



Utilizing Produced Water as a New Water Resource

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Introduction

The energy industry has an issue with produced water and its associated costs.

- Produced water is water that is generally mineralized and contains particulate and dissolved organics and is brought to the surface with oil and gas operation
- Produced water originates in both conventional and unconventional oil and gas formations
- The amount of energy that can be produced is directly related to how much produced water can be disposed of into injection wells or discharged to the surface water.
- It is currently the industry standard to re-inject produced water into Class II injections wells, wasting a valuable water resource

We also face a significant water shortage in the western United States. This water shortage is causing significant issues associated with water transfers from agricultural to urban areas as well as constraints on growth of urban areas in the west.

We believe that produced water can be part of the portfolio of water rights that can assist with less dependence of ag-to-urban transfers as well as becoming a new water resource for the western United States. This will also allow for the increase in domestic energy development by removal of the constraint on energy production.

Energy – Water Nexus of Produced Water

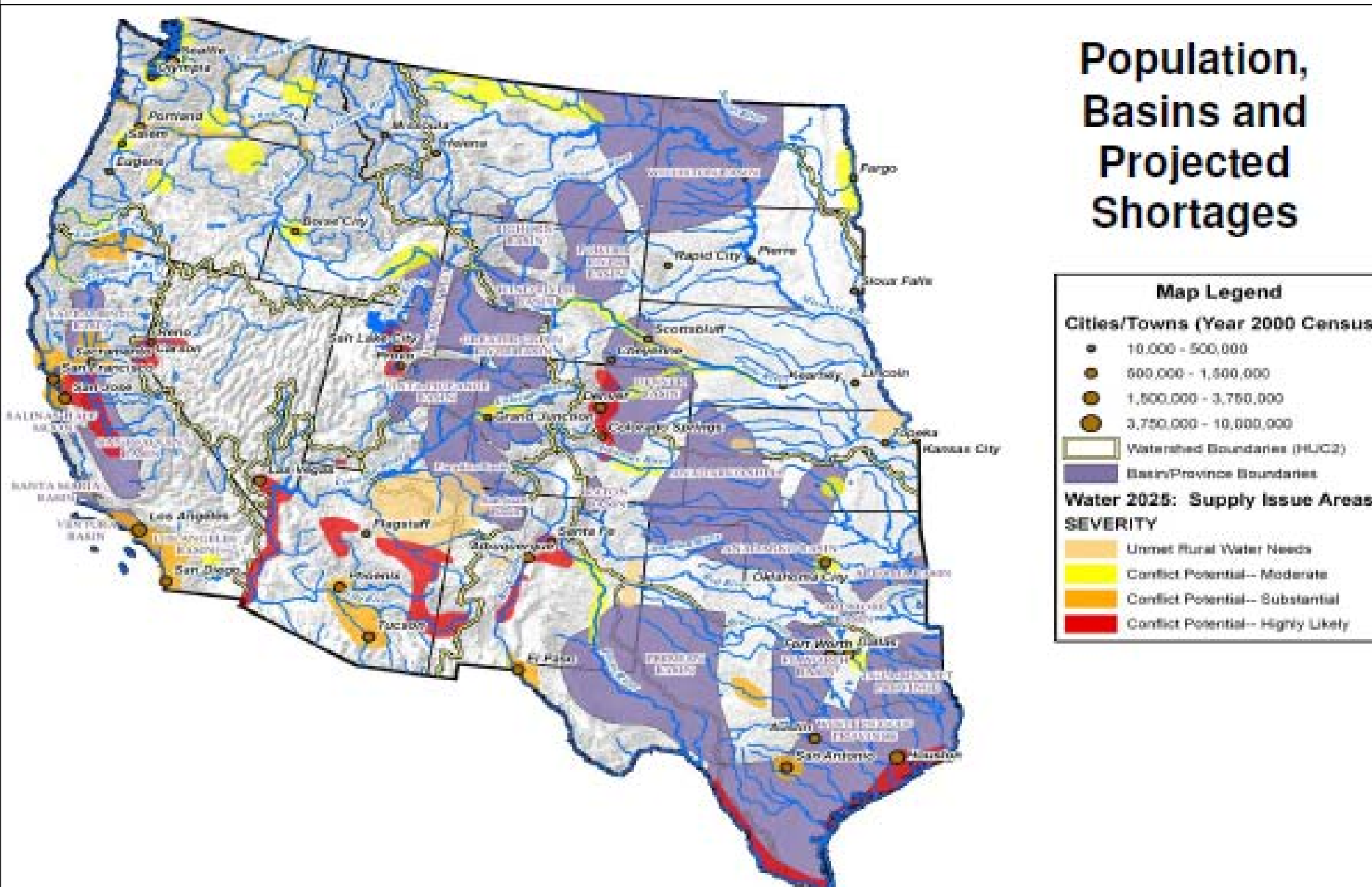


Figure 1 – Produced Water Generation overlain on Water Short Areas

- 20% to 30% of the energy that is produced is consumed through re-injection to a deep aquifer
- Produced water is the constraint to more domestic energy production – if the constraint to produced water is removed, then more domestic energy production is possible
- Treatment of produced water uses 5% to 8% of the energy produced, depending on the type of treatment employed
- The amount of produced water generated in the United States is estimated at 20 to 25 billion barrels per year.
- Produced water can be another asset that can be maximized if treated properly

A Resource and an Asset

Conventional Thinking

- Waste Product
- High Disposal Costs
- Environmental Concerns

New Reality

- New source of water
- Treatable for beneficial use
- Substantial quantities

A Resource and an Asset

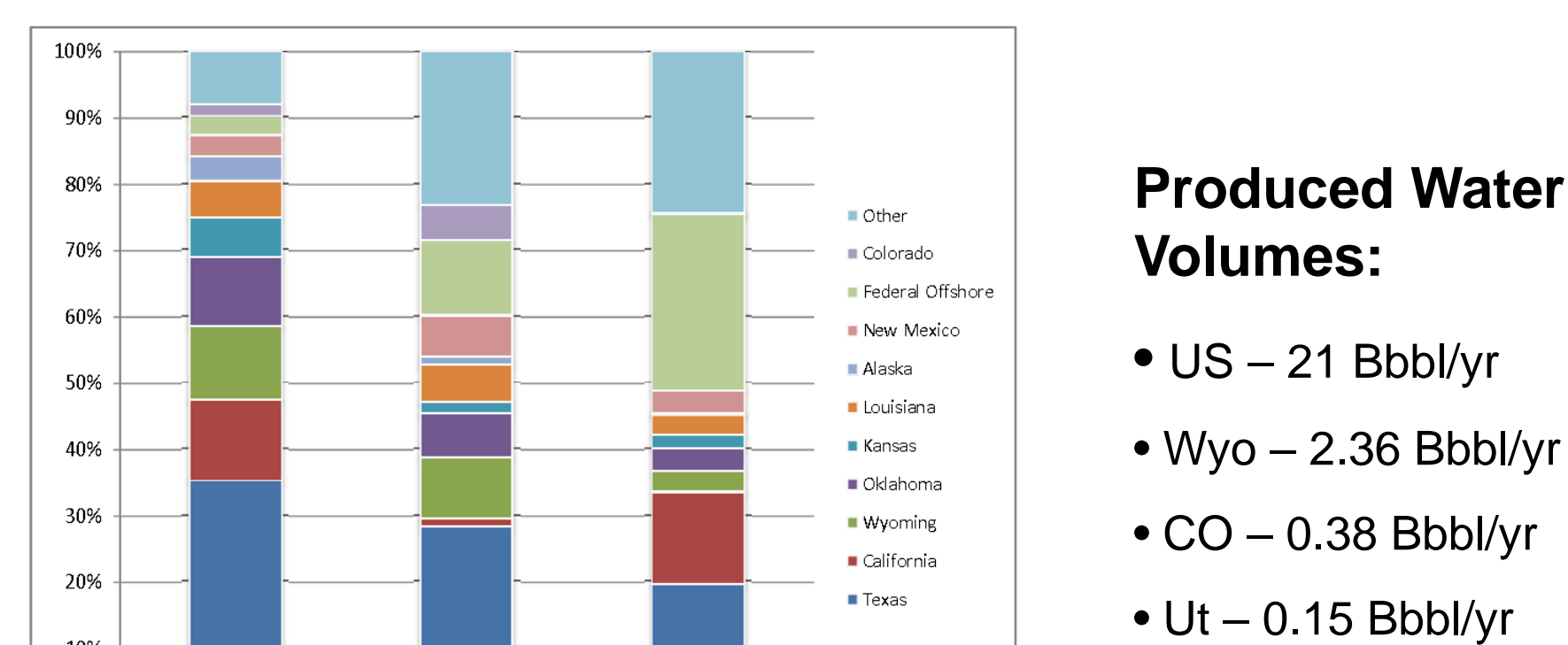
Historically, produced water has been treated as a waste product

- Current methods of disposal – reinjection (Class II Injection Wells), evaporation ponds and direct discharge – are being challenged due to adverse environmental impacts

Turn this wastewater into an asset - a marketable product - by:

- Treating for surface discharge
- Conceiving a unique water delivery system - augmenting tributary water supplies with non-tributary water
- Pioneering a path through the numerous legal and regulatory obstacles

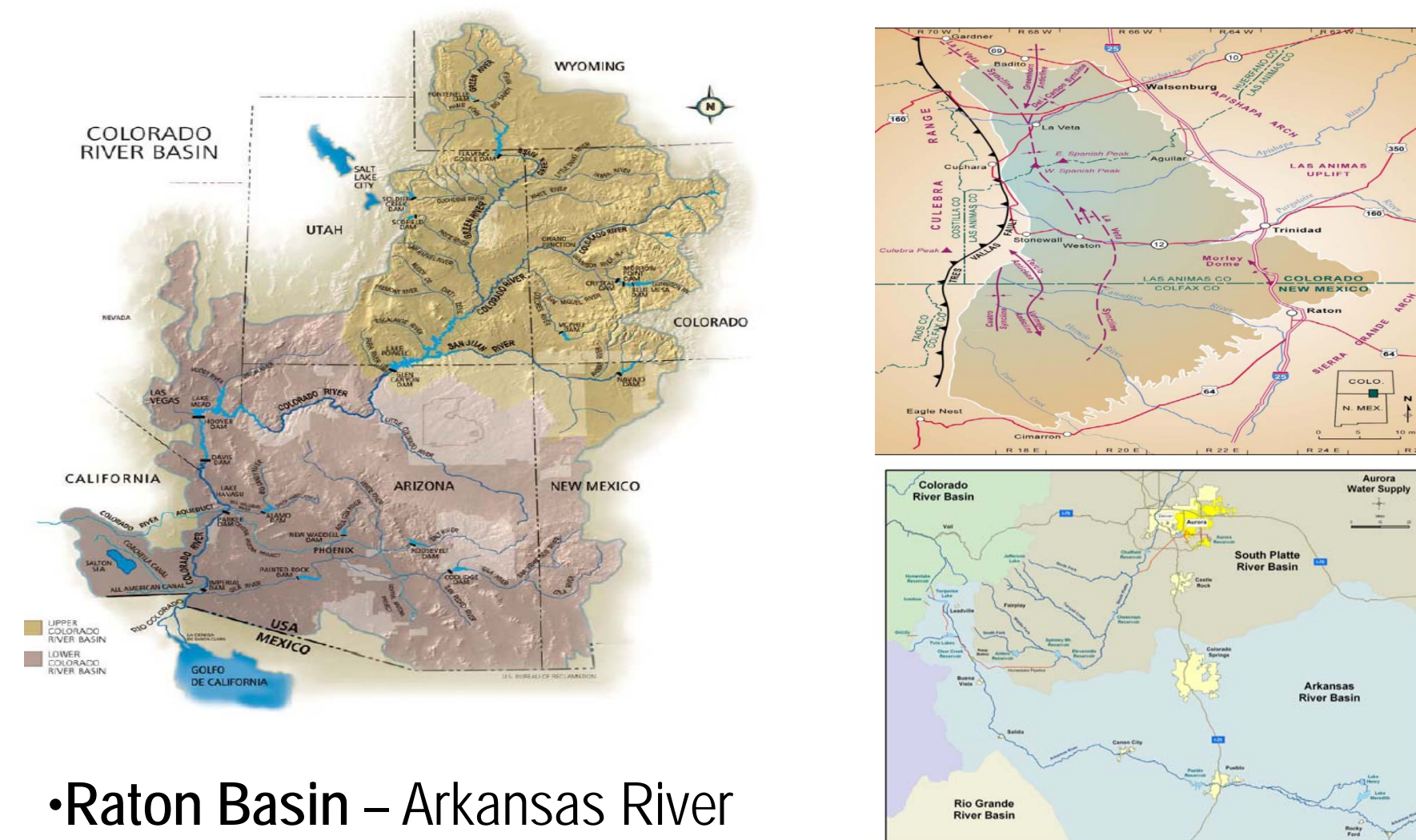
How Much is there in the US?



Examples of Beneficial Use

Upper Colorado River Basin – at 2 bbl's/MCF – 70,000,000 AF or potentially 500,000 to 1,000,000 AF per year

- Potential users are entities on the lower Colorado River Basin
- Need all entities within the Colorado River Basin to cooperate
- Discussions with State Engineers of the Upper Colorado River Basin



Who Owns the Water?

Colorado Example

- Tributary – Non-Tributary Groundwater
- HB 1303 – how does this apply in Colorado
- SB 165 – produced water beneficial use
- COGCC Rules (907)
- State Engineer
 - Agreement on non-tributary status (Fossil water in other states)

Who Owns the Water?

Colorado Example - continued

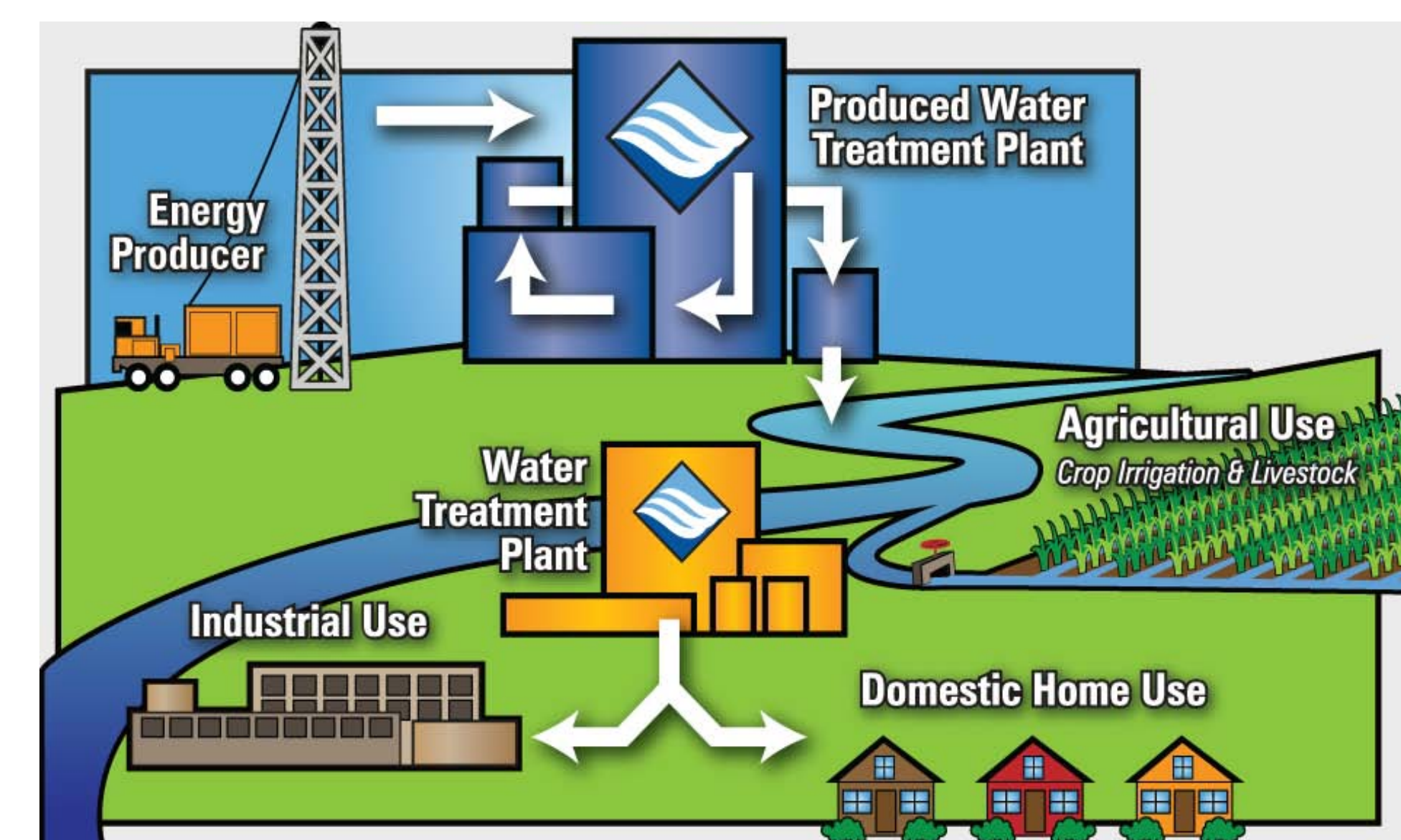
- CDPHE Technical Review, Permit and approval
- Landowner issue
- Water Rights & Court

Legislation introduced this year to streamline this process

Other Western States

- Prior appropriation
- First in Use – First in Right
- Wyoming – 1,000 AF non export law

Four Example Projects



Wellington Water Works – Wellington Colorado

First facility in the United States to beneficially utilizing produced water as a water resource:

- Agriculture water for organic farm
- Augmentation water for local municipality
- Water for hydraulic fracturing make up water

- State Engineer approval
- Colorado Department of Public Health and Environment approval
- Colorado Oil and Gas Conservation Commission Approval
- Water Court Approval

Utah Facility

Westwater Utah

- 5,000 bbl per day facility expandable to 15,000 bbl/day
- Very tight discharge standards
 - Metals
 - VOC's
 - Salt Loading (Sodium Adsorption Ratio)
- Utilization of patented treatment system
- Selling of water for pipeline testing, fracturing make-up water
- Class II injection well for brine solution
- Interstate transfer of water



Wyoming Tight Sand and CBM Projects

Savory WY project (CBM)

- Treatment of CBM waters for discharge
 - Issues with Microbiology
 - Lower cost (by 65%) for treatment when compared to produced water from oil wells or hydraulic fracturing flowback fluid
- Output of the facility 980 AF will increase to > 10,000AF/yr
- Discharge to the upper basin of Colorado
- Recovery of lithium from formation

Riverton WY project (Tight Sands)

- Treatment of tight sands waters for discharge
 - Issues with silica and scale forming compounds
 - Lower cost (by 65%) for treatment when compared to produced water from oil wells or hydraulic fracturing flowback fluid
- Output of the facility 980 AF will increase to > 10,000AF/yr
- Discharge to the upper basin of the North Platte

Texas/New Mexico Brackish Water project

New opportunity for treatment of brackish waters as a new water resource for energy development.

Summary & Notes

- Projects underway in major US basins
- Process for both conventional and unconventional energy formations
- Bench-scale Laboratory & Pilot testing is imperative
- Ceramic Microfiltration was critical to the overall operation
- Will utilize brine to manufacture acid and bases
- Custom Blending of discharge for unit operation reuse adds value

Conclusions

1. Produced Water is a viable water resource
2. Produced Water treatment is cost effective
3. Produced Water should be pursued as a new water resource for the United States
4. Colorado River basin transfers – significant potential - Need for cooperation

More Information

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