Investments in low and zero-emission technologies

Bart Stoffer
GE Energy

UNFCCC Workshop on Mitigation SBSTA 26
Power Generation, including Clean Fossil Fuels and Renewable Energy

Bonn, 15 May, 2007

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GE… Six businesses at a glance

GE Infrastructure




- Aviation
- Water & Process Tech
- Oil & Gas
- Transportation
- Aviation Fin Services
- Energy Fin Services
- Energy

GE Commercial Finance




- Healthcare Fin Services
- Global Media & Communications
- Real Estate
- Corporate Financial Services
- Leasing

GE Industrial




- Consumer & Industrial
- Plastics
- Security
- Equipment Services
- Sensing
- Silicones / Quartz
- Strategy / Integration
- Fanuc
- Inspection Technology

NBC Universal




- Network
- Sports / Olympics
- Entertainment
- Universal
- Stations

GE Consumer Finance




- Europe
- Asia
- Americas
- Australia / New Zealand

GE Healthcare




- Diagnostic Imaging
- Bio Sciences
- Info Technology
- Clinical Systems
- Services

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Global Trends…

Population | Consumption | Energy Security | Environment

… Create Big Challenges

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And Big Challenges … Drive Technology

- High Fuel Prices…
  Higher Energy Efficiency
- Energy Security…
  Technology Diversity
- Environmental Requirements…
  Emission Reduction, Renewable Energy, Nuclear, Clean Coal

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GE Energy … Technology Diversity

Thermal

Gas turbines

- Heavy duty (40–500MW)
- Aeroderivatives (15-100MW)
- CCGT
- CHP

Coal

- IGCC
- Steam turbines

Nuclear

Nuclear

- ABWR & ESBWR
- Adv nuclear fuel
- Candu fuel & services
- Reactor & field services
- Performance services
- Nuclear isotopes

Renewables

Wind

- Land based
- Offshore

Solar

- Grid connected
- Stand alone

Biomass

- Gas engines
- Container Sets
- Biogas Power Houses
- Wood gas and Pyrolysis gas engines

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ecomagination… committed to deliver

1. Increase R&D investment from $700M to $1.5B by 2010
2. Grow revenues to $20B by 2010 by delivering customer value
3. Improve our energy efficiency and lower our GHG emissions
4. Keep the public informed on progress

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ecomagination … grow the portfolio

Launch	Current	Goal
17	32	40+

Driving ecomagination into R+D

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A Way to Classify Environmentally Friendly Technology

	Cleaner	"Greener"	
	Reduced Fossil Emissions	Zero Emissions +	Renewable Energy
Commercial	Efficient CCGT (H, LMS) Emissions Environmental Services Efficient ST (HEAT)	Nuclear Large Hydro	Onshore Wind Small Hydro/ Refurbishment Biomass Geothermal
Emerging	Clean Coal Technology (IGCC) Plant Optimization		Offshore Wind Photovoltaics Hydro Std Plant
NextGen	Carbon Storage	NextGen Reactor Energy Storage Grid Integration & Mini-Grids	Fuel Cells Hydrogen Ocean Energy

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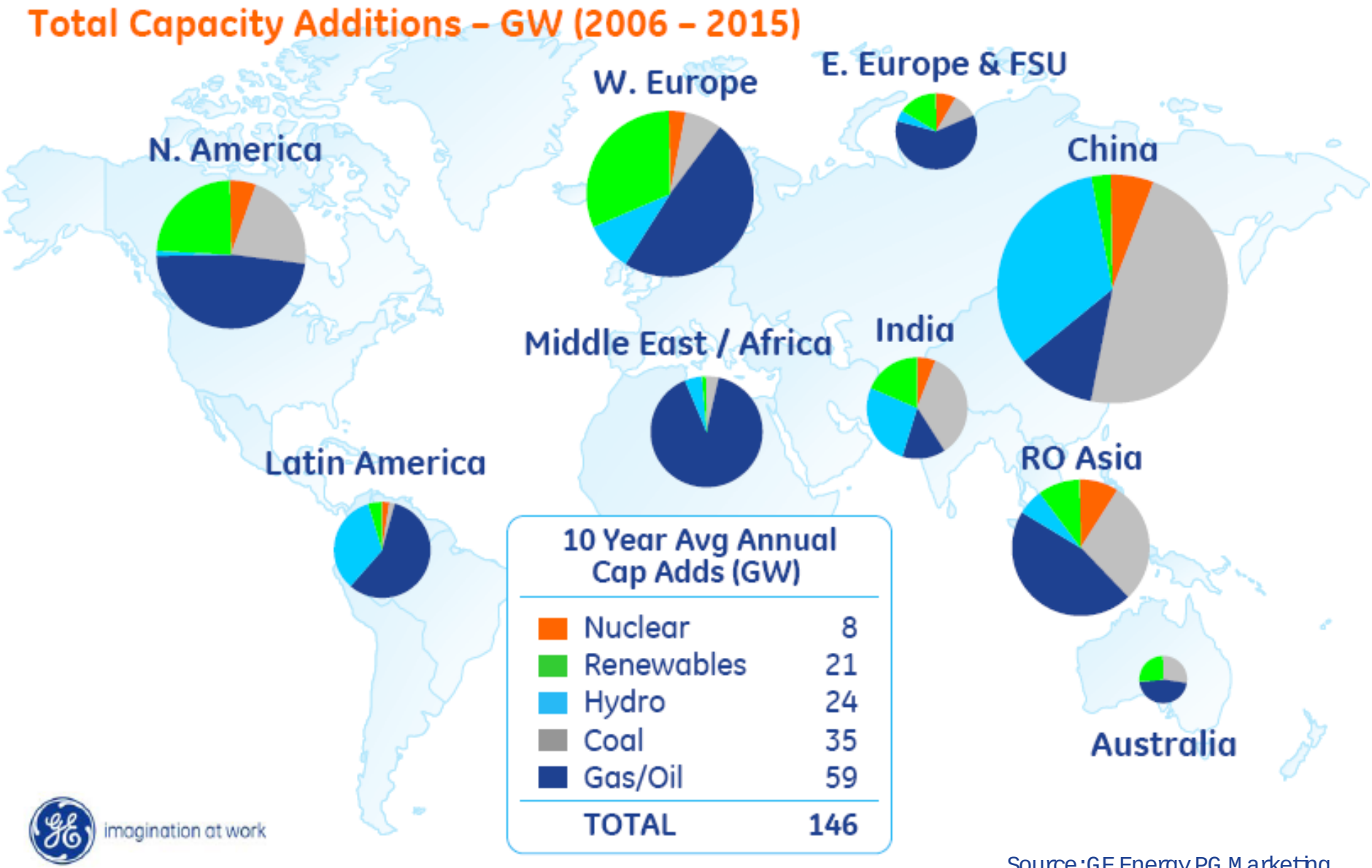
PowerGen Forecast… Next 10 Years



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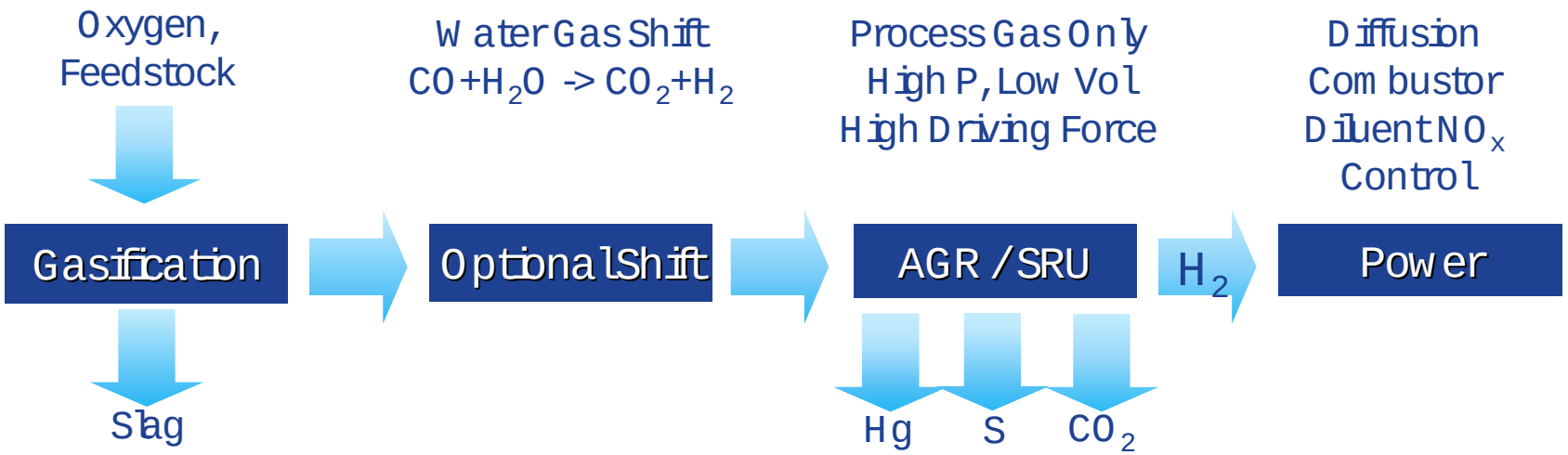
Source: GE Energy PG Marketing

IGCC Carbon Capture … Proven Process



Proven Gasification

- 60+ GE Licensed Gasification Units operating worldwide
- 12 with solid feedstock

Proven Shift & CO_2 Capture Process

- >25 GE Licensed Gasification Units using shift reaction
- 8 with solid feedstock
- Used in refineries to produce H_2
- >25 GE Licensed Units using AGR technology to remove CO_2 from shifted syngas
- 8 with solid feedstock
- Used in NG processing & ammonia plants

Proven Gas Turbines

- 28 GE Gas Turbines operating at 50% + H_2
- F-class combustion validation up to 90% H_2

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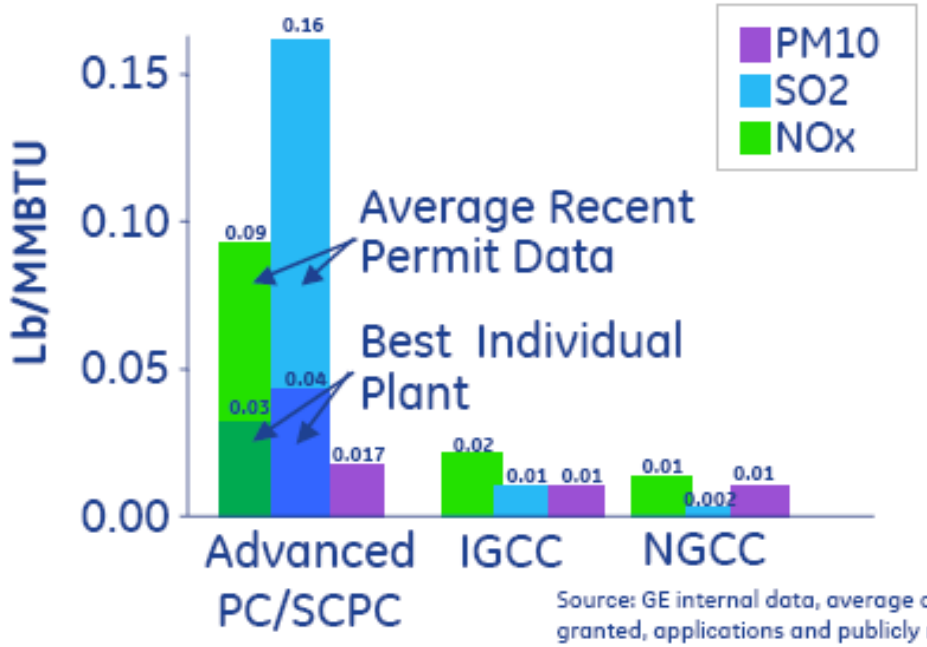
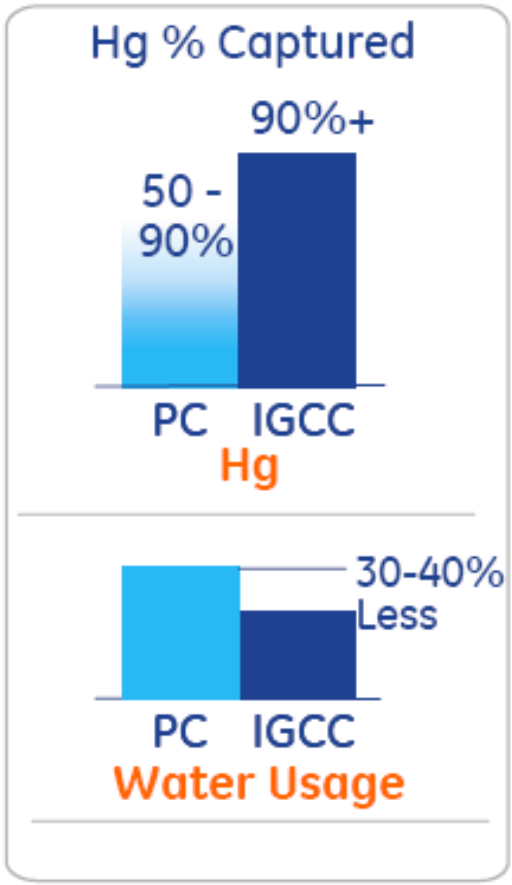
IGCC … Emissions approaching CCGT



Source: GE internal data, average of 30 permits granted, applications and publicly reported emissions



IGCC Environmental Benefits Versus Best in Class Supercritical Pulverized Coal

- 33% less NO_x
- 75% less SO_x
- 40% less PM_{10}
- 90% + Hg removal
- 30% less water
- CO_2 capture ready

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The answer to climate change is technology

Mitigation technology already exist or is fast emerging

- Technology diversity is key … there is no silver bullet addressing all customer and policy needs
- Solutions require big bets on technology development… anything else does not work
- Renewable energy continues to require dedicated policies to achieve ambitious gobal targets
- Technology for carbon capture already exists … or is emerging fast

- GE is part of USCAP, the US Climate Action Partnership of companies and NGOs, to urge the US government to introduce a mandatory cap and trade system for GHG
- GE is part of 3C, Combat Climate Change, an initiative of business leaders in Europe

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Utilize all policy instruments in a coordinated matter

Principles for energy policy

- Implement a portfolio of policy instruments … to drive energy efficiency, renewable energy and low carbon energy technologies
- Utilize all policy levers in coordinated manner
- Develop a global market for CO_2, enable trading between regional trading systems, and create a long term price for carbon to drive technology deployment, thus development
- Combine cross-atlantic efforts between EU and US to support R&D, technology development and deployment

Specific on CCS policy

- Implement a legislative framework for storage
- Implement market based instruments (ETS) and financial incentives to drive commercialization
- Create awareness, drive demonstration and public acceptance

"We are living in a carbon constrained world. The ability to lead innovation will be the primary management focus for this decade."

– Jeff Immelt
Chairman and CEO GE

"I find out what the world needs, then I proceed to invent."

– Thomas Edison
founded GE in the year 1892

Investments in low and zero-emission technologies
Back-Up

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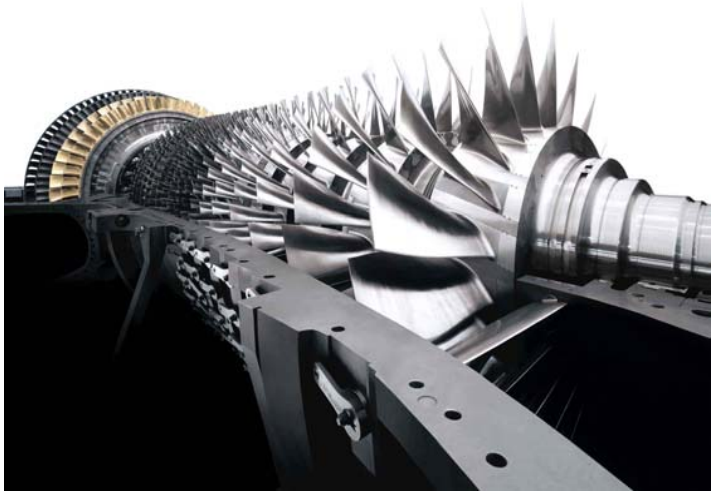
Power Generation Technology – Higher Energy Efficiency

Advanced GT technology

Combined Cycle Gas Turbine H-Turbine

- ✓ GE's highest combined cycle efficiency … 60%
- ✓ Advanced steam cooling and integrated control system



109H 50 Hz - 520 MW

- <15ppm NO_x emissions to 50% load
- CO_2 – 3-5% improvement vs. F Class
- Baglan Bay Wales - 11,600+ fired hours

107H 60 Hz – 400 MW

- CO_2 vs. F Class = 73,000 tons/yr. improvement
- NO_X vs. F Class ~ 20 tons/yr. improvement

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Simple Cycle Gas Turbine LMS100™

Flexible Power

- 44% simple-cycle efficiency
- 10-minute fast starts
- Hot day performance
- Load following and cycling capabilities without maintenance penalties

Better efficiency means less fuel burned per megawatt and less CO_2 emissions.

- Yields up to $0.6MM/year CO2 tax savings
- Reduces CO_2 emissions by more than 30,000 tons -- the equivalent of the amount of CO_2 absorbed by approximately 7,400 acres of forest!

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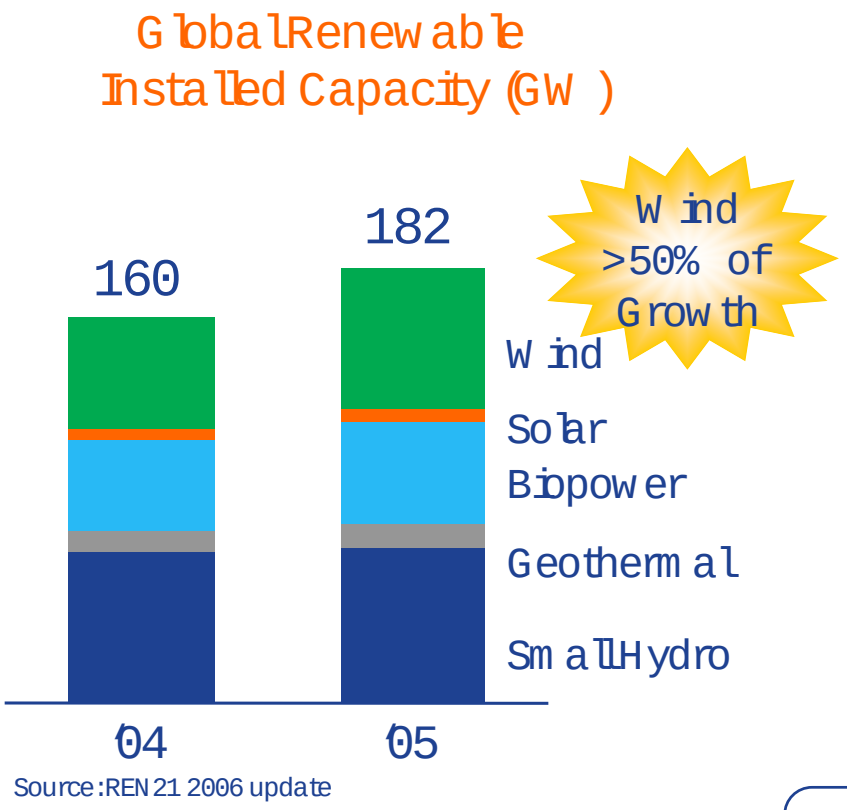
Power Generation Technology - Renewables

Renewable Energy … Growing Demand



Source: REN 21 2006 update

- Significant growth … ~25% CAGR ('95 – '13)
- ~40% global power capital spending
- Ambitious global targets
- Only 3% of electricity production

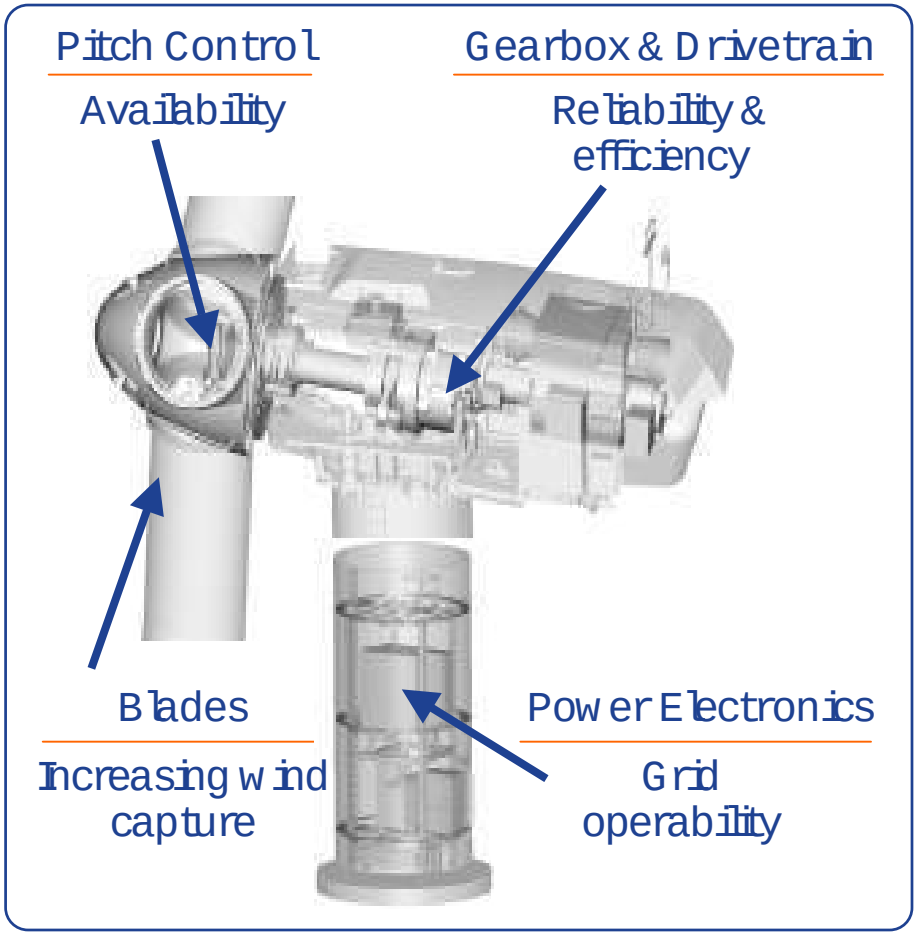
World continues to require dedicated policies for renewable energy

Wind … Advancing Technology

NextGen Turbines…

- Higher Capacity Factors
- Improved Reliability
- Lighter, longer Blades
- Advanced Controls
- Seamless Grid Integration

~30% More Energy Capture



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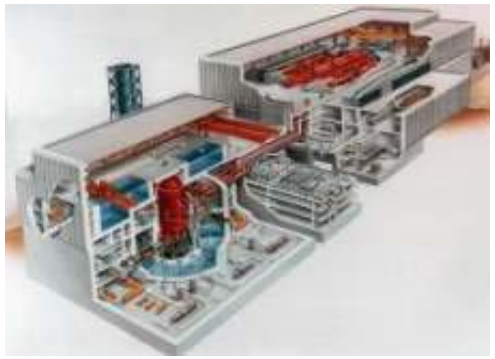
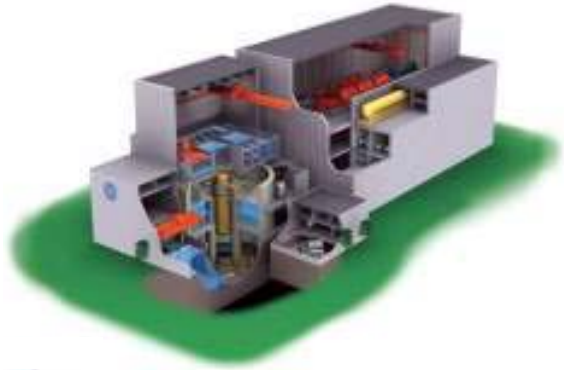
Power Generation Technology - Nuclear

Nuclear Technology Development



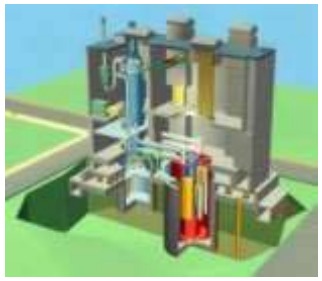
ABWR

- Licensed in three countries
- Improved safety & reliability
- Enhanced operability & maintainability
- Reduced capital and O&M costs



ESBWR

- Passive safety & simplified design
- Standardized/modular
- Reduced CAPEX/improved OPEX
- Faster construction schedule



GEN IV - PRISM

- Sodium cooled fast reactor
- Passive safety
- Modular/scalable
- Factory build

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Nuclear Gen 3 Project Pipeline

Kashiwazaki 6 & 7, Japan

Online

Hamaoka 5, Japan

Online

Shika 2, Japan

On Line

Shimane 3, Japan

Building

Lungmen 1&2 Taiwan

Building

Ohma, Japan

Approved

Higashidori 1&2, Japan

Planning

STP / NRG 3&4

Planning

USA 3&4

Study

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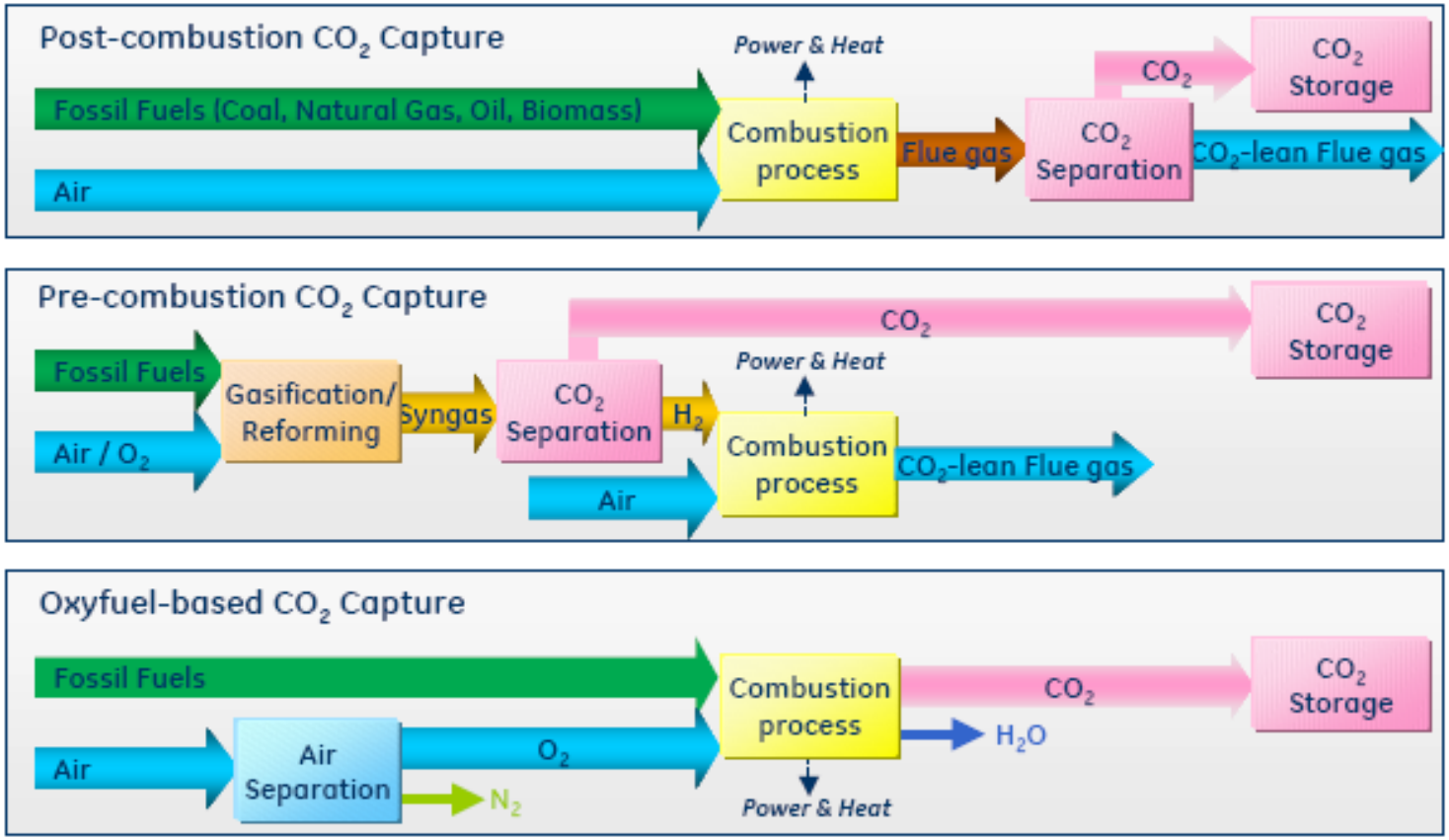
Power Generation Technology - IGCC

Capture Routes for Fossil Power Plants



Natural Gas	Coal
Advanced CCGT	Pulverized Coal
Integrated Reforming CC	Integrated Gasification CC
Oxyfuel CC	Oxyfuel Coal

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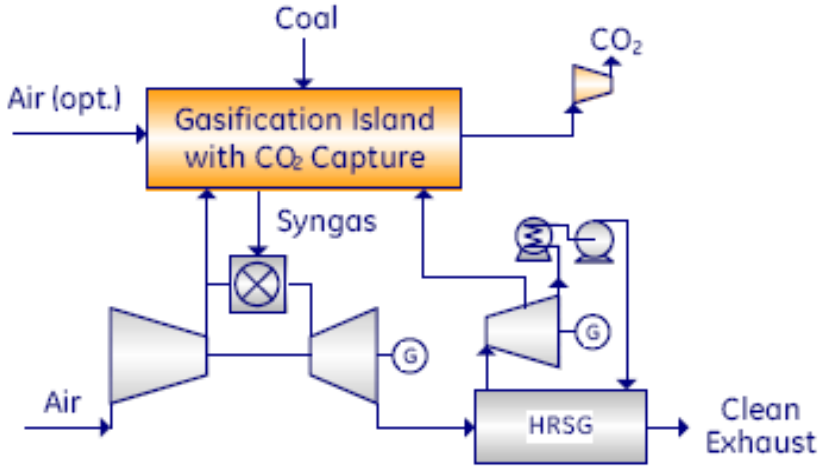
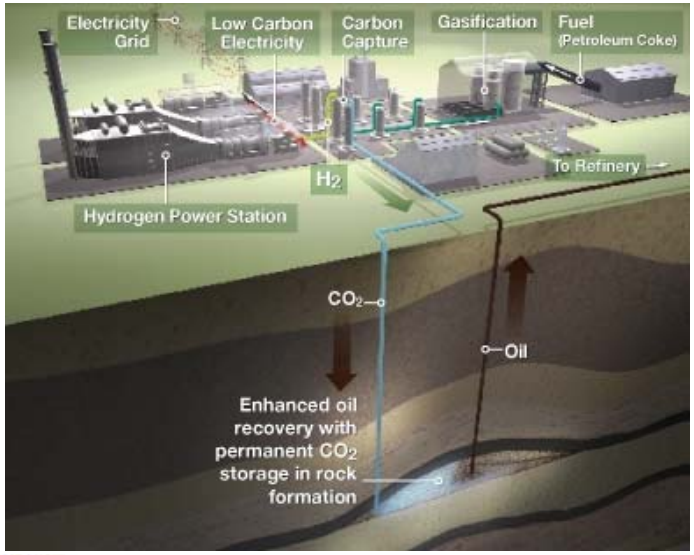
IGCC … Solution for Cleaner Coal

Pre-combustion CO_2 capture





BP/Edison-Mission Carson CA. – Petcoke IGCC with EOR and carbon storage

Main Drivers

- Fuel flexibility … ie. coal, petcoke
- Syngas allows for polygeneration
- Simplified CO_2 capture
- Low emissions and usage of water

Gas Turbine & Cycle Status

- Components commercially available … focus on optimization
- Commercial petcoke plant with EOR planned (Carson CA.)
- 3 Reference plants planned in US

Development trends

- Fuel flexibility, efficiency, low NO_x

IGCC Reference Plant status

Meigs County, Ohio

AEP IGCC Project

- 9/05 announced FEED study
- 2012 expected commercial start up*

Mason County, West Virginia

AEP IGCC Project

- 08/06 announced project
- 2014 expected commercial start up*

Edwardsport, Indiana

Duke IGCC Project

- 03/06 announced FEED study
- 2011 expected commercial start up*

… and multiple projects in Europe at a feasibility stage

* Pending project approval