

# Addendum to the Promise of Centralized Renewable Energy in the San Diego Region: Report to the SANDAG Energy Working Group

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# OUTLINE

- SUMMARY of APRIL PRESENTATION
- KEY FINDING as Stated in Conclusions
  - In 2020 Projection, Most (93%) of Central Electric Renewables Are In Imperial County
  - Several Power Links Needed from Imperial to San Diego Cty
- Projection Falls Short of Regional Goal of 50% of Renewables from San Diego Cty
- QUESTIONS
  - Can We Raise Share of Energy Generated in San Diego Cty?
  - Can Sunrise Power Link Be Delayed or Avoided?
- CONCLUSIONS
- RECOMMENDATIONS
- BACKUP

# SUMMARY of APRIL BRIEFING FINDINGS

# CONCLUSIONS

- **DISTRIBUTED PV IS NOT A SUBSTITUTE FOR THE REST OF THE RENEWABLE ENERGY FAMILY**
  - 170MW to 250MW\* by 2020 Which Is About 1% to 2% of Total Energy
- **CONCENTRATING SOLAR POWER SYSTEMS HAVE THE MOST TECHNICAL POTENTIAL --- 30,000MW**
  - Over 90% Is In Imperial County \*\*
- **FAMILY OF RENEWABLE RESOURCES CAN PROVIDE ABOUT 3,000 MW in SAN DIEGO REGION BY 2020**
  - This Is About 50% of Projected Power and Energy Needed in Region
  - 93% of Renewable Energy Is In Imperial County \*\*
- **DISPATCHABILITY USING THERMAL STORAGE OR HYBRID OPERATION ENHANCES CONCENTRATING SOLAR POWER SYSTEMS ABILITY TO MEET UTILITY SUMMER PEAK LOADS**
  - Prime Candidates for Large Scale Deployment After Geothermal
- **SEVERAL MAJOR TRANSMISSION LINES ARE NEEDED OVER THE NEXT 20 YRS**
  - Transmission Needs Will Be More Than Sunrise Power Link

\*Range Represents if San Diego Receives 9 to 13% of Total State Funds

\*\* Added for emphasis

# CONCLUSIONS, continued

- NEED TO FIND SOME SOLAR LAND RESOURCE WEST OF ANZA-BORREGO PARK to MINIMIZE PARK DISRUPTION
- WIND IS NOT A UTILITY STABILITY ISSUE UNTIL LARGE USE IN GRID -  
-- More than 20% to 30%
- WHEN PLUGABLE HYBRID VEHICLES START TRANSITION AWAY FROM IMPORTED OIL, THEN WIND RESOURCES IS BETTER MATCHED TO THIS HUGE NEW EVENING TRANSPORTATION LOAD
- PLUGABLE HYBRID VEHICLES CAN BACKUP-UP GRID INCLUDING PEAK POWER
- RENEWABLES ADDRESS:
  - ENERGY DEMAND GROWTH
  - GLOBAL WARMING
  - LOCAL AIR POLLUTION
  - JOB CREATION
  - ENERGY SECURITY

# RECOMMENDED ACTIONS

1. Build Solar Power Parks in San Diego and Imperial Counties and Include All Stakeholders to the Park
  - Example\*:  
SOLAR POWER PARK with Water, Natural Gas, Power Transmission and Environmental Impact Statement Set Up By State of Nevada with Nevada Power in the El Dorado Valley,
2. Address Values Beyond Least Cost of Generation.
3. Develop Metrics To Quantify The Utility Values of: Local Energy Availability, Global Warming, Local Air Pollution, Job Creation, and Energy Security
4. Develop Local Incentive to Ensure That Renewables Will be Given Higher Priority Than Fossil Fuels

\* Added for emphasis

# RECOMMENDED ACTIONS, continues

5. Support Federal, State and Local Incentives to Reduce the First Cost of Renewable Power Systems
  - Especially Support Long Term (~10 yr) Production Tax Credit (PTC) for Wind and Other Renewables
  - Direct Low-Cost Government Loans
  - Loan Guarantee Programs
  - Interest-Rate Buy-Downs
6. Build the New or Enhanced Transmission Capabilities to Access Renewable Resources
  - More Than Sunrise Link
  - How Can CalTrans' Objection to Rt. 8 Transmission Corridor Be Satisfied
  - How Can Transmission Corridor in Mexico Become Part of New Transmission Capability e.g. Joint US/Mexican Transmission Authority ?
  - Investigate Ways to Move Electricity East Instead of West and Import Energy to Avoid Park Transmission Lines
7. Assess and Access Solar Land West of Anza-Borrego Park

# Recommendations continued from Western Governors Association

## Recommended Set of Policies/Incentives

- **Extend the 30% Federal ITC and expand its use to utilities**
- **Exempt sales and property taxes on central solar plants**
- **Allow longer-term Power Purchase Agreements and set equitable central solar price references**
- **Encourage State PUC, utilities, and IPPs to seek means for aggregating plant orders and project bids to accelerate CSP scale-up cost reductions**

ITC= Investment Tax Credit

PUC= Public Utilities Commissions

IPP= Independent Power Producers

CSP= Concentrating Solar Power



# Key Findings Stimulating Addendum

- Most (93%) of Central Electric Renewables Are In Imperial Cty Including Solar, Geothermal and Wind
- Several Power Links Needed to Move Desert Power to San Diego Cty Over Next Decade or Two
- Build Renewable Power Parks in Imperial Cty and San Diego Cty to Expedite the Introduction of Renewables
- Assess and Access Solar Land West of Anza-Borrego Park

# Source of Resource Data

- Study Done for SANDAG
  - Potential for Renewable Energy in the San Diego Region, San Diego Regional Energy Group, Scott Anders, et al, August 2005
- Solar Estimate Based on **Best** Solar Isolation
  - Only 10% in San Diego Cty
  - All of This Is in Borrego Springs Which Is Inside State Park
- Based Initial Estimate on **All** Solar Plants Located in Imperial Cty Deserts
- This Plus Geothermal Results In Almost All of Central Renewables In Imperial Cty

Thus,

- Fails to Meet Regional Goal of 50% from San Diego Cty
- Relies Heavily on Transmission Links

# Questions Addressed in Addendum

- Can We Raise Share of Central Electric Power in San Diego Cty?
- Can Sunrise Power Link Be Delayed or Avoided?

# San Diego Cty Resource

- 60% of Regional Wind Resource in SD Cty
  - 2020 Estimate Predicted 200 MW
- 10% of Best Solar in SD Cty But Located Inside Anza-Borrego Park in Borrego Springs ???
- Other Central Renewable Sources Projected at 70 MW by 2020
  - bio-mass, bio-gas and small hydro
- What Could Be Extent of Solar In SD Cty Back Country?

# Solar Plant Land Requirements

- For Commercially Viable Plants:

– Plant Type	Power, MW	Area, acres	Shape
– Dish-Stirling/ConPV*	~ 5	25	Irregular
– Parabolic Trough	~100	~ 600	Rectangular
– Central Receiver	~200	~ 1200	Oval

- Land Treatment:

- Dish Stirling/ConPV Land Can Be Up to 5 degree Slope and Low Ground Cover Is Not Removed
- Parabolic Trough Land Needs to be Scraped and about 1 degree slope limit
- Central Receiver In Between

\* ConPV -- Concentrating Photovoltaics

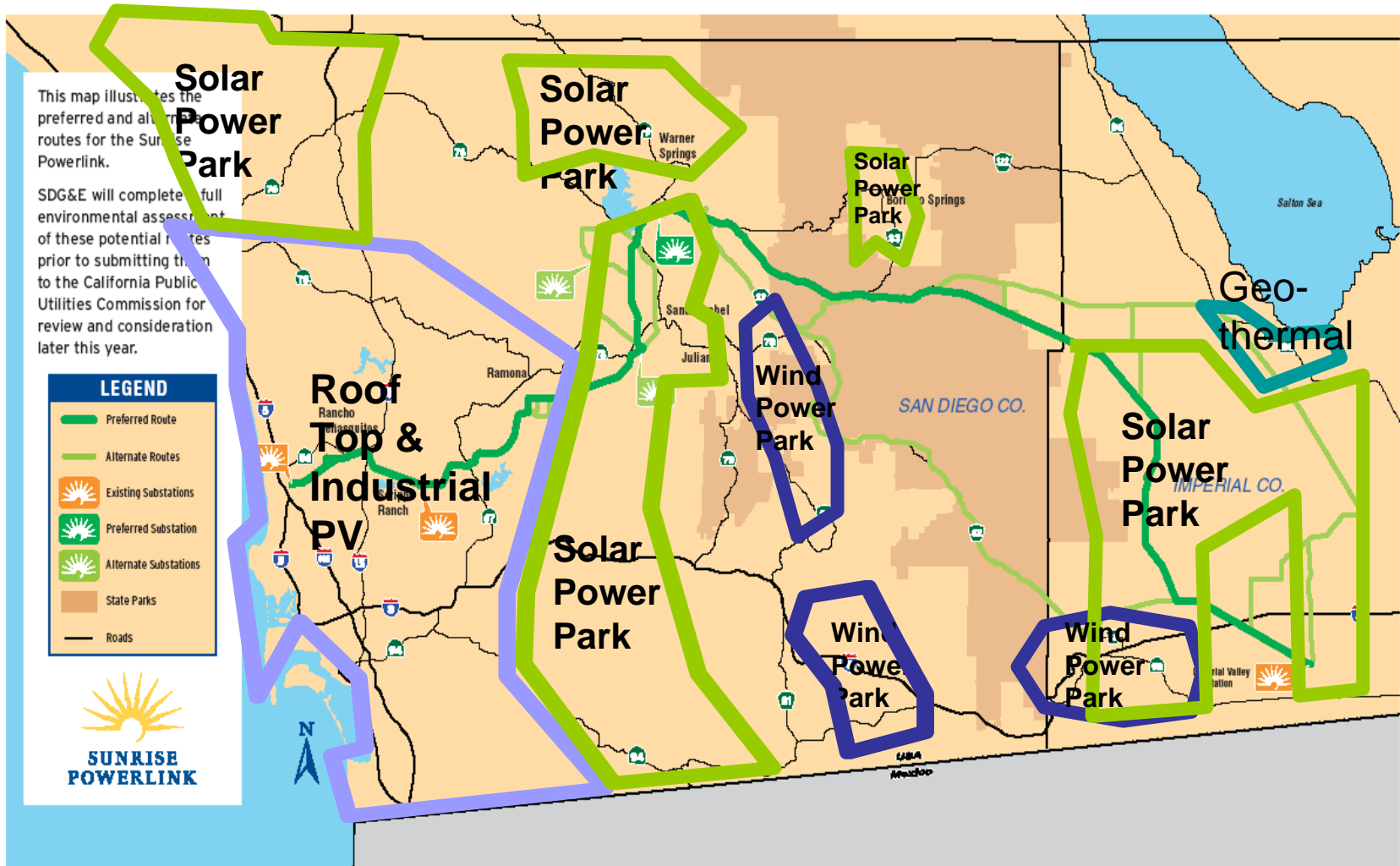
# APPROACH TO FINDING MAGNITUDE OF SOLAR IN SAN DIEGO CTY

- Use Dish-Stirling/ConPV Technology:
  - Smaller Parcel Required ( > 25 acre)
  - Irregular Shape
  - w/o Disturbing Low Ground Cover
  - Compatible with Grazing
- Find Amount of Land in Parcels > 25 acres
- Assess Land Availability:
  - For Sale
  - Ranching Land

# San Diego Cty Land

- About 5400 acres Currently for Sale in Parcels Greater Than 25 acres in Back Country (multiple listing)
  - 50 Total Locations
  - 19 Locations Greater Than 100 acres
    - 2 in Boulevard (near Rt 8) at 150 and 160 acres
    - 2 in Jamul at 535 and 100 acres
    - 2 in Julian at 300 and 130 acres
    - 4 in Ramona at 220, 160, 120 and 110 acres
    - 1 in Ranchita at 320 acres
    - 1 in Mesa Grande at 175 acres
    - 1 in Warner Springs at 150 acres
    - 6 in Valley Center at 220, 130, 120, 120, 105 and 105 acres
- About 202,000 acres in Grazing (SD Cty Farm Bureau)
- About 2000 acres of Citrus Farming in Borrego Springs Which Are Depleting Only Water Supply Aquifer

# San Diego County Could Provide Sites For Solar & Wind Power Parks, Where Environmental Assessment, Permits, Power Lines & Water are Pre-arranged For All Solar Power Plant Developers





# Central Solar Potential in SD Cty

- For Scale, 900 MW Planned for Desert Plant in Imperial Cty Will Occupy 5000 acres
- Total of 1600 MW of Solar Thermal Electric Estimated In April Projection by 2020
  - 1000 MW Dish-Stirling
  - 500 MW Parabolic Trough/Central Receiver
  - 100 MW Concentrating PV
- Borrego-Springs (San Diego Cty Desert) Has Potential of 50 to 100 MW Based On:
  - Purchasing Citrus Farm Land to Reduce Water Overdraft
  - Not Require Additional Transmission Capability
- If Land Potential Is 10% of Available (back country land for sale and grazing dual-use lease)
  - 20,740 acre Total
  - **4000 MW Potential**

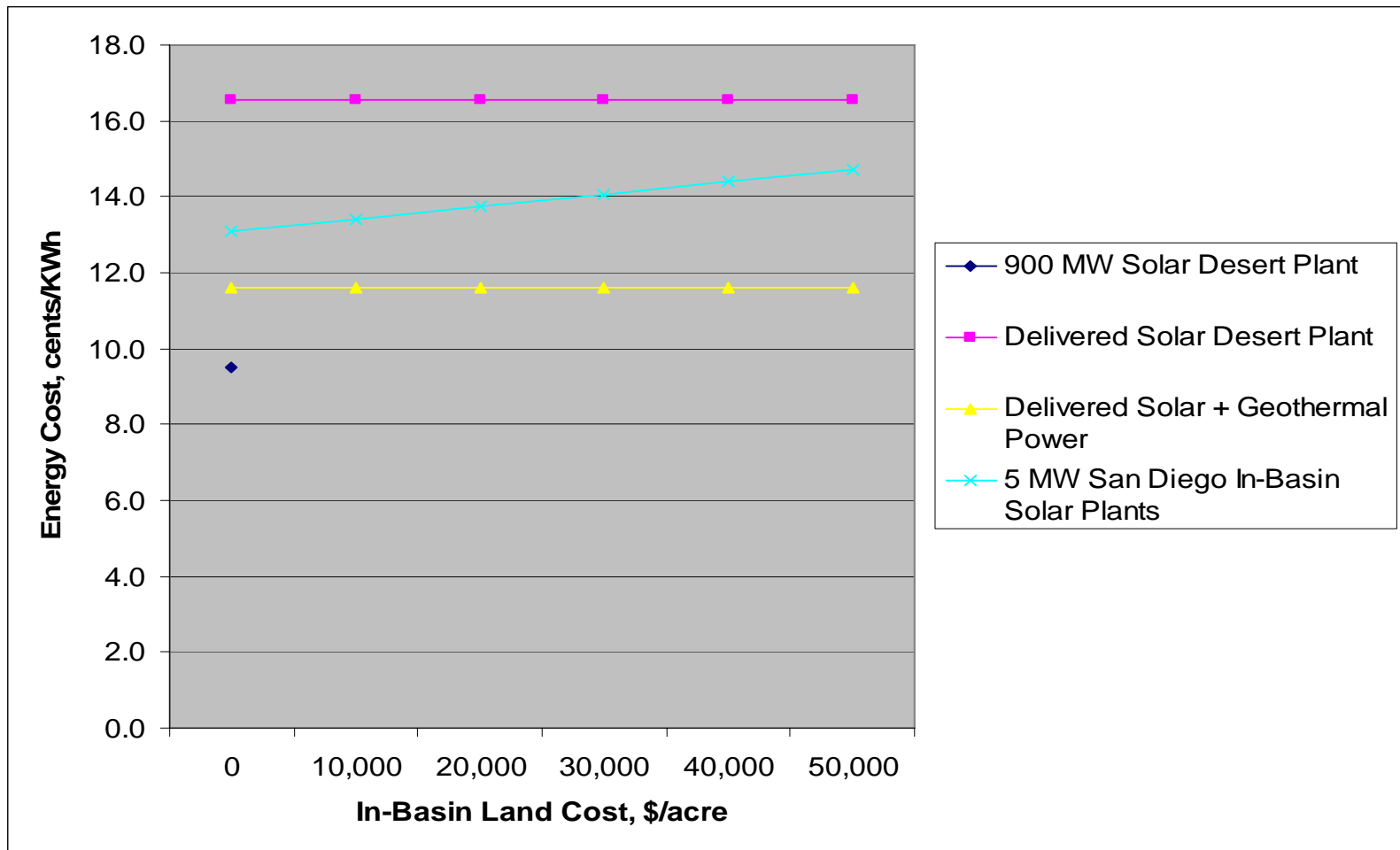
# Cost of Desert Solar Delivered to City versus San Diego Solar Plant

## Assumptions:

- Later Dish-Stirling Plant Design and Cost (\$1800/KW)\*
- Desert Plants
  - Transmission Link Costs \$1.2 B
  - Plant Capacity Factor
    - Solar is 0.27
    - Geothermal is 0.95
    - Combined is 0.90
  - Power Transmitted is 900 MW
- San Diego Back Country Plants
  - Capital Cost Increment for Smaller Plant is 10%
  - Energy Cost Increment for 15% Lower Isolation is 20%
  - Energy Park Concept Implemented and Preliminary Site Approvals Completed
- Financial Costs Same for Solar and Geothermal Plants, as well as for Transmission Link
- In-basin Transmission/Distribution Costs Ignored for Both Plant Locations

\* ConPV has similar land and cost characteristics to Dish-Stirling

# Energy Cost of Desert and In-Basin Dish-Stirling Power Plants



# Issues for Distributed Solar Plants in SD Cty

- 10 to 100 Plant Sites to Generate About 1000 MW
- Preliminary Solar Park Approval Needed to Expedite Multiple Plants
- Would It Be Easier to,
  - Have Sunrise Power Link Thru State Park? or
  - About 50 Site Approvals Throughout San Diego Back Country?
- Would 3% of Ranchers Support Leasing Land for Dual-Use?
- Would the Extra Costs of 10 to 100 Solar Parks Become Excessive:
  - Grid Connections, Permits and Approvals, other Utilities, EIS, etc
- Economic Comparisons Based on Simplified Assumption of Treating Cost of Financing to be Same for Solar Plants and Transmission Link
  - Different Sources of Funds for Private Solar Plants and Public Transmission Line

# San Diego Renewable Resource by 2020

- Wind Resource
  - 200 MW Producing 550 GWh/y
- Borrego Springs Desert Solar
  - 75 MW Producing 210 GWh/y
- Other (bio-mass, bio-gas and small hydro)
  - 70 MW Producing 480 GWh/y
- Distributed Dish-Stirling Plants
  - 1000 MW Producing 2,400 GWh/y
- Total Is 1350 MW Producing About 3600 GWh/y
- Total Central Renewables from San Diego Cty
  - Increase from 7% to 22% of All Renewables
  - Increase to 15% of Total Electric Energy in 2020
- For Total of All Renewables, Add 200 MW Roof Top PV (+3%), Hot Water for Residential/Commercial and Low and Mid-temperature Industrial

# Addendum Conclusions

- Sufficient Land in San Diego County for Technical Potential of Up to 4000 MW of Smaller and Distributed Solar Plants (using 10% of available grazing land)
- Adjusted 2020 Projection Estimates That in San Diego Cty:
  - Total Central Renewables Is About 1350 MW (3600 GWh/y)
  - Add About 200 MW of Roof Top PV
  - Add Distributed Solar Thermal for Residential/Commercial Hot Water and Low to Mid-Temperature Industrial Applications
- Economics of Comparing Delivered Desert Plant Cost to Distributed San Diego Cty Plants Is a Wash
  - Some Reservations About Financial Costs and Different Funding Sources

# Addendum Conclusions, continued

- Dish-Stirling/ConPV Most Compatible with Dual-Use Grazing
  - Sun-Only Operation Has Capacity Factor of 0.27 and about 67% of Nameplate Rating Contributing to Summer Peak Load
  - Dish-Stirling Can Be Operated in Hybrid Mode When Dual Fuel Engine Developed (Solar and Natural Gas) for 100% Peak Load
- Other (Parabolic Trough/Central Receiver) Solar Electric Technologies More Compatible With Thermal Storage for Greater ( $> 0.3$ ) Capacity Factor
  - Large Land Requirements and Restrictions of Land Characteristics Are Poorer Match to Available Land in San Diego Back Country and for Dual-Use with Ranching
- Likely to Have Combination of Central Solar Technologies with Dish-Stirling Capable of Location in San Diego Cty and Other Technologies Located in Desert
  - April Briefing Projects 2 to 1 Ratio of Installation of Dish to Other
  - 1000 MW Dish and 500 MW Trough/Central Receiver

# BOTTOM LINE

- If Sunrise Power Link Is Not Approved and Alternative Transmission Links Are Not Found, It Is Possible To Develop an Alternative Strategy To Meet Over Half of the Goal of 50% Renewable Energy by 2020 in San Diego County



# RECOMMENDATIONS

- **Start In-Depth Look at Renewable Power Parks for solar and wind**
  - Identify and Evaluate Different Approaches
  - What Are Elements of Preliminary and Final Approval
  - What Are the Up-Front Costs
    - Permitting, Land, Grid Connection, Utilities, etc
  - Mechanisms for Providing Up-Front Costs
  - Specific Sites for Solar and Wind
- **Review Preliminary Study (Renewable Energy Team Briefings Plus Addendum) With More Rigorous Treatment to Verify Conclusions**

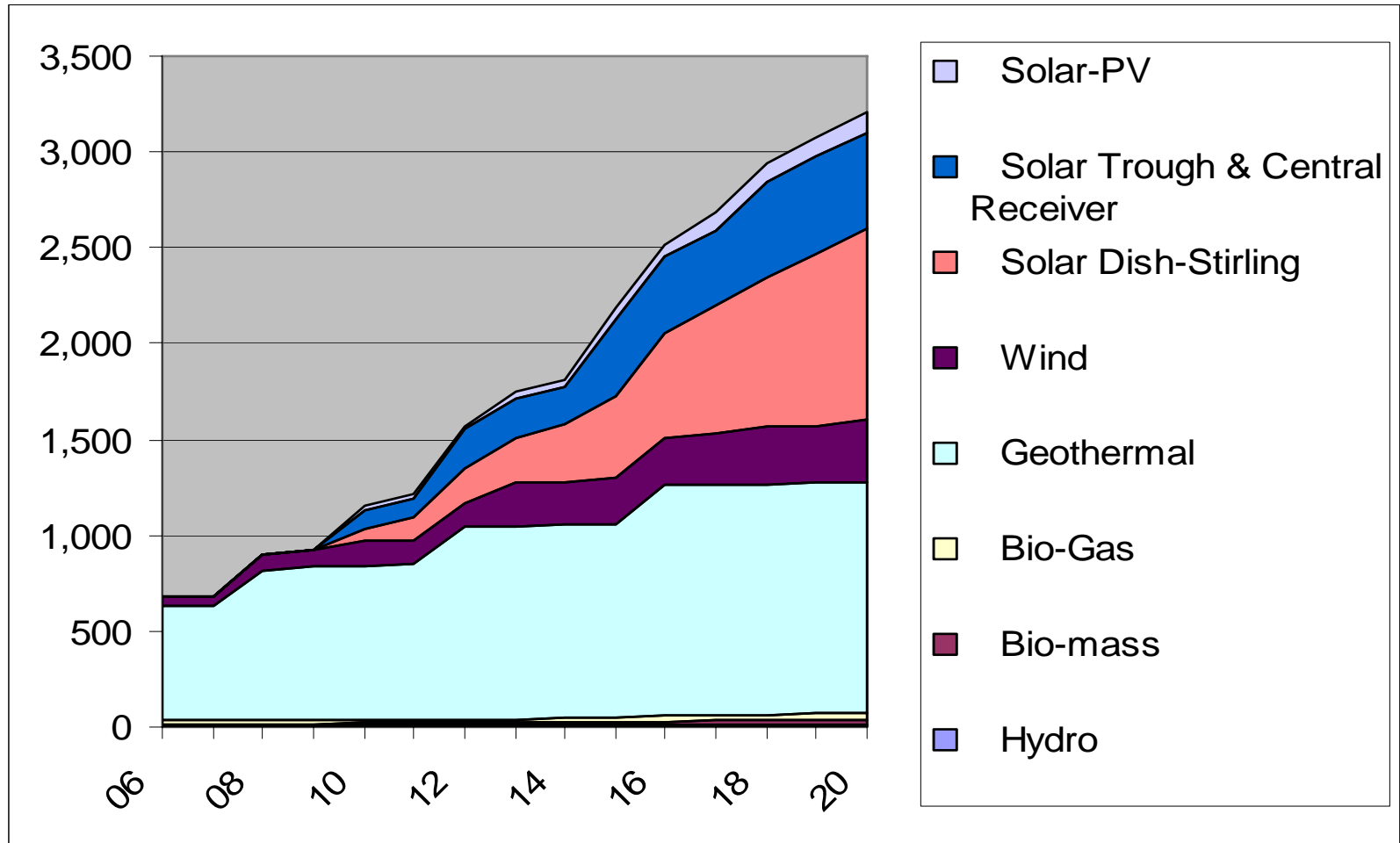
# Selected Slides from April Presentation For Background Information

# RESOURCE MAGNITUDE, MW

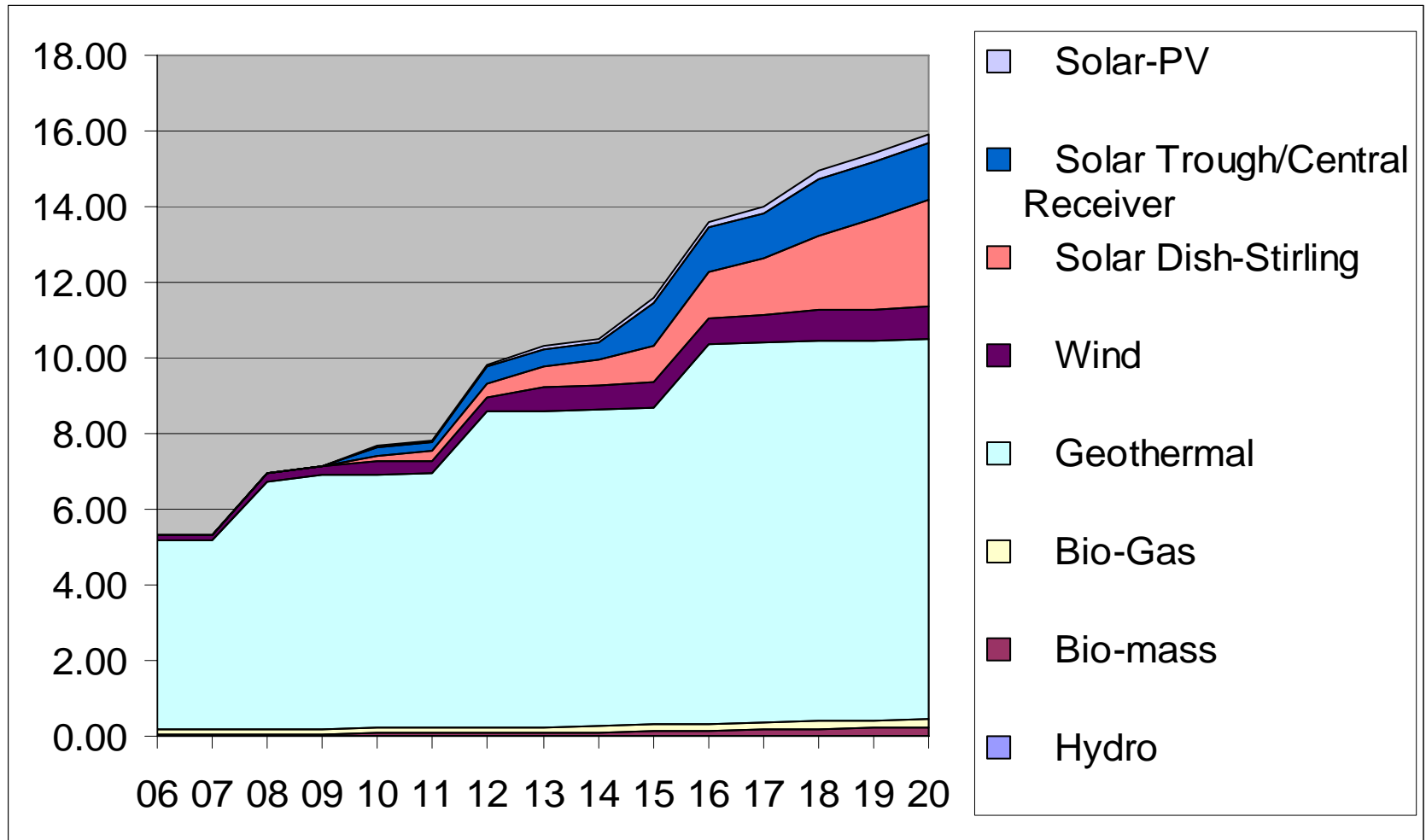
TECHNOLOGY	GROSS POTENTIAL	TECHNICAL POTENTIAL	CURRENT
CONCENTRATING SOLAR (San Diego)	300,000	36,000* (up to 7,000)*	Zero
WIND (San Diego Cty) (Imperial Cty) (Baja California)	2,500 to 2,800	1,680 to 1,830 (up to 960) (up to 570) (up to 300)	50 MW
GEOHERMAL (Baja California)	?	2,500 to 3,400 (840)	1257 MW (720)
BIO-MASS	?	44 to 106	5 MW
BIO-GAS	?	72	18 MW
HYDRO (small) (San Diego Cty) (Imperial Cty) (Baja California)	?	170 (10) (up to 86.5) (up to 75)	8.3 MW (8.3)

\* Adjusted Based on Addendum Results

# Installed POWER of Central Station Renewable Energy in San Diego Region, MW



# ENERGY GENERATED by Central Station Renewables in San Diego Region, GWh/y thousands



# ACHIEVED POTENTIAL in 2020

TECHNOLOGY	POWER in 2020 MW	Technical MW	Potential % Achieved
HYDRO	12	170	7
BIO-MASS	29	70	42
BIO-GAS	32	72	45
GEOHERMAL	1,200	3,000	40
WIND	325	1,700	19
DISH-STIRLING	1,000	36,000*	4*
TROUGH and CEN RECEIVER	500	“	“
SOLAR PV	100	“	“
TOTAL	3,200	41,000*	8*

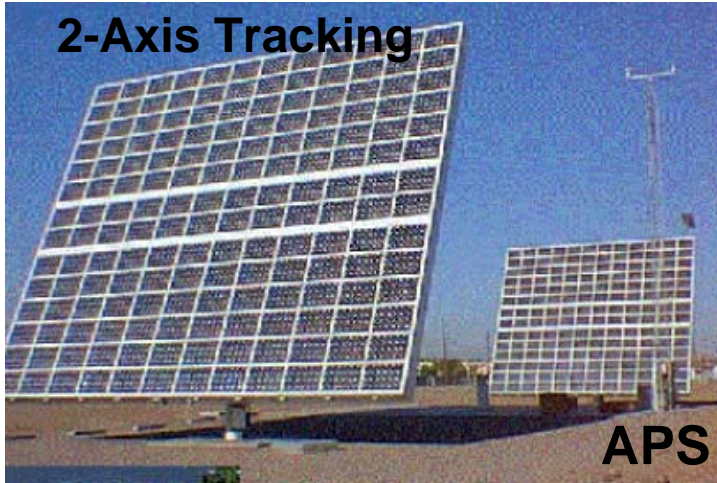
\* Adjusted Based on Addendum  
Results

# ACCESS TO RESOURCE

- Highest Intensity SOLAR RESOURCE PRIMARILY IN IMPERIAL CTY (29,000 MW) with 10% IN SAN DIEGO CTY (Borrego Springs)
- Lower Intensity SOLAR RESOURCE IS WEST OF ANZA-BORREGO PARK (4000 MW)
- LARGE WIND RESOURCE IN EASTERN SAN DIEGO CTY and in SW Corner of IMPERIAL CTY
- GEOTHERMAL RESOURCE AT Southern SALTON SEA
- SIGNIFICANT SOLAR and WIND RESOURCE IN NORTHERN BAJA
- AVERAGE DISTANCE TO LOAD CENTER IS ABOUT 130 MILES
- LIMITED EXISTING TRANSMISSION FROM EAST CTY & IMPERIAL CTY
  - EXCEPTION IS SW CORRIDOR with 500KV Line
- RELATIVELY SMALL AMOUNTS OF BIO AND HYDRO ARE FAIRLY WELL INTEGRATED INTO GRID NOW

# TYPES OF TECHNOLOGY

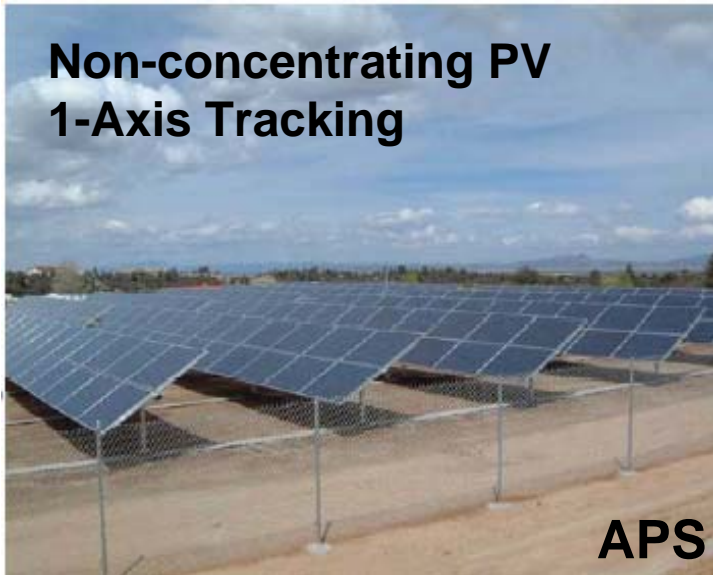
**Amonix Concentrator PV  
2-Axis Tracking**



**Solar Two Central Receiver (Power Tower)**



**Non-concentrating PV  
1-Axis Tracking**



**SAIC and SES Solar Dish Systems  
in Operation  
UNLV Installation, 8/17/01**





# The USA's Largest Solar Electric Generating System (SEGS) Over 354MW Operating For Over 20 Years in Kramer Junction, CA



*Central – Kramer Junction (CA) Solar Electric Generating Station*

Photo David Rib, Kramer Junction Co.



*Cooling towers and piping at a power plant at The Geysers.*

# COST

Technology (dry cooling)	EARLY \$/KW	PLANTS cents/KWh	LATER \$/KW	PLANTS cents/KWh	CapacityFactor (earlier – later)
Parabolic					
- solar only	3820	19.5	3160	15.0	0.28-0.3
- hybrid	4110	20	na	na	0.30
- 6 hr stor	5620	20	4310	14.6	0.4 -0.42
Dish-Stirling					
- solar only	3000	17.0	1800	9.5	0.25-0.27
- hybrid	3300	16.5	2000	10.4	0.30
CENTRAL RECEIVER					
- solar only	4500	22.9	2690	12.8	0.28 - 0.30
- hybrid	na	na	na	na	
- 6 hr stor	6600	23.5	3660	12.4	0.40 - 0.42

18% increase in energy cost for use of Dry vs Wet Cooling

Nominal Levelized Cost of Energy (LCOE) or Market Price Is Used Throughout with Simplified

Costing Formula where  $\text{cents/KWh} = 0.125 \times \text{\$/KW} / (\text{CF} \times 87.5)$

# COST

Technology	EARLY (2006) .....\$/KW	PLANTS cents/KWh	LATER (2017) \$/KW	PLANTS cents/K Wh	Capacity Factor
Concentrating PV (35% later)	7,000	37	2,100*	11*	0.27
Flat Plate PV	8,000	76	3,700	35	0.15
Wind	1,500	5 - 7	\$1,000	3.5 - 4.5	0.31-0.4
Geothermal	2950	5 – 7	2400	4 – 5.5	0.95
Bio-Gas	1200- 1500	4 - 5	na	3.7	0.8
Bio-Mass	2,500	8 – 10	na	7 – 8.5	0.8 - 0.95
Small Hydro	1700- 5000	10 – 28	na	8 – 18	0.25

\* Adjusted based on latest estimates of ConPV Efficiency

# COMPARISON TO TRADITIONAL ENERGY

TECHNOLOGY	CAPITAL COST \$/kw	CAPACITY FACTOR	CENTS/KWh
Peaking Gas - 5 \$/MBtu -10 \$/Mbtu -15 \$/Mbtu	600	0.09	21 33 35
Combined Cycle - 5 \$/MBtu -10 \$/Mbtu -15 \$/Mbtu	600	0.9	5.6 9.8 14.1

# San Diego REGION and Goals

- San Diego REGION:
  - San Diego County
  - Imperial County
  - Some Resource Data Is Given for Northern Baja California
- Regional Energy Strategy Goal
  - 40% of Renewable Electricity by 2030
  - Half from San Diego County
- California Renewable Portfolio Standard Goal for Investor Owned Utility Electricity
  - 20% by 2010
  - 30% by 2020

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