



# Leading Efficiency Lower Emissions Power & Heat in a Coal rich world: Critical Element of the Green Bridge Initiative

United Nations ECE and Ministry of Energy, Republic Kazakhstan  
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Chief Technology Office

# A DIGITAL INDUSTRIAL COMPANY

With more than 300,000 people operating in 175 countries, GE is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive and predictive. GE is organized around a global exchange of knowledge that we call the GE Store. It's through the

GE Store that each business shares and accesses the same technology, markets, structure and intellect. At GE, each invention further fuels innovation and application across our industrial sectors. With people, services, technology and scale, GE delivers better outcomes for customers by speaking the language of industry.



POWER

~\$28B



ENERGY  
MANAGEMENT

~\$11B



RENEWABLE  
ENERGY

~\$9B



OIL & GAS

\$18.7B



AVIATION

\$24B



TRANSPORTATION

\$5.7B



HEALTHCARE

\$18.3B



APPLIANCES  
& LIGHTING

\$8.4B

2014 REVENUES



# GE POWER

~\$21.5B '15 revenue ~62,000 staff >125 countries



Steve Bolze, CEO  
Schenectady, NY

## Gas Power Systems

*High Efficiency, Scale Power*

- Power Plants (combined & simple cycle)
- Gas Turbines
- Steam Turbines
- Generators & Controls
- Heat Recovery Steam Generators



## Power Services

*Optimizing Plant Performance*

- Installation planning/execution
- Maintenance, repairs & outage solutions
- Multi-year service agreements
- Hardware/software blended upgrades
- Data-driven software solutions



## Steam Power Systems

*Advanced Steam Power Expertise*

- Integrated advanced Steam Power solutions
- Steam Turbines and Generators
- Advanced Boilers
- Air Quality Control Systems (AQCS) including CCS
- Nuclear Turbine Island Solutions



## Distributed Power

*Broad, Efficient Portfolio*

- Reciprocating engines (0.1 to 10 MW)
- Jenbacher engines, power equip. & services
- High efficiency & fuel flexibility: Natural gas, CHP, oilfield power, diesel & special gas applications



## GE Hitachi Nuclear

*Advanced Reactor Technologies*

- ESBWR, ABWR, PRISM
- Outage & Asset Optimization Services
- Fuels & Engineering Services



## Water & Process Technologies

*Energy Efficient Water Solutions*

- Chemical & Monitoring Solutions
- Engineered Systems
- Mobile Water
- Build-Own-Operate Services



**Digital Capabilities – Building for the Future**

# Full Turnkey Coal-fired Plant

1 Unit 1000MW, 1 B\$ contract:

## 15% Civil works

2,234 piles, 200ft each  
3 million ft<sup>3</sup> concrete  
650 feet high chimney

## 55% Power block supply

Boiler 26'000 tons, 56'000 shop welds  
Largest part 470 ton generator by barge  
10'000 tons piping

## 12% BoP

650 miles cables  
12 000 I/O in DCS

## 18% Erection

23 million hours worked  
4.000 workers on site peak  
50'000 welds at site



**Manjung 4 ... turnkey Coal-fired Power Plant**

First ultrasupercritical plant & most efficient coal plant in Southeast Asia

270 bar/595 °C/603.5 °C/Condenser vacuum is 75 mbar



# Creating value for customers



Understanding Market Drivers

Understanding Technology & how to apply it

How do we differentiate?

Creating Customer value

- Difficult fuels
- Emissions compliance
- Project risk



- Leading products
- Plant Integrator™
- Platform building blocks
- Proven results



# GE Steam Power Systems: Solutions that can address customer value

## Boiler island

- Boilers for all fuels: Coal, Oil, Gas
- Two-Pass, Tower and CFB technology
- Coal Mills
- NOx control: SCR Systems (Selective Catalytic Reduction, low-NOx burners)

## Turbine Island

- Steam turbine
- Generator
- Condensers/heaters

## Flue Gas Desulphurization (FGD)

- Wet FGD (OST, FLOWPAC\*)
- Dry FGD (SDA & NID\*)
- Seawater FGD

## Particulate Control

- Fabric Filter
- Electrostatic Precipitators (Wet and Dry)

## Mercury Control

- KNX\*
- Mer-Cure\*
- Filsorption\*

## Carbon Dioxide Control

- Chilled Ammonia
- Oxy Firing

**Plant Integrator™**  
OPTIMISED SOLUTIONS  
ADDED VALUE

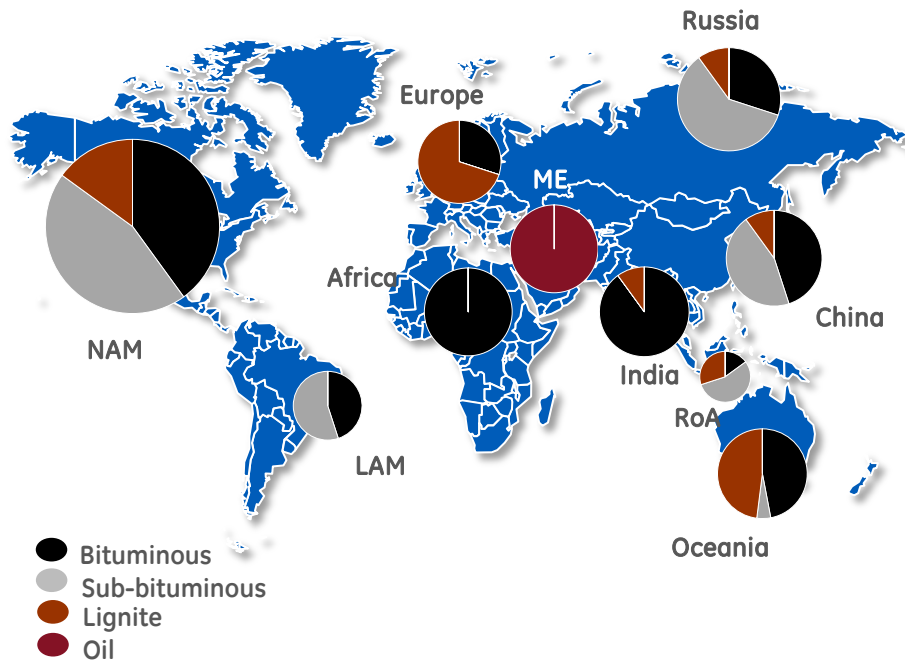
- Integrated power package (iPP)
- Turbine Island (EPC)
- Power Block (EPC)
- Full turnkey (EPC)



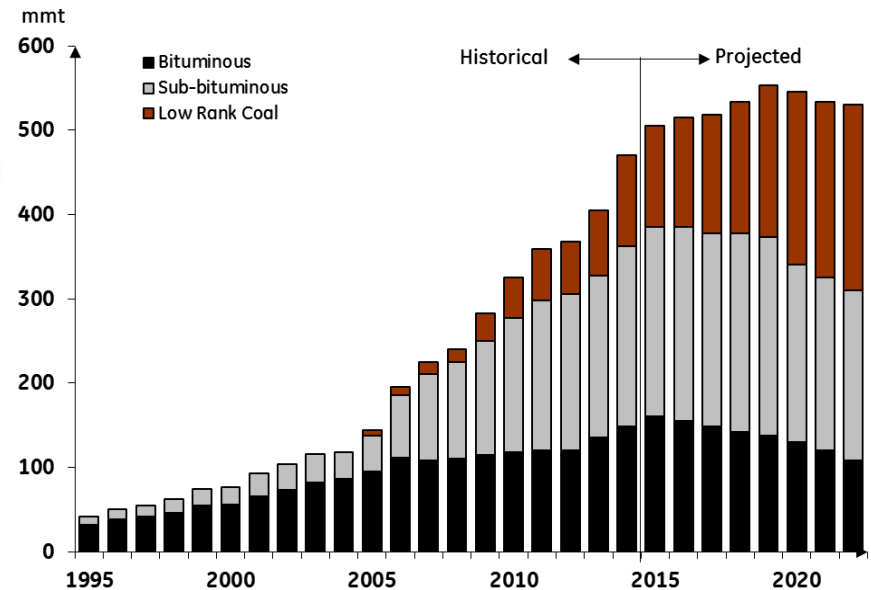
# Market Dynamics – Coal

## Fuel Diversity & Quality

(1) Reserves: Diversified Fuel Type Globally



(2) Lower Quality Coal (e.g. Indonesia)



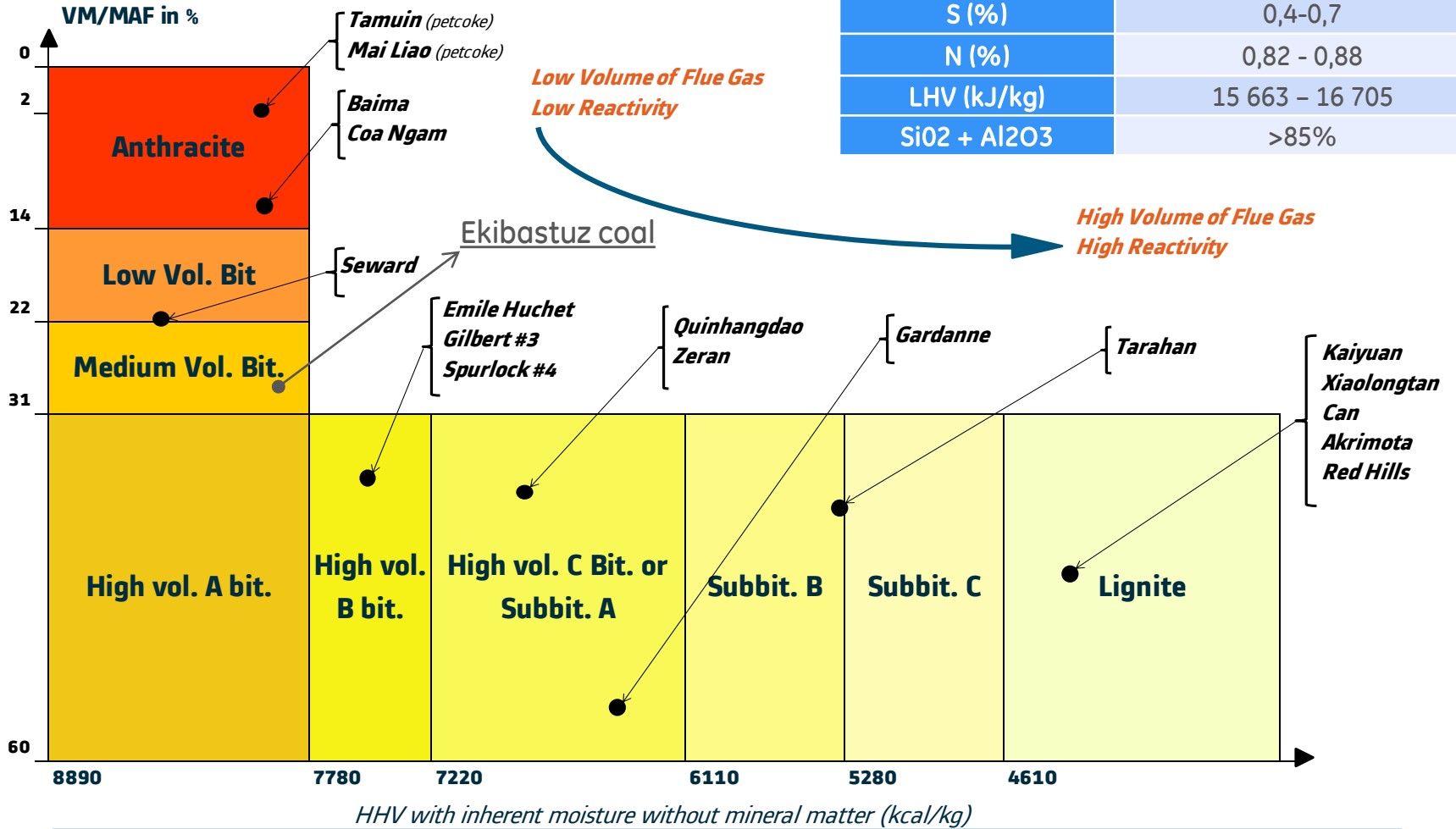
Diverse fuels require expertise to utilize



# GE Circulating Fluid Bed Boilers with Range of Coal

Ekibastuz coal

Moisture (%)	5% to 9%
Ash (%)	39,1 - 40,1
Vol. matter (%)	17,3 - 20,8
S (%)	0,4-0,7
N (%)	0,82 - 0,88
LHV (kJ/kg)	15 663 - 16 705
SiO <sub>2</sub> + Al <sub>2</sub> O <sub>3</sub>	>85%



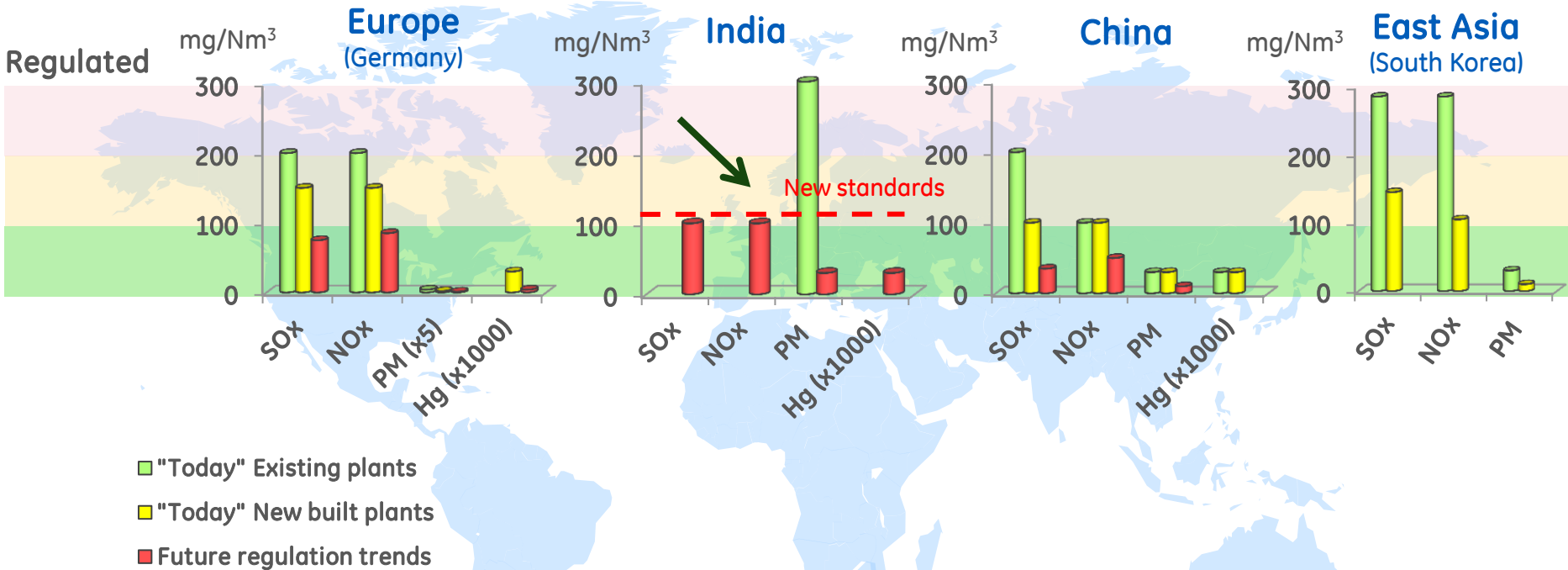
Indigenous Fuel – Independence and Local Jobs





# Market Dynamics - Coal

## Stringent Emissions Regulation



- New regulations expected in key market (India)
- Close to CCPP (Gas) emission level set for plants in 11 provinces in Eastern part of China
- New standards on lower emission levels than previous European levels

**Future regulations will increase demands on efficiency and emission control**



# Current Emission limits

	Particles Mg/Nm <sup>3</sup>	SO <sub>x</sub> Mg/Nm <sup>3</sup>	NO <sub>x</sub> Mg/Nm <sup>3</sup>	Reference
Steam flow >499 t/h	500	780	500	Kazah Government Decree No 1232 dd 14.12.2007
Industrial Emission Directive >300 MWth	10	150	150	Directive 2010/75 Nov 2010
<i>Proposed new EU Emission Limits Values (ELV)</i>	<i>2-5</i>	<i>10-75</i>	<i>65-85</i>	<i>Not approved yet</i>
EHS IFC/WB Solid fuels plant >600 MWth	30-50	200-850	200-510	EHS Guidelines Thermal Power Plants December 2008



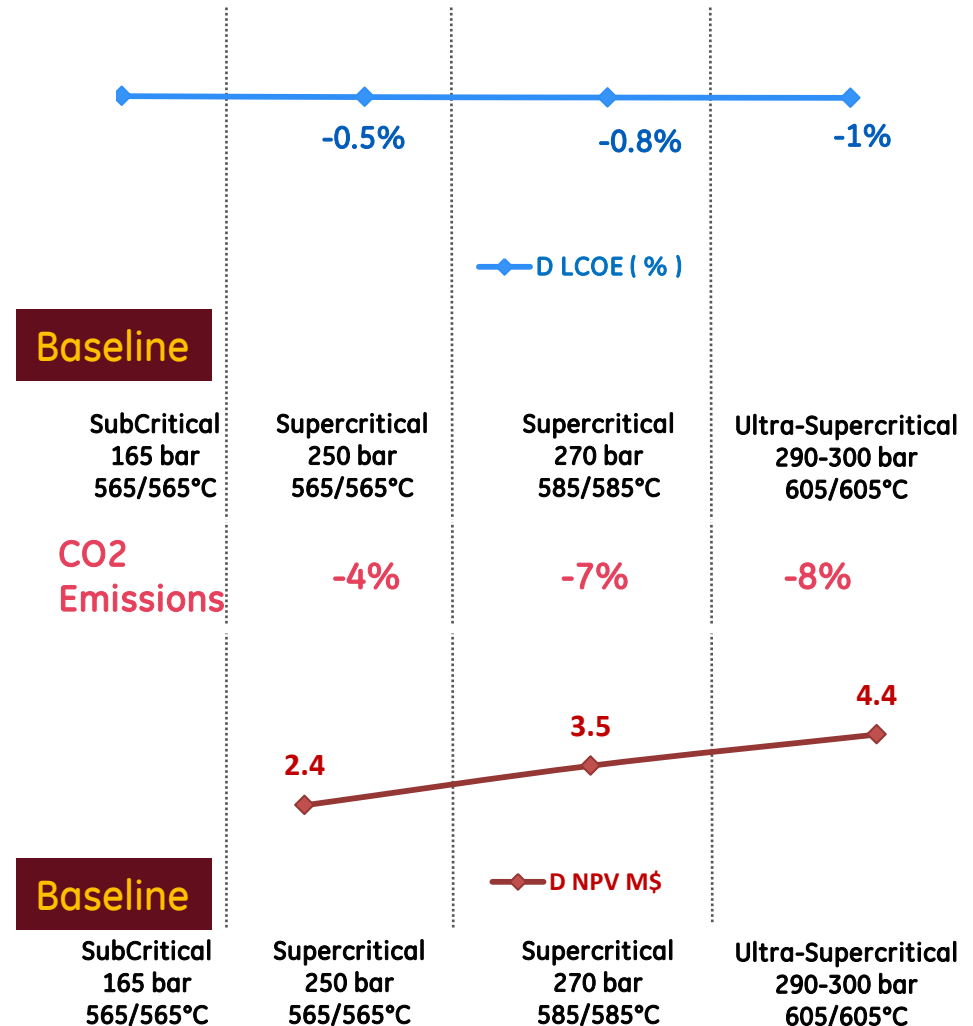
# Customer value generated with higher efficiency

## Assumptions:

- Bituminous Coal : Ekibastuz Kazakhstan
- Fuel Price : 10\$/ton
- Operating hours : 6500
- Net Capacity : 150 MW
- No additional Capex to move to SC
- No additional Opex

## SC/USC vs SubC:

- Efficiency improvement from 2% to 3% point
- CO2 emissions reduction from ~4% to 8%



# Kazakhstan Intended Nationally Determined Contribution -COP21

The Republic of Kazakhstan wishes to communicate the following Intended Nationally Determined Contributions (INDC), and intends to achieve an economy-wide target of 15%- 25% reduction in greenhouse gas emissions by 2030 compared to 1990

The implementation of the «Green» Economy Concept, and adoption of related legislative acts, should lead to modernisation of key infrastructure and production technologies based on energy-efficient technologies, and will make a significant contribution to reducing the emissions of greenhouse gases.

## Critical Element of the Green Bridge Initiative

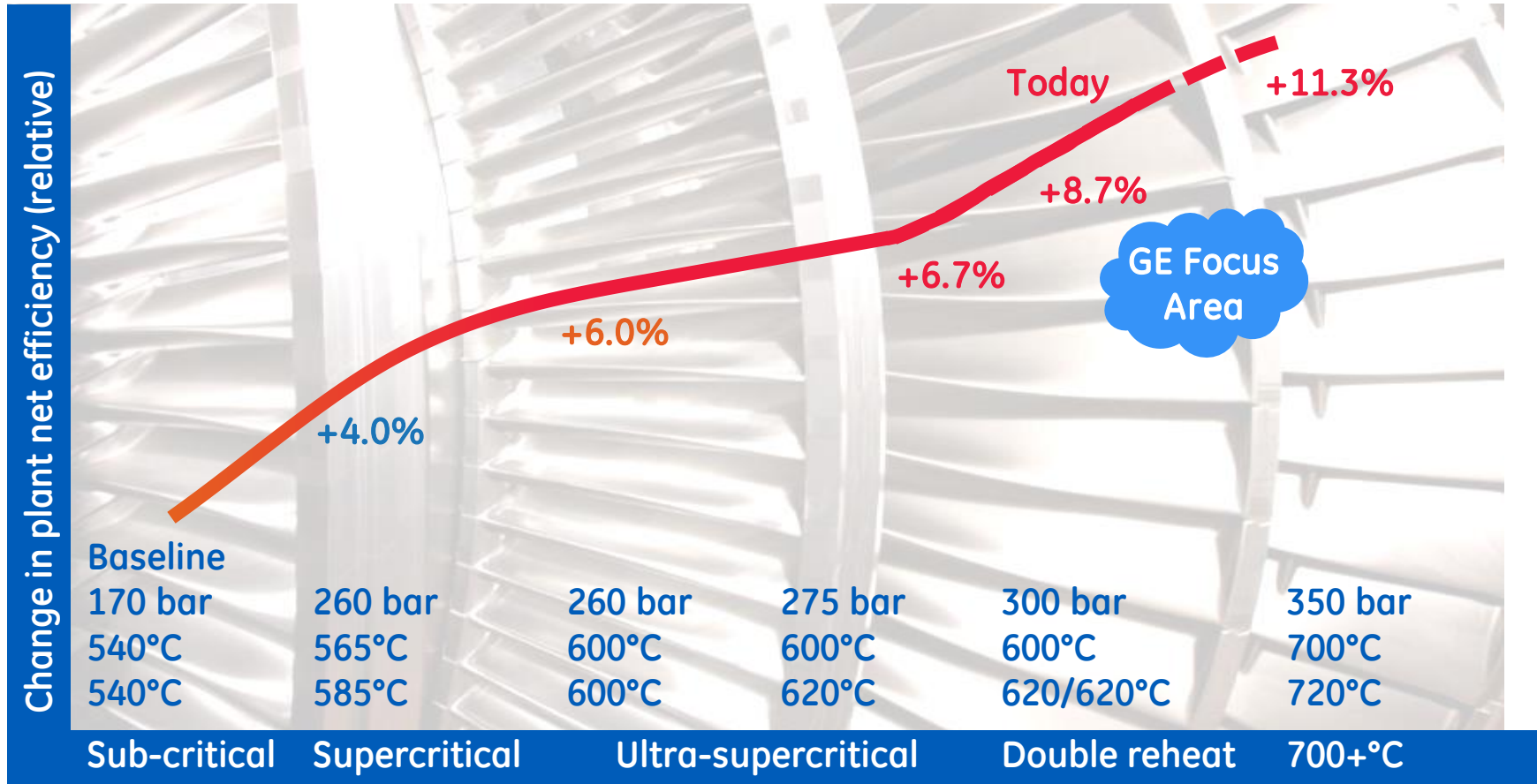


# Technology Update

- Efficiency
- Emissions
- Carbon Capture Systems
- Fuel Flexibility with CFB



# High Performance Double Reheat & 700+°C

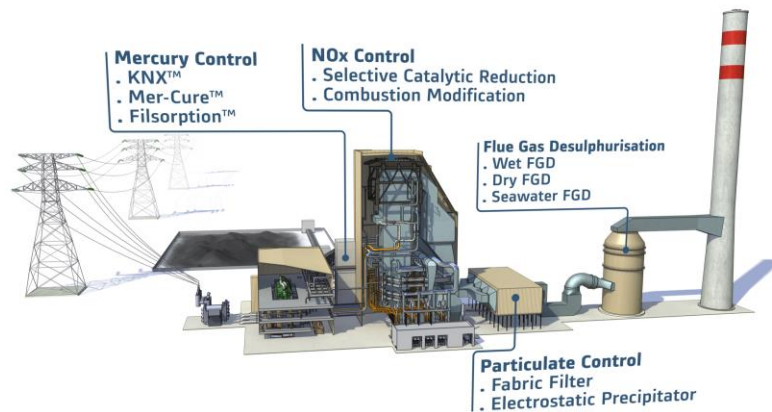


Efficiency delivers reduced Emission and Fuel costs



# Air Quality Control Systems (AQCS) for Power Generation & Industry

## For power generation



## Pollutant Removal performance

SO <sub>x</sub>	SO <sub>2</sub>	NO <sub>x</sub>	Particulates	Mercury
>95%	>99%	≥98%	<10mg/Nm <sup>3</sup>	>90%

## Industrial portfolio



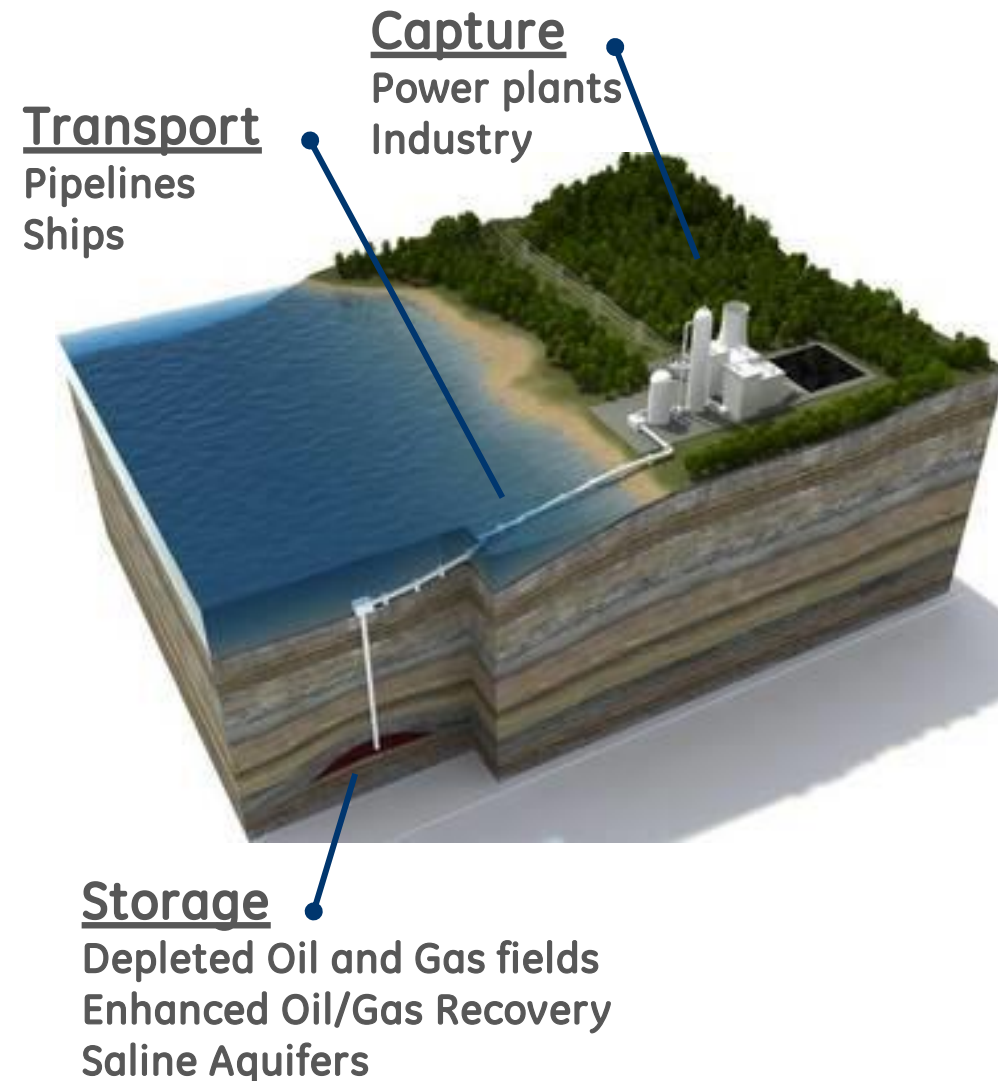
5000+ gas cleaning  
industrial units  
installed worldwide



>80 years of experience, compliance with strictest international standards



# Carbon Capture Technology

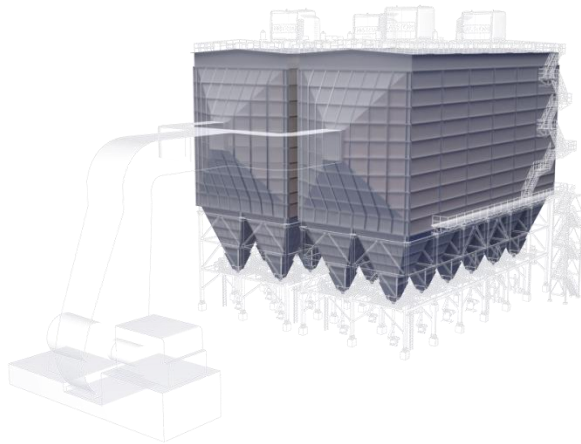


- 14 GE pilots in EU & USA
- Pre, Oxy and Post-combustion technologies
- 90% capture and 99% purity achieved on coal & gas
- Full CCS chain demonstrated
- Ready for large-scale deployment





# Particulate control – Electrostatic Precipitator (ESP)



- 233+ GW installed in power generation
- Effective Cleaning System design with robust tumbling hammer
- Best-in-Class Integrated ESP Control systems: 3<sup>rd</sup> Generation Intelligent Controller (EPIC III)
- Switch Integrated Rectifiers (SIR) for increasing power input into ESPs



Shoaiba, Saudi Arabia

## IMPROVED COST BASIS



- Lower capital cost through more compact sizing
- Lower power consumption by minimum 5% thanks to best-in-class controllers

## LOWERING ENVIRONMENTAL FOOTPRINT



- > 99.95% removal efficiency
- <10 mg/Nm<sup>3</sup> emissions

## INCREASING FLEXIBILITY & RELIABILITY



- Largest fuel flexibility, including heavy fuel oils
- Constant efficiency for varying boiler load conditions

Largest reference base on a variety of fuels



# Particulate control – Fabric Filters (FF)



- **46+ GW** installed in Power on a stand-alone basis
- Renowned **Optipulse®** filtration technology with gravimetric flow
- **Optipow®** plunger valves for efficient bag cleaning
- **Standalone** applications
- **or Integrated** at the down stream of SDA, NID™, Abart™, Mer-Cure™, Filsorption™



## IMPROVED COST BASIS



- Lower Capital Cost with tall bag designs of up to 12 m
- Lower auxiliary consumption like compressed air

## LOWERING ENVIRONMENTAL FOOTPRINT



- > 99.97% removal efficiency
- High PM<sub>10</sub> & PM<sub>2.5</sub> removal efficiency
- < 5 mg/Nm<sup>3</sup> emissions

## INCREASING FLEXIBILITY & RELIABILITY









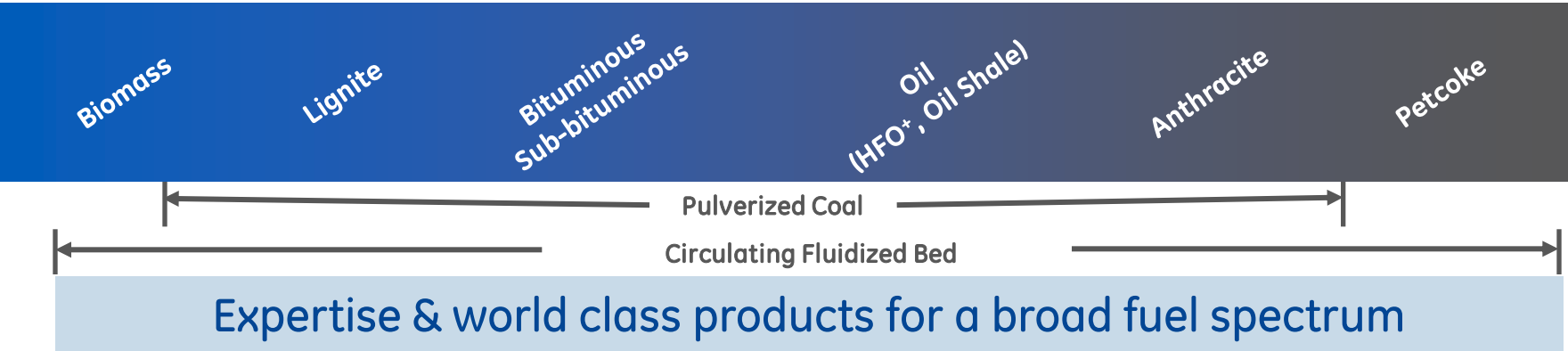
- Largest fuel flexibility and ability to handle varying boiler loads
- Bag life of 5+ years achieved

Consistent lower compliant costs for dynamic process requirements



# SPS Boilers - Fuel Flexibility

Specialist experience	World Class Products	Specialist experience
 <p><b>Fiddlers' Ferry*</b>  <b>Drax*</b>  <b>Amer*</b>            (*Biomass Co-firing)</p>  <p><b>Niederlaussem K</b>  <b>Patnow II</b>  <b>Maritza East</b>  <b>Belchatow II</b>  <b>Neurath F/G</b></p>	 <p><b>Waigaoqiao II and III</b>  <b>RDK 8</b>  <b>Westfalen D/E</b>  <b>latan</b>  <b>Comanche 3</b>  <b>Pee Dee</b>  <b>Manjung 4</b>  <b>Tanjung Bin 4</b></p>  <p><b>Shoaiba</b>  <b>Chalk Point 3</b>  <b>Ravenswood 3</b>  <b>Pittsburgh 7</b>  <b>LaSpezia 4</b>  <b>Narva</b>  <b>Yanbu 3</b></p>	 <p><b>Tamuin</b>  <b>Mailiao</b></p>  <p><b>Tonghae,</b>  <b>Luohuang</b></p>



\*Oil-fired boiler

# Narva, 2 x 300 MWe, Estonia



## 2 x 300 MW CFB Plant

### Customer

- Narva Elektriijaamad AS

### Product

- 2 x 300MWe Oil Shale and Biomass-fired power plant – Circulating Fluidised Bed Boiler

### Scope

- Full turnkey power block

### Benefits

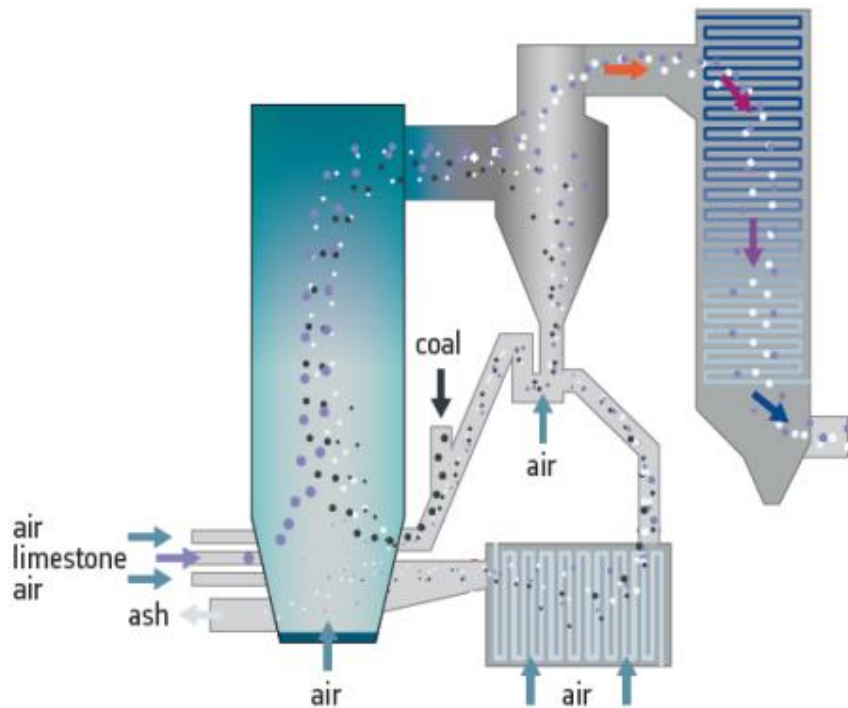
- Plant efficiency
- Reduction in emissions:
  - SOX 200mg/Nm<sup>3</sup>
  - NOX 150mg/Nm<sup>3</sup>
  - Particulates 10mg/Nm<sup>3</sup>

Plant adapted to local Fuel with Biomass and Operational flexibility



# CFB Boilers

## Key features and benefits



### Features:

- Low furnace temperature
- Hot circulating solids
- Long solids residence time

### Benefits:

- Low NO<sub>x</sub>
- Low SO<sub>2</sub>
- Fuel flexibility
- Handles low grade fuels
- Simple feed system
- Good fuel burnout
- Good sorbent utilisation

High combustion efficiency with low emissions



# CFB advantages local and high ash coals

## Advantage 1 : Fuel flexibility

CFB technology is able to burn a wide range of fuels:

- CFB less sensitive to coal variations than a PC boiler  
    **residence time** of the fuel particles is longer in CFB than PC (10 to 15mn for CFB against a few seconds for PC),
- Residence time ensures the combustion performance

CFB is the practical response to variation of coal characteristics (moisture, ash, sulfur, ...).

CFB self-adaptation to coal variation makes it trouble-free for operators



# CFB advantages local and high ash coals

## Advantage 2 : CFB is designed for high ash fuels

CFB suitable for high ash content fuel :

- 1) Low velocity in the CFB furnace compared to the PC (6 m/s against 15 m/s) prevents excessive erosion in the furnace,
- 2) CFB does not require mills, which need to be significantly oversized to resist to the abrasiveness of the ash,
- 3) CFB, 50 % of the ash is extracted as Bottom Ash and 50 % as Fly Ash. In a CFB the back pass is much less exposed to wear than in a PC.

CFB is more suitable than PC for Ekibastuz high ash content coal



# CFB advantages local and high ash coals

## Advantage 3 : Low NOx emissions

The NOx emissions are combustion temperature dependent, therefore the low bed temperature of 850°C in the CFB boilers is a serious advantage compared to the  $> \sim 1100^{\circ}\text{C}$  in the PC boilers.

=> GE CFB can meet the NOx limit at 200 mg/Nm<sup>3</sup> without any additional equipment (SNCR, SCR)

CFB technology has naturally low Nox emissions





# CFB advantages local and high ash coals

## Advantage 4 : In-furnace sulfur capture, low SO<sub>2</sub> emissions

In CFB, the sulfur capture is done by in-furnace limestone injection,

=> GE CFB can meet the SO<sub>2</sub> emission limit at 200 mg/Nm<sup>3</sup> without additional equipment like FDG.

The chemical reactions result in gypsum:

- $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- $\text{CaO} + \text{SO}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{Ca SO}_4$

This byproduct is almost neutral and can be disposed or used in various industries like cement production,

CFB technology does SO<sub>2</sub> capture in the boiler



# Conclusion

## GE invests in low Emissions Coal, Gas and Renewables

- Coal is a Growing fuel for many Growing economies
- GE Technology adapted to market conditions
- CFB has benefits for High Ash coal
- We adapt to the needs of Kazakhstan



# Questions & Discussion