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Renewable Energy Transmission Initiative 2.0 (RETI 2.0)

Transmission Technical Input Group (TTIG) Update

August 15, 2016

TTIG Background

Goals and Objectives:

The Transmission Technical Input Group will assemble relevant in-state and west-wide transmission capability and upgrade cost information to inform resource development conservations on the reasonably-needed transmission system implications and to assist in the developing potential corridor scenarios.

TTIG participants include all California Transmission Planning Entities

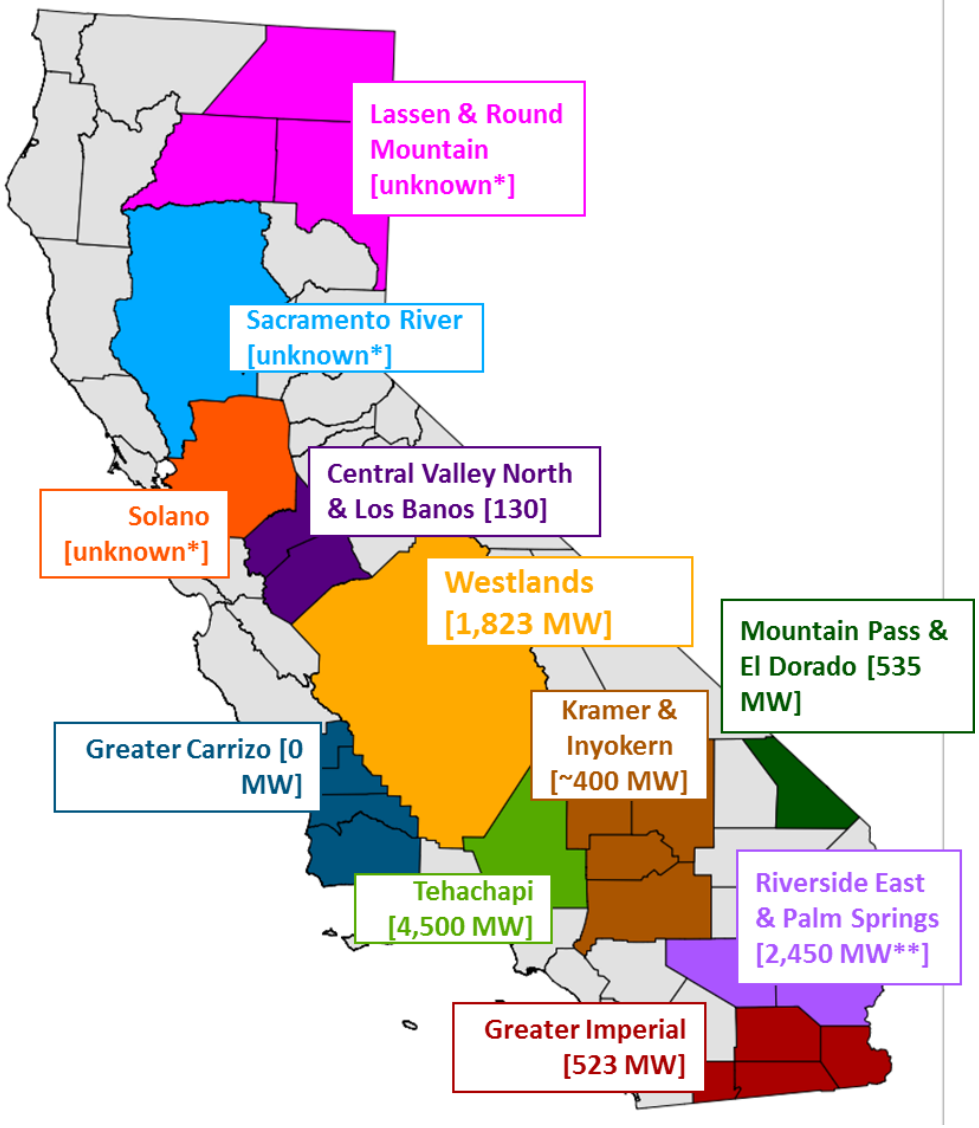
Sacramento Municipal Utility District	California Independent System Operator
Imperial Irrigation District	Los Angeles Department of Water and Power
Silicon Valley Power	Turlock Irrigation District
Modesto Irrigation District	Western Area Power Administration - SNR
San Francisco PUC	Transmission Agency of Northern California
City of Santa Clara	Pacific Gas & Electric
Southern California Edison	San Diego Gas & Electric

TTIG Deliverables Status

Identified Deliverables	Status
Characterize **existing transmission system capacity** and planned improvements/ changes and their implications for accessing additional renewable resources	TTIG stakeholder Workshop Interim Report June 9, 2016
Provide **initial transmission input on likely in-state developments** necessary to access potential renewable generation and refine the data as combinations of renewable resources are developed through other RETI groups' activities	TTIG Stakeholder Workshop July 29, 2016
Compile transmission planning information on **potential WECC-wide system reinforcements** that may provide or improve access to renewable generation or to integration resources	Interim Report June 9, 2016 and WIEB outreach project; Aug-Sept
Work interactively with RETI Plenary Group to evaluate transmission implications for accessing potential renewable energy generation areas	Sept-Oct

California ISO Fully Deliverable Capability Estimate

- Sufficient capacity to meet 33% RPS but not 50% RPS
- Additional capacity would be required to meet 50% RPS with full deliverability



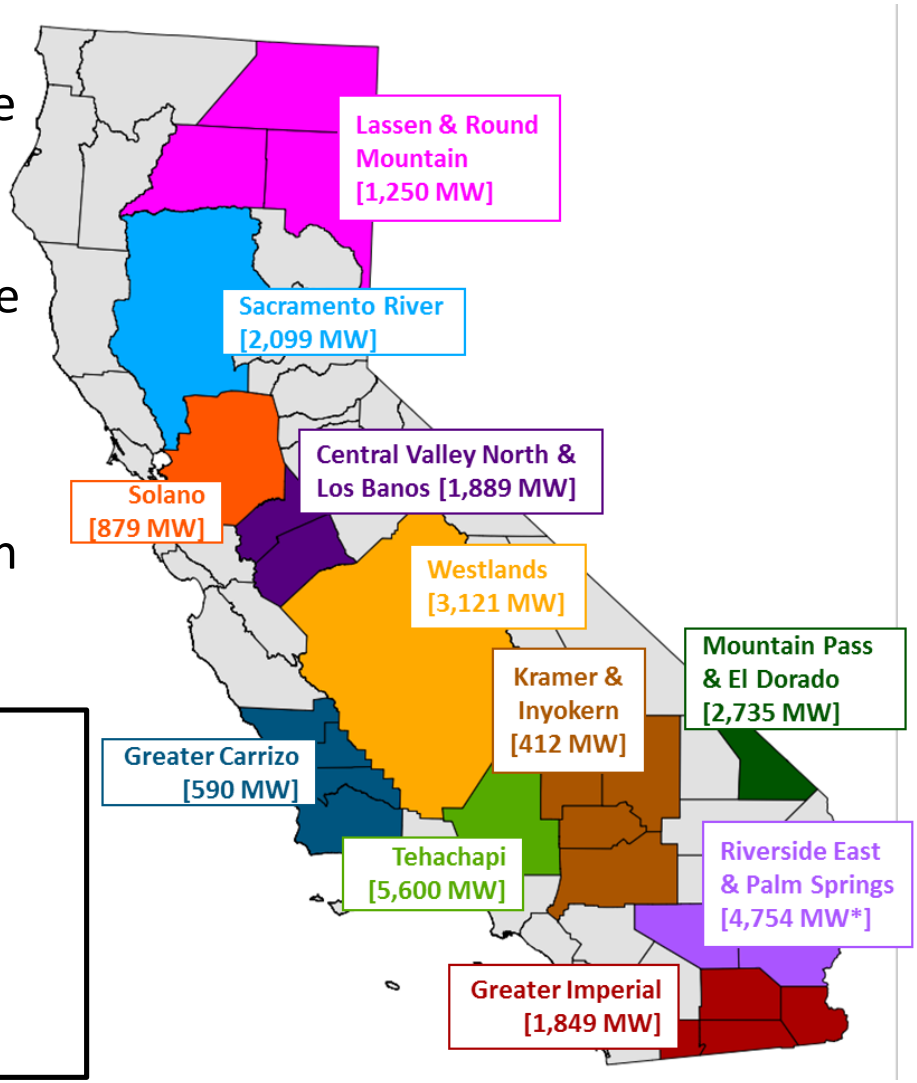
**Note: Not enough information available for transmission areas with little or no commercial interest*
***Note: West of Devers upgrade factored in*

California ISO Energy-Only (EO) Capability Estimate

- There is significant transmission available to accommodate resources beyond 33% on an "energy only" basis (with some concerns that Northern CA values may be optimistic)
- May allow faster and less expensive resource interconnection
- EO capacity areas generally comport with commercial interests

Estimated EO capacity is over 22,000 MW subject to curtailment

- *Being assessed again as part of the 50% special study in the 2016-2017 TPP*
- *The sufficiency of EO from a policy perspective is yet to be determined*



***Note: West of Devers upgrade factored in**

TAFA Evaluation – Proposed Study Ranges

Import – CA-OR Intertie (study range: ~2,000 MW)

Northern CA
Sacramento River Valley (study range: ~1,000 MW)
Solar: 2,000 MW
Wind: 1,000 MW
Geothermal: 0 MW
Lassen and Round Mountain (study range: ~2,500 MW)
Solar: 1,000 MW
Wind: 1,000 MW
Geothermal: 450 MW

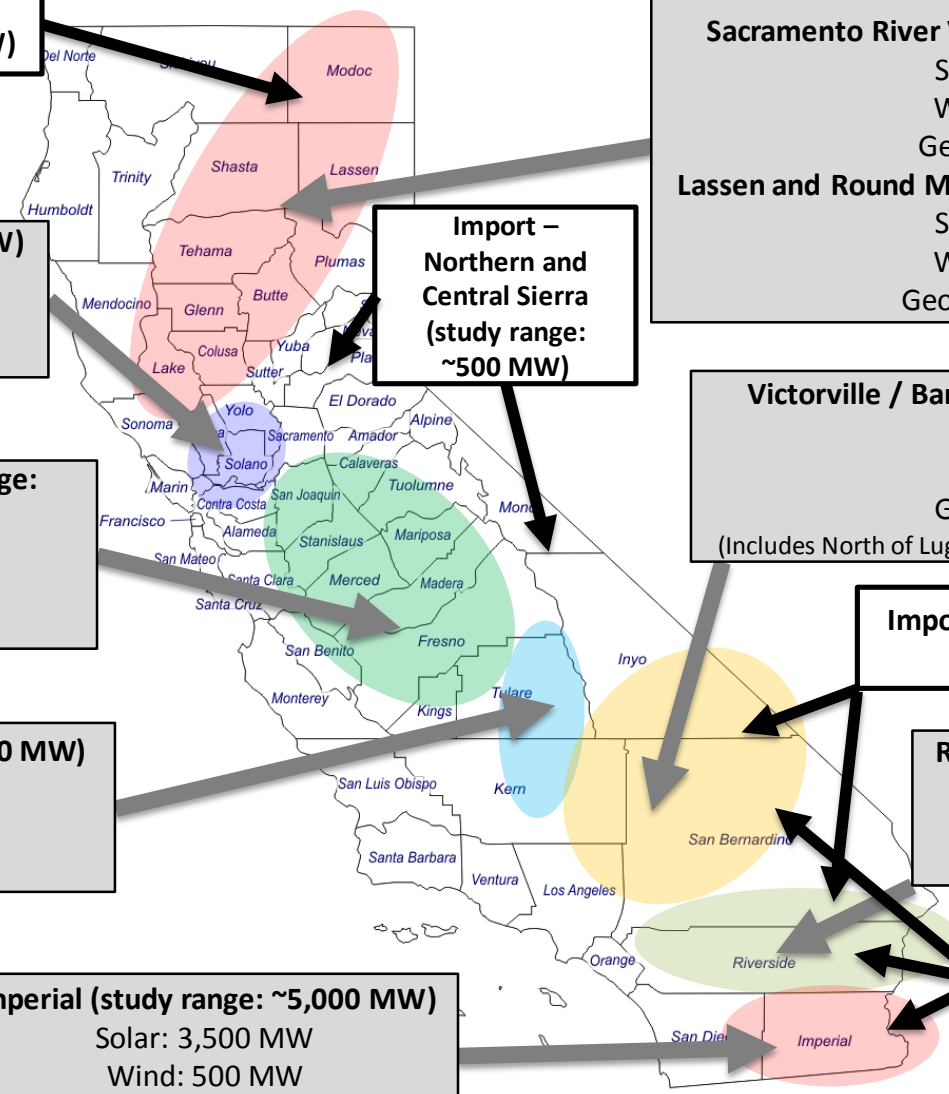
Solano (study range: ~1,000 MW)
Solar: 2,000 MW
Wind: 1,000 MW
Geothermal: 0 MW

Import – Northern and Central Sierra (study range: ~500 MW)

Victorville / Barstow (study range: ~5,000 MW)
Solar: 4,500 MW
Wind: 500 MW
Geothermal: 0 MW
(Includes North of Lugo, East of Lugo, Lucerne, San Bernardino)

San Joaquin Valley (study range: ~5,000 MW)
Solar: 5,000 MW
Wind: 0 MW
Geothermal: 0 MW

Import – Eldorado/Mead/Marketplace (study range: ~3,000 MW)



Tehachapi (study range: ~5,000 MW)
Solar: 4,500 MW
Wind: 500 MW
Geothermal: 0 MW

Riverside (study range: ~5,000 MW)
Solar: 4,000 MW
Wind: 1,000 MW
Geothermal: 0 MW

Import – Palo Verde/Delaney (study range: ~3,000 MW)

Imperial (study range: ~5,000 MW)
Solar: 3,500 MW
Wind: 500 MW
Geothermal: 1,000 MW

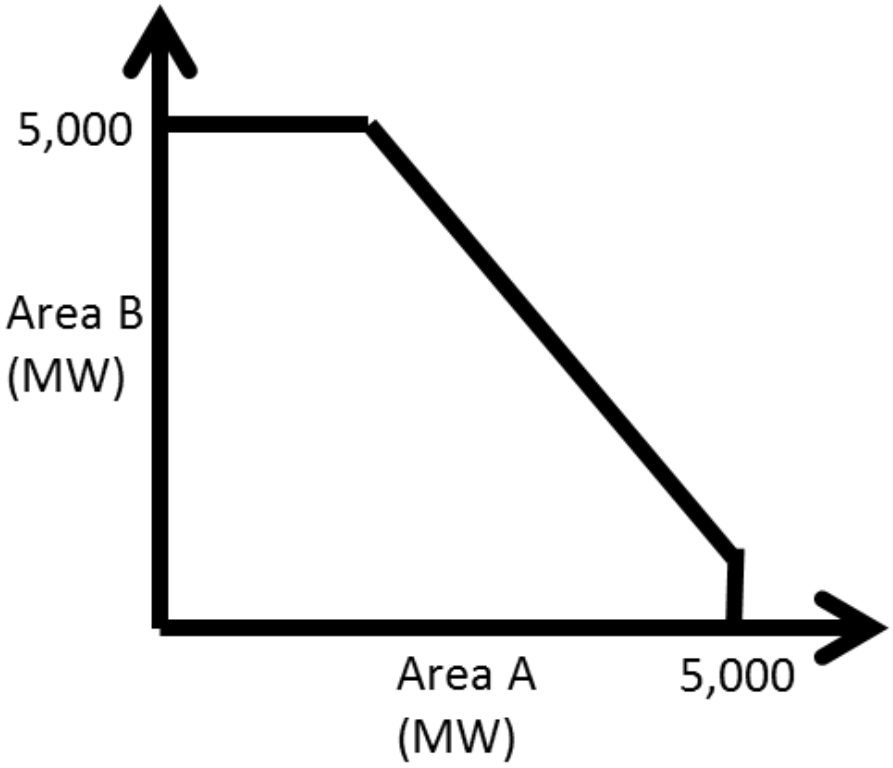
Transmission Assessment Focus Areas (TAFAs)

Study Ranges Hypothetical additions of new renewable resources	
Delivery Area or path	**Study Range of New Capacity (MW)**
Tehachapi	Up to 5000
Victorville/Barstow	Up to 5000
Riverside East	Up to 5000
Imperial Valley	Up to 5000
San Joaquin Valley	Up to 5000
Solano	1500-3000
Sacramento River Valley	1500-3000
Lassen / Round Mountain	1450-2450
Path 46 / Palo Verde / Delaney	Up to 3000
Path 46 / Eldorado / Marketplace	Up to 3000
Path 66 / California-Oregon Intertie	Up to 2000
Central/Northern Sierra (Path 76; Path 24; Path 52)	Up to 500

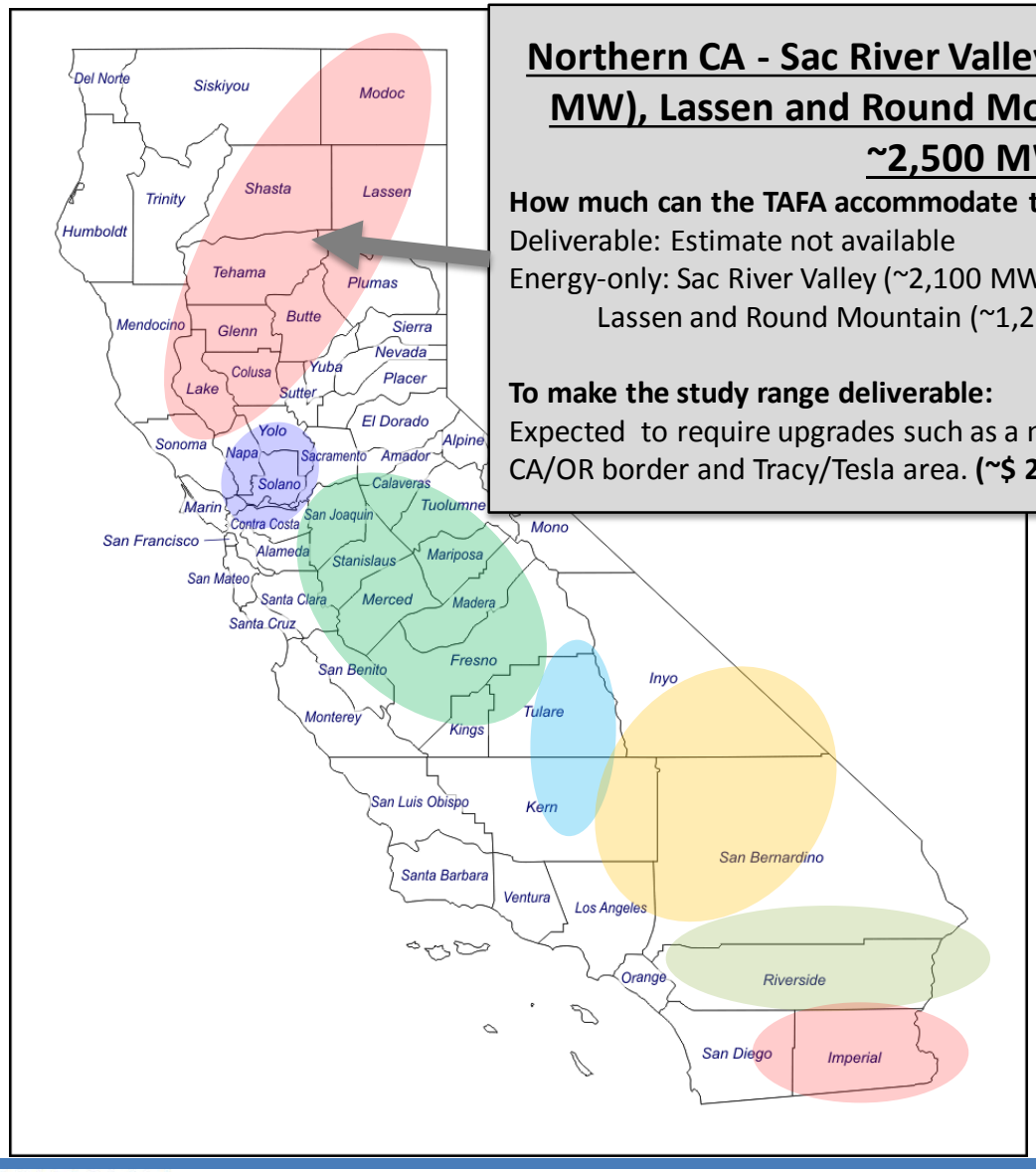
Interaction Between TAFAs

Not all capacity from all transmission areas is simultaneously available

- Transmission capacity is dynamic – resources additions in one area may impact transmission availability in another area
- Mitigating a constraint that limits multiple TAFAs can benefit two or more renewable development areas
- The TAFA capacity assumes all incremental MW in each area to be FCDS (for the purpose of identifying conceptual upgrades)
- Specific studies will be required to estimate impact of a mix of resources across TAFAs



Northern CA TAFA – Evaluation Summary



Northern CA - Sac River Valley (study range: ~1,000 MW), Lassen and Round Mountain (study range: ~2,500 MW)

How much can the TAFA accommodate today?

Deliverable: Estimate not available

Energy-only: Sac River Valley (~2,100 MW)

Lassen and Round Mountain (~1,250 MW)

To make the study range deliverable:

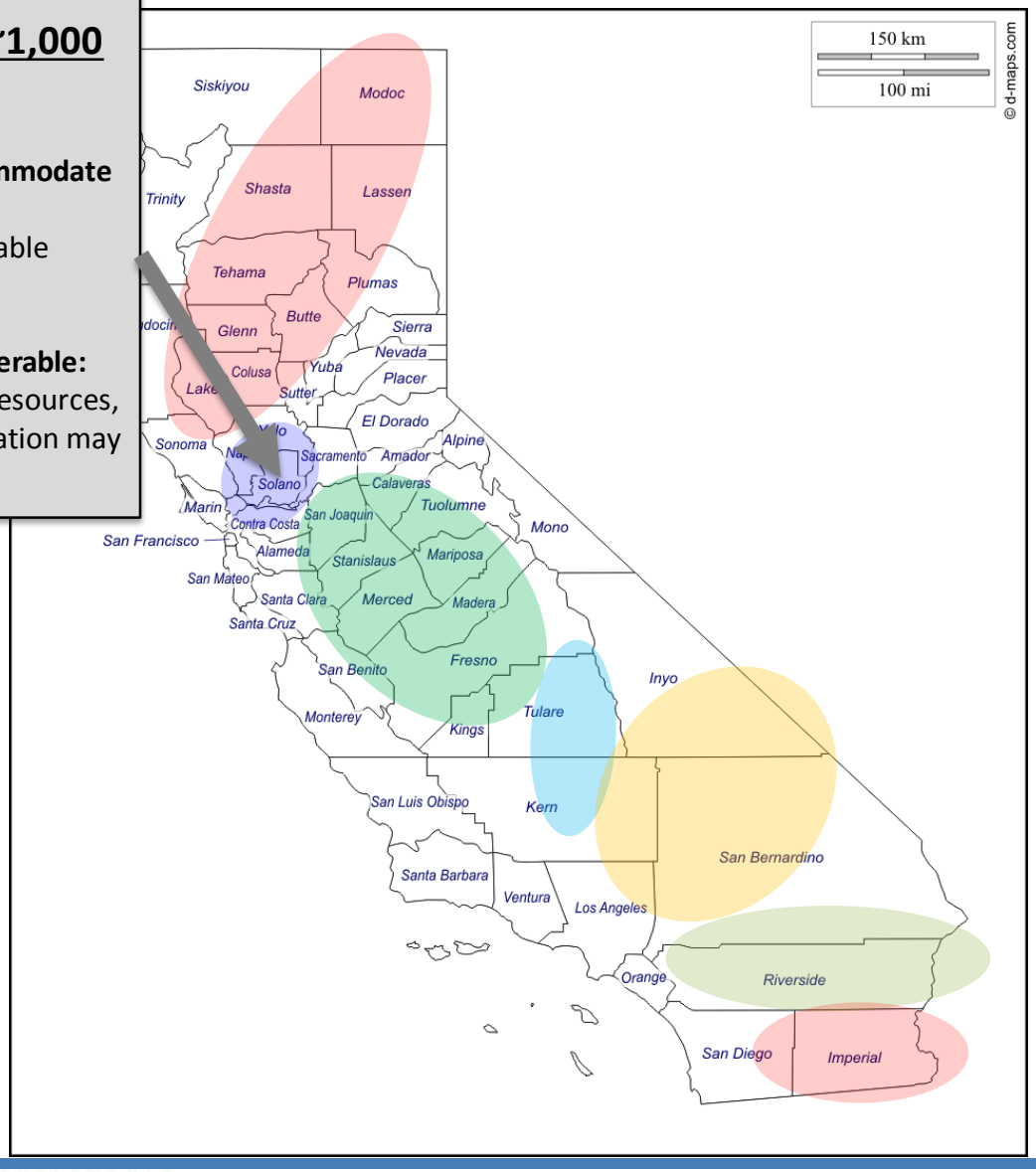
Expected to require upgrades such as a new 500 kV line between CA/OR border and Tracy/Tesla area. **(~$ 2-4 billion)**

Solano TAFA – Evaluation Summary

Solano (study range: ~1,000 MW)

How much can the TAFA accommodate today?
Deliverable: Estimate not available
Energy-only: ~880 MW

To make the study range deliverable:
Depending on the location of resources, a 230 kV or 500 kV collector station may be needed.

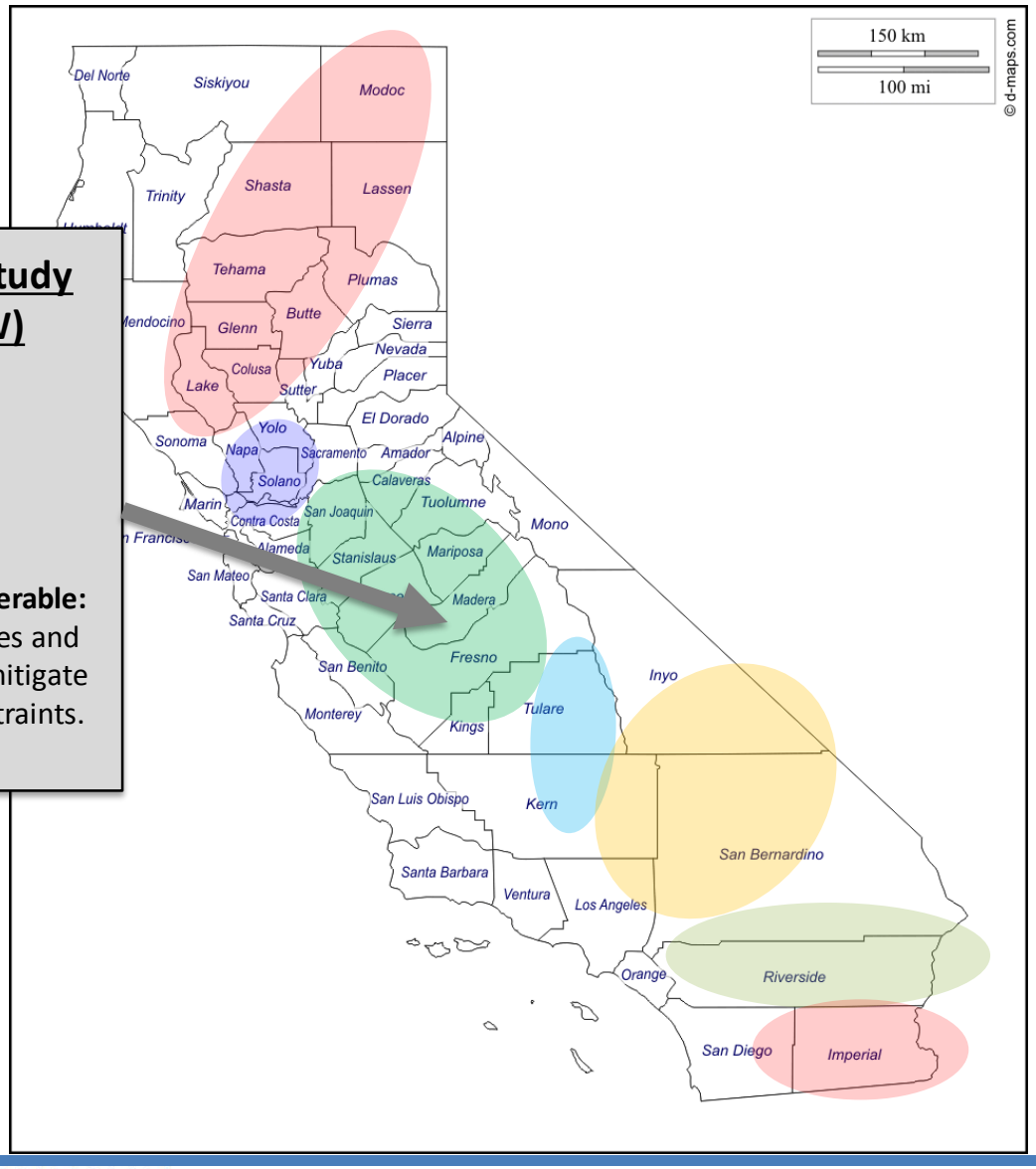


San Joaquin Valley TAFA – Evaluation Summary

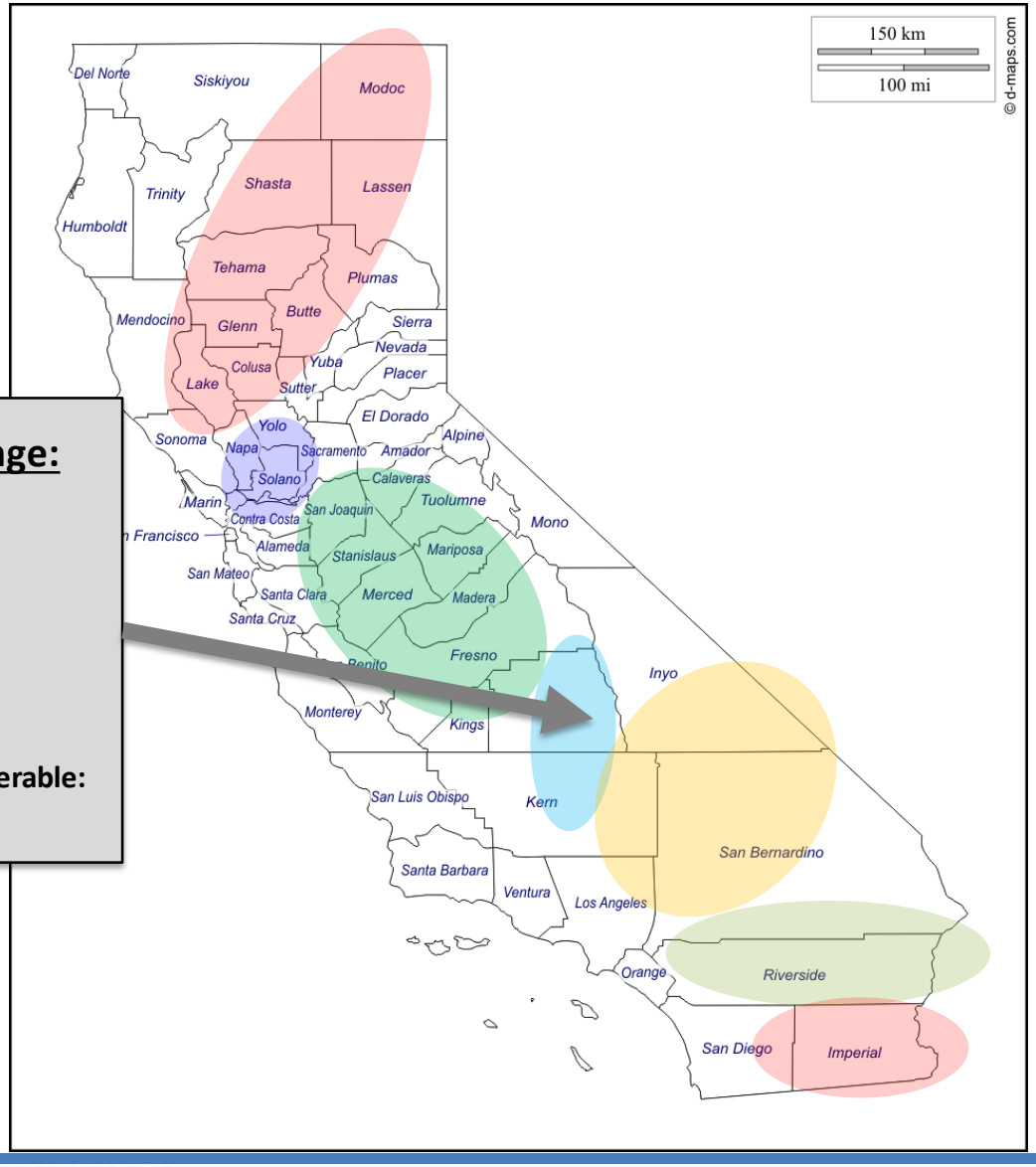
San Joaquin Valley (study range: ~5,000 MW)

How much can the TAFA accommodate today?
Deliverable: ~1,823 MW
Energy-only: ~3,131 MW

To make the study range deliverable:
Several upgrades between Gates and Los Banos will be required to mitigate 230 kV, 115 kV and 70 kV constraints.
(~$440 million)



Tehachapi TAFA – Evaluation Summary

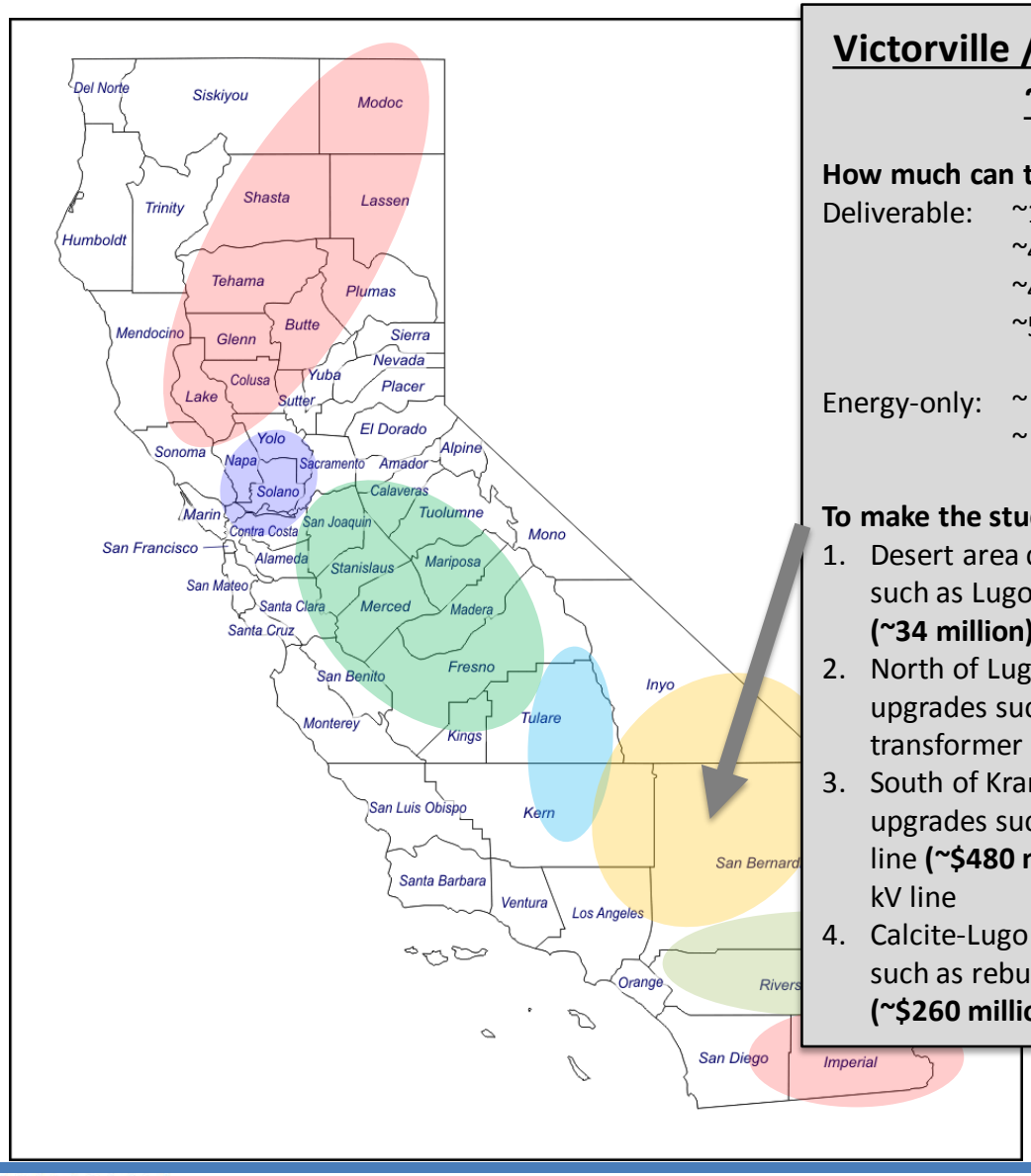


Tehachapi (study range: ~5,000 MW)

How much can the TAFA accommodate today?
Deliverable: ~4,500 MW
Energy-only: ~5,600 MW

To make the study range deliverable:
No area-wide issues expected.

Victorville/Barstow TAFA – Evaluation Summary



Victorville / Barstow (study range: ~5,000 MW)

How much can the TAFA accommodate today?

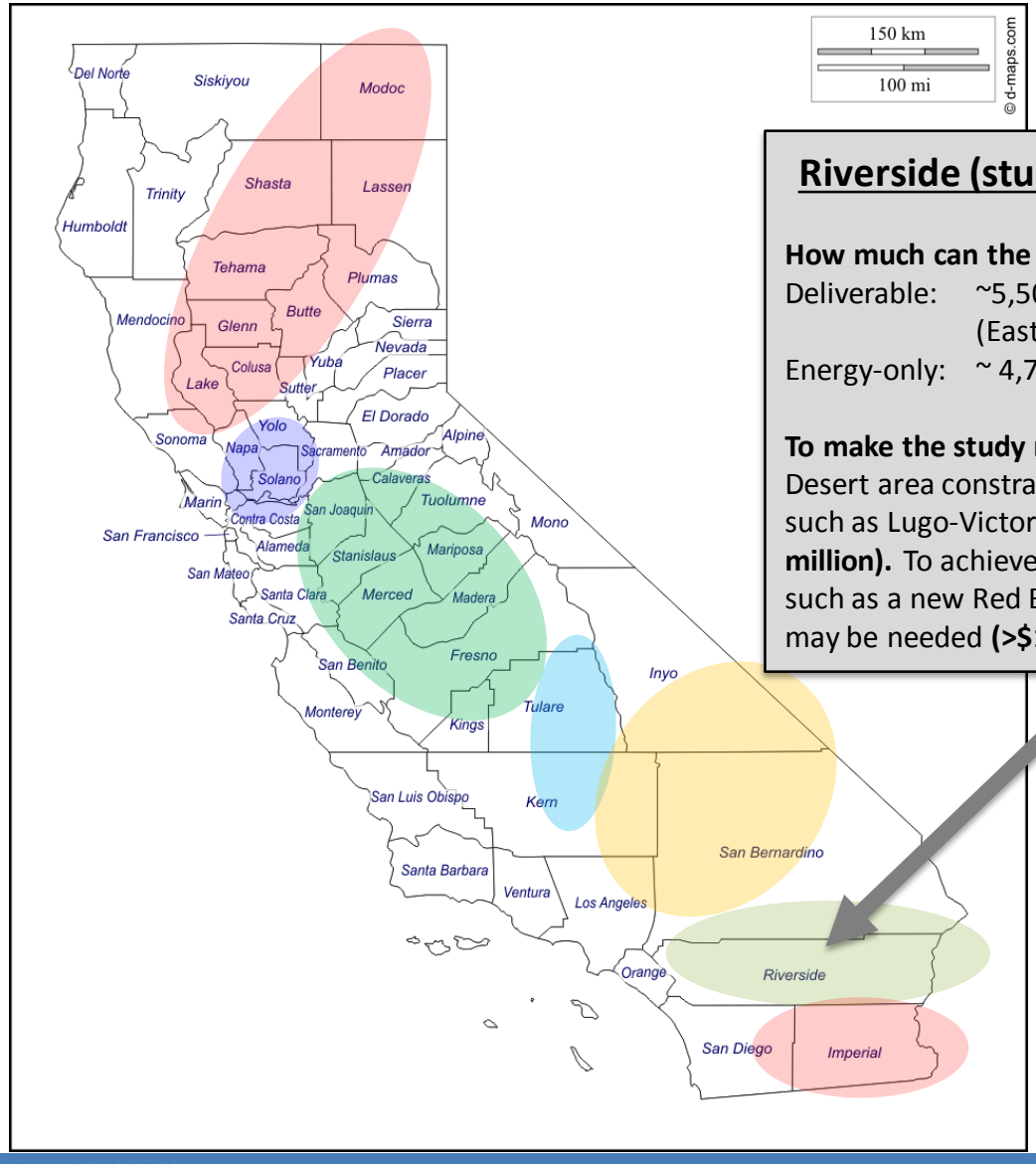
Deliverable: ~1,000 MW (North of Lugo total)
~470 MW (North of Kramer)
~400 MW (Calcite-Lugo area)
~5,500 to ~8,500 MW (East of Pisgah, Riverside, Imperial)

Energy-only: ~ 2,735 MW (East of Pisgah)
~ 470 MW (North of Kramer)

To make the study range deliverable:

1. Desert area constraint will require upgrades such as Lugo-Victorville 500 kV upgrade. **(~34 million)**
2. North of Lugo area constraints may need upgrades such as a new 500/230 kV transformer bank at Lugo **(~$150 million)**
3. South of Kramer constraint will require upgrades such as Coolwater – Lugo 220 kV line **(~$480 million)** or Kramer – Llano 500 kV line
4. Calcite-Lugo constraint will require upgrades such as rebuilding the Calcite – Lugo line **(~$260 million)**

Riverside TAFA – Evaluation Summary



Riverside (study range: ~5,000 MW)

How much can the TAFA accommodate today?

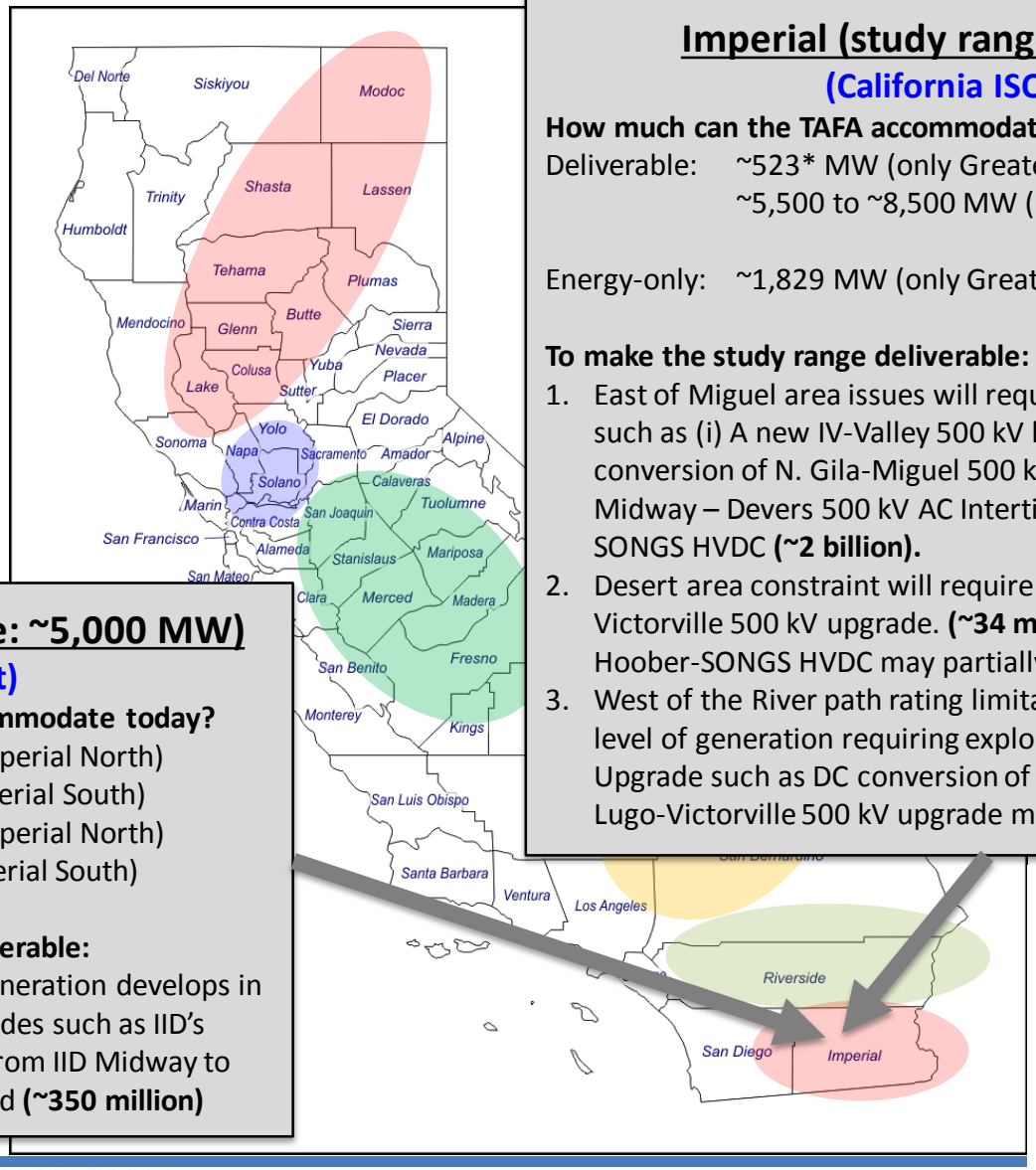
Deliverable: ~5,500 to ~8,500 MW
(East of Pisgah, Riverside, Imperial)

Energy-only: ~ 4,754 MW (Riverside only)

To make the study range deliverable:

Desert area constraint will require an upgrade such as Lugo-Victorville 500 kV upgrade. **(~34 million).** To achieve more capability, upgrades such as a new Red Bluff – Mira Loma 500 kV line may be needed **(>$1 billion)**

Imperial Valley TAFA – Evaluation Summary



Imperial (study range: ~5,000 MW)

(IID Input)

How much can the TAFA accommodate today?

Deliverable: ~1,200 MW (Imperial North)
~200 MW (Imperial South)

Energy-only: ~1,400 MW (Imperial North)
~370 MW (Imperial South)

To make the study range deliverable:

1. If a large amount of this generation develops in Imperial North, then upgrades such as IID's STEP project (500 kV line from IID Midway to SCE Devers may be required **(~350 million)**

Imperial (study range: ~5,000 MW)

(California ISO Input)

How much can the TAFA accommodate today?

Deliverable: ~523* MW (only Greater Imperial)
~5,500 to ~8,500 MW (East of Pisgah, Riverside and Imperial)

Energy-only: ~1,829 MW (only Greater Imperial)

To make the study range deliverable:

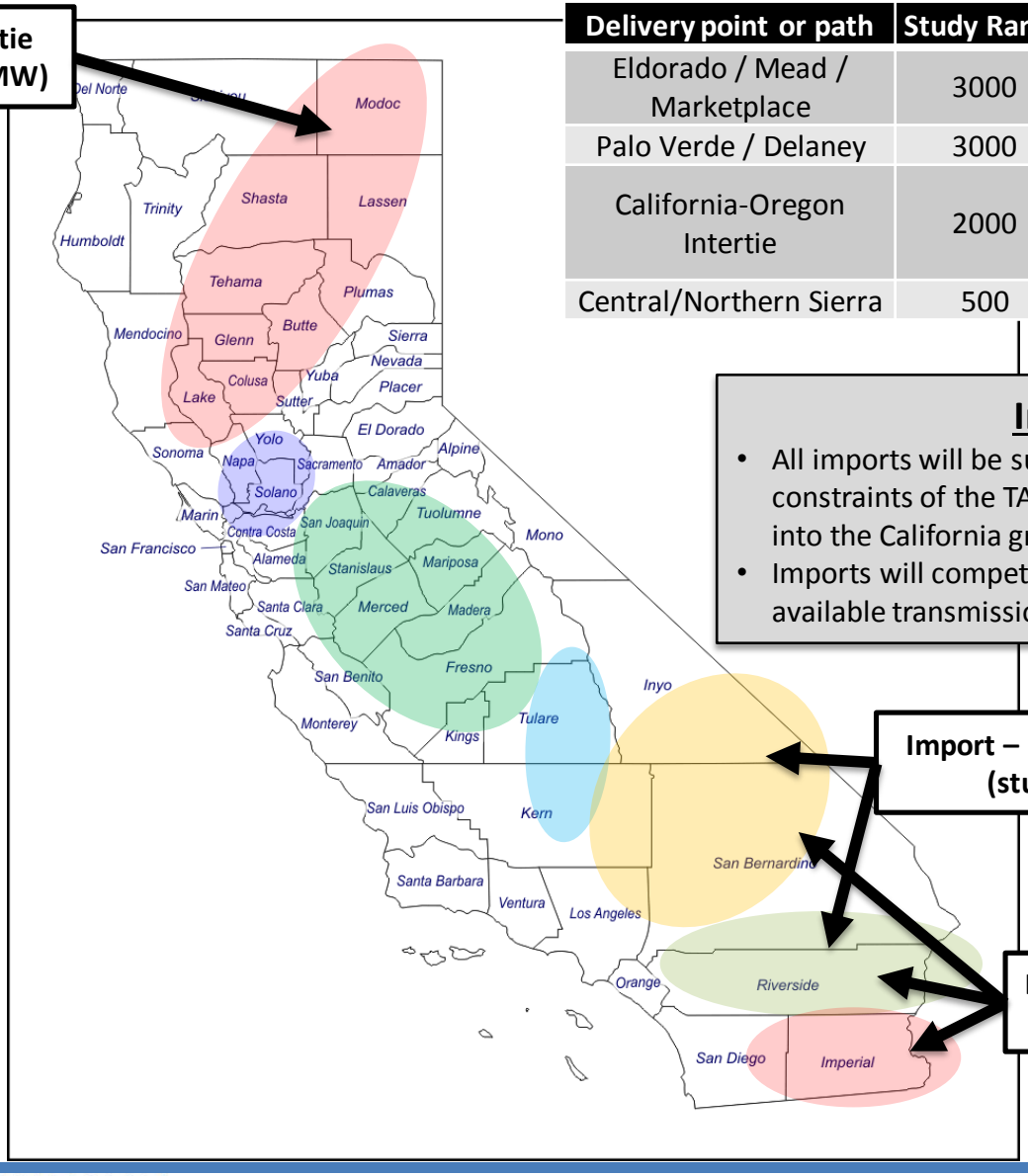
1. East of Miguel area issues will require one or more upgrades such as (i) A new IV-Valley 500 kV line **(~$2 billion)**, (ii) DC conversion of N. Gila-Miguel 500 kV line **(~$900 million)**, (iii) Midway – Devers 500 kV AC Intertie **(~350 million)** (iv) Hoober – SONGS HVDC **(~2 billion).**
2. Desert area constraint will require upgrades such as Lugo-Victorville 500 kV upgrade. **(~34 million).** Upgrades such as Hoober-SONGS HVDC may partially help mitigate this constraint.
3. West of the River path rating limitation may be reached at this level of generation requiring exploration of path rating increase. Upgrade such as DC conversion of N. Gila-Miguel 500 kV line and Lugo-Victorville 500 kV upgrade may increase Path 46 rating.

*** This number is subject to change. IID has recently provided the ISO with new study assumptions regarding its system that will require further study. The ISO 2016-2017 Transmission Plan currently under development will take into account the latest system conditions and provide information regarding additional deliverability expected to be available for IID and ISO connected Imperial area generation.**

Imports into TAFAs – Evaluation Summary

Import – CA-OR Intertie (study range: ~2,000 MW)

Delivery point or path	Study Range	Affected TAFA
Eldorado / Mead / Marketplace	3000	Victorville (East of Lugo) and Riverside
Palo Verde / Delaney	3000	Riverside
California-Oregon Intertie	2000	Northern CA (Round Mtn, Lassen and Sacramento R.)
Central/Northern Sierra	500	Information not available



Imports

- All imports will be subject to the transmission constraints of the TAFAs at their point of injection into the California grid
- Imports will compete with in-state resources for available transmission in respective TAFAs

Import – Eldorado/Mead/Marketplace (study range: ~3,000 MW)

Import – Palo Verde/Delaney (study range: ~3,000 MW)

TAFA Evaluation Summary

1. The total of the resource ranges for each TAFA evaluated by TTIG is larger than the resource levels needed to meet the 50% renewable goal

2. Based on the existing and prior transmission studies across California, TTIG has provided estimates of available transmission capability assuming all the planned upgrades.

3. TTIG has provided conceptual transmission upgrades based on prior and existing studies performed by California planning entities. Upgrades such as these will be required in all but Tehachapi TAFA to make the prescribed resource ranges deliverable.

4. Limited information is available on the implications of Energy Only resource development prescribed by RETI 2.0 plenary group.

5. Out-of-state resources being delivered to California will be injected into one of the TAFAs and will be subjected to the same transmission constraints experienced by the TAFA.

Next Steps

- The **regional outreach** project will gather stakeholders' input about existing and potential transmission capability to deliver out-of-state renewable energy to California.

- TTIG will **deliver the information presented today** to the RETI 2.0 plenary group (as a final report) and will follow up with any consequent requests for evaluation.