2007 IEPR Project
Scenario Analyses of the Electricity Sector
(Responses to Questions)

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California Energy Commission

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Background

- This scenario project was designed to:
  - develop a greater understanding of the implications of high penetrations of the preferred resources believed to be needed to achieve major reductions in CO2 emissions for the electricity sector,
  - Assess preferred resources: energy efficiency, rooftop solar PV, and supply-side renewables
  - Understand at least some of the consequences of these actions on generation patterns, fuel use, costs, and
  - Permit some degree of tradeoff comparisons.

Development of Preferred Cases

Multi-Step Process:

- Finalize broad theme
- Develop assumptions for preferred resource additions
- Back out generic resource additions from Case 1 (to the extent remaining)
- Verify sufficient capacity using RA protocol
- Prepare dataset
- Run/review baseline
- Run fuel price and hydro sensitivities

Preferred Resource Assumptions

- Energy Efficiency
  - Itron Potential Study for California IOUs
  - CDEAC EE Goals for Rest-of-WECC
- Rooftop Solar PV
  - California Solar Initiative Studies
  - Navigant Consulting study for Arizona Dept. of Commerce
- Supply-Side Renewables Generating Technologies
  - Intermittency Analysis Project for California
  - CDEAC Renewables and Transmission reports for Rest-of-WECC

Renewable Generation Feasibility

- Instate renewables approximated the proposed 33% RPS requirement in Case 4A using IAP assumptions
- All agree that substantial transmission development is required to achieve this level, and that this study was just a first approximation of needed additions
- Staff and utilities agreed intermittent resources present operational and reliability challenges
- Utilities and CAISO assert that further study of intermittent generation “backup” needed before high levels can be considered feasible or the full costs can be understood
- A large potential for wind exists in Rest-of-WECC, which was assessed in Case 4B, but only by using the CDEAC results, not independent analysis

Conclusions from Study

- Many analytic, data and modeling uncertainties were encountered. Some were excluded by the study design. Others had to be ignored to meet the 2007 IEPR schedule.
- Study design means the results are not directly applicable to each LSE's GHG reduction strategy
- With some extensions, this study could be a useful starting point in determining how the electricity sector as a whole might participate in achieving AB 32 reduction goals
- Major changes in "market purchase" imports among scenarios illustrates strong interconnections with Rest-of-WECC, and suggests careful examination of how states design their GHG mitigation programs because of "spillover" consequences
- Compliance mechanisms must recognize substantial variation in CO2 emissions due to hydro-electric production swings

Followup

- Draft Report Source:

http://www.energy.ca.gov/2007_energypolicy/documents/index.html#0618070907

- Final Report will be posted very soon.
- Contact:
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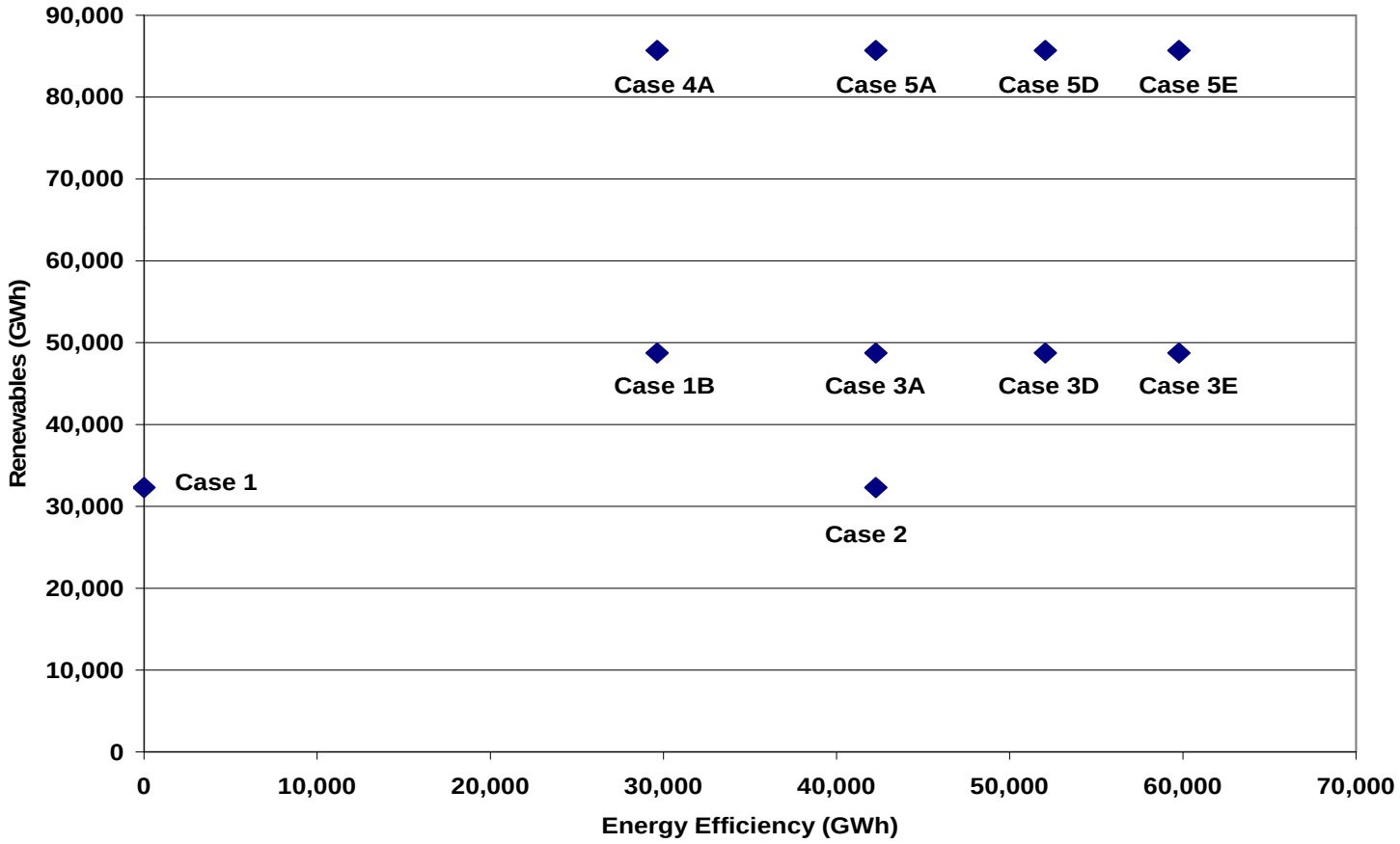
  - mjaske@energy.state.ca.us
  - 916-654-4777

Response to Questions 2a,b,c

Thematic Scenarios Assessed

- Case 1 — Current conditions extended into the future.
- **Case 1B — Compliance with current requirements.**
- Case 2 — High sustained natural gas and coal prices.
- Case 3A — High energy efficiency (EE) in California only.
- Case 3D – Higher EE in California only.
- Case 3E – Highest EE in California only.
- Case 3B — High energy efficiency throughout the West.
- **Case 4A — High renewables in California only.**
- Case 4B — High renewables throughout the West.
- **Case 5A — High EE and renewables in California only.**
- Case 5D – Higher EE and renewables in California only.
- Case 5E – Highest EE and renewables in California only**.**
- **Case 5B — High energy efficiency and renewables throughout the West.**

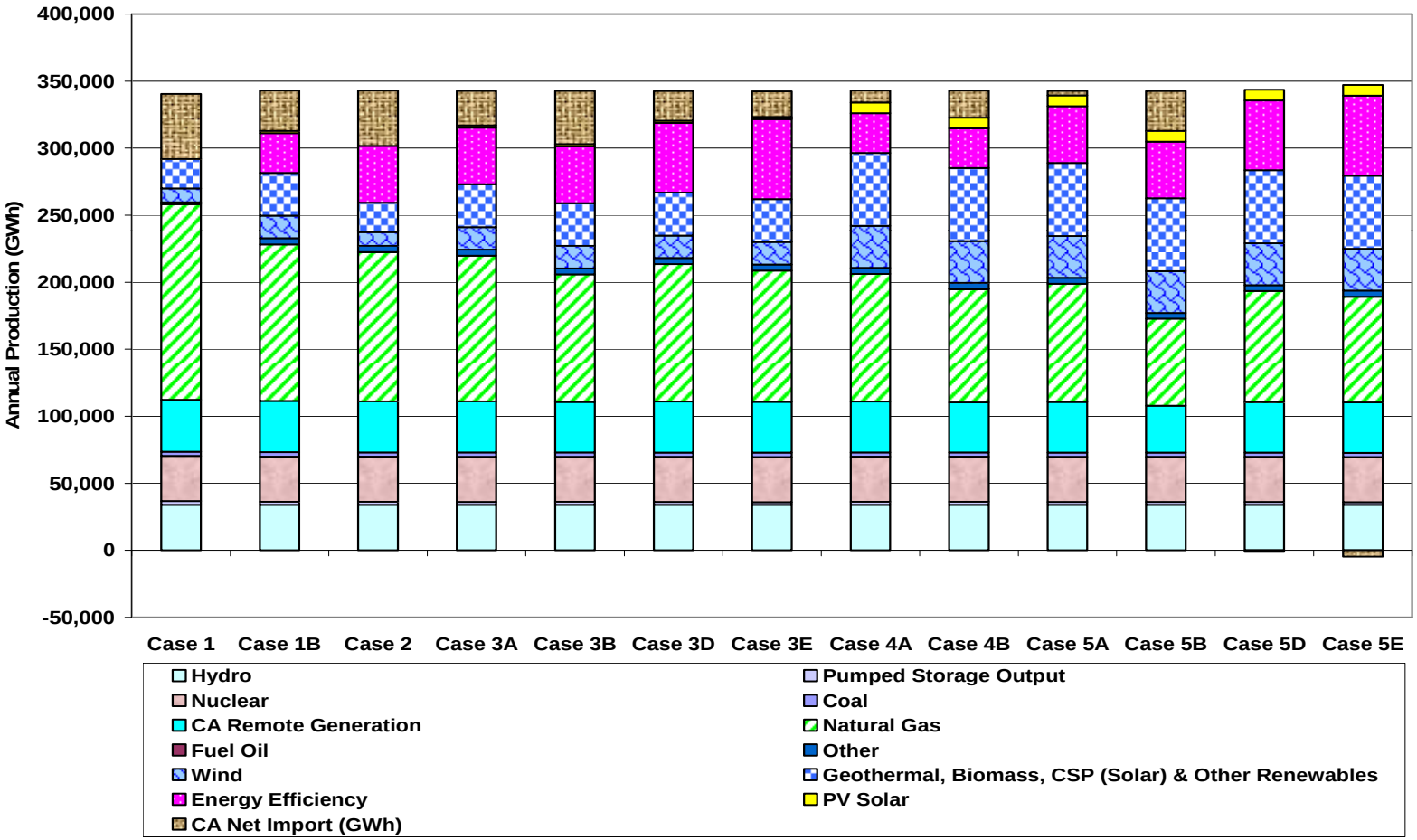
2020 Preferred Resource Assumptions (Base Load Forecast of 339,831 GWh)



RPS Equivalence of Scenarios
(Base 2020 Forecast of 339,831 GWh)

Scenario	Renewable Generation	Efficiency and Rooftop PV	Equivalent RPS Percentage
Case 1B	45,587	31,267	17.0
Case 4A	85,710	37,674	32.6
Case 5A	85,710	57,298	34.3

Composition of Generation to Meet California Load in 2020

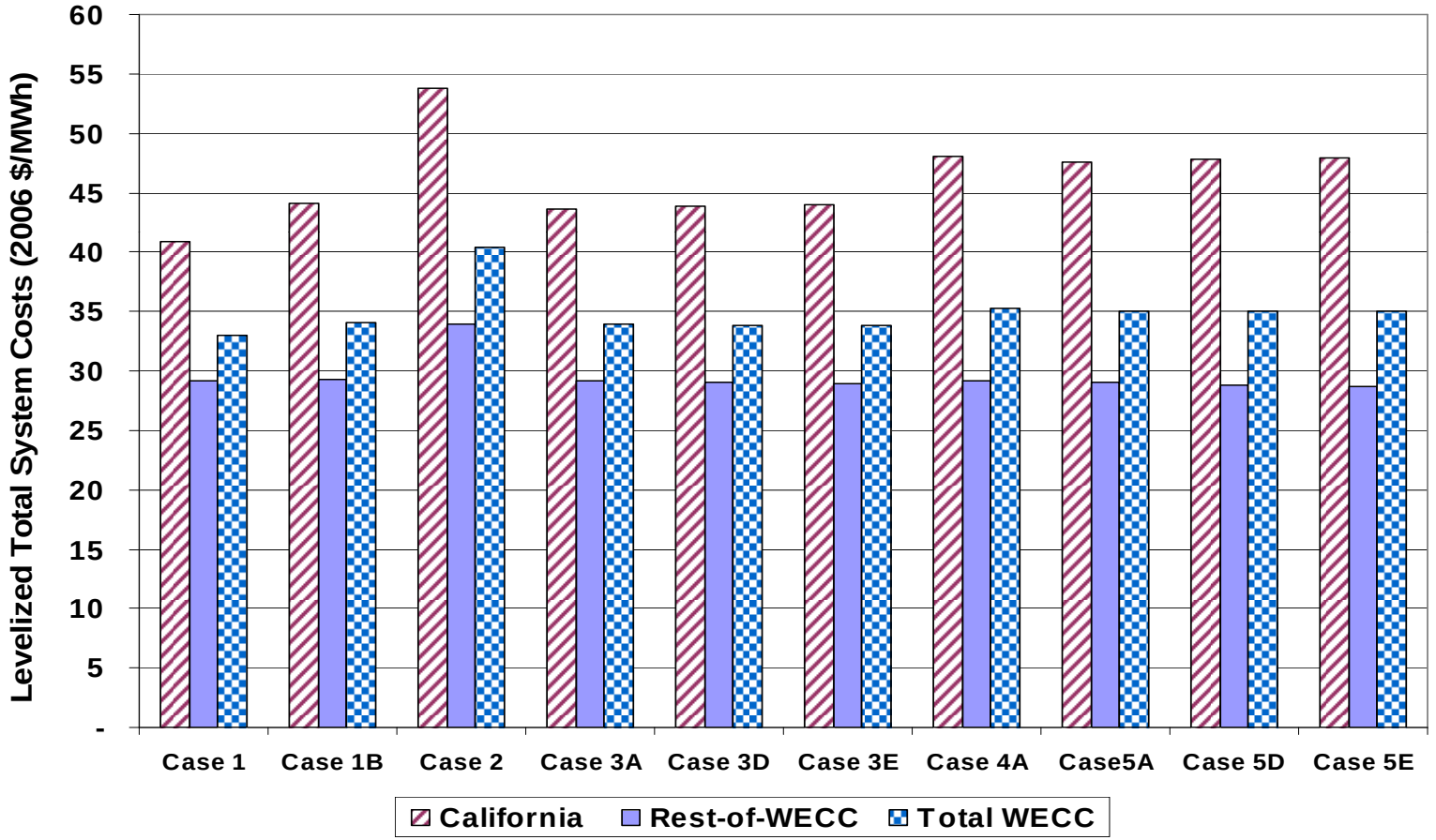


Response to Question 4a,b

Cost Assessment

- All capital cost differences between scenarios were captured in a deterministic manner
- Some production cost differences are examined through fuel price and hydro sensitivities
- All cost categories have uncertainties, but some are more readily quantified than others
- Truncating analyses at 2020 creates problems for assets with 30-50 year lives
- Levelizing results is a common technique to facilitate comparison and partly resolves end-effect problems

Levelized Costs for Calif. Cases



Overview of 2020 Sensitivity Results

Thematic Scenarios		Calif. System Costs (thousands)				Calif. CO2 Emissions (thous. short tons)			
		Low NG	Base	High NG	$20 NG	Low NG	Base	High NG	$20 NG
Case 1 - Current Conditions	High Hydro		16,164,681				69,142		
	Base	12,265,962	16,684,128	19,177,074	36,167,167	74,630	75,803	76,034	76,617
	Low Hydro		16,875,608				79,968		
Case 1B - Current Requirements	High Hydro		15,945,868				58,866		
	Base	13,004,270	16,354,098	18,224,842	29,195,113	63,100	63,907	63,850	60,912
	Low Hydro		16,507,640				67,441		
Case 3A - High EE in Calif. Only	High Hydro		15,299,757				55,124		
	Base	12,617,673	15,701,704	17,434,336	29,203,469	59,156	60,032	60,221	58,921
	Low Hydro		15,843,813				63,401		
Case 3B - High EE West-wide	High Hydro		15,077,660				49,691		
	Base	12,569,545	15,576,942	17,257,192	28,779,015	55,004	54,868	54,762	53,251
	Low Hydro		15,757,903				57,804		
Case 4A - High Renewables in Calif. Only	High Hydro		18,617,701				53,438		
	Base	16,452,327	18,935,010	20,318,987	29,552,188	57,233	58,078	58,338	58,014
	Low Hydro		19,039,752				60,914		
Case 4B - High Renewables West-wide	High Hydro		18,501,518				49,585		
	Base	16,443,014	18,904,156	20,272,379	29,362,372	53,804	54,172	54,268	53,303
	Low Hydro		19,055,587				56,826		
Case 5A - High EE and Rewables in Calif. Only	High Hydro		18,121,512				50,467		
	Base	16,184,232	18,407,604	19,636,497	27,774,812	54,047	54,836	55,030	54,450
	Low Hydro		18,491,545				57,592		
Case 5B - High EE and Rewables West-wide	High Hydro		17,799,534				42,429		
	Base	16,145,825	18,238,302	19,369,073	26,811,373	46,848	46,356	46,068	44,364
	Low Hydro		18,450,465				49,318		

Response to Question 5a

Resource Adequacy Protocol

- Determine peak month for each control area
- Identify on peak capacity of preferred additions in both nameplate and “NQC” versions
- Starting from previous case:
  - Back out generic additions with energy corresponding to preferred additions
  - Perform RA check on whether capacity value of resources equals annual peak load * 1.15
  - If short, add combustion turbines to satisfy requirement

Derate for Renewable Technologies (NQC as percent of nameplate)

Technology	California	Rest-of-WECC
Wind	26-32%	27-51%
Central Solar	87	70-82
Rooftop PV	42-48%	42

Case 4A Satisfaction of RA

Resource	Nameplate Capacity	Derated Capacity	Implied Capacity Deficit	July Peaking Resources
Central Solar	2748	2387	361	
Rooftop PV	4398	2335	2063	
Wind	12458	3824	8634	
Demand Response				3357
Steam Turbines				7766
Subtotal	19604	8546	11058	11123

Evaluation of the Assessment

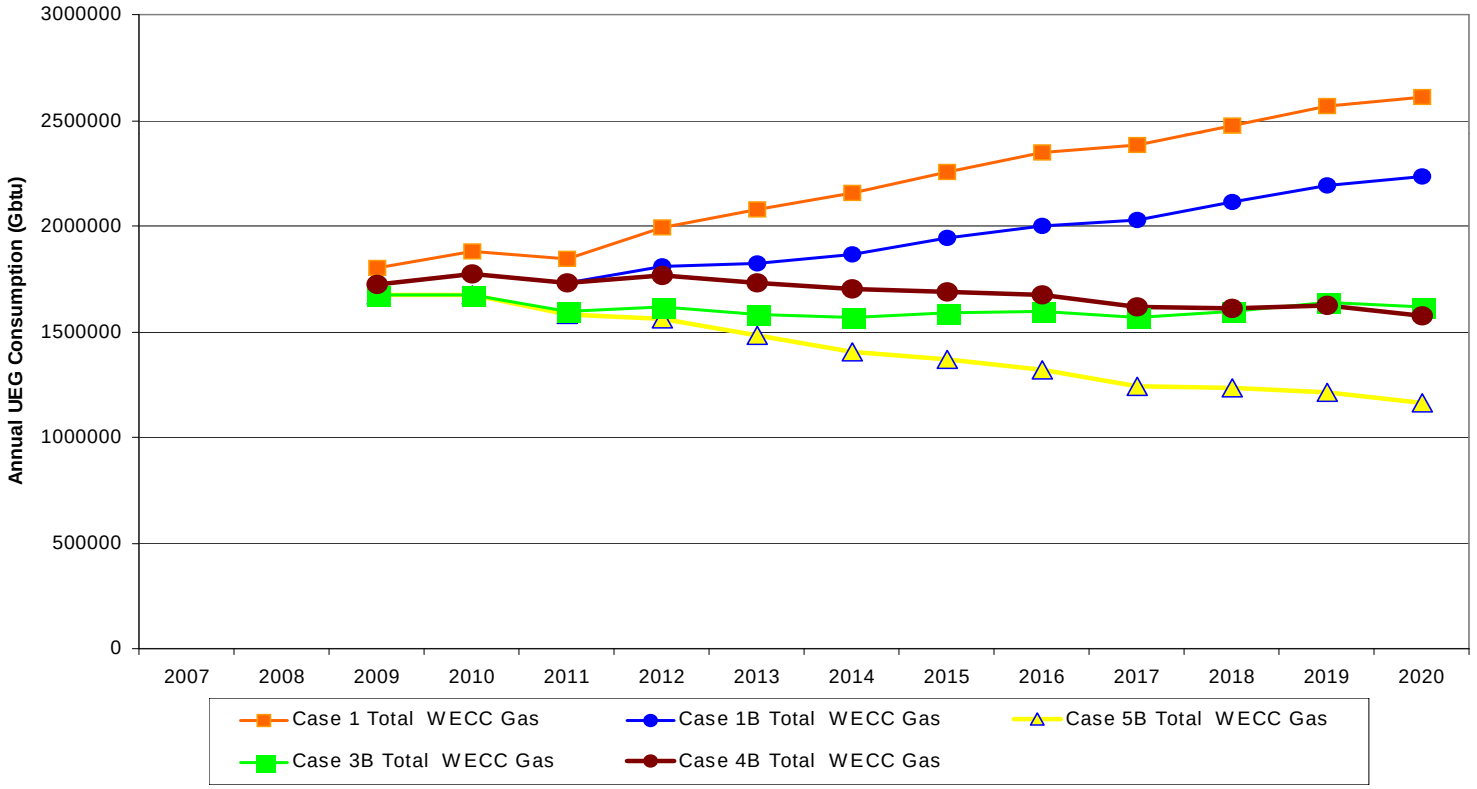
- Scenario Analyses Project did not fully implement CPUC/CAISO RA requirements
- By only examining July rather than all months, the DR solution may not be feasible in other months
- No attempt to examine local RA requirements was possible, since the analysis was conducted for broader geographic areas
- Planning Reserve Margin OIR at CPUC is beginning to examine these issues more fully

Response to Question 6a,f

Natural Gas Price Implications

- The potential for impacting natural gas market clearing prices was recognized.
- Global Energy conducted a specific analysis of this question using the basic scenario assessment results.
- It examined Case 5B – high West-wide penetration of both energy efficiency and renewables – since this is the case with the greatest likelihood for major reductions in power plant natural gas usage.
- Non-WECC power plant usage was assumed to remain at reference case levels.

WECC-wide UEG for Scenario Cases



Contrasting these Assessments

- The policy preferred cases clearly have lower UEG consumption than do Cases 1 and 1B.
- some version of business as usual, while the policy preference cases are predicated on a substantial change in course.

Impacts on Natural Gas Market Clearing Prices

- Reduction in Case 5B is a major portion of WECC-wide, and even national, gas demand
- Are there impacts on natural gas prices?
  - Previous studies have found an effect, but one with a very wide range
  - Staff commissioned Global Energy to determine the size of this impact
  - Given the importance of this issue, Staff also contracted with Altos to develop an independent estimate
  - Since the views were so different, the 2007 IEPR notes the uncertainty of these assessments

Natural Gas Forecasts Using GPCM® for IEPR 2007 Scenario Analysis Project: Results and Methodology

Ann T. Donnelly, Ph.D.

August 16, 2007

Global Energy Decisions

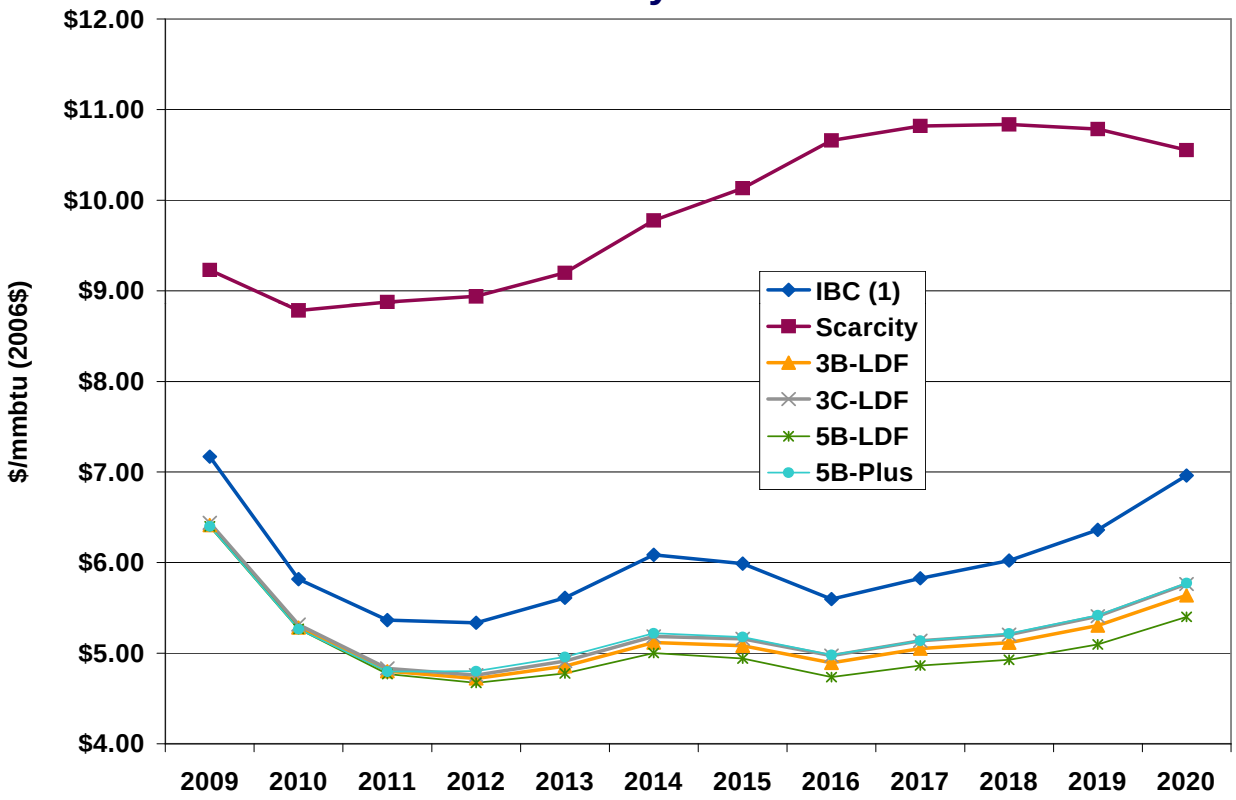
California Energy Commission

Executive Summary of the Henry Hub Forecast Results Low-Demand Forecasts (2006$/MMBtu)(1) Compared to IBC and Scarcity Forecasts

An Illustrative Base Case (IBC) and five scenarios were run. The five scenarios included a Gas Scarcity Case and four Low-Demand cases.

The scarcity prices are approximately $4-$5/MMBtu higher than the Base Case.

The Low Demand Cases are approximately $0.50-$1.00/MMBtu lower than the Base Case.

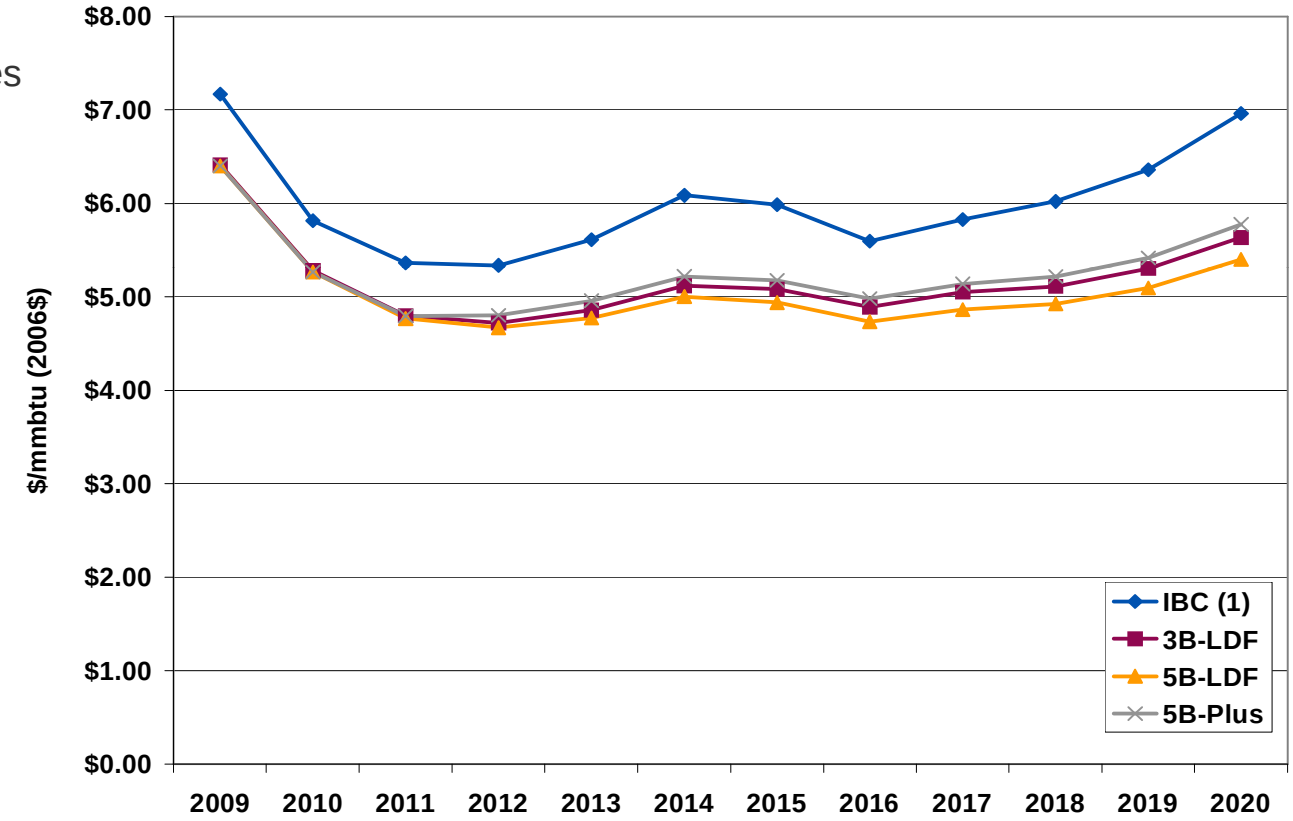


1) For Henry Hub forecast GED uses NYMEX for the first 24 months and then mean reverts for following 24 months to our fundamental forecast. For IBC forecast starting in 2007 for NYMEX an average of the latest available three days were used (i.e. Dec 19-21 2006).

California Energy Commission

Results of 5B-Plus (Production Curtailment Response)
IBC, 3B, 5B, and 5B-Plus: Henry Hub (2006$)(1)

This case demonstrates the impact of lowered demand from aggressive use of EE and renewables even when the industry responds with production curtailment.



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Scenario Project

Preliminary Results of Case_5B

Case_5B completed

by

Altos Management Partners

Results: Henry Hub Price Track