Large Load Demand Flexibility: Operational Realities in the Dominion Zone

Setting the Context for Large Load Flexibility via a Shared Understanding of how Dominion has Managed and Will Continue to Manage Significant Large Load Growth

9/18/26

***Note**: this deck covers materials presented to stakeholders at session 1 of the Large Load Demand Flexibility Stakeholder Working Group. The materials have been updated to improve clarity for those who did not attend the working group*

Powering the world's largest data center market

The following slides provide an overview of how Dominion Energy Virginia operates and plans the grid in one of the fastest-growing energy regions in the world

This deck covers:

1. The extensive large load demand that Dominion already manages, and the growth Dominion is already accommodating
2. How Dominion manages the network safely and reliably to N-1 conditions
3. How Dominion will continue to meet N-1 requirements given extensive large load growth
4. Lessons Dominion has learned from its CAPFLEX demand flexibility pilot for existing large loads

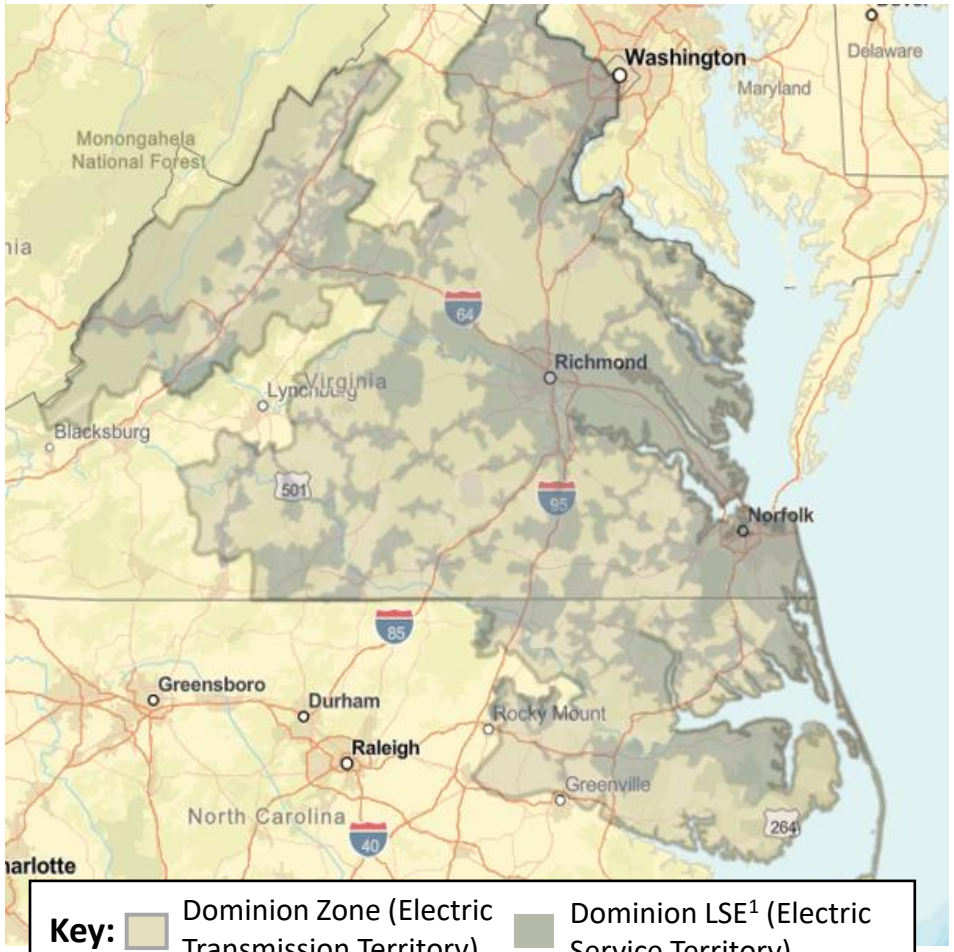
Dominion’s System in Virginia

The extensive large load demand that Dominion already manages, and the growth Dominion is already accommodating

Dominion operates a broad, interconnected grid

Serving the region requires systemwide planning and real-time coordination

Dominion Energy Virginia's Electric Transmission and Service Territory



A connected regional network

Thousands of miles of transmission and distribution infrastructure move electricity across the territory, supporting, businesses, hospitals, communities, manufacturing, public infrastructure, and large loads.

Local decisions, system-wide impacts

Because the grid is interconnected, changes in one area can influence power flows and operating conditions throughout the broader network.

Real-time balance is essential

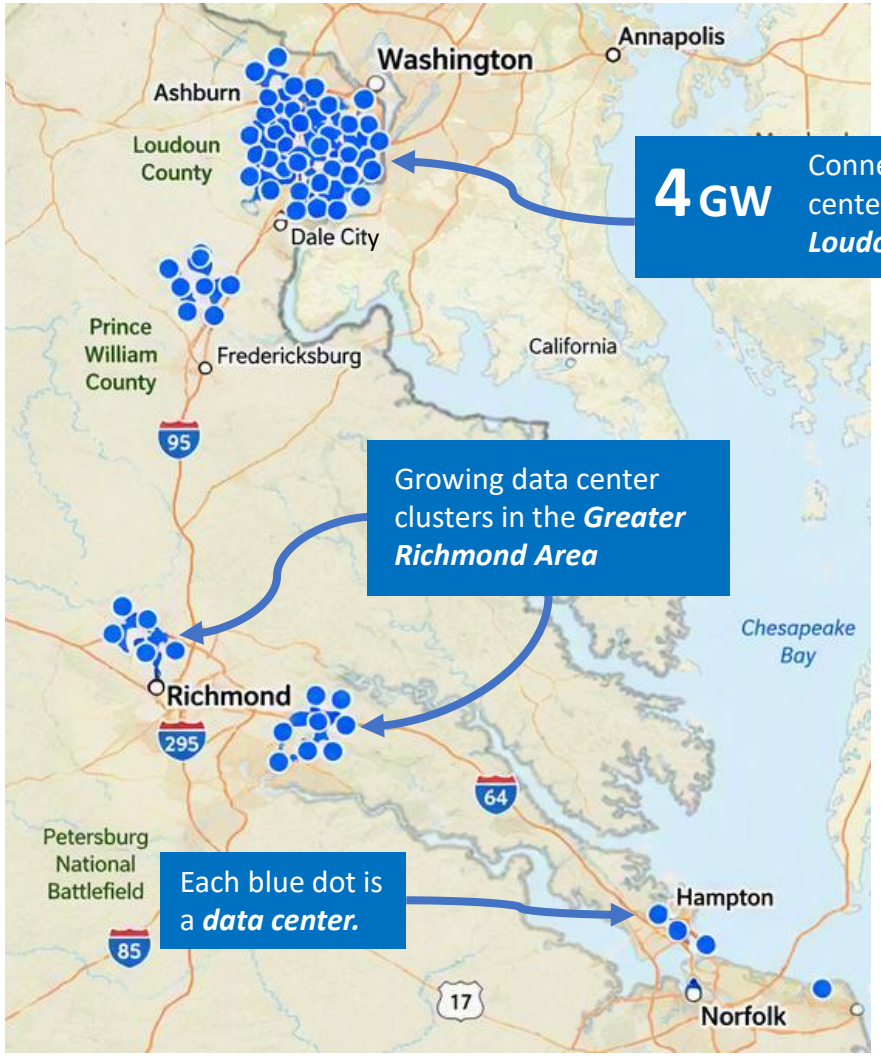
Generation and customer demand must remain continuously coordinated as weather, maintenance, equipment availability, and usage patterns change.

[1] Load Serving Entity

Dominion manages unmatched data center capacity

Dominion has connected extensive data center capacity while maintaining reliability

Dominion-managed large load clusters



A global digital infrastructure destination

Scale	Northern Virginia supports one of the most concentrated data-center markets in the world
Execution	Dominion has connected significant new load while maintaining expected safety and reliability standards
Responsibility	Every interconnection is studied against network capability, outages, equipment limits, and future needs
Commitment	The mission is to enable continued economic growth while keeping the grid safe and reliable

Growth at this scale is a privilege and a responsibility:
deliver capacity while preserving reliability.

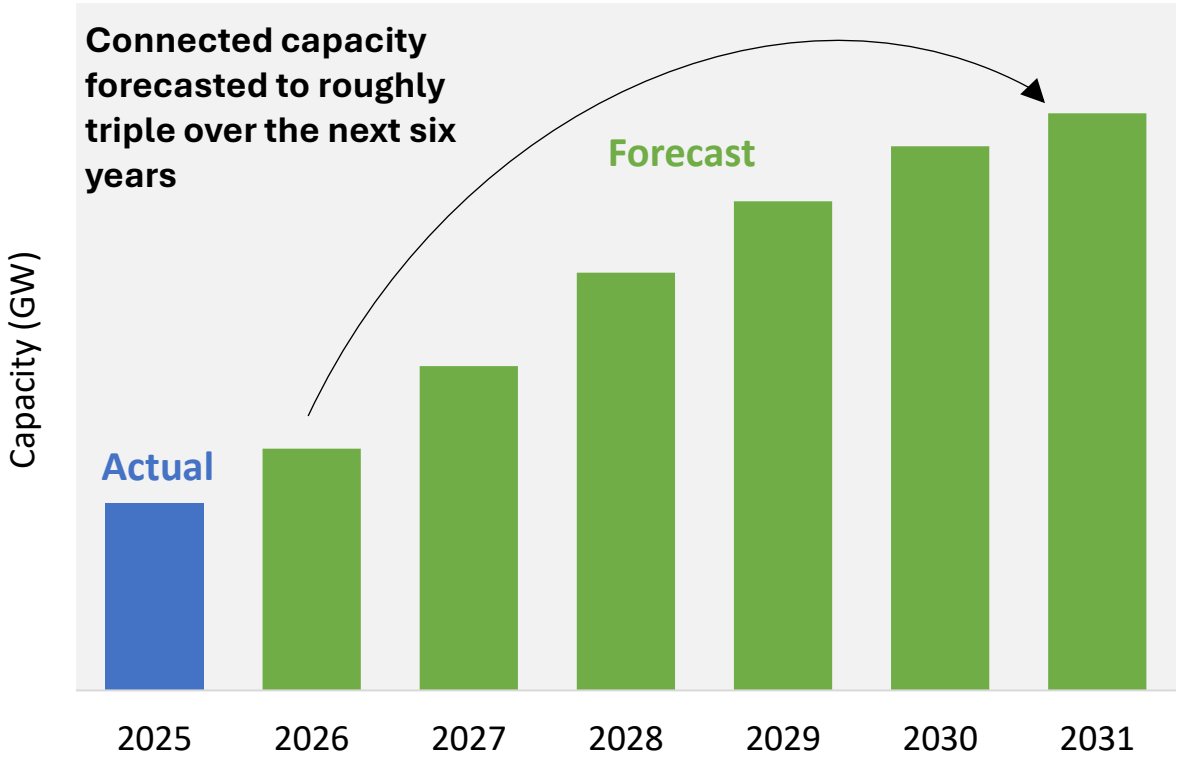
Across multiple standard transmission reliability metrics,
Dominion ranks highest among NATF[1] member utilities

[1] North American Transmission Forum

Data center capacity forecast to grow rapidly

Dominion is already planning to connect 20+ GW of new data centers by 2031

Cumulative connected data center capacity for Dominion LSE (GW)



Demand Growth is accelerating

- Demand has been expanding **beyond historically concentrated areas** since 2022.
- **Dominion is connecting 20+ GW of new data centers by 2031**
- Post-2031, a **further ~45 GW** is batched for future connection dates.
- Dominion Energy continues to receive ~10 new large-load requests per month **(2–3 GW**)

This creates transmission infrastructure challenges

- Permanent transmission infrastructure requires several years to plan, permit, sequence outages, and construct.
- System capacity must support normal operation and remain reliable during planned or unexpected outages.
- The challenge is to enable exceptional growth while maintaining safe and reliable operation.

Let’s explore how Dominion operates an interconnected grid that can reliably serve growing demand as conditions change

How Dominion maintains reliability today and will maintain it in the future

How Dominion manages the network safely and reliably to N-1 conditions, and continue to meet N-1 requirements given extensive large load growth

Dominion operates its system to *N-1 conditions*

This means the power grid can keep running safely even if any one single component fails

What is N-1?

N-1 ← Sudden loss of one piece of equipment

All equipment needed to run the system normally (Transmission lines, transformers, generation facilities, large circuit breakers, etc.)

Goal: Prevent a single breakdown from causing cascading blackouts or loss of power to customers

Planning: Dominion is required to operate at N-1[1].

- **Power flow modeling** tests whether the grid can operate if a specific line or generator drops to zero.
- If a model shows a failure would overload other lines, planners **add new infrastructure** before a real emergency happens

How does Dominion maintain N-1?

- **Multi-line connections:** Loads are fed by multiple transmission and/or distribution lines → if one line goes down, others can take up the slack to maintain power.
- **Equipment headroom:** Transmission lines typically do not operate at their maximum capacity → this leaves headroom to accommodate outages and maintain system reliability.
- **N-1 contingency:** Dominion takes operational actions to maintain N-1. These include:
  - **Line switching:** Line switches are devices installed in transmission lines with the primary function of isolating a faulted line section following an outage.
  - **Generation redispatch:** Dominion adjusts scheduled power plant outputs to prevent or relieve physical bottlenecks and overloads on the grid.

Let's see how these operational actions can be applied to situations that may threaten N-1

[1] By North American Electric Reliability Corporation (NERC); [2] Post Contingency Local Load Relief Warning

Planned *and* real-time conditions can threaten N-1

Dominion uses operational actions to manage these conditions and maintain N-1

1. **Generation trip**
2. Equipment fault
3. Maintenance and line upgrades
4. Added load growth (new large loads)

Real time operational events — *Planning events*

N-1 Contingency	Corrective Action	Corrective Action	Result
Generator X stops generating, for example due to a power plant equipment failure	Dominion dispatches generator Y to cover the shortfall	Line switches move power through a different path to keep serving load while accommodating decreased output from generator X and increased output from generator Y	Local system remains N-1 secure

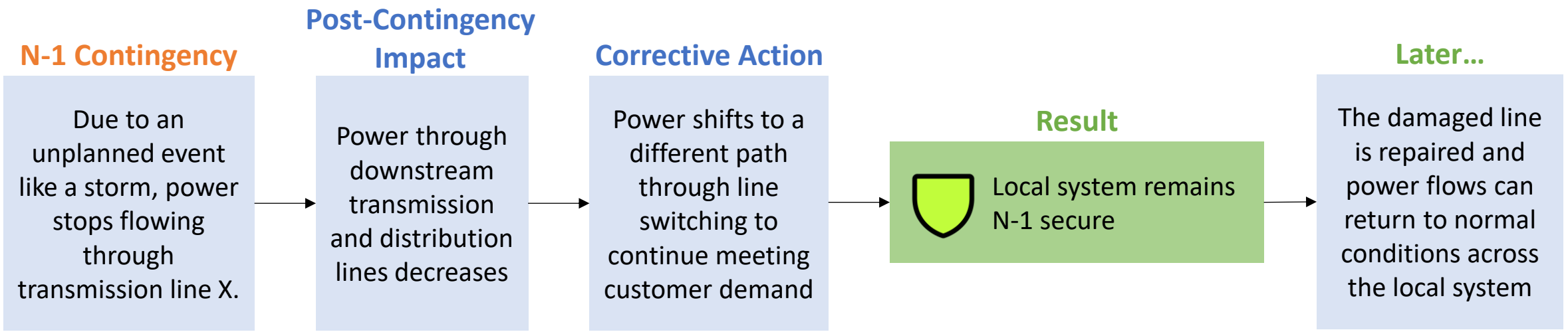
These scenarios all apply to a portion of Dominion's transmission system in Virginia, for instance Loudoun County

Planned *and* real-time conditions can threaten N-1

Dominion uses operational actions to manage these conditions and maintain N-1

① Generation trip ② **Equipment fault** ③ Maintenance and line upgrades ④ Added load growth (new large loads)

Real time operational events | *Planning events*



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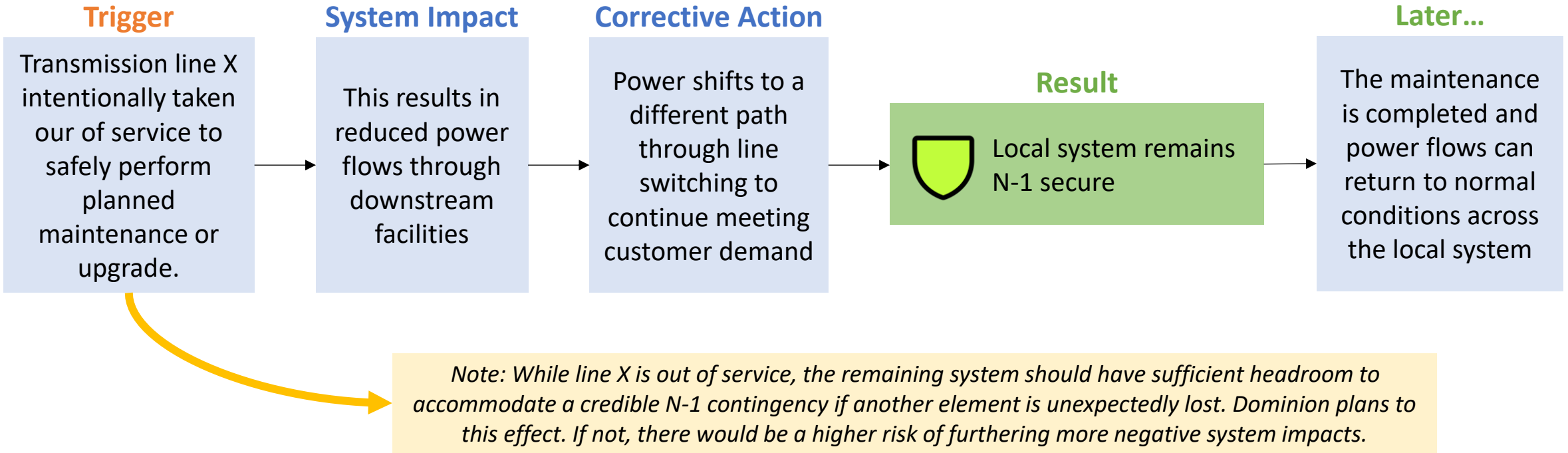


Note: While line X is out of service, the remaining system should have sufficient headroom to accommodate a credible N-1 contingency if another element is unexpectedly lost. Dominion plans to this effect. If not, there would be a higher risk of furthering more negative system impacts.

New large loads need associated infrastructure (1/2)

New large loads must be carefully integrated to ensure N-1 is maintained

① Generation trip ② Equipment fault ③ Maintenance and line upgrades ④ **Added load growth (new large loads)**

Real time operational events *Planning events*

Load Growth Trigger

Several new data centers connect to the local system[1], increasing demand and reducing available transmission headroom.

→

System Impact

Existing transmission lines become heavily utilized, leaving limited headroom to accommodate the loss of another system element.

→

System Impact

If a generator or transmission element trips, power must redistribute across the remaining system. With insufficient headroom, facilities may overload and the local system may no longer remain N-1 secure.

→

Issue

New infrastructure needed to keep local system N-1 secure…

***Without* new infrastructure**

[1] For instance, in Loudoun County

New large loads need associated infrastructure (2/2)

New large loads must be carefully integrated to ensure N-1 is maintained

① Generation trip ② Equipment fault ③ Maintenance and line upgrades ④ **Added load growth (new large loads)**

Real time operational events | *Planning events*

Load Growth Trigger	Action	System Impact	Result
Several new data centers connect to the local system[1], increasing demand and reducing available transmission headroom.	New transmission lines and substations are constructed to accommodate the new load	Local system now has sufficient headroom to manage planned and unplanned outages	Local system remains N-1 secure

***With* new infrastructure**

Note: The maintenance/upgrades required for new or additional transmission infrastructure may necessitate outages for neighboring lines

What if an N-1 Contingency is not enough?

Post-contingency warnings and subsequent actions come into play

Dominion uses 'PCLLRWs' as a key signifier of localized grid stress that will require localized operational actions to maintain reliable system operations

PCLLRW = Post Contingency Local Load Relief Warning

Origin: PJM issues a PCLLRW as an emergency procedure to indicate a localized threat to Dominion's[1] system

Localized: Addresses stress on *specific transmission facilities or areas*, not necessarily a system-wide shortage

Preventative: Alerts operators that *immediate action will be needed* to prevent system being compromised. Importantly, it signals that **standard operational actions are not available to alleviate a post-contingency emergency**

(i.e. line switching and generation redispatch will not work should the contingency occur)

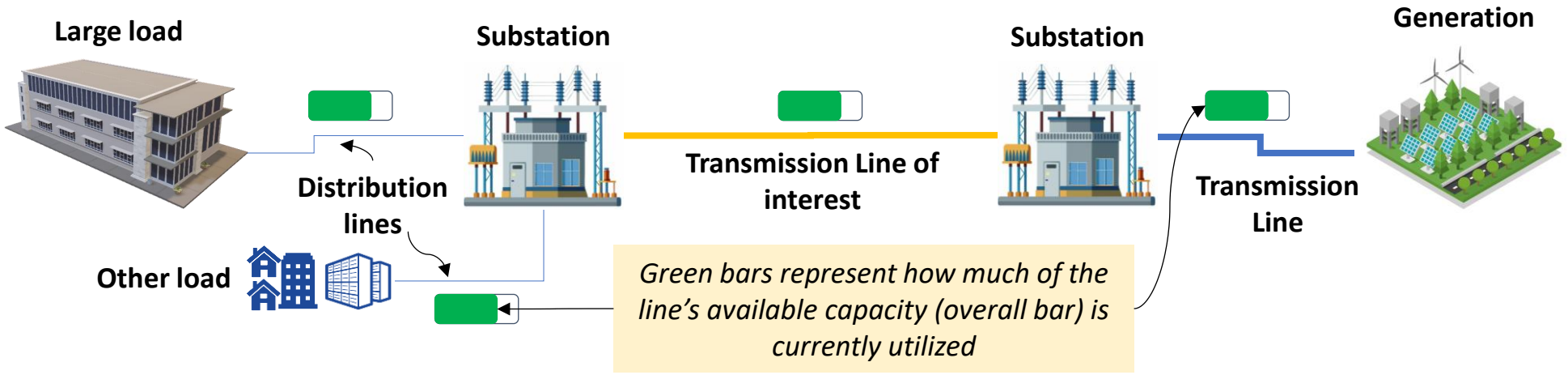
Action-oriented: PCLLRW provides a plan for manual load shed should a contingency occur.

[1] Or any other Transmission Owner

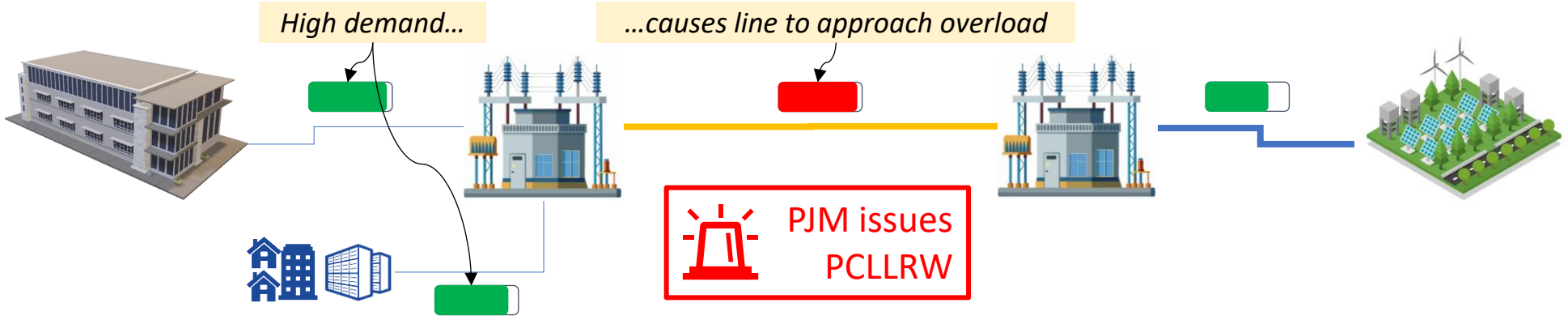
What does a PCLLRW look like in practice? (1/2)

Let's consider the yellow transmission line below in the diagram below[1]

Under normal conditions



PCLLRW trigger

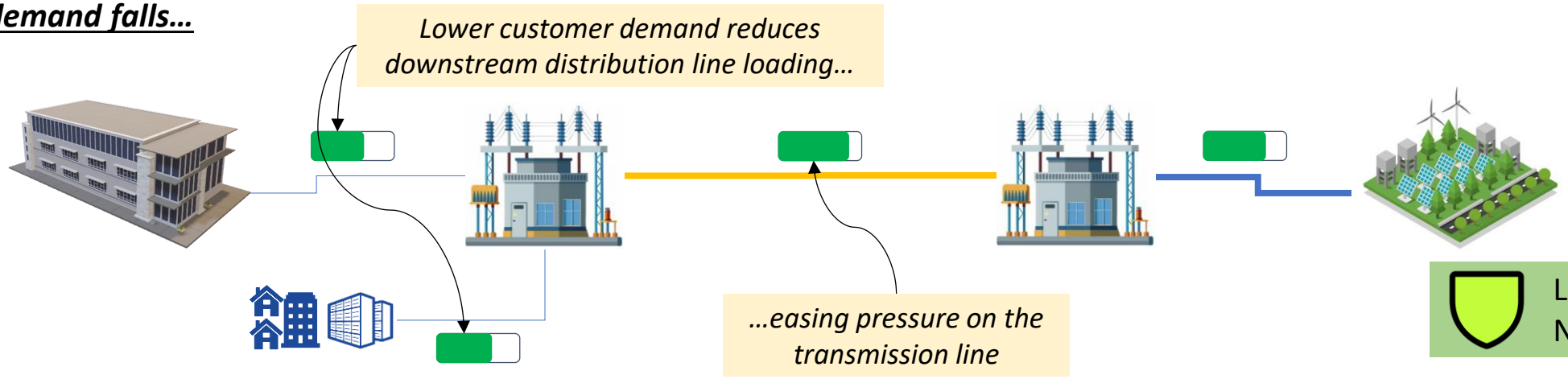


[1] A simplified, illustrative system from generation (right) to demand (left) via transmission lines, substations, and distribution lines

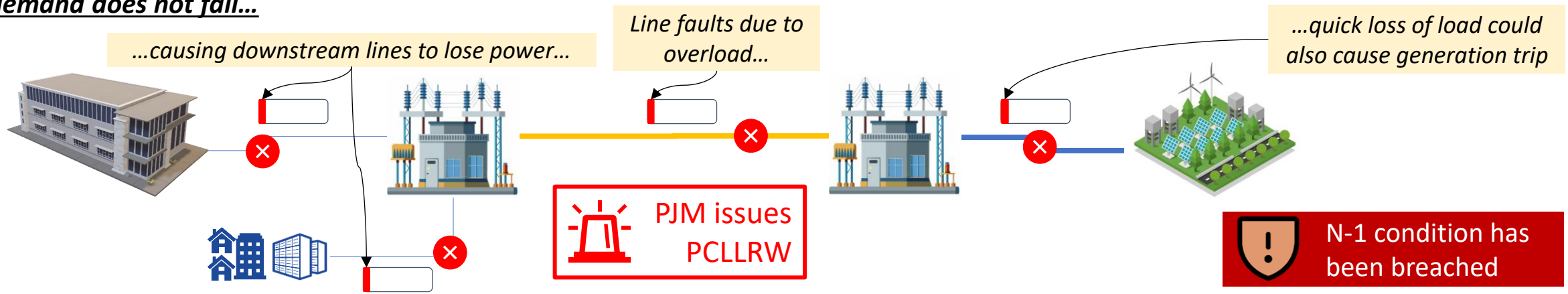
What does a PCLLRW look like in practice? (2/2)

Let's consider the yellow transmission line below in the diagram below

If demand falls…



If demand does not fall…

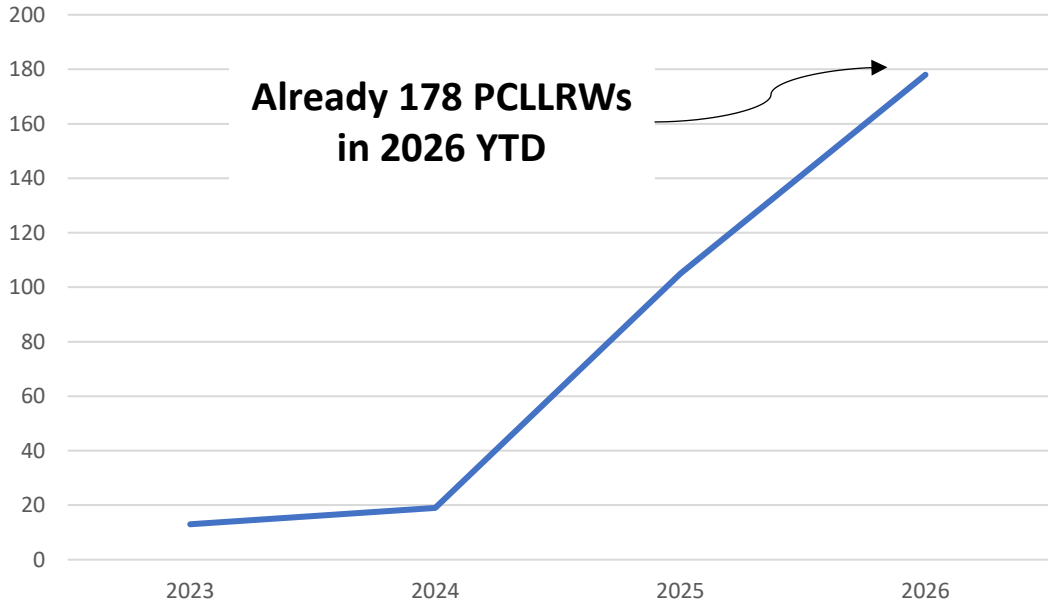


PCLLRWs are now more frequent and lasting longer

This is increasing Dominion's operational strain

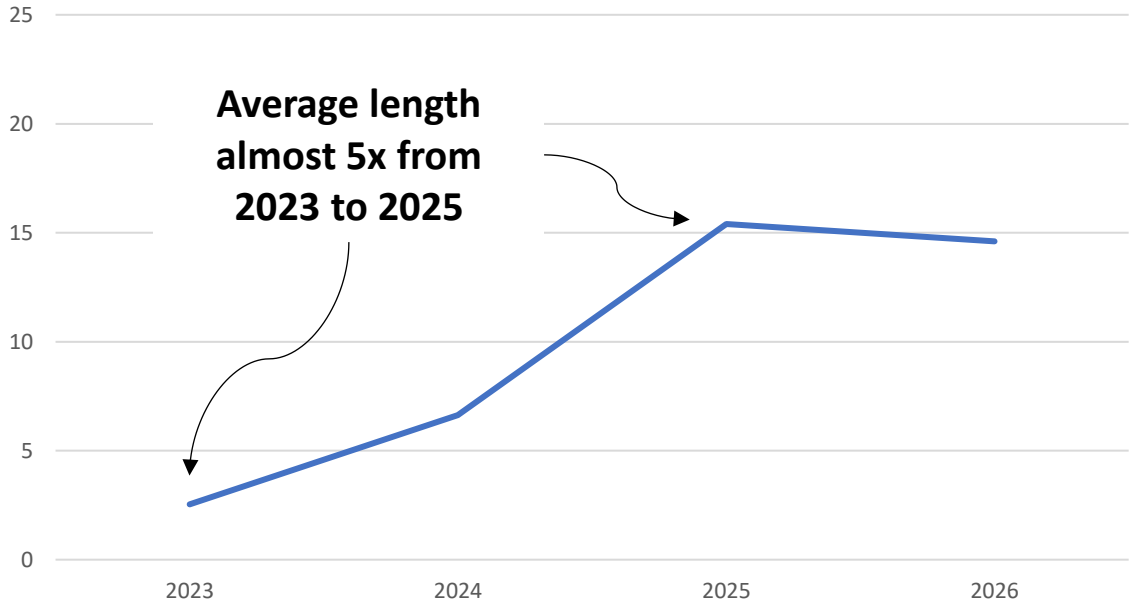
PCLLRWs are occurring more often[1]

Number of PCLLRWs issued for Dominion Zone / year



An average PCLLRW length is trending longer

Avg. length of PCLLRW issued for Dominion Zone / year (hours)

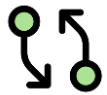


PCLLRWs demand a localized response

Electrically proximate resources to provide local congestion relief in response to a PCLLRW

Electrically proximate points on the grid that share nearly identical electrical characteristics because they are:

1) **Physically close enough**, or
2) **Physically distant but connected with such low resistance**



Two points could be physically close but **not** be electrically proximate because they are on different circuits

Resources are **highly impacted** by changes in grid conditions at an electrically proximate point.

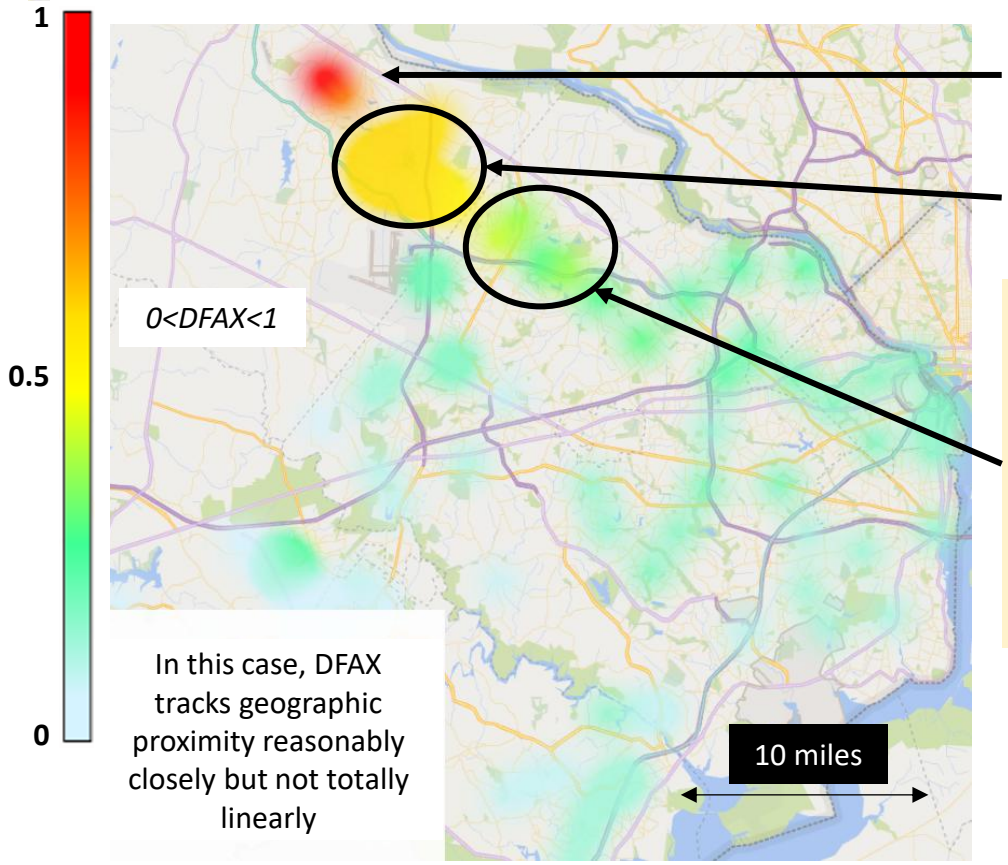
Equally, electrically proximate resources play an outsized role in relieving local grid stress.

How does Dominion evaluate electrical proximity?

Dominion uses DFAX to measure electrical proximity

Distribution Factor (DFAX) estimates how a change in power flow at one location impacts the power flow at another.

Example DFAX map for a node in Northern Virginia



In this case, DFAX tracks geographic proximity reasonably closely but not totally linearly

This is the location of the constrained node itself

Electrically proximate lines have a relatively higher DFAX

- In this example, the DFAX falls to less than 0.5 a short geographic distance from the constrained node
- This is not always the case. DFAX falls quickly here due to the localized nature of power flows in a high-power dense area like Loudoun County.
- Under different system conditions, such as outages, DFAX could remain significant even at locations that are geographically further from the constrained node.

If a PCLLRW is issued for this constrained node, flexible capacity with DFAX closer to 1 will have a much greater impact on transmission congestion than less electrically proximate resources

Lessons from CAPFLEX

Lessons Dominion has learned from its CAPFLEX demand flexibility pilot for existing large loads

CAPFLEX: Dominion's large load flex pilot

CAPFLEX provides participating *existing large load customers* conditional, non-firm capacity while long-term transmission upgrades are completed

CAPFLEX

What is CAPFLEX?

- Pilot program applying to existing large load customers
- Participating customers can access additional capacity by using existing grid capacity on a non-firm basis (on top of their already allocated firm load)
  - They gain temporary access to capacity in the most constrained load pocket in the Dominion Zone (Loudoun County)
  - But they must reduce load when local conditions become constrained. The trigger for this is a PCLLRW[1]
- Program supports customer growth while infrastructure upgrades are underway

Lessons Learned

- Existing data centers were not designed for flexibility
- To maintain N-1 while accommodating new large load on a non-firm basis, curtailments cannot be triggered solely by forecasting events. Some curtailment can only be triggered by more real-time scenarios like PCLLRWs
- As the statistics on the right show, long periods of curtailment are occasionally warranted. These may last longer than customers had anticipated

2026 total **CAPFLEX Curtailment** hours[2]

507.82

Total # of events	Avg duration of event in hours
29	18.14

Longest event duration in hours

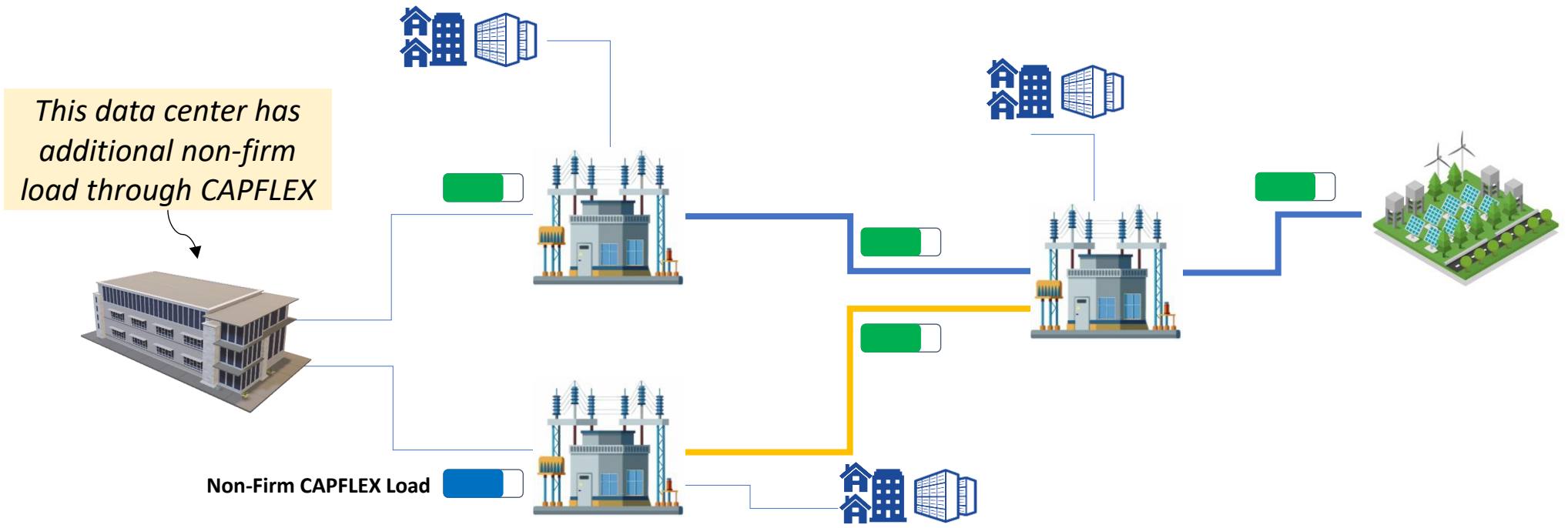
194.48

05.24.2026 - 06.01.2026

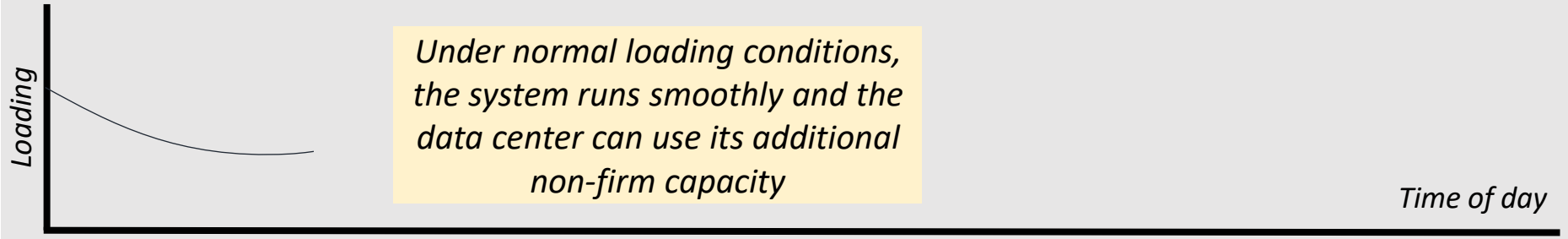
[1] Issued for the Dominion zone with DCA substation lists within the load shed plan; [2] Year to date. For reference, 2025 statistics were: 288 curtailment hours across 32 events with average duration 9 hours and longest duration 52.8 hours

How does CAPFLEX work in practice?

With CAPFLEX, the data center can access additional capacity unless curtailed



Loading of yellow transmission line



Under normal loading conditions, the system runs smoothly and the data center can use its additional non-firm capacity

Legend

- Data Center/ Large Load
- Transmission Substation
- Generation Facility
- Other Load
- Available Capacity
- Utilized Capacity
- Non-Firm Capacity
- Transmission Line
- Distribution Line
- Transmission Line on graph

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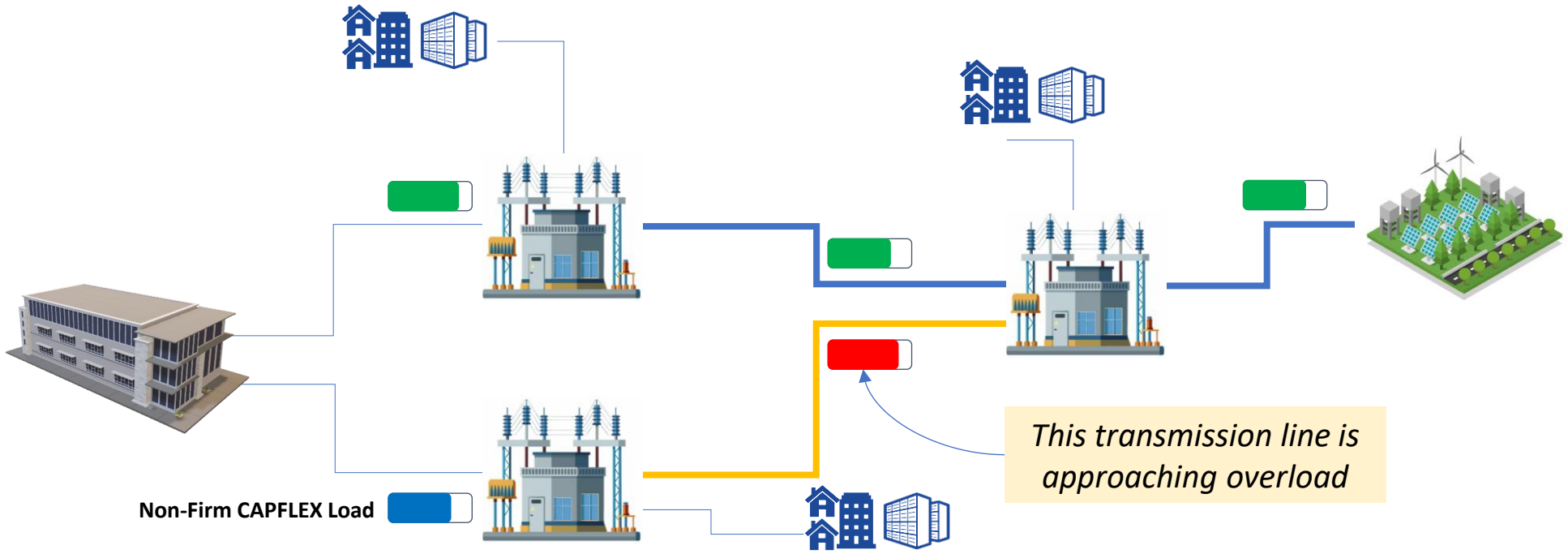

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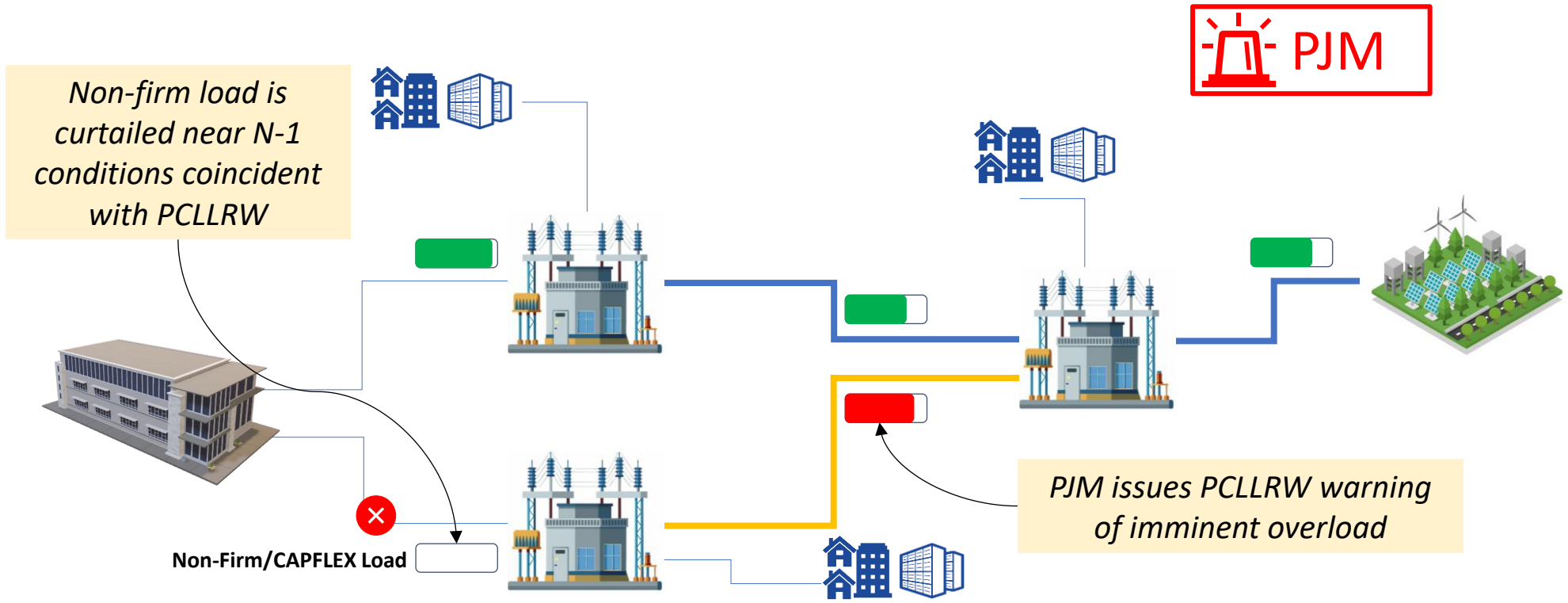

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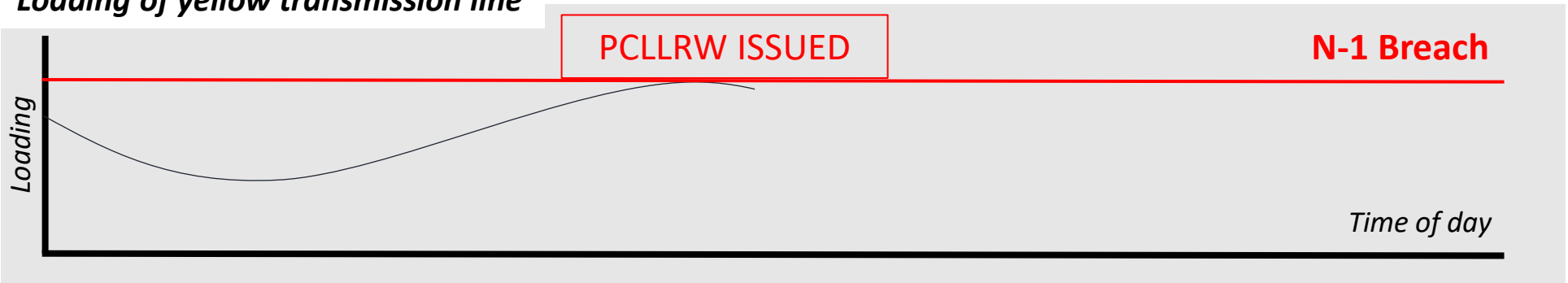

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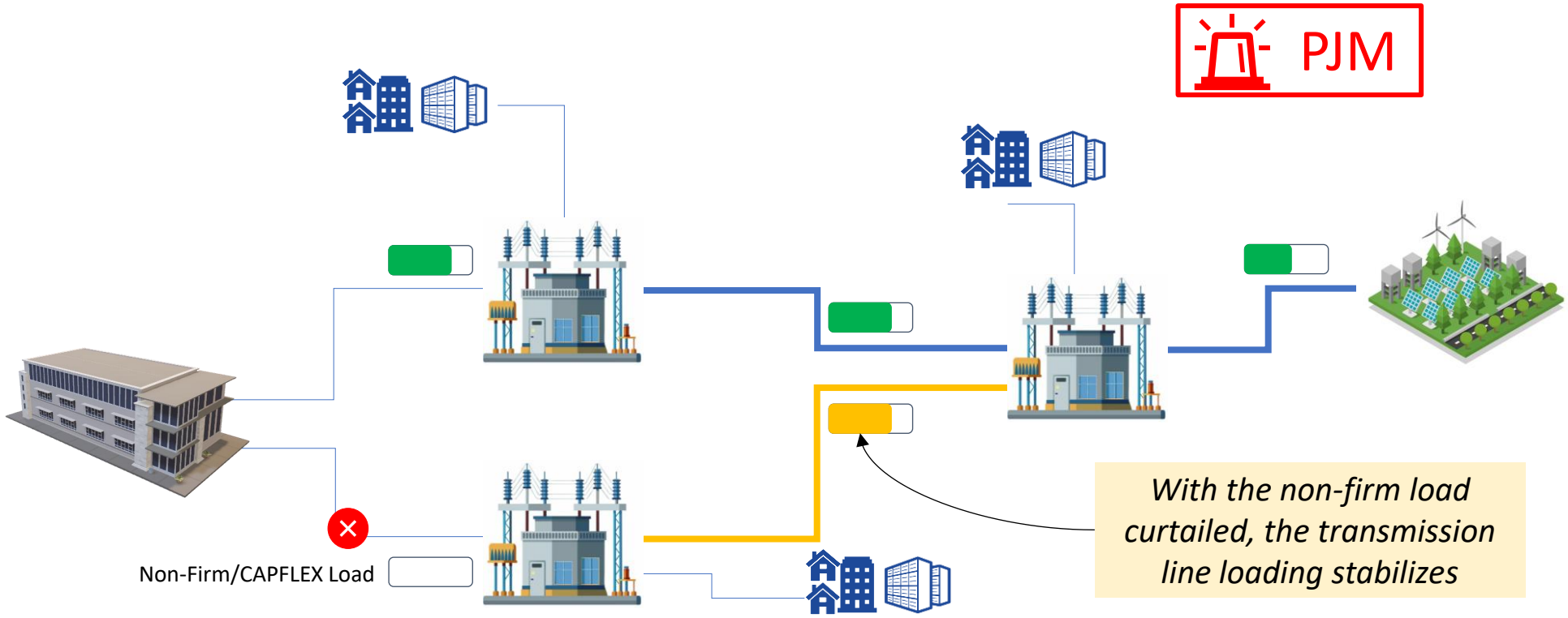

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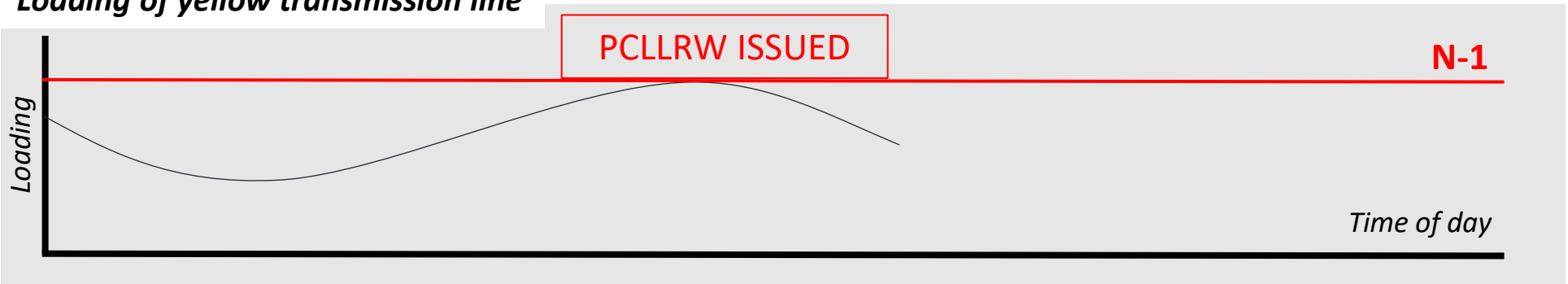

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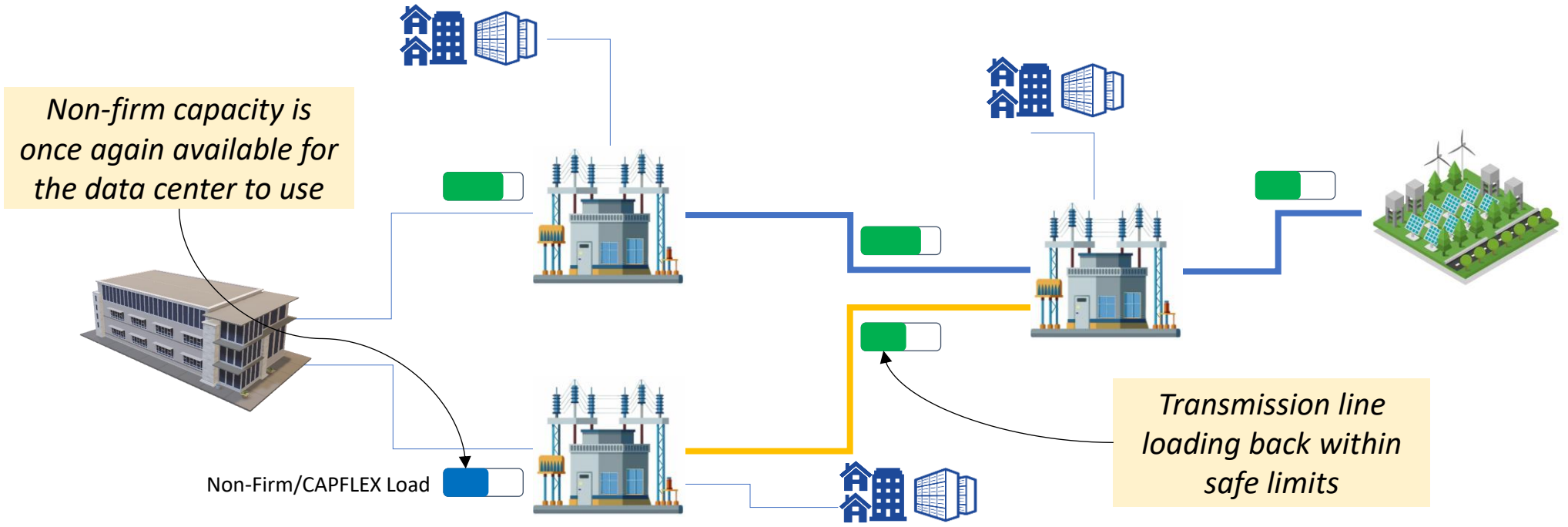

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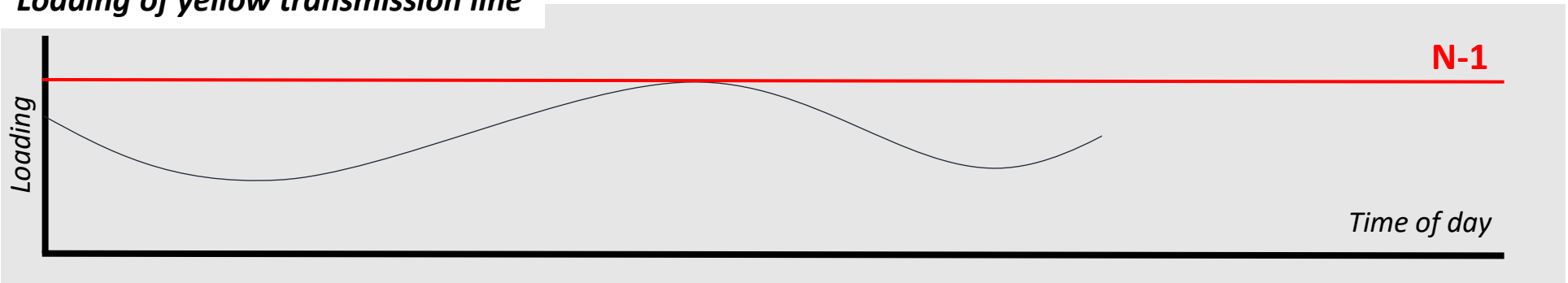

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