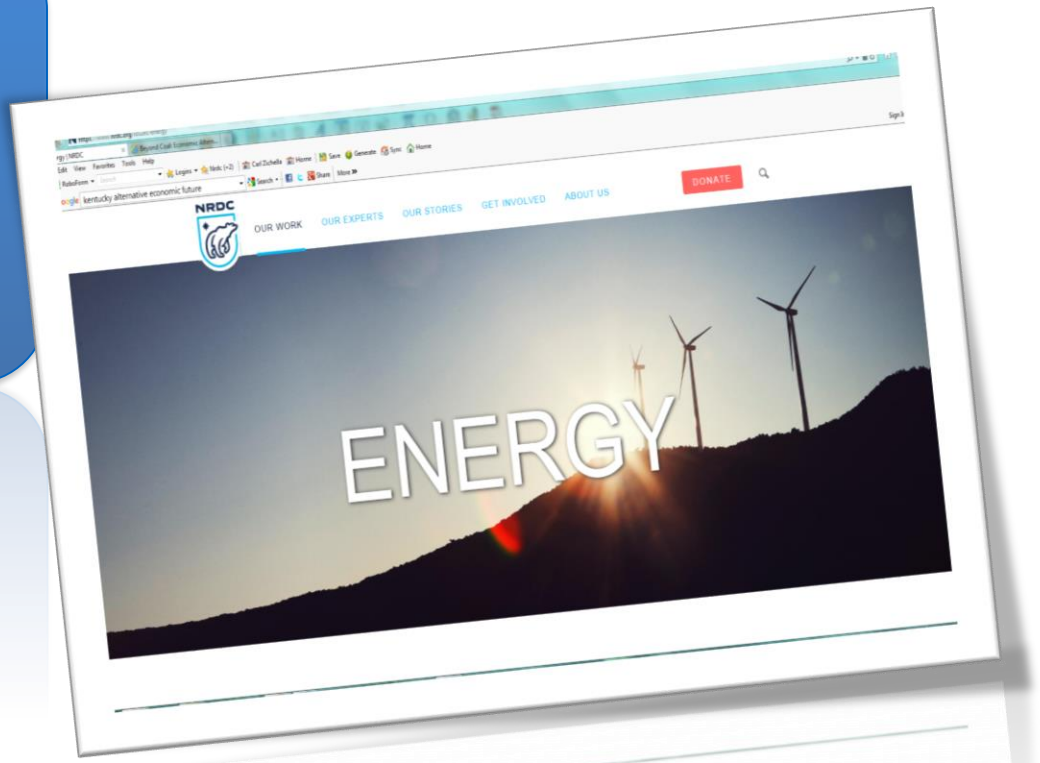
GRIDS MEET RENEWABLES, A WESTERN U.S. PERSPECTIVE

BRUSSELS, BELGIUM
20 FEBRUARY, 2018

CARL ZICHELLA
DIRECTOR OF WESTERN TRANSMISSION
NRDC

What is NRDC?

NRDC uses law, science and the support of 2 million members and online activists to protect the planet's wildlife and wild places and to ensure a safe and healthy environment for all living things.



http://www.nrdc.org

Agenda

- Renewable and Transmission Development in the Western U.S.
  - Geography and resources
- Planning Issues
  - CREZ, RETI, WREZ, WECC: the alphabet soup of transmission planning
- Geospatial Information
- Cultural Resources
- Public acceptance

THE WESTERN INTERCONNECTION

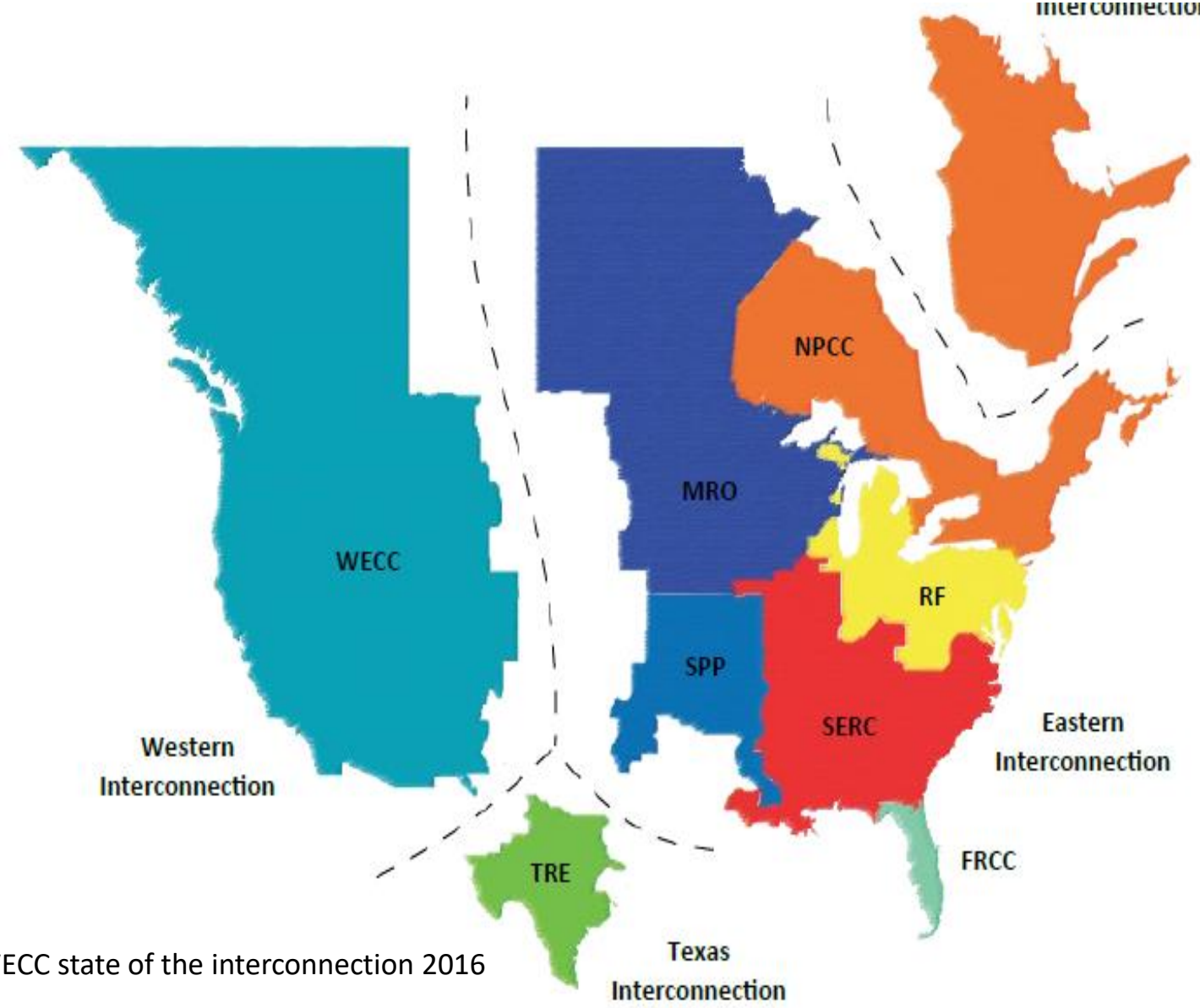
US Interconnections

The North American Interconnections

The Western Interconnection is one of four major electric system networks in North America. Serving a population of over 80 million, the Interconnection spans more than 1.8 million square miles in all or part of 14 states, the Canadian provinces of British Columbia and Alberta, and the northern portion of Baja California in Mexico. The Western Interconnection differs from the other Interconnections in a number of ways.

The responsibility for assuring BES reliability across North America is delegated to eight Regional Entities. WECC has jurisdiction over the entire Western Interconnection. Texas RE has jurisdiction over the entire Texas Interconnection. The Eastern Interconnection is under the jurisdiction of six Regional Entities.

Source: WECC state of the interconnection 2016



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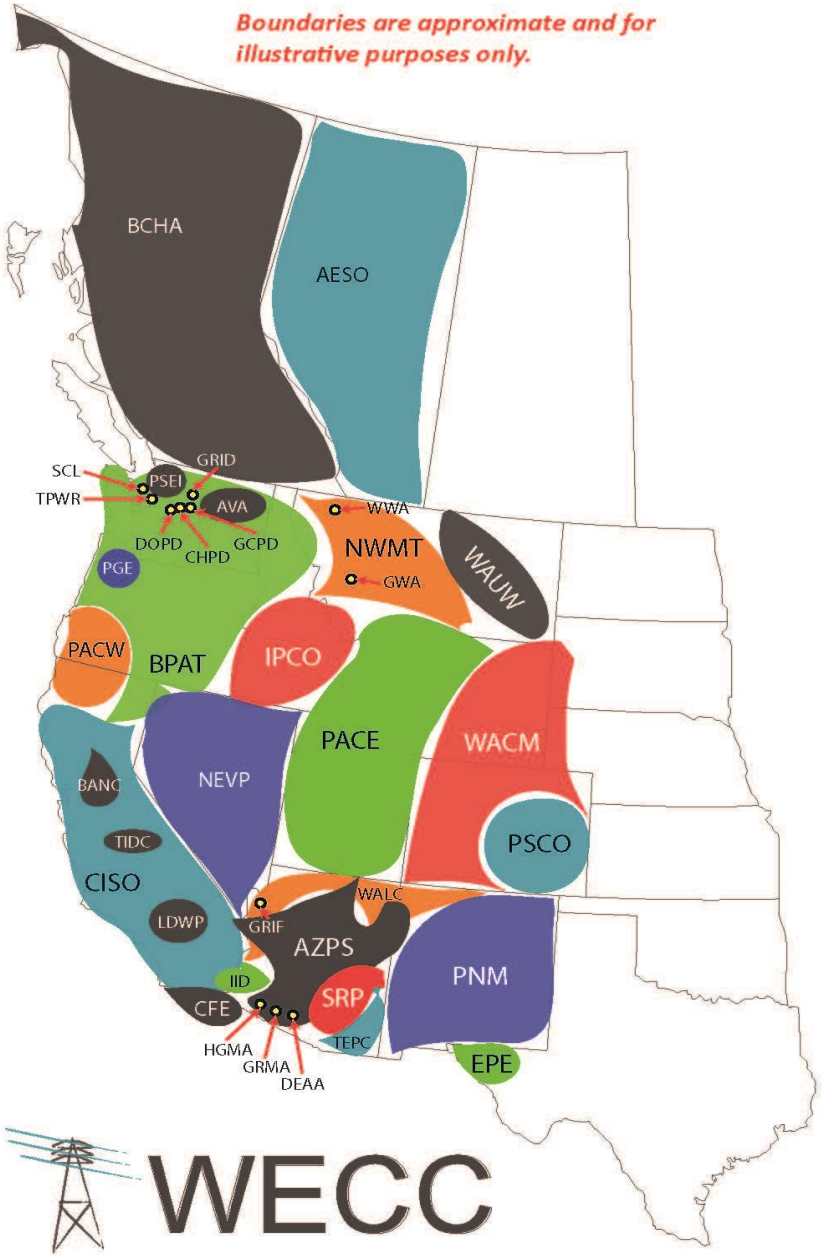


Western Interconnection Balancing Authorities (38)

AESO - Alberta Electric System Operator
AVA - Avista Corporation
AZPS - Arizona Public Service Company
BANC - Balancing Authority of Northern California
BCHA - British Columbia Hydro Authority
BPAT - Bonneville Power Administration - Transmission
CFE - Comision Federal de Electricidad
CHPD - PUD No. 1 of Chelan County
CISO - California Independent System Operator
DEAA - Arlington Valley, LLC
DOPD - PUD No. 1 of Douglas County
EPE - El Paso Electric Company
GCPD - PUD No. 2 of Grant County
GRID - Gridforce
GRIF - Griffith Energy, LLC
GRMA - Sun Devil Power Holdings, LLC
GWA - NaturEner Power Watch, LLC
HGMA - New Harquahala Generating Company, LLC
IID - Imperial Irrigation District
IPCO - Idaho Power Company
LDWP - Los Angeles Department of Water and Power
NEVP - Nevada Power Company
NWMT - NorthWestern Energy
PACE - PacifiCorp East
PACW - PacifiCorp West
PGE - Portland General Electric Company
PNM - Public Service Company of New Mexico
PSCO - Public Service Company of Colorado
PSEI - Puget Sound Energy
SCL - Seattle City Light
SRP - Salt River Project
TEPC - Tucson Electric Power Company
TIDC - Turlock Irrigation District
TPWR - City of Tacoma, Department of Public Utilities
WACM - Western Area Power Administration, Colorado-Missouri Region
WALC - Western Area Power Administration, Lower Colorado Region
WAUW - Western Area Power Administration, Upper Great Plains West
WWA - NaturEner Wind Watch, LLC

Source: Western Electricity Coordinating Council

Active and Pending Energy Imbalance Mkt. Members

Participants

Active

PacifiCorp – entered 2014

NV Energy – entered 2015

Puget Sound – entered 2016

Arizona Public Service – entered 2016

Portland General Electric – entered 2017

Pending

Idaho Power Company – entry 2018

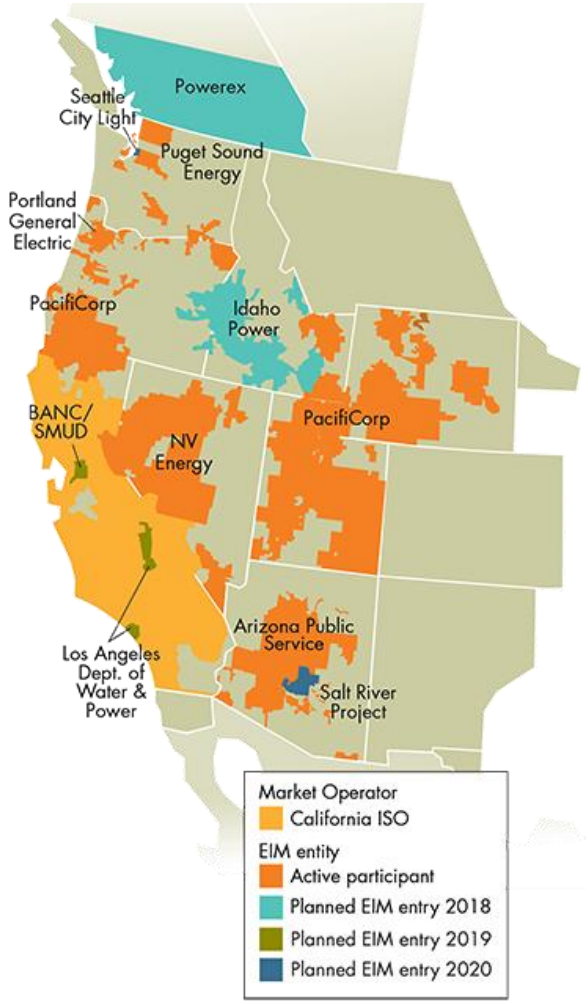
Powerex – entry 2018

Los Angeles Department of Power & Water – entry 2019

Balancing Authority of Northern California/SMUD – entry 2019

Salt River Project – entry 2020

Seattle City Light – entry 2020 (previously 2019)



Source: California Independent System Operator

Transmission Statistics

TRANSMISSION

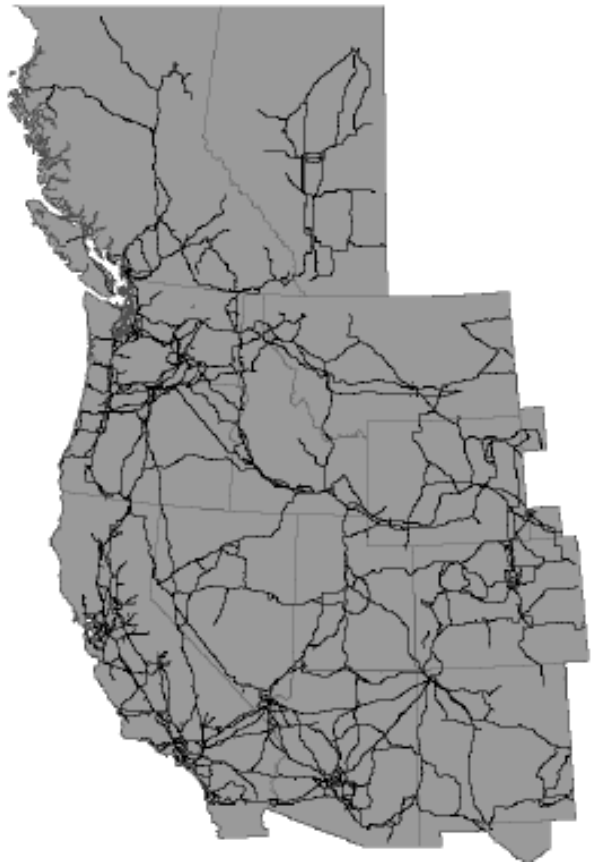
The Western Interconnection is made up of approximately 121,200 circuit-miles of transmission that carries power long distances from remote areas where generation resources are located to load located primarily along the West Coast. Electricity flows south and west in a "doughnut" pattern, contrasting with the spider-web configuration in the East.

Circuit-Miles by Interconnection[5]

	Miles	*Percent*
Eastern	273,140	63%
Western	121,200	28%
Texas	21,300	5%
Quebec	17,200	4%

Source: WECC state of the interconnection 2016

Major Transmission Lines of the Western Interconnection

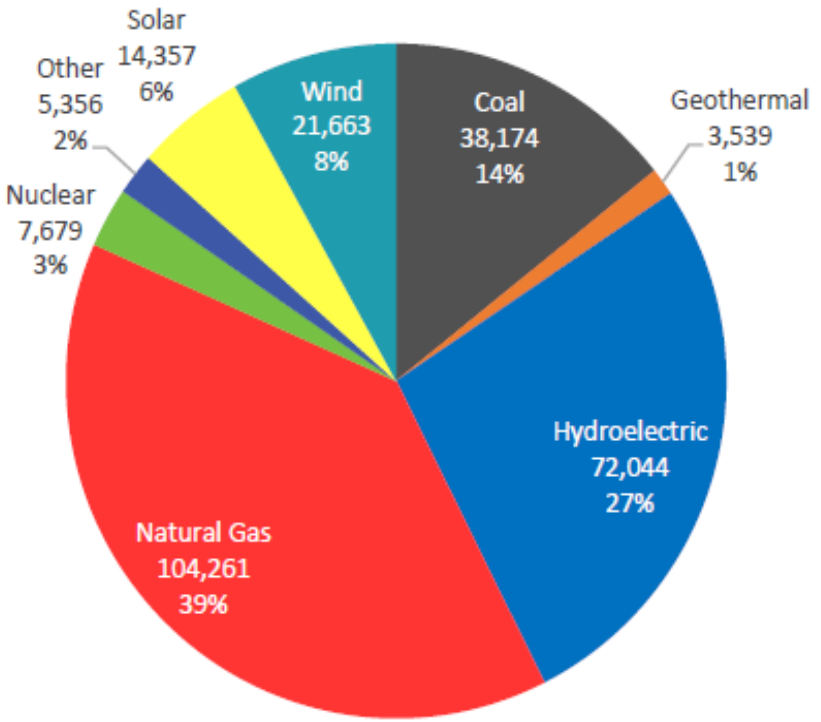


Resource Portfolio

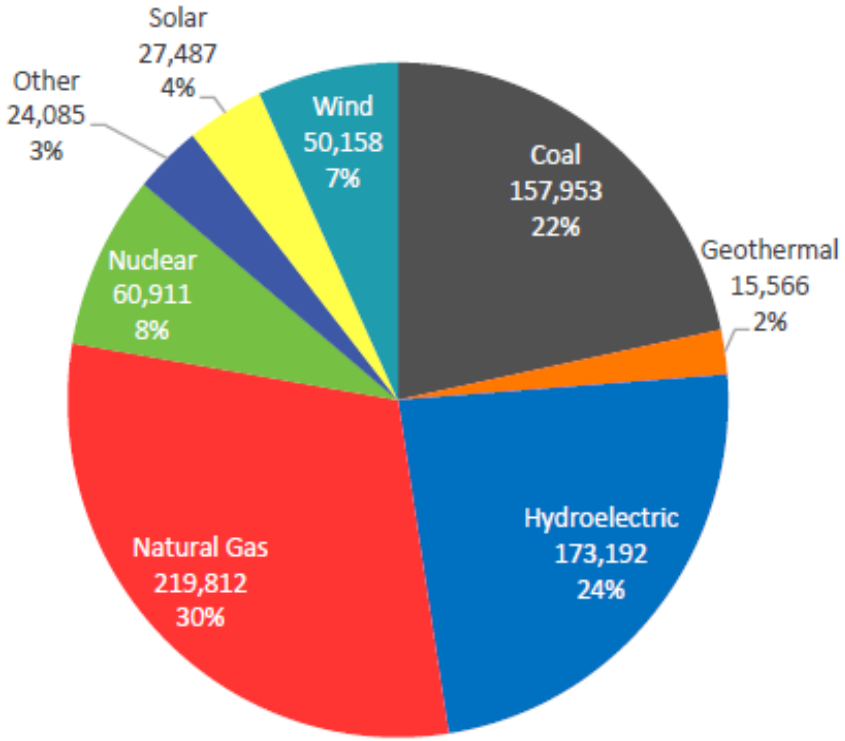
The Western Interconnection has a diverse mix of resources, including large amounts of hydro and renewable resources. Although the generation capacity of the Western Interconnection represents approximately 20 percent of total capacity in the United States and Canada, it encompasses over 70 percent of all solar capacity and one-third of all hydro capacity.

In 2016, the combined nameplate capacity of all utility-scale resources in the Western Interconnection was 267,000 MW. This is a 1 percent increase from 2015. Retirement of coal and steam-turbine gas units lead to slight decreases in capacity from these fuel types, while the installed capacity of utility-scale solar increased by over 6,000 MW.

2016 Nameplate Capacity (MW)



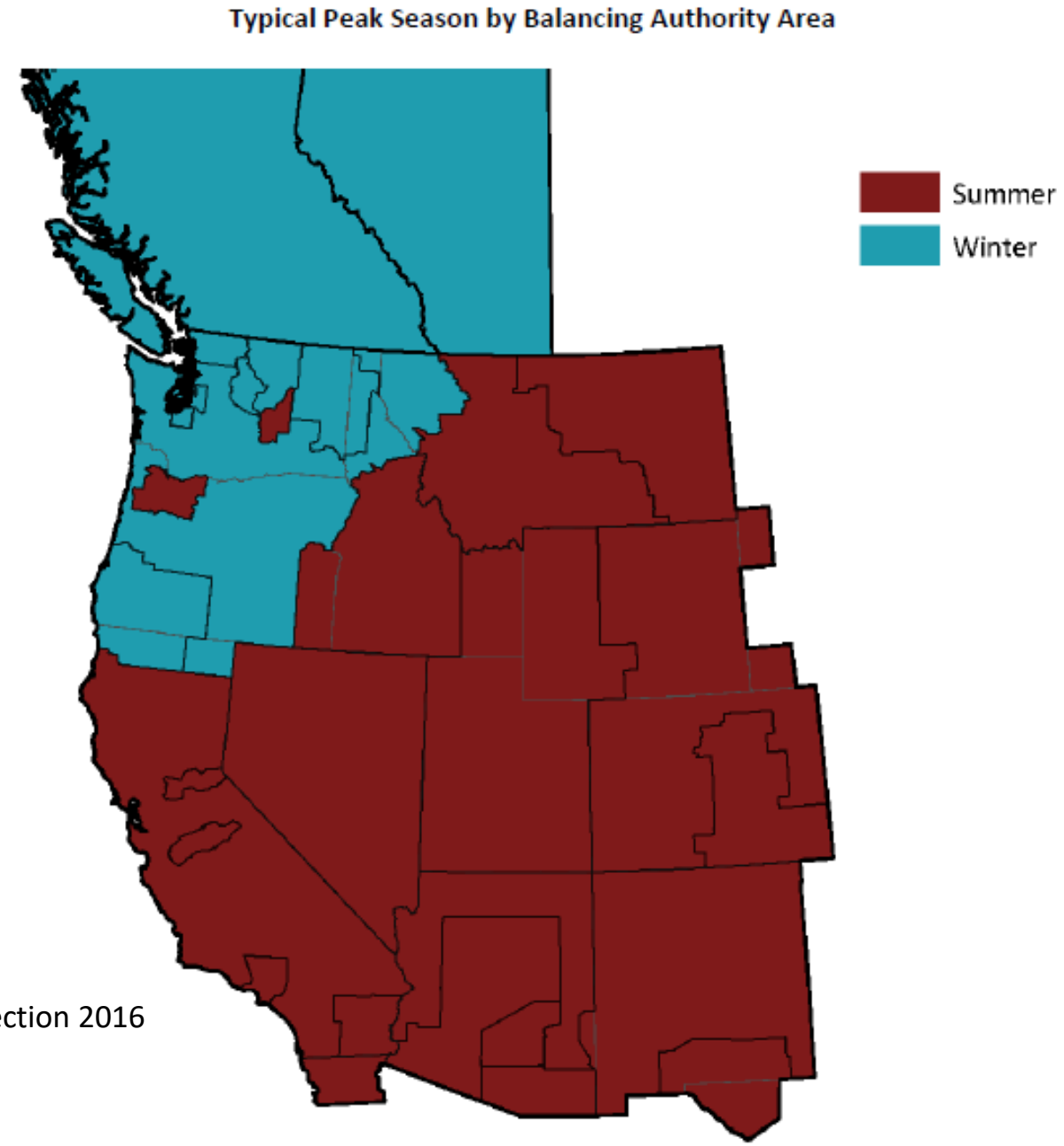
2016 Net Generation (GWh)



Peak Demand

The Western Interconnection covers a large geographic region with diverse weather and temperature conditions. Different areas within the region peak at different times of year.

The Western Interconnection as a whole experiences peak demand in the summer, but areas in the Pacific Northwest peak in the winter. This diversity allows the Northwest to export large amounts of electricity to California and the Southwest during the summer, when demand is lower in the Northwest.



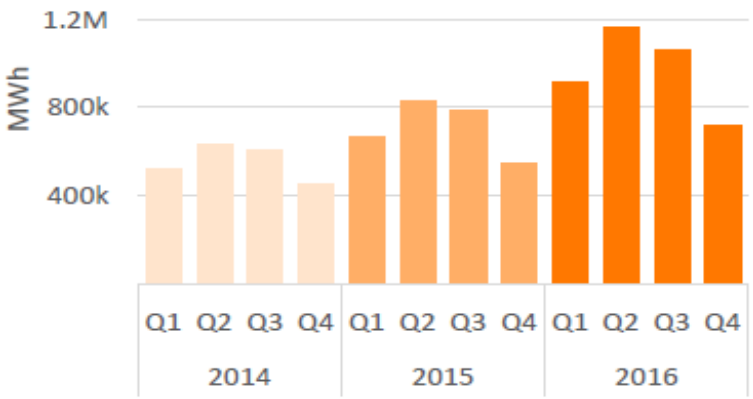
Source: WECC state of the interconnection 2016

Western Renewable Energy Profile

Renewables

The growth of wind and solar resources is driven by political, economic and social factors. Increased installation of wind and solar units is associated with the availability of tax credits and other financial and political incentives. Technological improvements also increase penetration of these units, especially photovoltaic solar. Other types of renewable resources have not experienced the same changes.

Estimated Rooftop Solar Net Generation

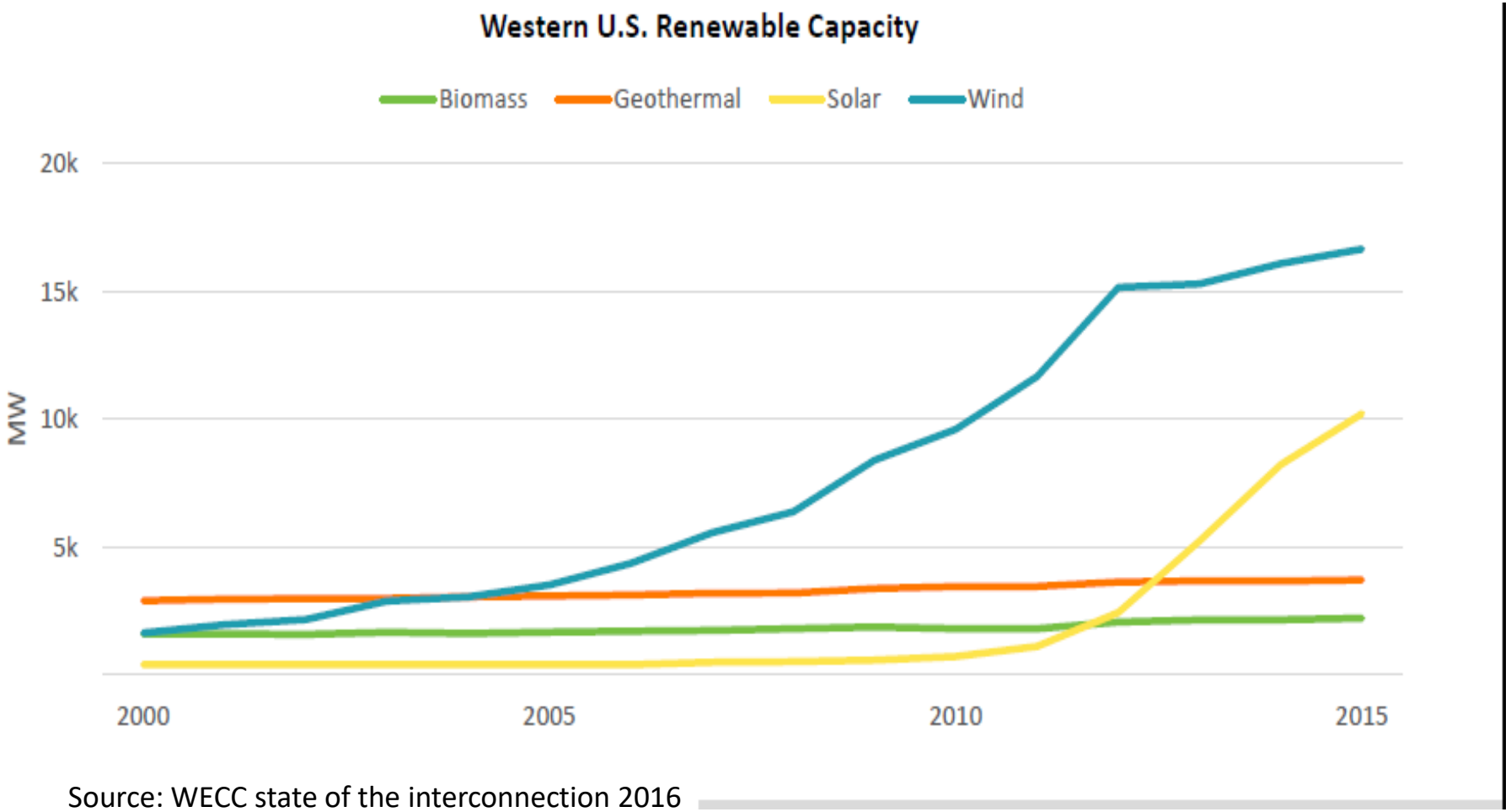


Source: WECC state of the interconnection 2016

Potential by Subregion

The West is characterized by a high degree of renewable potential. The Southwest has the highest solar potential in the nation, and is the only region in the US with areas of significant geothermal potential. There are also areas of significant wind potential, including along the eastern edge of the Rocky Mountains and along the Columbia River.

Renewables are Continuing to Grow



Source: WECC state of the interconnection 2016

PLANNING ISSUES CREZ, RETI, WREZ, WECC: THE ALPHABET SOUP OF TRANSMISSION PLANNING

Environmental Priorities

Transmission for Renewables

Maximum Use of Existing ROWs

Maximum Use of Existing Transmission

- Upgrades first

Use Geospatial Analysis to Avoid Risks

Account for all Environmental Costs in Capital Costs

Renewable Transmission Challenges

- Remotely constrained
- Lengthy transmission
- Fragmented Transmission Authorities
- Generation v. Transmission Time Horizons
- Public v. Private Lands
- ROW’s are precious and difficult to create

Planning for renewable transmission

Competitive Renewable Energy Zones: Texas, 2005-

Western Governors' Association Western Renewable Energy Zones – 2008

Renewable Energy Transmission Initiative (RETI): California and neighboring states – 2008-2012

Federal Energy Regulatory Commission Order 1000, 2011

Western Electricity Coordinating Council (WECC) Regional Transmission Expansion Project – 2011-2013

Eastern Interconnection Planning Collaborative – 2011-2013

National Renewable Energy Laboratory: Renewable Electricity Futures 2012

RETI 2.0 – 2016

San Joaquin Valley Solar Initiative 2015-2016

Common themes in Planning Processes

- Identify areas of excellent resource values
- Identify risks
  - Environmental and cultural resource conflicts
- Identify load centers
- Identify, evaluate and designate best routes
  - Conduct stakeholder-engaged routing
- Identify beneficiaries
- Allocate costs

Planning: Rights of Way are Precious

- Extremely difficult to site
- ROWs should be intended to meet present and ***future*** needs
- Could take more than a decade to site
- Mitigation costs can be high
- Available Transfer Capacity from western interconnection power plant retirements needs to be factored in
- Transmission should be designed to be scalable/ upgradable

ROW planning should consider grid needs

- Does the location serve renewable energy resource areas the state prioritizes?
  - Low environmental conflicts
  - Supports economic development
  - Reduces community impacts
  - Access to high quality renewable resources
  - Facilitates access to available storage

Planning, ctd.

- Does the location enhance grid modernization and expansion goals
  - Will it serve to future system upgrade/expansion needs?
    - Increase flows and allow for ↗ RE transfers to neighboring balancing areas
    - Reduce congestion in existing lines

Planning CTD.

- Is it designed to be expandable?
  - Towers that can accommodate higher voltage rating conductors
  - Towers that allow for adding a circuit

Extending ROW life

New technologies and enhanced electronics can help

- Flow controllers reduce congestion
- PMUs (synchrophasors) and automation
- High capacity conductors
  - Where towers cannot easily or cost effectively be replaced
  - Defer or altogether avoid reconstruction
  - Increase transfer capacity with same or similar voltage ratings

Planning v. Siting

Planning at a “high” level

- Not Environmental Review
- Not too Granular
- Intended to make Environmental Review Easier

Siting done “close to the ground”

- EIS, localized decisions

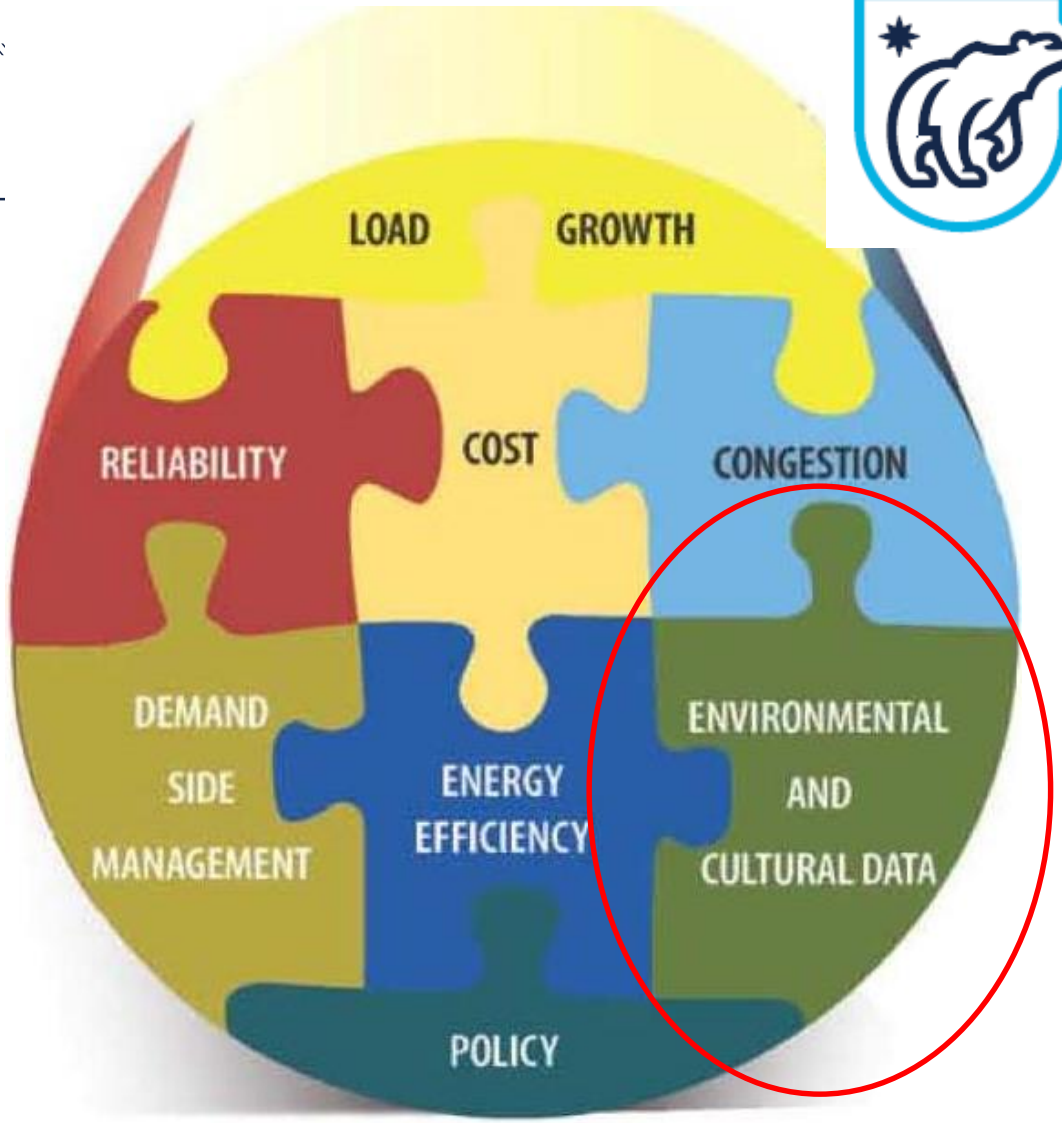
Planning Example: WECC RTEP

Regional Transmission Expansion Project (RTEP)

- DOE Funded
- Stakeholder Shaped
  - Environmental, Technology, Utility, TO's, Tribes, Consumer Advocates, States, Wildlife, Cultural Resource Advocates
- Interconnection Wide
- 10 and 20 Year Plans, Final product 12/2013

Environmental and Cultural Factors –

One piece of the regional transmission planning puzzle



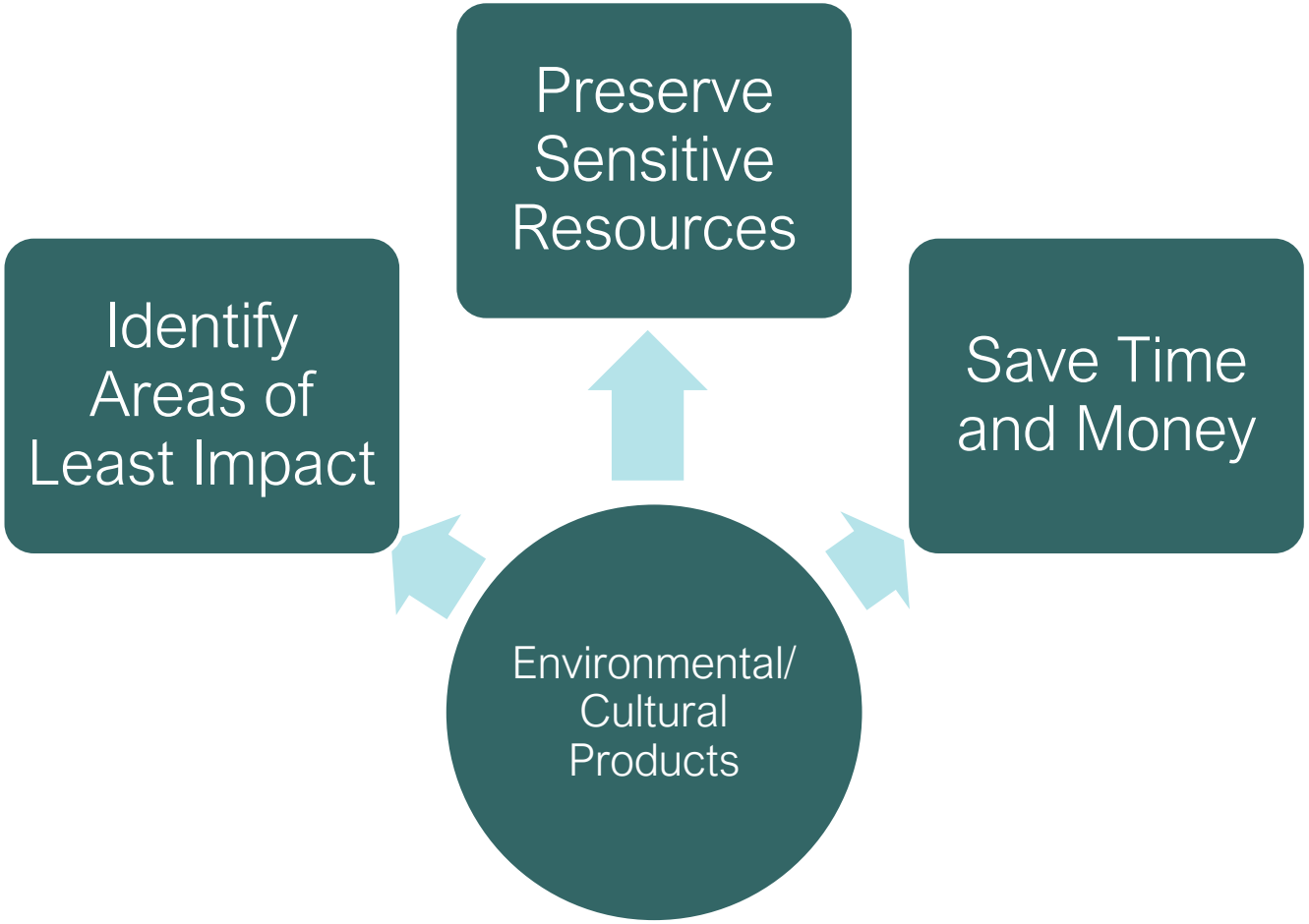
Source: WECC Environmental Data Working Group

Primary Environmental Data Work Group Products

Preferred Data Sets	• Available • Reviewed for Quality • Relevant to Transmission Planning
Risk Classification System	• Four Risk Levels • Low Risk (1) to Exclusion Area (4)
Comparison Methodology	• Compares relative risks of transmission alternatives • Alternatives identified in long-term study cases • Available for use outside of WECC
Review of Study Case Results	• Considers “environmental risk contours” • Also considers cultural risks • Considers capital costs of “bending lines”

Source: WECC Environmental Data Working Group

Using Environmental/Cultural Data



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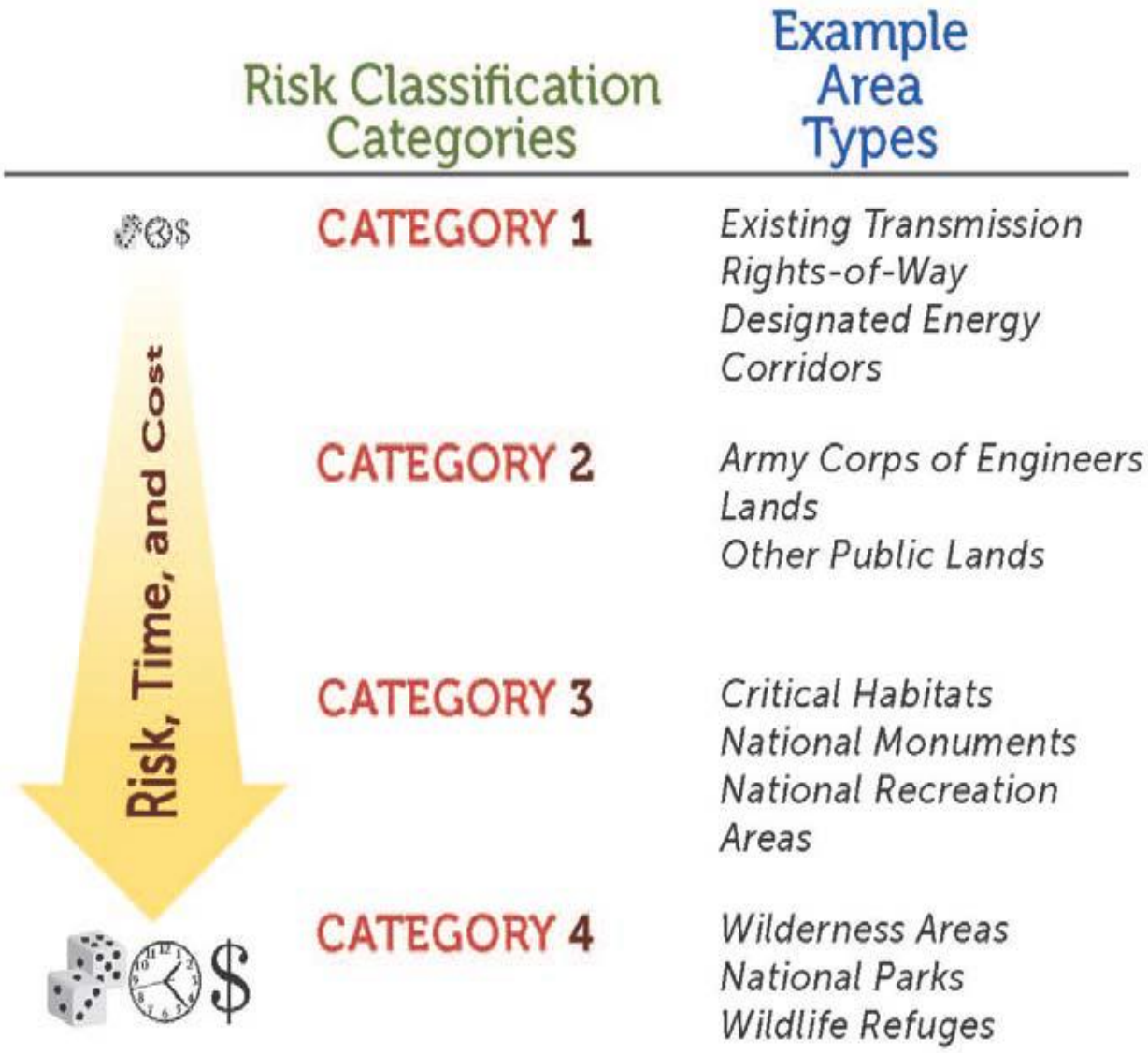
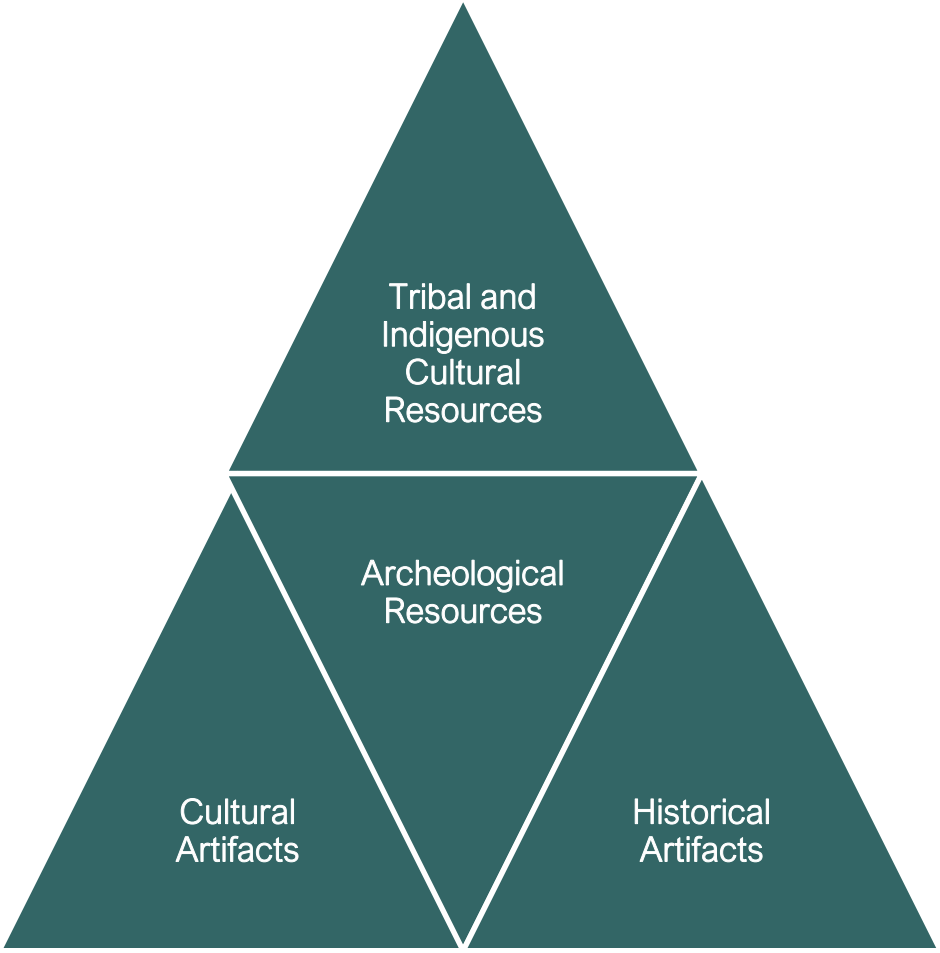


Source: WECC Environmental Data Working Group

What Is Cultural Resource Data?



Source: WECC Environmental Data Working Group

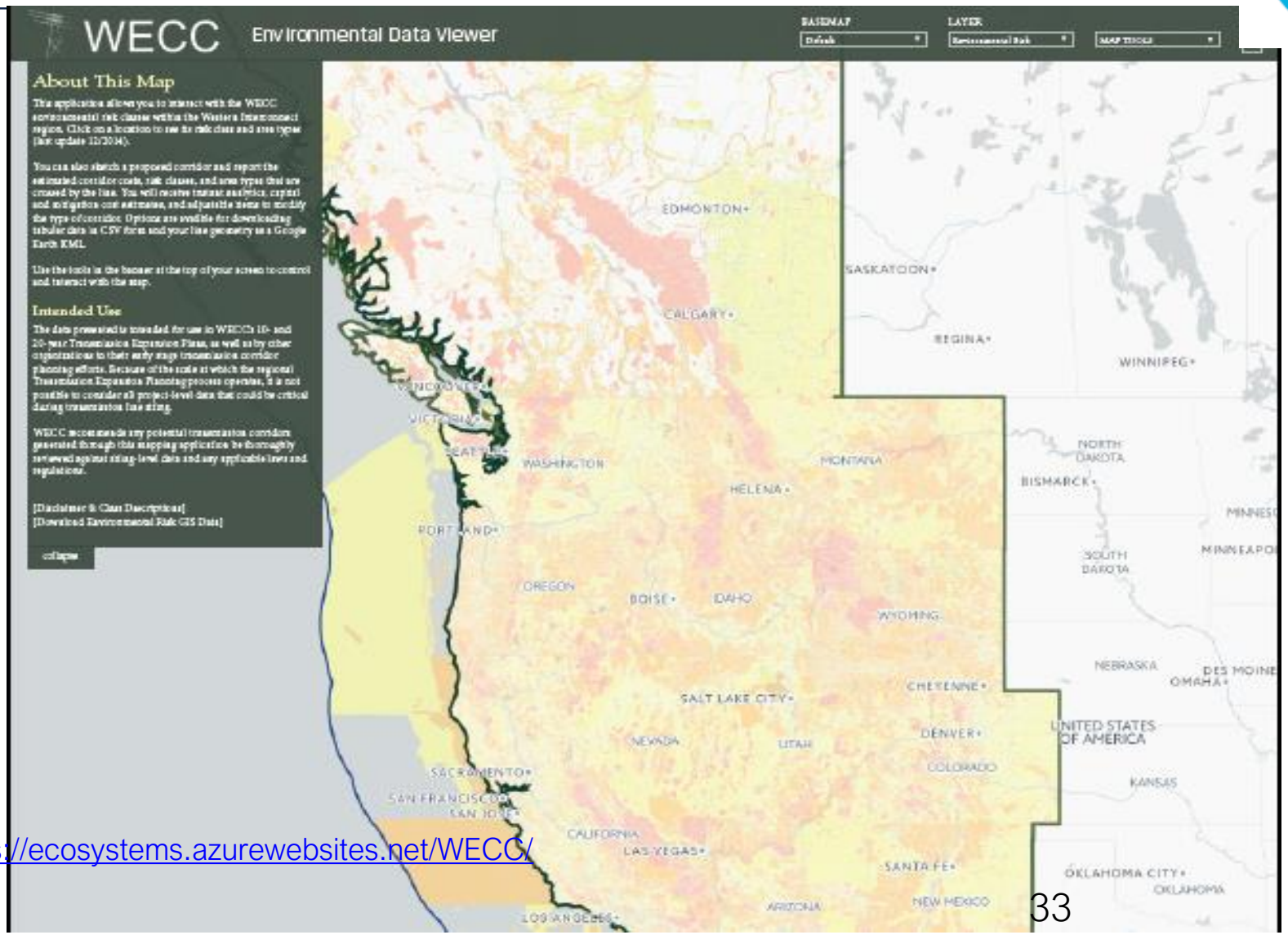
Cultural Data Challenges

- Important, but difficult to acquire
- Gaps in geospatial data
- Acquiring and standardizing across jurisdictions
- Limitations on sharing due to protection concerns
- Need to document while avoiding or mitigating sensitive areas

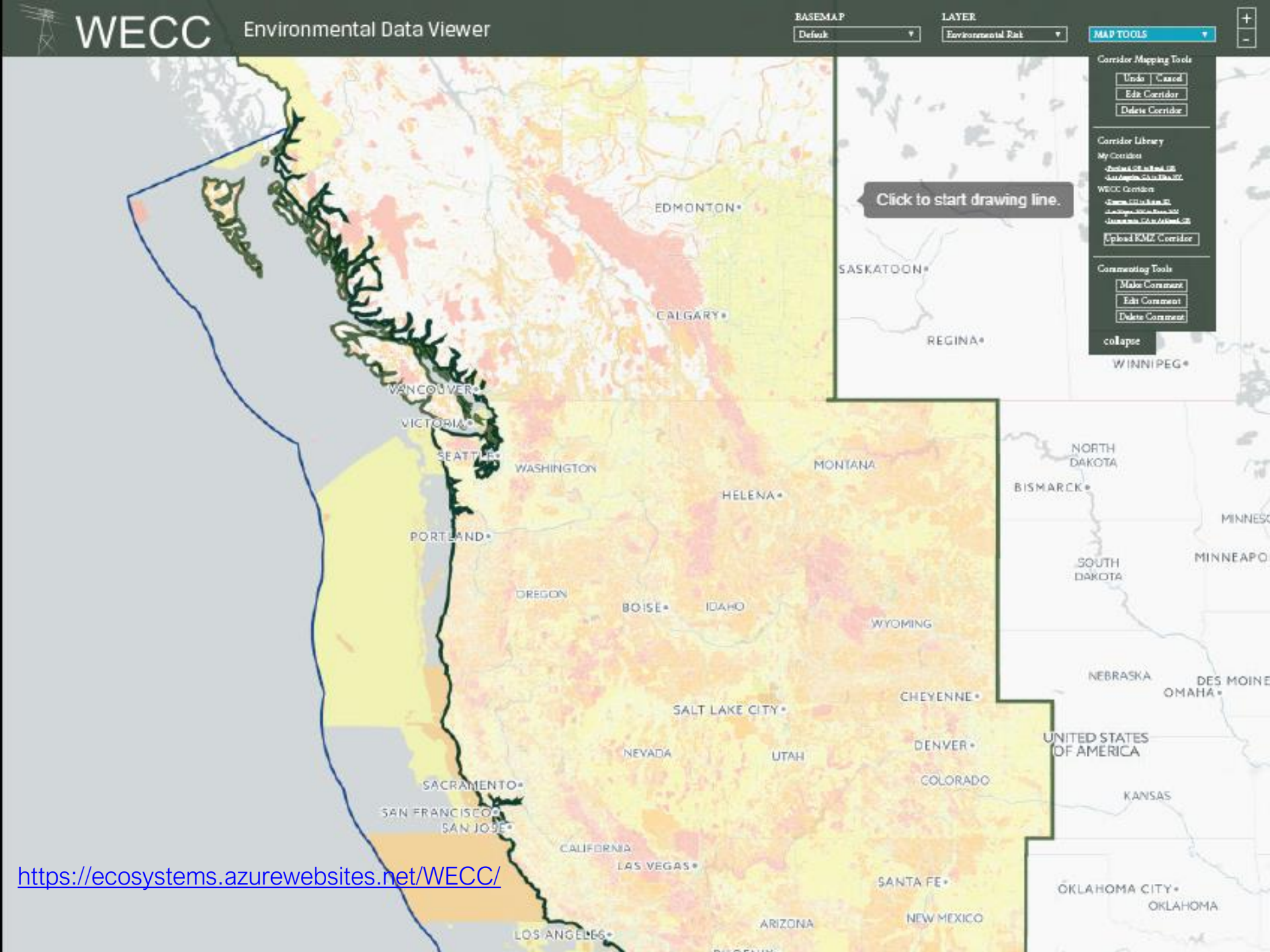
Source: WECC Environmental Data Working Group

ROLE OF GEOSPATIAL INFORMATION

WECC Environmental Data Viewer



https://ecosystems.azurewebsites.net/WECC/



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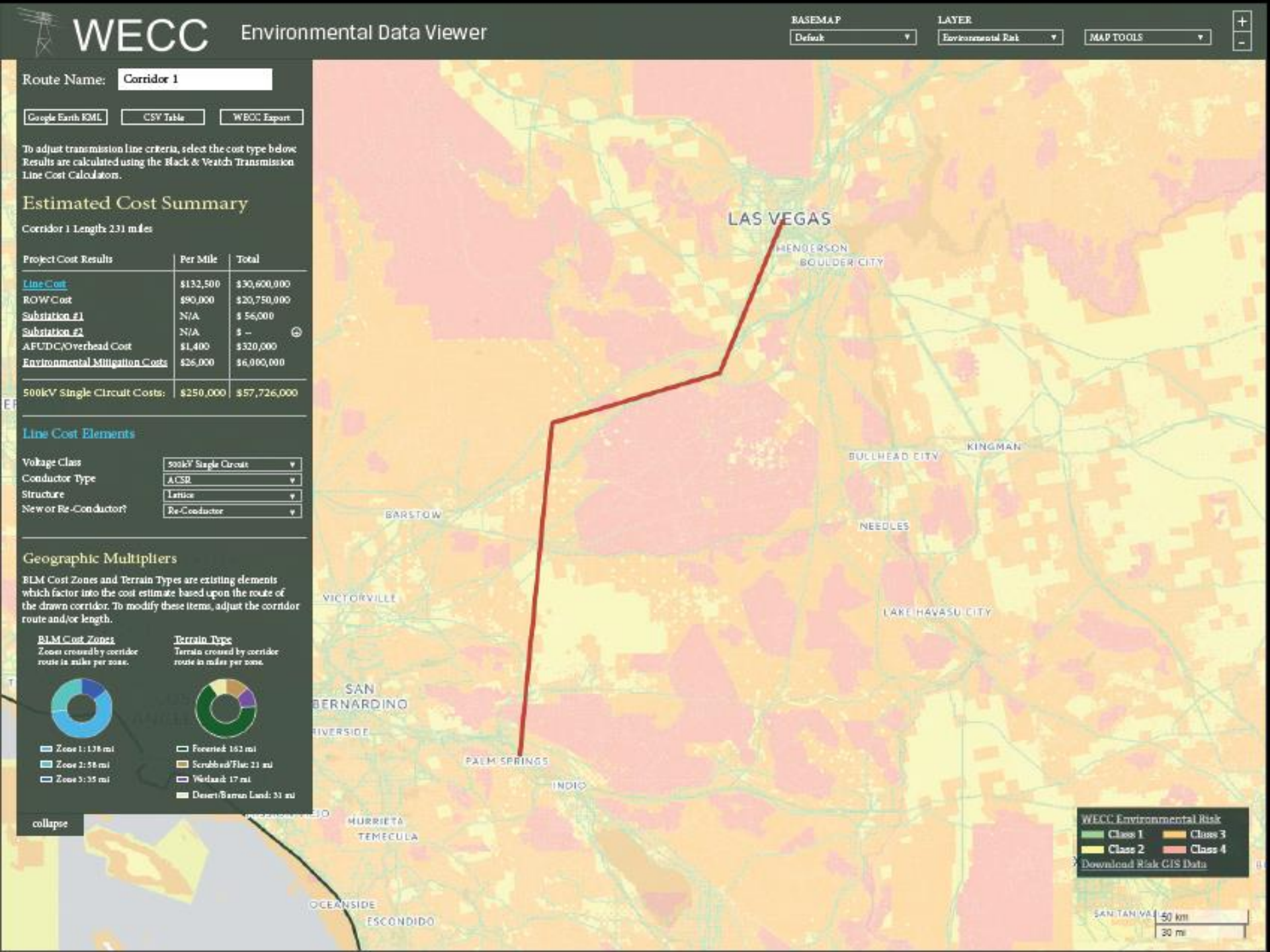
WECC
Environmental Data Viewer
BASEMAP
Default
LAYER
Environmental Risk
MAP TOOLS
Route Name:
Corridor 1
Google Earth KML
CSV Table
WECC Export
To adjust transmission line criteria, select the cost type below. Results are calculated using the Black & Veatch Transmission Line Cost Calculators.
Estimated Cost Summary
Corridor 1 Length: 231 miles
Project Cost Results | Per Mile | Total
Line Cost | $132,500 | $30,600,000
ROW Cost | $90,000 | $20,750,000
Substation #1 | N/A | $ 56,000
Substation #2 | N/A | $ --
AFUDC/Overhead Cost | $1,400 | $320,000
Environmental Mitigation Costs | $26,000 | $6,000,000
500kV Single Circuit Costs: | $250,000 | $57,726,000
Line Cost Elements
Voltage Class: 500kV Single Circuit
Conductor Type: ACSR
Structure: Lattice
New or Re-Conductor?: Re-Conductor
Geographic Multipliers
BLM Cost Zones and Terrain Types are existing elements which factor into the cost estimate based upon the route of the drawn corridor. To modify these items, adjust the corridor route and/or length.
BLM Cost Zones
Zones crossed by corridor route in miles per zone.
Zone 1: 138 mi
Zone 2: 58 mi
Zone 3: 35 mi
Terrain Type
Terrain crossed by corridor route in miles per zone.
Forested: 162 mi
Scrubbed/Flat: 21 mi
Wetland: 17 mi
Desert/Barren Land: 31 mi
collapse
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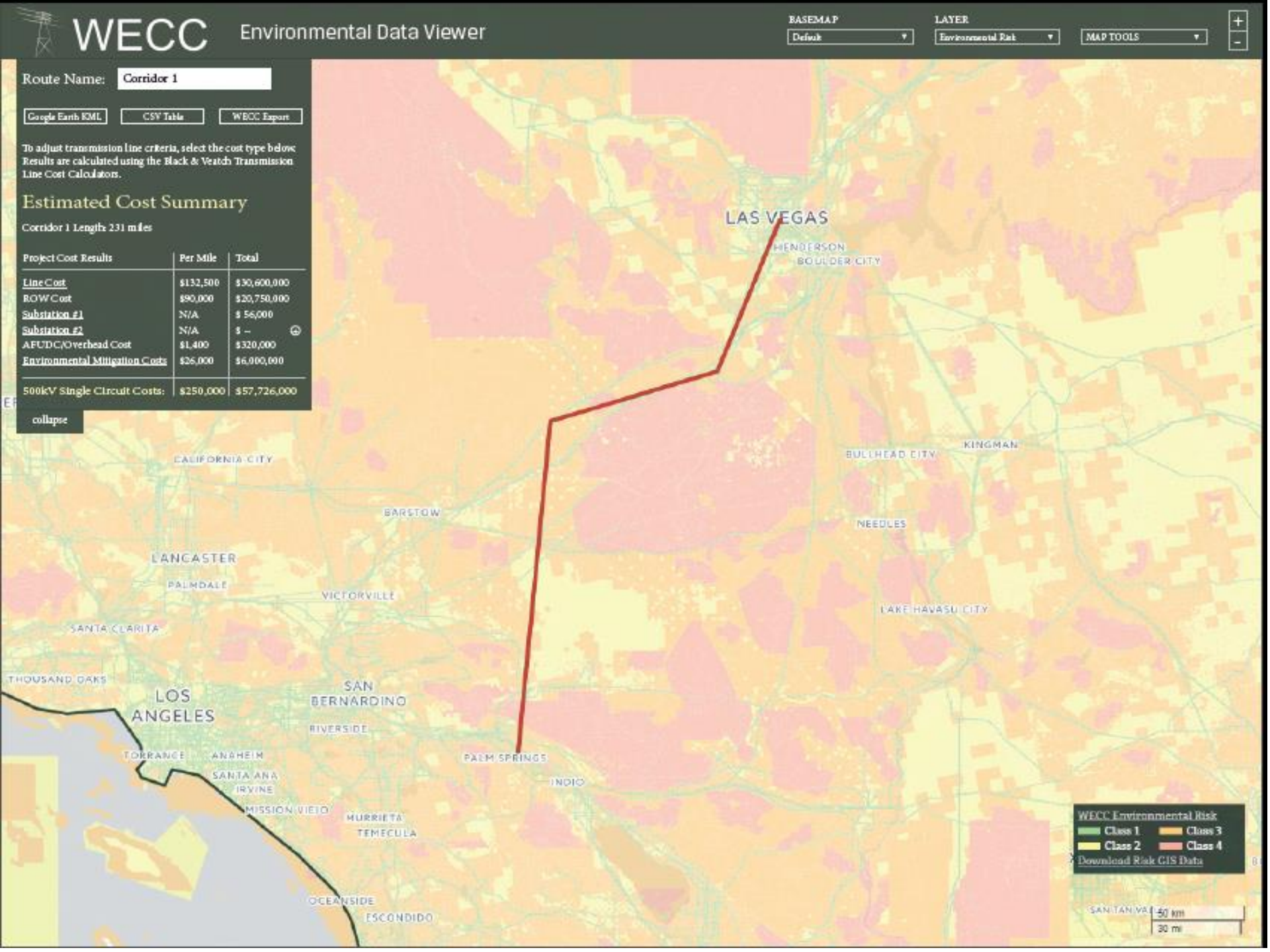
WECC Environmental Risk
Class 1
Class 2
Class 3
Class 4
Download Risk GIS Data
50 km
30 mi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30 mi

WECC Environmental Data Viewer

BASEMAP: Default | LAYER: Environmental Risk | MAP TOOLS

Route Name: Corridor 1

Google Earth KML | CSV Table | WECC Export

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WECC Environmental Risk
Class 1 | Class 3
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Environmental Mitigation Costs

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Corridor Mapping Tools
Draw Corridor
Edit Corridor
Delete Corridor

Corridor Library
My Corridor
WECC Corridor
Upload KMZ Corridor

Commenting Tools
Cancel
Edit Comment
Delete Comment

collapse

(Comment Label)
(Enter your comment here)
Save

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Class 4
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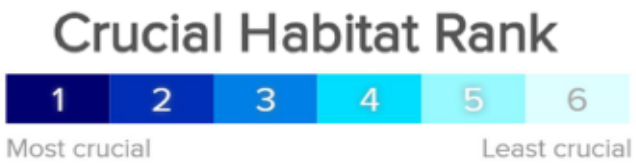
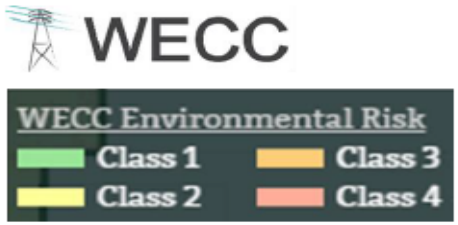
50 km
30 mi

The data are updated biennially

2017 Environmental Risk Layer – WAFWA CHAT Wildlife

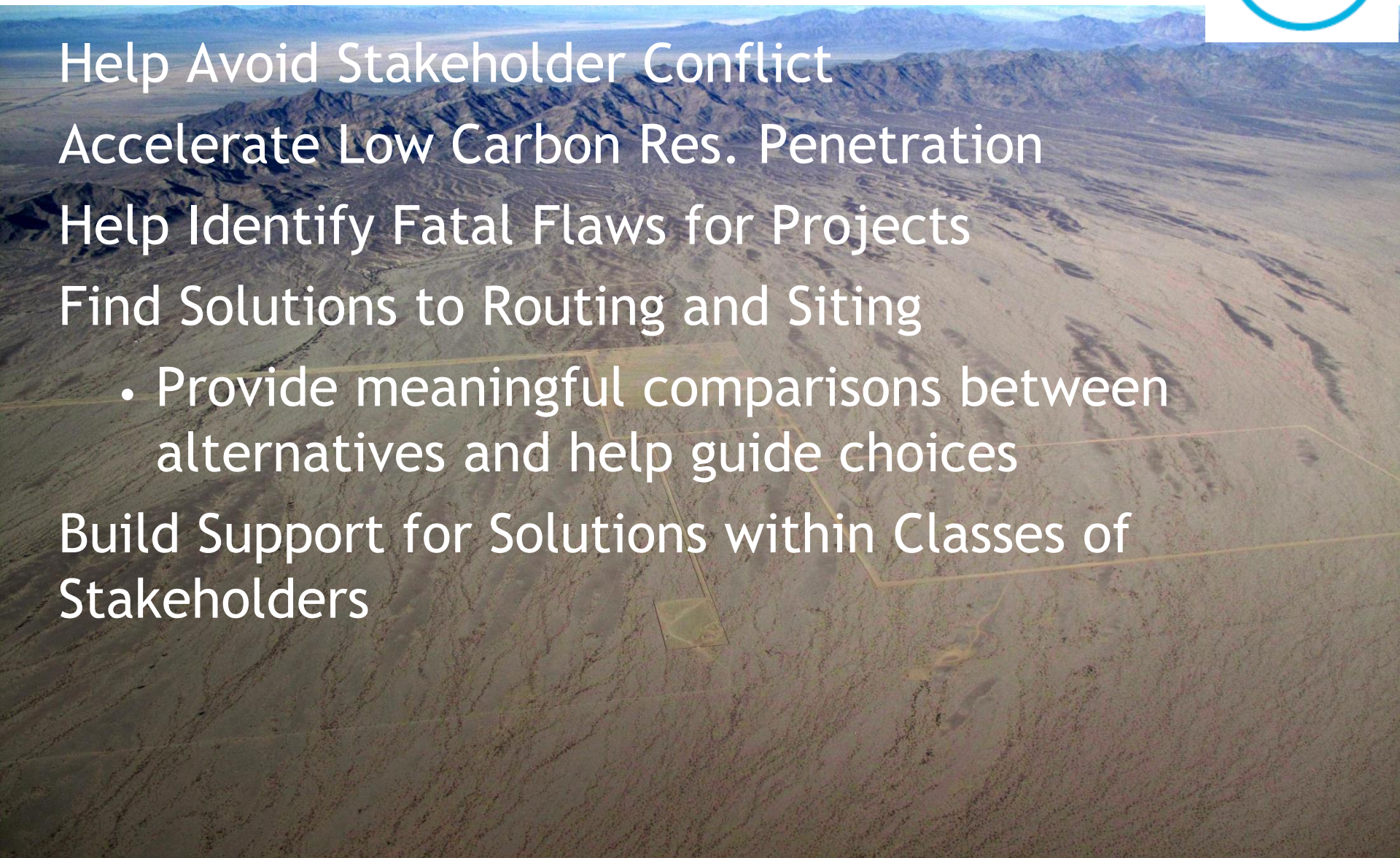
- *Meeting with WAFWA May 2017; agreed on mapping approach:*





CHAT Crucial Habitat Rank	WECC Environmental Risk Score
1 – Most Crucial	3 – High Risk
2	3 – High Risk
3	2 – Moderate Risk
4	NA
5	NA
6 – Least Crucial	NA

Role of Public Participation



Help Avoid Stakeholder Conflict

Accelerate Low Carbon Res. Penetration

Help Identify Fatal Flaws for Projects

Find Solutions to Routing and Siting

- Provide meaningful comparisons between alternatives and help guide choices

Build Support for Solutions within Classes of Stakeholders

Questions?

For more information:

Carl Zichella
Director of Western Transmission
Natural Resources Defense Council
111 Sutter Street, 20th Floor
San Francisco, CA 94104
czichella@nrdc.org
(916) 837-7127

Read my blog here: http://switchboard.nrdc.org/blogs/czichella/

Follow me on Twitter @CarlZichella