NATURAL GAS TODAY AND THE FUTURE

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WARTSILA NORTH AMERICA, INC.

PRESENTED TO CIBO ANNUAL MEETING

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NG Today and in the Future

- Brief Introduction to Wartsila
- Modern Power Generation – Natural Gas Reciprocating Engine Technology
- Plant output trend
- Renewables – Making Wind and Solar Dispatchable using Flexible NG Generation
- US Oil and Natural Gas Resources
- Reciprocating power plants in combined cycle – the ultimate in flexibility

Natural Gas Today and in the Future

Brief Introduction to Wartsila

Who is Wärtsilä?

- Established 1834, based in Finland
- Publicly traded $9+ Billion company
- World leader in
  - Decentralized power plants 1-900 MW
  - Engine room solutions for ships
  - O&M services for power plants and ships
- Local subsidiary / service outlets 70 countries
- More than 18,000 employees globally

WÄRTSILÄ

About Wärtsilä

Power Plants

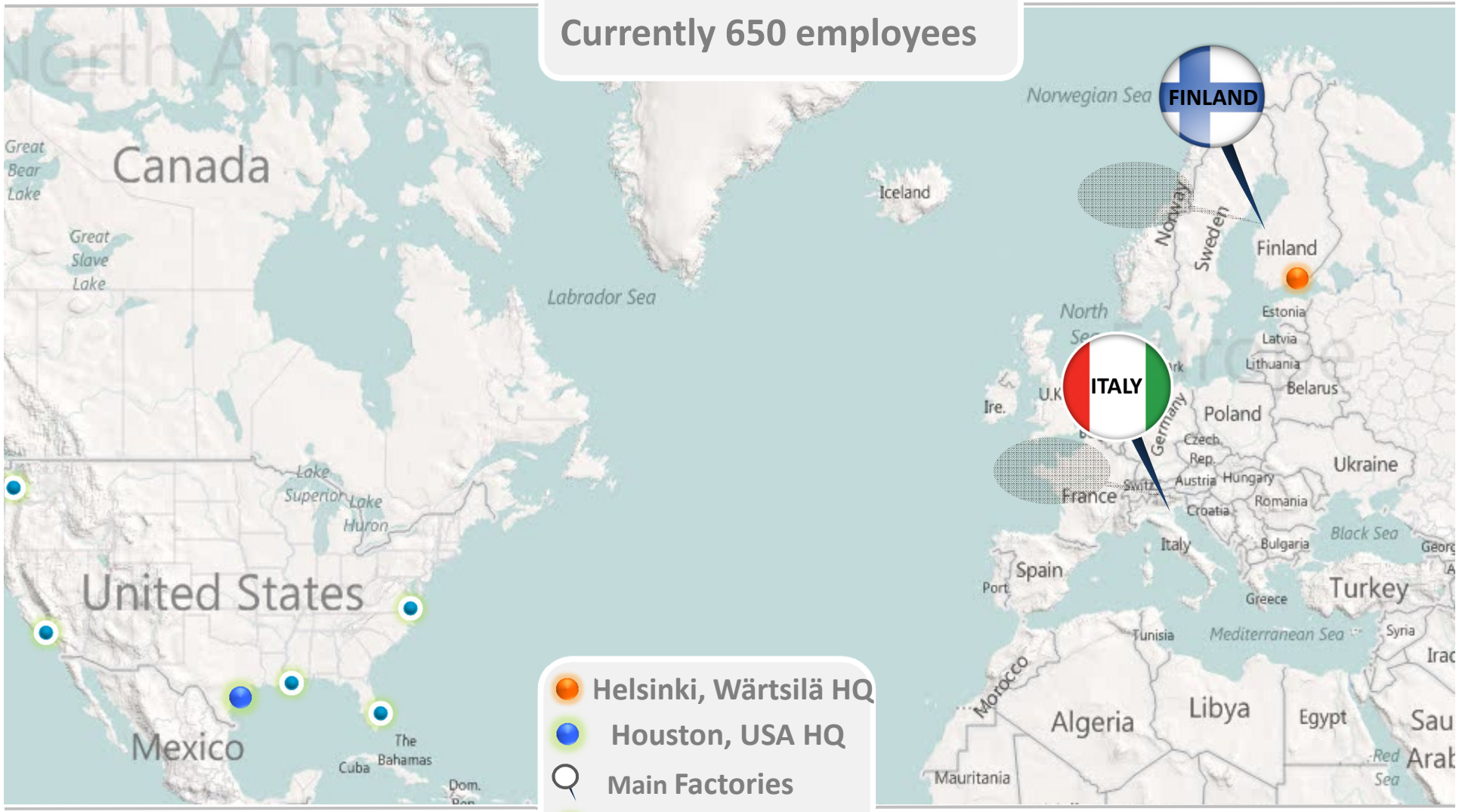
Marine

Service

Wärtsilä provides complete lifecycle power solutions for the marine and energy markets. The company is based Finland and has operations 70 countries. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.

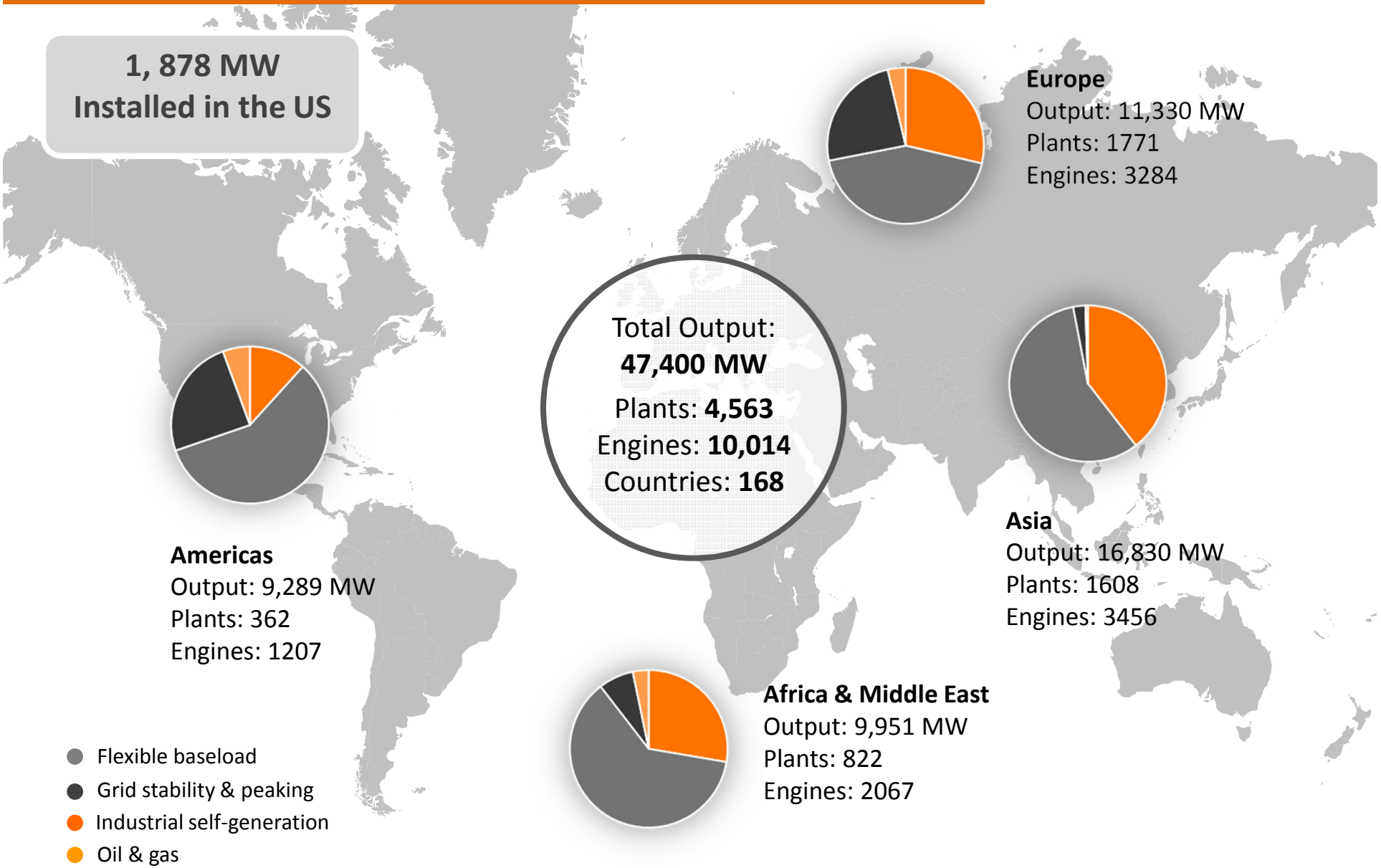
About Wärtsilä

Wärtsilä NA since 1979.
Currently 650 employees



- Helsinki, Wärtsilä HQ
- Houston, USA HQ
- Main Factories
- US Service Offices

Power Plant Installed Base



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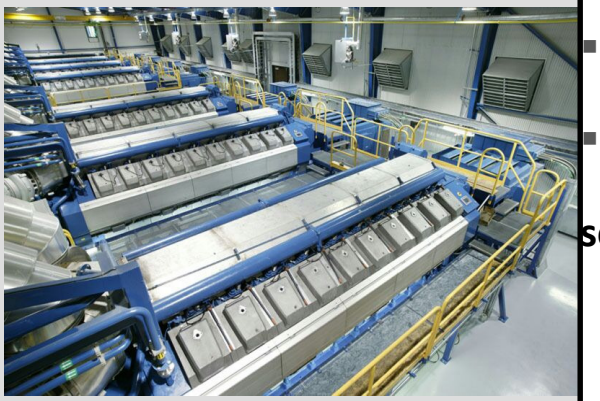
Modern Power Generation – Natural Gas and Reciprocating Engine Technology

Gas Engines

	34SG	50SG
Output	9.3 MWe	18.7 MWe
Heat Rate (HHV)*	8520 Btu/kWh	8118 Btu/kWh
Speed	720 rpm	514 rpm
Dimensions (L/WH)	42’ x 11’ x 15’	63’ x 18’ x 21’

* *At generator terminals (0% tolerance)*

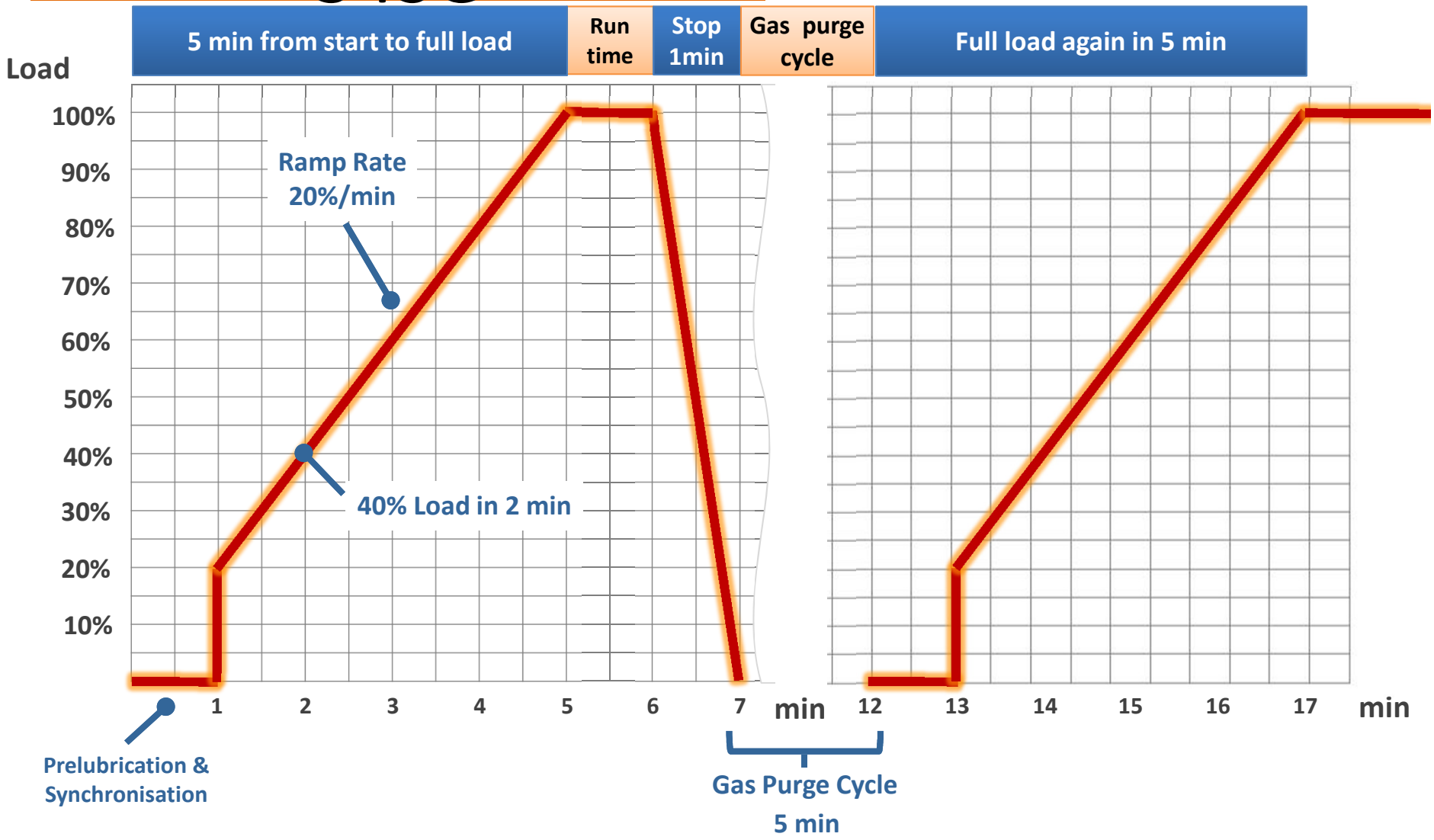
Recip Technology Advantages Burning Gas



- No cooling tower; no visible plume
- Operates on low gas pressure (85 psi)
- Multi-fuel operation
- Multi-unit plants, increased reliability
- Single digit NOx levels
- No process water consumption
- Provides superior grid ancillary services
  - Ready reserve
  - Spinning reserve
  - Voltage control
  - Regulation up and down
  - Black start
- 12-16 months for new projects

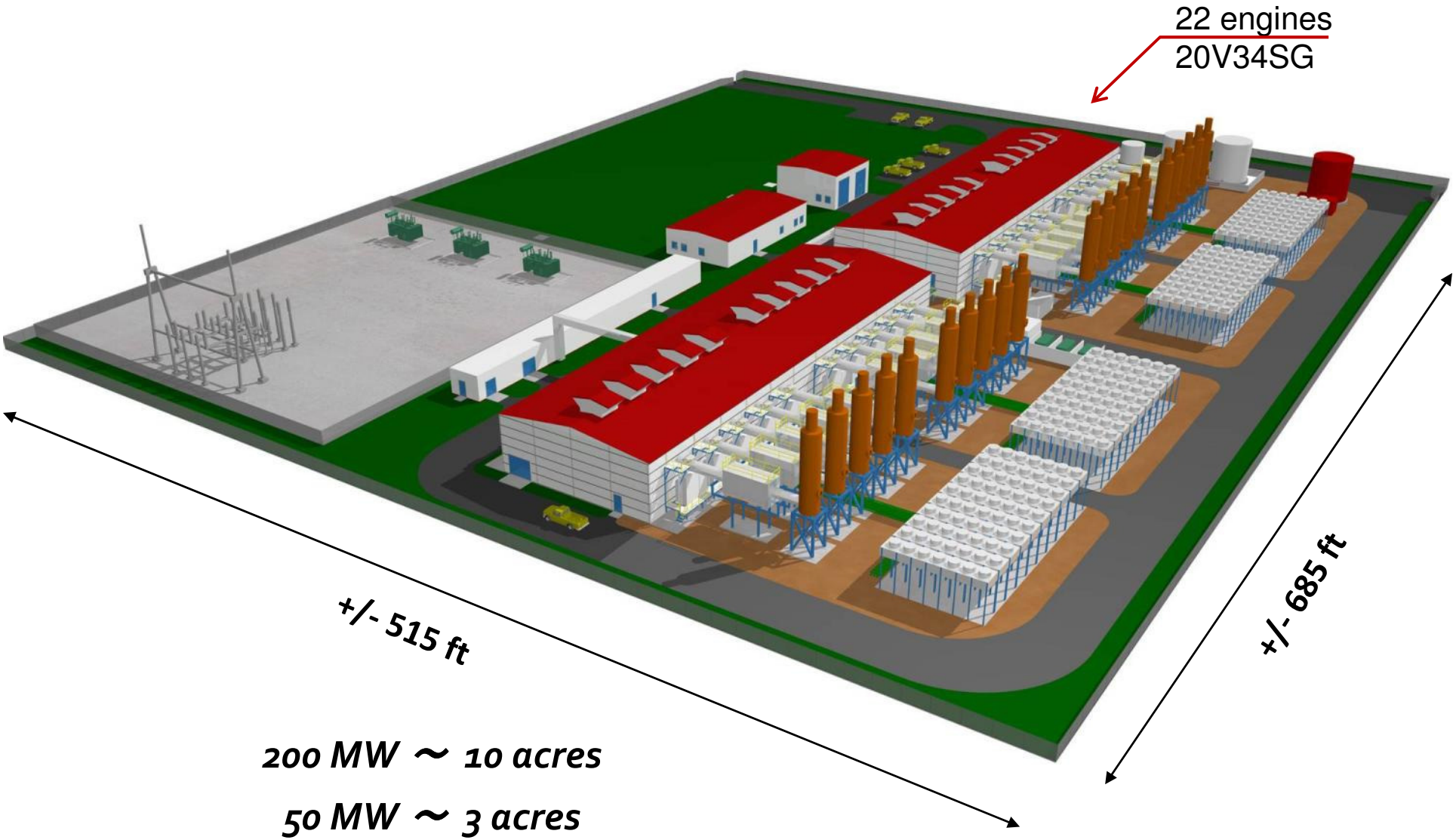
Quick start/stop: 34SG

Applicable to the whole plant



Engines in HOT STANDBY mode, i.e. preheated (HT water temp. >70 °C)

Typical view of a 200 MW Plant



200 MW ~ 10 acres

50 MW ~ 3 acres

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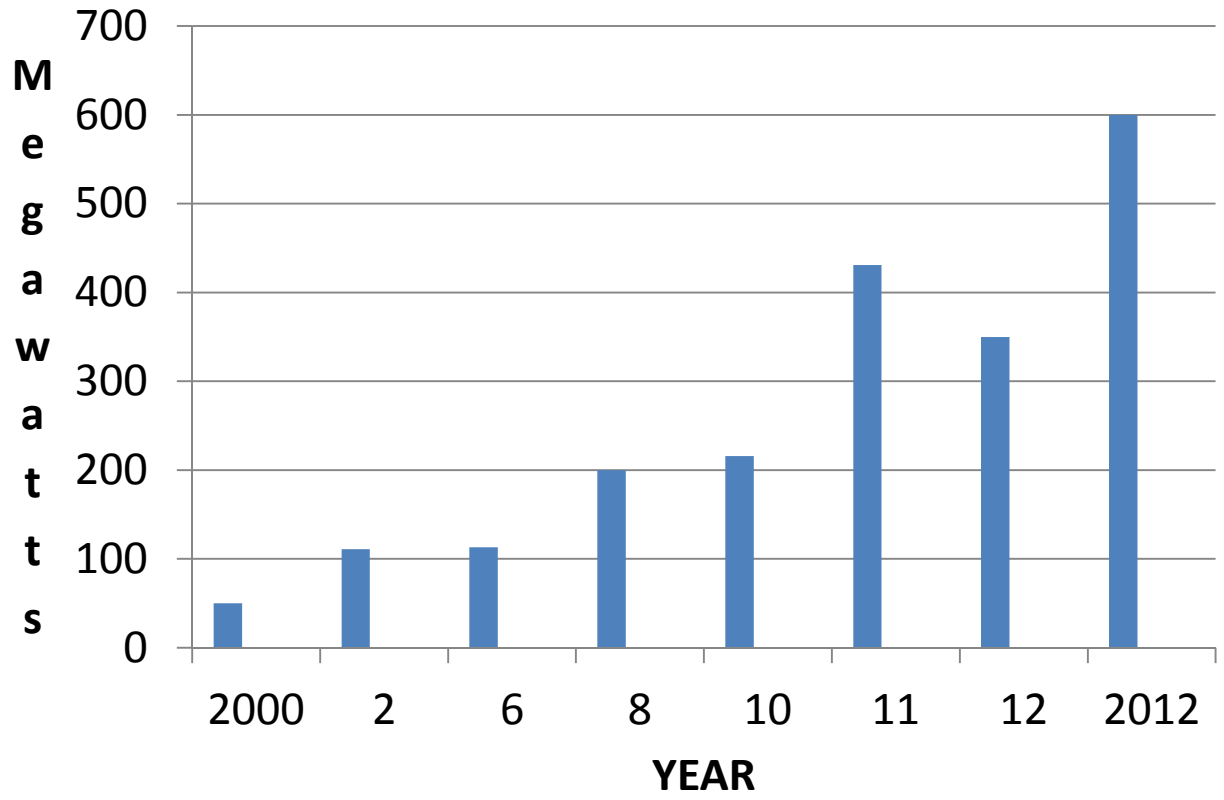
Plant output trend

Growth in Output of NG Fueled Recip Plants



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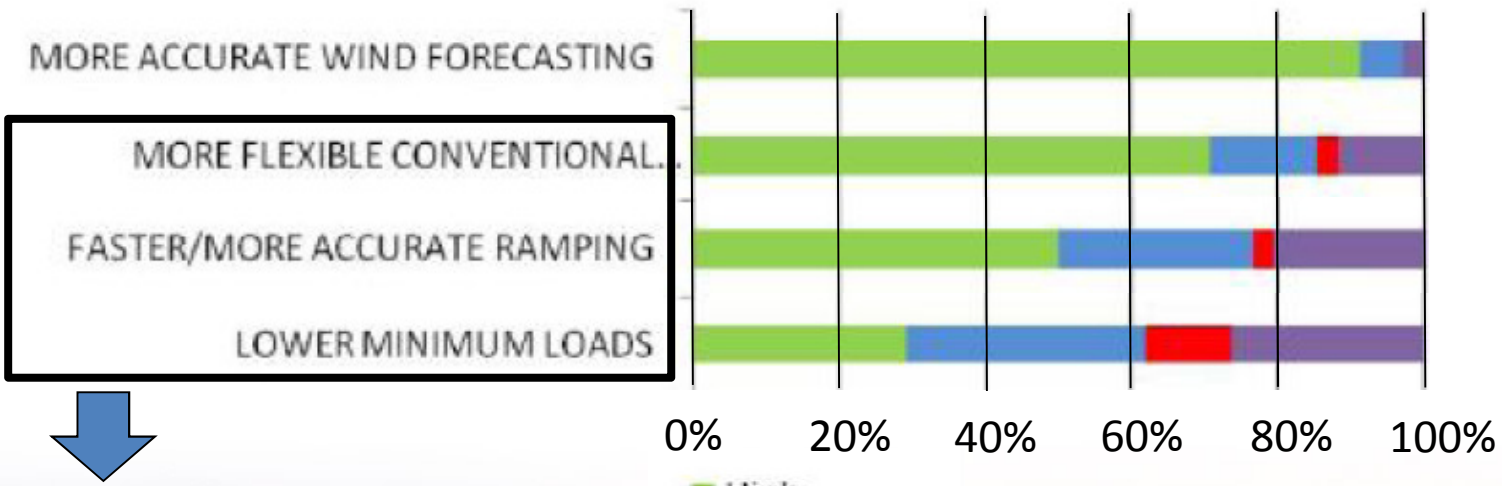
Renewables – Making Wind and Solar Dispatchable using Flexible NG Generation

Issues integrating the windmills

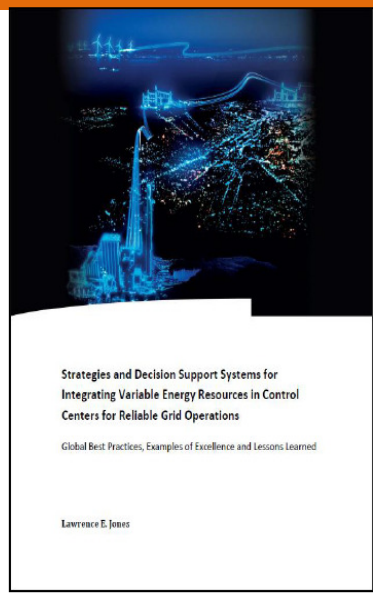
- Matching wind generation to load (improve forecasts)
- Spinning reserve & 10 min. start resources needed to manage intermittent nature of wind
- Ancillary service needs increase with increased wind penetration
- Fast responding peaking units become more critical

What do Grid Operators Say they need?

Survey of 33 grid operators, 72% of global wind capacity



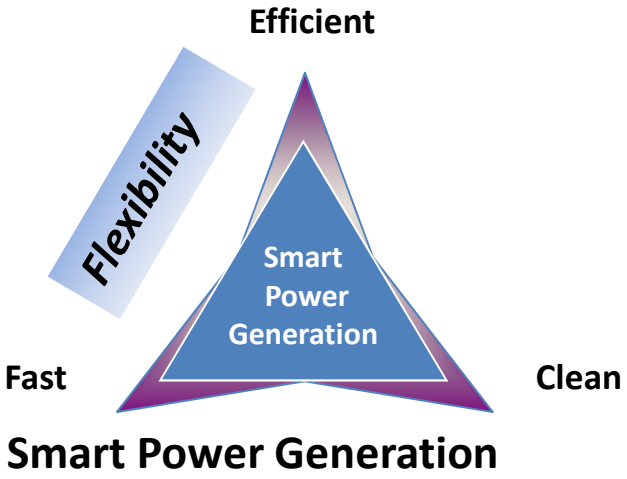
Flexibility



From Figure 38, Jones, LE (2012)
http://www1.eere.energy.gov/wind/pdfs/doe_wind_integration_report.pdf

FLEXIBILITY

- Cycling (without penalty)
- Fast Start
- High ramp (up/down)
- Low min load
- Efficient (full and part load)



Smart Power Generation

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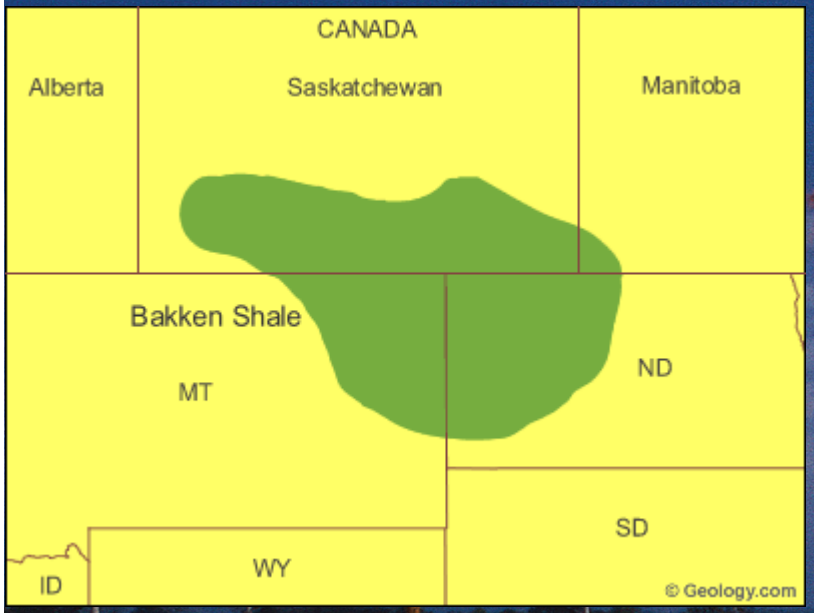
US Oil and Natural Gas Resources

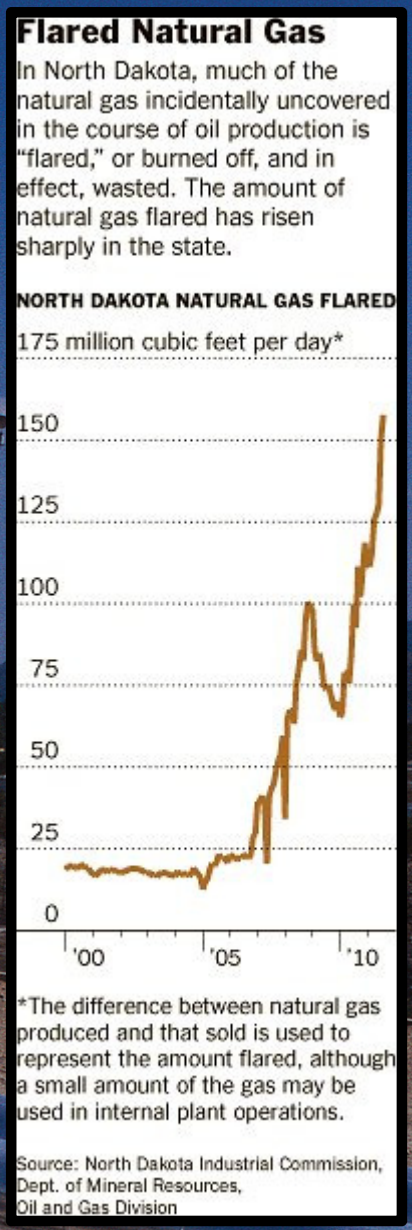
Shale Gas - Lots of Heavy constiutents which must be considered

Bakken Oil – Lots of Associated Gases, some of which is currently being flared

Fuel Flexibility and Flare Gas

Bakken Formation





OPTIMUM SOLUTION FOR FLARING REDUCTION

Gas – Diesel (GD) Engines

- Use Diesel (Compression Ignition) in Gas & Liquid fuel operation

- Fuel Sharing: Varying gas quality / quantity, compensated for by liquid fuel as needed- optimizes power production

- Accepts a wide variety of gas compositions, heating values

Wärtsilä 46GD

Technical data 60 Hz/514 rpm		12V46GD	18V46GD
Power, electrical	kW	11384	17076
Heat rate	kJ/kWh	7941	7941
Electrical efficiency	%	45.3	45.3

Wärtsilä Flexicycle

Configuration:	**6 x 18V50DF**
Flexicycle	**106 MW ***
Heat Rate (LHV/HHV)	**7,139 / 7,916 ***

Dimensions	**(feet)**
Length	342
Width	105
Roof Height	52
Stack Height	95
Draught	13

*** Combined cycle output and performance at 95° F on natural gas**
This configuration utilizes once-through cooling

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Conclusion

Natural Gas will be used for:

- **Making renewables dispatchable by being flexible enough to firm up the variations in renewables generation**
- **Base Load, with Reciprocating Engine generation giving GTCCs a run for their money**
- **Industrial Island mode installations – like Encana and Dygoil**
- **Industrial/Commercial CHP – like Madrid Airport**

Associated Gas – An Example

Secoya (Dygoil)

- Engines: 2 x Wärtsilä 16V32GD
- Electrical output: 11 MW
- Type:Fuel sharing, Island mode
- Location: Ecuador
- Owner: Petro Ecuador
- Delivered: 2003
- Speciality: Operates on associated gas and CRO, either or, or both simultaneously.

WÄRTSILÄ

Cabin Creek Gas Processing Facility

Airport Tri-generation Installation

Flexible Power by Wärtsilä

Thank you!

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