Benefit Estimates Technical Workshop

Risk/Reward Work Group

August 16, 2005

Agenda

- ***Estimating Redispatch Efficiencies***
  - Grid West Market and Operational Functions
  - Study Hypothesis
  - PowerWorld Model Description and Results
- ***Reliability Benefit Estimates***
  - Probabilistic Reduction in Frequency of Cascading Disturbances
  - Reductions in Momentary and Sustained Outages
- ***Minimization and Elimination of Overlapping Benefits***
  - Redispatch, Rate Pancaking and Reconfiguration/Utilization
  - Reliability Categories

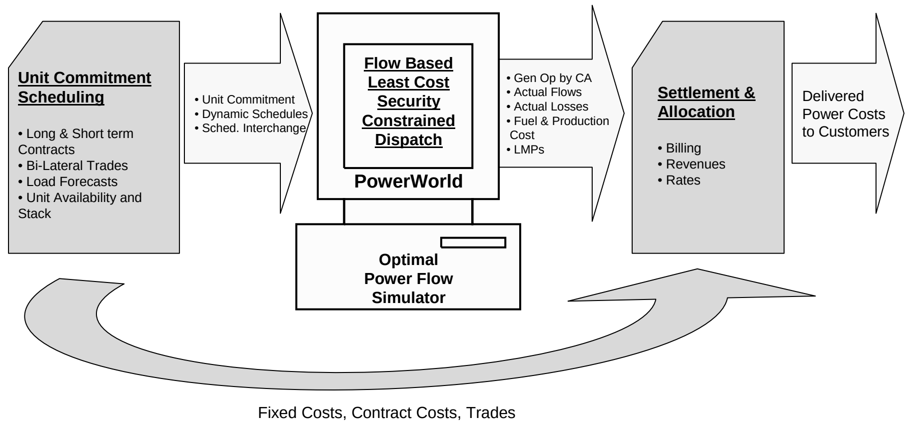
Redispatch Efficiencies

- ***What is the effect of changing the system control topology and implementing Real-time Balancing Service (RBS)?***
- ***Study Hypothesis***
  - By consolidating control area operations and creating a market for real-time balancing energy, Grid West can achieve lower hourly, system-wide production costs than multiple autonomous control areas.
- ***Basis for Study***
  - Measure of benefits determined by comparing dispatch costs of multiple, autonomous control areas with various consolidated control area configurations.
  - Implementation of Grid West Real-time Balancing Service (RBS)
  - Redispatch market within CCA – utilizing all physically available transmission system capability (security constrained economic dispatch)
  - Eliminating real-time area-to-area schedule constraints within the CCA – no Scheduled Interchange within consolidated areas
  - Larger pool of generating resources available for real-time dispatch
  - Flow-based, netting, reduction of transmission reserve margin (TRM), Capacity Benefit Margin (CBM)

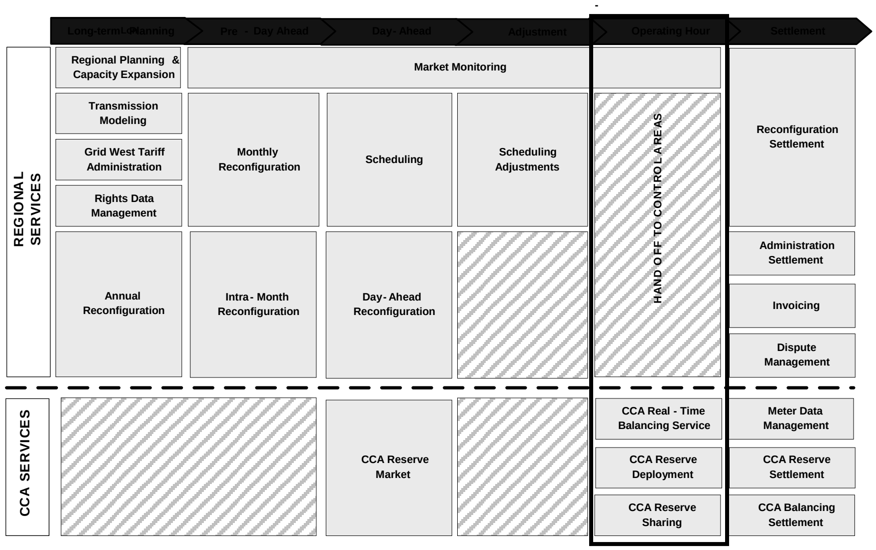
Interchange Schedule Input Values, Factors for Consideration and Constraints:

- Power and transmission contracts rights, interpretation and use
- Contract Path Point-to-Point type 888 Tariff Schedules
- NERC, WECC, NWPP and other scheduling rules
- Bilateral energy trades
- Capacity margins (e.g., Capacity Benefit Margin, Transmission Reserve Margin)
- Transmission rights held for flexibility and for hedging outage performance
- WSPP bilateral wholesale power products
- Treatment of load forecast error and risk
- Planned maintenance (transmission and generation-if known)
- Unit Commitment plans
- Pricing of transmission
- Reserves
- Treatment of weather forecasts and other external factors
- Assumptions of other operational conditions, e.g., loopflow (inadvertent flows)

Modeling Process



Market and Operational Functions



Base Case Description

– 4 Seasons, light-load and heavy-load hour WECC operating cases used for individual control area to control area schedules and net scheduled interchange.
– June 14, 2004 disturbance case used as the spring, LLH case, based upon actual interchange scheduled.
– These cases were used to analyze performance over a “typical” year.

Grid West Case:

Consolidated Control Area Cases

- ***4 Control Areas Consolidated***
  - BPA
  - PAC – East
  - PAC – West
  - Idaho Power Company
- ***10 Control Areas Consolidated***
  – BPA, Idaho, PACW, PACE, Avista, British Columbia Transmission Corporation, NorthWestern Energy, Portland General Electric, Puget Sound Energy and, Sierra Pacific.

Case Assumptions

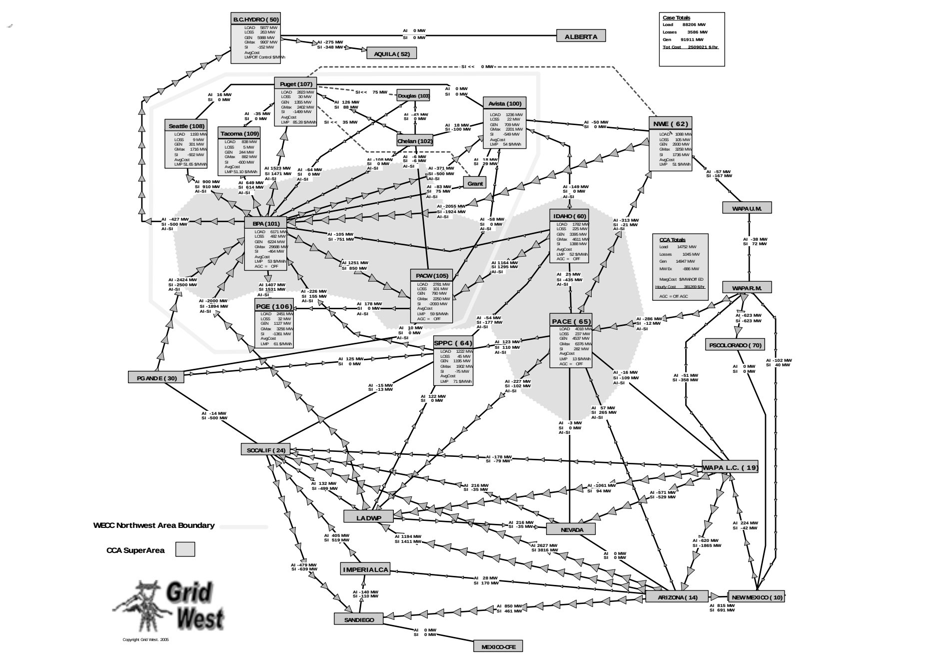
- WECC max/min generator limits
- WECC data reflects actual interchange schedules
- Attempted to replicate actual operations (e.g., dynamic schedules, discretionary and non-discretionary hydro dispatch)
- SSG-WI and RMATs variable costs for thermal units
- Sensitivities on Hydro opportunity costs ($20; $30; $40; $50; $65/MW-hour; Dow Jones average Mid-C and weighted average)

Modeling Approach

PowerWorld Simulator

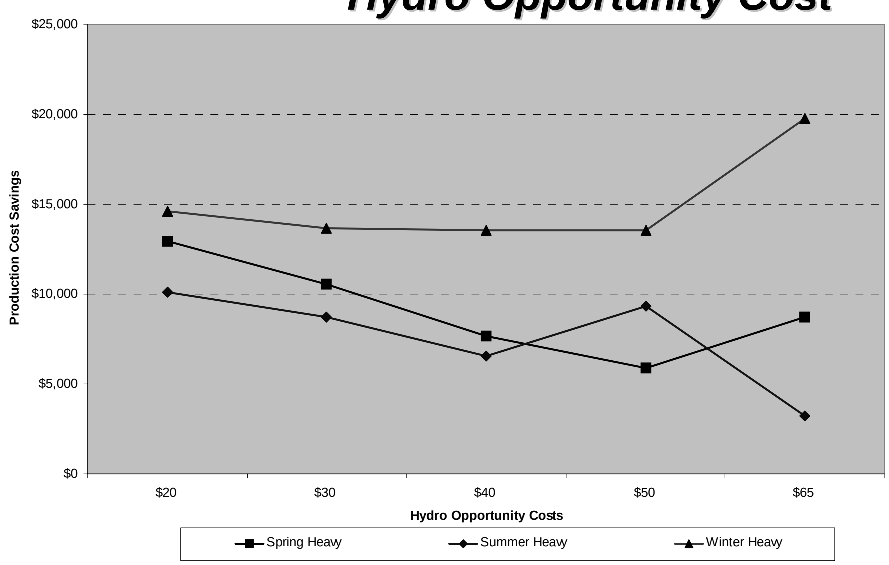
- ***Time domain simulation of electric power grid***
  - Models defined for a representative one-hour period
- ***Topology changes to WECC operating cases***
  - Separated WECC Northwest Area into separate control areas
  - Added flowgates and detailed path ratings
  - Created zones defined by flowgates
  - Modeled dynamic schedules, e.g. Mid-C unit allocations
  - Load following scheduled most hydro in the CCA (limited amount of hydro available for Real-time Balancing Service)
- ***Solves Optimal Power Flow in individual Control Areas while holding Net Scheduled Interchange constant as a proxy for actual Control Area generation dispatch (AGC)***
  - Economic Dispatch constrained by system physical limits: WECC path ratings, system element limits, voltage schedules
  - Modeled both individual control areas (base cases) or consolidated control areas (change cases)

Western Interconnection Area-to-Area Interchange



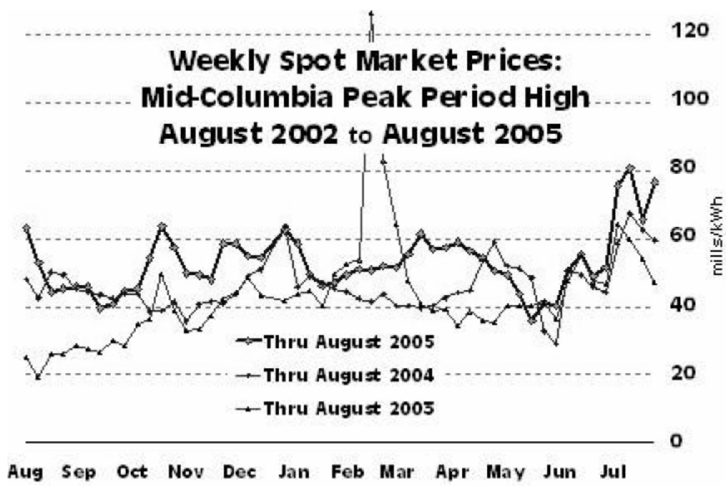
Grid West

Production Cost Savings v. Hydro Opportunity Cost



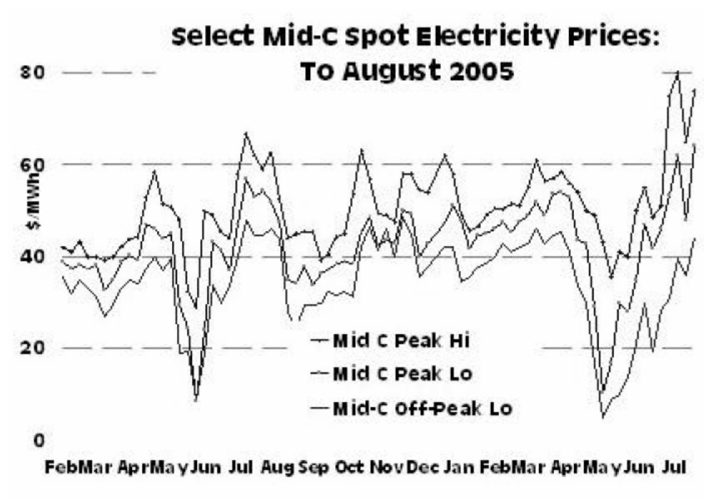
4 CCA Cases

Historical Price Probability Data



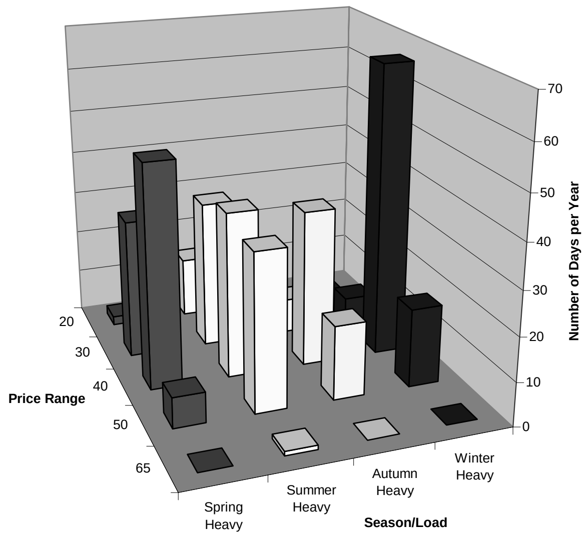
Source: Clearing Up 1197

Recent Price Probability Data



Source: Clearing Up 1197

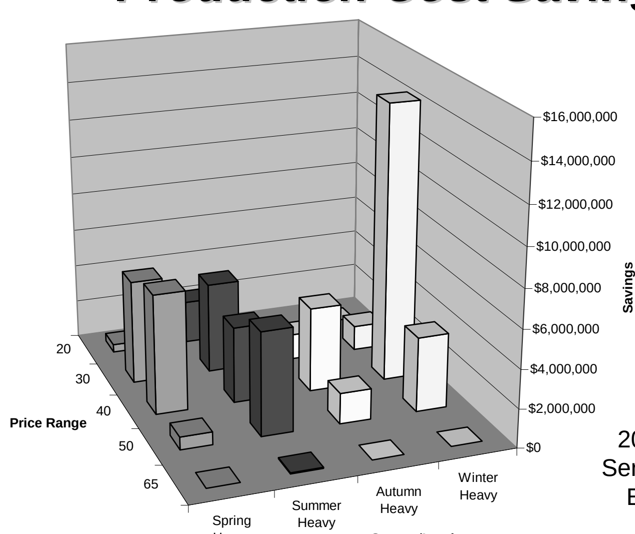
Price Frequencies for Annualization



2004 Data Series

HLH = 16 hrs/day

Resulting Product: Annualized Production Cost Savings



2004 Data Series – HLH Example

Redispatch Efficiency Benefit Estimates

Range	4 CCA	10 CCA
High	$65	$385
Medium	$56	$332
Low	$41	$128

Note: Units are in millions per year

Grid West Policies Affecting Reliability

- Wide visibility of operating data
- Independent centralized state estimator
- Single combined operation and control to flowgate nomogram limits
- Centralized planning with reliability backstop authority
- Outage Coordination
- Single operation of Consolidated Control Area (CCA)
- Re-dispatch market and congestion re-dispatch
- CCA Balancing Market Flow Based ATC & Scheduling
- Independent oversight and use of “best practices” for O&M by Grid West

Historical Analysis of Outages and How Grid West Might Have Affected them

- ***Mittelstadt analysis***
  - Looked at 20 outages culled from NERC data that occurred over the last 12 years
  - Examined cause of outages (26 different categories)
  - Correlated cause of outage to Grid West Policies.
  - Determined that 45% of WECC outages might have been "correctable" by Grid West policies.
  - Only looked at a sampling of large scale grid outages – not more common outages
- ***PAC analysis***
  - Looked at 31 out of 36 disturbances reported to WECC since 1999.
  - Using reported cause/s of outages correlated cause of outage to Grid West policies.
  - Determined that at least 20% of the WECC outages could be mitigated.
  - Only looked at a sampling of outages – not comprehensive

Types of Outages

- ***Momentary outage***
  - events lasting less than 5 minutes.
- ***Sustained outages***
  - greater than 5 minutes typically less than 12 hours, mostly in a single utility area.
- ***Cascading***
  - large scale grid region wide prolonged outages (one in 15-20 year events)—can overlap with sustained.

Quantitative Estimates Cascading Outages

- ***Method:***
  - GDP displacement
  - Similar to that used for assessing cost of the August 14, 2003 Blackout
  - Referenced in the final Blackout report.

Assumptions...

If:

- ***2004 Gross Product for Grid West Region***
  - based on BEA and BC data for MT, ID, UT, OR, WA, WY
  - US $761,208 million
- ***85% of production occurs on weekdays and 15% on weekends.***
  - (based on US Census Bureau wage/earnings data)
- ***Grid West avoids 1 catastrophic outage of 1 productive day every 20 years***
  - *or* it avoids 1 catastrophic outage of 1 productive day every 15 years.
- ***There is an outage, 50% of the day's GDP is lost,***
  - the rest will be recovered in future production or was protected by back-up generators.

Assumptions...

- 1 weekday's GDP = $2,489,000,000
- 1 weekend day's GDP = $1,098,000,000
- 1 catastrophic outage of 1 day reduces GDP by $548,948,000 to $ 1,244,283,000.
- Annualizing that over 20 years means annual reliability savings resulting from Grid West would be ***$27 million to $62 million every year***.
- If that same outage were avoided every 15 years, the annualized benefits would be

  $37 to $83 million per year.

This Estimate Is Conservative Because:

- ***It does not take into account the growth in GDP that will occur in the out years***
  - it is based on 2004 data.
- ***It assumes that GDP will be reduced by 50% for every day of lost productivity***
  - as opposed to 100% assumed in other studies.
- ***It does not take into account the following costs often associated with catastrophic outages:***
  - Spoilage of stock on hand
  - Agricultural losses
  - Utility level costs of a blackstart
  - Potential costs of unrest (riots, looting,etc.)
- ***It does not count the costs outside of WA,OR,UT,ID, WY and MT of an outage***
  - (i.e., CA, AZ, NV, etc.)
- ***If you made the same assumptions about the whole WECC, You would get additional savings of $68 to $200 million /year.***

Momentary and Sustained Outages

- There is no universal and consistently applied measurement for the more common and localized outages, Momentary or Sustained outages.
- IEEE has established standard definitions for Sustained Average Interruption Duration Index (SAIDI) and Momentary Average Interruption Frequency Index (MAIFI) to allow for better consistency of data, however improvements are needed.
- Between 1990 and 2001 BPA reported over 13,000 outages at its PODs.
- Over 8,500 outages were momentary,
- About 4,500 outages had durations over 5 minutes
- On average annually there were about 1,100 outages in the BPA system.
- PacifiCorp data for 2003-2005 shows that there were between 4.6 and 5.6 million customer-hours of transmission related outages.

On average, 10% of all outages are transmission related

Economic Cost of Outages

- Independent national study conducted by LBL in 2004 showed that Momentary and Sustained outages are most costly form of outages.
- LBL estimated that on average annually these type of outages are costing the US economy about 80 billion dollars.
- LBL estimated the annual outage cost to NW economy to be about $2.8 billion.
- Nationally customers cost of outages are 0.07 percent of GNP
- For the WECC cost of outage are about 0.1 percent of total GSP for the region.
- Customer's outage costs do not enter into the utility balance sheet except through cost of mitigating them.
- LBL study and our own investigation clearly shows that there are not sufficient transparency and consistency in measuring these types of outages to get a real picture of the cost to the customers.

These type of outages are not attention grabbing, not news worthy. And not as much attention is paid to them.

LBL Estimated Outage Cost-per-Outage-per Customer (2002$)

Region	Outage Duration	Residential	Commercial (Small C&I)	Industrial (Large C&I)
Mountain	Momentary Sustained	3 4	583 981	1875 3928
Pacific	Momentary Sustained	2 2.5	604 1050	1881 4111
US total	Momentary Sustained	2 3	605 1067	1893 4227

Impact of Grid West on Reliability

– Major immediate benefit from increased reliability of transmission system will be felt by reductions in customer costs

– BPA review of the major past outages showed that nearly half outages in the past years could be mitigated through Grid West.

– Using LBL analysis and BPA's findings the total potential for reducing customer's cost is over $145 million dollars.

Range of Customer Benefits ($M)

	4 CCA Case			10 CCA Case		
Mitigation	High	Base	Low	High	Base	Low Range
%	70%		-70%	70%		-70%
5%	25	14	4	51	30	9
10%	49	29	9	102	60	18
20%	**98**	**58**	**17**	**203**	**119**	**36**
30%	148	87	26	305	179	54
40%	197	116	35	406	239	72
50%	**246**	**145**	**43**	**508**	**299**	**90**

Utility Benefits from Increased Reliability

– Reduced regulatory requirements for significant increase in the transmission investments in response to increased outages.

– Reduced O&M costs in the long-term.

– Better economy of scale in response to outages

– Reduced cost of generation

– Reduced cost of blackstart

Grid West

Minimization and Elimination of Overlapping Benefits

- ***Redispatch, Rate Pancaking and Reconfiguration/Utilization***
  - Preschedule, Unit Commitment (see Modeling Process)
    - Affected by Reconfiguration Services (RCS)
    - IWRs are not pancaked
    - Physical system capabilities are optimized before the operating hour
  - Grid West Real-time Balancing and Redispatch (see Market and Operational Functions)
    - Affected by Real-time Balancing Service (RBS)
    - Forecast errors in preschedule are resolved during operating hour/real-time

- ***Reliability Categories***
  - Refer to slide: Types of Outages
  - Bulk Electric System Cascading Disturbances
  - Momentary and Sustained Outages

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Estimated Benefits of Grid West
Seminar Participant Benefits Worksheet

Cost Saving Category		4 Consolidating Control Areas				10 Consolidating Control Areas				
		High	Medium	Low		High	Medium	Low		**Participant Workspace**
Quantified Benefit Estimates		$ million/year				$ million/year				
1	Contingency Reserves	39	30	20		73	55	37		
2	Regulating Reserves	10	8	5		26	21	14		
3	Redispatch Efficiencies (PowerWorld simulations)	65	56	41		385	332	128		
4	Bulk Electric System Reliability - Cascading Disturbances	83	50	27		83	50	27		
5	Power Delivery System Reliability - Momentary, Sustained Outages (2002$)	98	58	17		203	119	36		
6	Rate Pancakes (TCA, GridView, Henwood)	61	20	4		61	20	4		
7	Reconfiguration-Transmission Utilization (GridView)	52	30	18		52	30	18		
<u>Qualitative Benefit Estimates</u>										
	Improved Transmission Planning									
	Long-term Siting Efficiencies									
	Construction Deferral (G, T and D)									
	Conservation and Demand Side Management	33	17	1		61	32	4		
	Coordinated Generation and Transmission Maintenance									
	Load Following									
	Market Innovation									
	Market Monitoring									
Totals ($millions per year)										
Notes:										
Highlighted items may include some benefit overlaps. See discussion in the report.										

Production Cost Savings Between No CCA and CCA (4 control areas)

Update History

July 9 batch updated runs	July 12 Heavy Summer update
July 16 spring/autumn reruns	July 28 Final Runs

Results expressed in $ per hour		Hydro Base Price ($/MWh)				
Case	WECC Designation	$20	$30	$40	$50	$65
Heavy						
Spring	HSP	$12,927	$10,574	$7,670	$5,862	$8,697
Summer	HS	$10,108	$8,702	$6,552	$9,357	$3,218
Autumn	HSP	$12,927	$10,574	$7,670	$5,862	$8,697
Winter	HW	$14,618	$13,645	$13,574	$13,531	$19,758
Light						
Spring	LSP	$266	$659	$53	$119	$27
Summer	LS	$12,505	$7,975	$3,850	$775	$194
Autumn	LSP	$266	$659	$53	$119	$27
Winter	LW	$7,406	$8,030	$8,534	$8,018	$14,312

Seasonal Tabulation

Heavy	Hours per Year	Seasonal Production Cost Savings ($)				
Spring	1240	$16,029,480	$13,111,760	$9,510,800	$7,268,880	$10,784,280
Summer	1648	$16,657,984	$14,340,896	$10,797,696	$15,420,336	$5,303,264
Autumn	816	$10,548,432	$8,628,384	$6,258,720	$4,783,392	$7,096,752
Winter	1216	$17,775,488	$16,592,320	$16,505,984	$16,453,696	$24,025,728
Light						
Spring	968	$257,488	$637,912	$51,304	$115,192	$26,136
Summer	1280	$16,006,400	$10,208,000	$4,928,000	$992,000	$248,141
Autumn	648	$172,368	$427,032	$34,344	$77,112	$17,496
Winter	956	$7,080,136	$7,676,680	$8,158,504	$7,665,208	$13,682,272

Annual Totals		
Low	$41,181,141	
Dow Jones	$56,416,193	
High	$65,457,195	Weighted by price frequency data shown below

Analysis of DJ Price Frequency for Use in Aggregation of Hourly Savings

2003 Daily Price	**20**	**30**	**40**	**50**	**65**
Spring Heavy	16	53	11	4	8
Summer Heavy	6	28	76	12	0
Autumn Heavy	0	53	8	0	0
Winter Heavy	2	38	42	4	4
Spring Light	48	31	2	4	7
Summer Light	26	75	21	0	0
Autumn Light	23	38	0	0	0
Winter Light	14	52	19	1	4

2004 Daily Price	**20**	**30**	**40**	**50**	**65**
Spring Heavy	2	32	51	7	0
Summer Heavy	14	34	38	36	1
Autumn Heavy	0	8	36	17	0
Winter Heavy	0	6	67	18	0
Spring Light	6	67	19	0	0
Summer Light	20	58	39	5	0
Autumn Light	0	23	33	5	0
Winter Light	0	36	49	6	0

2003 Values	**20**	**30**	**40**	**50**	**65**	**Total**	
Spring Heavy	$3,309,312	$8,966,752	$1,349,920	$375,168	$1,113,216	15,114,368	
Summer Heavy	$970,368	$3,898,496	$7,967,232	$1,796,544	$0	14,632,640	
Autumn Heavy	$0	$8,966,752	$981,760	$0	$0	9,948,512	
Winter Heavy	$467,776	$8,296,160	$9,121,728	$865,984	$1,264,512	20,016,160	$59,711,680
Spring Light	$12,768	$353,224	$8,056	$0	$0	374,048	
Summer Light	$2,000,800	$3,700,400	$1,201,200	$31,000	$0	6,933,400	
Autumn Light	$0	$121,256	$13,992	$4,760	$0	140,008	
Winter Light	$0	$2,312,640	$3,345,328	$384,864	$0	6,042,832	$13,490,288
						2003	**73,201,968**

2004 Values	**20**	**30**	**40**	**50**	**65**	**Total**	
Spring Heavy	$411,784	$5,389,279	$6,230,271	$653,560	$0	$12,684,894	
Summer Heavy	$2,253,900	$4,712,370	$3,965,509	$5,365,134	$51,254	$16,348,167	
Autumn Heavy	$0	$1,347,320	$4,397,839	$1,587,216	$0	$7,332,375	
Winter Heavy	$0	$1,303,966	$14,485,186	$3,879,215	$0	$19,668,366	$56,033,802
Spring Light	$1,589	$43,952	$1,002	$0	$0	$46,543	
Summer Light	$248,963	$460,448	$149,468	$3,857	$0	$862,736	
Autumn Light	$0	$15,088	$1,741	$592	$0	$17,421	
Winter Light	$0	$287,766	$416,265	$47,889	$0	$751,921	$1,678,621
						2004	**57,712,423**
						Average	**65,457,195**

Production Cost Savings Between No CCA and CCA (10 consolidated control areas)

Update History

July 9 batch updated runs — July 12 Heavy Summer update

July 16 spring/autumn reruns — July 28 Final Runs

Results expressed in $ per hour		Hydro Base Price ($/MWh)				
Case	WECC Designation	$20	$30	$40	$50	$65
Heavy						
Spring	HSP	$70,888	$54,578	$36,914	$15,793	$4,285
Summer	HS	$54,146	$40,674	$27,240	$19,993	$11,542
Autumn	HSP	$70,888	$54,578	$36,914	$15,793	$4,285
Winter	HW	$94,931	$81,768	$68,683	$64,153	$63,315
Light						
Spring	LSP	$21,464	$25,923	$15,639	$11,054	$544
Summer	LS	$72,710	$51,345	$33,140	$18,158	$5,202
Autumn	LSP	$21,464	$25,923	$15,639	$11,054	$544
Winter	LW	$71,357	$56,598	$42,547	$24,561	$16,430

Seasonal Tabulation

Heavy	Hours per Year	Seasonal Production Cost Savings ($)				
Spring	1240	$87,901,120	$67,676,720	$45,773,360	$19,583,320	$5,313,400
Summer	1648	$89,232,608	$67,030,752	$44,891,520	$32,948,464	$19,021,216
Autumn	816	$57,844,608	$44,535,648	$30,121,824	$12,887,088	$3,496,560
Winter	1216	$115,436,096	$99,429,888	$83,518,528	$78,010,048	$76,991,040
Light						
Spring	968	$20,777,152	$25,093,464	$15,138,552	$10,700,272	$526,592
Summer	1280	$93,068,800	$65,721,600	$42,419,200	$23,242,240	$6,658,202
Autumn	648	$13,908,672	$16,798,104	$10,134,072	$7,162,992	$352,512
Winter	956	$68,217,292	$54,107,688	$40,674,932	$23,480,316	$15,707,080

Annual Totals	
Low	$128,066,602
Dow Jones	$331,844,569
High	$385,543,588

Weighted by price frequency data shown below

Analysis of DJ Price Frequency for Use in Aggregation of Hourly Savings

2003 Daily Price	**20**	**30**	**40**	**50**	**65**
Spring Heavy	16	53	11	4	8
Summer Heavy	6	28	76	12	0
Autumn Heavy	0	53	8	0	0
Winter Heavy	2	38	42	4	4
Spring Light	48	31	2	4	7
Summer Light	26	75	21	0	0
Autumn Light	23	38	0	0	0
Winter Light	14	52	19	1	4

2004 Daily Price	**20**	**30**	**40**	**50**	**65**
Spring Heavy	2	32	51	7	0
Summer Heavy	14	34	38	36	1
Autumn Heavy	0	8	36	17	0
Winter Heavy	0	6	67	18	0
Spring Light	6	67	19	0	0
Summer Light	20	58	39	5	0
Autumn Light	0	23	33	5	0
Winter Light	0	36	49	6	0

2003 Values	**20**	**30**	**40**	**50**	**65**	**Total**	
Spring Heavy	$18,147,328	$46,282,144	$6,496,864	$1,010,752	$548,480	72,485,568	
Summer Heavy	$5,198,016	$18,221,952	$33,123,840	$3,838,656	$0	60,382,464	
Autumn Heavy	$0	$46,282,144	$4,724,992	$0	$0	51,007,136	
Winter Heavy	$3,037,792	$49,714,944	$46,154,976	$4,105,792	$4,052,160	107,065,664	$290,940,832
Spring Light	$8,242,176	$6,428,904	$250,224	$353,728	$30,464	15,305,496	
Summer Light	$15,123,680	$30,807,000	$5,567,520	$0	$0	51,498,200	
Autumn Light	$3,949,376	$7,880,592	$0	$0	$0	11,829,968	
Winter Light	$7,991,984	$23,544,768	$6,467,144	$196,488	$525,760	38,726,144	$117,359,808
						2003	**408,300,640**

2004 Values	20	30	40	50	65	Total	
Spring Heavy	$2,258,105	$27,816,918	$29,984,907	$1,760,776	$0	$61,820,706	
Summer Heavy	$12,073,574	$22,026,080	$16,486,639	$11,463,623	$183,833	$62,233,748	
Autumn Heavy	$0	$6,954,230	$21,165,816	$4,276,170	$0	$32,396,216	
Winter Heavy	$0	$7,814,047	$73,293,502	$18,392,082	$0	$99,499,632	$255,950,301
Spring Light	$1,025,589	$13,831,570	$2,366,323	$0	$0	$17,223,482	
Summer Light	$11,580,720	$23,715,789	$10,292,681	$723,019	$0	$46,312,209	
Autumn Light	$0	$4,748,151	$4,109,929	$440,150	$0	$9,298,230	
Winter Light	$0	$16,226,132	$16,602,613	$1,173,569	$0	$34,002,314	$106,836,235
						2004	**362,786,536**
						Average	**385,543,588**