

LIFE CYCLE CONSUMPTIVE WATER USE OF U.S. OIL SHALE

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BACKGROUND

Oil shale is abundant resources in the U.S. Expanding U.S. energy mix to include synthetic crude oil from oil shale might be another important component in diversifying and securing the U.S. energy supply. Most of the oil shale resources are within the Green River Formation in Colorado, Utah, and Wyoming. This region, however, has been experiencing water scarcity for the past decades.



Oil shale - Image by U.S. DOE

RESEARCH QUESTIONS

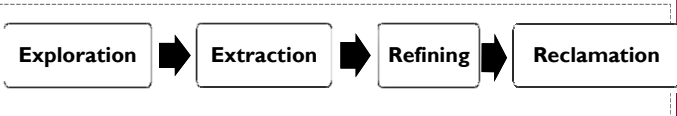
- What is the life cycle consumptive water use of U.S. oil shale?
- How and where to obtain water for U.S. oil shale development?

CONCLUSIONS

We found that water availability might be the deal breaker for oil shale production, not GHG emissions or costs. Although, technical solutions could address some of the problems associated with the use of water resources, it could not solve the potential conflicts among different consumers in different states that would be affected by oil shale project development.

STUDY BOUNDARY

Life cycle of crude oil

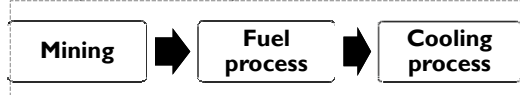


Electricity

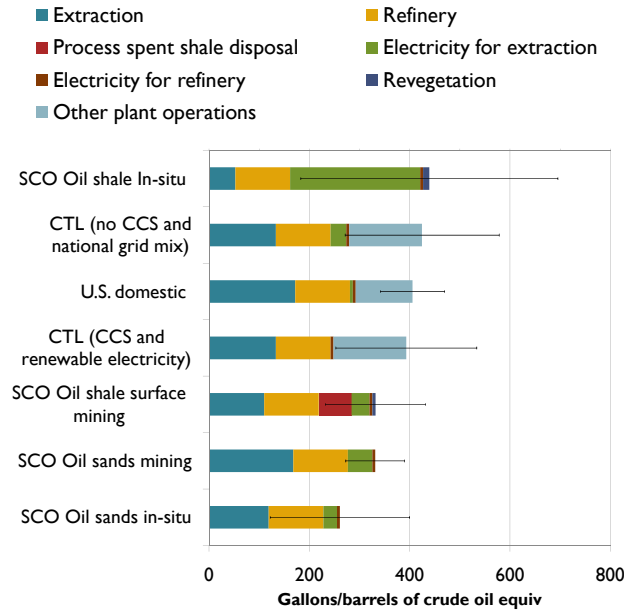
- 50% Coal
- 19% Nuclear
- 20% Natural gas
- 2% Petroleum
- 7% Hydro
- 2% Renewable

87% Conventional oil
13% EOR (5% CO₂ flooding, 6% steam, 2% others)

Life cycle of electricity



RESULT: LIFE CYCLE CONSUMPTIVE WATER USE

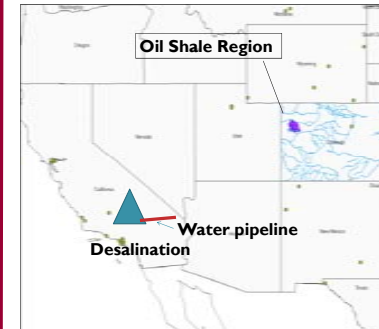


Note: *Other plant operations*: includes plant service and boiler make-up water. For coal facilities, this also includes ash handling and flue-gas desulfurization process make-up water.

- Life cycle consumptive water use of oil shale surface mining and *in-situ* process is estimated to be 234-433 and 177-711 gals/bbl of crude oil, respectively.
- The comparison illustrated by above figure, however, can be misleading since water is a regional problem. As a result, life cycle consumptive water use for oil production should be examined at a regional level.

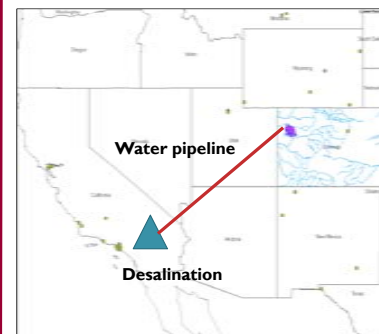
WATER SUPPLY FOR OIL SHALE PRODUCTION SCENARIOS

We developed two scenarios of how and where to obtain water for U.S. oil shale development. The scenarios also include assumptions about the locations of the refineries that would receive the oil shale-derived petroleum.



SCENARIO I

Trades water rights with the lower Colorado River basin by investing in construction of a desalination plant in California and a water pipeline from California to Arizona



SCENARIO II

Construct a desalination plant in the West Coast and a water pipeline to transport desalinated water from the West Coast to the oil shale region, Piceance basin, Colorado

DISCUSSION OF RESULTS

- Water availability near the oil shale region is limited and seasonally fluctuates.
- The additional desalination plants and water pipelines that may be needed to meet the water demand by the oil shale industry do not significantly affect life cycle GHG emissions or total consumptive water use of oil shale production.
- Consumptive water use and GHG emissions in desalination plants, water and crude oil pipelines would contribute only 1-4% and 1-2% to life cycle consumptive water use and GHG emissions, respectively.

References

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- (2) Brandt, A. R., Converting Oil Shale to Liquid Fuels: Energy Inputs and Greenhouse Gas Emissions of the Shell In-Situ Conversion Process. *Environmental Science and Technology* **2008**,
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