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Canada Oil Sands

Minimizing the Water Usage

for Thermal In Situ Oil Sands Schemes

Trade-off and Challenges

CHOA Presentation

October 29, 2009

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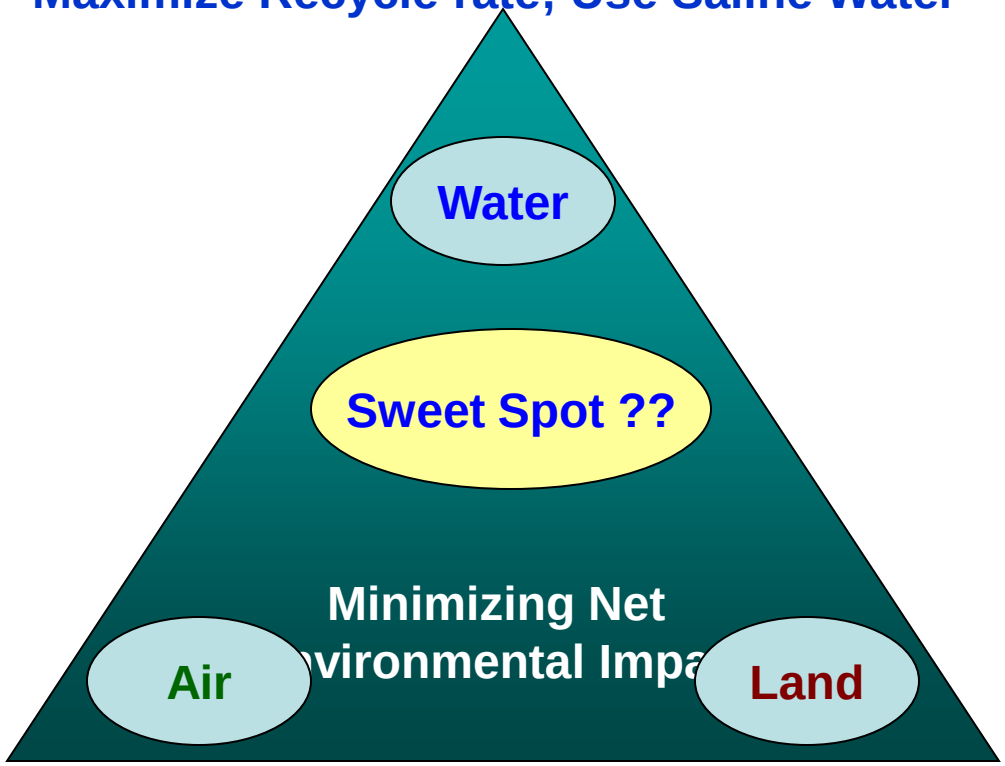
Environmental Trade-offs

Protect Fresh Water Aquifers < 4000 TDS

Maximize Recycle rate; Use Saline Water



Reduce GHG

Reduce Emissions

Improve Energy Efficiency

Reduce Footprint

Minimize Land use

Reduce potential for contamination

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Approaches & Challenges

- Simultaneous optimization the competing objectives:
  - Minimizing fresh water consumption,
  - Minimizing energy use → Reduce the GHG and emissions.
  - Minimize land footprint → Wastewater injection, solid waste disposal, and potential for contamination
- Use of saline water to replace fresh water
  - Increase wastewater blowdown required to maintain the salt balance
  - Build longer pipelines, more source + disposal wells → Larger footprint
  - Drive competition for saline water between producers
- Reduce wastewater disposal
  - Use more energy intensive water recovery technologies resulting in increased GHG emissions
- Eliminate wastewater entirely by converting the it to solid (ZLD)
  - Use significant energy to remove the last droplet
  - Increase GHG and fugitive emissions
  - Build more landfills to store leachable salt with high organic

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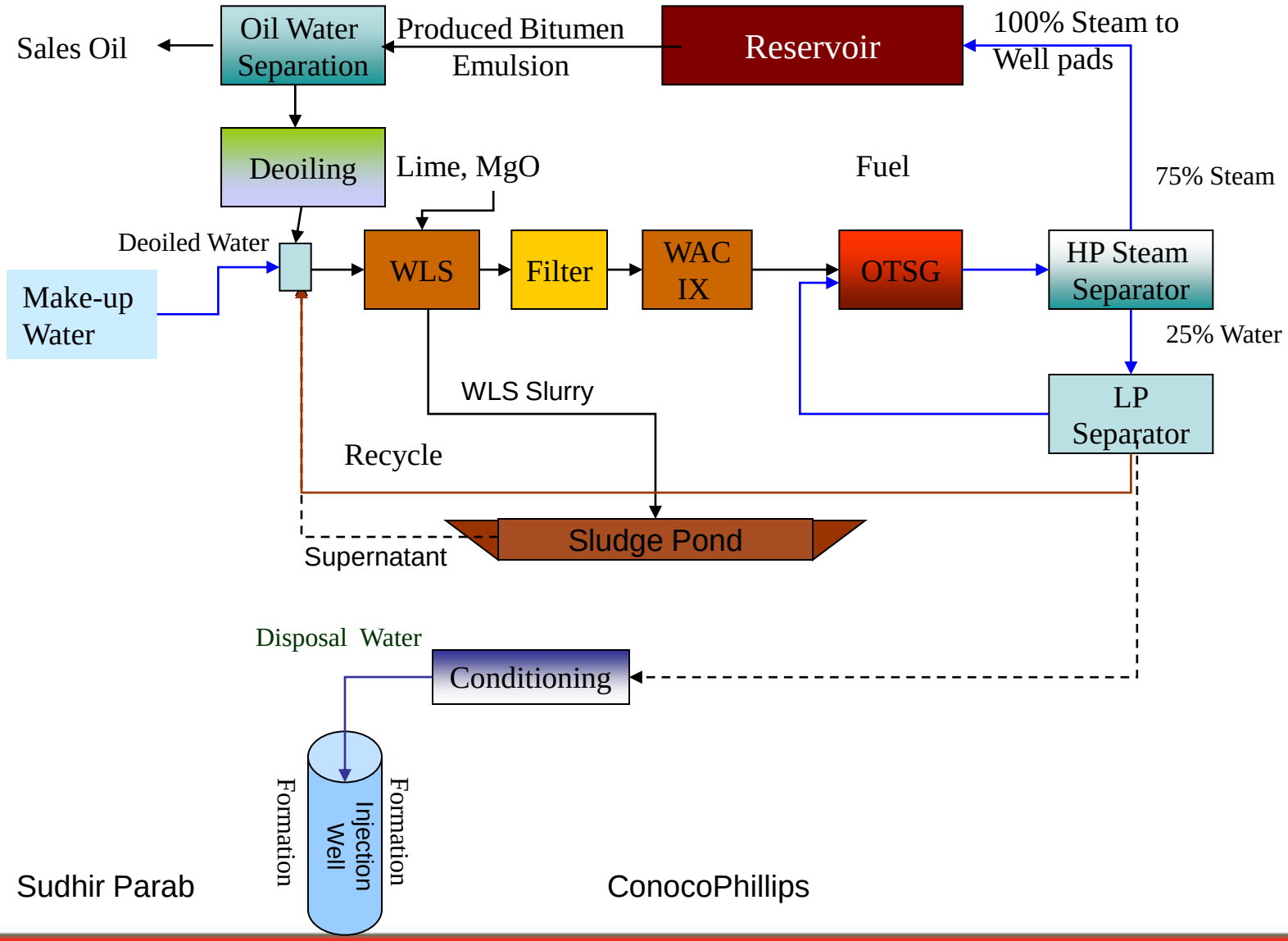
SAGD Water Treatment Scheme
(Conventional)



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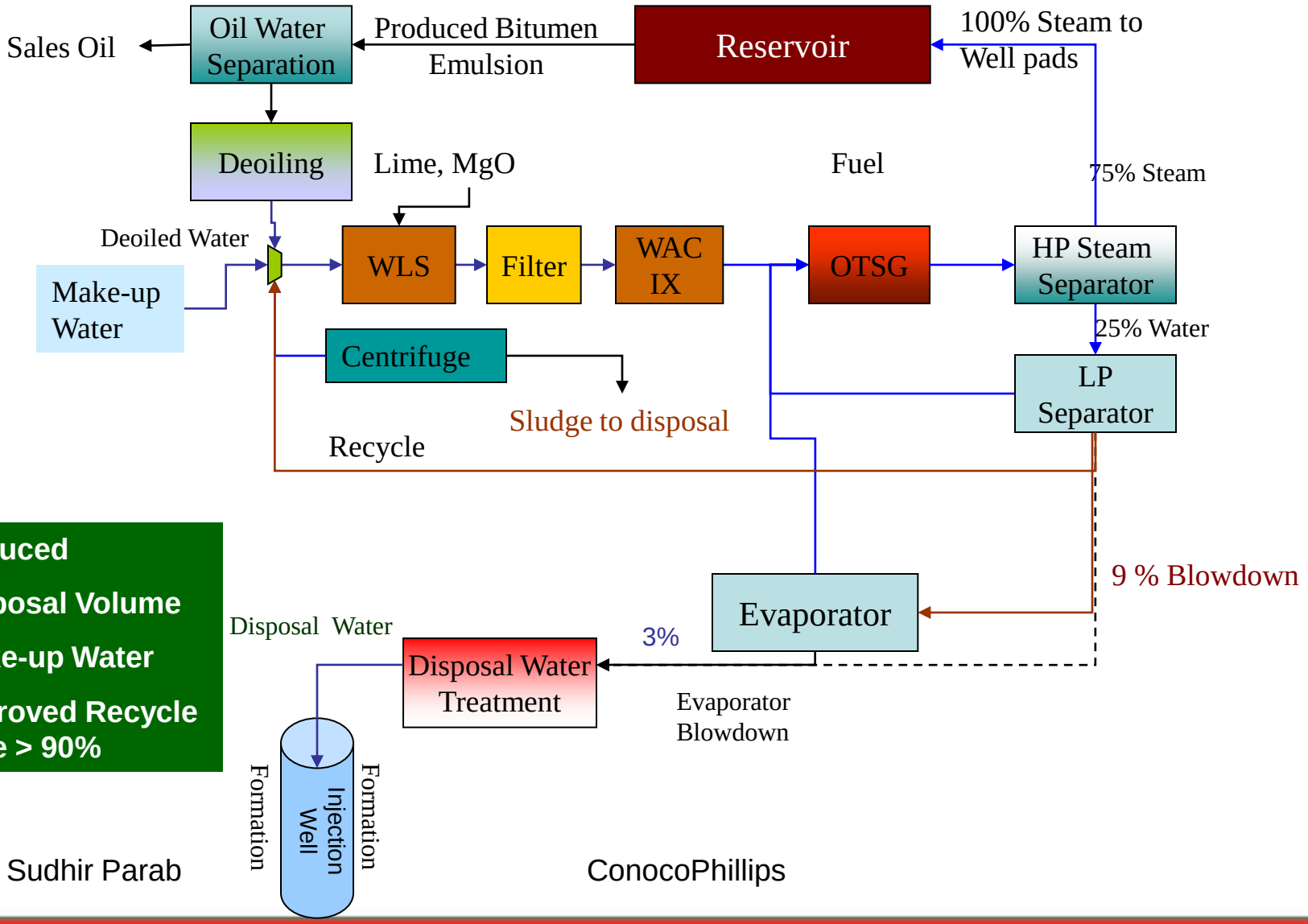
SAGD Water Treatment Scheme
(Enhanced configuration)



Reduced

Disposal Volume

Make-up Water

Improved Recycle Rate > 90%

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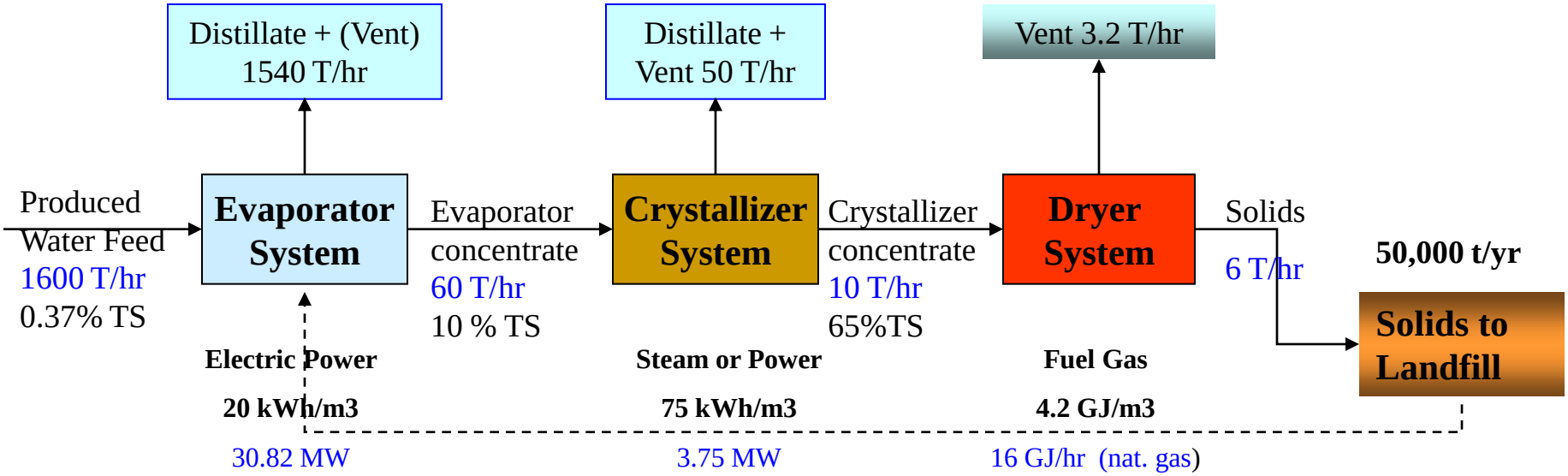
Reducing Disposal Water

Water Treatment System	Recycle Rate Prod. Water	Incr. Energy/ Incr. Water kW-hr/m3	Solids % in Disposal Water	Make-up water use
Conventional X 10 CF	Up to 90%	2 - 3	0.35%	20% - 22%
+ Evaporator X 3 CF	90% – 95%	20 - 30	10%	14%
+ Crystallizer X 6 CF	96% - 98%	80 - 100	60%	12%
+ ZLD Gas dryers	98% No incr. water recovered	**Natural Gas** 4.2 GJ/m3	97% +	12%

Reservoir retention assumed to be 12%

PW Evaporator/Crystallizer ZLD



Zero Liquid Discharge of Concentrate

- Commercial technology mainly used by producers with no access to disposal wells
- Limited long-term operation experience of ZLD for evaporator on produced water
- Increasing energy requirements: Evaporation –> Crystallizer —> Dryer
- Challenges in handling high conc. of organics, silica and TDS in concentrate
- Solids needs to be stored in a landfill in perpetuity
  - Long term liability concerns (potential solid stabilization requirements)
  - Preference to find a deep well disposal solution

Technology Development
for Sustainable Development of Resources

- Technology development is required to address the environmental challenges and sustainable development of resources
  - Evaluation of near commercial and emerging technologies
    - Produced Water evaporation
    - Disposal water treatment for well disposal
    - Zero Liquid Discharge, Fixation
  - Saline Make-up Water Treatment technologies
    - Hardness reduction using Ion Exchange
    - Desalination using Reverse Osmosis, EDR and Thermal processes
  - Sustainable Waste Management
    - Treatment and disposal of SAGD waste streams
  - Enhanced reservoir recovery methods (Longer term)
    - ES SAGD, Vapex and THAI

- Focus is on minimizing the water use & net environmental impact

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Saline Water Treatment

- Panel discussion
- Any questions