2020 SPRING VIRTUAL LEARNING SERIES
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Cost Implications of Solar and Time of Use Rate Interactions in Arizona

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BACKGROUND

Balancing generation and demand on the electricity grid can be challenging with additional weather-dependent resources. Some utilities are implementing time of use rates (TOU) incentive load shifts with

RESEARCH QUESTIONS

1. Does the optimal time period for load change caused by TOU rates change with additional solar generation?
2. Can TOU rates make it easier to integrate additional solar generation by reducing the ramp required of thermal generators?
3. How does the dispatch stack change when TOU rates are implemented in combination with increased solar penetration?

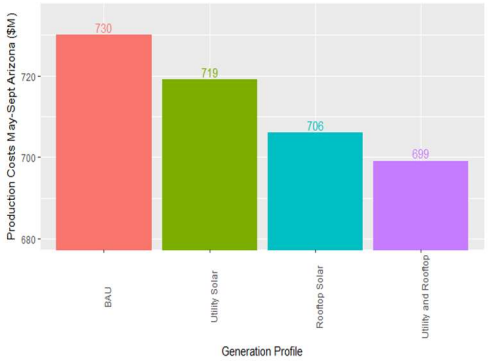
METHODS

Load Change
- Predicted 2024 load was adjusted for the major AZ balancing areas
- Levels of response were Low, Mid and High
- TOU time periods were 3-7pm and 4-8pm

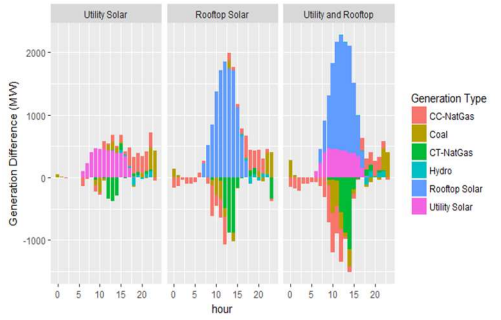
Additional Solar Generation
- Utility scale solar was generating using NREL's SAM Model

Production Cost Modeling
- Used PLEXOS
- Ran hourly for 2024
- Focused on Arizona

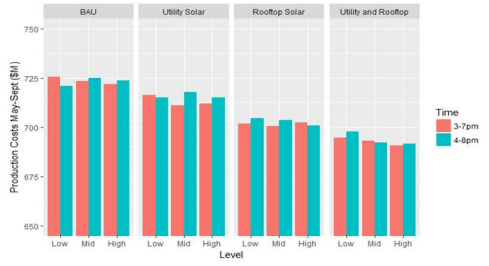
RESULTS



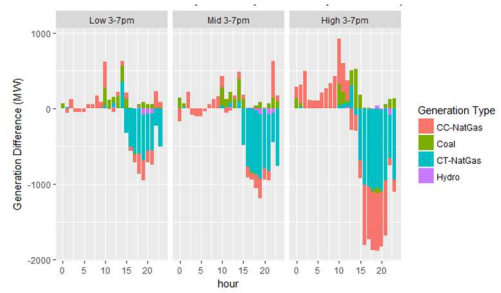
This figure shows the total production cost from May-September for the four generation profiles with no TOU load changes. The decrease in production cost for Utility+Rooftop Solar is not cumulative. The addition of utility solar decreased the production cost by $11M and the addition of rooftop solar decreased the production cost by $24M, while the Utility+Rooftop additions decreased the production cost by $31M. If the decrease were cumulative, it would have been $35M. Because the additional solar generates at the same time, it becomes less valuable as more is added in a balancing area.



This figure shows the change in generation dispatch between the BAU generation case and the three additional solar cases, and does not include any TOU load changes. As displayed in the figure, in all cases the additional solar generation results in decreased use of combustion turbines, combined cycle and some coal-fired generation. The decrease in these types of generation increases as the additional solar generation increases, but the decrease is never as much as the additional generation. This means the additional generation is also replacing imports or being exported, thus taking advantage of the interconnected system.



This figure shows the impact of the TOU rates on the production cost for the four generation profiles used in this study. The leftmost panel shows production costs for the BAU generation profile, which are higher than the others due to less solar generation. The patterns for the BAU generation case and the Utility Solar case are very similar. Overall, the 3-7pm time period results in the lower production cost more often than the 4-8pm time period



This figure shows the generation dispatch for the TOU 3-7pm cases compared to the Utility-and-Rooftop BAU load case, so the changes shown in the figure are directly attributable to the level of TOU response. The change in load results in less generation from combustion turbine and combined cycle plants. In the Low and Mid cases, the majority of decrease in generation in is CT-NatGas, compared to the High case where there is a significant decrease in CC-NatGas generation.

CONCLUSIONS

Production costs give insight into how valuable additional resources or changes in load are to operation of the bulk electric system. As the amount of solar added is increased, its incremental value goes down. When implementing a load change due to a TOU rate, the production cost always decreases. Of the two time periods tested, the 3-7pm time period results in the lower production cost more often than the 4-8pm time period.

Regarding generator dispatch, when additional solar was added, there was decreased usage of combustion turbines, combined cycle and coal-fired generation. The decrease was less than the additional solar generation, which means the additional generation replaced imports or was exported. This is another result that points to the importance of the interconnected electricity system.

ACKNOWLEDGEMENTS

The authors would like to thank Energy Exemplar for the academic license for PLEXOS, and Karin Wadsack for her support and feedback.

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