



Introduction to Global Produced Water Strategies

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Produced Water Fundamentals

- Different types of oil & gas production have different water needs and generate different amounts and types of byproducts.
- Oil and gas companies must manage the water in a way that meets regulations and has an affordable cost
- There are different water management options that are chosen in different locations. Production companies may choose different options and strategies over time as the factors affecting their decisions change.
- At present, the average global produced water-to-oil ratio is at 5:1 barrels with a range from 3:1 to 22:1 for conventional and 1:1 to 8:1 for unconventional (Wood Mackenzie, 2018 and Coffee, 2018)
- 210 billion bbl/yr now (GWI Market Report, 2016) and forecasted by many to go to much higher in the near future.
- **Produced water should be thought of as an asset, not a waste**





Produced Water Recycle & Reuse

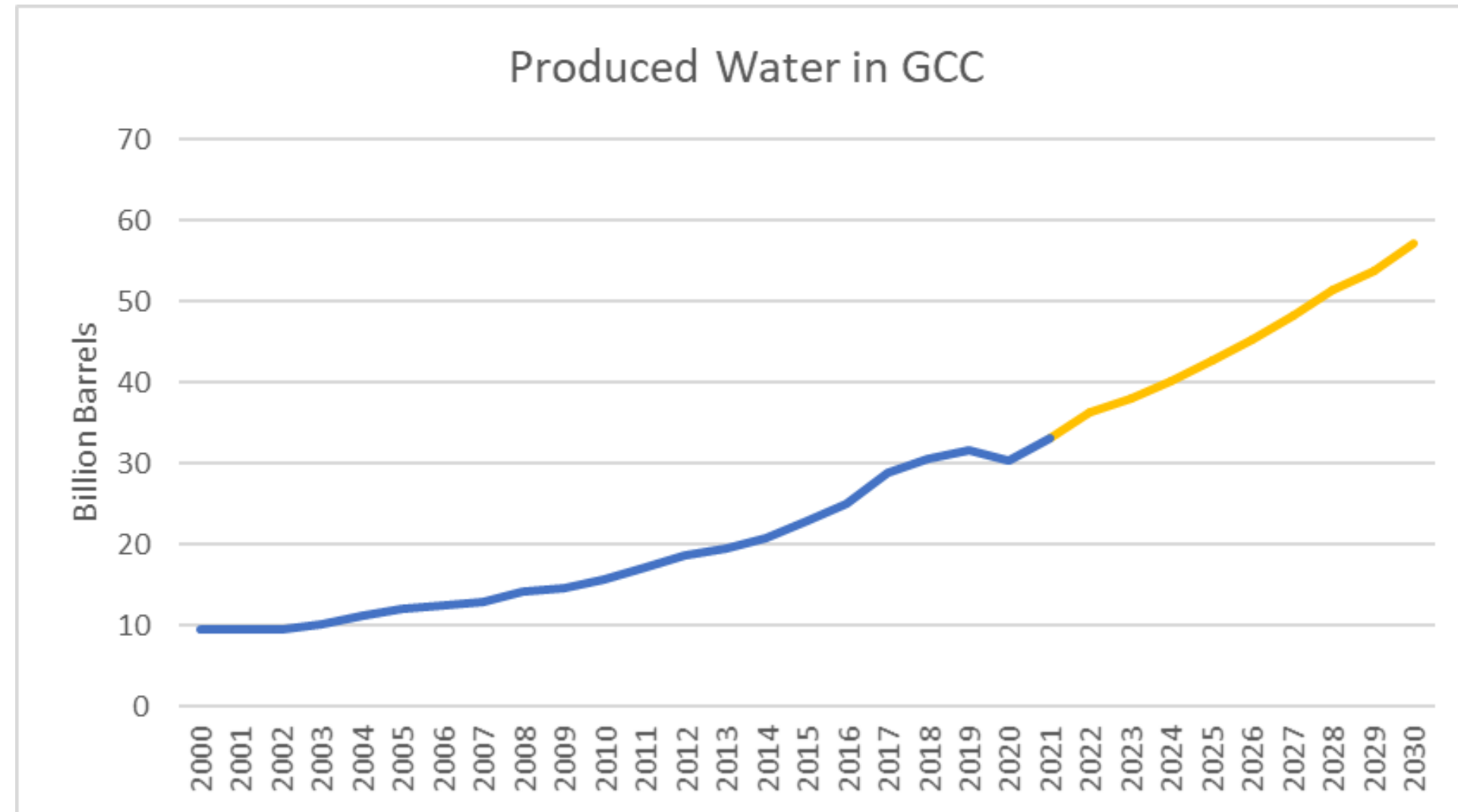
- Over the past decade, the concept of produced water and reuse for activities other than secondary recovery has been discussed and promoted. But beneficial use remains a challenge for various reasons.
- Only a small percentage of the total produced water is recycled and put to a beneficial use other than secondary recovery in the conventional market.
- Unconventional market (specifically shale plays in the US), is still a very low recycle percentage
- There are several market drivers and restraints. Drivers include: oil price; water-to-ratio; environmental regulations; water scarcity; and, the industry's conservative approach.





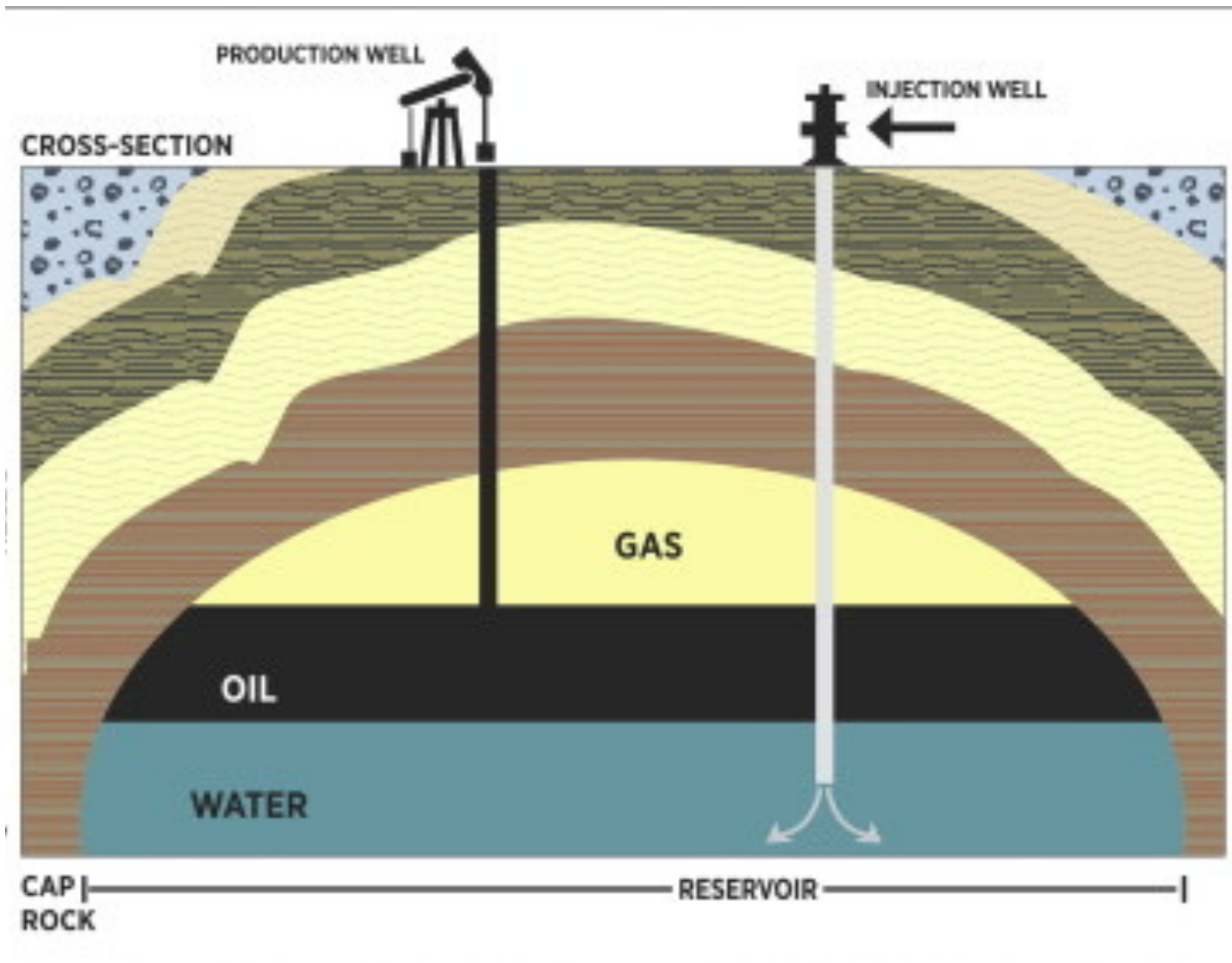
Overview of Produced Water in the GCC

- Increasing at 6-7% Annually
- Increasing CAPEX and OPEX
- Reservoir Issues
- Operational Challenges
- Environment Concerns





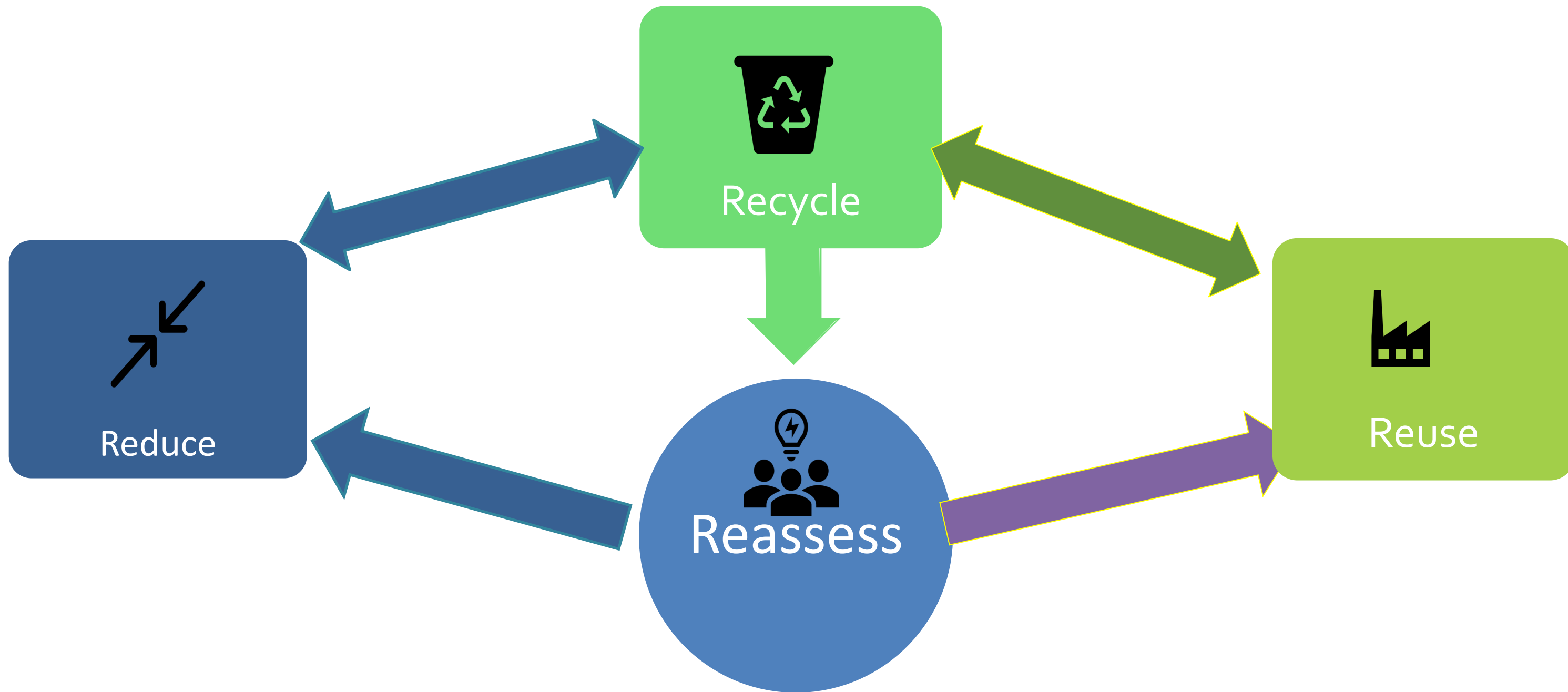
Overview of Produced Water



- Naturally Exist
- Hypersaline (>100,000 mg/l)
- Contaminated (Oil, H₂S, NORM...etc.)
- Costly to Treat

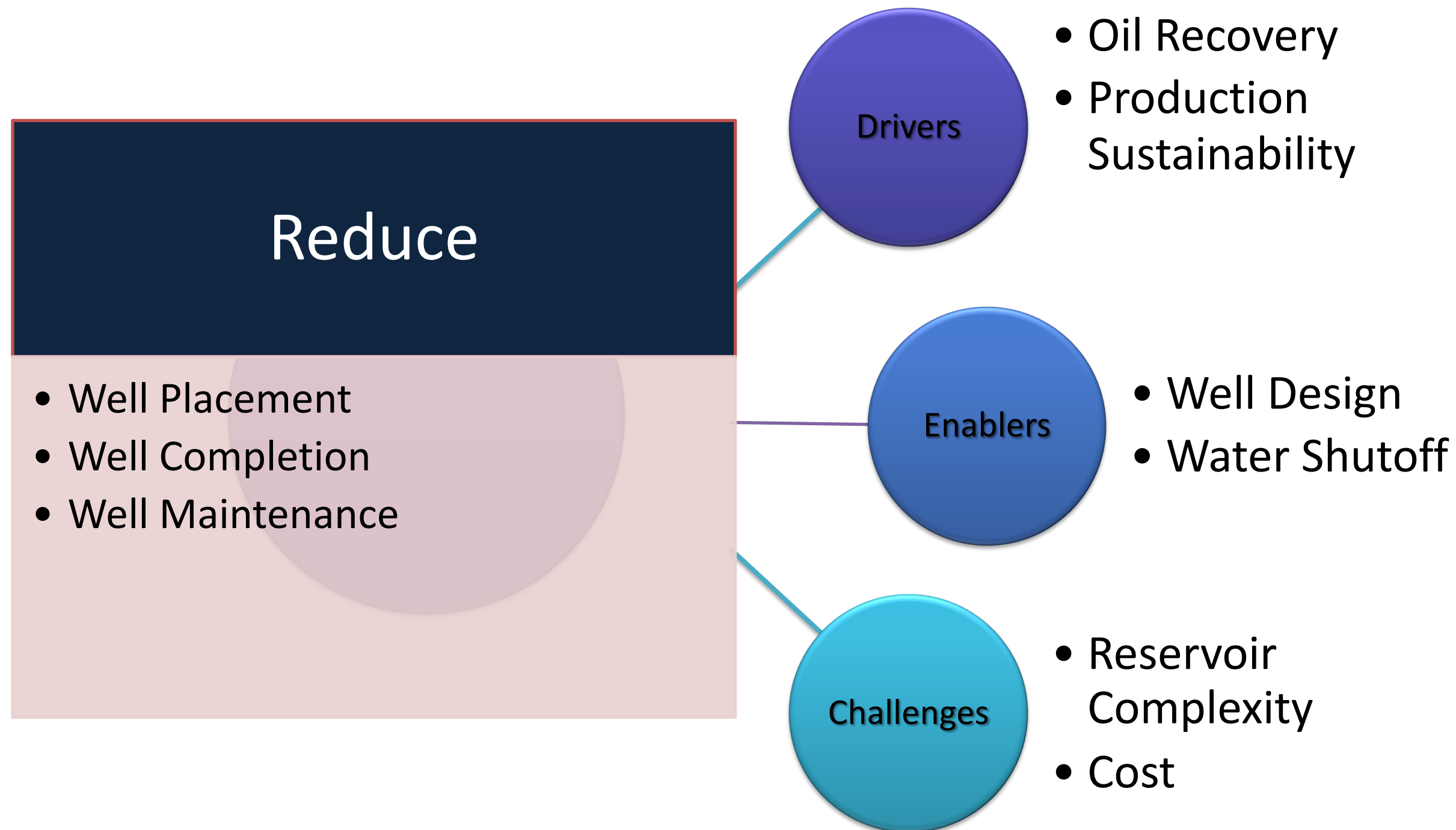


Areas of Focus for Global Produced Water Strategies



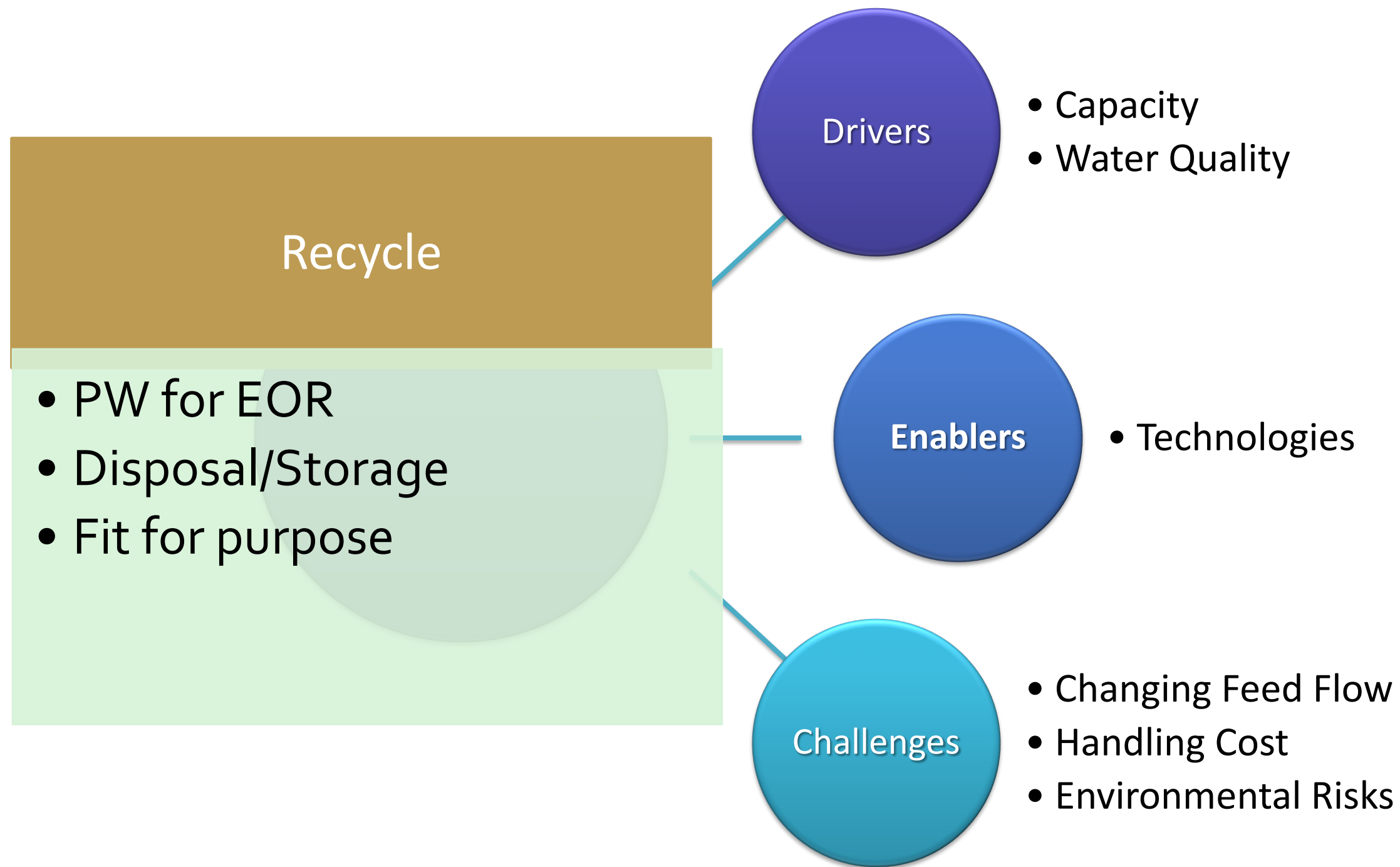


Discussion and Findings



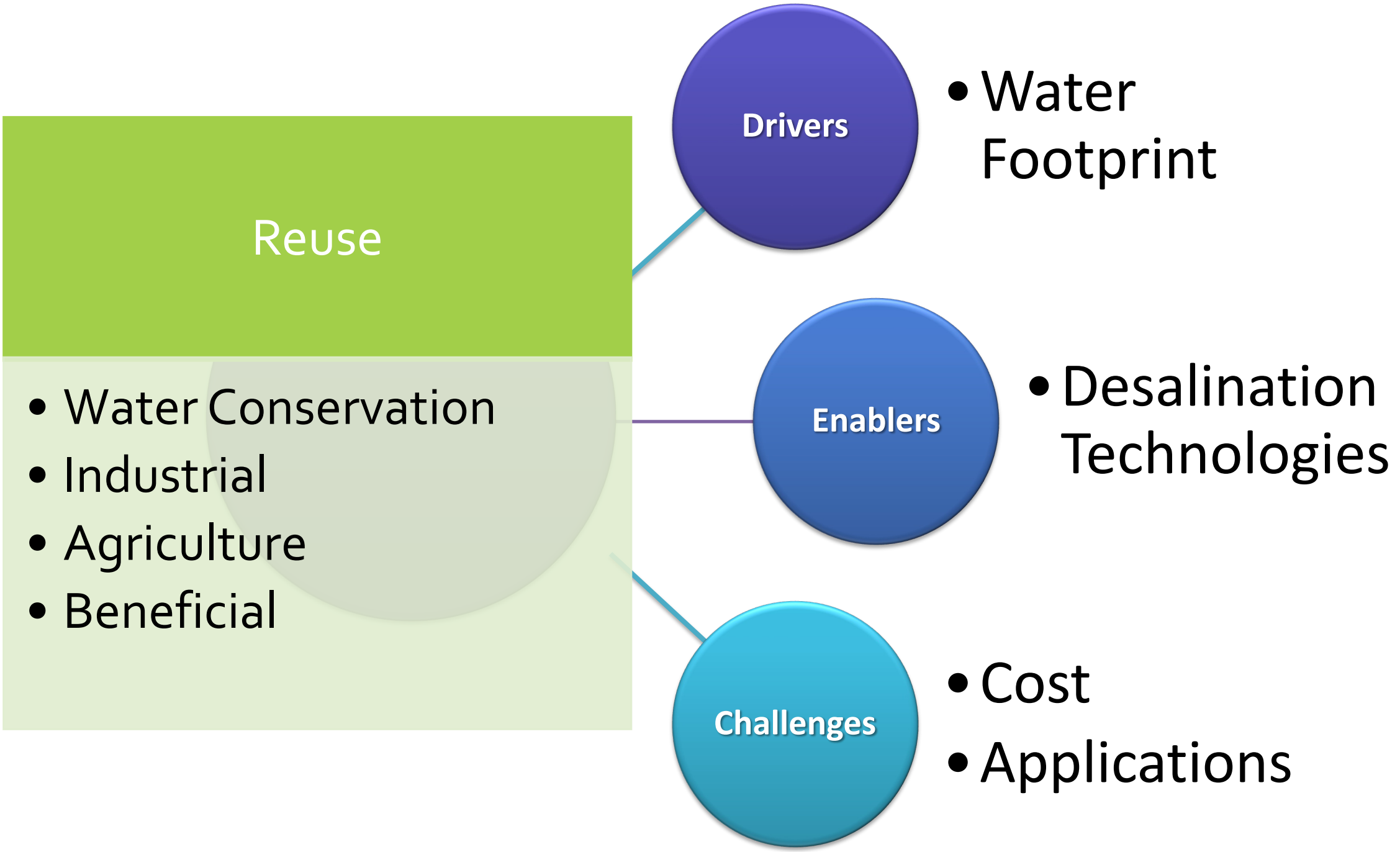


Discussion and Findings





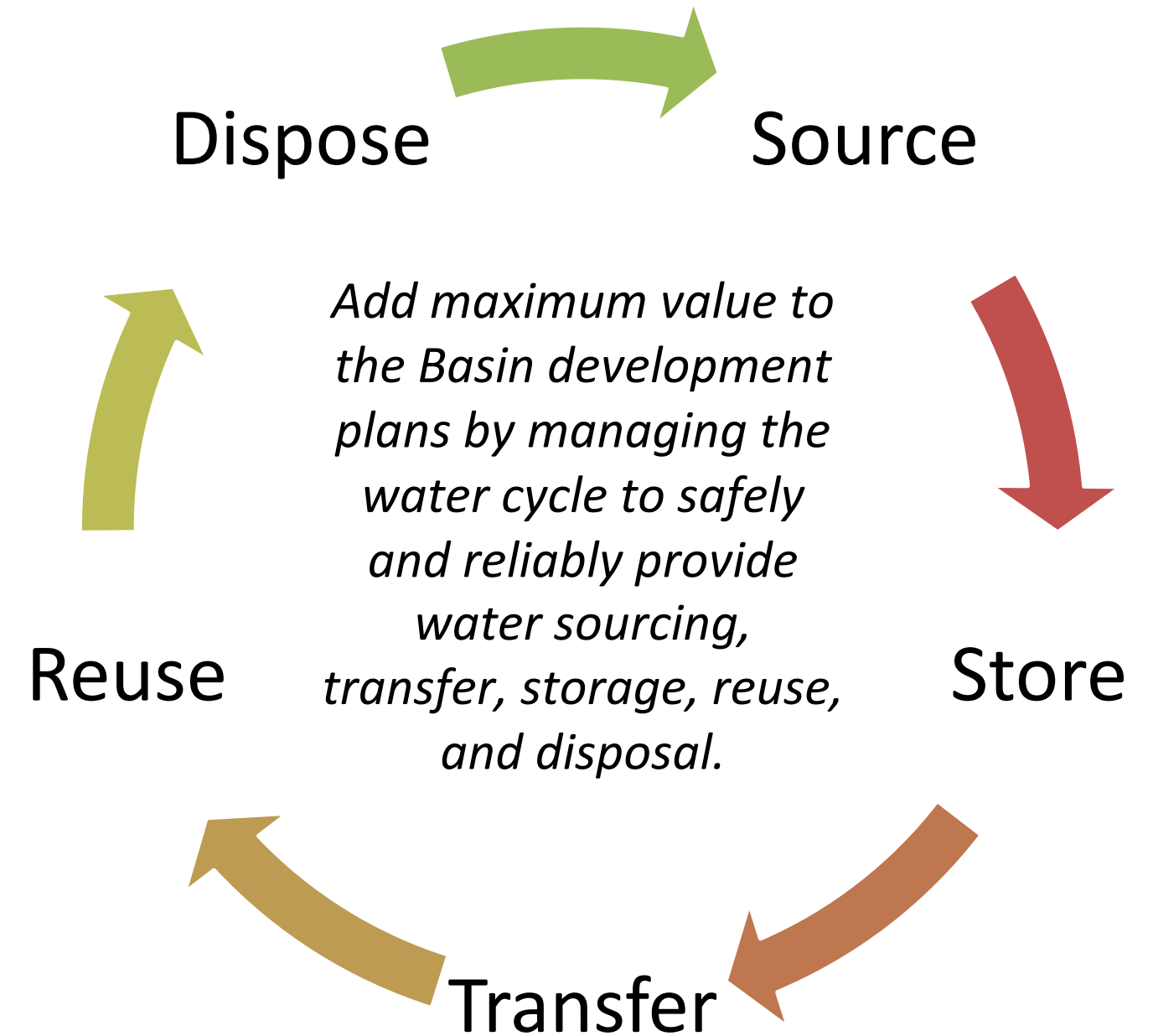
Discussion and Findings





Decision Analysis: Integrated Multidisciplinary Team

- Completions and Drilling Engineering
- Reservoir Engineering
- Development Engineering
- Geoscience
- Technology
- Strategic Sourcing, Supply Chain
- Operations and Production
- HSE
- Land, Surface, Legal, Regulatory





Why is Produced Water Not Reused and Recycled More Often?

Barriers and Solutions to Overcome Them - Economics

- Water is heavy and is expensive to move long distances
- Injection into disposal wells has been convenient, inexpensive, and accepted by regulators—little incentive to look at other water management options in many regions
- Solutions—Continue the development of cost-effective desalination approaches that can work dependably in harsh oil field environments
- Induced seismicity in a few regions has reflected negatively on disposal wells and created a new opportunity for the beneficial use of produced water
- Lack of experience and education for known cost-effective treatment solutions





Why is Produced Water Not Reused and Recycled More Often?

Barriers and Solutions to Overcome Them - Policy

- Water rights. As long as produced water is a waste, water rights owners are not too concerned. But if produced water can be sold, water rights owners will want a cut of the fee.
- Liability. Large oil and gas companies are worried about the risk of later lawsuits if produced water is sold or given to end users.
- Solutions—Try to educate lawmakers and staffers
- Look to establish third-party entities that can accept produced water and distribute it to end users (mitigates liability)
- Look to states that have developed innovative regulatory programs to allow and encourage beneficial use
- Again, lack of experience and education for known cost-effective treatment solutions





Results...

- Produced Water Rates and Handling Cost are Continuously Rising
- The **Three Domains of Produced Water Management** (Reduce, Recycle and Reuse) are Typically Handled Independently of each other (**then reassess**)
- Unnecessary Cost Might Be Realized with Lack of Integrated Approach
- Low Reuse Applications of Produced Water due to:
 - Availability of Alternatives
 - Higher Treatment Cost
 - Uncomplete Cost/Benefit Analysis of Produced Water System
- Challenges in Developing and Retaining Produced Water Management Skills



Conclusion and Recommendations

- Integrated Produced Water Management Framework Should Be Adopted
- Centralized Produced Water Management Department:
 - Develop Needed Skills
 - Retain Expertise
 - Centralized Decision Making
 - Enhance Communication
- Holistic Approach Should Always be Used for Reuse Applications Evaluation
- More Regional R&D is Needed to Develop Lower Produced Water Treatment Cost
- Collaboration with Regional Universities
- Decision Making Process Should be Continuously Reassessed to Converge to the Most Optimum





Produced Water Programs of the Future

Produced water programs of the future:

- Should commit to a viable, sustainable water source for continued production gains
- Must not pose a safety risk
- Must be cost effective and fit for purpose
- Should offer flexibility and choice for short and long term
- Should have central gathering and distribution locations
- Will use existing and new technologies to facilitate recycling and reuse efforts
- Should deliver a resource comparable to the fresh water used prior to injection
- Will reuse produced water for stimulation whenever appropriate
- Will be based on solid evidence gleaned from a collaborative research effort
- Must be sustainable (should not cause any long-term production issues or life-of-well problems)





How Can We Do Better?

- Learn & share more
- Encourage more and better data collection
- Look to applications for better data use and visualization
- Initiate research efforts to collect more data on produced water quality
- Regulations may need to be revised to allow these interactions
- Develop and publish case examples to help educate user and potential users





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