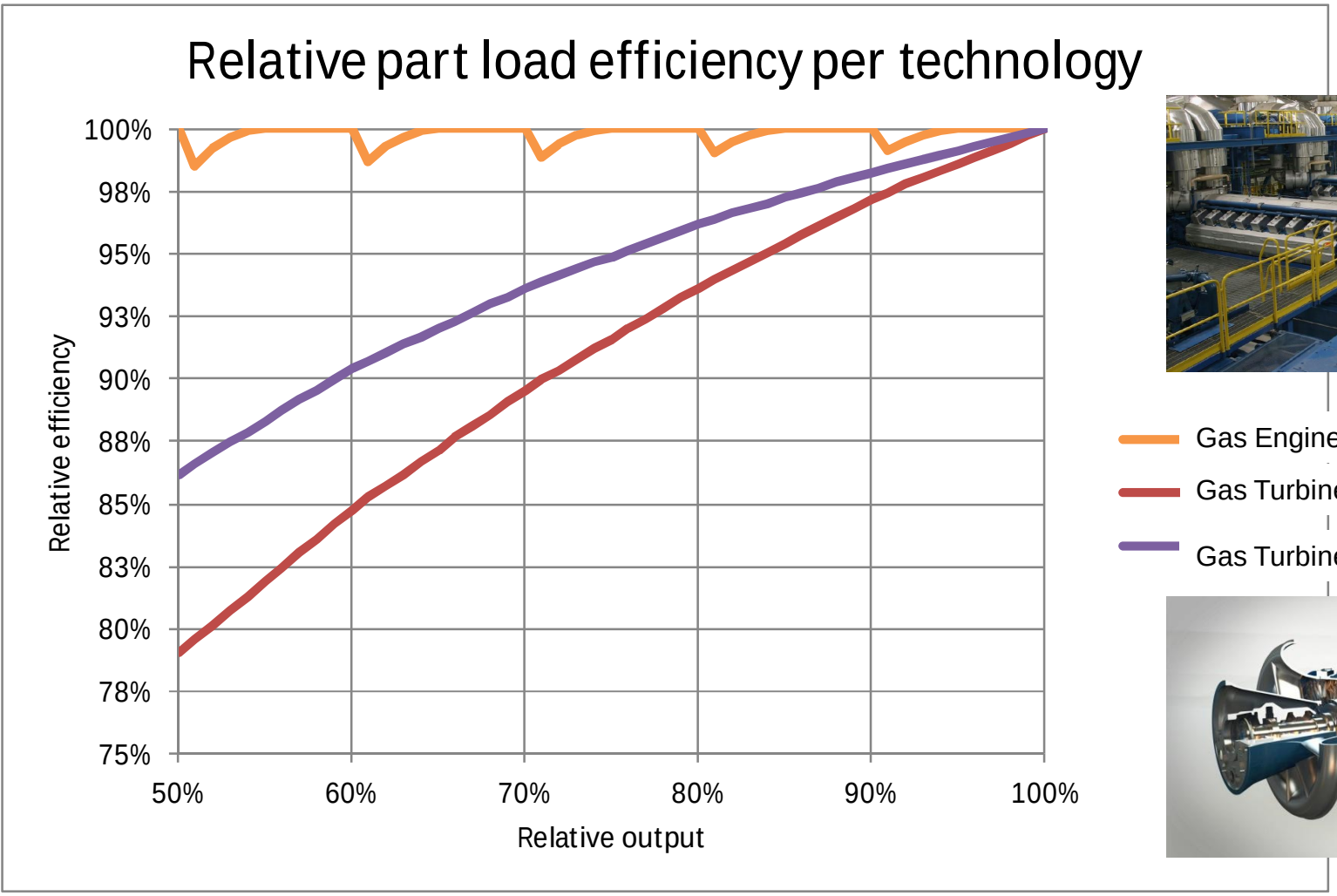


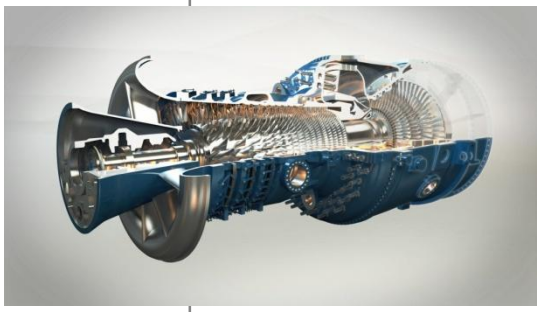
Case Study*

STEC Pearsall	24 x W20V34SG Simple Cycle
STEC Sam Rayburn	3 x 1 GE LM6000 Combined Cycle
ERCOT Market at $3,000/MWh	$895,000 per start
ERCOT Market at $100/MWh	$30,000 per start
ERCOT Market at $30/MWh	$10,000 per start

* John Packard, STEC, PowerGen 2011 Presentation

Combustion Engines, Multiple unit efficiency





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No start penalties & No start-up costs

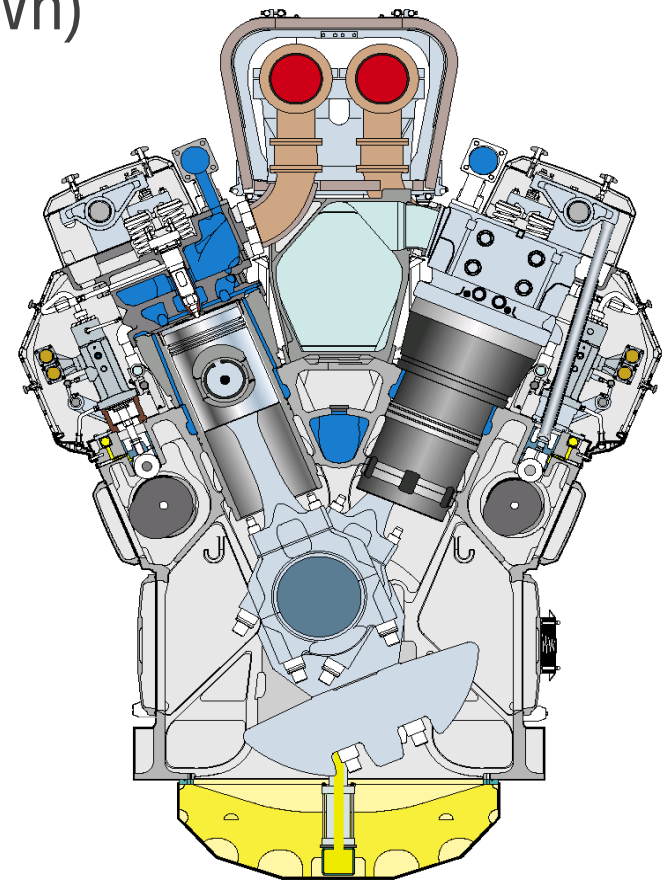
Unlimited starts & stops with no impact on cost or maintenance schedule.

This is unique, no competing technology offers the same.

Dispatcher's dream plant
Plains End 227 MW
Colorado

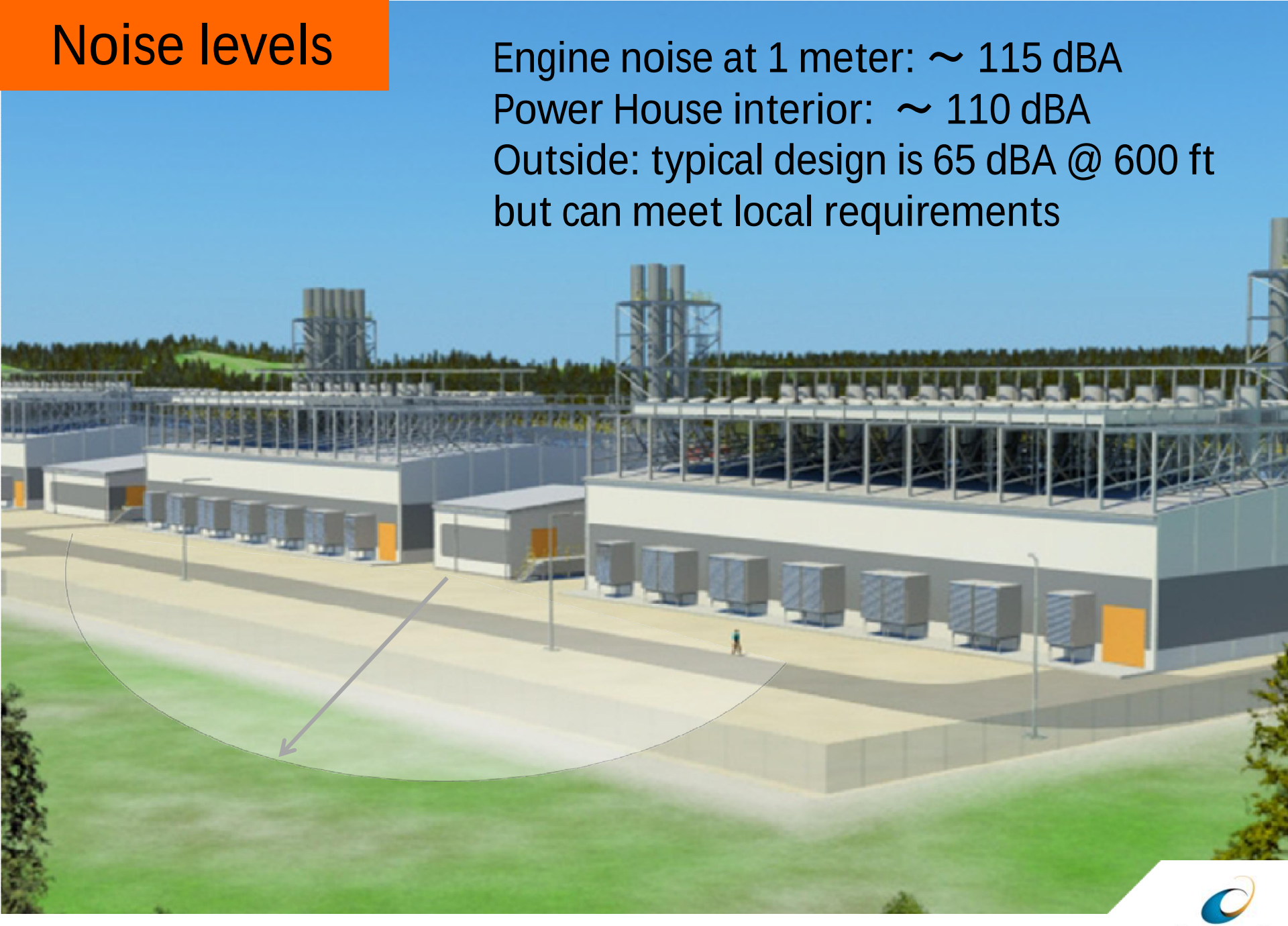
Emissions

- Nox - Nitrogen oxides: 5 ppm (0.064 g/kWh) (as NO2) (dry, at 15 vol-% O2) - with SCR
- CO - Carbon monoxide: 15 ppm (0.12 g/kWh) (dry, at 15 vol-% O2) - with CO catalyst
- VOC 25 ppm (0.12 g/kWh) (dry, at 15 vol-% O2)
- Particulates (total) (0.12 g/kWh) (at 15 vol-% O2)



Noise levels

Engine noise at 1 meter: ~ 115 dBA
Power House interior: ~ 110 dBA
Outside: typical design is 65 dBA @ 600 ft
but can meet local requirements



Minimum water use

Wärtsilä' solutions minimize not only fuel but also water consumption thereby providing major environmental benefits. Our power plants use a closed loop cooling system that requires minimum water

Simple Cycle water consumption = 1 gal/engine/week

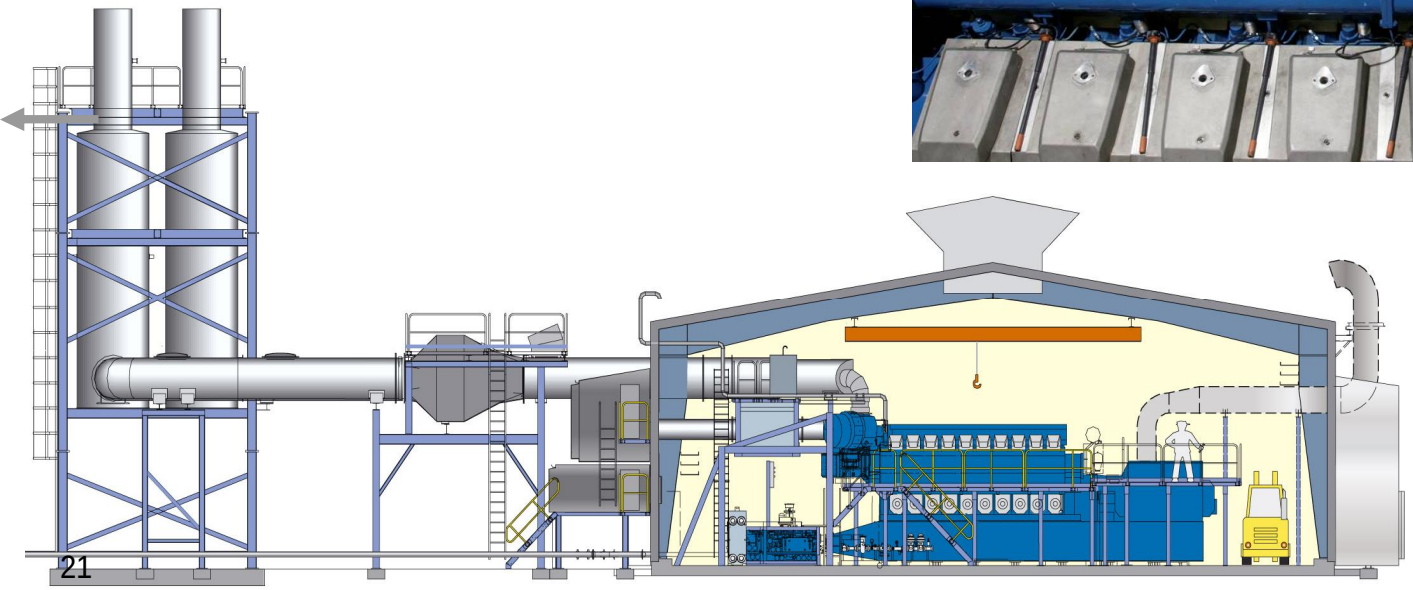
Combined Cycle water consumption is 1/3 of GTCC Plant

Low pressure gas

Wärtsilä power plants use low pressure natural gas (75 psig).
No need for aux. gas compressor or high pressure gas line

Modularity

Our modular design allows for easy capacity additions and makes it simple for our customers to construct an optimally sized plant



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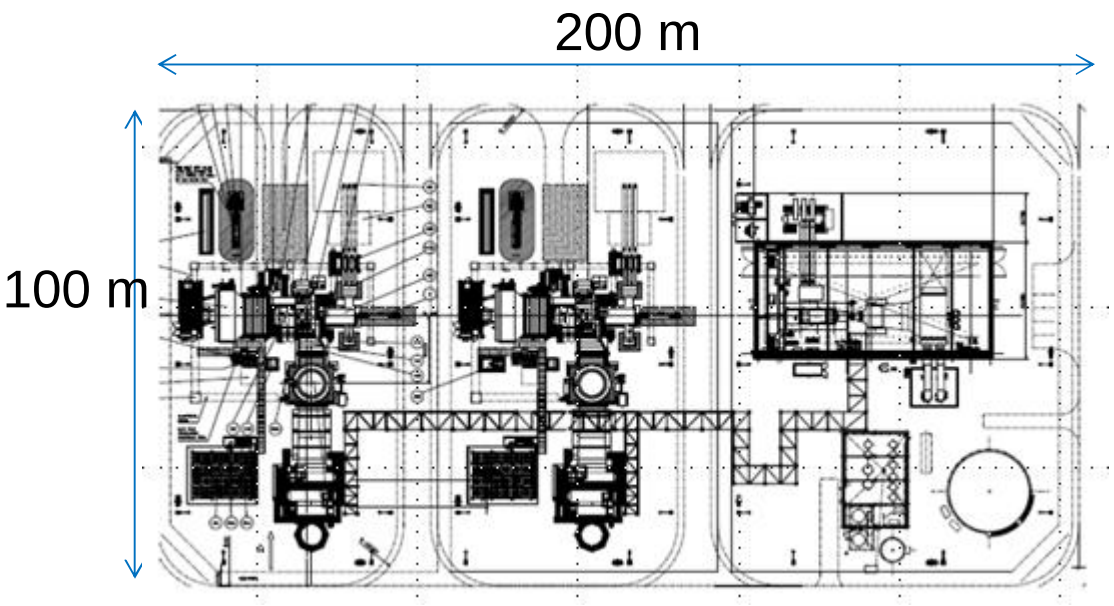
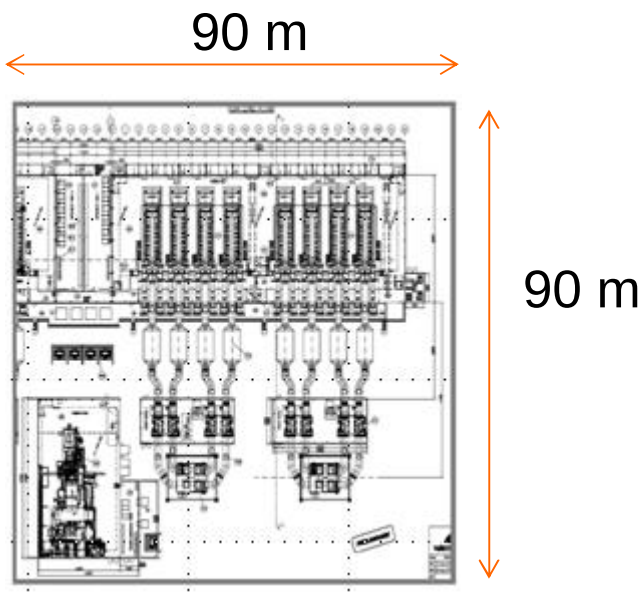
Busting a myth: the power density disadvantage





2x CCGT

Output: 360MW
Area req.: 20,000m2
Power density:18 kW/m2

8x 18MW Gas Engine

Output: 155MW
Area req.:8,100m2
Power density: 19 kW/m2

Comparison

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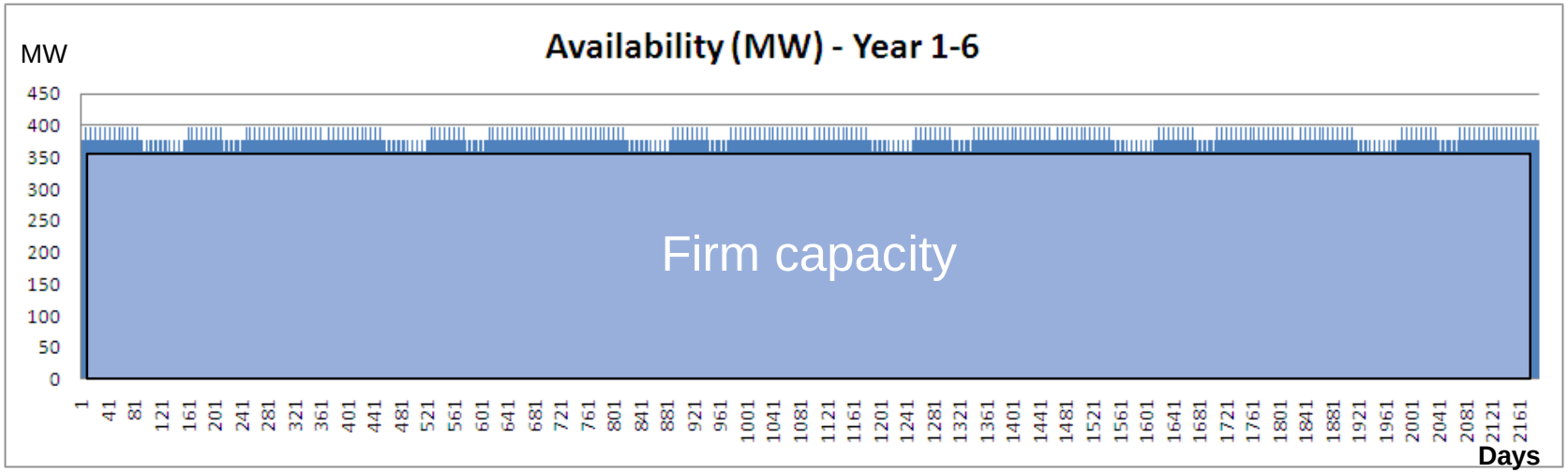
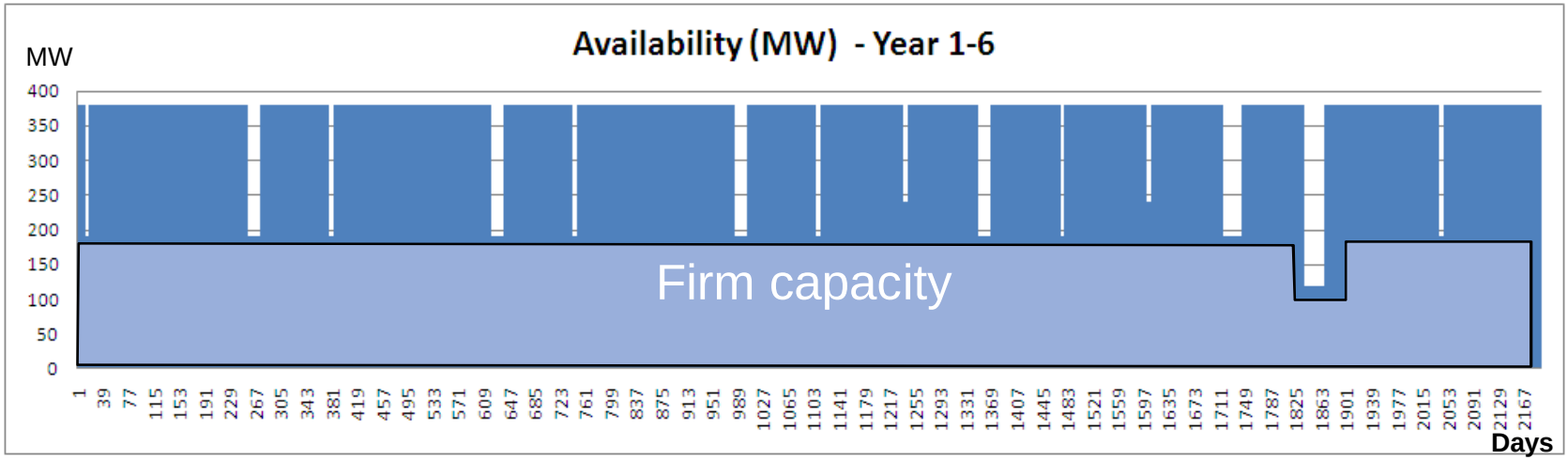
Availability and reliability

22x18V50SG



CCGT (2-2-1)



Comparison

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Light industrial look to the plant

Wärtsilä design makes the project look like a commercial building.

No visible smoke, fumes or steam release

Levelized Cost, Capex+Opex

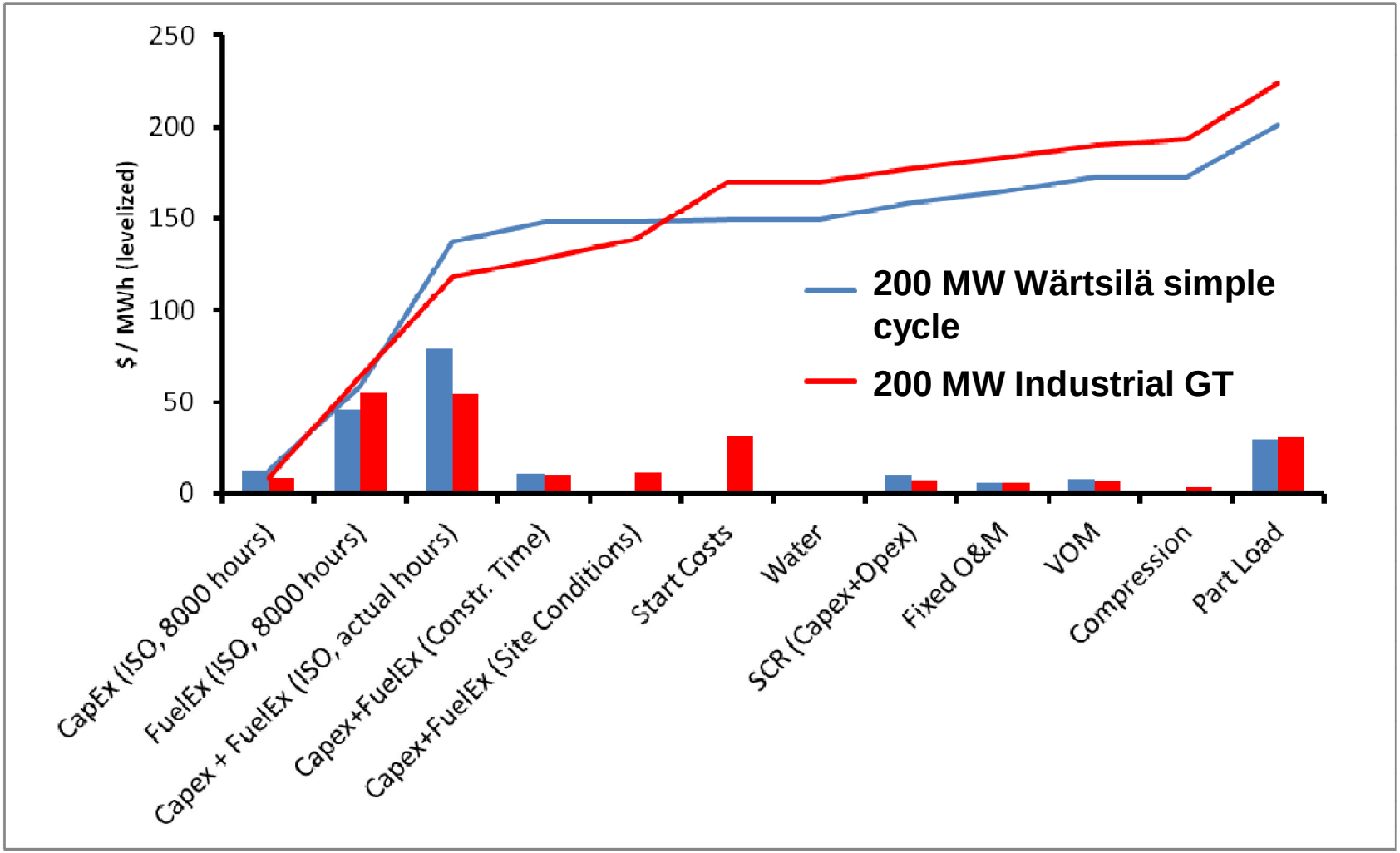
KEMA study (CAISO) & Redpoint (UK) studies…..

1) **Adding SPG reduces OPEX, total operational cost of fleet**
2) **But we have not addressed CAPEX**

To take CAPEX into account (along with OPEX), we can look at levelized cost

1) **For simple cycle, look at capacity factors 10% to 20%**
2) **For others (GTCC, Flexicycle) look at capacity factor of 30% & 40%**
3) **Assume plant running 80% load**
4) **Daily starts/stops, across 5 day / week (hours per day adjusted to achieve cf).**

Wärtsilä 200 MW vs. Industrial GT (10% cf)



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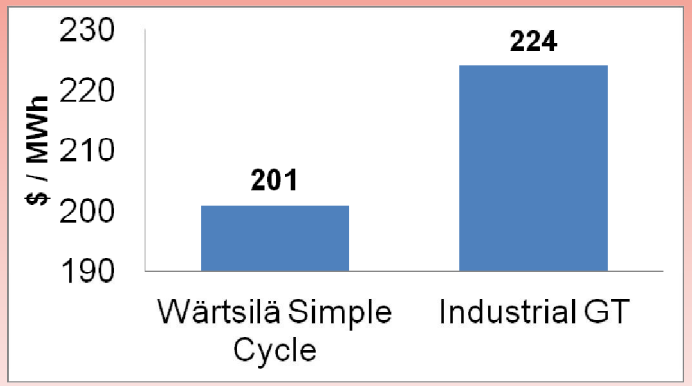
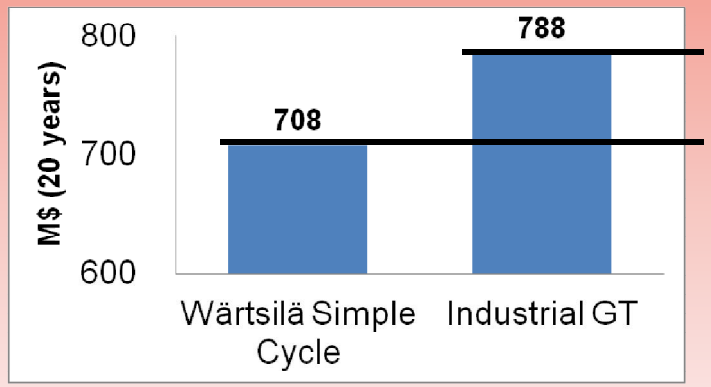
Wärtsilä vs. Industrial GT (200 MW)

Busbar Cost

Total Production Cost

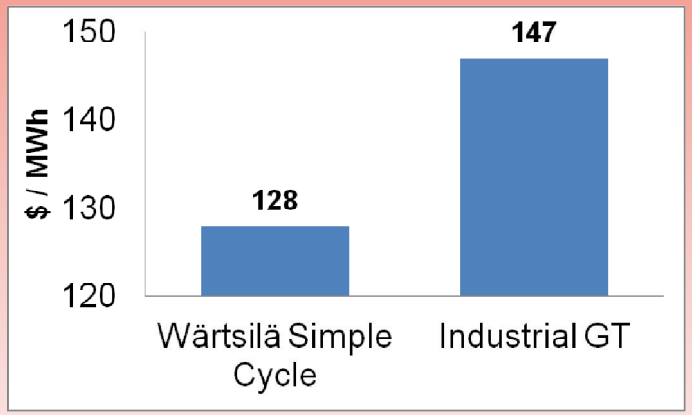
10% CF

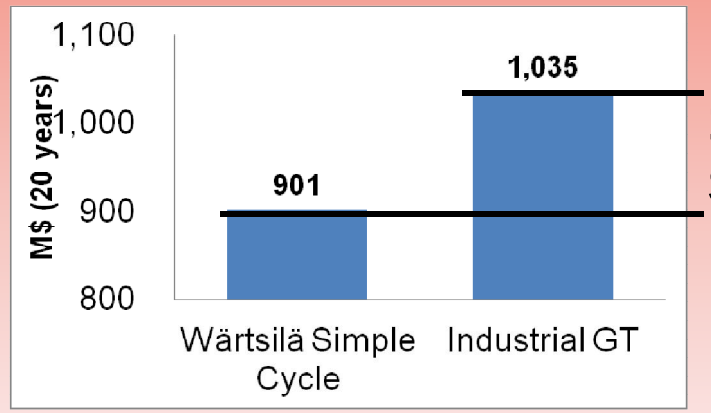




80 MUSD Savings

20% CF





134 MUSD Savings

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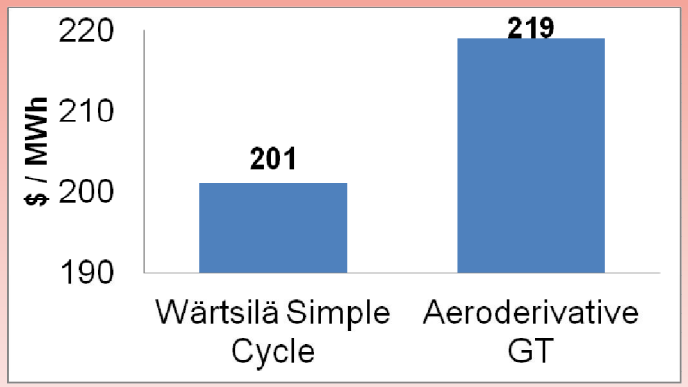
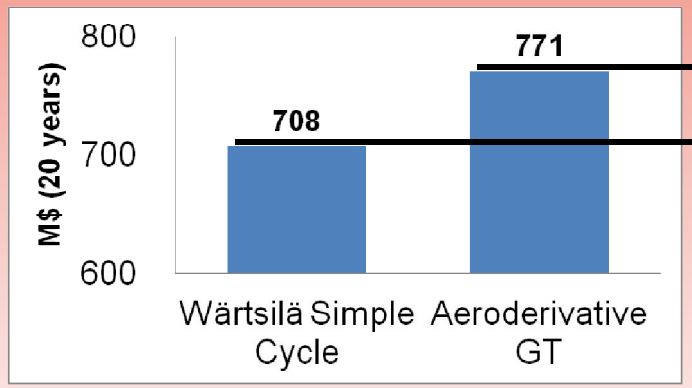
Wärtsilä vs. Aero GT (200 MW)

Busbar Cost

Total Production Cost

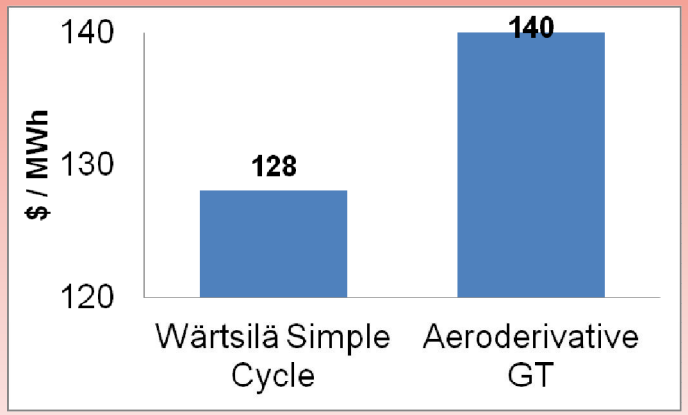
10% CF

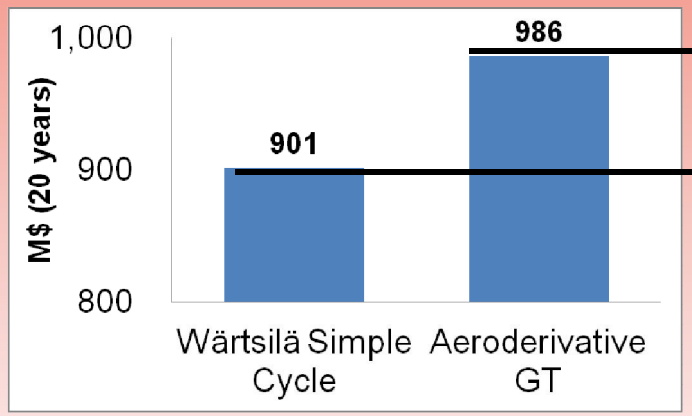




63 MUSD Savings

20% CF





85 MUSD Savings

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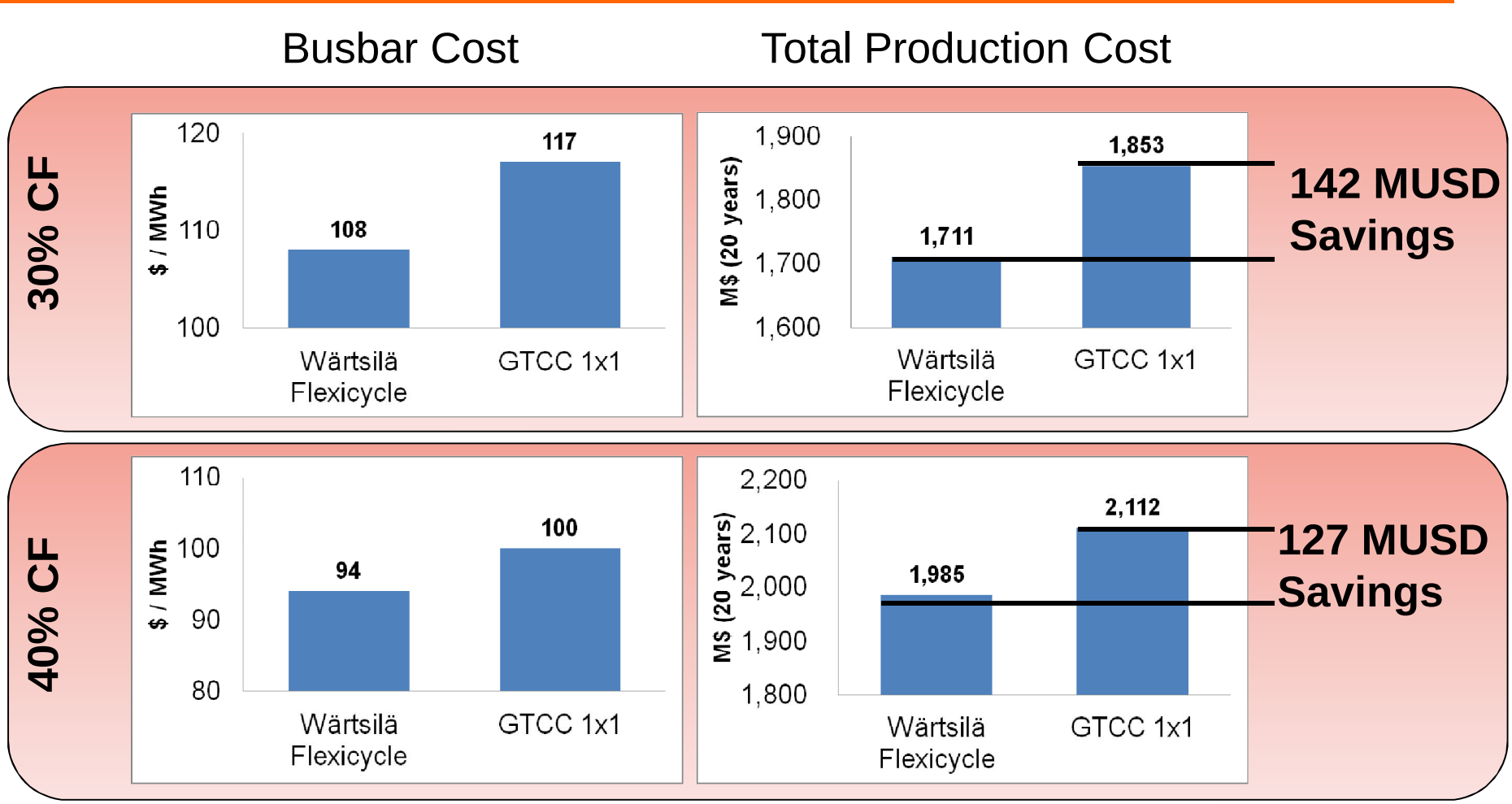
Wärtsilä Flexicycle vs. GTCC 1x1 (300 MW)



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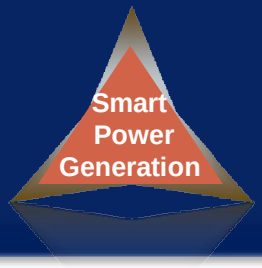
System benefits of Smart Power Generation

NEED FOR SYSTEM FLEXIBILITY

1. Unplanned outages of power plants or/and transmission lines
2. Electricity demand (load) deviating from the forecast
3. Intermittent renewable generation output deviating from forecast

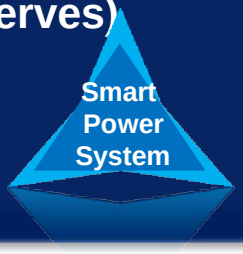
SMART POWER GENERATION CAN

- Provide spin capacity for regulation, spinning reserve, load following
- Provide MW to grid in 1 minute or less
- Produce energy & AS at high efficiency over a wide load range



SYSTEM BENEFITS OF SMART POWER GENERATION

- Reduce costly cycling/starts for high efficiency thermal plants
- Enable high efficiency thermal plants to full load instead of part load
- Enable stopping part loaded low efficiency steam power plants (that are providing reserves)



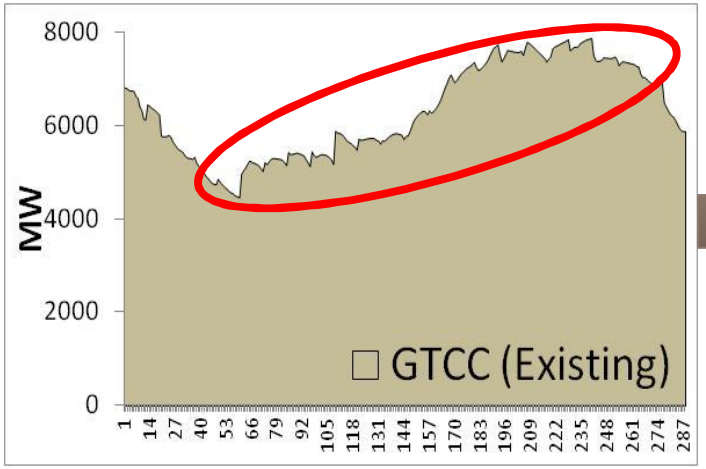
VALUE OF SMART POWER GENERATION

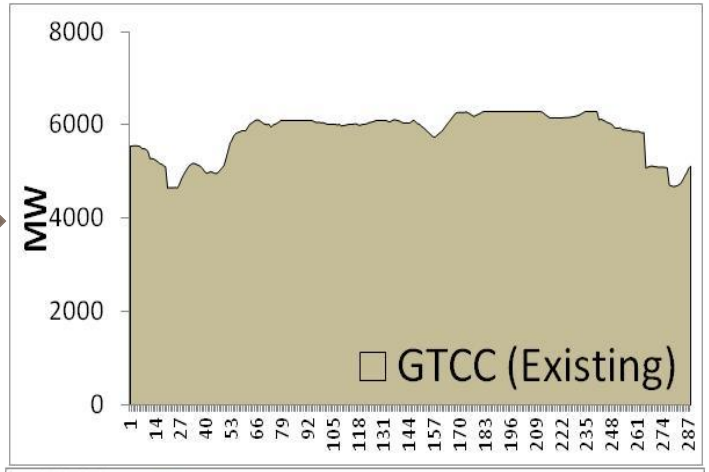
- Reduced use of fuels
- Reduced CO2 emissions
- Reduced system operating costs
- Lower wholesale price of electricity
- Lower cost of electricity to consumers

KEMA DNV

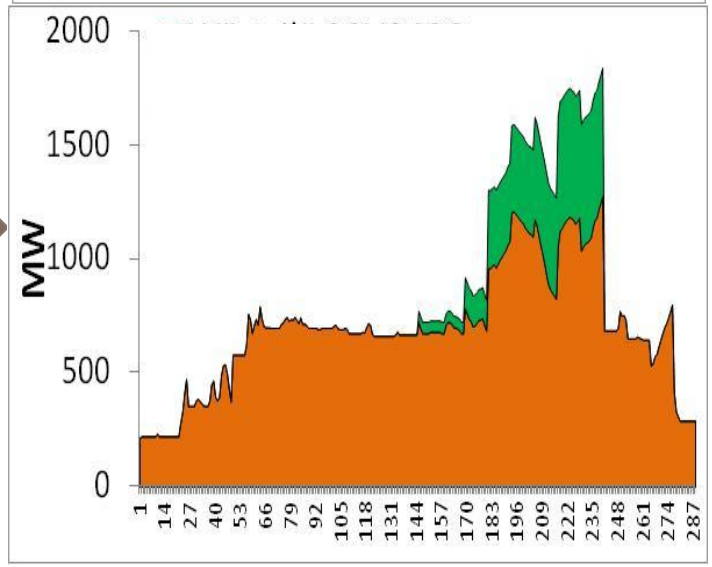
REDPOINT

REDUCTION OF CYCLING ON THE GTCC





- Recip units can cycle on and off as needed w/o start/stop penalty
- High efficiency from part load through full load
- Take over AS provision (Load Following, Reg Up) and ramping
- Reduce Cycling on the GTCCs and don't exercise the stress curve on the GTs and HRSGs as much thus reducing maintenance cost and maintaining life of the GTCCs



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Recent Wärtsilä US Flexible Power

34SG

- *Plains End I / II, Colorado, 227 MW*
- *Barrick, Nevada, 116 MW*
- *Midwest Energy, Kansas, 76 MW*
- *STEC Texas 203 MW*
- *Greenville, Texas, 25 MW*
- *Modesto, California, 50 MW*
- *Golden Spread Texas 170 MW*
- *Lea County Coop 43 MW*

Wärtsilä Smart Power Generation - Texas

34SG

3 x 20V34SG

25 MW – GEUS – Greenville, TX

18 x 20V34SG 170 MW – GSEC - Abernathy, TX

24 x 20V34SG 203 MW – STEC - Pearsall, TX

GEUS – Greenville, Texas

3 x 20V34SG
25 MW

STEC – Pearsall, Texas

34SG

24 x 20V34SG 203 MW

The South Texas Electric Cooperative (STEC) Pearsall Power Plant in addition to serving load at member cooperatives, participates in the ERCOT Ancillary Services Market providing quick start reserves, spinning reserves , regulation and other high value products.

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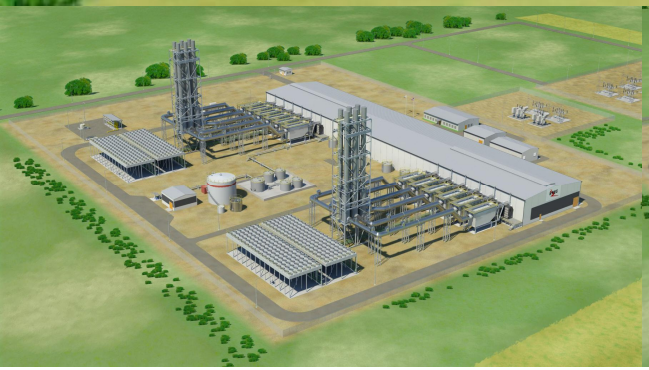
Wärtsilä Smart Power Generation

50SG



Simple Cycle 221 MW *

Future Combined Cycle 239 MW *

The South Texas Electric Cooperative (STEC) Red Gate Power Project is one Wärtsilä's new flexible power plants with fast start, fast ramping, high efficiency at full and part load with minimal water use.. Commercial operation is planned for early 2015. The plant layout will accommodate future expansion to Flexicycle™ (combined cycle). *** Net Output at 95 F**

NEW 12x18V50SG PROJECTS

STEC Red Gate
Edinburg, TX

PGE Port Westward II
Clatskanie, OR

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Wärtsilä Smart Power Generation - California

50DF

Pacific Gas & Electric, Humboldt - Eureka, California

10 x 18V50DF - 162 MW

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PGE – PORT WESTWARD II

- 2,964 Stone Columns completed for soil stabilization
- Engine Halls underway
- Underground pipe and electric underway
- Tie Ins to PW1 started

12 x 18V50 SG (224 MW)

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Wärtsilä Smart Power Generation - Azerbaijan

50SG

21 x 18V50SG

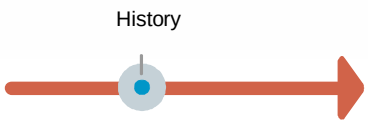
384 MW Boyuk Shor – Baku, Azerbaijan

Reciprocating engines in the 21st century

- Reciprocating engines are no longer a technology only suitable for small-sized projects or emergency generation

- Today's engines are competitive in many aspects
  - All plant sizes 1-600 MW
  - Operation on all kinds of gas and liquid fuels
  - Baseload, grid stability, standby-backup
  - Combined cycle, CHP, trigeneration
  - Industrial self-generation

- They are excellent for Smart Power Generation, a concept in which Wärtsilä is the global leader



Conclusions

Today's reciprocating engines...

... are generally more efficient than comparable gas turbine technology

... perform much better at part load and at extreme ambient conditions

... are less sensitive to changing operational conditions

... offer better availability

... offer solutions for all kind of industrial needs

... are very competitive in terms of CAPEX and OPEX

Wärtsilä the Leader in Smart Power Generation

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