



Minimizing the Water Usage

for Thermal In Situ Oil Sands Schemes

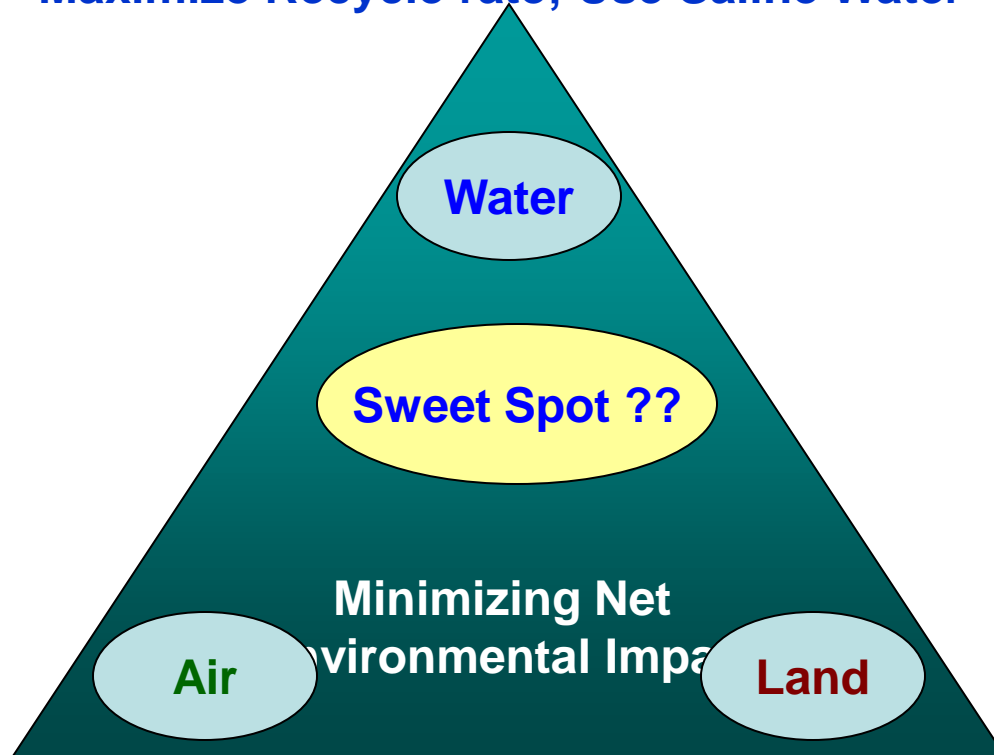
Trade-off and Challenges

CHOA Presentation
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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

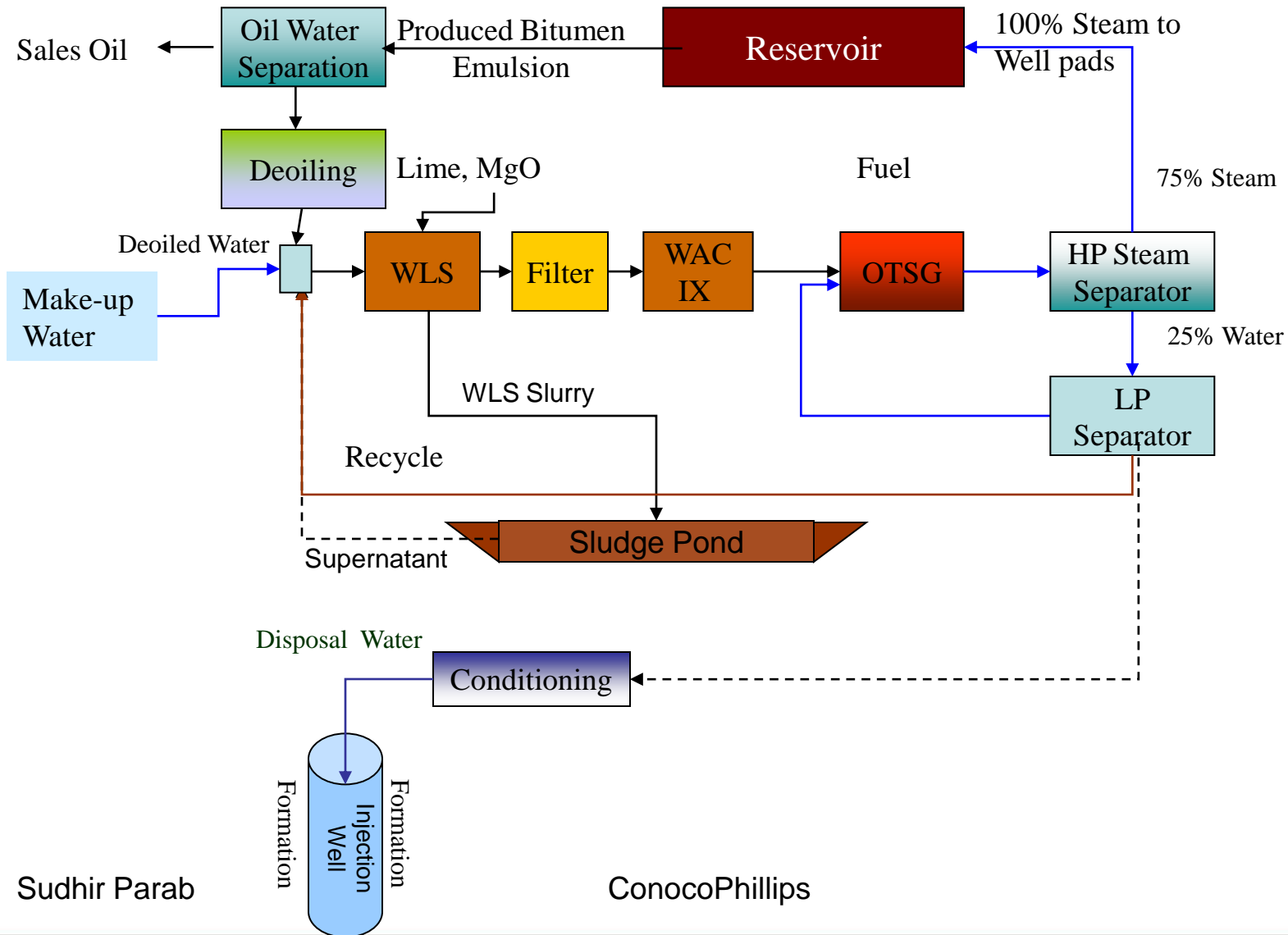
Reduce Footprint

Minimize Land use

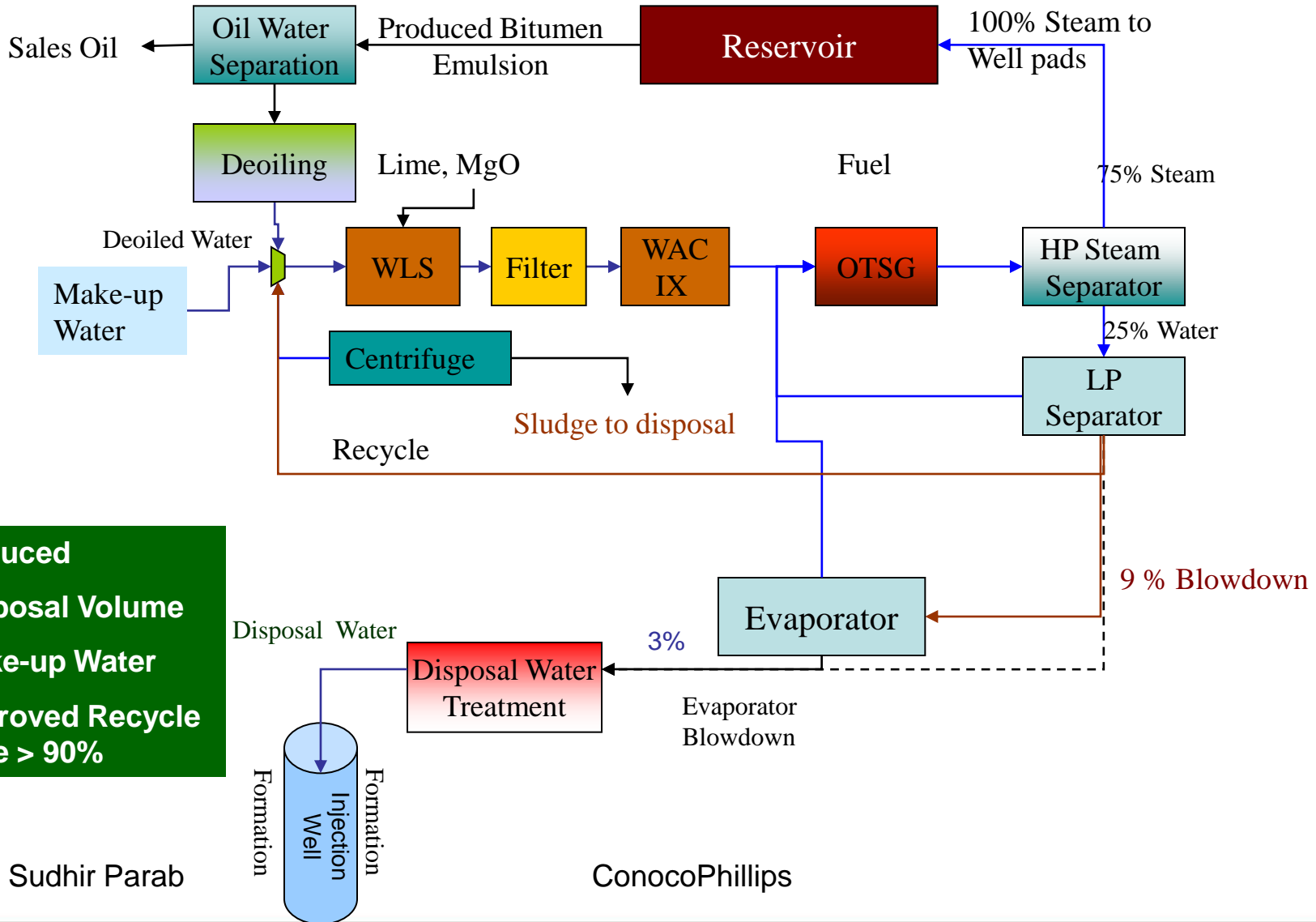
Reduce potential for contamination

- 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

SAGD Water Treatment Scheme (Conventional)



SAGD Water Treatment Scheme (Enhanced configuration)

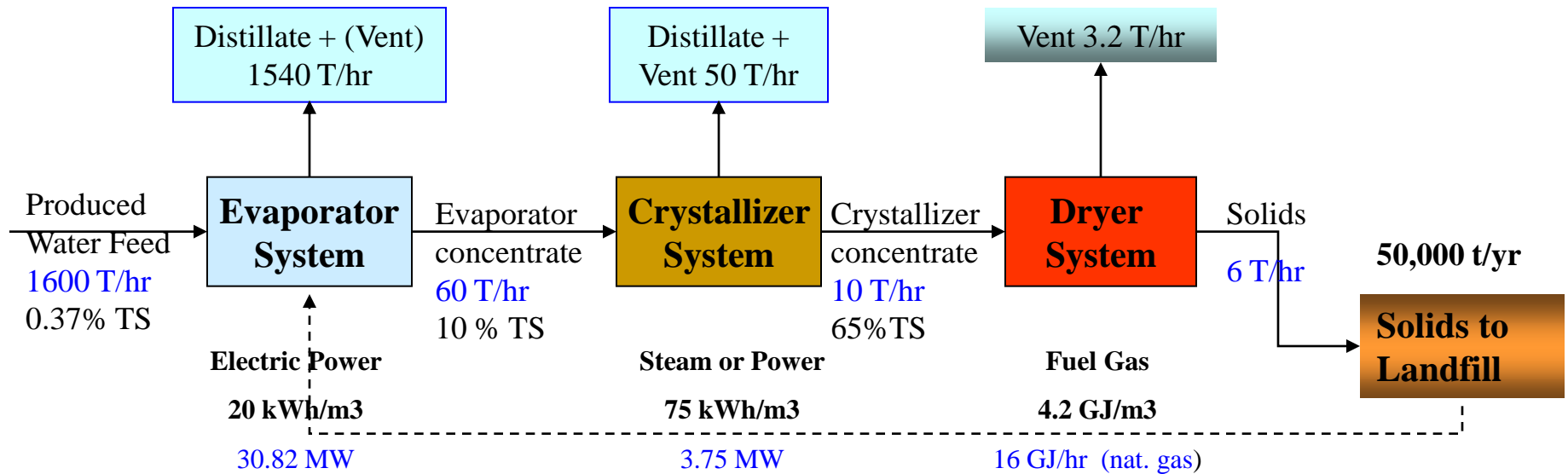


Reducing Disposal Water

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 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

- Panel discussion
- Any questions