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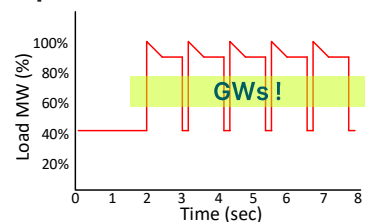
ARTIFICIAL INTELLIGENCE DATACENTER INTEGRATION

STABILITY RISKS & MITIGATIONS

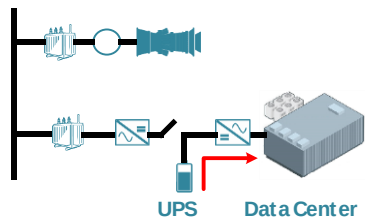
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Artificial intelligence datacenters may cause broad range of instabilities ... especially in weak grids

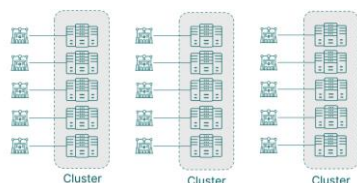
Highly varying repetitive load



Sensitive UPS operation



Unstable power electronic coordination



Voltage instability

Unstable voltage esp in weak grids

Frequency instability

Ramp rates challenge frequency ... esp at workload start/stop

Small signal instabilities

High ramp rates → unwanted oscillations & torsional risk

Example solution: Batteries / load banks

Cycle to counter load ramping

UPS transition challenges voltage esp in weak grids

UPS transition challenges frequency

Absorb shock of DC transition to UPS

Undamped characteristic → voltage oscillations

Power oscillations lead to frequency excursions

IBR interactions → undamped oscillations & torsional risk

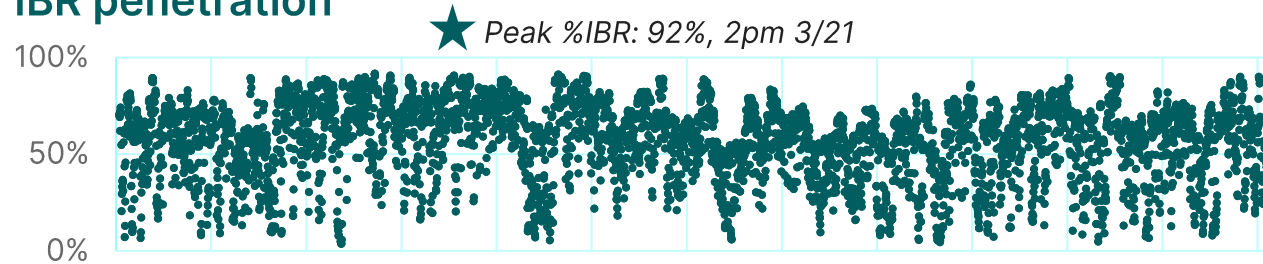
Damp oscillations ... act as filter

Given risks, how to serve load with near zero trips?

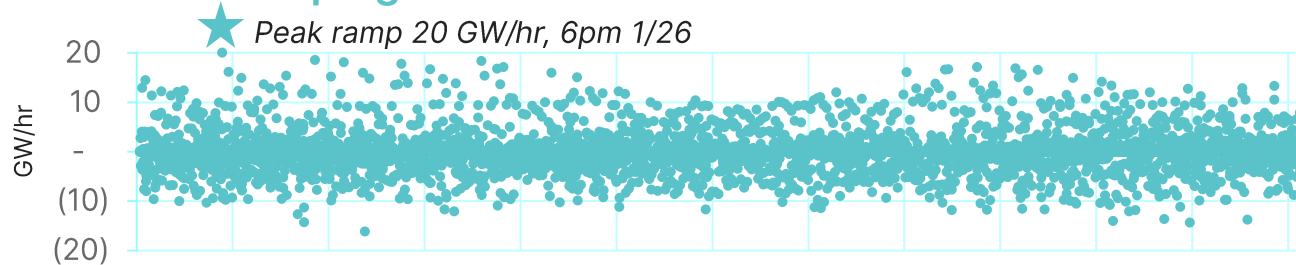
Renewables operation may affect severity of data center stability risks

Example: ERCOT 2040 hourly production cost simulation

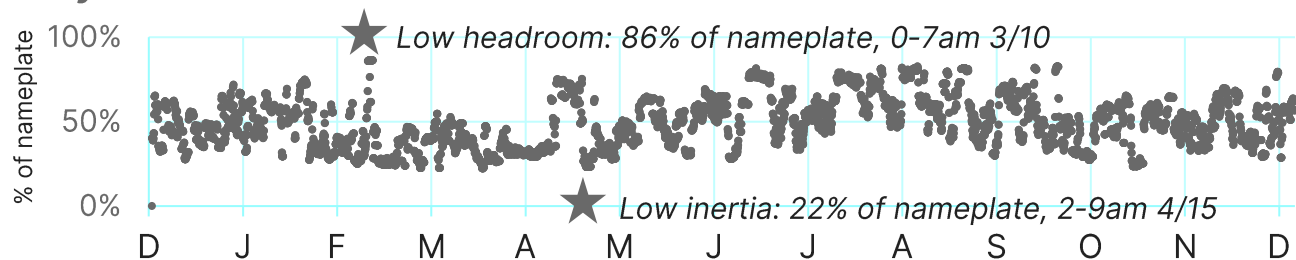
IBR penetration



Net load ramping



Synchronous machine commitment



Ref: GEV Consulting Services, non-proprietary database

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System conditions with highest stability risk

1. **Workload start/stop coincident with:**
 - High net load ramps
 - Low SM headroom ... low renewables
2. **Load cycling coincident with:**
 - High IBR % ... weak grid
 - Low inertia
3. **Sensitive UPS transitions coincident with:**
 - High net load ramps
 - Low SM headroom
4. **Unstable power electronic coordination coincident with:**
 - High IBR % ... weak grid

Assess collective impact of datacenters & renewables to mitigate risks

1

Interconnection & planning procedures need to be updated to include data centers which are neither pure loads nor pure generators nor pure storage

2

Models should be required from data center owners: power flow & stability models to represent load, generation, & storage controls for each facility

3

Resource performance requirements (e.g. ride-thru, frequency response...) need to be defined via system-wide impact assessment across resource types (e.g. renewables, data centers, storage, etc...)

**Integrated
planning
approach
required to
holistically
assess &
mitigate
risks**



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