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on
THE FUTURE OF COAL FOR ENERGY
by

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Sustainable development at reasonable cost and with minimal long-term negative environmental impacts must be our goal.

HIGHLIGHTS

- *Coal will play an important role in the global energy picture over the next 20 years and beyond.
- *Coal is the most affordable clean source of energy to drive global economy and high standards of living.
- *Coal will be the “fuel of choice” for base-load generation.
- *Coal will be a savior for continued economic growth in developing Asia - particularly in India and China.
- *Coal processing will play a major role to provide affordable, clean coal energy globally.
- *All countries, in the longer term, should strive for a balanced energy mix to achieve sustainable development without degradation to the environment.

OUTLINE

- *World energy demand and supply projections and the role of coal in the energy mix.
- *Environmental issues affecting coal usage.
- *Clean coal technologies for coal utilization.
- *A case for a balanced energy mix for sustainable development.

*A Futuristic view

GLOBAL ENERGY DEMAND AND SUPPLY PROJECTIONS

- *50% increase in global energy consumption from 2000 to 2020.
- *Energy consumption is correlated with economic growth.
- *Most of the growth in developing countries - Mainly in China and India.

WORLD ENERGY SUPPLY PROJECTIONS- FUEL TYPE, 1970–2020

- *Fossil fuels (oil, coal, and natural gas) should provide over 90% of the energy needed.
- *Global coal use expected to grow at an average annual rate of 1.5%.
- *Natural gas should grow about 3.0% per year.
- *Nuclear power as source of energy will decline.
- *Renewable energy resources will grow some.

OUTLOOK FOR COAL

COAL AS A FUEL FOR POWER GENERATION

- *Coal is cheap fuel. Fuel cost/kwh using coal is 30-40% cheaper than natural gas or nuclear.
- *CO₂ emissions/ BTU from coal are 80% higher than natural gas and 20% higher than for oil.
- *Land, water, and air impacts and solid waste emissions from coal use as fuel are of concern.
- *Oil and natural gas resources have limited life.
- *Coal will maintain the cost edge as fuel thru productivity gains and clean coal technologies.
- *Coal will be the “fuel of choice” for base load power generation.

AN OUTLOOK FOR COAL IN THE ENERGY MIX

- *Over 55% of coal worldwide (5-b tons/yr) is used for electrical power generation.
- *Most projected coal growth will be for base load electrical power generation.
- *Coal share of world energy production should drop from 22% in 1999 to about 19% in 2020.
- * Coal outlook could change based on the environmental concerns - global warming, acid rain, solid waste, and water management issues.

GLOBAL OUTLOOK FOR COAL-2020

- *Global coal use expected to grow to about 6.4 billion tons.
- *Increases mostly expected in the U.S.A, Japan, and developing Asia.

*China and India will represent 92% of the total coal use increase over the next two decades.

* World coal trade should increase 180 m. tons

ENVIRONMENTAL ISSUES

ENVIRONMENTAL ISSUES AFFECTING COAL USE (LAND)

*Disposal of mining and processing wastes (20- 40% of mined coal)

*Changes in surface topography due to surface mining.

*Surface subsidence- short-term and long-term, and associated agricultural impacts.

*Management of solid wastes and byproducts generated from combustion of coal (CCBs), and dry and wet flue-gas desulfurization byproducts.

* With controls on Nox and mercury emissions, byproduct characteristics will change for worse. Land impacts of management could become more serious.

ENVIRONMENTAL ISSUES AFFECTING COAL USE (WATER)

*Surface and ground water contamination.

*Acid or alkaline drainage, suspended and dissolved solids, and trace elements are important from mining, processing, and solids and CCBs waste management.

* From power plants, concerns are thermal discharges into waterways, and inorganic and organic trace element discharges from waste liquid streams.

ENVIRONMENTAL ISSUES AFFECTING COAL USE (AIR)

*Air quality and greenhouse effects are major concerns. SO_x, NO_x, CO_x, air toxics, mercury, and particulates are regulated.

*SO_x and NO_x controls have reduced emissions over the last decade.

*Carbon dioxide and methane (greenhouse gases) emissions must be controlled.

* Coal accounts for 35% of carbon dioxide, and 9% of methane emissions globally. This could increase significantly with large scale coal use.

US CLEAN COAL UTILIZATION STRATEGIES

PROGRESS TOWARD CLEAN COAL UTILIZATION

*Over the last 20 years, SO₂ emissions have been reduced by 50% even as coal use has increased.

*This has been achieved through coal processing to remove ash and sulfur, advanced coal combustion technologies such as fluidized bed combustion (FBC), and flue-gas desulfurization (FGD) technologies.

* SCR and NSCR technologies are used for Nox reduction. However, they lead to higher levels of LOI, volatile trace elements and mercury in CCBs.

VISION 21 Ultra-clean Energy Plant of the Future

(with permission from USDOE/NETL - Dr. Rita Bajura's Opening Address)

Energy Plants for Post-2015

- *Use available feeds. Coal, Gas, Biomass, Waste
- * Electricity Primary Product May co-produce fuels, chemicals, steam, heat
- Goal- Absolutely minimize environmental implications of fossil energy use.
- Approach-
- *Maximize Efficiency 60% coal to electric
- * Near zero emissions Option for carbon sequestration

DEVELOPING CLEAN COAL TECHNOLOGIES FOR COAL UTILIZATION

- *Coal Processing for SO_x, NO_x, Air Toxics, and solid byproducts control. Advanced fine coal cleaning.
- *Higher Efficiency and Cleaner Power Generation
- Group 1: ~ 40% efficiency. Low-emission boiler system (LEBS), first generation PFBC, and first generation IGCC.
- Group 2: ~ 45% efficiency. Externally fired combined cycle (EFCC), second generation PFBC, and second generation IGCC.
- Group 3: ~ 50-60% efficiency. High Performance Power System (HIPPS), improved second generation PFBC, integrated gasification advanced cycle (IGAC) and IGFC (integrated gasification fuel cell).

CLEAN COAL TECHNOLOGIES FOR COAL UTILIZATION

- *Group 3 technologies should be commercially designed by 2010.
- *The 2nd and 3rd generation gasification based systems have higher potential for new plant applications.
- *These should result in reduced electric power generation cost compared to new plants today.
- * Through reuse of waste heat, overall energy efficiencies may approach 85%.

COMBUSTION SYSTEMS

Enabling Technologies-

- *Advanced materials
- *Heat transfer and aerodynamics
- *Combustion- Coal gas capability
- *Sensors and controls

CLEAN COAL TECHNOLOGIES –LONGER TERM

- *Marketable liquid fuels and clean gases.

- *Coal-derived liquid fuels and clean gas utilization as natural gas and oil prices rise.
- *Gasification of coal is the most critical step for IGCC, liquid fuels, and clean gaseous products.
- *Low-temperature fluidized bed gasification systems could find significant applications.
- * Clean coal technologies in new power plants and retrofits to existing plants can decrease carbon dioxide emissions by 15-20%.

TACKLING CLIMATE CHANGE

BACKGROUND

- *Rising levels of greenhouse gases in the atmosphere are changing the climate
- *To avoid dangerous changes, will need to stabilise greenhouse gas concentrations
- *IPCC1 has indicated that deep reductions (>60%) will be required in global emissions
- *To stabilise atmospheric concentrations of greenhouse gases, will eventually need zero net emissions

A CASE FOR BALANCED ENERGY MIX

- *Sustainable development at reasonable cost and with minimal long-term negative environmental impacts must be our goal.
- *Free enterprise growing as a business model.
- *Utilities dispatch power/power plants at different levels based on capability and cost. This is central to electric utility economics. Dispatch models vary by region.
- *All energy technologies have varying capabilities, dispatch characteristics, location advantages, and economic and environmental limitations.
- * Public policy and regulatory agencies should create environments for growth of different energy resources and technologies, including renewable resources.

A FUTURISTIC VIEW

- *Over 90% of the energy in most industrial countries and 75% of the energy worldwide today is provided by fossil fuels.
- *Remaining resources of all fossil fuels today represent only about 11 days of sunshine.
- *Environmental impacts of current energy sources may require future energy patterns to be more efficient and de-centralized.
- * The main fuel of the future could be hydrogen, the lightest and most abundant element in the universe.

CONCLUSIONS

- *Coal will continue to be one of the main pillars of energy security and economic

development.

***More efforts are needed to protect the environment.**

***Clean coal technology development must continue.**

***Implementation of clean coal technologies world wide is the key to sustained coal utilization. Capture and storage of CO2 can contribute to a more sustainable outcome**

*** The future lies with a combination of policy, technology and sustained effort.**