A decision-making tool for the optimal selection and allocation of renewable energy generation and storage systems

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Renewable Energy

https://youtu.be/Gg7r5yMD6NQ

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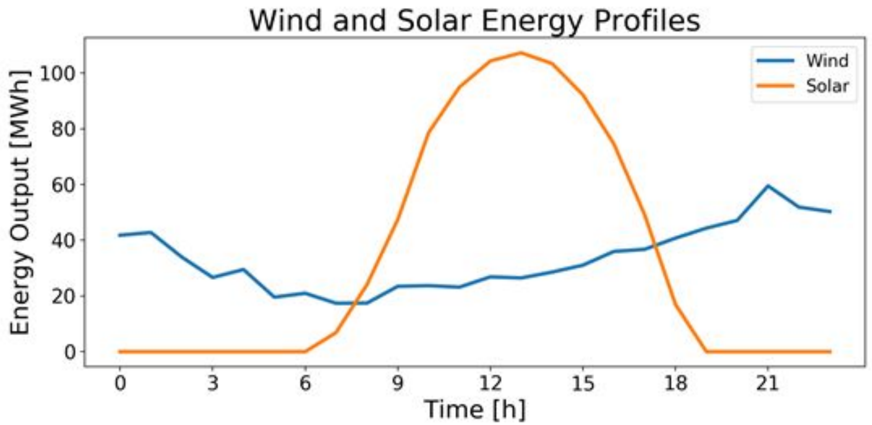
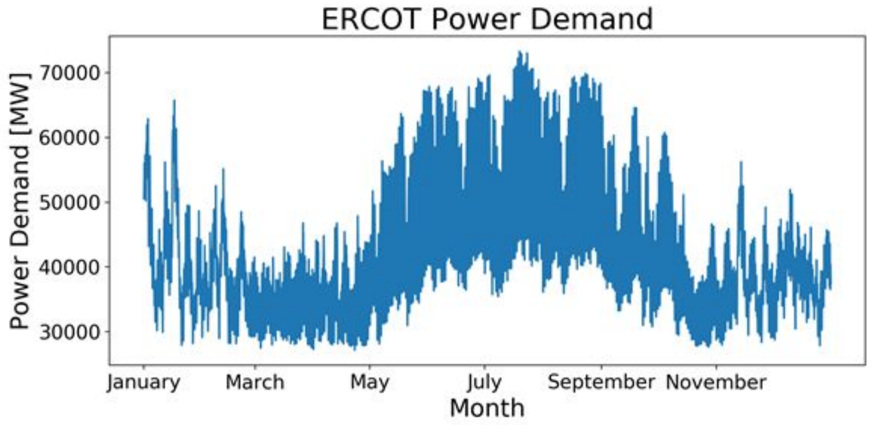
Introduction

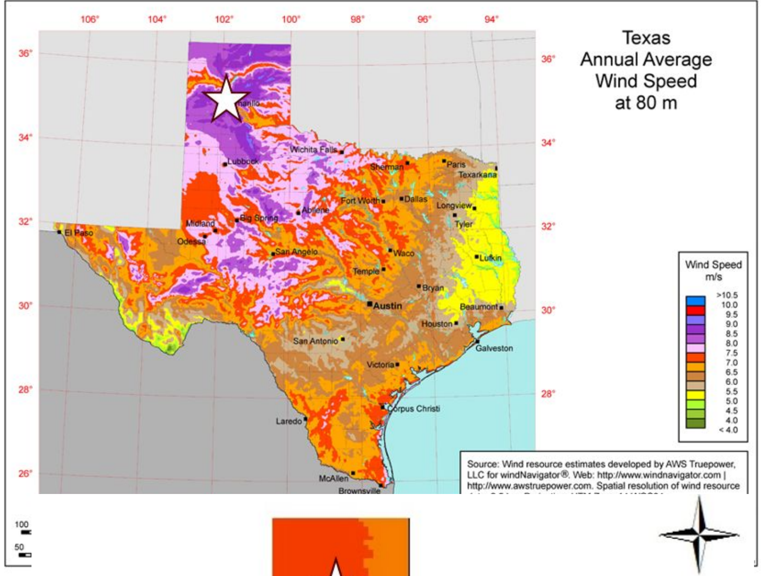
- Motivation
  - Increasing population and energy demand
  - Move electric grid away from fossil fuel dependence
  - Reduce harmful emissions
- Challenges
  - Inconsistent solar and wind energy profiles
  - Variable energy demand
  - Storage feasibility

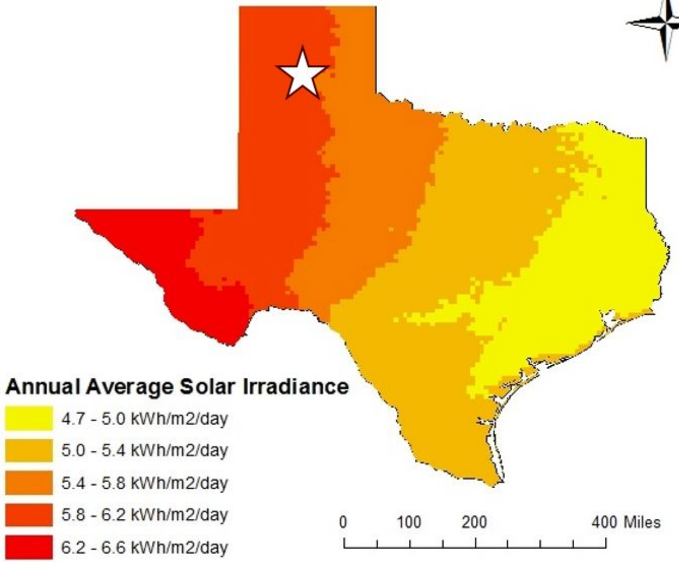




Objective

- Create model framework to:
  - Optimize renewable energy generation systems
  - Optimize energy storage systems
- Constraints
  - Limited area
  - Limited water use
- Objectives
  - Minimize cost





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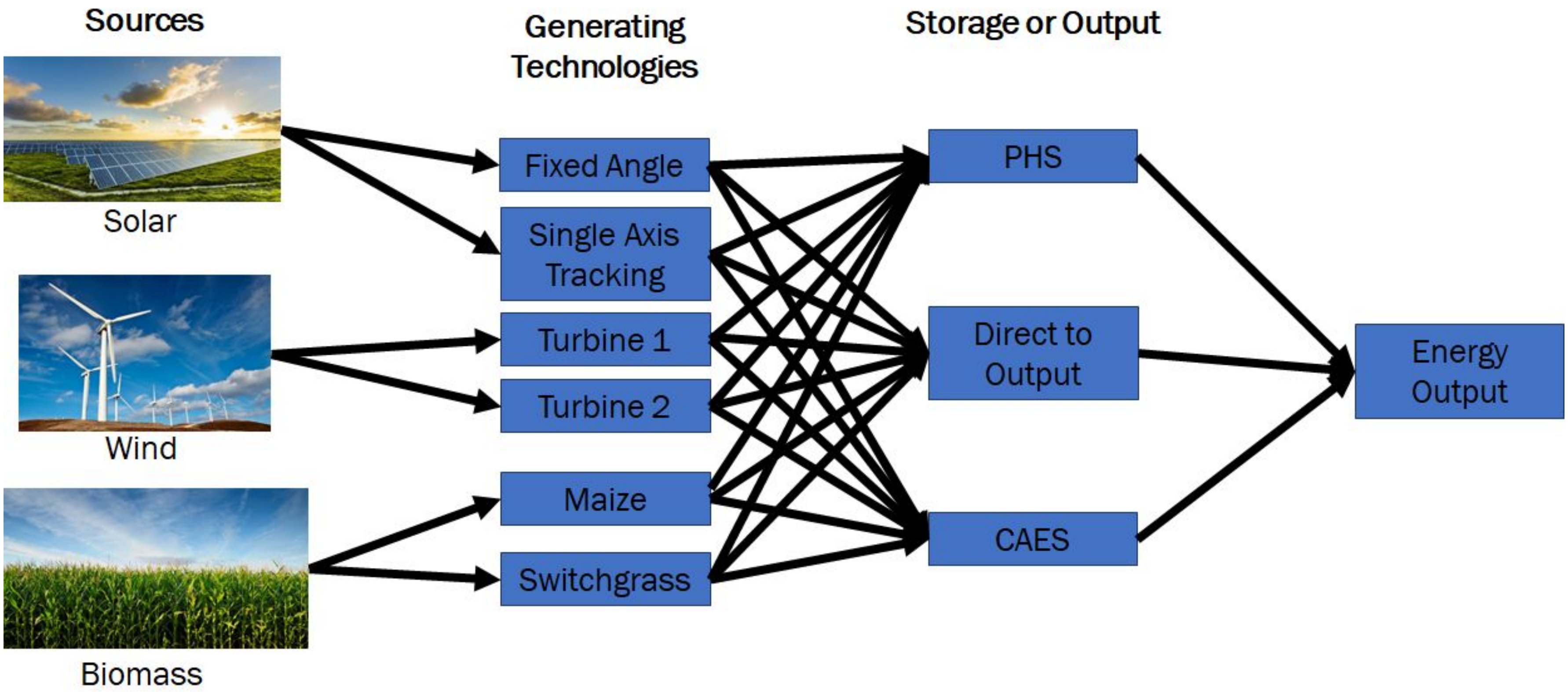
Methods - Superstructure



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Methods - Preprocessing

- Solar
    - Minimized cost of panels and land for year of real solar data varying required power output
- Wind
    - Minimized cost of turbines and land varying wind turbines utilized and spacing to meet specified energy output
    - Mixed Integer Nonlinear Program (MINLP)
    - Four days of real wind speed profiles to represent one year through k-means clustering
- Biomass
    - Amount of energy produced per area from converting total yield into biomethane
    - Divided into hourly average energy output
    - Water use higher for dry, warm climates

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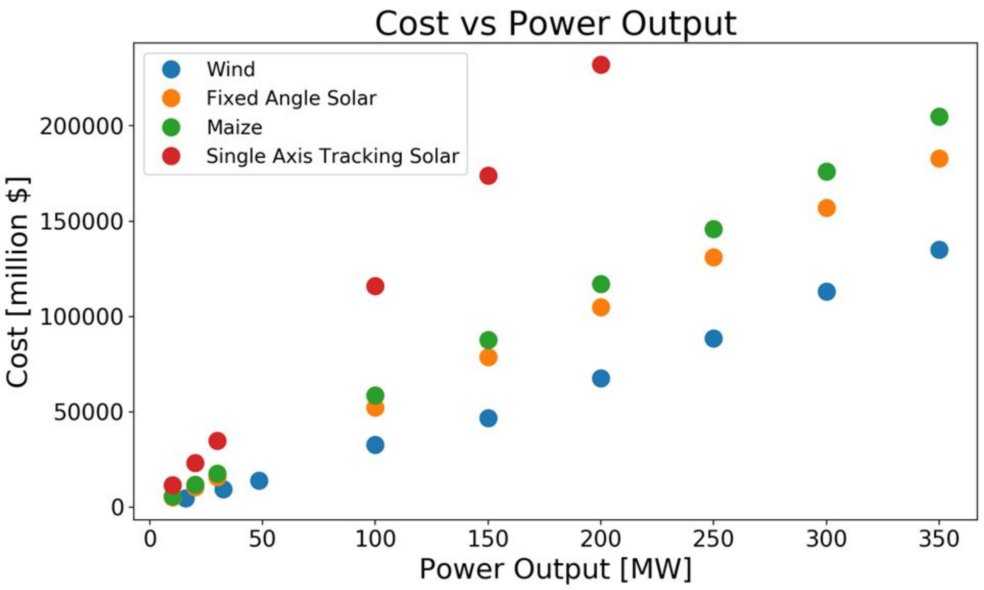
Methods - Combined Model

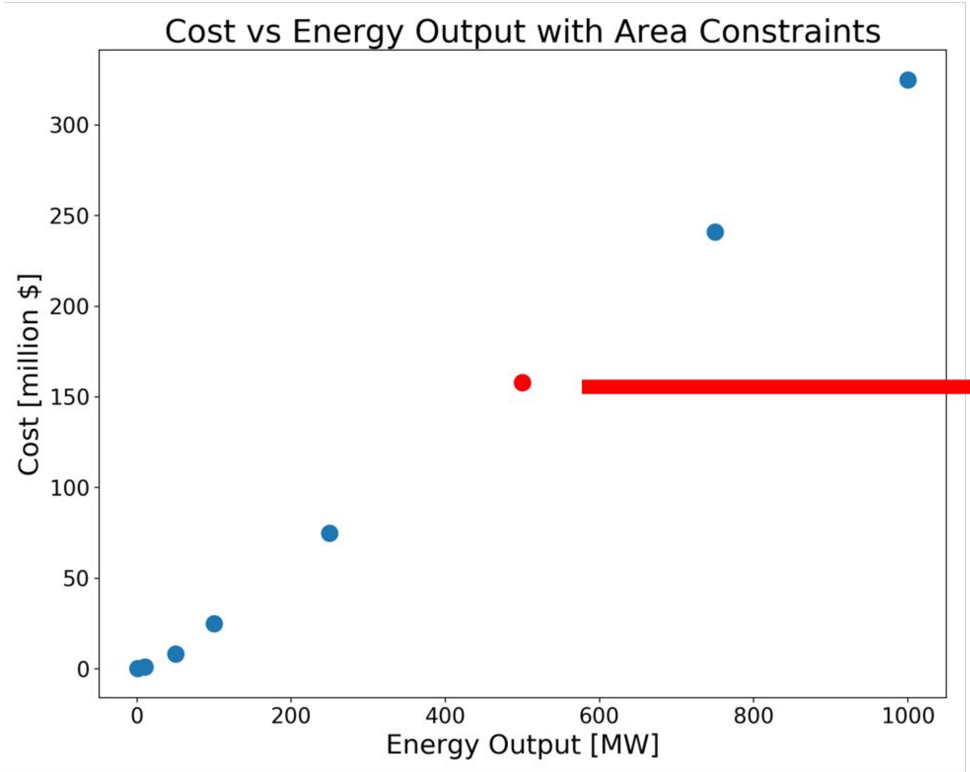
- Mixed Integer Linear Program (MILP)
- Simplify data from solar, wind, and biomass preprocessing
- Input scalable weekly energy profiles
- Storage
  - Pumped Hydropower Storage (PHS)
  - Compressed Air Energy Storage (CAES)
- Solve
  - Optimize objective while staying within constraints

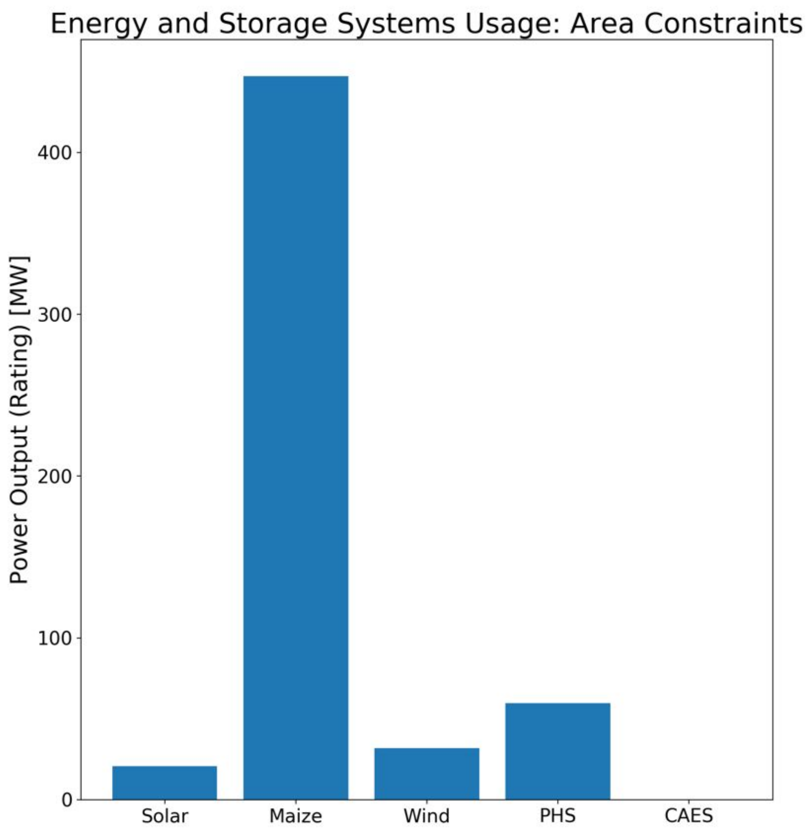


Results - Case Studies

- Limited area
    - Minimize total cost
    - Fixed area to energy ratio
- Limited water use
    - Minimize total cost
    - Fixed water use to energy ratio

Results - Area Limited





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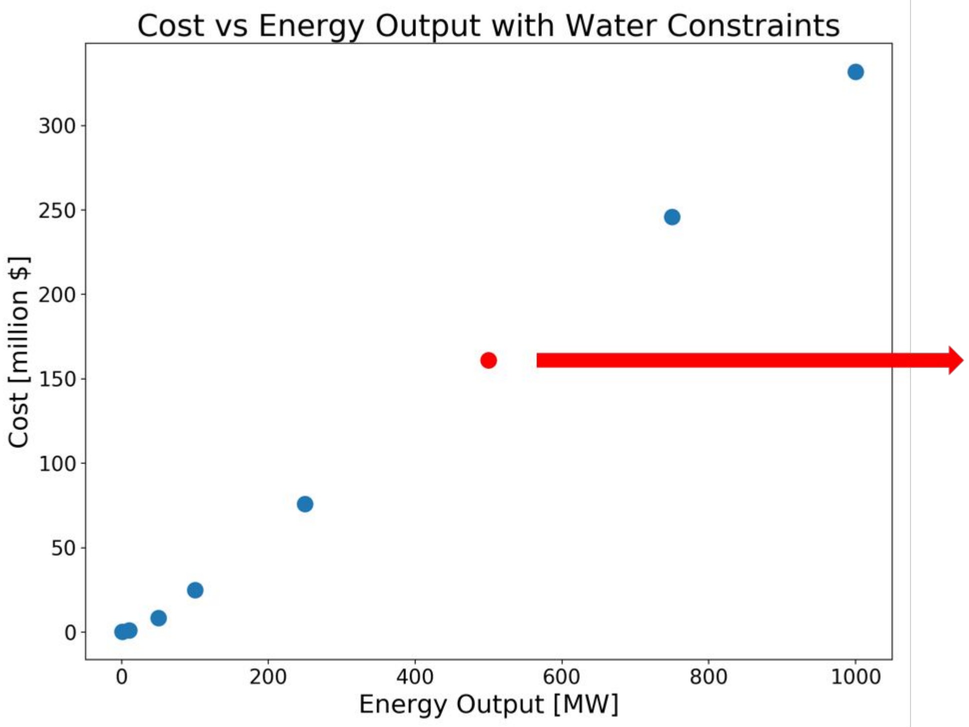
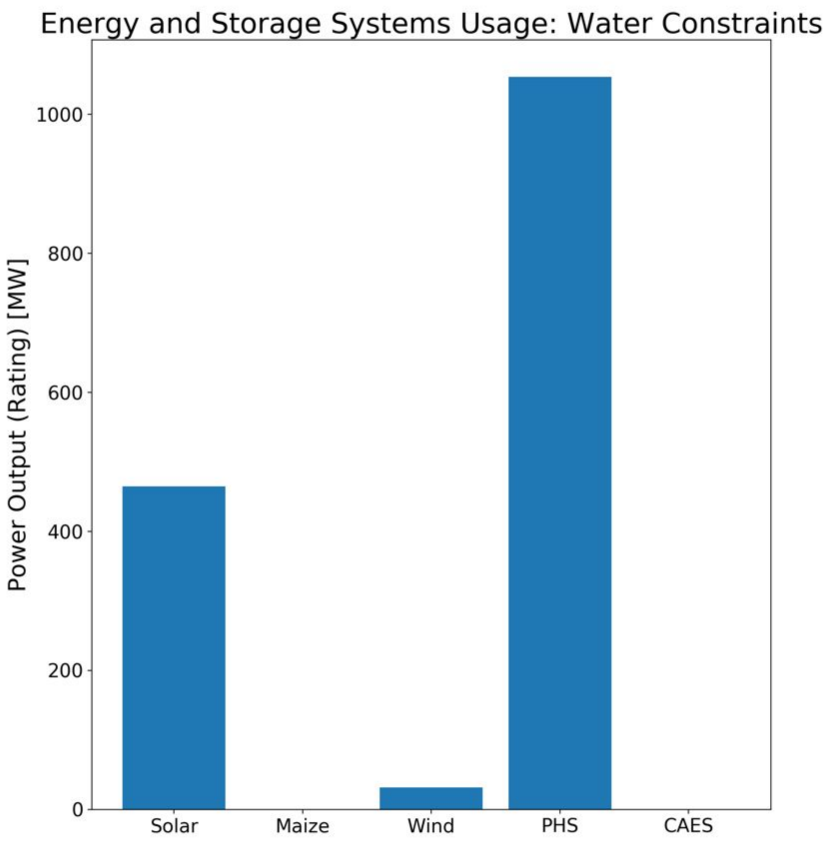
Results - Water Limited





Conclusions

- Varying scenarios and objectives greatly affect optimum energy production and storage methods

- Geographic factors and energy demand profiles have significant impact

Future work

- Updated pricing for single axis tracking
- Additional case studies including government subsidies
- Sensitivity analysis if water availability varies

References

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Acknowledgments

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