The Global Value of Coal: Clean Coal Technologies Open the Door

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ELECTRICITY IS GOOD
More People, Living Better, Living Longer

Electricity Use and Infant Mortality Rate
Electricity Use and Life Expectancy

Source: developed from The World Bank, 2010b
A Transmission Line for Much of the World

In Africa, women typically carry 20 kilograms of fuel wood an average of 5 kilometers every day – it takes 5 hours.
Global Electricity Poverty is Real

1,500 million
No electricity at all

2,000 million
Only Partial access to electricity

America—306 million
Full access
SCALE SETS THE CONTEXT:
If Current Electricity Demand Was a 6 Foot Tall Man

Global Electricity Consumption-1970-2030

- **1970**: 5,200 (billion kWh)
- **1990**: 11,800 (billion kWh)
- **2007**: 19,200 (billion kWh)
- **2030**: 33,265 (billion kWh)
The coming wave of rising expectations

Millions under age 15

- India: 457 million
- China: 344 million
- Nigeria: 123 million
- EU: 77 million
- Indonesia: 67 million
- USA: 61 million
Everything, Everywhere, All the Time: Increases needed by 2030 to meet demand

- Nuclear power: 35%
- Oil production: 22%
- Hydro: 61%
- NG production: 42%
- Coal production: 54%

Plus substantial increases in renewables and biomass
The Future of Electricity is Being Formed at the Global Level

Increase in Billion Kilowatt Hours
2010 - 2035

USA
1,020

Rest of World
12,810
Coal’s Ever Growing Role

Population of Countries that depend on coal for at least 40% of electricity

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>2,361 Million</td>
</tr>
<tr>
<td>2010</td>
<td>3,002 Million</td>
</tr>
<tr>
<td>2030</td>
<td>4,113 Million</td>
</tr>
</tbody>
</table>

IEA Current Policies Scenario
In the U.S., coal will be the leading source of incremental power generation through 2035.
Out of Poverty: Coal Based Energy has Propelled China Forward

“China is an example for the developing world”  IEA, 2007

Note: Poverty measure follows World Bank Definition of $1 per day income
Source: IEA, 2007; EIA, 2008
India’s Desperate Need for Power

- 400 Million: Equals Population of USA and Germany
- 600 Million: Cook with Wood or Dung
- 900 Million: Equals Population of USA, UK, Italy, Germany, France, and Spain

Source: developed from IEA 2010
Asian Electricity Demand is a Rising Tide

<table>
<thead>
<tr>
<th>Year</th>
<th>Gas (TWh)</th>
<th>Coal (TWh)</th>
<th>Hydro (TWh)</th>
<th>Nuclear (TWh)</th>
<th>Wind (TWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>896</td>
<td>4,022</td>
<td>881</td>
<td>881</td>
<td>509</td>
</tr>
<tr>
<td>2015</td>
<td>2,390</td>
<td></td>
<td>2,124</td>
<td>1,964</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>4,022</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2025</td>
<td>8,761</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2035</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Coal Generation is projected to exceed 8,700 TWh in Asia in 2035

Replace Coal in Asia?

- Build 1,100 nuclear power plants
- Construct 2,500 Hoover Dams
- Produce 80 TCF of gas
- Burn 11 billion barrels of oil
- Install over two million wind turbines stretching 500,000 miles—then build gas backup.
The Scale of the Challenge by 2050

- GDP: 254%
- Electricity Generation: 140%
- Energy Demand: 84%
- World Population: 9.0 Billion
- People Living in Cities: 6.8 Billion

Goal for: Greenhouse Gases
- 80%

Source: developed from EIA, UN, IEA, 2010 and 2009 (trend data through 2050)
Clean Coal Technology Works: the United States

Coal Consumption for Electricity 1989 - 2007

Regulated Emissions *

* Sulfur Dioxide and Nitrogen Oxides
The Path to Near-Zero Emissions

- Advanced Supercritical Combustion Plants
- Demonstrating Carbon Capture / Storage (CCS)
- Commercial CTG/CTL with CCS
- Commercial IGCC with CCS
- Retrofitting PC Plants with CCS

2007 2010 2020 2030
Supercritical Technology has Enormous Environmental Benefits

Technology Achieves One-Fifth the Average Emission Rate of Existing U.S. Coal Fleet and Lower CO₂ Emission Rate

China and India House 50% of the World’s Advanced Coal Fleet

429 GW On Line and Under Construction

- China 175 GW
- India 37 GW
- ROW 45 GW
- U.S. 96 GW
- Other EU 11 GW
- Russia 16 GW
- Japan 20 GW
- Germany 12 GW
- S. Korea 17 GW
Clean Coal Technology is Making Huge Inroads in Asia

Data source: Professor Janos Beer, Massachusetts Institute of Technology, 2010
China’s Progress in Efficiency Means Significantly More Power and Reduced Emissions

Over 114,000 MW of small units will be decommissioned. China is proceeding with construction of 112,000 MW of Ultra Supercritical
CCS is the Path to Climate Policy Goals

“Gas doesn't get us there”
Dave Hamilton, Director for Global Warming, Sierra Club

Global Warming Potential Based on Life Cycle Analyses by U.S. National Energy Technology Laboratory (NETL)
The World’s Greatest Energy Resource---9 times the Btu of Ghawar Field in Saudi Arabia

One year of PRB coal equals 6.1 TCF of gas —more than the gas production of two Gulfs of Mexico

Powder River Basin Coal Provides 20% of U.S. Electricity

Domestic Coal--The Epitome of Energy Security
Lest We Forget: Ohio and its Neighbors have Coal Reserves Surpassing Foreign Oil Reserves

Coal Reserves*   Oil Reserves**

<table>
<thead>
<tr>
<th>Country</th>
<th>Quadrillion BTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>OH-KY</td>
<td>2188</td>
</tr>
<tr>
<td>WV-PA</td>
<td>882</td>
</tr>
<tr>
<td>Venezuela</td>
<td>573</td>
</tr>
<tr>
<td>Iran</td>
<td>480</td>
</tr>
<tr>
<td>Iraq</td>
<td>322</td>
</tr>
<tr>
<td>Russia</td>
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</tbody>
</table>

*Demonstrated Coal Reserve Base  **Proven Reserves
Electricity Makes the Difference: Korea

South Korean preschool children average 3 inches taller and 7 pounds heavier than North Korean Children.

The Infant Mortality Rate in North Korea is 12 times higher than South Korea.

South Korea ranks 32nd in GDP/capita. North Korea ranks 156th.