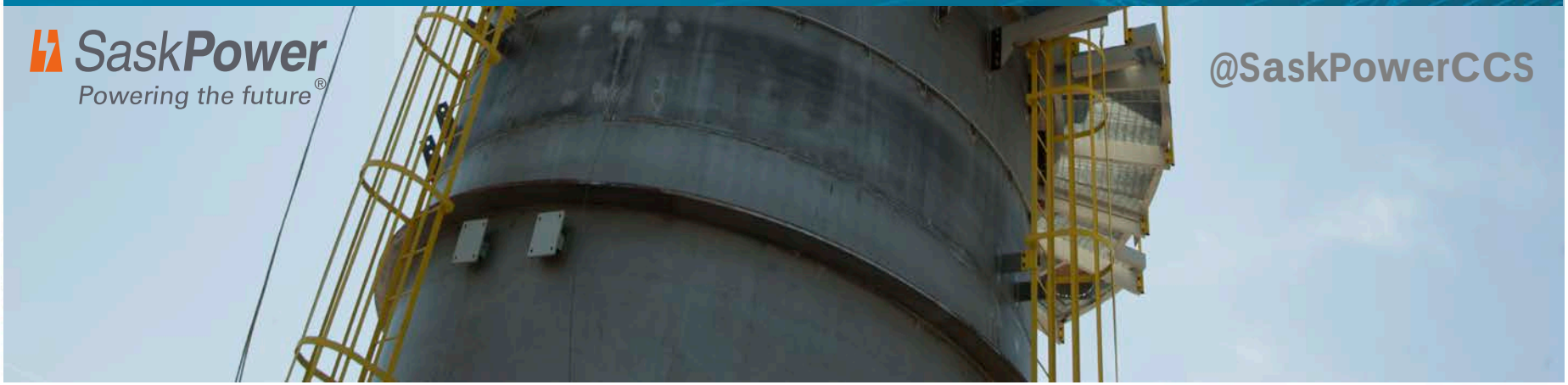
SASKPOWER CCS

BOUNDARY DAM CCS PROJECT



SaskPower
Powering the future®

@SaskPowerCCS

FUTURE IS HERE VIDEO GOES HERE

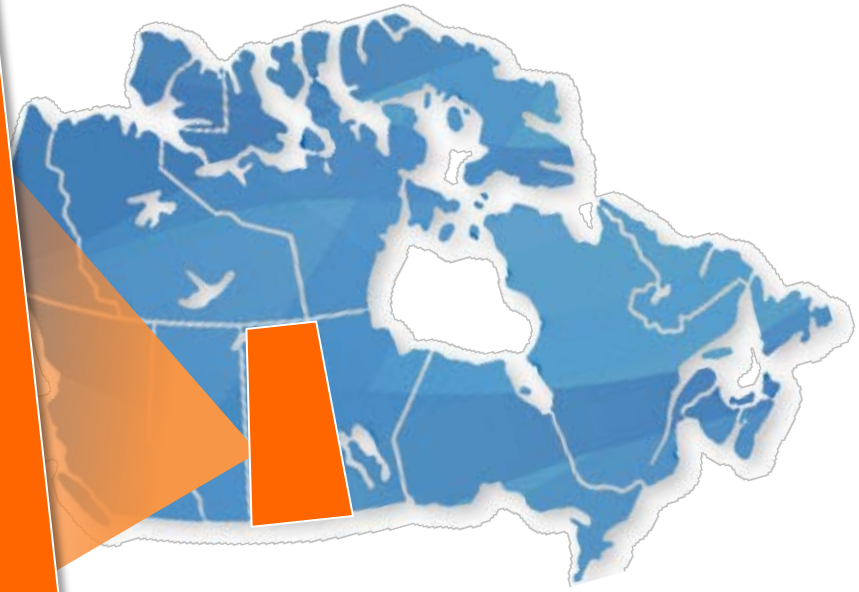

SASKATCHEWAN'S PRINCIPLE
POWER PROVIDER

SASKPOWER'S ENERGY MIX

511,000
CUSTOMERS

151,000 KM OF
TRANSMISSION LINE

4,181 MW AVAILABLE
GENERATING CAPACITY



SASKATCHEWAN, CANADA
EPICENTRE OF CCS EXPERTISE

5. Weyburn-Midale Project

4. Amine Chemical Laboratory

1. The Boundary Dam CCS Project

2. Carbon Storage and Research Centre (Aquistore)

3. Carbon Capture Test Facility (CCTF)

BOUNDARY DAM

CCS PROJECT

SASKPOWER DECISION FACTORS

- SaskPower: Crown Corporation – obligation is to customers
- Lowest electricity costs over long term while meeting high standards for reliability, environmental performance and affordability
- Conventional coal no longer an option
- Diverse power generation fleet has been a proven strength
- External economic considerations

FIRST OF A KIND BUSINESS CASE

- **Unique project characteristics**
  - High capital cost
  - Government financial support
  - Non-electricity revenue
  - Additional engineering/hardware to minimize new technology risk
  - Older unit requiring SOx/NOx emissions control
- **Baseload generation – cost competitive alternative was Natural Gas Combined Cycle**
- **Significant economic benefits outside of SaskPower**

CCS FACILITY

CO_2 AND SO_2 ABSORBERS

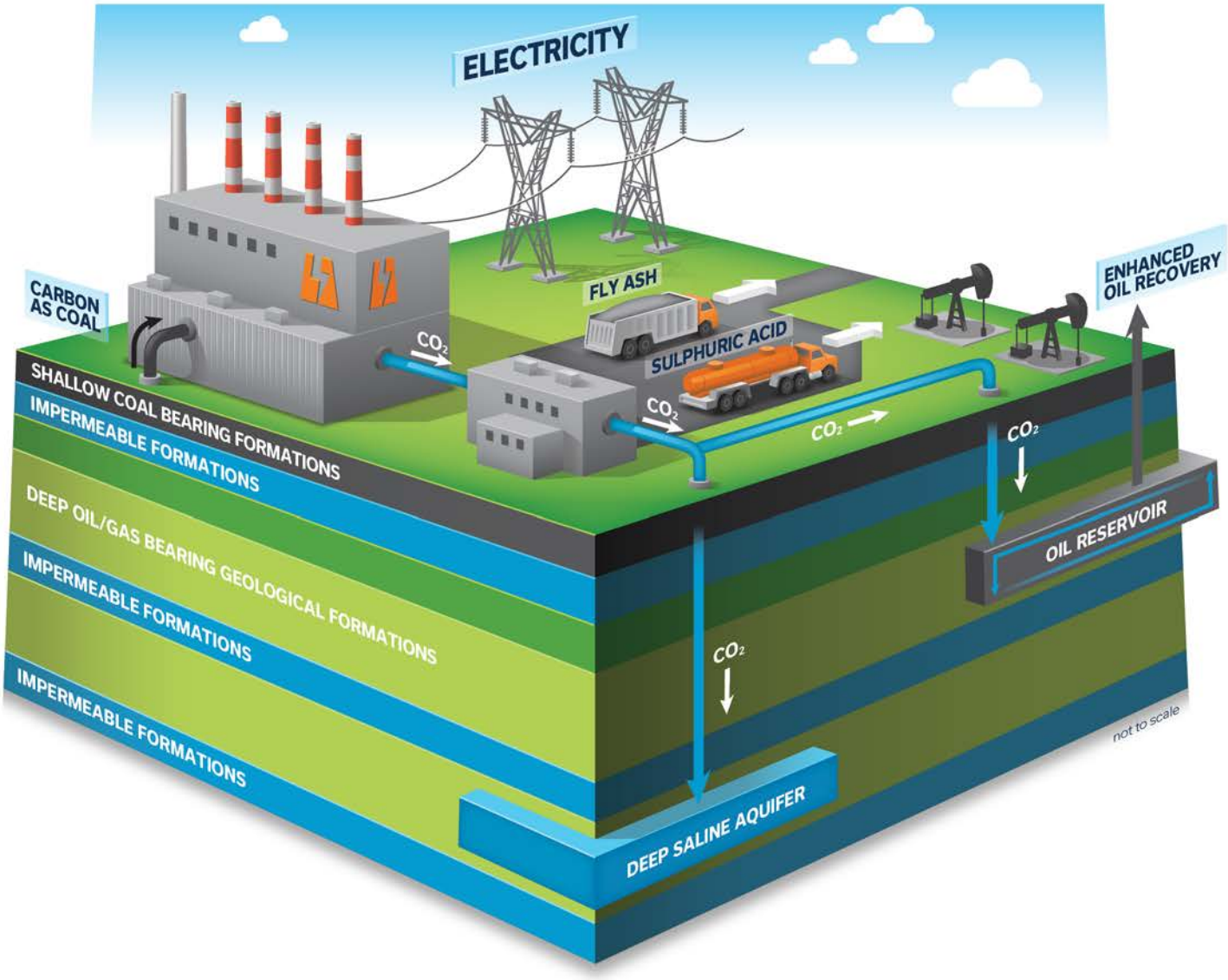
CO_2 STRIPPER


SO_2 STRIPPER

ACID PLANT

CO_2 PIPELINE

BUSINESS CASE AT A GLANCE




REGULATIONS

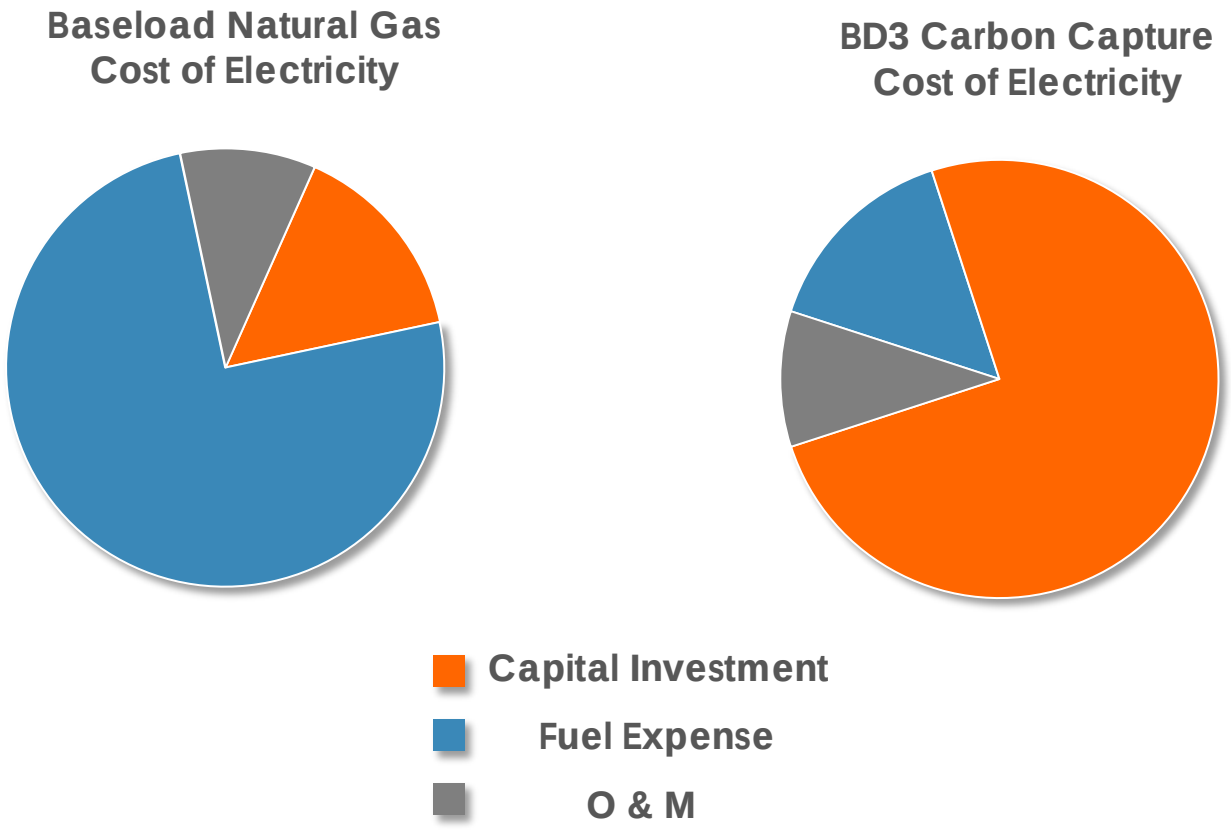
WHY IS CCS IMPORTANT TO SASKPOWER?

- Deliver affordable electricity
- Sustainability
  - Refurbishing aging Infrastructure
  - Environmental obligations
- Portfolio diversification
- Unpredictable natural gas prices

ENVIRONMENTAL OBJECTIVES

Performance	Pre-CCS	Post-CCS	Change
CO_2	1,139K	112K	90%
SO_2	7K	0	100%
NO	2.4K	1.05K	56%
PM10	190	15	92%
PM2.5	65	7	70%

COMPARING COSTS



THE EQUIVALENT OF:

TAKING ALL THE CARS OFF THE ROAD IN REGINA, SK (POP. 220K)

+ CAPTURING ALL CO_2 FROM HEATING/COOLING OF EVERY HOME

+ KEEPING THE LIGHTS ON IN HALF OF THE CITY.

400,000 TONNES

OF CO_2 CAPTURED SINCE START-UP – OCT 1, 2014

CAPABLE OF 90% CO_2 CAPTURE

AT FULL EFFICIENCY

120 MWh NET TO GRID

ESTIMATED 110 MWh

99.9%

CO_2 PURITY WE'RE EXPERIENCING

COSTS TO DATE

OVERALL PROJECT TOTAL……..……...$1,467M
CANADIAN FEDERAL GOVERNMENT PAID AMOUNT…….……..$239.6M
NEST COST TO SASKPOWER……..……...$1,227M

*Approx. an 18% increase

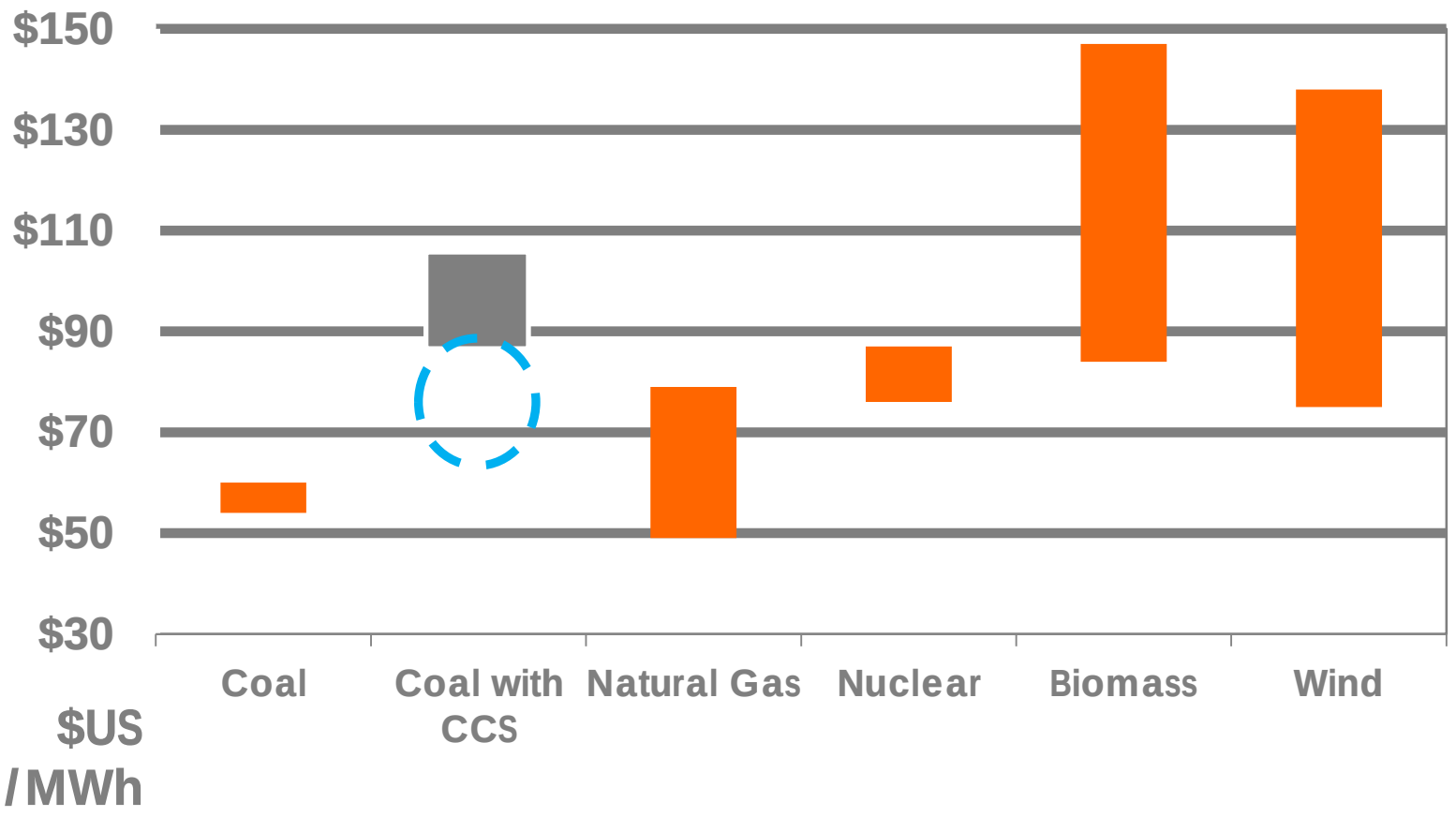
CCS FACILITY CONSTRUCTION COSTS
$905M

POWER PLANT REFURBISHMENT
$562M

***Most of cost increase was in power plant rebuild**
IE: "Brown field" work

As with any major infrastructure project, we are still finalizing outstanding financial arrangements with some vendors.

GENERATION COSTS



Data Source: 2010 Electrical Power Research Institute, Program on Technology Innovation: *Integrated Generation Technology Options*

MANAGING THE DETAILS

- Construction Management
- Change Management
- Safety Management
- Risk Management
- Permitting
- Knowledge Building
- Onboarding and Training
- Unfamiliar Processes and Equipment
- Transition to Operation

THE LEARNINGS

BE FOCUSED

Priority #1

Stable, Cost-effective Power Supply

Priority #2

Carbon Capture and By-Products

BE BOLD

Choose a technology sufficiently close to commercial viability to be successful

BE ENERGIZED BY CHALLENGES

The team navigated many changes such as equipment choices, corporate policy changes, construction hurdles, third-party review

BE COMMITTED

Overworked but determined
to deliver as promised

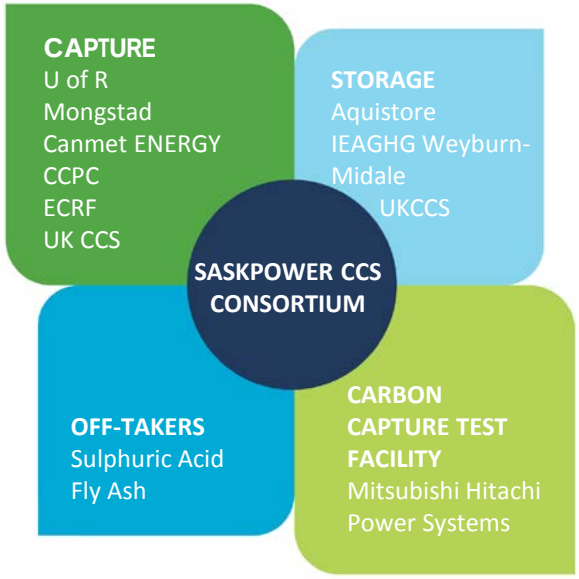
BE SAFE

During the 4.5 million person hours of construction time there were no lost-time injuries


DELIVERED AS PROMISED

COLLABORATION

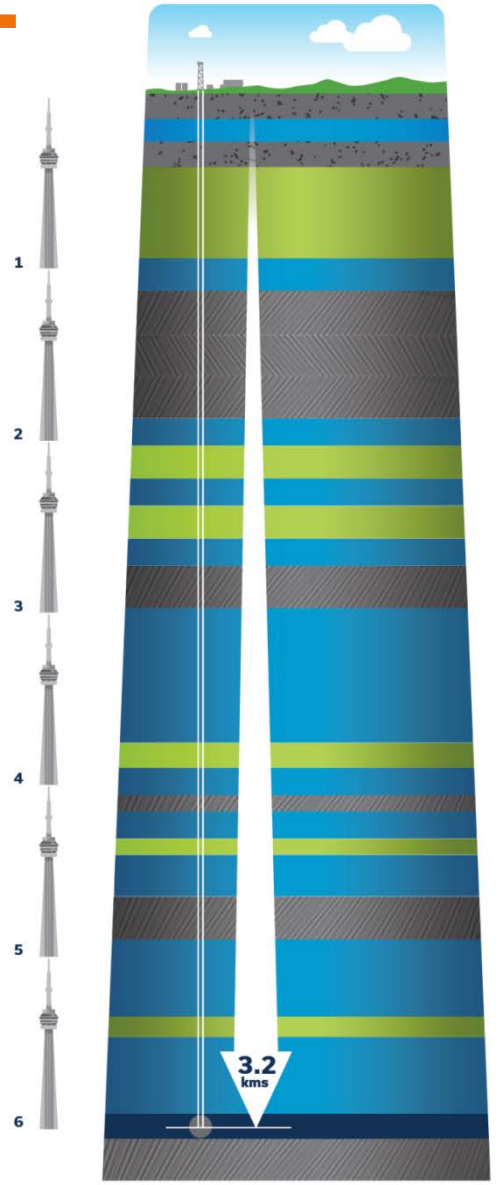
- The key to SaskPower's success – past, present and future
- The way <u>you</u> can learn from SaskPower




AQUISTORE

GEOLOGICAL STORAGE

- Pure CO_2 storage with SaskPower's Carbon Storage and Research Centre's host project, Aquistore.
- Independent monitoring project that identifies feasibility of injecting CO_2 into a deep saline reservoir in an effort to reduce GHG emissions.
- Aquistore will receive approximately 350,000 tonnes of CO_2 over its life. Storage is regulated by the Ministry of Environment.
- Will be measured, monitored, verified and audited.
- Saskatchewan has experience with storage due to the Weyburn Midale project. Approximately 25 million tonnes of CO_2 stored and monitored.



Deep Saline Aquifer Storage

CARBON CAPTURE
TEST FACILITY


bhpbilliton
PARTNERSHIP

BOUNDARY DAM
UNITS 4 & 5

OPPORTUNITIES FOR FUTURE PROJECTS

Unit	Initial Investment	Final Investment	In Service
BD 4/5	2016	**2019***	**2025***
BD 6	2022	2024	**2028***
PR 1	2024	2026	**2030***
PR 2	2026	2026	**2030***
Shand 1	2037	2039	**2043***
New Build	New costs more than rebuild today		

*** Fixed by regulation**

OPPORTUNITIES FOR FUTURE PROJECTS

- Federal government requirements set the schedule for unit retirement or CCS retrofit
- Over capture not necessary – hit 420 mark
- Must be competitive with natural gas and wind
- Still depends upon enhanced oil recovery (EOR) market – diversified customer base likely needed

OPPORTUNITIES FOR FUTURE PROJECTS

- **Configurations under consideration, reflect upon savings from….**
  - Two generating units or one for capture
  - Equivalence needed by larger units

- **Capital cost reduction Initiatives**
  - Capture at 420; not 140 kg/MWh
  - Economies of scale
  - Lower integration costs – risks known
  - Numerous BD3 technical learnings
  - Increased modularization

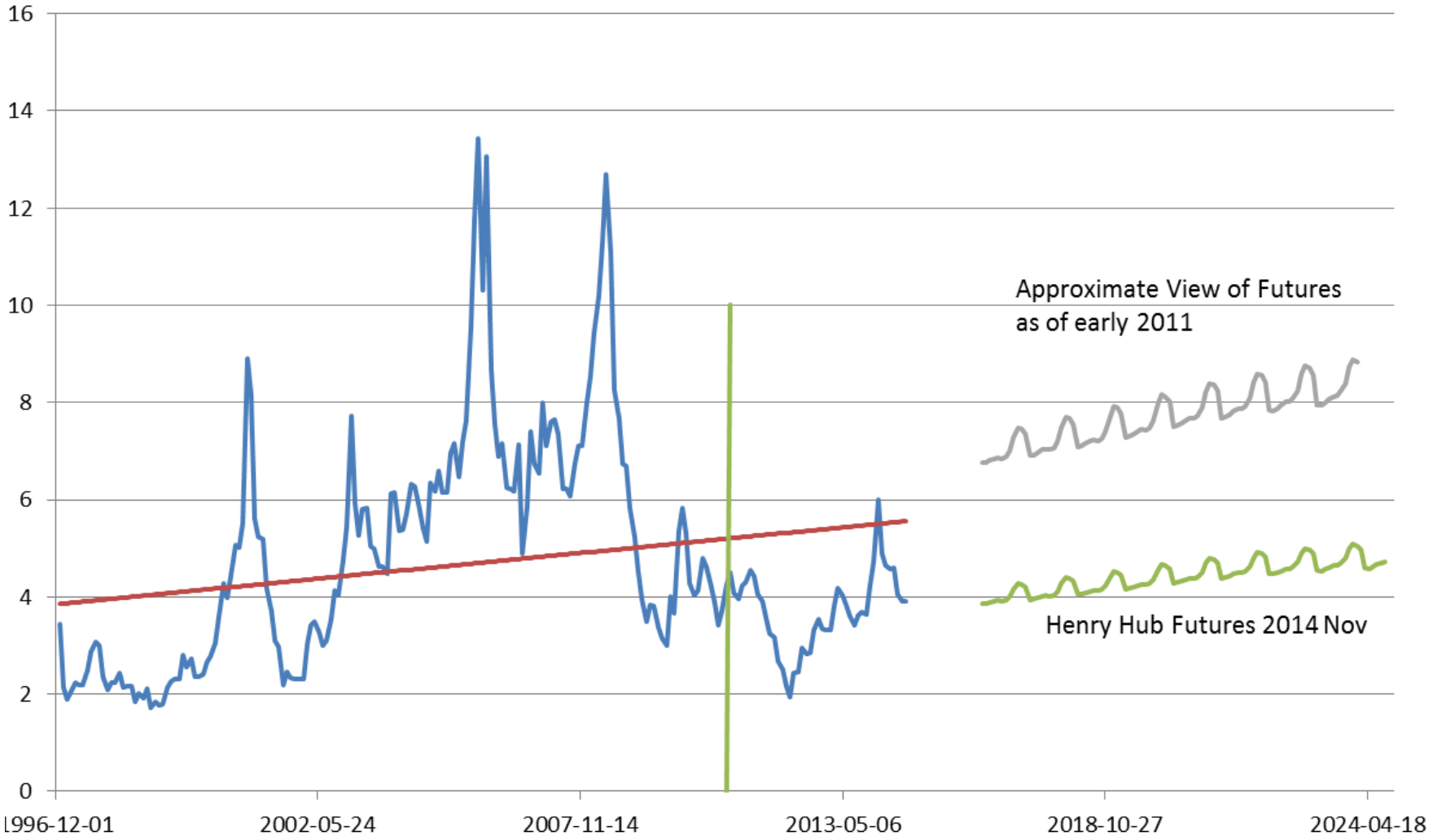
- **Avoid natural gas price volatility**

MUST BE COST COMPETITIVE WITH ACCEPTABLE ALTERNATIVES

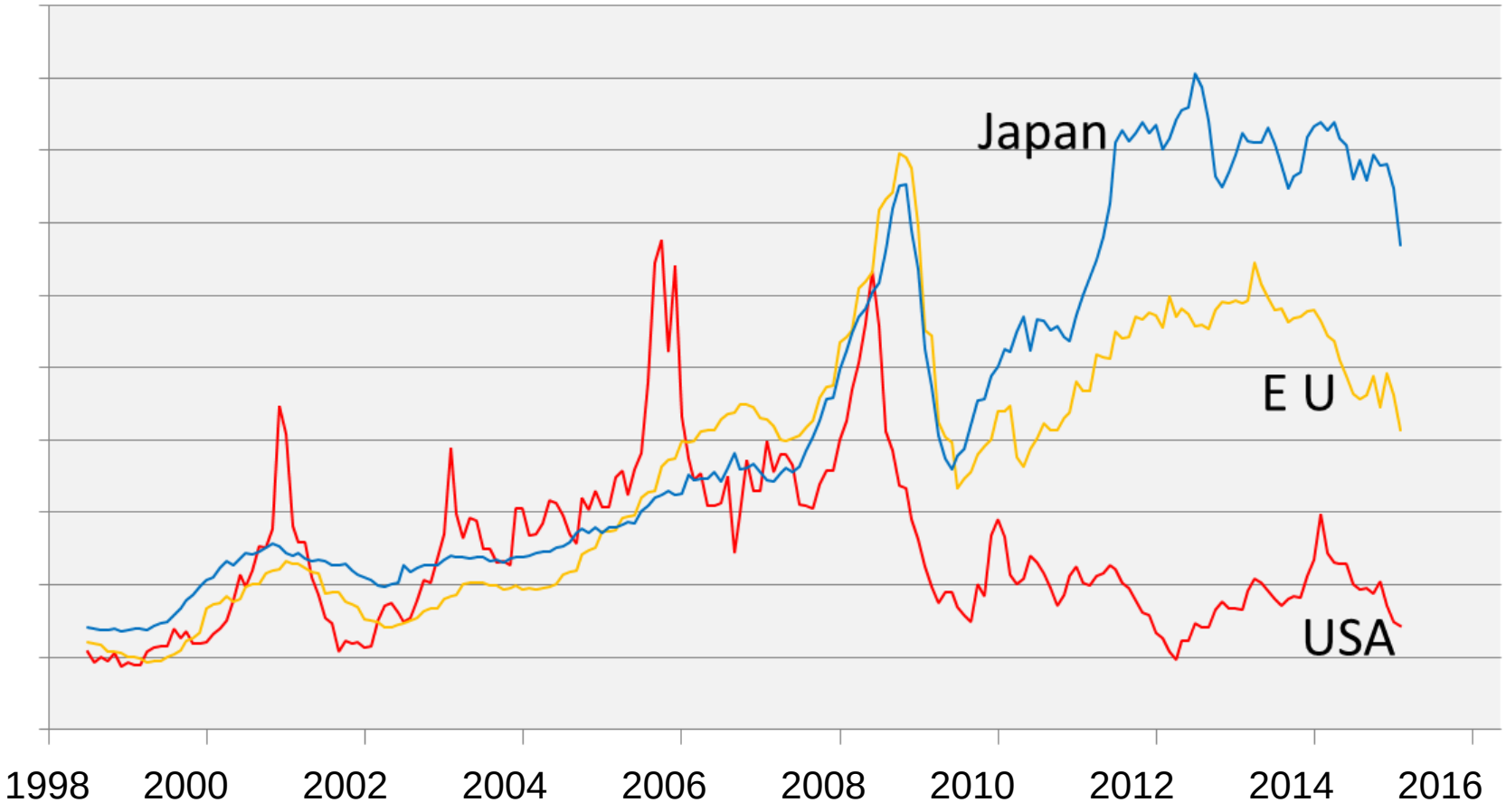





NATURAL GAS PRICES



SAMPLE GLOBAL NATURAL GAS PRICES



OPPORTUNITIES FOR FUTURE PROJECTS REGULATORY EQUIVALENCY

- Federal-Provincial discussions on coal fired CO2 equivalency
- Requirement to eliminate coal fired CO2 emissions would be unchanged, however could allow for capture from alternative units if meets same overall requirement
- Could allow SaskPower to capture from one 300 MW unit rather than BD4/5
- Significant savings in power plant refurbishment costs

BD3 CCS ECONOMICS

INFLUENTIAL VISITORS

30 COUNTRIES AND COUNTING

VISITORS HAVE TRAVELLED FROM MORE THAN 30 COUNTRIES TO SEE WHAT WE'VE DONE. AS THE WORLD COMES WITH QUESTIONS, WE'LL HAVE THE ANSWERS.

WHAT THE WORLD IS SAYING

"Boundary Dam is one of 10 Energy Breakthroughs in 2014 That Could Change Your Life."
WENDY KOCH, NATIONAL GEOGRAPHIC

"CCS on coal-fired power plants provide us the largest opportunity for application, and Boundary Dam shows how it can be done. Unless we do CCS, we're never going to meet long-term climate change goals. This project provides us an opportunity to learn how we can directly apply CCS in China."
ASHOK BHARGAVA, ASIAN DEVELOPMENT BANK (ADB)

"The level of fossil fuel consumption in the world is going to stay with us all the way through 2050. If we want to take the emissions out, we must have CCS in our armory in order to achieve that objective."
DR. GRAEME SWEENEY, ZERO EMISSION FOSSIL FUELS POWER PLANTS (ZEP)

"As long as fossil fuels and carbon-intensive industries play dominant roles in our economies, carbon capture and storage (CCS) will remain a critical greenhouse gas reduction solution."
MARIA VAN DER HOEVEN, INTERNATIONAL ENERGY AGENCY (IEA)

WHAT THE WORLD IS SAYING VIDEO HERE

COMING SOON


TOURS

TAKE THE VIRTUAL TOUR

www.SaskPowerCCS.com/Tour

SASKPOWER CCS

CCS Session

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