California ISO
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California Independent
System Operator Corporation

Economic Benefits Assessment of the LEAPS Project

September 7, 2006

Regional Transmission South

Economic Benefits Assessment of LEAPS Plant

- **Background**
- **RMR Benefits**
- **Capacity Benefits**
- **AS Benefits**
  - Benefits in the presence of Tehachapi (wind integration)
  - Over-generation Benefits
- **Summary**

Economic Benefit Categories

- **Economic Benefits of LEAPS Plant**
  - Energy saving
  - RMR
  - Capacity
  - Ancillary services
    - Over-generation
    - Wind integration

LEAPS Energy Benefits

- **Energy benefits of LEAPS plant and transmission are studied using production cost simulation tool (GridView)**
  - Results are pending
- **Ancillary service benefits were not captured by production cost simulation tool**
  - Special analysis is conducted to determine the ancillary service benefits

LEAPS RMR Benefits

- **RMR benefits are developed based on SDG&E import limit analysis in connection with the Sun Path project**
- **Capacity benefits are estimated based on the prevailing capacity costs at the location of the LEAPS power plant**

RMR Benefit Methodology

- **Basic Principle: Adding LEAPS and Sun Path will reduce or eliminate the RMR requirement in SDG&E area**
- **Same analysis as in the Sun Path project**
- **CAISO RMR payment data were used**

RMR Benefit Results

		SDG&E Import limit with Sun		
Year	Load and Losses	No new projects	Path and LEAPS	Largest Unit Out
2010	4971 MW	2500 MW	4500 MW	561 MW
2015	5192 MW	2500 MW	4500 MW	561 MW

RMR Benefit Results

	RMR		RMR Available	Required RMR Generation	
Year	No New Projects	with Sun Path and LEAPS		No New Projects	with Sun Path and LEAPS
2010	3032 MW	1032 MW	1380 MW	1652 MW	0 MW
2015	3253 MW	1253 MW	1380 MW	1873 MW	0 MW

RMR Benefit Results

	Year 2010	Year 2015
RMR cost, no new projects	$71.55M	$81.12M
RMR cost with Sun Path and LEAPS	$0	$0
RMR savings with Sun Path and LEAPS*	$71.55M	$81.12M
RMR savings attributed to each project*	**$35.78M**	**$40.56M**

In 2006 dollar

Capacity Benefits

- **SCE's RFO as approved by CPUC shows that there is value for capacity in Southern California**
- **CPUC is implementing a resource adequacy requirement**
- **As the results of the RFO are not available yet, we use typical plant data to value the capacity benefits for LEAPS**

Capacity Benefits

- **SDG&E area capacity cost is estimated based on:**
  - Equipment costs
  - Land costs
  - Air emission permit costs
  - OM costs
  - Financing costs.
- **The capacity value is estimated to be: $62.91/kw-year in 2006 dollar**
- **Capacity value: $31.45M in 2006 dollars**

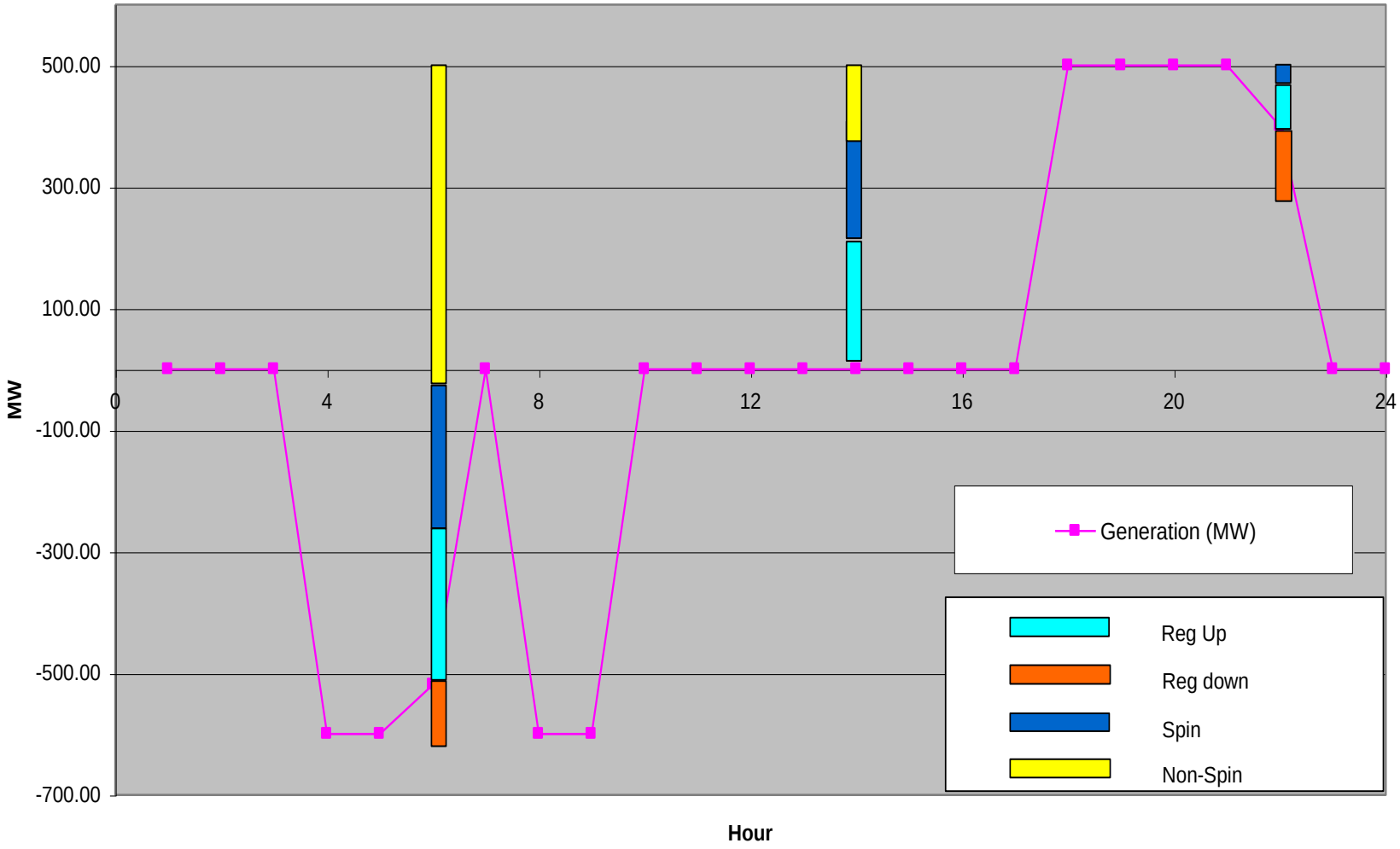
Ancillary Service Benefits

- **Assumptions and Simplifications**
  - Energy dispatches from GridView run are used
  - Impact of LEAPS on ancillary service market prices is not accounted for in this study
  - Energy produced from spin and non-spin uses are negligible
  - The upper reservoir level is properly maintained so that the plant is capable to provide required ancillary services
  - For base A/S benefit calculation, impact of wind generation and over-generation mitigation is ignored

Ancillary Service Benefit Scheduling Rule

- **LEAPS provides no more than 25% of the total AS requirement**
- **Spinning and regulation capacity is limited by mode reversing operation**
  - The spinning and regulation capacity provided by LEAPS will not cross zero MW output
- **Non-Spinning will allow mode reversing**

LEAPS AS Scheduling Illustration



Ancillary Service Benefits Preliminary Result

AS Services	Benefit*
Regulation Up	$10.46M
Regulation Down	$ 5.88M
Spin	$ 11.25M
Non-Spin	$ 1.29M
Total	$ 28.89M

** In 2005 dollar*

Over-Generation Benefits

- **Basic Principle: Adding LEAPS will reduce/eliminate the over-generation condition that take place during spring season**
- **The impact of over-generation on market is that regulation down prices spike**
- **In addition, over-generation had caused major operation difficulties, resulting in reliability criteria violation**

Over-Generation Methodology

- Estimate the number and duration of over-generation conditions using historical data
- Estimate extra ancillary service costs for over-generation conditions
- Estimate the potential costs saving of LEAPS plant due to the reduction of ancillary service costs for over-generation conditions

Over-Generation Calculation

- **Obtain yearly average price of Reg down from 12 month data in 2005 (average = $13.65/MW)**
- **Obtain data of the following study period:**
  - April 2006 to June 2006
- **Compute the costs exceeding the normal market condition:**
  - Select cases where regulation down price is more than twice of the average price
  - The extra cost is calculated as:

    (Reg down price – average price)* Reg down Requirement

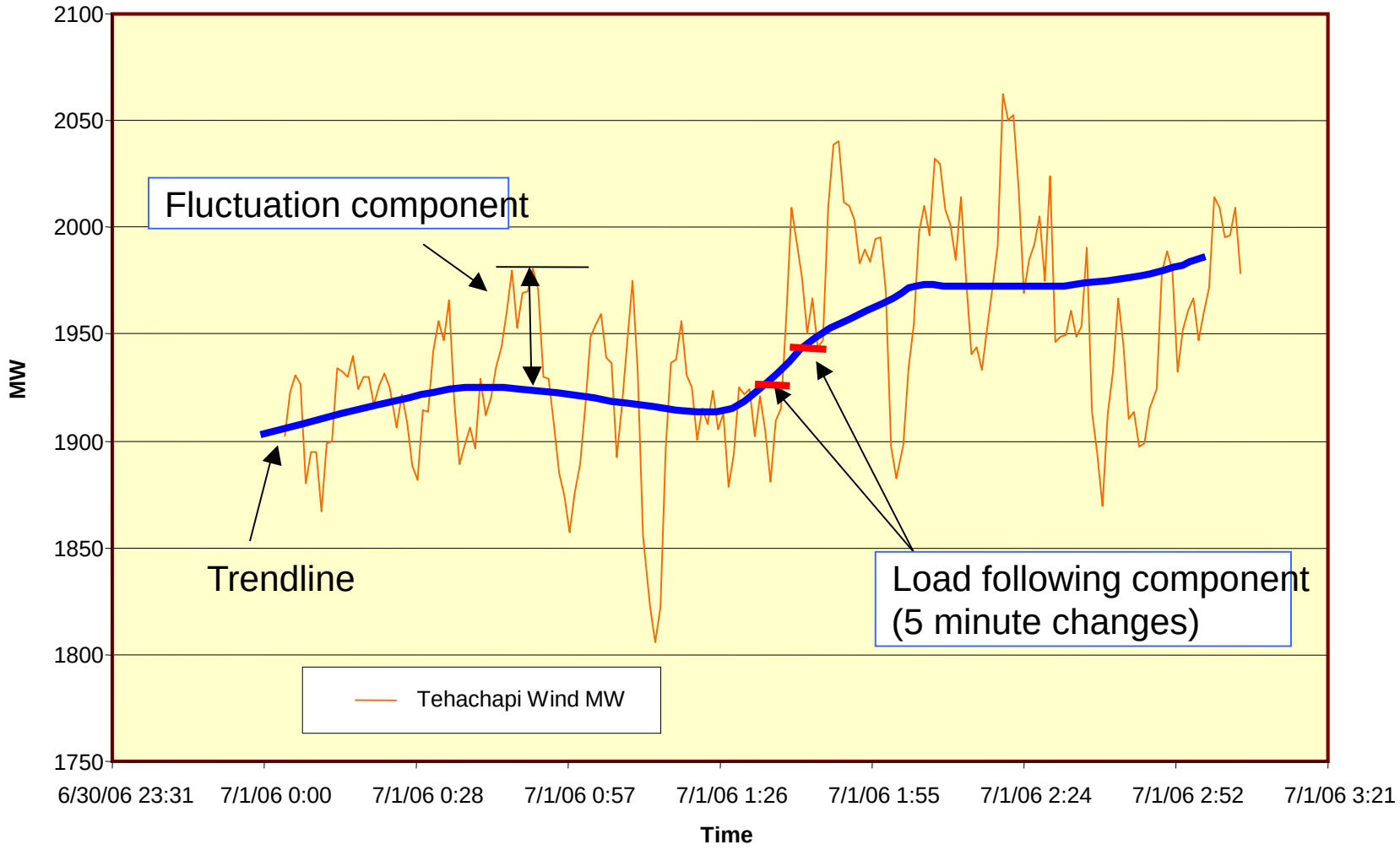
Over-Generation Result

- **The total over-generation costs computed are $17.46M**
- **Assuming that over-generation pattern will continue to exist given similar growth of loads and generation capacity, over-generation benefit of LEAPS plant will continue to accrue**
- **We did not estimate the impact of negative energy prices**

Wind Integration Benefit

- **Potential Benefits**
  - LEAPS can provide additional regulation service to help with increased regulation and load following needs due to large volume of wind generation
    - Fluctuation on AGC signals
    - Fast load following needs in between 5 minute RTMA runs
  - LEAPS can also reduce the magnitude of wind generation curtailment
- **We have estimated the benefits due to increased regulation and fast load following requirement**

Tehachapi Wind Fluctuations and Trendline



Analysis Steps

- **Obtain the data of following time series**
  - Tehachapi Wind
  - System Load
  - Net system load = System Load-Tehachapi Wind
- **Compute separately the moving averages of the above three time series (trendlines)**
  - 5 minute window is used

Analysis Steps

- **Generate the following time series**
  - Tehachapi Wind fluctuation and 5 minute changes using its trendline
  - System Load fluctuation and 5 minute changes using its trendline
  - Net system load fluctuation and 5 minute changes using its trendline

Where

Fluctuation= Time series data – its moving average

5 minute changes= Moving average[t]- Moving average[t-5]

Statistical Results

Selected statistics of the time series are computed for use in the subsequent analyses.

- ***Variance =*** $\dfrac{\sum_{i=1,N}(x_i - \sum_{i=1,N} x_i / N)^2}{N}$
- ***Standard deviation = square root of its variance***
- ***Minimum***
- ***Maximum***

Statistical Results

	Fluctuation			5 Minute Change of Trendline		
	Tehachapi Alone	System Load Alone	Net System Load	Tehachapi Alone	System Load Alone	Net System Load
Variation	788	4577	5331	1535	25008	26555
Standard Deviation (α)	28	68	73	39	158	163
3α	84	203	219	118	474	489
Minimum	-420	-603	-592	-594	-728	-660
Maximum	288	407	419	457	519	568

Statistical Calculation Observation

- **Wind fluctuations are not correlated with system load fluctuations (correlation coefficient <0.01)**
- **Wind output clearly impacts the AGC signals**
- **There are not established methodologies or protocols for quantifying the additional regulation and fast load following requirements**

Statistical Solution Result

- **Assume three scenarios**
  - Tehachapi alone
  - System load (without Tehachapi Wind Gen)
  - Net system load (system load & Tehachapi Wind Gen)
- **Use 3 x standard variations as the regulation requirement**

Statistical Result

- **Tehachapi alone**
  - 202 MW for load fluctuation and load following
- **System load alone**
  - 677 MW for load fluctuation and load following
- **Net system load**
  - 708 MW for load fluctuation and load following

Regulation Requirement

- **Method 1: Pro rata allocation**
- **Very weak correlation of wind and system load**
- **There is saving for serving the net load. The saving is computed as:**

  (677+202 – 708)/(677+202) = 19.5%
- **The regulation requirement is allocated to wind and system load proportionally**
  - Wind = 202*(1-19.5%)=162 MW
  - System load=677*(1-19.5%) = 546 MW
  - The average load used in the analysis= 34375MW

    Wind=0.47%

    System load=1.58%

Regulation Requirement

- **Method 2: Shapley value based on cooperate game theory [for comparison purpose]**
- **The idea is to share the benefits based on average incremental impact**
- **Data**
  - Wind and system load together: 708 MW
  - Tehachapi alone: 202 MW
  - System load alone: 677 MW
- **Results**
  - Wind = 116.5 MW
  - System load = 591.5 MW

Regulation Requirement

- **Notes**
  - This analysis is used primarily for the economic benefit assessment of the LEAPS project. In-depth studies may be needed for future operational needs.
  - This analysis is not intended to assign costs of regulation.
  - We note that absent must-offer requirements, the total regulation requirement may increase from the current level.

LEAPS Project Incremental Ancillary Services Benefit

- **Simple pro rata method is assumed for LEAPS economic benefit assessment**
- **When regulation requirement is increased by 162 MW, LEAPS can supply additional amount of ancillary service. The ancillary service benefit increases by $6.16 million per year in 2005 dollar.**

Preliminary Result Summary

	Year 2010*	Year 2015*
Energy saving	TBD	TBD
RMR	$35.78M	$40.56M
Capacity	$31.45M	$31.45M
Ancillary Services	$29.46M	$29.46M
- Over-generation	$17.46M	$17.46M
- Wind Integration	$6.28M	$6.28M

**In 2006 dollar*