

Reliable Capacity Estimation: EASiTool

Project Description

An analytical-based Enhanced Analytical Simulation Tool (EASiTool) was developed for technical and nontechnical users with minimum engineering knowledge. EASiTool produces a fast, reliable estimate of the storage capacity of geologic formations. EASiTool includes closed-form analytical solutions that can be used as a first step for screening of geologic formations to determine which formation can best accommodate storage needs over a given period of time. EASiTool was developed with a highly user-friendly interface; however, the analytical models behind EASiTool are cutting-edge models that incorporate the effects of evaporation of brine near the wellbore, as well as salt precipitation and relative permeability of the rock. A net present value (NPV) based analysis was implemented to devise the best field development strategy to maximize the stakeholder’s profit by optimizing the number of injection wells.



This highly user-friendly tool provides a unique strategy for CO<sub>2</sub> injection combined with brine extraction to optimize any CO<sub>2</sub> project by maximizing the project’s NPV. Benefits include

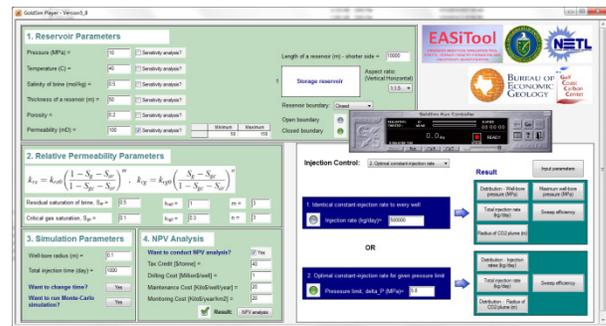
- ◆ Application of advanced closed-form analytical solutions to estimate CO<sub>2</sub> injectivity into geologic formations.
- ◆ Estimation of the number of injection/ extraction wells necessary to reach the storage goal.
- ◆ Determination of NPV analysis for multiple injection scenarios.
- ◆ Uncertainty analysis of input parameters’ effect on outputs.

Accomplishments

- ◆ Development of analytical solutions for closed and open boundary conditions.
- ◆ Implementation of solutions into a user-friendly interface using the Goldsim platform.
- ◆ Capable of running analytical models for as many as 200 injection wells and optimizing injection rates to maximize storage capacity.
- ◆ First version of the program released successfully and made available to sponsors with user manual and help file.

Impacts

- ◆ Provides a scientific yet fast and reliable tool for storage capacity estimation.
- ◆ Analytical solutions allow for implementation of fast algorithms for capacity estimations. This allows for Monte Carlo simulations over a range of possible input parameters.



EASiTool user interface

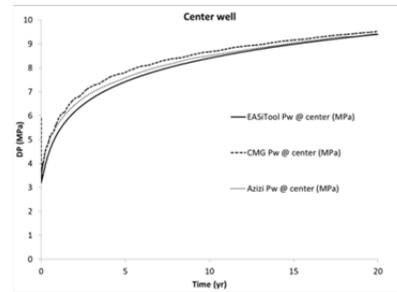
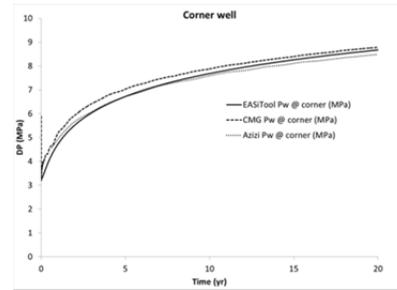
Tool/Approach Name	DOE/NETL	EERC	CSLF	USGS	EASiTool	Numerical Simulators
Reservoir scale	Yes	Yes	Yes	Yes	Yes	Yes
Accuracy	Low	Medium	Low	Low	Medium/High	High
Boundary conditions	No	No	No	No	Yes	Yes
Rock geomechanics	No	No	No	No	Yes	Yes
Brine management	No	No	No	No	Yes	Yes
Required expertise	Low	Low	Low	Low	Low	High
Cost of use	Low	Low	Low	Low	Low	High
Speed	High	High	High	High	High	Low
Dynamic	No	No	No	No	Yes	Yes
Uncertainty quantification	No	No	No	Simple	Yes	Yes

Comparison of EASiTool with other capacity estimation methods

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### Verification

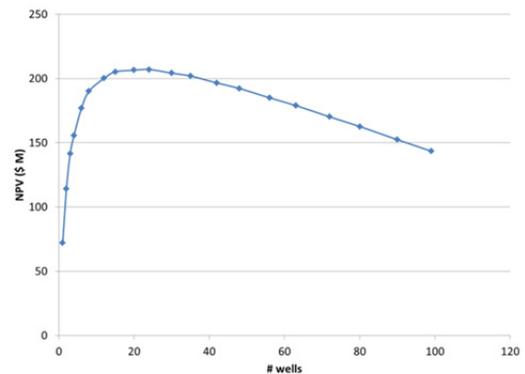
One important step in developing analytical tools and their application is to verify the results of these tools. We used CMG numerical simulations to verify the pressure buildup calculation of EASiTool for both open and closed boundary conditions. In addition EASiTool can work in multiwell injection scenarios. We verified that the superposition theory, in fact, works for CO<sub>2</sub> injection scenarios. For this purpose we used a five-spot injection scenario and compared EASiTool with CMG and another analytical solution. Our collaborator C12Energy tested the software and independently verified the validity of the results.



EASiTool results for a center well and a five-spot injection scenario

### Net Present Value Analysis

One part of EASiTool is devoted to NPV analysis of the given injection scenario. Input data include the tax credit value, drilling costs, monitoring costs, etc., and EASiTool will simulate all the possible scenarios from one injection well to as many as 200 injection wells and find the optimal number of the wells. (See figure.)



For this specific case, 15 to 20 injection wells maximize the value of the project

### Selected Citations

Hosseini, S. A., Mathias, S. A., and Javadpour, F., 2012, Analytical model for CO<sub>2</sub> injection into brine aquifers containing residual CH<sub>4</sub>: Transport in Porous Media, v. 94, p. 795–815.

Mathias, S. A., Gluyas, J. G., Gonzalez Martinez de Miguel, G. J., and Hosseini, S. A., 2011, Role of partial miscibility on pressure buildup due to constant rate injection of CO<sub>2</sub> into closed and open brine aquifers: Water Resources Research, v. 47, W12525, doi:10.1029/2011WR011051, 11 p.

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