California Energy Commission

2008 Integrated Energy Policy Report Update Staff Workshop

Impacts of Higher Levels of Renewables on the Electricity System Summary of Recent Studies

July 21, 2008, 10 a.m.

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Passcode: IEPR , Call Leader: Suzanne Korosec
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Agenda

Welcome and Opening Comments

Suzanne Korosec, IEPR Lead

Staff Presentation (Pam Doughman, Commission Staff)

1. Estimating 33 percent of statewide retail sales for 2020.
2. Comparison of Resource Mix Scenarios.
3. Impacts of contract delays or cancellations on meeting Renewable Portfolio Standard goals.
4. Range of potential wholesale and retail price impacts and strategies to mitigate negative impacts. Range of assumptions, levelized costs

Panel Discussion and Public Comments on Topics 1-4

Afternoon Presentations (invited speakers and staff)

5. Operational and physical changes needed to integrate renewables while maintaining reliability, including discussion of when those changes would be needed and at what level of renewable penetration, the need for energy storage technologies, and the impacts of using peaker plants. [General modeling studies.]
6. Potential impacts on natural gas demand, supply, and price.
7. Environmental concerns and mitigation for developing large-scale renewable facilities: solar, wind, biomass, geothermal. [Overview]

Panel Discussion and Public Comments on Topics 5-7.

2008 IEPR Update Workshop Schedule for 33 Percent Renewables by 2020

July 21	Impacts of Higher Levels of Renewables on the Electricity System – Summary of Recent Studies
July 23	Transmission issues for 33 percent renewable energy by 2020
July 31	Research and development needs and enabling technologies for integration of high levels of renewable energy into the electricity system
Aug 21	IEPR Committee Workshop: Achieving Higher Levels of Renewables in California's Electricity System

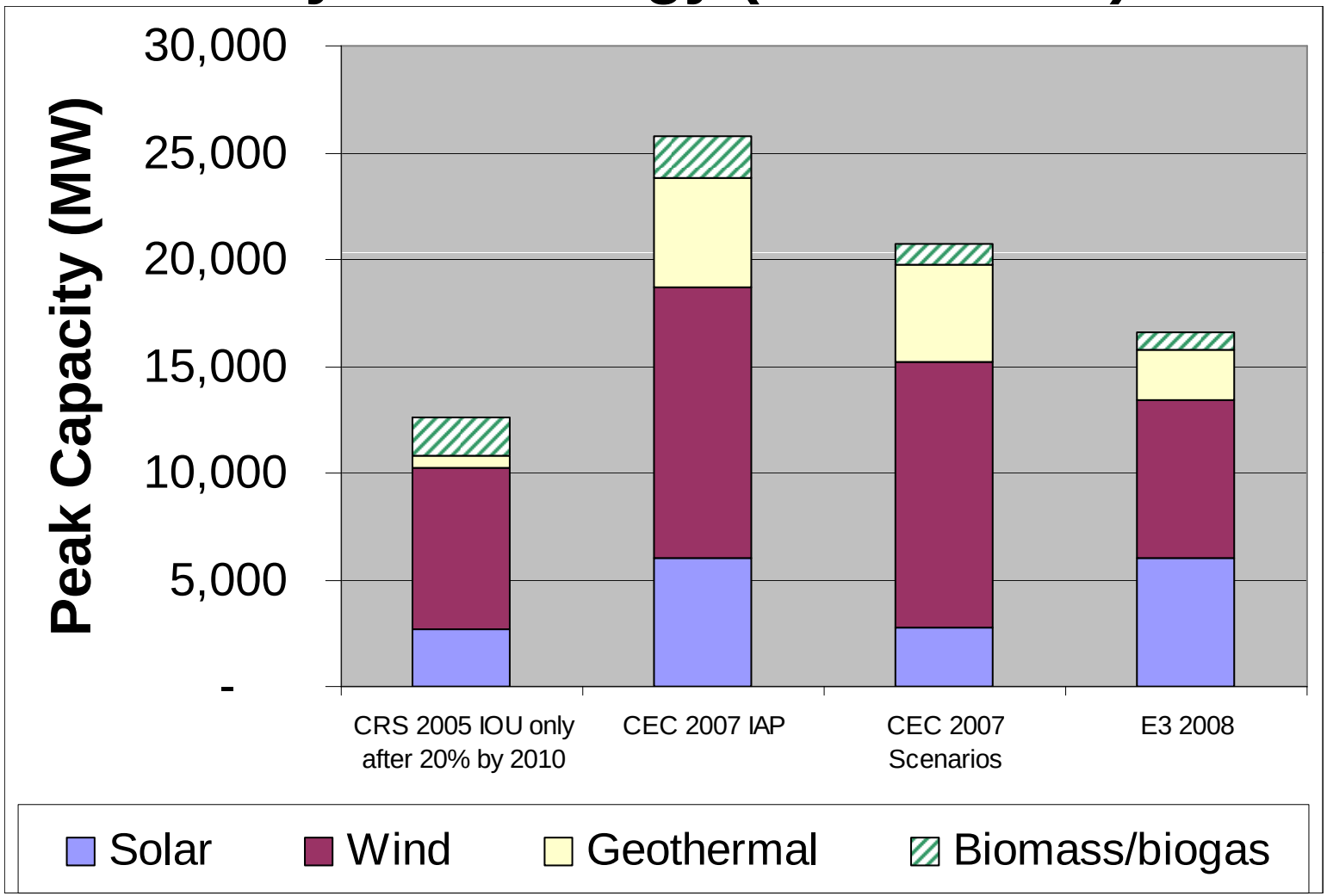
Estimating 33 percent of statewide retail sales for 2020

- “It is the intent of the Legislature in establishing this program, to increase the amount of electricity generated from eligible renewable energy resources per year, so that it equals at least 20 percent of total retail sales of electricity in California per year by December 31, 2010.” California Public Resources Code Section 25740
- "Beyond 2010, the goal of achieving 33 percent of our energy from renewable resources by 2020 is possible, but we must work together to determine the most effective means of attaining this goal. All energy suppliers, including municipal utilities, energy service providers and community choice aggregators should meet the same renewable energy goals required of the investor-owned utilities."
  Governor’s response to the 2003 IEPR and 2004 IEPR Update.

33 Percent Statewide Retail Sales Estimate for 2020 is about 102,000 GWh

- Based on estimate for statewide retail sales in 2020 of 308,070 GWh delivered to end users
- Excludes non-RPS deliveries: CDWR, WAPA, MWD
- Energy efficiency and distributed generation beyond the amount included in the forecast would reduce retail sales and reduce the renewable energy required for 33 percent of retail sales by 2020.
- Estimates of generation to meet this requirement must take transmission line losses into account.
- Source: California Energy Demand 2008 - 2018: Staff Revised Forecast, FINAL Staff Forecast, 2nd Edition, publication # CEC-200-2007-015-SF2. 11/27/07. Form 1.1c. Statewide Sales by LSE. Forecast extended to 2020 by Energy Commission staff.

Comparison of Resource Mix Scenarios by Technology (MW in 2020)



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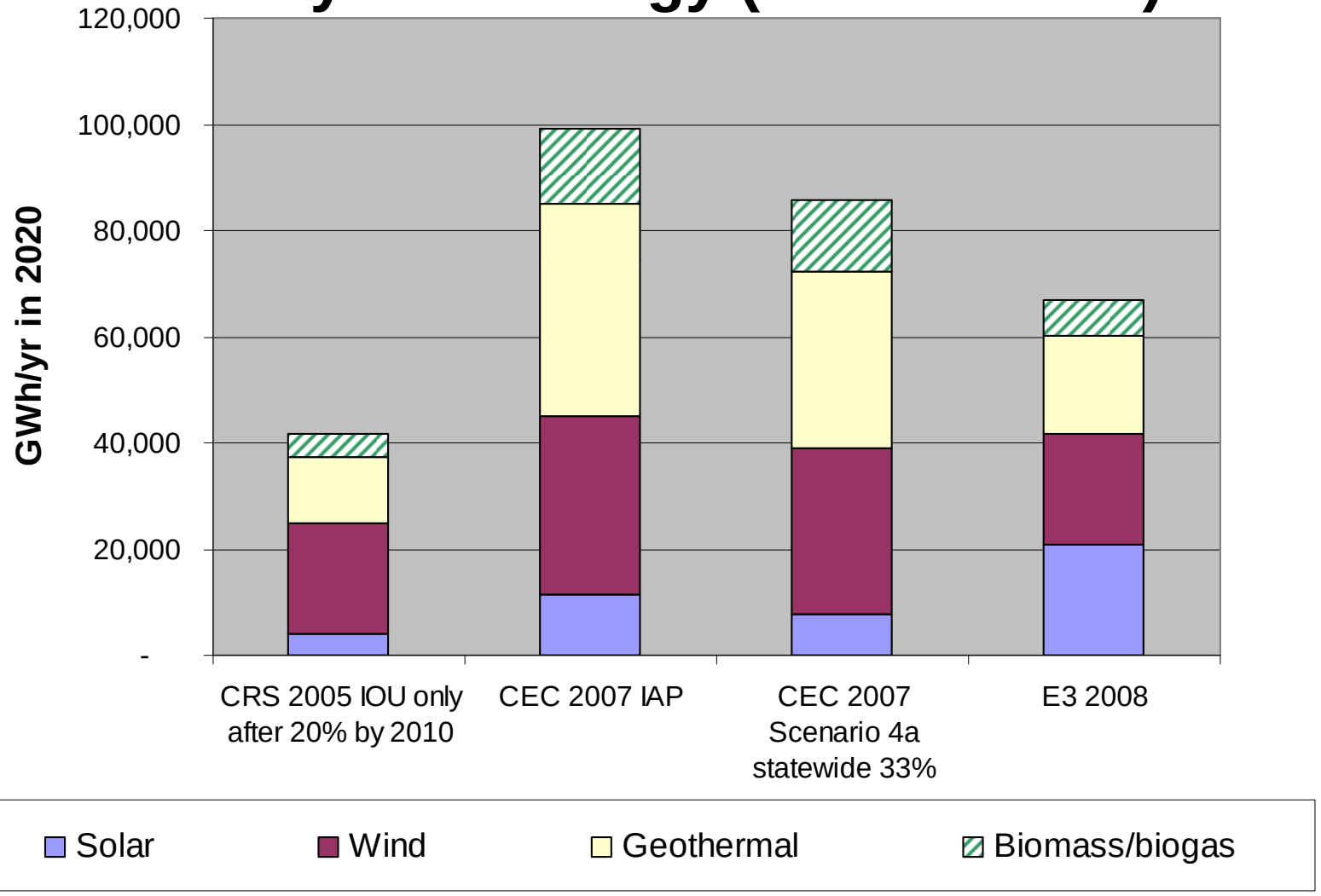
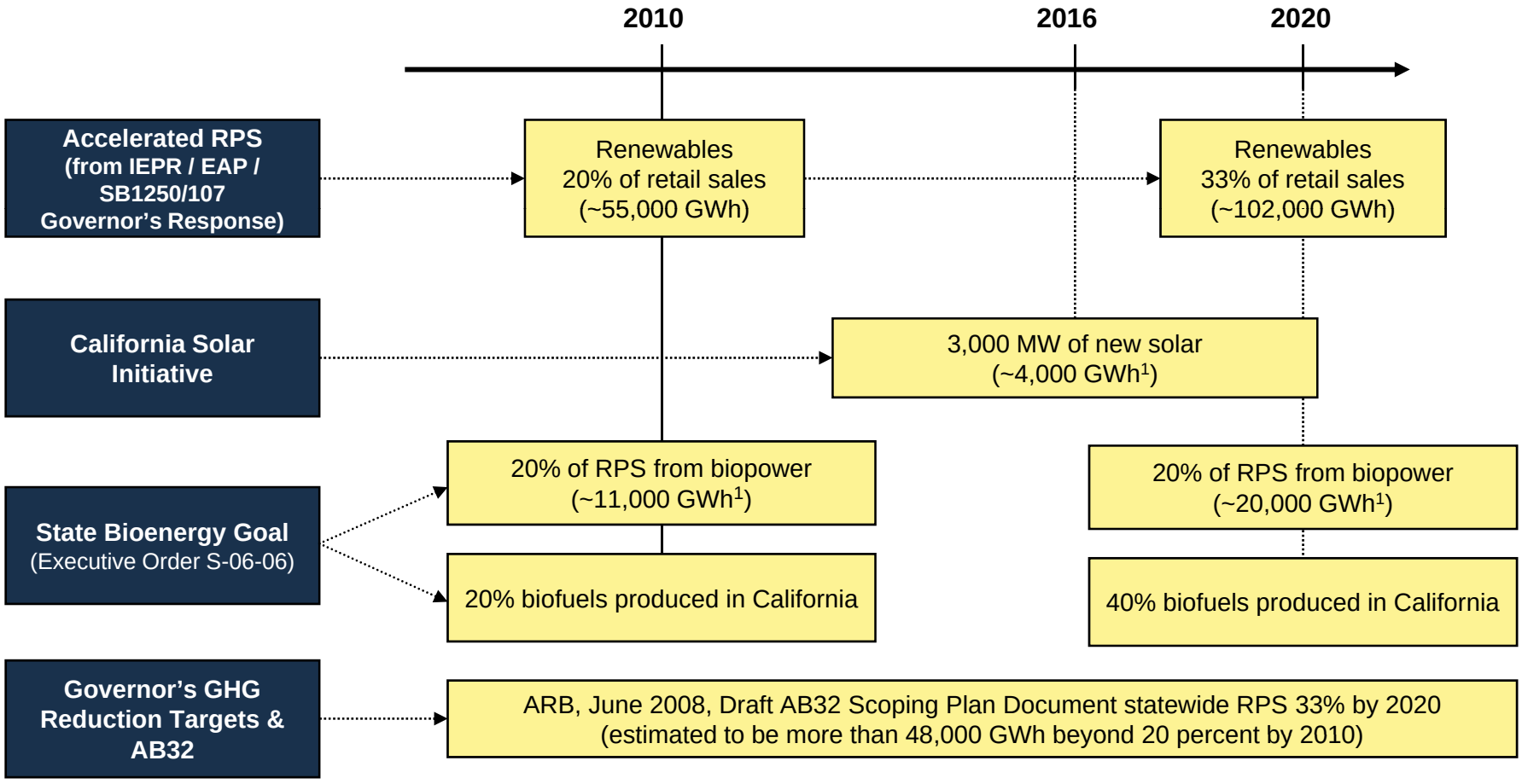


Additional Scenarios Needed for Biopower Goal (20 percent of RPS)



[1] Assumes average capacity factors are 15% for solar and 90% for biopower.

Additional Scenarios Needed to Model Uncertainties

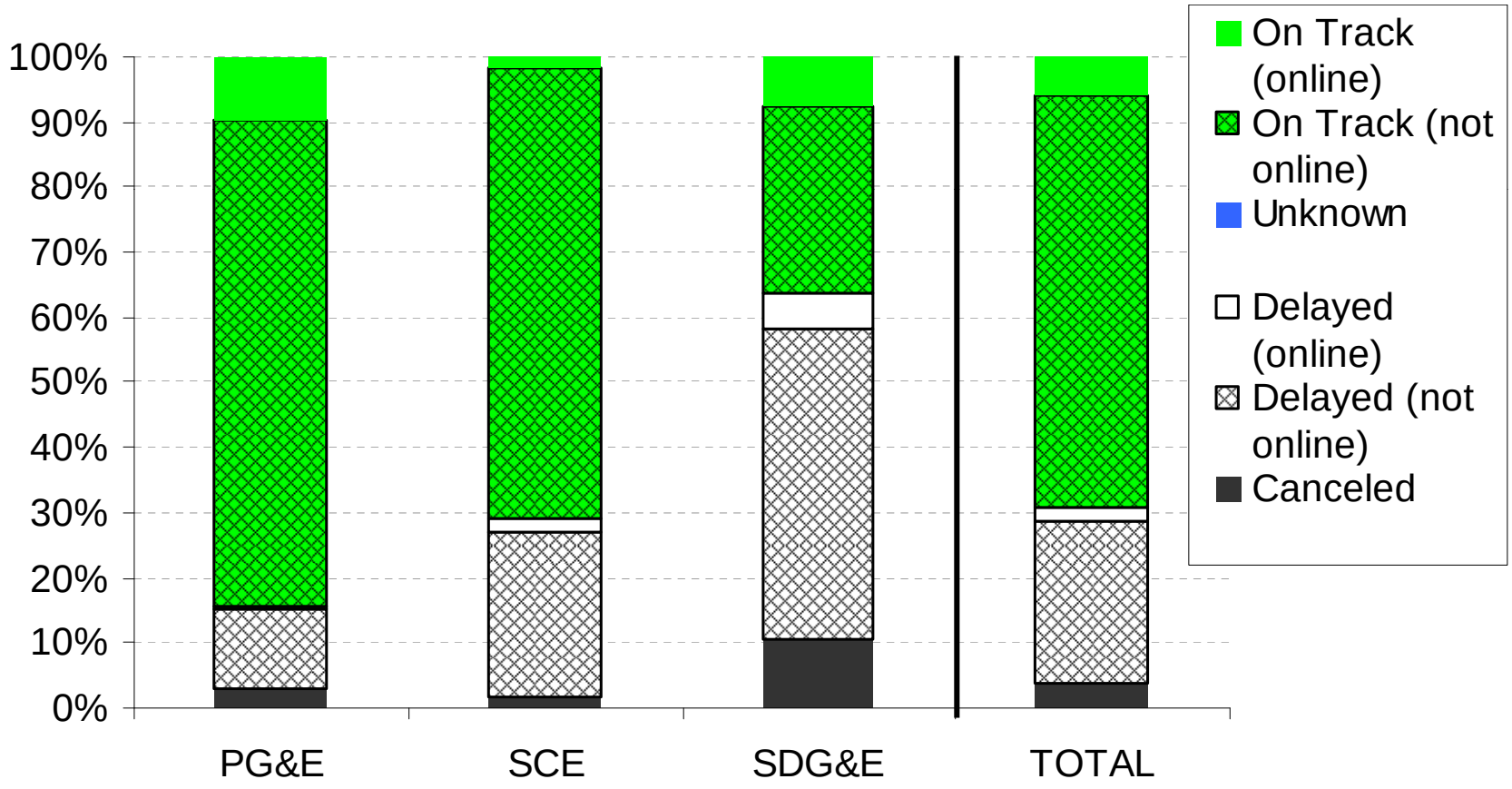
- There is a degree of uncertainty regarding how the electricity and supporting infrastructure may develop over time, which will affect the implications of alternative development strategies for achieving 33 percent renewables by 2020. For example, once-through cooling concerns and greenhouse gas emission policies may require a number of existing generation facilities to be replaced. The fuel and development costs for these different generation technologies may also vary over time to alter scenario economics. Given the range of uncertainty for these relevant factors, a rigorous study of the electricity system will require an examination of different renewable and conventional generation mixes to ensure system stability at the least cost possible.

Comparison of POUs' and IOUs' Renewable Energy Contracts and Projects

- "Since the beginning of 2003, publicly owned utilities have contracted for approximately 1,600 megawatts of renewable electricity capacity, 1,300 megawatts of which are from new resources that began, or are expected to begin, operation after passage of the state's RPS law in 2002. The 1,300 megawatts include approximately 900 megawatts of wind, 200 megawatts of geothermal, and 200 megawatts of biomass (including 100 megawatts of municipal solid waste to be developed by LADWP)."
- "As of July 2007, more than 550 megawatts of the contracted new capacity was on line and delivering energy to the California publicly owned utilities, while only 324 megawatts of new, repowered, or re-started RPS capacity contracted by the investor-owned utilities were on line as of early August."
- "New publicly owned utility wind projects make up almost all of this capacity, with the two largest projects located outside California."

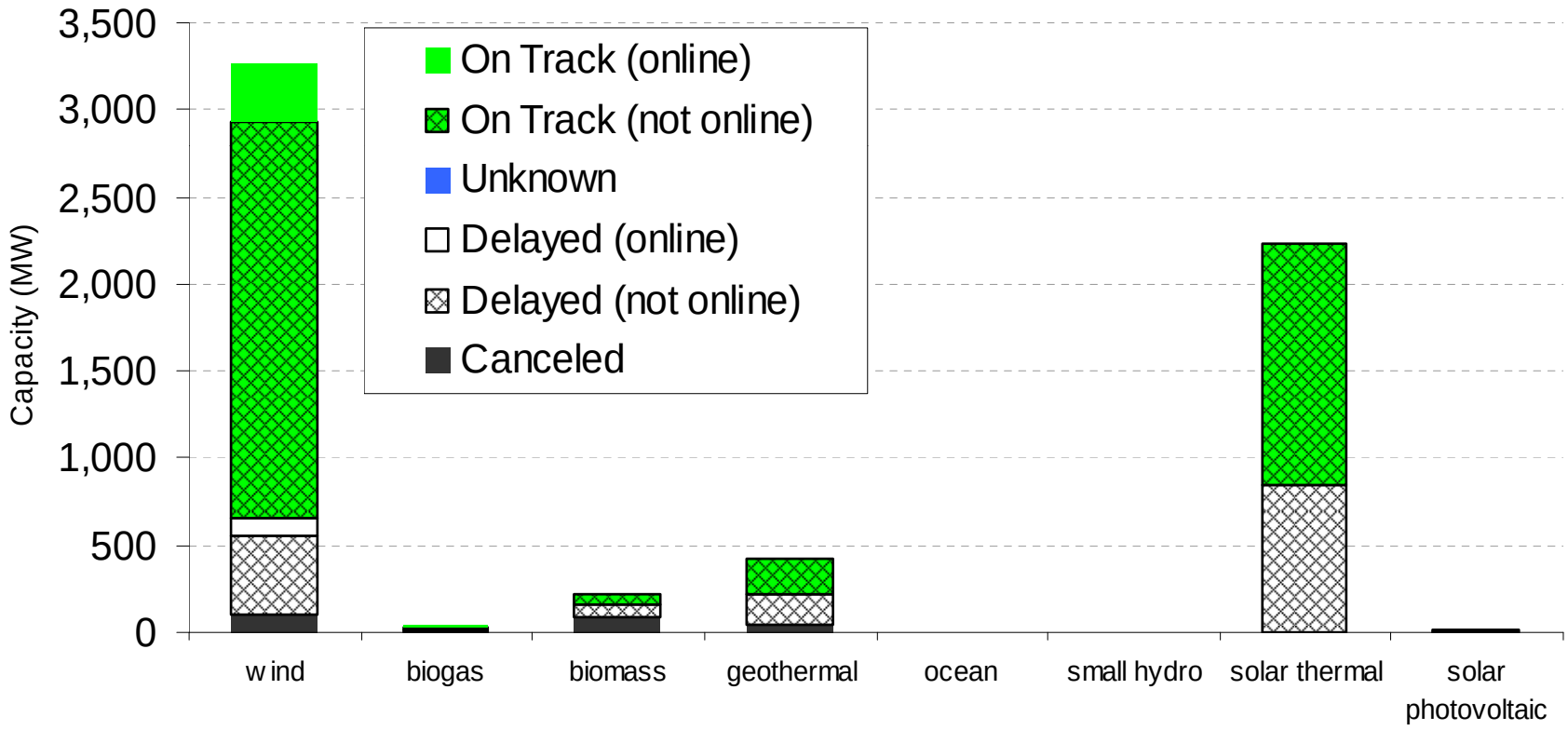
Source: California Energy Commission, 2007 Integrated Energy Policy Report, p. 135.

Contract Status for New, Repowered, and Re-Started Capacity from IOU Contracts Signed Since 2002 (by minimum MW)



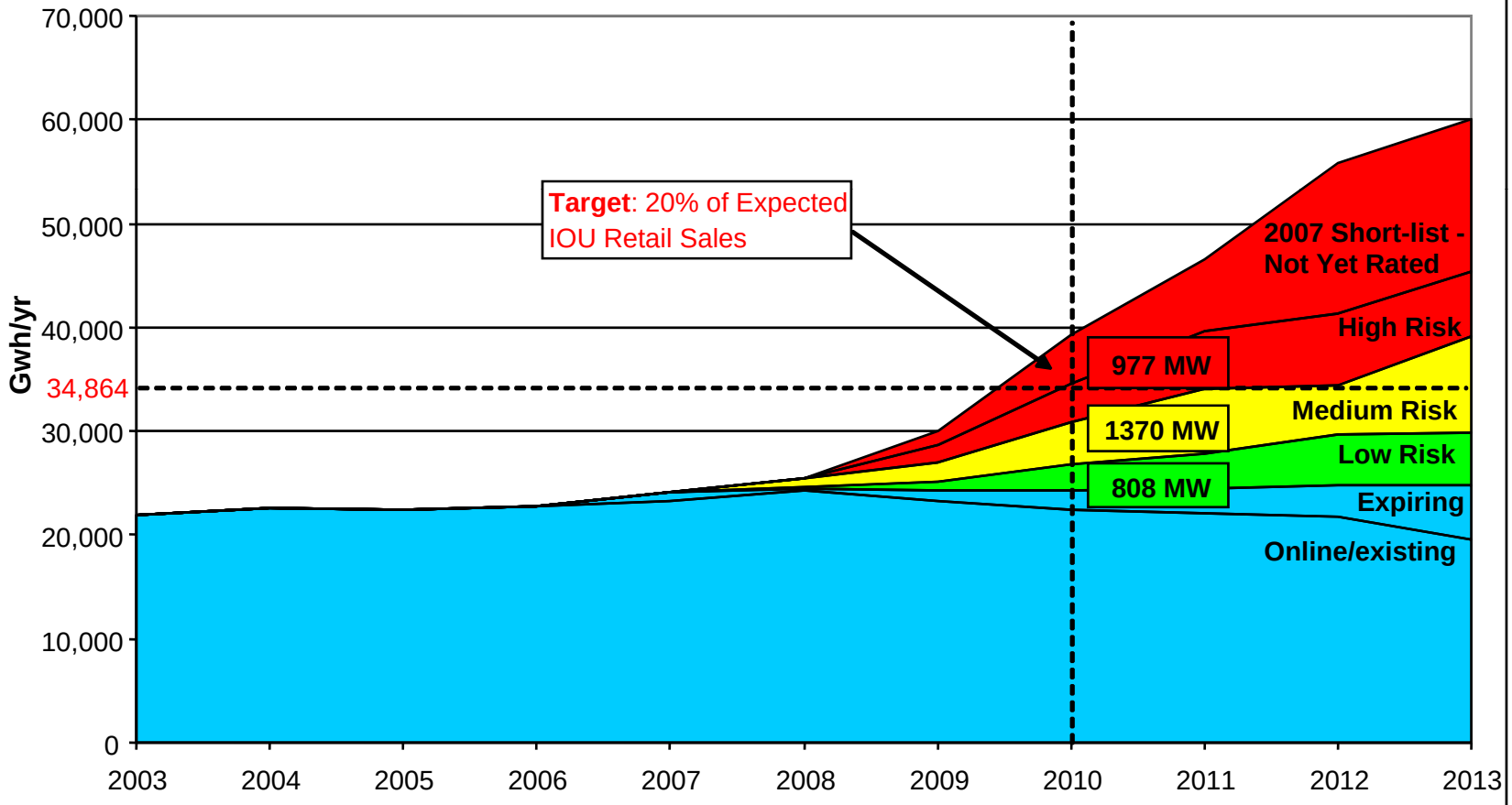
Source: California Energy Commission, Database of IOU Contracts for Renewable Generation, July 2008 update, www.energy.ca.gov/portfolio/IOU_CONTRACT_DATABASE.XLS.

Contract Status for New, Repowered, and Re-Started Capacity from Contracts Signed Since 2002 (by minimum MW, technology)



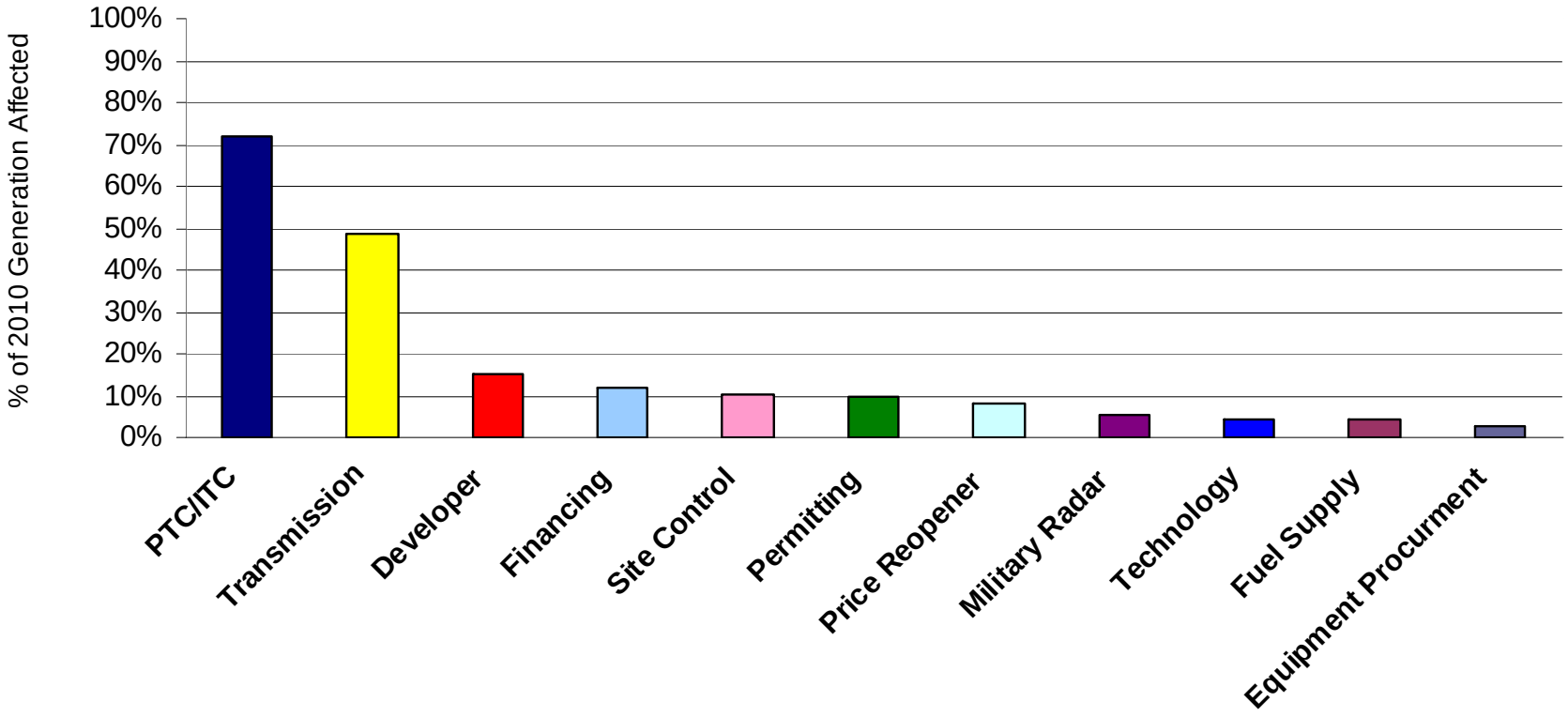
Source: California Energy Commission, Database of IOU Contracts for Renewable Generation, July 2008 update, www.energy.ca.gov/portfolio/IOU_CONTRACT_DATABASE.XLS.

IOU Expected RPS Generation and Risk



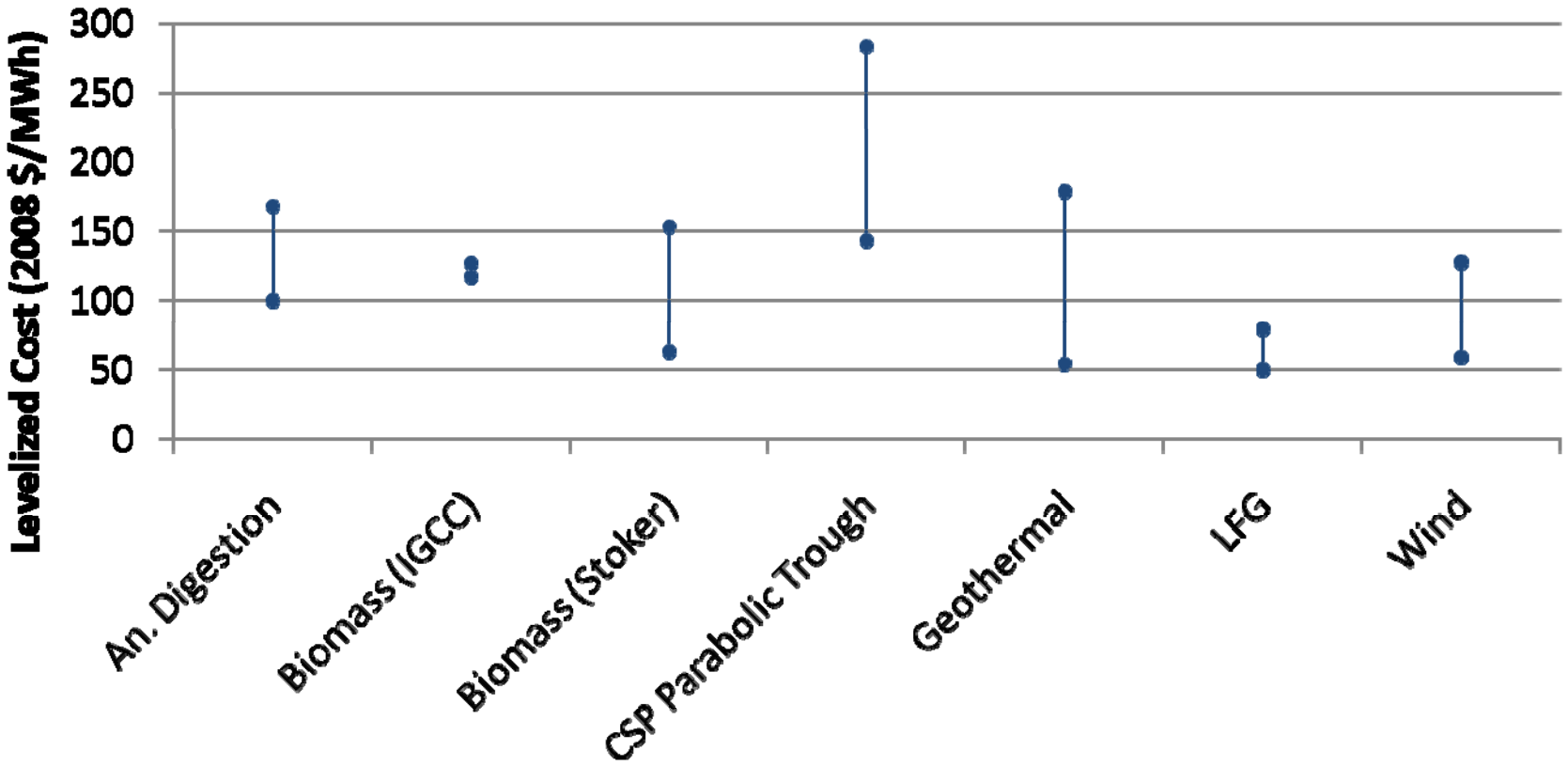
Source: CPUC, April 2008, Renewables Portfolio Standard Quarterly Report

Risk Factors for 2010 RPS Generation



Source: CPUC, April 2008, Renewables Portfolio Standard Quarterly Report

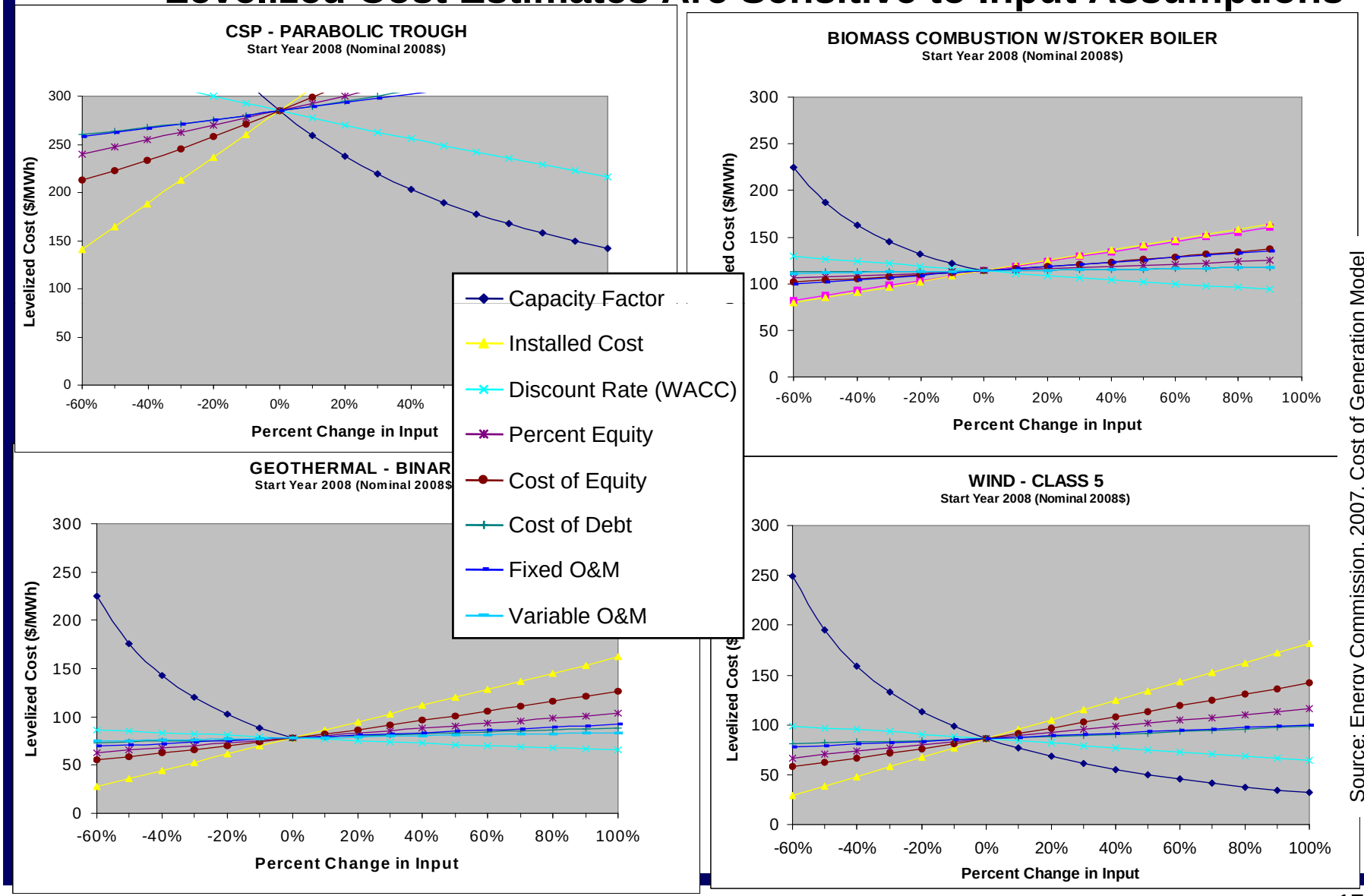
Levelized Costs in Studies on 33 Percent Renewable by 2020 Target



Data Sources: [1] California Energy Commission, 2005, *Strategic Value Analysis* [cost data reports]; [2] California Energy Commission, Dec 2007, *Comparative Costs of California Central Station Electricity Generation Technologies*, Final Staff Report; [3] California Energy Commission, 2008 (forthcoming), *Scenario Analyses of California's Electricity System: Final Results for the 2007 Integrated Energy Policy Report*, Final Staff Report; [4] CPUC, Nov 2005, *Achieving a 33% Renewable Energy Target,* by CRS for the CPUC; [5] E3, 2008 (forthcoming), *CPUC GHG Modeling*; [6] RETI Coordinating Committee, March 2008, *Renewable Energy Transmission Initiative Phase 1A Draft Report*; [7] US Department of Energy, EERE, May 2008, *20% Wind Energy by 2030 Increasing Wind Energy's Contribution to U.S. Electricity Supply*.

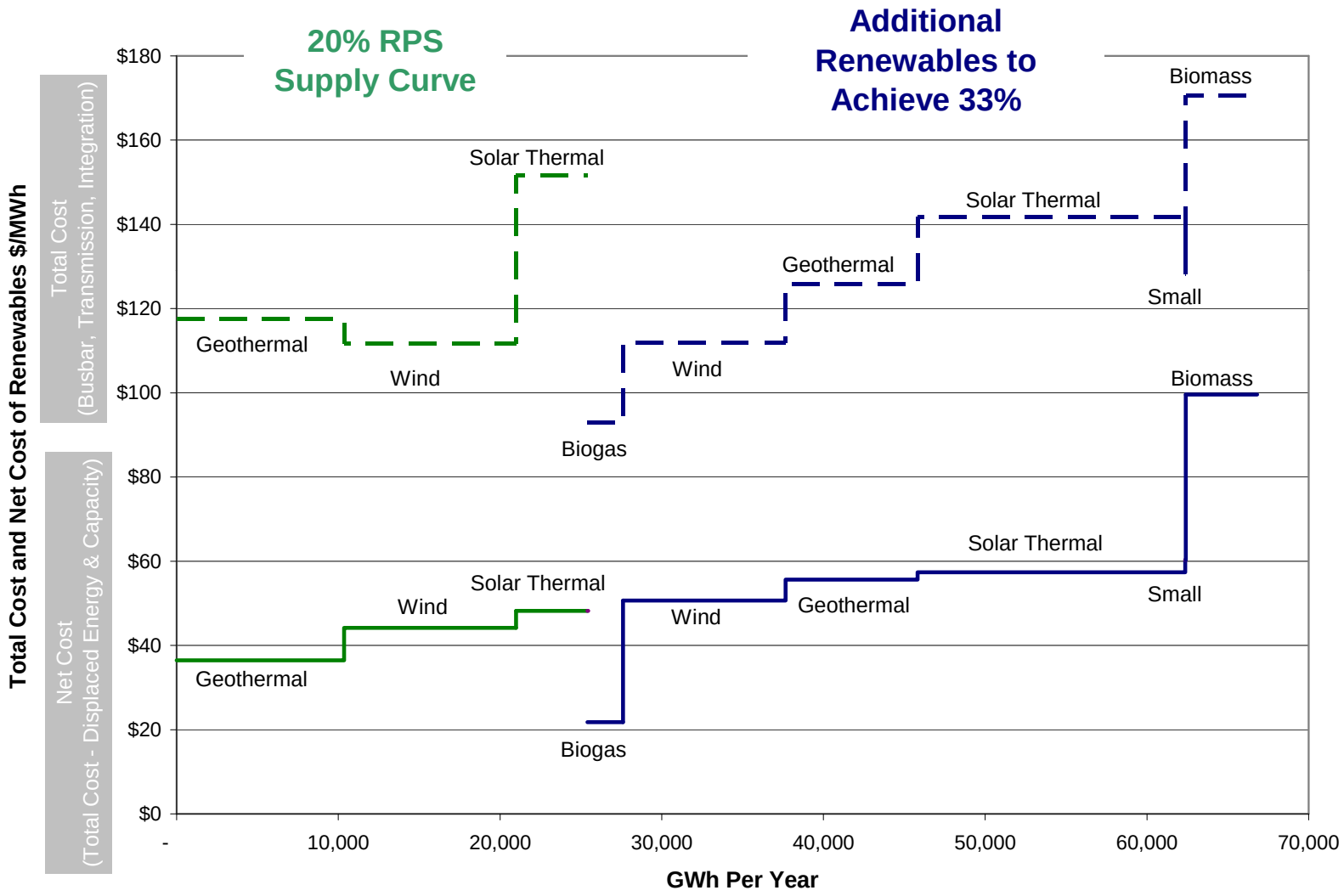
Note: Anaerobic Digestion data from [2] and [6]; Biogas data from [2] and [5]; Biomass data from [2], [3], [5], and [6]; Concentrating Solar Power and Geothermal data from [1], [2], [3], [4], [5], [6]; Landfill Gas data from [1], [2], [4], [5], [6]; and Wind data from [1], [2], [3], [4], [5], [6], and [7].

Levelized Cost Estimates Are Sensitive to Input Assumptions



Source: Energy Commission, 2007, Cost of Generation Model

E3 Supply Curves of 20% & 33% RPS



Potential Retail Price Impacts: CRS/CPUC (2005)

Table 1 - Net Present Value of RPS Costs for California Ratepayers – Sensitivity Analysis (Negative number indicates rate reduction)

	10 year (2011-2020) NPV $million (2011$, 9% discount rate)	2011-2020 Average Rate Impact	20 year (2011-2030) NPV $million (2011$, 9% discount rate)
33 percent RE Base Case	$1,264	0.57%	-$175
Gas Price 125% of *33 percent base case*	-$672	-0.42%	-$4,512
Gas Price 75% of *33 percent base case*	$3,200	1.77%	$4,162
High Renewables Costs	$3,517	1.75%	$4,188
Low Renewables Costs	-$230	-0.20%	-$3,068
PTC/ITC Continue	-$445	-0.26%	-$2,875

Source: California Public Utilities Commission, Nov 2005, Achieving a 33% Renewable Energy Target, prepared by Center for Resource Solutions (CRS) for the CPUC.
http://www.resource-solutions.org/lib/librarypdfs/Achieving_33_Percent_RPS_Report.pdf

Potential Retail Price Impacts: E3 (2008)

Total Investment Costs - Millions of Dollars ($2008)

	Existing to 20% RPS	Existing to 33% RPS
Renewable Generation Cost $M	$ 21,126	$ 54,517
Transmission Cost $M	$ 3,550	$ 6,372
Total Investment Costs $M	$ 24,676	$ 60,889

Annual Cost of Investments in $2020 - Millions of Dollars per year ($2008)

	Existing to 20% RPS	Existing to 33% RPS
Annual Cost in 2020 $M/year	$ 3,379	$ 8,839
Annual Benefits in 2020 $M/year	$ 2,613	$ 6,319
Net Cost in 2020 $M/year	$ 766	$ 2,520

Impact in 2020 of a 33% RPS		
	Impact	Percent Change
Increased Costs per Year ($M)	$2,520	5%
Increased Rates on Average ($/kWh)	$0.008	5%

Change in Rates and Costs between 2008 and 2020 (in real terms)		
	20% RPS	33% RPS
Change in Costs	31%	35%
Change in Rates	13%	17%

Panel Discussion and Public Comments on Topics 1-4

- Summary of Scenario Analysis for the Electricity Sector (Topics 1-4)
- Panelists
  - Mike Jaske, Energy Commission
  - Jan Hamrin, CRS
  - Dora Yen Nakafuji, LLNL
  - David Hawkins, CA ISO
  - Snuller Price, E3
  - Jaclyn Marks, CPUC

Operational and Physical Changes Needed to Integrate 33 Percent Renewables

- Jan Hamrin, CRS
  - So What's New? An Update on Achieving a 33 Percent Renewable Energy Target
- Mike Jaske, Energy Commission Staff
  - Resource Adequacy
- Dora Yen Nakafuji, LLNL
  - Intermittency Analysis Project
- David Hawkins, CA ISO
  - CA ISO Integration of Renewable Resources Program

Note: Studies on specific transmission needs will be discussed on July 23.

Suppressing Natural Gas Prices

An Ancillary Benefit of Renewable Generation

Mark Bolinger and Ryan Wiser

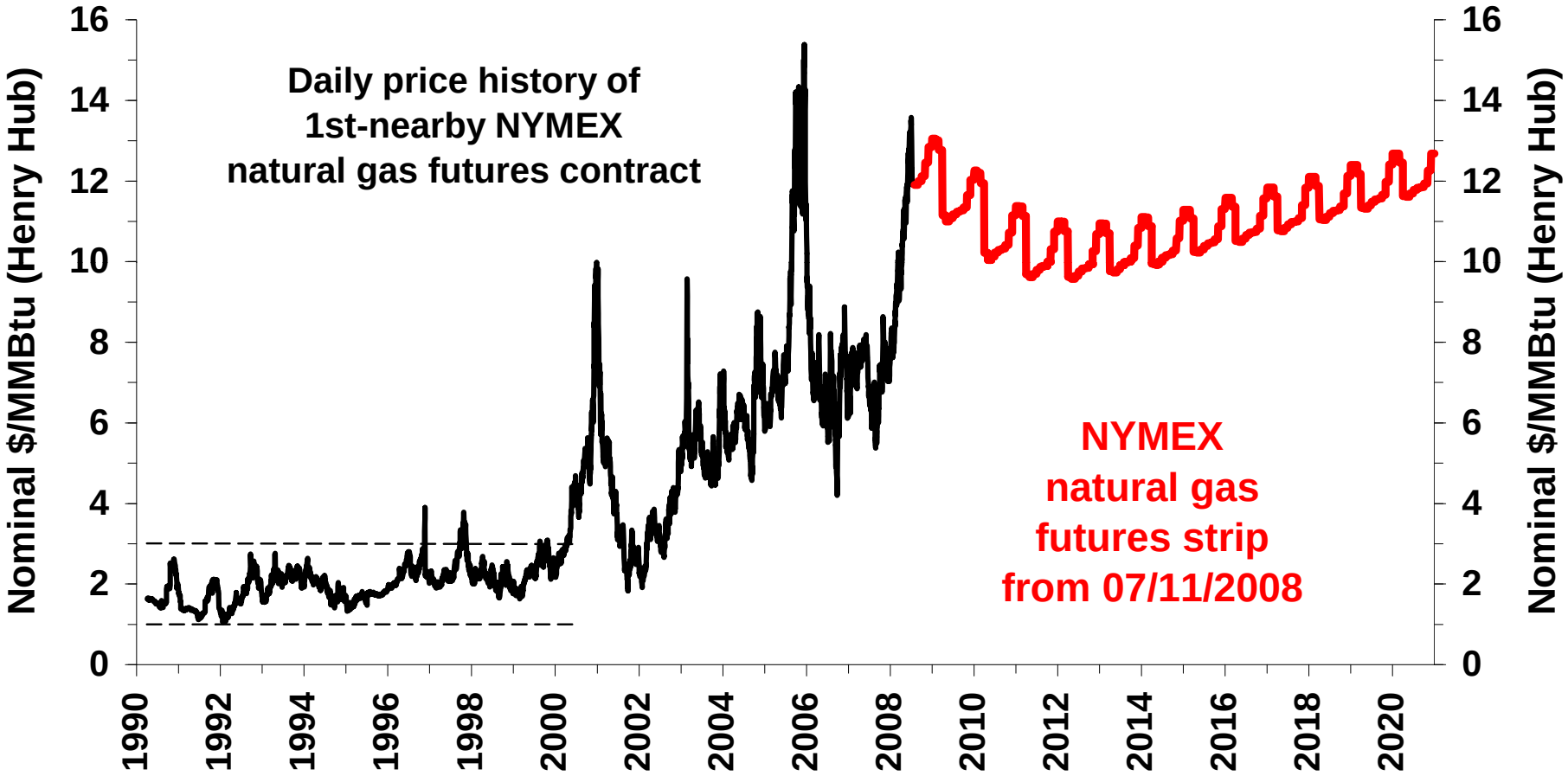
Lawrence Berkeley National Laboratory

(Consultants to KEMA for Energy Commission Renewable Energy Support)

California Energy Commission

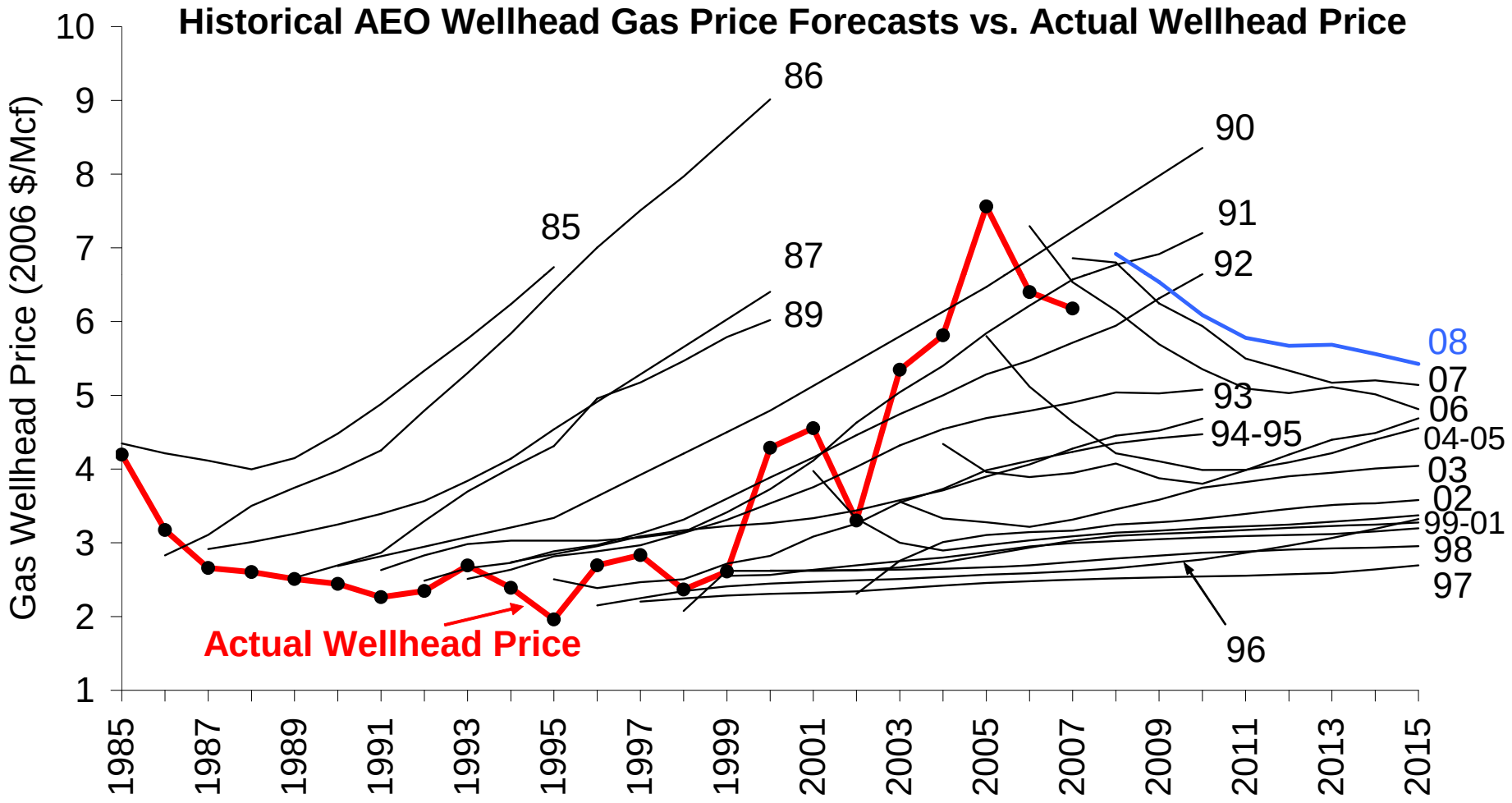
July 21, 2008

Natural Gas Prices Are High and Volatile



Source: LBNL

Natural Gas Price Forecast Accuracy Has Been Wanting



Initial (Obvious) Implications

- Natural gas price forecasts should be current and reflect up-to-date gas price expectations
- History shows us that “base case” gas price forecasts have a good chance of being wrong by a factor of two
- Little emphasis should be placed on the “base case”
  - a sizable range of future natural gas prices should be used in any economic analysis of alternative resource options
- The value of hedging natural-gas risk exposure and of reducing natural gas prices should be evaluated

Renewables Can Help in Both of These Latter Respects

Renewables provide a hedge against volatile and escalating natural gas prices in two ways:

#1: RE Reduces Exposure to Gas Price Risk:

Incremental renewable generation (often fixed-price) displaces gas-fired generation (often variable-price)

#2: RE Reduces Natural Gas Prices:

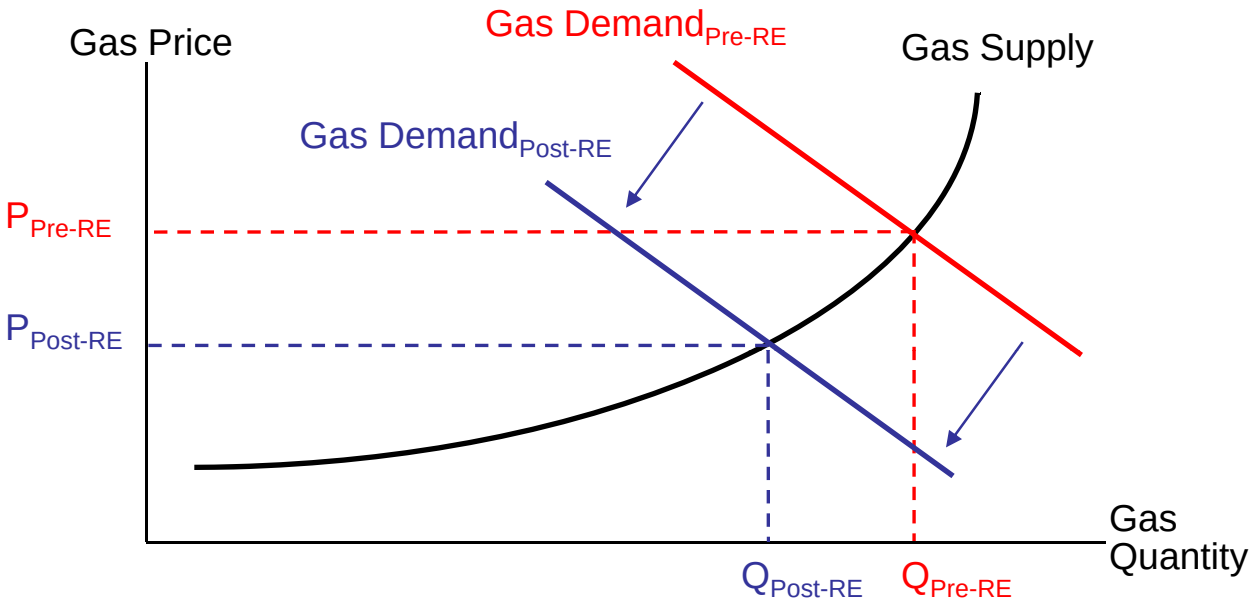
By displacing gas-fired generation, incremental RE reduces demand for natural gas, and consequently puts downward pressure on gas prices

This presentation only covers hedge benefit #2

(note: this benefit is not unique to RE, but comes from any generation source or demand savings that reduces natural gas demand)

Hedge Benefit #2: Renewables Reduce Gas Prices

Theory: Increased RE penetration displaces gas-fired generation, reducing demand for natural gas and placing downward pressure on natural gas prices



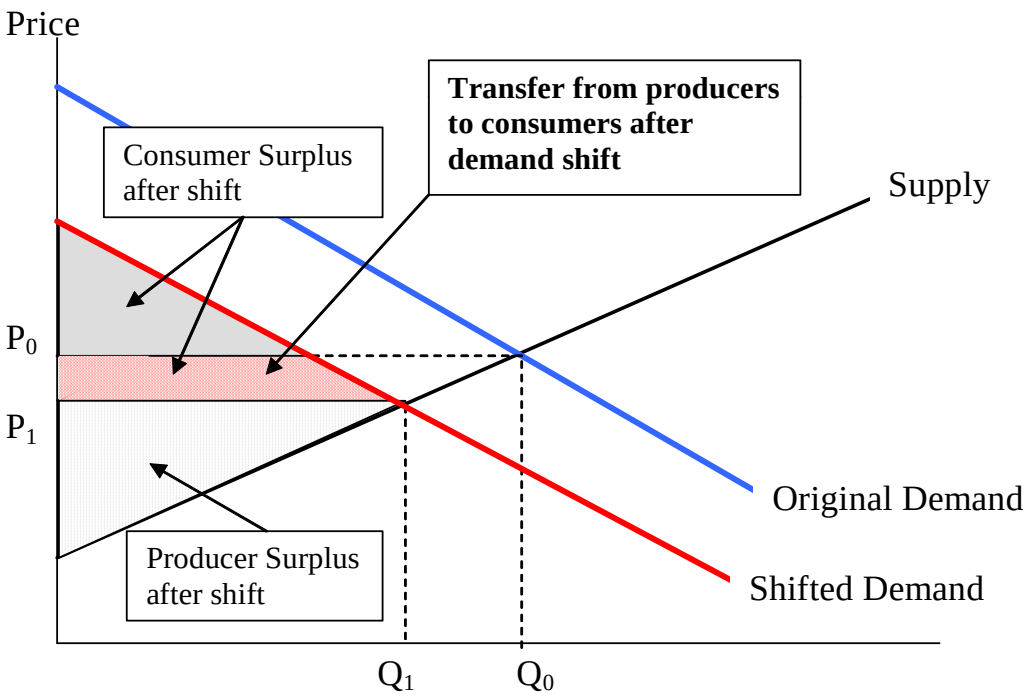
- Price reduction flows through to ***all*** consumers in the form of lower natural gas and electricity bills
- Magnitude of price reduction depends on shape of gas supply curve: impact expected to be larger in the short-term than in the long-term due to short-term supply constraints and longer-term price/supply adjustments
- Price reduction may be greater, in near-term, in regions with natural gas transportation constraints

What Does this Price Reduction Represent?

Price reduction ***may not strictly lead to a net gain in social welfare***: lower prices may benefit gas consumers at the expense of producers

However…

- ✓ Energy programs are frequently evaluated based on consumer bill impacts
- ✓ Economy-wide macroeconomic costs from gas-price increases may be significant
- ✓ California consumes gas, but produces little gas, so there may be a net gain to California



Review of Recent Modeling Studies

Many modeling studies have, at least indirectly, evaluated the impact of increased RE and EE deployment on natural gas prices.

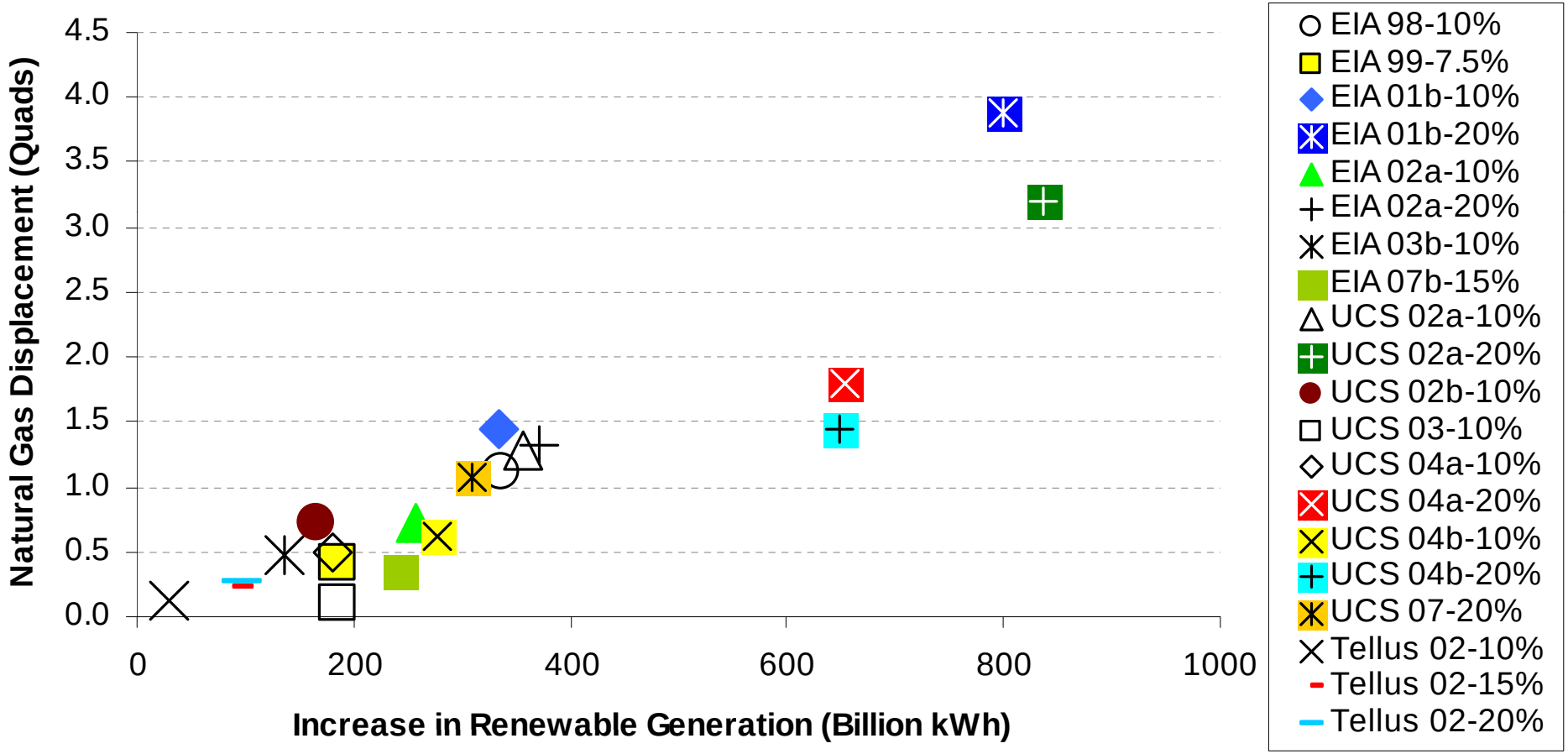
We have analyzed results from 13 of these studies:

- 6 EIA studies of the impact of a national RPS, two of which model multiple RPS scenarios
- 6 UCS studies of the impact of a national RPS (3 model multiple RPS scenarios, 1 includes aggressive EE as well)
- 1 Tellus study of the impact of New England RPS (focus on RI)

All 13 studies of these studies use the EIA's National Energy Modeling System (NEMS), and we focus on national (not regional) impacts

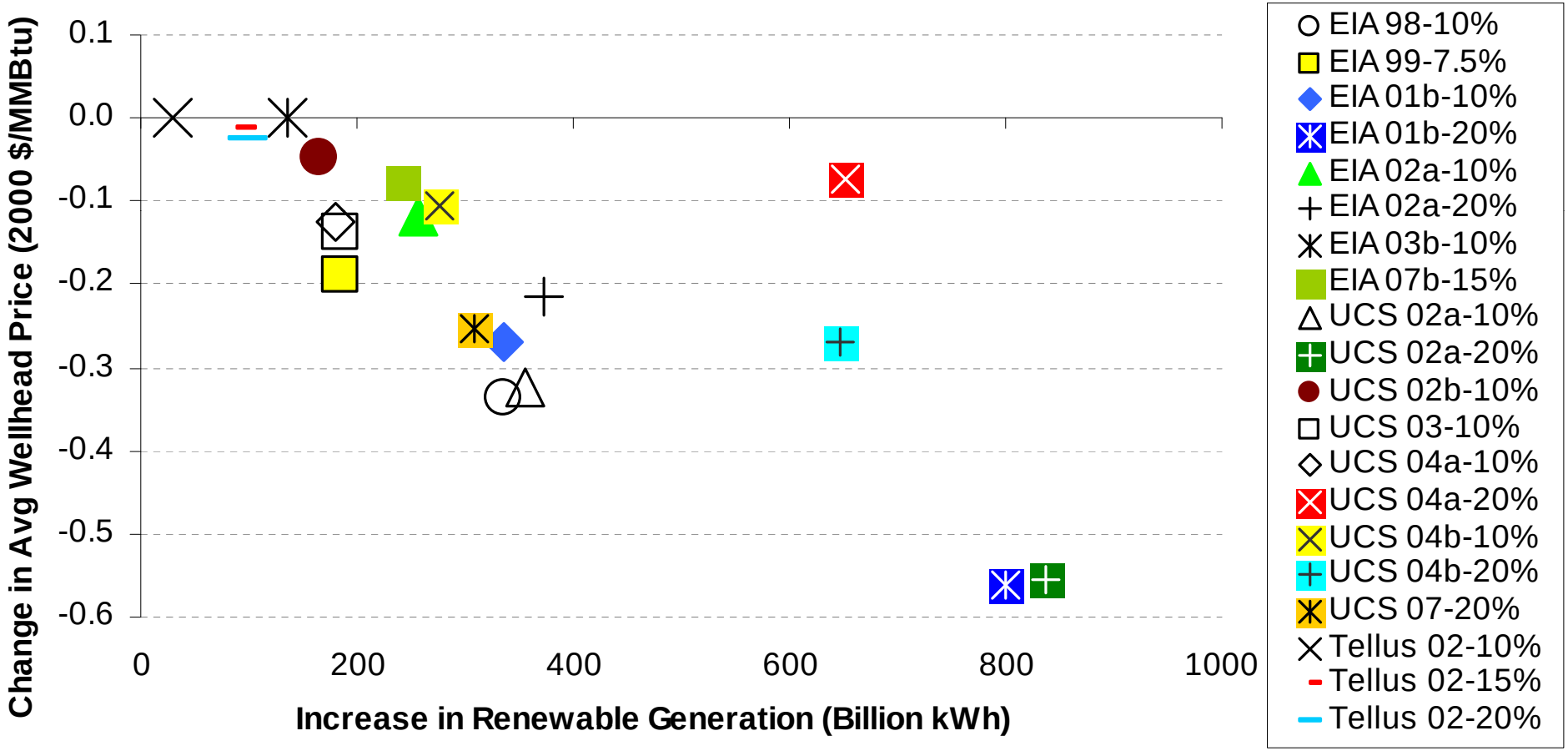
Increased Renewables Penetration Displaces Natural Gas Demand

Projected Gas Displacement in 2020 Under RPS Studies



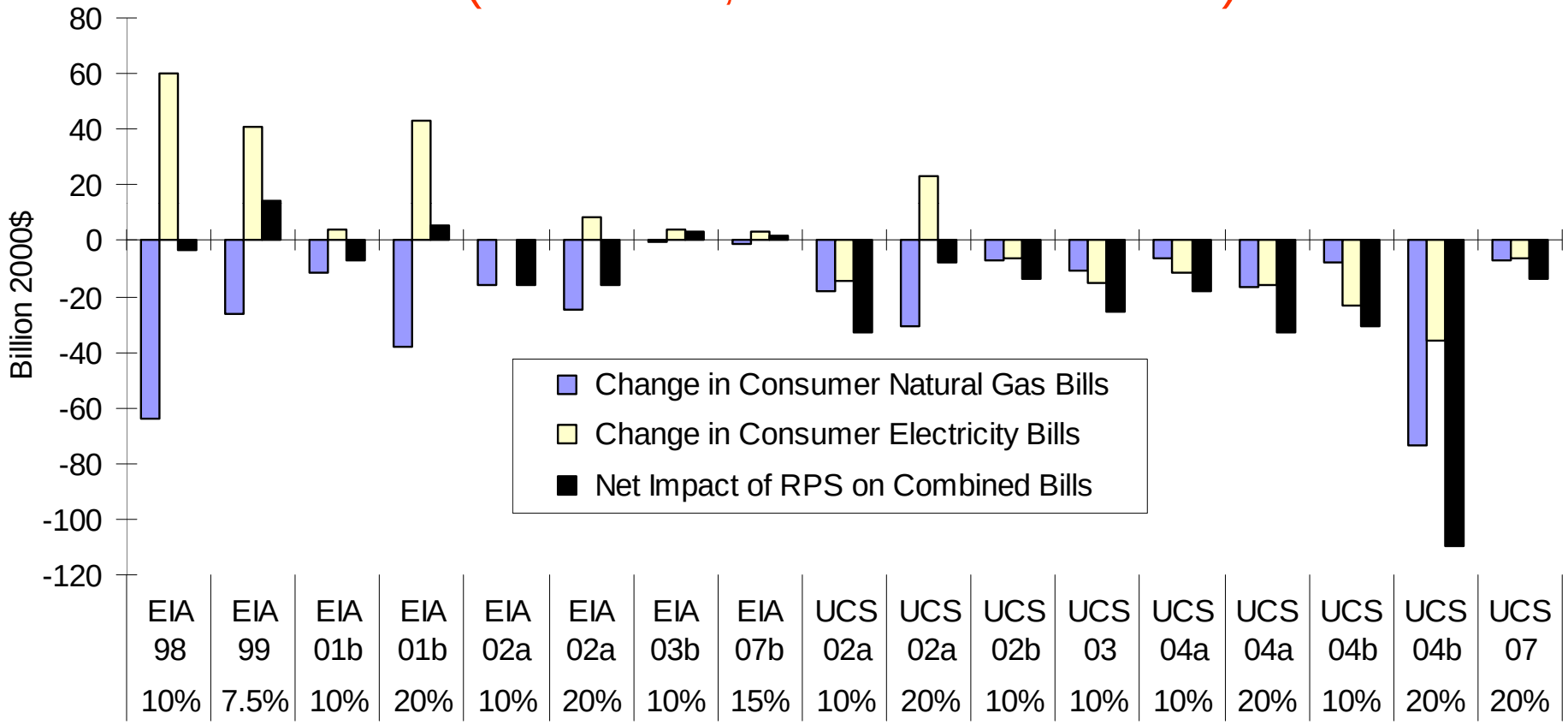
Increased Renewables Penetration Reduces Natural Gas Wellhead Prices

Projected Gas Price Change in 2020 Under RPS Studies



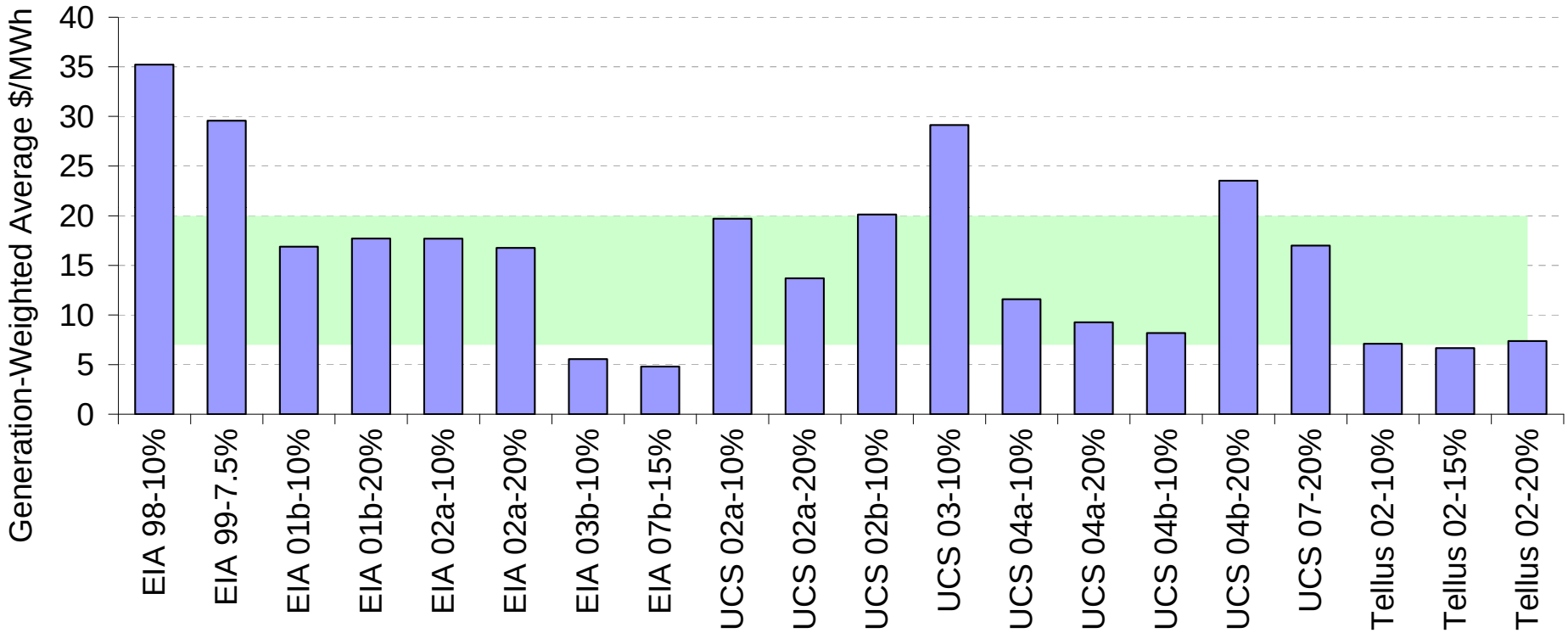
National Gas Bill Reductions Substantially Offset Any Increase in Electricity Bills

NPV of RPS Impacts on Natural Gas and Electricity Bills
(2003-2020, 7% real discount rate)



Expressed as $/MWh of Incremental RE, National Gas Bill Savings are Substantial

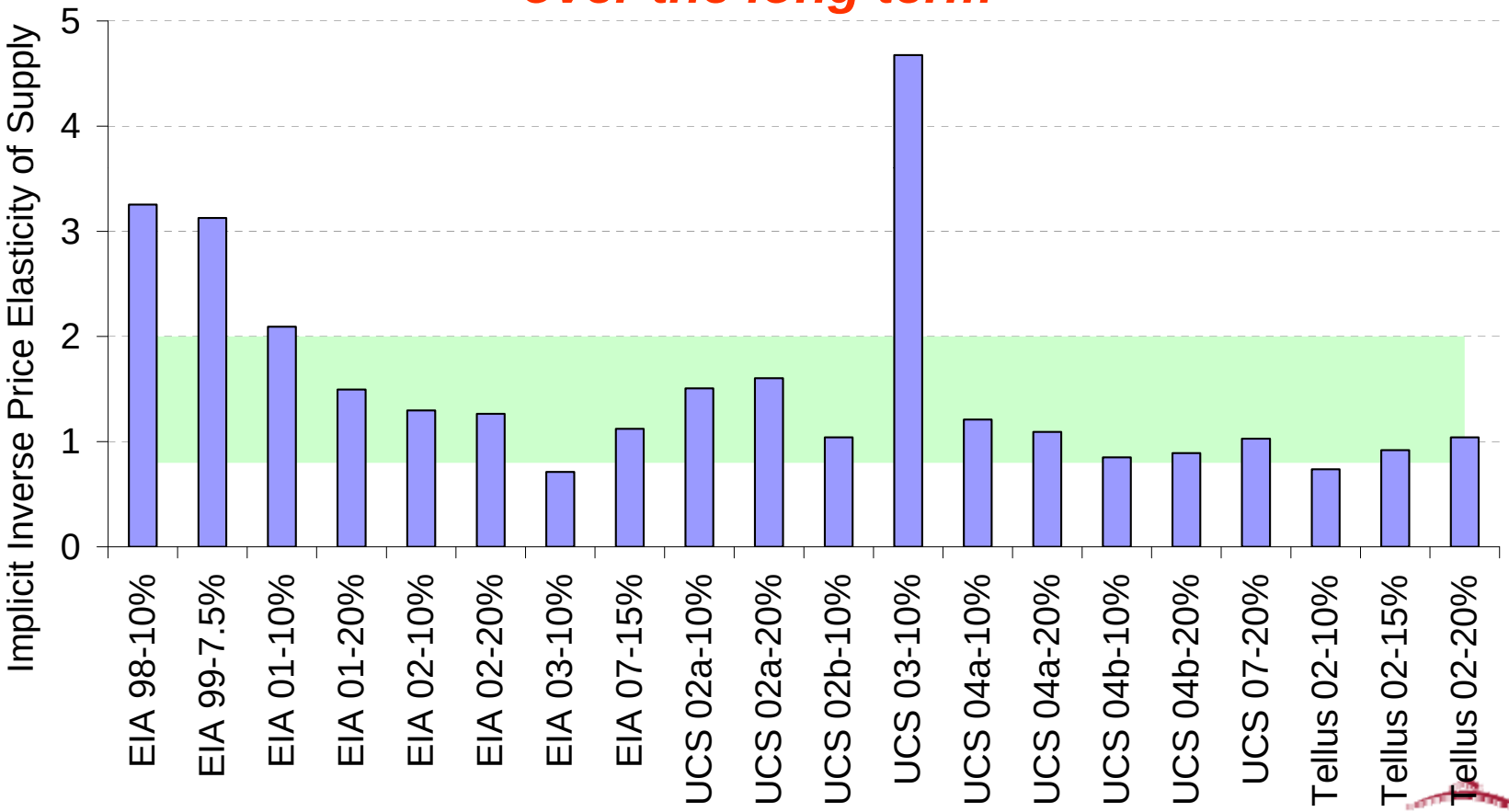
Range of $7-$20/MWh captures most studies (some larger)



Implied "Inverse Elasticity of Supply"

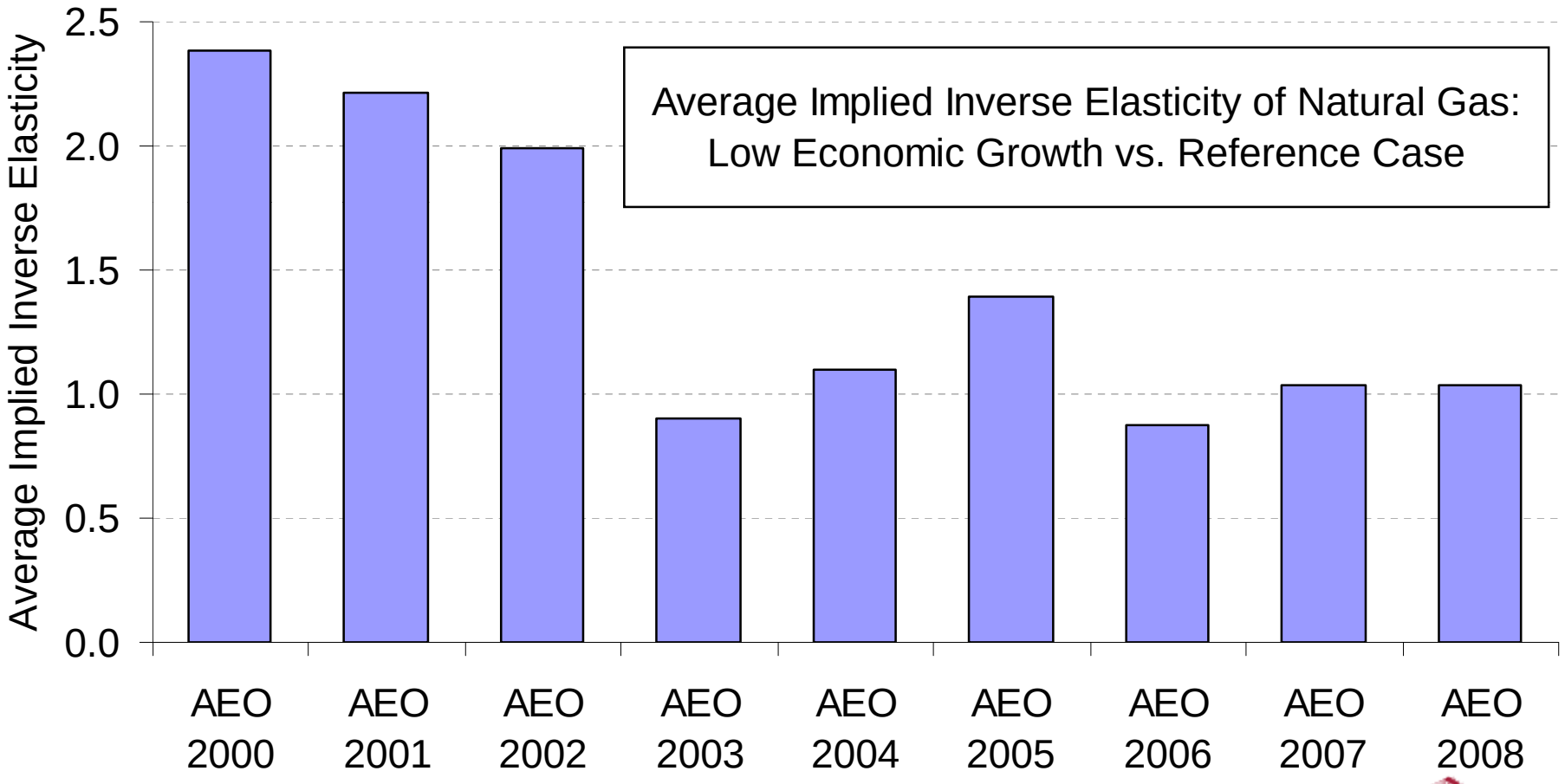
(Defined as %ΔP/%ΔQ, measures shape of long-term supply curve)

Central tendency of 0.8-2.0 suggests that *a 1% drop in nationwide gas demand causes a 0.8%-2.0% drop in average wellhead prices over the long term*



Other Measures of Inverse Elasticity

The ability to measure this nationwide natural-gas price suppression effect is not limited to RPS studies



NEMS Consistent With, or Even Conservative Relative To, Other Models

Stanford's Energy Modeling Forum:

Most models used in EMF 20 (2003) exhibit national U.S. inverse elasticities that are consistent with those in NEMS

EMF 20 Model	2010 Inv. Elast.	2020 Inv. Elast.
POEMS	1.8	1.8
CRA	2.5	0.9
NANGAS	1.0	5.1
E2020	1.0	0.7
MARKAL	2.0	2.1
NARG	12.4	2.4

More recently, the 4 models (besides NEMS) used in EMF 23 (2007) exhibit inverse elasticities that are consistent with those in NEMS*

EMF 23 Model	2020 Inv. Elast.
RITE	1.1
NEMS	0.9
INGM	1.6
NANGAS	1.5
CRA	1.3

*Note: EMF 23 measured price changes in the U.S. in response to higher GLOBAL (rather than just U.S.) demand

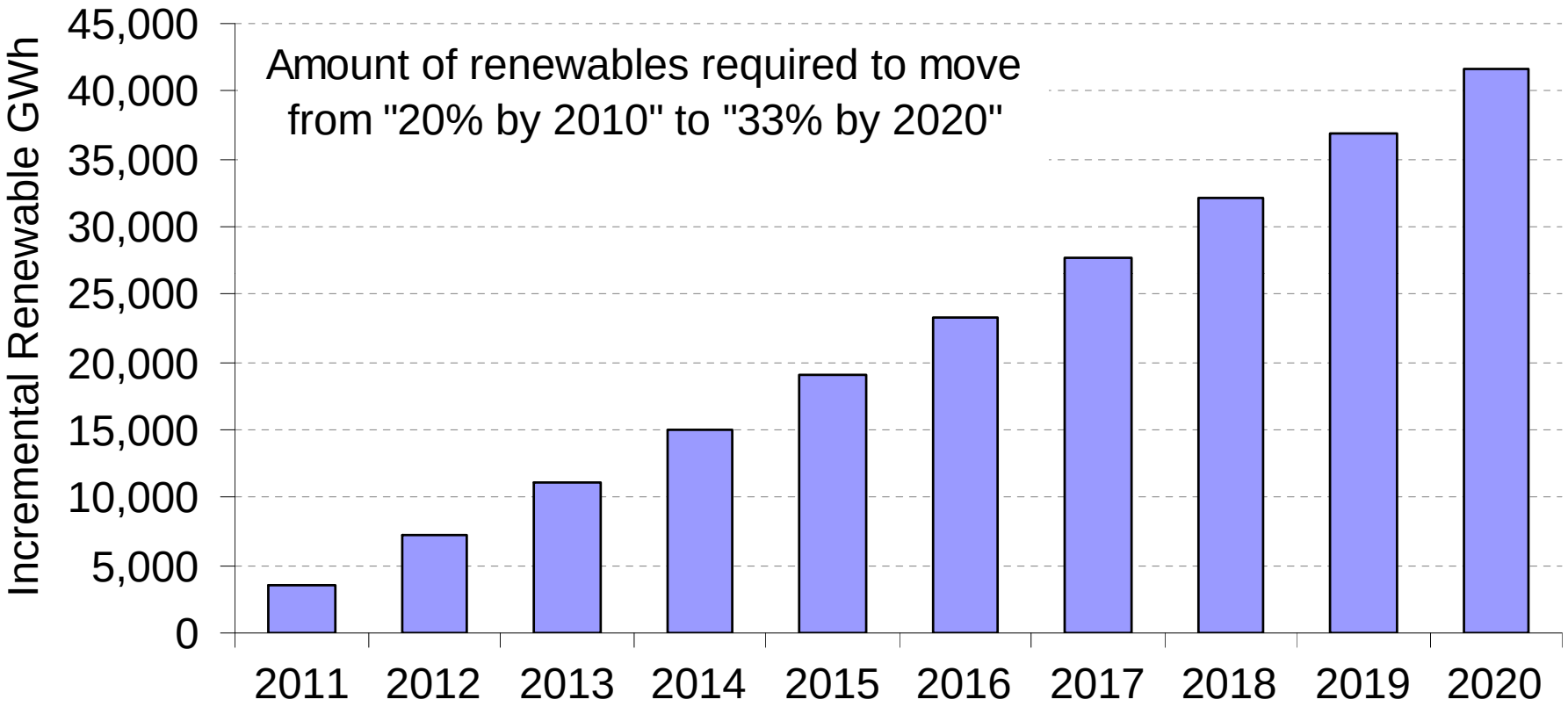
Additional Studies:

- Results from EEA model (used by ACEEE, NCEP, and NPC) imply even higher inverse elasticities (>10 short-term, ~4 long-term)
- CEC (2007) used a model from Global Energy Decisions, which found long-term inverse elasticity of ~5.0
- U.S. DOE (2008) used range of inverse elasticities with AEO as the "low" estimate
- B&V (2007) finds that 32% rise in 2020 CA power sector gas demand (due to RPS non-compliance, higher load growth, and warmer summers) could increase gas prices by $1.20/MMBtu (PG&E) and $0.60/MMBtu (SoCal) relative to baseline

Achieving a 33% Renewable Energy Target (Prepared by CRS for the CPUC in 2005)

- Side analysis conducted to estimate natural gas price suppression effect (based on LBNL analysis)
- Methodology:
  - Nationwide natural gas demand estimate from EIA
  - Projection of California natural gas demand and delivered gas prices to California electric generators from 2005 IEPR and Energy Commission staff
  - Projection of *incremental* renewable generation (above 20%, to achieve 33%) from CRS report, and no incremental RE after 2020 (see next slide)
  - Assumption that each MWh of new renewable generation offsets 0.75 MWh of gas-fired generation, at an average heat rate of 7,500 Btu/kWh
  - Assumption that CA gas price reductions will be temporarily amplified relative to national price reduction on ratio of 3:1, declining to 1:1 by 2020

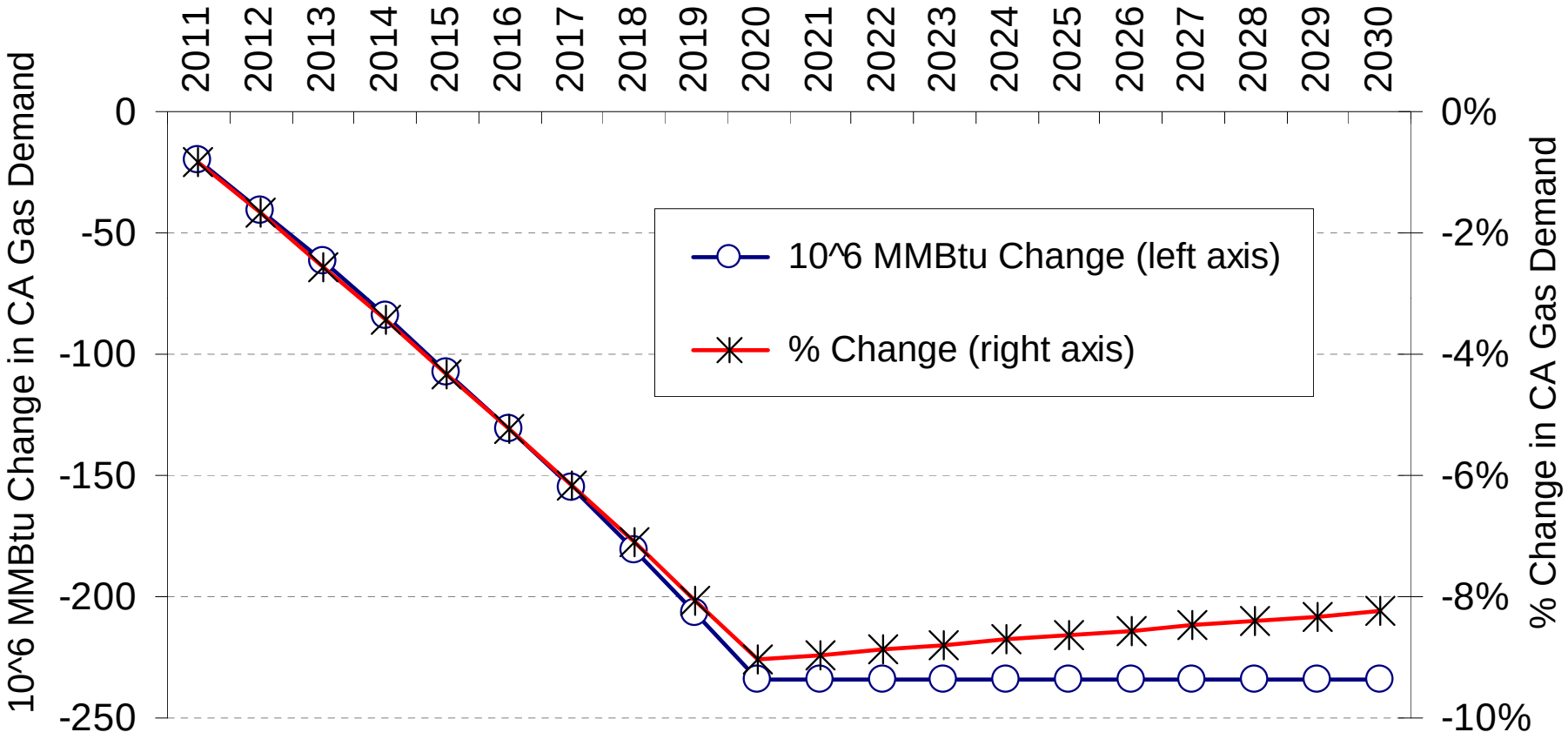
Incremental RE Required Under “33% by 2020” (Relative to “20% by 2010”)



Source: *“Achieving a 33% Renewable Energy Target”* Prepared by The Center for Resource Solutions for the California Public Utilities Commission, November 1, 2005.

http://www.resource-solutions.org/lib/librarypdfs/Achieving_33_Percent_RPS_Report.pdf

Natural Gas Demand Reduction in CA Under "33% by 2020" (Relative to "20% by 2010")



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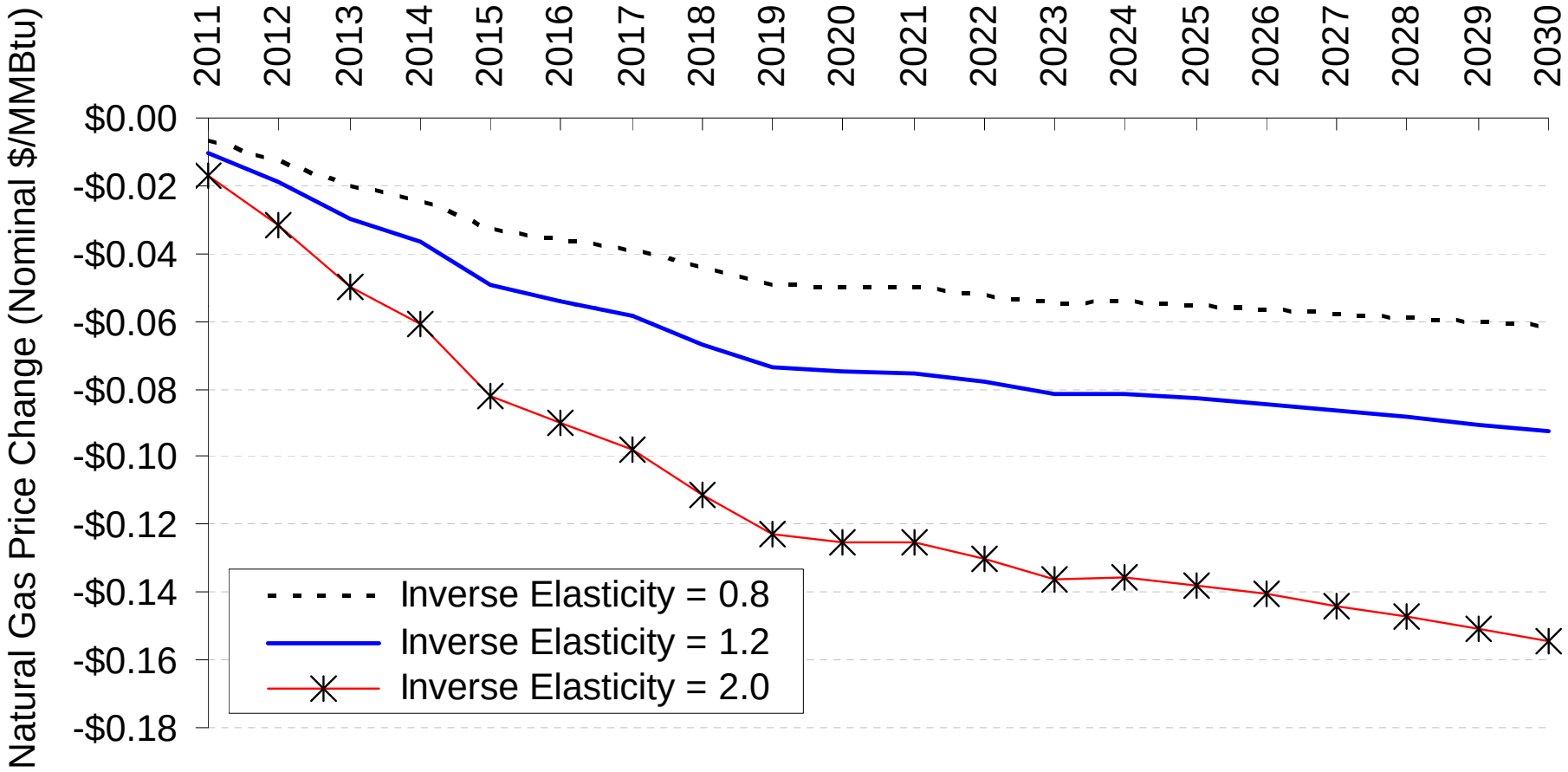
Incremental California Price Suppression from "20% by 2010" to "33% by 2020"



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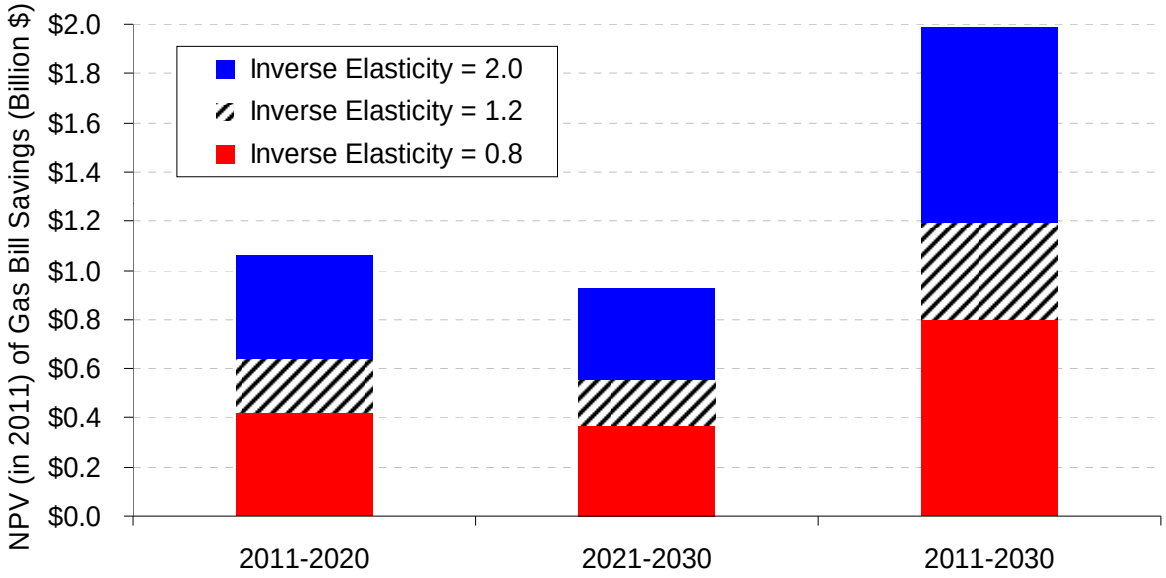
Resulting Impacts from 33% vs. 20% Renewable Energy

Natural Gas Bill Savings for California



Incremental "Value" of RE

Inv. Elast.	California Only, 2011-2030
0.8	$3.5/MWh
1.2	$5.1/MWh
2.0	$8.5/MWh

Note: Value = CA gas bill savings divided by incremental renewable MWh, reported in nominal $

Source: *"Achieving a 33% Renewable Energy Target"* Prepared by The Center for Resource Solutions for the California Public Utilities Commission, November 1, 2005.

http://www.resource-solutions.org/lib/librarypdfs/Achieving_33_Percent_RPS_Report.pdf

Open Questions / Areas for Further Study

- More comprehensively evaluate historical/empirical inverse elasticities of gas supply to help benchmark model results
- Deeper understanding of degree to which gas price reduction is a social benefit rather than a transfer payment from producers to consumers
- Better evaluate regional price impacts of regional reduction in gas demand with more finely tuned gas models*
- Better understand physical changes to natural gas supply, delivery, and storage system to respond to 33% renewable energy
  - *Possibly* reduced demand for and economic competitiveness of LNG
  - *Possibly* reduced need for new natural-gas transport capability to California
  - *Possibly* increased need for gas storage and increased cycling of that storage to integrate variable and uncertain renewable energy sources**

** ACEEE sought to address this with the EEA model for the Pacific West in 2006*

*** Xcel's 2006 wind integration study for Colorado estimated a cost of $1.45/MWh-wind for 15% wind penetration due to this gas storage effect*

Partial Bibliography

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Panel Discussion and Public Comments on Topics 5-7

- Summary of Scenario Analysis for the Electricity Sector (Topics 5-7)
- Panelists
  - Mike Jaske, Energy Commission
  - Dora Yen Nakafuji, LLNL
  - David Hawkins, CA ISO
  - Snuller Price, E3
  - Jaclyn Marks, CPUC

General Discussion

8. Please see Attachment B to the notice for a list of existing studies related to achieving 33 percent by 2020 at the workshop. Are there other completed studies related to achieving 33 percent renewables by 2020 (or on higher levels of renewables in general) that should be included in this summary?
9. What other studies are planned or underway related to achieving 33 percent renewables by 2020 (or on higher levels of renewables in general)?
10. What additional studies are needed to better understand the impacts of higher levels of renewables on the system and/or to identify ways to mitigate those impacts?

Written Comments

- Written comments on the questions attached to the notice and workshop topics must be submitted by 5 p.m. on Friday, August 1, 2008.
- Please include the docket number **08-IEP-1B** and indicate "***2008 IEPR Update* – 33 Percent Renewable Electricity"** in the subject line or first paragraph of your comments.
- See the notice for further instructions: http://www.energy.ca.gov/2008_energypolicy/notices/index.html

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