WHO IS WRA?

Western Resource Advocates

• We are a conservation organization with more than 30 years experience in the Interior West.

• WRA tackles climate change to sustain the environment, economy, and people of the West.

• Our team of policy experts, scientists, economists, and attorneys has a 30-year history of working where decisions are made, sweating the details, creating evidence-based solutions, and holding decision makers accountable.

OUR MISSION: WESTERN RESOURCE ADVOCATES IS DEDICATED TO PROTECTING THE WEST’S LAND, AIR, AND WATER TO ENSURE THAT VIBRANT COMMUNITIES EXIST IN BALANCE WITH NATURE.
Transmission Basics

- What is transmission?
  - Generation, transmission, sub-transmission distribution connections
  - “Low” versus “high” voltage
  - Alternating current vs. direct current
- What do transmission wires and poles look like?
- What different types of power lines are transmission?
- Is transmission evolving through research and innovation?
- How much transmission does Nevada have?
- Why does transmission matter?
Parts of the Electric System – Simplified

![Diagram of the electric system]

- **Power plant**
- **Step-up transformer**
- **High-voltage transmission line**
- **Step-down transformer (substation)**
- **Step-down transformer**

- **Generation**
- **Transmission > 115 kV**
- **Sub-transmission and Distribution <115 kV**

https://courses.lumenlearning.com/austincc-physics2/chapter/23-7-transformers/
High Voltage Transmission comes in Discreet Sizes and Flavors

- 69 kV and 115 kV – Sub-Transmission – carrying energy to distribution hubs
- 230 kV small backbone transmission generally within a state (500 MW)
- 345 kV – substantial backbone transmission (1,000 MW)
- 500 kV – long distance, high efficiency transport (2,000 MW)
- 500 kV DC (HVDC) very long distance, high capacity, low loss (greater than 2,000 MW)
- 750 kV and above (AC and DC) super high voltage “regional” transport
The Higher the Voltage, the Bigger the Tower
Transmission takes generation to load

- Higher voltages are more efficient
- Losses are minimal – typically less than 1% - 2%.
- In the picture on the right, this is a tower supporting double circuit 345 kV lines. Each side of the tower supports conductors for each of three phases of 60 hz power.
- This tower is carrying energy into a switching substation where the 345 kV is transformed down to a lower voltage (see switch yard and substation building in the background)
This double circuit tower diagram conceptually shows the area that must be protected from other trees, poles, buildings, etc.

- High voltages can arc to objects that are too close
- If lines sag due to heat, they can get too close to objects and arc
- Arcing creates heat that can cause fire. So does “line slap” where two conductors touch in high wind – creating sparks that can cause fire
- Keeping vegetation cut down is important to help reduce fire risk
Underground Transmission

- Underground transmission is expensive, but has benefits.
- Initial cost of undergrounding is significantly more than overhead lines. Generally between five and ten times the cost.
- The advantages of undergrounding are: increased reliability, reduced risk of fire, and avoiding the aesthetics of transmission towers.
- The primary disadvantage is cost, with some additional technical issues such as heat dissipation for higher voltage lines that are undergrounded.
Advanced Transmission Technologies (ATTs)

- Advanced transmission conductors allow for higher capacity
- Dynamic Line Rating increases capacity based on real time weather
- Topology optimization
- Hardware solutions - Power Flow Controllers
- Advanced pole/wire geometries

Image source: https://www.energetica-india.net/
Advanced Transmission Conductors

Evolution of conductors for heat tolerance, low sag, better strength, higher capacities.

- ACSR “Aluminum Conductor Steel Reinforced” is the most commonly used conductor type (1908) (pictured)
- ACSS “Aluminum Conductor Steel Supported” (1970s)
- ACCR “Aluminum Conductor Ceramic Reinforced” (1990s)
- ACCC “Aluminum Conductor Carbon fiber Composite Core” (2000s)
- Technology still evolving with better core compositions and designs


WesternResourceAdvocates.org
Dynamic Line Rating (DLR)

- Traditional static line ratings are very conservative.
- FERC recently ordered the use of Ambient Adjusted Ratings (AAR) (Order No. 881).
- DLR utilizes sensor technology to adjust line ratings in almost real time based on temperature, wind, sun, conductor sag, etc.
- The capacity of a line can double under good conditions.

For more information, see, for example, www.linevisioninc.com.
Topology Optimization and Power Flow Converters

- In a highly interconnected grid, electricity may not flow in optimal ways.
- Topology optimization is hardware and software that can help levelize flows for more capacity.
- Power flow converters can push or pull energy onto or off of circuits to levelize energy flow.

For more information, see, for example, www.smartwires.com.
Advanced Pole/Wire Geometries

- New pole/tower geometries and line spacing promise higher capacities on long spans.
- Transmission spans over 90 miles are limited by factors other than thermal limits of the conductor.
- The technology is called High Surge Impedance Loading (HSIL).

For more information, see www.boldtransmission.com
Existing High Voltage Line in Nevada – ON Line, 500 kV

https://www.energy.gov/lpo/one-nevada-line
Existing High Voltage DC Lines in Nevada – Pacific DC Intertie (aka Path 65)

- Pacific DC Intertie, aka Path 65
  - 846 miles long (The Dalles, WA, to Los Angeles, CA)
  - 1,000 kV and 3,100 MW
  - Does not interconnect with Nevada’s grid
  - Owned and operated by BPA

- Also: Intermountain Power Project, 500 kV DC (not shown; passes through Nevada south of Las Vegas)
  - www.ipautah.com

https://en.wikipedia.org/wiki/Pacific_DC_Intertie
Map of Sub-Transmission Lines in Nevada, from 46kV to 125 kV

https://hifld-geoplatform.opendata.arcgis.com/
WesternResourceAdvocates.org
Map of Transmission lines in Nevada Above 125 kV, without DC Intertie

https://hifld-geoplatform.opendata.arcgis.com/

WesternResourceAdvocates.org
All Sub-Transmission and Transmission lines in Nevada, without the Pacific DC Intertie

https://hifld-geoplatform.opendata.arcgis.com/

WesternResourceAdvocates.org
Grid Operations Today (in rest of U.S.)

- Organized energy markets (called RTOs or ISOs) cover large portions of the U.S.
- In the U.S. portion of the Western Interconnection, CAISO is the only RTO/ISO
- In RTOs/ISOs, multiple BA footprints are combined into a large BA with a centralized market operator
- Development of renewable energy outside of RPS mandates regularly occurs in RTO/ISO regions of the country
Western Interconnection: *Interconnectedness*

- 136,000 miles of existing, operating transmission lines that cover 80+ million people over ~ 1.8 million sq. mi.
- Growing share of resources are remotely located relative to the “load pockets”
- Pacific Northwest hydropower (CAN; USA – WA, OR, ID, MT) often provides the shock-absorber (surplus resources)
Nevada’s Role in Western Transmission System

- Donut system is akin to a large connected outer-wheel with few spokes in the middle

<table>
<thead>
<tr>
<th>Proposed</th>
<th>Operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwest Intertie Project (SWIP), 500 kV</td>
<td>One Nevada Line, 525 kV (in operation)</td>
</tr>
<tr>
<td>TransCanyon Cross-Tie 500 kV</td>
<td></td>
</tr>
<tr>
<td>Greenlink North, 525 kV</td>
<td></td>
</tr>
<tr>
<td>Greenlink West, 525 kV</td>
<td></td>
</tr>
</tbody>
</table>

Congress of the US, Office of Technology Assessment, “Electric Power Wheeling and Dealing”, (1989), Figure 4-5, p. 114.
Accessible Transmission Infrastructure:

- Geographic Diversity
  - Import: Wind, Hydro
  - Export: Solar, Geothermal
- Reliability
  - Access resources across the west
- New resources in Renewable Energy Zones
- Addresses issues with greenhouse gas accounting
  - Generate attributes that help other states
- Import zero-carbon resources

<table>
<thead>
<tr>
<th>Proposed</th>
<th>Operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwest Intertie Project (SWIP), 500 kV</td>
<td>One Nevada Line, 525 kV (in operation)</td>
</tr>
<tr>
<td>TransCanyon Cross-Tie 500 kV</td>
<td></td>
</tr>
<tr>
<td>Greenlink North, 525 kV</td>
<td></td>
</tr>
<tr>
<td>Greenlink West, 525 kV</td>
<td></td>
</tr>
</tbody>
</table>
RTO – A Pathway to Decarbonization: Sustainable and Economic Transmission

• Transmission is one component to enhancing clean energy resources flow

• Decarbonization needs new transmission to reduce “curtailments” and ensure all clean energy resources are used to the fullest extent

• Multi-state agreements or coordination is critical to a transparent, functional and an economically viable RTO.
Regional Grid Expansion and/or Market Coordination Studies: Key Finding

- Western Flexibility Study (2019)
- Utah State Led “Markets Study” (2021)
- FERC Proposal in Docket No. RM21-17-000

- Market coordination and integration of high levels of renewables → Need new transmission
- Transmission is required to integrate more renewables and provide for reliability.
- A west-wide RTO or wholesale market(s) in the West could benefit from added transmission across the West.
- Just released on 4/21 and appears to greatly expand states’ roles in transmission planning and cost allocation.
Questions?

Cameron Dyer – Managing Sr. Staff Attorney, Nevada
Ken Wilson – Engineering Fellow

cameron.dyer@westernresources.org
ken.wilson@westernresources.org