Imperial Irrigation District

Salton Sea Revenue Potential Study
Final

December 10, 2013

Prepared by:

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December 10, 2013

Mr. Greg Broeking
Chief Financial Officer
Imperial Irrigation District
333 E. Barioni Boulevard
P.O. Box 937
Imperial, California 92251-0937

SUBJECT: Salton Sea Revenue Potential Study

Dear Mr. Broeking:

Please find our final draft of the Salton Sea Revenue Potential Study prepared by EES Consulting. We would like to acknowledge and thank you and your staff for your contribution to this study.

In addition, we would like to recognize the following contributors: Abengoa and Development Design Engineering. It has been a pleasure to work on this project with you and your team, and we look forward to your feedback on this draft report.

Please contact me directly if there are questions.

Very truly yours,

Gary S. Saleba

Gary Saleba
President

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Section 1 - Executive Summary

Imperial Irrigation District (IID) has asked EES Consulting (EES) to develop a feasibility study for revenue potential from land leases in the Imperial Valley for renewable energy projects. IID is interested in helping to develop renewable energy resources in the Salton Sea area that would partially fund the restoration of the Salton Sea. IID has asked EES to estimate the revenue potential available to help fund the Salton Sea Projects. Initially, IID would like to know if there is enough economic potential in the Imperial Valley at the Salton Sea to substantially help fund Salton Sea restoration projects. This report reviews renewable project potential and provides a conceptual analysis of the revenue potential available both to IID and to fund the Salton Sea Projects.

This report evaluates the following revenue sources:

- Unit, $/MWh, charge on renewable energy development
- Mining rights and associated royalties
- Algae-based products and associated royalties
- Transmission ownership rate of return
- Falling water charge at Hoover Dam

Each of these revenue sources are described below.

Revenue Potential Analysis

Renewable Energy

First, renewable resource potential is estimated based on previous work completed for IID regarding geothermal resource assessments, interviews with industry experts and EES' experience in renewable project development. The costs of renewable resource projects are estimated and compared with publicly available forecasts of renewable energy prices in California. The revenue potential is the difference between renewable energy price forecasts and Salton Sea renewable resource costs.

Three types of renewable resources are evaluated including thermal gradient ponds, solar, and geothermal. Thermal gradient ponds were found to be useful for environmental mitigation and industrial power purposes; however, these resources were not included in the revenue potential estimates.

Solar Development

Solar resources are available in the Imperial Valley. Currently, these resources are being sited on agricultural land which may have potential negative effects on the local economy. Solar resource development is expected to be constrained by transmission, land issues, and the lower cost of development in other locations. Lands near the Salton Sea may not be desirable for photovoltaic or concentrated solar power generation due to the impact of ambient conditions on solar components. Additional evaluation of the suitability of solar energy located on playa areas is in the planning stages and may further inform the viability of solar energy in these areas. Until those studies are completed it is difficult to accurately project solar revenue. Therefore, this study conservatively estimates revenue potential of $150 million over the study period from 1,000 MW of solar resources.

Geothermal Development

Finally, the study concludes that significant geothermal resources are available at the South end of the Salton Sea. As the Salton Sea recedes over the study period, prime geothermal sites are exposed. The resource development costs are estimated assuming economies of scale and a development schedule is estimated based on streamlined permitting processes and assumed recession rate of the Salton Sea. This study estimates that approximately 2,000 MW (15,000 GWh) of geothermal resources are available over the study period 2016 through 2045. The levelized cost of energy for these resources are estimated to range from $90/MWh to $120/MWh depending on resource type (high temperature, or lower temperature gradients) and location (onshore or offshore).

Renewable Energy Prices

Because renewable energy prices are dependent on several factors that vary over time, four forecasts are reviewed for this analysis:

- **Current Market** – the Current Market forecast was developed based on the 2012 expenditures of three California investor-owned utilities for geothermal contracts as published annually in the California Public Utility Commission's (CPUC) Padilla report.[1] The bundled price of $82.10/MWh for 2012 was escalated at the rate of inflation (1.5 percent).
- **RFP** – The RFP forecast is based on the price cap set in Southern California Public Power Authority's (SCPPA) renewable energy request for proposals (RFP).[2] SCPPA's RFP caps proposals at $95/MWh in 2016 escalating at 1.5 percent per year.
- **Market** – The Market forecast is based on projected levelized costs for merchant flash geothermal plants estimated by the California Energy Commission (CEC).[3] The average

[1] California Public Utilities Commission. The Padilla Report to the Legislature. The Costs of Renewables in Compliance with Senate Bill 836 (Padilla, 2011). March 2013 Available at: http://www.cpuc.ca.gov/NR/rdonlyres/F0F6E15A-6A04-41C3-ACBA-8C13726FB5CB/0/PadillaReport2012Final.pdf

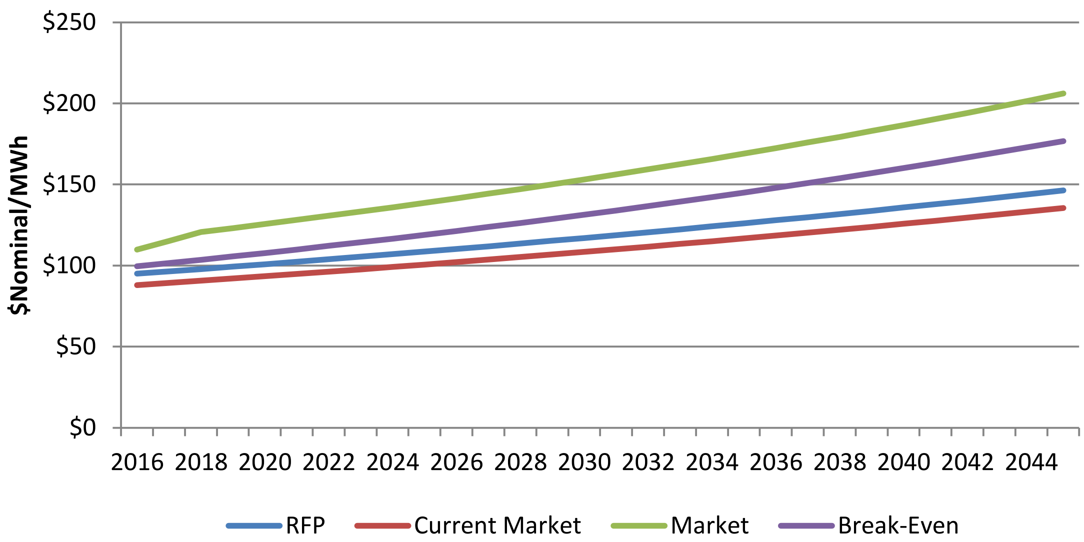
[2] Southern California Public Power Authority. Request for Proposals for Renewable Energy Projects. Response Deadline: December 31, 2013.

nominal levelized cost for the 2009 and 2018 in-service dates are $78.91 and $120.72/MWh respectively. The average increase is 4.8 percent annually. This increase appears to be high based on information in the Padilla report. Therefore, the Market forecast was developed by using the escalating $120.72/MWh in 2018 at the assumed rate of inflation for this study (2 percent).

- **Break-Even** – The break-even price forecast was developed to show the prices needed in order for the proposed geothermal projects to produce enough revenue such that the total geothermal based revenue estimated in this report is $2 billion over the study period. Note that the break-even price is not required for geothermal projects to be economic.

Figure 1 illustrates the four forecasts described above.

Figure 1
Forecast Renewable Energy Prices



The levelized prices for the three forecasts are shown in Figure 2.

Figure 2 Levelized Prices Renewable Energy Forecasts $2013/MWh				
	RFP	**Market**	**Current Market**	**Break-Even**
30-Year Levelized Price	$103.32	$132.02	$101.10	$113.89

[3] California Energy Commission. Comparative Costs of California Central Station Electricity Generation. Final Staff Report January 2010.

The RFP and Current Market forecasts represent the lowest expected renewable energy prices. It is more likely that renewable energy costs will increase as base load energy is required to meet California's renewable portfolio standards (RPS). Current RPS will require 33 percent renewable energy by 2020. A proposed bill (AB 177) could increase the RPS requirement to 51 percent by 2030. The revenue potential estimates in this report assume the break-even renewable energy price. As noted above, the estimated revenue under this price is $2 billion over the study period. Note that the break-even price does not include the value of renewable base load generation. Estimated geothermal resource costs developed in this study range from $89/MWh to $118/MWh in levelized terms (without any base load credit).

Mineral Recovery

Mineral recovery is possible in conjunction with the development of geothermal projects. Specifically, minerals such as manganese and lithium may be extracted from the geothermal brines. Revenues from mining royalties are estimated based on high-level gross revenue estimates provided in a draft report developed for IID.[4] These royalties are included in the revenue potential for Salton Sea restoration projects. The mining royalties are estimated at $1.5 billion over the period 2016 through 2045.

Algae Product Royalties

The business of growing algae to produce fuel has made significant progress in recent years. The process utilizes enhanced or genetically altered algae to produce various oil products ranging from fuel oils to cooking oils. Specifically, the production of ethanol is the target of some of the leading companies. The cultivation of algae for fuel production can require large volumes of water varying from 3 to 3,000 times the volume of oil produced. However, the water quality can be saline, wastewater/non potable, or recycled water. In addition, algae cultivation requires nutrients such as nitrogen and phosphorus. Given the receding Salton Sea, algae production could be an alternative to exposed playa. Estimated revenues from royalties on algae-based products are over $260 million for the study period.

Transmission Ownership

In order to provide transmission services to and from the proposed renewable energy projects, a new transmission line will need to be built in the Imperial Valley. As a part-owner, IID would receive a return on investment for its ownership share of the transmission line. IID has suggested that half of IID's return be allocated to Salton Sea Projects. The Salton Sea project revenues from IID's transmission ownership are estimated at $42 million over the study period.

[4] A Roadmap for the Imperial Irrigation District Public-Private Partnership Strategic Plan to Develop Untapped Resources and Restore the Salton Sea. July 7, 2013.

Falling Water Charge

In addition to the revenue collected through Salton Sea royalties, IID asked EES to develop an analysis of a falling water charge for the Hoover Dam. The falling water charge is a charge in dollars per megawatt hour (MWh) of output produced by the Hoover Dam. Proposed falling water charges are compared to current wholesale rates of electricity at Hoover Dam to determine rate impacts. Revenue collected from the proposed charge would be used to help fund Salton Sea rehabilitation and restoration projects. Figure 3 shows the estimated revenues for various falling water charges. The revenue potential estimates in this report assume the falling water charge is $1/MWh.

Figure 3
Hoover Dam Falling Water Charge Summary

Falling Water Charge in 2016	Rate Increase over Hoover Dam Projected Rate	Total Revenue 2016-2045 ($Millions, Nominal)
$0.25/MWh	0.9%	$47.3
$0.50/MWh	1.9%	$94.7
$1.00/MWh	3.8%	$189.4
$2.00/MWh	7.5%	$378.6
$3.00/MWh	11.3%	$567.9

Revenue Potential Results

Figure 4 below shows the results of the revenue potential analysis.

Figure 4
Estimated Revenue Potential 2016-2045
$Millions, Nominal

Solar Development	$150
Geothermal Development	$2,001
Mineral Recovery	$1,495
Algae Products	$260
Transmission Revenue	$42
Falling Water Charge Revenue, $1/MWh	$189
Total	$4,138

The primary sources of revenue from renewable energy development are from geothermal resource development and mineral royalties. The revenue potential estimate from geothermal project development is sensitive to the renewable energy price or the value of an integration credit.

Conclusion

The break-even renewable energy price is a reasonably attainable forecast; therefore, it may be possible to reach the $2 billion revenue goal over the period. The following requirements are needed for geothermal projects to meet the $2 billion revenue goal:

- Geothermal resource costs are estimated to range from $89/MWh to $118/MWh depending on resource type and location. At current renewable energy prices (RFP price forecast), an integration credit of $18/MWh is required in order for the high temperature, offshore Salton Sea geothermal projects to be economic.
- Given the break-even value of renewable energy $113.89/MWh, a $/MWh charge could be placed on all geothermal output estimated based on the development schedule. Figure 5 shows the projected revenue provided a range of $/MWh charges.

Figure 5
Geothermal Charge

$/MWh Charge	Projected Revenue ($millions)
$6	$1,623
$8	$2,164
$10	$2,705

- A 500 kV transmission line must be financed by a third party and the CPUC must allow recovery of costs through rates.
- Blanket permitting for geothermal projects approved by state.
- State provides assistance to Salton Sea geothermal resource development through RPS or financing incentives. These financing incentives could be a loan guarantee program similar to the current Department of Energy loan guarantee program. These incentives are necessary in order for developers to take on geothermal development risk and be able to pay Salton Sea Project charges/royalties.

Based on the analysis, there is significant revenue potential available for Salton Sea restoration and rehabilitation projects. If IID pursues renewable project development in the Salton Sea area, and obtains support from the State of California, the proposed projects could become increasingly economic.

Action Plan

Based on the study conclusions the following actions are recommended to IID:

- Meet with State of California Officials and Regulating Agencies (CPUC, CEC, California Department of Fish and Wildlife, etc) in order to:
    - Expedite the transmission line investment/construction.
    - Obtain state guaranteed loans or state funds set aside for geothermal project developer access to capital and long term financing.
    - Indentify permitting issues and responsible agencies. Seek blanket permits for multiple geothermal project developments located near or under the existing Salton Sea.
    - Through the CPUC or CEC, modify California renewable portfolio standards to provide incentives for Salton Sea renewable development or to require utilities to purchase Salton Sea project output.
    - Meet with CPUC, CEC, utilities and other government agencies to clarify costs and include value adder to base load renewable energy projects.
    - Implement the pilot project to evaluate solar energy facilities located on Salton Sea playa areas.

- Initial Development Activities
    - Perform transmission study for 500 KV line to finalize route, right of way issues, capacity and cost. Identify potential line developers and financing parties. Prepare study report on ownership and operation structure.
    - Meet with geothermal developers to discuss interest in developing Salton Sea resources, technical, permitting and financing issues and leasing requirements.
    - Prepare an environmental study to identify permitting issues and options. Initiate discussions with permitting agencies (U.S. Army Corp of Engineers, State and County Agencies, etc) and stakeholders (local tribes) to mitigate the impact of geothermal development and further improve the environment around the Salton Sea.
    - Prepare financing studies and planning documents.
- Funding For 2013-2014
    - Initial studies estimated to cost $0.5 to 1.0 million
    - Legal, consultants and additional staffing $500,000

Section 2 - Introduction

Imperial Irrigation District (IID) has asked EES Consulting (EES) to develop a feasibility study for revenue potential from land leases in the Imperial Valley for renewable energy projects. IID is interested in helping to develop renewable energy resources in the Salton Sea area that would partially fund the restoration of the Salton Sea.

Background

The Colorado River provides much of the water supply in Southern California. The water rights to the river are shared among various western states; however, until recently, Arizona and Nevada did not use their full share. California was allowed to use the water not used by these states. Growth in Arizona and Nevada has now required that California reduce its use of the Colorado River to its allocation. Due to the reduction in California's use of the Colorado River, and many other factors, both the water quality and quantity are declining at the Salton Sea.

Legislation in California provides that the state is responsible for the restoration of the Salton Sea and the protection of the wildlife dependent on its ecosystem. Full restoration of the Salton Sea is expected to cost on the order of $3 to $9 billion. The legislation also recognizes that certain California water agencies (including IID) and the State of California have entered into the Quantification Settlement Agreement (QSA). Pursuant to the QSA, the State is responsible for funding the mitigation of environmental impacts resulting from the QSA in excess of $133 million funded by the California water agencies.

IID's goal is to leverage funds generated by new renewable energy projects located at the Sea to help finance activities for air quality management and habitat restoration (Salton Sea Projects). Suggested revenue sources include the development of renewable energy in the Salton Sea area, and mineral or lithium mining. The Salton Sea shoreline recession is exposing acreage of land where the potential for geothermal energy exists. In particular, known geothermal resource areas are being exposed as the shoreline recedes. Much of the newly exposed lands are owned by IID.

Report Purpose

IID has asked EES to estimate the revenue potential available to help fund the Salton Sea Projects. Initially, IID would like to know if there is enough economic potential in the Imperial Valley at the Salton Sea to substantially help fund Salton Sea Projects. This report reviews renewable project potential and provides a conceptual analysis of the revenue potential available to fund the Salton Sea Projects.

Section 3 - Overview of Analytical Framework

The overall approach of this report is to determine the revenue potential around the Salton Sea and to rely primarily on available information and industry knowledge. In addition to the renewable energy projects, an analysis of a falling water charge at Hoover Dam is included. Finally a cash flow analysis is presented to summarize the estimated revenue potential available in each year of the study. These various analyses are described more below.

Renewable Energy

First, renewable resource potential is estimated based on previous work completed for IID regarding geothermal resource assessments, interviews with industry experts and EES' experience in renewable project development. Then the costs of these projects are estimated and compared with publicly available forecasts of renewable energy prices in California. The revenue potential is the difference between renewable energy price forecasts and Salton Sea renewable resource costs. Geothermal, solar, and solar gradient ponds are evaluated.

Mineral Recovery

Mineral recovery is possible in conjunction with the development of geothermal projects. Revenues from mineral royalties are estimated assuming a royalty on gross revenues from mineral recovery. These royalties are included in the revenue potential for Salton Sea Projects.

Algae

The business of growing algae to produce fuel has made significant progress in recent years. The process utilizes enhanced or genetically altered algae to produce various oil products ranging from fuel oils to cooking oils. Specifically, the production of ethanol is the target of some of the leading companies. The cultivation of algae for fuel production can require large volumes of water varying from 3 to 3,000 times the volume of oil produced. However, the water quality can be saline, wastewater/non potable, or recycled water. In addition, algae cultivation requires nutrients such as nitrogen and phosphorus. Given the receding Salton Sea, algae production could be an alternative to exposed playa. Estimated revenues from royalties on algae-based products are included in this report.

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Cash Flow Analysis

The results of the revenue estimates are presented to show the timing of the estimated revenue potential. The cash flow analysis is based on the development schedule for renewable resources, price forecasts, and other financial assumptions.

Report Organization

This report first describes the renewable resource potential and estimated project capital and operation and maintenance costs. Next, the revenue potential analysis is presented including revenue from proposed renewable projects, the falling water charge, and the cash flow analysis. The revenue potential estimates include deterministic scenario analysis for renewable energy prices and the falling water charge. Lastly, conclusions and recommendations are made based on the study results.

Section 4 - Resource Potential

Introduction

EES was requested to develop an economic model of the potential geothermal developments which could result from the receding of the Salton Sea and usage of IID owned/controlled lands. As part of this study, a review of available data on potential geothermal development including prior studies, by Geothermal Resource Council (GRC) published reports, public developer data, and CEC publications was undertaken as well as discussions with developers and other experts. This section of the report provides an estimate for the resource potential available in the Salton Sea area. Both onshore and currently offshore lands by the Salton Sea were evaluated for geothermal resource potential. Other resources such as solar technologies and mineral mining are also discussed.

Resources

IID has completed several studies that help identify renewable energy potential in the Salton Sea area. These studies have indicated as much as 2,500 MW (19,000 GWh) of economic geothermal potential and 28,000 MW (49,000 GWh) solar potential are available.[5] The California Energy Commission resource plan has estimated that the state will require an additional 5,000 to 17,000 GWh by 2020 of renewable energy to comply with California's renewable portfolio standards.[6] Renewable energy sources evaluated in this study include:

- **Solar gradient ponds**– Many pilot projects have been implemented to test the viability of solar gradient ponds technologies including a project in Israel (Ormat) and El Paso. IID has asked if the technology has been proven as a long-term solution. Solar gradient ponds can be combined with geothermal projects to maximize use of the land.
- **Solar** – Significant solar potential exists in the Imperial Valley. A report by Summit Blue[7] estimates 28,000 MW of economic potential; however, there may be site issues with these potential estimates. For example, it would not be desirable to site solar resources on farm land. This study conservatively estimates that Imperial Valley solar resource development will be 1,000 MW over the study period.
- **Geothermal** – IID has completed several studies analyzing the resource potential of geothermal. Because geothermal resources provide base load energy, IID believes that this resource type is the most valuable to the state. Significant geothermal resources

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[5] Summit Blue Consulting, LLC. Renewable Energy Feasibility Study Final Report. Boulder, CO. April 1, 2008.

[6] California Energy Commission. Integrated Energy Policy Report. 2011. CEC-100-2011-001-CMF.

[7] See id.

exist near the Salton Sea. Currently, 600 MW of geothermal potential has been developed in the Imperial Valley including 375 MW in the Salton Sea Known Geothermal Resource Area (KGRA).

The following is a summary of EES's investigation into each of the renewable areas of interest.

Solar Gradient Ponds

A solar gradient pond is a type of solar thermal energy technology that captures solar radiation and stores it in a very dense, saline layer of water at the bottom of a specially designed artificial pond. Dark colored, absorbing material is often used to line the pool to enhance the absorption of solar radiation and to prevent groundwater contamination.

The pond is designed to hold saline water at the bottom and fresh water on the top. As the solar energy passes through the water layers it is absorbed and heats the saline water on the bottom. Although the salt water is heated, it cannot rise to the surface because it is heavier than the fresh water on top. The upper water layers act as an insulting blanket and the temperature of the bottom of the pond can approach the boiling temperature.

The heated salt water layer can be used for industrial processes or for energy production. Because the heated water's maximum temperature is limited to the local boiling temperature (212°F at sea level), using the water in a power cycle has a very low theoretical efficiency when compared to conventional power plants or concentrated solar power (CSP).

Case Studies

A renewable energy developer, Ormat, installed a solar gradient pond power plant in Israel that operated until 1988. The pond was approximately 52 acres in size and the plant generated approximately 0.5 MW on average with a maximum output of 5 MW. Using a photovoltaic or concentrated power solar systems, this same area would generate approximately 5 MW. This discrepancy in capacity demonstrates the low efficiency of the gradient pond.

Additionally, solar ponds have been used in industrial processes. A food cannery plant in El Paso, Texas utilizes solar ponds to power its operations. The low cost of these ponds makes this resource technology an attractive option for industrial plants.

Summary

As the sea recedes, and new shoreline develops, solar gradient ponds might be a feasible option to reduce exposed lands. Because solar ponds are less affected by humidity, salt and particulate matter, thermal gradient ponds may be appropriate for locations near the Salton Sea for industrial use, water purification processes, or in support of energy generation. The solar ponds will also provide an added benefit as dust suppression on exposed playa areas and may mitigate some water quality issues by providing treated water to habitat areas. It is not known if the economic value of these resources will be greater than the costs when environmental benefits are excluded. Therefore, solar gradient ponds are not evaluated further in this report. However, it is recommended that solar gradient ponds continue to be evaluated for industrial purposes or dust reduction measures.

Solar Electric Power Generation

A review of solar generation options, photovoltaic (PV) and concentrated solar power (CSP), was performed to provide a cursory summary of the current market and provide IID with a comparison of several renewable options.

The PV solar systems have made great strides in the last couple of years that have improved collector efficiencies and reduced panel costs. Panel costs represent approximately 55 to 65 percent of the PV solar capital cost. All solar systems collect solar energy during daylight hours and provide peak energy during the late afternoon. Because output characteristics typically coincide with California peak loads, solar plants are now displacing the need for peaking gas plants. The low cost and peak-serving ability makes solar a preferred option for peaking power. Currently, the purchase price for PV solar ranges from $90-130 per MWh.[8] In addition to the purchase price, solar PV projects may also receive credits for peaking power or time-of-use premiums further increasing the value of solar energy. These prices are necessary in order for solar resources to be cost effective. It is assumed that the current prices for solar resources recover both capital costs and integration costs. Integration costs alone are estimated at $38/MWh.

Concentrated Solar Power (CSP) is another technology option for solar energy and allows for storage. Energy storage can boost generation during cloudy periods during the day and can also be used to provide power for sometime after the solar intensity has peaked. Abengoa, a solar project developer, was contacted about CSP options. Abengoa has evaluated CSP in the Imperial Valley with a focus on center tower design. These designs are more efficient than parabolic trough type solar systems because they can be designed to operate at much higher temperatures. Higher temperatures provide higher thermodynamic efficiencies in the power cycles. The center towers evaluated are approximately 750 feet tall, and Abengoa found that the soil conditions in the Imperial Valley for the center tower designs are poor and would create design issues. Abengoa indicated that CSP tower projects with some storage require approximately $150 per MWh in order to be cost-effective.

Abengoa noted that locating solar power in the Imperial Valley is an issue with regard to the proximity of the Salton Sea. The humidity near the sea reduces solar intensity and sea evaporation can result in a salt mist. In addition, the Imperial Valley is a large agricultural area. Dust from the agriculture operations, and other desert activities around the Salton Sea, can

[8] Standing offer per SCPPA RFP for renewable energy. Southern California Public Power Authority. Request for Proposals for Renewable Energy Projects. Response Deadline: December 31, 2013.

Pricing based on 100 MW solar projects. Source: Los Angeles Department of Water & Power. Feed-in Tariff Workshop FIT Program. May 30, 2013.

collect on mirrors resulting in reduced performance. Additional evaluation of these conditions along with specific conditions on exposed lakebed is planned to better understand the impacts.

Solar Public Benefits Charge

On January 24, 2012, the Imperial County Board of Supervisors adopted a Public Benefit Program (Program) that applies to solar projects sited in the county. The Program consists of three main elements, which are incorporated into a voluntary agreement between the county and solar project developers. The first is an Agricultural Benefit Payment, proceeds from which are being placed into a fund that is utilized to mitigate the impact of solar resource development on the farming industry and to create economic development opportunities in the ag sector, thus offsetting the temporary loss of farmland. The initial fee is $5,000 per acre for prime farmland and $2,000 per acre for projects sited on land of lesser quality. Certain adjustments in those payments resulting from consideration of crop history and other factors have resulted in an average payment of approximately $1,000/acre on those projects that have participated in the program.

The second element of the Program is a Community Benefit Payment, which is an annual payment of $150-200 per acre during the operating life of each project. In most cases, project developers are given an option of making annual payments or converting that to a “lump sum” amount. Multiple incentives and credits are available under this Program for such things a local resident and veteran hiring which will likely reduce the amounts payable under this program. These Community Benefit Payments will be utilized to fund other economic development and infrastructure projects in the county.

A third section of the program deals with a Sales Tax guarantee which seeks to capture, to the extent possible, appropriate sales and use tax revenues for the County.

Resource and Revenue Potential

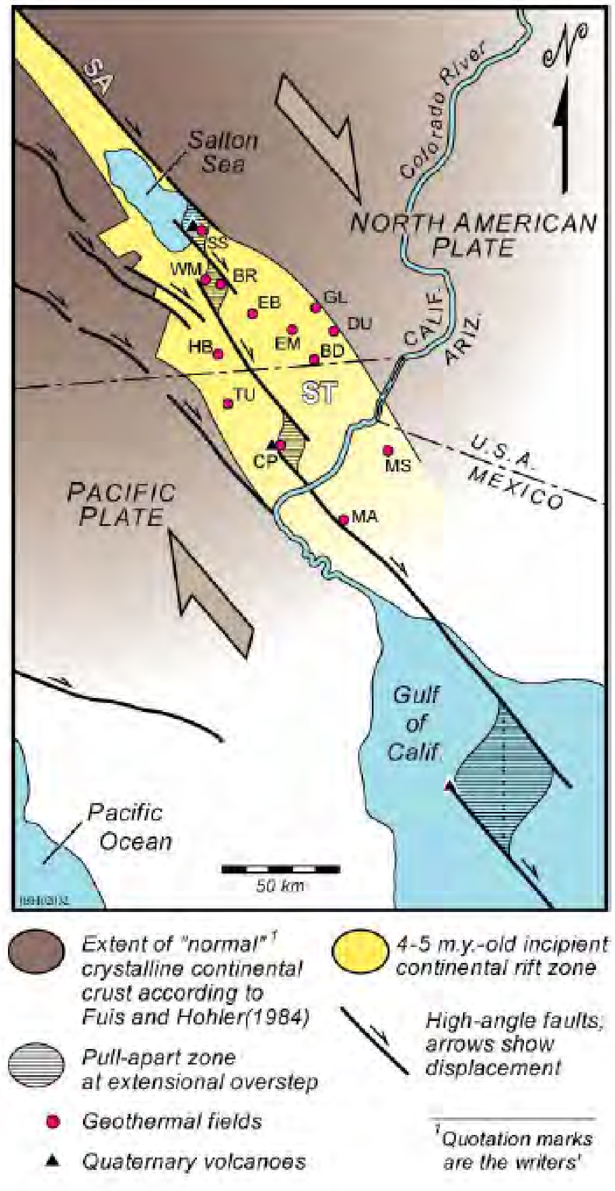
Solar is a good renewable resource option for the Imperial Valley; resources could be sited away from the Salton Sea, and other dust prone areas and agriculture activities. Based on the current development, it is conservatively estimated that potential solar generation in the Imperial Valley will be 1,000 MW over the study period. These estimates are lower than the Summit Blue potential estimates (28,000 MW) since resource development is expected to be constrained by transmission, land issues, and the lower development cost in other locations. IID asked EES to include revenue potential from solar projects assuming a conservative 1,000 MW sited on IID lands. EES assumed that 250 MW of solar could be available by 2019 and an additional 250 MW every 2 years after until 2025 when the full 1,000 MW are installed. The development schedule assumes that a transmission line is constructed and fully operational by 2019. The solar projects are estimated to require 5,000 to 10,000 acres of IID land.

Geothermal

Geothermal energy is generally considered the most desirable renewable energy because it is a base load energy resource and can be controlled to match system loads. Other renewable resources, such as wind energy, often produce output at times where energy requirements are met by base load resources or can negatively impact the transmission grid due to variable output. Solar energy typically coincides with system load peaks; however, it is limited in time of operations (when the sun shines) and is not economical for base load operations. Conversely, geothermal provides base load renewable energy.

Geologically, the Imperial Valley is located in area known as the Salton Trough where the North American Plate and Pacific Plate are pulling apart. The San Andreas Fault terminates near the south end of the Salton Sea and numerous other faults occur in this area. Because the plates are pulling apart, magma is rising closer to the surface resulting in a large geothermal anomaly. Figure 6 shows the geological structures in the Salton Trough zone.

Figure 6
Location and Tectonic Map of Salton Trough[9]



The south end of the Salton Sea covers one the largest geothermal anomalies in the United States. The Salton Sea resource has approximately 375 megawatts (MW) of existing

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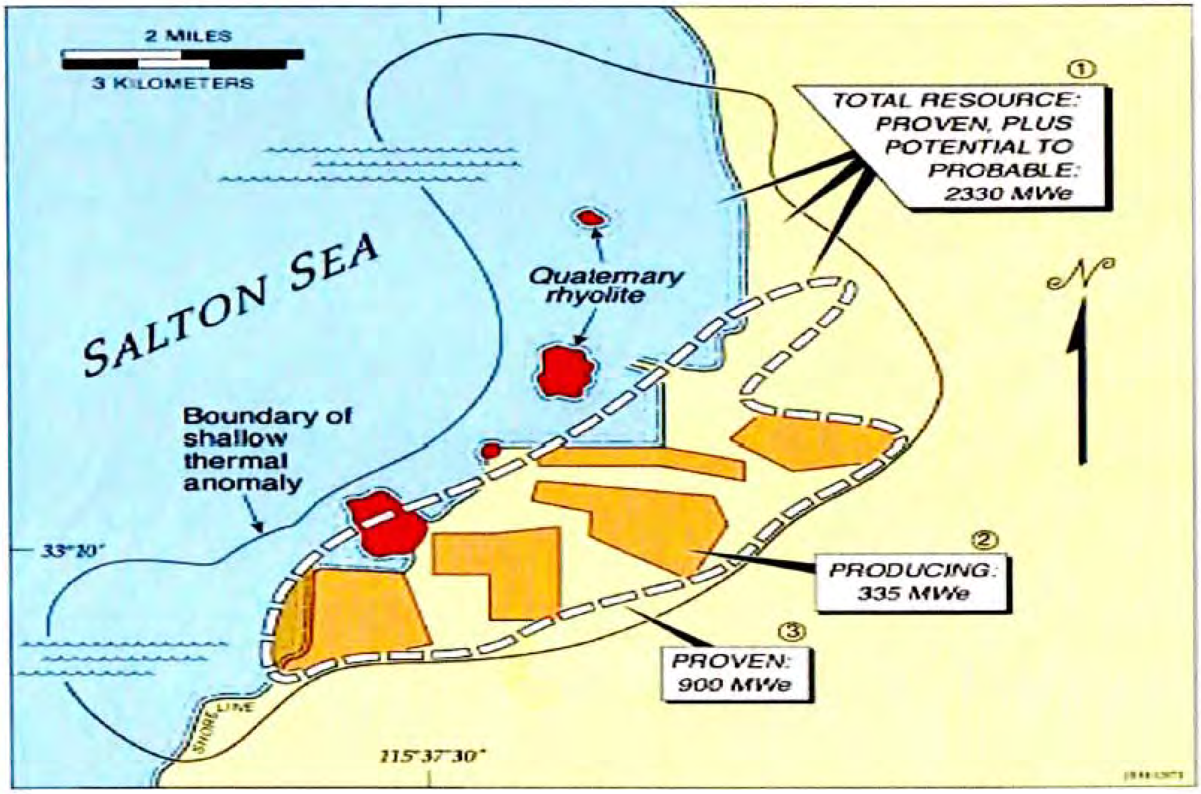
[9] Geothermal field abbreviations: BD – Boarder; BR – Brawley; EB - East Brawley; EM – East Mesa; GL – Glamis, HB – Heber; MA – Mesa de Andrade; MS – Mesa de San Luis; SS – Salton Sea; TU – Tulecheck; WM – Westmorland. Large arrows show modern relative motion of tectonic plates.

Source: Hulen, Jeffery B, et al. The Role of Sudden Dilational Fracturing in Evoluition and Mineralization of the Southwestern Salton Sea Geothermal System, Imperial Valley, California. Stanford Geothermal Workshop. Session: Geology. 2003.

development with an estimated potential of 1,600 to 2,400 additional MW. Figure 7 shows the extent of the geothermal resource along with estimated generation. This figure is consistent with several other expert estimates.

Figure 7
Salton Sea Resource Area, Imperial Valley, CA[10]



1. Beneath shallow thermal anomaly
2. Five parcels within proven sector
3. Sector endorsed by open-dashed line

Since the late 1970s, this resource has been difficult and expensive to develop and operate. The resource is extremely hot by geothermal standards (>600°F), highly saline and difficult to operate due to scaling and corrosion issues. The latter issues have increased the cost of development which, in turn, drives up the cost of electricity produced from these plants. In addition, much of the resource has been covered by the existing sea level. The result is that these specific issues related to the Salton Sea geothermal resources have slowed development. However, with increased operating experience and technology improvements, the cost of

[10] Hulen, Jeffery, et al. Refined Conceptual Modeling and a New Resource Estimate for the Salton Sea Geothermal Field, Imperial Valley, California. IEnergy & Geoscience Institute. University of Utah. Salt Lake City, UT. Available online: http://saltonsea.ca.gov/pdfs/physical-geography/geothermalresourcesatss.pdf

potential power from the geothermal resource has stabilized. Project capacity factors have also improved and now exceed 95 percent.

With increased demand for renewable energy and the base load characteristic geothermal resources, the Salton Sea resources will play an expanding role in meeting the renewable market demands.

Geothermal Resource Potential Methodology

EES was provided maps showing how the Salton Sea shoreline is forecast to recede over the next 30 years. There are many negative consequences to the lake recession such as increased air pollution issues and further concentration of sea salts. However, the advantage to the sea recession is that it exposes new shore lands and provides access to prime undeveloped geothermal resources.

In order to evaluate geothermal resource potential, published data on Salton Sea geothermal resources was reviewed and EES conducted discussions with representatives from the operating geothermal companies. The published data is fairly consistent with the forecasts of the Salton Sea resource capabilities. In general, there is a thermal gradient anomaly which has been measured using temperature gradient holes and production wells that have been confirmed with gravity (Figure 31 in the appendix), magneto-telluric (MT), and seismic surveys. IID had a geothermal evaluation prepared by Clear Creek Associates and The Aerospace Corp that outlines the location of the resource.[11] In general, approximately 25 to 35 percent of the resource is located on existing shoreline lands. The remainder of the resource is located below the existing Salton Sea. The Salton Sea is receding and, as forecast by IID, the sea shore will eventually recede to a level which exposes most of the geothermal resource. Much of the land exposed by the recession is controlled by IID with any remaining land exposure belonging to the Federal government.

After review of this resource data and the Salton Sea recession forecast, EES has prepared an estimate of potential resource capability over time.

Temperature Gradient and Plant Technology

Two levels of temperature gradients were identified in the geothermal resource area. A high temperature resource, the 10°F and greater temperature gradient, was used as the basis for the lands located above the high temperature, deep resource. Temperature gradients less than 10°F and greater than 8°F were given credit for potentially lower temperature and shallower resource. Projects in the higher temperature gradients were assumed to follow designs similar to the new Hudson Ranch geothermal project located over the geothermal anomaly near the

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[11] The Aerospace Corporation and Clear Creek Associates. Imperial Irrigation District: Geothermal Resource Assessment. Arlington, VA. January 10, 2011.

Salton Sea. Hudson Ranch, and similar projects owned by developer CalEnergy, use double flash technology. Projects in the lower temperature gradients are assumed to use binary technology.

Land Potential Evaluation Calculations

The geothermal resource area is separated into the two temperature gradient categories (>10^{0} F and 8-10^{0} F) according to information provided in Figure 7. Figure 8 shows the results of this estimate.

Figure 8
Land Acreage by Temperature Gradient
Acres

Gradient	Total Acres	Currently Onshore	Currently Offshore
>10°	18,200	6,300	11,900
8-10°	27,300	17,200	10,100

Using the data from Figure 8, a value of 75 MW per section (640 acres) was applied for the temperature gradients greater than 10° F and 20 MW per section was applied to the 8-10° F temperature gradients. These values are based on expert forecasts of resource potential. Discussions with operations personnel indicated that these numbers may be conservative; however, the current limited development of the large, high temperature resources lends some uncertainty regarding the MW availability per section; thus conservatism is appropriate at this time. As development of the resource expands, these values should be adjusted to reflect resource performance. Figure 9 shows the forecast magnitude of the resource when the number of acres is applied to the capacity per section assumptions. A total of 2,900 MW of technical potential is estimated for the geothermal resource area identified. The amount of potential is technically feasible without cost considerations or achievability (i.e. the land is currently under water).

Figure 9
Generation Potential
MW

Gradient	Onshore	Offshore	Total
>10°	700	1,400	2,100
8-10°	540	260	800

Currently there is 375 MW of high temperature resource in operation (located in >10°F gradient). After removing the existing resource capacity from the onshore potential, there are approximately 325 MW of onshore and 1,400 MW of offshore new generation potential from the high temperature gradient. It is estimated that the initial onshore developments will be from geothermal resources where 75 percent of the capacity is sited on IID land.

Next, in order to determine the achievable geothermal resource potential, a temperature gradient map (Figure 32, see Appendix) was overlaid onto the IID forecast schedule for Salton Sea recession (Figure 33, see Appendix). Figure 10 shows the forecast of land availability for resource development. Current onshore land is used for current (2013) land available.

Figure 10
Forecast Land Availability Schedule
Acres

Gradient	2013	2020	2025	2030	2035	Total
>10°	6,300	3,300	6,700	1,900		18,200
8-10°	17,200	1,300	2,900	1,700	4,200	27,300

The land availability forecast (Figure 10) was then applied to determine generation potential. Figure 11 is a summary of the technical and achievable potential for new generation by year. A total of 2,525 MW is estimated to be available by 2035. Note that Figure 9 shows 2,900 MW of technical potential; Figure 11 shows the same potential when achievability factors are assessed (recession of Salton Sea shoreline).

Figure 11
Forecast Geothermal Potential Based on Land Availability
MW

Gradient	2013	2020	2025	2030	2035	Total
>10°	360[1]	385	790	190		1,725
8-10°	540	40	90	55	75	800

1. Excludes existing generation (375 MW)

Finally, the estimated generation that would be located on IID land was estimated using Figure 11 and IID land ownership maps (Figure 34, see appendix). Most of the remaining generation would be federal lands with some private onshore lands. Note that the 8-10°F gradient generating capacity is greatly reduced for this study. Figure 12 is a summary of the forecast geothermal potential on IID land.

Figure 12
Forecast Geothermal Potential on IID Lands
MW

Gradient	2016	2020	2025	2030	2035	Total
>10°	100	700	200	200		1,200
8-10°	0	50 *	25 *	0 *		75

* Denotes offshore lands that will not be developed in this study due to economic considerations.

Due to cost considerations, offshore low temperature gradient resources were eliminated from development and it is assumed that only 50 percent of the onshore low gradient lands will be developed. The total economic and achievable resource potential near the Salton Sea is estimated at 2,000 MW for projects located on IID, federal, and privately owned land. The economic and achievable resource potential located on IID and federally owned land is estimated at 1,675 MW. Most of this potential (1,600 MW) is from high temperature resources. The resource potential on IID and federal lands was used in the economic analysis of revenue potential.

Currently there are reports[12] that forecast 1,400-2,000 MW of new generation from the Salton Sea resource. Figure 32 in the appendix shows a probable resource size of 2,330 MW. Based on these forecasts, the assumptions used in this analysis to forecast 1,800 MW of new high gradient resource and 200 MW of low gradient resource are reasonable.

Project Development Schedule

Using the information generated in the above figures, a schedule for new projects was developed by online date. The schedule is aggressive and assumes that the blanket permitting will be completed in a timely manner, adequately priced power purchase agreements will be available, and capital funding requirements can be met by a developers and government sources. The startup schedule assumes a nominal project size of 200 MW net for the greater than 10° gradient resource, which is an upper limit for plant size based on gathering system designs and well spacing. It is assumed that maximizing plant size will reduce the capital and operating costs. The assumed plant size is reasonable since a geothermal resource developer, CalEnergy, has proposed a plant similar in size (200 MW).

For the lower temperature gradient resource, the nominal plant size is 50 MW net and assumes that a binary or lower cost flash plant will be an option. The magnitude of lower temperature resource generation is reduced to eliminate current offshore lands and probability of success. Most of the expert forecasts for development potential of the Salton Sea resource are based on the high temperature resource. Figure 13 summarizes the proposed development schedule by resource temperature.

[12] Summit Blue Consulting, LLC. Renewable Energy Feasibility Study Final Report. Boulder, CO. April 1, 2008.

Figure 13
New Generation Online Schedule

Year	>10°F Generation	8-10°F Generation	Cumulative Generation	Generation on IID Lands (MW)
2016	200		200	100
2018	200		400	100
2020	200	50	650	200
2022	200	50	900	200
2024	200	50	1,150	200
2026	200	50	1,400	150
2028	200		1,600	150
2030	200		1,800	50
2032	200		2,000	50
Totals	**1,800**	**200**		**1,200**

Mineral Recovery

The hot geothermal brines have a solids concentration ranging from 150,000 to 250,000 parts per million (ppm). This means that 15 to 25 percent of the solution is some form of salt or other valuable minerals. The mining of these minerals has been part of the goal of all geothermal developers; however, so far the technologies have not been economical. In the early 2000s, CalEnergy attempted to extract zinc from geothermal brine, but after a few years of operation the process was abandoned. Currently a company by the name of Simbol Materials has been working on a process to extract lithium from the brines.[13] The process is in the early stages of development, but early testing has had good results and is proceeding to develop into commercial operation for 2014.[14]

At this time, it is hard to estimate the value of mining the fluids; however, lithium could be a strategic metal in the future because of its application for batteries and the market could greatly expand to provide significant value in any geothermal operation. As such, a high-level estimate of mining revenues is included in this report.

[13] Biello, David. Geothermal Power Plants Could Help Produce Lithium for Electric Cars. Scientific American. September 29, 2011. http://www.scientificamerican.com/article.cfm?id=geothermal-power-plants-could-help-produce-lithium-for-electric-cars

[14] Gutwald, Paul. Simbol Materials Receives 2012 Geothermal Energy Association Special Recognition Reward. Simbol Materials. Pleasanton, CA. August 9, 2012. http://www.simbolmaterials.com/documents/Simbol%20GEA%20Award%20Press%20Release%20080912%20FINAL.pdf

Development Issues

This section summarizes various development issues related to geothermal resources in the Imperial Valley.

Transmission

IID's grid is currently connected with other major transmission systems and utilities. However the capacity of the interconnection, and IID load, limits how much new generation capacity can be installed without a major new transmission line. A new 500 kV transmission line has been proposed to meet the transmission requirements caused by the proposed renewable projects sited in the Imperial Valley. When completed, the new transmission line could handle an estimated 2,500 MW of new generation plus provide other utilities access to the Imperial Valley renewable resources. The proposed line is 150 miles long and would connect to the main grid at Devers substation. A map of the proposed transmission line and the geothermal resource development area is provided in the Appendix (Figure 35).

The cost of a 500 kV line is estimated to range from $2-4 million per mile[15] depending on right of way (ROW) and substation costs. The cost of this line can be recovered using CPUC Transmission Revenue Requirement (TRR) rules and can be financed using a merchant transmission company. As such, the process for developing a transmission line of this size would require some certainty as to cost recovery through approved rates. In order to encourage transmission line investments, IID could seek assistance from the state (through the CPUC) to help streamline renewable project development or reduce the cost of funding for private developers (developers of geothermal projects or transmission line projects or both). The CPUC could offer loan guarantees for transmission project developers to reduce costs and defer upfront payments for the system from renewable project developers.

The certainty of a transmission line will help proposed projects acquire financing needed to commence project development and without upfront transmission payments. When the projects are constructed, the developer could then access a fee to interconnect to the new system. This method would allow other utilities to access power (via power purchase agreements, PPAs) from Imperial Valley renewable energy projects at major substations and hubs. This plan would be a win-win for all parties (IID, developers, and other utilities that desire renewable energy).

IID would manage the development of the transmission line, contribute to right of way and environmental studies for the line, perform maintenance, and collect revenue from use of the new line. Because of IID's investment in the transmission line, it is assumed that IID would have a 10 percent ownership share in the new transmission line. IID's ownership results in revenue

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[15] Black & Veatch. Western Electricity Coordinating Council – TEPPC Transmission and Substation Capital Costs. August 7, 2012.

potential according to the approved rate of return. The revenue potential is described in Section 6.

In addition, IID has proposed upgrades to its transmission system at an estimated cost of approximately $200M to accommodate new generation in its system. Since most of this cost will benefit developers and other utilities, IID has proposed payment plans that required the developers to pay for the upgrades upfront of project development. This payment option has been an issue for developers because it requires financing a transmission project before project confirmation and approval.

Power Purchase Agreements

Currently geothermal developers are required to obtain PPA's early in the development phase prior to knowing resource conditions and costs. This process has lead to developers needing to renegotiate agreements or cancel agreements because economics do not satisfy financial requirements. IID has proposed having the CPUC and State of California designate a portion of future state energy purchases as coming from Imperial Valley renewables. Pricing and capacity needs would be known and could be allocated to developers based on land parcels. Similar to the transmission line funding proposal, IID could ask the state to offer loan guarantees to renewable project developers or to loan funds at low interest rates. These solutions would allow developers access to lower cost financing which is currently only available to public entities. Changing PPA procedures, and reducing the cost of money, would reduce the cost of power from these projects by lowering the cost of equity and reducing risk of project development.

Environmental Review

All new projects 50 MW or greater will require review and approval by the California Energy Commission (CEC). As the lead agency, the CEC will issue the final permit to build a power plant (Authorization for Construction, AFC). The CEC will control the timelines and requirements imposed on the plant. Because the Salton Sea recession will occur over a period of years, and any development in the new land areas will face difficult permitting requirements, IID has proposed having a blanket environmental study of the area. This could significantly reduce the time required to meet the California Environmental Quality Act (CEQA) and make it a joint effort to permit the plants and improve air quality and wildlife habitat. A Salton Sea area study will also provide the opportunity to minimize the negative aspects of the Salton Sea recession. In particular, the Desert Renewable Energy Conservation Plan[16] includes an accelerated environmental review of renewable projects and local, state, and federal permitting processes.

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[16] Renewable Energy Action Team. Best Management Practices and Guidance Manual. December 2010. http://www.energy.ca.gov/2010publications/REAT-1000-2010-009/REAT-1000-2010-009-F.PDF

Other Benefits of Renewable Development

The development of geothermal resources near the Salton Sea will result in hundreds of high paying construction and long term operations support jobs. There will be direct and indirect benefits of these jobs in other industries. The multiplicative economic effect of geothermal development was not evaluated in this study.

Summary

The resource analysis evaluated several resource types; however, due to unique conditions near the Salton Sea, resource costs, and load considerations, only geothermal resources have been selected for further evaluation in this report. The known geothermal anomaly is a unique characteristic of the Salton Sea. Further, the base load characteristic of geothermal energy is valuable in utility operations.

While geothermal is the recommended resource in this report, current market conditions, permitting, and transmission issues are currently slowing the development of geothermal resources in the Imperial Valley. Stream lining PPA's, permitting, and transmission interconnection processes as well as providing access to lower cost funds should allow developers to take a more aggressive approach to developing projects. Currently, many geothermal projects take up to 10 years to develop due to the risks and issues encountered during exploration and early development. However, the project development schedule in this report takes advantage of the exploration already completed for lands near the Salton Sea. Further, the geothermal reservoir issues should be greatly reduced with the coordinated development strategy described in this report.

Section 5 - Geothermal Resource Costs

This section of the report summarizes the geothermal resource costs used for this study.

Resource Costs

The details of the cost data for the operating geothermal projects, and the recently built Hudson Ranch project, are generally subject to non-disclosure agreements. Hudson Ranch's web site does disclose the total cost the project at $400 million which is assumed to include wells, plant, gathering system, interconnection cost ($20 million), financing, interest during construction, legal, administration, permitting, exploration, etc. The plant is a 50 MW plant which results in an $8,000/kW cost which is very high even for complex projects. It is not known how much excess capacity is available from the wells currently drilled for this project.

For future projects, project research and development and exploration should be lower along with all permitting, legal, financing, and other overhead costs. Building larger projects (assume 200 MW for this study) will result in economies of scale cost reductions. Blanket permitting for geothermal resources, PPA incentives, transmission access, and shared facilities should further reduce costs. For this study the capital cost was assumed to be $6,000 per KW for onshore facilities and $6,500 per KW for offshore facilities.

The operation of these facilities involves multiple chemical processes to avoid scaling and to remove solids from geothermal brines to avoid plugging the injection wells. These processes are complex and can significantly impact operating cost. Geothermal operating costs can vary significantly ($15 to $30 per MWh) and the Salton Sea plants will be on the high end of the operating costs. For this study, $20 per MWh was used for variable O&M costs, assuming that the plant size will again result in economies of scale cost reductions. Additional cost allowances for major outages and well work are included and are separate costs from the variable O&M cost.

The low gradient plants were assumed to be binary plants using a low temperature resource (<375° F) with much lower salinity. The capital cost of these plants was assumed to be $5,000/kW with variable O&M costs assume to be $15 per MWh. As shown by current developments in the Imperial Valley, development of this type of plant has been limited.

Summary of Resource Costs

Figure 14 summarizes the resource costs. Fixed operation and maintenance costs include both periodic major maintenance and annual well costs. Major maintenance includes major outage maintenance items. For each 50 MW plant capacity, major maintenance costs are $5 million every 3 years for the >10 degree resources and every 7 years for the 8-10 degree resources. Annual well costs include allowances for scale removal and workovers. Well costs are $1 million per year for >10 degree resources and $500,000 per year for 8-10 degree resources.

Figure 14
Summary of Geothermal Resource Costs

	Capital Cost $/kW	Variable O&M $/MWh	Fixed O&M [1] $/kW-yr	Capacity Factor
On Shore				
>10°F Generation	$6,000	$20	$57.24	95%
8-10°F Generation	$5,000	$15	$27.75	95%
Off Shore				
>10°F Generation	$6,500	$20	$57.24	95%
8-10°F Generation	$5,000	$15	$25.00	95%

1. Includes both major maintenance and annual well costs.

Integration Credit

Geothermal resources provide renewable base load energy. The base load characteristic of geothermal output is valuable when compared to other renewable resources such as solar or wind. Both wind and solar resources require backup power options in order to ensure that the power demands are met. This integration of backup power and transmission with wind and solar sources is expensive and must be accounted for in the total cost of power from these systems.

Geothermal Power is a base load energy source that operates 8,760 hours per year and does not require integration. Geothermal plant operations are very similar to conventional fossil fuel plants in responding to changing ambient weather conditions. Most geothermal power plants operate with a capacity factor exceeding 90 percent, and most new plants are capable of operating at capacity factors that are 95 percent of more after an initial shake down period. More importantly, geothermal power plants are capable of being dispatched from 75 to 100 percent of rated load with minimal impact on operating costs.

Currently, the base load characteristics of geothermal are undervalued in the market as integration costs are not yet well-defined for intermittent renewable resources. Therefore, this study presents base costs that do not include the value of base load renewable energy as well as costs that include an integration credit. For the purposes of our analysis, integration credits ranging from $10/MWh to $25/MWh are evaluated. In order to define the appropriate integration credit, a detailed integration study would need to be conducted.

Interest during Construction

This study assumes a four year development period for geothermal resources. The timing of capital cost expenditures required in each year by resource location (onshore or offshore) is shown in Figure 15.

Figure 15
Timing of Capital Expenditures and Interest During Construction Accrual
Percent of Capital Cost Expenditure

Year	Onshore	Offshore
1	0%	10%
2	25%	20%
3	35%	30%
4	40%	40%

Transmission

A new 500 kV transmission line will need to be constructed in order to service the proposed renewable projects. The cost of the new transmission line is estimated at $3 million per mile or $510 million total. Of this, the 2,000 MW of renewable projects would utilize approximately 80 percent of the transmission line capacity. Therefore a wheeling rate is developed based on a 30-year transmission line life financed at 8 percent in dollars per MWh output from 2,000 MW of geothermal capacity. An annual rate of return on the investment of 10 percent is included in the transmission costs.

In addition, IID estimates that $200 million in system upgrades are required to connect the proposed geothermal projects to the transmission line. This study assumes that the upgrade costs may be financed by developers.

The resulting combined wheeling rate (transmission line investment plus IID system upgrades) is $5.76/MWh.

Summary

Given the costs developed in this section, the levelized cost of energy from the proposed geothermal plants is calculated in the next section and compared with the market value of renewable energy.

Section 6 - Revenue Potential

This section outlines the assumptions used for the base case economic analysis and provides additional details behind the development of various assumptions.

General Assumptions

The revenue potential model was developed based on the following financial assumptions:

- Cost of capital is 8 percent for private developers (nominal)
- Inflation is 2 percent
- Study period is 2016 through 2045 (30 years)
- A 10 percent investment tax credit (ITC) is available to private developers
- Depreciable life of assets is 30 years (consistent with planning period)
- 4 percent royalties are added to all projects regardless of land ownership
- Overhead is $1.8 million/year per 200 MW plant and includes general commercial insurance, taxes, licenses, leases and fees.

Because of the 10 percent ITC, it was assumed that all projects would be nominally owned by private developers or that a public-private partnership model would be employed. Ownership scenarios were not evaluated as part of this study.

Resources

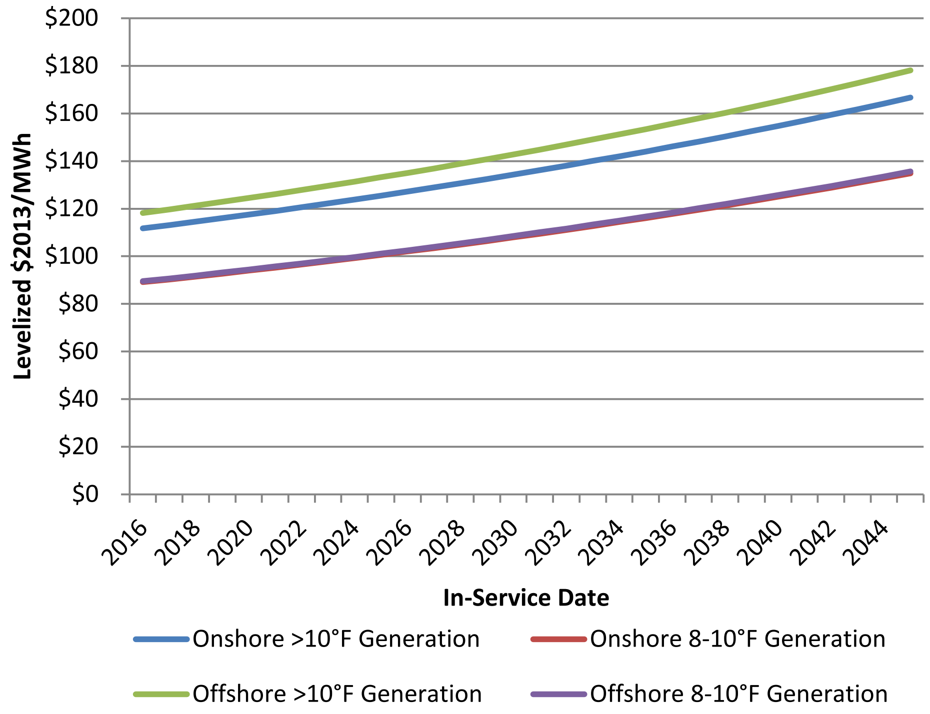
The costs detailed in the previous section and the general assumptions above are combined to develop 30-year levelized costs for each of the geothermal resource types. Figure 16 compares the geothermal resource levelized costs given an in-service date of 2016.

Figure 16
Summary of Geothermal Resource Levelized Costs
In-Service 2016
Levelized $2013/MWh

	No Integration Credit	$10/MWh Integration Credit	$25/MWh Integration Credit	$35/MWh Integration Credit
On Shore				
>10°F Generation	$111.70	$101.30	$90.90	$85.70
8-10°F Generation	$89.11	$78.71	$68.31	$63.11
Off Shore				
>10°F Generation	$118.13	$107.73	$97.33	$92.13
8-10°F Generation	$89.52	$79.12	$68.72	$63.52

Geothermal resource costs are expected to change over the planning period. For this study, it was assumed that geothermal resource costs would increase at the rate of inflation. Therefore, the geothermal resource levelized costs will be higher for resources with later in-service dates. Figure 17 summarizes the estimated unit development costs over time.

Figure 17
30-Year Levelized Geothermal Resource Costs by In-Service Date
No Integration Credit



Forecast Renewable Energy Prices

This section discusses renewable energy prices in California. These market values for renewable energy are then compared to the cost of renewable energy development in the Salton Sea area.

Factors that Affect Renewable Energy Prices

As with any commodity, the price of renewable energy is determined by the supply and demand. Renewable energy supply and demand are influenced by many factors, including loads, regulatory framework (renewable portfolio standards), development costs, greenhouse gas prices, conservation, and others.

Development costs vary by technology, site characteristics, ownership structure (cost of borrowing), and available tax credits or incentives. Greenhouse gas costs under California's cap-and-trade program affect the costs for alternative resources such as natural gas-fired plants. If cap-and-trade instrument prices increase significantly, base load renewable resources may begin to replace conventional base load resources requiring compliance instruments. Cap-and-trade considerations are discussed in more detail in this section. Lastly, loads and conservation are directly related to California's Renewable Portfolio Standards (RPS). The regulatory framework for California's RPS is discussed below.

California RPS

Senate Bill X1-2 (SBX1-2), signed in April 2011, made several major changes to California's RPS. The foremost change is the increased requirement for California's electric utilities to have 33% of their sales derived from eligible renewable energy resources in 2020 and all subsequent years. Interim targets of 20% of sales derived from renewable energy by 2013, and 25% by 2016 were also specified in the bill.

Technologies eligible for the RPS include PVs; solar thermal electric; wind; certain biomass resources; geothermal electric; certain hydroelectric facilities[17]; ocean wave, thermal and tidal energy; fuel cells using renewable fuels; landfill gas; and municipal solid waste conversion, not the direct combustion of solid waste. For most technologies, the facility had to have been constructed after 1996 to be counted towards the RPS.

The California Public Utilities Commission (CPUC) issued a decision on January 13, 2011 to authorize the use of tradable RECs (TRECs) for California RPS compliance. From the 2010 compliance year to December 31, 2013, the use of TRECs was capped at 25% of a utility's RPS requirement, and the price of a TREC was capped at $50/MWh. SBX1-2 put new restrictions on the use of TRECs. Under the law, the use of TREC transactions signed after June 10, 2010 will be capped at 25% of a utility's requirement for the compliance period ending December 31, 2013, and will shrink to 10% of the requirement by 2017. Western Renewable Energy Generation Information System (WREGIS) is responsible for tracking and certifying TRECs for use with California's RPS requirements.

A proceeding by the CPUC by March 1, 2012 could allow for the adoption of requirements for utilities (IOUs) to procure energy storage systems. This proceeding follows legislation (AB 2514), enacted in September 2010, allowing for the possibility of such storage requirements. This legislation also requires the governing boards of municipal utilities with more than 60,000 customers to consider similar requirements.

17[17] Eligible hydro facilities produce electric generation of less than or equal to 30 MW, and must have been in place before December 31, 2005. Facilities that began operating after this date are only eligible, "so long as it does not cause an adverse impact on in-stream beneficial uses or cause a change in the volume or timing of stream flow." *CA Senate Bill X1 2*, http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0001-0050/sbx1_2_bill_20110412_chaptered.html

Finally, AB 177, introduced by V. Manuel Perez, would increase RPS from 33 percent to 51 percent by 2030 for all electrical corporations and publicly owned utilities. The bill is a 2-year bill that will provide lawmakers with several months to develop specific mandates and a vote will be held in the 2014 legislative session.[18]

Under current California RPS, in-state renewable resources, such as those proposed for the Salton Sea area, will be instrumental in meeting the standards. Because TRECs may only be used to meet 10 percent of RPS requirements after 2017, bundled energy sales will be the primary compliance instrument over the course of the revenue potential study period. The proposed RPS changes (AB 177) would increase the 33 percent renewable energy requirement by 2020 to 51 percent by 2030. Unless the TREC limitations are altered in the proposed bill, there will be significant demand for in-State resources. Further, the base load nature of geothermal resources will be instrumental in achieving the new standard.

Cap-and-Trade

The California Environmental Protection Agency Air Resources Board (ARB) is facilitating California's cap and trade program. The cap and trade program regulates greenhouse gas emissions at the source. Sources include refineries, power plants (including qualifying facilities, or QFs), industrial facilities, and transportation fuels. Beginning in 2012, the program covers electricity generation and large industrial sources and processes with annual GHG emissions at or above 25,000 $MTCO_2e$ (metric tons of carbon dioxide equivalent). In 2012, the number of allowances issued by ARB equaled the expected level of emissions from sources in 2012 (165.8 million CO_2e). The number of allowances will decrease through 2020. Covered entities may use either allowances or offset credits to comply with the program. Because offset credits may be used to meet up to only 8 percent of the total requirement, it is expected that allowances will be the primary compliance instrument.

In addition to the allowances allocated across industries and covered entities, ARB holds allowances in a containment reserve. Covered entities may purchase allowances from the reserve at fixed prices. The reserve allowances are priced in 3 tiers; prices begin at $40, $45, and $50/MT in 2012 and escalated at the rate of inflation. Allowances purchased from the reserve would add significant cost to traditional generating resources.

Allowance Prices

The first auction for California's cap-and-trade program was conducted in November 2012. The settlement price for this first auction was $10.09/$MTCO_2e$. There have been two auctions since the first. The last settlement price for 2013 compliance instruments was $14 per $MTCO_2e$ (May 2013 auction). According to the latest auction for 2013 allowances, the cost of compliance would increase a conventional combined cycle gas plant costs by approximately $14 per MWh.

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[18] Newsdata. California Energy Markets. June 7, 2013 No. 1235.

Looking forward, the cost of compliance is generally expected to increase over time. According to the Los Angeles Department of Water and Power (LADWP) 2012 integrated resource plan, LADWP expects the cost of compliance to increase from $10 per $MTCO_2e$ in 2012 to $36 per $MTCO_2e$ by 2020.

Summary

Even at $40-$50/MWh, the cost of cap-and-trade compliance will not likely affect utility resource choice such that geothermal resources are selected over natural gas resources. If the price of natural gas increases significantly and cost of compliance is high, the cost of geothermal resources may drop below the cost of conventional gas turbines. This study assumes that the primary driver of renewable energy prices is California's RPS and resource development costs.

Price Forecasts

This report's revenue potential analysis is a comparison of forecast renewable energy prices in California and estimated renewable resource costs for projects located in the Imperial Valley. Because renewable energy prices are dependent on several factors that vary over time, three forecasts are reviewed for this analysis:

- **Current Market** – the Current Market forecast was developed based on the 2012 expenditures of three California investor-owned utilities for geothermal contracts as published annually in the CPUC's Padilla report.[19] The bundled price of $82.10/MWh for 2012 was escalated at the rate of inflation (1.5 percent).
- **RFP** – The RFP forecast is based on the price cap set in Southern California Public Power Authority's (SCPPA) renewable energy request for proposals (RFP).[20] SCPPA's RFP caps proposals at $95/MWh in 2016 escalating at 1.5 percent per year.
- **Market** – The Market forecast is based on projected levelized costs for merchant flash geothermal plants estimated by the California Energy Commission.[21] The average nominal levelized cost for the 2009 and 2018 in-service dates are $78.91 and $120.72/MWh respectively. The average increase is 4.8 percent annually. This increase appears to be high based on information in the Padilla report. Therefore, the Market

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[19] California Public Utilities Commission. The Padilla Report to the Legislature. The Costs of Renewables in Compliance with Senate Bill 836 (Padilla, 2011). March 2013 Available at: http://www.cpuc.ca.gov/NR/rdonlyres/F0F6E15A-6A04-41C3-ACBA-8C13726FB5CB/0/PadillaReport2012Final.pdf

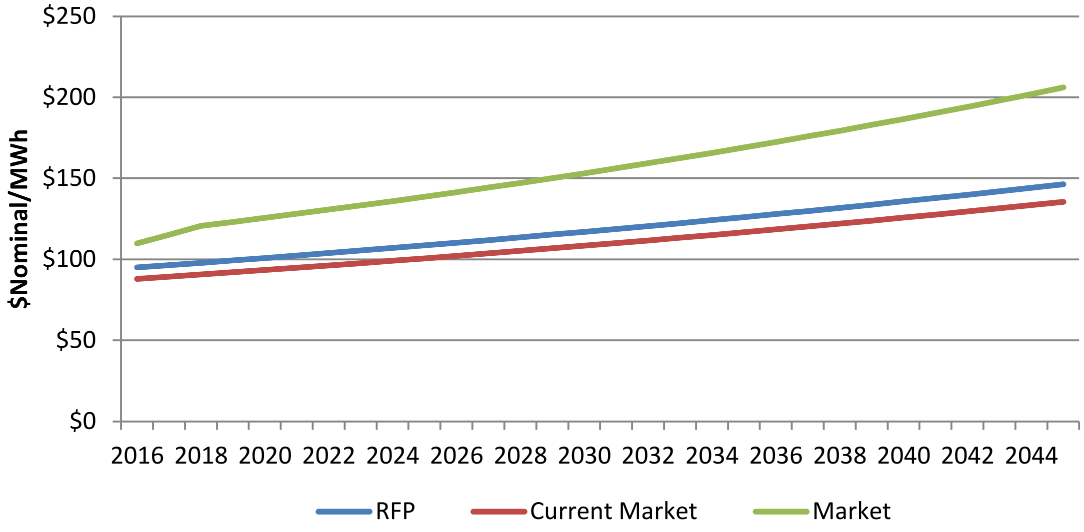
[20] Southern California Public Power Authority. Request for Proposals for Renewable Energy Projects. Response Deadline: December 31, 2013.

[21] California Energy Commission. Comparative Costs of California Central Station Electricity Generation. Final Staff Report January 2010.

forecast was developed by using the escalating $120.72/MWh in 2018 at the assumed rate of inflation for this study (2 percent).

Figure 18 illustrates the three forecasts described above.

Figure 18
Forecast Renewable Energy Prices



The levelized prices for the three forecasts are shown in Figure 19.

Figure 19 Levelized Prices Renewable Energy Forecasts $2013/MWh			
	RFP	**Market**	**Current Market**
30-Year Levelized Price	$103.32	$132.02	95.72

Renewable Resource Revenue Potential Estimates

Geothermal

The development schedule and geothermal resource costs are compared with the renewable energy price forecast to determine the margin available to fund Salton Sea Projects. It is assumed that 50 percent of geothermal output charges (royalties) paid to federal land owners be paid to Imperial County and are not available for Salton Sea Projects. Figure 20 summarizes the results of the revenue potential analysis when only the delta between the geothermal costs and the selected renewable energy price is considered. The Current Market and RFP forecasts results in total revenues of less than 400 million for the period (nominal). A break-even renewable price forecast was calculated such that the total nominal revenue for the period is $2 billion from geothermal development assuming no integration credit. The levelized price for the break-even forecast is $113.89/MWh ($2013). The break-even price is not required for geothermal projects to be economic since a range of geothermal costs were developed for this study. Note that Figure 20 shows the delta between estimated Salton Sea geothermal resource costs and respective renewable energy price forecasts.

Figure 20
Revenue Potential Estimates 2016-2045
$Nominal in Millions

Renewable Price Forecast	30-year Levelized Price $/MWh	Total Revenue Potential
RFP	$103.32	$354
Current Market	$95.72	$147
Market	$132.02	$7,393
Break-Even	$113.89	$2,002

Not all projects have positive margins in all years between the forecast renewable energy prices and forecast resource prices. In particular, the high temperature resources (>10^{o} F) are more expensive on a unit-cost basis and have negative margins in some years. The revenue potential shown in Figure 20 does not include project revenue when the margin between forecast prices and forecast cost is negative. Figure 36 in the appendix shows the delta between the break-even price of renewable energy and resource costs by resource type, location, and property ownership. Similarly, Figure 37 in the appendix shows the annual delta between resource cost and energy value by resource type and location for the break-even renewable energy price.

Output Charges

In addition to calculating the delta between geothermal resource costs and the value of renewable energy, revenue potential estimates are calculated assuming a unit, $/MWh, charge on geothermal output. Figure 21 summarizes the revenue potential assuming a range of charges without regard to project economics; Figure 21 assumes that an integration credit, or similar mechanism, would result in cost-effective projects regardless of the $/MWh charge.

Figure 21
Geothermal Output Revenue Potential

$/MWh Charge	Revenue Potential, Millions
$6	$1,623
$8	$2,164
$10	$2,705

A charge of $7.40/MWh is required in order to collect $2 billion in revenue from geothermal project output. This analysis assumes that the $/MWh charge is not escalated over time.

Solar

This report presents estimated revenues based on 1,000 MW of solar (PV) development over the study period. Revenue potential estimates are based on a $/MWh charge for output. Output is estimated based on a 25 percent capacity factor. Figure 22 shows a range of revenue potential estimated from these projects.

Figure 22
Revenue Potentiall from Solar Development
$Nominal

$/MWh Charge	Revenue Potential (Millions)
$2	$149.8
$4	$299.6
$6	$449.5
$8	$599.3

This study presents revenue potential based on solar project development assuming that the projects are economic when a Salton Sea Project royalty ($/MWh charge) is assessed. However, there are many factors that can affect solar development on IID lands or other lands located in Imperial County. In particular, lands near the Salton Sea may not be desirable for PV or CSP solar generation because of the impact of ambient conditions on solar components. The affect of environmental conditions could reduce output due to soiling of collectors and increase solar project costs so that the projects are no longer economic when compared with solar projects sited in more favorable locations. Finally, the solar benefit charge may further exacerbate the economics of solar projects located in the Imperial Valley especially near the Salton Sea.

Other Revenue Potential

In addition to the estimated revenue from renewable energy development, revenue could be accrued through IID's mining rights, transmission ownership, or a falling water charge at Hoover Dam. This section describes the revenue potential estimates from IID's transmission ownership, mining rights, algae-based fuel production, and Hoover Dam falling water charge.

Transmission Ownership

As mentioned in Section 4 of this report, IID expects that its will own 10 percent of the proposed transmission line needed to serve the new renewable projects sited in the Imperial Valley. It is estimated that the transmission line owners will collect a 10 percent rate of return on the investment. IID plans to designate half of the return to fund Salton Sea Projects. The revenue potential from the transmission project is estimated based on the use of the transmission line by the geothermal projects proposed in this study. Therefore, revenue is included for each MWh of geothermal potential. The revenue potential from IID's ownership share of the transmission project is estimated at $42 million over the study period. This analysis assumes the total project investment is $510 million.

IID Mining Rights

IID owns property with mining rights. Currently IID has 104,551 acres with mining rights retained to 100 percent of the property and an additional 8,982 acres where some mining rights are retained (less than 100 percent). As discussed in the Resource Potential section of this report, minerals such as salt or lithium could be mined from geothermal byproducts for plants located on IID property. The royalties from mining operations could be used to fund Salton Sea restoration and rehabilitation. Mineral information is provided below.

Salt

Total salt production in the United States decreased by 11 percent in 2012. Salt in brine production accounted for 47 percent of total salt production in 2012. Figure 23 summarizes salt statistics in the United States for the past five years.

Figure 23 Salt Statistics United States Source: USGS Minerals Information[22]	2008	2009	2010	2011	2012
Production	48,000	46,000	43,300	45,000	40,200
Sold or used by Producers	47,400	43,100	43,500	45,500	40,200
Imports for Consumption	13,800	14,700	12,900	13,800	10,500
Exports	1,030	1,450	595	846	1,000
Consumption					
Reported	53,100	45,000	48,600	47,600	49,700
Apparent	60,200	56,400	55,800	58,500	49,700
Price, Average value of bulk, pellets and packaged salt, $/ton f.o.b mine and plant:					
Vacuum and open salt pan	$158.59	$178.67	$180.08	$174.00	$175.00
Solar salt	$64.33	$72.09	$57.41	$51.11	$50.00
Rock salt	$31.39	$36.08	$35.67	$38.29	$36.00
Salt in brine	$7.99	$7.85	$7.49	$8.15	$8.00
Employment, mine and plant	4,100	4,100	4,100	4,100	4,100
Net import reliance as % of Apparent Consumption	21	24	22	22	19

Lithium Carbonate

According to the USGS, there was only one active lithium mine in the United States. The 2012 production came primarily from this mine while a small amount was recovered during the recycling of lithium-ion batteries. Lithium is used in the production of glass (30%), batteries (22%), lubricating greases (11%) and other uses.[23] With the wide-use of lithium batteries to power portable electronics, the demand for lithium may increase in the future. Figure 24 summarizes lithium statistics for the past five years in the United States. Because of the small number of lithium producers, production numbers were withheld.

[22] USGS Minerals Information. Salt Statistics and Information. Mineral Commodity Summaries 2013. Available at: http://minerals.usgs.gov/minerals/pubs/commodity/salt/

[23] USGS Minerals Information. Lithium Statistics and Information. Mineral Commodity Summaries 2013. Available at: http://minerals.usgs.gov/minerals/pubs/commodity/lithium/mcs-2013-lithi.pdf

Figure 24 Lithium Statistics United States* Source: USGS Minerals Information[24]					
	2008	**2009**	**2010**	**2011**	**2012**
Production	W	W	W	W	W
Imports for Consumption	3,160	1,890	1,960	2,850	2,700
Exports	1,450	919	1,410	1,310	1,300
Consumption					
Reported	W	W	W	W	W
Apparent	2,300	1,300	1,100	2,000	2,000
Employment, mine and plant	68	68	68	68	68
Net import reliance as % of Apparent Consumption	>50%	>50%	>50%	>50%	>50%

*W denotes withheld information due to small number of firms.

Revenue Potential Estimates – Mineral Recovery

Commercial operations for mineral recovery from geothermal byproducts are expected to be both economic and commercially available during the study period. For this study, mining royalties are estimated at a high level based on a report prepared for IID (Roadmap).[25] Revenue potential is based on a 2 percent royalty on gross mineral recovery revenue. The Roadmap report estimates that a 50 MW geothermal plant could recover $237 to $271 million in mining revenues each year. These numbers are based on the Simbol/Hudson Ranch I estimates and have not been verified. For this study, EES conservatively assumes half the Roadmap study's low estimate of gross revenue, or $2.4 million in gross revenues for a 50 MW geothermal plant. Based on geothermal plants sited on IID property, the total mining royalties are estimated at $1.5 billion over the period.

Algae-Based Fuel

The business of growing algae to produce fuel has made significant progress in recent years. The process utilizes enhanced or genetically altered algae to produce various oil products ranging from fuel oils to cooking oils. Specifically, the production of ethanol is the target of some of the leading companies. The cultivation of algae can be accomplished through various configurations including: in vessels (photobioreactors); closed systems (large ponds with algae exposed to CO_2 source); or open systems (large ponds with algae exposed to the atmosphere). Growing algae for fuel production can require large volumes of water varying from 3 to 3,000 times the volume of oil produced. However, the water quality can be saline, wastewater/non

24 See id.

25 A Roadmap for the Imperial Irrigation District Public-Private Partnership Strategic Plan to Develop Untapped Resources and Restore the Salton Sea. July 7, 2013.

potable, or recycled water. In addition, algae cultivation requires nutrients such as nitrogen and phosphorus.

There are several companies that have emerged as leaders in the process of cultivating algae for fuel production. Some of the leading companies are Algenol Biofuels, Solix Biofuels, Sapphire Energy, Solazyme, and Seambiotic. The level of development, experience and funding is varied for each company. All of these companies, except for Solazyme which uses indoor photobioreactor system, require large areas for cultivating the algae. During the cultivating process, the algae convert CO_2 and sunlight into oil. The algae are generally grown in salty ponds and the process from start (algae state) to finish (oil) takes approximately 14 days. In order to produce one gallon of fuel, 12 to 14 kilograms of CO_2 are required.

Published public information was used in the revenue potential analysis from algae-based fuels.

Algae Products and System Types

Described below are two examples of algae-based products: ethanol and green crude/biodiesel.

Closed System Ethanol Production

At this time, the most economic algae-to-fuel system is owned and operated by Algenol. The system is a closed system that produces fuel. The cost of production is as low as $50 per barrel (42 gallons). The Angenol system production goal is approximately 10,000 gallons/acre per year. This closed system has lower water demand, and based on limited data, it appears to be approximately 3 gallons of water per gallon of fuel.

Fermenting Systems

Solazyme is currently producing significant quantities of fuel products for government defense contracts. The entire cultivation and production facility is located inside one building. Solazyme algae are heterotrophic, meaning the algae grow in the dark in fermenters by consuming sugars derived from plants. The cultivation system uses wood waste or other waste vegetation. In addition to the government contract, Solazyme is also supplying algae-produced oils to other industries. Lastly, Solazyme is currently developing large scale facility in Brazil. Based on the information available, the Solazyme facilities appear to be economic and are taking advantage of economies of scale savings.

Open Cultivation Systems

The costs of production using an open cultivation system are not known, but some publications indicate that fuel produced using the open system process costs $200 or more per barrel of oil and is not economic at this time. The goal production rate for open cultivation systems is 6,000 gallons/acre/year. Sapphire has proposed a 300-acre, open system facility in New Mexico that is designed to produce 100 barrels per day. Based on draft discharge permit applications, the water requirement for the New Mexico facility is approximately 75 to 100 gallons of water per gallon of fuel. Open and closed algae cultivation systems may be commercial within the next 5 years.

Suitability of Salton Sea for Algae-Based Fuel Production

Algae production using open and closed ponds require large areas of low quality land. The newly exposed land near the Salton Sea is salty and not suitable for crop production. However, these lands could be covered with algae ponds that produce fuel or other oil products. Algae cultivation would limit future air pollution (CO_2) from these lands and could integrate well with geothermal power facilities as a source for CO_2. Because the algae facilities require low quality of water, the water source could be Salton Sea water or other low quality water sources.

Revenue Potential Estimate

EES performed a simple calculation of potential revenue from green fuel production using the New Mexico facility design parameters (Sapphire). The land available for algae cultivation was determined by applying a 25 percent achievability factor to the total future land exposure on south end of the sea estimated at 30,000 acres. Based on this assumed achievability factor, 7,500 acres of newly exposed playa near the Salton Sea could be used for algae cultivation. A $10/BBL royalty results in $9.1 million per year in revenue once the full 7,500 acres are developed ($2013). This assumed royalty is consistent with current fuel royalties and the current price of oil. The total revenue estimate from algae-based fuel royalties is $260 million over the study period. Non-fuel applications for algae products may also be of value; however, other uses are not evaluated in this study.

Falling Water Charge

A range of falling water charges were developed to show the revenue potential from Hoover Dam. On average, Hoover Dam produces 4.2 million MWh annually at a 23 percent capacity factor. The output from the Hoover Dam is sold at energy rates, capacity rates, and the LBDF charge. The LBDF charge is the Lower Basin Development Fund contribution and differs across some states. In California, the LBDF charge is approximately $2.50/MWh. These rates are forecast over the planning period to determine rate impacts for a falling water charge. It is assumed that the LBDF rate will increase by 2.5 percent annually. The energy rate is estimated at $11.59/MWh in 2016 and the capacity charge is estimated at $2.05/kW-month. The energy and capacity rates are escalated at 3 percent annually based on historic rate increases. The resulting projected average rate for a California utility is $26.63/MWh in 2016.

Based on the projected rates over the period, four falling water charges are summarized in Figure 25. The falling water charge for 2016, shown in the table below, is escalated so that the rate increase in subsequent years is the same rate increase as the first year. For example, the falling water charge of $0.25/MWh is a 0.9 percent increase over the current projected rate.

The charge is escalated so that the rate increase over current projected rates in future years is approximately 0.9 percent (approximate escalation is 2.8 annually).

Figure 25
Falling Water Charge Summary

Falling Water Charge in 2016	Rate Increase over Hoover Dam Projected Rate	Total Revenue 2016-2045 ($Millions, Nominal)
$0.25/MWh	0.9%	$47.3
$0.50/MWh	1.9%	$94.7
$1.00/MWh	3.8%	$189.4
$2.00/MWh	7.5%	$378.6
$3.00/MWh	11.3%	$567.9

With a falling water charge of $1/MWh, the projected rates are estimated to be 3.9 percent higher compared with the rates without the falling water charge. At this level, $189.4 million in nominal dollars could be collected over the period 2016 through 2045.

Cash Flow Analysis

The timing of the estimated revenue is important in determining the use of the funds. The primary driver for revenue potential is the rate of playa exposure at the Salton Sea. Figure 26 shows the annual expected revenue potential assuming a $7.40/MWh charge on geothermal output. The resulting revenue potential does not consider whether or not the $/MWh charge would change the economics of the geothermal projects. The amount of revenue available for Salton Sea Projects will depend on the development risk. Measures that reduce development risk will increase revenue potential toward Salton Sea Projects. These measures are discussed in more detail in the Action Plan. The revenue from the falling water charge is shown assuming a $1/MWh charge beginning in 2016 and escalated at 3 percent annually. The revenue from solar development assumes a $/MWh charge in output of $2.

Figure 26
Projected Annual Revenue 2016-2045
Using Break-Even Renewable Energy Price
$Millions (Nominal)

	Geothermal Development[1]	Solar Development[2]	Transmission Revenue	Mineral Recovery	Algae Products	Falling Water Charge[4]	Total
2016	$0.0	$0.0	$0.1	$3.6	$0.0	$4.2	$7.9
2017	$0.0	$0.0	$0.1	$3.6	$0.0	$4.3	$8.1
2018	$0.0	$0.0	$0.2	$7.4	$0.0	$4.5	$12.1
2019	$0.0	$1.2	$0.2	$7.6	$0.0	$4.5	$13.5
2020	$4.5	$1.2	$0.5	$17.3	$2.3	$4.7	$30.5
2021	$5.2	$2.4	$0.5	$17.7	$3.0	$4.8	$33.7
2022	$8.3	$2.5	$0.8	$27.1	$3.8	$4.9	$47.4
2023	$9.4	$3.8	$0.8	$27.6	$4.6	$5.1	$51.3
2024	$10.6	$3.8	$1.0	$36.5	$5.3	$5.2	$62.5
2025	$11.7	$5.2	$1.0	$37.2	$6.1	$5.3	$66.7
2026	$14.8	$5.3	$1.3	$44.5	$6.9	$5.5	$78.3
2027	$18.8	$5.4	$1.3	$45.4	$7.8	$5.6	$84.3
2028	$22.8	$5.6	$1.5	$53.1	$8.5	$5.8	$97.2
2029	$27.0	$5.7	$1.5	$54.1	$9.1	$6.0	$103.4
2030	$31.2	$5.8	$1.7	$57.6	$9.9	$6.1	$112.3
2031	$35.5	$5.9	$1.7	$58.7	$10.2	$6.3	$118.4
2032	$39.9	$6.0	$2.0	$62.3	$10.5	$6.5	$127.2
2033	$44.4	$6.1	$2.0	$63.6	$10.9	$6.6	$133.6
2034	$49.0	$6.3	$2.0	$64.8	$11.2	$6.8	$140.1
2035	$53.6	$6.4	$2.0	$66.1	$11.6	$7.0	$146.7
2036	$58.4	$6.5	$2.0	$67.5	$12.0	$7.2	$153.5
2037	$73.1	$6.6	$2.0	$68.8	$12.4	$7.4	$170.3
2038	$95.4	$6.8	$2.0	$70.2	$12.8	$7.6	$194.7
2039	$118.1	$6.9	$2.0	$71.6	$13.2	$7.8	$219.6
2040	$141.3	$7.0	$2.0	$73.0	$13.6	$8.0	$245.0
2041	$165.0	$7.2	$2.0	$74.5	$14.0	$8.2	$270.9
2042	$191.8	$7.3	$2.0	$76.0	$14.5	$8.4	$300.0
2043	$224.1	$7.5	$2.0	$77.5	$14.9	$8.7	$334.7
2044	$257.0	$7.6	$2.0	$79.0	$15.4	$8.0	$369.1
2045	$290.6	$7.8	$2.0	$80.6	$15.9	$8.2	$405.1
Total	**$2,002**	**$150**	**$42**	**$1,494.6**	**$260**	**$189**	**$4,138**

1. Assuming break-even renewable energy price.
2. $2/MWh charge
3. $1/MWh charge

Section 7 - Risks and Uncertainties

Geothermal Development Risk and Uncertainties

This section discusses various risks or uncertainties related to obtaining the target $2 billion in revenue from the proposed geothermal resource development.

Renewable Energy Prices

One of the greatest uncertainties with regard to the revenue potential analysis is the future price of renewable energy in California. It is unlikely that renewable energy prices will fall below the cost of geothermal project costs for long periods over the study period. It is more likely that renewable energy prices will increase or remain fairly stable over the study period due to renewable portfolio standards, reduced reliance on TRECs, and the cost of in-state, base load resources. The break-even price of renewable energy without integration credits is $113.89/MWh in levelized 2013 dollars. Figure 27 illustrates that the break-even price is much lower than the CEC price forecast. However, current market prices for geothermal resources are 10 to 20 percent lower compared with the break-even price and do not include the value of renewable base load energy. Figure 27 compares the break-even price with the three other price forecasts presented in the analysis.

Figure 27
Renewable Energy Price Comparison

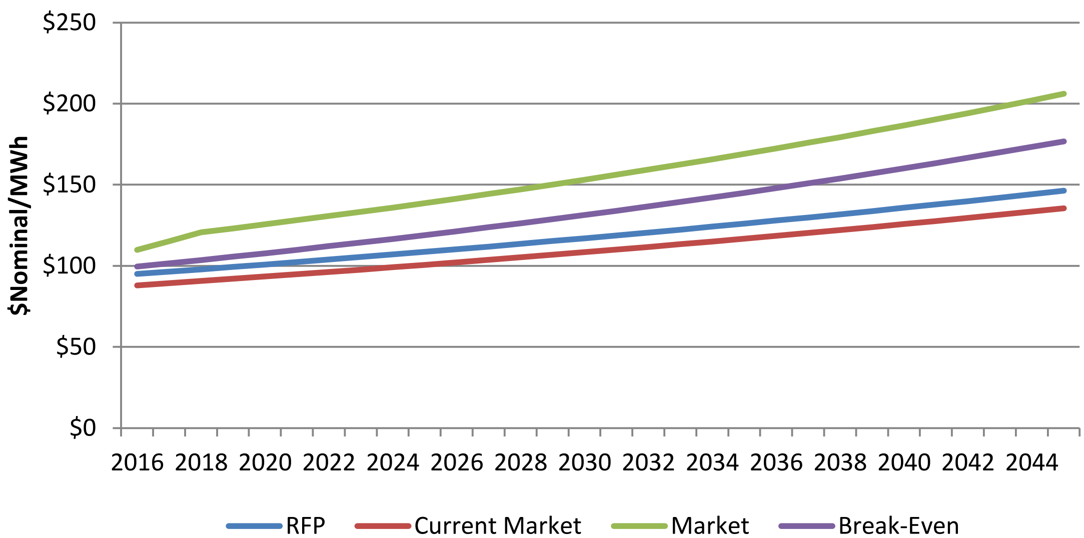


Figure 28 shows the revenue estimates given a range of integration credits and the RFP renewable energy price.

Figure 28
Geothermal Development Royalties given RFP Renewable Energy Price $103.32/MWh Levelized

Integration Credit $/MWh	Royalties $Millions
$10	$841
$18	$2,011
$20	$2,516
$25	$4,221

The RFP price forecast is the current price of renewable energy for projects scheduled to come online in 2016. Therefore, considering the RFP price forecast, the integration credit to geothermal would need to be $18/MWh in order to result in $2 billion in projected revenue over the period 2016-2045.

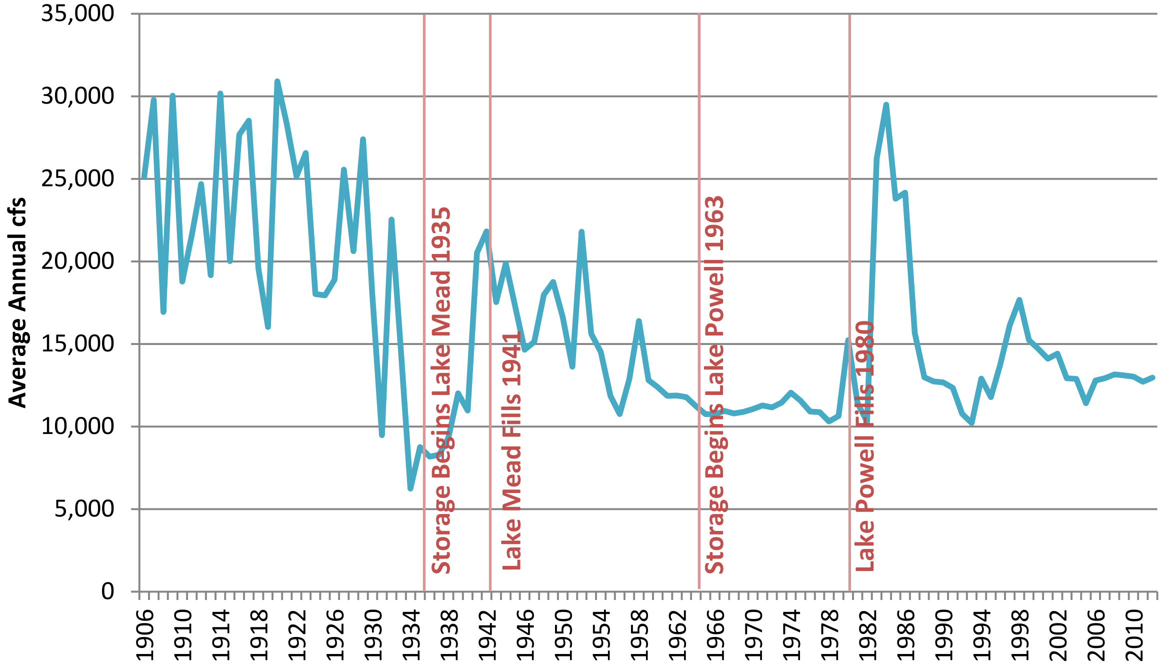
Capital Costs

While there are currently some projects operating in the Salton Sea area, the Salton Sea geothermal resources are largely undeveloped. The capital costs for geothermal development on the proposed properties may result in higher than anticipated costs due to the nature of the resource (high mineral content of water supply). Exploration wells and production wells must be drilled in order to develop the resources. The failure rates of exploration wells affect the cost-effectiveness of the resources. The >10 degree resources are associated with lower development risks as there is more certainty that exploration and production well drilling will be successful. While the capital costs for the higher temperature resources are higher, the development risk is lower compared with the 8 to 10 degree resources. Due to reduced development risk, and project scalability, the high temperature resources are expected to contribute to over half of the revenue potential ($1.4 billion out of $2.0 billion) in the break-even price forecast case.

Falling Water Charge Uncertainties

Hoover Dam output is dependent on annual precipitation, operating constraints, and the elevation of Lake Mead. Figure 29 illustrates the average annual flow (cubic feet per second, cfs) below Hoover Dam.

Figure 29
Historic Average Annual Flow below Hoover Dam
Calendar Years



As stated previously in this report, the average annual production from 1947 through 2000 is 4,200 GWh. The lowest historic power production occurred in 1947 with only 2,648 GWh. The highest level of production occurred in 1984 with 10,348 GWh.

In a 2008 study by researchers at the University of California in San Diego it was predicted that Lake Mead has a 50 percent chance of decreasing to a point too low for power generation at Hoover Dam by 2017 if no changes to consumption are made. The report also estimates that there is a 50 percent chance that Lake Mead will be dry by 2021.[26]

The UC San Diego study shows that there is uncertainty with regard to relying on Hoover Dam output for Salton Sea Project funding. However, even at $3/MWh, the nominal amount of the falling water charge revenue is small compared with the revenue potential from geothermal development, algae-based fuel production, or mineral recovery.

[26] Monroe, Robert. Lake Mead Could Be Dry by 2021. U.C. San Diego News Center. February 12, 2008. http://ucsdnews.ucsd.edu/newsrel/science/02-08LakeMead.asp

Section 8 - Conclusion

This study reviewed the geothermal resource development potential in the Imperial Valley and developed potential revenue estimates based on the difference between forecast renewable energy prices and the Imperial Valley resource costs. A "break-even" renewable energy price forecast is estimated such that the delta between renewable energy costs and renewable energy prices totals $2 billion over the period 2016-2045. This break-even renewable energy price is $113.89/MWh in levelized cost terms ($2013) with no integration credit. While geothermal resource output is currently being sold for prices less than $113/MWh in levelized terms, the future price of renewable energy will likely increase over the study period as California's RPS increases to 33 percent in 2020 and base load resources are required. The break-even renewable energy price is a reasonably attainable forecast; therefore, it may be possible to reach the $2 billion revenue goal from geothermal resources alone over the period. The following assumptions are needed for the projects to meet the $2 billion revenue goal:

- At current renewable energy prices (RFP price forecast), an integration credit of $18/MWh is required in order for some of the Salton Sea geothermal projects to be economic.
- A $/MWh charge could be placed on all geothermal output. Figure 30 shows the projected revenue provided a range of $/MWh charges. The revenue estimates assume that all projects are economic after the charge is applied.

Figure 30
Estimated Geothermal Revenue given $/MWh Charge

$/MWh Charge	Projected Revenue ($millions)
$6	$1,623
$8	$2,164
$10	$2,705

- A 500 kV transmission line must be financed by a third party and the CPUC must allow recovery of costs through rates.
- Blanket permitting for geothermal projects approved by state.
- State provides assistance to Salton Sea geothermal resource development through RPS or financing incentives. These financing incentives could be a loan guarantee program similar to the current Department of Energy loan guarantee program. These incentives

are necessary in order for developers to take on geothermal development risk and be able to pay Salton Sea Project charges/royalties.

Based on the analysis, there is significant revenue potential available for Salton Sea restoration and rehabilitation projects. If IID pursues renewable project development in the Salton Sea area, and obtains support from the state of California, the proposed projects could become increasingly economic.

Section 9 - Action Plan

Based on the study conclusions the following actions are recommended to IID:

- Approach State of California (CPUC, CEC, California Department of Fish and Wildlife, and other agencies) with the following proposals:
  - Identify funding and developers for 500 kV transmission line to expedite development and ensure transmission access for renewable projects. With the closure of San Onofre Nuclear Generating Station (SONGS), this transmission line has increased importance in meeting load demands from Southern California major cities. The California Independent System Operator (CAISO) could state the need for the line prior to renewable project development under FERC Order 1000 (transmission planning for renewable energy development).
  - State guaranteed loans or state funds set aside for geothermal project developer access to capital and long term financing. Lower cost of financing will reduce the cost of energy from the projects
  - Indentify permitting issues and responsible agencies. Seek blanket permits for multiple geothermal project developments located near or under the Salton Sea. Identify and integrate project development with benefits for Salton Sea restoration. A blanket permit approach reduces development timelines.
  - Change California RPS to provide incentives for Salton Sea renewable development. An example would be a bonus energy payment for generation from Salton Sea geothermal or other renewable resources. Proposed AB 177 provides opportunity to implement changes to RPS in the next year.
  - Meet with CPUC, CEC, utilities and other government agencies to clarify costs and include value adder to base load renewable energy projects.
- Fund Preconstruction Studies
  - Acquire funding and perform transmission study to define route, right of way issues, cost, and financing parties.
  - Approach geothermal community about interest in developing Salton Sea resources.
  - Find partner(s) to help with transmission project.

- o Begin discussions with permitting agencies (U.S. Army Corp of Engineers, Ecology, etc) and stakeholders (local tribes) to mitigate impact of geothermal development and further improve environment around the Salton Sea.
- o Continue evaluation of solar renewable energy, including but not limited to, solar gradient ponds, photovoltaic and solar concentration on exposed Salton Sea lakebed.
- o

- Funding For 2013-2014
  - o Initial studies estimated to cost $0.5 to $1.0 million
  - o Legal, consultants and additional staffing $500,000

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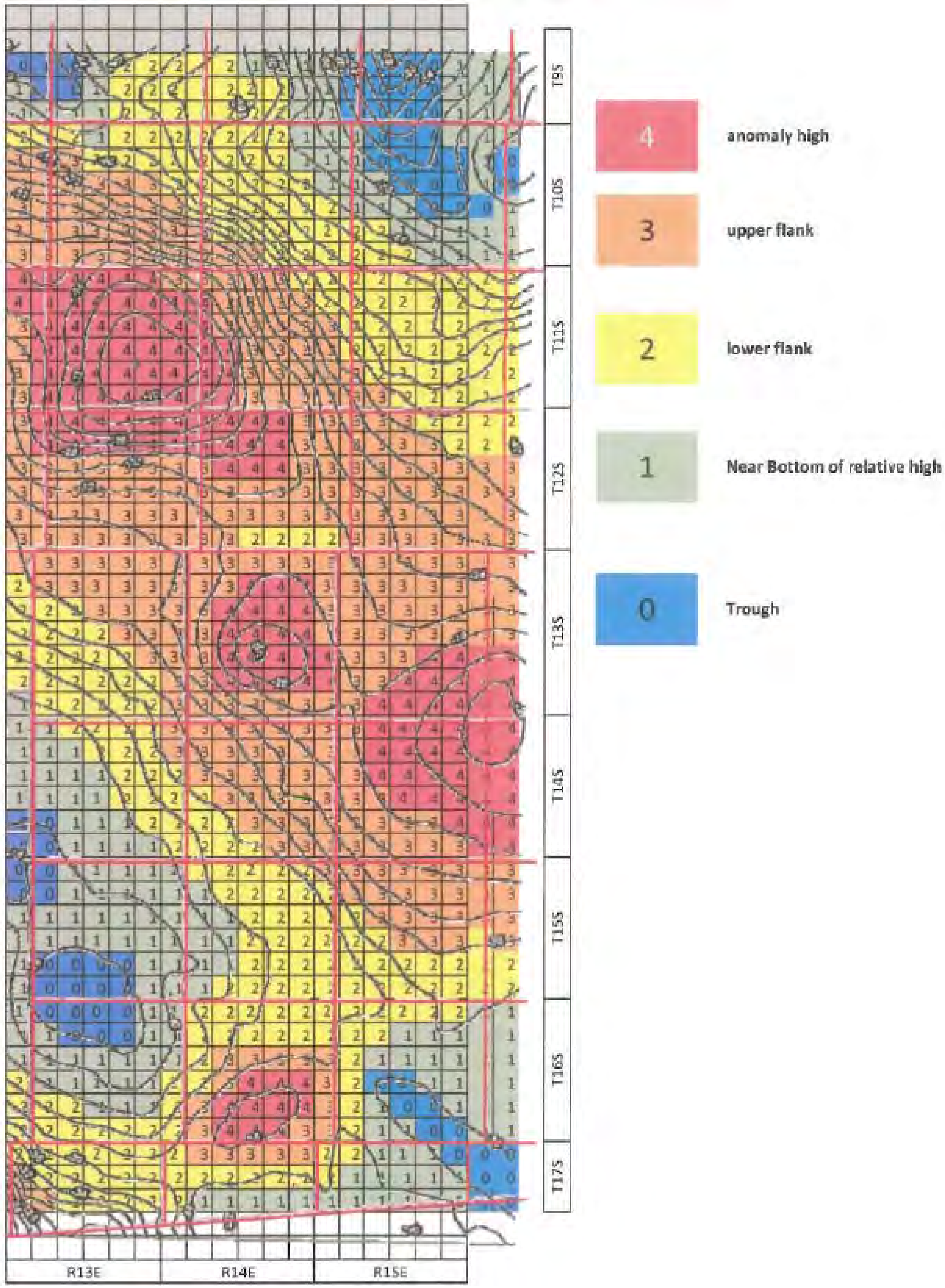
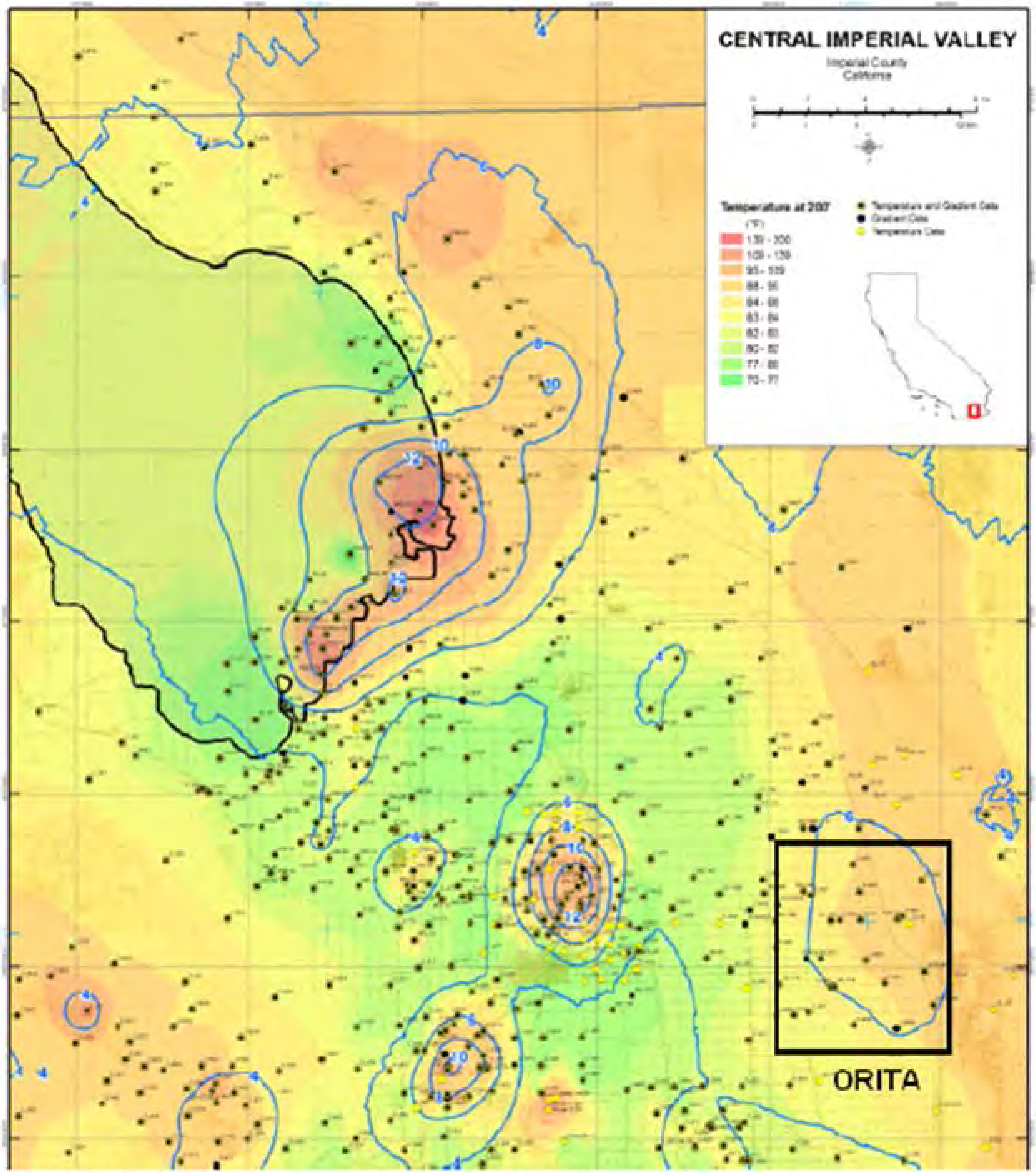
Appendix

Figure 31
Bouguer Gravity Prioritization Matrix[27]



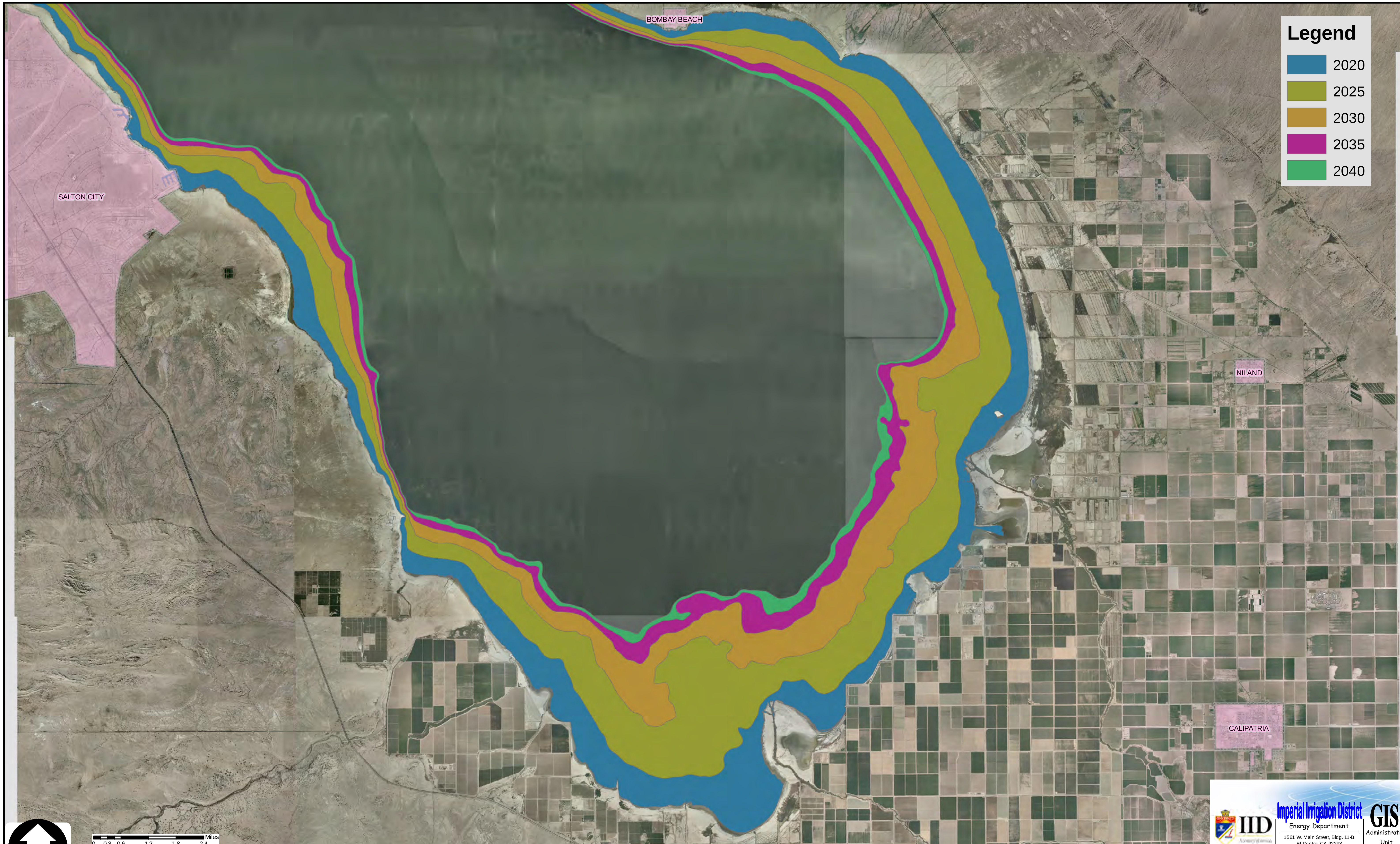
[27] The Aerospace Corporation and Clear Creek Associates. Imperial Irrigation District: Geothermal Resource Assessment. Arlington, VA. January 10, 2011.

Figure 32
Central Imperial Valley Geothermal Resource Map



CENTRAL IMPERIAL VALLEY
Imperial County
California
Temperature at 200'
(°F)
130 - 200
Temperature and Gradient Data
Gradient Data
Temperature Data
ORITA

Figure 33
Estimated Playa Exposure 2020-2040



Imperial Irrigation District
Energy Department
1561 W. Main Street, Bldg. 11-B
El Centro, CA 92243
GIS
Administration Unit

Estimated Playa Exposure 2020 - 2040

DISCLAIMER:

This is not an official map. Imperial Irrigation District does not guarantee the accuracy of data in this map. Any errors or omissions shall not be considered the responsibility of the Imperial Irrigation District.

Plotted by: llgallegos
Date: 6/25/2013

CURRENT COORDINATE SYSTEM: NAD_1983_StatePlane_California_VI_FIPS_0406_Feet
\\Supv5\public\share\ESRI_GIS\Management\Other_Dept\GENERAL SERVICES\ENVIROMENTAL\Salton Sea Project\MXD\SaltonSeaShoreline.mxd

Figure 34
Salton Sea Land Ownership Map

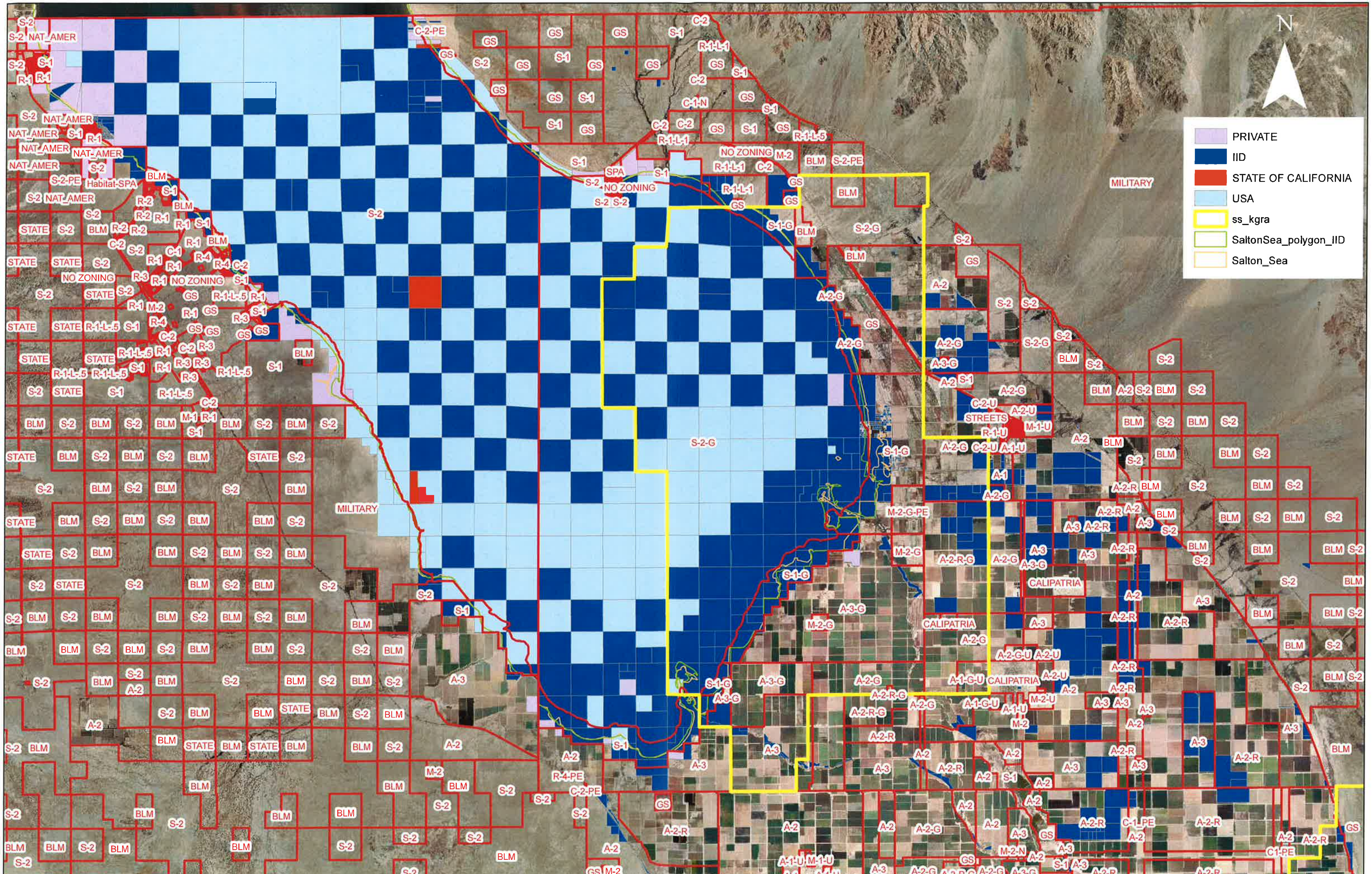

N
PRIVATE
IID
STATE OF CALIFORNIA
USA
ss_kgra
SaltonSea_polygon_IID
Salton_Sea
MILITARY
CALIPATRIA
STREETS

Figure 35
Proposed Transmission Line and Geothermal Resource Area

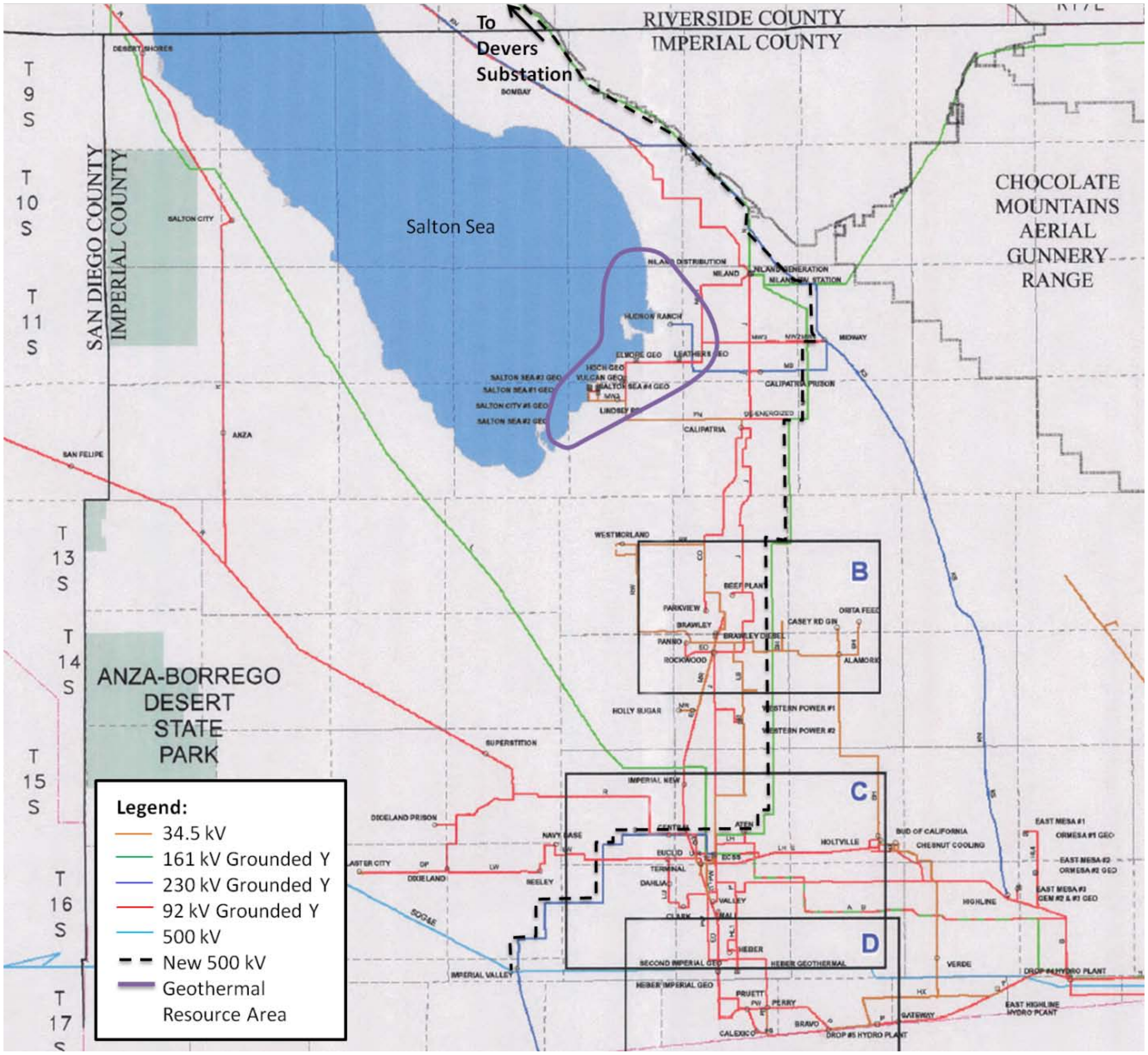


Figure 36
Average Differential Renewable Energy Price and Resource Costs
Break-Even Price*
Nominal, $/MWh

	IID-Owned				Federal Owned			
	On-Shore		Off-Shore		On-Shore		Off-Shore	
	10º	8º	10º	8º	10º	8º	10º	8º
2016	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2017	-$12.38	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2018	-$11.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2019	-$11.12	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2020	-$9.69	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2021	-$8.23	$10.86	-$20.29	$0.00	$0.00	$0.00	$0.00	$0.00
2022	-$6.74	$12.55	-$18.80	$0.00	$0.00	$0.00	$0.00	$0.00
2023	-$5.22	$13.36	-$19.08	$0.00	$0.00	$0.00	$0.00	$0.00
2024	-$3.67	$15.12	-$17.53	$0.00	$0.00	$0.00	$0.00	$0.00
2025	-$2.09	$16.92	-$17.79	$0.00	$0.00	$0.00	$0.00	$0.00
2026	-$0.48	$18.75	-$16.18	$0.00	$0.00	$0.00	$0.00	$0.00
2027	$1.16	$20.62	-$16.05	$0.00	$0.00	$0.00	-$22.10	$0.00
2028	$2.84	$22.53	-$14.37	$0.00	$0.00	$0.00	-$20.42	$0.00
2029	$4.54	$24.47	-$14.34	$0.00	$0.00	$0.00	-$20.73	$0.00
2030	$6.29	$26.45	-$12.60	$0.00	$0.00	$0.00	-$18.98	$0.00
2031	$8.07	$28.48	-$11.48	$0.00	$0.00	$0.00	-$20.94	$0.00
2032	$9.88	$30.54	-$9.67	$0.00	$0.00	$0.00	-$19.12	$0.00
2033	$11.73	$32.64	-$8.63	$0.00	$0.00	$0.00	-$19.84	$0.00
2034	$13.62	$34.79	-$6.75	$0.00	$0.00	$0.00	-$17.96	$0.00
2035	$15.54	$36.98	-$4.82	$0.00	$0.00	$0.00	-$16.03	$0.00
2036	$17.51	$39.21	-$2.86	$0.00	$0.00	$0.00	-$14.07	$0.00
2037	$19.51	$41.49	-$0.86	$0.00	$0.00	$0.00	-$12.06	$0.00
2038	$21.55	$43.81	$1.19	$0.00	$0.00	$0.00	-$10.02	$0.00
2039	$23.64	$46.18	$3.27	$0.00	$0.00	$0.00	-$7.94	$0.00
2040	$25.76	$48.60	$5.40	$0.00	$0.00	$0.00	-$5.81	$0.00
2041	$27.93	$51.06	$7.57	$0.00	$0.00	$0.00	-$3.64	$0.00
2042	$30.14	$53.58	$9.78	$0.00	$0.00	$0.00	-$1.43	$0.00
2043	$32.40	$56.14	$12.03	$0.00	$0.00	$0.00	$0.82	$0.00
2044	$34.70	$58.76	$14.33	$0.00	$0.00	$0.00	$3.13	$0.00
2045	$37.05	$61.43	$16.68	$0.00	$0.00	$0.00	$5.47	$0.00

*Values of $0.00, indicates no resources scheduled.

Figure 37
Annual Revenue Projection by Resource Type and Ownership
Break-Even Price*
Nominal, $/MWh

	IID-Owned				Federal Owned			
	On-Shore		Off-Shore		On-Shore		Off-Shore	
	10°	8°	10°	8°	10°	8°	10°	8°
2016	$0	$0	$0	$0	$0	$0	$0	$0
2017	$0	$0	$0	$0	$0	$0	$0	$0
2018	$0	$0	$0	$0	$0	$0	$0	$0
2019	$0	$0	$0	$0	$0	$0	$0	$0
2020	$0	$0	$0	$0	$0	$0	$0	$0
2021	$0	$4,517,522	$0	$0	$0	$0	$0	$0
2022	$0	$5,221,729	$0	$0	$0	$0	$0	$0
2023	$0	$8,340,357	$0	$0	$0	$0	$0	$0
2024	$0	$9,439,342	$0	$0	$0	$0	$0	$0
2025	$0	$10,560,307	$0	$0	$0	$0	$0	$0
2026	$0	$11,703,691	$0	$0	$0	$0	$0	$0
2027	$1,929,481	$12,869,943	$0	$0	$0	$0	$0	$0
2028	$4,719,068	$14,059,520	$0	$0	$0	$0	$0	$0
2029	$7,564,446	$15,272,888	$0	$0	$0	$0	$0	$0
2030	$10,466,732	$16,510,524	$0	$0	$0	$0	$0	$0
2031	$13,427,064	$17,772,912	$0	$0	$0	$0	$0	$0
2032	$16,446,603	$19,060,548	$0	$0	$0	$0	$0	$0
2033	$19,526,532	$20,373,937	$0	$0	$0	$0	$0	$0
2034	$22,668,060	$21,713,594	$0	$0	$0	$0	$0	$0
2035	$25,872,419	$23,080,044	$0	$0	$0	$0	$0	$0
2036	$29,140,865	$24,473,822	$0	$0	$0	$0	$0	$0
2037	$32,474,679	$25,895,477	$0	$0	$0	$0	$0	$0
2038	$35,875,170	$27,345,564	$9,886,062	$0	$0	$0	$0	$0
2039	$39,343,671	$28,824,653	$27,228,566	$0	$0	$0	$0	$0
2040	$42,881,541	$30,333,324	$44,917,919	$0	$0	$0	$0	$0
2041	$46,490,170	$31,872,169	$62,961,060	$0	$0	$0	$0	$0
2042	$50,170,970	$33,441,790	$81,365,064	$0	$0	$0	$0	$0
2043	$53,925,387	$35,042,804	$100,137,147	$0	$0	$0	$2,743,777	$0
2044	$57,754,892	$36,675,838	$119,284,673	$0	$0	$0	$10,402,787	$0
2045	$61,660,987	$38,341,532	$138,815,148	$0	$0	$0	$18,214,977	$0