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Water use for in situ production of oil from oil shale

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Water consumption in the extraction of oil from oil shale will clearly be a central issue in interactions between potential producers and external stakeholders, including regulators at least in the United States, but likely wherever water resources are scarce. We have modelled the likely water production and consumption of an in situ process using a simplified model, but capturing significant uncertainties in all parameters. The process modelled resembles the Shell In Situ Conversion Process (ICP), chosen because of the availability of more comprehensive descriptions of at least test arrays. It consists of electric heaters placed at depth and powered by one of several different closed loop, steam-based power plant types, all of which involve evaporative cooling of steam. The heated block and a buffer zone around the block are contained by a freeze wall. Water use is defined in various phases, including construction, drilling, heating and production, and reclamation. Reclamation involves circulation of water through the heated block until contaminant levels are reduced below regulatory limits. Power plant water usage is defined by the heat required to achieve in situ retorting temperatures. Results indicate that the primary consumptive uses of water are for the reclamation and for power plant cooling. Large uncertainties remain in the number of pore volumes required to achieve reclamation, and in the efficiency of recycling of reclamation water. As a consequence, the reclamation water volume could even exceed the commonly cited upper estimate of five barrels of water per barrel of oil. However, the large uncertainty also allows for very low values of water consumption. Companies must focus on the high end when acquiring water rights and receiving authorization for water use permits, and yet may be able ultimately to justify the low end on the basis of RD&D results. Nuclear power plants show the highest water use requirements, whereas combined cycle natural gas power plants have quite modest water requirements, with more traditional closed loop, steam-based power cycles in between. Uncertainties are mainly derived from variations in shale grade and moisture content. Power plant choice seems unlikely to be dependent upon RD&D results. Very low or low water use options exist for heat generation, and water issues may encourage selection of such options.