



COMMERCIAL CCS OPERATING EXPERIENCE

PACIFIC NORTHWEST ECONOMIC REGION
MIKE MONEA – PRESIDENT, CCS INITIATIVES, SASKPOWER

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Powering the future[®]

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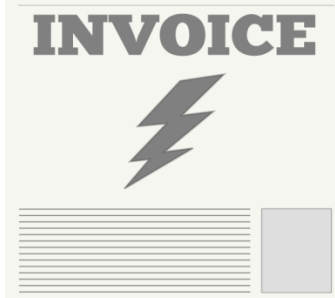
BOUNDARY DAM CCS PROJECT IS NOW 6 MONTHS OLD!



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 CO₂ recovery rates
- Some equipment issues to be resolved

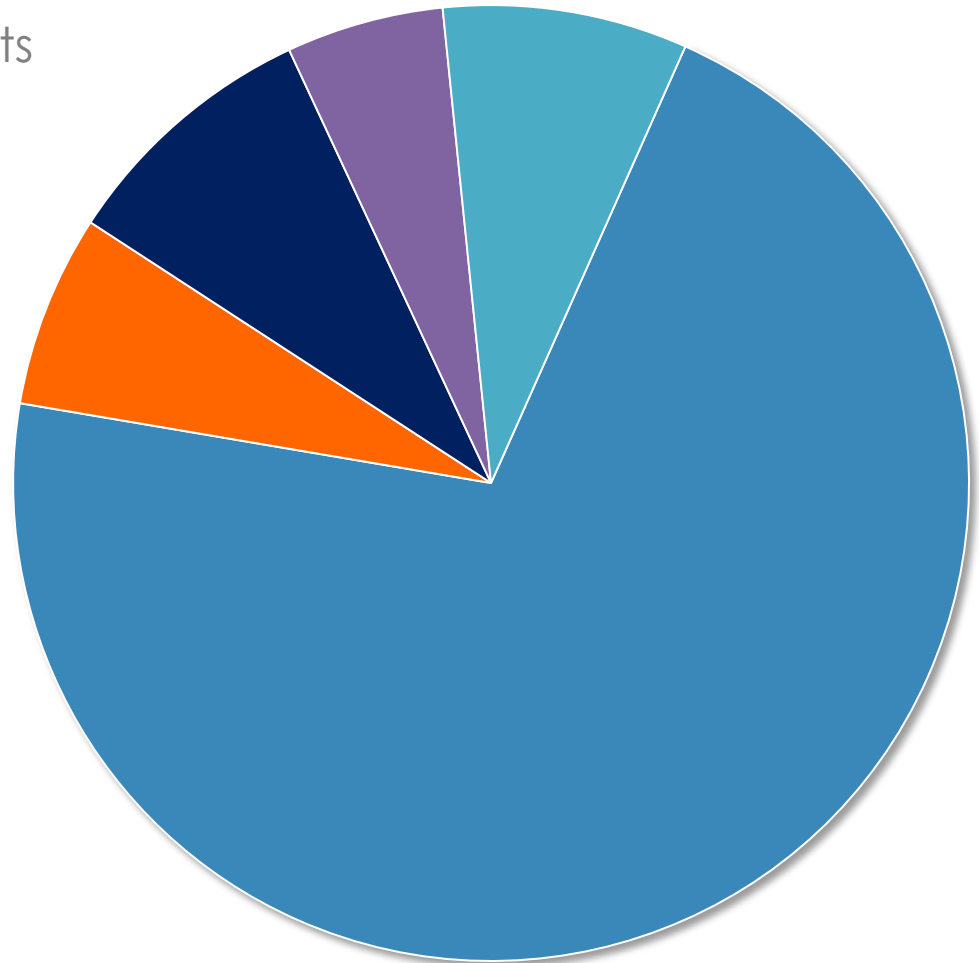


OPTIMIZING PERFORMANCE

Viability requires minimizing . . .

- thermal energy requirements
- parasitic electrical load

- Power to Grid (120 MW)
- Existing parasitic load (11 MW)
- Compression (15 MW)
- Capture CO₂, SO₂ (9 MW)
- Amine & heat regeneration (14 MW)






EXCEEDING
EXPECTATIONS

EXCEEDING EXPECTATIONS

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





Absorber Towers



CO2 Stripper



SO2 Stripper



Acid Plant



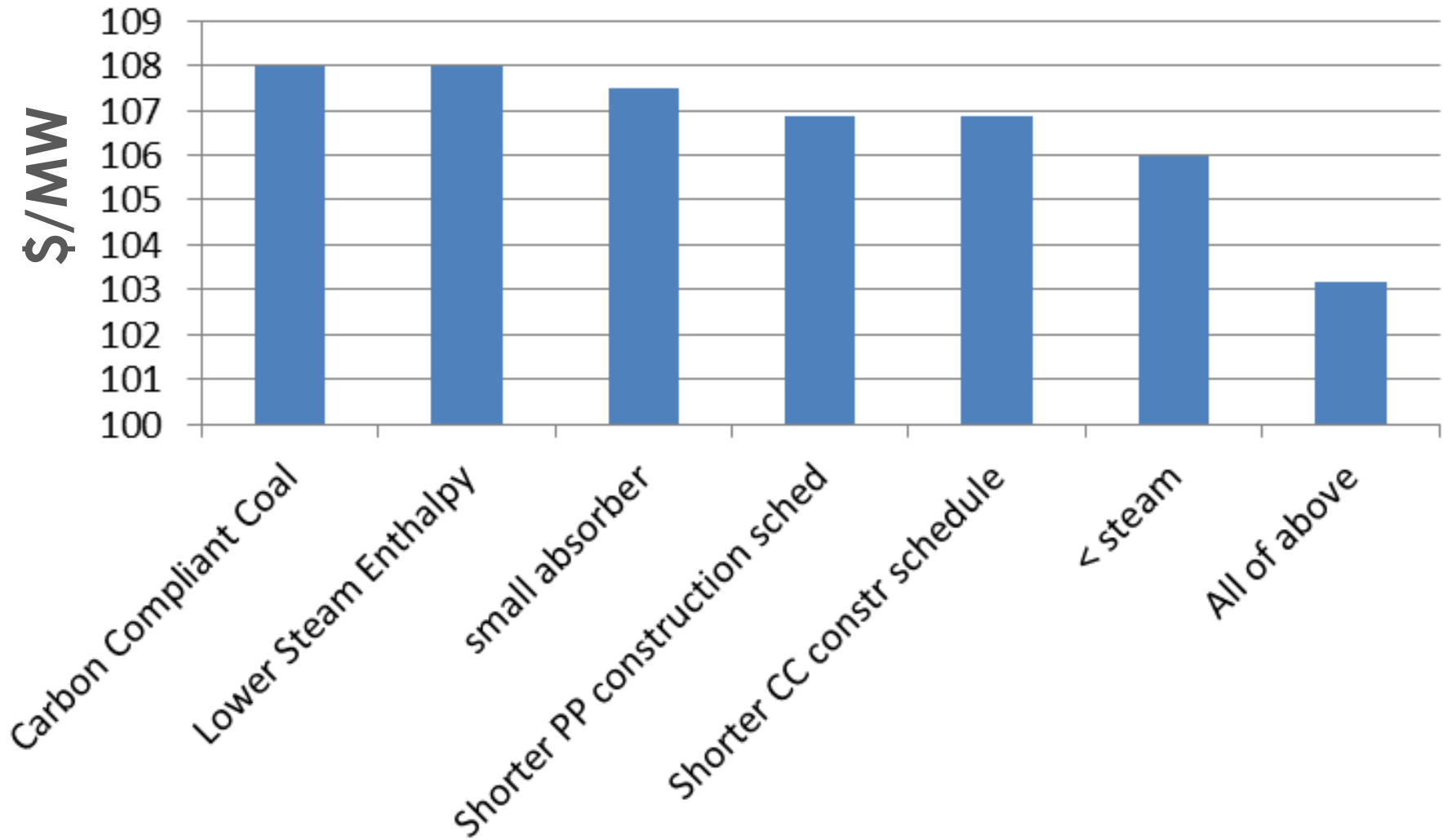
CO2 Pipeline

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**

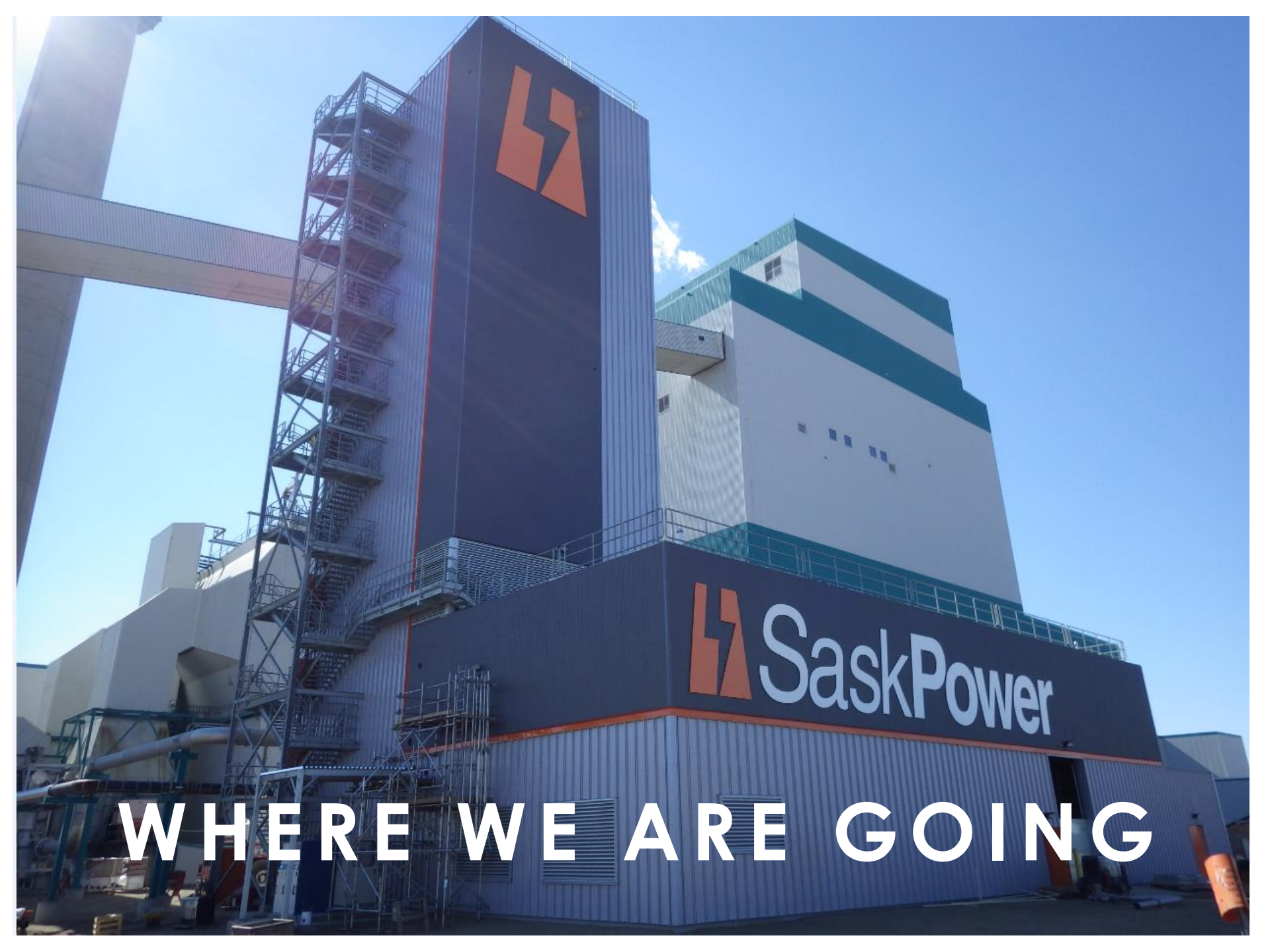
THE FUTURE OF CCS AT SASKPOWER

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



LEARNING STARTS HERE.
OUR NEXT PLANT WILL BE
UP TO 30% CHEAPER.



CONSORTIUM

TAKE THE TOUR

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SASKPOWER CCS

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