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250 Megawatts Tianjin Integrated Gasification Combined Cycle Power Plant Project

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GDI and Operational Knowledge
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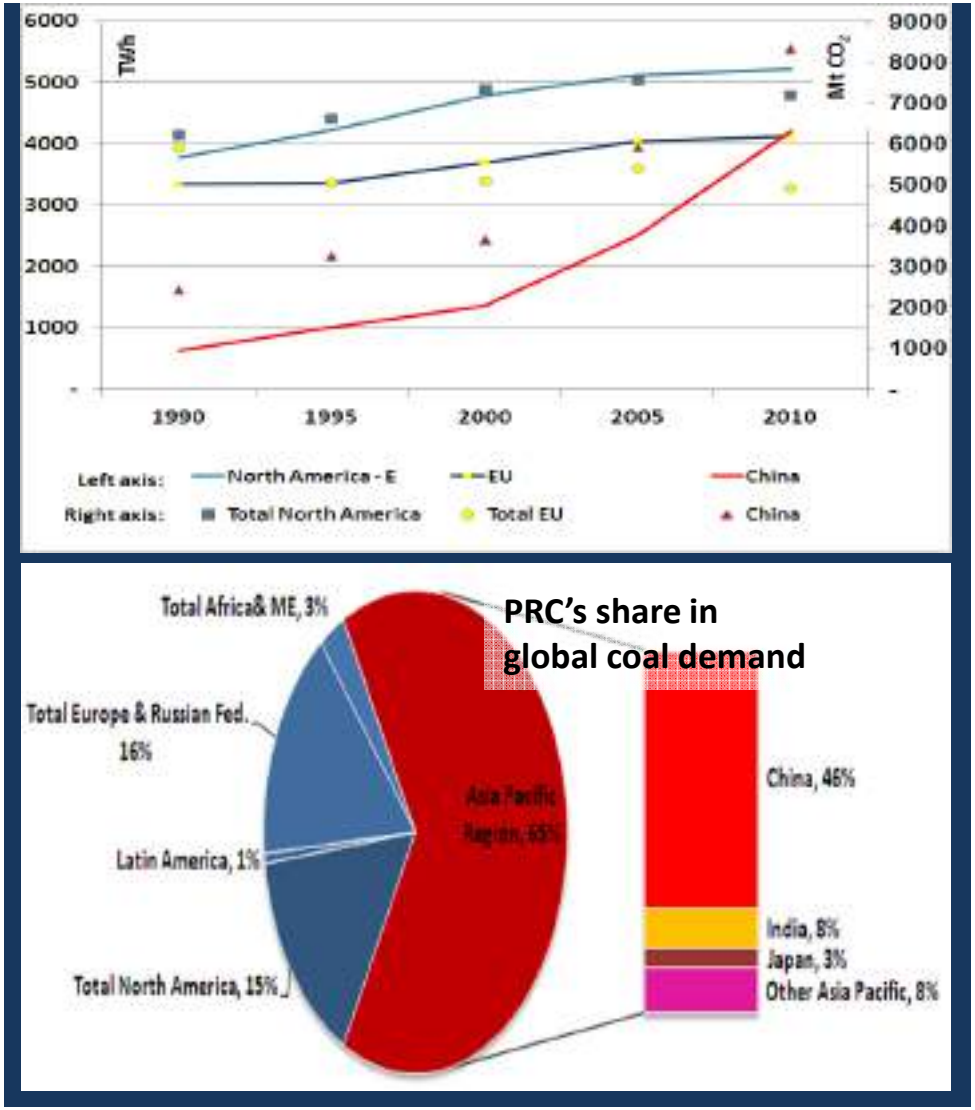
50 YEARS ADB

Agenda

- Development Challenges
- Why IGCC?
- Implementation risks and barriers
- Innovative solutions ADB value added
- Development outcomes and persisting challenges

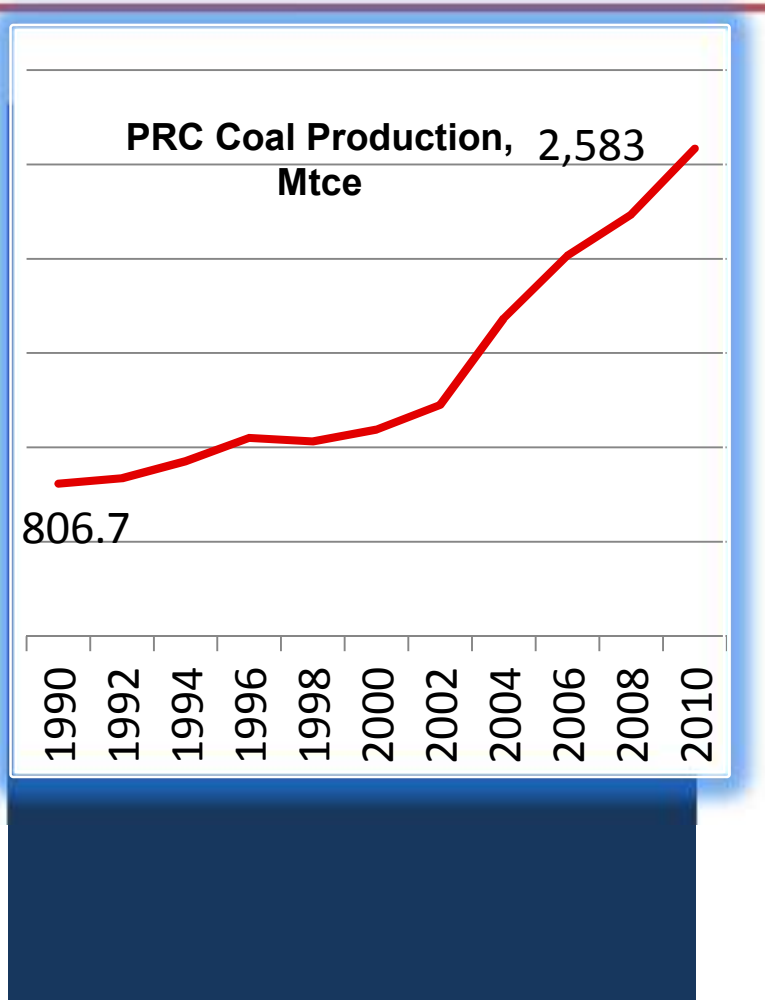
DEVELOPMENT CHALLENGES

Coal dependence of the PRC's Economy (1)



- Coal is most widely available fossil fuel resource in PRC; representing 95% of proven fossil reserves
- PRC's energy security strategy is based on its vast coals reserves.
- Coal forms backbone of economic growth and will continue to play a dominant role in energy mix up to 2035 and beyond -- despite strong incentives for energy efficiency and to renewable energy sources deployment

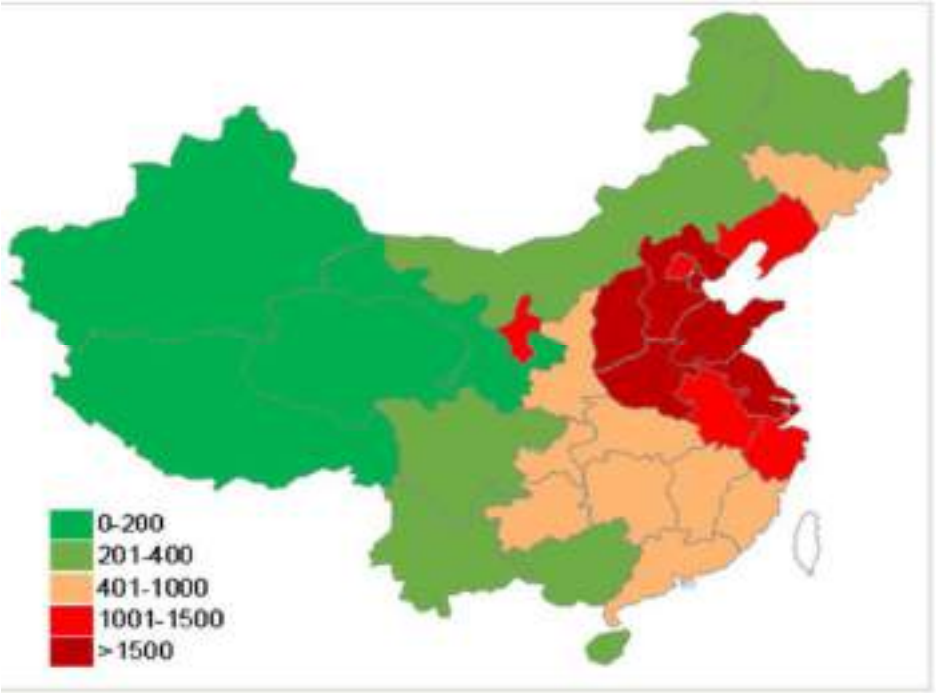
Coal dependence of the PRC's Economy (2)

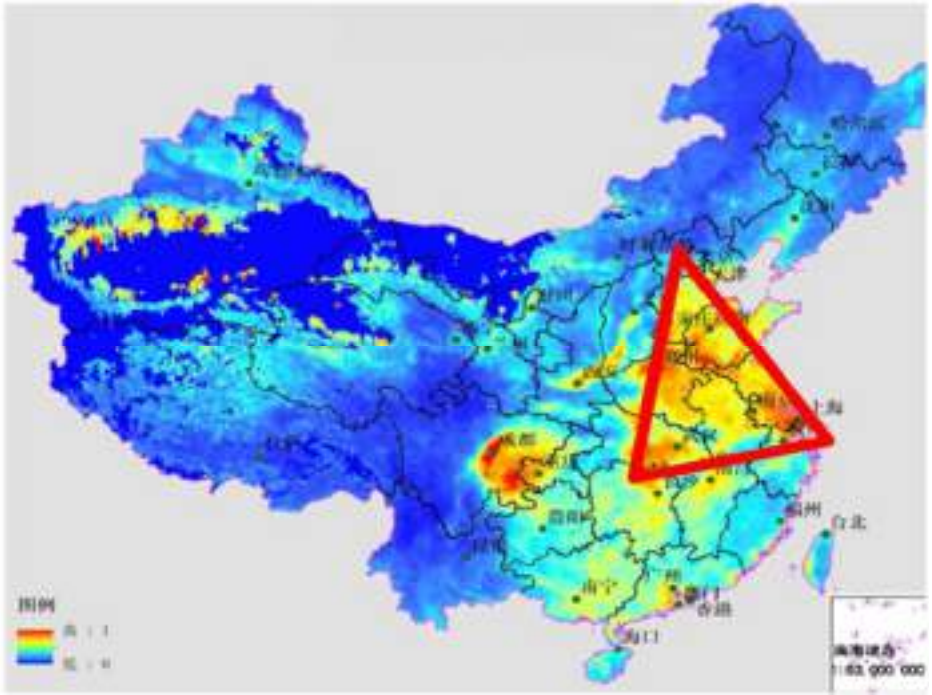


In PRC, coal accounts for

- more than 75% and 66% of primary energy production and consumption;
- more than 60% of electricity is generated with coal;
- main cause for air pollution-- about 80% of SO_2, NO_x and harmful dust and heavy metal discharges; and
- about 70% $PM_{2.5}$ was caused by energy consumption.

China's Coal Consumption Density and PM2.5 Concentrations in 2012

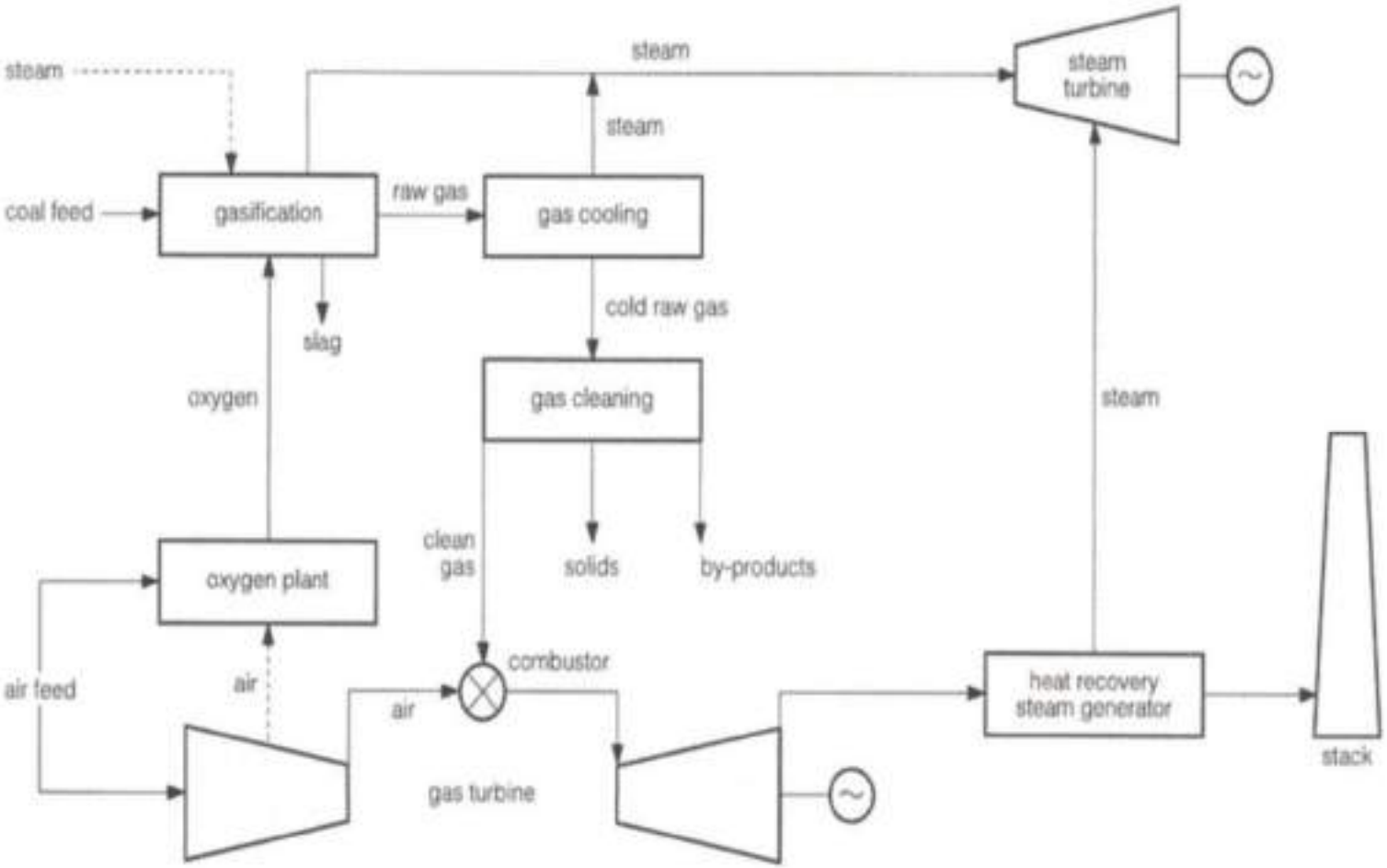




PRC needs a revolution in energy and heat supply to ensure sustainability of its development

WHY IGCC?

How does IGCC Technology Work?



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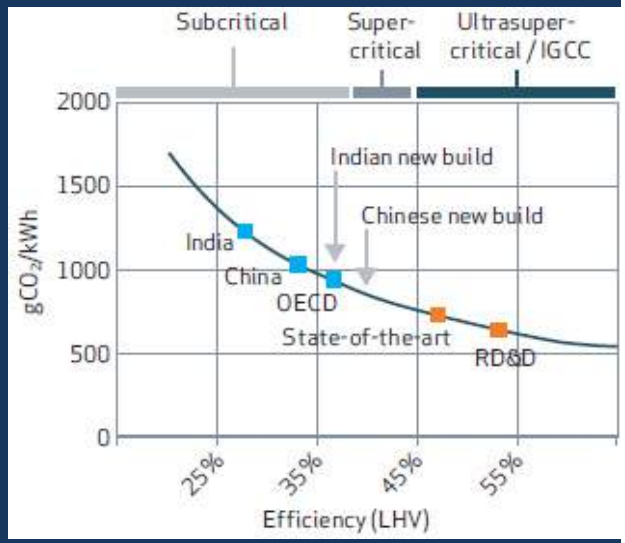
IGCC Technology: a logical next step for coal-based power generation in PRC



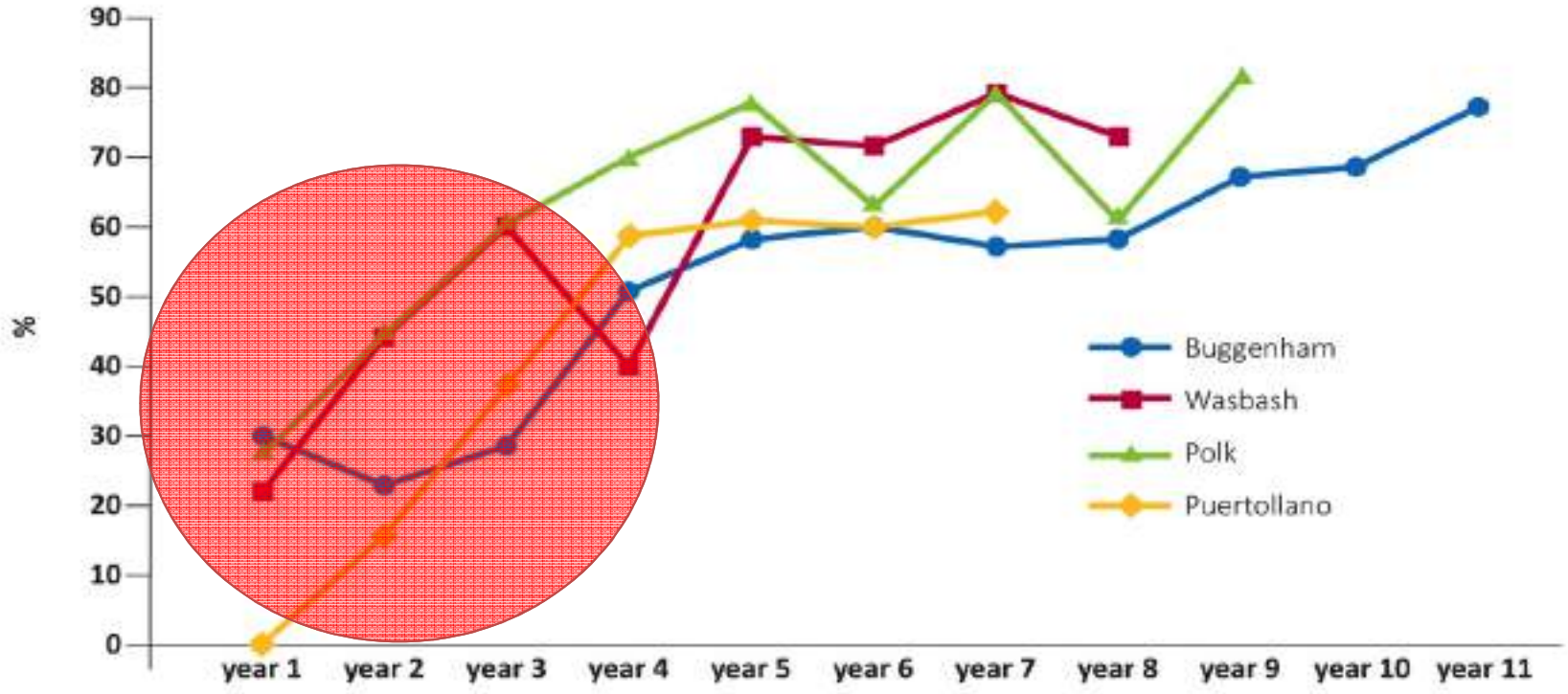
IEA, 2012.

- Up to 50% gross efficiency
- Can minimize SOx, NOx, and mercury emissions
- Can reduce cooling water demand by up to 35%
- Offers poly-generation possibility of H2, slurry and syngas
- Offers low cost option for CCS demonstration

IGCC produces power from coal with emissions equal to those of a highly efficient natural gas fired combined cycle power plant

IMPLEMENTATION RISKS AND BARRIERS

Availability profiles for early EU and USA commercial prototype demonstration projects



Early demonstration projects four and more years to reach acceptable availability levels and struggled to maintain them

Status of Key Components

Component	Status
Gasifier	Wet and dry feed systems established on a commercial basis in non-power sector
Gas cleaning	Various systems have been established
Oxygen production	Commercially proven technology
Gas turbine	Proven on natural gas. For syngas, experience limited to E-class machines
High temp syngas cooling and heat recovery	Radiant and/or convective heat exchanger and/or direct quench system proven in non-power applications
Coal flexibility	Sudden changes in coal type caused major problems on some early demo plants
Overall integration trade-offs	Critical. Higher degrees of integration favour higher thermal efficiency but compromise on flexibility. Partial integration is favoured for future designs as it gives more rapid start-up and greater operating flexibility, while maintaining the efficiency advantage of gas turbine air extraction

Identified Barriers to IGCC Technology Deployment

For large-scale demonstration and deployment of IGCC technology PRC needs capacity strengthening in:

- Component manufacturing
- Engineering, planning, and construction
- Plant operation and maintenance

Other factors impeding demonstration and deployment of IGCC Technology :

- Low policy priority, including for carbon capture and storage
- High capital costs
- Regulation and tariff setting
- Limited environmental protection incentives

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INNOVATIVE SOLUTIONS AND ADB VALUE ADDED

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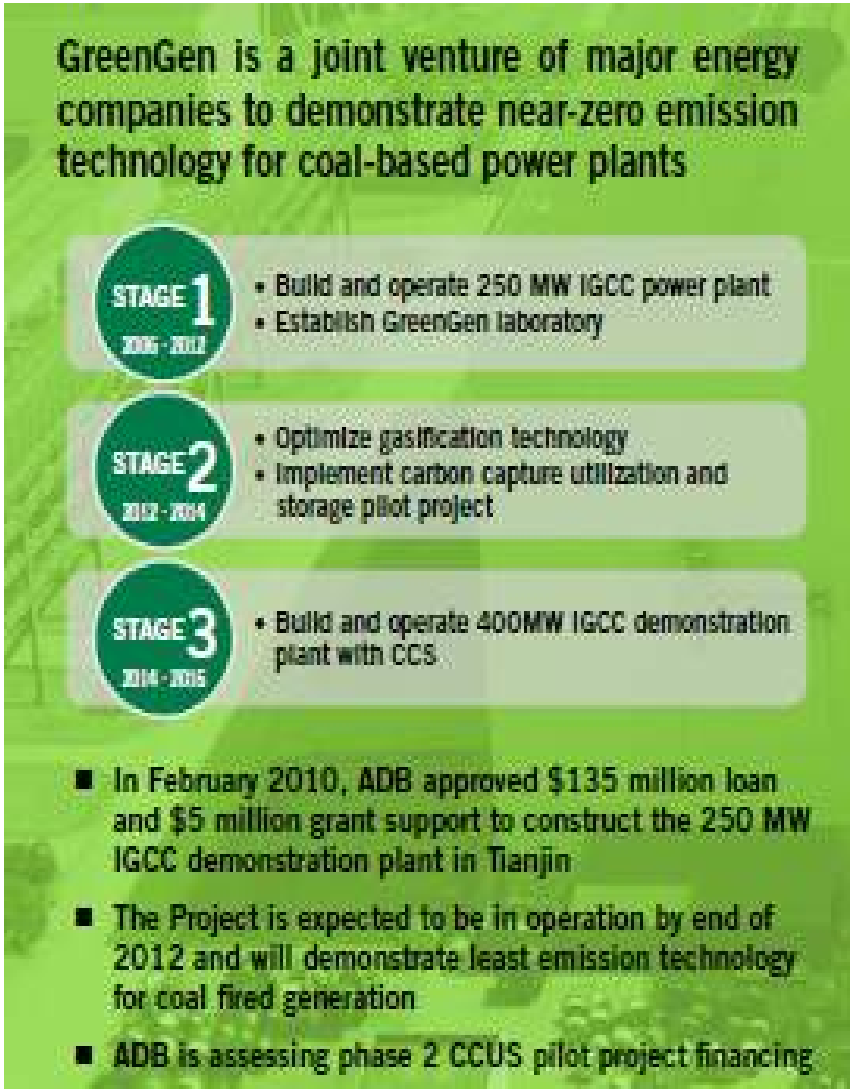
ADB support to the GreenGen program



Oct 2008 – Jun 2011: Technical assistance (TA) for Capacity Strengthening on IGCC projects

May 2009: TA for Strategic Analysis and Capacity Development on CCS Demonstration

Feb. 2010: ADB approved $135 million loan and $5 million grant support to construct the 250 MW IGCC demonstration plant in Tianjin; project

Oct. 2013: ADB approved TA for supporting preparation of Carbon Capture Use and Storage Pilot Project at Tianjin IGCC

Innovative risk mitigation measures without increasing project cost

- **How?** Utilize grant assistance for additional risk mitigation measures.
- **Longer grace period** – to overcome anticipated teething problems during initial years of operation
- **Strengthened O&M assistance** – long-term suppliers' O&M contracts during initial 2 years of operation
- **Seek additional revenue stream through potential carbon revenues**

DEVELOPMENT OUTCOMES AND PERSISTING CHALLENGES

250MW Tianjin IGCC Power Plant Project

Self developed, designed, constructed, commissioned, and operated.
Commissioned on time … and reliable after only 2 years

Technical Performance of the Tianjin IGCC

- Constructed on time
- No cost overrun in design costs, but some early issues had to be resolved in the first 1.5 years, increasing commissioning costs
- Reached reliability after only 2 years---much better than earlier plants
- Technical performance can be enhanced with strengthened capacity of operator

Environmental Performance of the Tianjin IGCC Emissions (mg/m^3)

	Emission level of from Tianjin IGCC	National air pollutant emission standards for thermal power plants		
		Coal-fired boiler		Natural gas turbine unit
		General area	Key area[1]	
Smoke dust	**<0.6**	<30	<20	<5
Sulfur dioxide	**<0.9**	<100(New)	<50(New)	<35
Nitric oxides	**<50**	<100	<100	<50

[1] Applicable for the Beijing-Tianjin-Hebei Area

Comparison with Natural Gas fired Power Plant

Disadvantages

- Slow availability adjustment capacity – base load plant
- Relatively high investment costs

Advantage

- High reliability fuel reserves
- Lower fluctuation of fuel price
- Flexibility in coal quality use
- Tends to have better environmental performance

CCUS Pilot Project at Tianjin IGCC

Project will pilot test

(i) CO2 capture, liquefaction and compression of up to 70,000 tons of CO2 p.a.,

(ii) H2 utilization for Fuel Cell test,

(iii) CO2--EOR and CO2 sequestration at nearby oilfield

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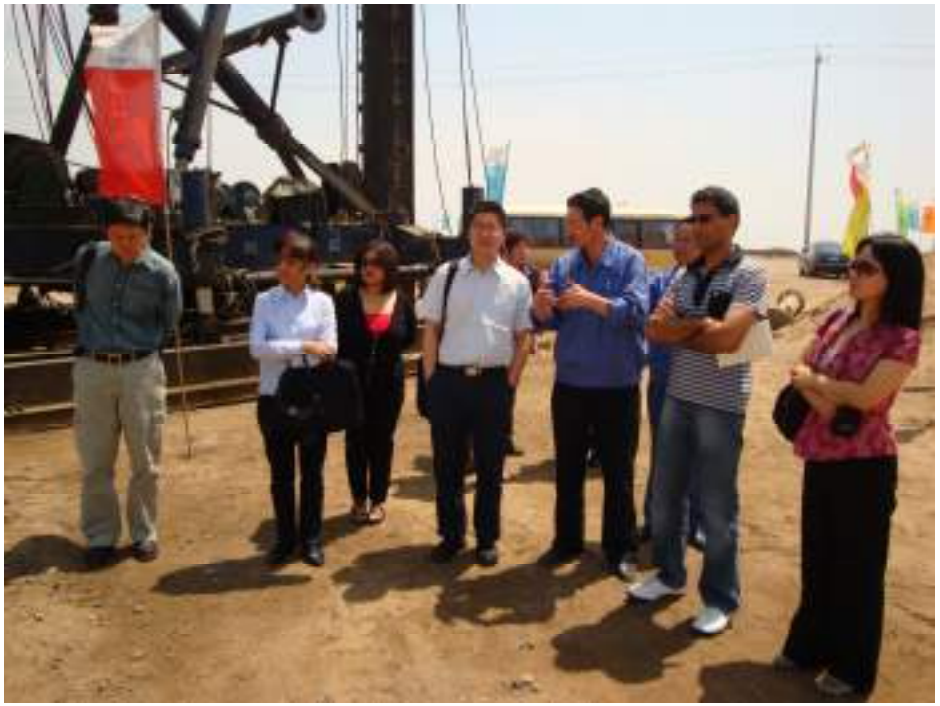
THANK YOU!



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