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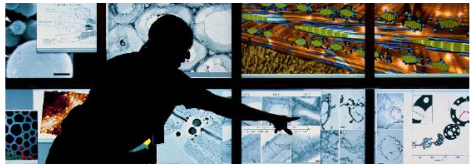
The Potential for Renewable Energy Development to Benefit Restoration of the Salton Sea

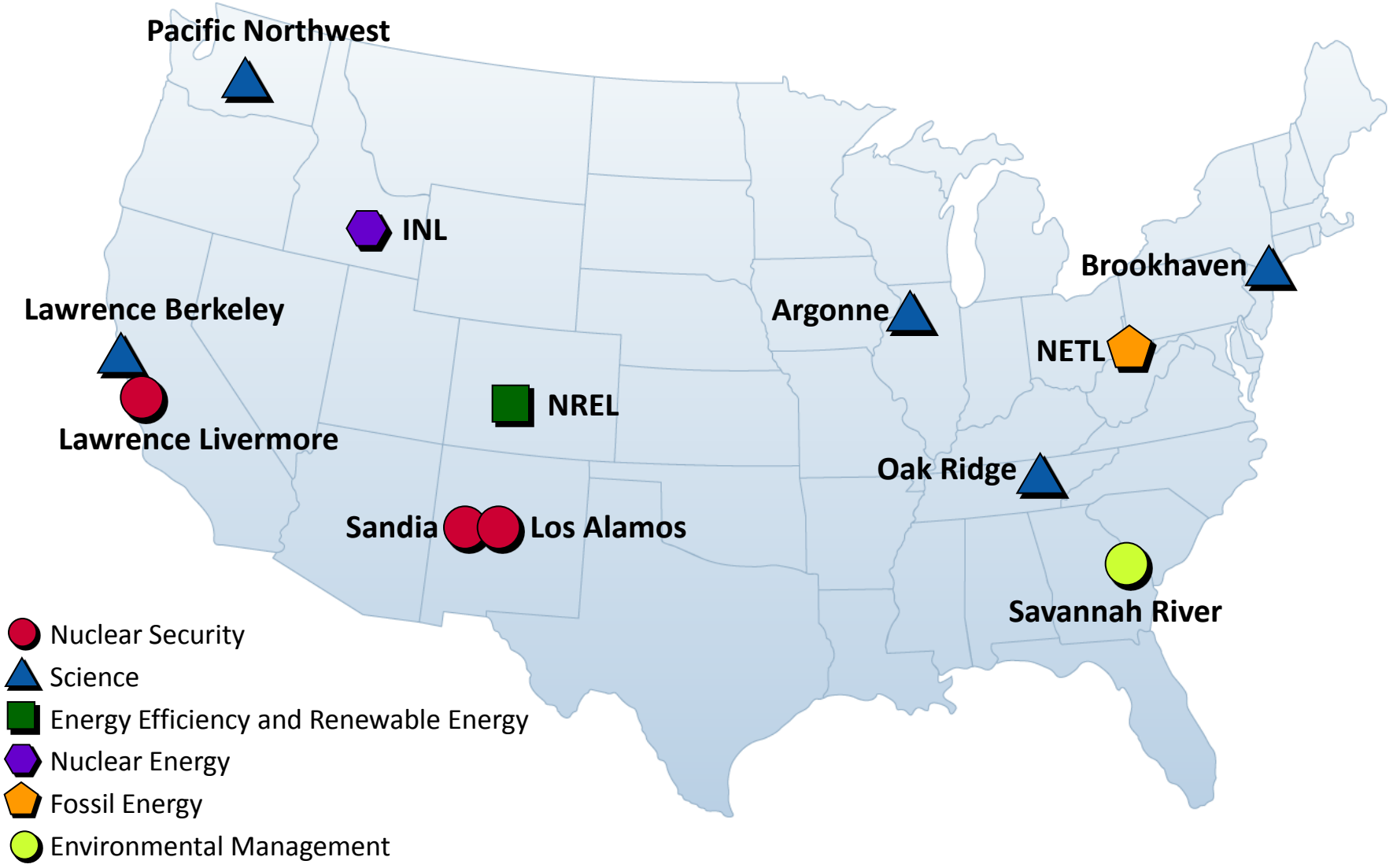



Scott Haase

Imperial Valley Renewable Energy Summit

March 11, 2016

U.S. Department of Energy Laboratory System



Salton Sea Study Overview

The Potential for Renewable Energy Development to Benefit Restoration of the Salton Sea: Analysis of Technical and Market Potential

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National Renewable Energy Laboratory

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Office of Energy Efficiency & Renewable Energy
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Technical Report
NREL/TP-7A40-64969
November 2015

Contract No. DE-AC36-08GO28308

- Published November 2015
- Funding from Salton Sea Authority through a grant from CNRA

Goals:

- Provide the SSA with a better understanding of the potential for renewable energy and mineral development in the region

- Estimate potential funding that could be available for SS restoration from these sources

http://www.nrel.gov/docs/fy16osti/64969.pdf

General Topics Covered

1. **GIS analysis and developable land areas**
2. **Renewable resource potential and costs**
   - PV, concentrating solar, geothermal, solar ponds, algae
   - Proximity to transmission
3. **Mineral recovery from brines**
4. **Desalination technologies**
5. **Long term - hydrogen production**
6. **Competitiveness of Salton sea renewables within the broader CA market**
7. **Potential for revenue generation for Salton Sea restoration through an "adder" on generation**

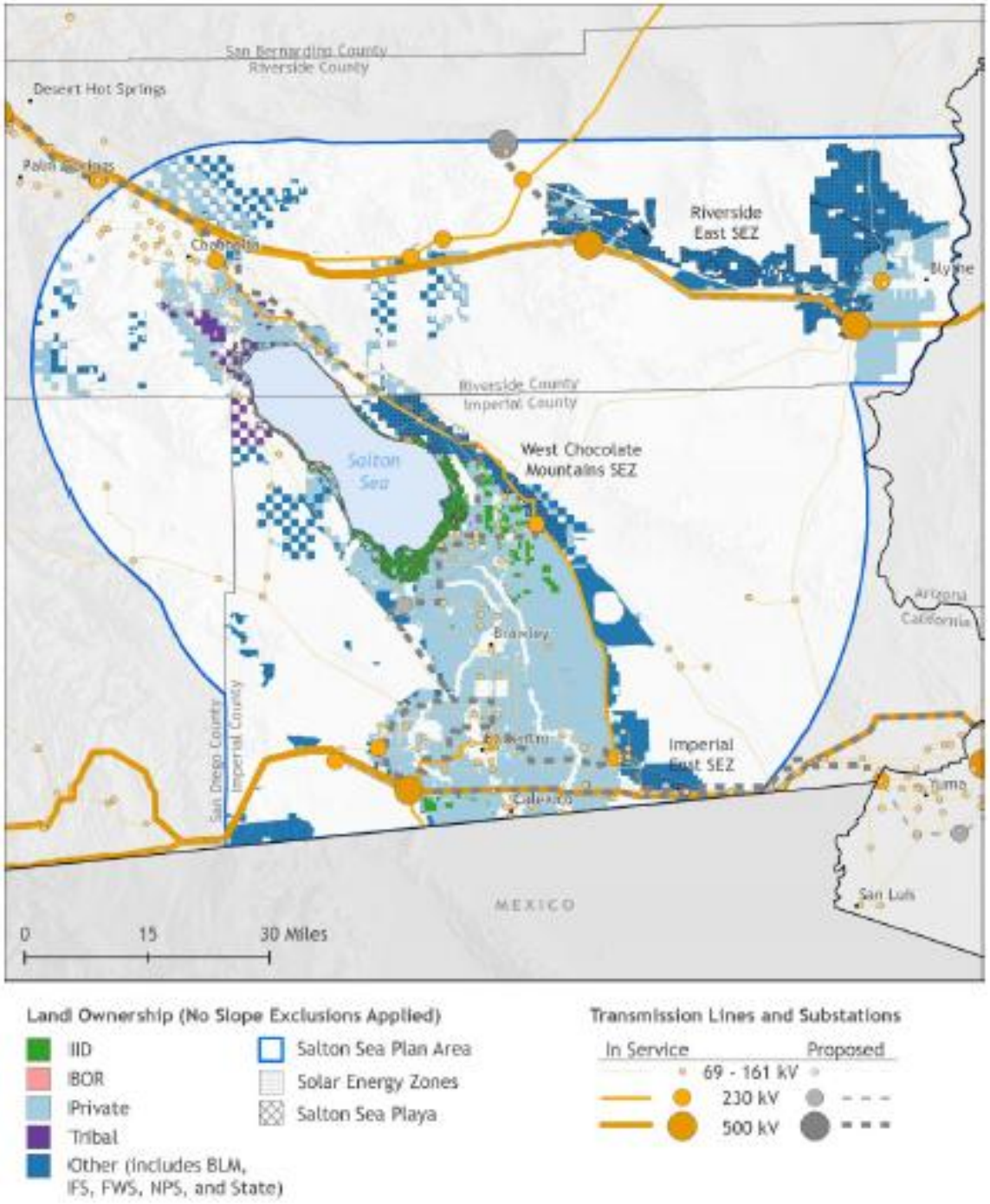
Study Area

Land ownership: IID, DOI (USBR, BLM, BIA, FWS), Tribal, Private, State

Superb solar and geothermal resources; 3 BLM solar energy zones

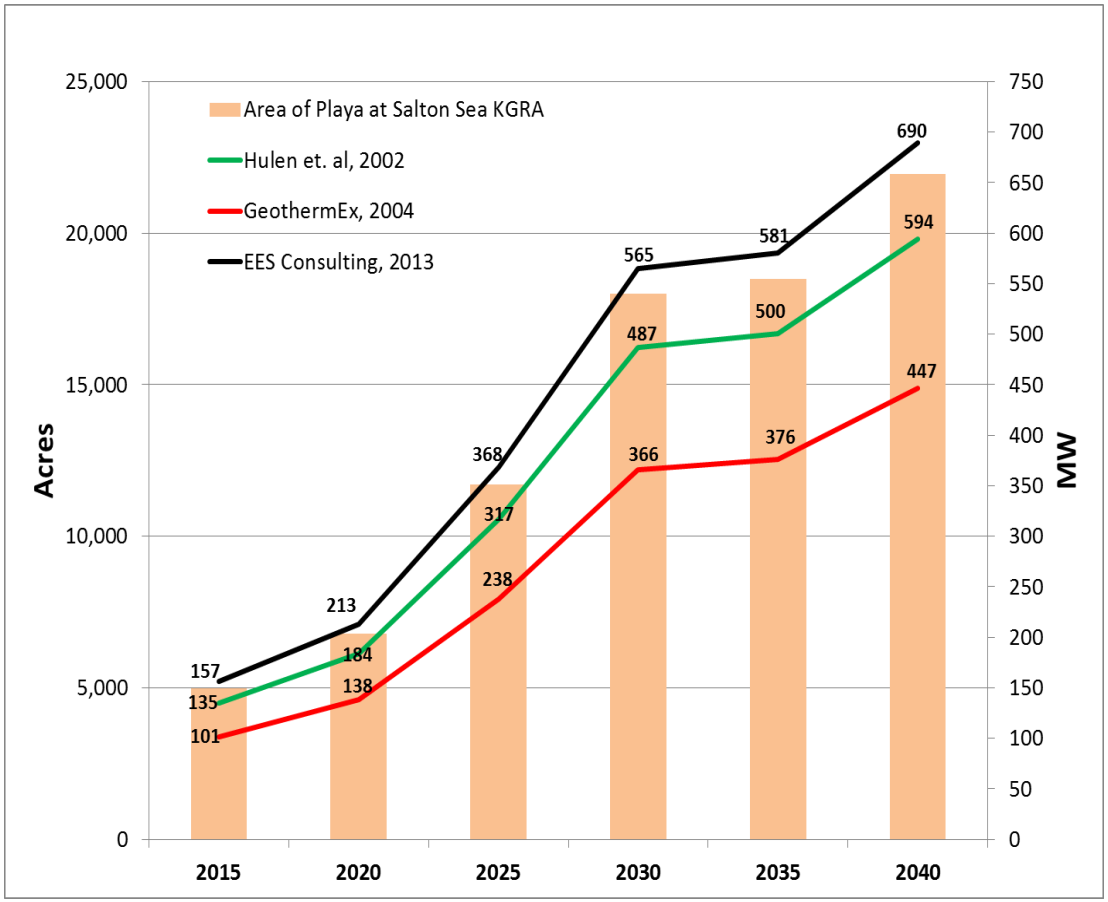
Large part of Desert Renewable Energy Conservation Plan (DRECP) area

GIS data from Imperial and Riverside counties, IID, BLM, Ventyx, DRECP agencies



Resource Potential - Geothermal

- There is additional technical potential of ~1,800 MW in the Salton Sea region.
- The Salton Sea KGRA comprises ~ 1,300 MW of the most likely developable capacity, much of which is still underwater within the Salton Sea.
- Additional foundation and drilling requirements associated with building on the playa may make development uneconomic.
- Geothermal plants, if built on the playa, provide roads, berms and infrastructure

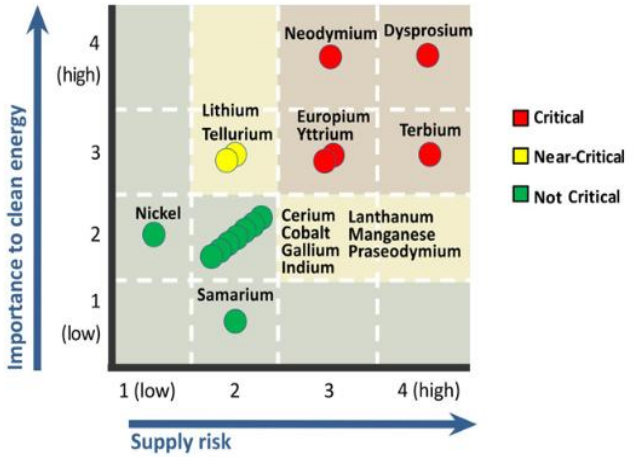


Potential development of Salton Sea KGRA based on the shoreline recession in 25 years

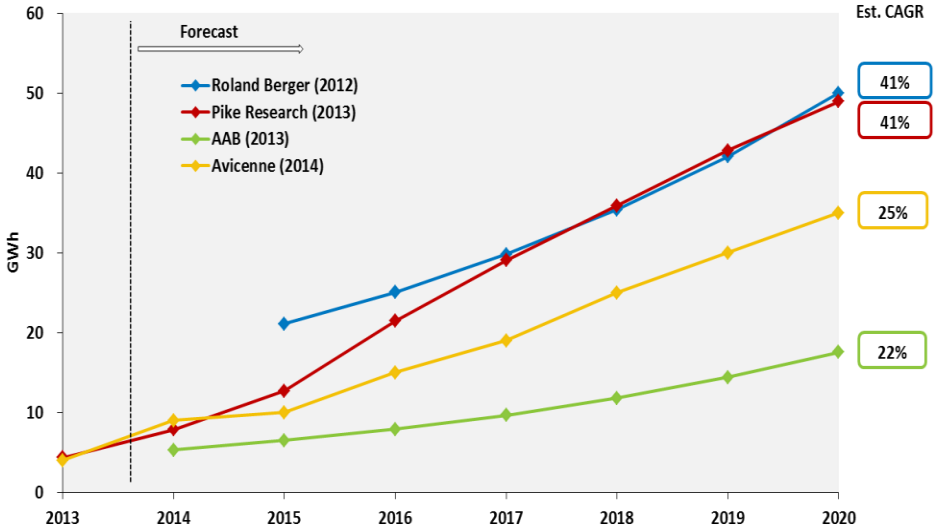
Market Analysis - Lithium

- Lithium is not an element identified as a critical near-term strategic concern by government organizations – however, **global supply is concentrated in the hands of a few major companies and countries.**

- **Strong acquisition appetite by both materials and upstream companies** for lithium assets in order to secure future supply



Strategic Importance and Scarcity of Selected Raw Materials (2015-2025)



Projected growth in global li battery demand for automotive applications.

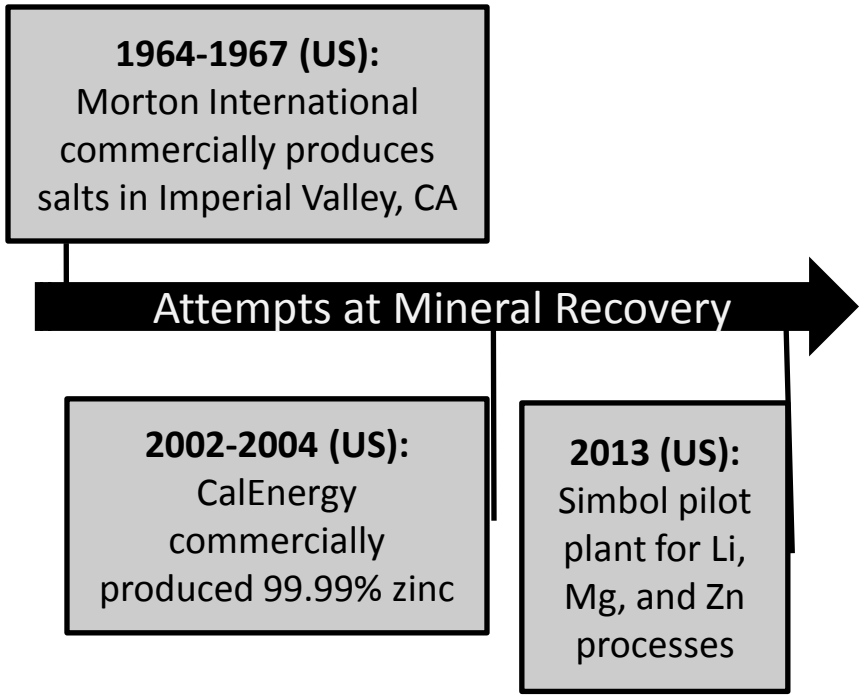
Chung, Donald, and Elgqvist, Emma, Automotive Lithium-ion Battery (LIB) Supply Chain and U.S. Competitiveness Considerations, 2014.

- Anticipated growth in EV markets will result in increased Li battery demand, which may **drive increase in lithium price**

Resource Estimation – Lithium Mineral Recovery

- Mineral recovery from brines is a proven technology – but **lithium recovery has not yet been commercial** for geothermal fluids
- **Not any geothermal well will do:** concentrations of lithium in the brines must be high enough for recovery.
  - Imperial Valley has abnormal but highly variable chemistry.

Lithium recovery creates a revenue stream:
$91-118 million
Estimated annual gross revenue flow equivalent to a 50MW geothermal plant, assuming Simbol's 93% recovery efficiency estimate, and lithium price of $6.6/kg.

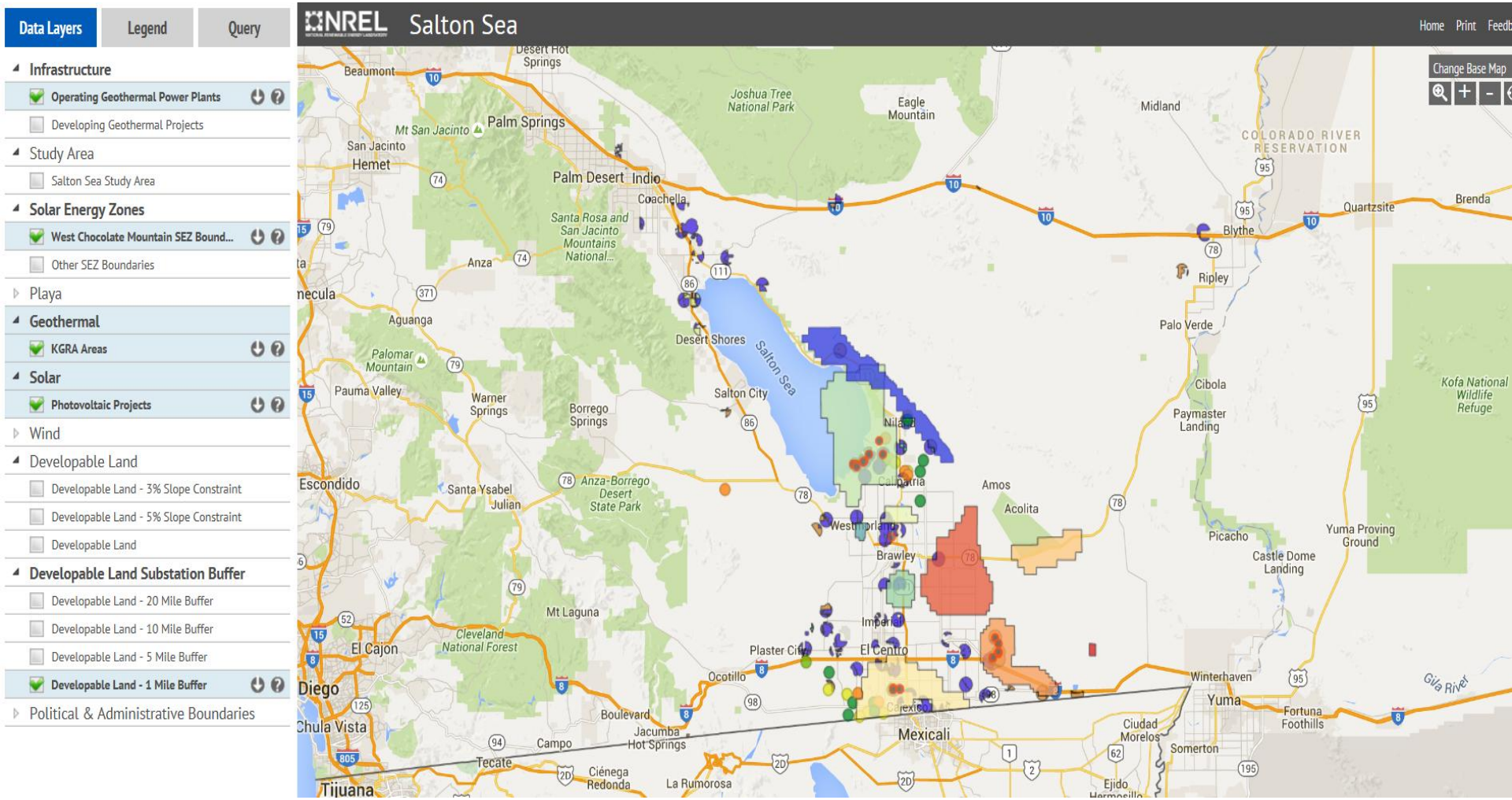


In 2013, Simbol Technologies reported that it had **successfully produced battery grade lithium carbonate (99.99% purity)**

- Simbol shut down operations at the Hudson Ranch plant as of February 2015

Preliminary Interactive Online Mapping Tool

http://maps.nrel.gov/salton-sea



2030 Potential Revenues – Current Policies/Conditions

	Current Conditions [Annual Millions]	Notes: See Appendix C for full calculations
Geothermal (KGRAs)*	$7 to 15	Onshore: BLM land lease royalties: $1-3 Offshore: IID land lease royalties : $6 -12
Solar PV (onshore)	$0	Available onshore land is predominantly private, and BLM Solar Energy Zone royalties are currently fully allocated to the U.S. Treasury.
CSP (onshore)	$0	
Other:		
AB 1471 (CA 2014 Water Bond)	$0 to 14.3	Total CA water bond is $475M, $200M assumed as upper limit given other obligations.
Total (annual):	$7 to 29.3	Annual revenues calculated assuming 14 years, from 2016-2030. Figures do not account for inflation or the time value of money.
14 year total:	$98 to 410.2	Note: The mitigation revenues in Tables ES-2 and ES-3 are additive.

Potential Revenues – Future Conditions

	Potential Future Conditions [Annual Millions]	Notes: See Appendix C for full calculations
Mineral recovery from geothermal brines (offshore KGRA)	$0 to 25.8	Assumes offshore development of up to 570 MW of geothermal, 3% IID royalty rate on gross lithium sales
Algal biofuels (offshore non-KGRA)*	$1.2 to 2.3	Assumes $3/gal cost competiveness by 2030, 1-2% IID land lease rate on gross proceeds.
Salinity Gradient Solar Ponds (offshore non-KGRA)*	$0.6 to 1.6	Assumes $80-$100/MWh PPA, 90% capacity factor, IID land lease rate (1-2% - gross proceeds).
Solar PV (offshore non-KGRA)*	$1 to 3	Assumes $40-60/MWh PPA, 23.2% capacity factor, IID land lease rate (1-2% - gross proceeds).
Solar PV (onshore BLM Solar Energy Zones)	$1.5-4.4	Assumes passage of S-1407and development of 1.8 GW of BLM SEZ's. Assumes $40-60/MWh PPA, 23.2% capacity factor, royalty rate between 1-2% of gross proceeds.
Other:		
Desert Renewable Energy Conservation Plan - Habitat Restoration	$3.5 to $44.6	Lower case based on allocable revenues to desert pupfish habitat, upper case is for full habitat restoration amounts for Imperial & Riverside Counties
Total (annual):	$5.6 to 77.8	The potential revenues above typically require a change in policy, development of the offshore playa, or technological developments.
14 year total:	$78.4 to 1,089.2	

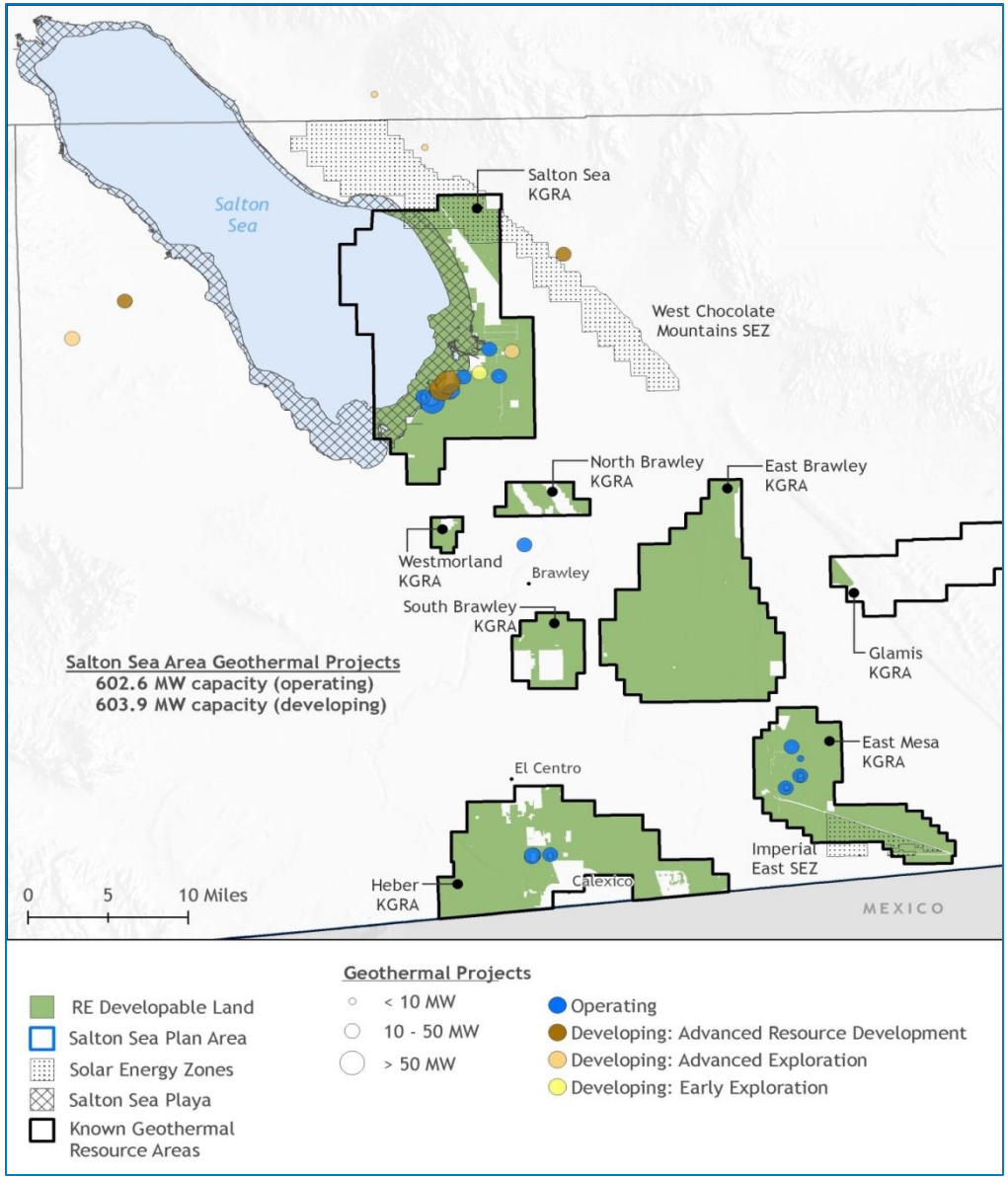
Potential Next Steps

- Conduct Lithium manufacturing supply chain study in conjunction with DOE Clean Energy Manufacturing Analysis Center (CEMAC)
- Conduct expanded power system modeling to better understand trade-offs and dispatch strategies between geothermal and other resources in meeting 50% RPS and GHG targets
- Expand online mapping tool to include additional data (e.g. well database, habitat, ownership, potential build outs under various RPM/PLEXOS scenarios, one stop permitting)
- Jobs and Economic Development Impact model for geothermal and solar build-out in the region

Additional Slides

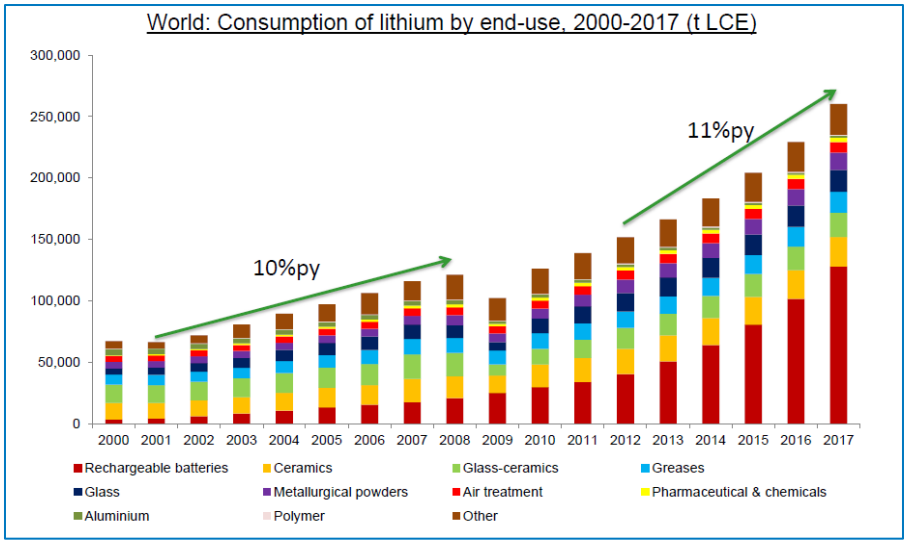
Known Geothermal Resource Areas

- **600 MW current operating capacity**
- **Cost challenges to geothermal when competing with wind and solar under CA's least-cost, best-fit RPS policy (50% renewable by 2030)**
- **2014 state legislation requiring 500 MW of new geothermal procurement did not pass**



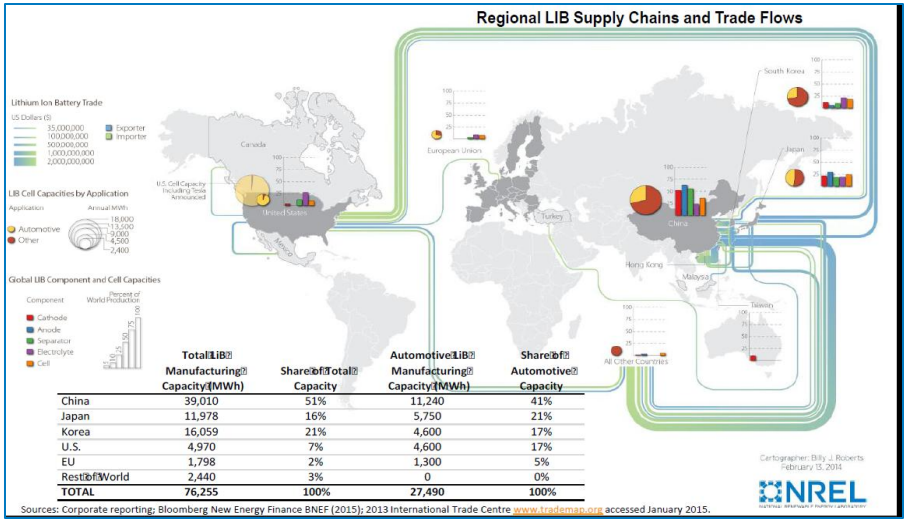
Salton Sea Lithium Supply Chain Analysis

- Lithium is a fundamental material in the value chain of advanced energy storage technologies
- Manufacturing of lithium ion batteries is rapidly growing market
- Strong interest in developing this resource in the Salton Sea



Potential Analysis:

Conduct a detailed supply chain study for lithium production from the Salton Sea, within the context of new battery manufacturing for U.S. industry, especially the automotive sector



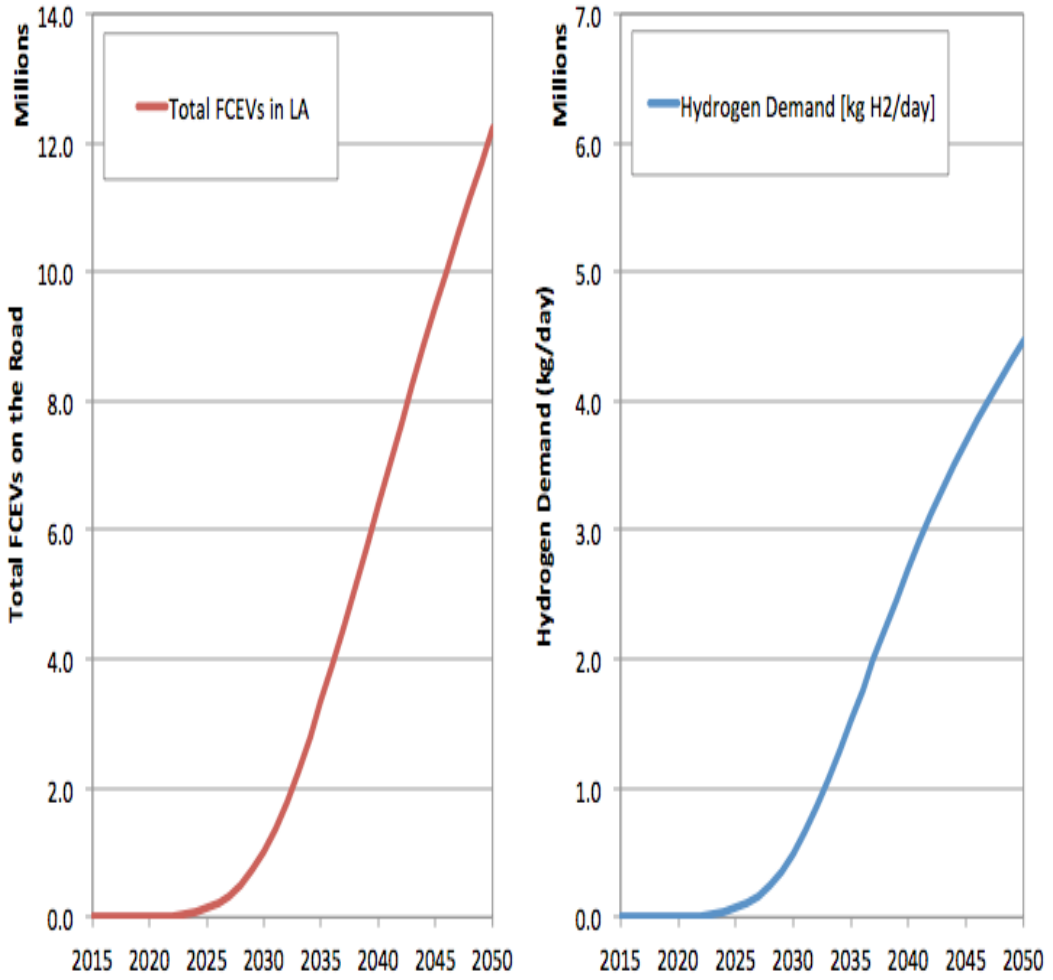
	Total LiB Manufacturing Capacity (MWh)	Share of Total Capacity	Automotive LiB Manufacturing Capacity (MWh)	Share of Automotive Capacity
China	39,010	51%	11,240	41%
Japan	11,978	16%	5,750	21%
Korea	16,059	21%	4,600	17%
U.S.	4,970	7%	4,600	17%
EU	1,798	2%	1,300	5%
Rest of World	2,440	3%	0	0%
TOTAL	76,255	100%	27,490	100%

Sources: Corporate reporting; Bloomberg New Energy Finance BNEF (2015); 2013 International Trade Centre www.trademap.org accessed January 2015.

Source: CEMAC, Automotive Lithium-ion Battery Supply Chain and U.S. Competitiveness Considerations, http://www.manufacturingcleanenergy.org/products.html.

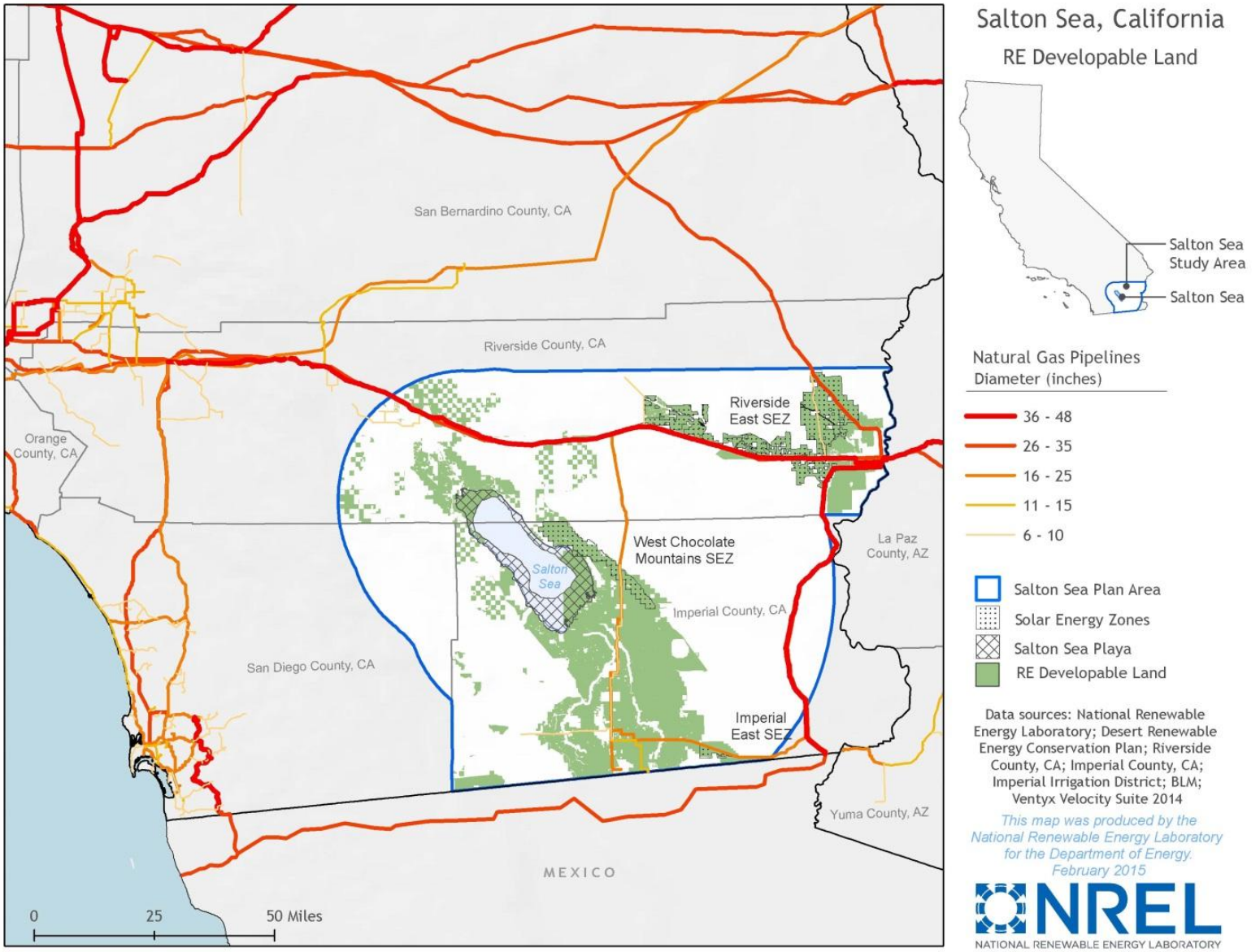
Resource Confirmation- Hydrogen

- A hypothetical renewable hydrogen production facility with 100,000 kg/day capacity would dominate the FCEV market up to approximately 2025 to 2030.
- As additional market forces level the playing field for low-carbon fuels approximately 2035 to 2040, this 100,000 kg/day facility would be a small part of the overall demand



Total FCEV sales in Los Angeles (left) and resulting hydrogen demand (right).

Major natural gas pipelines for potential distribution of Salton Sea Hydrogen



Resource Potential and Costs

Technology	Land Developable by 2030 (acres)	Undeveloped Energy Resource Potential	Resource Potential Developable by 2030	Current levelized-cost ($/MWh)***	Estimated 2030 levelized-cost in ($/MWh)***
New Geothermal power (KGRA*)	50,330	1.78 GW - 2.94 GW	1.05-1.81 GW	$107-$131	$107-$131
Mineral recovery from geothermal brines (KGRA)	50,330	115-222 thousand MT Lithium	54.3-122 thousand MT Lithium	Not commercial	Not available
Onshore Solar PV	14,405	31.9 GW	1.8 GW	$100-$113	$49-$94
Offshore Solar PV	9,938	4.2 GW	1.25 GW	$100-$113**	$49-$94**
Onshore CSP	13,147	23.9 GW	1.3 GW	$181	$84-$132
Offshore Algal Biofuels	32,821	39M gal/year	Not commercial	$>10/Gallon	$3/gallon
Offshore Salinity-Gradient Solar Ponds	9,938	0.444 GW	.1 GW	$80-110	Not available

*Known geothermal resource areas, **offshore playa construction requirements may result in higher LCOE,
***Excludes state and federal incentives, but are inclusive of MACRS depreciation. Deal provisions, such as: escalation rate, ITC, term length, state income and sales tax rates, project financing, and additional grid services can all result in a disparity between the LCOE and ultimate PPA price of a technology.

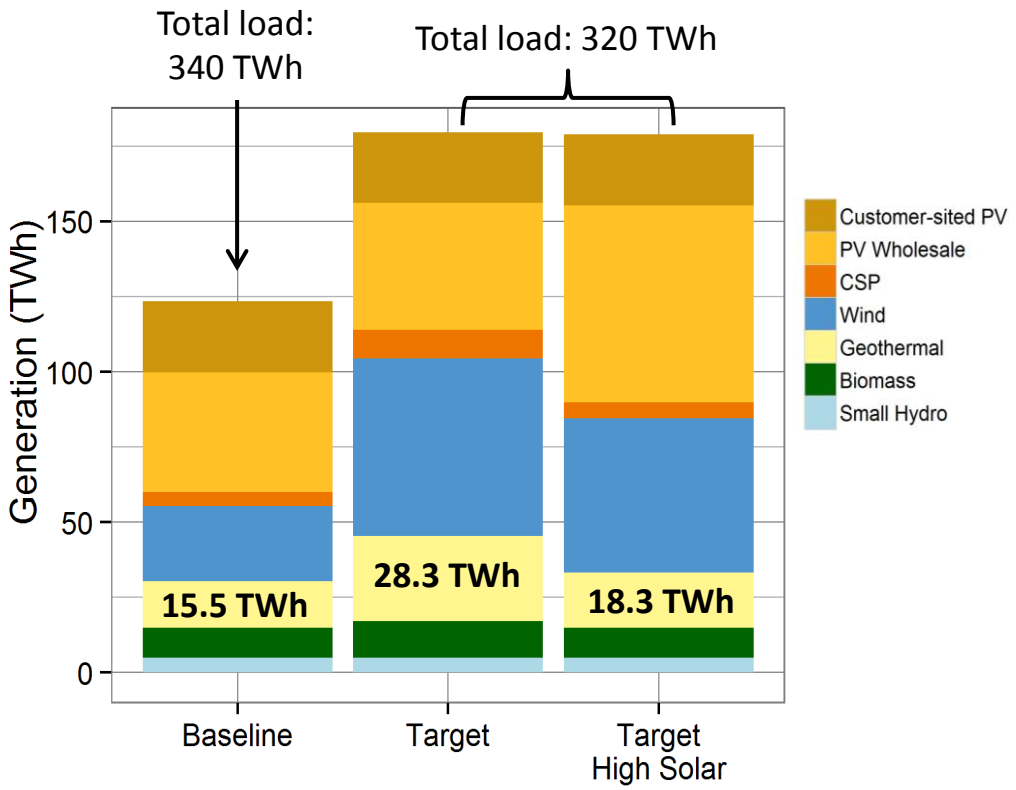
Low Carbon Grid Study, January 2016

- **Studied grid impacts of scenarios that reduce emissions from the CA electric sector by 50% in 2030[1]**
  - Modeling performed by NREL; capital cost analysis by JBS Energy, reliability impact analysis by GE
  - Reviewed by TRC of utilities and energy offices in CA and west
  - Combined generation portfolios with different flexibility options

Flexibility options

Conventional	Enhanced
restrictions on in-state and regional trading and ancillary service provision	more flexible trading, additional 2.2 GW storage

Generation portfolios



[1]Baseline year for emissions reduction is 2012

Low Carbon Grid Study - Results

Emissions reduction target achieved in all main scenarios; total cost, emissions, and curtailment depend on portfolio mix and flexibility options.

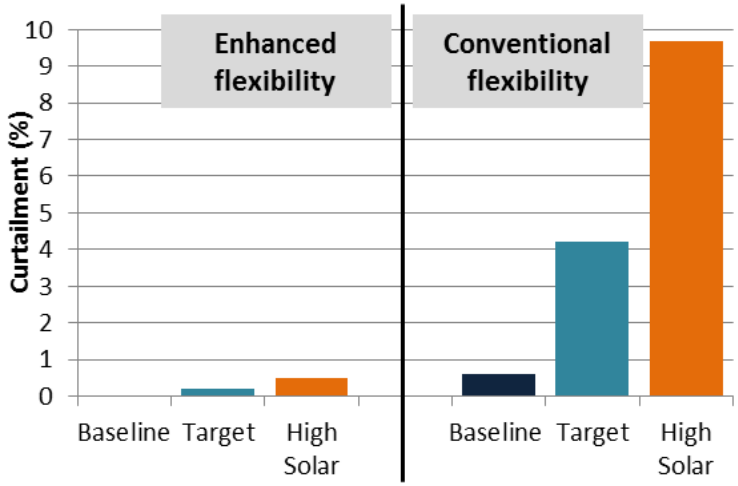
Production cost savings

Annual, relative to Target High Solar, conventional flex.

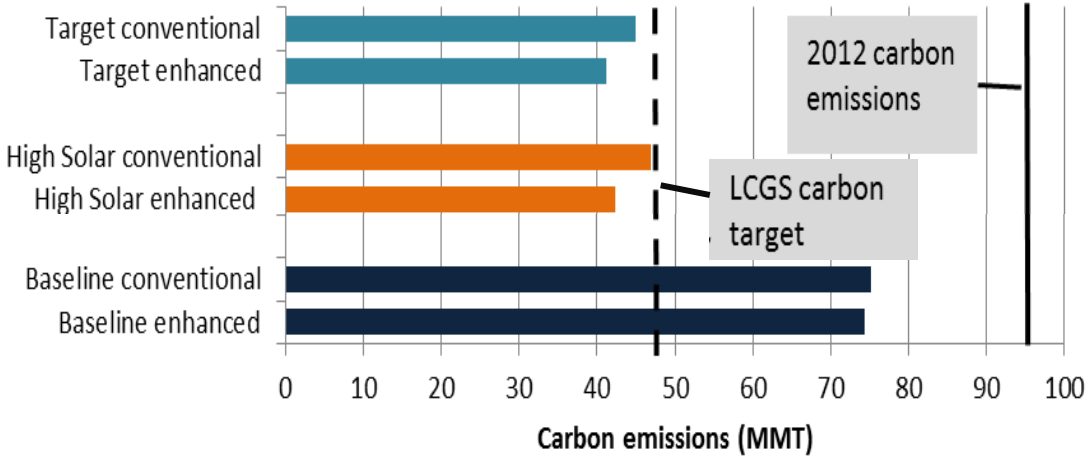
	Target	Target High Solar
Conventional flexibility	+$230m	-
Enhanced flexibility	+$770m	+$560m

- Total production cost ranged from $7.87 billion to $8.64 billion in the Target and Target High Solar scenarios.
- Including capital costs, total impact of these scenarios ranged from 0.75% – 3% of annual utility revenue requirement, relative to the Baseline cases (JBS Energy).

Curtailment



Emissions



Additional Resources

For additional information:

- Low Carbon Grid Study website: http://lowcarbongrid2030.org/
- Full NREL LCGS report: http://www.nrel.gov/docs/fy16osti/64884.pdf

- **Continued LCGS study will:**
  - Explore changes to the geothermal portfolio
  - Analyze impact of changing 10 TWh of CA geothermal to CA solar PV