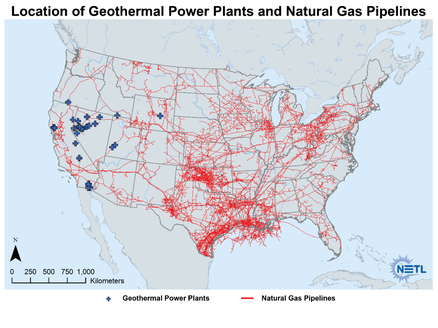
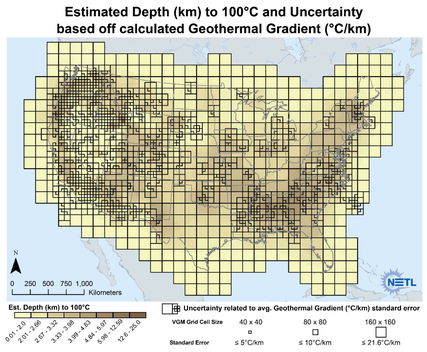
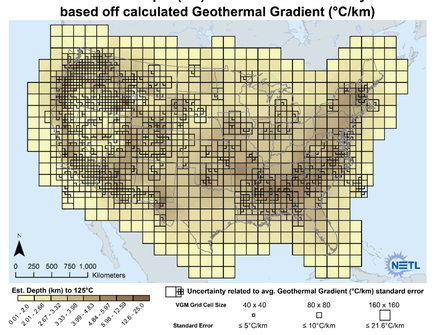
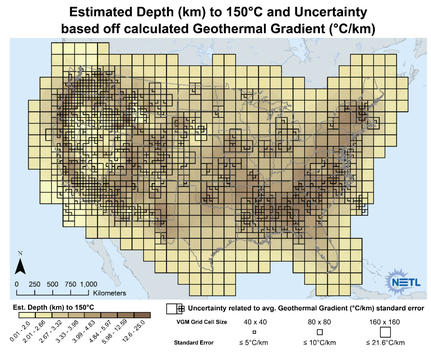




2GRT





GEOTHERMAL/GAS RECUPERATED TURBINE

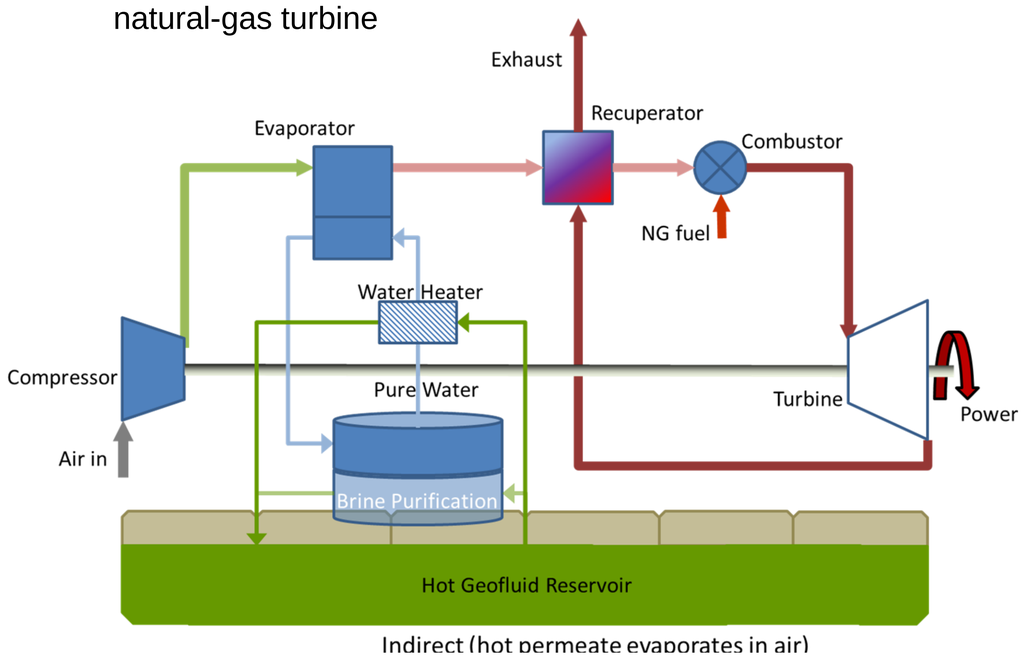
Dan Oryshchyn, James Black, Grant Bromhal, Christopher Harriman, Farida Harun, Kevin Kitz, George Richards,
Nicholas Siefert, David Tucker, John VanOsdol, Jennifer Bauer, Kelly Rose

Objectives

- Utilize otherwise marginal geothermal reservoirs
- Limit or eliminate cooling water consumption
- Reduce CO_2 intensity from the natural gas

The Concept:

- Use geothermal heat to create steam for “steam-injected” natural-gas turbine



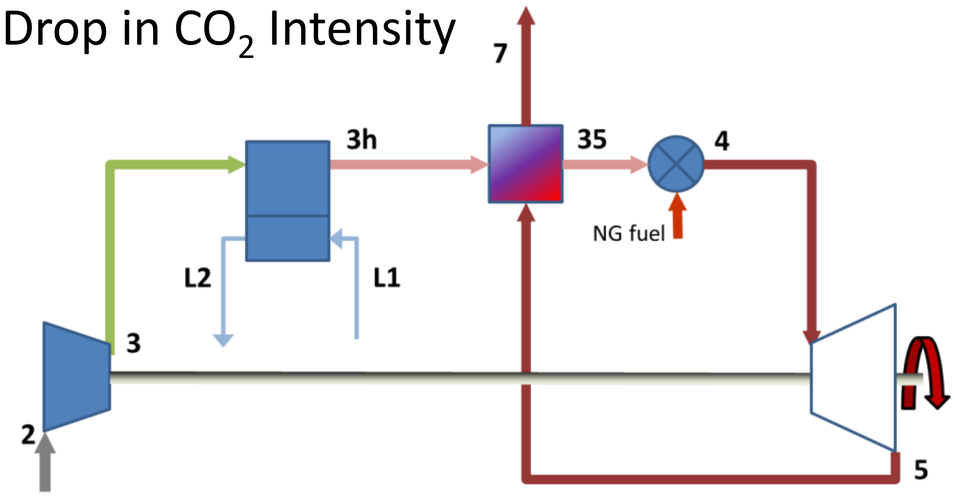
Advantages

- The baseline natural gas turbine provides predictable electric revenue
- The system does not require cooling towers
- The system can use relatively low-temperature geothermal sources

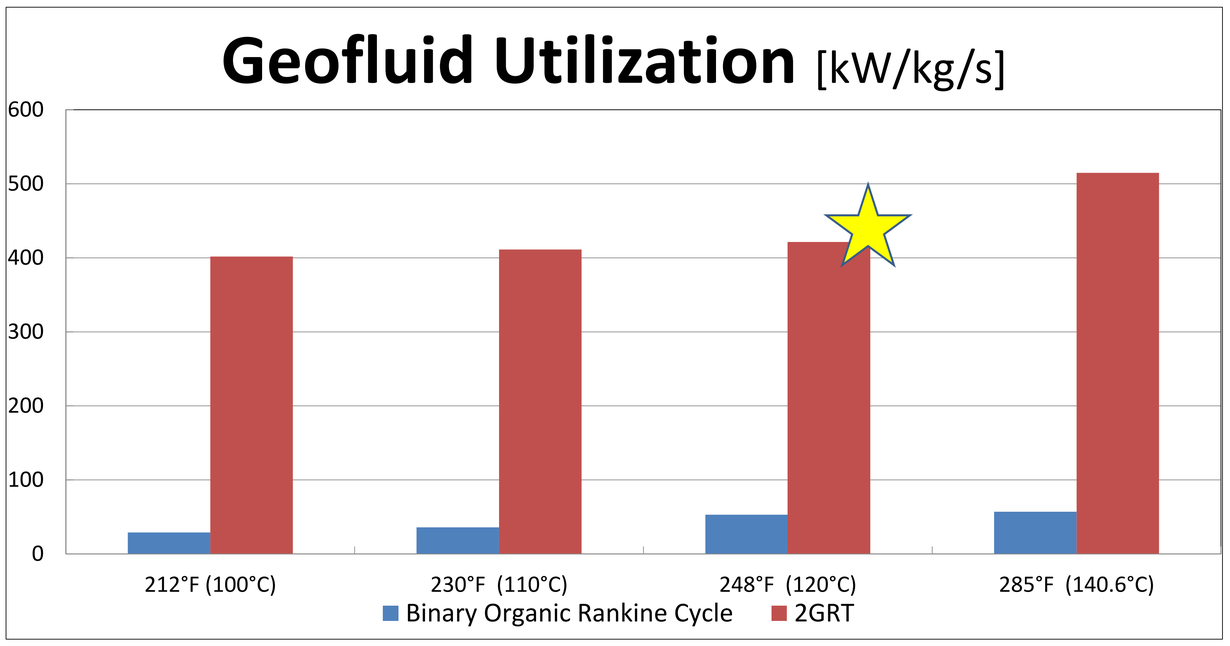
Background

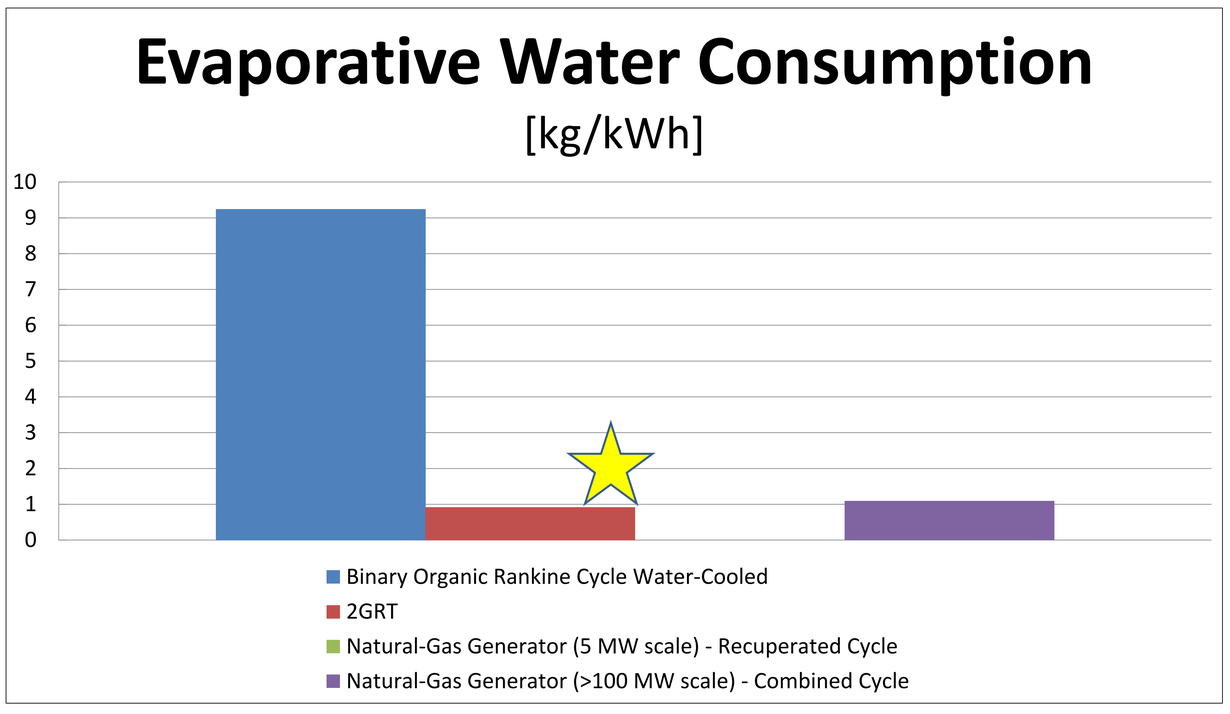
- Steam injection has been used for more than three decades, on more than 300 gas turbines, to provide additional power and improve efficiency
- Few studies have considered using steam generated by geothermal heat either as direct flash (clean geofluid) or indirect (clean water vaporized by geothermal heat)

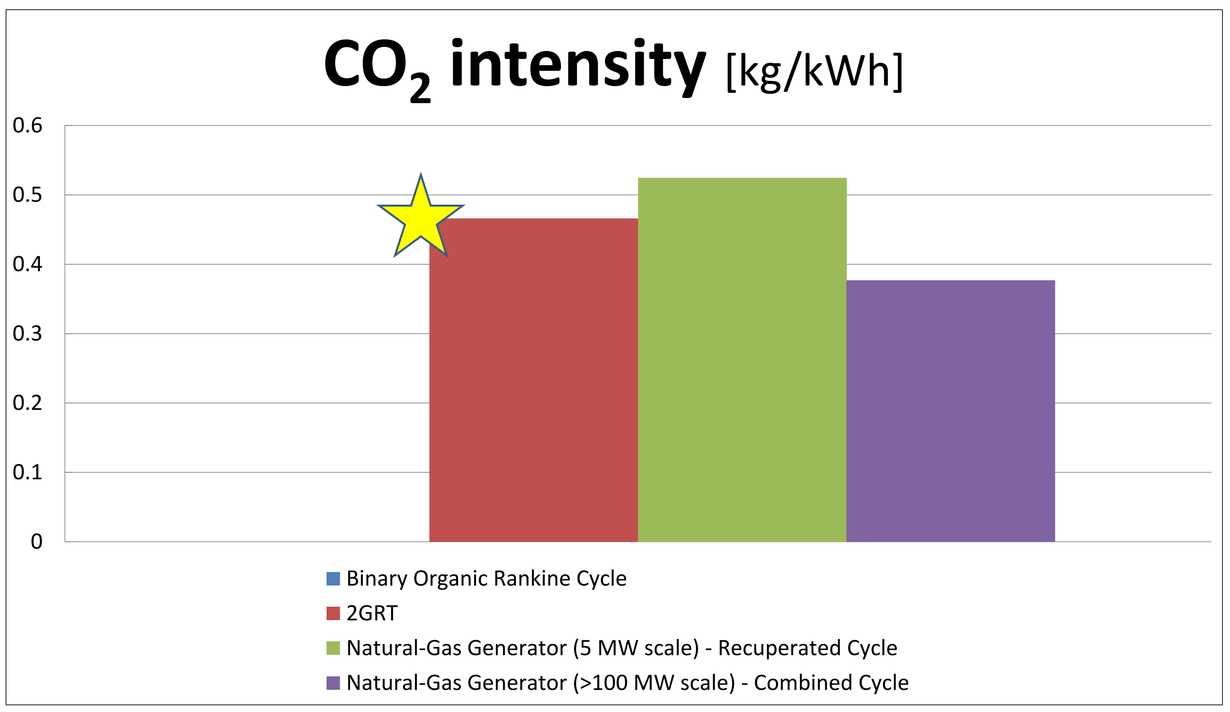
Model Study - Minimum Brine Flow to Achieve 10% Drop in CO_2 Intensity



	Stream	2	3	3h	35	4	5	7	L1	L2	NG	LHV Efficiency [%]	Power [MW]
Base													
P	atm	1	10	NA	9	9	1	1	NA	NA	17	38	4.7
T	°F	59	630	NA	1142	2192	1179	740	NA	NA	80		
m	tph	69	63	NA	63	64	70	70	0	0	1		
2GRT													
P	atm	1	10	10	10	9	1	1	11	10	17	44	6.4
T	°F	59	630	234	1142	2192	1202	426	248	234	80		
m	tph	69	62	68	68	70	77	77	8	1	1		







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Map Data Sources

National Geothermal Data System (NGDS), Southern Methodist University (SMU), Esri, NETL, Bauer & Rose (in press)

Coordinate System

GCS: NAD 1983

PRJ: USA Contiguous Equidistant Conic

Units: Meters

NETL

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