

CUSP Status Update: California

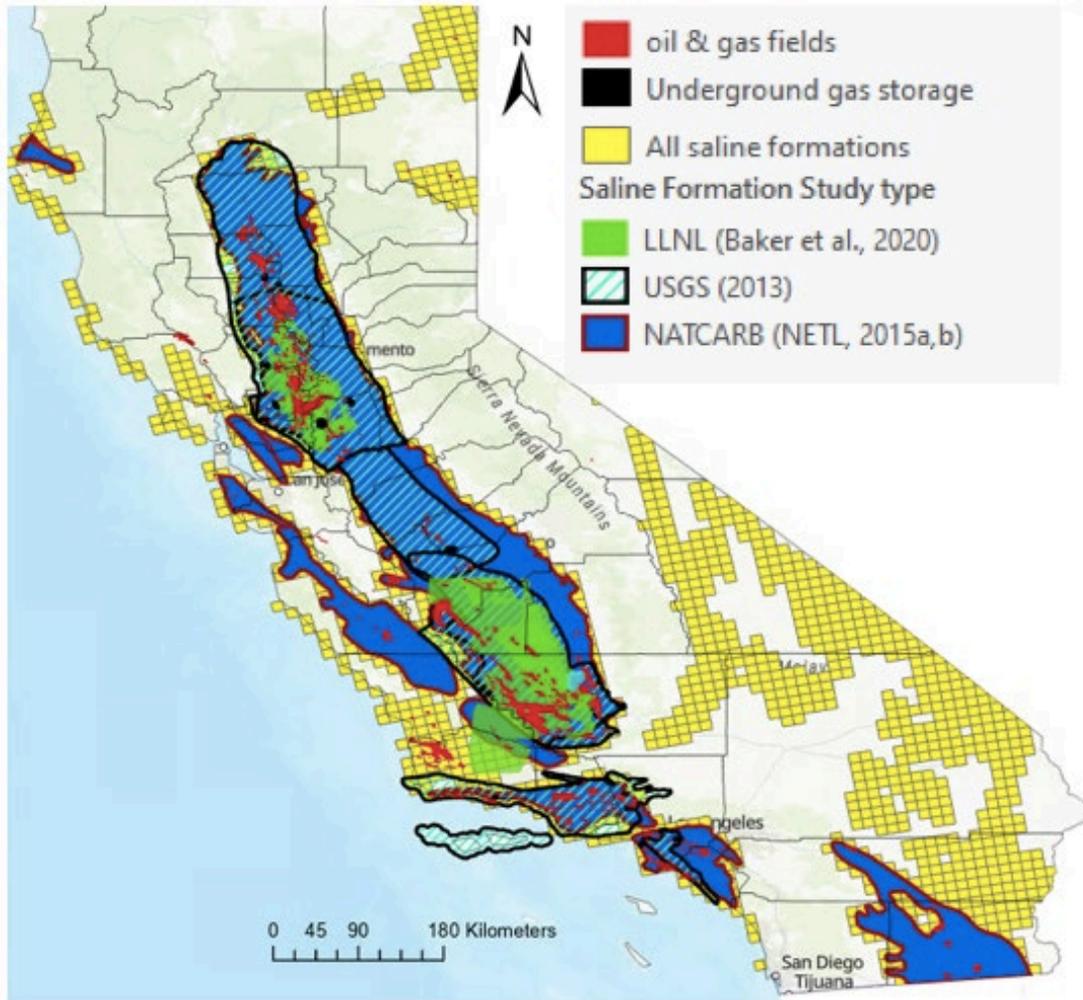
June 2, 2022

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California update

- CO₂ Storage Resources
- CO₂ Emitters
- Potential CO₂ Pipeline ROW
- Technology Transfer
- Summary

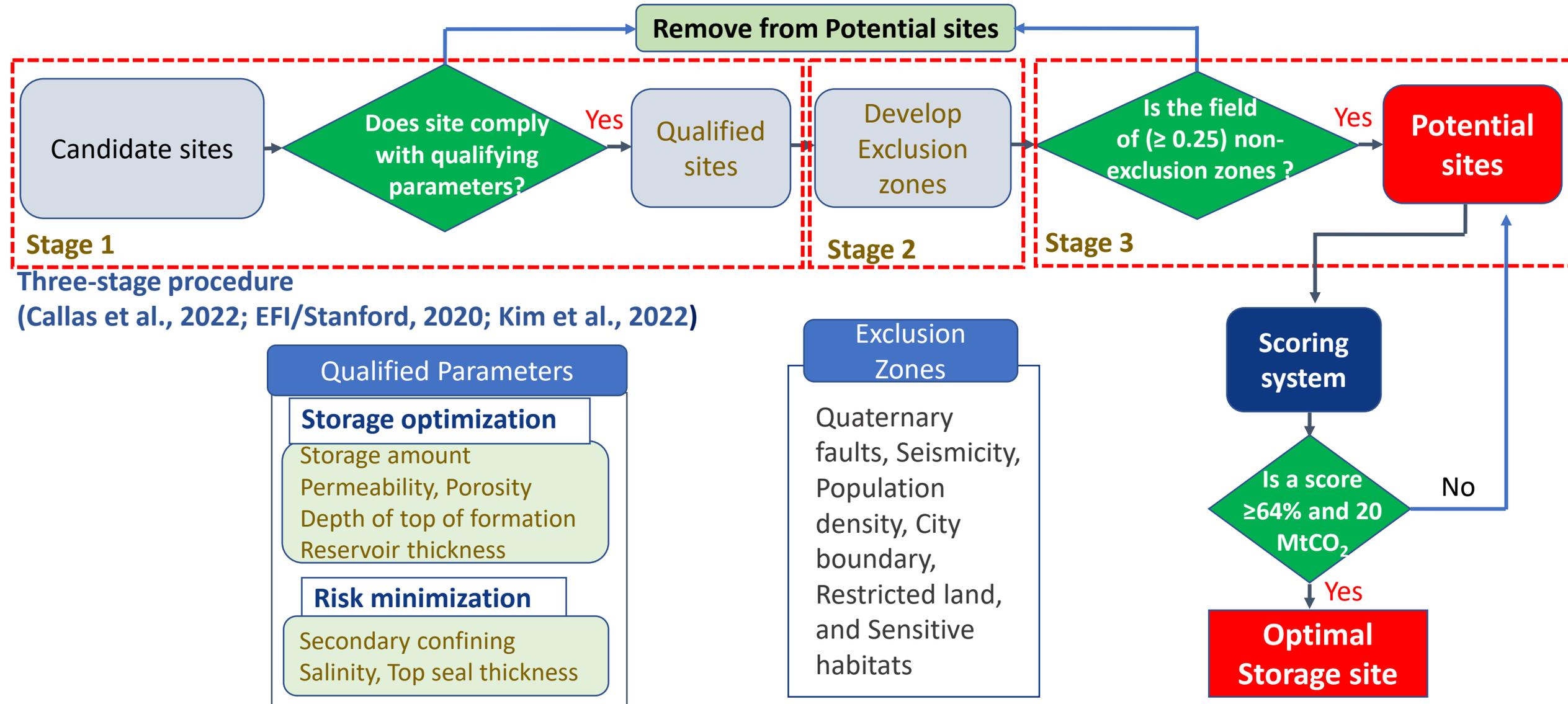
Task 3.1.1 Identify data requirements & needs



- 503 O&G fields and 13 UGS
- 27 saline formations assessed among 104 sedimentary basins
- Four different prior assessments: USGS (2013, WESTCARB (2015), LLNL (2020), EFI & Stanford (2020).

Type	Study	Low, GtCO ₂	High, GtCO ₂
Hydrocarbon fields	NATCARB (2015)	3.6	6.6
Saline formations	USGS (2013)	61	124
	NATCARB (2015)	30	417
	LLNL (2020)	17	200
	EFI & Stanford (2020)	69.1 (mean)	

Task 3.1.2 Update geologic data for CCUS assessment



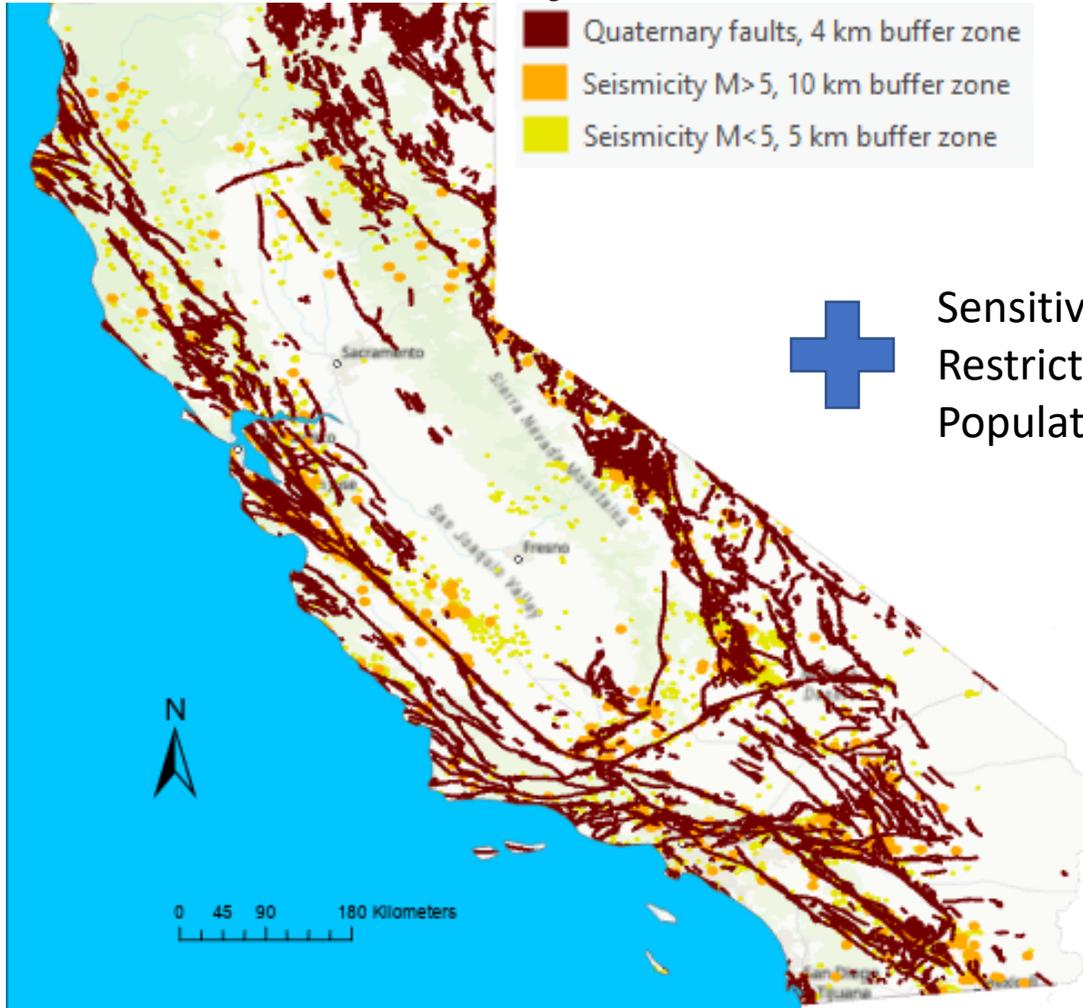
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Qualifying criteria for OG and saline formations

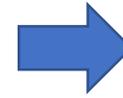
Category	Geological parameters	Qualifying Threshold
Storage Optimization	Storage resource (high estimate)	> 3 MtCO ₂ (OG field)
	Depth (to top of formation)	> 800 m
	Permeability	> 10 mD (mean)
	Porosity	> 10 % (mean)
	Reservoir Thickness	Target one layer > 10 m
Risk Minimization	Secondary confining	Exist secondary confining unit
	Top seal thickness	> 25 m: Saline formation only
	Salinity	> 10,000 ppm (TDS): Saline formation only

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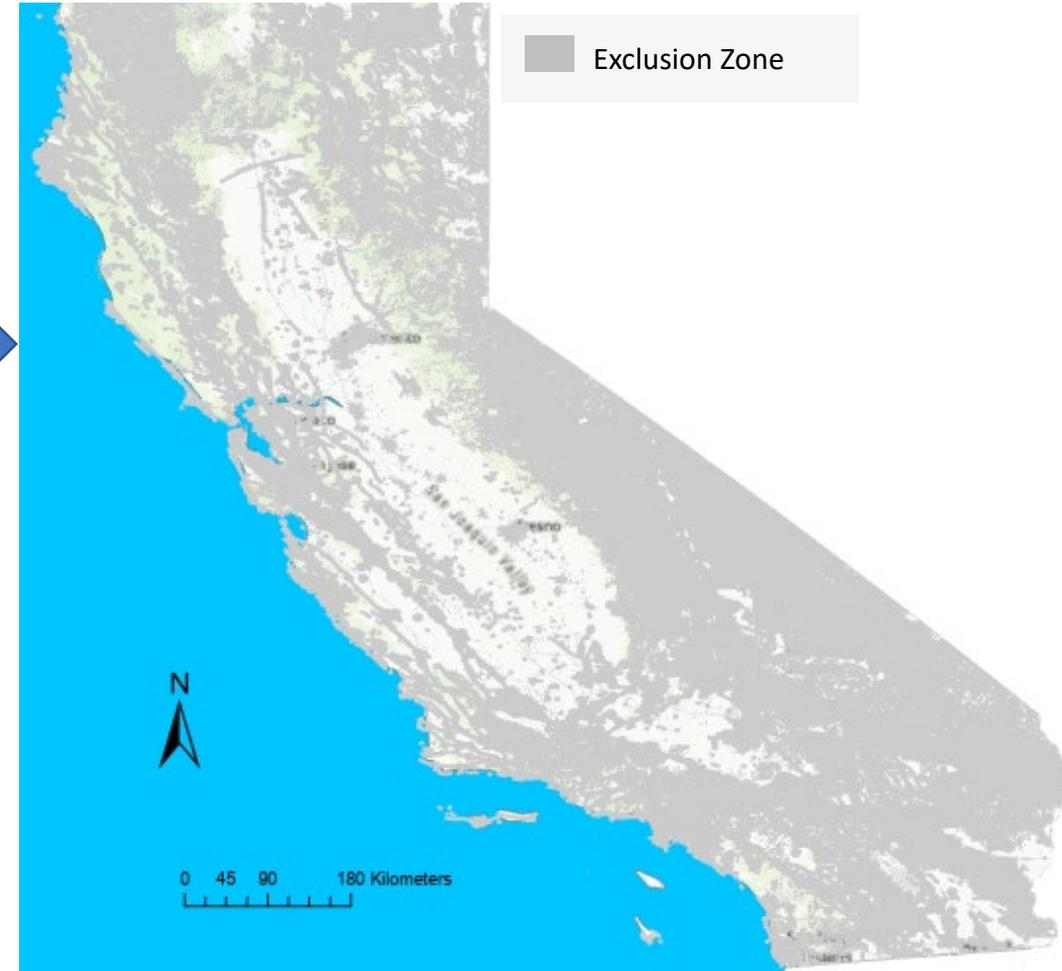
Faults and seismicity



Sensitive habitats
Restricted lands
Population zones



Total exclusion zones



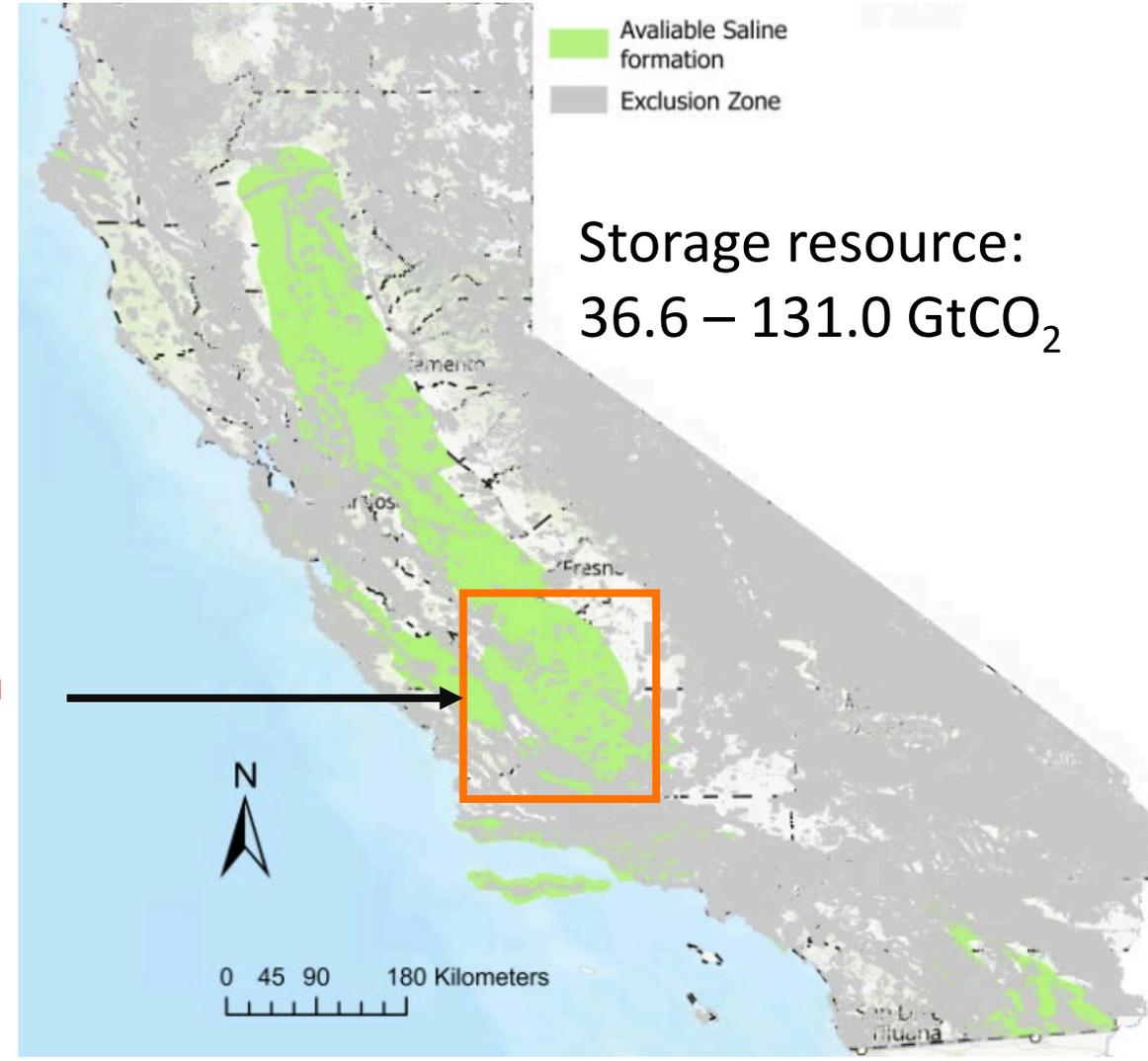
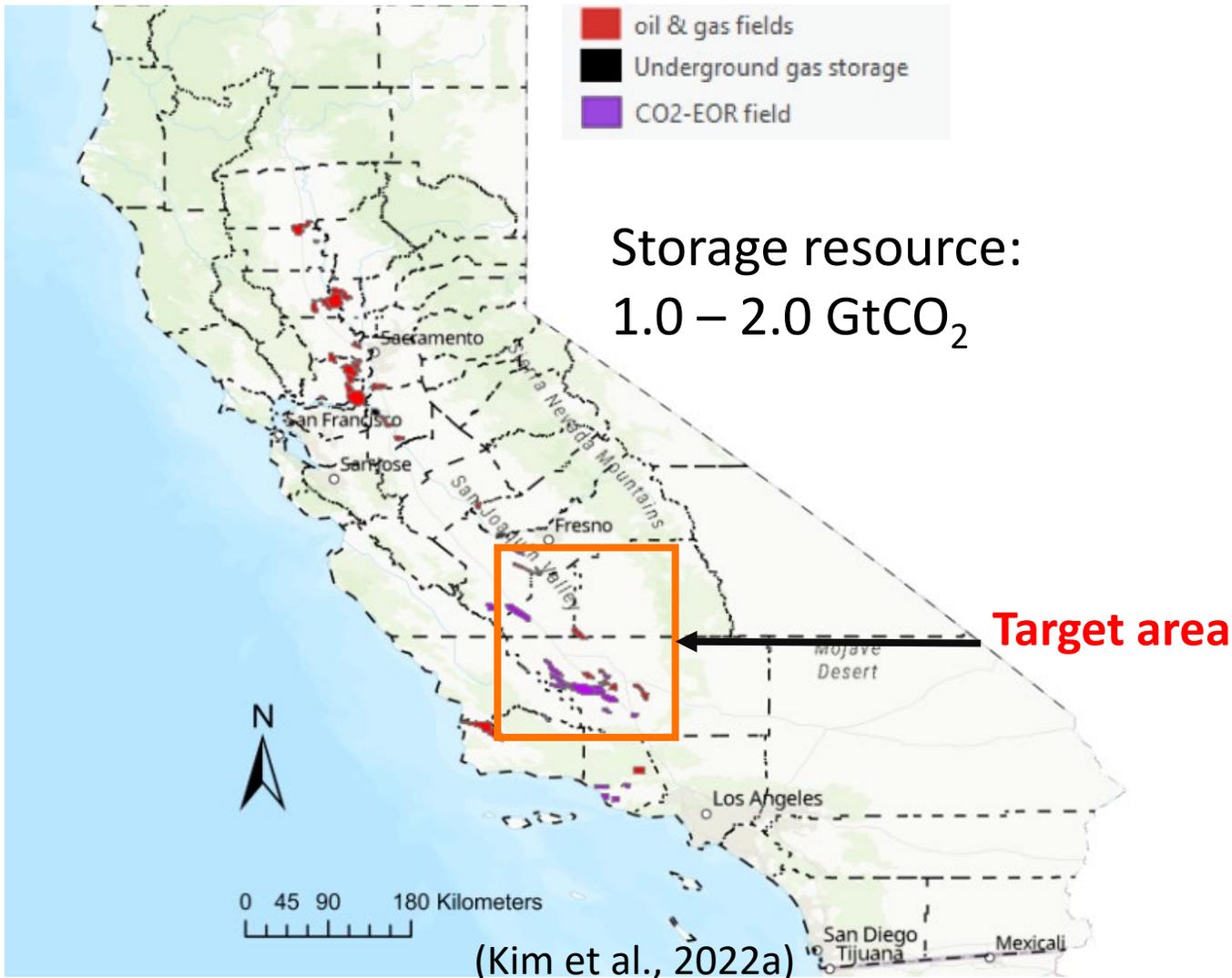
(Kim et al., 2022a)

(Kim et al., 2022a)

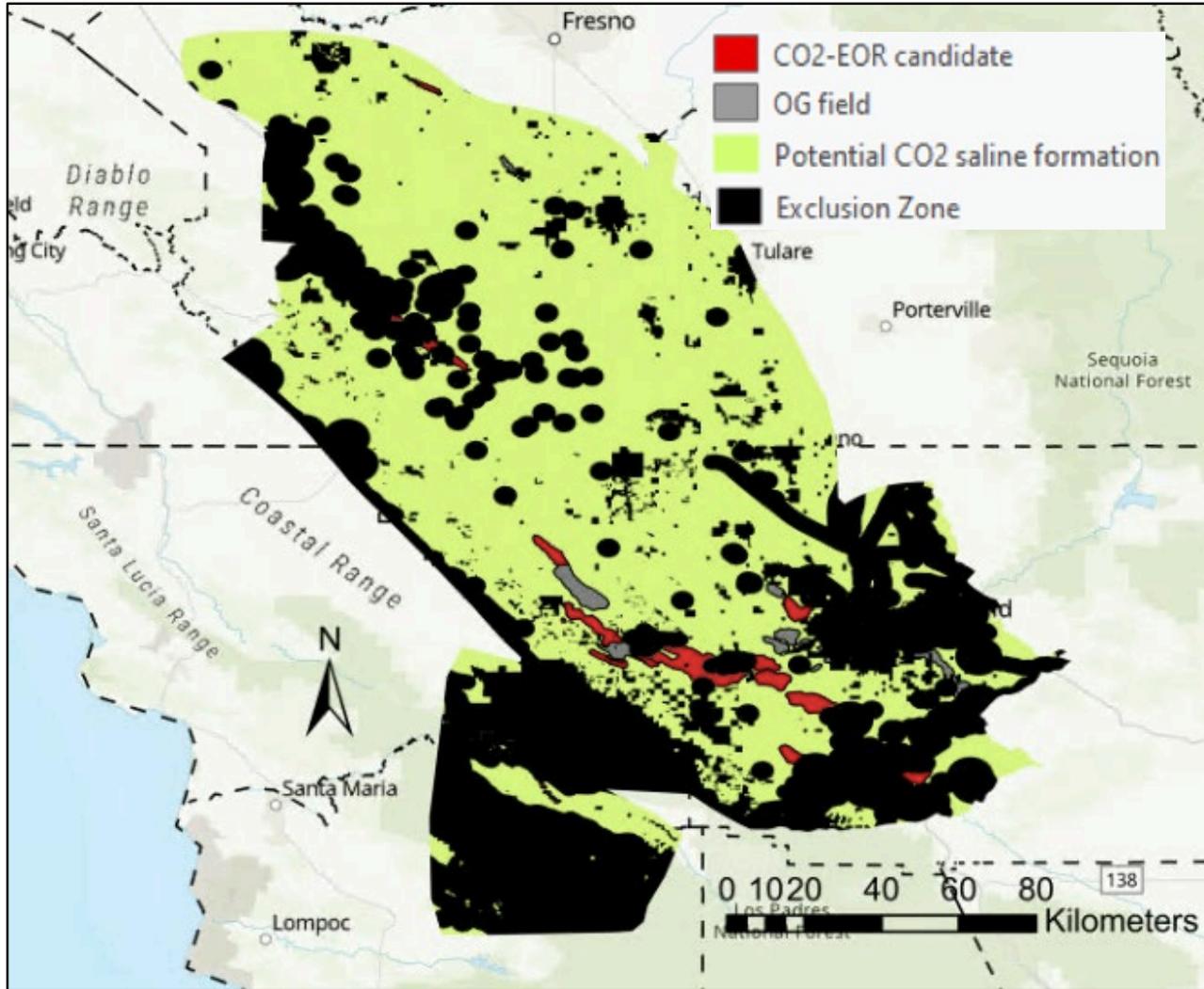
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Hydrocarbon fields

Saline formations

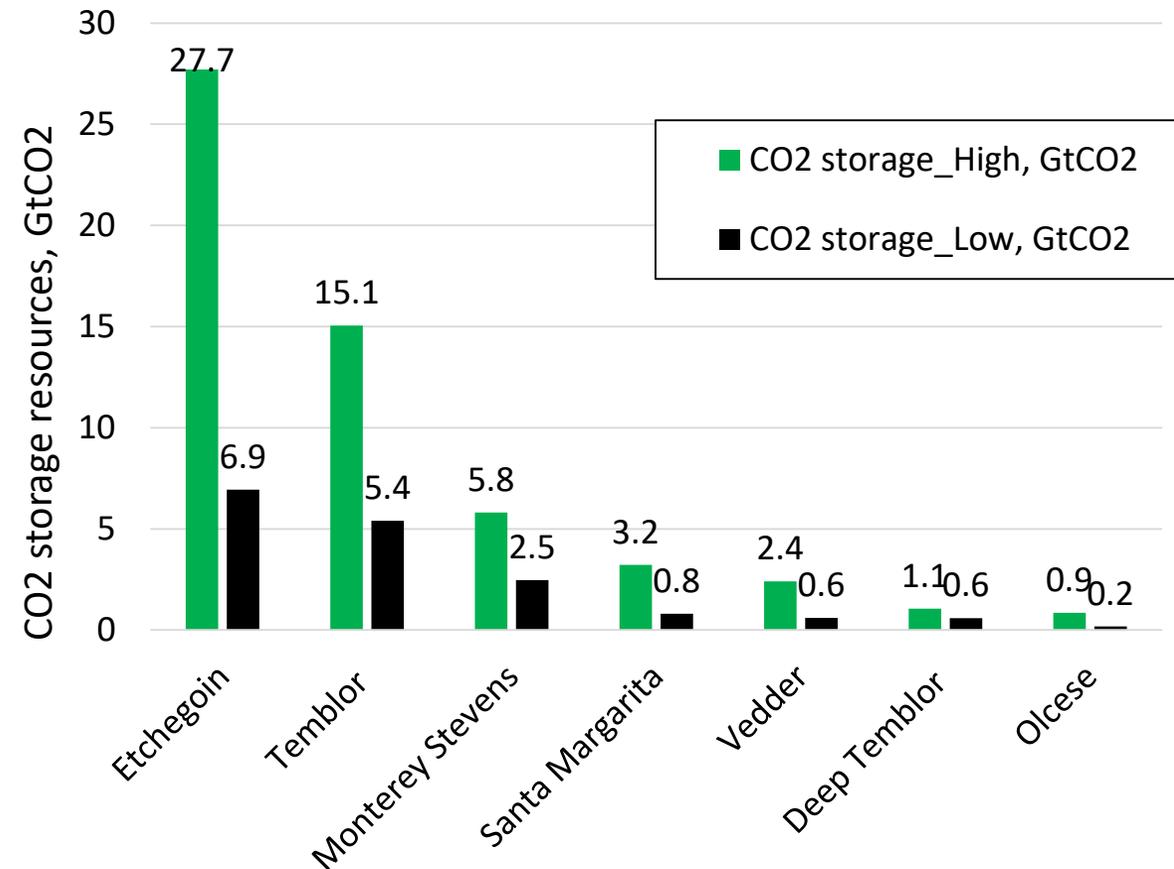


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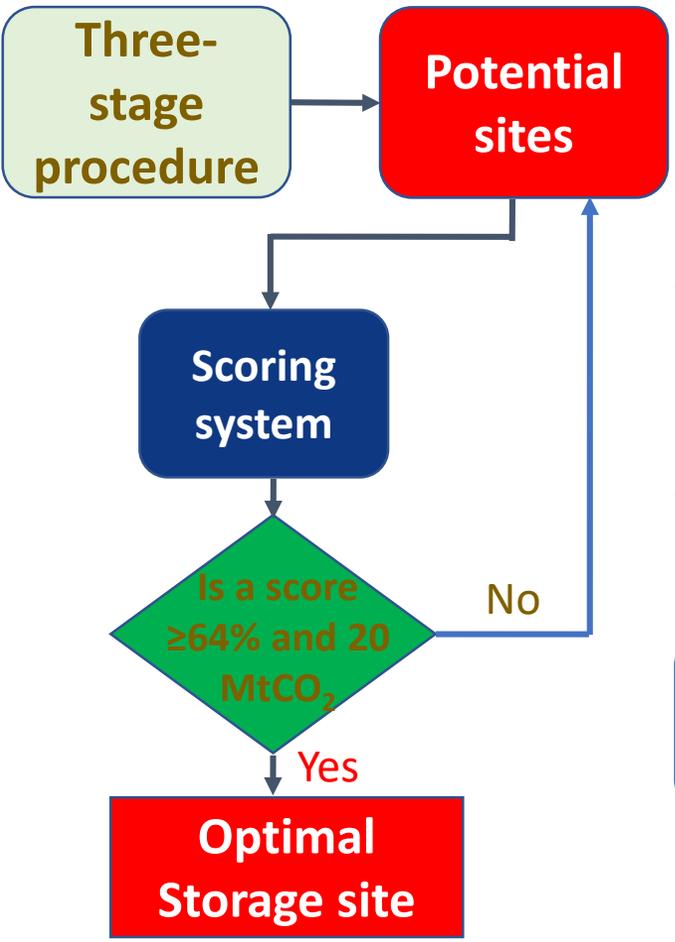


(Kim et al., 2022b)

Hydrocarbon fields: 0.45 – 1.15 GtCO₂
 Saline formations: 16.6 – 52.0 GtCO₂



Task 3.1.2 Update geologic data for CCUS assessment



Scoring Parameters

$$Total\ score\ ratio = \frac{\sum_i^n Score_{p_i}}{\sum_i^n Score_{p_{max,i}}}$$

Range of $Score_{p_i}$: 1 - 5

Geological properties

Permeability, Porosity, Depth of top of formation, Reservoir thickness, Geothermal gradient

Geological structures

Bottom seal, Top seal thickness¹, Reservoir compartment

OG field:
10 parameters

Risk

Quaternary fault, Salinity¹

Storage

Storage capacity, Injectivity

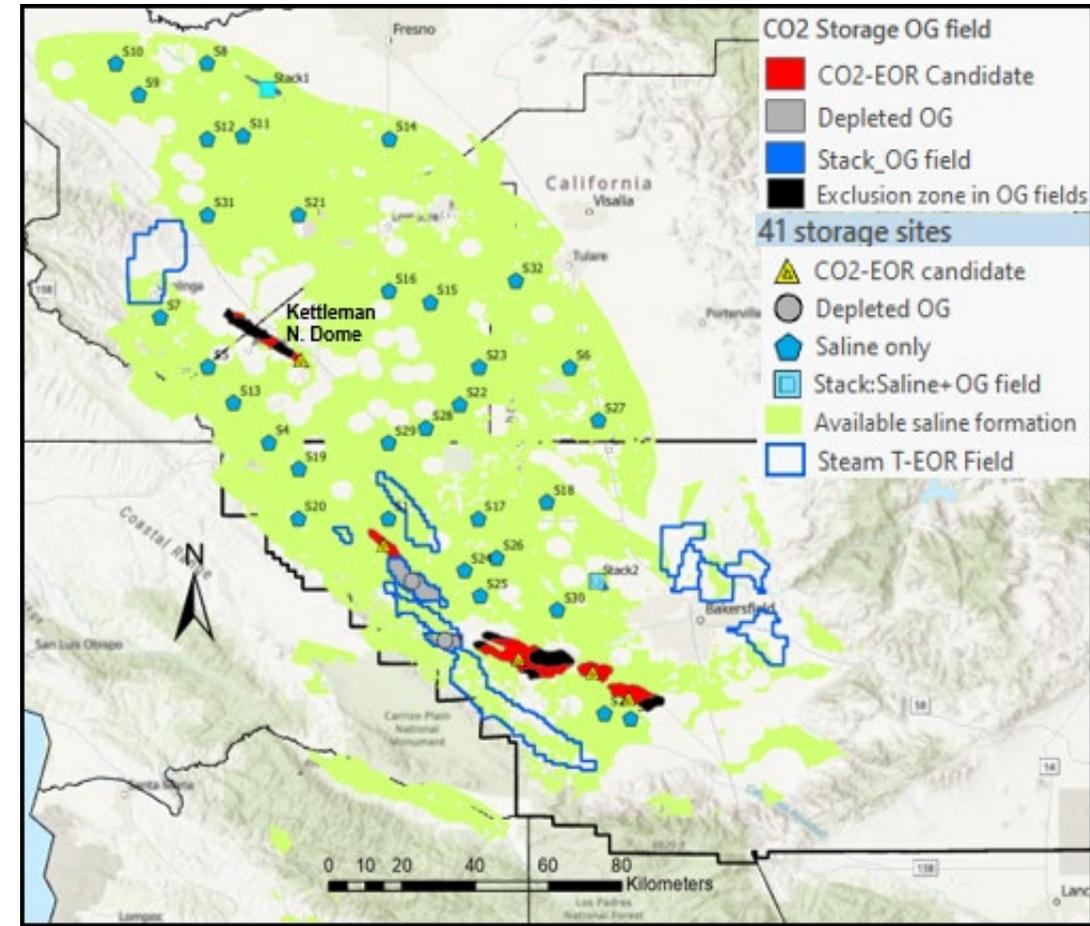
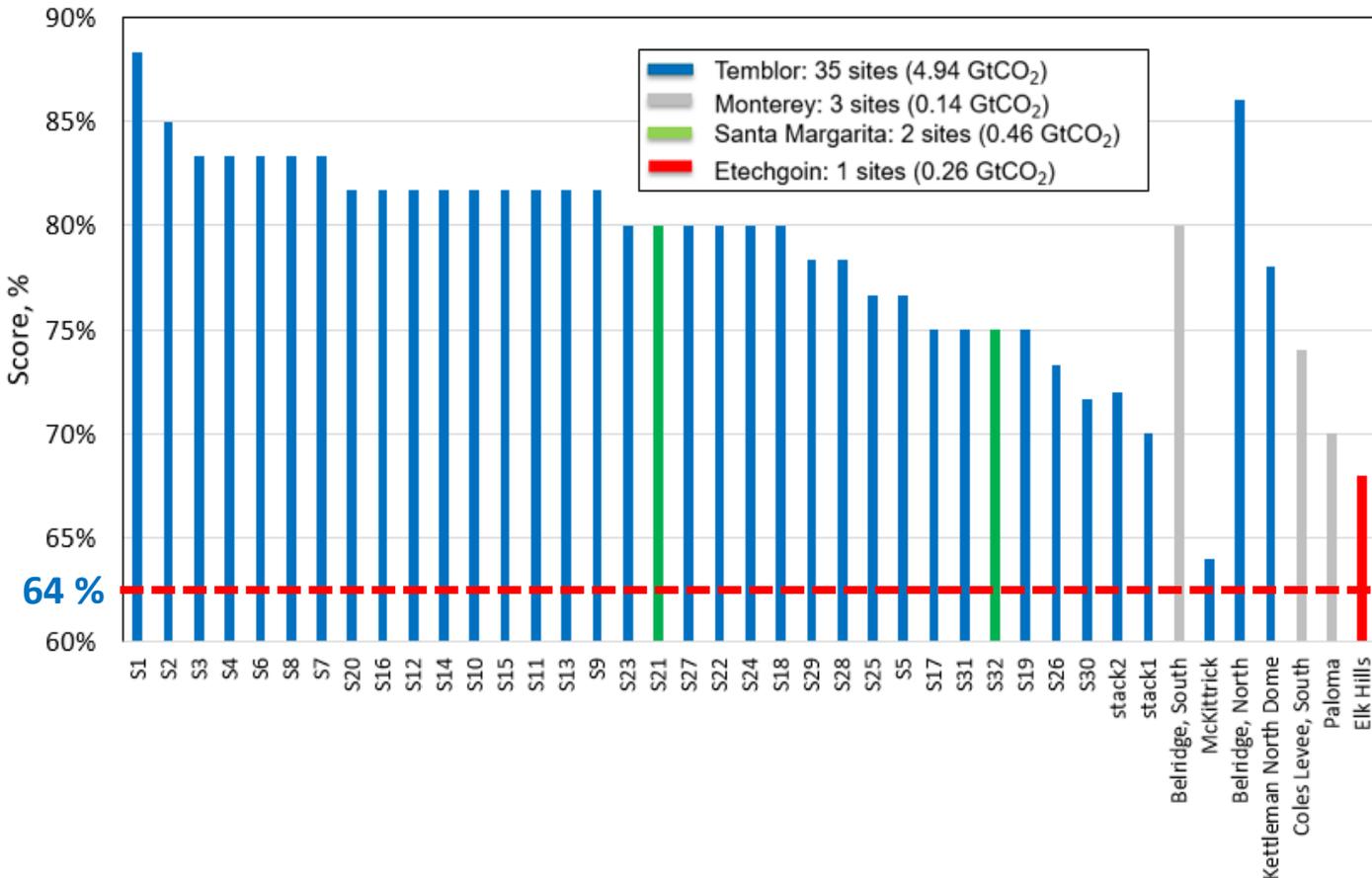
Saline formation:
12 parameters

¹: Parameter for only saline formation

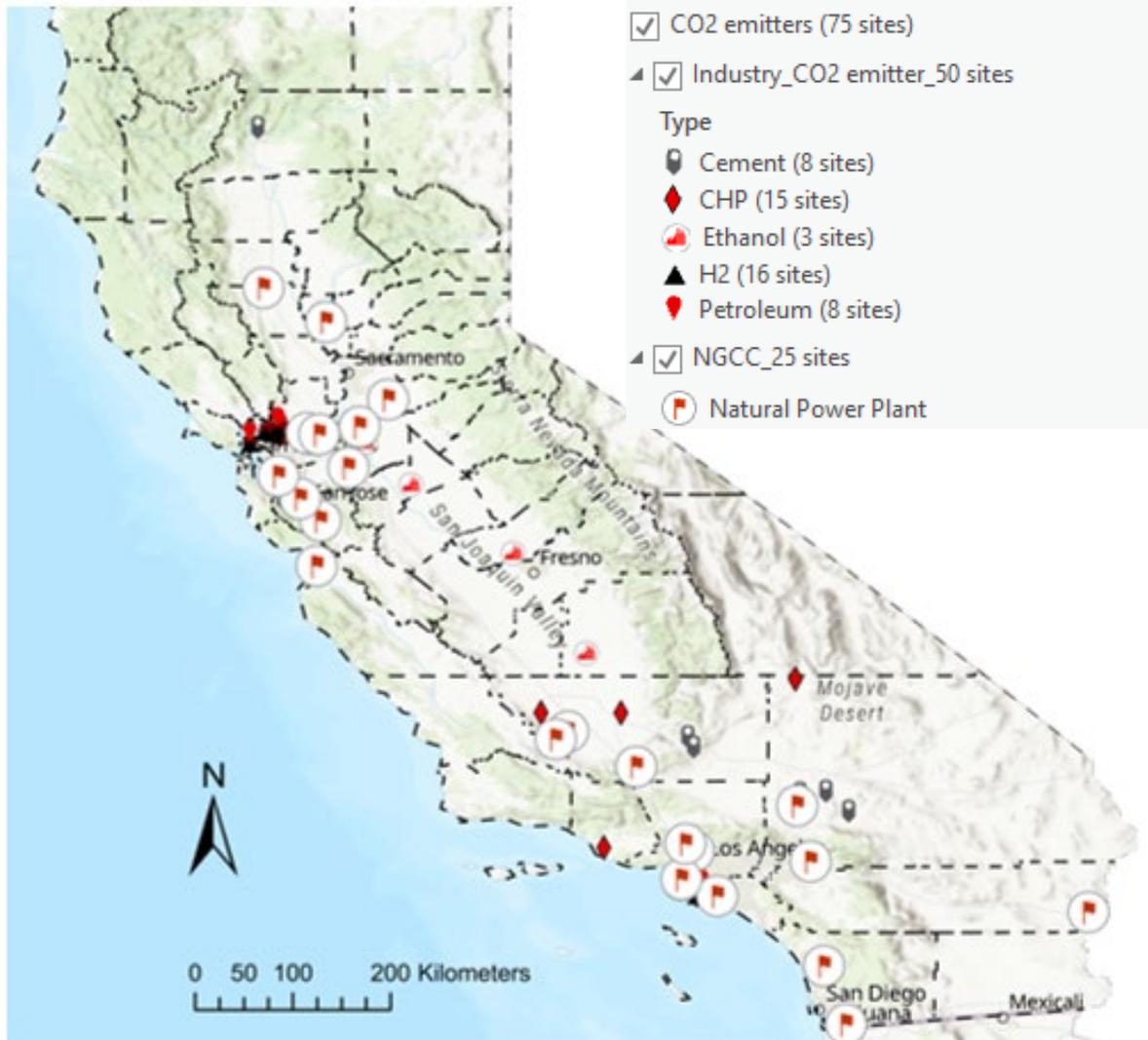
(Modified from Callas et al. 2022 and Kim et al. 2022a)

Task 3.1.2 Update geologic data for CCUS assessment

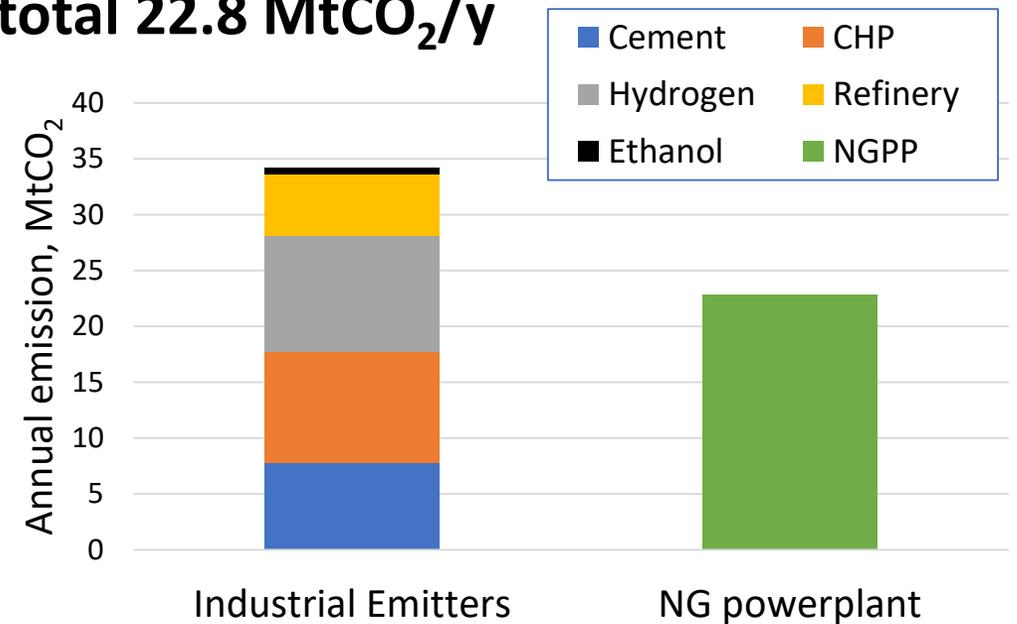
- Total: 5.8 GtCO₂ with 41 optimal storage sites
 - Saline: 4.9 GtCO₂ - Stack: 0.3 GtCO₂
 - CO₂-EOR: 0.5 GtCO₂ - Depleted OG: 0.1 GtCO₂



Task 3.1.4 Gather and catalog CO₂ emissions



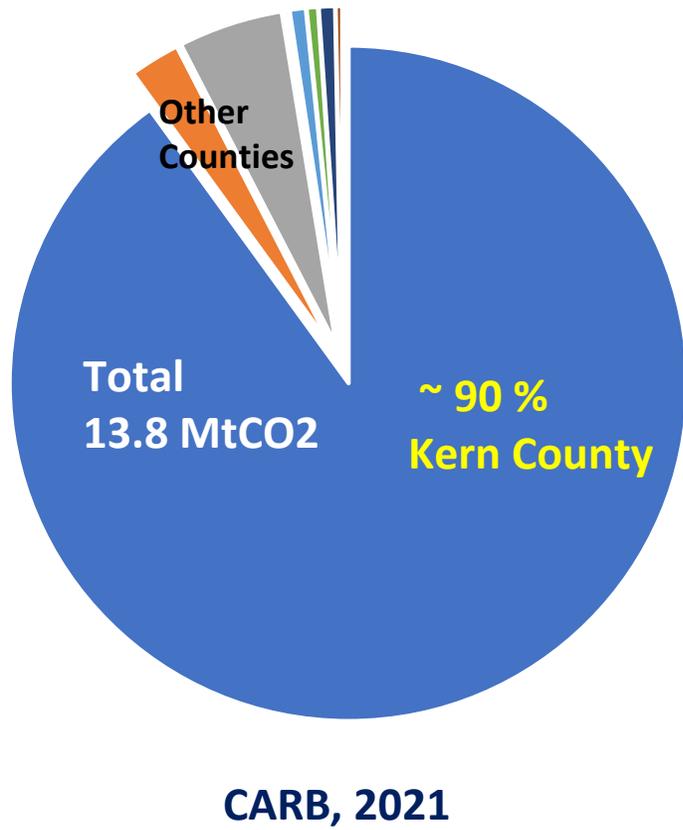
- Industrial emissions > 0.3 MtCO₂/y except Ethanol plant (>0.1 MtCO₂/y) total 34.2 MtCO₂/y
- NG powerplants capturable amount > 0.5 MtCO₂/y total 22.8 MtCO₂/y



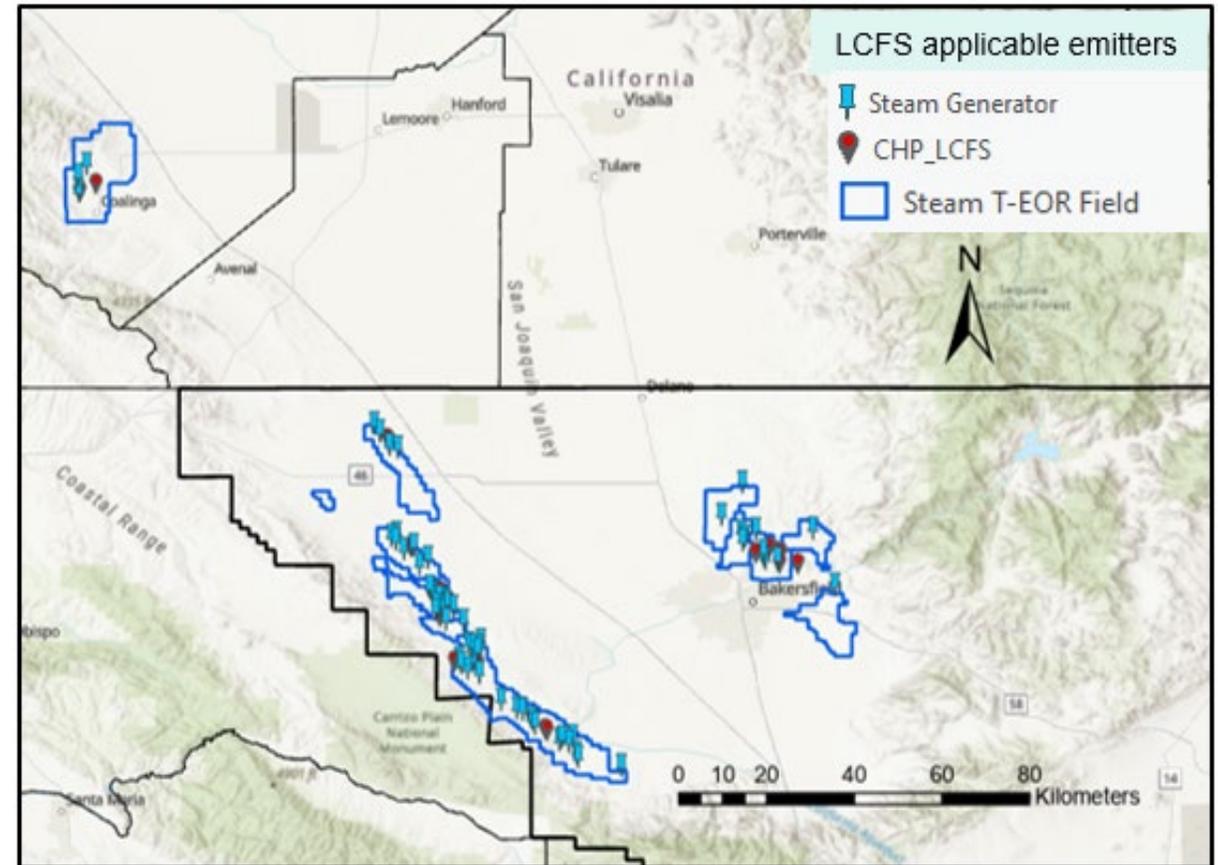
Data Sources: EPA Flight, eGRID, CARB emission data

Task 3.1.4 Gather and catalog CO₂ emissions

Oil & gas production facilities

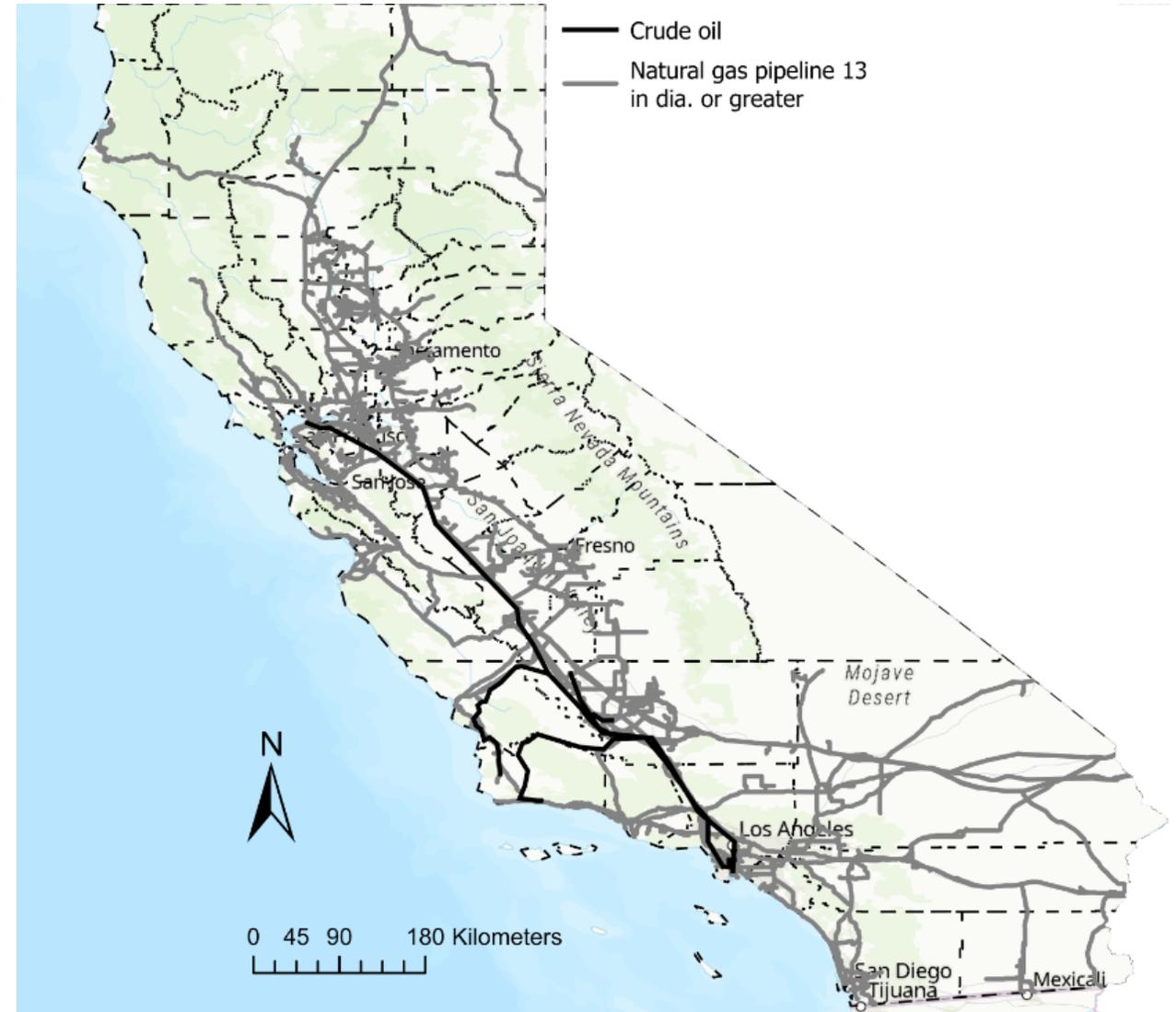


Capturable emissions: 11.4 MtCO₂/y (90% capture)



4.2. Identify and add rights-of-way for new pipelines

- No existing CO₂ pipeline network in CA
- Potential rights-of-way (ROW) for CO₂ in CA
 - Natural gas pipelines
 - Crude oil pipelines



Technology Transfer Products

- Kim, T.W., Callas, C., Saltzer, S.D., Kavscek, A.R. (2022a), Assessment of oil and gas fields in California as potential CO₂ Storage sites, *International Journal of Greenhouse Gas Control*, 114, p.103579.
- Kim, T.W., Yaw, S., Kavscek, A.R. (2022b), Evaluation Of Geological Carbon Storage Opportunities In California And A Deep Look In The Vicinity Of Kern County, *Proceedings of the SPE Western Regional Meeting*, SPE 209340-MS, April 26 – 28, Bakersfield, California.
- Callas, C., Saltzer, S.D., Davis, J.S., Hashemi, S., Kavscek, A.R., Okorofofor, E.R., Wen, G., Zoback, M.D, and Benson, S.M., 2022. Criteria and Workflow for Selecting Depleted Hydrocarbon Reservoirs for Carbon Storage, *Applied Energy*, submitted (2022).

Summary

- Potential CO₂ storage resources in CA were assessed using a 3-stage procedure
 - O&G and UGS: 1.0 -2.0 GtCO₂
 - Saline formations: 36.6 – 131 GtCO₂
- Southern San Joaquin Basin
 - 5.8 GtCO₂ storage resource
 - 41 optimal sites
 - potential hub for emissions from Kern Co & SoCal
- Identified emissions
 - large emitters 57 MtCO₂/y and O&G production 12.7 MtCO₂/y
- SimCCS identified optimal deployment scenarios.