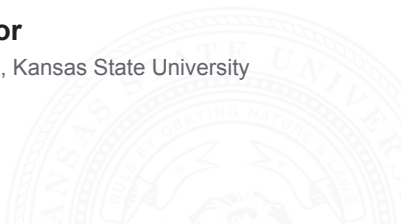


Small Modular Reactors for Hyperscale Data Centers

Buxin She | Assistant Professor

Mike Wieggers Department of Electrical and Computer Engineering, Kansas State University

Joint work with Honglin Li and Jie Zhang



Acknowledgments

Dr. Honglin Li

First author

Postdoctoral researcher in my group
Kansas State University

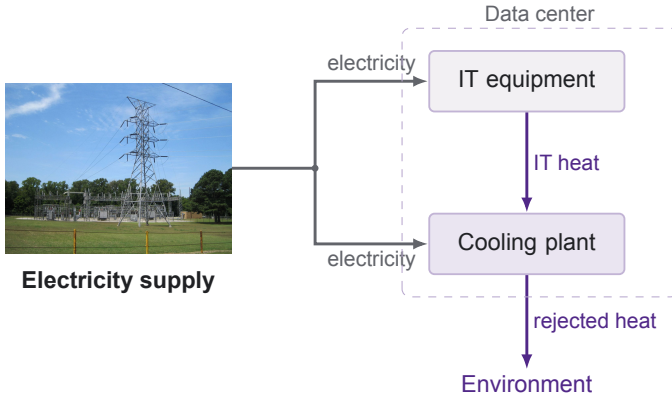
Prof. Jie Zhang

Coauthor and collaborator

The University of Texas at Dallas

H. Li, B. She, and J. Zhang, “Techno-Economic Boundary Analysis of Small Modular Reactor Cogeneration for Hyperscale Data Center IT and Cooling Loads,” *arXiv preprint*, 2026.
[arXiv:2608.10999](https://arxiv.org/abs/2608.10999).

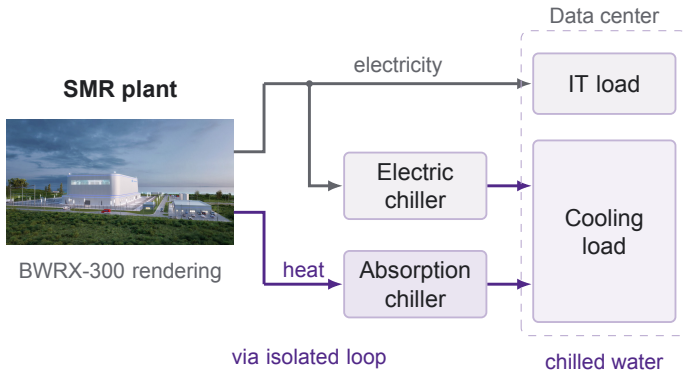
Data Centers Couple Electricity and Heat



- **Electrical demand**
IT equipment and cooling both need power.
- **Thermal load**
IT power becomes heat that must be removed.
- **Coupled operation**
Cooling conditions affect electricity demand.

Data centers are integrated energy systems coupling electricity and heat removal.

Connecting SMRs and Data Centers



- **Electrical pathway**
Power serves IT and electric cooling.
- **Thermal pathway**
Heat drives absorption cooling.
- **Joint operation**
Steam extraction trades turbine output for cooling.

SMR cogeneration combines electricity supply with steam-driven cooling.

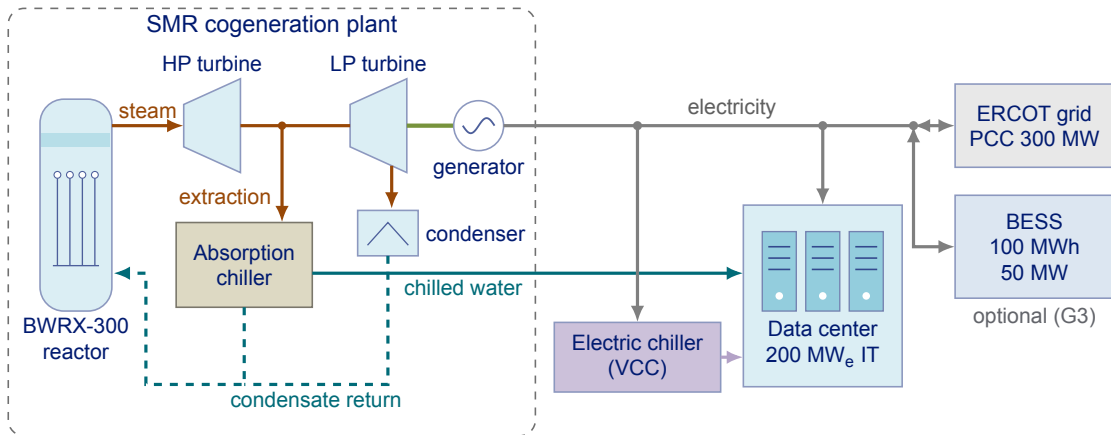
Research Questions

- **Q1.** Can a colocated SMR supply a data center at lower annual cost than the grid?
- **Q2.** Does steam-driven cooling save money compared with power-only SMR supply?
- **Q3.** Can lower reactor capital make SMR supply cost-competitive with the grid?

Study Configurations

Case	Key configuration
■ C0	Grid electricity + electric chiller
■ C1	SMR electricity + electric chiller Grid imports and exports allowed
■ C2	SMR electricity + electric and absorption chillers Grid imports and exports allowed
■ C3	On-site natural gas combined cycle + electric chiller Islanded operation

SMR Configurations: C1 and C2



C1 uses electric cooling. C2 adds steam extraction and absorption cooling.

Total Annualized Cost at Hourly Resolution

Minimize

$$\min_u \text{TAC} = C_{\text{cap}}^{\text{ann}} + C_{\text{O\&M}} + C_{\text{fuel}} + C_{\text{grid}} + C_{\text{CO}_2} - R_{45\text{Y}}$$

$R_{45\text{Y}}$: production tax credit on net nuclear generation.

Constraints

Power balance

$$P_{\text{gen},t} + P_{\text{import},t} = P_{\text{IT},t} + P_{\text{cool},t} + P_{\text{export},t}$$

Thermal balance

$$Q_{\text{abs},t} + Q_{\text{elec},t} = Q_{\text{demand},t}$$

Operating factors

Capacity limits, ramping and outages.

Chiller performance and steam extraction losses.

Inputs

Hourly data

IT load, weather, electricity prices and grid carbon intensity.

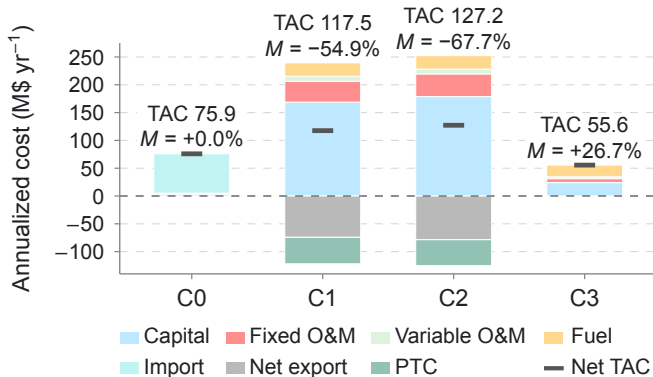
Equipment and costs

Capacities, capital and fuel costs, O&M and financing.

Policy assumptions

Carbon price and 45Y credit rate.

Q1: SMR Supply versus the Grid



- **Both SMRs cost more**

C1: +54.9%. C2: +67.7% relative to grid supply.

- **Capital dominates**

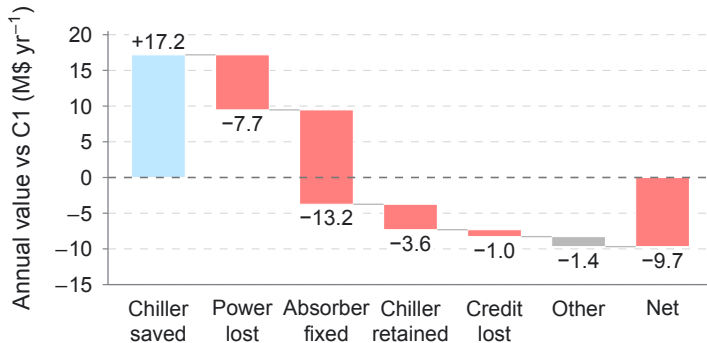
Export revenue and 45Y credits do not offset the capital burden.

- **NGCC is cheapest**

Natural gas combined cycle has the lowest annual cost in this comparison.

Grid-cost margin $M = 1 - \text{TAC}_{\text{case}} / \text{TAC}_{\text{grid}}$. Positive M : cheaper than the grid.

Q2: Does Steam-Driven Cooling Save Money?

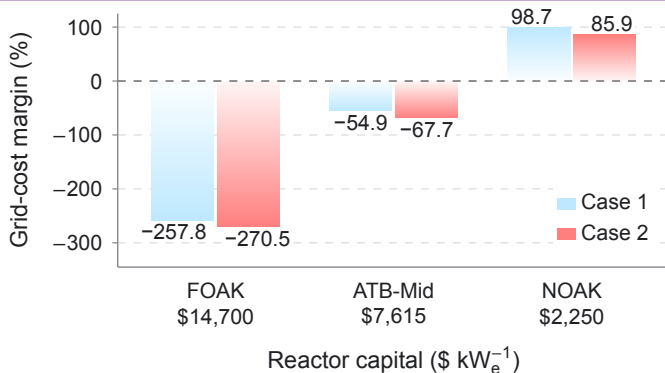


- **Cooling saves power**
Avoided electricity is worth \$17.2M/yr.
- **No net cost saving**
Absorber: \$13.2M/yr.
Lost power: \$7.7M/yr.
Forgone 45Y: \$1.0M/yr.

C2 relative to C1, 2023 baseline. Positive bars reduce cost.

No. Steam cooling adds \$9.7M/yr relative to power-only supply at the baseline.

Q3: Can SMR Supply Be Competitive?



- **Competitive at NOAK**

Both cases beat the grid at the NOAK target under 2023 prices.

- **A large capital reduction**

The NOAK target is about 85% below the FOAK capital estimate.

FOAK: First-of-a-kind. **NOAK:** Nth-of-a-kind.

ATB-Mid: Mid-range estimate. NOAK is a cost target.

■ **Yes, but reactor capital must fall substantially under the 2023 assumptions.**

Data-Center Demand and SMR Learning

Capital cost dominates SMR economics.

Learning from repeated deployment can lower that cost.

- **U.S. demand and learning**

Can U.S. data centers anchor enough SMR deployment to drive learning and lower capital cost?

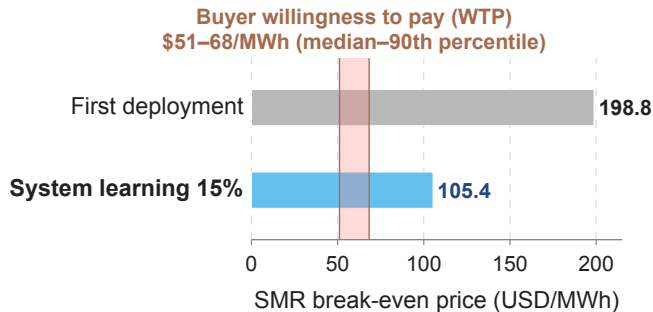
- **Break-even timing**

When can SMR supply costs fall within data centers' willingness to pay?

- **Policy and market conditions**

What policy support is needed, and how do market prices and demand growth affect the outcome?

Learning Lowers Cost, but a Gap Remains



- **A gap of about \$37/MWh**

Even the lowest tested SMR price remains above the 90th-percentile WTP.

Preliminary comparison at the assumed 2050 deployment scale; prices include grid delivery.