



# COMMERCIAL CCS OPERATING EXPERIENCE

## CSLF TECHNOLOGY WORKSHOP

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# BOUNDARY DAM CCS PROJECT IS NOW 6 MONTHS OLD!



5,000,000 MHR



Heavy Loads



\$1.467B  
600MM Power plant  
800MM Capture plant  
(On budget!)



81 months instead of 72 months



Up to 120MW vs 110MW



300,000+ tonnes delivered for revenue

# BOUNDARY DAM CCS PROJECT IS NOW 6 MONTHS OLD!

- Some subsystems found to be conservative
- Some subsystems have deficiencies yet to solve: in reliability, capacity, automation or operability
- No “regulatory-reportable” spills
- On track for planned CO<sub>2</sub> recovery rates
- Some equipment issues to be resolved

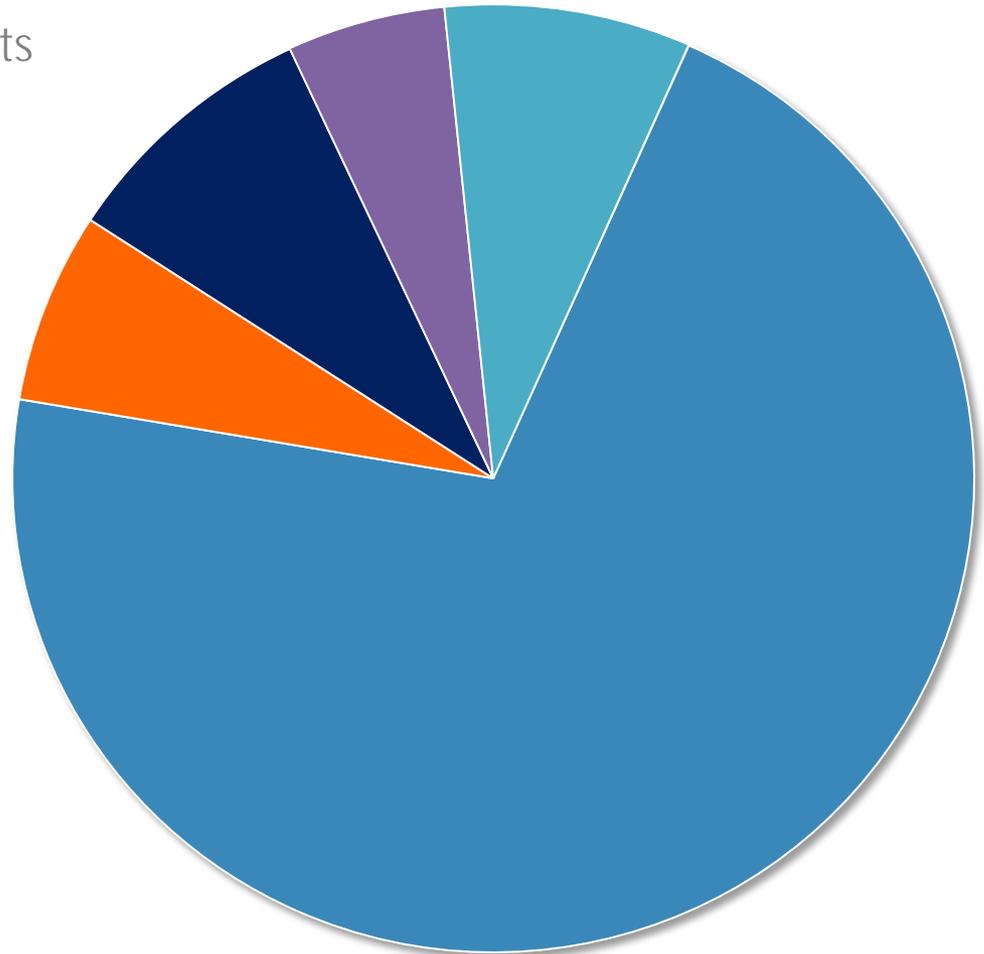


# OPTIMIZING PERFORMANCE

Viability requires minimizing . . .

- thermal energy requirements
- parasitic electrical load

- Power to Grid (120 MW)
- Existing parasitic load (11 MW)
- Compression (15 MW)
- Capture CO<sub>2</sub>, SO<sub>2</sub> (9 MW)
- Amine & heat regeneration (14 MW)





EXCEEDING  
EXPECTATIONS

# EXCEEDING EXPECTATIONS

Performance Metric	Expected (pre-launch)	Actual (post-launch)
MWs	110	120
CO <sub>2</sub> Purity	95.5%	99.9%
CO <sub>2</sub> Capture/Year	1 Million Tonnes	1 Million Tonnes
CO <sub>2</sub> Emission/Year	1 Million Tonnes	100,000 Tonnes





Absorber Towers



CO2 Stripper



SO2 Stripper



Acid Plant



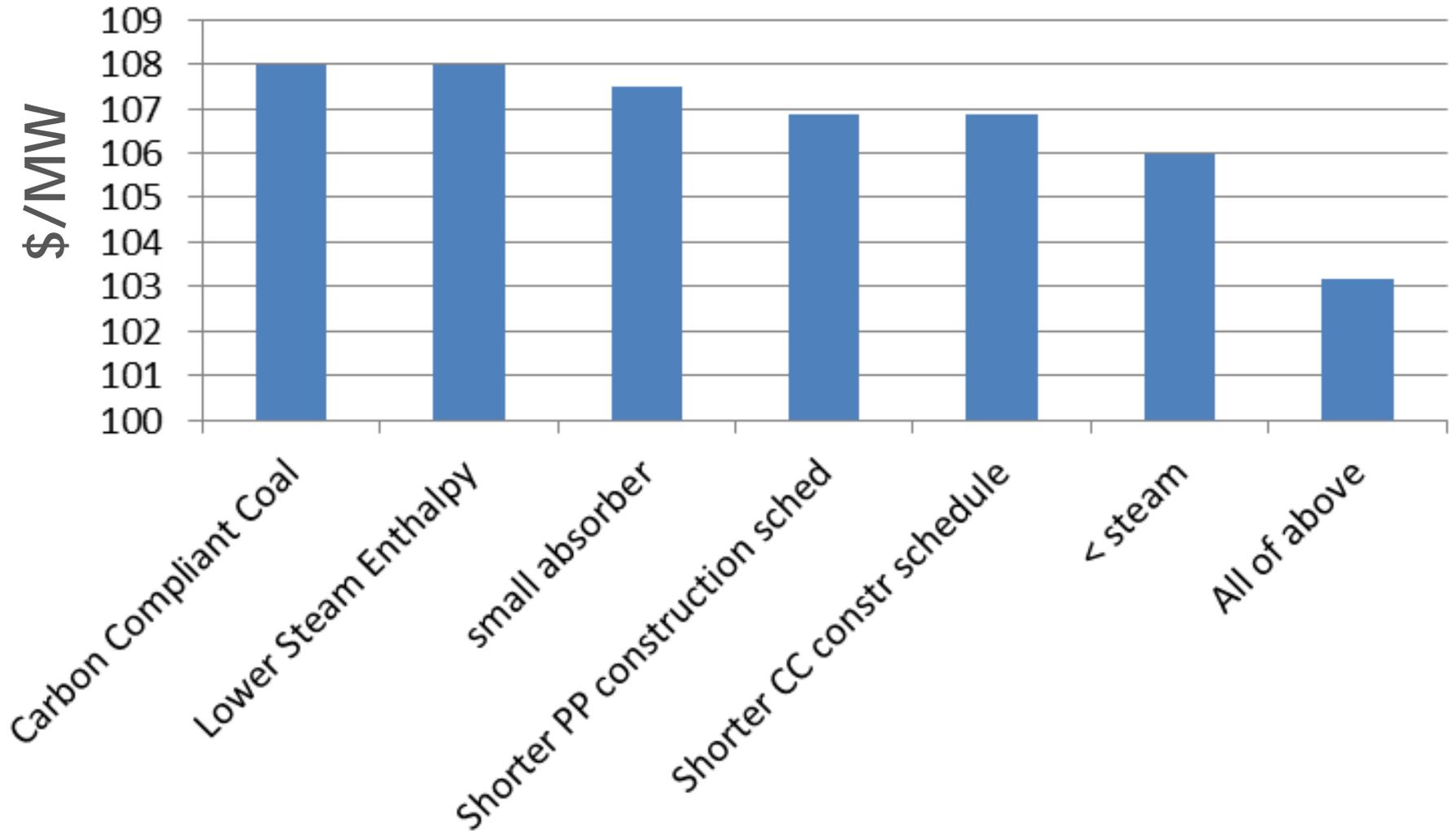
CO2 Pipeline

# CHALLENGES ENCOUNTERED AND MANAGED

(Every Significant Project Has Challenges)

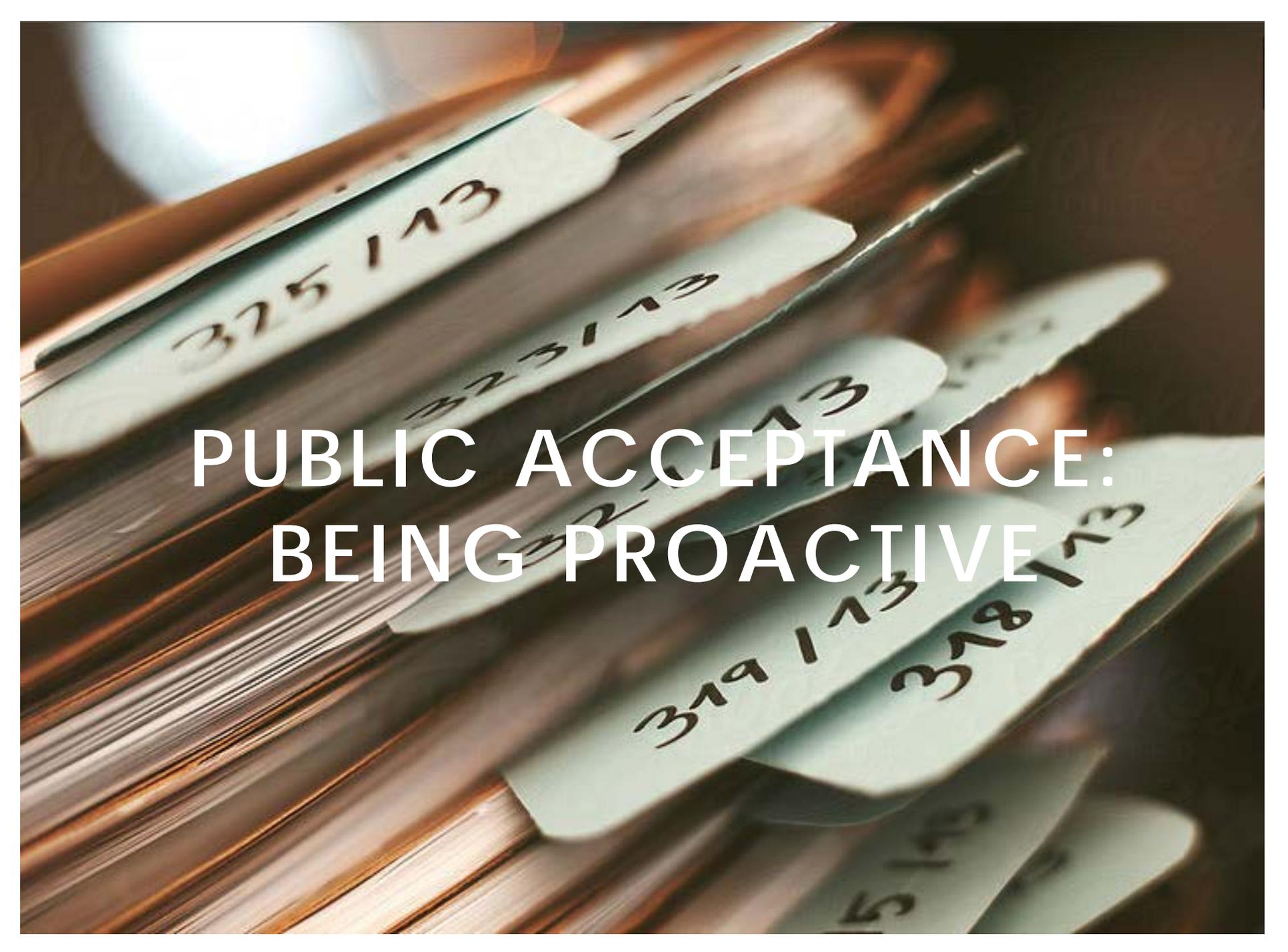
- Focused engineering vs. exploration of all avenues
  - Focus delivering to the business case
- Procurement Strategies
  - Value - transparency - timeliness
- Construction Productivity
- Management of IP
  - Maintaining proprietary process (commercial) information while objectively sharing critical knowledge with stakeholders
  - Trust
- HSE concerns
  - Many Initial unknowns – most resolved
  - Ongoing Refinements
  - No Insurmountable issues

# ECONOMIC EFFECT OF "PERFECT INVENTIONS"



# WHAT DO YOU NEED FOR CCS TO SUCCEED?

1. PEOPLE NEED TO SEE THAT IT WORKS
2. MUST HAVE SOCIAL ACCEPTANCE
3. MUST BE COST-COMPETITIVE WITH OTHER  
ACCEPTABLE ENERGY FORMS



PUBLIC ACCEPTANCE:  
BEING PROACTIVE

# MUST HAVE SOCIAL ACCEPTANCE

## GLOBAL ASSESSMENT

### 2008

- 10 or 20 pilot plants globally
- Large financial incentives for development:
  - Canada
  - USA
  - EU
  - Australia
  - UK
  - Germany
  - Spain
  - Norway

### 2015

- Number of pilot plants roughly unchanged (+/- in various regions)
- Kemper County under construction
- Petra Nova announced
- Capture from fertilizer and gas processing
- China/US accord
- Future Gen 2.0 and other flagship projects shut down
- Loss of public confidence in some regions

### 2020

- Now have years of operating data
- Areas of confidence?
- Areas of weakness?
- Critical mass?

# UNDERSTANDING THE BARRIERS

What are the social barriers to CCS?

- Perception of cost
  - Capital cost
  - Social cost
  - Lifecycle cost
- Perception of health risk
- Perception of Environmental risk
- Preference for alternate solutions

Updated and robust socioeconomic assessments needed

# MUST BE COST-COMPETITIVE WITH ACCEPTABLE ALTERNATIVES



# CAN WE CLOSE THE GAP?

- Technical improvements
- Business case improvements
  - Economies of scale and replication
  - Better certainty in design and performance
  - Reduced financial, business and execution risk
  - Equivalent tax treatment

# WILL THE GAP CLOSE ITSELF?

- Gas price increase
- Emissions regulations for gas

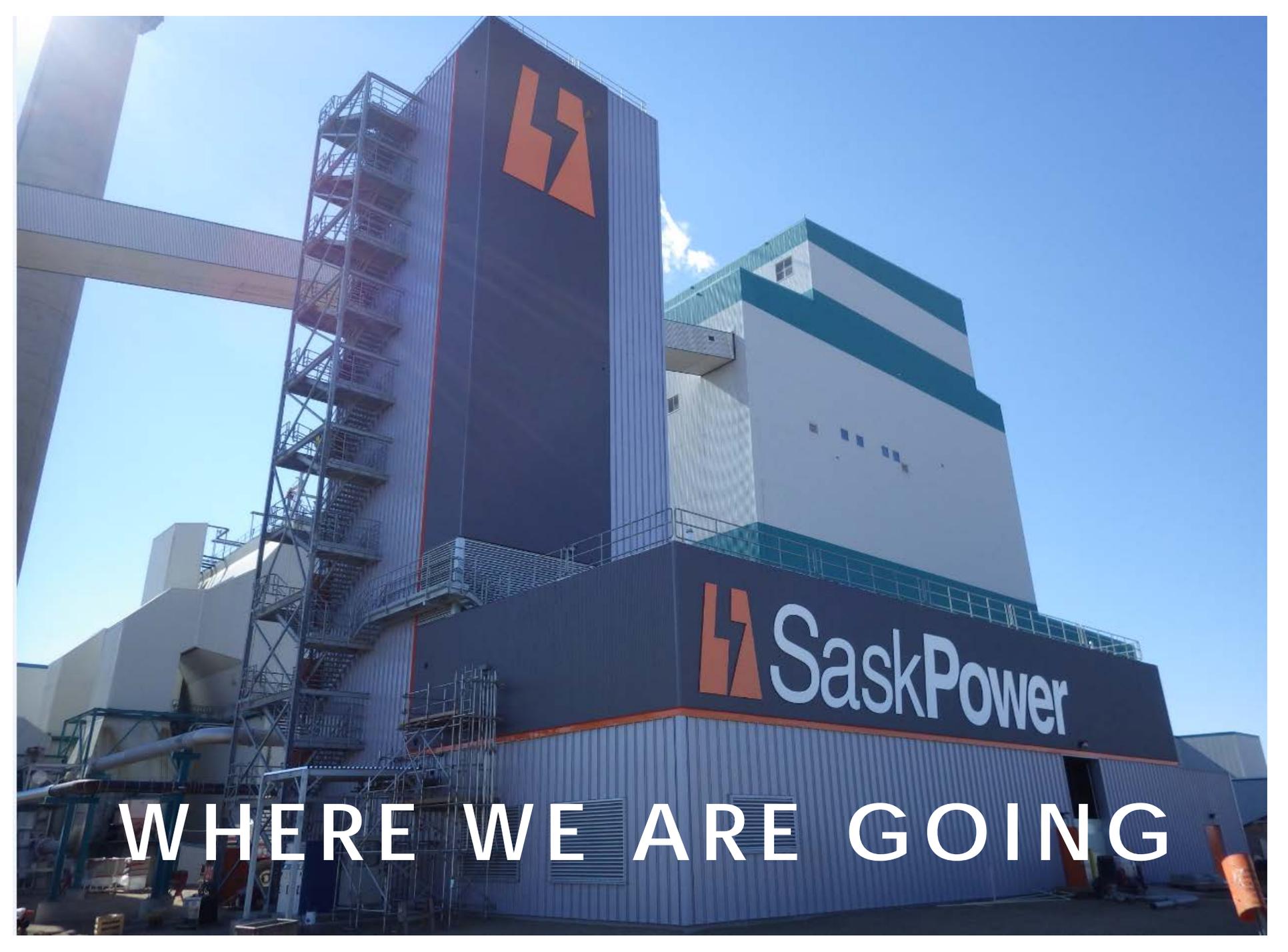
# THE FUTURE OF CCS AT SASKPOWER

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



POSSIBLE FUTURE OF CCS AT SASKPOWER  
BOUNDARY DAM UNITS #4 & 5



 SaskPower

WHERE WE ARE GOING



# SYMPOSIUM

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