IEAGHG Investigation of Extraction of Formation Water from CO_2 Storage

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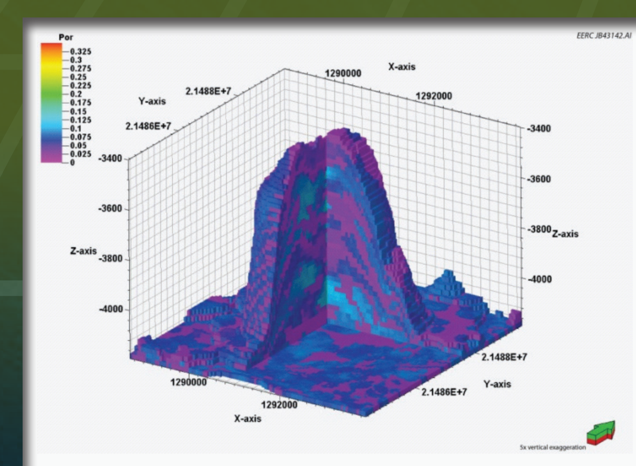
Abstract

The Energy & Environmental Research Center has investigated the proposed practice of formation water extraction from carbon dioxide (CO_2) storage reservoirs for the purpose of enhancing CO_2 storage. The project was performed under joint sponsorship by the IEA Greenhouse Gas (IEAGHG) R&D Programme and the U.S. Department of Energy.

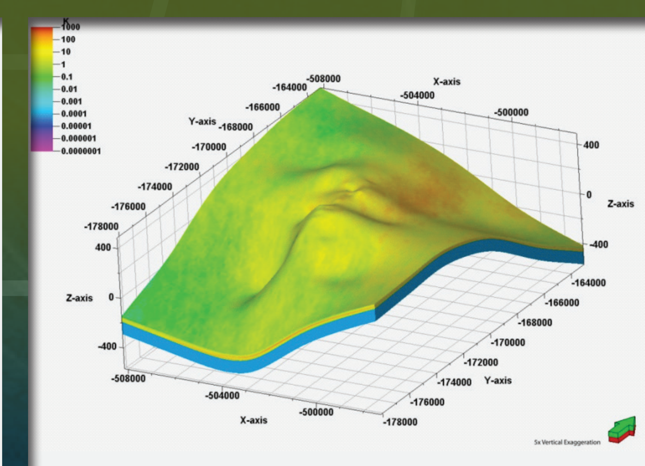
The concept of extracting saline waters from reservoirs has been proposed as a means of managing storage formation pressures, increasing reservoir storage capacity, and controlling migration of CO_2 plumes and displaced formation water. The practice may also provide water that may be put to beneficial uses, such as the supply of potable water, where treatment can be performed at a reasonable cost. This concept's utility will depend on feasible water extraction rates, which will, in turn, depend on site-specific factors such as geologic structure, permeability, heterogeneity, and project design features (i.e., the desired CO_2 injection rate).

The impacts of formation water extraction were tested through heterogeneous geologic modeling and dynamic simulations of four case study sites. Reservoir-scale dynamic simulations were conducted to investigate the impact formation water extraction could have on storage capacity and reservoir management strategies. Storage capacity was found to increase through water extraction at all test sites, generally doubling available storage. Use of extracted water was also found to be effective for reservoir pressure management and plume control. Analysis of the resulting water quality and quantity, available treatment technologies, and potential transportation costs reveals that barriers remain for potential beneficial use of extracted water from carbon capture and storage (CCS) facilities.

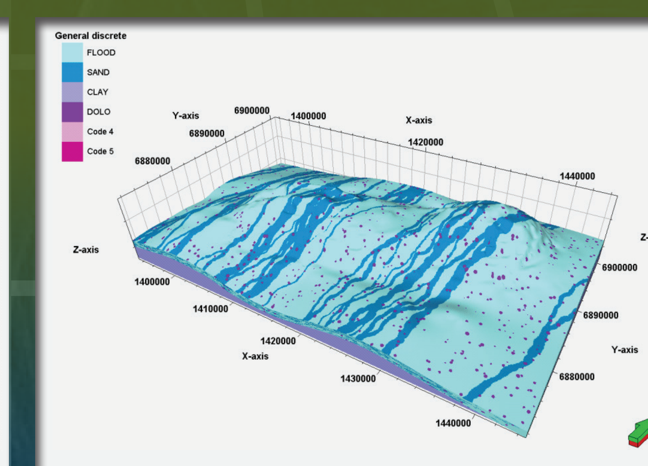
Zama Hypothetical Case Study Model



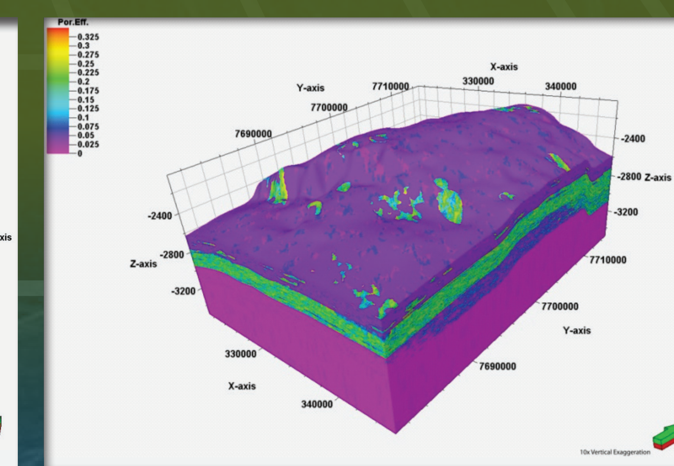
Teapot Dome Hypothetical Case Study Model



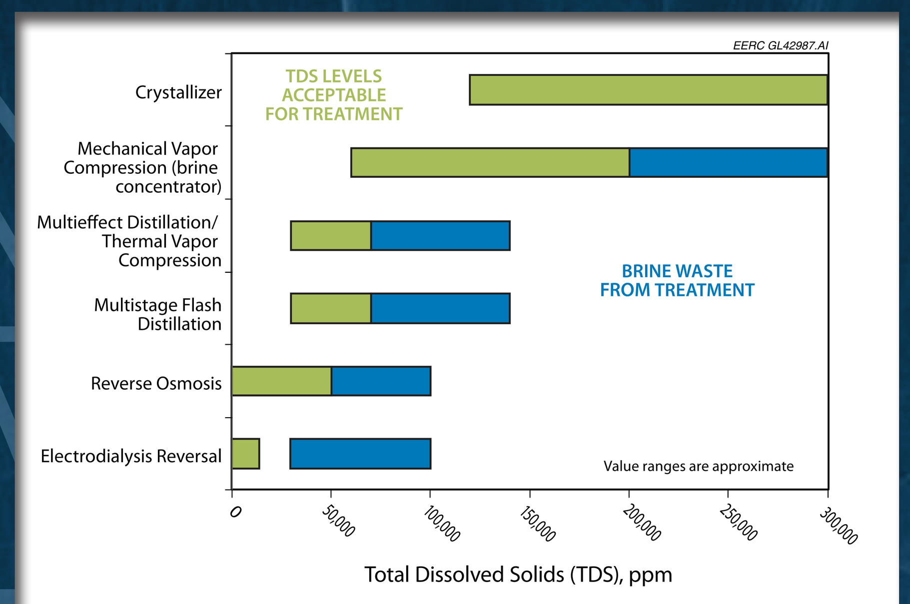
Ketzin Hypothetical Case Study Model



Gorgon Hypothetical Case Study Model

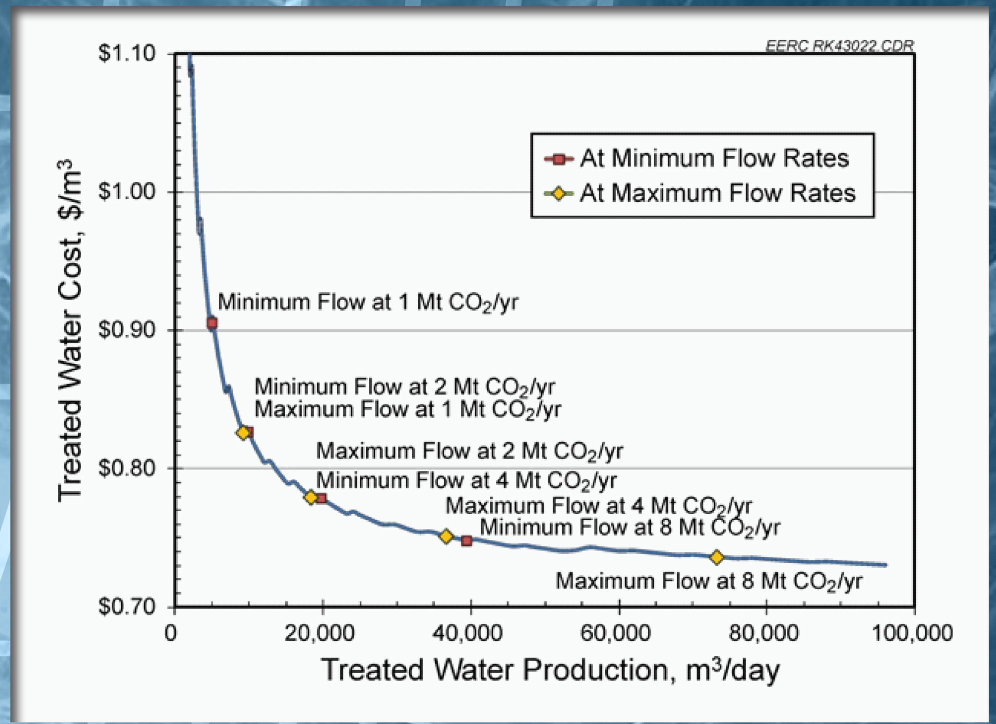


Water Treatment Options

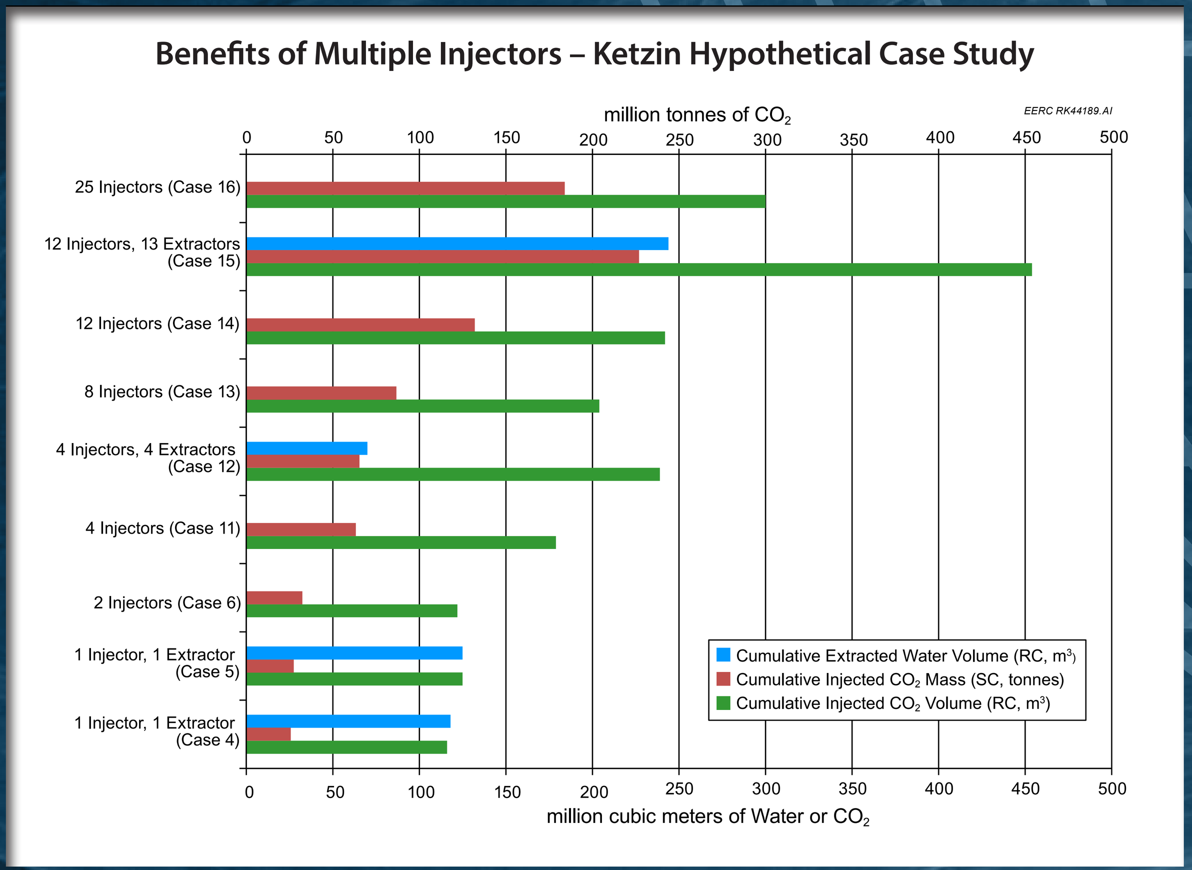


Potential Beneficial Uses

Water Treatment Costs (reverse osmosis) – Teapot Dome Case Study



Benefits of Multiple Injectors – Ketzin Hypothetical Case Study



Conclusions

As a tool for increasing storage capacity, formation water extraction was generally found to be effective, although each hypothetical case study site reacted differently to its implementation. The results of these four case studies illustrate the wide range of results that may be possible and that geologic and reservoir engineering factors may both have a large influence on the final results. It can also be said that if it is feasible to utilize a large number of injection and extraction wells, overall storage may be increased by a large margin, even in high-quality storage reservoirs.

With respect to treatment of extracted water, treatment and beneficial use may be feasible under certain conditions: likely a combination of high-to-moderate extracted water quality, availability of inexpensive energy, and sufficient local water demand. Of the case study sites, the best candidate for treatment and use of extracted water was the Teapot Dome site, where estimated treatment costs were comparable to that of local water supplies.

Hypothetical Simulation Results

Site	Variable	Base Case	W/ Extraction	Increase (%)	Potential Economical Treatment?
Ketzin	Cumulative Injected CO_2 (SC, tonnes)	13,000,000	27,400,000	110%	No
Zama	Cumulative Injected CO_2 (SC, tonnes)	50,000	680,000	1260%	No
Gorgon	Cumulative Injected CO_2 (SC, tonnes)	97,300,000	196,000,000	101%	Yes
Teapot	Cumulative Injected CO_2 (SC, tonnes)	5,160,000	11,100,000	115%	Yes

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