

# Transmission Challenges for Renewables in California and in the West

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**Presentation to Special Panel Session- Transmission Challenges in the  
Western United States**

**Tuesday, Oct 2, 2007**

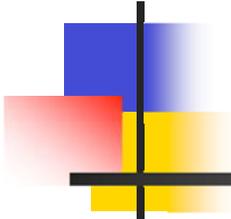
**Geothermal Resources Council**

**2007 Annual Meeting**

**John Ascuaga's Nugget Resort**

**Sparks, Nevada**





# Outline:

**Policy Drivers**

**Projections to Meeting RPS  
Challenges**

**Transmission Activities at CEC**

Transmission Planning

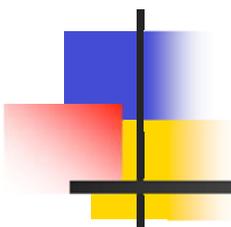
Intermittency Analysis Project

Feasibility of Interconnecting to the Pacific  
HVDC Intertie

Renewable Energy Transmission Initiative

Regional Integration of Renewables

Final remarks



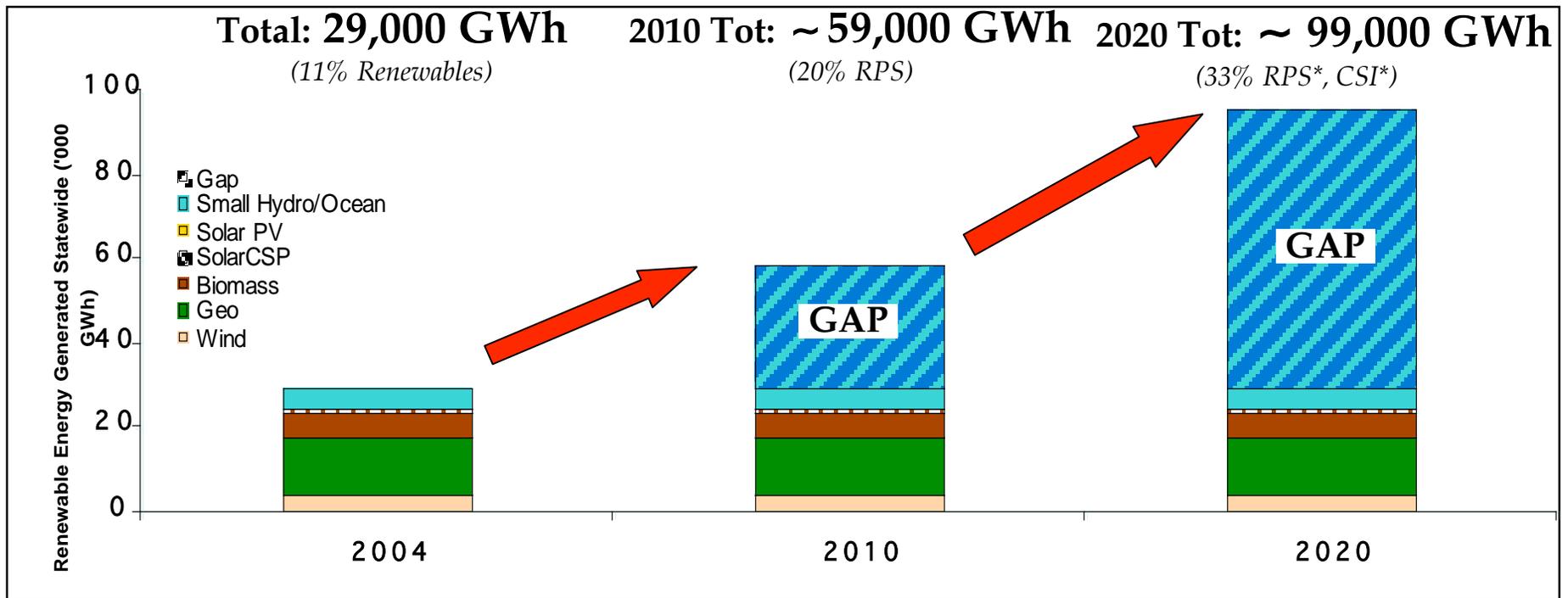
# Policy Drivers

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- Renewable Portfolio Standard (RPS)
- Climate Change, AB 32
- FERC Order 890
- Strategic Transmission Plan, SB 1565
- Integrated Energy Policy Report
- Western Electricity Coordinating Council's  
Transmission Expansion Planning
- SB 1059 Corridor Designation Process
- EAct-05 Sections 1221 and 368

# Projections to Meeting RPS

## Projected Renewables to Meet California Policy Goals



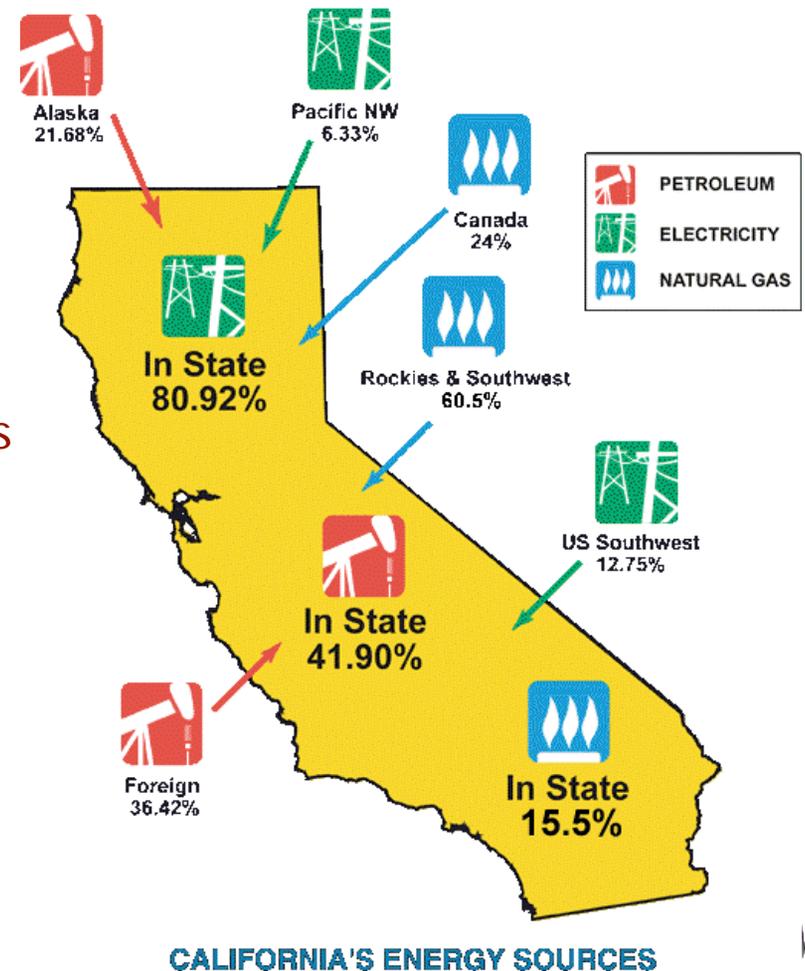
Data Sources: 2004, CEC Electricity Report which includes all renewables in the State, not just IOUs; 2010 and 2020, PIER Renewables Projections.

\*RPS: Renewable Portfolio Standard

\*CSI: California Solar Initiative

# Challenges

- Achieving RPS & Greenhouse Gas Policy Goals (AB 32)
- Constrained and insufficient transmission and distribution (T&D) infrastructure
- **Limited peak generating capacity**
- Lack of operating experience at high renewable penetration levels
- **Abundant in-state renewable resources and aggressive policy for growth, but lacking a “game plan” (RPS) to help prioritize development**
- Lack of integrated system
- Lack of coordinated transmission planning & permitting
- Public opposition
- Financing/Cost Allocation/Cost Recovery



# Strategic Transmission Plan



SB 1565 (Bowen) added PRC section 25324

- Energy Commission shall adopt a strategic plan for the state's electric transmission grid
- The plan shall identify and recommend actions required to implement investments needed to
  - Ensure reliability
  - Relieve congestion
  - Meet future growth in load and generation including but not limited to: renewable resources, energy efficiency, and other demand reduction
- In August 2007, the Strategic Transmission Investment Plan was drafted in support of the 2007 Integrated Energy Policy Report

<http://www.energy.ca.gov/2007publications/CEC-700-2007-018/CEC-700-2007-018-CTD.PDF>

# Strategic Transmission Investment Plan

*Based from September 13, 2007, Joint Committees  
(IEPR & Electricity Committees) Draft 2007 Strategic Transmission  
Investment Plan.*

## Key Recommendations Relating to Recent Policy Drivers

- Continue staff participation in EAct-05 Section 1221 (NIETC) effort.
- California ISO should implement its integrated transmission planning process in a timely fashion.
- CEC staff participation in CAISO subregional planning process.
- Monitor implementation of FERC Order 890 and continue staff participation in WECC's Transmission Expansion Planning Policy Committee.

[http://www.energy.ca.gov/2007\\_energypolicy/documents/2007-09-13\\_workshop/presentations/](http://www.energy.ca.gov/2007_energypolicy/documents/2007-09-13_workshop/presentations/)

*Judy Grau, CEC*



# Strategic Transmission Investment Plan

## Key Recommendations Relating to Removing Renewable Transmission Barriers

- Establish a more cohesive statewide approach for renewable development.
- Active staff participation in California Renewable Energy Transmission Initiative
  - <http://www.energy.ca.gov/creti/index.html>
  - As appropriate, vet and integrate CRETI results into the next Strategic Plan.
- CEC, CPUC, and CAISO should include stakeholders early and often.

Judy Grau, CEC

[http://www.energy.ca.gov/2007\\_energypolicy/documents/2007-09-13\\_workshop/presentations/](http://www.energy.ca.gov/2007_energypolicy/documents/2007-09-13_workshop/presentations/)



# Strategic Transmission Investment Plan

## Key Recommendations Relating to Removing Renewable Transmission Barriers

- CAISO Remote Resource Interconnection Policy should consider the benefits of renewable feed-in tariffs.
- CAISO should prioritize the interconnection queue based on project viability.
- CAISO should continue to approve new renewable interconnections before completion of network upgrades.
- CAISO should continue to investigate a clustered interconnection study approach for the Tehachapi project for use in other areas.

Judy Grau, CEC



# Strategic Transmission Investment Plan

## **Key Recommendations Relating to Removing Renewable Transmission Barriers**

- CAISO should coordinate and synchronize interconnection studies within its transmission planning process to the extent feasible.
- CPUC should continue to coordinate its generation procurement and transmission CPCN processes.
- Continue PIER funding of CERTS work on transmission system integration barriers and the PACT model.

Judy Grau, CEC



# Strategic Transmission Investment Plan

## **Key Recommendations Relating to Instate Transmission Corridor Planning**

- Support legislation that would allow IOUs to keep transmission corridor investments in their ratebase for as long as the CEC designates the corridor.
- When evaluating future transmission projects within a designated corridor, the CPUC and other permitting agencies should accept the need and environmental findings resulting from the CEC's transmission corridor designations.

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# Strategic Transmission Investment Plan

## Key Recommendations Relating to Instate Transmission Corridor Planning

- Encourage SB 1059 applications for three categories of corridors on non-federal lands:
  - Corridors that would provide access to renewable resource areas
  - Corridors that would interconnect with existing or proposed federal EPC Act section 368 corridors
  - Existing corridors that may be required for future facility upgrades
- CAISO should consider designated corridors in its transmission planning process.

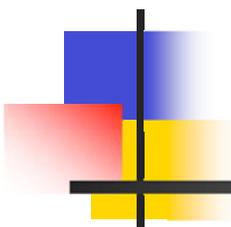
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# Strategic Transmission Investment Plan

## **Key Recommendations Relating to Instate Transmission Corridor Planning**

- Seek agreement among interested parties with similar transmission needs during development of Strategic Plan and before accepting a corridor designation application.
- Explore options for earlier consideration of non-wires alternatives in statewide planning processes.

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# Strategic Transmission Investment Plan

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## **In-state Transmission Projects**

- Criteria for inclusion
  - On line by 2017
  - Requires permitting
  - Provides statewide benefits
- Data Sources
  - CAISO and utility transmission plans
  - Presentations and comments at IEPR workshops
  - Forms and Instructions data responses

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# Strategic Transmission Investment Plan

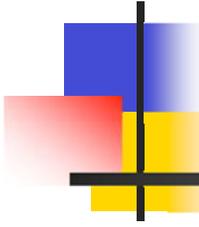
## **In-state Transmission Projects**

- Resulting Categories
  - 2005 Recommended Projects – no change
  - 2007 Recommended Projects of Statewide Significance
  - 2007 Supported Projects of Local Significance
  - Projects Deferred to the 2009 Strategic Plan

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# Strategic Transmission Investment Plan



## Recommended Transmission Projects

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### 2005 Recommended Projects

- Tehachapi Phase 1
- Palo Verde-Devers  
No. 2
- Trans Bay Cable
- Sunrise Powerlink
- Imperial Valley  
Upgrades

### 2007 Recommended Projects of Statewide Significance

- PG&E Central CA Clean Energy  
Transmission Project (CCETP)
- Lake Elsinore Advanced  
Pumped Storage (LEAPS)  
Project [TL portion only]
- Green Path Coordinated  
Projects
- LADWP Tehachapi  
Transmission Project
- SCE Tehachapi Expansion

# Strategic Transmission Investment Plan

## 2007 Recommended Projects of Statewide Significance

- PG&E and CAISO should convene a study group to develop need analysis for CCCETP.
  - If needed, PG&E should bring a corridor request to the CEC
- Permitting process for LEAPS should be divided into transmission and generation.
  - Permitting for Tallega/Escondido – Valley/Serrano transmission line should proceed

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# Strategic Transmission Investment Plan

## 2007 Recommended Projects of Statewide Significance

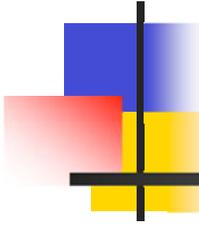
- IID should work collaboratively with other project proponents to develop mutually beneficial transmission projects in the Imperial Valley.
- LADWP should coordinate its Tehachapi transmission plans with SCE.
- Sunrise Powerlink, LEAPS transmission, and Green Path are critical for meeting renewable resource and GHG reduction standards.

Note: The Energy Commission is not endorsing specific routes for these projects.

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# Strategic Transmission Investment Plan



## 2007 Supported Projects of Local Significance

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- 2007 SMUD O'Banion Project
- SCE Magunden-Rector 230 kV
- SCE Devers-Mirage 230 kV
- SCE Alberhill 500/115 kV Substation
- SCE West of Devers upgrades
- SDG&E Orange County 230 kV

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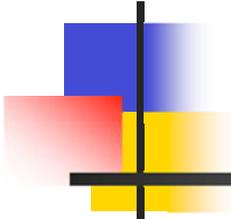
# Strategic Transmission Investment Plan

## Projects Deferred to 2009 Strategic Plan

- SDG&E renewable substation
- PG&E Bay Area 500 kV substation
- Five TANC "Greek Letter" projects [ $\alpha$ ,  $\beta$ ,  $\delta$ ,  $\epsilon$ ,  $\zeta$ ]
- MID Westley-Rosemead 230 kV project
- TID Westley-Marshall 230 kV project

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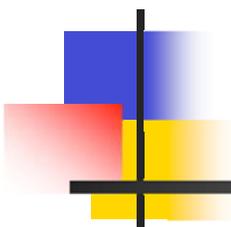
# Strategic Transmission Investment Plan



## Key Recommendations Relating to Western Regional Transmission Issues

- CEC's public outreach program should include education on benefits of regional transmission expansion.
- Continue and refine PIER research to address cost allocation and cost recovery issues for interstate projects.
- Staff should monitor status of regional projects that can help achieve state policy goals as they move beyond the conceptual stage.

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# Strategic Transmission Investment Plan

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## Next Steps

September 27 Written comments due

October 24 Publish Joint Committees  
Final *2007 Strategic  
Transmission Investment Plan*

November 7 Business Meeting Adoption

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# Intermittency Analysis Project (IAP) Focus

## Define Attribute Requirements

- Renewable generation performance curves
- Renewable resource potential & locations
- New technology attributes

## Reduce Uncertainty

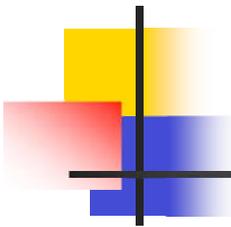
- Consistent statewide datasets
- Generation & load for multi-years
- Transmission datasets

## Resource Policies

- Mix including renewables and conventional
- Perspective on generation to load centers
- Mitigation/storage options
- Lessons learned (world-wide experience)

## Improve Planning and Modeling

- Quantified impacts
- Confidence in modeled options
- Expanded options and contingencies



# Renewable Integration Questions

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- What will the future electricity system look like and where will in-state resources are likely to come from?
- What is needed for the grid to accommodate renewables (infrastructure, market, regulation, technologies) ?
- What are the impacts of increasing renewable energy penetration on system reliability and dispatchability?

# IAP Objectives



- Focus on statewide transmission planning options to achieve policy goals
- Focus on providing quantitative impacts (pros & cons) of various options on transmission reliability, congestions and mix of renewable technologies
- Develop tools and analysis methods to evaluate renewables along with conventional generation
- Provide a common perspective for evaluating different technologies competing for limited system resources
- Provide a common forum for Commissions, utilities and developers to examine the location and timing of new generation/transmission projects and public benefits of these resources

# Production Cost Model address time scales necessary for System Reliability and Operation

Slower (Years) ↑  
Time Frame  
↓ Faster (seconds)

## Planning and Operation Process

## Technology Issues

Resource and Capacity Planning  
(Reliability)



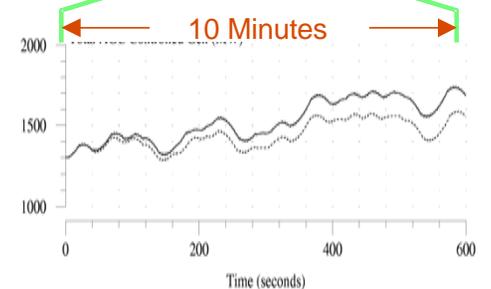
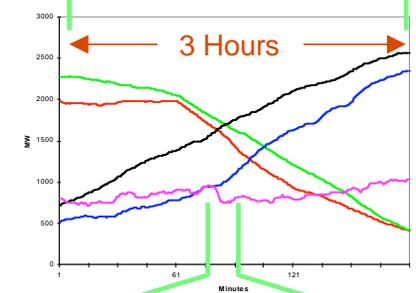
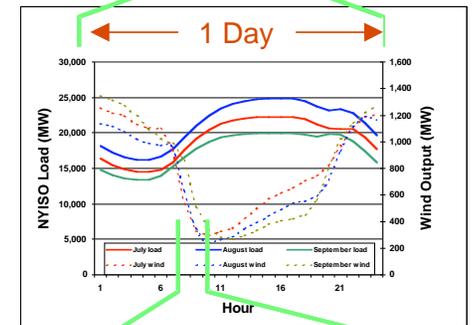
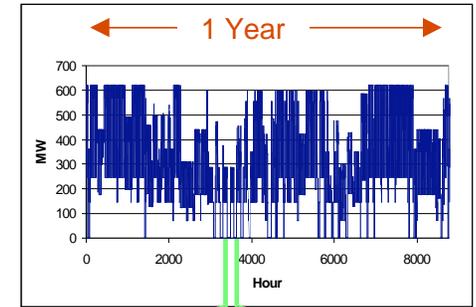
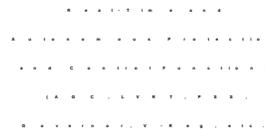
Unit Commitment and Day-Ahead Scheduling

Day-ahead and Multi-Day Forecasting

Load Following (5 Minute Dispatch)

Hour-Ahead Forecasting and Plant Active Power Maneuvering and Management

Frequency and Tie-Line Regulation (AGC)



## Four IAP study scenarios

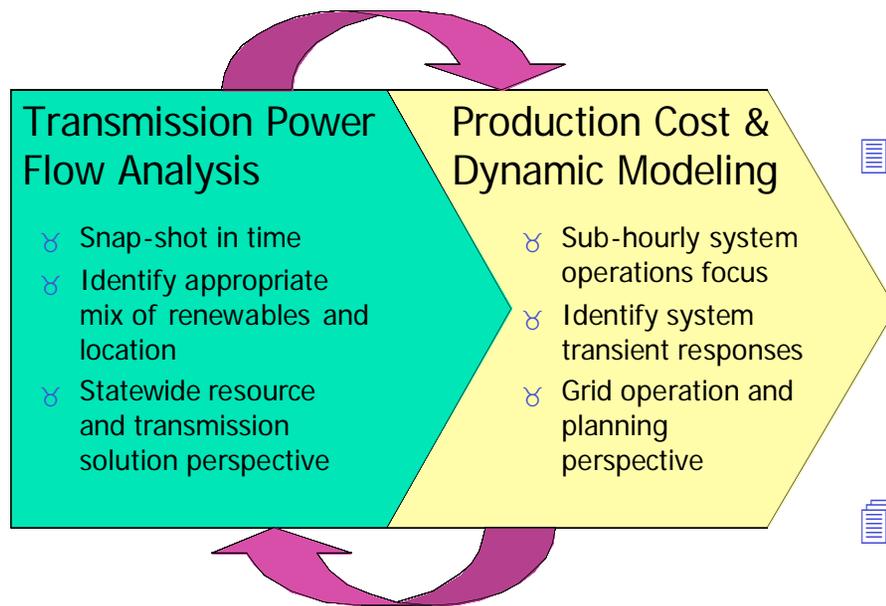
# Scenarios of Increasing Renewable Penetration

 **2006 Baseline**  
Existing system with existing mix of generation resources

 **2010 Tehachapi (2010T)**  
20% renewable energy with approximately 6 GW wind generation statewide, assuming 3000 MW concentrated at Tehachapi

 **2010 Accelerated (2010 X)**  
Sensitivity study cases to assess system buildout needs toward a 33% renewables electricity infrastructure

 **2020 33%**  
Blend of renewables designed to meet policy targets with high wind penetration



*End-to-End Approach*

# IAP Portfolio Mixes

	2006	2010T	2010X	2020
<b>Peak California Load, MW</b>	58,900	62,600	62,600	74,300
<b>Peak CAISO Load, MW</b>	48,900	51,900	51,900	61,200
<b>Total Geothermal, MW</b>	2,400	4,100	3,700	5,100
<b>Total Biomass, MW</b>	760	1,200	1,000	2,000
<b>Total Solar, MW</b>	330	1,900	2,600	6,000
<b>Total Wind, MW</b>	2,100	7,500	12,500	12,700
<b>Wind at Tehachapi, MW</b>	760	4,200	5,800	5,800
<b>CA Intermittent Capacity Penetration</b>	4%	15%	24%	25%
<b>CAISO Intermittent Capacity Penetration</b>	5%	18%	29%	31%

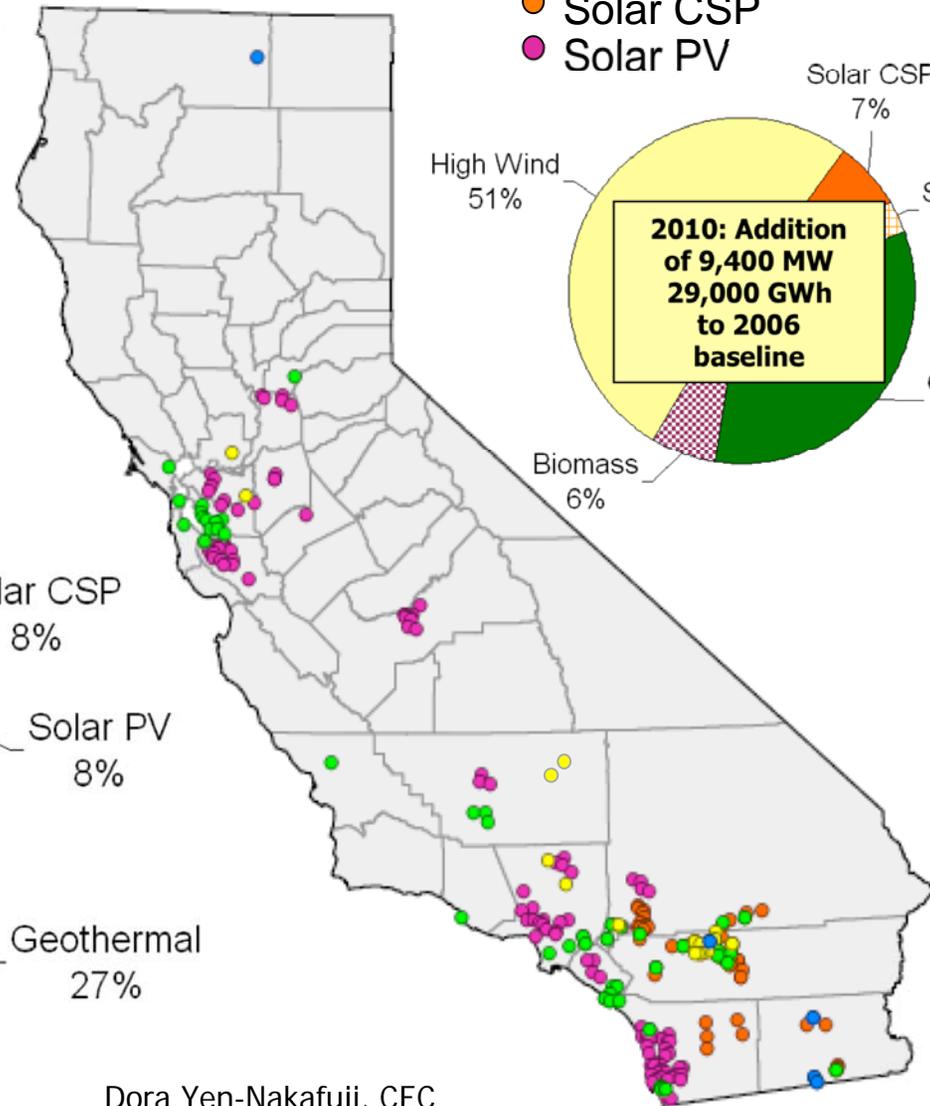
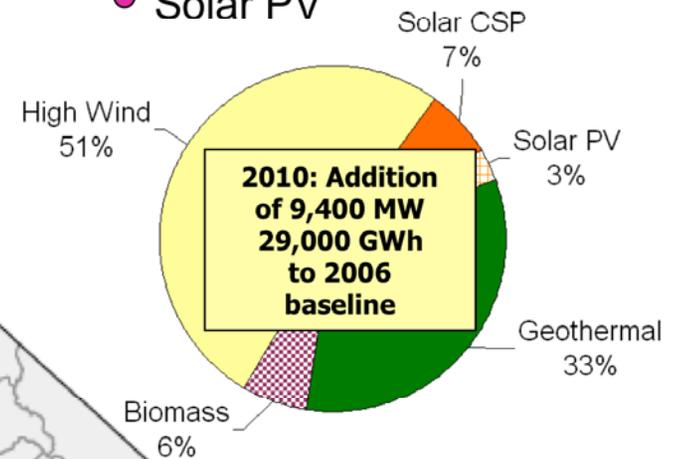
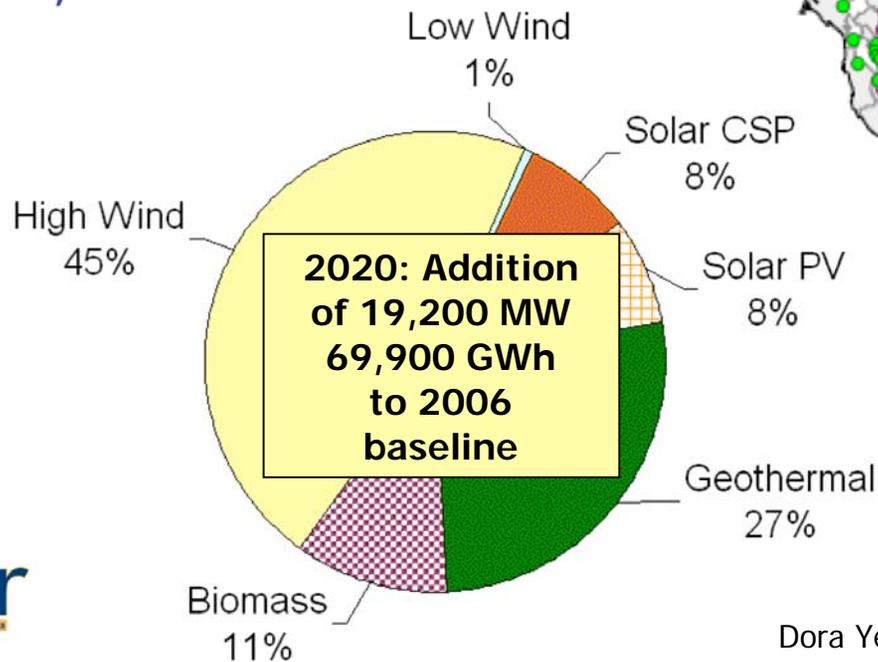


# 2010 & 2020 Scenario

- Up to 33% renewable generation penetration
- Portfolio mix of statewide resources
- 3,000 MW of wind at Tehachapi and nearly 3,000 MW of PV

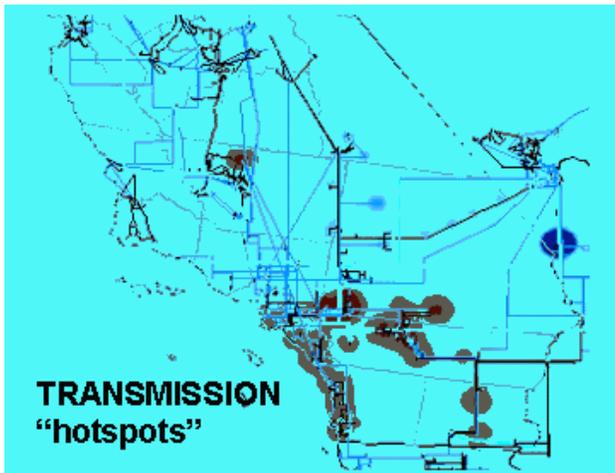
## INJECTION LOCATIONS

- Geothermal
- High Wind
- Distributed Biomass
- Solar CSP
- Solar PV



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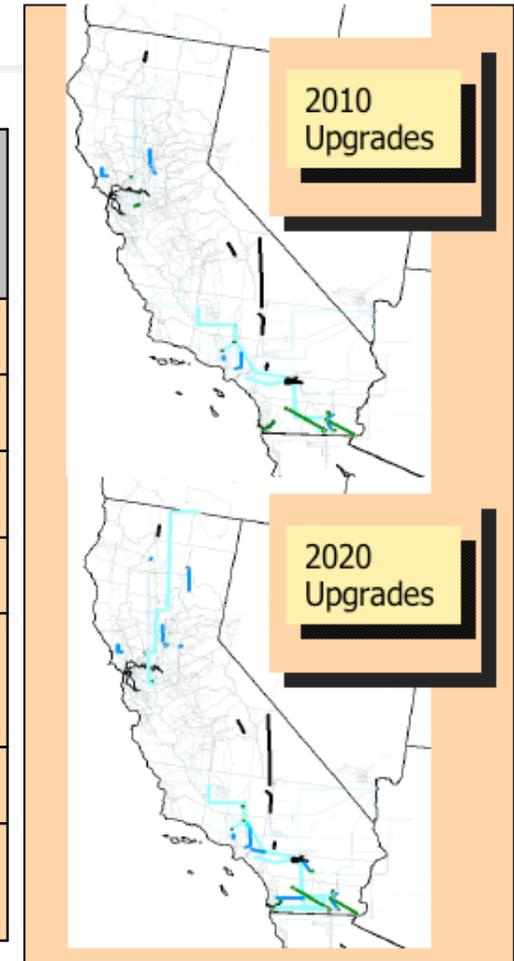
# Seasonal and Geographic Diversity of Renewables



Region	Resource	Spring	Summer	Fall
Medicine Lake	Geothermal	X	Neutral	X
Imperial Valley	Geothermal	X	Neutral	
Sulfur Bank	Geothermal			Neutral
LADWP	Wind		X	X
Altamont Pass	Wind	X		
Solano	Wind	X		X
Tehachapi	Wind		Neutral	X
Central Valley	Biomass			X
SDG&E	CSP		Neutral	Neutral
SCE	CSP			Neutral
Residential	PV			Neutral

# 2010 & 2020 Transmission Expansions

Line Voltage	2010 Line Segments	2020 Line Segments	2010 Transformers	2020 Transformers
500	8	22	2	9
230	8	38	6	18
161/138	0	2	1	0
115	49	49	9	5
Below 110	13	17	14	8
<b>Total #</b>	<b>78</b>	<b>128</b>	<b>32</b>	<b>40</b>
<b>Estimated Cost*</b>	<b>\$1.3 Bil</b>	<b>\$5.7 Bil</b>	<b>\$161 Mil</b>	<b>\$655 Mil</b>



\* Order of magnitude estimates based on N-1 contingency, lines greater than 230kV

\* Transmission plans and additions based on combination of utility projects and IAP team assessed needs

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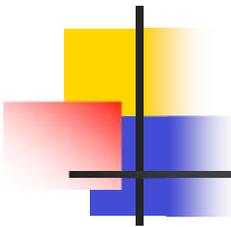
# IAP Findings/Observations Highlights

- **System operation at 33% with 12,500 MW of wind and nearly 3,000 MW of solar is feasible in the 2020 scenario**
- **Some operating conditions will require intermittency management strategies**
  - Periods of high load rise (summer morning or winter evening)
  - Periods of light load will increase in frequency and when combined with extremely high winds, may require mitigation
- **Value added by appropriate forecasting increase value of intermittent resources by \$4.37/MWh**
- **Possible additional cost for increased regulation and load following ranging 0 to 69¢/MWh**
  - Analysis show increased requirement of about 20MW
  - Present range of procured regulation (300-800MW up and 300-500MW down) sufficient to meet increases in need
  - If no additional regulation provided, CPS2 violations would be expected to increase about 1-2%

# Scenario Emission & Displacement

2020 Targets

	<b>In State (CA)</b>	<b>WECC</b>
NOx reduction	520 tons	4,000 tons
SOx reduction	700 tons	2,000 tons
CO2 reduction	~ 8 Mil tons	~ 23 Mil tons
Natural Gas Reduction	140 Bil ft <sup>3</sup> /yr	390 Bil ft <sup>3</sup> /yr

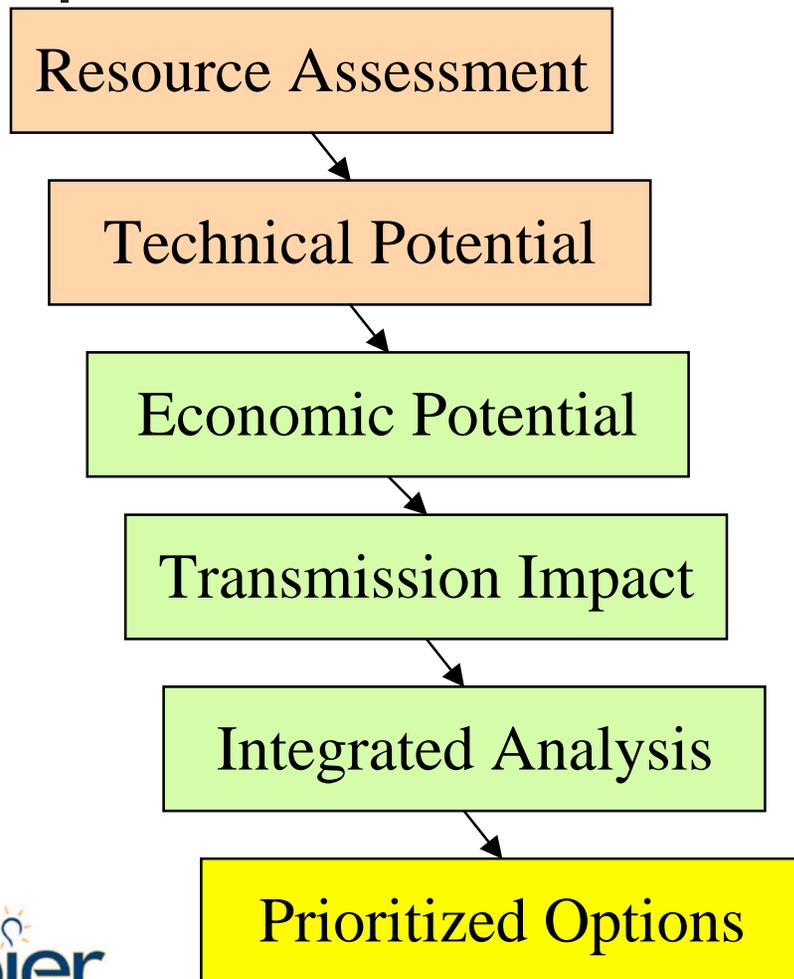


# IAP Recommendations & Conclusion

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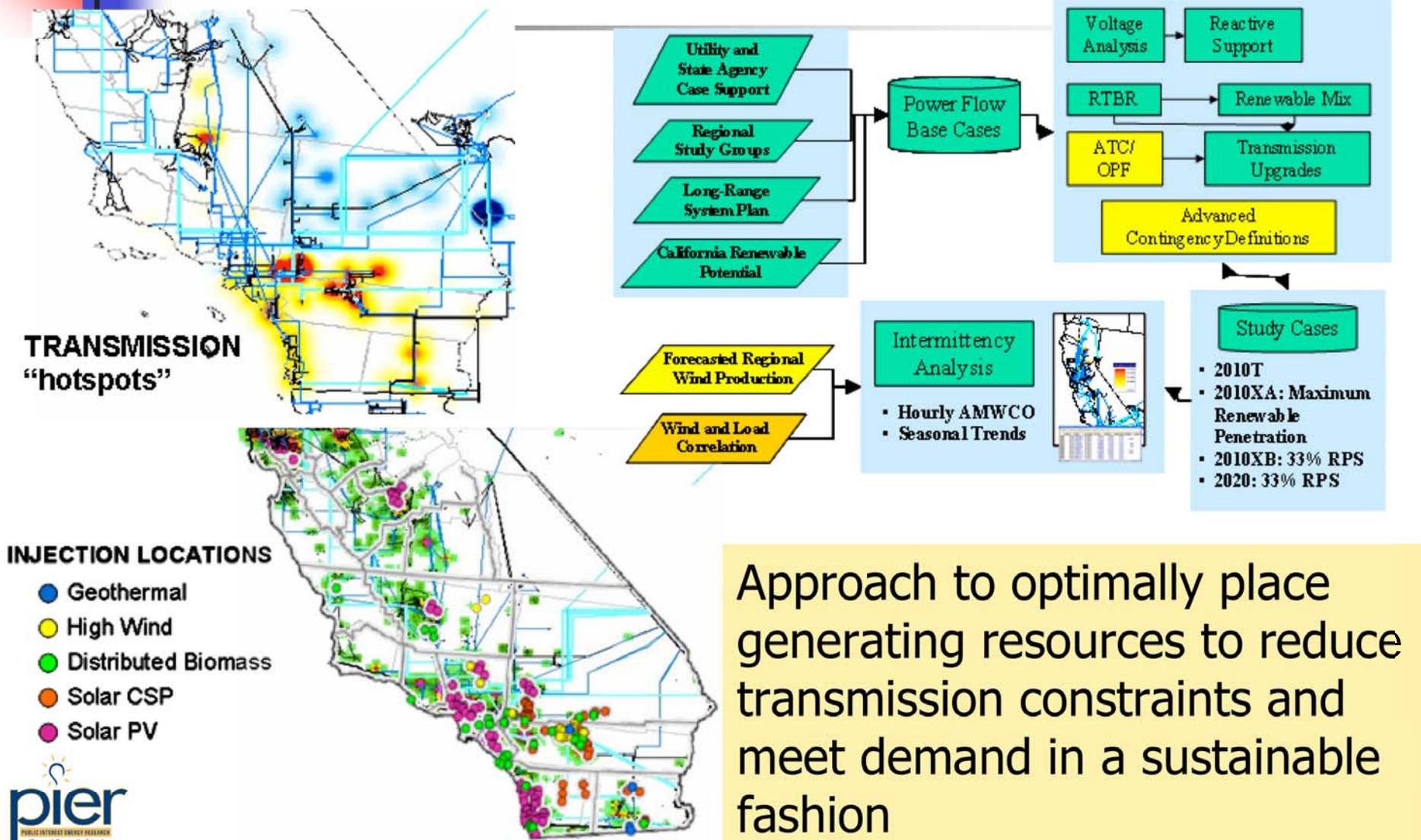
- Identified investments in transmission, generation and operations infrastructure (MW level and locations)
- Suggested appropriate changes in operations practices, policy and market structure to support a future 2020 renewable penetration level
- Emphasized continuing cooperation among all government and market participants in the longer-term, regionally-integrated transmission planning effort

# Strategic Assessment Approach

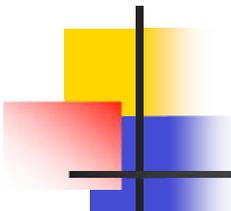


- Identifies key **focus locations** for development
- Considers **development timeframe and economics** for maximum public benefits
  - Transmission
  - Environmental
  - Other non-energy benefits
- **Graphically** integrate solutions for planning needs
- **Prioritizes** renewable and transmission build-out

# Transmission Analysis Approach



Approach to optimally place generating resources to reduce transmission constraints and meet demand in a sustainable fashion



# For Further Information

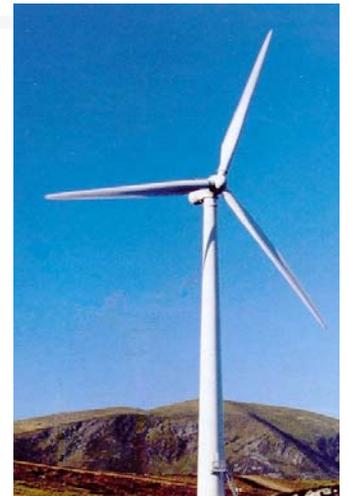
See the following links for details of IAP project, presentations and reports.

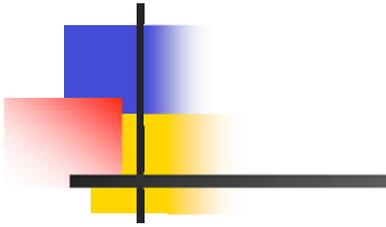
For more info about this project, please contact Dr. Dora Yen-Nakafuji at [dyen@energy.state.ca.us](mailto:dyen@energy.state.ca.us)

- August 15, 2006: 1st workshop  
[http://www.energy.ca.gov/pier/conferences+seminars/2006-08-15\\_RPS\\_workshop/index.html](http://www.energy.ca.gov/pier/conferences+seminars/2006-08-15_RPS_workshop/index.html)
- February 13, 2007: 2nd and final workshop  
<http://www.energy.ca.gov/pier/notices/> look at the Feb 13th presentations
- Three IAP reports providing methodology and the identification process for locating resource potential.
  - Intermittency Analysis Project: Characterizing New Wind Resource in California  
[www.energy.ca.gov/2007publications/CEC-500-2007-014/CEC-500-2007-014.PDF](http://www.energy.ca.gov/2007publications/CEC-500-2007-014/CEC-500-2007-014.PDF)
  - Intermittency Analysis Project: Summary of Preliminary Results for the 2006 Base and 2010 Tehachapi Cases - Interim Project Report  
[www.energy.ca.gov/2007publications/CEC-500-2007-009/CEC-500-2007-009.PDF](http://www.energy.ca.gov/2007publications/CEC-500-2007-009/CEC-500-2007-009.PDF)
  - Review of International Experience Integrating Renewable Energy Generation  
[www.energy.ca.gov/2007publications/CEC-500-2007-029/CEC-500-2007-029.PDF](http://www.energy.ca.gov/2007publications/CEC-500-2007-029/CEC-500-2007-029.PDF)
- For data files used in the scenario analysis, please contact Dora Yen-Nakafuji or Kevin Porter.
- Background documents supporting Commission IEPR process and renewable resource assessments can be found on the Commission websites  
<http://www.energy.ca.gov/pier>  
[http://www.energy.ca.gov/2005\\_energypolicy/documents/2005\\_index.html#070105](http://www.energy.ca.gov/2005_energypolicy/documents/2005_index.html#070105)

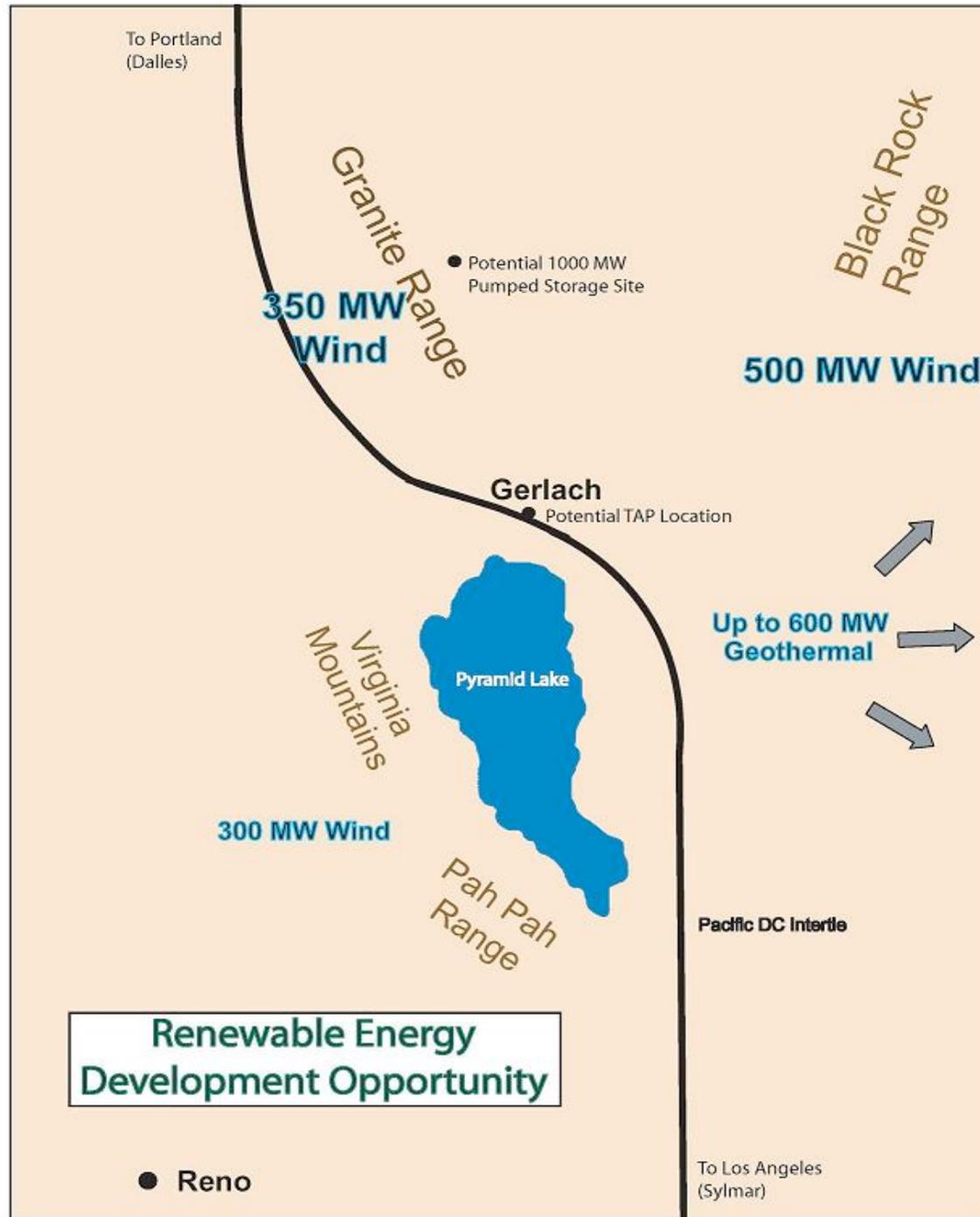
# Feasibility of Interconnecting to the Pacific HVDC Intertie

1. Determine costs to interconnect wind and geothermal to the Pacific HVDC Intertie
2. Determine ac transmission alternatives to connecting to the Pacific HVDC Intertie
3. Determine optimal interconnection points for renewables near the California – Nevada border
4. Determine relative costs and advantages of a collector system vs. using the existing grid.



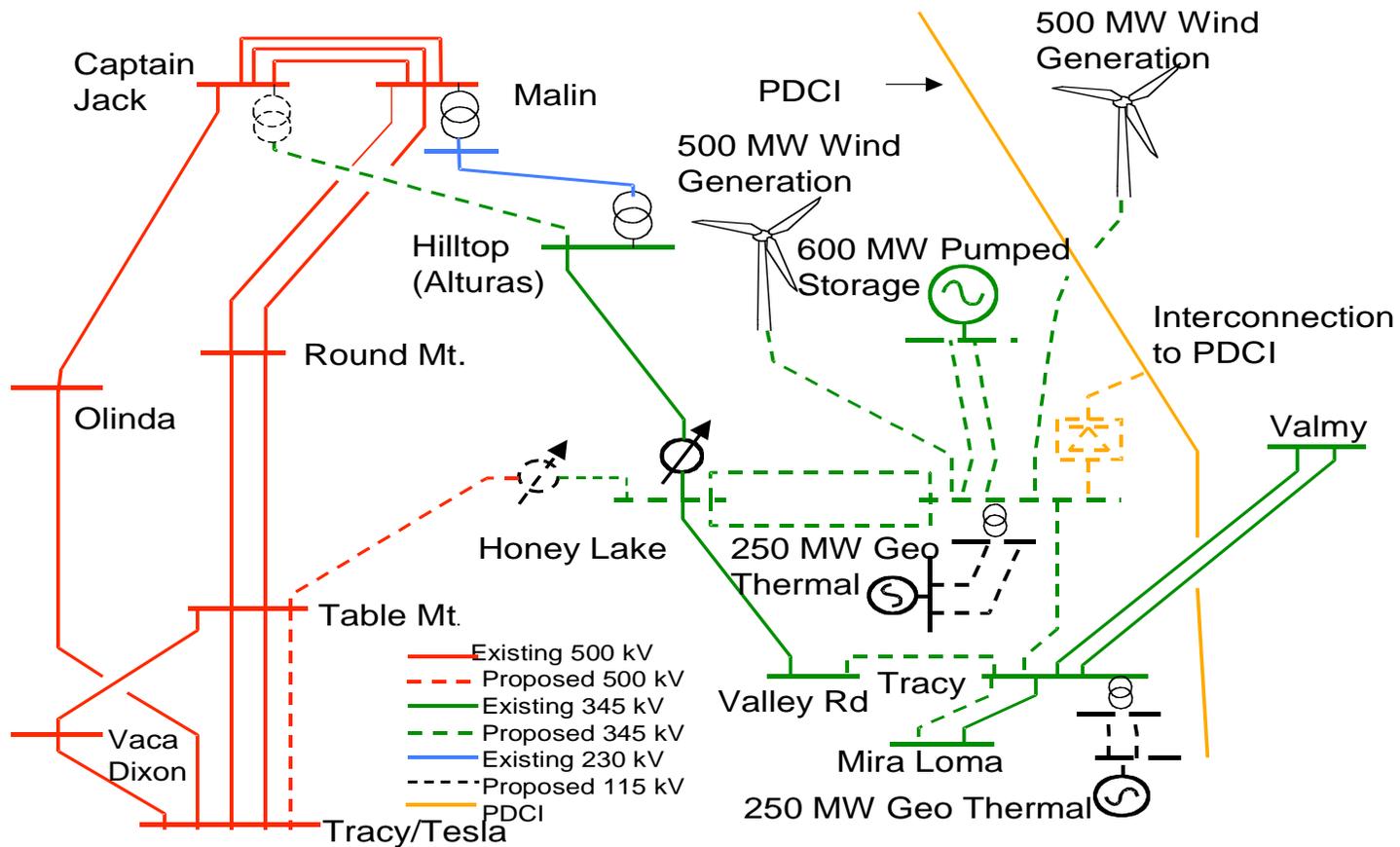


# Renewable Resources concentrated in Northwest Nevada



# Bringing Northwest Nevada Renewables into California

## NV/CA TRANSMISSION OPTIONS FOR RENEWABLE ENERGY



# Renewable Energy Development

in conjunction with

## Tapping the PDCI

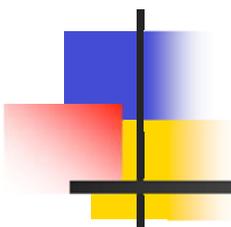
Adding a 3<sup>rd</sup> Terminal to the Pacific DC Intertie is technically feasible (maintain reliability)

There are sufficient renewable energy resources in northwest Nevada to supply 100% of the electricity requirements to support a 1500 MW tap

Transmission and interconnection costs would add about 20%

Energy market preferences in CA will drive decisions

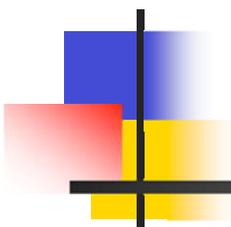
Public/private collaboration in NV is a key requirement



# Renewable Energy Transmission Initiative

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Kick-off Meeting was held on  
September 20, 2007



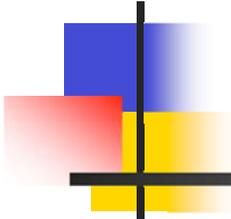
# California Renewable Energy Transmission Initiative (CRETI)

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## CRETI Purpose, Goals

Involve stakeholders to:

-  Identify zones having resources needed to meet state goals, justifying new transmission
-  Develop conceptual transmission plans to access priority zones
-  Work with Transmission Providers to develop Plans of Service able to support applications



## CRETI Structure

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### Coordinating Committee

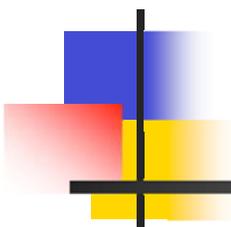
- ☐ CPUC, CEC, CAISO, POU's
- ☐ Ensures inter-agency cooperation, support
- ☐ Ensures RETI produces information needed for policy decisions; keeps process on schedule

### Stakeholder Steering Committee

- ☐ Directs RETI work; forms subgroups as needed
- ☐ Ensures active participation of member organizations
- ☐ Reports progress to Plenary Stakeholder Group

### Plenary Stakeholder Group

- ☐ Forum for all interested parties to provide input to SSC
- ☐ Reviews work of SSC, ensures all views represented



**PIER - Regional Integration of Renewables (RIR)**  
Northern California Sub-Regional Renewable  
Transmission Integration Beyond 2010

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**Staff Workshop**

**TUESDAY, OCTOBER 2, 2007, 2 p.m.**

**CALIFORNIA ENERGY COMMISSION**

**1516 Ninth Street**

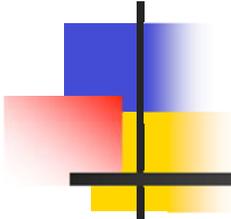
**First Floor, Hearing Room B**

**Purpose**

The purpose of this workshop is to introduce the Regional Integration of Renewables (RIR) project - the core analysis team, the research effort, stakeholder involvement and public benefits.

The focus is on assessing Northern California renewable integration and longer-term, sub-regional transmission planning options.

## PIER - RIR



**Core Analysis Team is comprised of:**

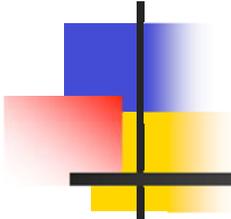
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**PG&E, WAPA, SMUD, Transmission Agency of Northern California (TANC) who have ownership and planning responsibility of transmission assets in California.**

**Additional team members include the CA ISO transmission planning staff, CPUC and the Energy Commission.**

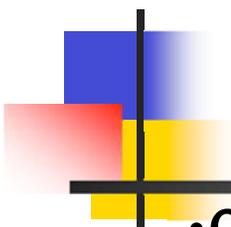
For more info about this project, please contact Dr. Dora Yen-Nakafuji at [dyen@energy.state.ca.us](mailto:dyen@energy.state.ca.us)

## **PIER - RIR**



**This RIR is tailored to build on the recommendations of the Energy Commission's Intermittency Analysis Project (IAP) and statewide renewable strategic resource assessments.**

**These efforts support the state's goal to ensure sustainable transmission capacity to access renewable resources through a comprehensive, coherent and transparent integrated transmission planning process that cross multi-utility service areas. Core Analysis Team members will contribute staff analysis, information and offer perspective.**

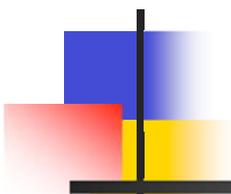


# Final Remarks

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- California must take actions to develop and maintain a cost-effective, reliable transmission system that is capable of responding to important policy challenges such as mitigating global climate change and meeting RPS goals.

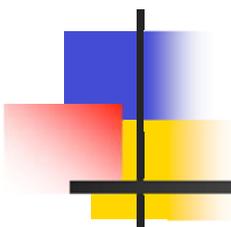
- In addition to serving California's growing population, the achievement of state greenhouse gas policy objectives by the electricity sector will depend on the large degree on the interconnection and operational integration of renewable generation to the transmission grid.



## Final Remarks

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- California utilities must continue to ensure that projects needed to meet traditional reliability and congestion management objectives are also developed.
- Actions are already underway at the state and federal levels to address planning, permitting, financing, and integration barriers to renewable generation interconnection must be assessed to ensure that state policy objectives are met in timely manner.
- Continue to address important transmission-related projects and transmission corridor planning and permitting barriers and resolve other barriers to help achieve the state's renewable generation and environmental policy goals.



# Thank You

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Grazie

Gracias

Merci

Dankë

Danke schön

Dankschen

Salamat po

Khawp khun makh

Danyavad

Tack så mycket

Arigato gozaimasu

Dank u

Dank u wel

Dziakuju

Kamsahamnida

Kiitos

Efcharist

Dzieki

Terima kasih

Labai dekoju