



Land-Use Evaluation for 2025-26 Busbar Mapping Cycle

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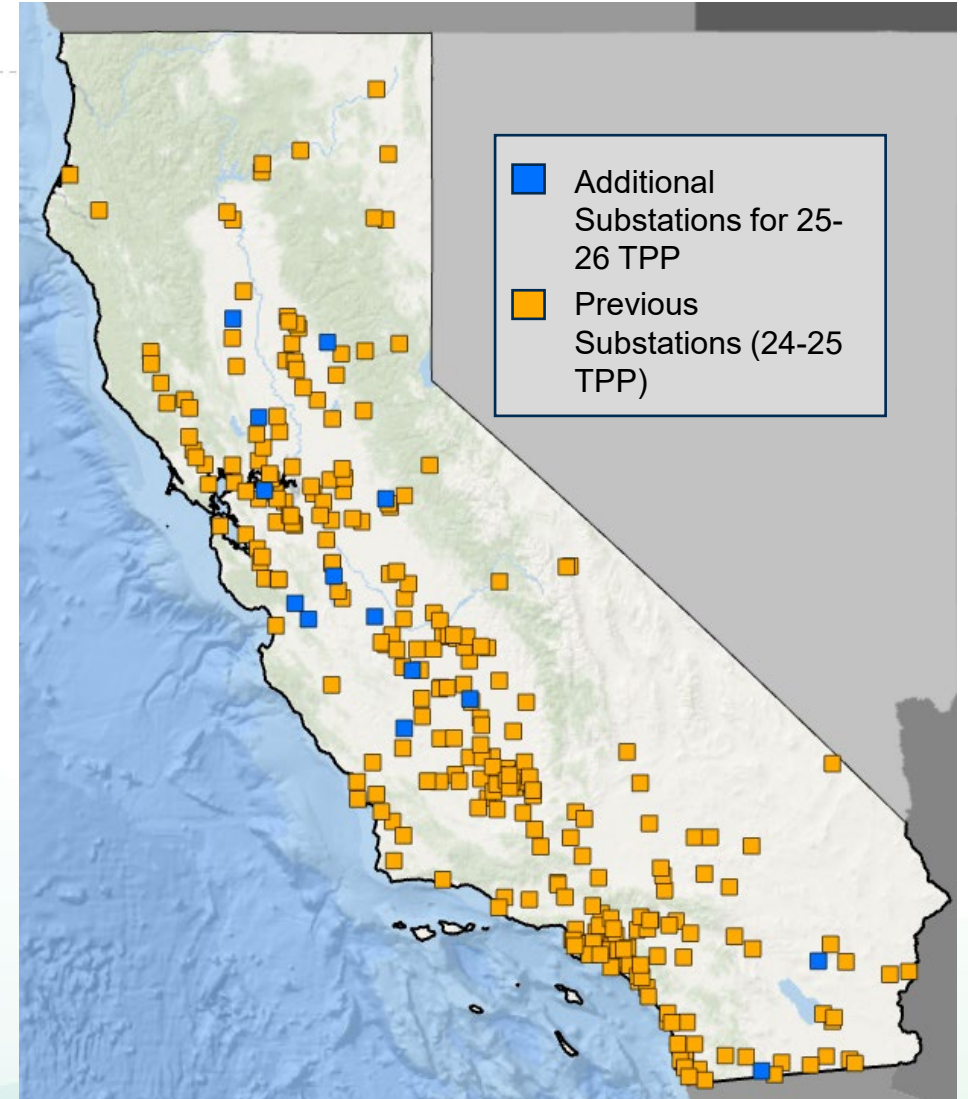
Siting, Transmission and Environmental Protection Division

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Overview

- General Approach for Land Use Evaluation around a Substation (Solar and Wind Resources)
 - Spatial Data for Metrics Calculations
- Geothermal Resources
- New Assessment for Pumped Storage Hydropower Resources
- Criteria Alignment Explanation for Example Results

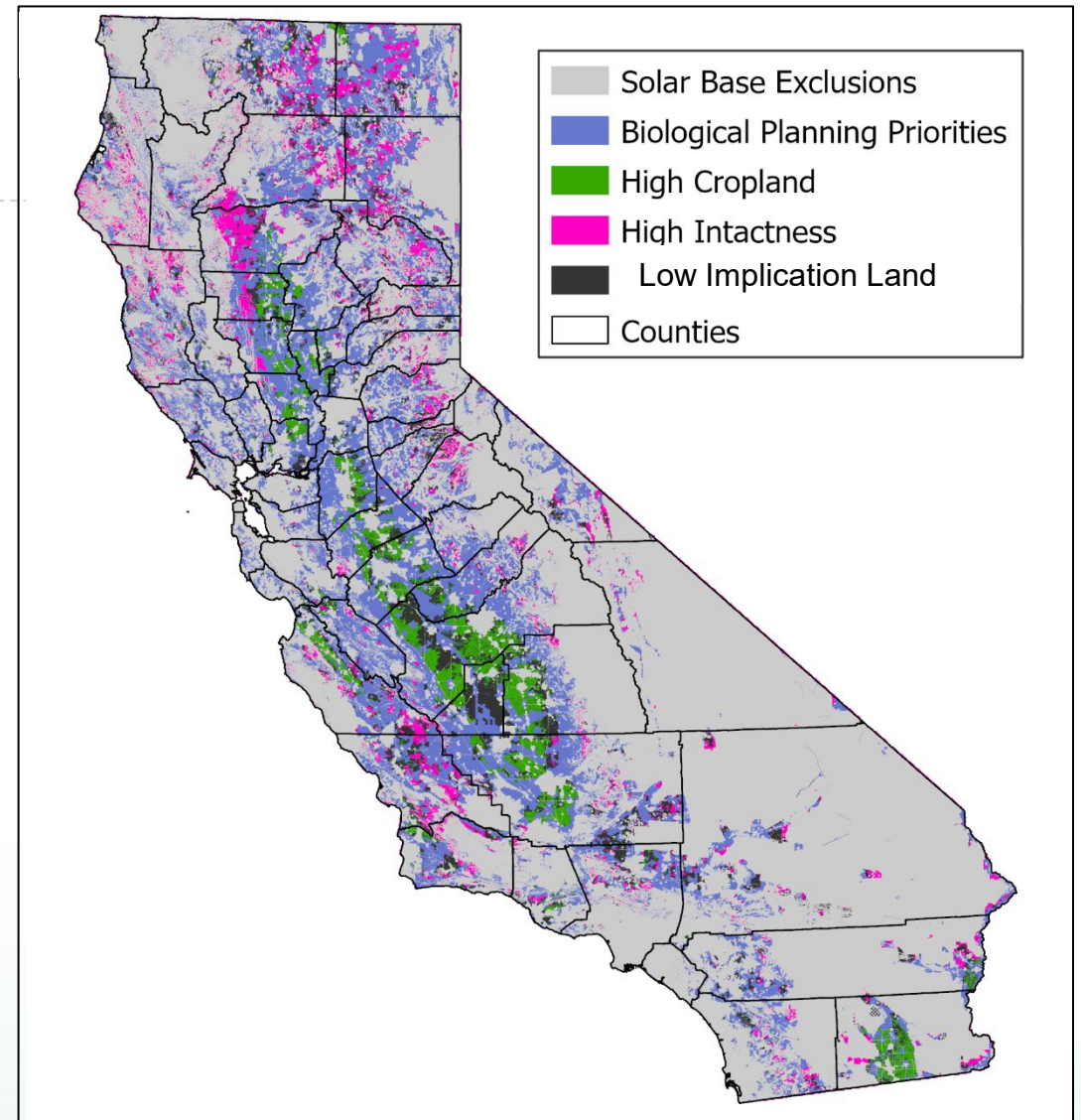


Substation points used for the land use and environmental evaluation for solar and wind resources in busbar mapping.



Statewide Core Land-Use Screen

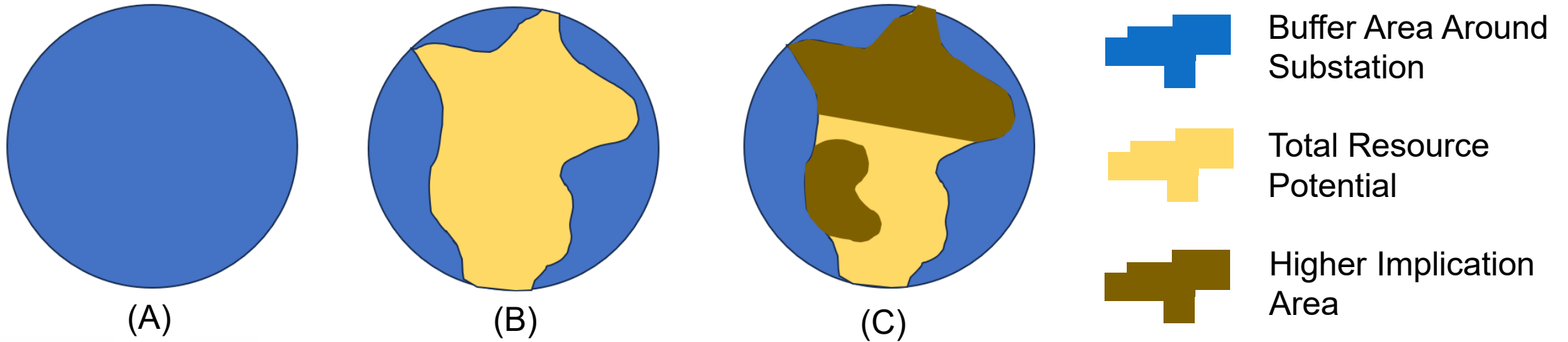
- In 2023, CEC completed an update to the statewide land-use screens for electric system planning ([report](#), [data viewer](#), [resource potential maps](#))
- Recent assessment of California land designations, physical characteristics, natural and working lands priorities
- Explicit geospatial data layers to estimate distribution and size of areas with renewable resource potential



Solar Screening Components and Remaining Low Implication Land



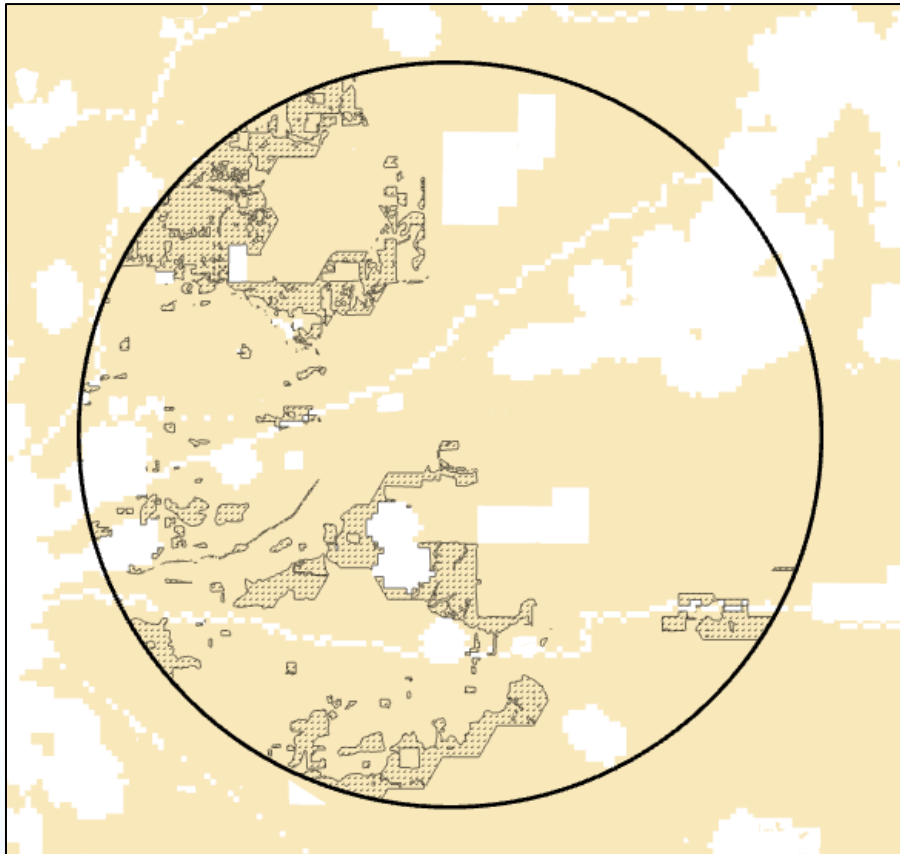
General Approach for Geospatial Evaluation (Solar and Wind Resources)





- Create a circular buffer (radii between 5 and 30 miles) around each substation
- Limit all datasets to total resource potential area (areas outside of the protected area layer and the techno-economic exclusion area)
- Calculate acreage and percent overlap with total resource potential area as basis of metrics
 1. Higher and lower implication acreages, defined by Core Land Use Screen
 2. Intersection of high environmental, biological, cropland, fire threat and parcelization factors
 3. Lower (and higher) implication area utilization by mapped MW
- Determine level of criteria alignment



Metrics Group 1: Land Use Feasibility



-  Total Resource Potential Area
-  Low Implication Land

Within the total resource potential area within each substation buffer, CEC staff calculate:

1. CEC Core Land Use Screen

- Acreage of lower and higher implication land

2. Parcelization*

- Acreage and percent of low and medium parcelization levels
- 10th percentile value

3. CEC Cropland Index Model*

- Acreage and percent of lower and higher cropland areas

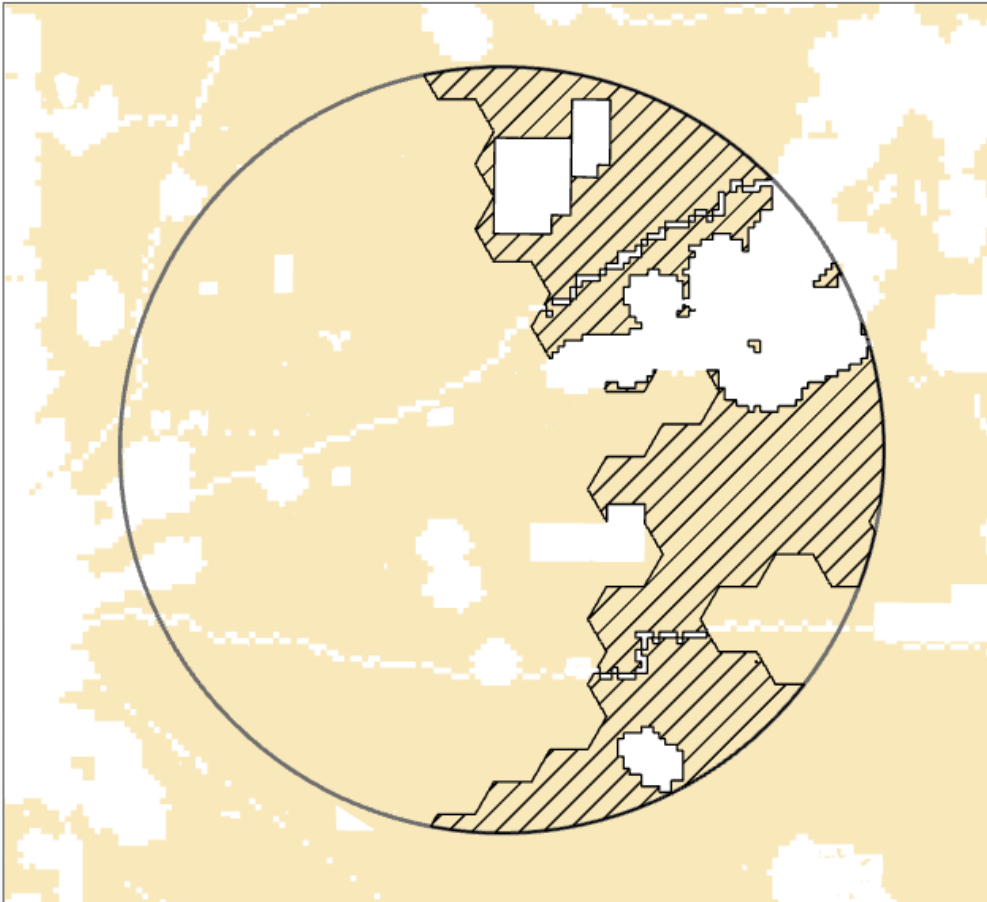
4. Fire Threat

- Acreage and percent of Tier 2 (Elevated), Tier 3 (Extreme) areas

*Applied for solar resources only





Metrics Group 2: Environmental (Conservation and Biological) Implications



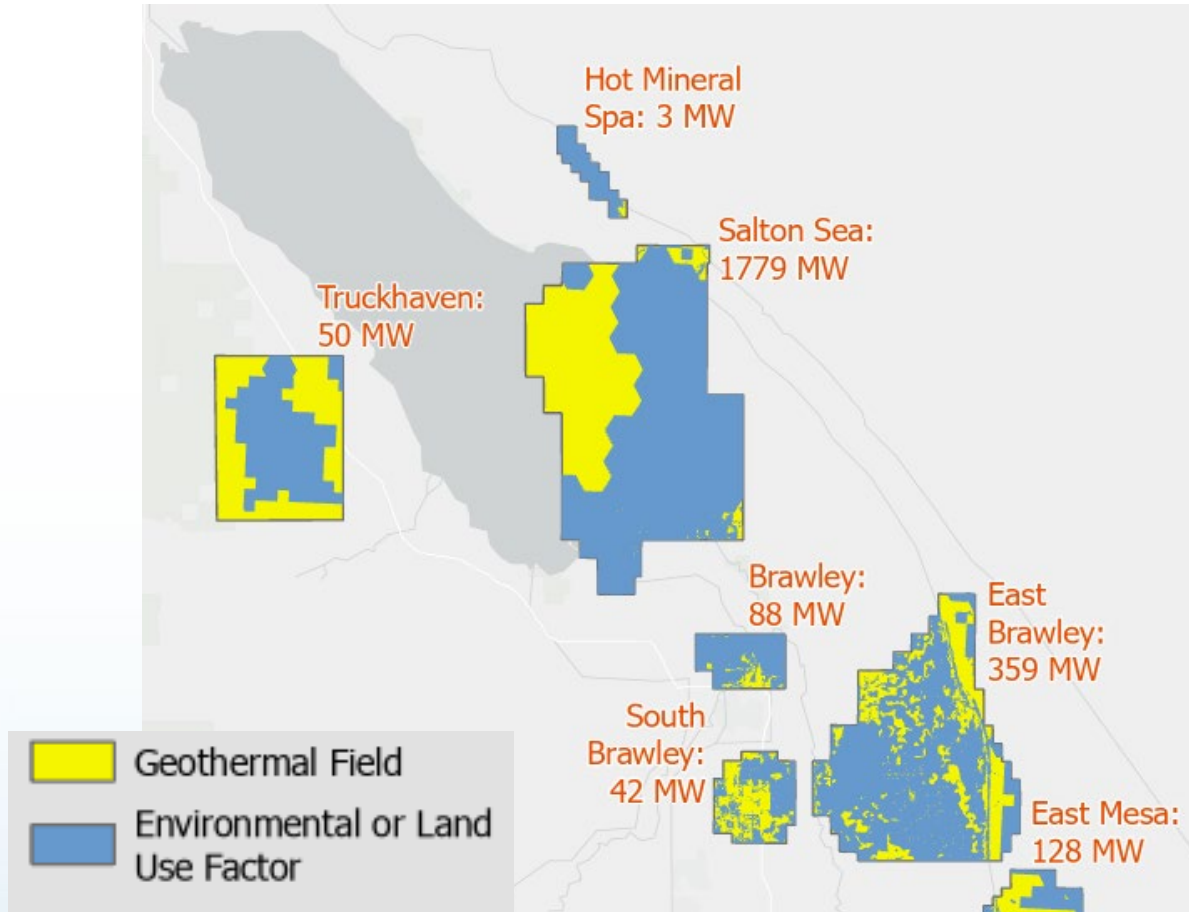
CEC staff calculates the intersection of the following factors with the total resource potential area within each substation buffer:

1. Biodiversity Rank 5
2. Connectivity Ranks 4 and 5
3. Irreplaceability Ranks 4 and 5
4. Wetlands
5. High Landscape Intactness

-  Total Resource Potential Area
-  High Connectivity Area (Ranks 4 and 5)



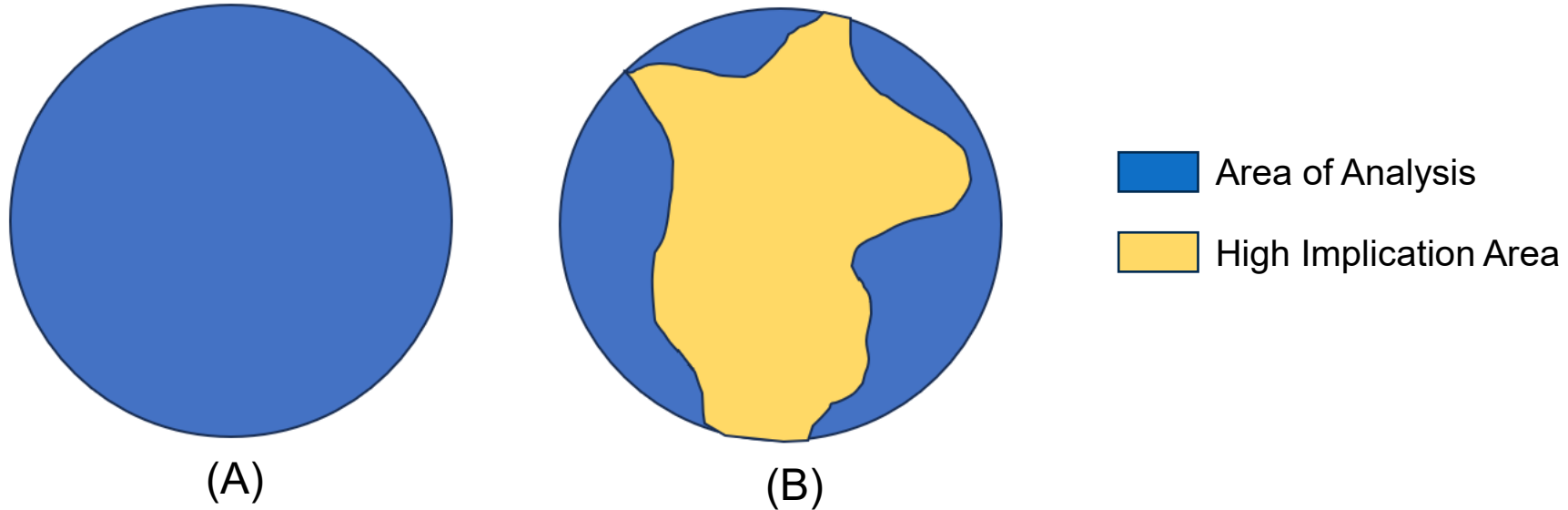
Geothermal Resources



- Land use and environmental metrics are calculated for the entire geothermal field
 1. Low implication area defined by the Protected Area Layer (“Core Screen Feasibility Alignment”)
 2. Biodiversity Rank 5
 3. Connectivity Ranks 4 and 5
 4. Irreplaceability Ranks 4 and 5
 5. Wetlands
 6. High Landscape Intactness
 7. Tier 2 and Tier 3 Fire Threat



Pumped Storage Hydropower (PSH)



- Create a 5-mile buffer area around a central point of identification for each potential PSH site, Figure (A)
- Partition each environmental, ecological, or biological factor by a threshold to determine the relatively higher implication area for each, Figure (B)
 - Terrestrial Biodiversity, Ranks 4 and 5
 - Terrestrial Connectivity, Ranks 4 and 5
 - Terrestrial Irreplaceability, Ranks 4 and 5
 - High Landscape Intactness
 - Aquatic Rare Species Richness, Ranks 4 and 5
 - Aquatic Irreplaceability, Ranks 4 and 5
- Calculate the percent of the total buffer area that is within the defined high implication area



Statewide Factors Evaluated for each Resource Type

	Solar	Wind	Geothermal	Pumped Storage Hydropower
Total Resource Potential	X	X		
Lower Implication Area (CEC Core Land Use Screen)	X	X		
Lower Implication Area (Protected Area Layer)			X	
Terrestrial Biodiversity	X	X	X	X
Terrestrial Connectivity	X	X	X	X
Terrestrial Irreplaceability	X	X	X	X
Wetlands	X	X	X	
High Landscape Intactness	X	X	X	X
CEC Cropland Index Model	X			
Fire Threat	X	X	X	
Parcelization	X			
Aquatic Rare Species Richness				X
Aquatic Irreplaceability				X

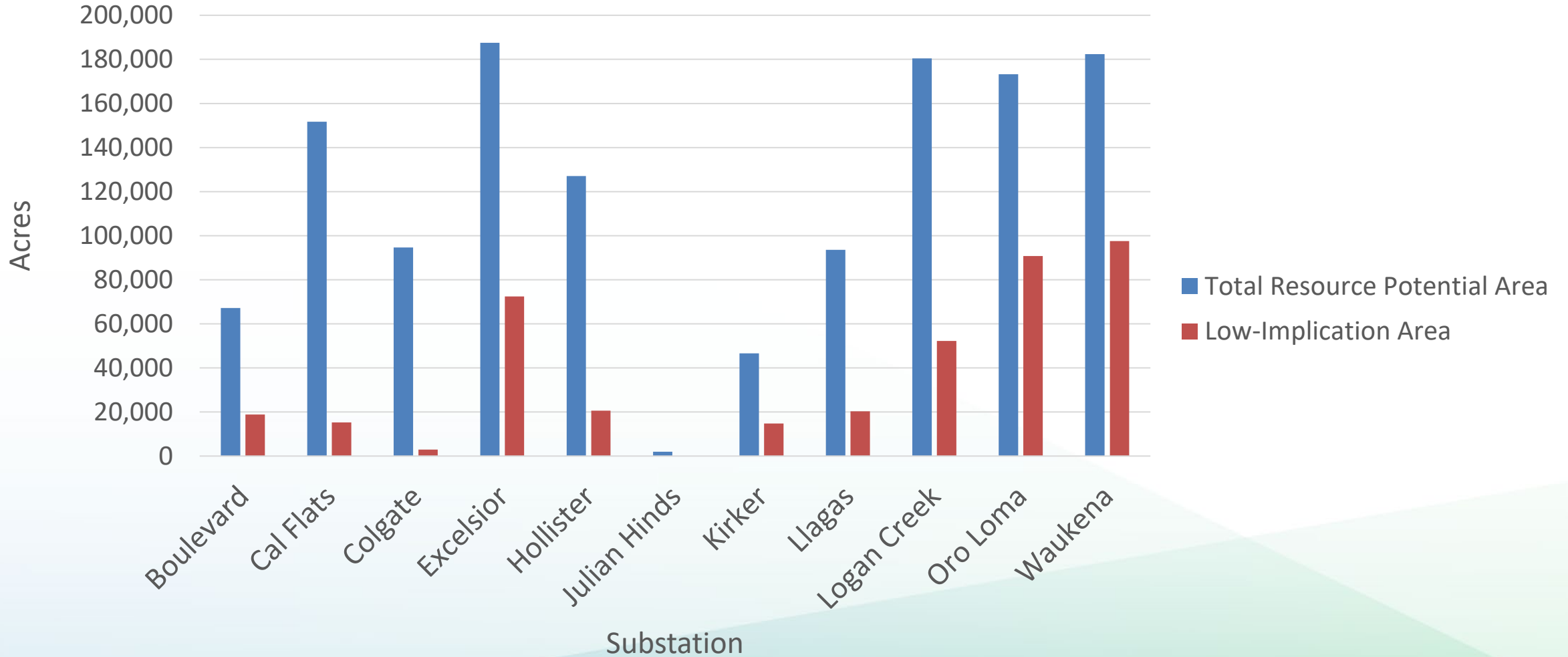


Application to Criteria Alignment



Land Use Feasibility

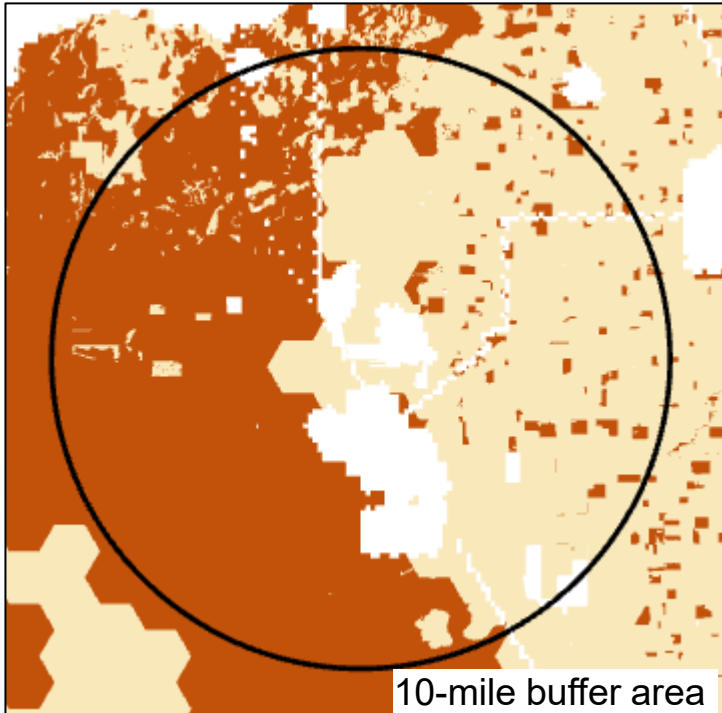
CEC Core Land Use Screen and Availability of Land Area for Resource Allocation (Solar, 10-Mile Buffer Radius)





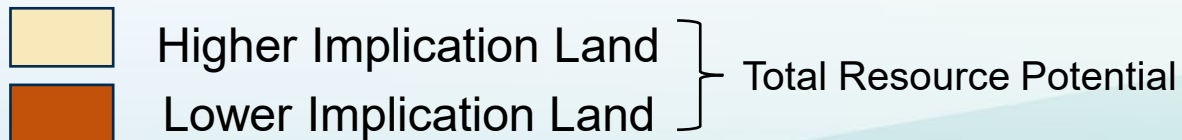
CEC Core Screen Criteria

Waukena Substation and Solar Resource Potential



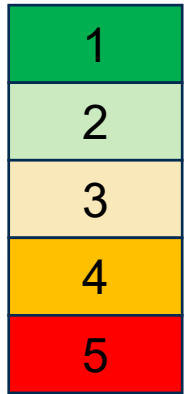
The amount of mapped resources that would utilize lower and higher implication areas determines the criteria alignment level.

Within 10-Mile Buffer area	
Total Resource Potential Acres	182,366
Lower Implication Acres	97,531
Higher Implication Acres	84,835





CEC Core Screen: Exploration of Criteria Alignment Levels



Desire

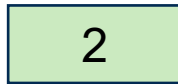
Strong compliance with criteria, alignment with criteria's prioritized or favorable conditions

Significant non-compliance with criteria, no alignment with stated criteria, fully meets conditions criteria seek to limit or avoid

Avoid



If MW mapped is less than 20% of low implication area, or 19,506 acres (~1,951 MW*)



If MW mapped is less than 50% of low implication area, or 48,766 acres (~4,877 MW*)



If MW mapped is less than 80% of low implication area, or 78,025 acres (~7,802 MW*)



If MW mapped is greater than 80% of low implication area and less than 10% of the high implication area, or between 78,025 and 106,015 acres (up to ~10,601 MW*)



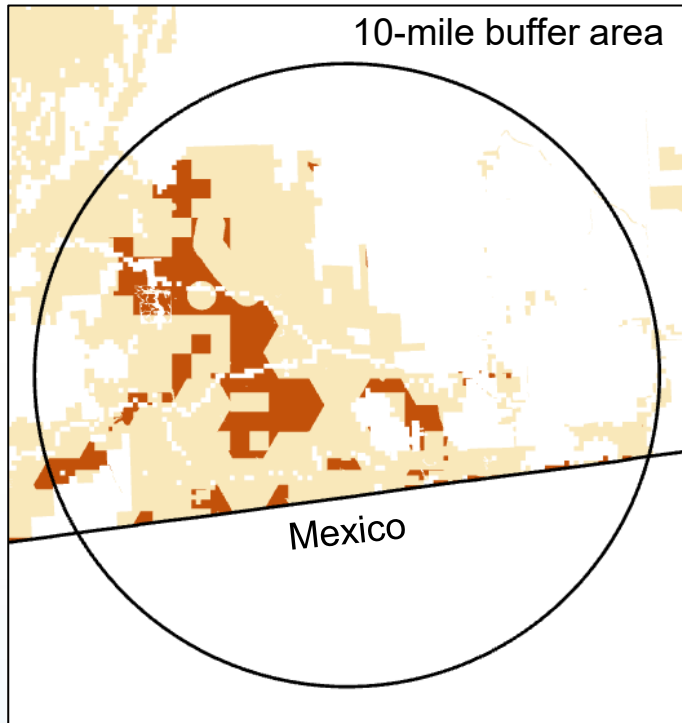
If mapping anything beyond ~106,015 acres

*Solar Capacity Density: 10 acres/MW



Wind Resources Example

Boulevard Substation and Wind Resource Potential



1

If MW mapped is less than 20% of low implication area, or 2,729 acres (~68 MW*)

2

If MW mapped is less than 50% of low implication area, or 6,823 acres (~171 MW*)

3

If MW mapped is less than 80% of low implication area, or 11,156 acres (~279 MW*)

4

If MW mapped is greater than 80% of low implication area and less than 10% of the high implication area, or between 11,156 and 17,598 acres (up to ~440 MW*)

5

If mapping anything beyond ~17,598 acres

Higher Implication Land (39,522 acres)

Lower Implication Land (13,646 acres)

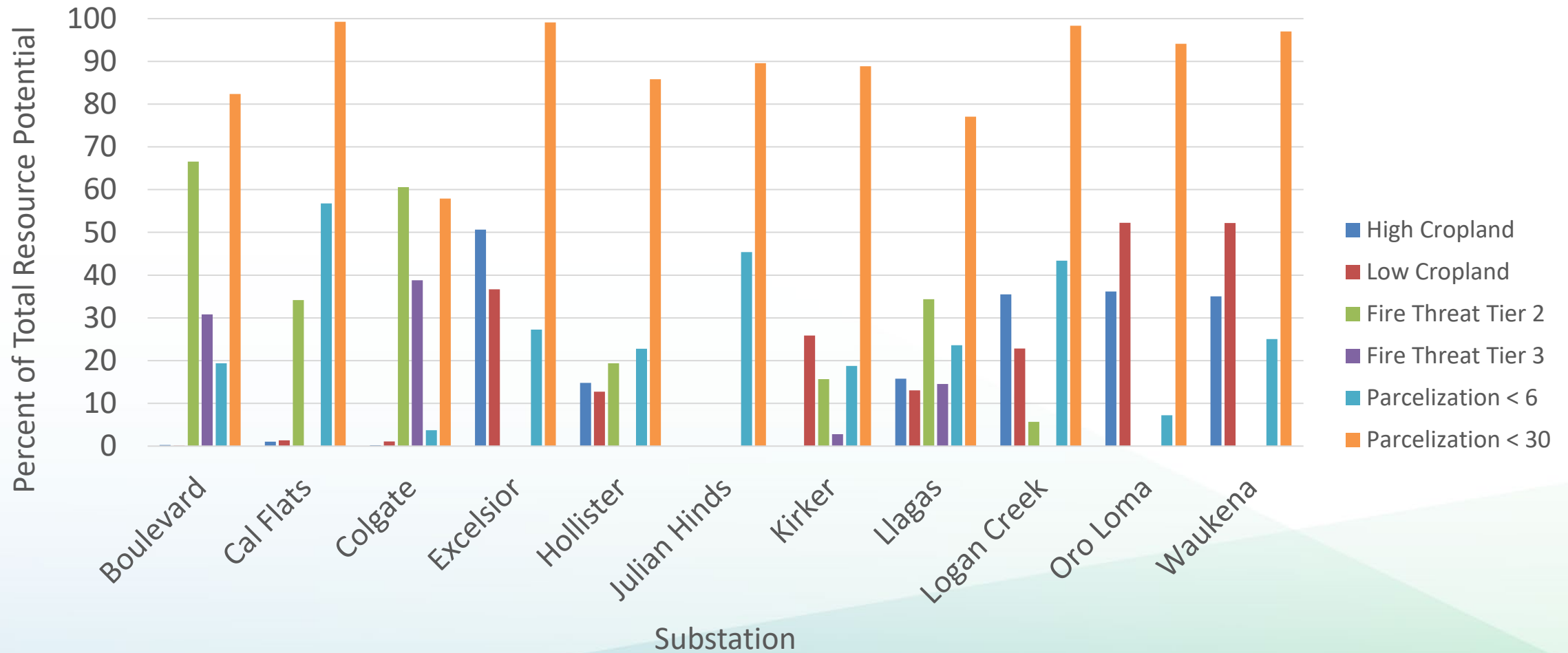
Total Resource Potential:
53,168 acres

*Wind Capacity Density: 40 acres/MW



Other Land Use Feasibility Factors

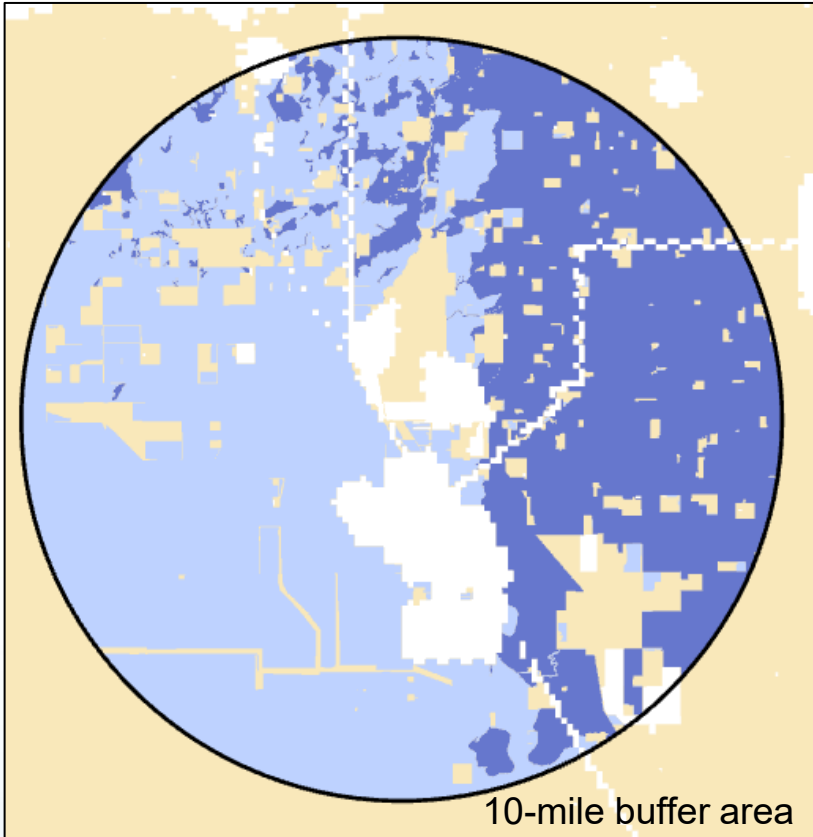
Land Use Feasibility Factors (Solar, 10-Mile Radius)





Cropland Criteria

Waukena Substation and CEC Cropland Index Model Evaluation



- Total Resource Potential Area
- Lower Cropland Index Value
- Higher Cropland Index Value

The amount of mapped resources that would utilize lower and higher implication cropland areas determines the criteria alignment level.

Within 10-Mile Buffer area	
Total Resource Potential Acres	182,366
Lower Cropland Index Value	95,210
Higher Cropland Index Value	63,933



Cropland Criteria: Exploration of Criteria Alignment Levels

- Assume MW are mapped to low implication, non-cropland areas first, then utilize cropland areas. → 232 MW

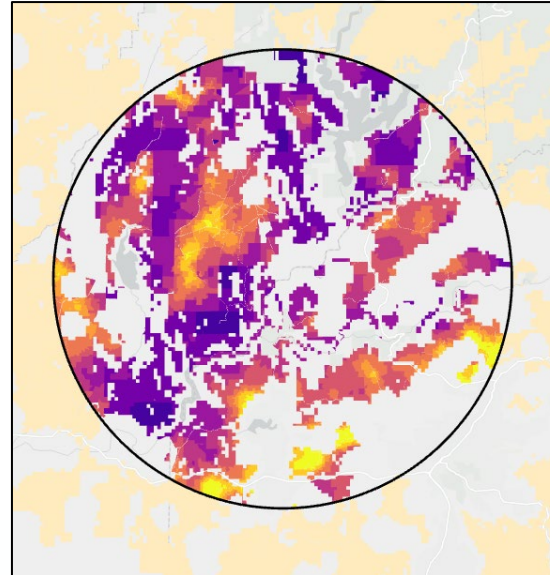
- 1** If MW mapped is less than 20% of lower cropland area and higher cropland area is less than 50% of total resource potential area; up to 2,136 MW
- 2** If MW mapped is less than 50% of lower cropland area and higher cropland area is less than 75% of total resource potential area; up to 4,993 MW
- 3** If MW mapped is less than 100% of lower cropland area; up to 9,753 MW
- 4** If MW mapped is less than 50% of higher cropland areas and all of lower cropland area utilized;
- 5** If MW mapped is greater than 50% of higher cropland areas and all of lower cropland area utilized.



Parcelization Criteria

Colgate Substation – 10-mile radius

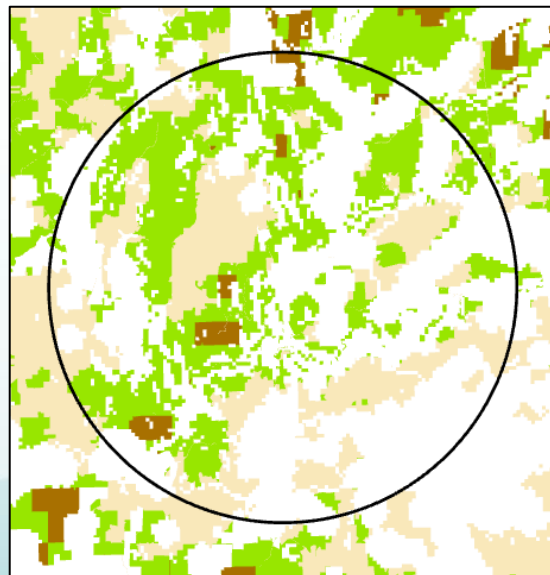
The 10th percentile value of parcelization and the MW utilization of available low to mid parcelization area determines the criteria alignment level.



Parcelization



10th Percentile: 19



- Parcelization < 6, Low (3,540 acres)
- Parcelization < 30, Mid (54,810 acres)
- Total Resource Potential Area (94,626 acres)



Colgate Examination of Parcelization Criteria Alignment Levels

Solar Resources Only

- Parcelization Level: 10th percentile value and the mapped MW utilization of the amount of the low or mid parcelization level in the total resource potential area

- MW Utilization of low or mid parcelization areas for Colgate Substation

1	< 12 AND mapped MW < 20% Low Parcelization
2	< 20 AND mapped MW < 80% Low Parcelization
3	< 30 AND mapped MW < 20% Mid Parcelization
4	Mapped MW < 80% Mid Parcelization
5	Mapped MW > 80% Mid Parcelization

<71 MW
<283 MW
<1,096 MW
<4,385 MW
>4,385 MW

- 10th Percentile value (19) already puts this substation at a level 2 alignment level



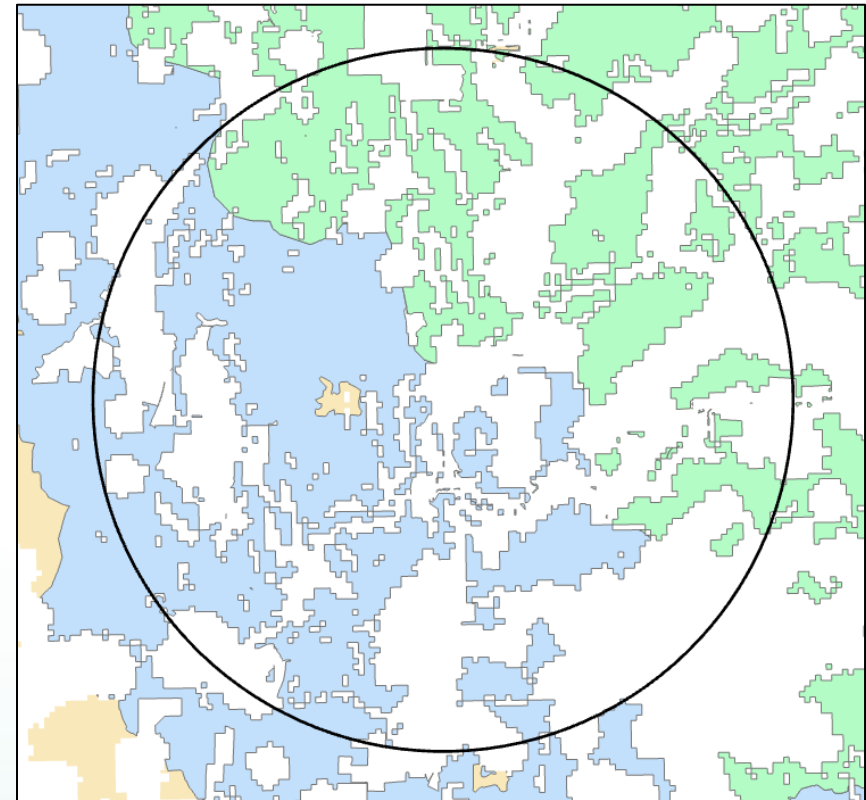
Fire Threat Criteria Alignment

The percentage of total resource potential area within a high fire threat area determines the criteria alignment level.

- 61% of total resource potential area consists of Tier 2 (Elevated) Fire Threat
- 39% of total resource potential area consists of Tier 3 (Extreme) Fire Threat

1	< 20% Tier 2 AND No Tier 3
2	< 50% Tier 2 or Tier 3 AND <10% Tier 3
3	< 75% Tier 2 or Tier 3 AND <20% Tier 3
4	< 75% Tier 2 or Tier 3 AND <30% Tier 3
5	> 75% Tier 2 or Tier 3 AND >30% Tier 3

Colgate Substation – 10-mile radius

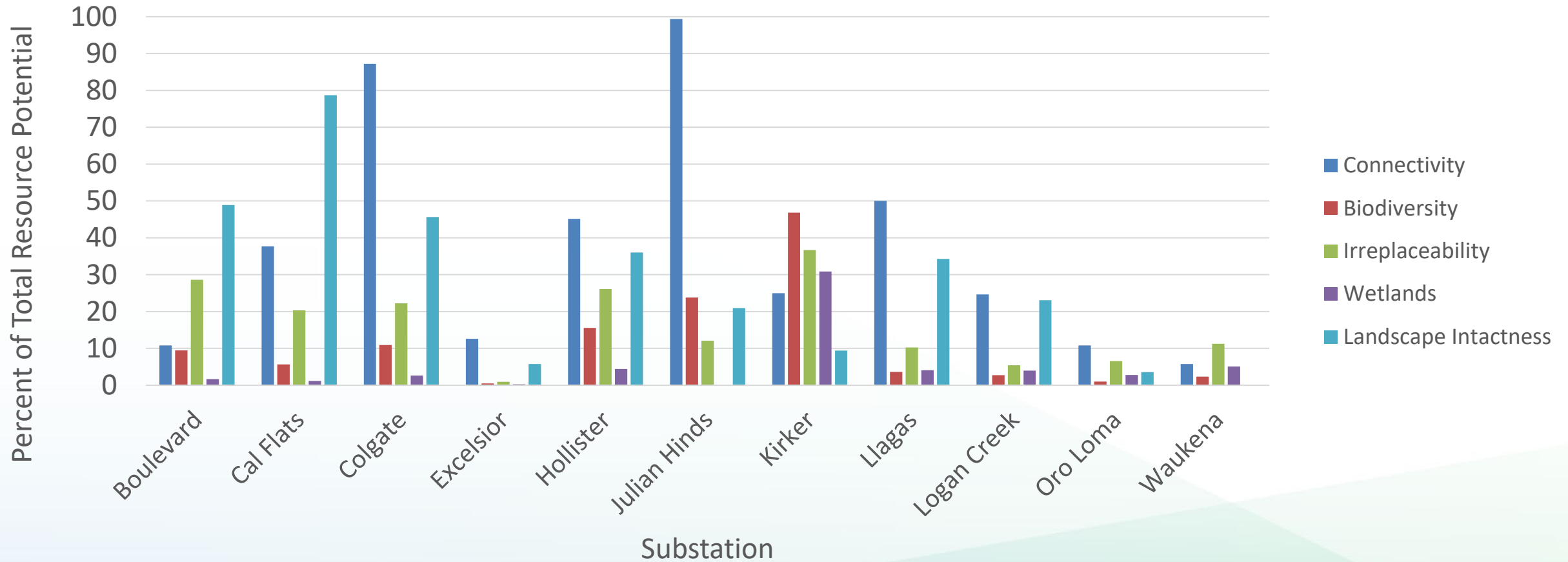


- Fire Threat Tier 2 (Elevated)
- Fire Threat Tier 3 (Extreme)
- Total Resource Potential Area



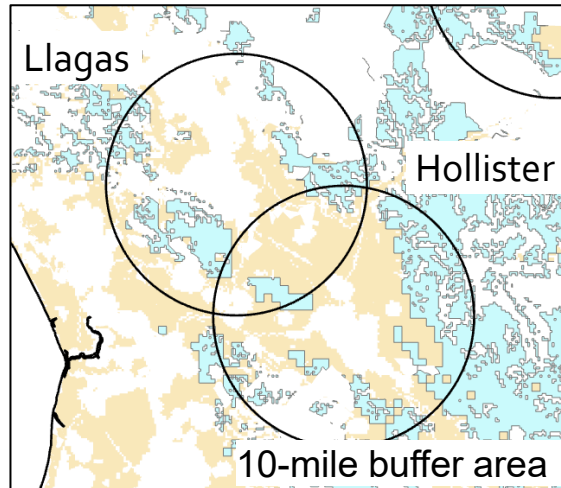
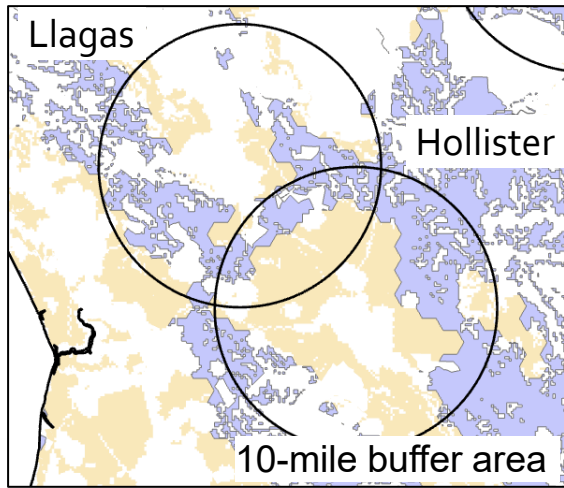
Environmental Implications

Percentage of Environmental Factors within Available Land Area (Solar, 10-Mile Buffer Radius)





Terrestrial Intactness and Connectivity Criteria Alignment



- High Landscape Intactness
- Terrestrial Connectivity, Ranks 4 and 5
- Total Resource Potential Area

Total Area of Intersection of High Connectivity:

- Llagas: 46,833 acres
- Hollister: 57,370 acres

Total Area of Intersection of High Intactness:

- Llagas: 32,090 acres
- Hollister: 45,789 acres

10-Mile Buffer Radius Metrics	Total Resource Potential (Acres)
Llagas	93,618
Hollister	127,098

The MW utilization of low implication acres and the percent of total resource potential area of high environmental characteristic determines the level of alignment.



Examination of Alignment Level

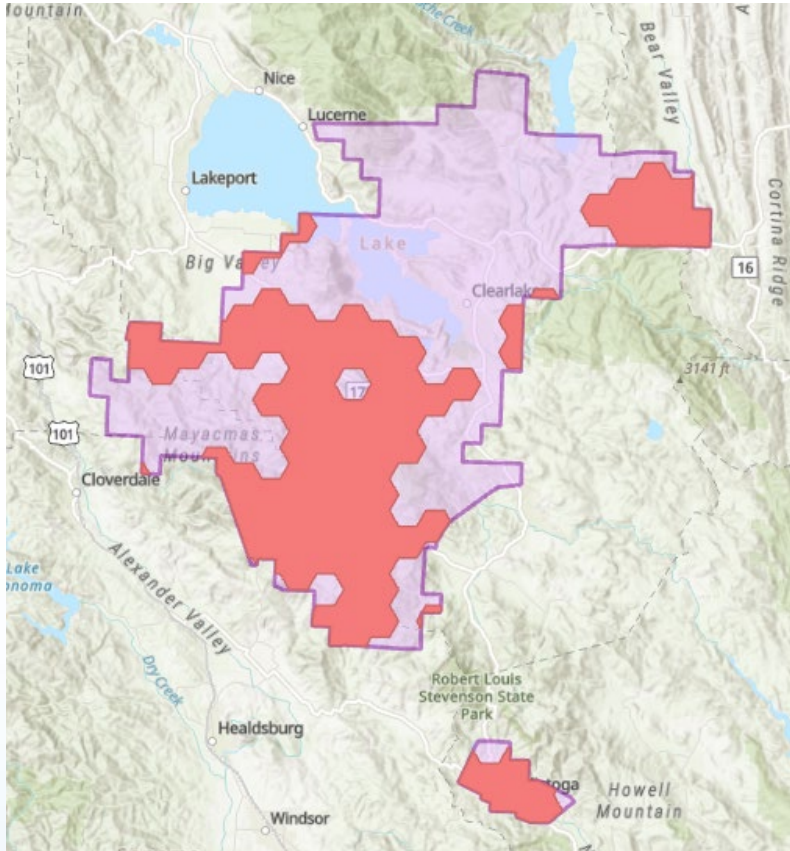
Analysis I: Mapped Resources Utilization of Low Implication Land	Level 1 (20%)	Level 2 (50%)	Level 3 (75%)	Level 4 (10% beyond lower implication area)	Level 5 (above 10%)
Llagas (intactness)	< 1,231 MW	< 3,076 MW	< 4,614 MW	< 6,474 MW	Above 6,474 MW
Llagas (connectivity)	< 936 MW	< 2,339 MW	< 3,506 MW	< 5,147 MW	Above 5,147 MW
Hollister (intactness)	< 1,626 MW	< 4,065 MW	< 6,098 MW	< 8,705 MW	Above 8,705 MW
Hollister (connectivity)	< 1,395 MW	< 3,486 MW	< 5,230 MW	< 7,547 MW	Above 7,547 MW



Analysis II: percent of total resource potential areas	Connectivity	Landscape Intactness
Llagas	50%	34%
Hollister	45%	36%



Geothermal Assessment

Geysers and Calistoga Geothermal Fields

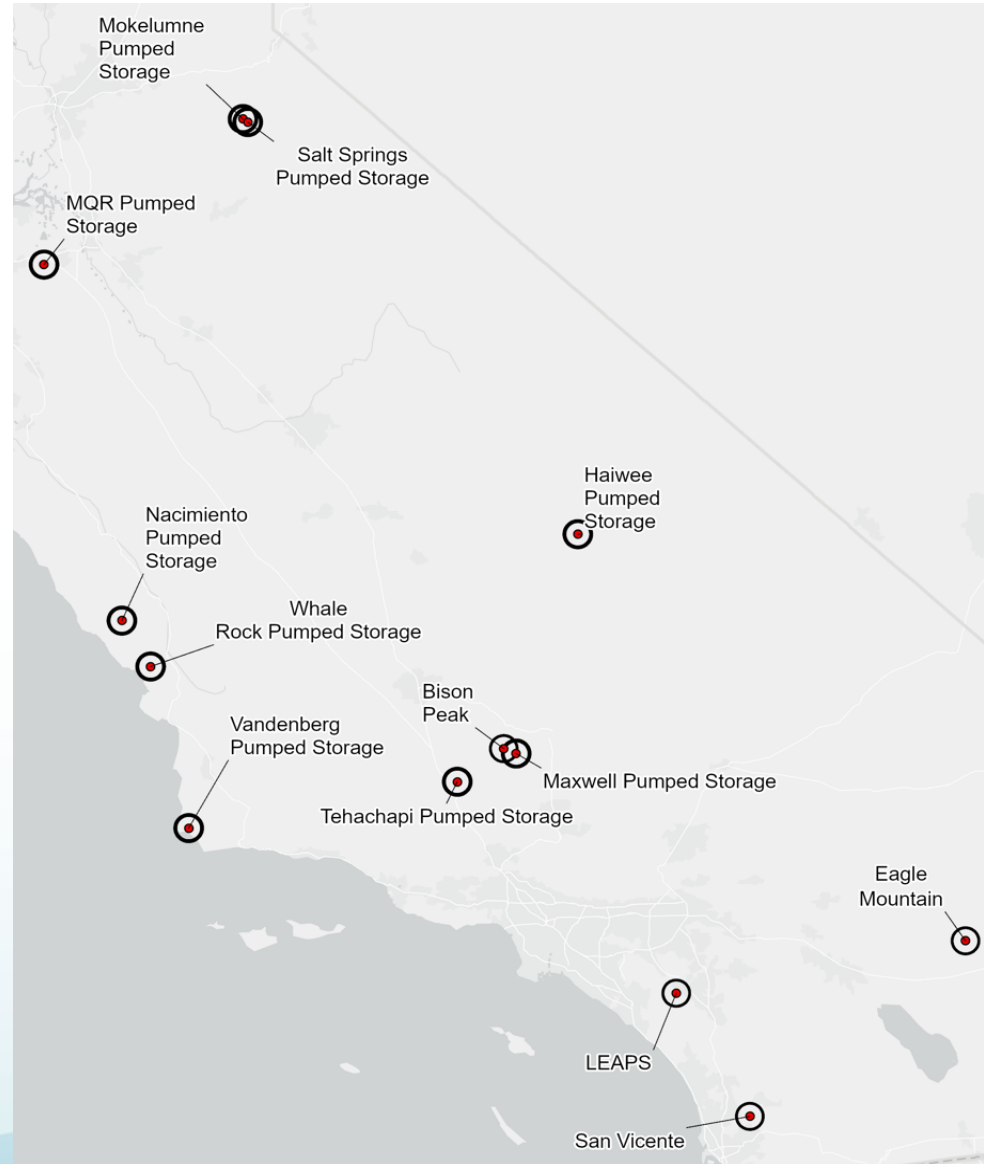


-  High Biodiversity
-  Geothermal Field

- Metrics are calculated for each geothermal field:
 - Percentage of geothermal field with high environmental characteristics
 - Percentage utilization of low implication area
- Criteria alignment levels are determined for each field using the same threshold settings and analyses as for solar and wind
- This information is applied to a nearby substation that is likely to interconnect the resource(s)

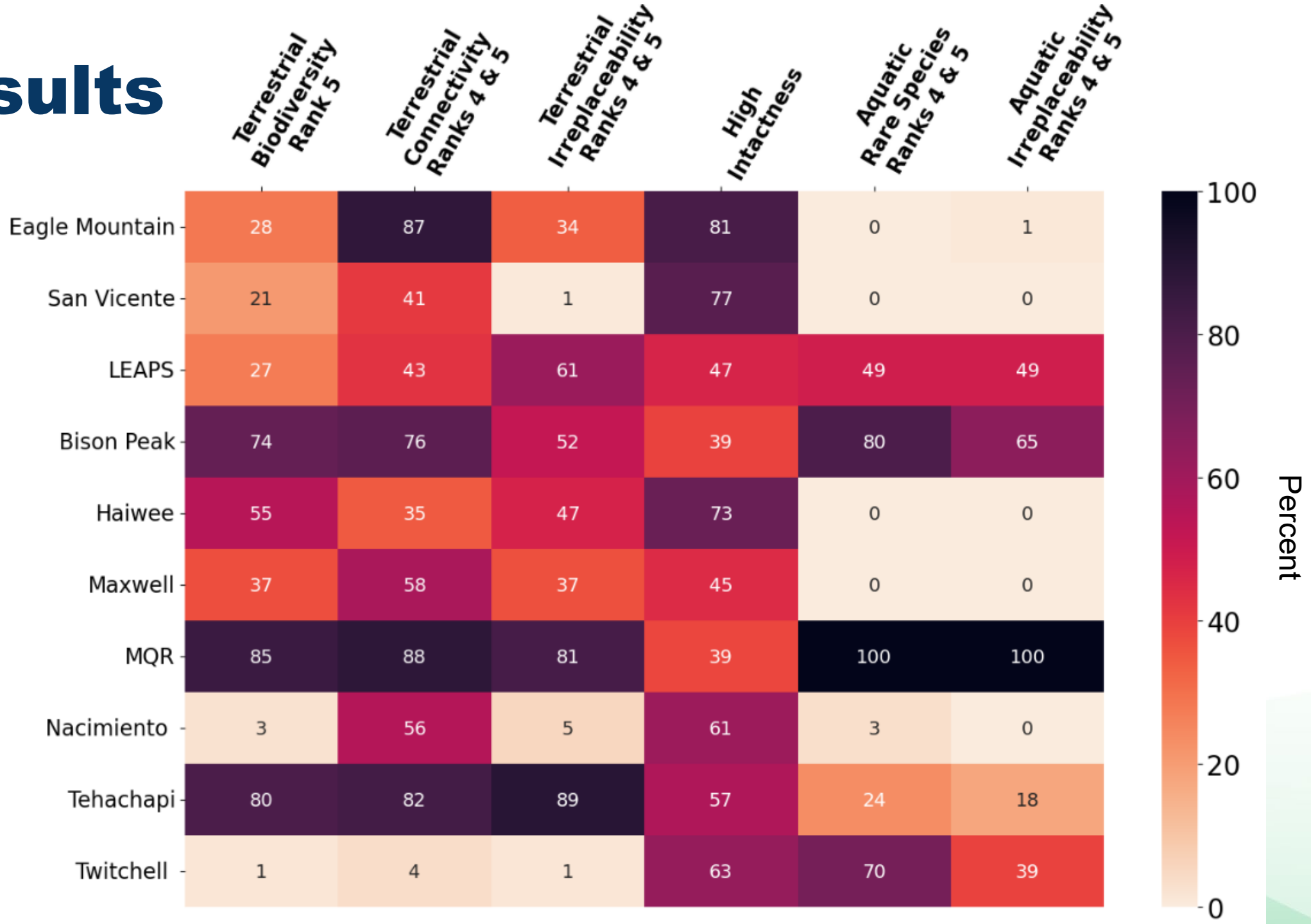


Pumped Storage Hydropower





Results

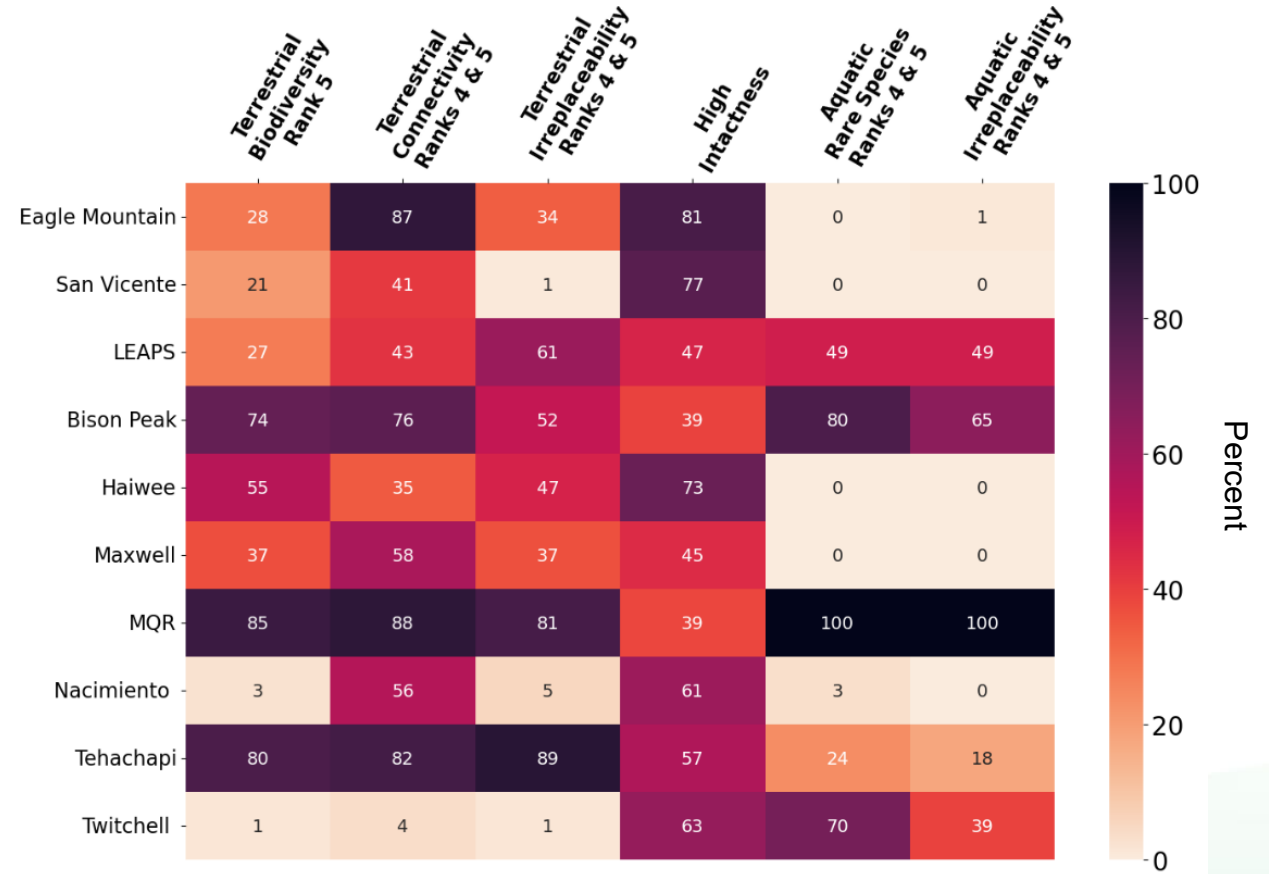




Results

Thresholds to Determine Criteria Alignment Level

1: < 50%
2: < 70%
3: < 90%
4: < 95%
5: > 95%





Summary of Topics Presented

- Methods for determining land use and environmental metrics around a substation
- Application of land use and environmental metrics for criteria alignment
- Main approach: wind and solar
 - Two groups of metrics:
 - Land use feasibility
 - Environmental (conservation and biological) implications
 - Mapped MW utilization of lower implication land
 - Percentage of total resource potential with high environmental characteristics
- Slightly different approach: geothermal and pumped storage hydropower resources



Thank you!

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Key Terms

- **Low Implication Land:** Area remaining after applying the CEC Core Land Use Screen. This land area is considered as having lower constraints according to the components of the Core Land Use Screen. Implication is defined as a possible significance or consequence of an action. For example, planning for energy infrastructure in areas within the Core Land Use Screen has implications for other land-use planning priorities. This term can also be applied to a specific environmental variable.
- **Total Resource Potential Area:** Land area remaining after removing the protected area layer and the techno-economic exclusion layer.
- **Core Land Use Screen:** A land use screen developed by the CEC that addresses several state policy priorities, including sustaining agriculture and protecting natural lands that support biodiversity. It includes statewide information about intact landscapes.
- **Techno-economic Exclusion Layer:** A GIS layer made up of spatial datasets that capture technical (for example, competitive wind resource locations), physical (for example, slope, water bodies), and socio-economic or hazardous criteria (for example, densely populated areas, railways, airports, highways, mines). This category also includes military lands. CPUC staff provided this exclusion set.
- **Protected Area Layer:** A GIS layer designed to encompass areas where utility-scale renewable energy or transmission development is precluded by state or federal law, policy or regulation.
- **Parcelization:** A measure of the average number of unique land parcels in a 0.5-mile radius.
- **Rank:** A final scoring index used in California Department of Fish and Wildlife's (CDFW) Areas of Conservation Emphasis (ACE) datasets to indicate the level of importance for conservation of each factor. For biodiversity and irreplaceability, ranks are defined by a quantile distribution of the raw summary data within each ecoregion, showing the relative level of importance for each variable. For connectivity, each rank is defined as its own category, with ranks 4 and 5 containing the most important attributes for conservation.



Data Sources for Metrics

- ACE Terrestrial Biodiversity Rank 5
<https://caenergy.maps.arcgis.com/home/item.html?id=d0bf5ee8dd0945f4aaaa98c5d8b3ecb5>
- ACE Terrestrial Connectivity Ranks 4 and 5
<https://caenergy.maps.arcgis.com/home/item.html?id=6379aba13aa5405b86ea4bb8de0e0abb>
- ACE Terrestrial Irreplaceability Ranks 4 and 5
<https://caenergy.maps.arcgis.com/home/item.html?id=3f94d0384f7542dcba2216635e8d103e>
- ACE Aquatic Irreplaceability Ranks 4 and 5
https://data.cnra.ca.gov/nb_NO/dataset/aquatic-irreplaceability-summary-ace-ds2752
- ACE Aquatic Rare Species Richness Ranks 4 and 5
https://data.cnra.ca.gov/nb_NO/dataset/aquatic-rare-species-richness-summary-ace-ds2748
- CDFW Wetlands
<https://caenergy.maps.arcgis.com/home/item.html?id=fe5a4336db404333887c3b54a3985ece>
- CBI Landscape Intactness (>Mean)
<https://caenergy.maps.arcgis.com/home/item.html?id=4311305423d847189205b8245dd435fb>
- CEC Cropland Index Model (>Mean)
<https://caenergy.maps.arcgis.com/home/item.html?id=83d4c6a2e9b04c0a925d5aa61d235437>
- CPUC Fire-Threat Map
<https://www.cpuc.ca.gov/industries-and-topics/wildfires/fire-threat-maps-and-fire-safety-rulemaking>
- Base Exclusions (to derive total resource potential area):
<https://caenergy.maps.arcgis.com/home/item.html?id=5648df9222964820a2431ffc897da5a3> and
<https://caenergy.maps.arcgis.com/home/item.html?id=d57834feacea4606b1dc6ac8dc5f72d5>
- Parcelization:
[Calculating Parcelization for Electric System Planning | California Energy Commission](#)

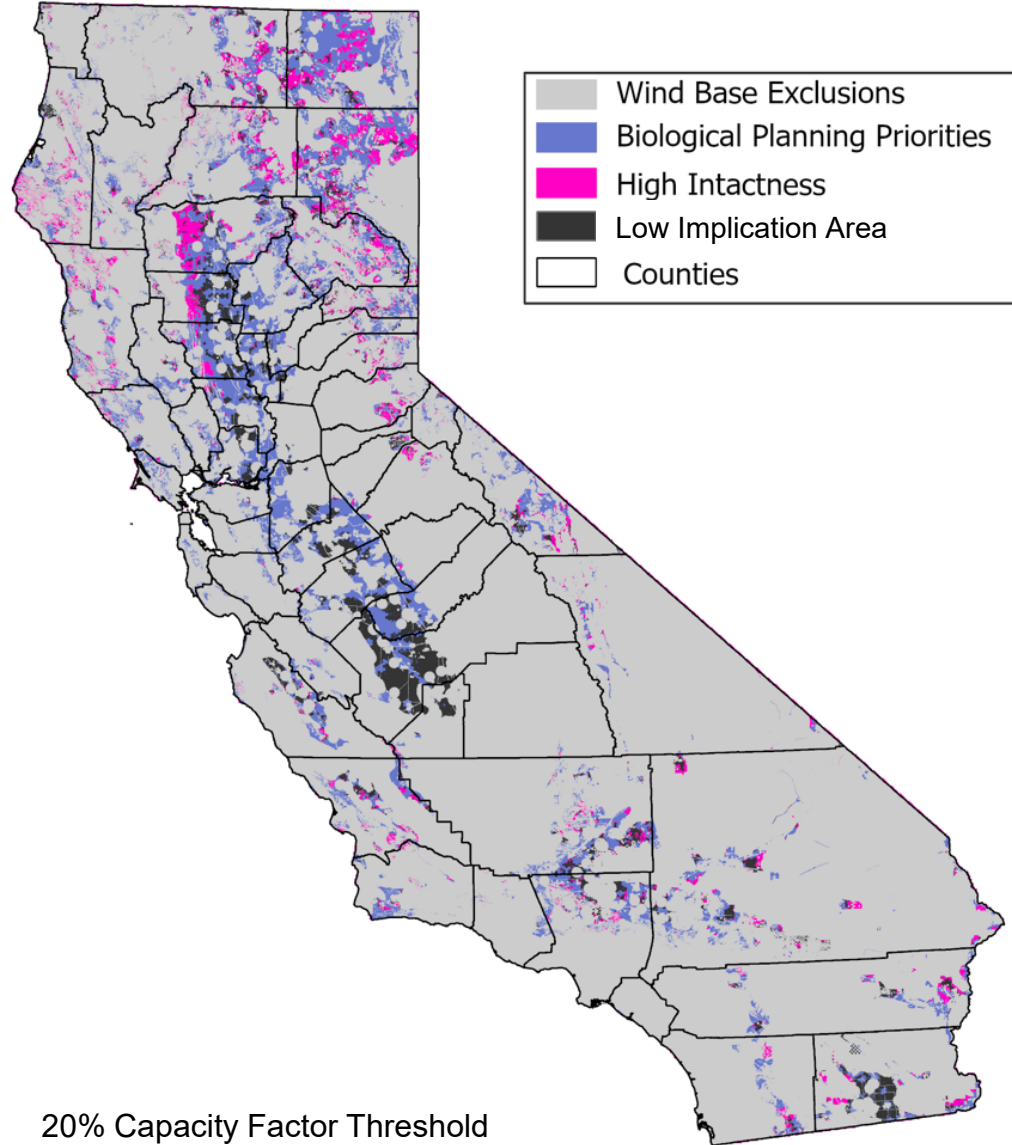


Substations Highlighted in this Presentation



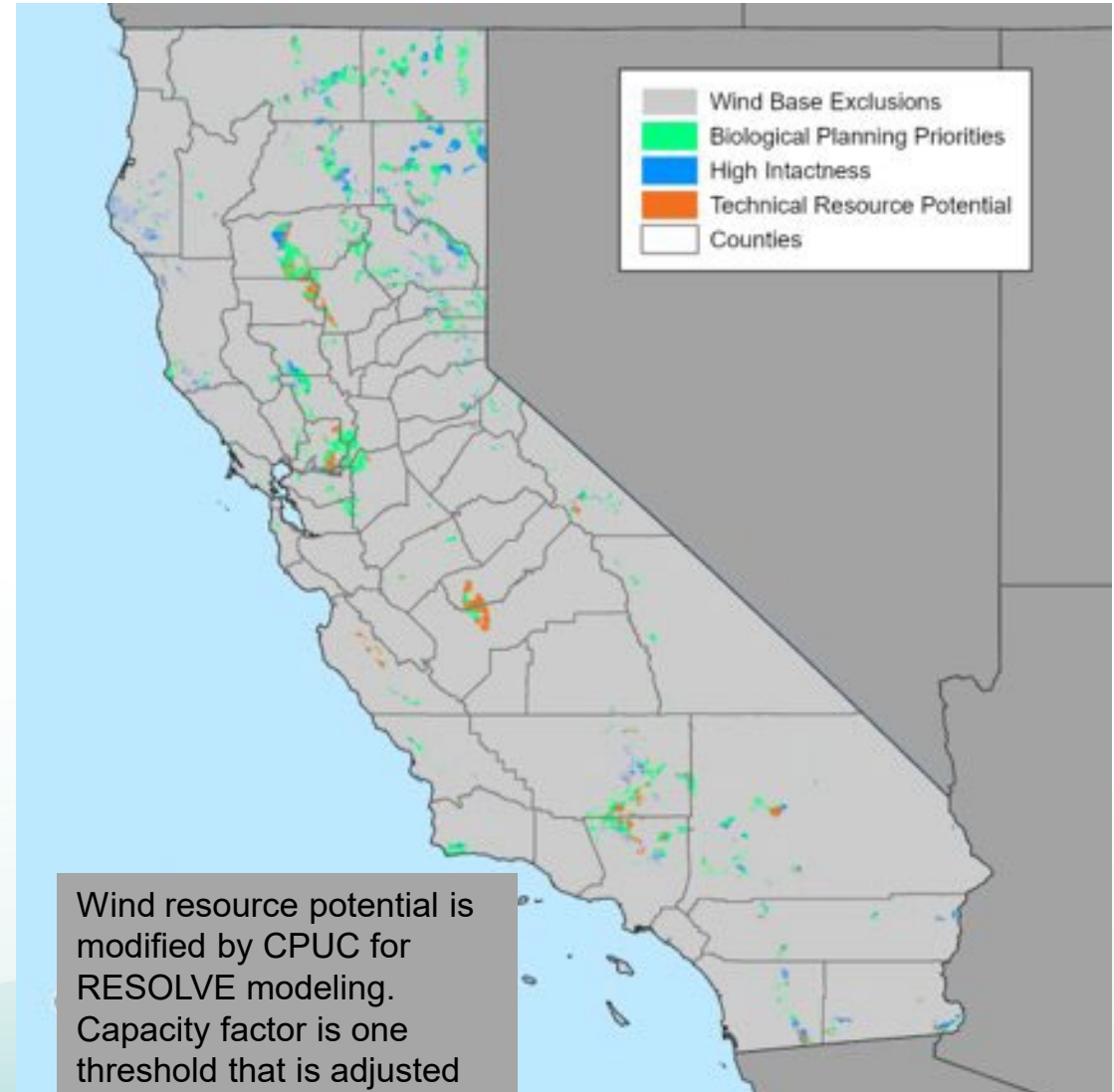


Core Land Use Screen (Wind)



20% Capacity Factor Threshold

Core Land Use Screen (CPUC Adjusted with 28% Capacity Factor Threshold)



Wind resource potential is modified by CPUC for RESOLVE modeling. Capacity factor is one threshold that is adjusted among other criteria.



RESOLVE Regions

