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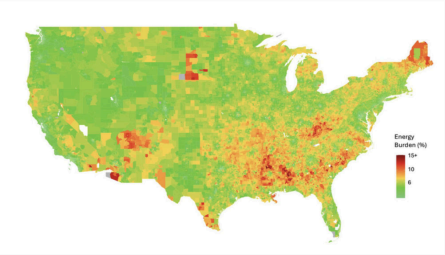
Randomness as a resource for electric power systems

Samuel Talkington

March 19, 2026

Georgia Tech Energy Day

Energy affordability crisis



Pricing growth has unequal impacts.[a]

[a]Carlos Batlle et al., US federal resource allocations are inconsistent with concentrations of energy poverty. *Sci. Adv.* **10**, 2024.

- Average US electricity bills **rose 4.8% per year** from 2019–2023[a]
- **1 out of 3 US households:** forgoing basic necessities (food/medicine) to pay energy bills in 2024[b]
- US electricity **consumer debt totaled $21.1 billion** as of September 2024.

[a]S. Forrester, et al. "Retail Electricity Price and Cost Trends," Lawrence Berkeley National Laboratory, 2024.

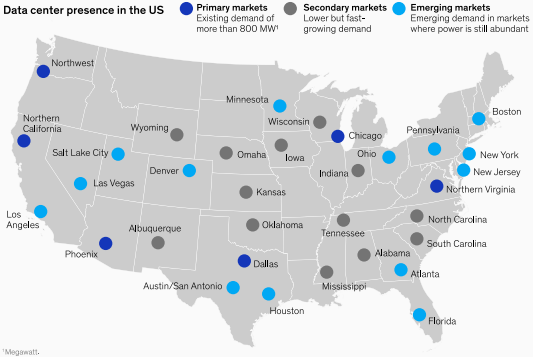
[b]U.S. Census Phase 4.2 Cycle 09 Household Pulse Survey: August 20 – September 16, 2024

Rapid load growth dilemma

- AI: Tsunami of new data centers
  - **At which node(s)** should we install a new data center?
  - **To which line(s)** should we interconnect?
- Ratepayers in **7 PJM states** paid $4.4 billion for data center transmission upgrades in 2024[a]
- Who pays? Risk of infrastructure costs shifting to residential ratepayers

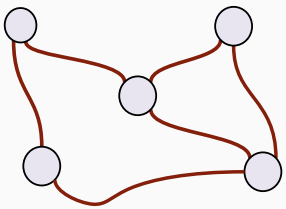
[a] Grid Strategies, "The Era of Flat Power Demand is Over," Dec. 2023; Utility Dive analysis, Oct. 2025.

Data centers are emerging in more remote locations, where power is still abundant and grids less strained.



McKinsey & Company

The grid reconfiguration bottleneck



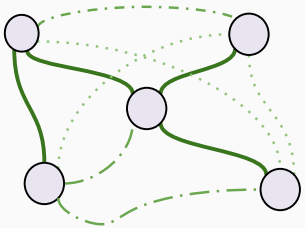
How should I connect the network?

What (single) config most reduces congestion?

Network Reconfiguration: Challenging, poorly scalable integer program

- How to answer these questions?
  - Operational switching, expansion planning, data center siting
  - Decide which lines to **open/close** (or **build/reconductor**) to reduce congestion
- These are **mixed-integer nonlinear optimization** problems
- State of the art: exact solvers take hours to days on realistic networks

Loaded dice: Fast network reconfiguration

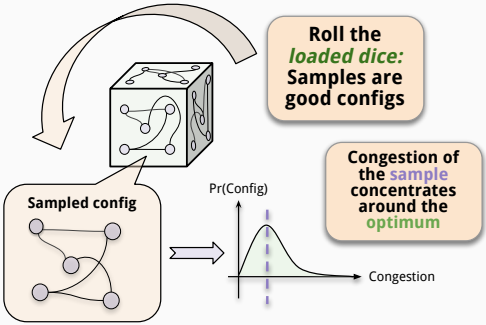


How should I connect the network?

What *family* of configs most reduces congestion?

Optimized switching probability

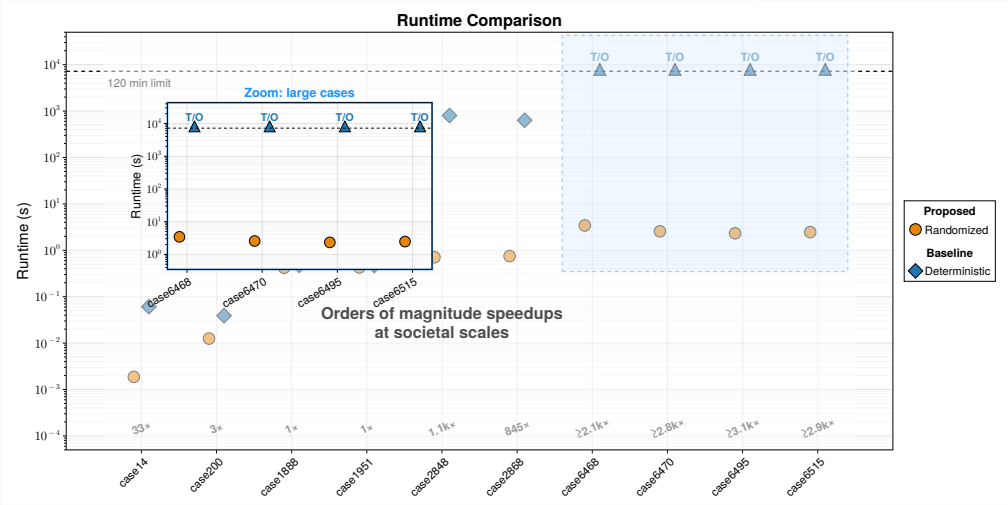
High Medium Low



What if we didn't have to commit to just one configuration?

Optimize over a probability distribution of configurations → samples *concentrate* around "good" solutions → families of near-optimal designs.

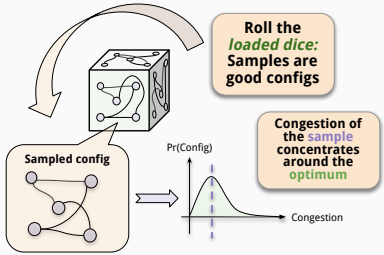
Loaded dice: Fast network reconfiguration



Loaded dice: Fast network reconfiguration

Key idea: Randomized switching

Near-optimal grid configurations in seconds, not hours or days.



- Can be **orders-of-magnitude** faster than exact methods
- **Solves *societal-scale*, realistic cases** that existing solvers cannot handle
- First provable **near-optimality guarantees** for reconfiguration

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S. Talkington, D. M. Ostrovskii, and D. K. Molzahn, "Efficient Network Reconfiguration by Randomized Switching," arXiv:2510.24458, Oct. 2025.

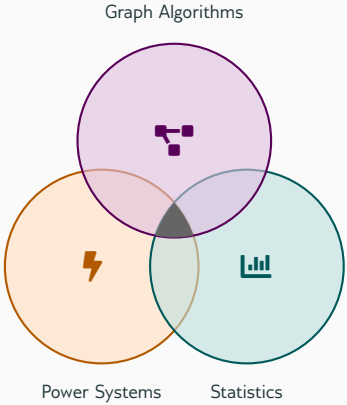
Randomness as a power engineering tool

Vision

What if **randomness** isn't just uncertainty to be managed—but a **computational resource** that makes **power engineering** algorithms *faster and more reliable*?

What randomness enables:

- **Operators:** real-time switching decisions
- **Planners:** screen data center and transmission proposals
- **Regulators:** families of actionable options



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