

# Reliability, Resilience and Transmission

ESIG

October 2, 2018

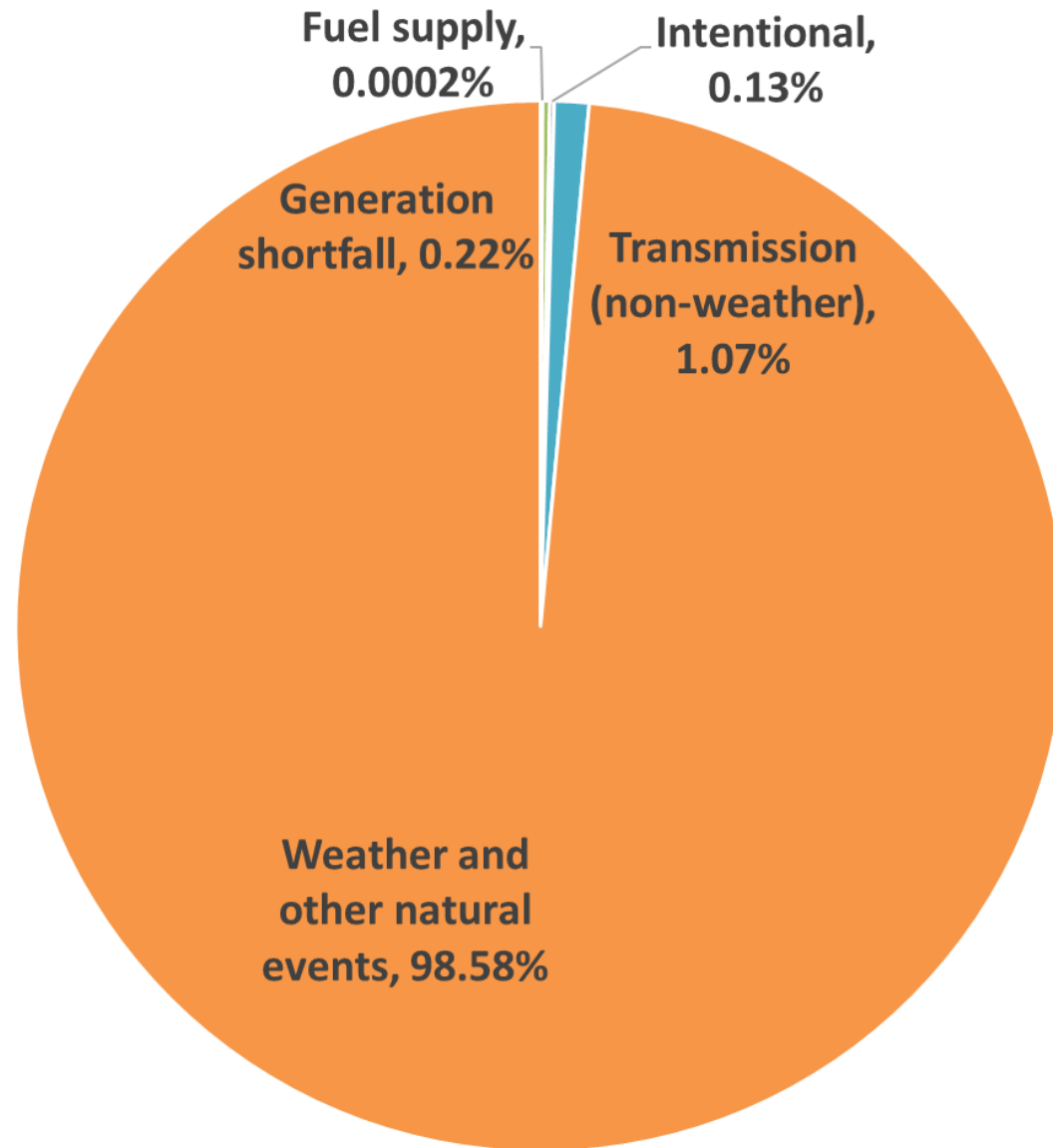
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# T&D account for 99+% of customer outage hours

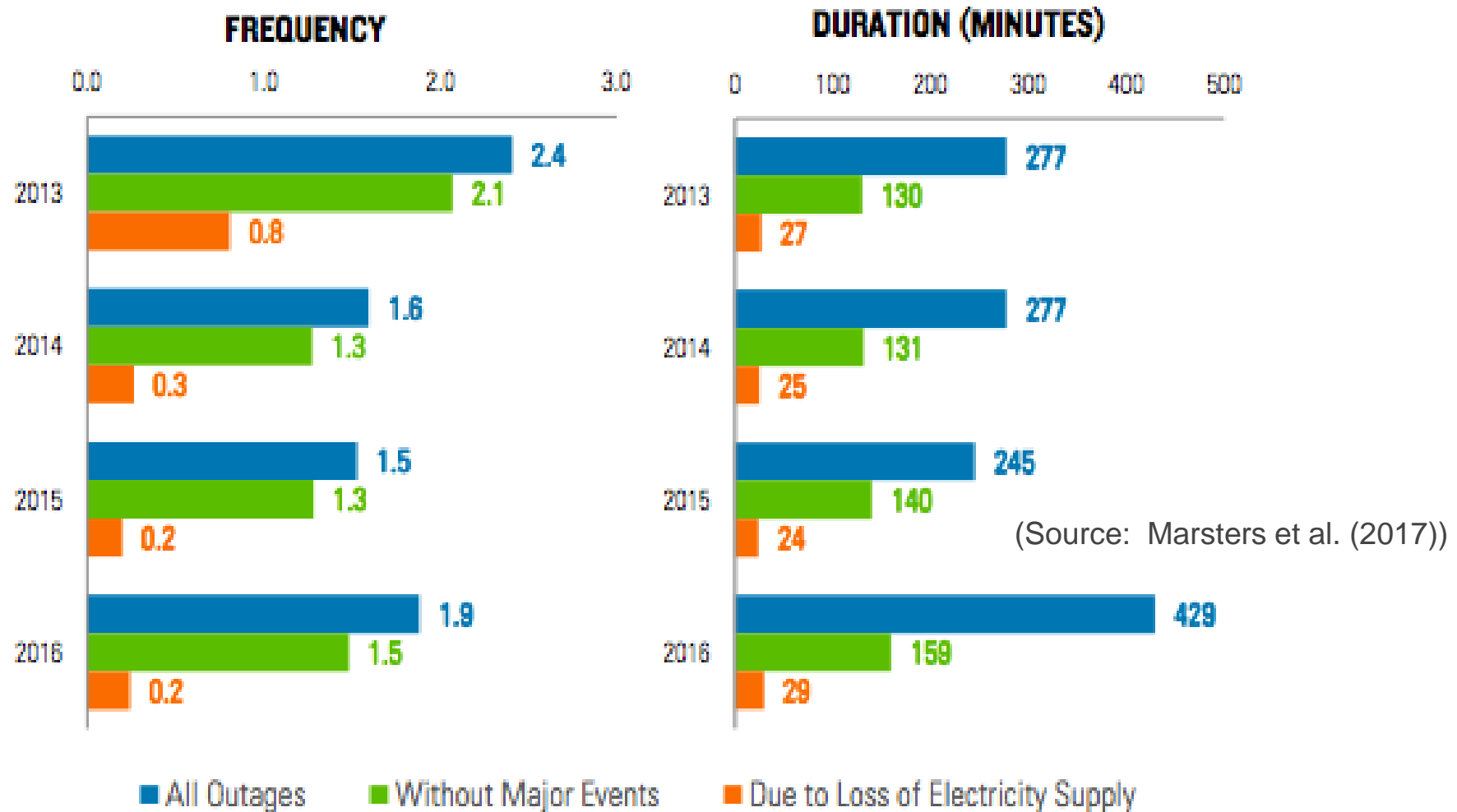


Source: Analysis of EIA data, 2004-2017



# Few customer outages due to loss of Bulk System

Confirms that distribution causes 90+% of outages, not generation or transmission



Source: Rhodium Group analysis, EIA. Note: Loss of supply during major events is included in loss of electricity supply.



# T&D solutions to improve resilience

- **Hardening infrastructure**

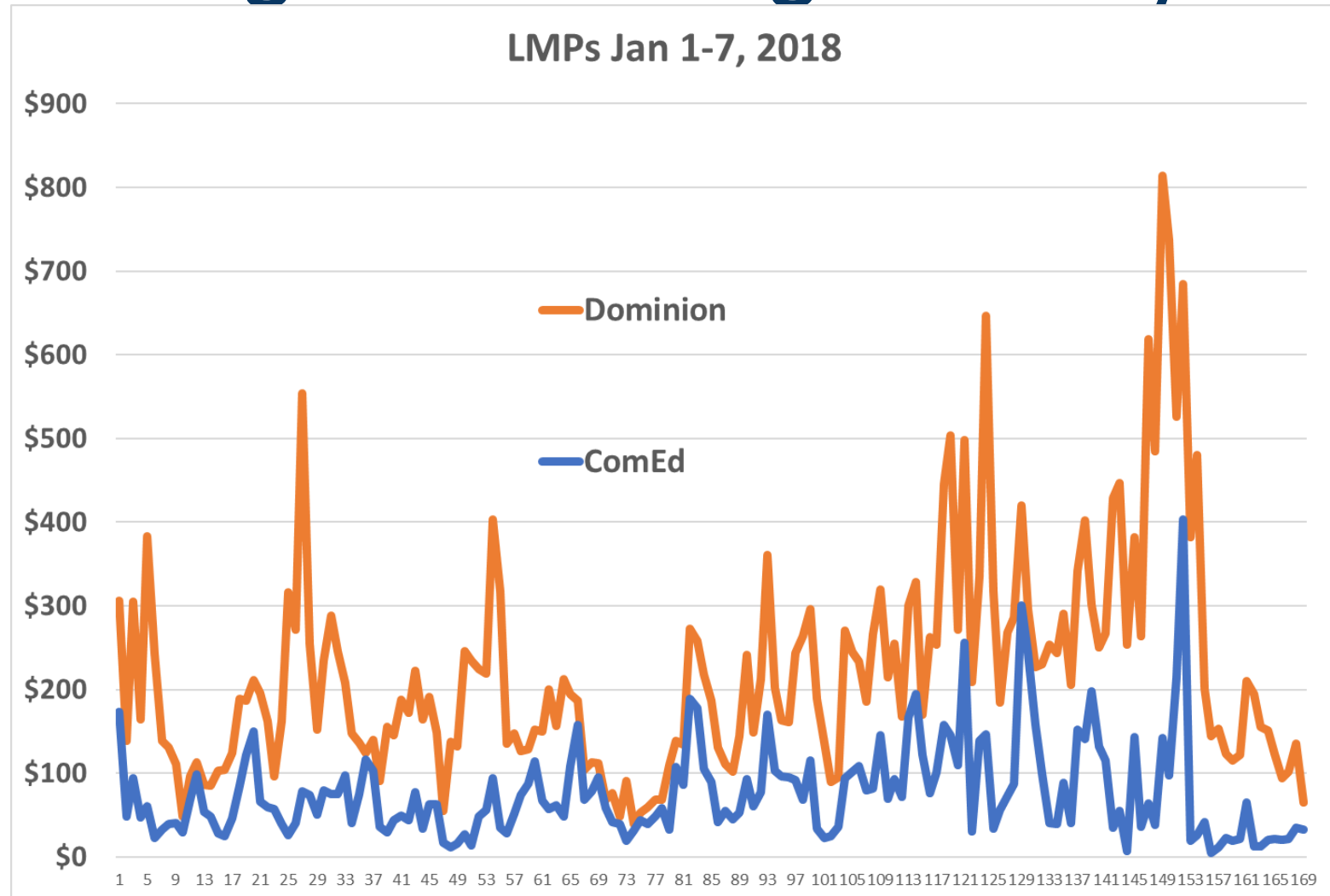
- Stronger towers
- Undergrounding critical circuits where appropriate
- Move infrastructure out of storm surge areas
- More O&M, tree trimming
- Spare equipment

- **More infrastructure**

- Healthy redundancy through looped instead radial networks
- Stronger network provides more optionality
- Inter-regional transmission particularly valuable because extreme events that affect electricity supply and demand have limited geographic scope



# PJM Congestion During Bomb Cyclone



- During week of Bomb Cyclone event, average Dominion LMP of \$222/MWh, versus \$76/MWh in ComEd; price difference caused \$400M in congestion for Dominion alone vs ComEd in one week.
- Almost \$900 million in PJM congestion costs in 1H2018, up from \$285 million in 1H 2017.
- 1H2018 average LMP in Dominion of \$51.20/MWh, versus \$29.33/MWh in ComEd.



# Energy and ancillary services market improvements

- **Energy market improvements**
  - Scarcity pricing with price cap at Value of Lost Load
  - Allow demand to participate and set price
  - Preserve incentives for flexibility, bring inflexibility costs into energy market
- **Ancillary services**
  - Remove barriers for wind, solar, storage, and DR to provide ancillary services, including revising market rules and PPA contract terms
  - Create markets for frequency response, including premium fast frequency response product
  - If needed, create additional flexibility services like MISO ramp capability product
  - Co-optimize of energy and ancillary services markets
- **Capacity market**
  - Inefficient because buying capability not service performance, rules arbitrary
  - If must exist, remove rules that limit participation of wind, solar, storage, DR



# Renewables and storage have excellent ability to provide services

Reliability Service	Wind	Solar PV	Demand Response	Battery Storage	Gas	Coal	Nuclear
<b>Voltage support</b>							
Key: <b>Green</b> is positive, <b>yellow</b> is medium, and <b>red</b> indicates that in most cases the resource does not provide that service.							
Reactive power and voltage control	Green	Green	Yellow	Green	Yellow	Yellow	Green
Voltage and frequency disturbance ride-through	Green	Yellow	Yellow	Green	Yellow	Yellow	Yellow
<b>Frequency support</b>							
Note: For the following reliability services, <b>yellow</b> means the resource can provide the service, but during many hours it may not be the most economic choice to do so.							
Fast frequency stabilization following a disturbance (through primary frequency response and inertial response)	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Yellow
<b>Ramping and balancing</b>							
Frequency regulation	Yellow	Yellow	Yellow	Green	Green	Yellow	Red
Dispatchability / Flexibility / Ramping	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Red
Peak energy, winter (color reflects risk of common mode unavailability reducing fleetwide output below accredited capacity value)	Green	Yellow	Yellow	Green	Yellow	Yellow	Green
Peak energy, summer (color reflects risk of common mode unavailability reducing fleetwide output below accredited capacity value)	Yellow	Green	Green	Green	Yellow	Green	Green

