Power sustainability through AI

Panel: Resource Impacts and Demands Anticipated from Artificial Intelligence

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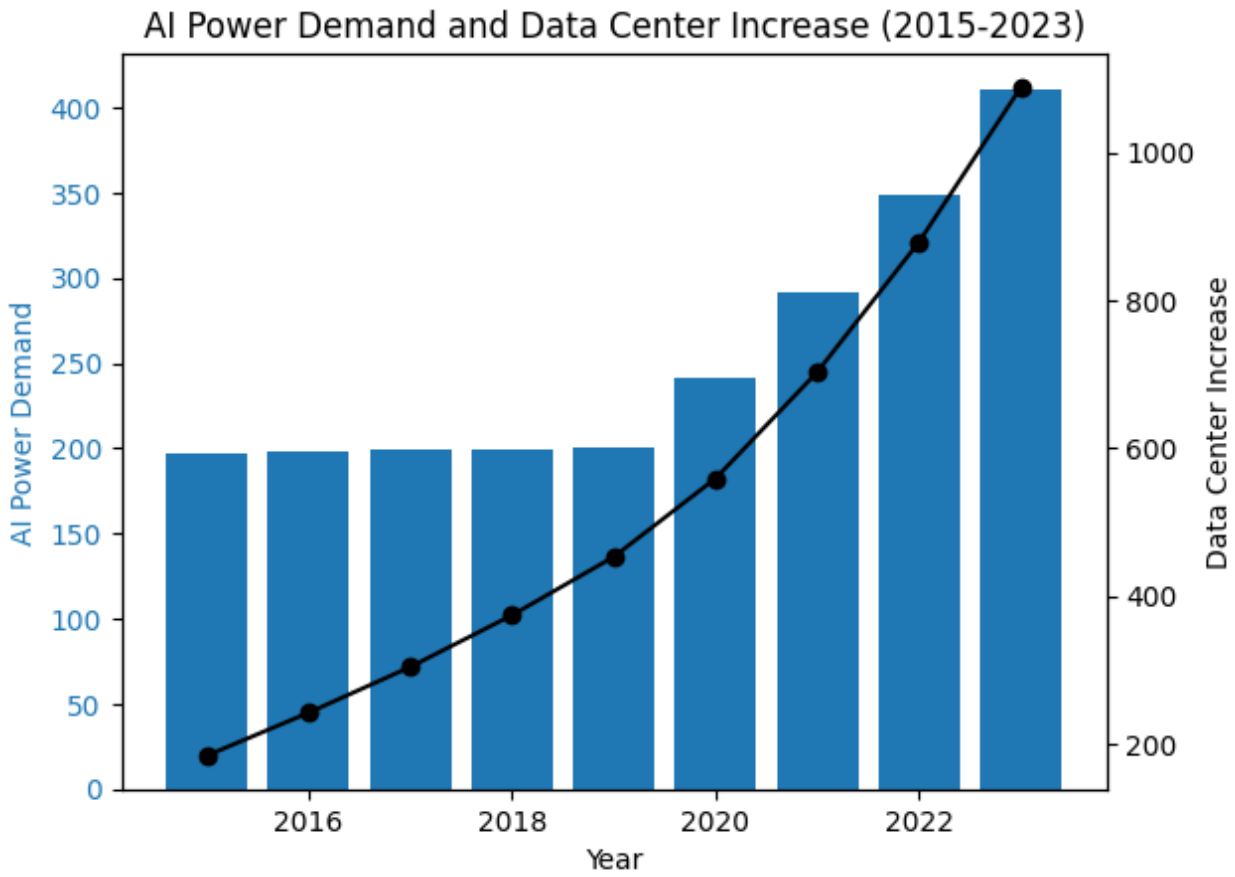
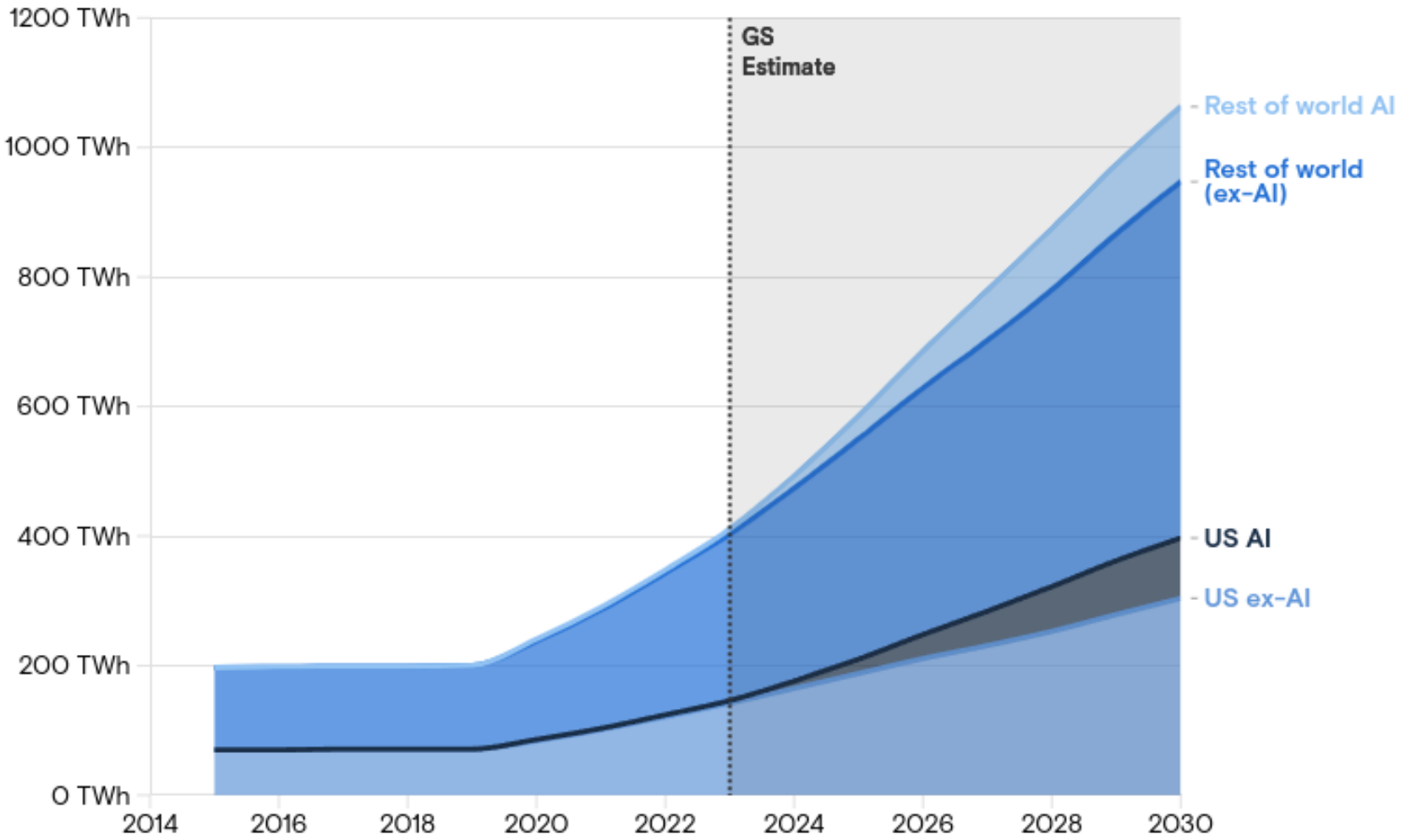
AI power demand is increasing



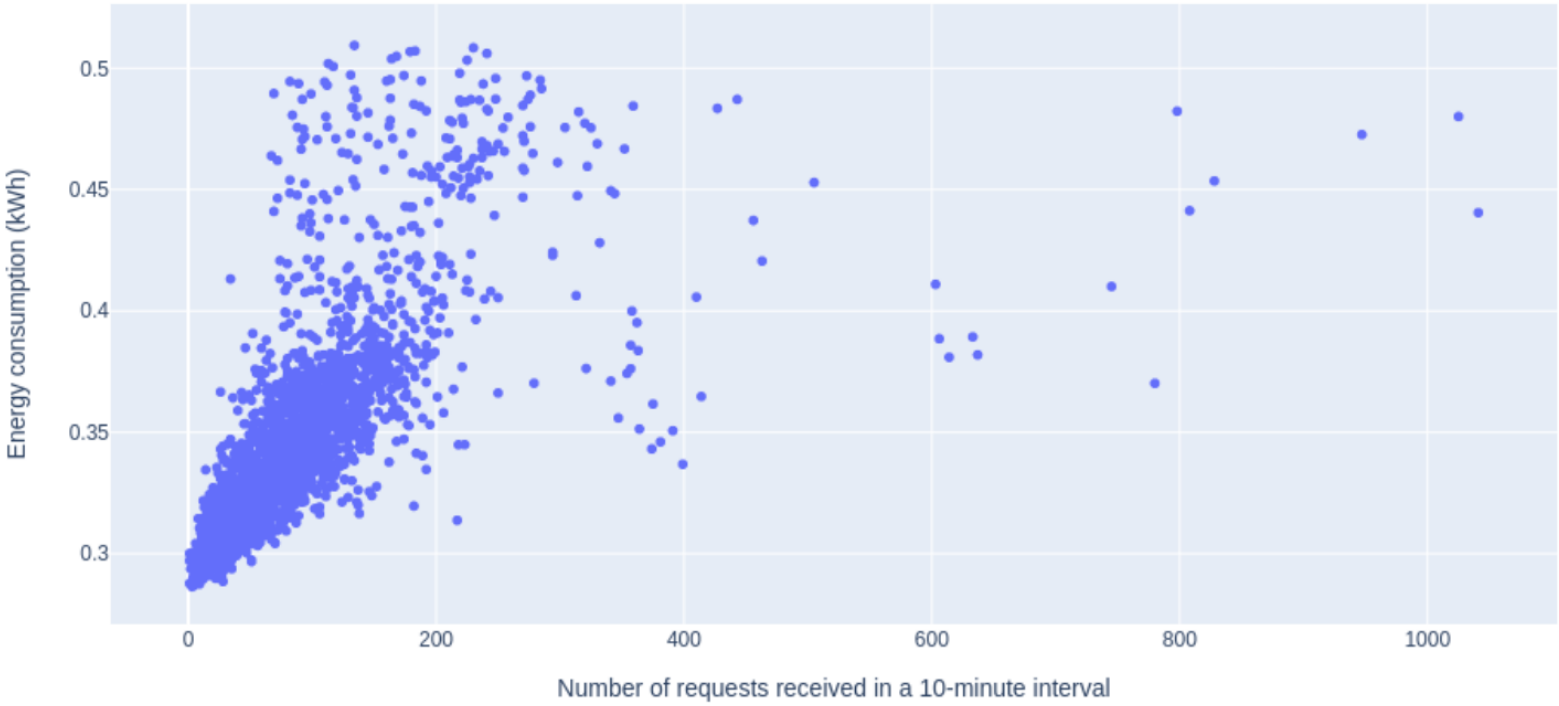
Source: Goldman Sachs, "AI, data centers and the coming US power demand surge", 2024.

AI power demand is increasing



Source: Goldman Sachs, "AI, data centers and the coming US power demand surge", 2024.

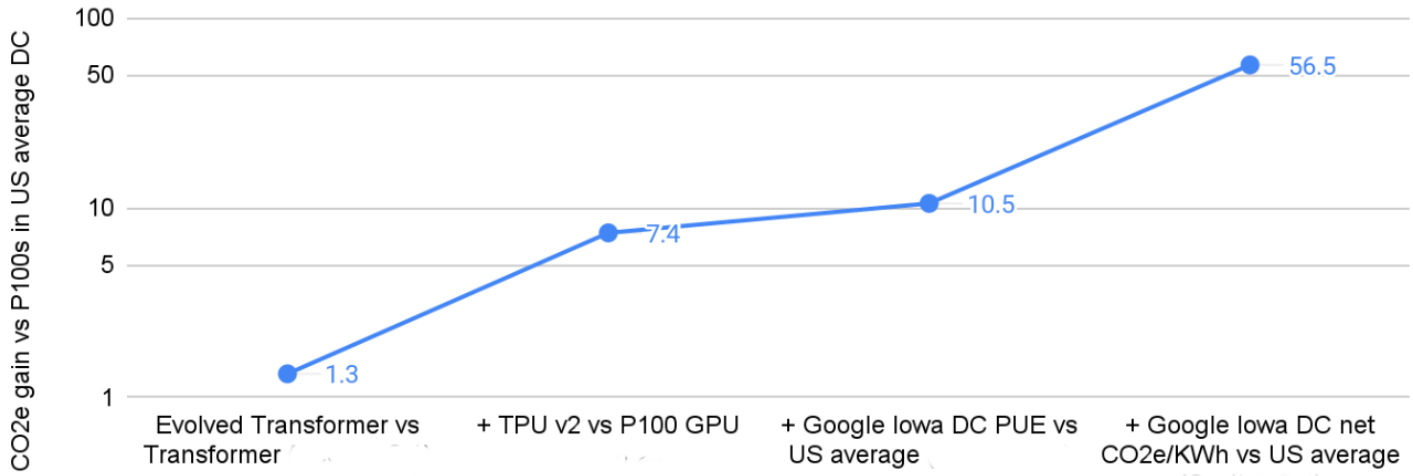
The cost of training and using a LLM



Training GPT-3: 1,287MWh, 502 Tm of $C0_2$.

Luccioni, A. S., et al. (2023). Journal of Machine Learning Research, 24(253), 1-15.

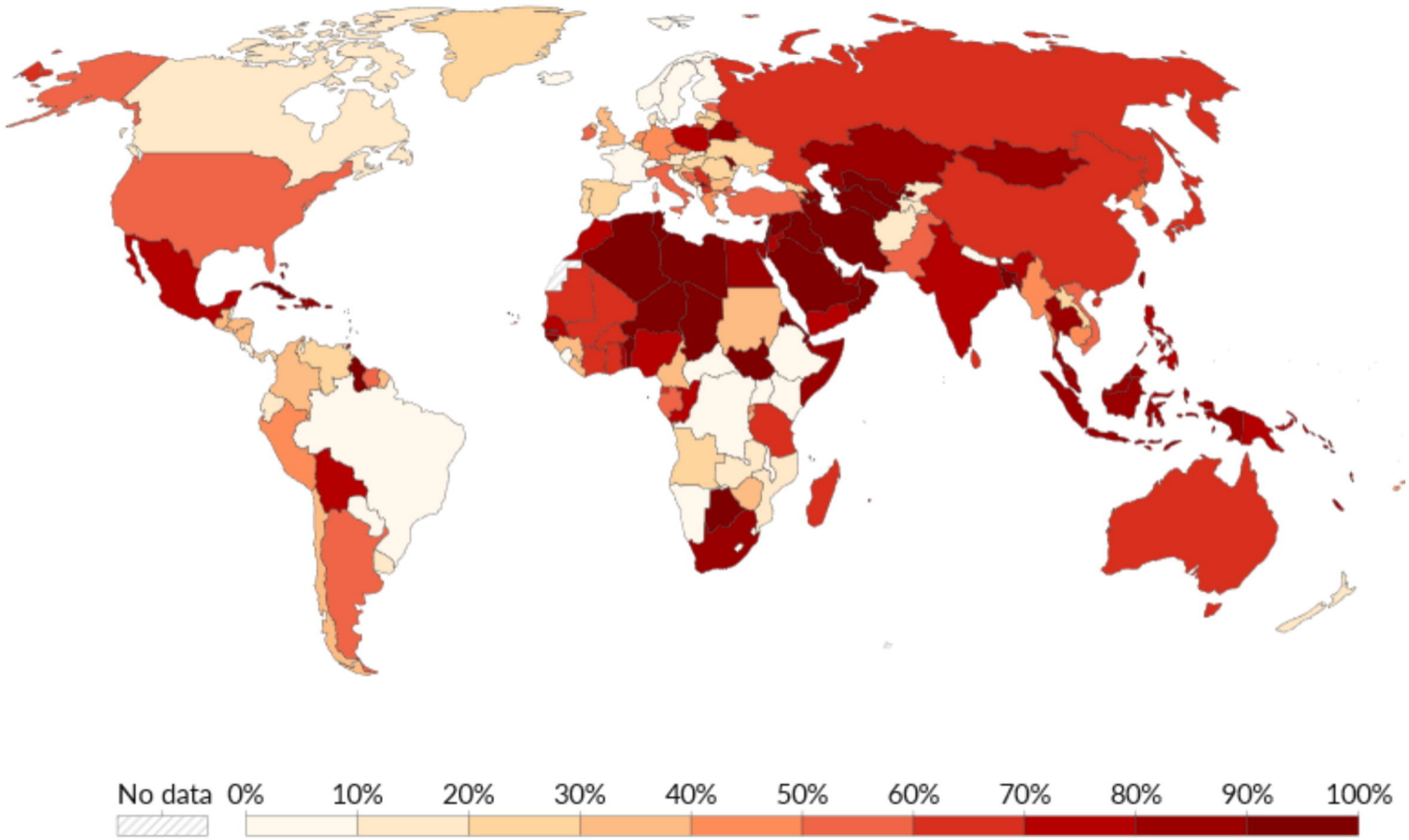
The quest for sustainability



- **Software**: Faster algorithms
- **Hardware**: Power-efficient processors
- **Datacenters**: Energy-efficient centers
- **Energy**: Mix improvement

Patterson, David, et al. (2021) "Carbon emissions and large neural network training." arXiv preprint.

Datacenter efficiency through AI



Share of electricity production from fossil fuels, 2023

Ritchie, H., Rosado, P.,& Roser, M. (2024). Energy mix. Our world in data.

Efficiency through AI: challenges

- Power usage effectiveness
- Cooling
- Renewable energy integration and limitations
- On-site renewable energy
- Energy supply management

Source: kentix.com

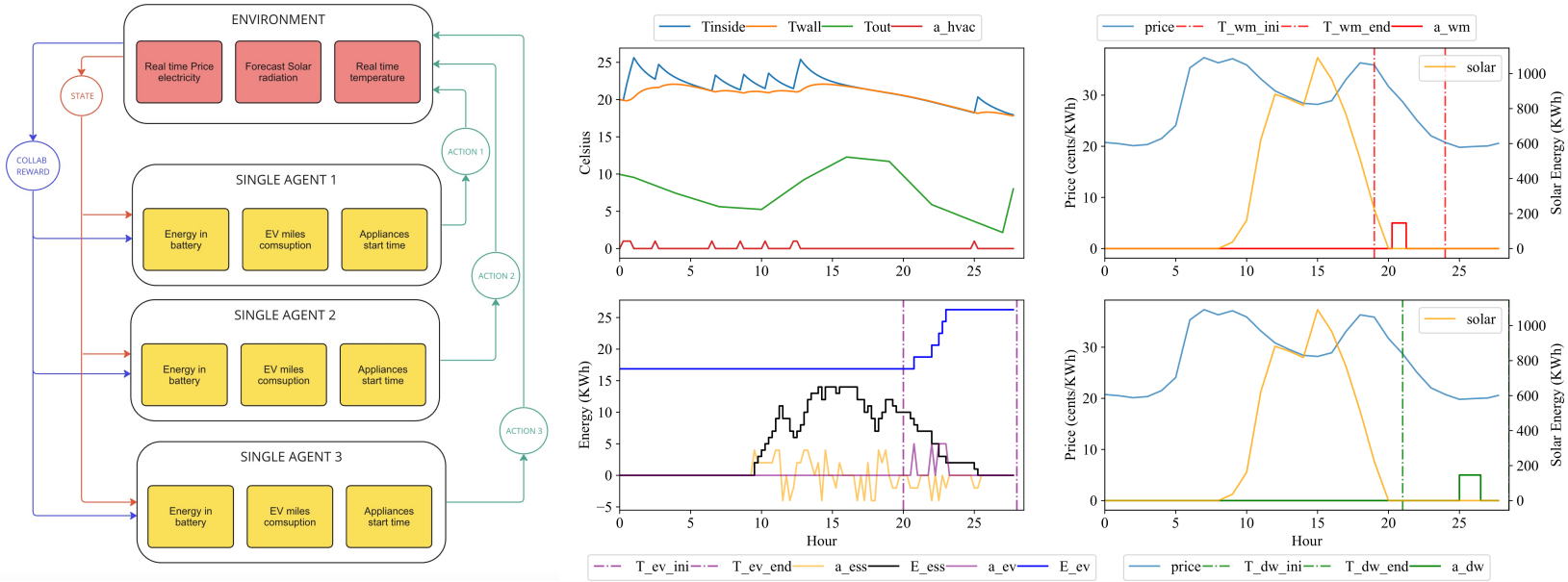
Efficiency through AI: solutions

Some active lines of research in academia

- Reinforcement learning
  - Adaptive optimization of resources.
  - Minimization of CO2.
  - Lowering the energy bill.
- Deep Learning
  - Workload, energy, and generation forecast.
  - Risk estimation and analysis.
  - Fault and cyber-attack detection.
  - Control of cooling systems
- Evolutionary algorithms
  - Optimal resource allocation among servers.
  - Workload balance.

Khosravi, A., et al. (2024). Review of energy efficiency and technological advancements in data center power systems. Energy and Buildings.

Adaptive, probabilistic resource management with uncertainty management.



Pereira, N., Martínez-Ramón, M. (2024) Enhancing Collaborative Home Energy Systems: Robustness through Bayesian Q-Learning and MDP Framework. Unpublished

Some examples: probabilistic forecast

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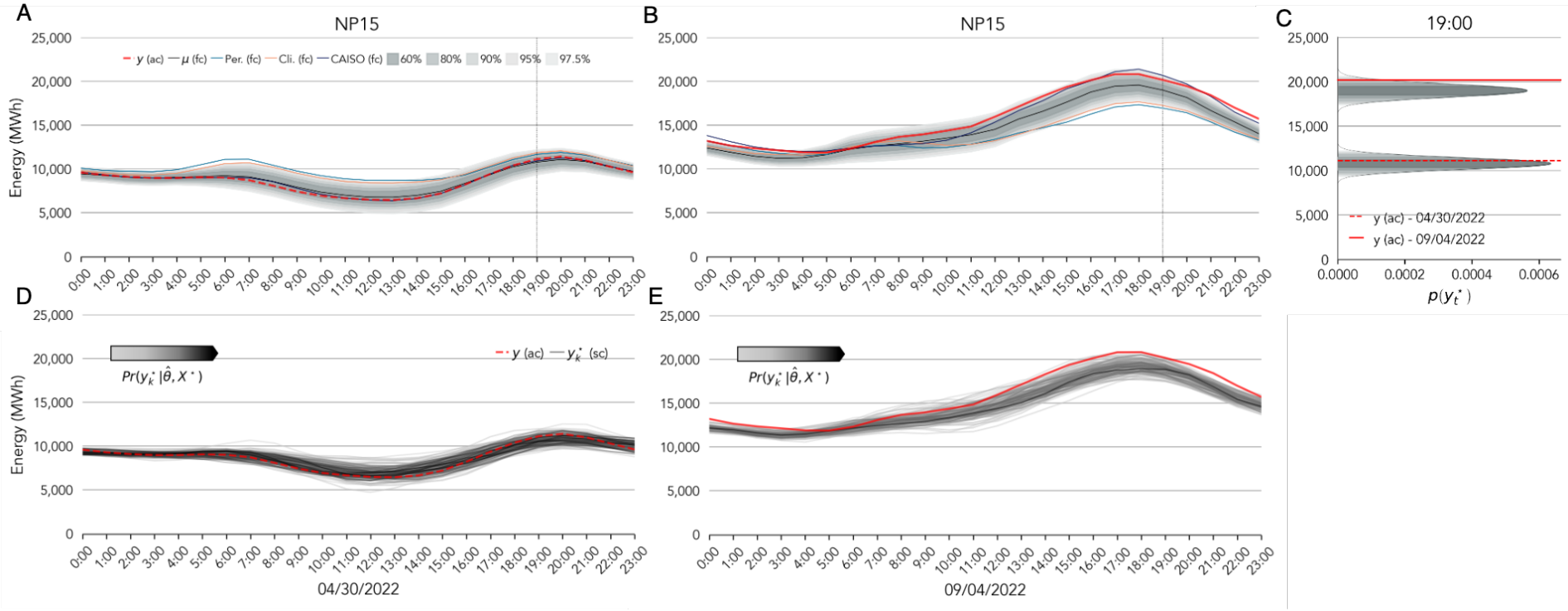
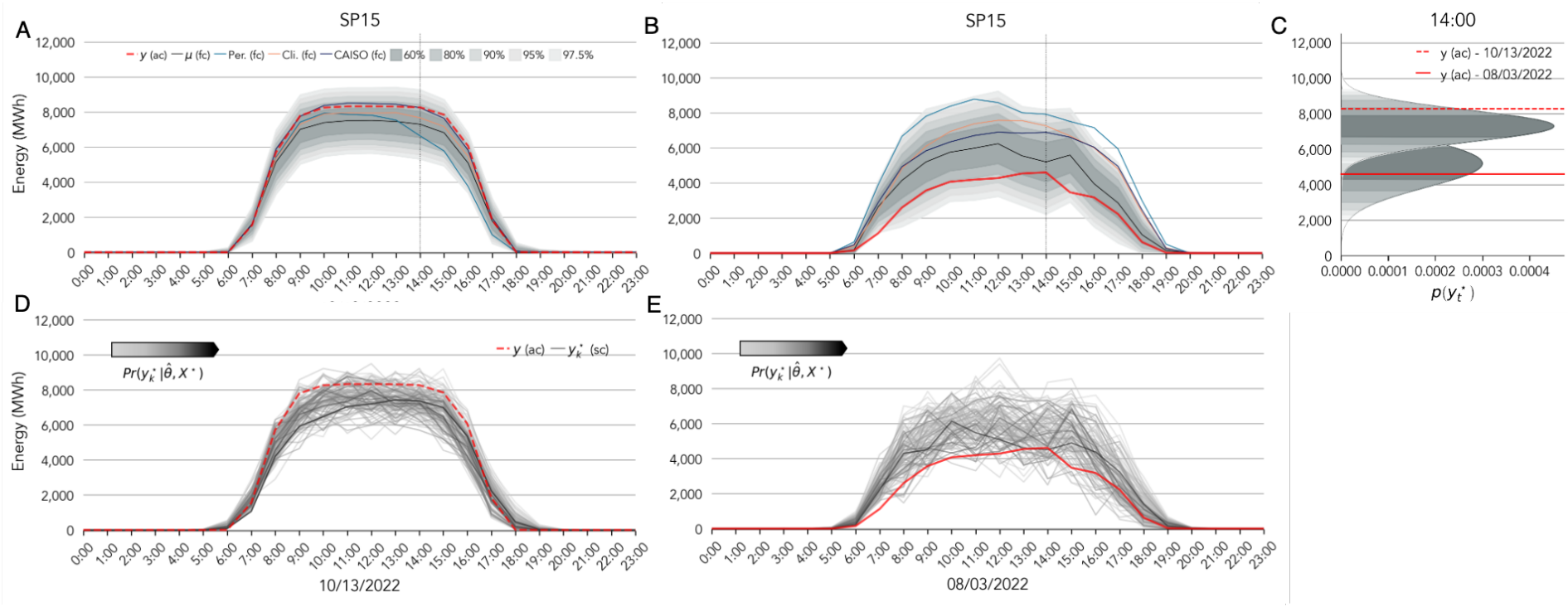
Energy demand forecast with reliable confidence intervals



Terrén-Serrano, G., Ranjit Deshmukh, R., Martínez-Ramón, M. (2024) Day-Ahead Energy Forecast for Operational Risk Assessment in Power Systems. Unpublished.

Some examples: probabilistic forecast

Solar generation forecast with risk estimation.



Terrén-Serrano, G., Ranjit Deshmukh, R., Martínez-Ramón, M. (2024) Day-Ahead Energy Forecast for Operational Risk Assessment in Power Systems. Unpublished.

Some examples: probabilistic forecast

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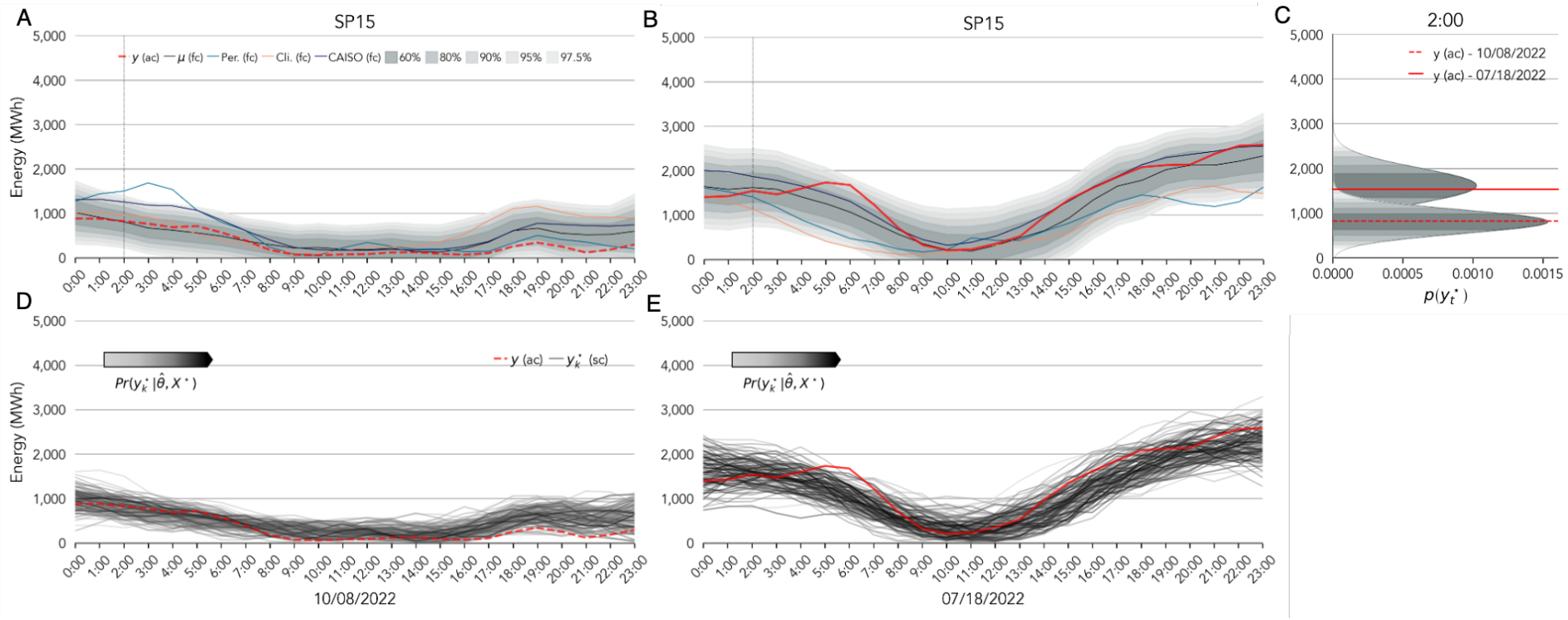
Wind generation forecast with reliable confidence intervals



Terrén-Serrano, G., Ranjit Deshmukh, R., Martínez-Ramón, M. (2024) Day-Ahead Energy Forecast for Operational Risk Assessment in Power Systems. Unpublished.

Conclusion

- AI is here to stay.
- AI faces challenges and barriers. Ethical and sociological concerns, but also energy and sustainability.
- AI is itself an extremely powerful tool for creating environmentally friendly AI.
- The University of New Mexico has the expertise and resources to significantly advance toward AI sustainability.