

The International Seminar:
Perspective for Near-term CCS Deployment in Brazil
Porto Alegre, Brazil
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Basin Electric Power Cooperative's
Approach to
CO₂ Capture, Transport and Sequestration
Technologies

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BASIN ELECTRIC
POWER COOPERATIVE

A Touchstone Energy® Cooperative 

Climate Change



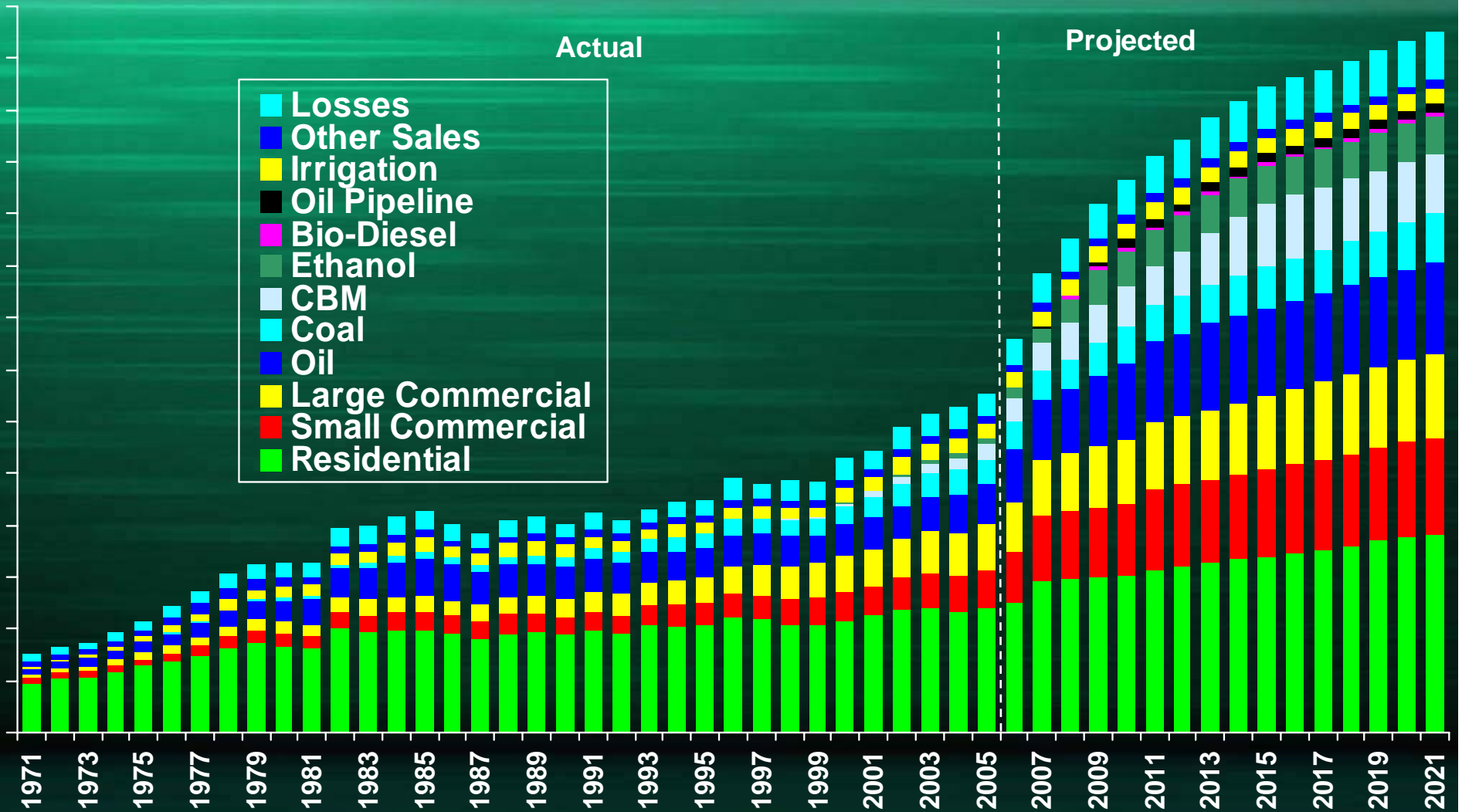
Coal is 'King' of Electrical Generation

- Coal-fired plants account for 50% of US production now
- Projected coal demand increase of 4% per year
- Projected electrical demand increase of 39% by 2030
- By 2030, coal will fuel 57% of US electrical production



BEPC Member System Energy Requirements by Class

Million
MWh





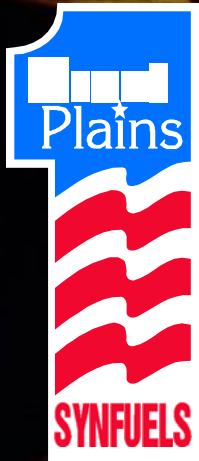
Coal's Image

- Viewed as 'dirty' in the past
- Now viewed as the # 1 contributor to GHG and global warming
- Regardless of our beliefs, the debate is largely over – the public and policy makers demanding action
- BEPC believes CO2 regulations are imminent
- BEPC believes carbon management techniques are necessary to continue use of coal

What is BEPC doing with CO2?

- BEPC's subsidiary, Dakota Gasification, began capturing and sequestering CO2 in 2000
- To date, captured 10 million tons and transported for EOR recovery process at Weyburn and Midale Oil Fields in Saskatchewan, Canada
- DGC expects to capture in excess of 3 million tons CO2 per year
- BEPC's next step – Pursue a demonstration project to capture CO2 at the Antelope Valley Station and sequester the CO2 by leveraging DGC's pipeline and knowledge

CO₂ Capture and Sequestration at Dakota Gasification Company



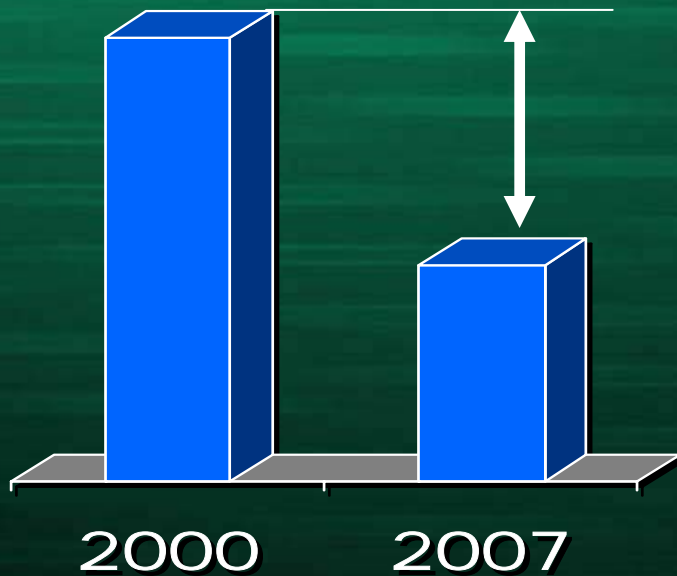


49% Reduction
in CO₂
Emissions
Since 1999!

HOW?

CO₂ Emissions Reduction at DGC's Synfuels Plant

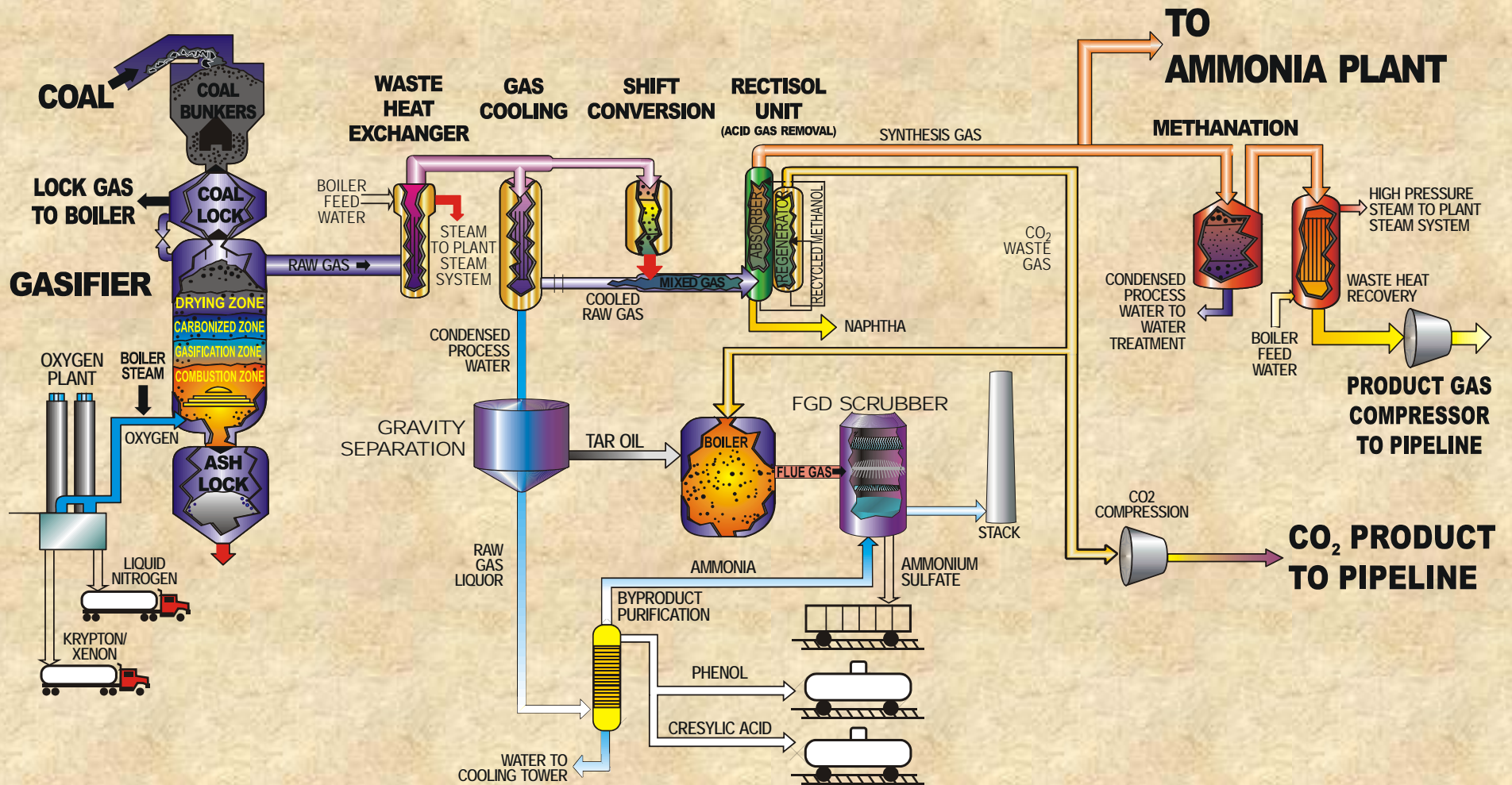
49% reduction in CO₂ emissions



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Great Plains Synfuels Plant Process Flow

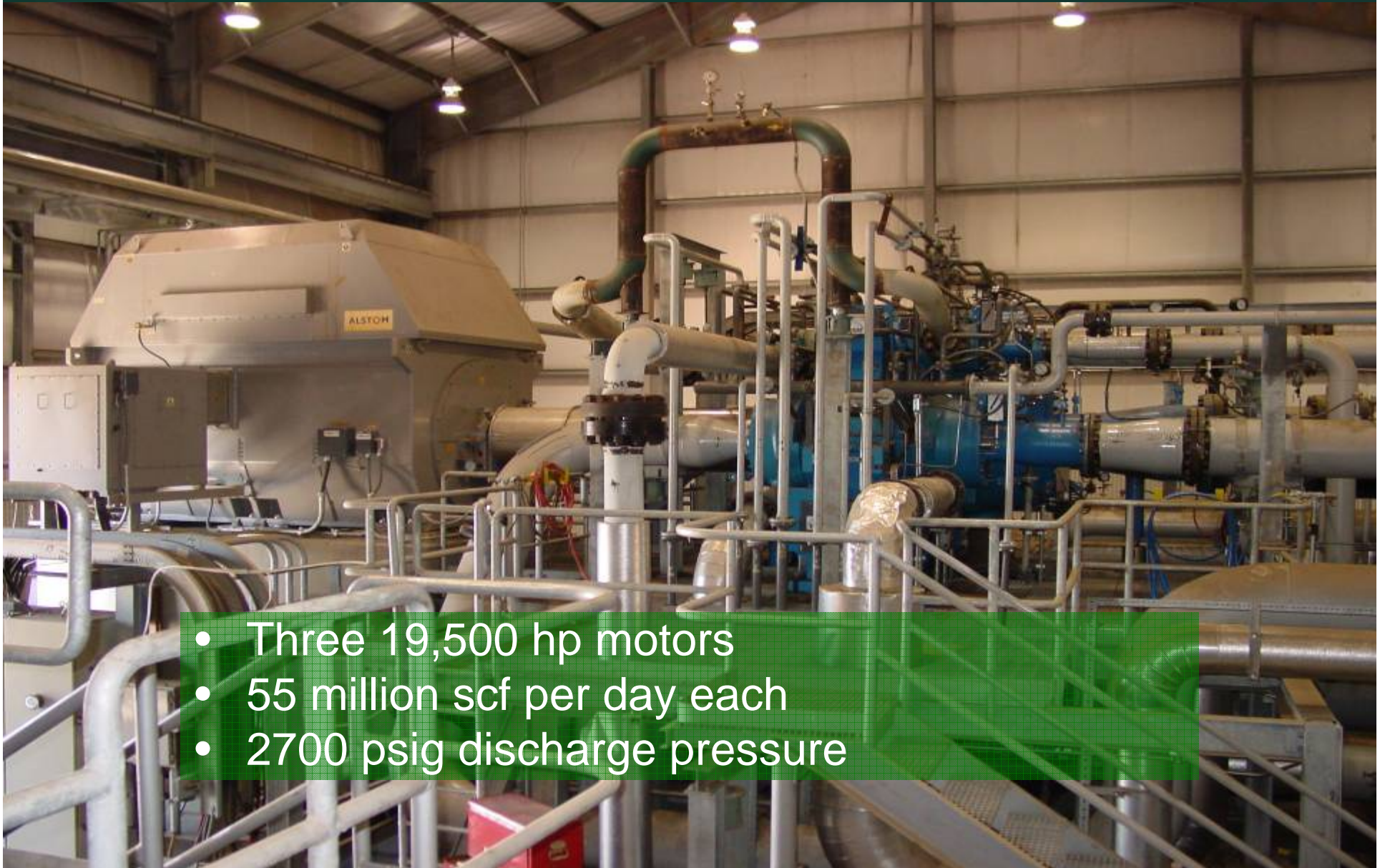


CO₂ Compressors



- Manufactured by GHH BORSIG (now MAN Turbomaschinen AG).
- Serial Numbers 1 & 2.

CO₂ Compressors



- Three 19,500 hp motors
- 55 million scf per day each
- 2700 psig discharge pressure

Compression Challenges

- Mechanical integrity and balancing
- Materials of construction for seals
- Control system
- Interstage cooling
- Contaminants in gas stream

CO₂ Pipeline



- 205 miles
- 14" and 12" carbon steel pipe
- MAOP 2700 psig & 2964 psig
- Strategically routed through Williston Basin oil fields

Carbon Dioxide - 153 mmscfd



Used in enhanced oil recovery



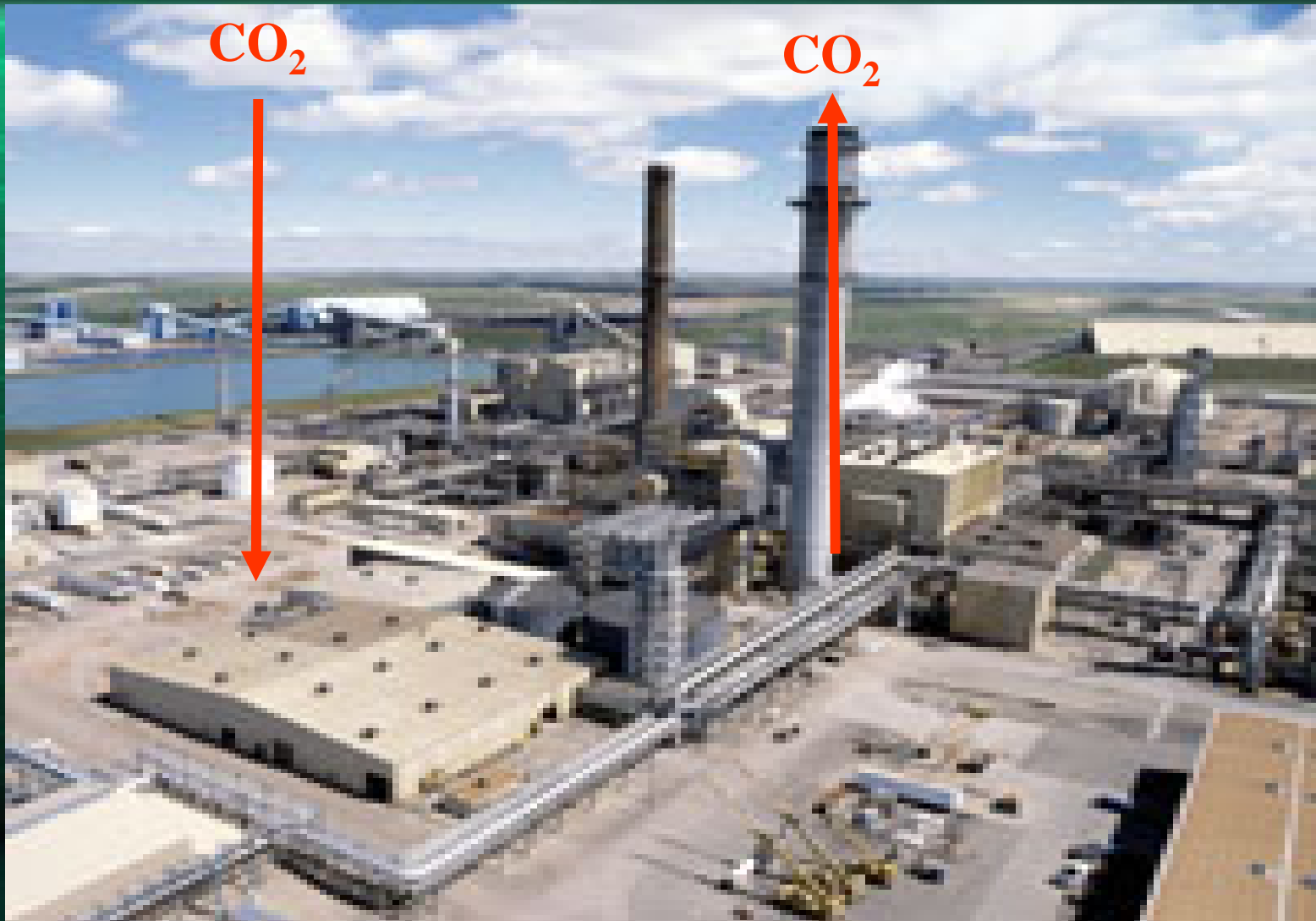


Transport Challenges

- Permits for pipeline
- Selection of lubricants and gaskets
- Safety requirements of CO₂ transport
- Importance of proper routing and pipeline design

Stack to Storage

Industrial Emissions to Value Creation



AVS CO₂ Capture Demonstration Project Concept

- Capture about 55 mmscfd of CO₂ post combustion
- Treat CO₂ at AVS to pipeline quality
- Compress CO₂ at AVS or DGC
- Use existing DGC pipeline and operation to transport CO₂
- Issued Request for Proposals in June 2007

Capture Technology is Major Hurdle

- Proven capture technology not yet available commercially
- Several companies in various R&D phases
- BEPC seeking to develop partnership or alliance with a promising technology vendor

Technologies to Consider

- MEA (amine) absorption
- Chilled ammonia absorption
- Membrane separation
- Oxy-fuel combustion
- Physical adsorption
- Cryogenics
- At this time, MEA and chilled ammonia are only viable choices

Transport Challenges

- Permits for pipeline
- Selection of lubricants and gaskets
- Safety requirements regarding to CO₂
- Importance of proper routing and pipeline design
- DOT requires monitoring of pipeline integrity every 5 years (smart pig)



Vendors Responding to RFP

- Alstom Environmental – chilled ammonia and amine based
- PowerSpan Corp. – chilled ammonia
- HTC Pureenergy – amine based
- CanSolv Technologies – amine based
- Mitsubishi Heavy Ind. – amine based
- Fluor – amine based

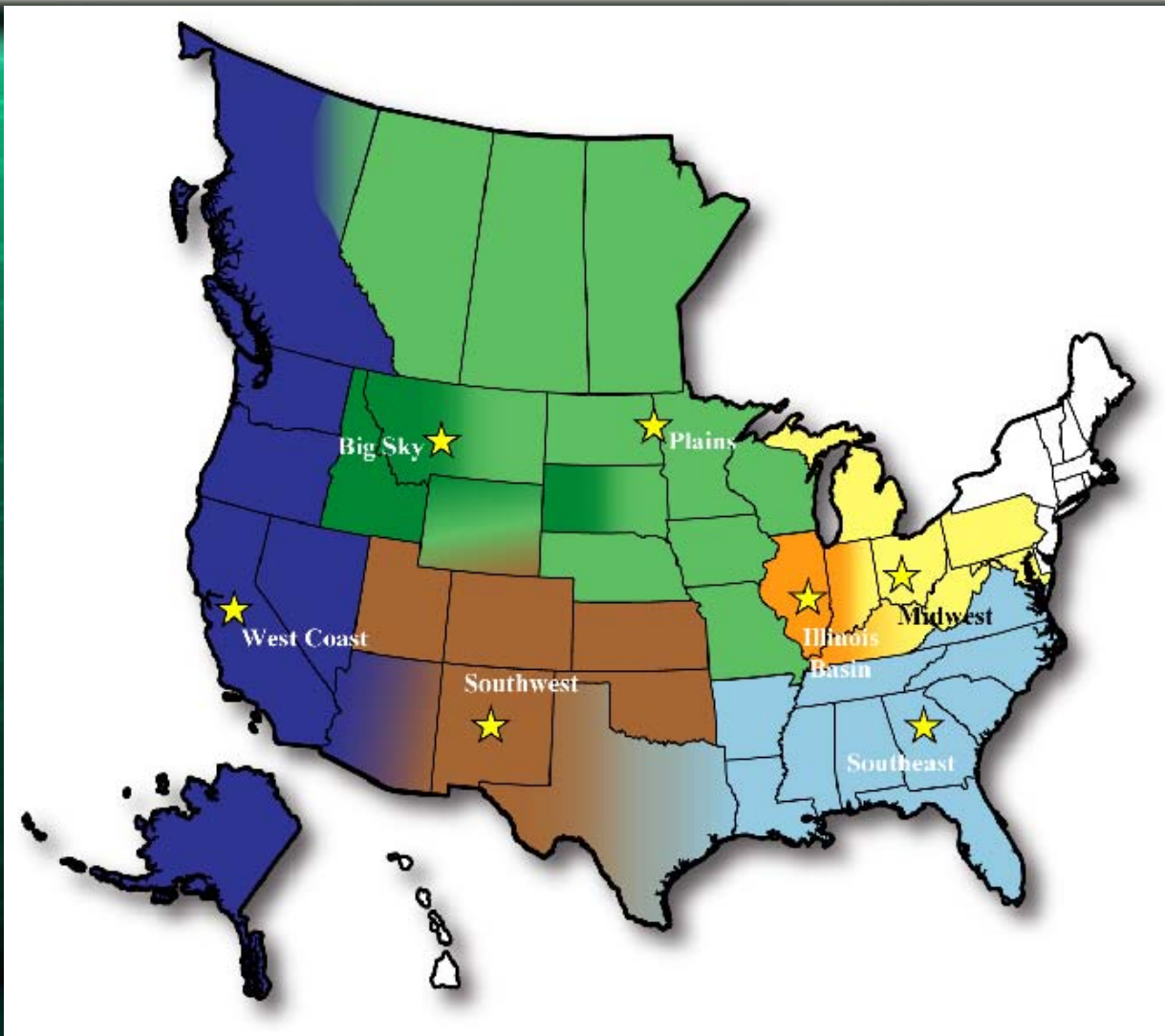
Challenges

- Additional Sox removal may be required
- Process cooling and heating will be very parasitic
- Water balance issues
- Solvent replacement
- Materials of construction
- High capital and operating costs
- Estimated cost of capture range from \$20 to \$60 per ton

Cost and Risk Reduction

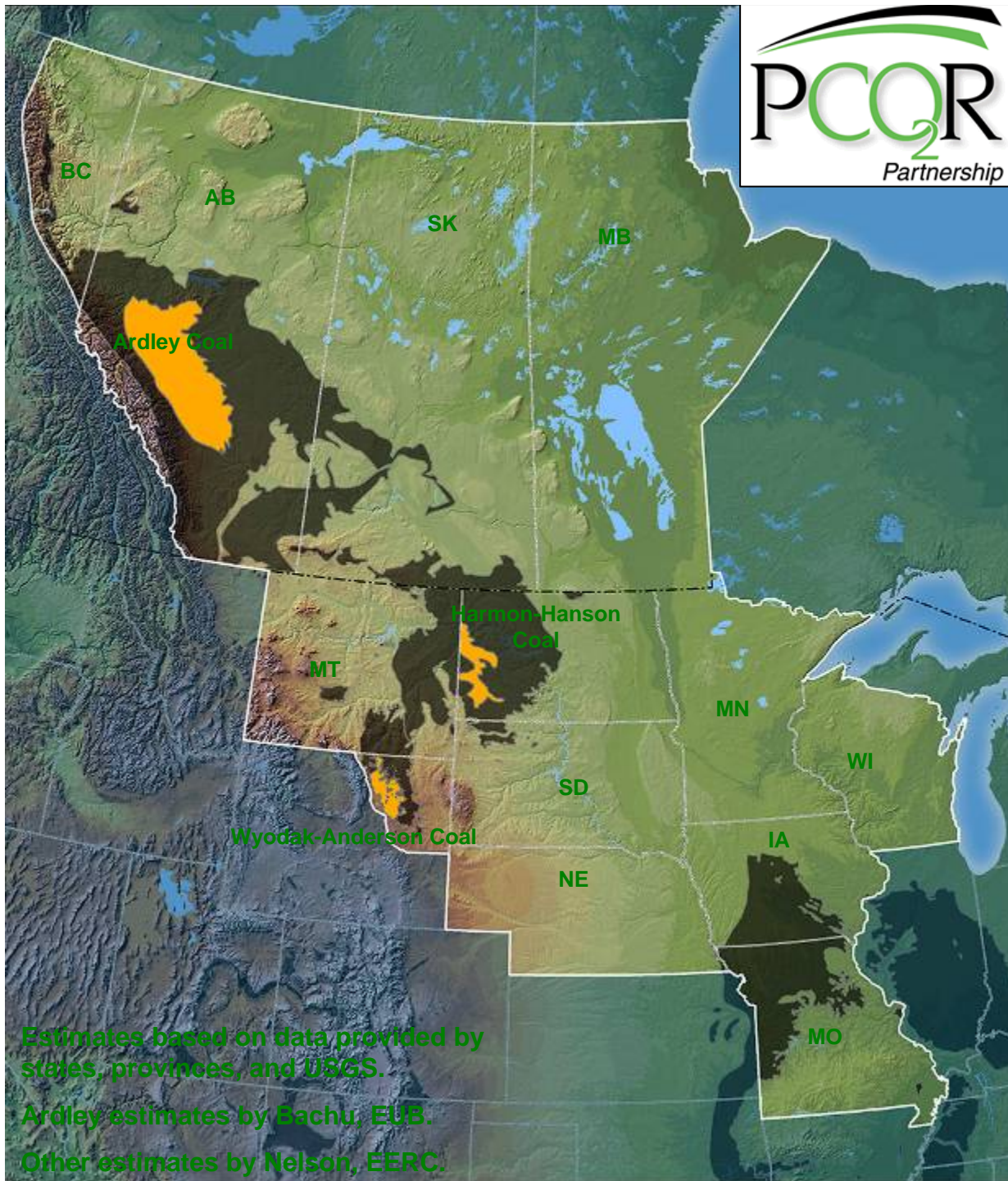
- With DGC pipeline location, ability to sell additional CO₂ for EOR to new customers or existing customers is very good
- Seek DOE funding
- Seek support or participation from State of ND and other area lignite users and producers
- Seek to have the project recognized as a PCOR– Phase III project

Regional Carbon Sequestration Partnerships



Plains Carbon Dioxide Reduction (PCOR) Phase III Project

- Implementation of large volume sequestration tests to demonstrate the safe, effective, and permanent storage of CO₂ in different geological formations in North America that could offset 50% of current CO₂ emissions in each region for the next 100 years.
- DOE funded
- Funding of up to \$67 million for each region



Coal Fields

Evaluated Wyodak–Anderson, Ardley, and Harmon-Hanson coals.

CO₂ sequestration capacity estimated to date: >8 billion tons

17 Tcf of methane potential from ECBM in these seams.

Don't need supercritical CO₂, and purity of stream isn't an issue (significant N may be good).

Estimates based on data provided by states, provinces, and USGS.

Ardley estimates by Sachu, EUB.

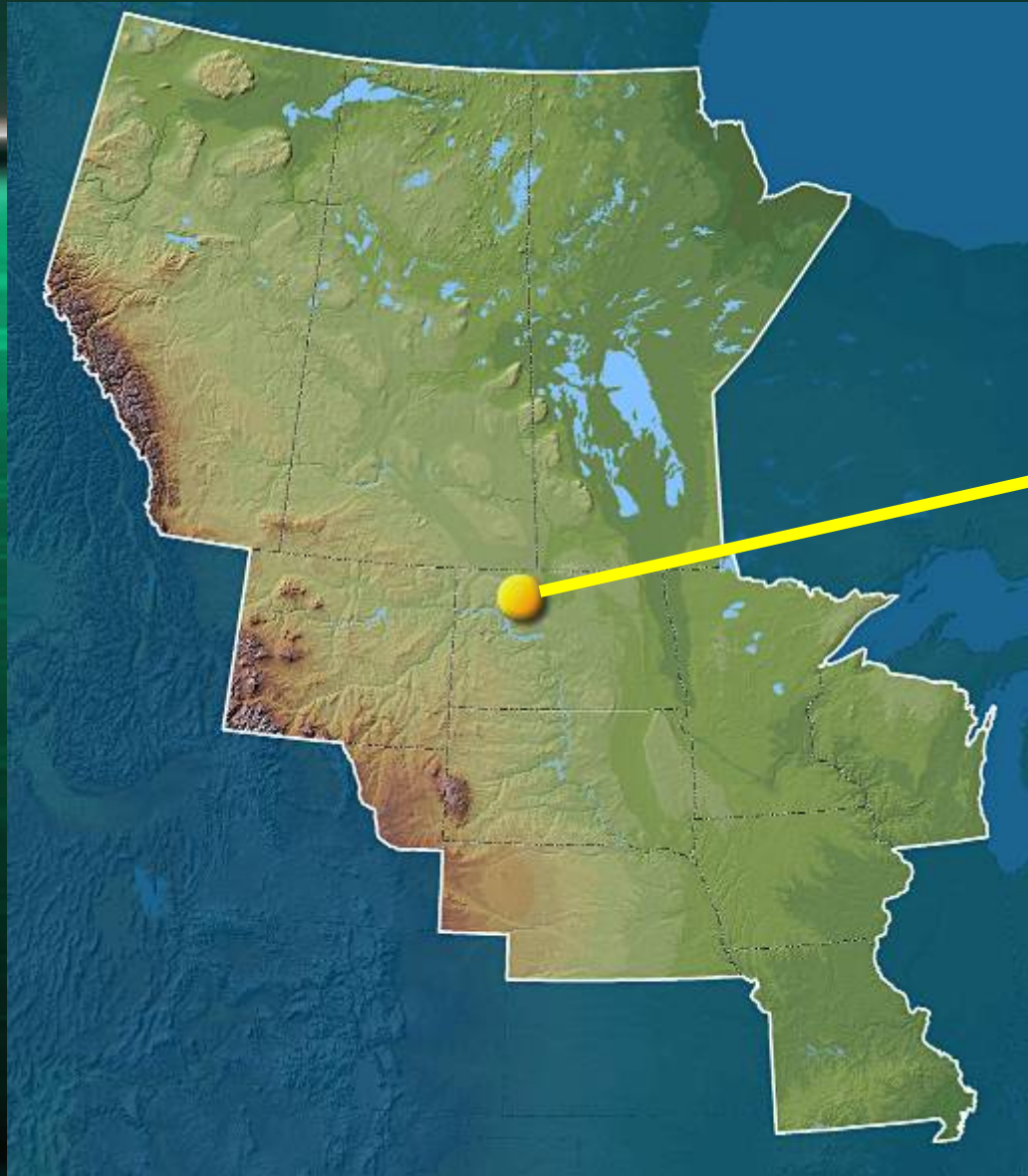
Other estimates by Nelson, EERC.

Beaver Lodge, North Dakota



- CO₂ in a deep oil reservoir – CO₂ will be injected into an oil-bearing zone at great depth in the Beaver Lodge oil field.
- Minimum of 3000 tons of CO₂ will be injected during demo period.

Lignite for CO₂ Sequestration and ECBM



- CO₂ in an unminable lignite seam – CO₂ will be injected for both CO₂ sequestration and enhanced coalbed methane production.
- State of North Dakota is providing surface and mineral rights access; drilling scheduled spring 2007.

Phase III Target Formations

- **Saline formations are primary target**
- **Oil, gas, and coal are secondary– Must be regionally significant**
- **Representative of the region's geology– Capacity and availability must be high**
- **Competent seals are a must**
- **Structure must be conducive to trapping**

Next Steps for AVS CO2 Capture Project

- **Complete Review of Six Proposals**
- **Make a 'Go' or 'No Go' Decision Based on Economic and Technical Issues**
- **If Project is a 'Go', Select Project Partner in December and Conduct Feasibility and FEED Studies**
- **Project Could be On-Line in 2011**

Summary

- **The CO₂ capture train has already left the station**
- **BEPC believes it is only a matter of time until CO₂ regulations are enacted**
- **CO₂ capture and sequestering will be costly and proven capture technology is not available**
- **BEPC is seeking to demonstrate capture technology in an economic manner**
- **CO₂ capture – not a question of who and what, but rather when and how?**

Thank you for your kind attention!

Questions ????