Formally Verified Autonomous Hybrid Control

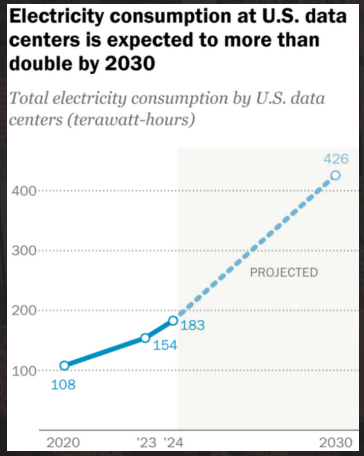
Dane A. Sabo
dane.sabo@pitt.edu

Dr. Daniel G. Cole
dgcole@pitt.edu

University of Pittsburgh

November 28, 2025

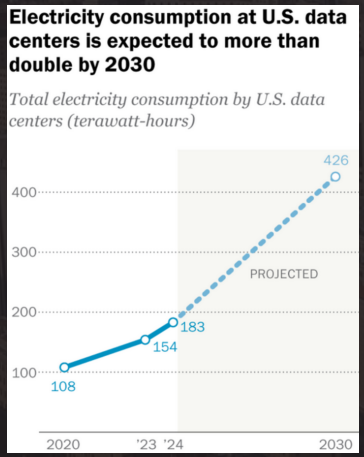
The United States stands on the precipice of a severe energy crises



Source: Pew Research Center, Data from IEA

How much baseload power increase is this?

The United States stands on the precipice of a severe energy crises

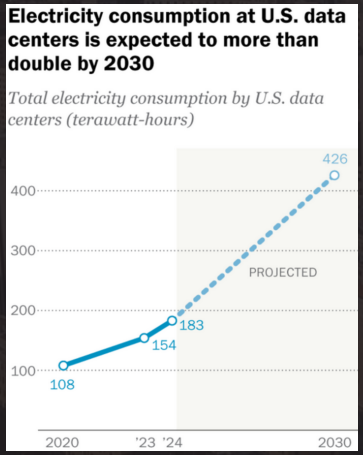


Source: Pew Research Center, Data from IEA

How much baseload power increase is this?

30 gigawatts!

The United States stands on the precipice of a severe energy crises



Source: Pew Research Center, Data from IEA

How much baseload power increase is this?

30 gigawatts!

Staffing these new reactors will be an incredible challenge

How many reactor operators are required to staff this new fleet?

For one Small Modular Reactor (SMR)...

Staffing these new reactors will be an incredible challenge

How many reactor operators are required to staff this new fleet?

For one Small Modular Reactor (SMR)...

One shift requires:

2 Senior Reactor Operators

2 Reactor Operators

Staffing these new reactors will be an incredible challenge

How many reactor operators are required to staff this new fleet?

For one Small Modular Reactor (SMR)...

24/7 operations require ∼6 shifts:

12 SROs

12 ROs

24 licensed operators per reactor

Staffing these new reactors will be an incredible challenge

How many reactor operators are required to staff this new fleet?

For one Small Modular Reactor (SMR)...

24/7 operations require ∼6 shifts:

12 SROs

12 ROs

24 licensed operators per reactor

To meet demand we require 2,400 new licensed operators!

Staffing these new reactors will be an incredible challenge

How many reactor operators are required to staff this new fleet?

For one Small Modular Reactor (SMR)...

24/7 operations require ∼6 shifts:

12 SROs

12 ROs

24 licensed operators per reactor

To meet demand we require 2,400 new licensed operators!

We currently have only 3,600 licensed operators total...

Nuclear reactors are operated with prescriptive handbooks

Key limitations prevent nuclear power from scaling economically

1. Workforce bottleneck: Training pipeline cannot meet demand
2. Economic infeasibility of human-dependent operations at scale
3. Operating procedures lack exhaustive formal verification
4. Human factors remain dominant cause of incidents