Planning for Grid Integration of sCO_2 Power Cycles using Capacity Expansion Models

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Background

- Supercritical carbon dioxide (sCO_2) power cycles offer high efficiencies of ~50% and a compact footprint
- sCO_2 power plants are being developed for a range of scales and fuel types
- **Puerto Rico**'s electric grid is still recovering from Hurricane Maria, and is in need of more resilient power production
- A capacity expansion model was built in TEMOA [1] to represent Puerto Rico's electricity supply and demand

Goals

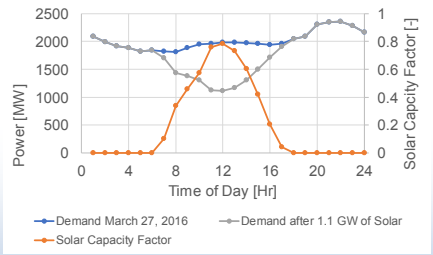
- Investigate sCO_2 characteristics for successful deployment into existing and future energy mix
- Investigate demand for distributed sCO_2 power plants to increase resilience against future hurricanes

Distributed sCO2 Power Plant

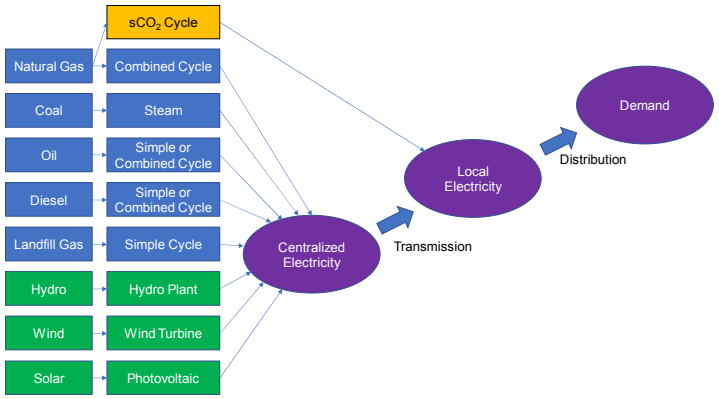
- Natural gas fired
- Efficiency: 50% [2]
- Investment Cost: 1000 $/kW [2]
- Ramp rate: Start-up/shutdown in 1 hour

"Duck Curve"

As more solar power comes online, other power plants will need to quickly ramp production to meet demand



Model Layout

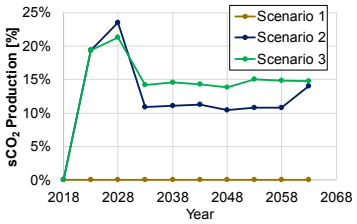


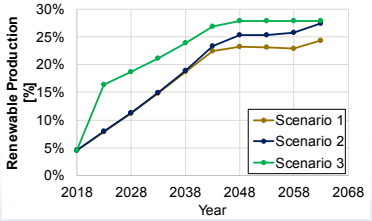
Scenarios

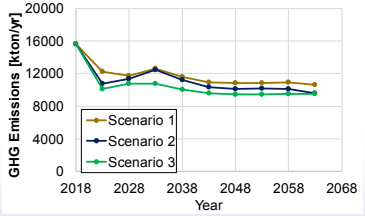
1. "Business-as-usual"
2. Introduction of distributed sCO_2 power plant
3. sCO_2 plant + high renewable deployment

Results

Baseline sCO_2 plant will fit into electricity mix as renewable deployment continues to increase

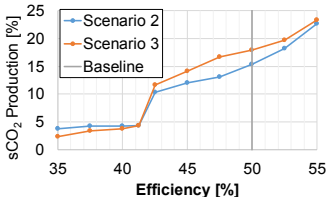


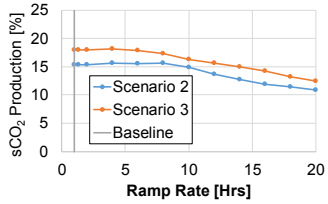


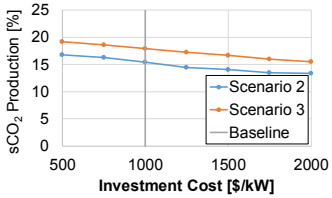


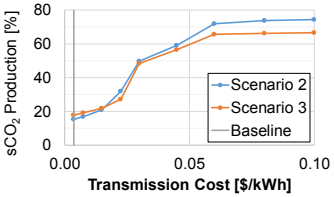
Sensitivity Studies

Each study compares sCO_2 production as percent of total energy production over period 2023-2063









Conclusions

- Predicted sCO_2 efficiencies and investment costs fit well with current energy mix
- sCO_2 plant ramp rates above 8 hours will result in increased deployment
- Distributed sCO_2 plants are attractive for Puerto Rico if transmission costs increase

References

[1] K Hunter, S Sreepathi, JF DeCarolis (2013). Modeling for Insight Using Tools for Energy Model Optimization and Analysis (Temoa), *Energy Economics*, 40, 339-349, ISSN 0140-9883.
[2] Dennis, R.A., Musgrove, G., Rochau, G., Fleming, D., Carlson, M., Pasch, J., (2017), "Overview", In Brun, K., Friedman, P., & Dennis, R., (Eds.), *Fundamentals and Applications of Supercritical Carbon Dioxide (sCO2) Based Power Cycles*, Elsevier Ltd.
[3] Puerto Rico Energy Commission, "Distribución Porcentual de la Generación de Energía por Tipo", http://energia.pr.gov/datos/distribucion-porcentual-de-la-generacion-de-energia-por-tipo/, Accessed 17Jan2018.