Alberta Innovates Energy and Environment Solutions

Technologie innovative per la produttività e la reduzione dell'impatto ambientale nelle risorse petrolifere non convenzionali

Milano, November 28, 2013

Eddy Isaacs, CEO

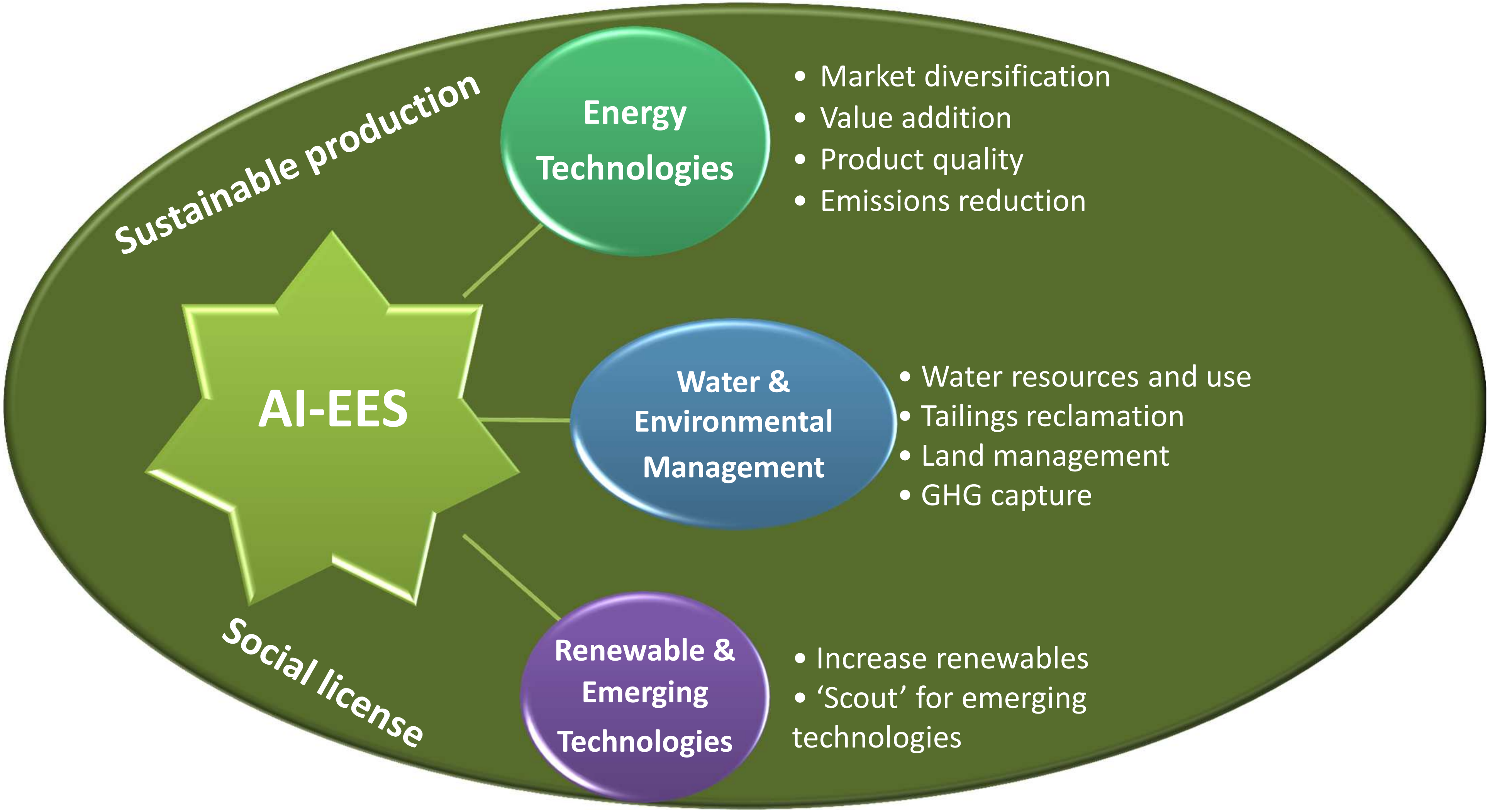
Alberta Innovates Energy & Environment Solutions (AI-EES)

Alberta

Alberta Innovates Energy & Environment Solutions (AI-EES)

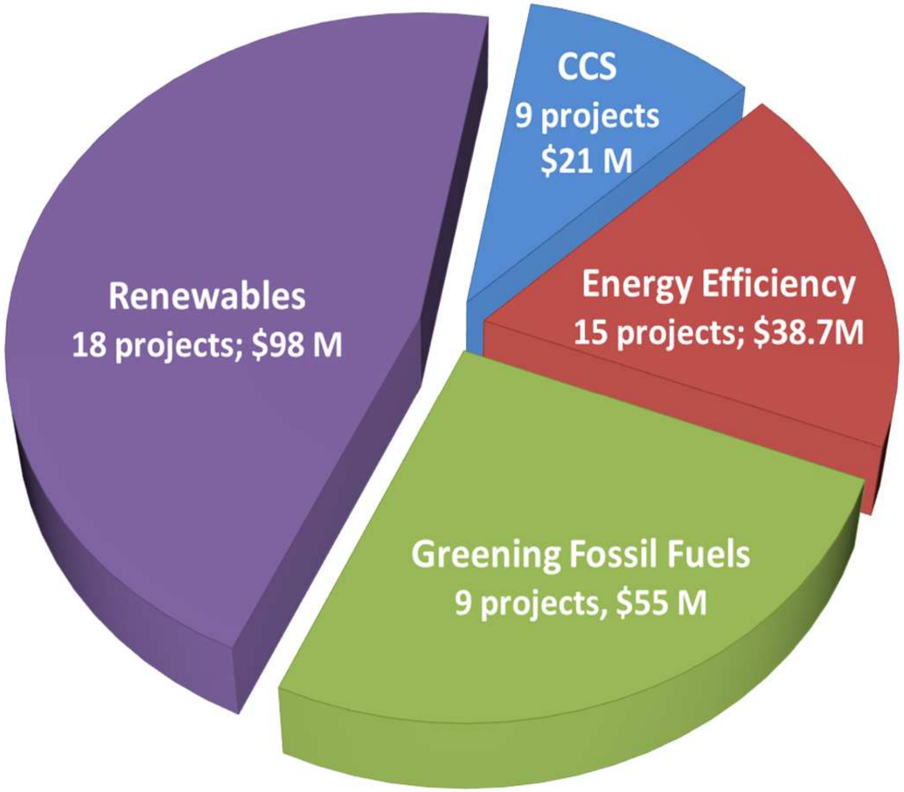
- Provincial Corporation formed January 1, 2010
- "Research, innovation and technology implementation arm of the Alberta Government in energy and environment"
- Builds on successes of the former:
  - Alberta Energy Research Institute - AERI (2000 to 2009)
  - Alberta Water Research Institute (2006 to 2009)
  - Alberta Oil Sands Technology and Research Authority - AOSTRA (1975 to 1999)
- **Goal:** Be at the forefront of technologies and processes that are of strategic importance to the development of Alberta's energy, environment and water sectors

Challenges facing our sector



AI-EES: Technical arm of the Climate Change & Emissions Management Corp (CCEMC)

- Compliance mechanism for reducing GHG emissions – “Technology Fund”
- Competitive funding process
  - Request for proposal – 2 stages
- Rounds 1 to 7
  - Renewables
  - Energy efficiency
  - CCS
  - Greening Fossil Fuels
- Round 8 – Grand Challenge (in progress)



$213 M for 51 technology initiatives; ~ $1.3 billion in total project value

Emissions reduction estimated by 2020 is 10.2 Mt

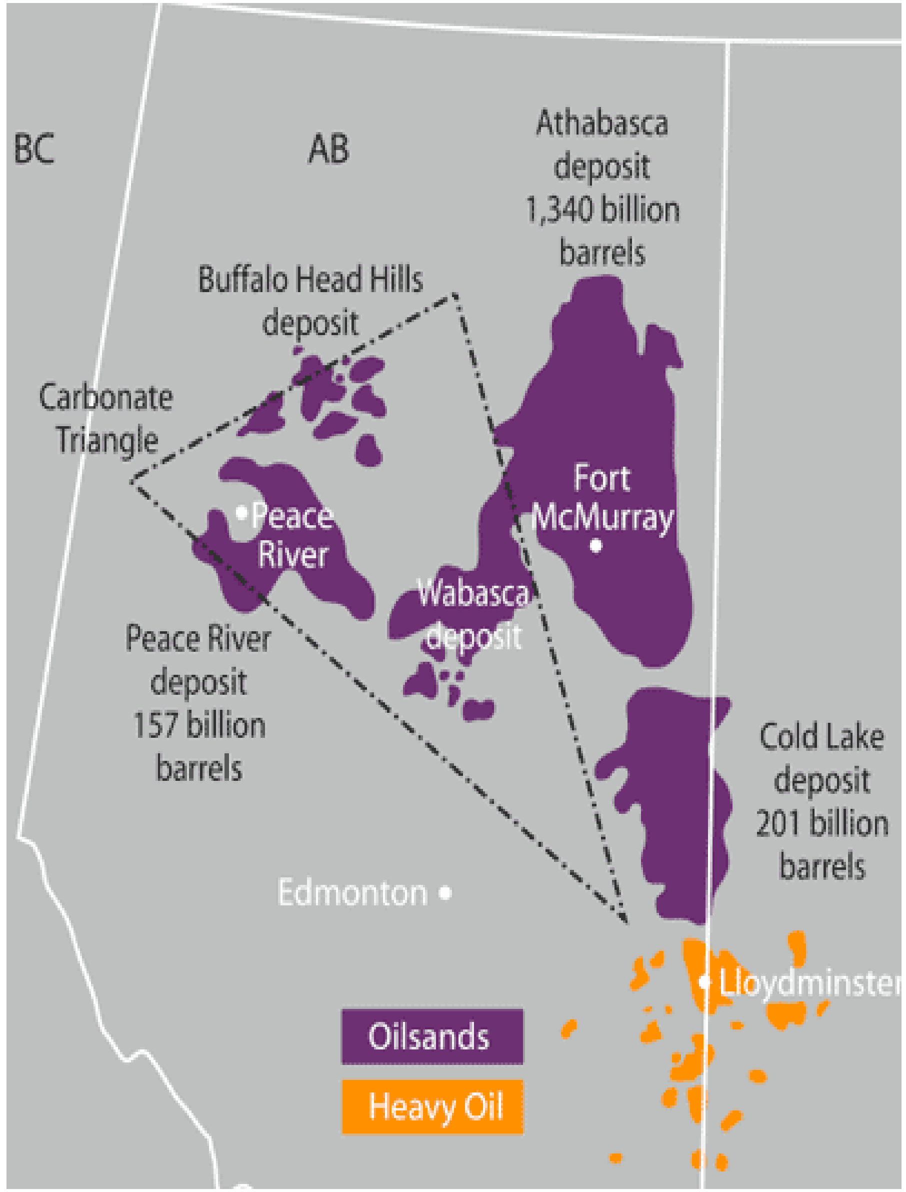
New developments to address environmental performance

- Launch of COSIA - alliance of 13 oil sands producers focused on accelerating environmental performance
  - Tailings
  - Water
  - Land
  - Greenhouse gases

cosia®
CANADA'S OIL SANDS INNOVATION ALLIANCE

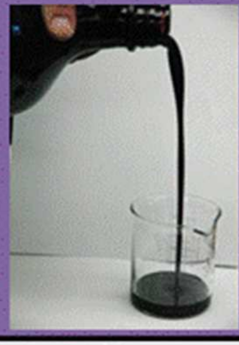
- Environmental Monitoring Agency
  - arms-length agency to integrate the monitoring, evaluation and reporting of air, land, water and wildlife
- Regulations such as Directive 074 and Land Use Framework

The Bitumen resources



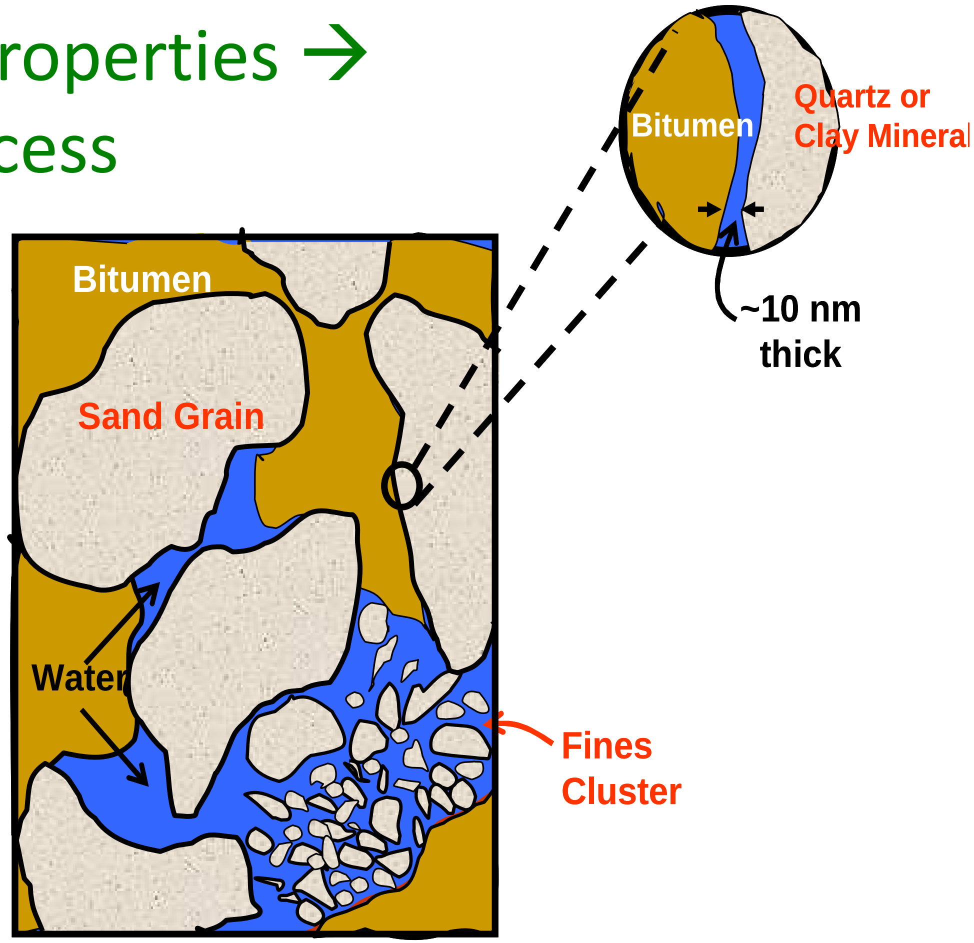
- Oil sands (Athabasca, Cold Lake, and Peace River)
- Carbonate triangle
- Resource: 1.6 trillion barrels
- Reserves: 170 billion barrels
  - 3rd largest

Characteristics of Conventional, Heavy Oil, and Bitumen

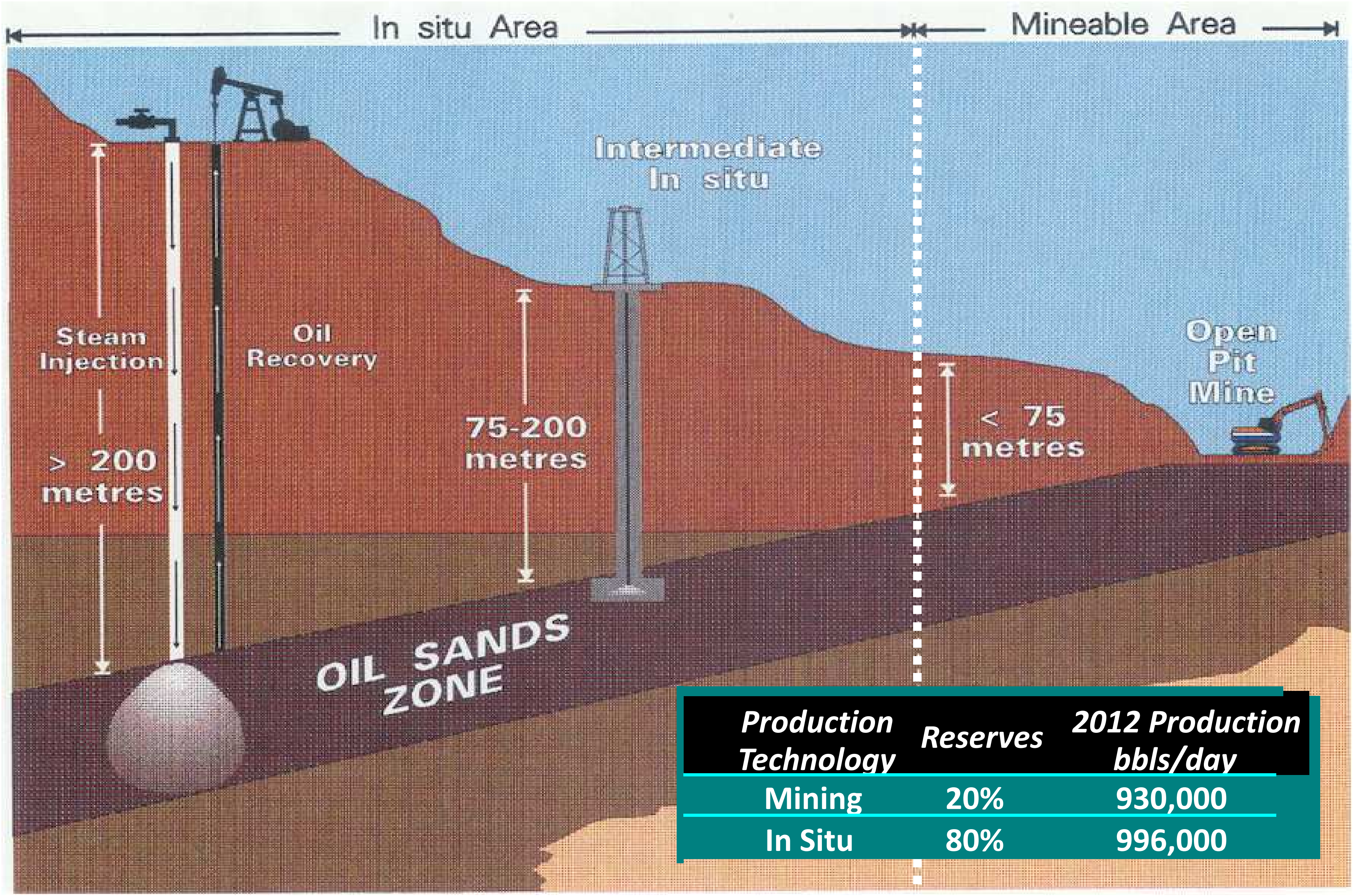
Property	Conventional Oil (average of 131 basins, 8148 deposits) 	Heavy Oil (average of 127 basins, 1199 deposits) 	Natural Bitumen (average of 50 basins, 305 deposits) 	Athabasca Bitumen 
Viscosity (38^0C), cP	10	642	198, 061	500,000
Analysis, Wt %				
- Carbon	85.3	85.1	82.1	83.2
- Hydrogen	12.1	11.4	10.3	9.7
- Sulphur	0.4	2.9	4.4	5.3
- Nitrogen	0.1	0.4	0.6	0.4
TAN, mgKOH/g	0.4	2	3	3.6
Asphaltenes, wt%	2.5	12.7	26.1	19
Asphaltenes + Resins, wt%	10.9	35.6	49.2	51
Metals, ppm	24	236	433	350

Oil Sands have unique properties → commercial success

- Unconsolidated sand
- Highly permeable
- Thick zones
- Relatively shallow
- Water film surrounding sand grains

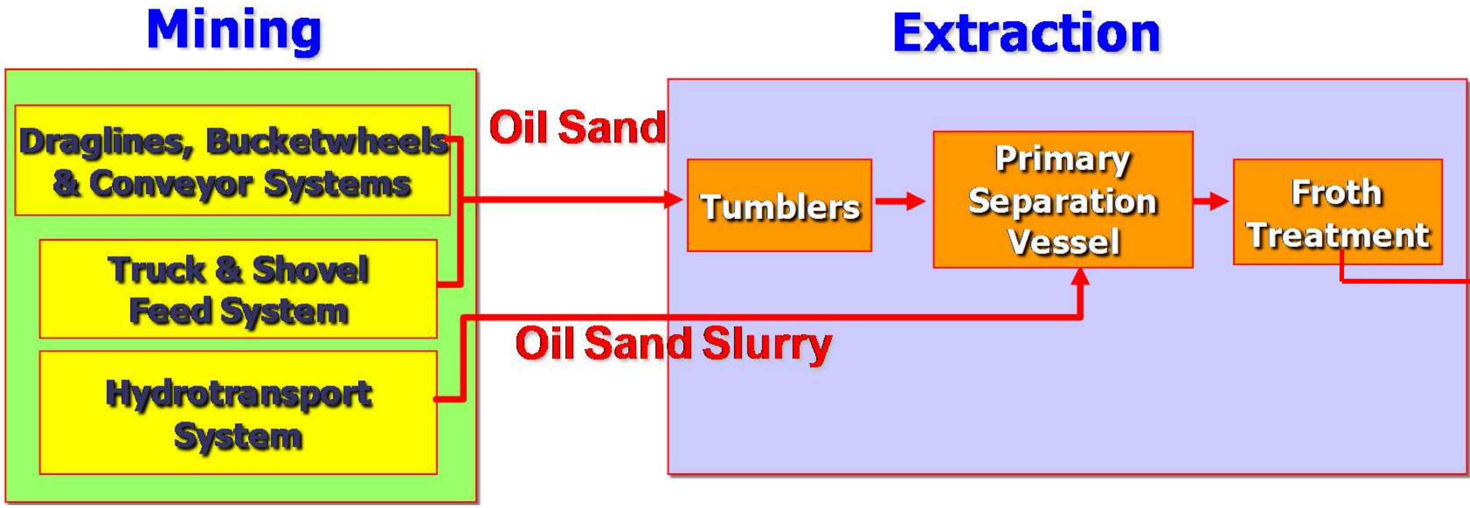


The Nature of the oil Sands resource

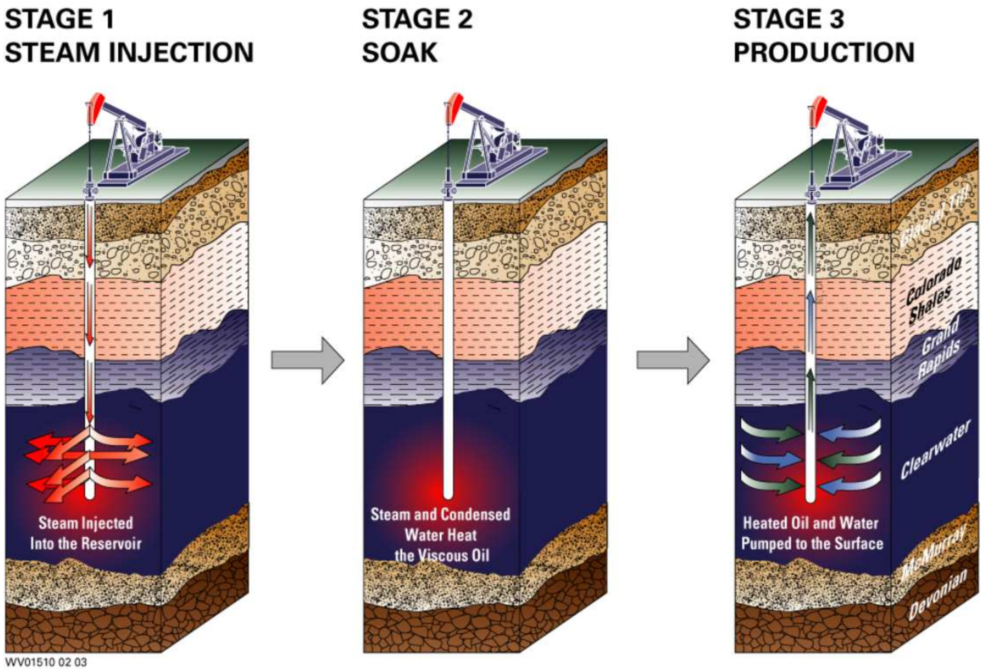


Production Technology	*Reserves*	*2012 Production bbls/day*
Mining	20%	930,000
In Situ	80%	996,000

Major innovation since 2000 – commercial surface mining



Cyclic Steam Stimulation (CSS) adapted from California heavy oil production processes



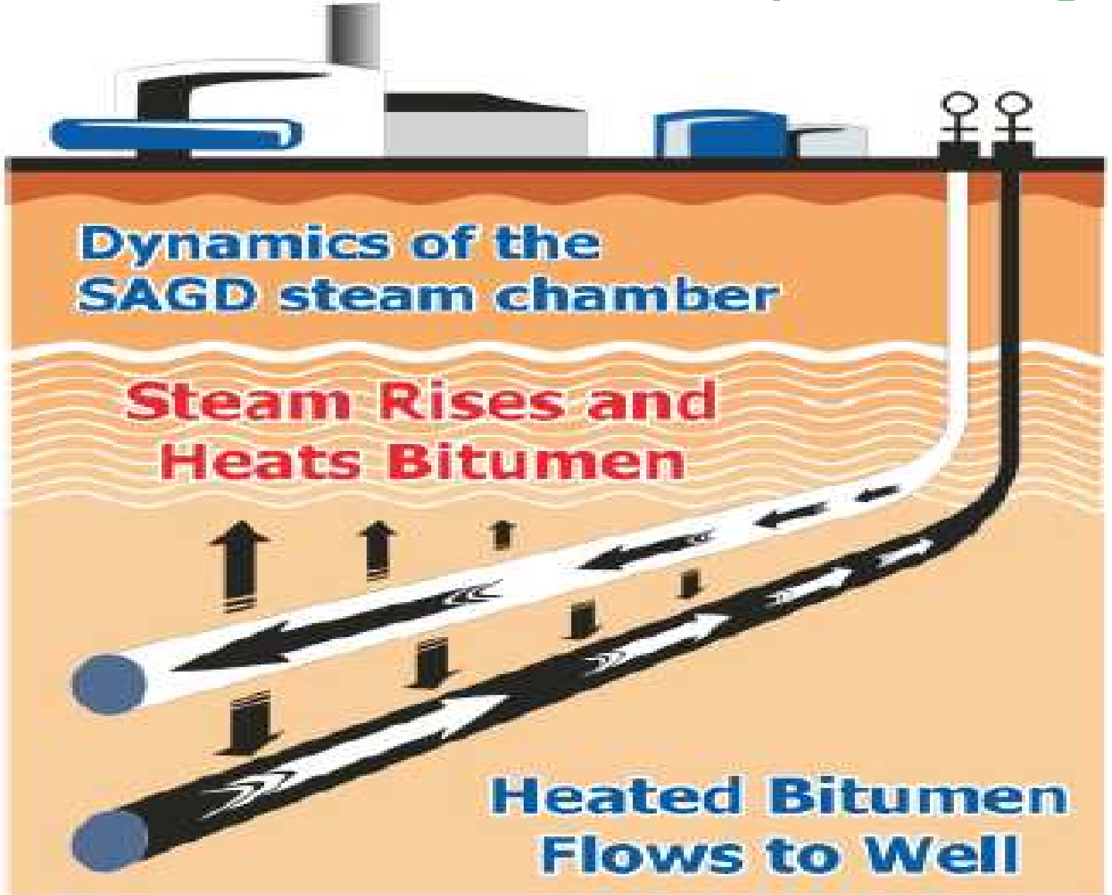
Cyclic Steam Stimulation

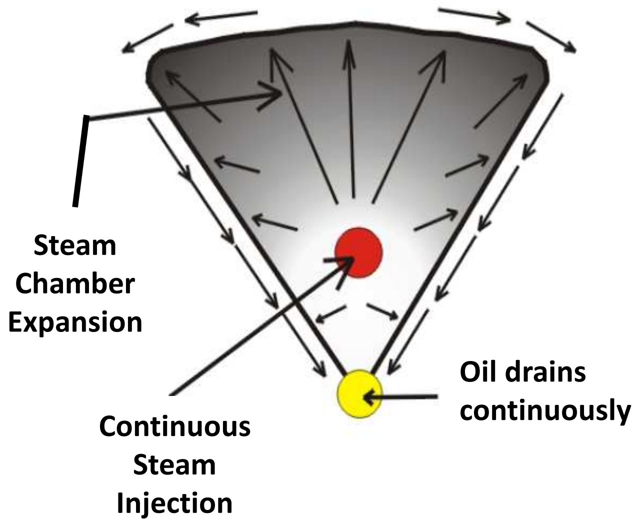
- Single well - cycles of steam injection, soak, and oil production
- Wells are typically drilled in groups from a central pads and extend in all directions
- Recovery – 25%

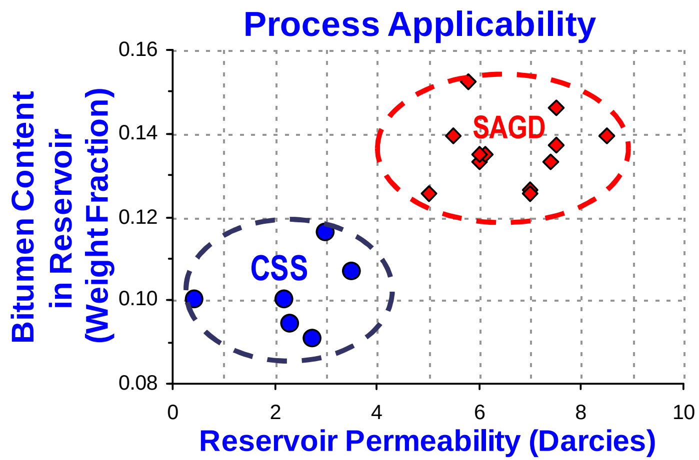
Recovery Mechanisms

- Viscosity reduction
- Fracturing drive (dilation or shear failure)
- Fingering of steam (unstable flow)
- Compaction drive ('squeezing' on flowback)
- Gravity drive
- Solution gas drive

Steam Assisted Gravity Drainage (SAGD) - Schematic







Recovery Mechanisms

- ***Initialization Phase:*** heating between wells, counter-current flow
- ***Growth Phase:*** gravity drainage of hot oil and condensed water
- ***Recovery:*** 50 - 60%

Upgrading – extract more value

- **Refiners -** require high conversion capacity

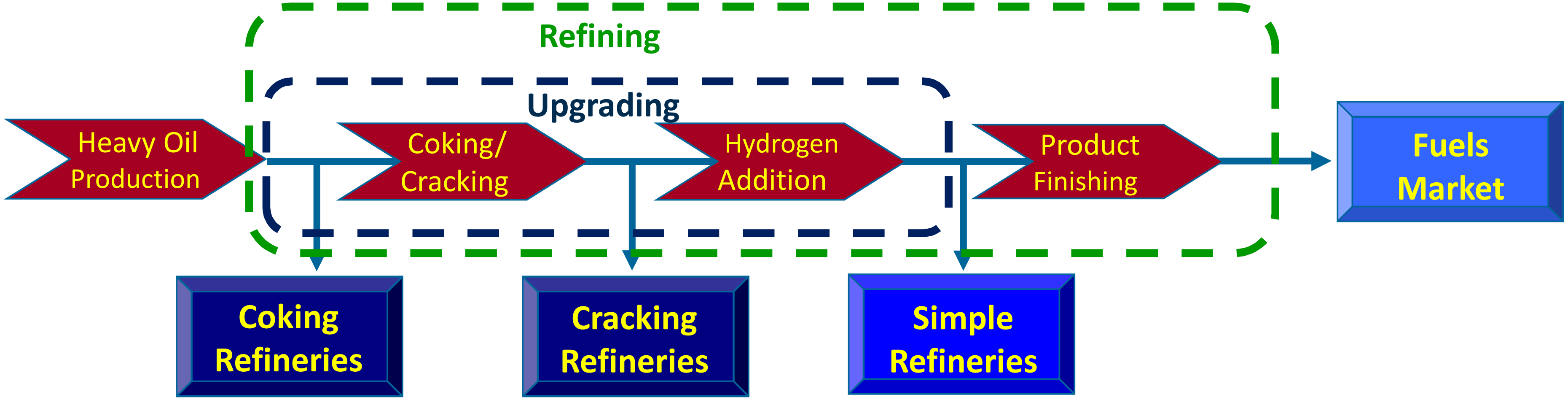


Figure Courtesy of MEG Energy

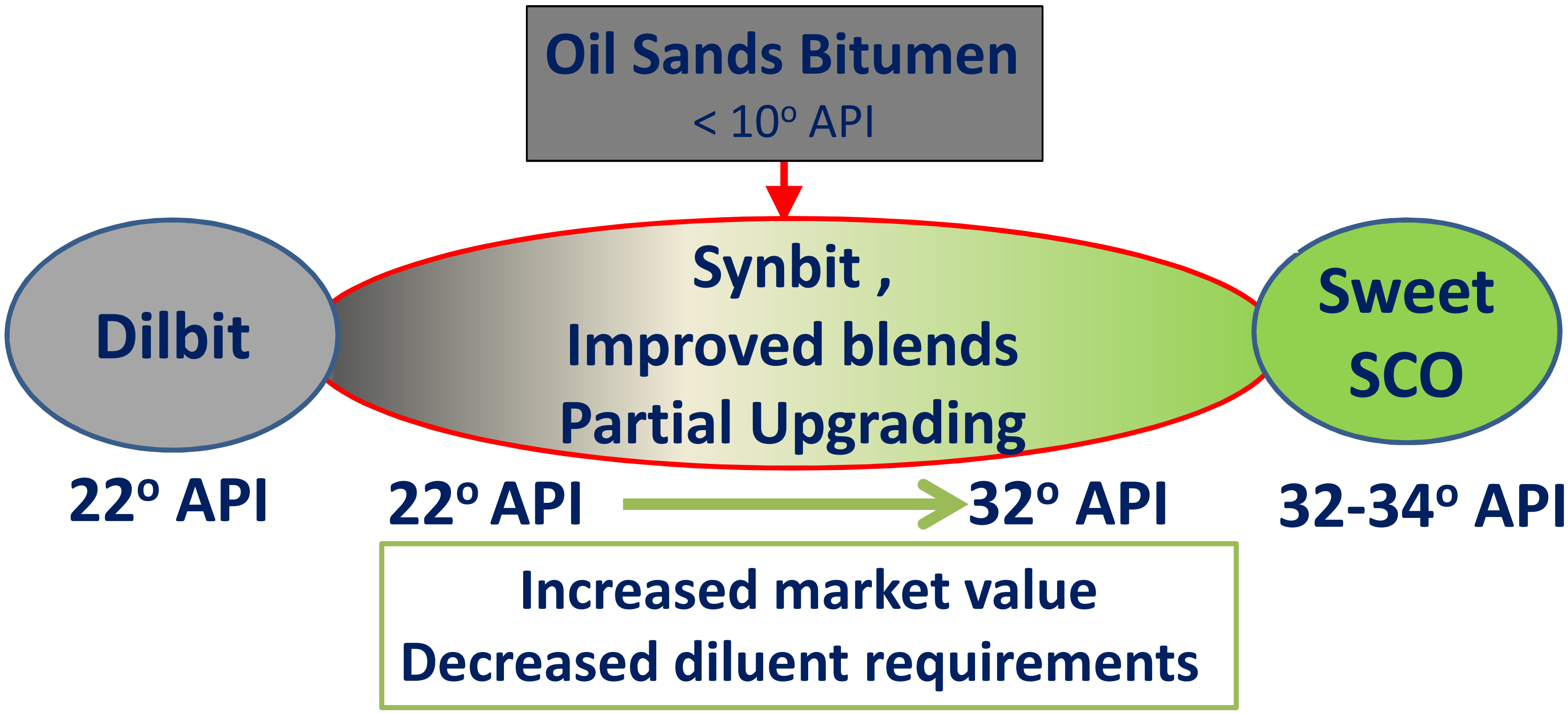
Upgrading - conversion requirements

Crude	API	Vacuum Residue		Processing Severity
		Vol %	Ni+V, ppm	
Arabian Light	33.4	14.8	141	Moderate
Arabian Heavy	27.9	23.2	269	Difficult
Russian Urals	30.6	19.4	269	Difficult
Mexican Maya	22.0	31.2	1,062	Severe
Canadian Athabasca Bit.	7.3	58.4	446	Severe
Venezuelan Zuata	8.4	51.0	995	Severe

Increasing energy Intensity

Courtesy of SFA Pacific

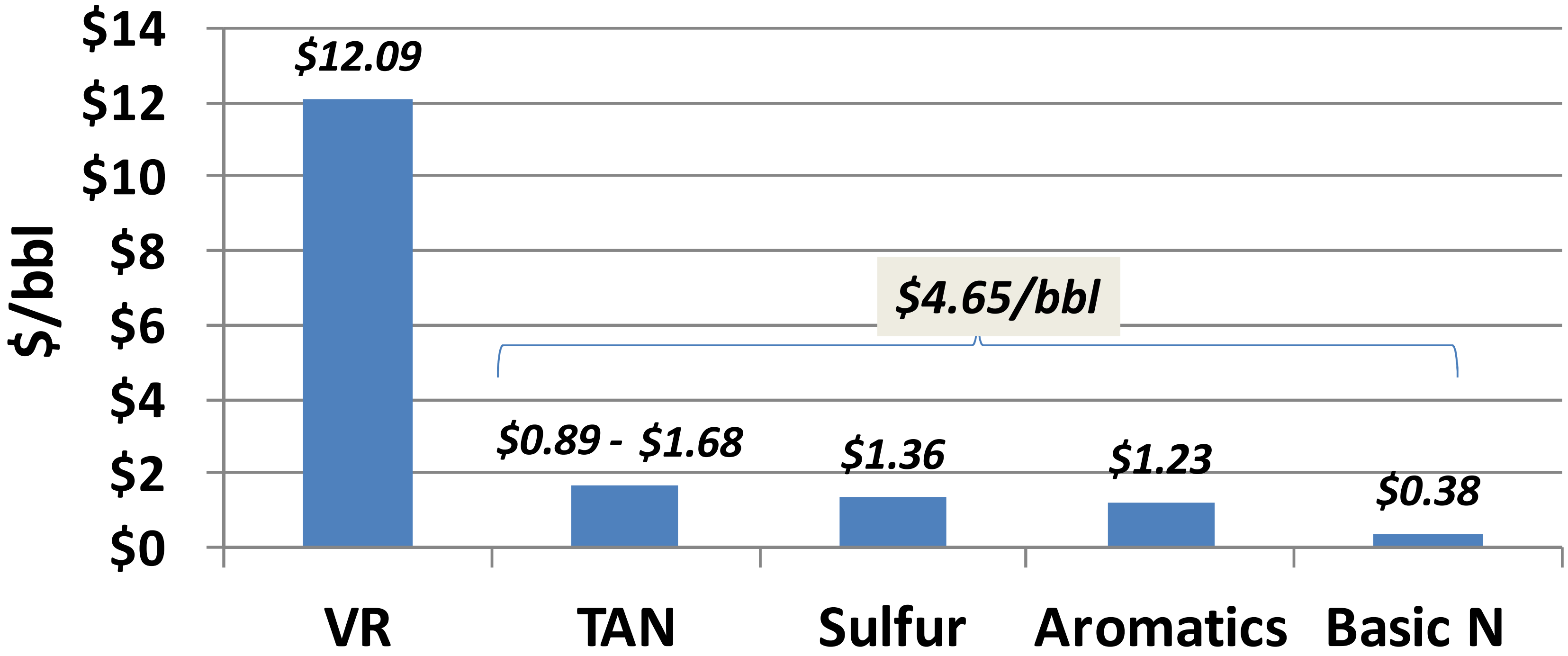
Can we improve competitiveness of oil sands products? Phase 1



Consider introducing new product(s):

- *More competitive & higher market value than dilbit*
- *More cost effective than sweet SCO*
- *Partially upgraded pipeline and refinery compatible crudes*

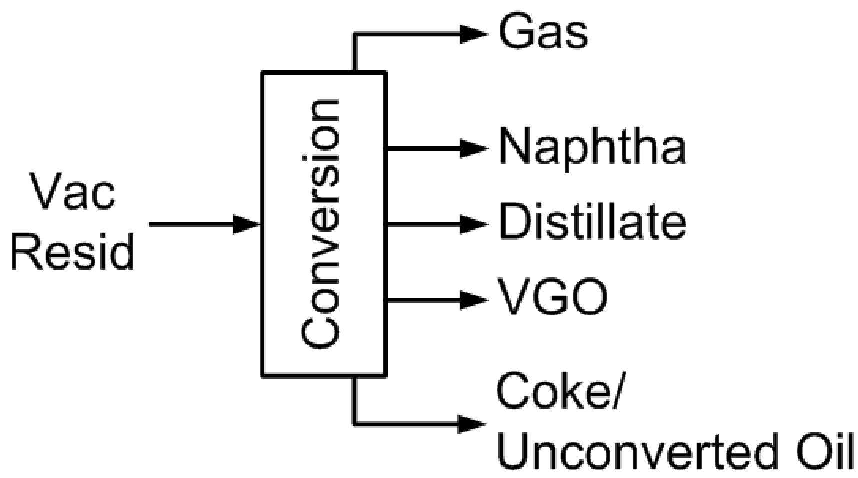
Market diversity and product quality
PADD II DilBit Quality Discounts

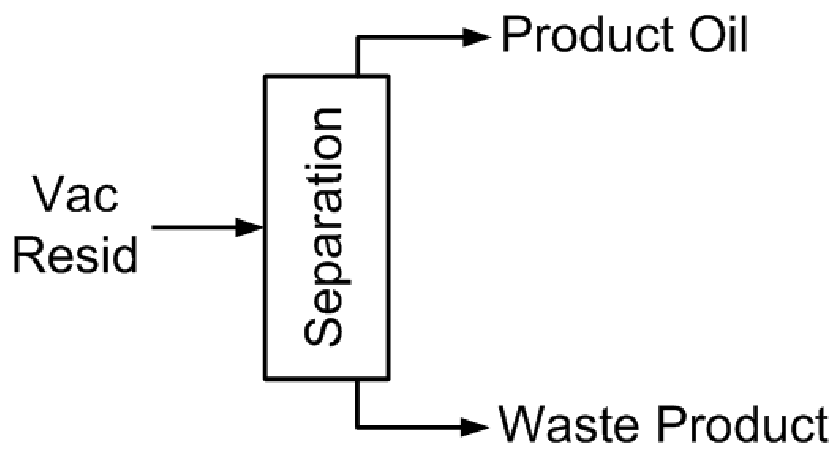


- **VR reduction and TAN reduction have the most potential benefit**
- **Consider introducing lower cost partially upgraded pipeline and refinery compatible products**

Technology options for VR reduction

- Conversion
  - Thermal conversion
  - Hydro conversion
- Separation
  - Solvent de-asphalting (SDA)
  - Advanced solvent extraction*





**** (AI-EES / CanmetENERGY tests underway)***

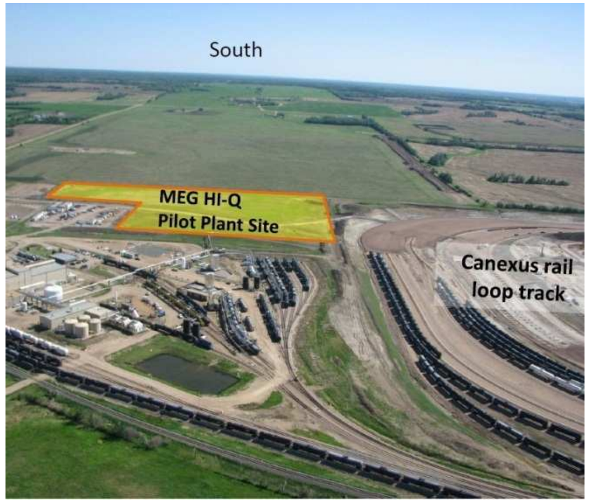
MEG/AI-EES partial upgrading project demonstrated at 5 bpd pilot scale

Visbreaking Skid, Installed 2008

- 250 days of testing operations
- Demonstrated: reliability, control of fouling, coking
- Yields and qualities

Solvent Deasphalting Skid, Installed 2011

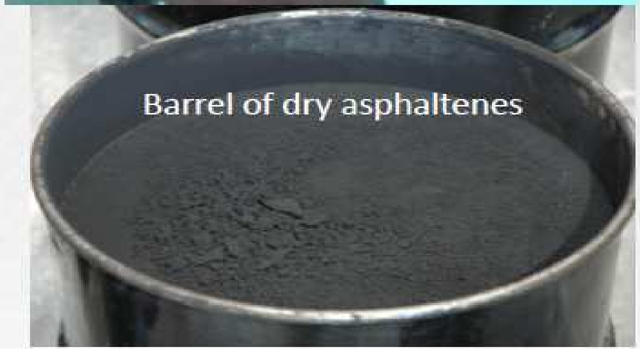
- 30 days testing operations
- Operating envelope defined
- Yields and qualities



Field Demonstration, 2014

- 1,500 bpd facility
- Cost: $130 million; CCEMC, SDTC supported
- Construction start - Q4, 2013

MEG/AI-EES partial upgrading - demonstrated at 5 bpd pilot scale



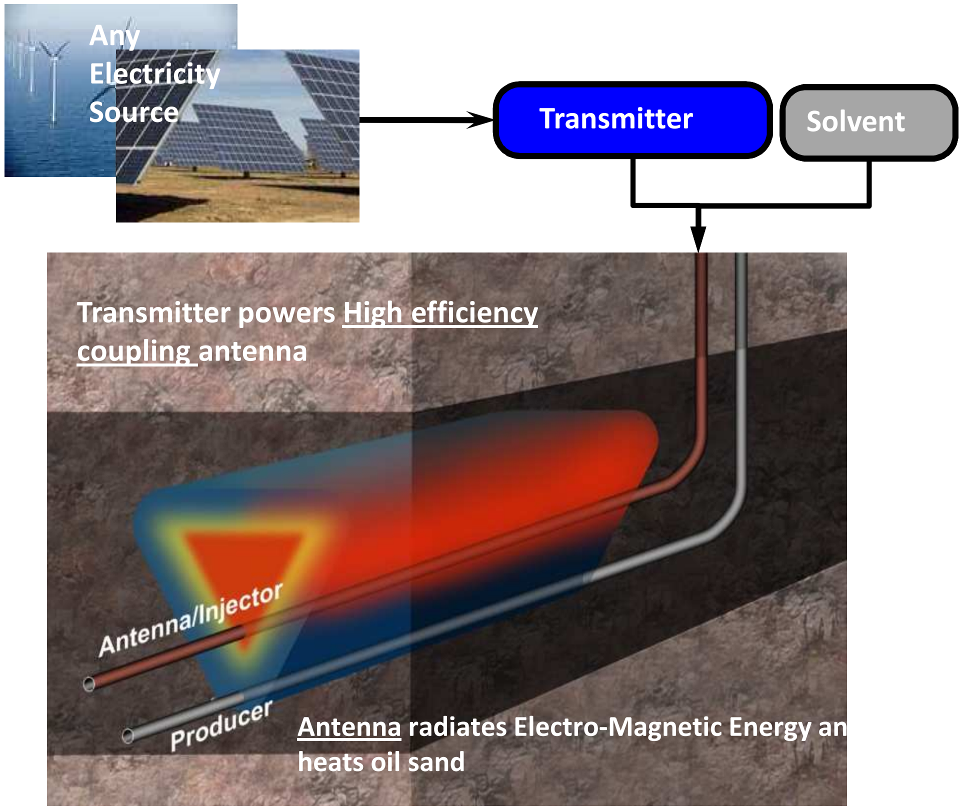
Combined Thermal-Solvent Deasphalting Process

- **Low VR**
- **Low Tan**
- **Low viscosity – pipelinable**
- **Low Metals**

- **Dry asphaltenes**
- **Easy to transport**
- **Suitable for combustion or gasification**

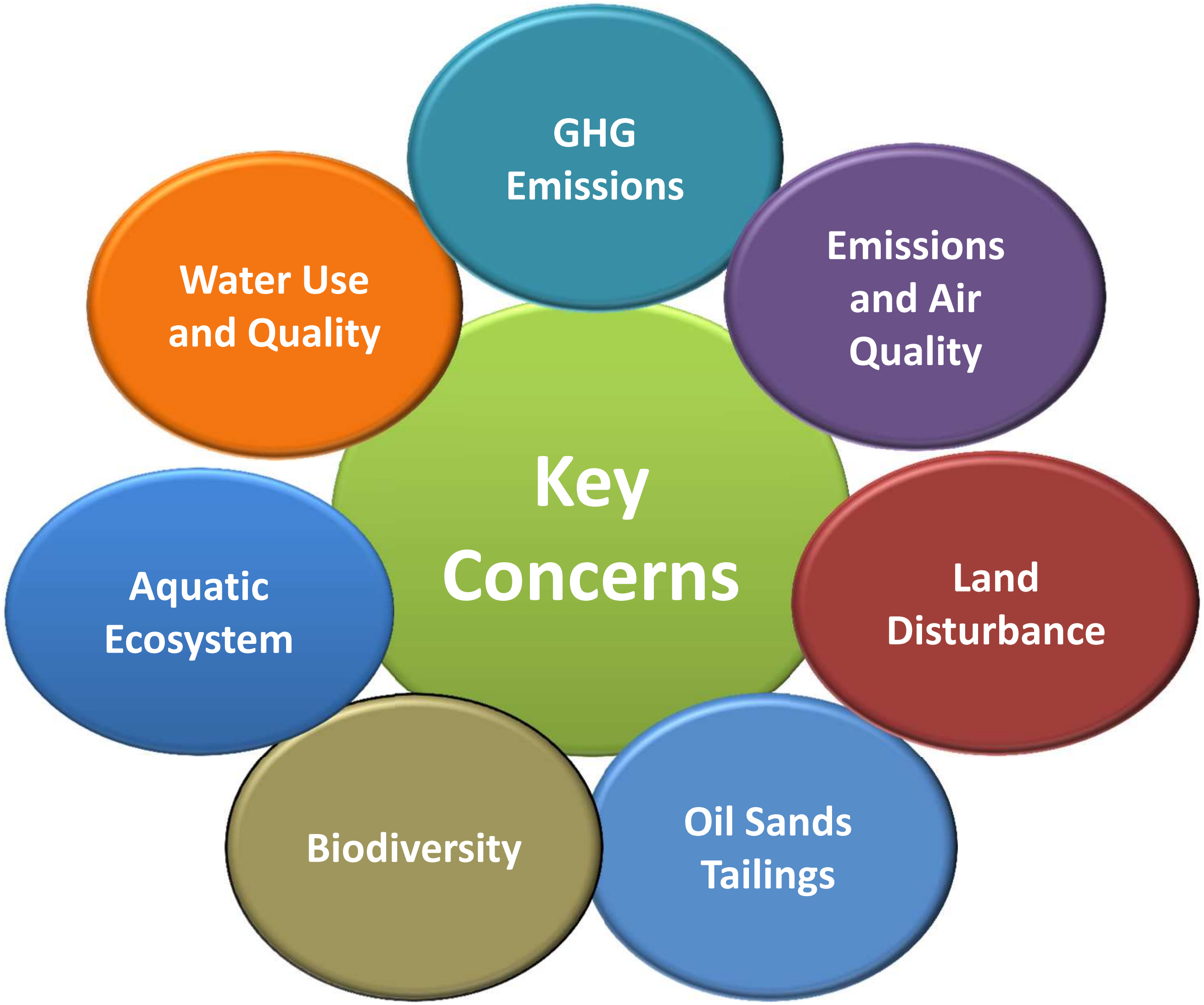
Novel recovery and processing technologies – Low energy and water use

- Solvent gravity drainage
- Cyclic solvent process
- Harris EM Technology
- Electric heating
- *MEG – eMSAGP*
- (HC)3 – HCAT slurry phase technology
- UOP – slurry phase upgrading
- MEG - field upgrading
- ETX - cross-flow coking
- Molten sodium upgrading

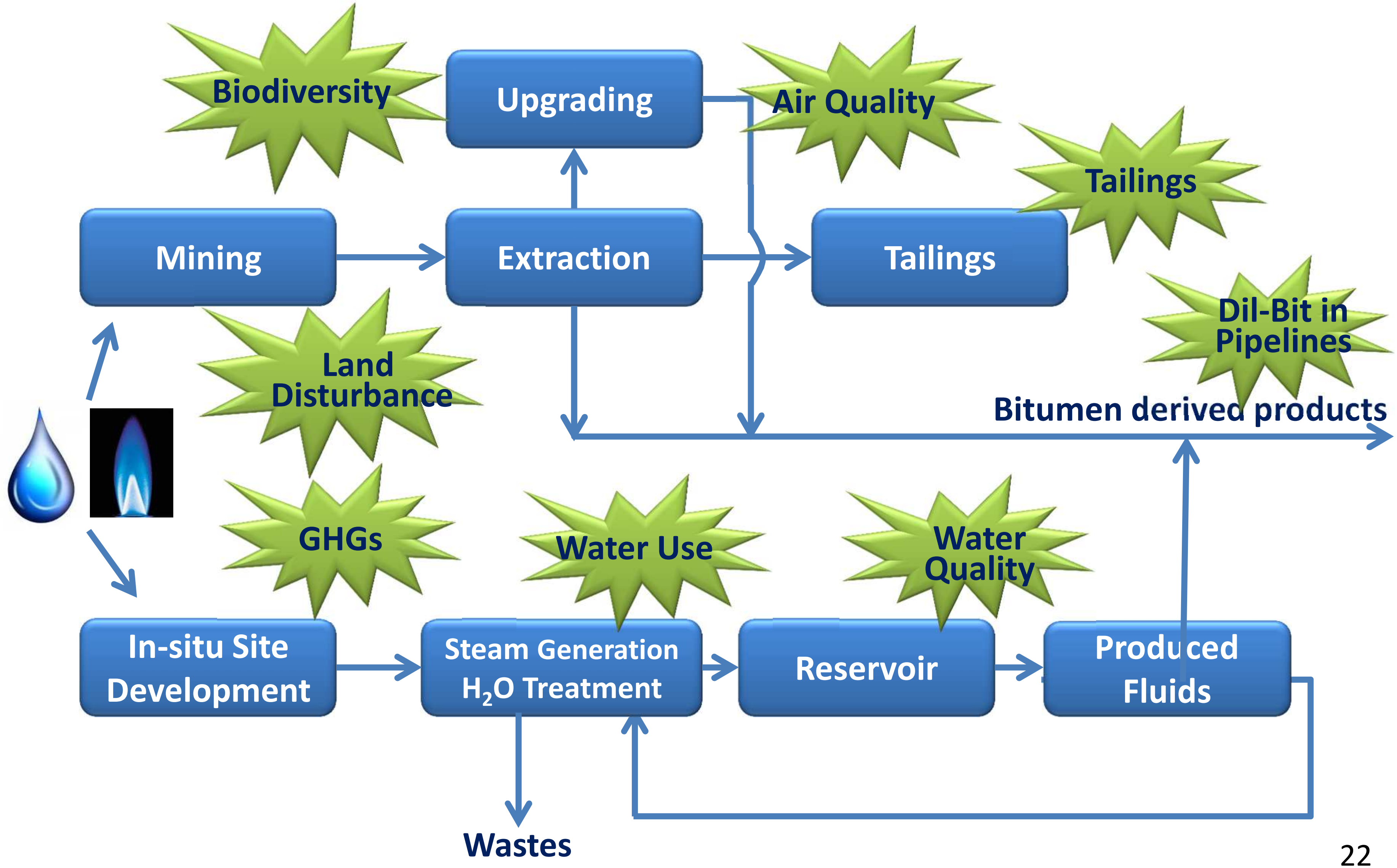


Innovation gap: Cost effective partial upgrading technology – high liquid yields and lower GHG emissions

Key environmental issues

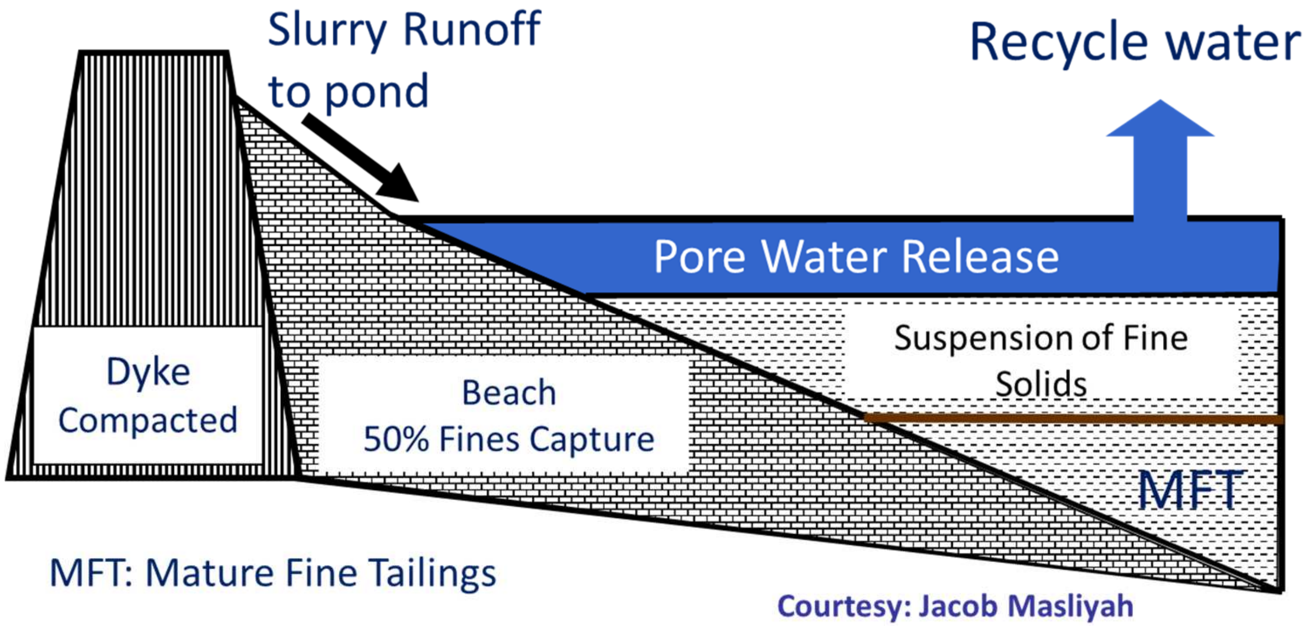


Addressing key environmental concerns in oil sands development



Tailing Ponds on a Grand Scale

Schematic Fate of the oil sands tailings suspensions - Schematic



The Reclamation Process

- Dewatering
- Remediation
- Stabilization
- Landform design
- Soil placement
- Revegetation
- Monitoring
- Certification

Innovation Gap: Inconsistent performance at large scale, decades to settle after treatment, high costs

Examples of tailings technology pathways

Thin Lift Drying (e.g. TRO™ ; Suncor)

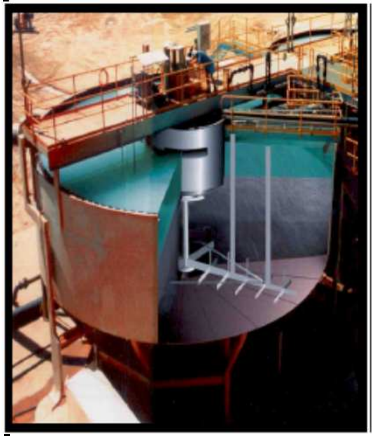
- Commercial demonstration

Water-Capped MFT Technology

- Monitored large test ponds over 20 years
- Commercial demonstration being constructed

High Compression Thickener

Large-scale pilot filed pilots started in 2001
Will be implemented at Arora N & S mine sites



Centrifuge Process

20 tonnes per hour pilot : Syncrude

one year after centrifuge process

Integrated land management

Focus

- Mined area reclamation
- Linear disturbance
- Biodiversity
- Wetland

Best practice innovation needed

- Cumulative effects management
- Up front planning to avoid/minimize
- Mitigation & restoration
- Assessment & monitoring

Major projects – reclamation and sustainability

- Linear corridor disturbance reclamation
- Sandy soil modification for reclamation
- Atmospheric deposition in NE Alberta in the last 60 years
- Land monitoring using satellite imagery
- Dilbit transportation and its potential environmental impact
- Chairs in Biodiversity – cause and effect

Collaboration with cosia

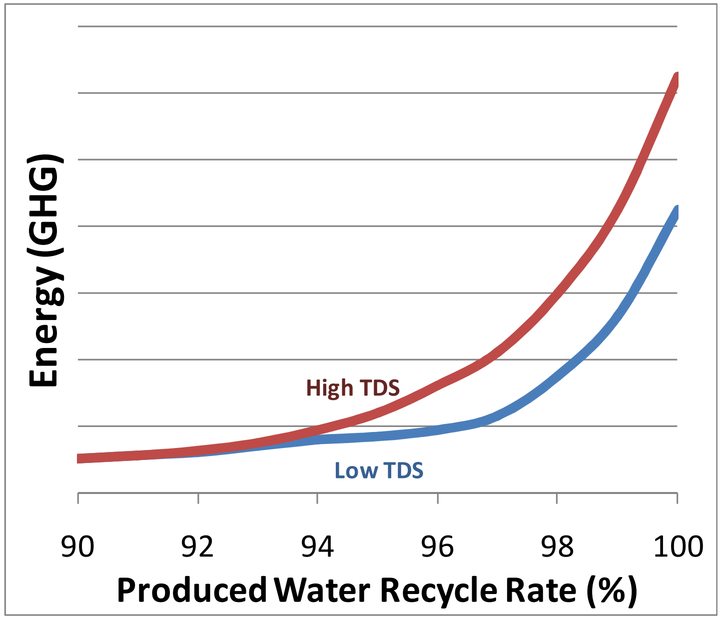
Water management in oil sands development

- Water use in thermal in-situ recovery (SAGD)
- Water in fluid tailings
- Impact to water quality in the Lower Athabasca

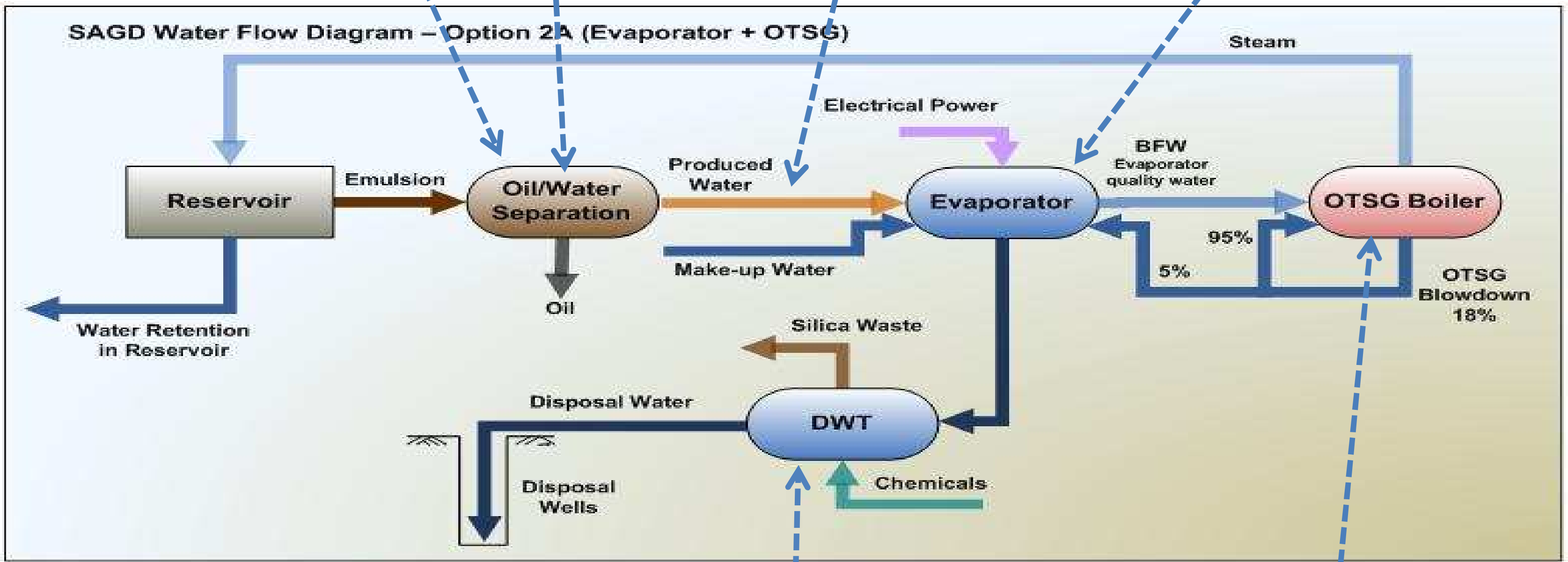
Challenges:

- Facilities handle more water than oil
- ~70% of operating costs to heat and treat water
- The more recycling and reuse the more GHG emissions

Innovation Gap: reduced fresh water use and energy requirements



SAGD water treatments

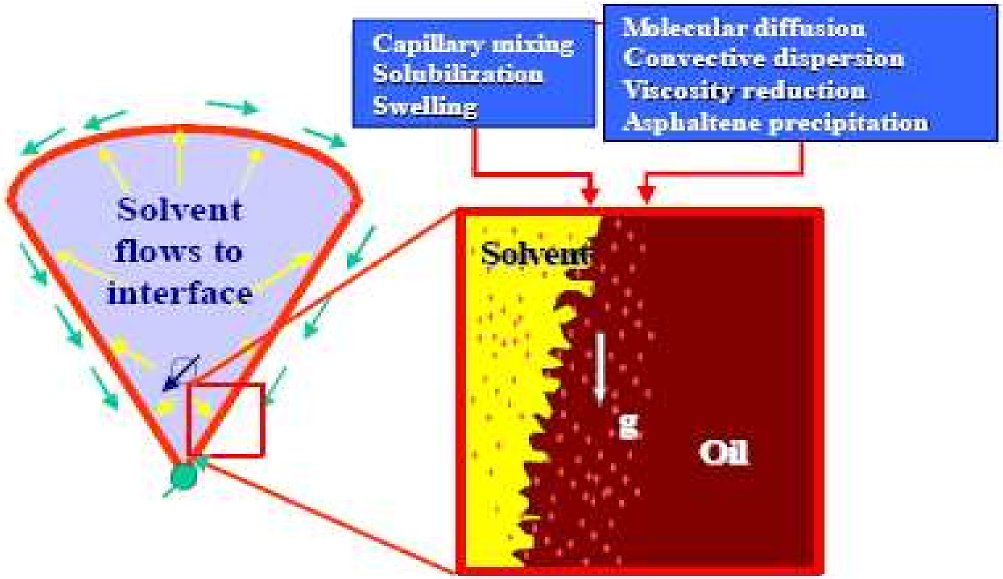


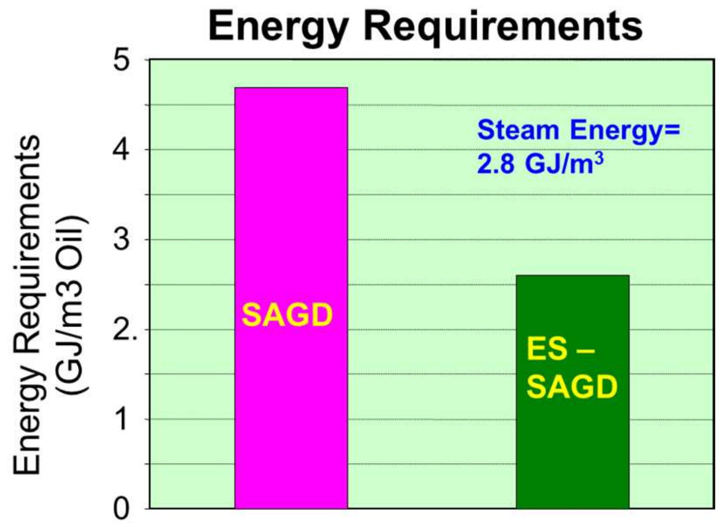
DOC – dissolved organic carbon
ZLD – zero liquid discharge

GHG emission in oil sands development

- New recovery/processing technologies
- GHG reduction: energy efficiency
- GHG reduction: carbon capture and storage
- Life cycle comparison with conventional crudes

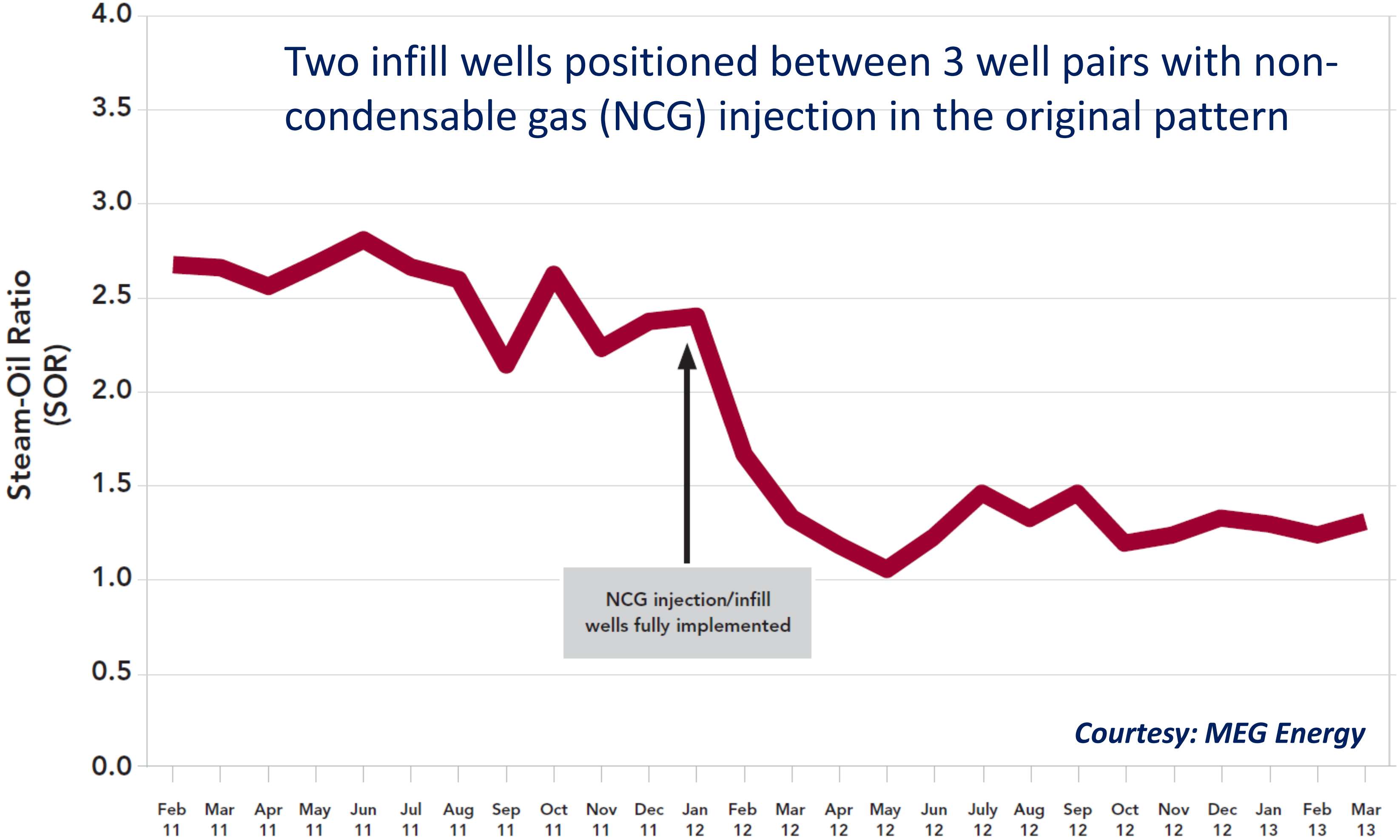
Steam solvent processes



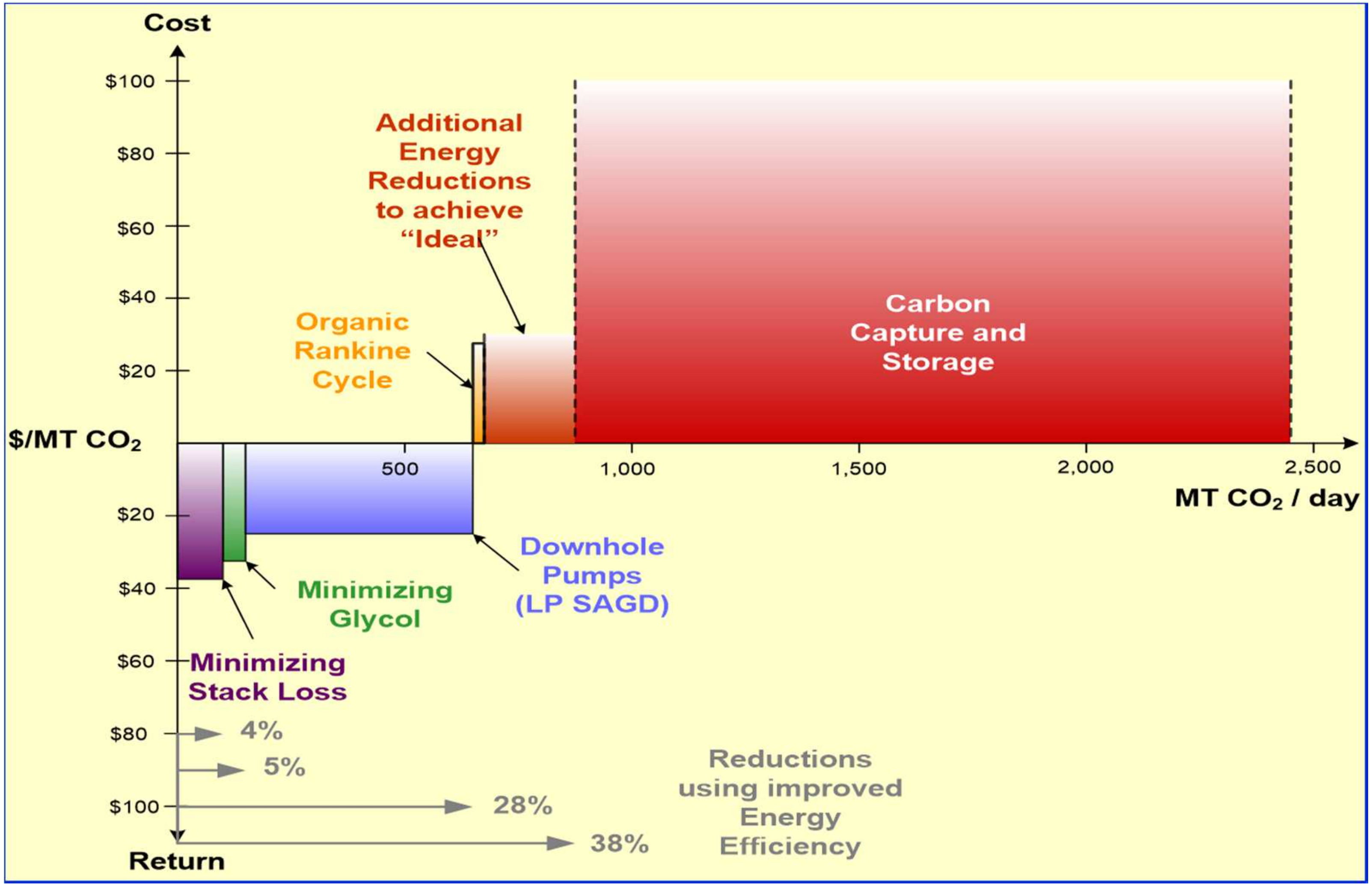


- 15 to 40% lower energy and water and higher recovery
- Viscosity reduction
- Asphaltene precipitation
- Complex mechanisms. Difficult to model
- Dependent on solvent properties and reservoir conditions

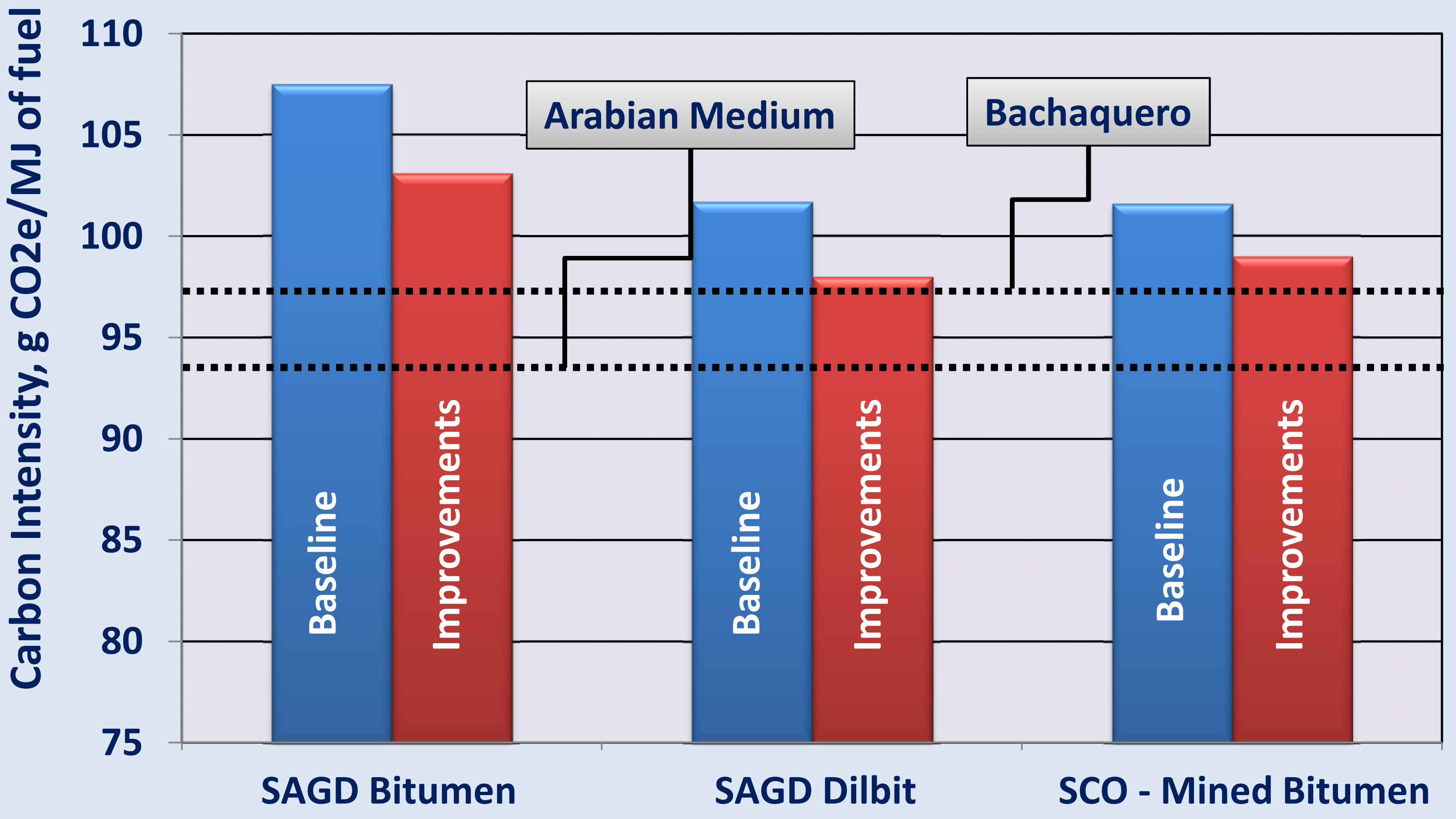
MEG Energy eMSAGP pilot performance



Energy efficiency and CCS in thermal operations

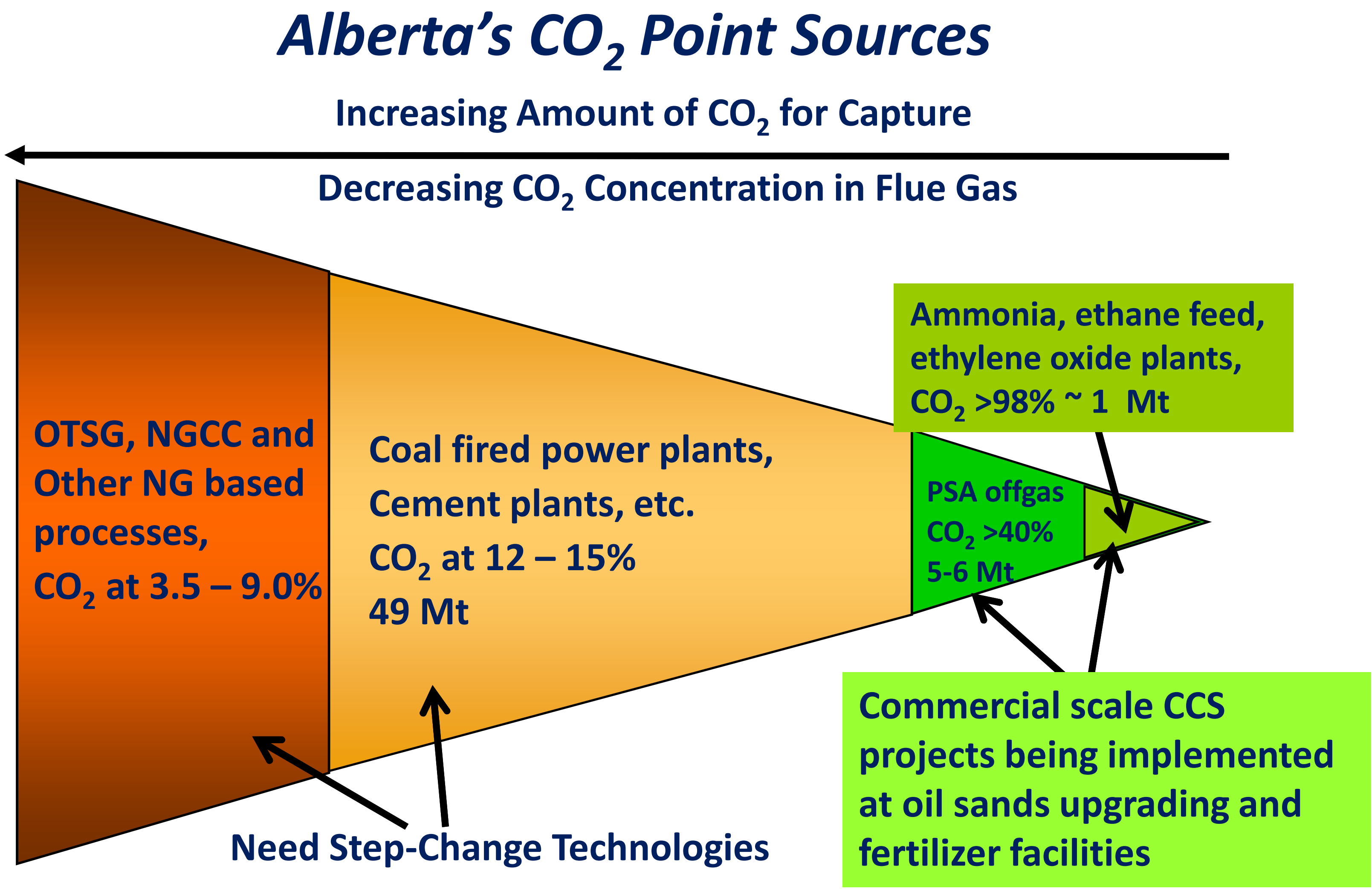


Practical energy efficiency and technology opportunities in the short-term



Source: CCEMC , "A Greenhouse Gas Reduction Roadmap for Oil Sands", May 2012

Carbon capture cost reduction: step-change technologies required



Longer term emission reduction

carbon capture and storage

Carbon Capture

Carbon Storage in Saline Aquifers

CO_2-Enhanced Oil Recovery (CO_2-EOR)

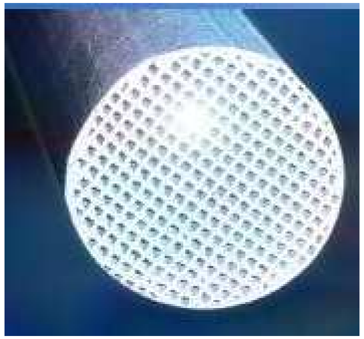
Alberta Innovates Energy and Environment Solutions

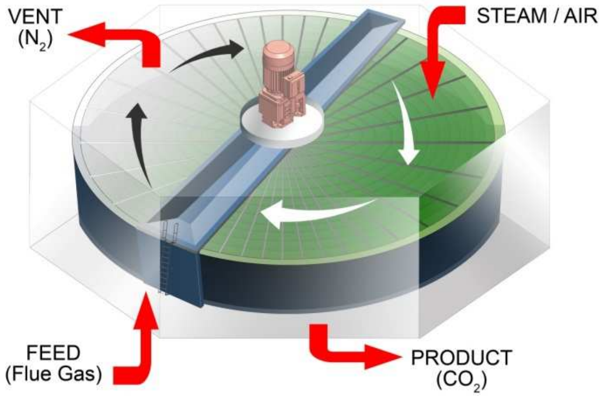
CCEMC Climate Change & Emissions Management Corporation

Innovation Gap: need at least 50% reduction in cost of carbon capture

1. Chemical solvent
2. Chemical solvent with enzyme
3. Solid sorbents
4. Polymeric membranes
5. Electrochemical membrane
6. Oxy-fuel combustion
7. Cryogenic
8. Chemical looping

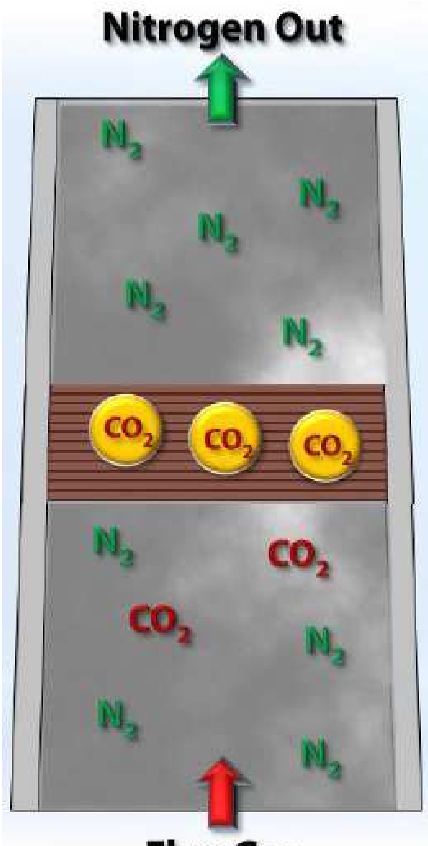
Solid sorbent example





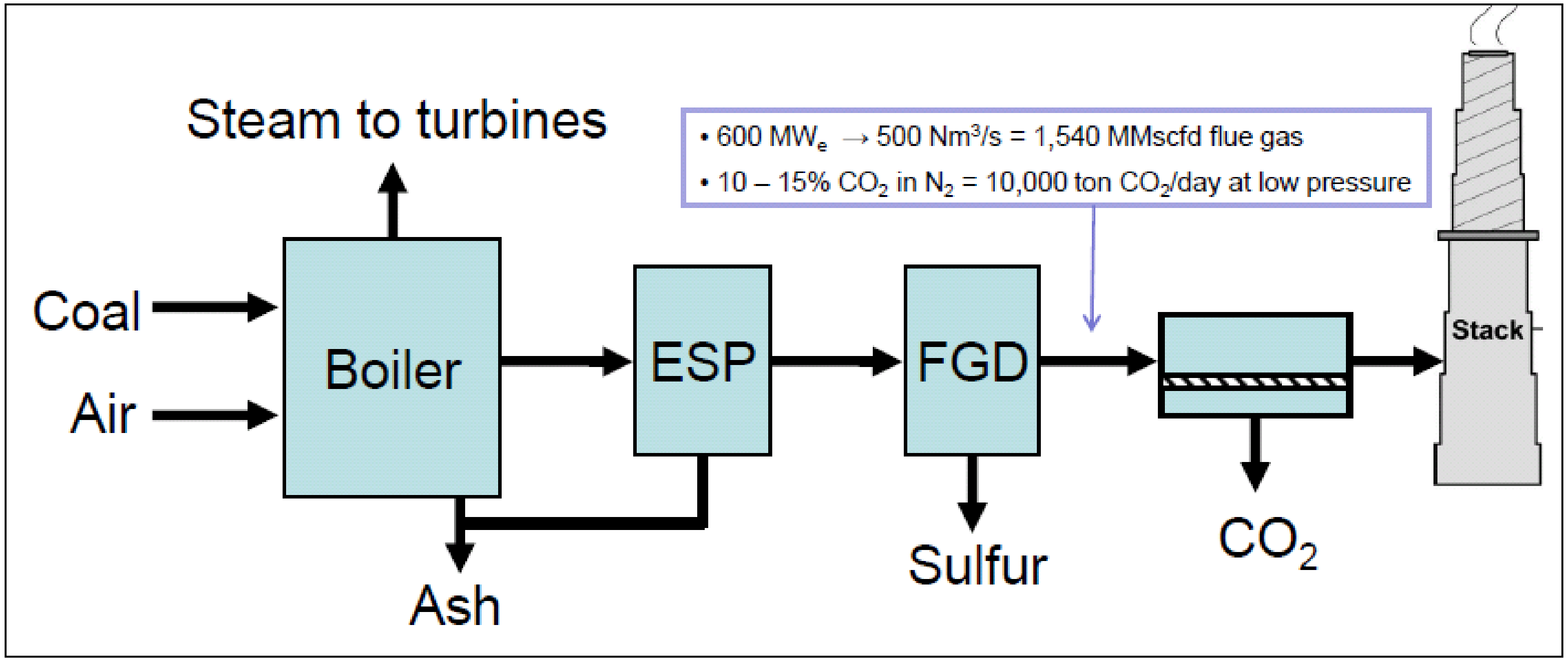
Uses commercial heat exchanger

Courtesy: Inventus, Burnaby, BC, Canada



Membrane for carbon capture

- Polymer membrane separation, MTR, USA
- Polymer membrane separation, NTNU, Norway
- Electrochemical membrane, FuelCell Energy, USA



Tim Merkel, MTR (2012)

Contact Organization Innovative Solutions	Focus
cosia CANADA'S OIL SANDS INNOVATION ALLIANCE www.cosia.ca	• Water • Tailings • Land • GHG Emissions
CCEMC Climate Change & Emissions Management Corporation www.ccemc.ca	Calls for proposals – GHG Reduction - Energy Efficiency - Renewables - Carbon Capture & Storage - Greening Fossil Fuels
Alberta Innovates Energy and Environment Solutions www.ai-ees.ca	• Energy Technologies • Water & Environmental Management • Renewable & Emerging Technologies

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