SaskPower CCS Global Consortium – *Bringing Boundary Dam to the World*

Mike Monea, President Carbon Capture and Storage Initiatives

SaskPower

Purpose of Today

A. CCS around the world

B. What SaskPower is doing

C. Sharing the Knowledge

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Operational April 2014

World Reliance on Fossil Fuels

By 2030 . . .

- Global demand for power increases **40%**
- Green house gas emissions increase **40%**
- Fossil fuels expected to account for **80%** of world energy production

Source: International Energy Association
World Energy Outlook - OECD/IEA 2009

Regulations Around the World

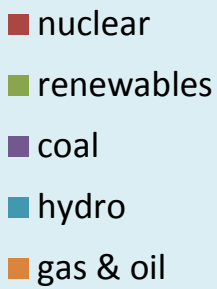
- 2012: Canada announces regulations on CO_2 emissions (420 tonnes CO_2/GWh)
- On the verge of finalizing CCS regulations for oil and gas industry

- EU Emissions Trade Directive enters 3rd Phase; includes single-EU wide cap
- Expanding to include more industries, refineries, chemical plants, airlines

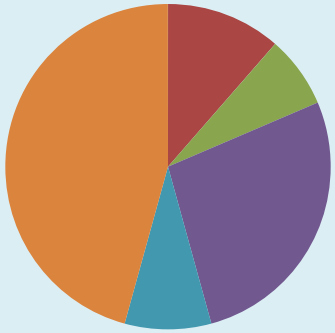
- 2011:Launched Clean Energy Package to cut 159 million tons of CO2 by 2020
- 2012: Announces agreement to link emissions trading system with EU by 2018

- 2010: Signed the National Climate Change Policy (PNMC) on reducing greenhouse gas emissions into a national law
- Requires Brazil's mitigation actions be quantifiable and verifiable

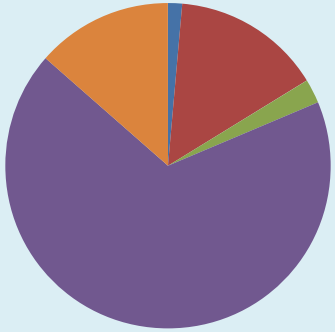
Cost + Performance + Risk + Environment



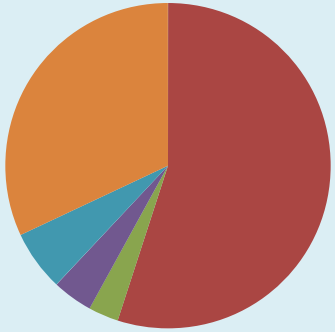
EON



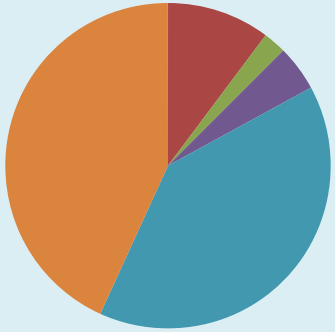
RWE



Exelon



Endesea

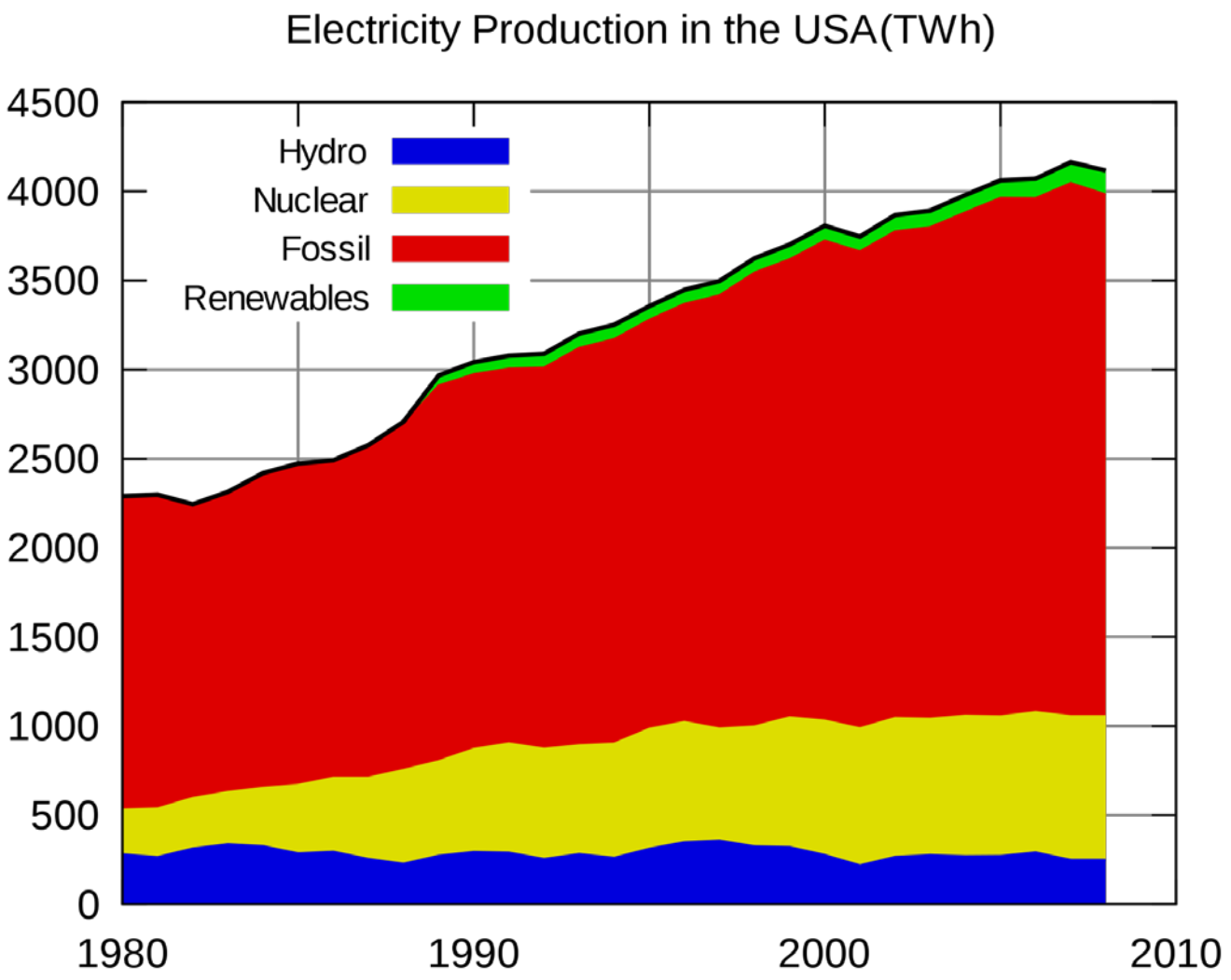


"No one technology can be relied upon to balance the triple challenge of… reducing carbon emissions, maintaining supply. . . at an affordable cost"
~ EON

Wind is getting stronger

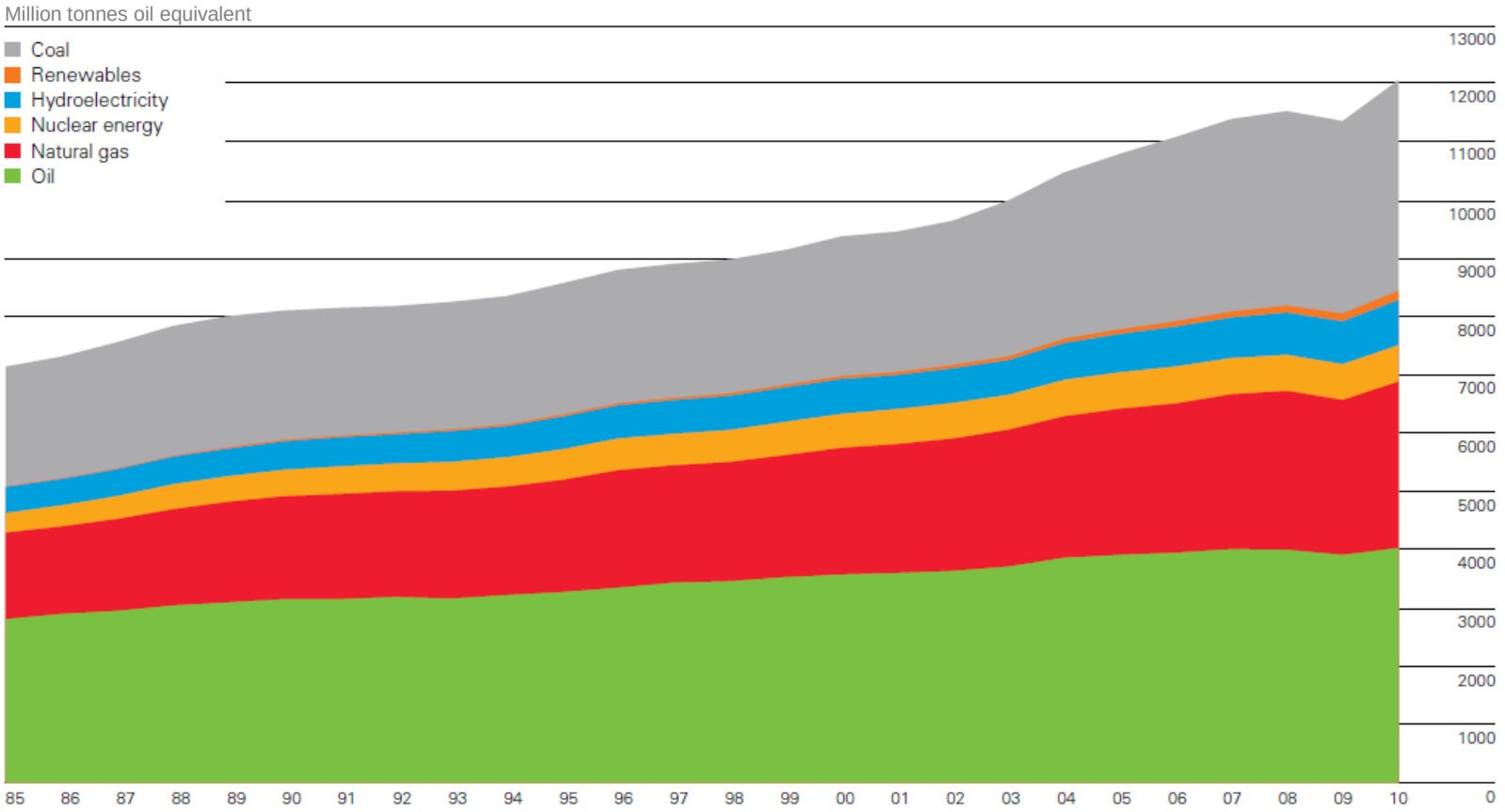
- Will more than double by 2020
  - 3% in 2013
  - 8% by 2018
- **Intermittent** technology . . . supplies only when it wants to
- Consumers need **24/7**

Growth in Context



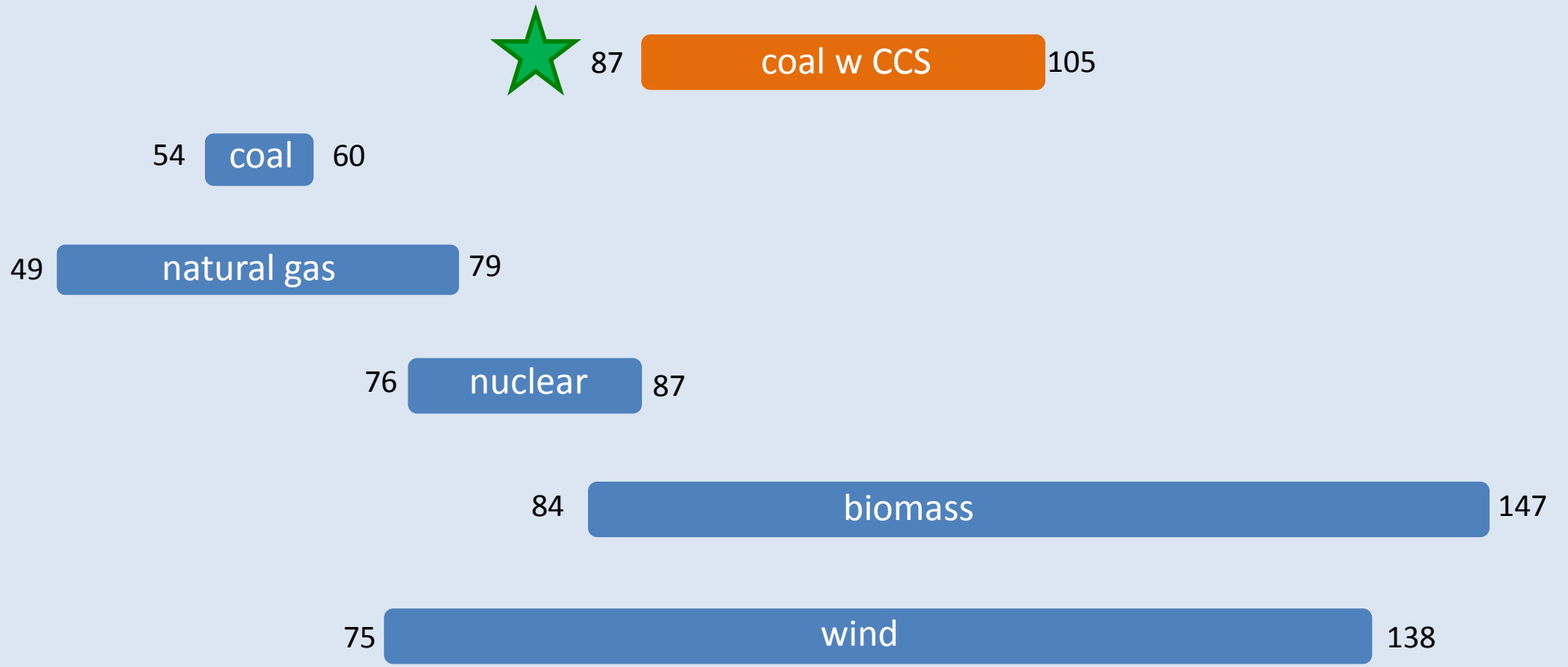
**Source: US Energy Information Association*

Global Energy Consumption by Source



Source: US Energy Information Association, 2012

Cost of Generation



$US /MWh

Source: 2010 EPRI, Program on Technology Innovation: *Integrated Generation Technology Options*

- GCCSI identified 75 CCS projects underway in 2012
- 16 are large-scale integrated CCS projects, active or in construction
- 2 off those are on power plants

Image Source: Complements of zeroCO2.no

What SaskPower is Doing

A. CCS around the world

B. What SaskPower is doing

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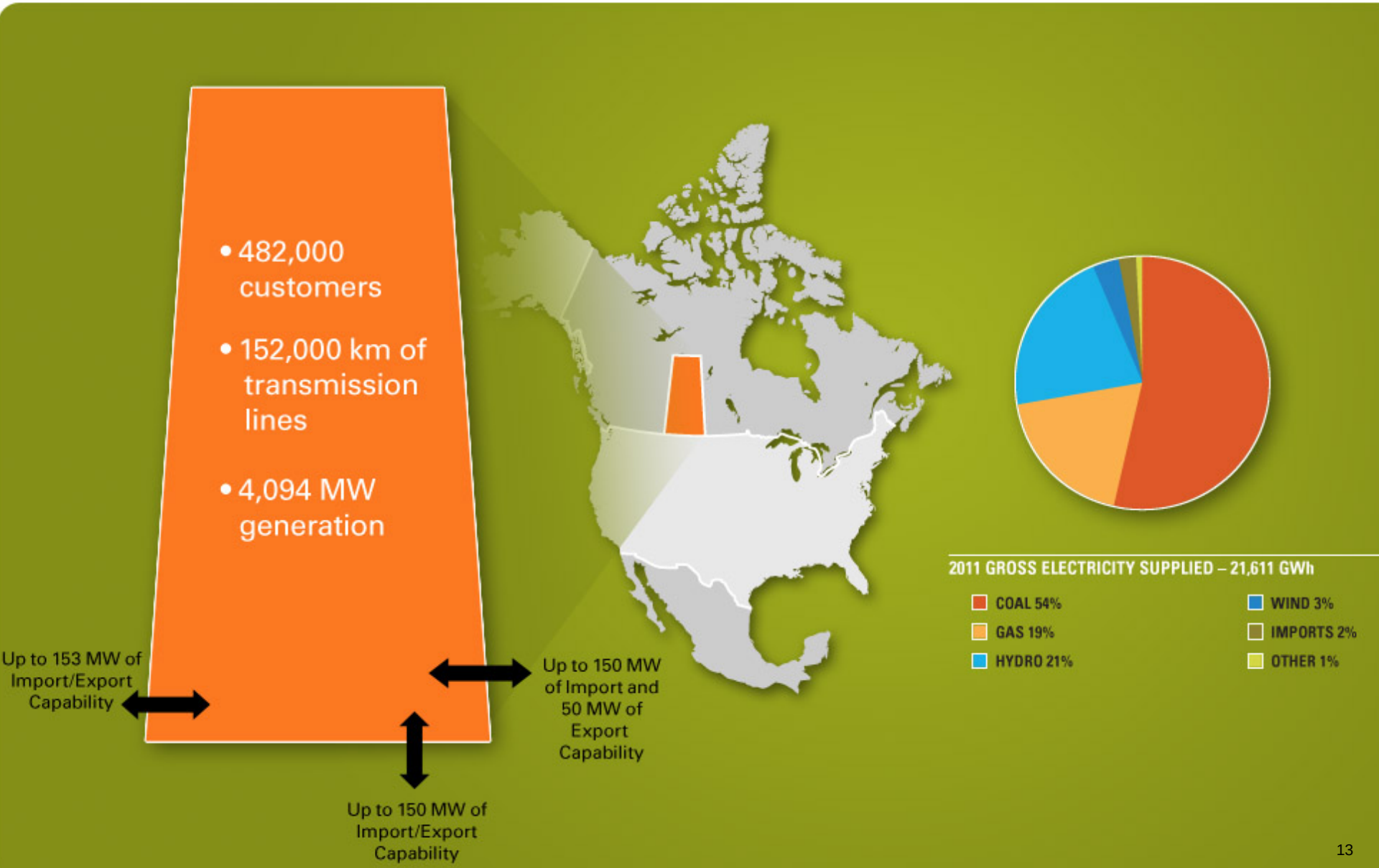
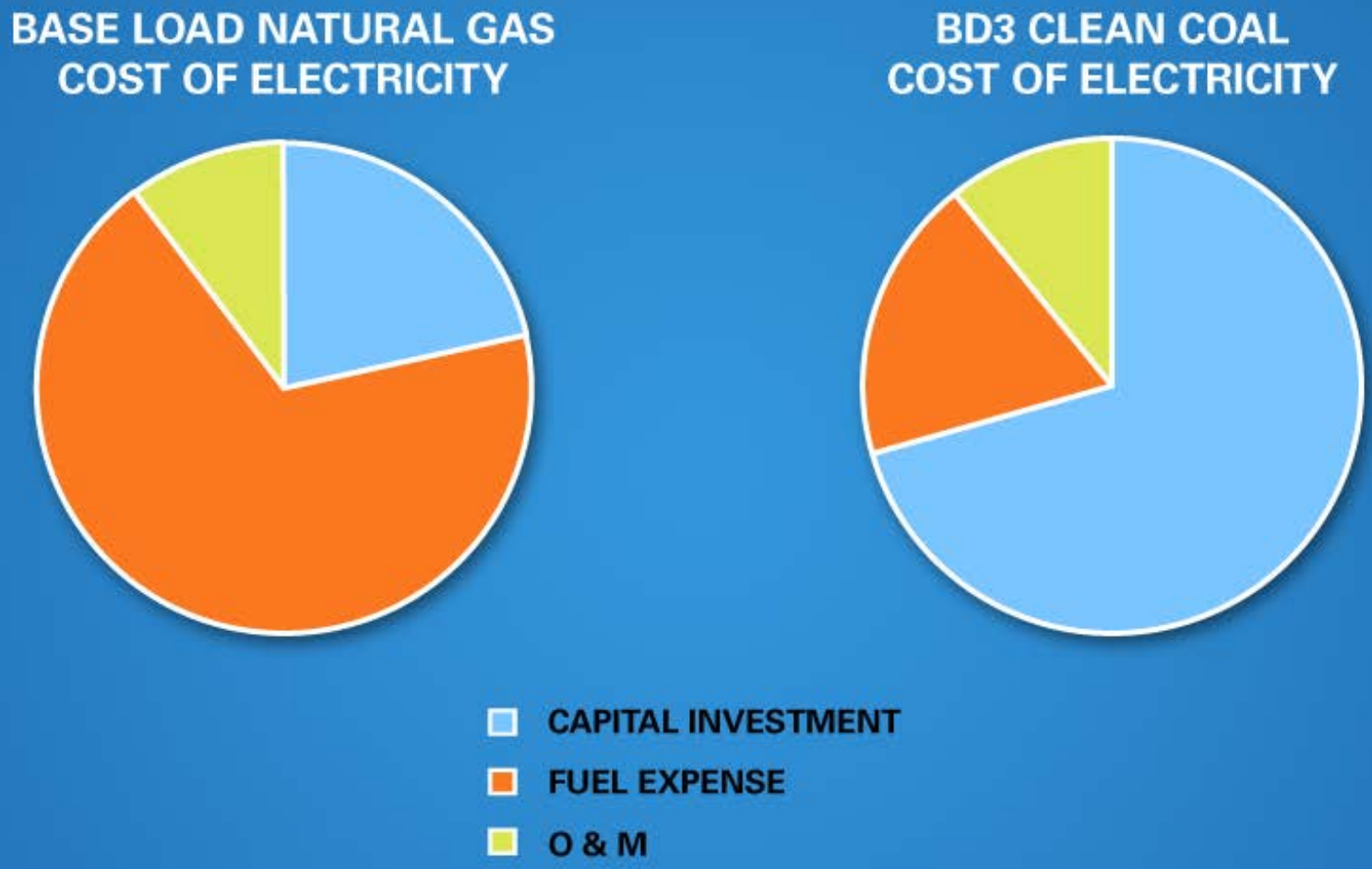
SaskPower Energy Mix



Economic Feasibility

- A first project of its kind is usually the most expensive
- Cost of **$1.24 billion** for net **110 MW**
  - $240 million provided by the Federal Government
- Feasibility defined as at least meeting the costs of a natural gas plant (combined cycle)

Comparing Costs



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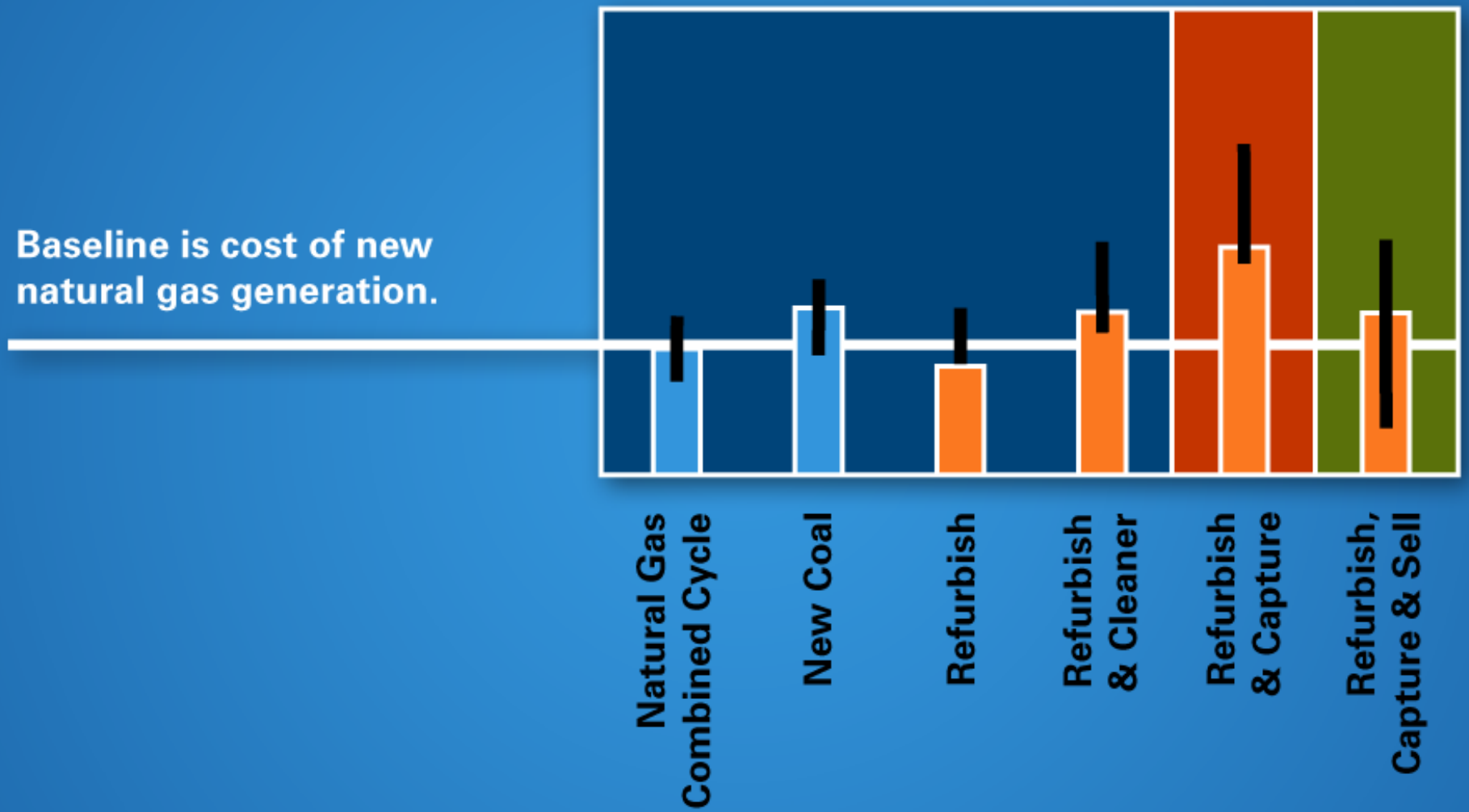
BD3 Error Bar Disappears in October



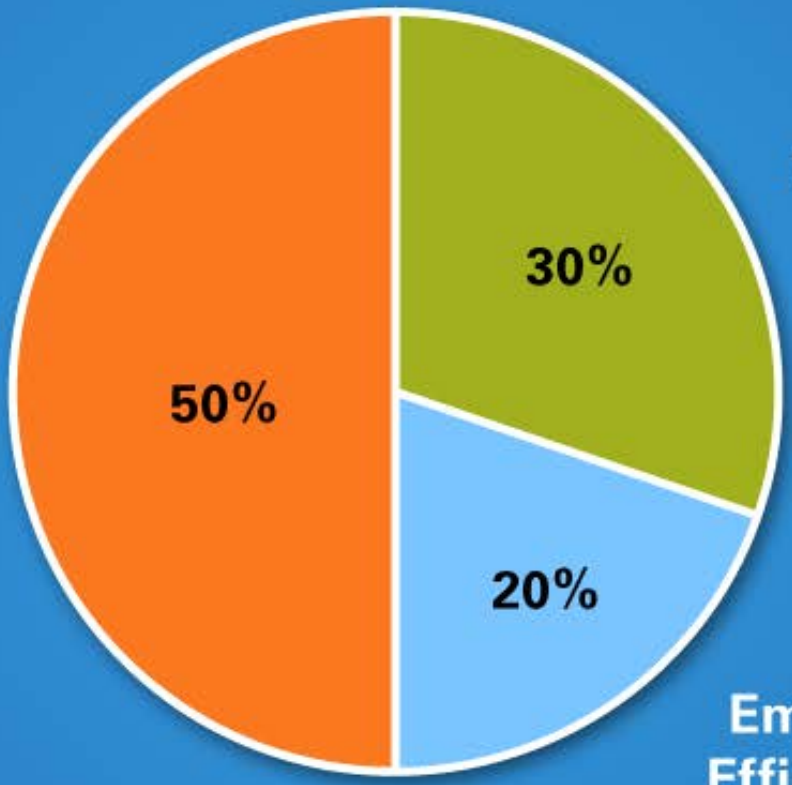
Coal and CCS

According to US Energy Department . . .

- Coal-fired plants with CCS require 24% - 42% more energy to operate [1]
- **Our facility anticipated to be 21%!**

1 Reuters, Nov 27, 2012

Cost Breakdown of $1.24 B



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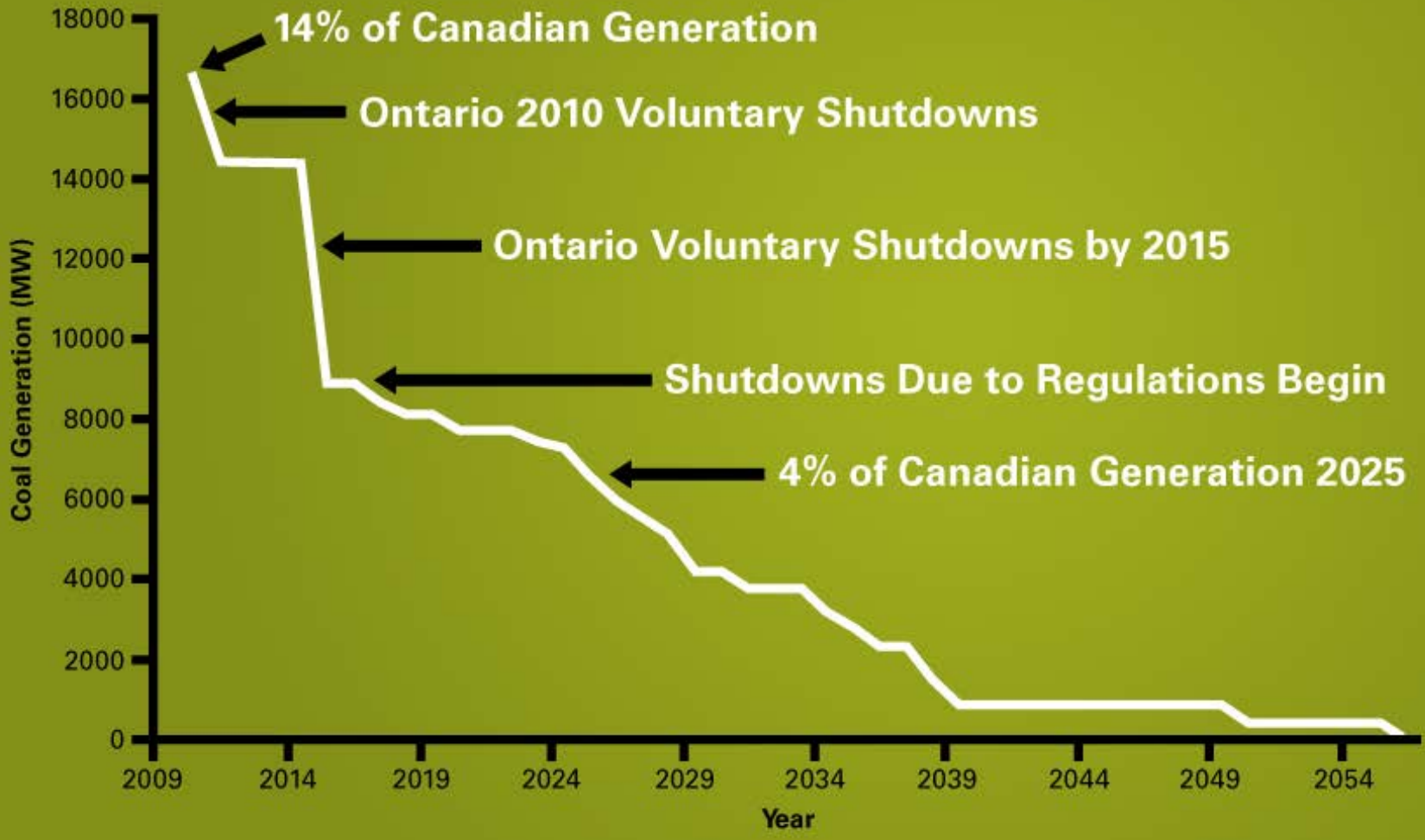
Coal Generation in Canada – Projected Trend without CCS



Canadian Regulations

2012 – Canadian government announced CO_2 regulations

- Limit of 420 tonnes CO_2/GWh (equivalent to natural gas combined cycle)
- Existing units must comply at 50 years of age or shut down
- Effective 2015

- Installed in 1969
- Comprised of 6 units
- Present output 140 MW/s

- Unit 3 emits 1.1 million tonnes CO_2 / year
- Construction of CO_2 and SO_2 capture facility underway
- Refurbished Unit #3 operational Q1, 2014

Status Update

- **On time and on budget**
- **BD3 now offline for retrofit**
- Average 450 to 900 workers
- 1,100 person-years of work
- **Approximately 60% complete**
- Reclaimer
  - 496,400 pounds
  - 81 feet tall
  - 24 feet diameter

Deliverables

1. **Life Extension**
   - Rebuild for 30 more years of operation
2. **Meet New Standards**
   - Reduce green house gas emissions
   - Prepare for new regulations
3. **Competitive Cost**
   - At or below combined cycle natural gas
4. **In-Service Q1 2014**
   - 60% complete

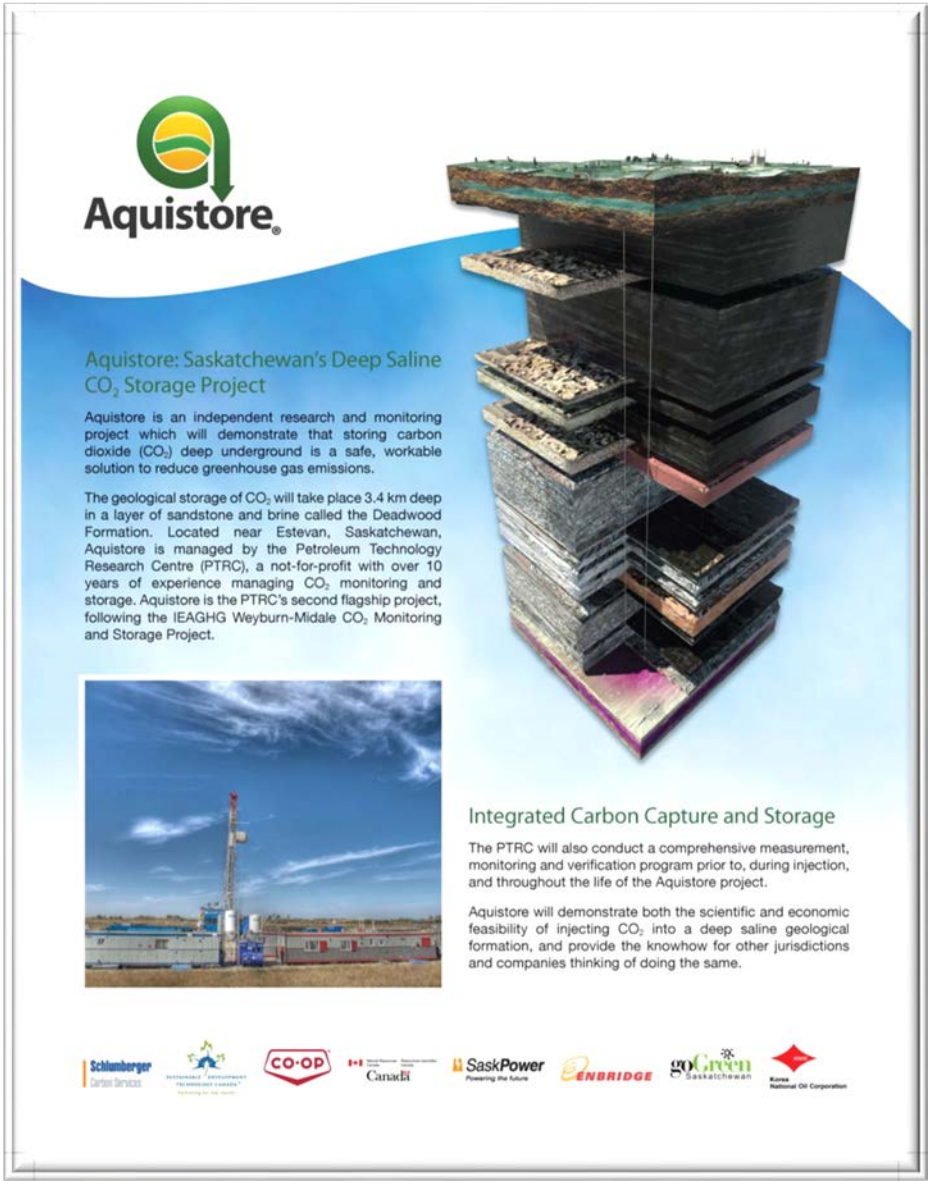
Environment Impacts

1. To keep temperature from rising 2°C by 2050, emissions must drop to 80% of 2000*
2. SaskPower's CCS facility will capture 90% of emissions (1 million tonnes of CO_2)
3. Equivalent to taking 250,000 cars off the road each year

**Source: UN's InterGovernmental Panel on Climate Change*

Virtual Tour of Boundary Dam

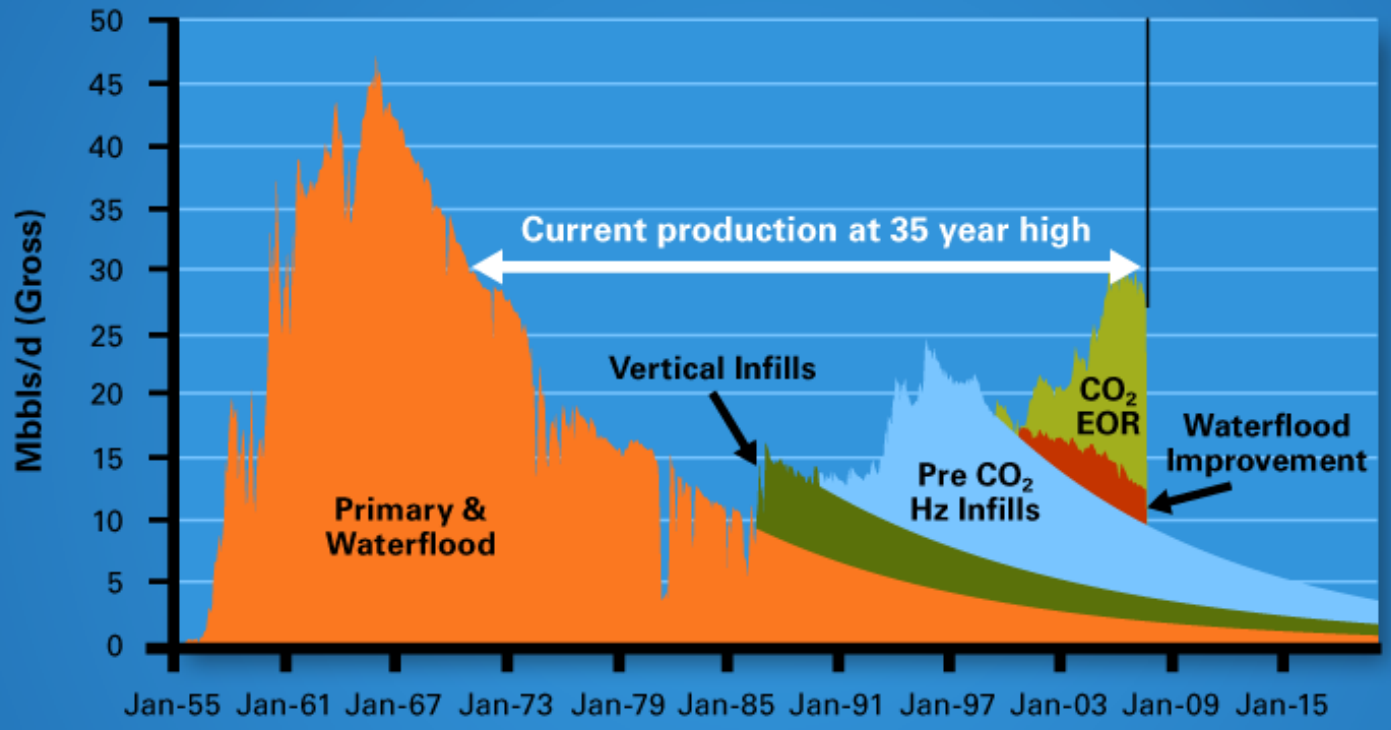
Storage



- Storage is a key part of CCS
- Aquistore is an independent research and monitoring project managed by the Petroleum Technology Research Centre
- Pipeline to site less than 2 km west of the Boundary Dam Power Station.
- BD3 will transport some captured CO_2 to Aquistore for testing
- Petroleum Technology Research Centre will monitor the CO_2

Enhanced Oil Recovery

- Around 30,000 bbl/day: a 35-year high
- 20,000 bbl/d are due to the CO_2 flood



CO_2 stored equivalent to removing more than 8 million cars off the road for a year

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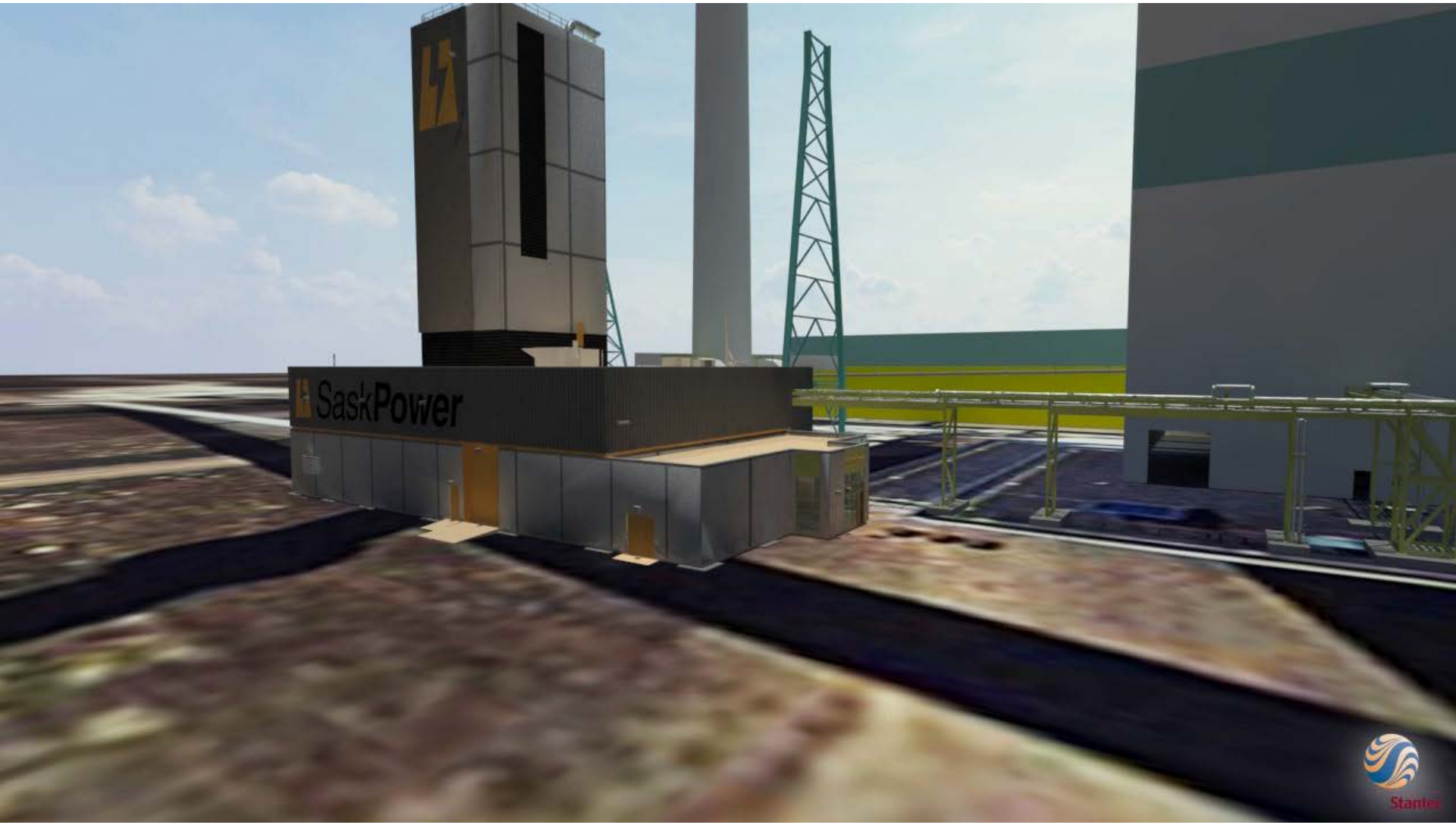
Carbon Capture Test Facility

- Located at SaskPower's 276-MW coal-fired Shand Power Station
- Neutral platform for vendors to verify and improve post-combustion technologies in commercial setting
- Primary test unit CO_2 capture capacity of 120 tonnes per day
- Hitachi Ltd.'s proprietary amine technology will be the first tested

Virtual Tour of Test Facility



Centre of Innovation

- SaskPower Boundary Dam Integrated Carbon Capture and Storage Demonstration Project
- SaskPower Carbon Capture Test Facility
- International Energy Agency GHG Weyburn-Midale CO_2 Monitoring & Storage Project
- Aquistore Deep Saline CO_2 Storage Project
- Petroleum Technology Research Centre (PTRC)
- International Performance Assessment Centre for Geological Storage of CO_2
- International Test Centre for CO_2 Capture

Bringing Boundary Dam to the World

A. The future of CCS

B. What SaskPower is doing

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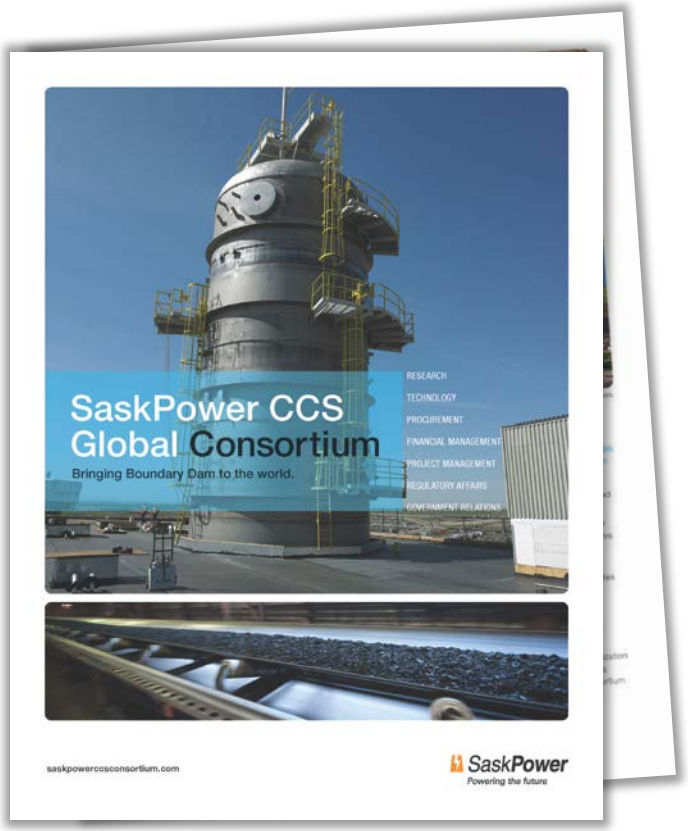
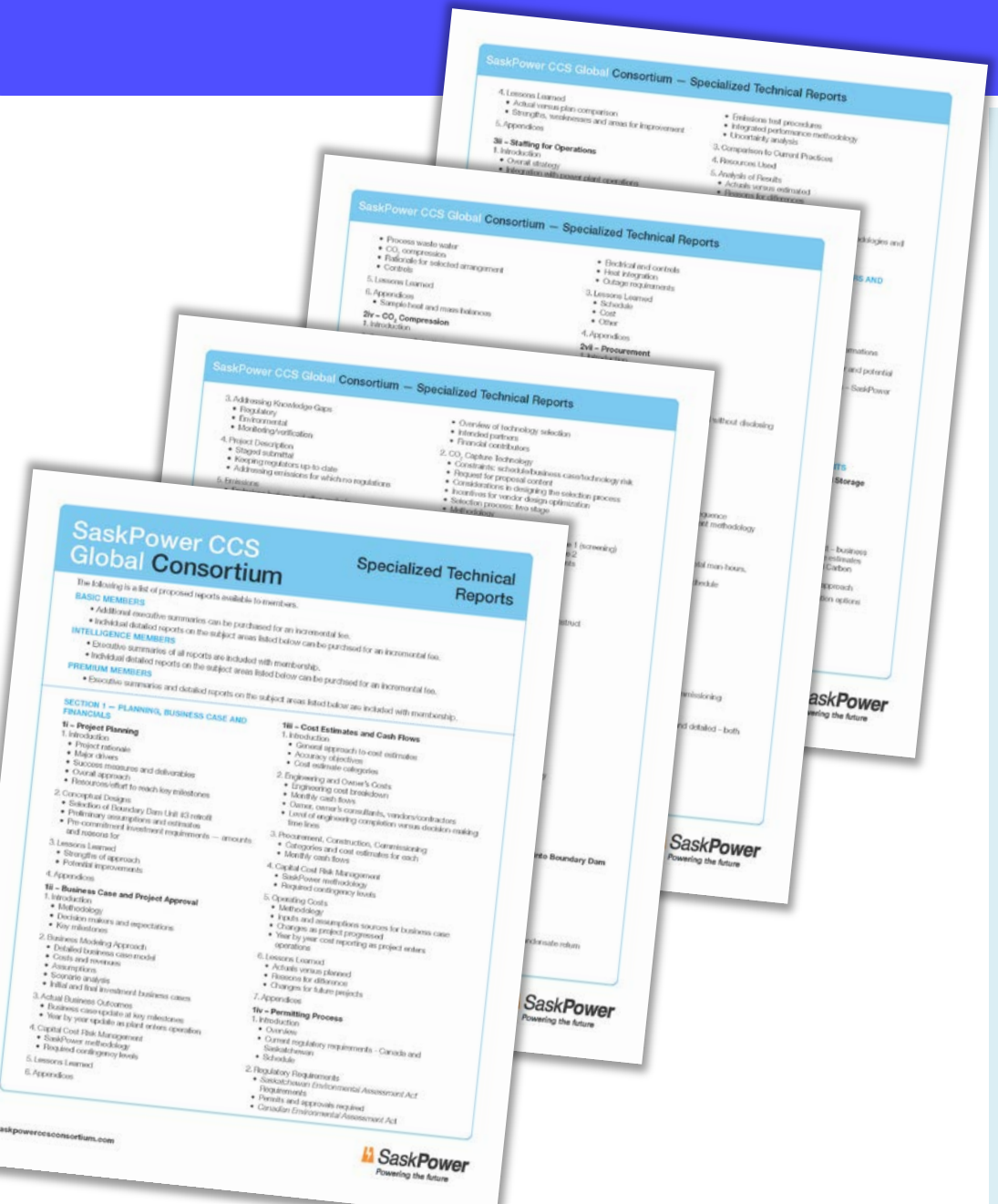
SaskPower CCS Global Consortium



- Knowledge platform
- Participants gain access to CCS expertise in:
  - Technology
  - Research
  - Procurement
  - Supplier management
  - Project management
  - Training
  - Regulatory affairs
  - Government relations

Why You Would Join



Cost of Project | $1.2 Billion

- design
- engineering
- construction
- project management

Performance Data

- parasitic load
- cost of electricity
- cost to operate
- revenues from by-products
- operations and maintenance
- projected cost for future builds

SaskPower CCS Global Consortium

Variety of membership options

- **Basic**
- **Intelligence**
- **Premium**

Variety of Membership benefits

- Monthly project reporting
- Annual technical symposiums
- Access to executive summaries and detailed reporting via secure website
- Participation in technical discussion forums
- Participation in forums on other collaborative projects such as the Carbon Capture Test Facility and Aquistore Project
- Annual non-technical presentation to CEOs and Executives
- Best Practices Manual

Info & Planning Symposium

- May 21 – 23
  - Conference
  - Banquet
  - Tour of Boundary Dam, Aquistore
- Areas of Knowledge
  - Find out what knowledge you can access
  - Inform which areas you're interested in
- Interested . . .
  - If you'd like to attend, visit our website and submit a formal expression of interest
  - www.saskpowerCCSconsortium.com

More Information

www.saskpowerccsconsortium.com

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