20.02 **The Energy, Water and Carbon Balance of Extracting Unconventional Petroleum Resources**

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The analysis addresses two specific issues of North America's demand for unconventional oil resources: the lifecycle carbon footprint and the water required to fully extract the resource. In order to determine what the most efficient extraction methods may be, the team is assembling available open source data on oil shale and sands technologies, production, energy usage, water usage and the associated carbon footprint per barrel of extracted unconventional petroleum within an integrated, interdependency model. The analysis will build on this methodology to initially assess the true scale of these less well developed petroleum resources. Unconventional petroleum, depending upon the resource and technologies employed, may require 2 to 4.5 barrels of water and 1 thousand cubic feet of natural gas (and correspondingly higher CO_2 emissions) per barrel of petroleum extracted, which is roughly 3 times the energy used to produce a barrel of conventional oil. Compared to conventional sources of petroleum such as in Saudi Arabia, 3 to 7 barrels of water is *produced* per barrel of petroleum. Thus, extracting unconventional petroleum reserves can be relatively water and energy intensive, which could result in correspondingly greater environmental impacts when the process is scaled up to the billions of gallons (and trillions globally) of potential petroleum in place. These discussions often arise when considering the oil shale in the Green River Formation covering portions of Colorado, Utah and Wyoming. This resource could produce enough syncrude to supply more than 100 years of U.S. oil consumption at the current demand levels. Exploiting this energy resource, however, may require 3 gallons of water per barrel of produced oil shale petroleum – competing for the already heavily used water resources of the Colorado River Basin. The analysis plans to develop metrics based on the quantity per barrel of produced unconventional petroleum including (1) $/barrel (2) gallons of water/barrel (3) CO_2/barrel over the coming several decades if these large-scale resources were to be more fully developed and (4) by specific extraction process. The final product will be a GUI-based decision tool that will develop fully integrated, systems-level scenarios as a function of the resource potential, energy use, water (use and produced), extraction costs, carbon footprint, infrastructure and other salient economic factors.