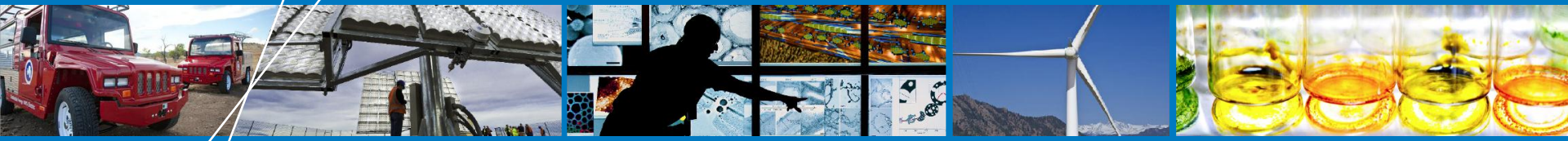
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Transmission Planning as Practiced by WAPA & Bonneville Administration

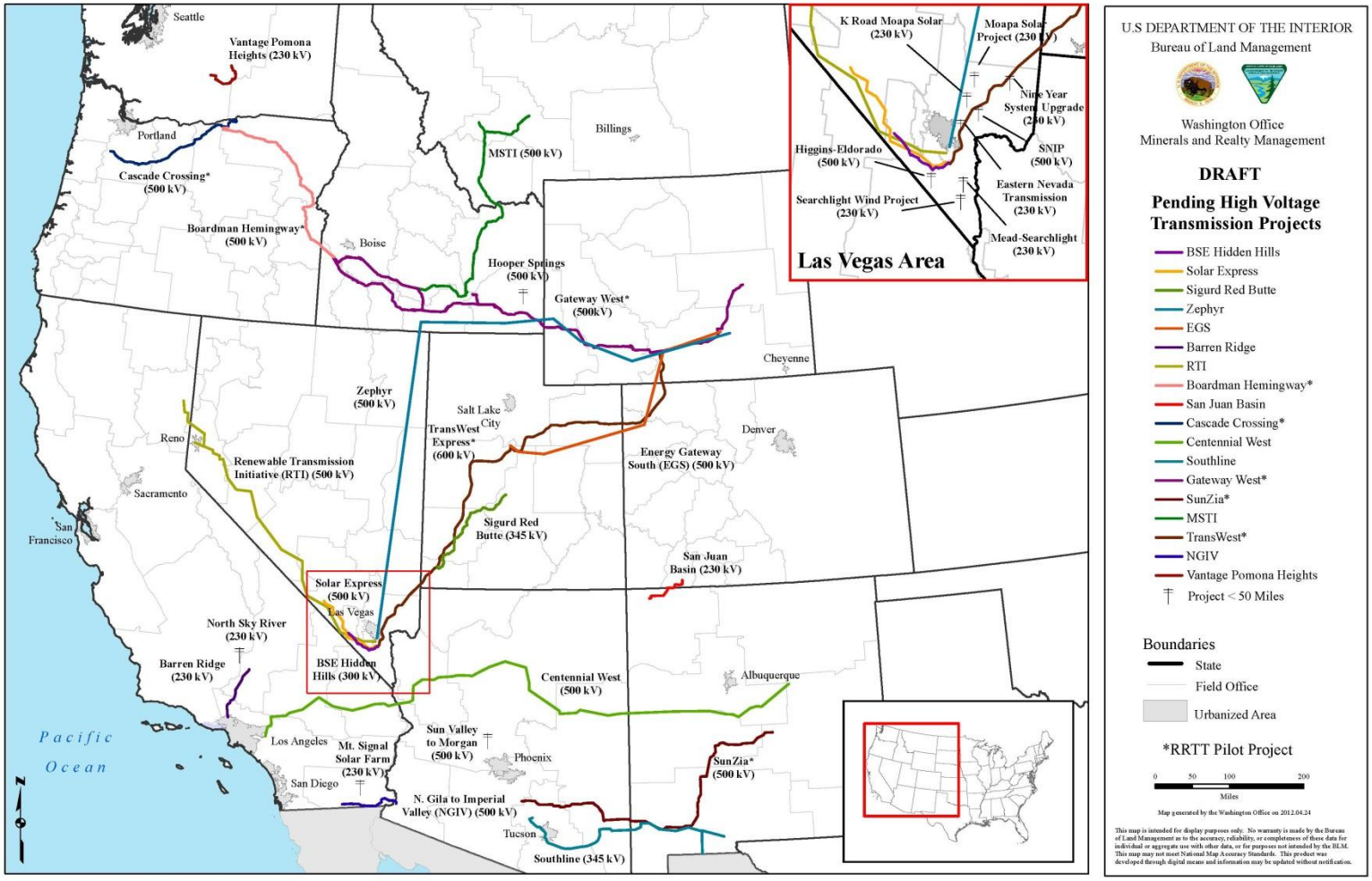


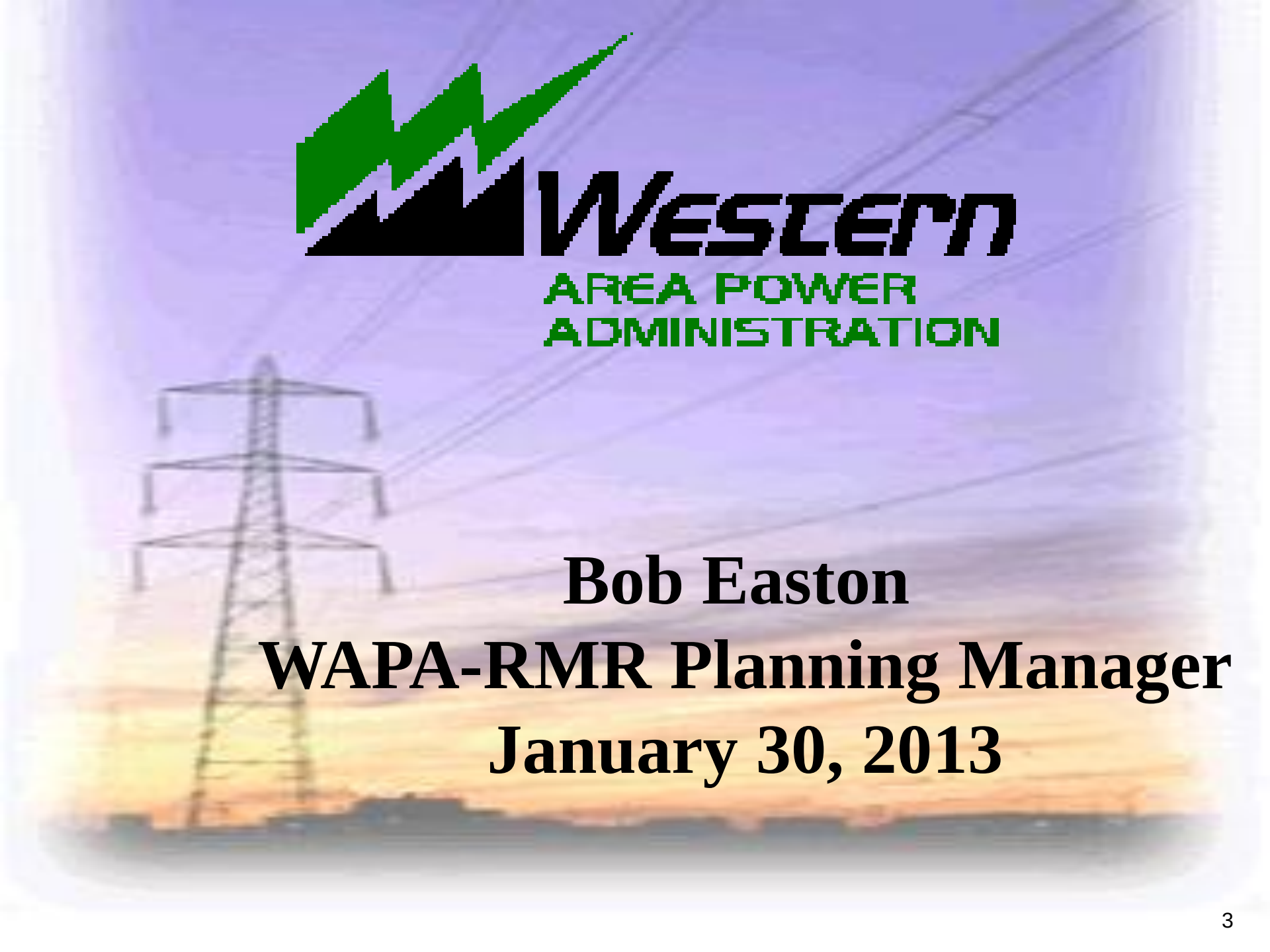
BLM Transmission Training Webinar Series

Webinar 3

January 30, 2012

MAP Pending High Voltage Lines





Bob Easton

WAPA-RMR Planning Manager

January 30, 2013

Western
AREA POWER
ADMINISTRATION

AGENDA
January 30, 2013

- **NERC/FERC**
- **WAPA Annual Planning Process**
- **Line Separation**
- **TOT3 Example**
- **Questions**

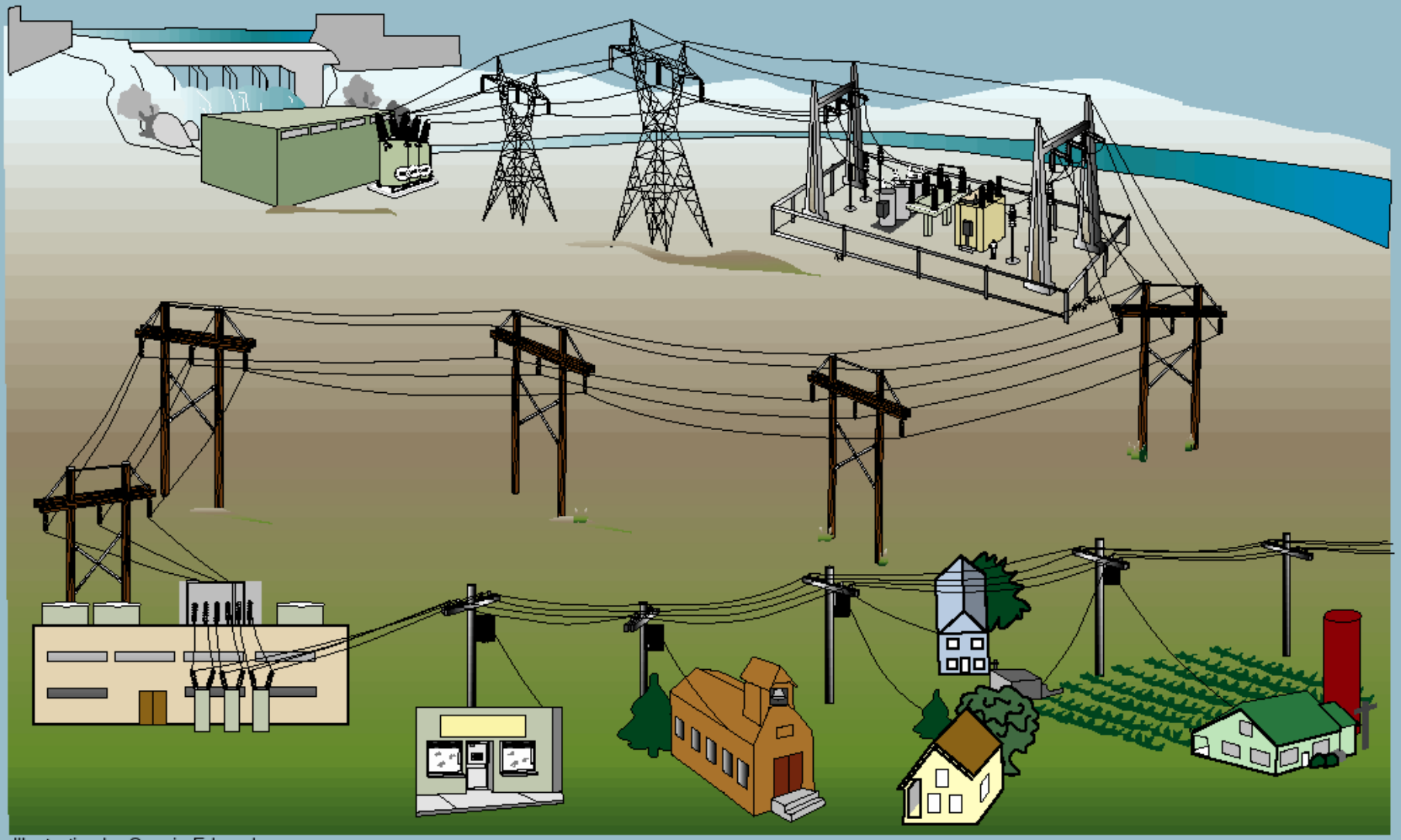


Illustration by Connie Edwards

- **NERC/FERC**

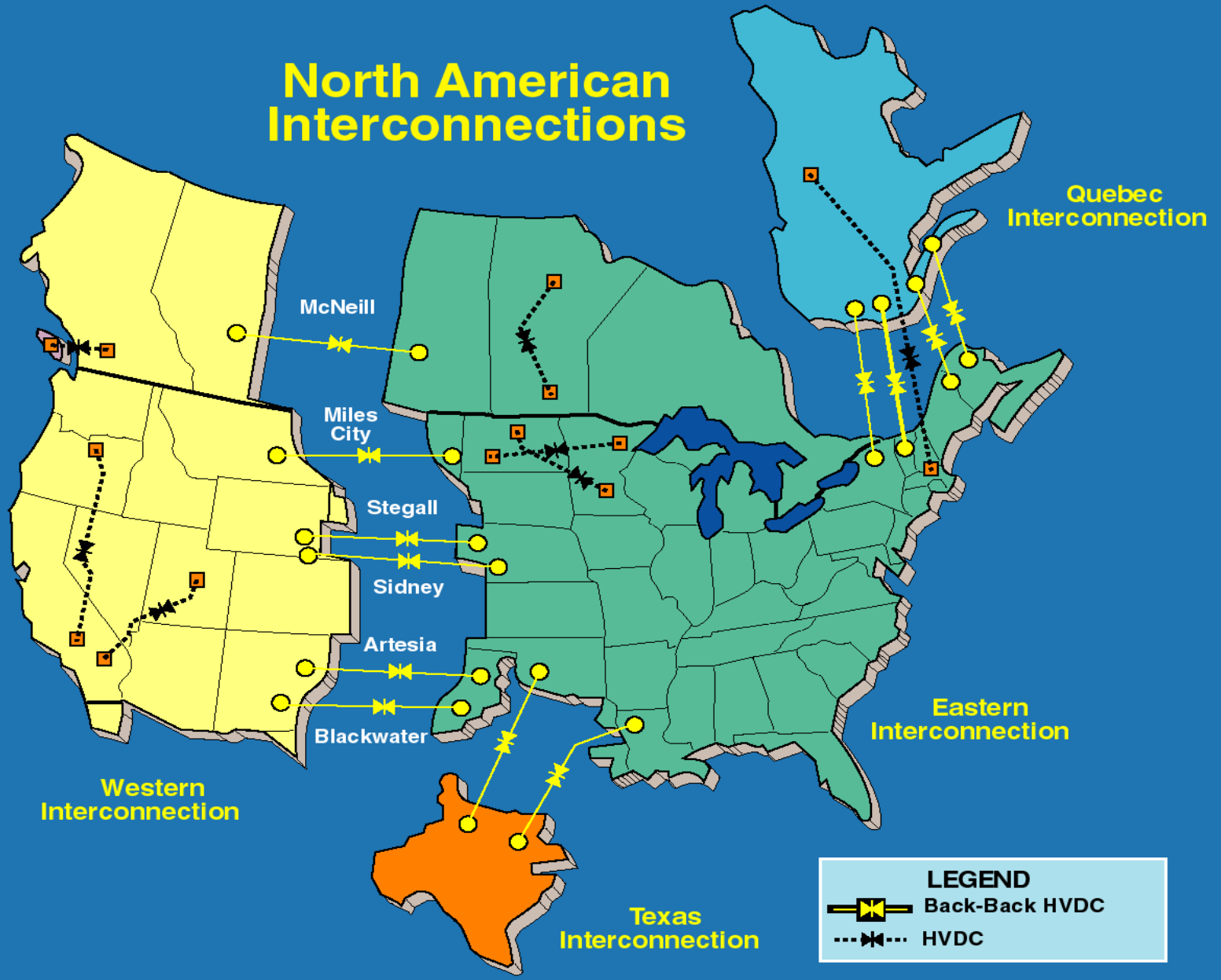
Electric Industry Recent Rulings

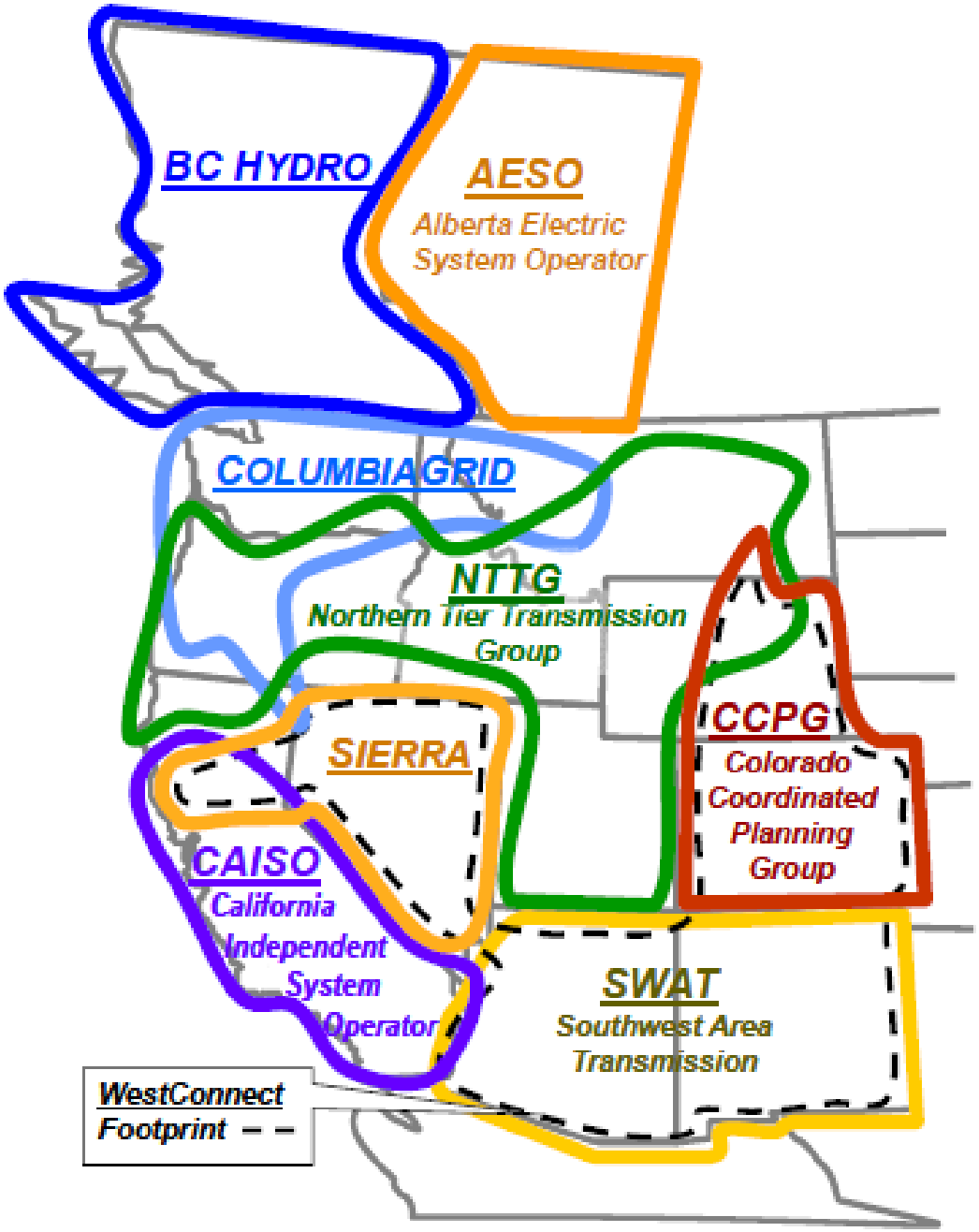
- Energy Policy Act of 1992
- Orders 888/889 – Separate Gen/Transmission; OASIS Postings
- Energy Policy Act of 2005
- FERC – Authority to Manage the ERO (NERC) who in-turn manages the RROs (WECC, MRO, SPP)
- Order 890 – Open Stakeholder Involvement

Electric Industry Recent Rulings

- American Recovery and Reinvestment Act of 2009
- Order 1000 – More Inclusive Planning Process; Cost/Benefit Analysis; Cost Allocation on both Intra- and Inter-Regional Basis

North American Interconnections



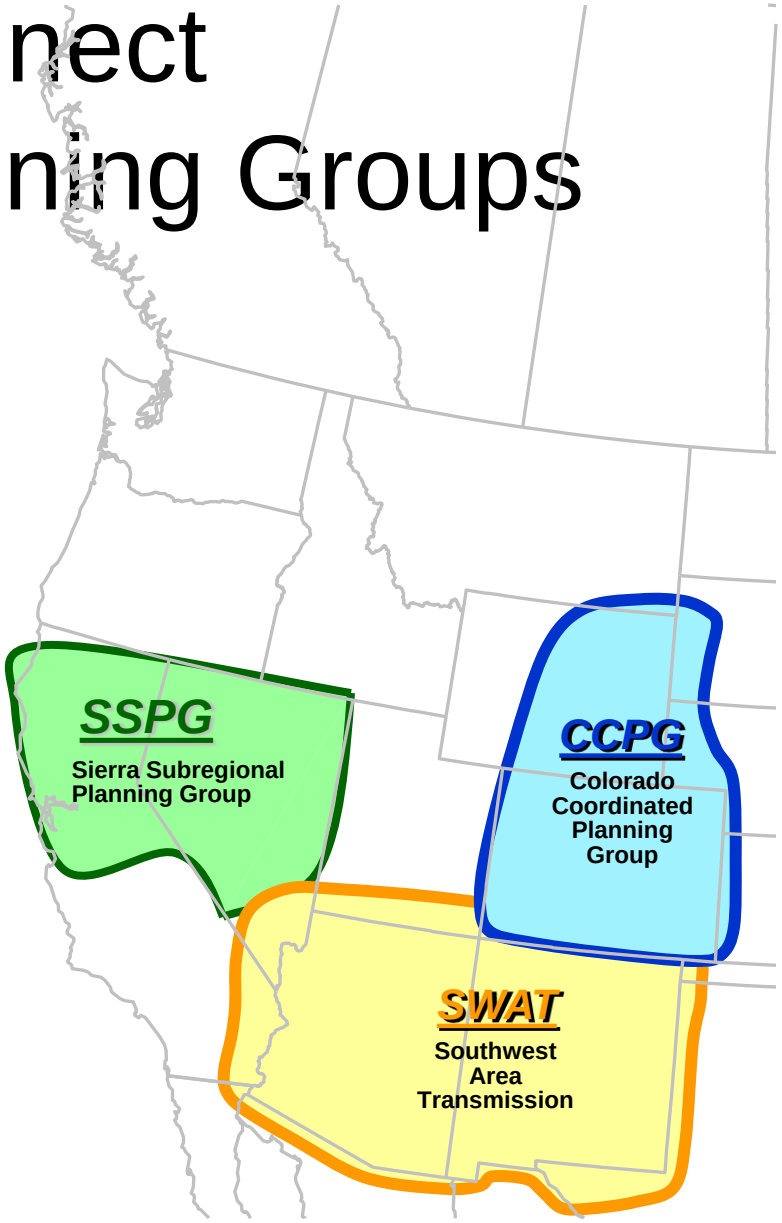

BC HYDRO
AESO
Alberta Electric System Operator
COLUMBIAGRID
NTTG
Northern Tier Transmission Group
SIERRA
CCPG
Colorado Coordinated Planning Group
CAISO
California Independent System Operator
SWAT
Southwest Area Transmission
WestConnect Footprint


WECC
WESTERN INTERCONNECTION

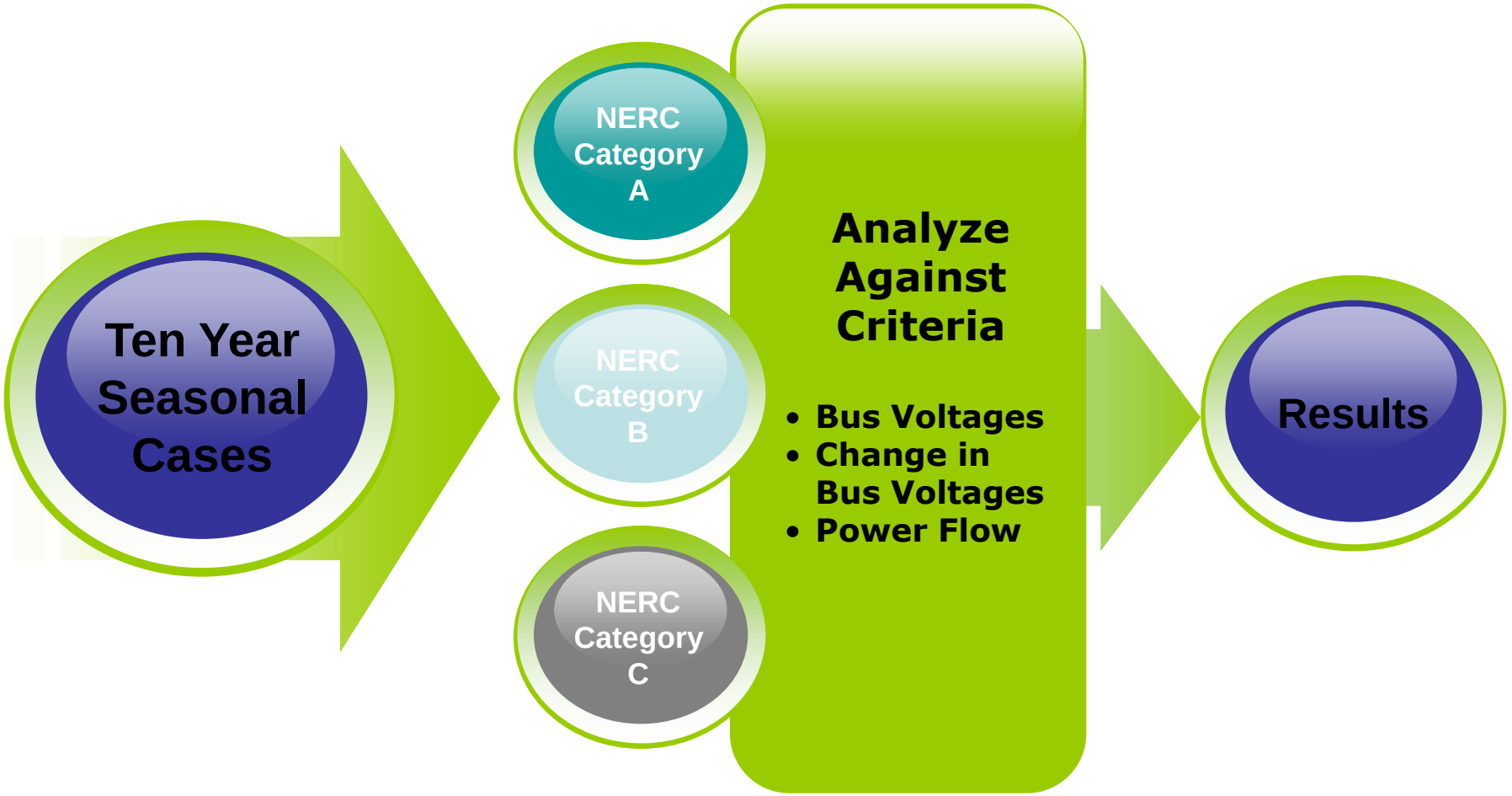
WestConnect Subregional Planning Groups

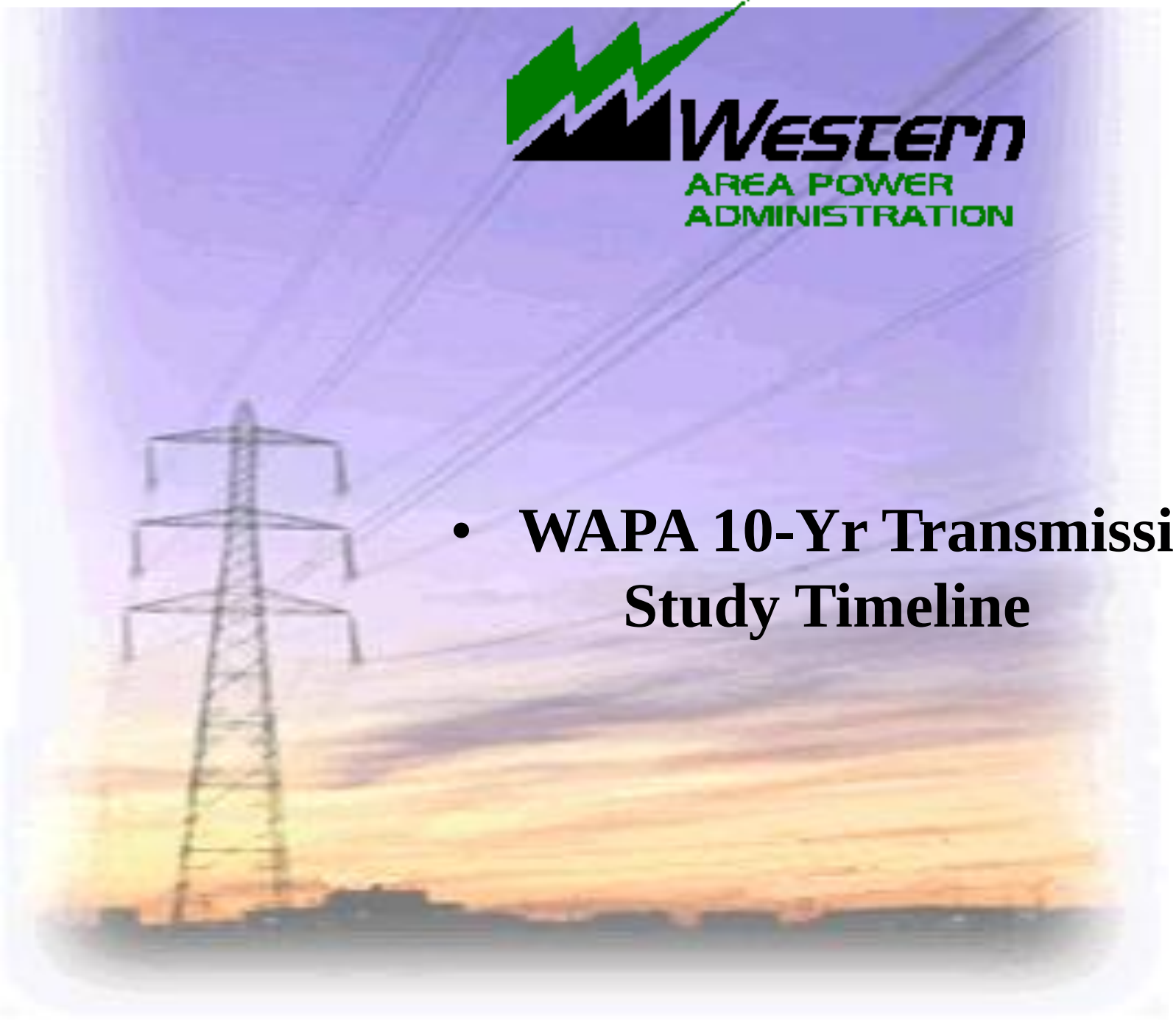
CCPG, SSPG and SWAT are technical planning work groups within the WestConnect Footprint

- Coordinate Information for use by all study participants
- Define subregional study plans, provide study resources, and perform studies
- Provide forum for coordination and peer review of planning studies and 10-year plans
- Agree on inter- and intra-Regional Projects and have a Cost Allocation process



NERC Planning Standards - TPL





- **WAPA 10-Yr Transmission Study Timeline**

Study Timeline

February 1

- Send 10YR load forecast request to all network customers
- Request submittal by March 15

March 15

- 10YR load request responses due.

March 15 – June 15

- Conduct annual study

July 31

- Annual report due to J5640

July 31 – November 30

- J5640 develops preliminary project scope and budgetary estimates for inclusion in CIP

November 30

- J5640 to incorporate projects into the CIP (10YR Plan Report)

Load Forecast Data Example

TOWN OR BUS NAME	Bus Number	Bus Name (as in case)	Company Meter Name	Western Meter Name	2009 Summer	2009-10 Winter	2010 Summer
AAAA	#####	ABCD			5,100.00	0.00	5,300.00
BBBB	#####	BCDE			420.68	333.45	443.62
CCCC	#####	CDEF			2,000.00	2,000.00	2,000.00
DDDD	#####	DEFG			13,546.96	1,728.65	10,265.67
EEEE	#####	EFGH			4,378.65	5,246.94	4,425.21

Study Process

RMR North Recommendations

Basin-Nahne Jensen 115 kV Line Recond

$2,500,000

106% load of norm/emerg. rating during YT-YTPACE N-1.

Case History: 2015-2016-2017

2009-part of YTS Transfer Project 2010-Removed 2012-confirmed N-1 thermal issue sensitivity study may alter scope.

Poncha 30 MVAR Reactor

$500,000

230 kV system history of high voltage during light loading; studies@ 1.067 pu. Project may be provided by PSCO.

Case History: 2015-2017-2022

Sidney 230/115kV Xfmr Joint Study

Loss of TSGT`s Sidney 230/115 kV transformer results in 6-10% voltage deviation on area 115 kV system; Joint study with TSGT recommended.

Case History: 2015-2016-2017

Big Horn Basin Sensitivity Study

69 and 115 kV reactive support needed; thermal overload on 115 kV system. Sensitivity study to determine long term, low cost solution for the Big Horn Basin Area.

Case History: 2015-2016-2017

Capacity Adequacy Analysis

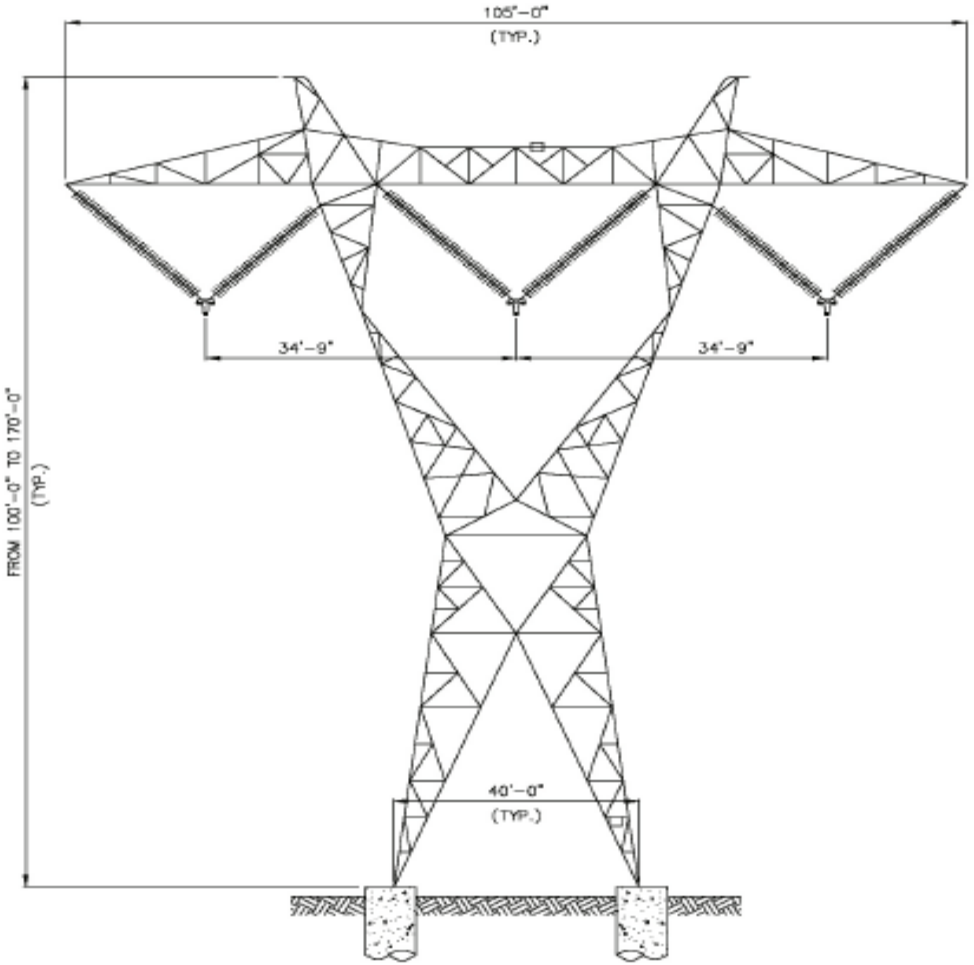
- Performed by the Transmission Business Unit
- Incorporated into the Ten Year Study as a means to identify transmission capacity issues that impede the commercial viability and efficient operation of the Western Transmission Network

CAA Results

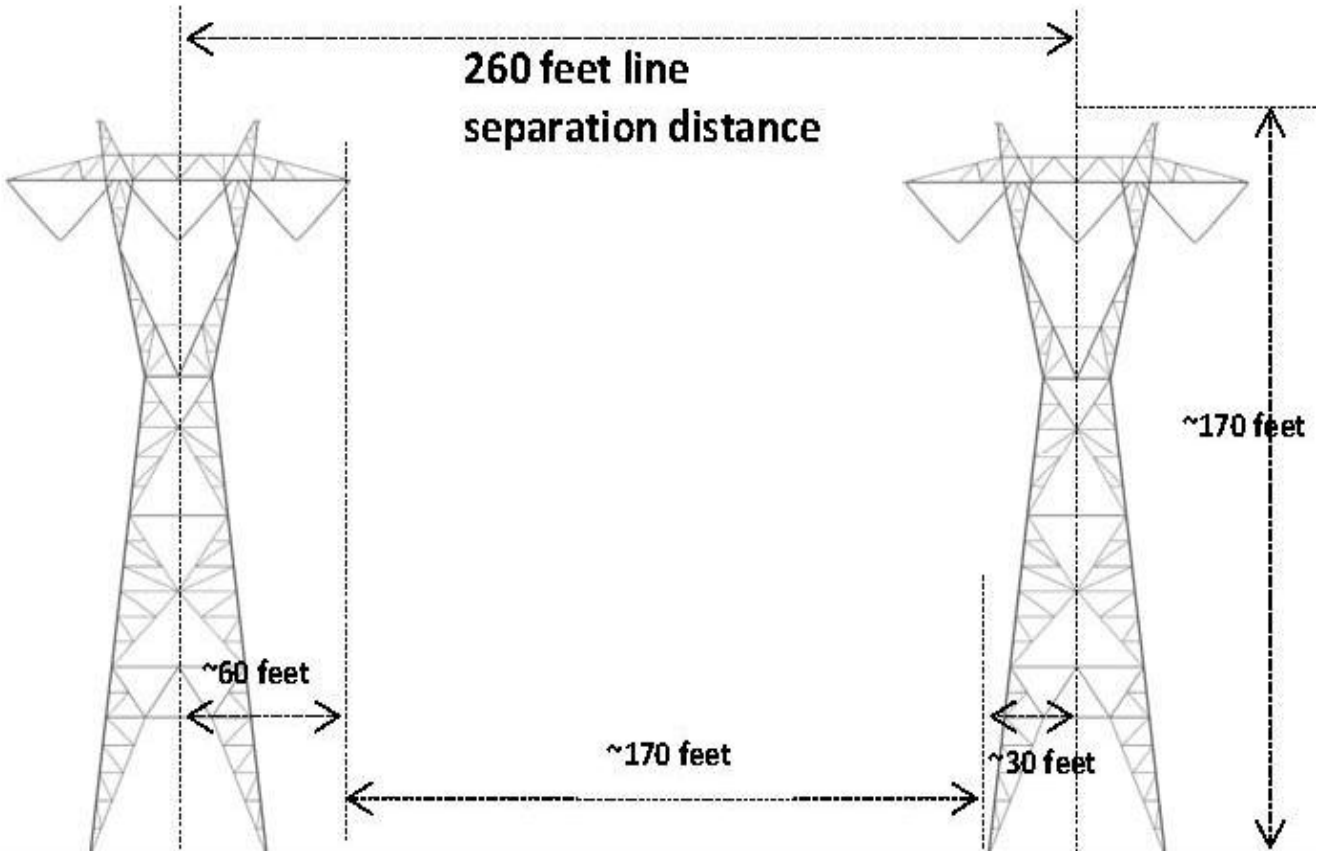
- Several Significant Path Constraints Identified including:
  - Craig-Bonanza (CRCM)
  - Dave Johnston-Ault (LAPT)
  - Four Corners area from the South (Southern CRSP)
  - Paths into CA from AZ

- **Line Separation**

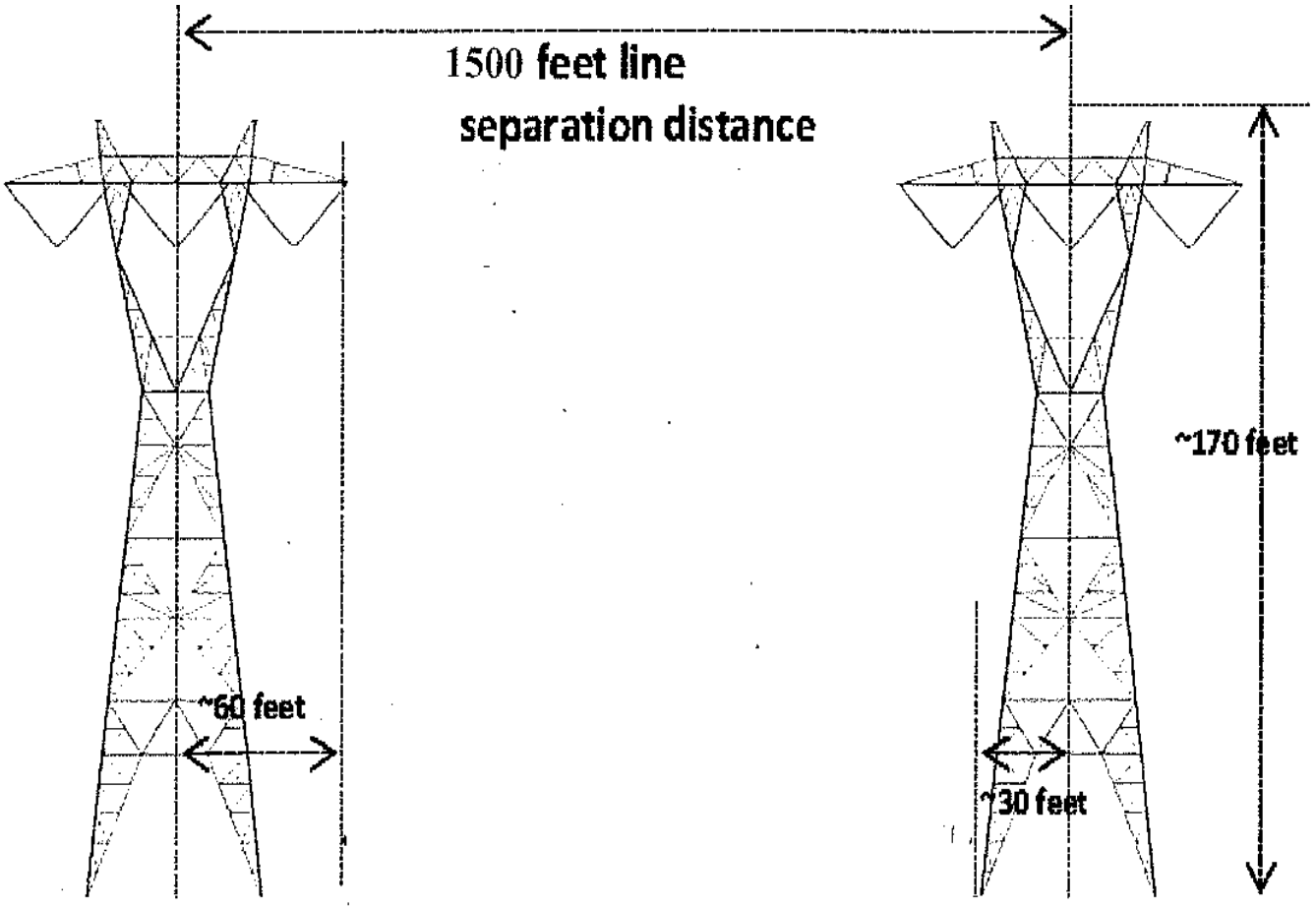
Typical 500-kV Transmission Structure



“Minimalist” Separation Distance



“Span-Length” Separation



No “One-Size Fits All”

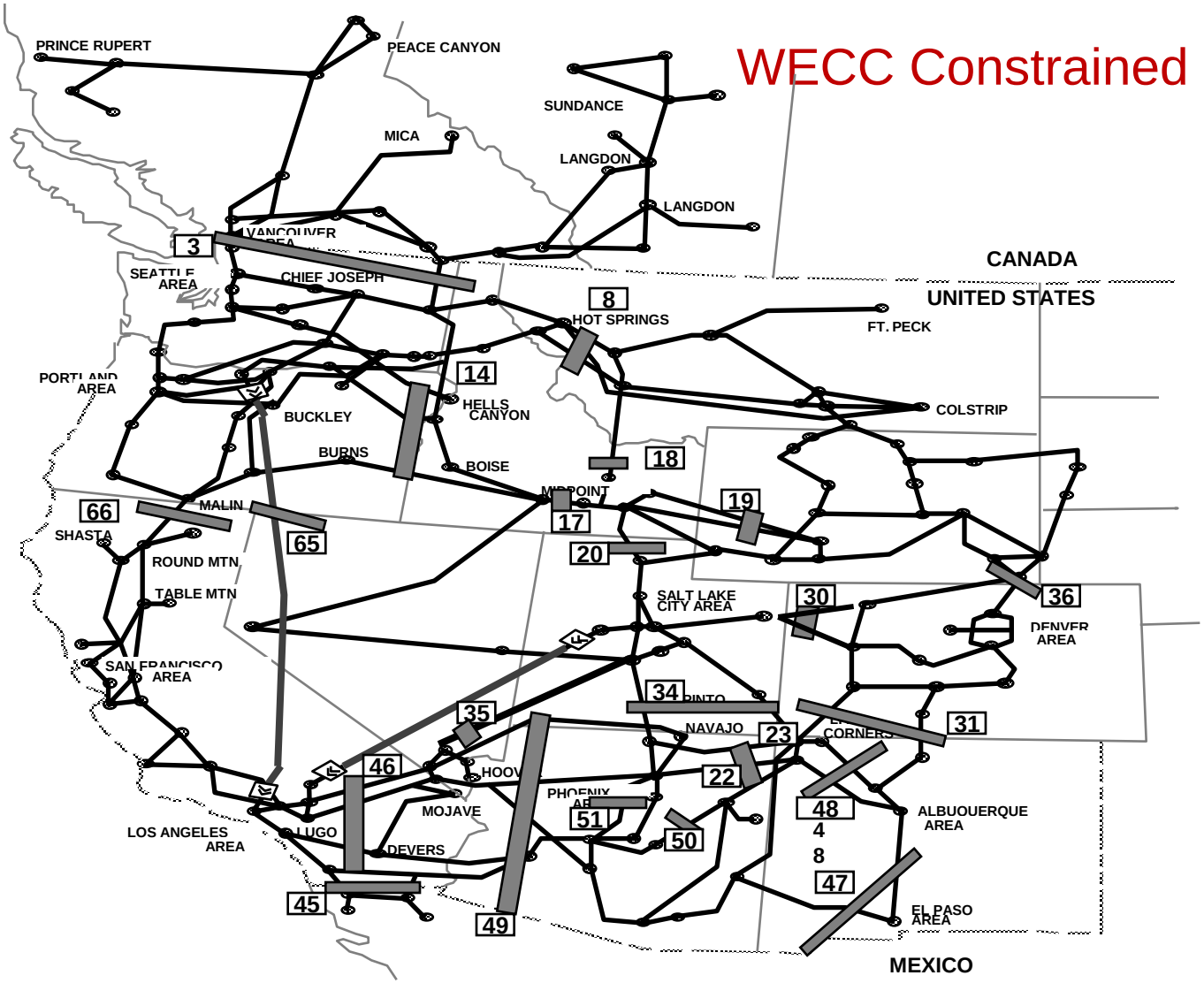
- Reliability Perspective – Further Apart to Minimize Possible Simultaneous Outages
- Further Apart – Land Use/Environmental
- Public/Stakeholder Input
- State/Regional/National Interests

No “One-Size Fits All”

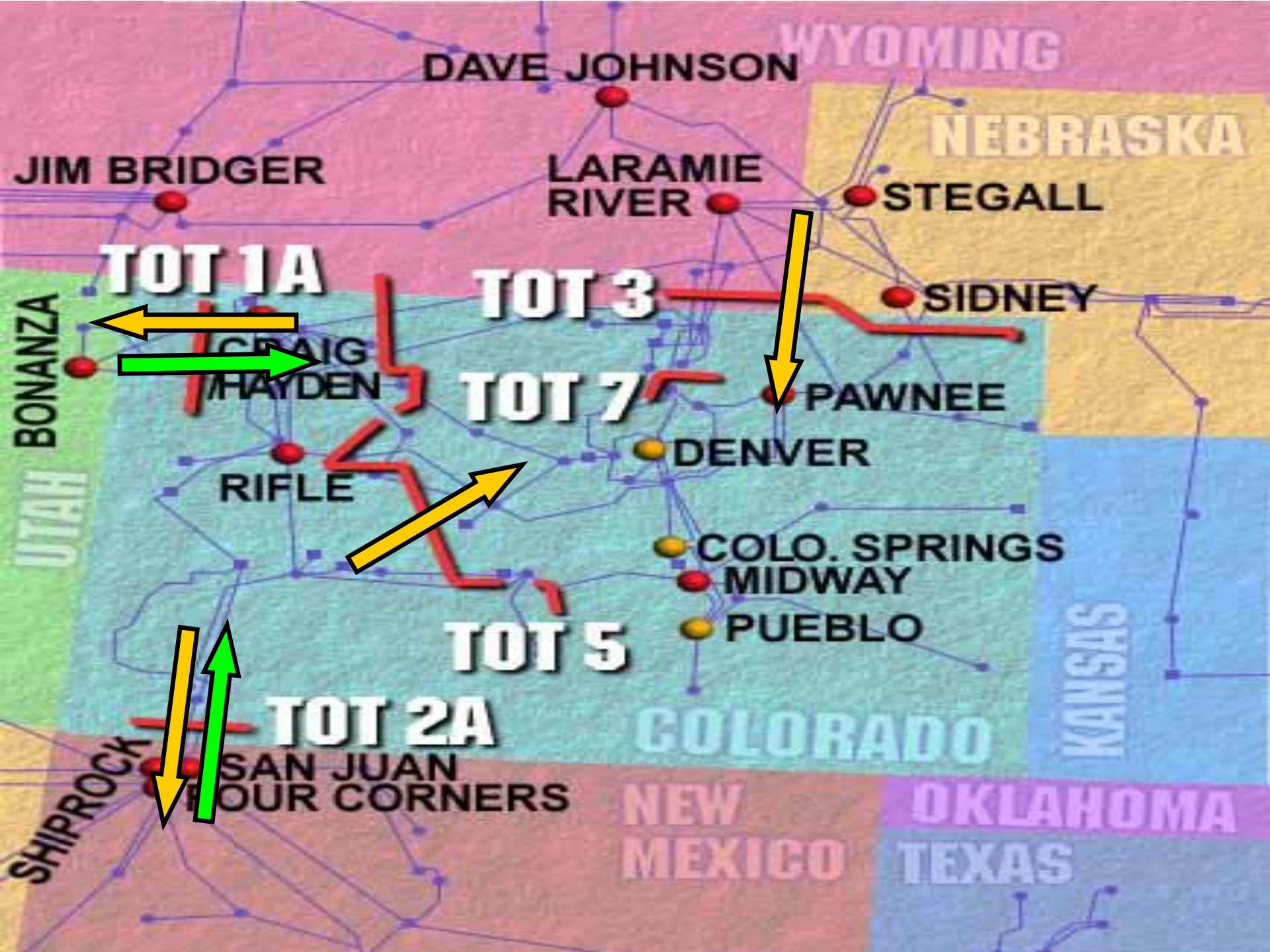
- Redundancy Leads to more Stable Network
- One-Span Length Cuts down the Probability of a Wire being Swung from One Circuit to the Other
- Terrain – Mountainous vs. Farmland
- NEW WECC Business Practice - Need 250’ Separation to Consider Separate for Fault Simulations

- **TOT3 Example**

WECC Constrained Paths

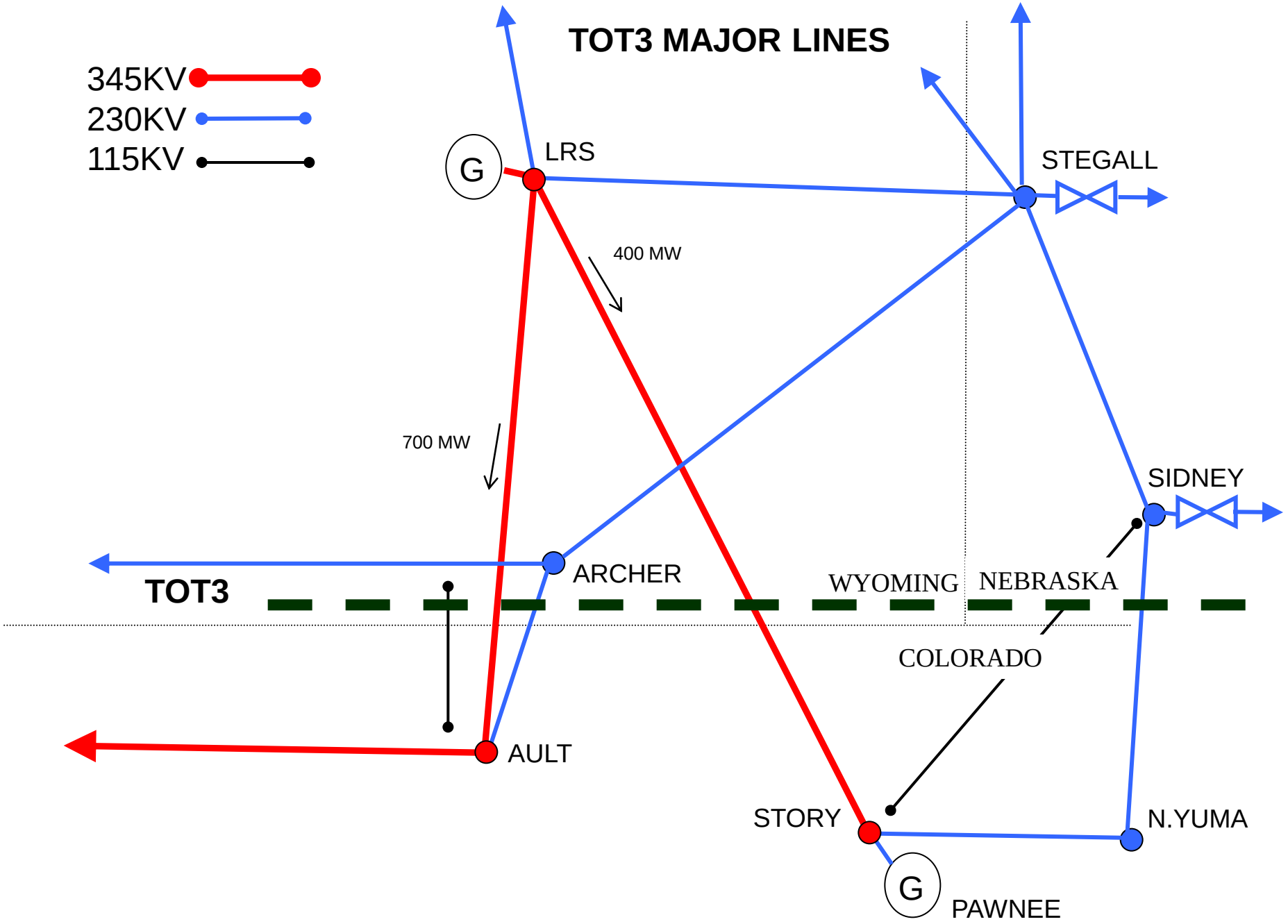


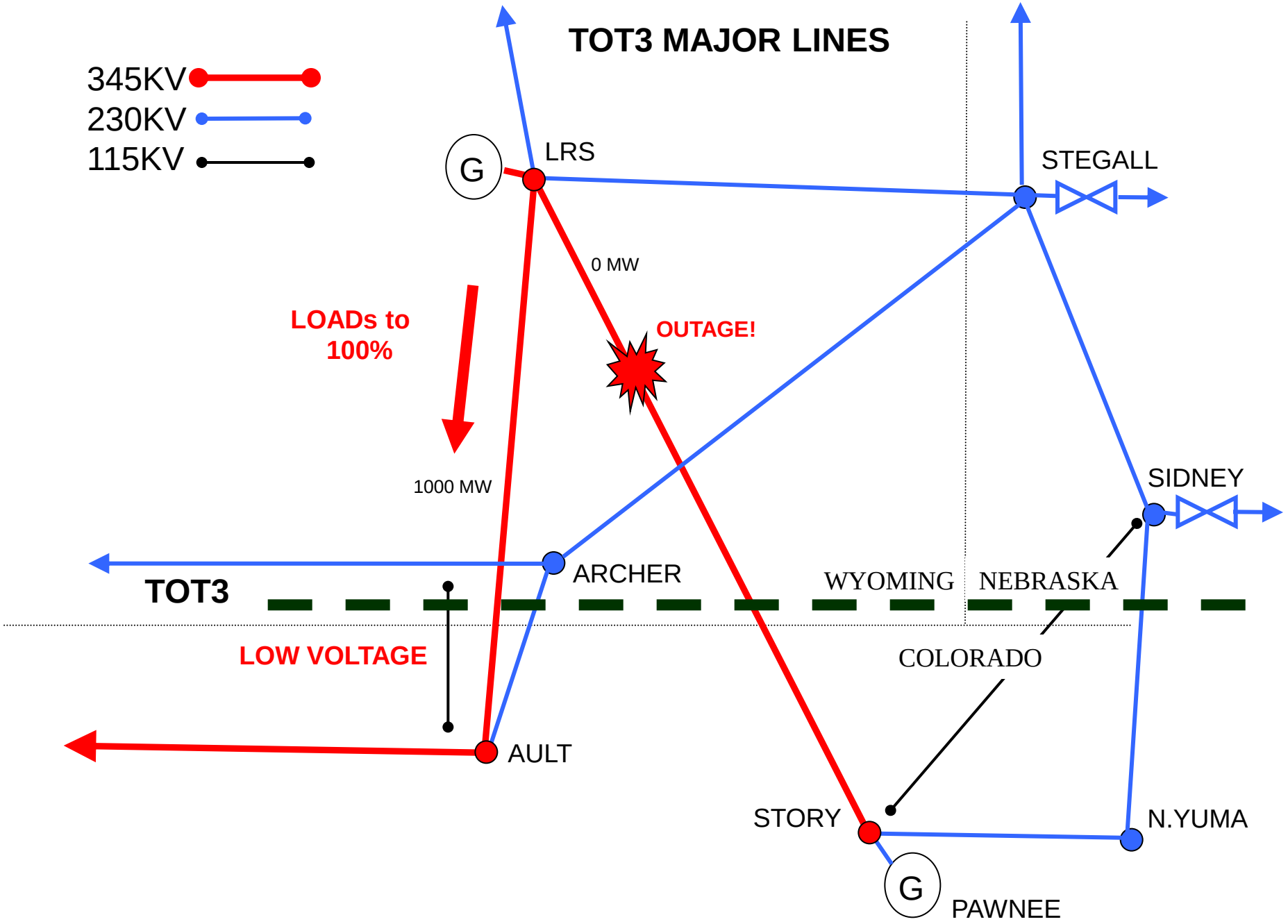
Transmission Paths

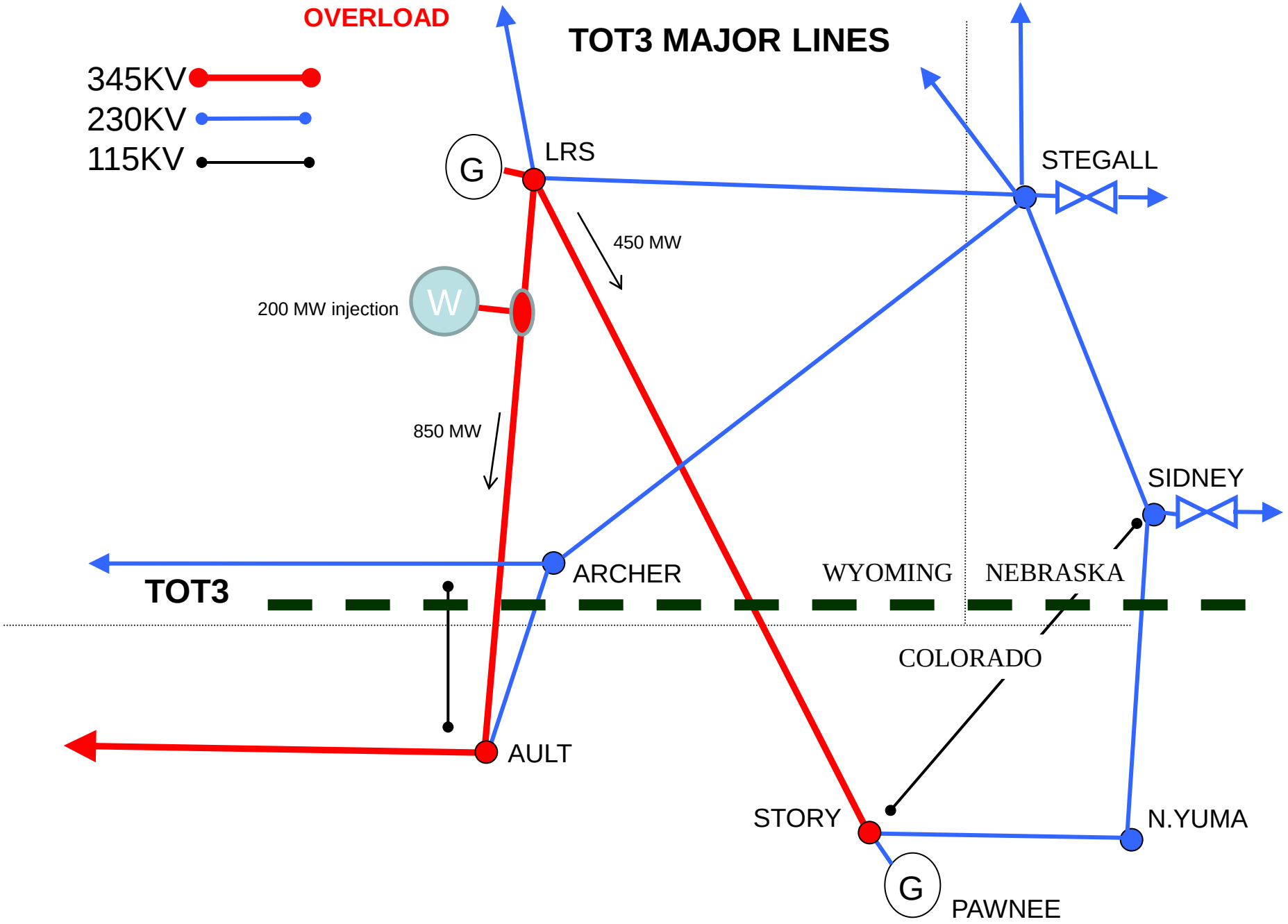

WYOMING
DAVE JOHNSON
NEBRASKA
JIM BRIDGER
LARAMIE RIVER
STEGALL
TOT 1A
TOT 3
SIDNEY
BONANZA
CRAIG
HAYDEN
TOT 7
PAWNEE
DENVER
UTAH
RIFLE
COLO. SPRINGS
MIDWAY
PUEBLO
TOT 5
KANSAS
TOT 2A
COLORADO
SHIPROCK
SAN JUAN
FOUR CORNERS
NEW MEXICO
OKLAHOMA
TEXAS

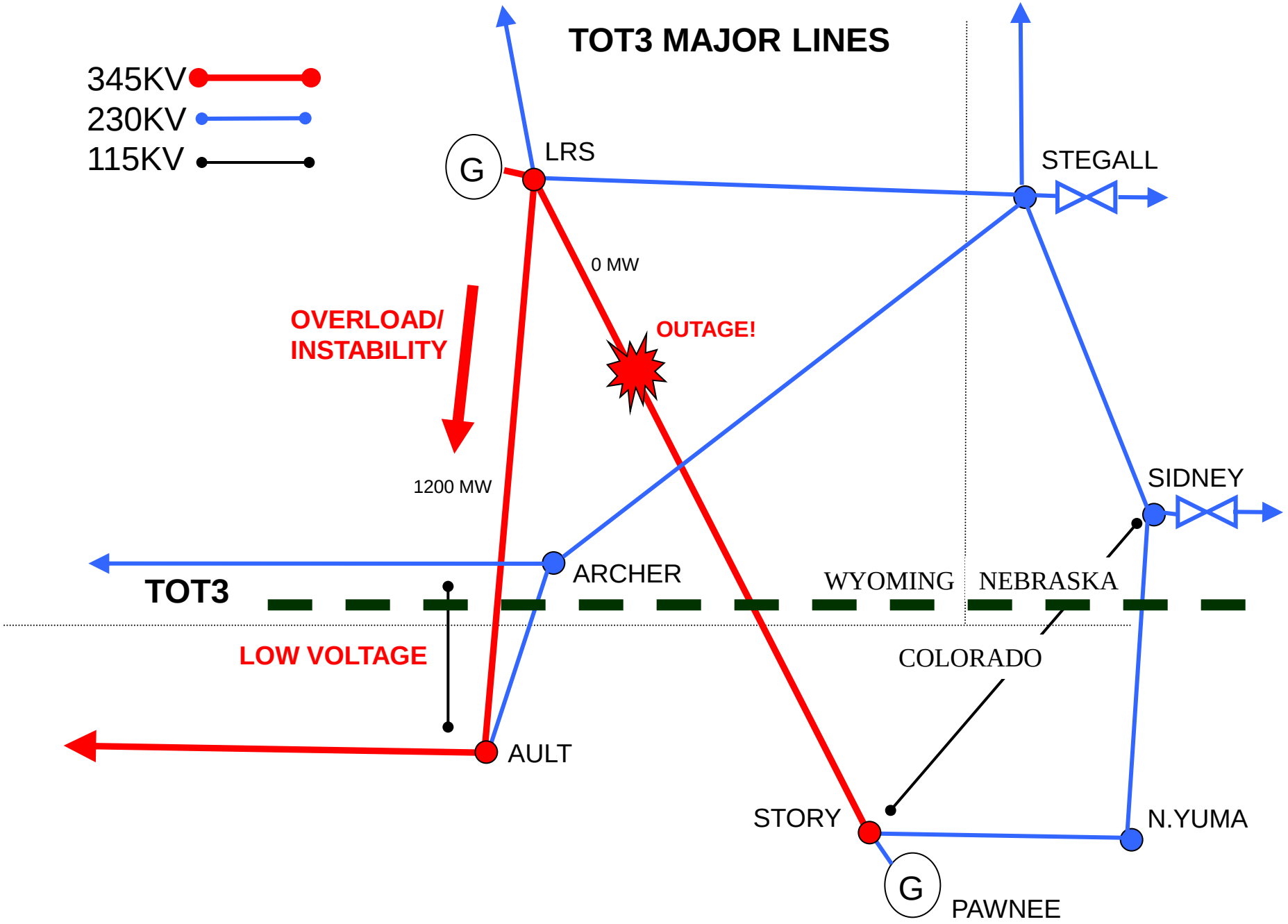
TOT-3 TTC/ATC Calculations

TOT3 Ownership	Capacity
MBPP – 70.5%	1132
Western – 24.93%	475
T. State – 0.83%	13
PSCo – 3.74%	60
	1680


TOT3 MAJOR LINES
345KV
230KV
115KV
G
LRS
STEGALL
400 MW
700 MW
SIDNEY
ARCHER
TOT3
WYOMING
NEBRASKA
COLORADO
AULT
STORY
N.YUMA
G
PAWNEE


TOT3 MAJOR LINES
345KV
230KV
115KV
G
LRS
STEGALL
0 MW
LOADs to
100%
OUTAGE!
1000 MW
SIDNEY
ARCHER
TOT3
WYOMING
NEBRASKA
LOW VOLTAGE
COLORADO
AULT
STORY
N.YUMA
G
PAWNEE


OVERLOAD
TOT3 MAJOR LINES
345KV
230KV
115KV
G
LRS
STEGALL
450 MW
200 MW injection
W
850 MW
SIDNEY
ARCHER
WYOMING
NEBRASKA
TOT3
COLORADO
AULT
STORY
N.YUMA
G
PAWNEE


TOT3 MAJOR LINES
345KV
230KV
115KV
G
LRS
STEGALL
0 MW
OVERLOAD/
INSTABILITY
OUTAGE!
1200 MW
SIDNEY
ARCHER
TOT3
WYOMING
NEBRASKA
LOW VOLTAGE
COLORADO
AULT
STORY
N.YUMA
G
PAWNEE

August 14, 2003


Western
AREA POWER
ADMINISTRATION
QUESTIONS?

Western Area Power Administration

Transmission Infrastructure Program

Presented to: BLM Webinar

TIP PROGRAM OVERVIEW

Implement Title III Hoover Power Plant Act 1984

(under American Recovery and Reinvestment Act)

Borrowing authority of $3.25 billion

Identify, prioritize and participate in the study, facilitation, financing, planning, operating, maintaining, and construction of new or upgraded transmission facilities

TIP MILESTONES

- Feb 2009: Western receives TIP borrowing authority from congress
- March 2009: Western published a “Notice of Availability of Request for Interest” in Federal Register
- April 2009: Western chartered a Sr Mgt and Transmission Planning team to evaluate over 200 statements of interest from potential project sponsors.
- Oct 2009: TIP names Program Manager and begins staffing
- TIP is transitioning from start up phase to permanent phase
- TIP remains open to new solicitations from Project developers.

TIP Future

TIP Optimization
Based on Continuous Improvement

- Evaluate the Program project development process
- Evaluate existing criteria for screening and prioritizing potential Program projects
- Increase the transparency of the vetting process for potential Program projects and
- Improve communications with Program applicants

TIP PROGRAM PRINCIPLES

- Projects must have one terminus within area served by Western
- Deliver, or facilitate the delivery of, power generated by renewable energy resources to be constructed or reasonably expected to be constructed
- Encourage broad-based participation
- Uses Project revenue as the only source of revenue for:
  - Repayment of loan for project
  - Payment of ancillary service and O&M expenses
- Maintain controls for accounting and repayment - projects under this authority are separate and distinct
- Ensure project beneficiaries repay project cost
- Must be in the Public Interest
- Must not impair system reliability or statutory obligations
- Have reasonable expectation of repayment of principal and interest of Treasury loan and associated project costs on a stand alone basis – costs cannot be integrated into existing projects
- Use a public process to set rates for new facilities
- Must independently obtain and arrange for the delivery of generation-related ancillary services

PROJECT SELECTION CRITERIA

Projects under consideration for TIP funding must:

- Facilitate the delivery to market of power generated by renewable resources constructed or reasonably expected to be constructed.
- Have at least one terminus located within Western's service territory.

In addition, project evaluation includes feasibility of developing a project that meets the following criteria:

- Provides economic developmental benefits, including an estimate of how many, the type, how fast, and where in the country jobs are created.
- Gives priority to projects that satisfy Western's Open Access Transmission Tariff (OATT) or related requests.
- Addresses the technical merits and feasibility of a project.
- Financial stability and capability of all potential project partners.
- Project readiness (e.g., permitting, local, state and/or regional approval).
- Project partners' participation in a region-wide interconnection-wide planning group or forum.

TIP PROJECT MODELS

- Financier model
  - Construction financing
  - Construction – Long-term financing
  - Western owns capacity
  - Example Project – Montana Alberta Tie Limited (MATL)

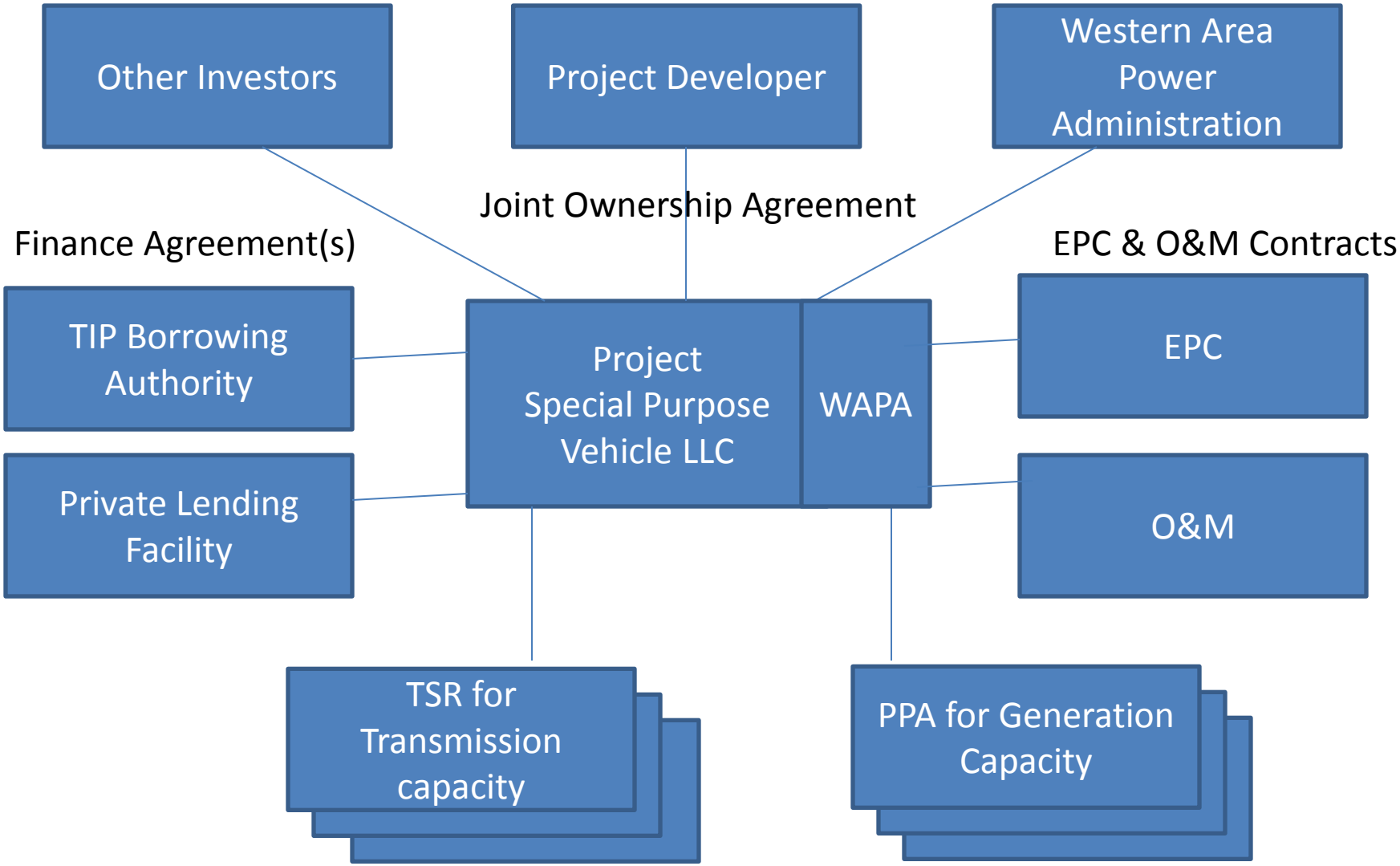
- Public-Private Partnership model
  - Partnership with Merchant Transmission Developer
  - Western uses borrowing authority to finance ownership in Project
  - Example Project - TransWest Express Transmission Project (TWE)

- Western internal transmission projects
  - Partnership with Western Regional office to add or upgrade needed transmission identified typically through 10-year planning process.
  - Example Project - Electrical District 5-Palo Verde Hub Project (ED5-PVH)

NEGOTIATING WITH DEVELOPERS

- Upon selection of SOI, Project Developers favoring Advanced Funding Agreements.
- TIP brings the following to the transaction:
    - Siting, Scoping and Permitting expertise for Environmental process approvals
    - WECC path rating expertise in terms of managing studies and process
    - Experience with Interconnection Agreements
    - Design expertise for transmission lines and sub-stations
    - Construction management and Quality Assurance for EPC
    - Financial structuring and project financing
    - Operations and maintenance capability
    - TIP Borrowing authority
    - Experience with Regulatory issues

EXAMPLE OF TRANSACTION STRUCTURE



UNDERWRITING REQUIREMENTS

- A solid business plan and Project operating plan
- Financing and commercially-sound project producing adequate cash-flow to:
  - Pay all operational costs
  - Service all debt
  - Provide owners with reasonable rate of return
- Track record of success on similar projects

WESTERN CERTIFICATION

Finally, Western's Administrator must certify, prior to borrowing funds from Treasury, that each project:

- Public interest nexus
- No adverse impact to system reliability or operations, or other statutory obligations.
- Reasonable expectation that the project will generate enough transmission service revenue to repay the principal investment; all operating costs, including overhead; and the accrued interest by the end of the project's service life.

Western Contacts

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Overview of Transmission Planning

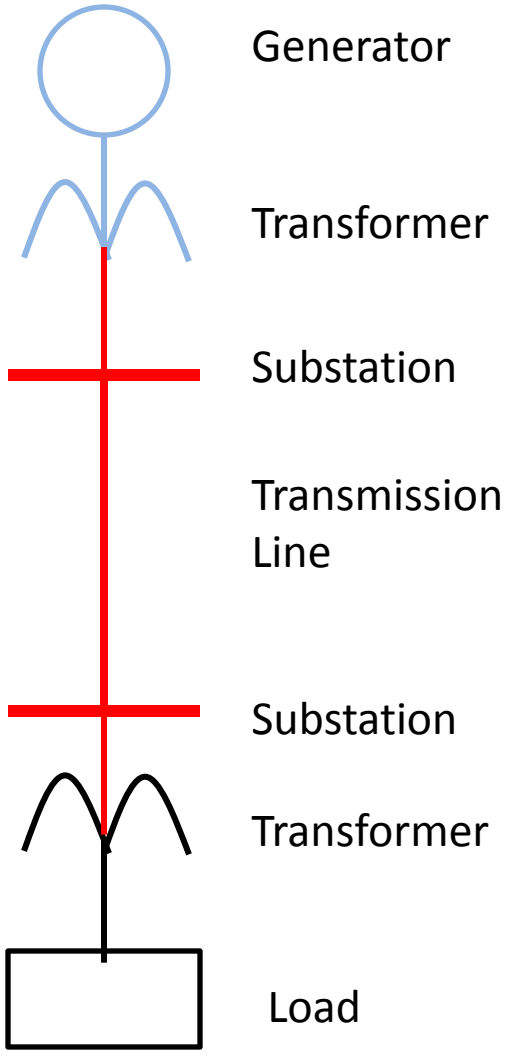
Anders Johnson

Bonneville Power Administration

Long Term Planning

Basics of Electric Transmission

- Alternating Current (AC) vs. Direct Current (DC)
- Generation and load must always be balanced
- Higher voltages used to move power long distances
- AC flows are closely monitored but difficult to precisely control



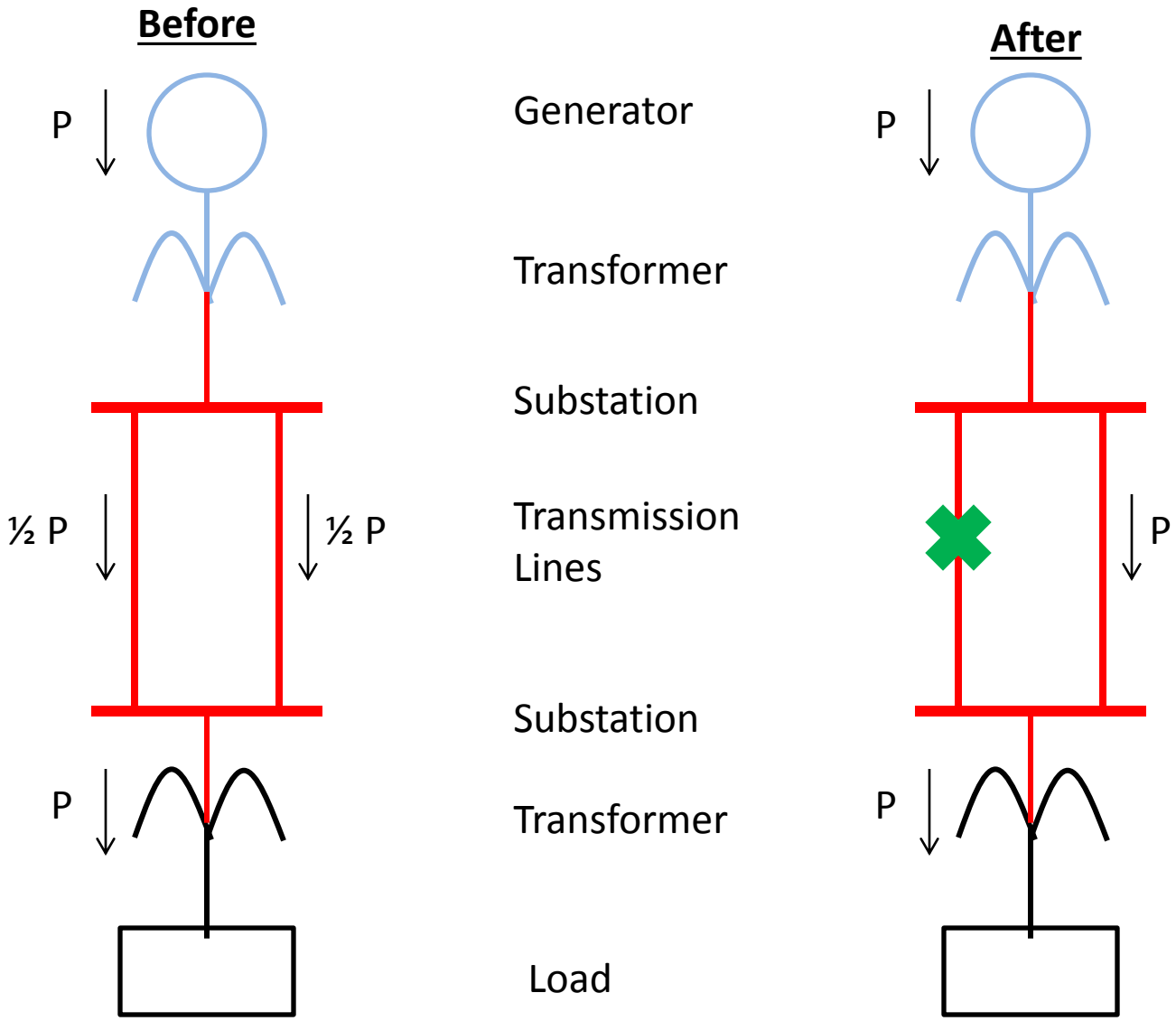
Drivers for New Transmission

- Load Growth
- New generators
  - Renewables
  - Dispatchable capacity
- Changes in asset utilization
  - Generator retirements (High emission coal)
  - Oversupply in some areas vs. shortages in others
- Open Access Transmission Tariff (OATT) requests

Transmission Planning Considerations

- NERC/WECC Transmission Planning Standards
  - Deterministic: System must withstand all credible single and common mode contingencies without violating performance requirements
  - Thermal overload, voltage stability, transient stability
- Integrated Resource Planning
  - Probabilistic: Must have enough transmission capacity to deliver generation to reduce loss of load probability
  - Production cost analysis
  - Transmission congestion increases cost to customers

Example: Line Outage



Capacity Increase Options

- Incremental upgrades: Push more power through existing lines
  - Substation equipment (capacitors, transformers, circuit breakers)
  - Increased line rating (increase clearance to ground, replace conductor
  - Control actions
- Build a new line
  - Sometimes the only technically feasible option
  - Rebuild existing line to higher capacity, build next to existing corridor, or build in new corridor
  - Lumpy

Additional Considerations

- Is project feasible to permit?
- Available Transfer Capacity
  - Commercial allocation of capacity
  - Firm vs. Non-firm
  - Need capacity all the way from generation to load, not just across monitored elements of a path
- "Too Big to Fail" Problem
  - Must plan for outages of double circuit, adjacent circuit, and HVDC lines
  - Double circuit does not always provide double the usable transfer capacity as single circuit

Questions?

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NATIONAL SYSTEM OF PUBLIC LANDS