# NorthernGrid

## FERC Order 1920
## Grid Enhancing Technologies

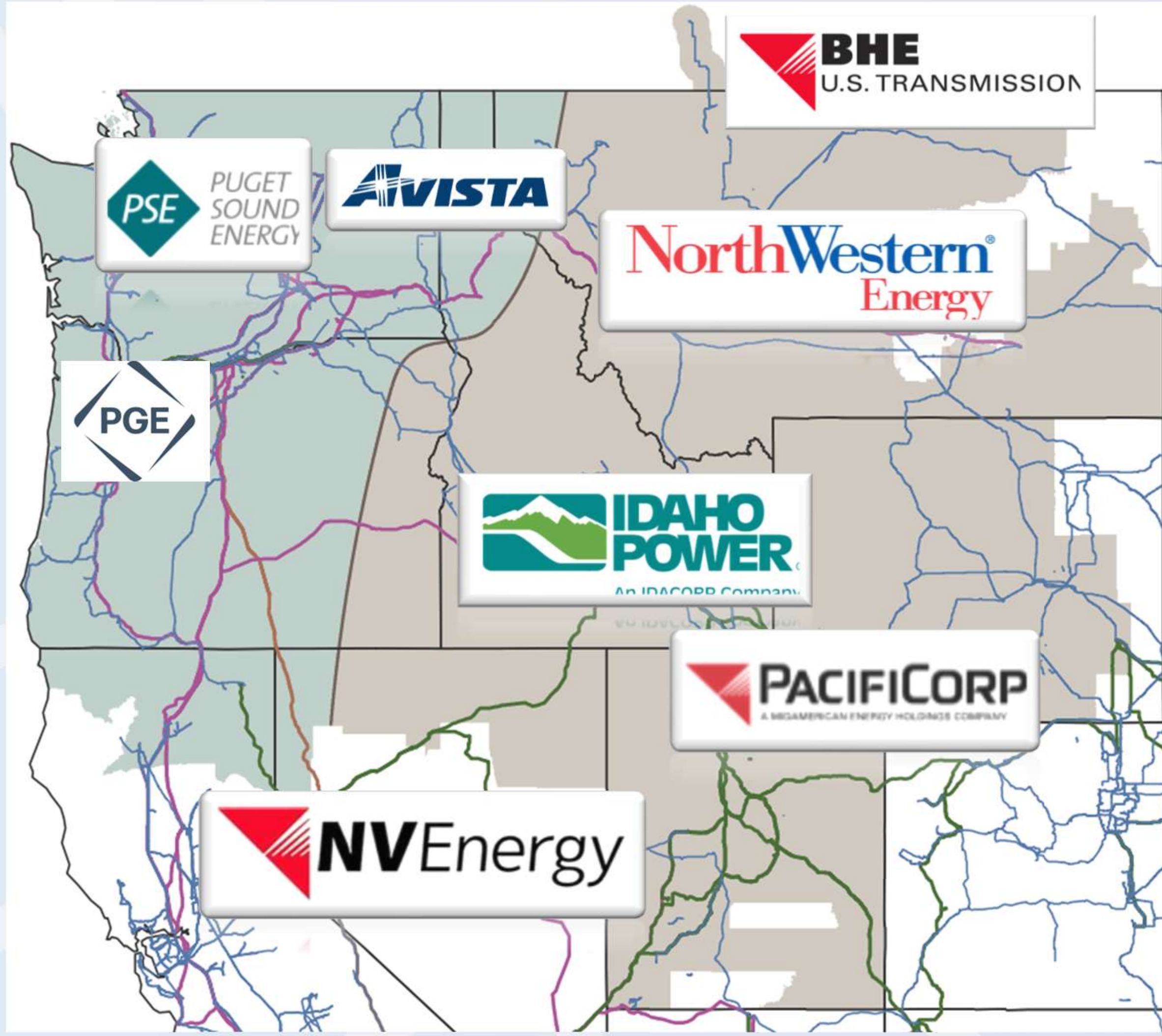
**Presentation to CREPC – Transmission Collaborative**
**1920 Ad Hoc Committee**
**December 3, 2025**

# Agenda

- Introduction to NorthernGrid
- Grid Enhancing Technologies (GETs)
- How GETs Impact Transmission Planning
- How Transmission Lines are Rated
- Transmission Planning – NERC Requirements
- Example – NorthernGrid Planning Process and the use of GETs
- Example – Boardman to Hemingway (B2H) Project
- Questions

# NorthernGrid Enrolled Parties

- Members who file a Regional Transmission Planning Tariff with FERC



# Grid Enhancing Technologies (GETs)

- FERC Order 1920 lists alternative transmission technologies as:
  - Dynamic Line Ratings
  - Advanced Power Flow Control Devices
  - Advanced Conductors; and
  - Transmission Switching
- GETs will be considered in both:
  - Regional Transmission Plan (10-year plan); and
  - Long-Term Regional Transmission Plan (20-year plan)

# Summary of Grid Enhancing Technologies

| Technology | Benefits | Limitations | Cost Impacts |
|---|---|---|---|
| Dynamic Line Ratings | Near-term benefit to optimize the existing transmission system | Limited impact when assessing the worst-case stress cases used in planning contingencies | Requires moderate investment in operational systems |
| Advanced Power Flow Control Devices | Longer-term benefit to increase control and manage congestion on the bulk electric system | Higher capital cost requirements with longer equipment lead-time | Moderate to higher capital costs relative to other GETs |
| Advanced Conductors | Incremental benefit to thermal capacity of transmission facilities | Less ability to mitigate issues related to voltage and frequency stability | Variable cost |
| Transmission Switching | Near-term benefit, may help defer capital expenditures of local transmission system | May reduce operational flexibility in real-time; limited impact on the regional transmission system | Lower incremental cost |

# How GETs Impact Transmission Planning

- NorthernGrid will build on and enhance the existing transmission planning process (approved March 2020), applying constraints from:
  - FERC Order 1000
  - FERC Order 1920
- GETs (along with non-wire alternatives):
  - May be considered in local planning processes before proposed regionally
  - Will be included in the regional study scopes (10-year and 20-year plans)
- GETs will be evaluated for regional transmission solutions
- Regional transmission plan results will provide clear rationale for why GETs were or were not selected into a plan

# How Transmission Lines are Rated

- Transmission lines are rated to the maximum power that can be transferred through a facility without damage.  Factors include:
  - Size, type, and configuration of conductor
  - Elevation, latitude, and atmospheric conditions of the facility
  - Maximum withstand temperature of the conductor
  - Ambient temperatures (i.e. by season)
  - Wind speed and direction
  - Age and condition of conductor
  - Etc.
- Ratings are traditionally “static”, do not change over a season, and represent the “worst-case” conditions for the entire season
- FERC Order 881 requires utilities to move toward ambient adjusted ratings (AAR) based on real-time weather rather than seasonal assumptions
- Transmission line capability is not always limited by the thermal rating of the conductor - for example, there may be limitations related to voltage or frequency stability inherent within the system



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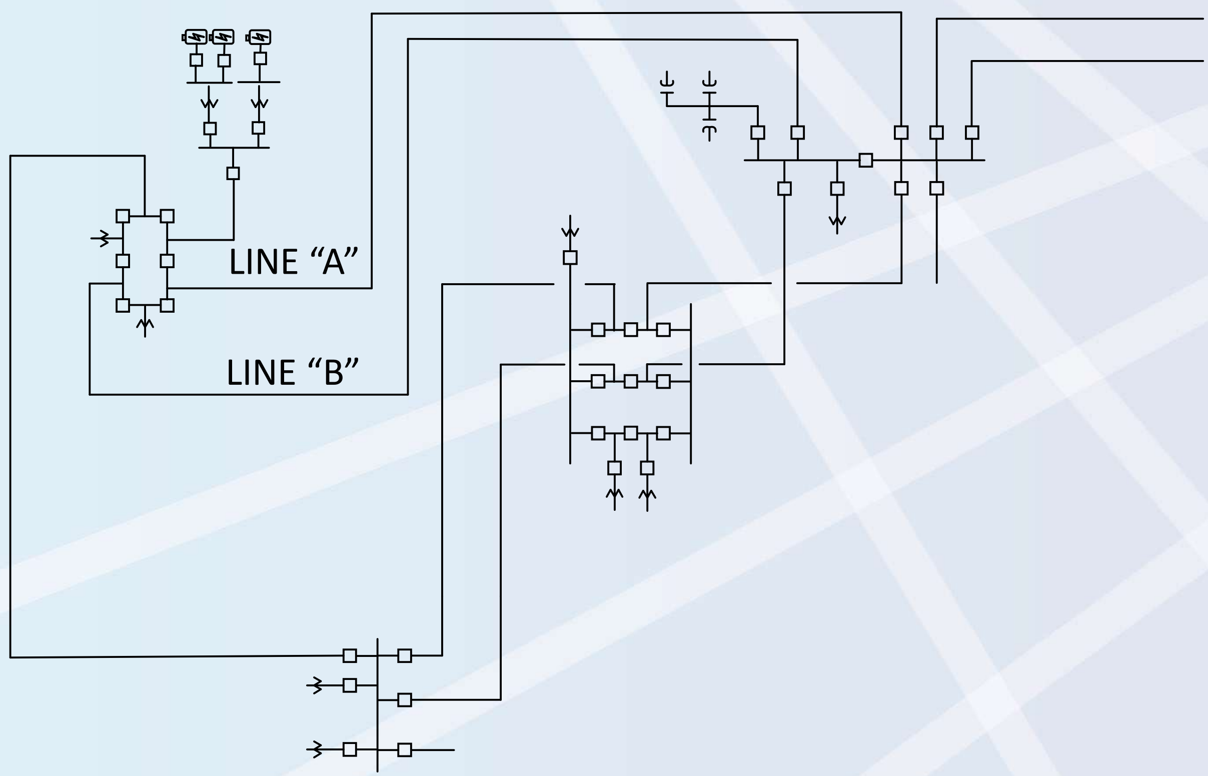
# Transmission Planning – NERC Requirements

- Traditional reliability planning at the local, regional, and interregional levels is conducted using NERC Transmission Planning standard criteria (NERC TPL-001-5.1)
- The NERC TPL standard requires analysis every year for three study years with different loading scenarios and sensitivities (each of these analyses have WECC-wide models that we call “cases”)
  - Year 1 or Year 2 Peak Load
  - Year 5 Peak Load
  - Off Peak Load for one of the five years
  - Year 10 Peak Load
  - Sensitivities for each of the analyses above
- The NERC TPL standard defines different types of outages that need to be applied to the models with specific performance criteria depending on the type of outage – we call this “Contingency Analysis”
- FERC Local Transmission Planning inputs into the Regional Transmission Planning process (Order 1000) often include projects identified through the NERC studies for the entire 10-year period
  - **Most Transmission Needs for the 10-year period have already identified projects to address the needs given the need for each NorthernGrid Enrolled Party to comply with the NERC TPL standard**

# Example – NorthernGrid Planning Process



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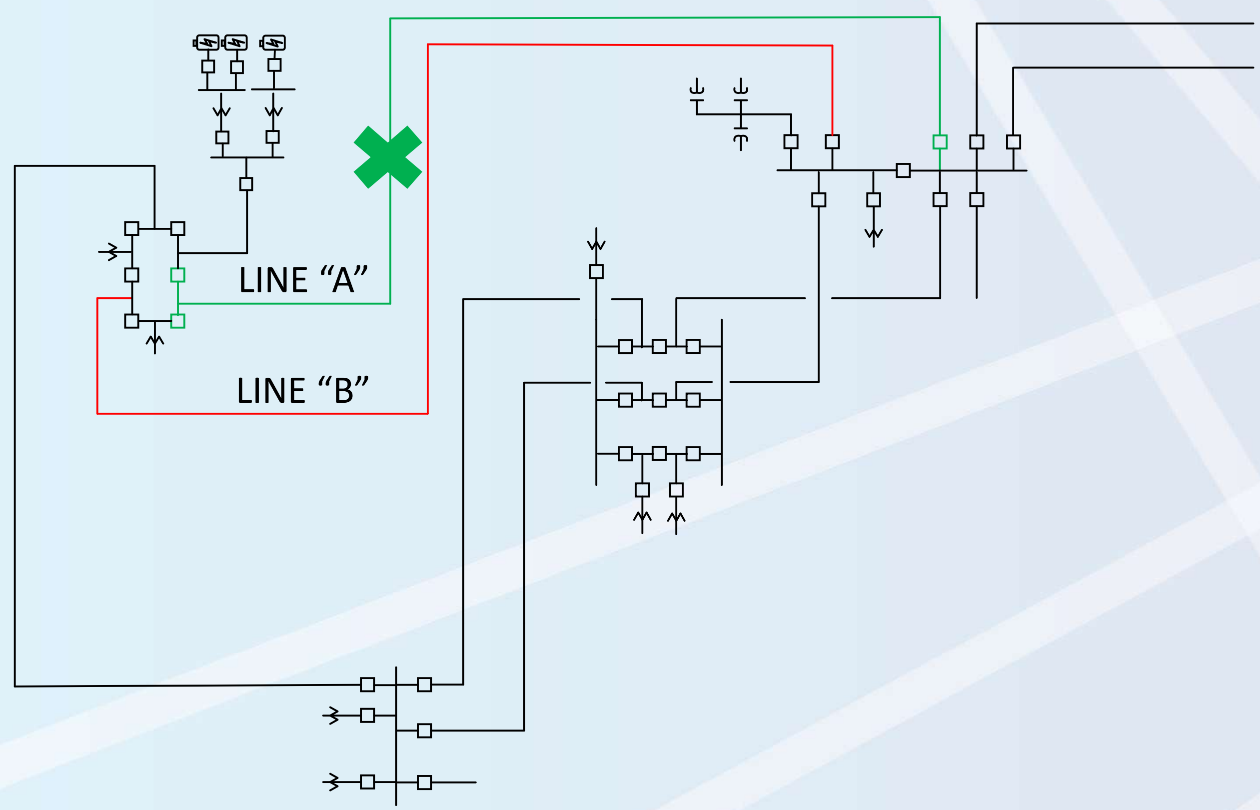
# Example – NorthernGrid Planning Process




- Perform Contingency Analysis on all cases, taking outages as defined in the NERC TPL standard
  - Powerflow software is designed such that we define all the outages, and then the software simulates each outage one at a time and produces results that show the impact of each outage
- One (or more) of the cases shows that an outage to Line A results in an overload to Line B
  - The "Transmission Need" is the lack of capacity on Line B
- Determine when the Transmission Need is required to be addressed
  - If the Year 10 case shows that an outage to Line A results in an overload to Line B at 110%, need to look at the same outage in the Year 5 case
  - If the Year 5 case shows that an outage to Line A results in Line B loading to 95%, the need date for the mitigation should be set around this timeframe, before the overload is projected to occur
  - Can interpolate between case years to determine the required in-service date



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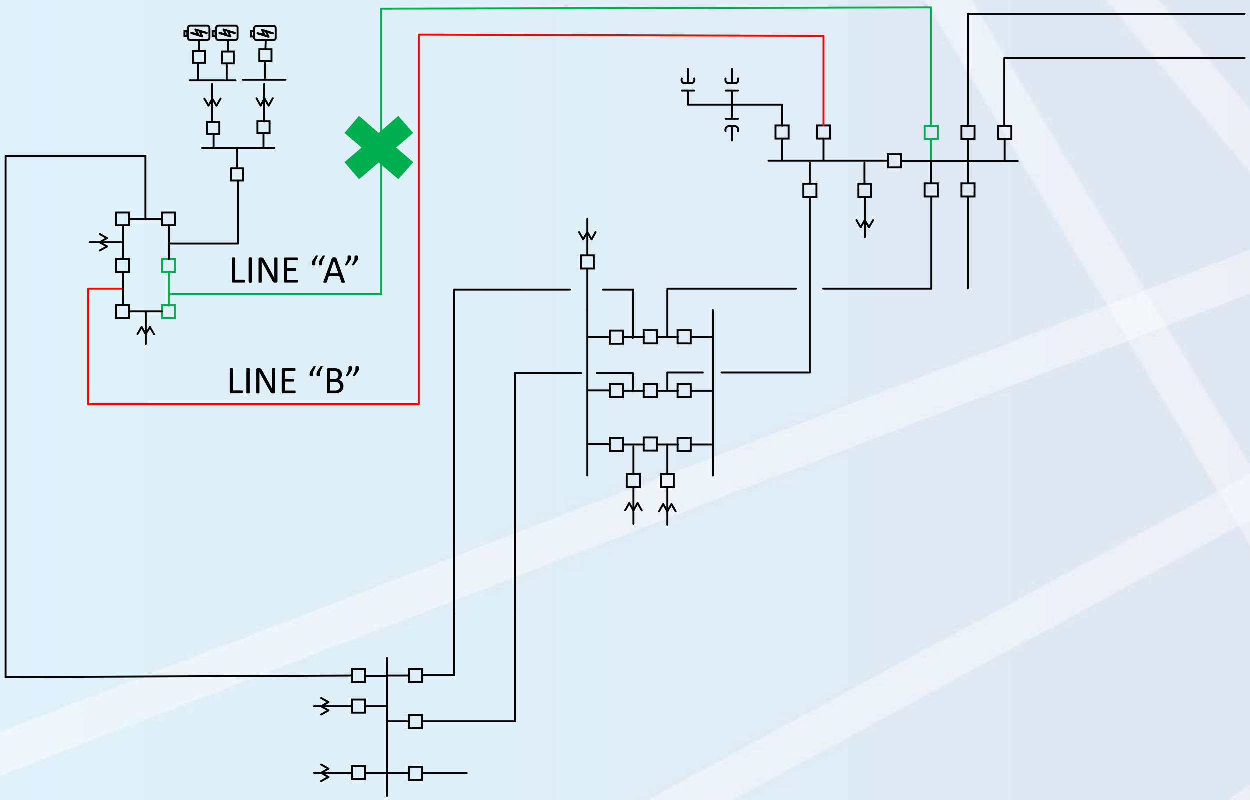
# Example – NorthernGrid Planning Process




- Develop options to mitigate the outage of Line A causing an overload on Line B in the required timeframe (some of these options may be combined to develop an optimal solution). Example options for mitigating the Line B overload include Grid Enhancing Technologies, many of which are commonly used today:
  - New transmission line
  - Replace substation terminal equipment (i.e., breaker) if this limits the rating of Line B
  - Reconductor Line B (could use an advanced conductor)
  - Install an advanced power flow control device on Line B
  - Install dynamic line rating sensors on Line B
  - Determine if transmission switching can eliminate the overload on Line B
- Each option is applied to cases to see if the overload to Line B can be mitigated
- If multiple options mitigate the overload, evaluate benefits of the options per the requirements of Order 1000 and Order 1920

# Example – NorthernGrid Planning Process

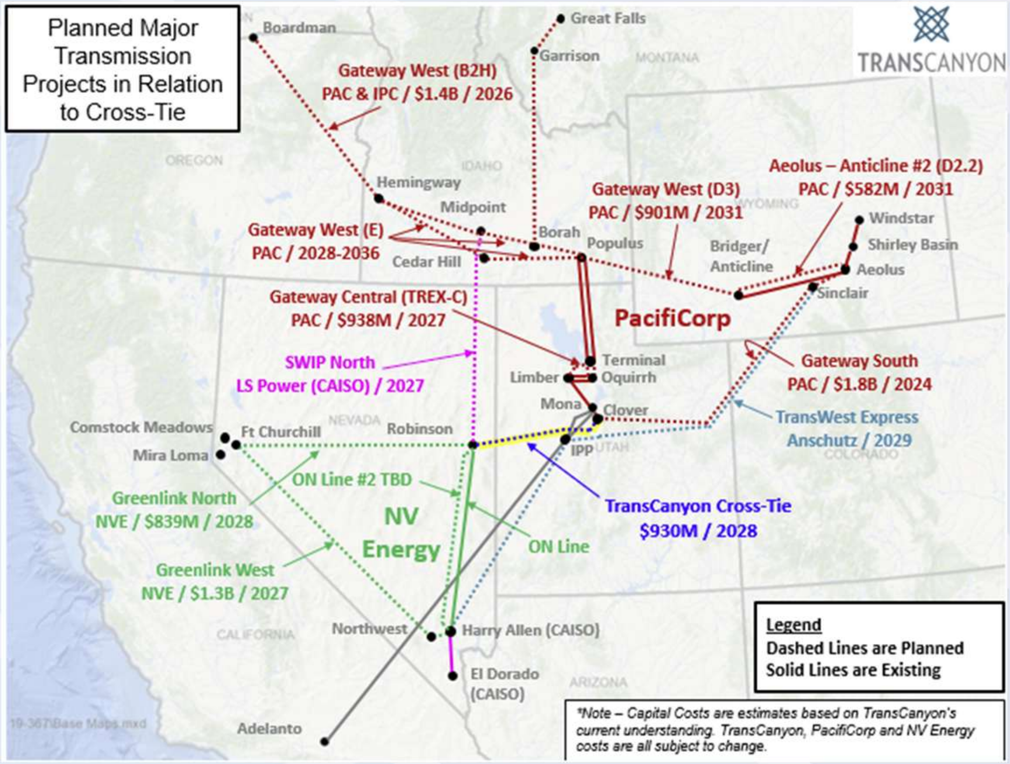
- NorthernGrid also performs Production Cost Modeling (PCM) studies, which are used to evaluate economic and market conditions and produce outputs such as production costs, losses, and congestion
- The software we (and WECC) use is called GridView, and it performs an 8760-hour analysis
- The PCM analysis is performed to identify stressed conditions in the NorthernGrid footprint; those hours are then also studied using the reliability planning tools with NERC Transmission Planning Criteria
- The reliability analysis mitigations are tested in the PCM to determine if they can provide any economic benefits

# Western Interconnection Regional Transmission Projects

Many transmission projects have been constructed or are under development.

For example:

- Harry Allen - Robinson Summit 525kV #2 (online)
- Harry Allen - Eldorado 525kV #2 (Desert Link)
- Gateway West
- Gateway South
- Boardman-Hemingway (B2H) Project
- Northwest - Ft. Churchill 500 kV (Greenlink West)
- Ft Churchill - Robinson Summit 525kV (Greenlink North)
- Robinson Summit - Clover 525 kV (Cross tie)
- Southwest Intertie Project North (SWIP-N)
- TransWest Express
- SunZia
- Colorado Power Pathway



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# Example - Boardman to Hemingway (B2H) 500kV Project

- Regional transmission projects in the west typically cover long distances and require extensive usage of GETs (series capacitors and/or phase shifters) as a baseline consideration to encourage or control flow on lines.
- Boardman to Hemingway (B2H) 500kV Project
  - The transmission line includes three controllable series capacitor bank locations to adjust flow on the line.
  - The capacitor banks help maximize the capacity uprate with the project.
  - Two Remedial Action Schemes (RAS) will also control series capacitor banks automatically in response to system outages on the surrounding system allowing regional transmission to be optimally utilized.
  - The line will use trapezoidal stranded conductors to reduce energy losses.

# Questions

# APPENDIX: GETs Considerations in Transmission Planning

# Dynamic Line Ratings

- Transmission line rating that applies to a time not greater than one hour and reflect up-to-date forecast of inputs such as (but not limited to):
  - Ambient temperature
  - Wind solar heating
  - Transmission line tension
  - Transmission line sag
- Can be used to address specific thermal limitations in times of:
  - Higher winds
  - Cooler temperatures
- Useful in real-time operations to optimize transmission capacity
- May not provide firm capacity in all hours
- Relatively new technology, allows for utilities to learn and adjust over time

# Advanced Power Flow Control Devices

- Devices that can help the system operator control power flows over a given path and can include:
  - Phase shifting transformers (also know as phase angle regulators) and
  - Devices or systems necessary for implementing optimal transmission switching
- Utilities use many of these technologies today to address system needs
- Helps “direct traffic” across the bulk electric system
- Has the most potential for use of GETs in transmission planning, and may contribute to incremental increases in the available transfer capability across regional transmission paths

# Advanced Conductors

- Includes present and future transmission line technologies whose power flows capabilities exceed the power flow capacities of conventional aluminum conductor steel reinforcement (ACSR) conductor and may include:
  - Superconducting cables
  - Advanced Composite Conductors
  - Advanced Steel Core
  - High Temperature low-sag conductors
  - Fibre optic temperature sensing conductors, and
  - Advanced overhead conductors
- Utilities are deploying advanced conductors today to address system needs
- Can be used to address specific thermal limitations, to provide incremental transmission capacity (less helpful for voltage issues and angular stability)
- Use case may include reconductoring of existing facilities, alternative conductors on planned new facilities

# Transmission Switching

- Includes the opening or closing of transmission elements to safely route power and direct flows away from congestion, based on pre-existing forward analysis
- Also known as sectionalization, is a method that applies to the real-time and operating horizon
- Can be enabled by advanced power flow control devices
- Can be an effective technique to defer capital expenditures, but can also limit system flexibility in the real-time horizon
- More effective at deferring capital at a local transmission system level rather than across the regional transmission system