



Working Smarter, Not Just Harder: Improving Energy Performance Using Intelligent Operation

EGI Annual Technical Conference 2023

EGI

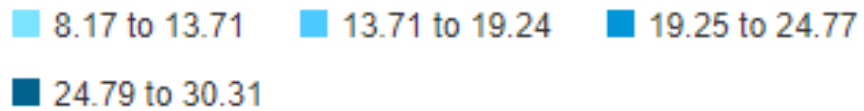
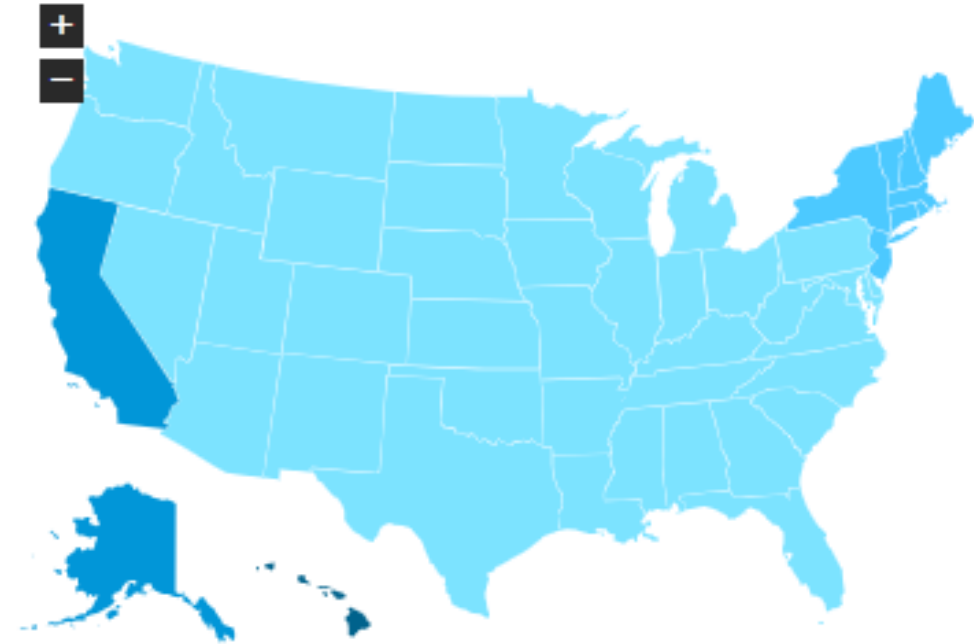
Energy & Geoscience Institute

AT THE UNIVERSITY OF UTAH

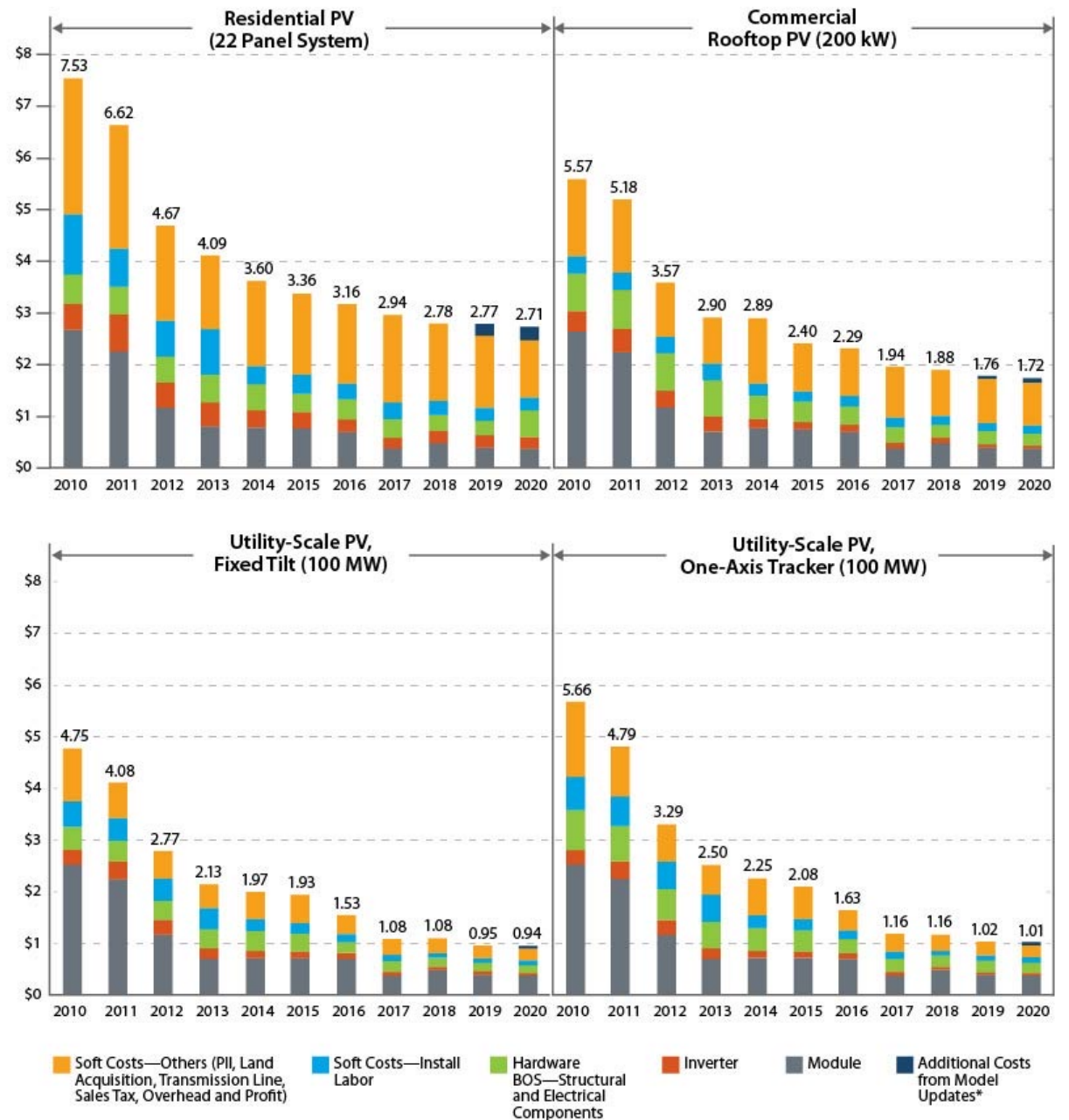


Declining Cost of Renewables?

U.S. average retail price per kilowatt-hour is 11.10 cents

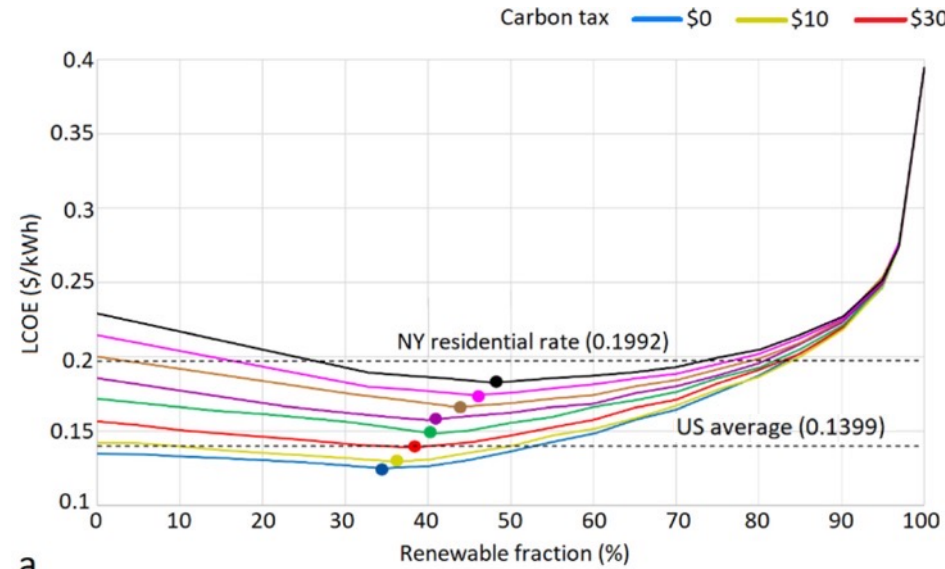


<https://www.eia.gov/electricity/state/>

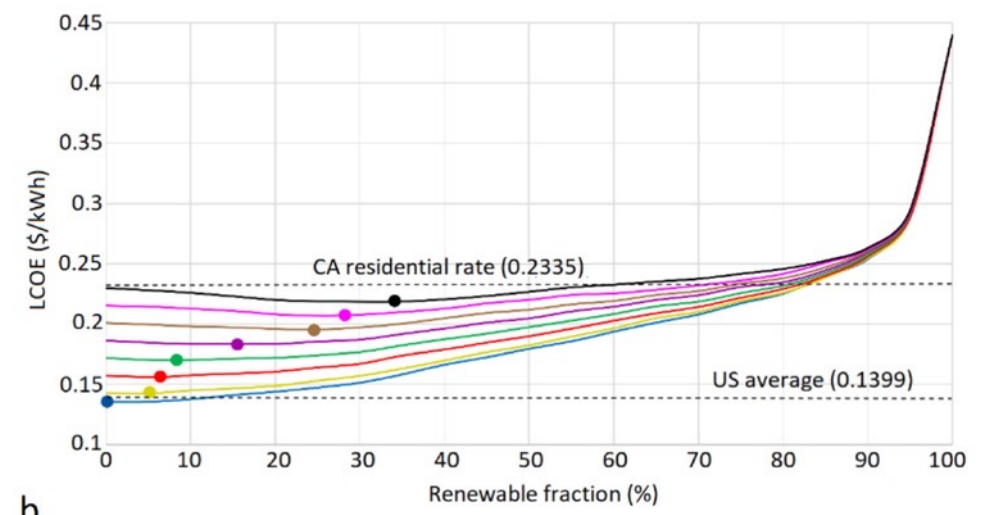


<https://www.nrel.gov/news/program/2021/document-ing-a-decade-of-cost-declines-for-pv-systems.html>

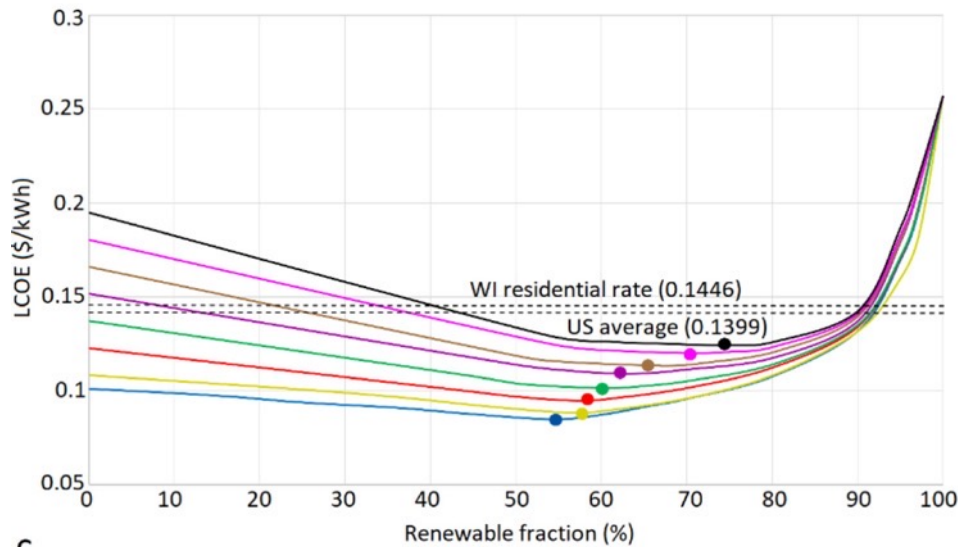
The True Costs of Decarbonization



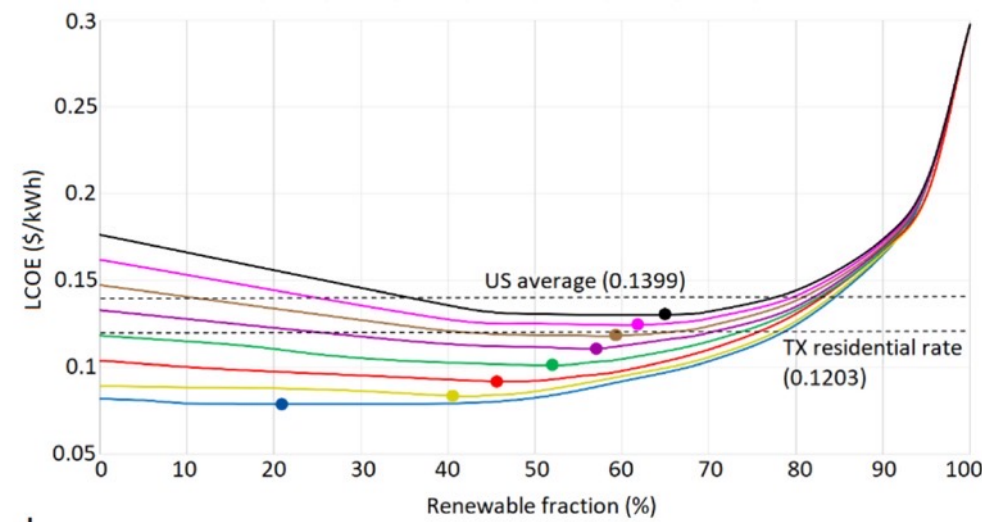
a.



b.



c.



d.

Khosravani et al., Energy Reports, 2023

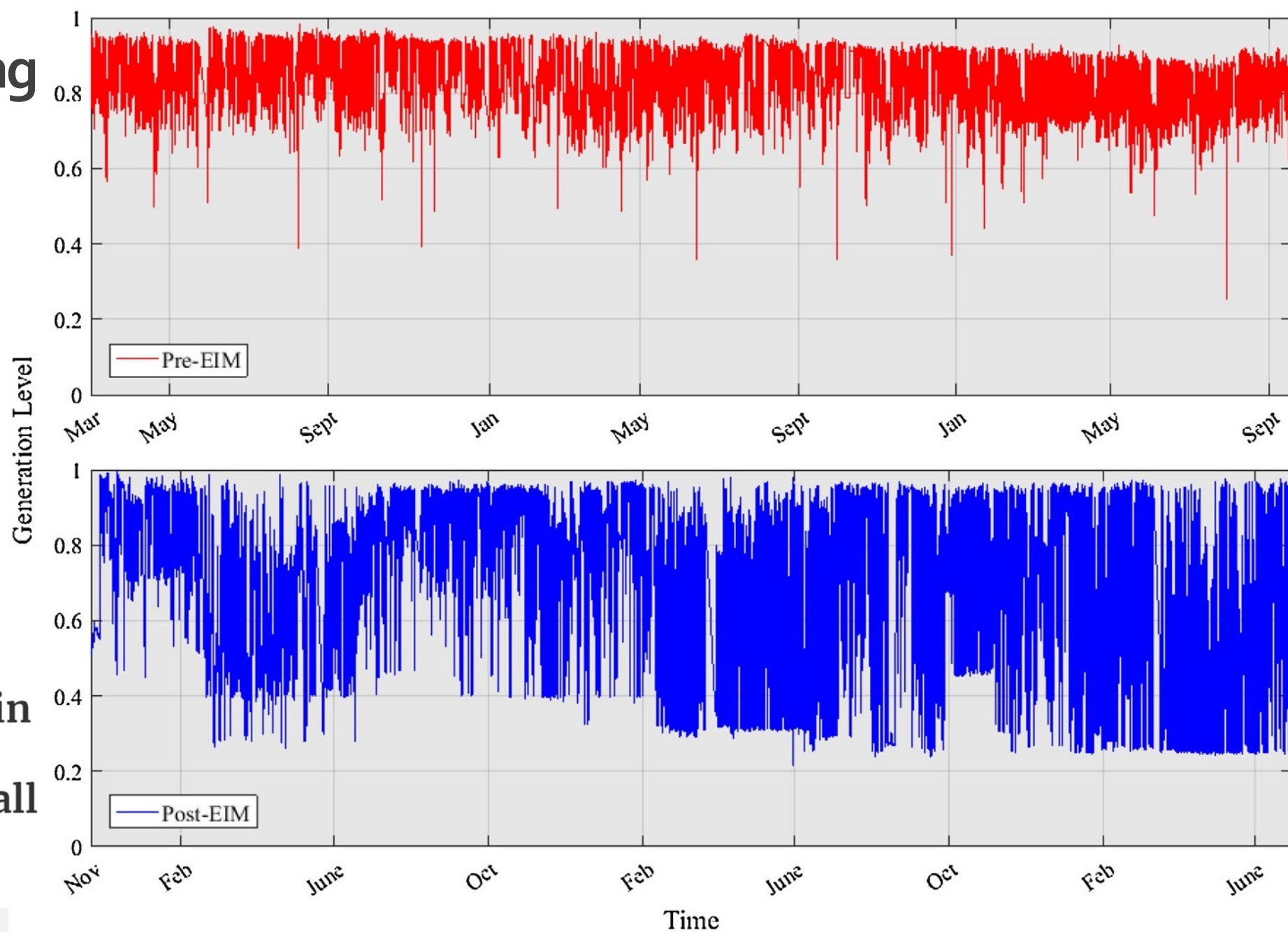
Fossil Fuel Is Enabling Renewables



<https://www.kuer.org/business-economy/2023-04-04/as-utahs-rocky-mountain-power-looks-to-nuclear-power-what-happens-to-all-the-coal-jobs>

Business & Economy

As Utah's Rocky Mountain Power looks to nuclear power, what happens to all the coal jobs?



Can we work smarter and not just harder?

“We can’t solve problems by using the same kind of thinking we used when we created them.”

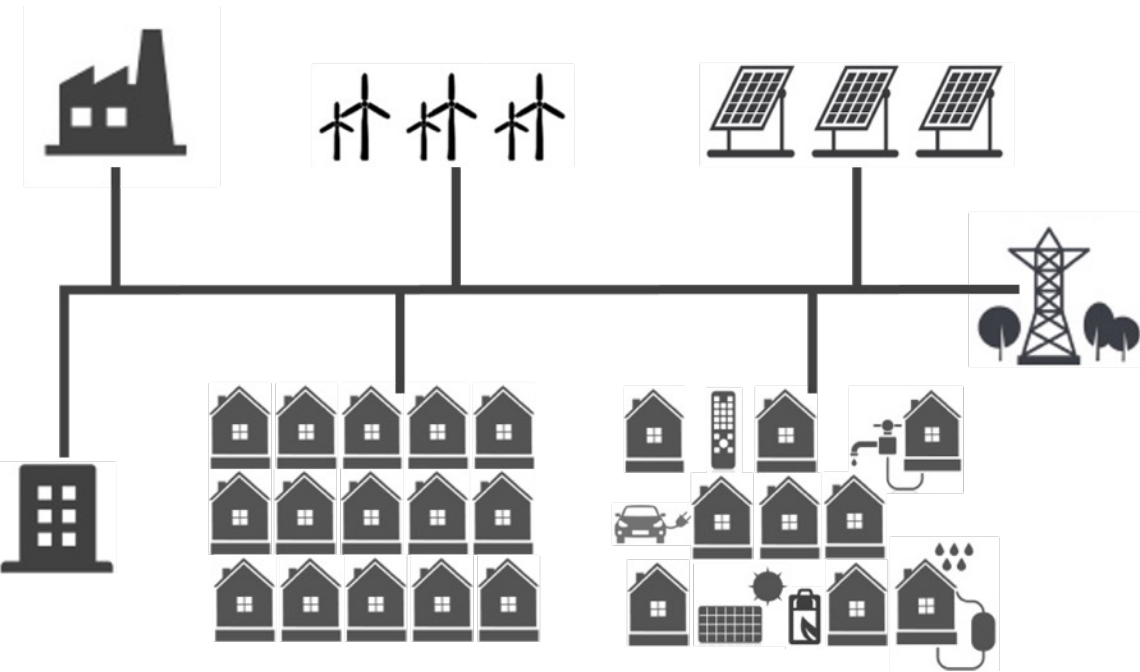
-Albert Einstein

Photo courtesy of NBC News

Improving Energy Efficiency Using Intelligent Operation

Intelligent Systems

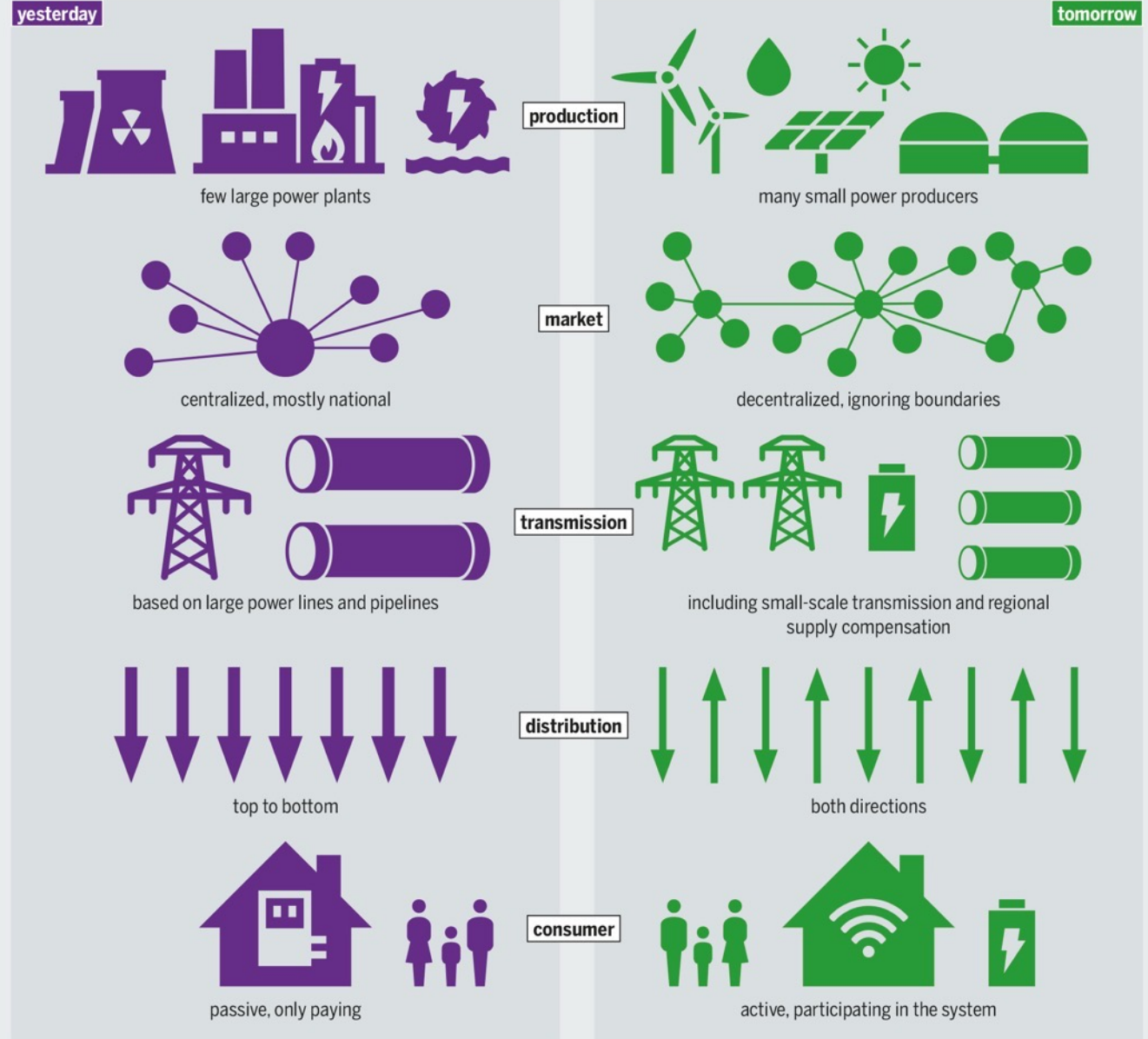
Using the Flexibility to Improve Performance



Sheha et al., *Energy Conversion & Mgmt*, 2020

STAYING BIG OR GETTING SMALLER

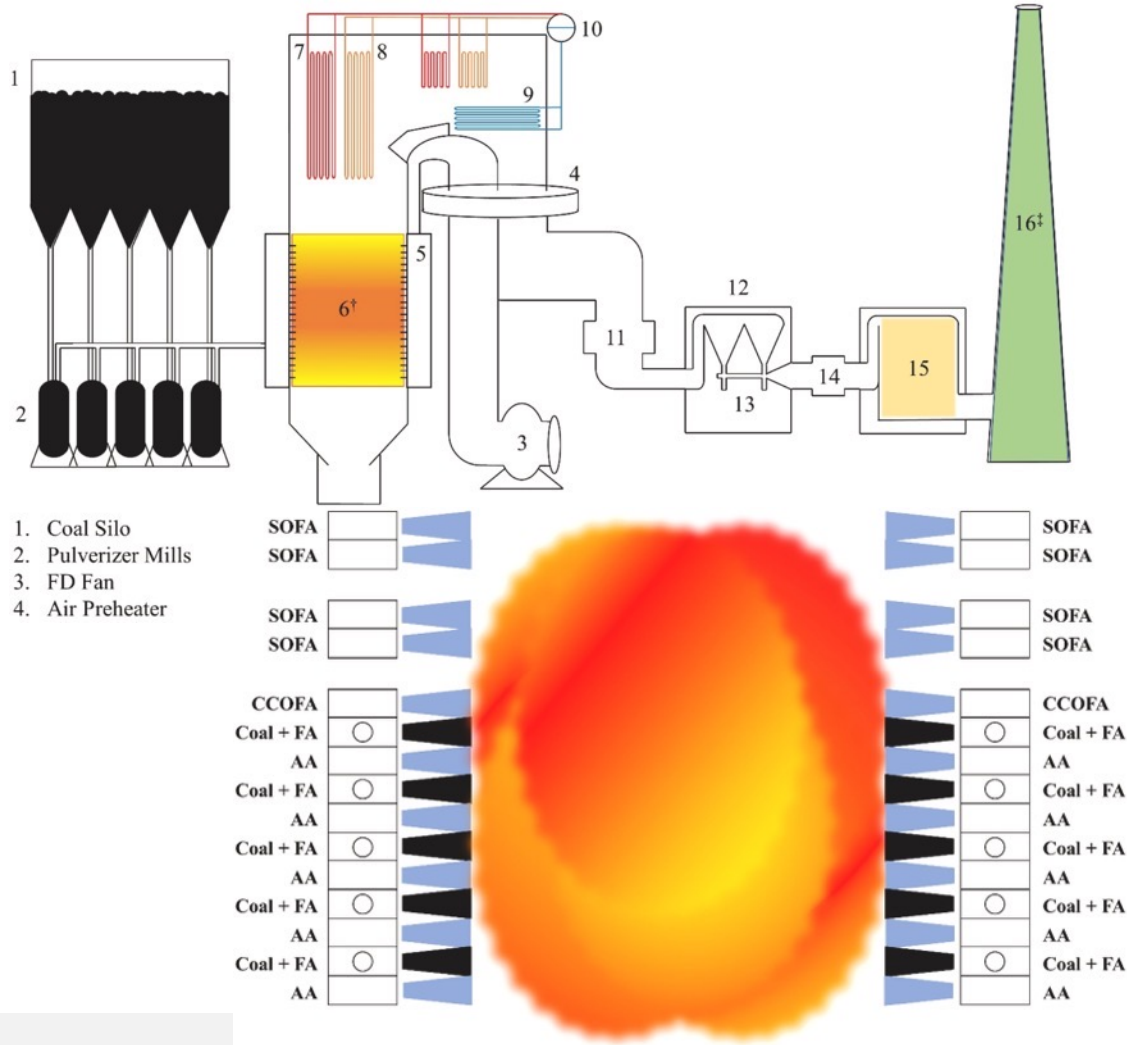
Expected structural changes in the energy system made possible by the increased use of digital tools



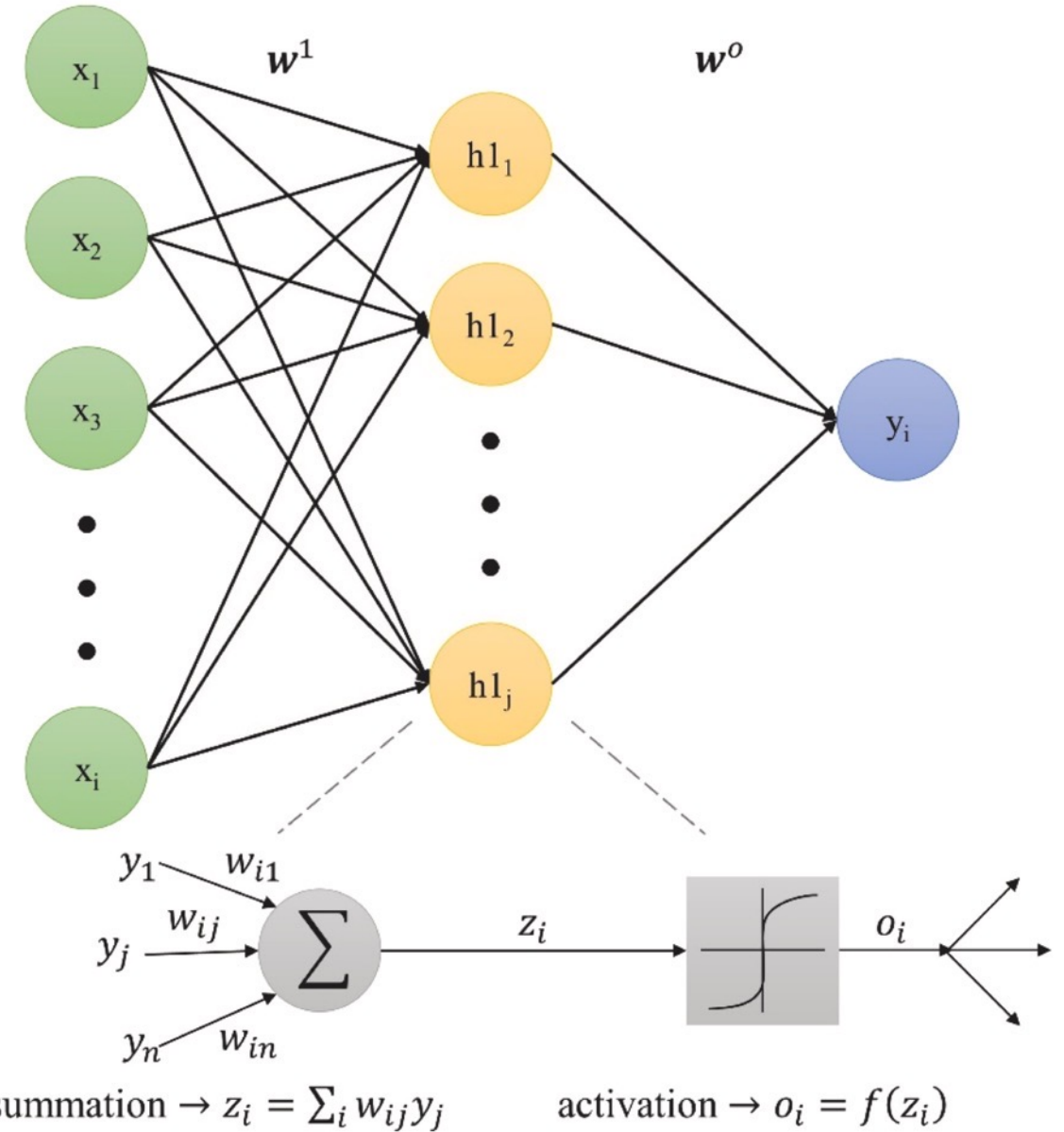
https://en.wikipedia.org/wiki/Smart_grid

Working Smarter: Case Study 1

Using AI to Optimize Coal Combustion

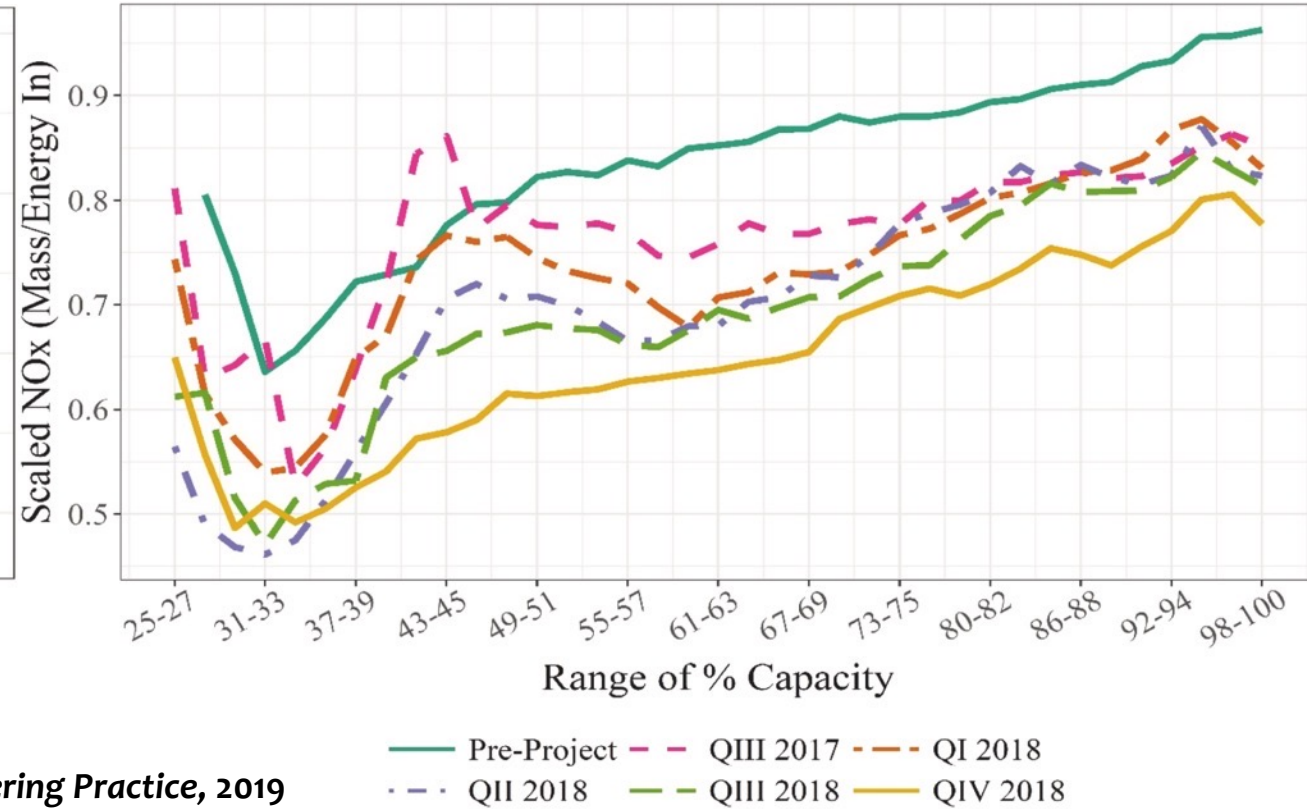
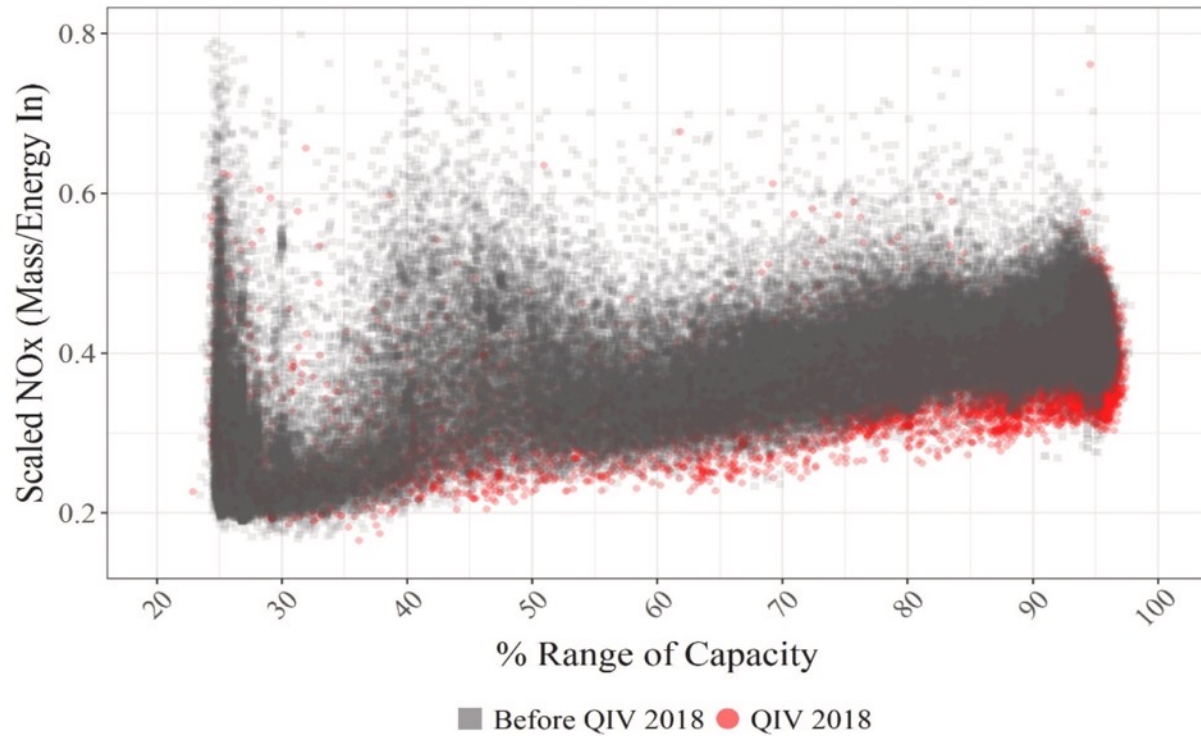


Input Layer Hidden Layer Output Layer



Working Smarter: Case Study #1

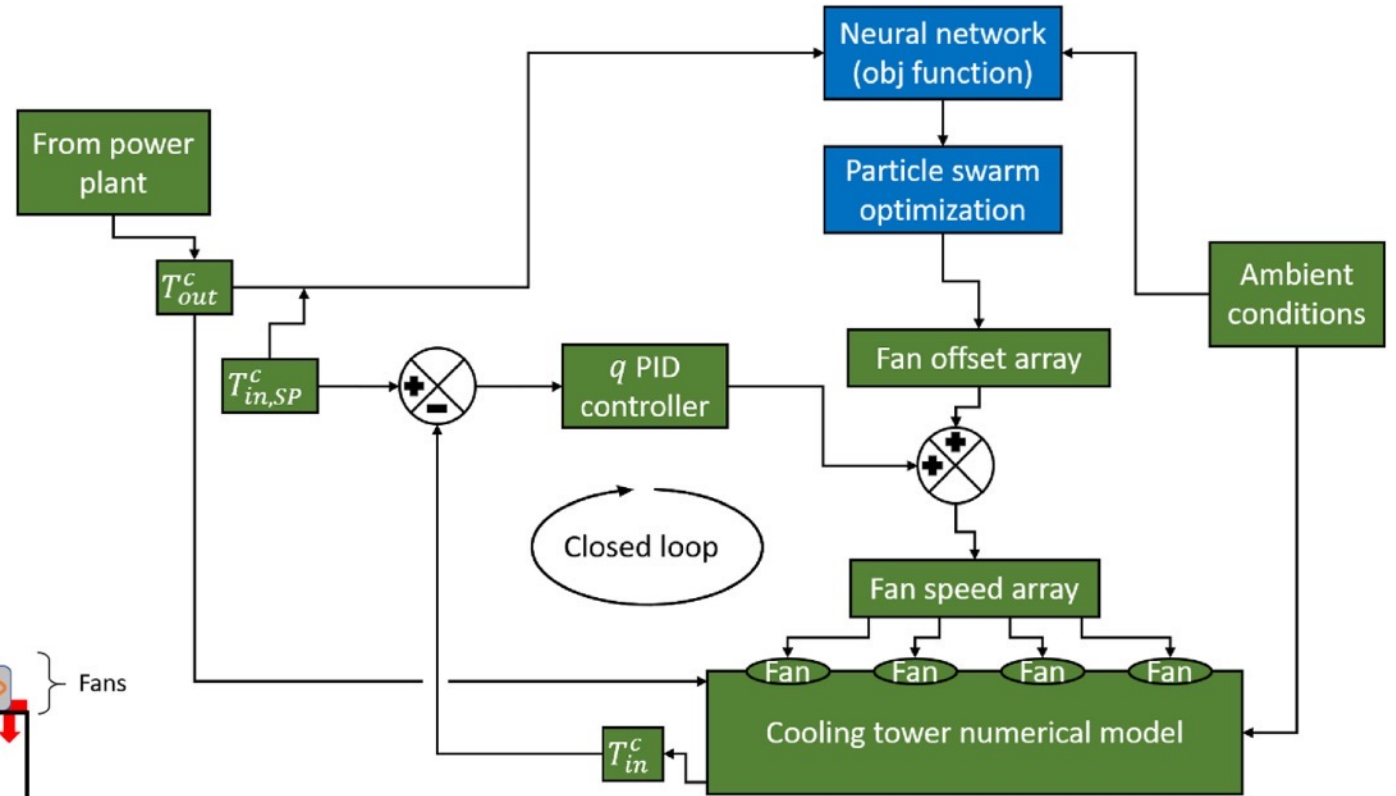
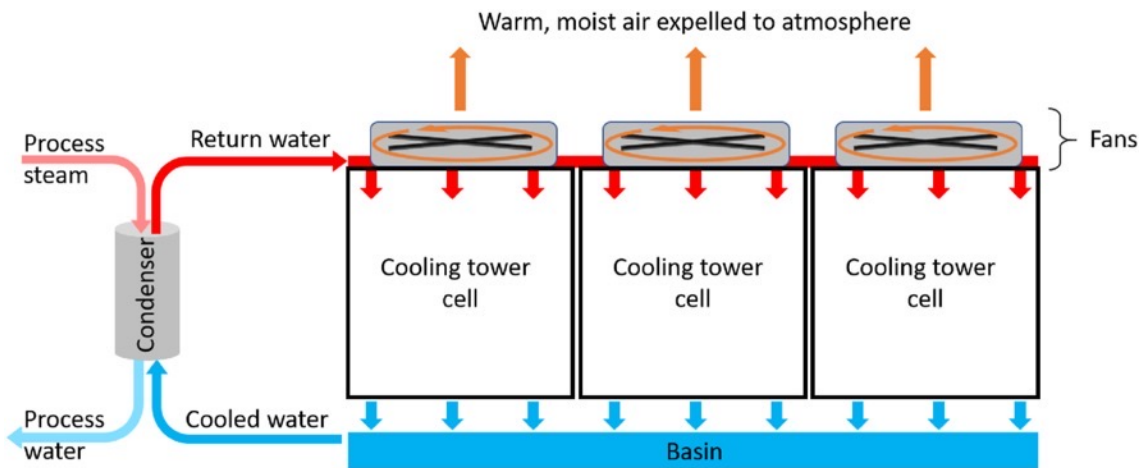
Using the Resources We Have to Their Full Potential



Tuttle et al., *Control Engineering Practice*, 2019

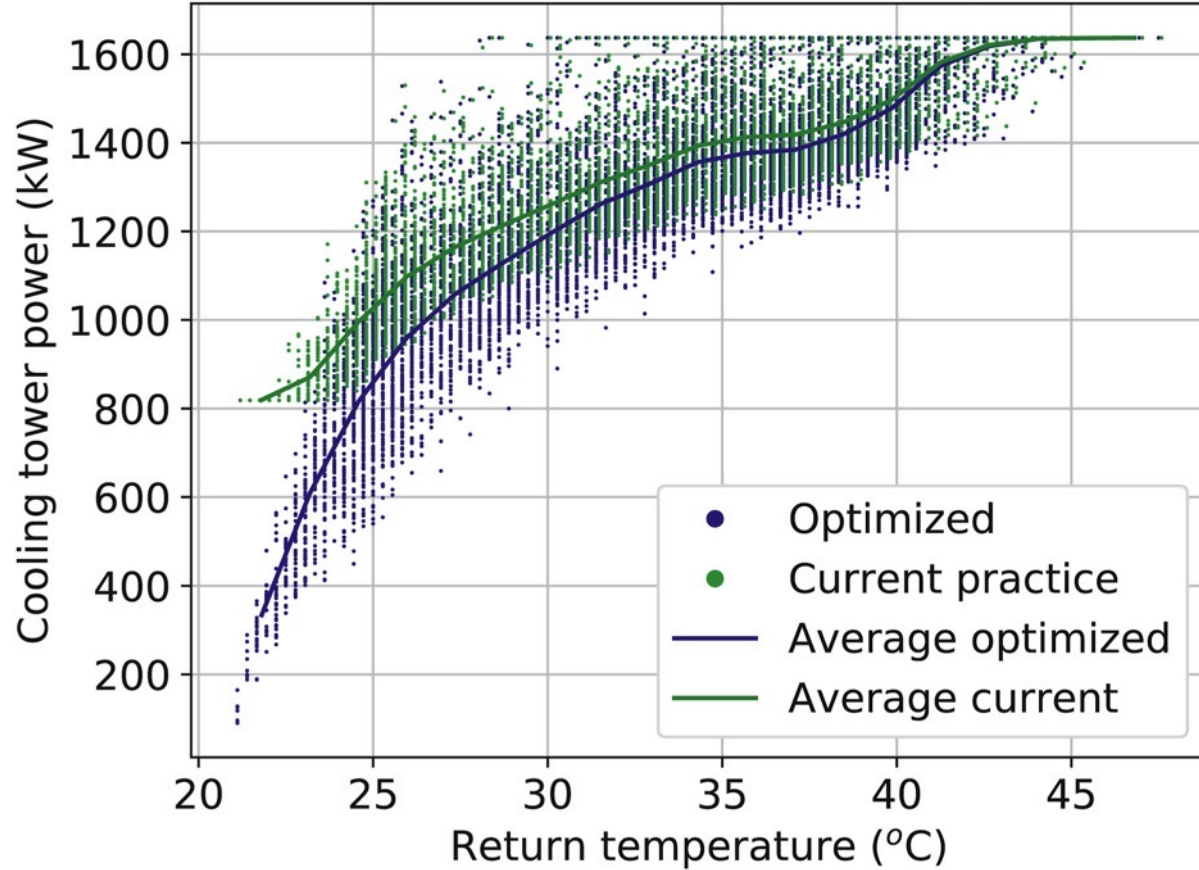
Working Smarter: Case Study #2

Using AI to Optimize Cooling Towers

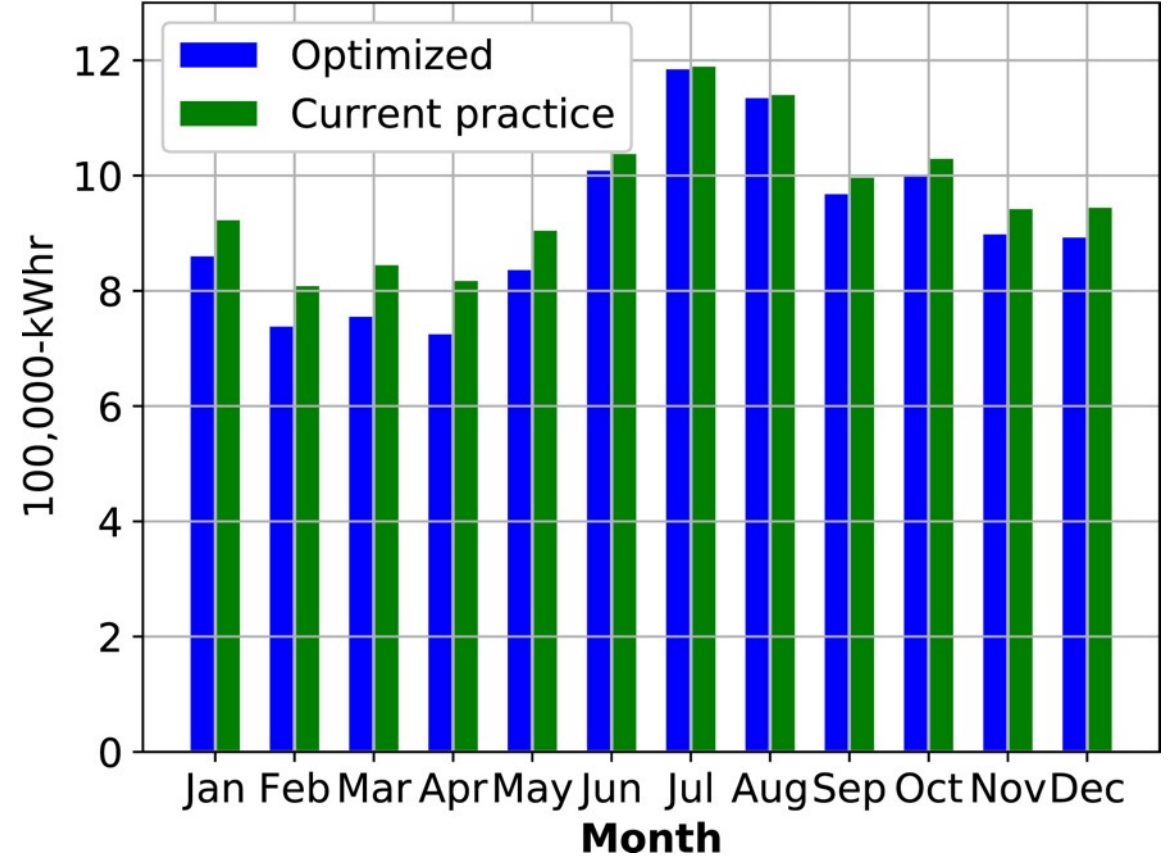


Working Smarter: Case Study #2

Cooling Tower Power vs Return Temperatures

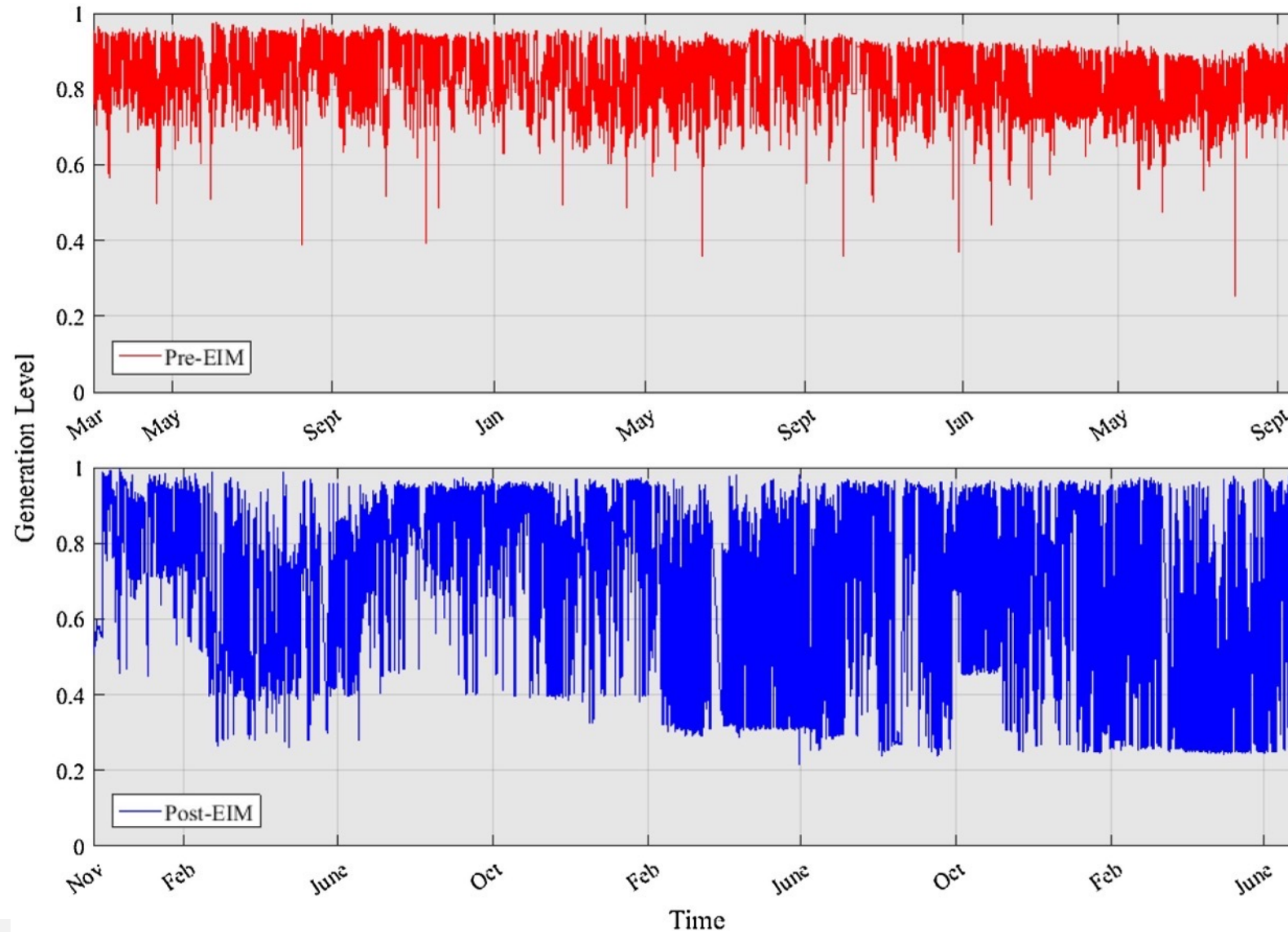


Energy Consumption by Month



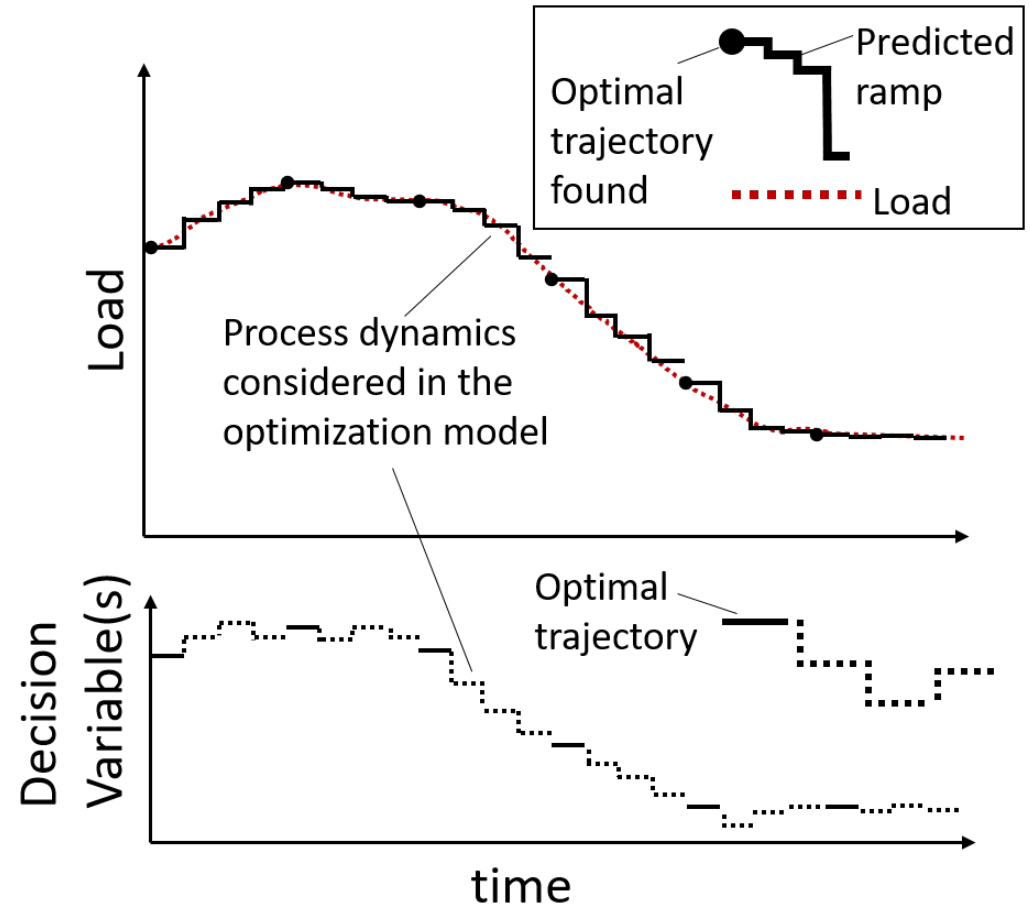
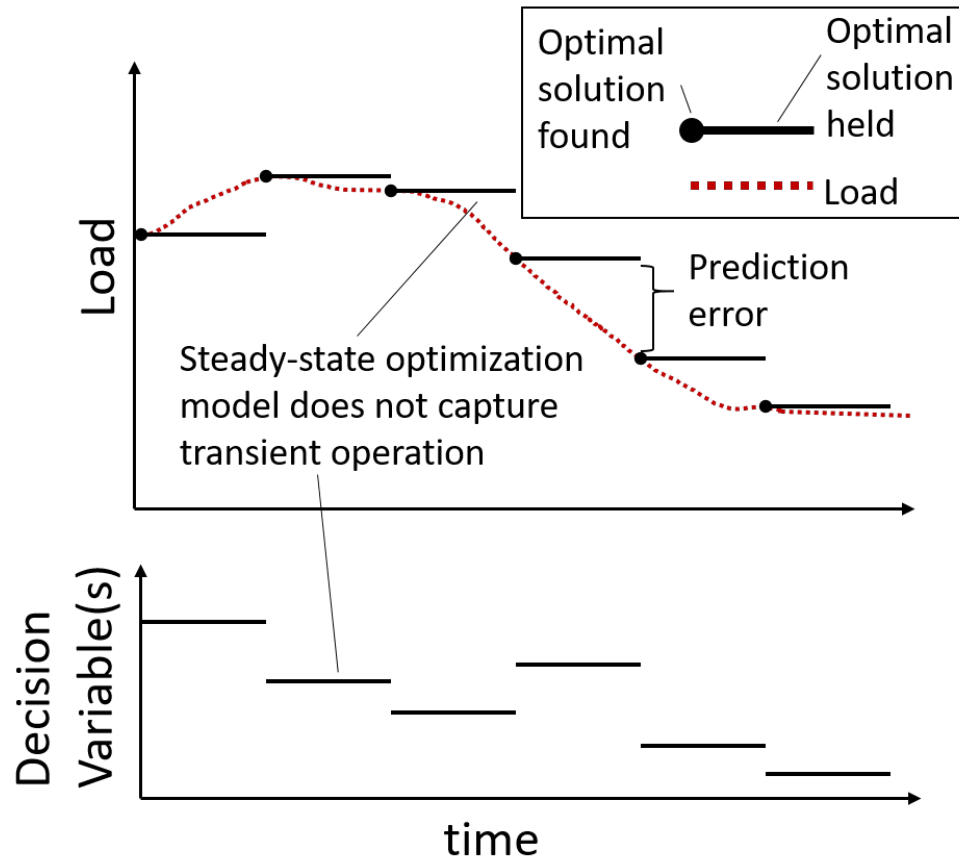
Working Smarter: Case Study #3

Incorporating Dynamics into Smart Operation

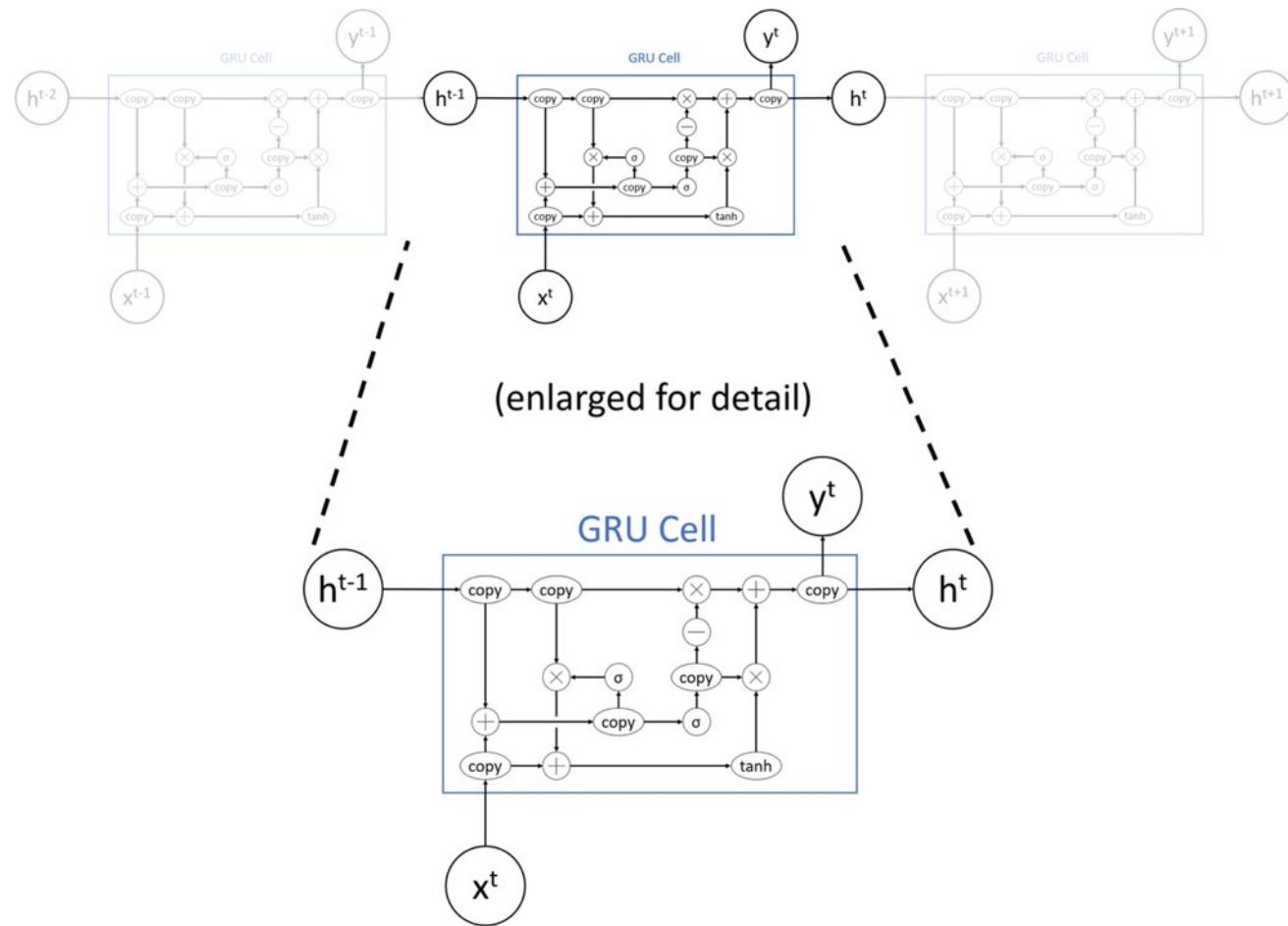
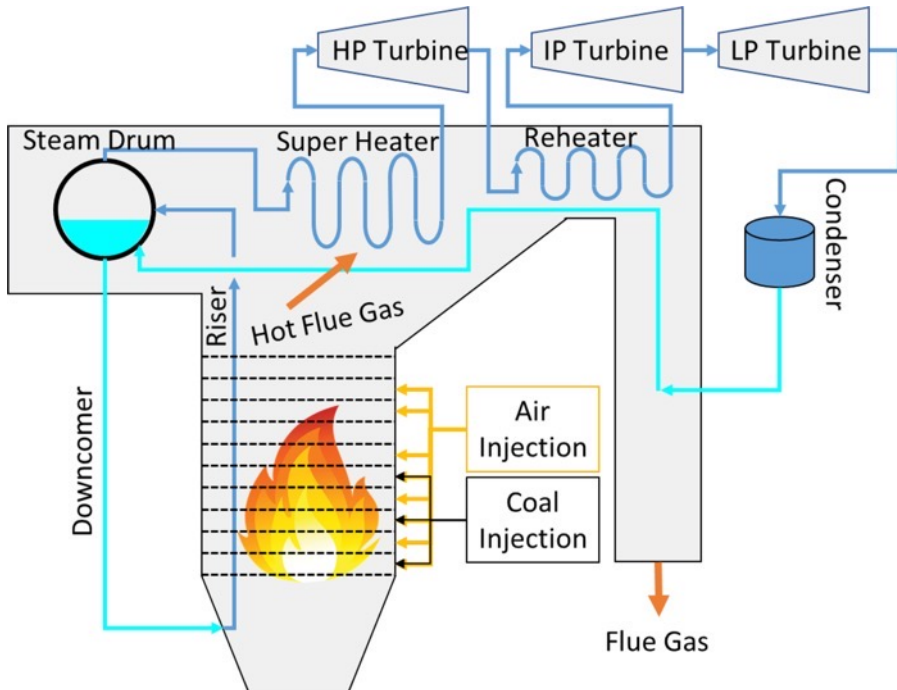
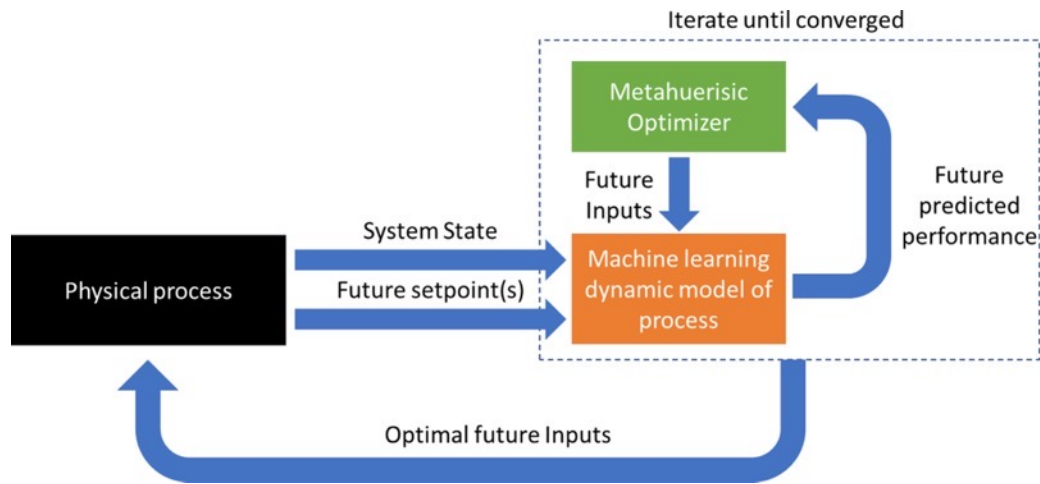


Working Smarter: Case Study #3

Incorporating Dynamics into Smart Operation



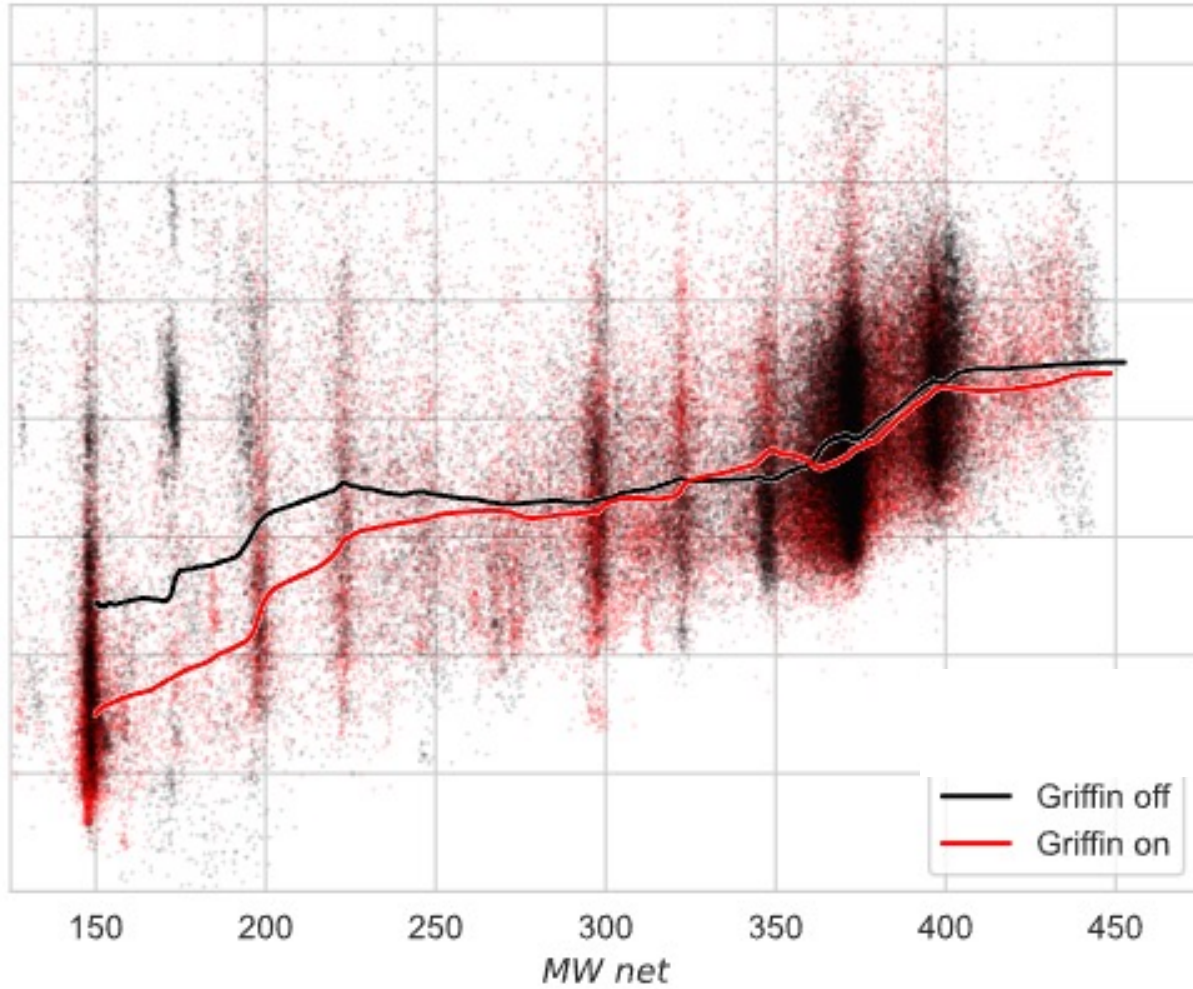
Working Smarter: Case Study #3



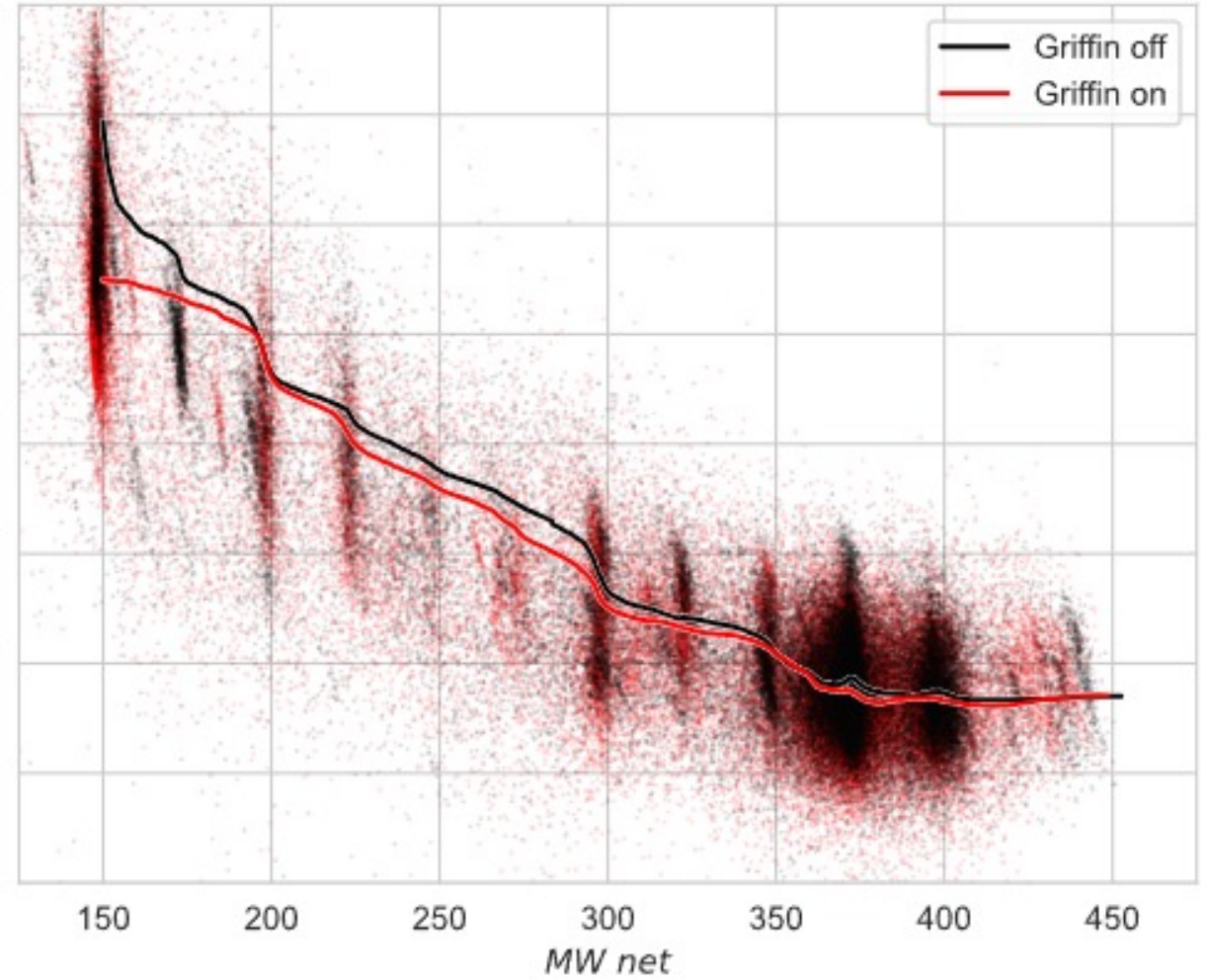
Blackburn et al., *Journal of Process Control*, 2022

Working Smarter: Case Study #3

NO_x/MWh



Coal Burned / MWh



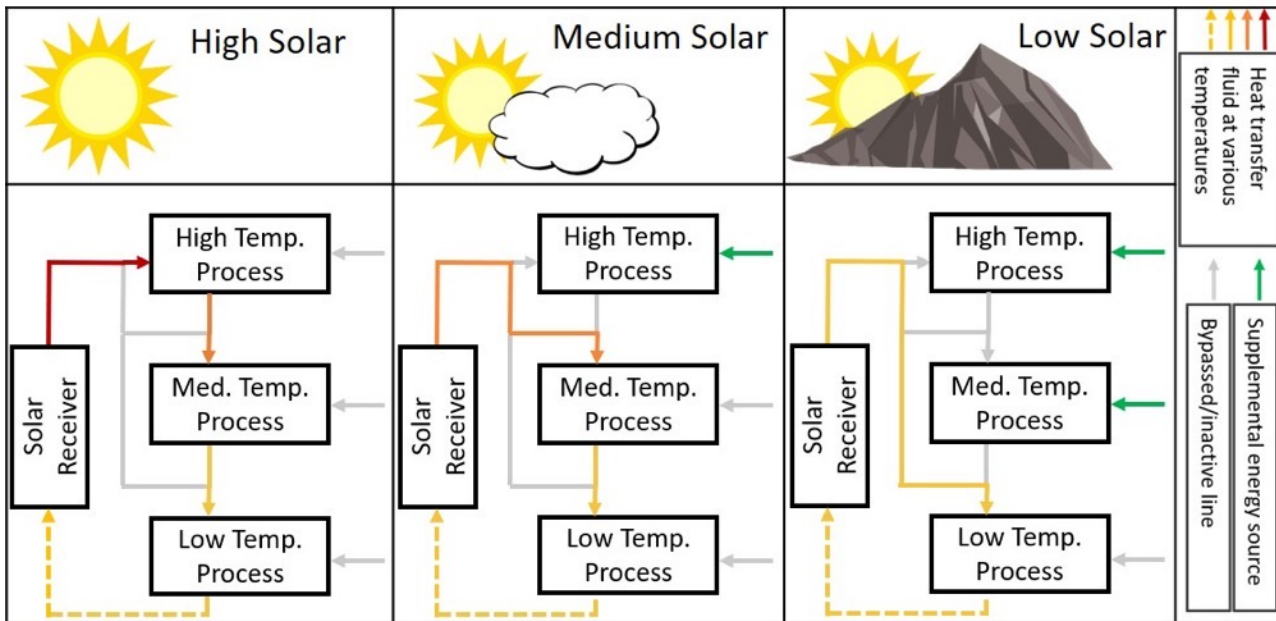
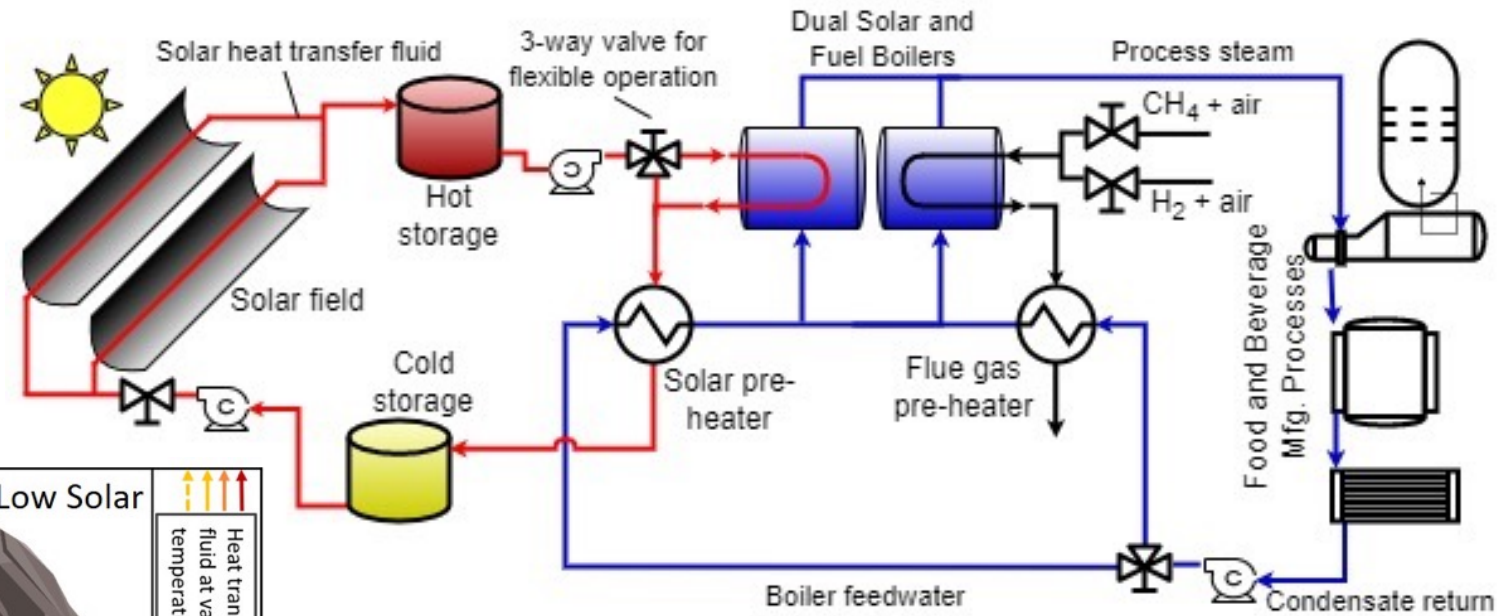


Let's Build Smarter Too!

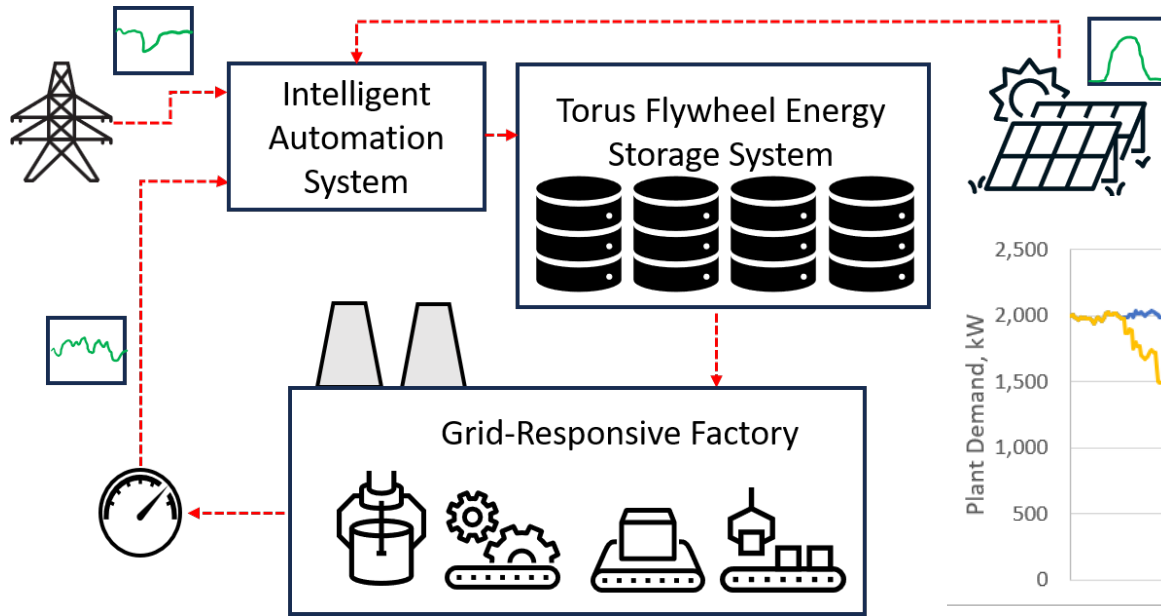
Hybridization as a Transition Vehicle

Building Flexible Hybrid Systems: Industrial Process Heat

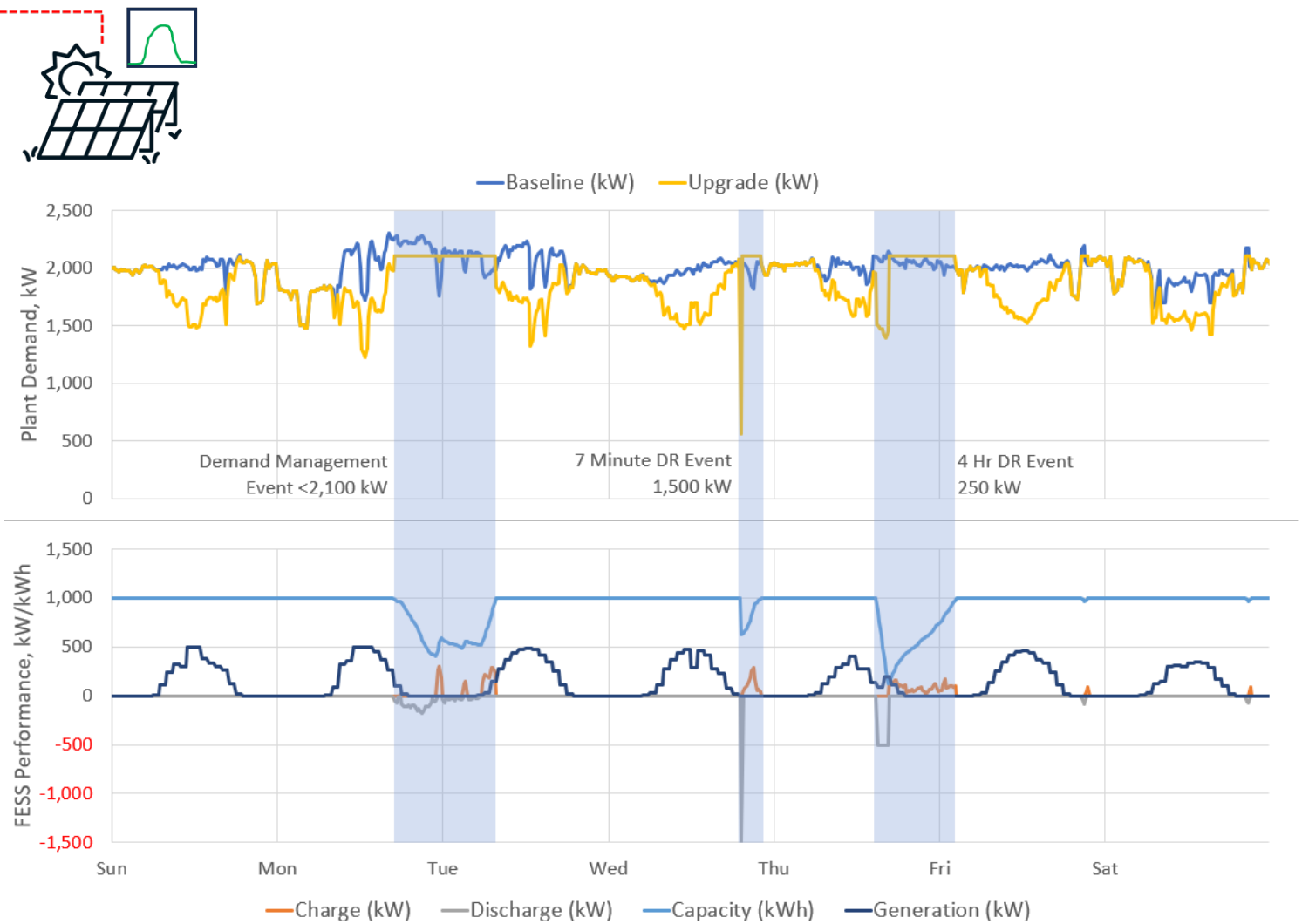
- Thermal Energy Storage
- Triple-Source Boiler
 - Solar
 - Natural Gas
 - Hydrogen
- Intelligent Operation



Building Flexible Hybrid Systems: Active Energy Storage



- Participate in Demand Response
- Use Solar More Effectively
- Reduce Peak Demand
- Reduce Process Impact from Outages

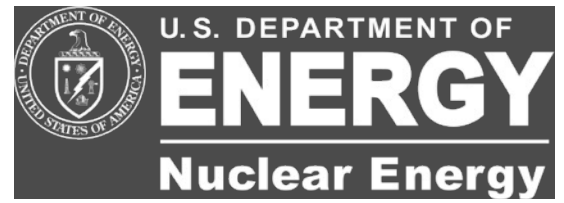
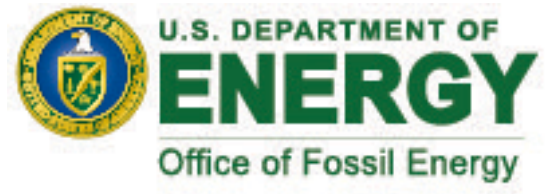


Conclusions

Operate Intelligently

Build Intelligently

Transition Intelligently



Thank You!

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