Transmission Overview in Nevada

For the Nevada Regional Transmission Coordination Task Force

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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.

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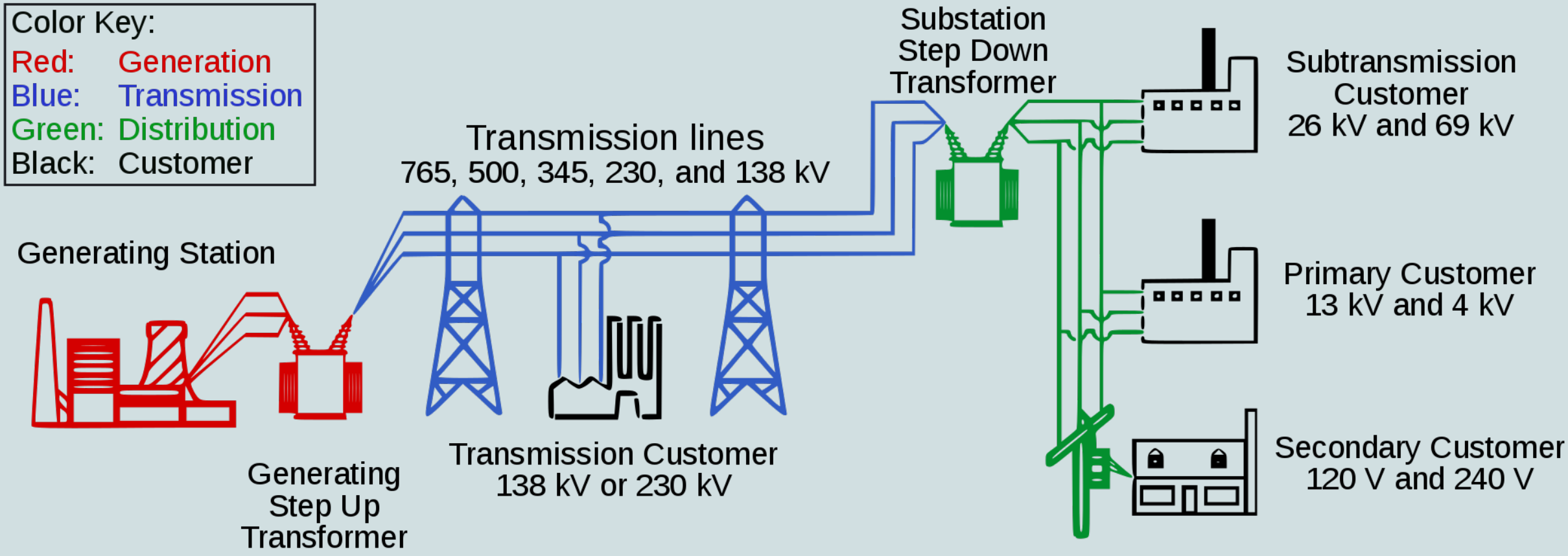
Transmission Basics

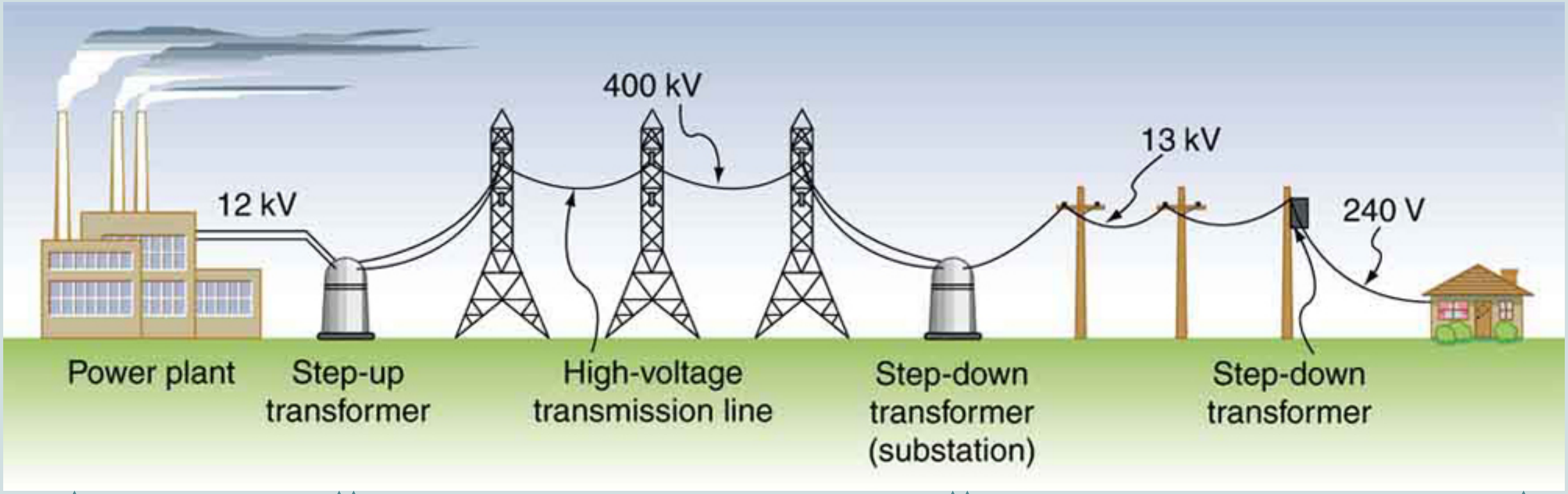
- What is transmission?
  - Generation, transmission, sub-transmission distribution connections
  - “Low” versus “high” voltage
  - Alternating current vs. direct current
- What do transmission wires and poles look like?
- What different types of power lines are transmission?
- Is transmission evolving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

Parts of the Electric System



https://en.wikipedia.org/wiki/Electric_power_transmission

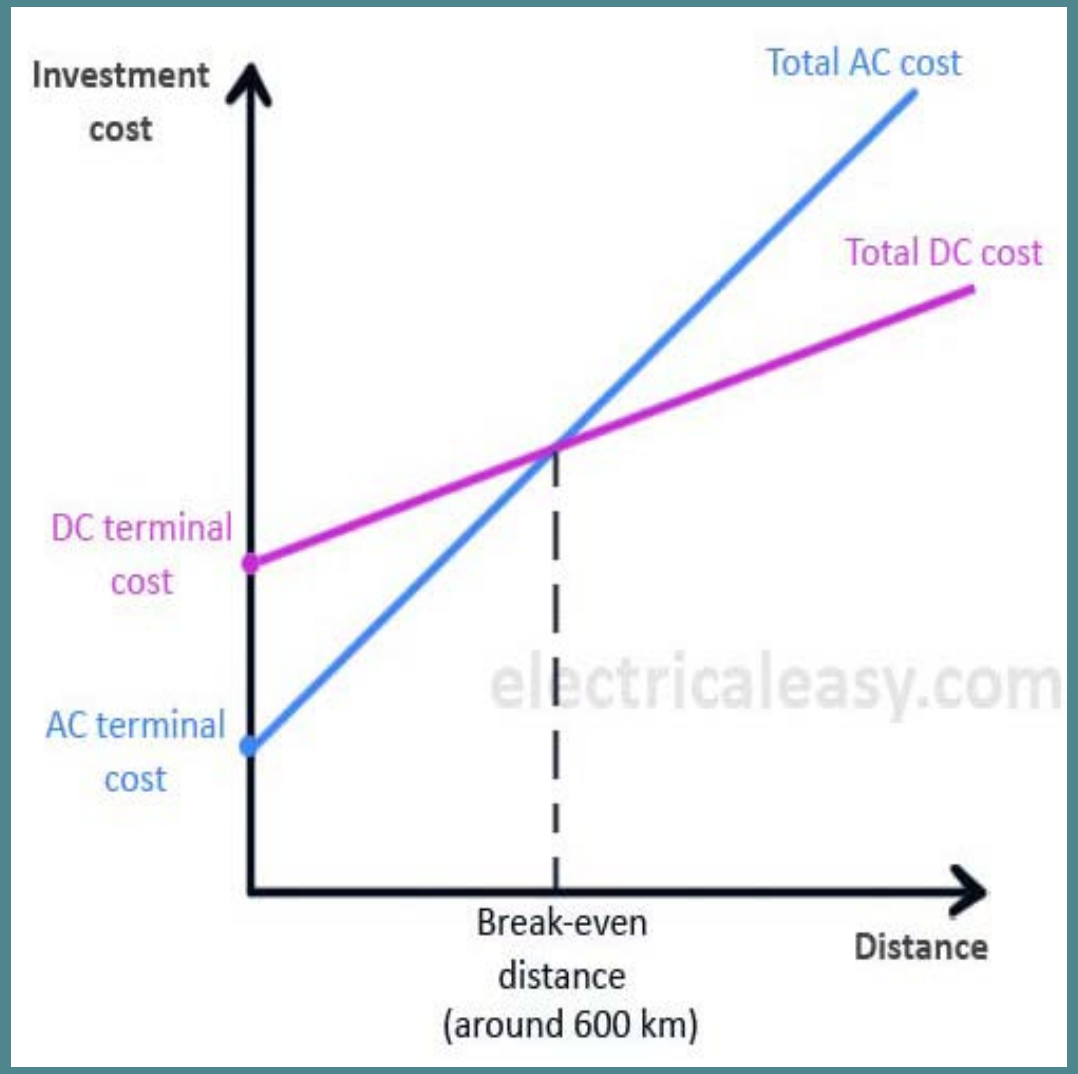
Parts of the Electric System – Simplified



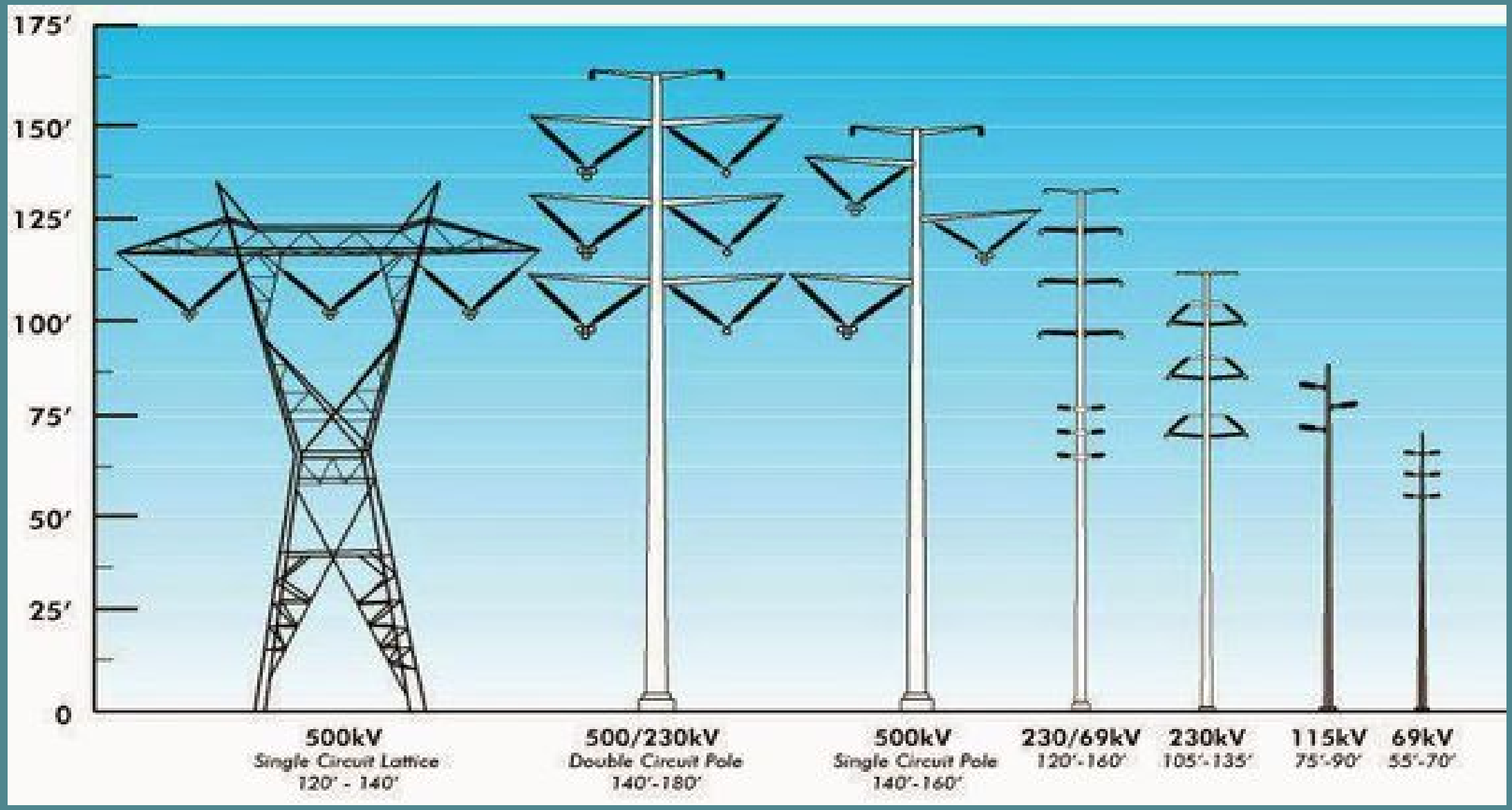
https://courses.lumenlearning.com/austincc-physics2/chapter/23-7-transformers/

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

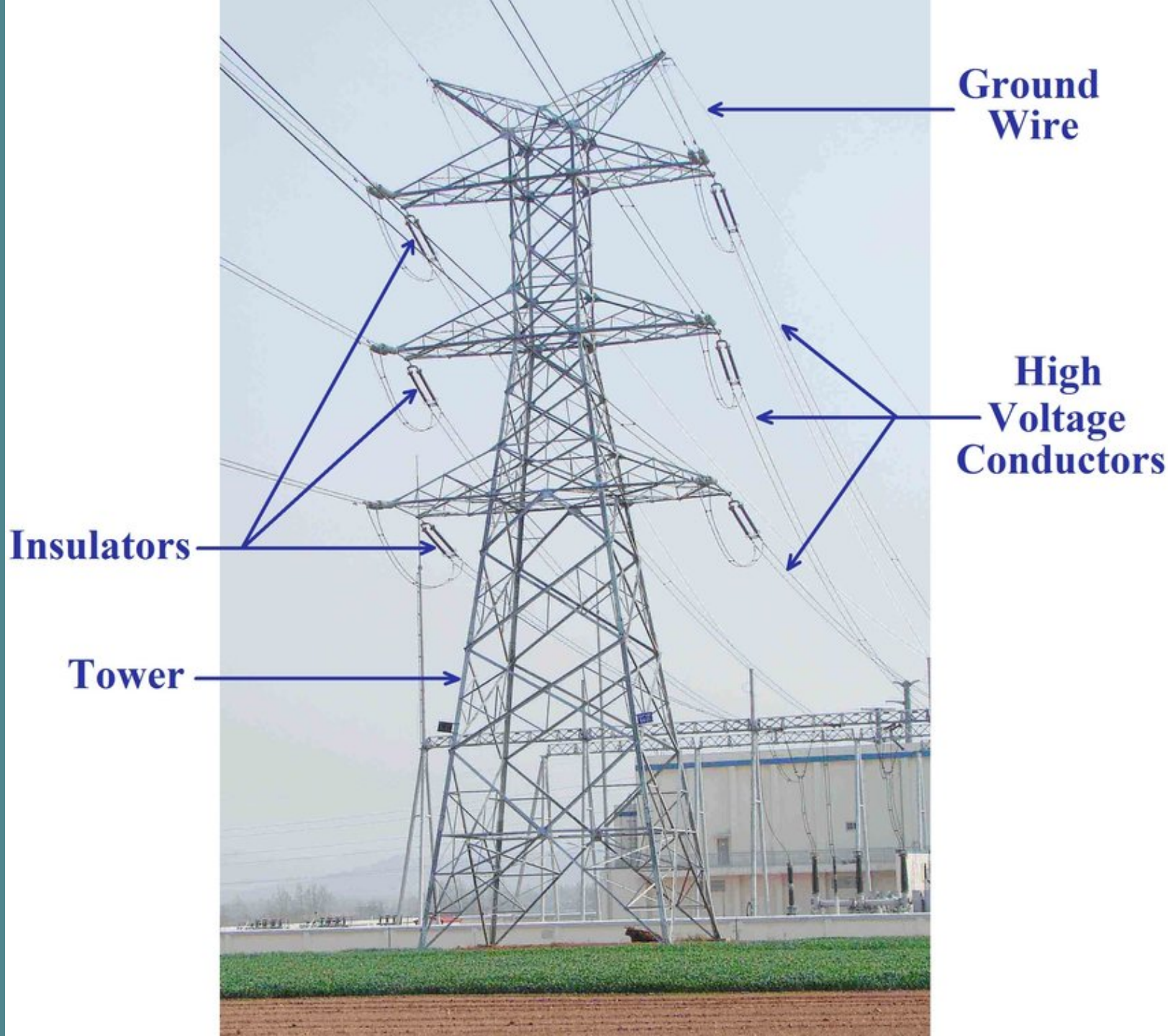


The Higher the Voltage, the Bigger the Tower



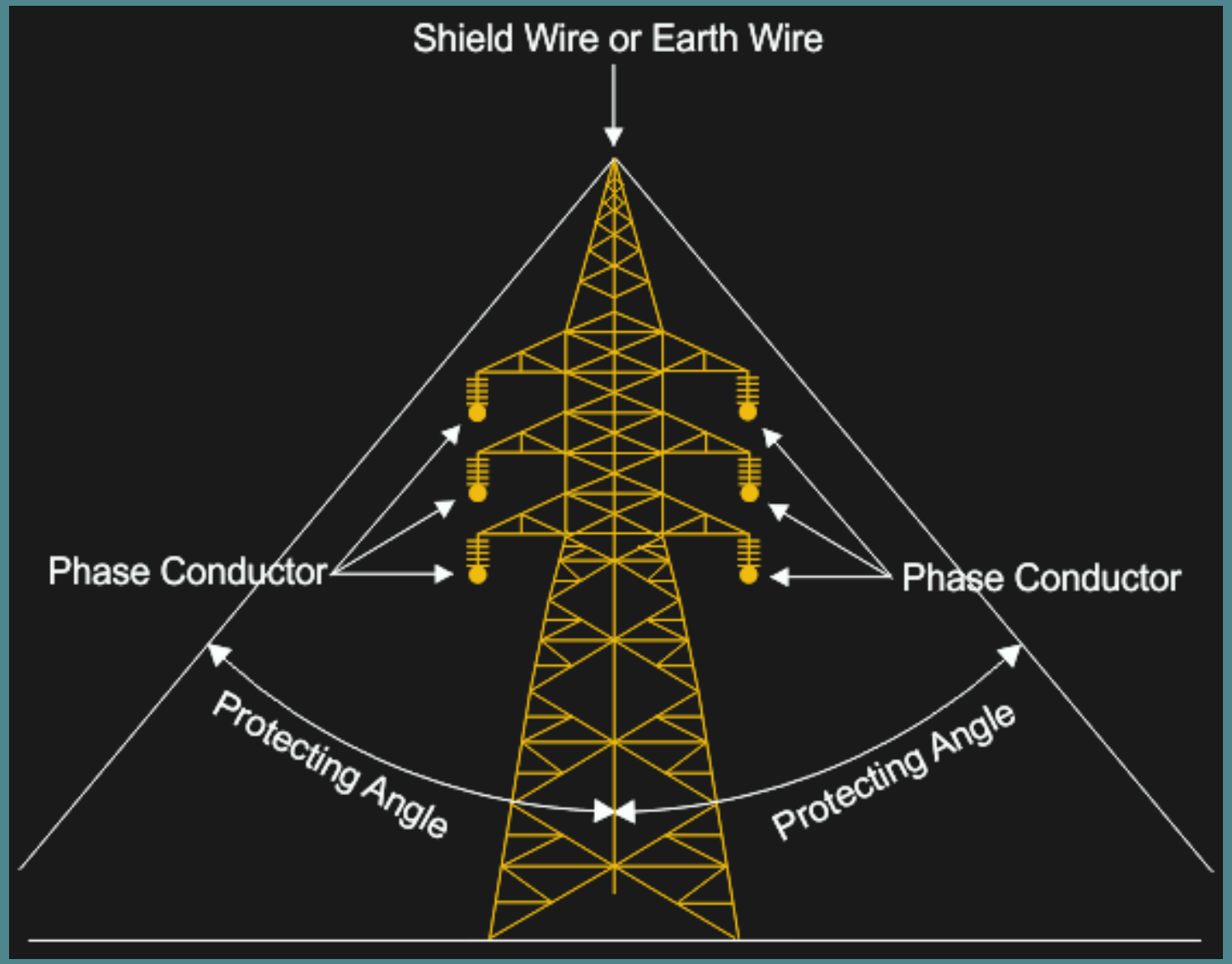
Transmission takes generation to load

- 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)



Adequate Right of Way is Important

- 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

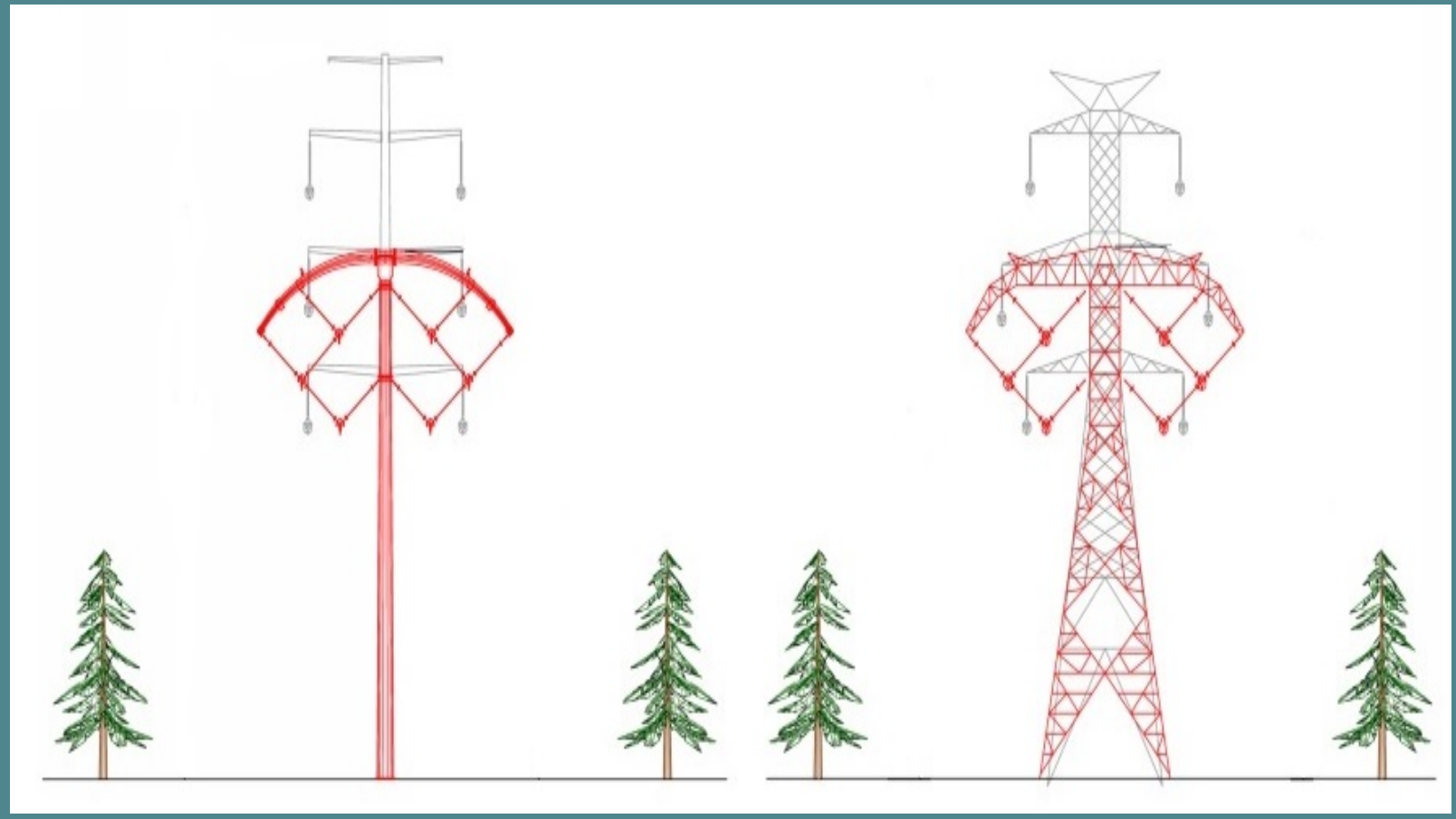


Image source: https://www.energetica-india.net/

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

https://www.deangeliprodotti.com/en/products/acsr-aluminium-conductor-steel-reinforced-acsr-aw/

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

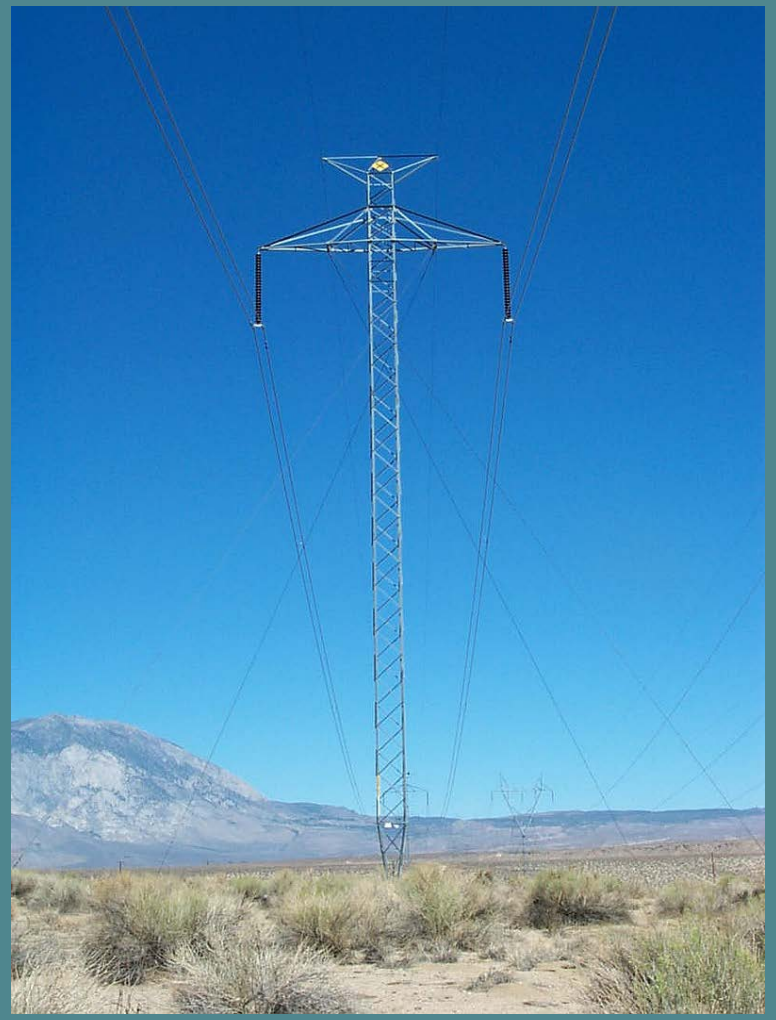
Existing High Voltage Line in Nevada – ON Line, 500 kV

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



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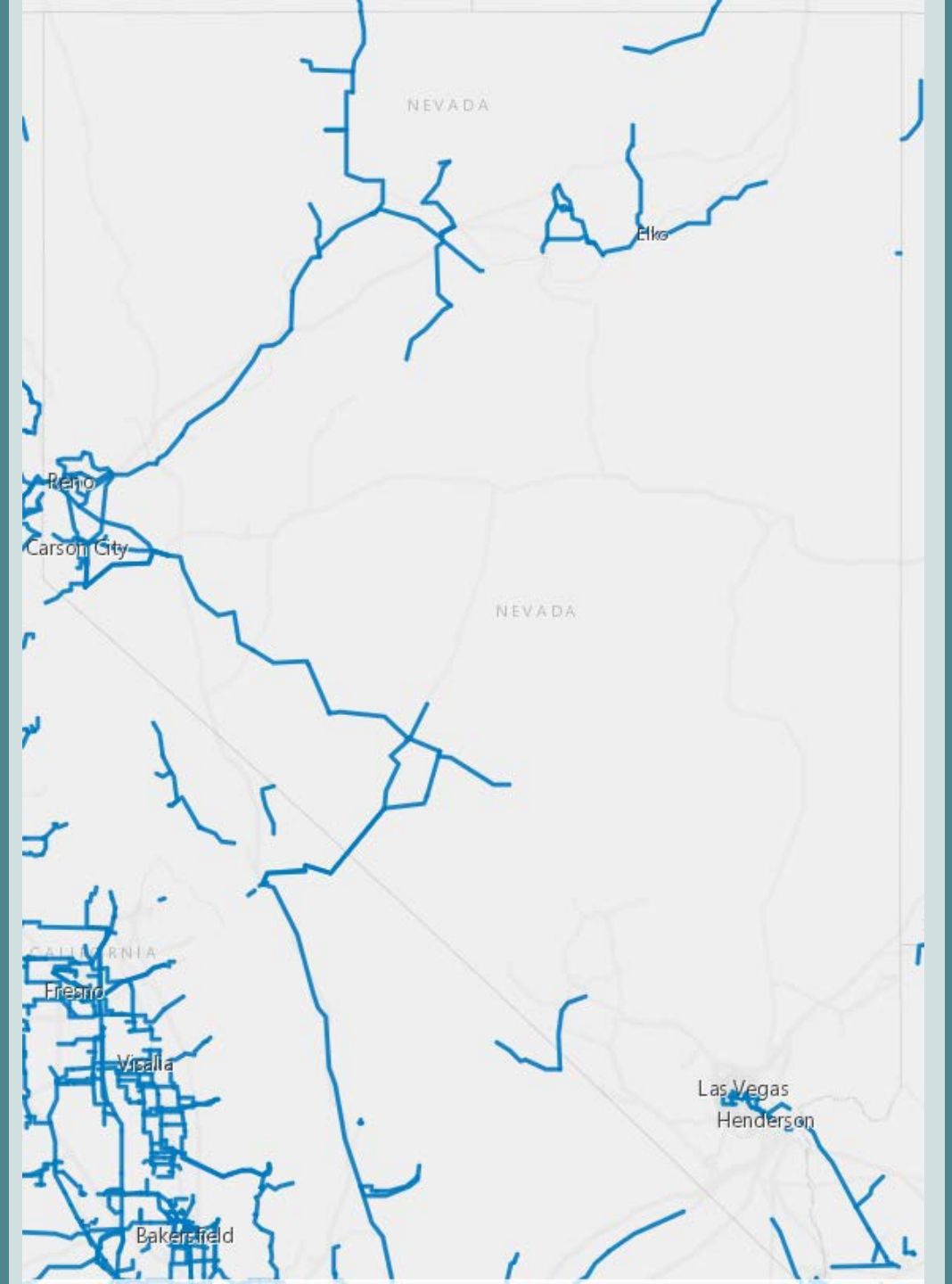
Map of Sub-Transmission Lines in Nevada, from 46kV to 125 kV



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

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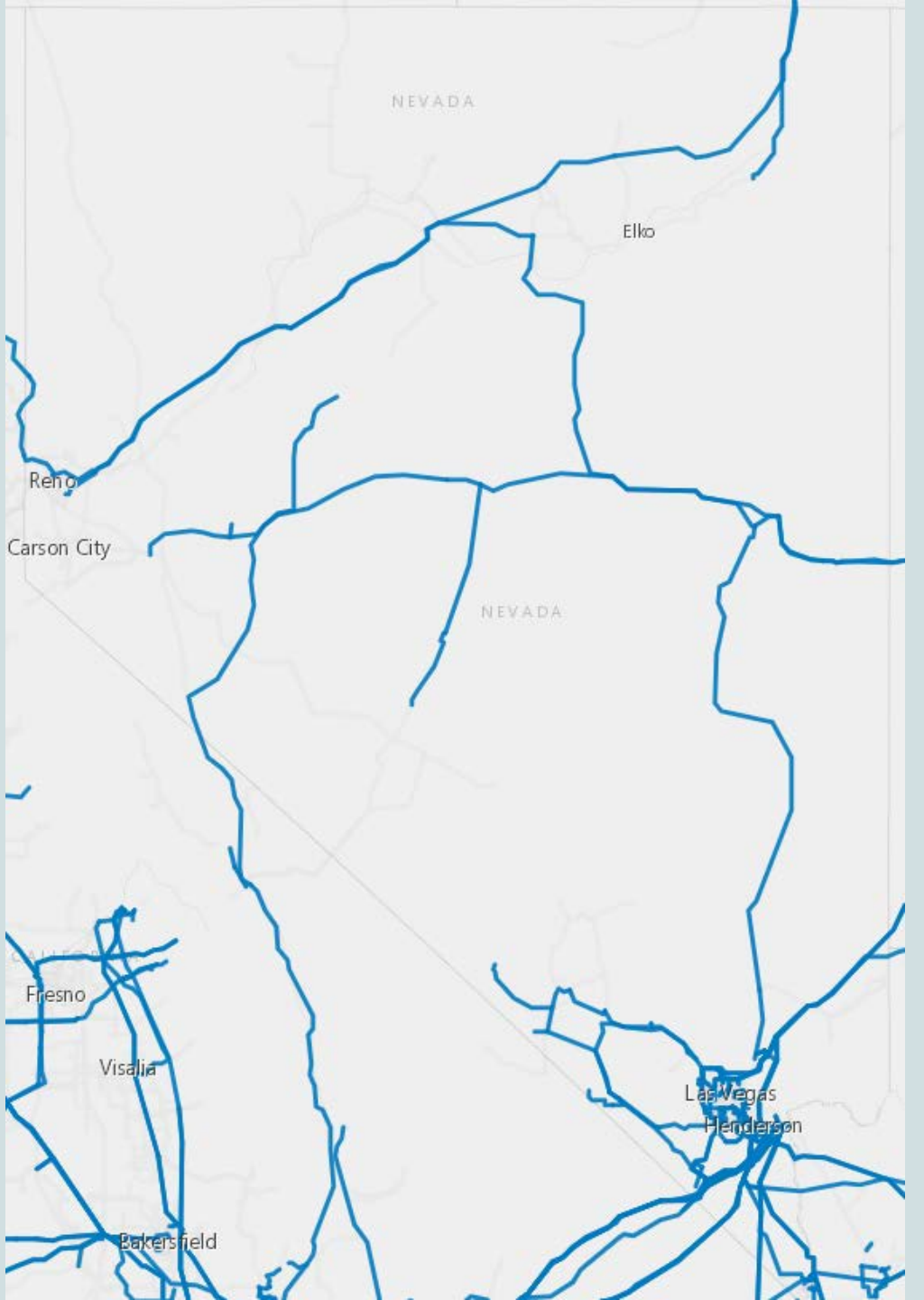
Map of Transmission lines in Nevada Above 125 kV, without DC Intertie



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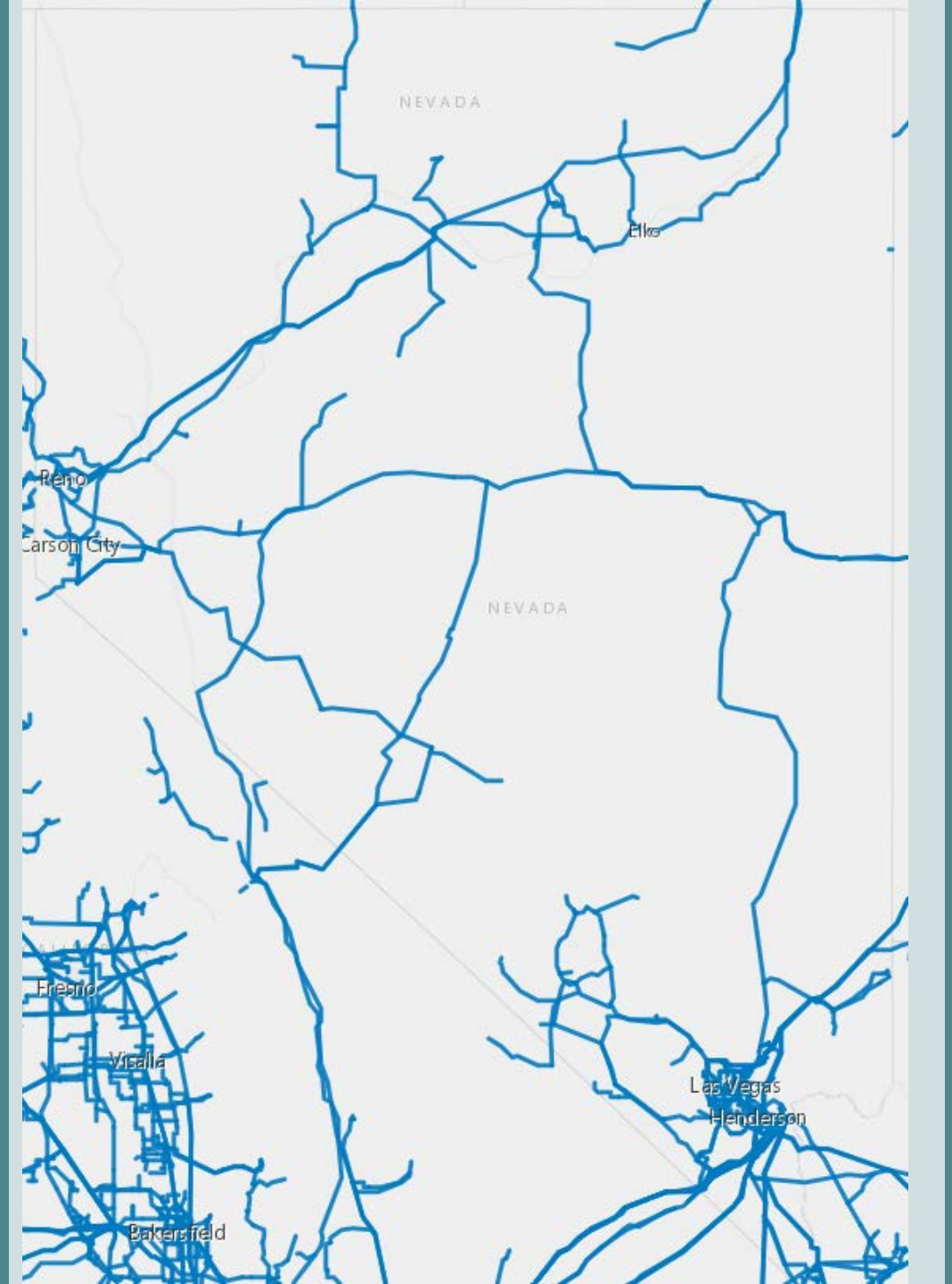
All Sub-Transmission and Transmission lines in Nevada, without the Pacific DC Intertie



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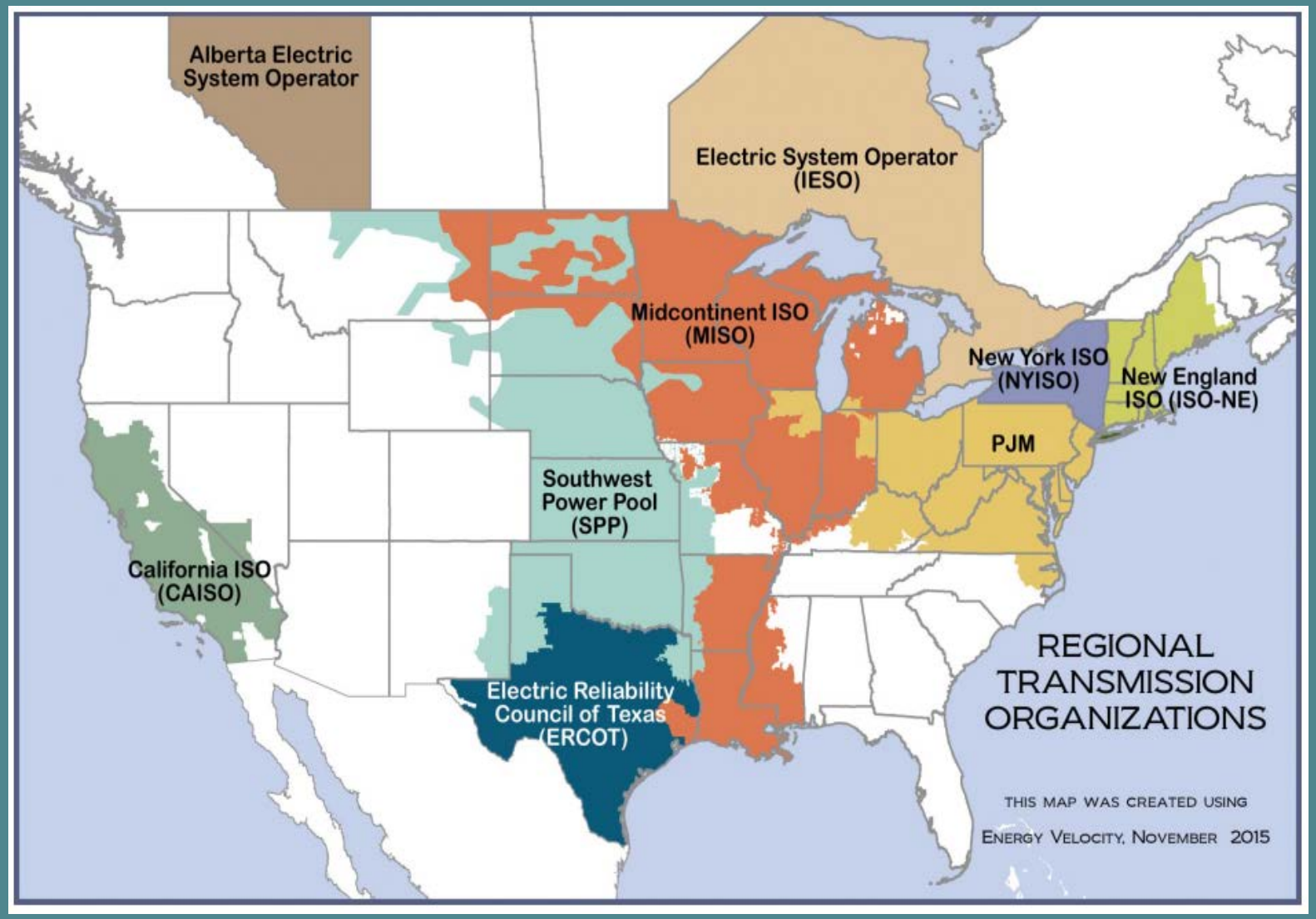
Grid Operations Today (in rest of U.S.)

- 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



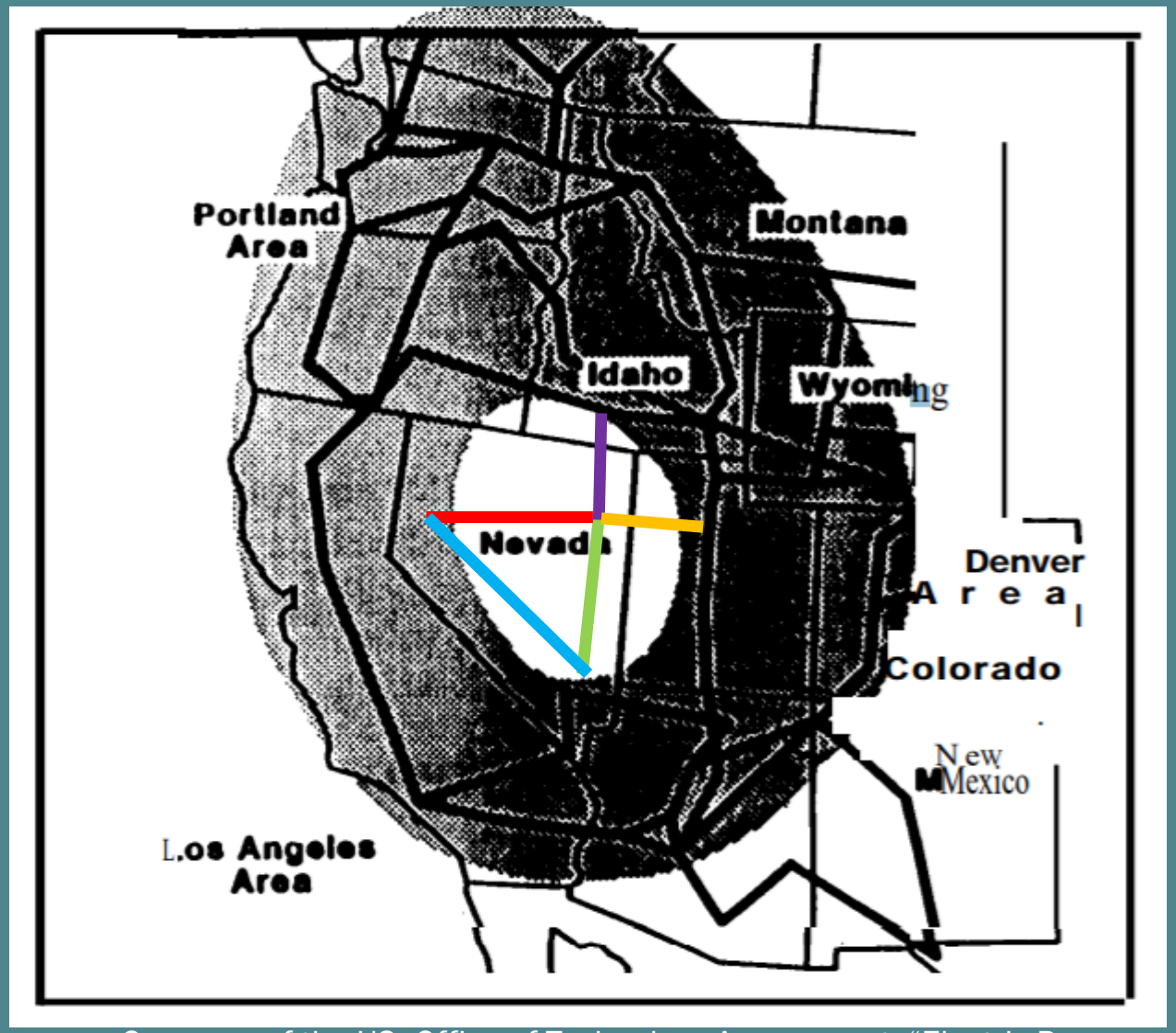
Western Interconnection: *Interconnectedness*

- 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)

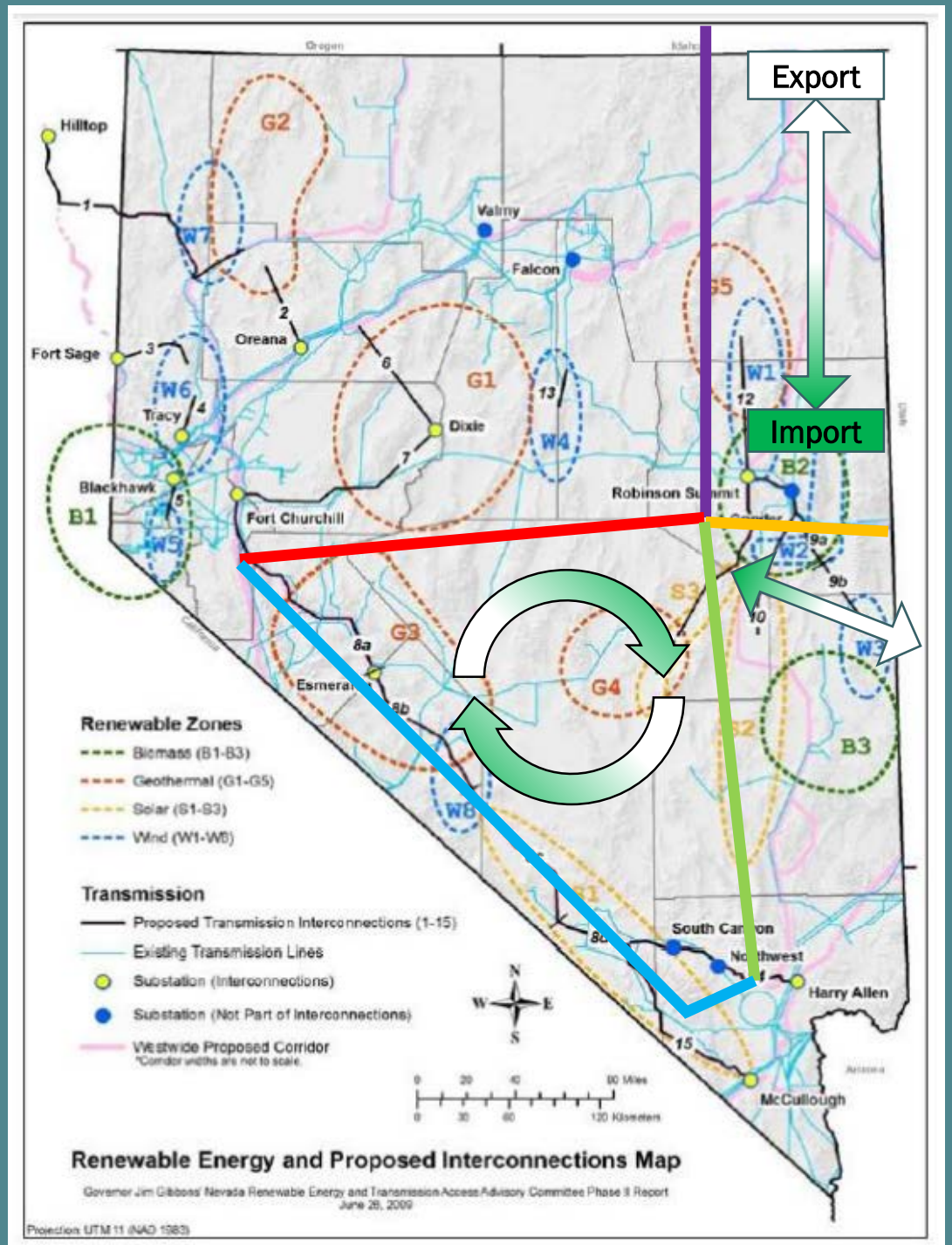
Nevada's Role in Western Transmission System

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

	Proposed
	Southwest Intertie Project (SWIP), 500 kV
	TransCanyon Cross-Tie 500 kV
	Greenlink North, 525 kV
	Greenlink West, 525 kV
	Operational
	One Nevada Line, 525 kV (in operation)



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

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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)	• Market coordination and integration of high levels of renewables → Need new transmission
• NV Energy's assessments in the Integrated Resource Plan, 21-06001, and prior amendment, 20-07023.	• Transmission is required to integrate more renewables and provide for reliability.
• Utah State Led "Markets Study" (2021)	• A west-wide RTO or wholesale market(s) in the West could benefit from added transmission across the West.
• FERC Proposal in Docket No. RM21-17-000	• Just released on 4/21 and appears to greatly expand states' roles in transmission planning and cost allocation.

Questions?

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