

# SSG-WI 2008 Base Case



September 2005



# Base Case Objectives

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- **Estimate production costs for 2008**
  - Using different natural gas price assumptions
  - Total west-wide and area bases
- **Identify areas of transmission congestion**
- **Employ new modeling capabilities**
- **Refresh west-wide database**
  - Detailed resource and transmission information
  - Improved fuel price forecasts
  - Fuller coordination with states and subject matter experts

# Base Case Results

- Wheeling charges & line losses
- Variable operation & maintenance costs (VOM)
- Congestion indicated by Locational Marginal Prices (LMP)
- Evaluation of congested paths

*All analyses were conducted with transmission wheeling charges & line loss calculation, except as noted*



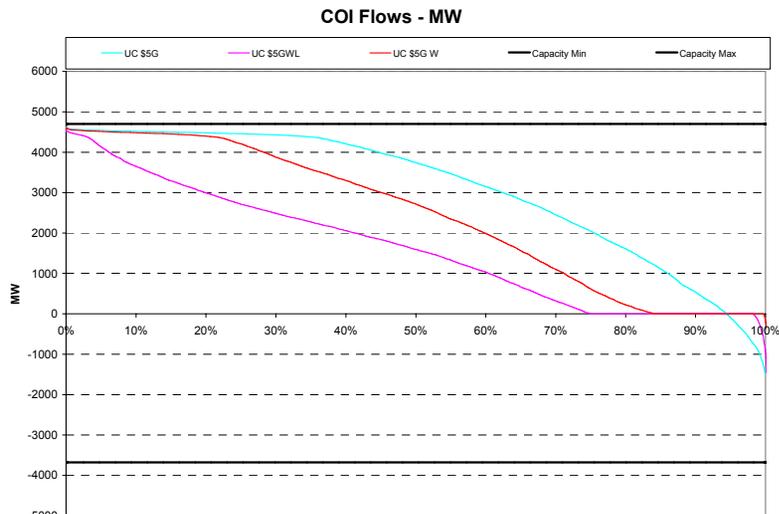
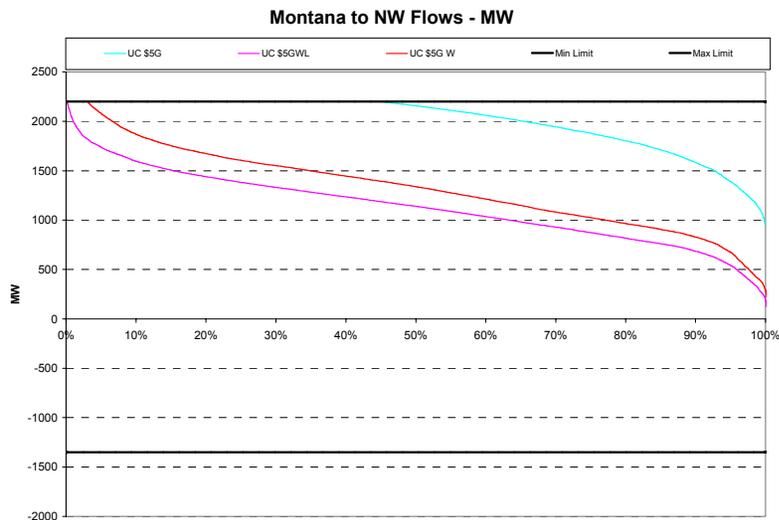
# Base Case Sensitivities

Base Henry Hub average prices in 2005 dollars			Transmission Losses
\$4 Gas	\$5 Gas	\$7 Gas	
	<b>X</b>		
	<b>X</b>		<b>X</b>
<b>X</b>			<b>X</b>
		<b>X</b>	<b>X</b>
2008 Average Loads & Average Hydro			

# Wheeling Charges and Line Losses



# Path Flow Impacts of Wheeling Charges and Transmission Losses



## Cases

- \$5 Gas: without line losses, and without wheeling charges
- \$5 Gas W: with wheeling charges
- \$5 Gas W L: with wheeling charges, and with line losses

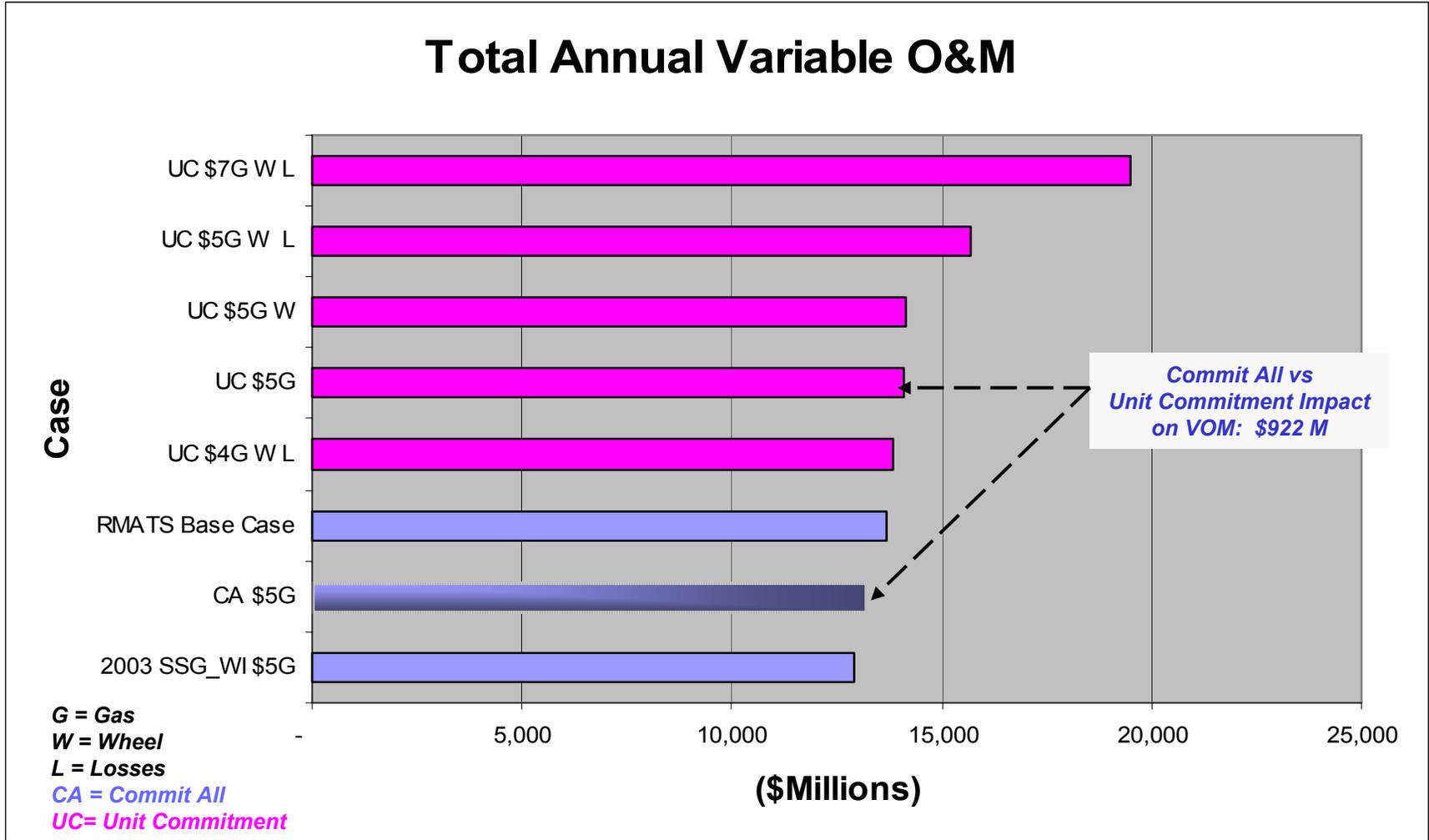
## Wheeling Charges

- Transmission wheeling charges place an added cost on using a line, which tends to reduce demand, in this case path flows (compare blue to red)

## Line Losses

- Transmission losses penalize the remote generator by requiring that more MWs be generated and sent on a line to meet demand at the other end. This added production cost makes remote generators more expensive and local generators more competitive, reducing flow on major transfer paths.

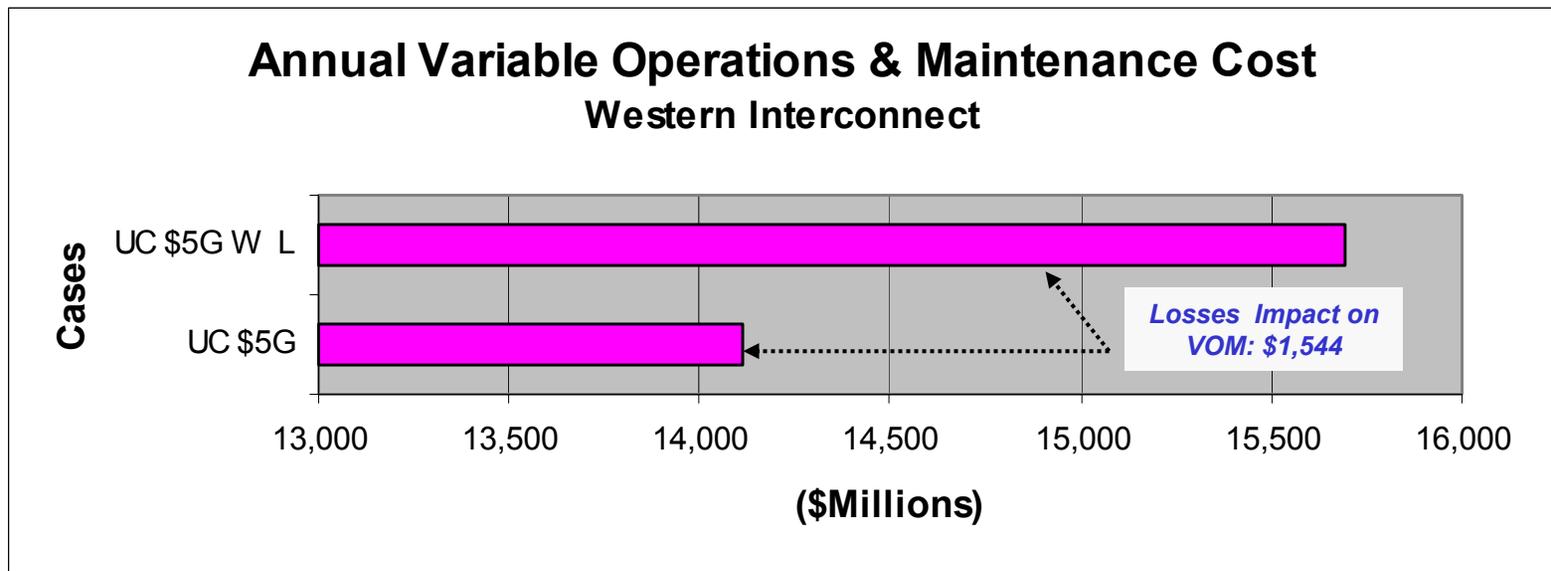
# Production Costs



# Production Cost Impact of Transmission Losses

In all cases, the model dispatches the least fuel cost generator (coal, wind, hydro). In the West, the least cost generators are far removed from the load centers, where local generation is less efficient (gas fired).

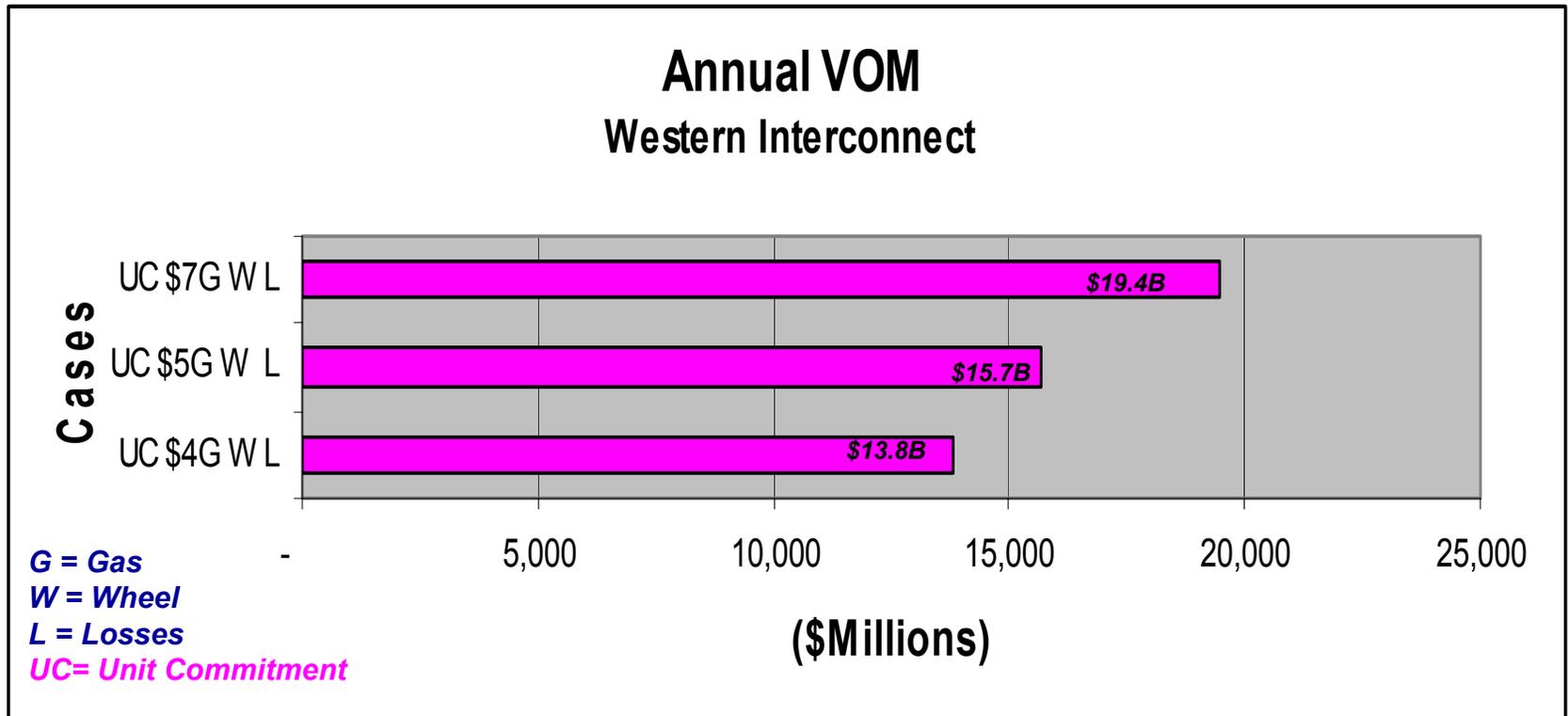
When we introduce losses, the remote generator has to generate more to offset them. Thus, the remote generator bears the cost of losses and becomes less competitive. The \$1,544 below is the fuel price driven differential between remote and local generation.



Note: Load Losses calculated by GridView, approximately 3% of total load, are applied on top of losses already embedded in the WECC loads; No simple way to back off Losses from WECC loads as losses = I<sup>2</sup>R and are time dependent.

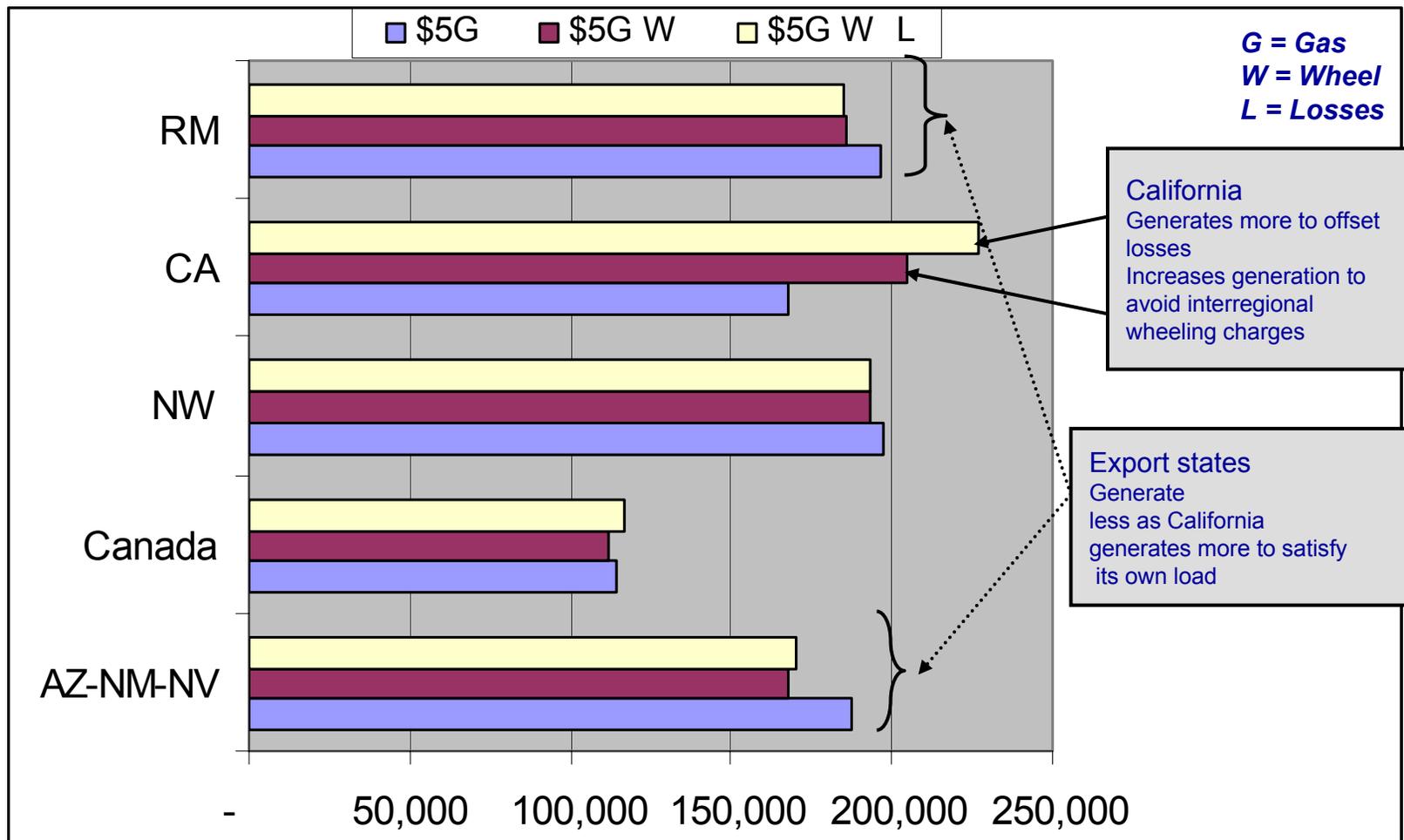
# Gas Price Sensitivities

*A \$2 increase in HH gas prices (\$5 to \$7 annual average) causes the West's annual production costs to increase by \$3.8 Billion*



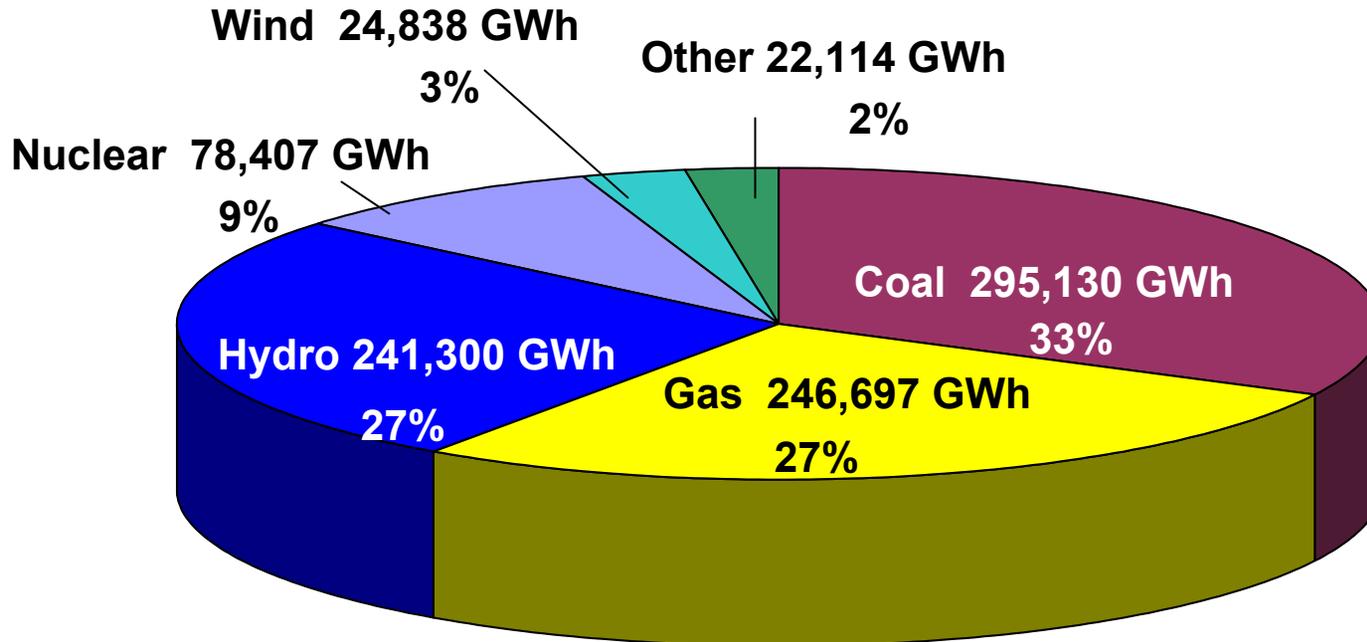
# Generation Impact of Wheeling Charges and Transmission Losses

Western Interconnect Annual Generation



# Generation (Energy) by Fuel Type

WECC Region – 2008 Base Case



**Total Generation = 908,486 GWh**

\$5 Henry Hub Gas, Wheeling Charges and Losses

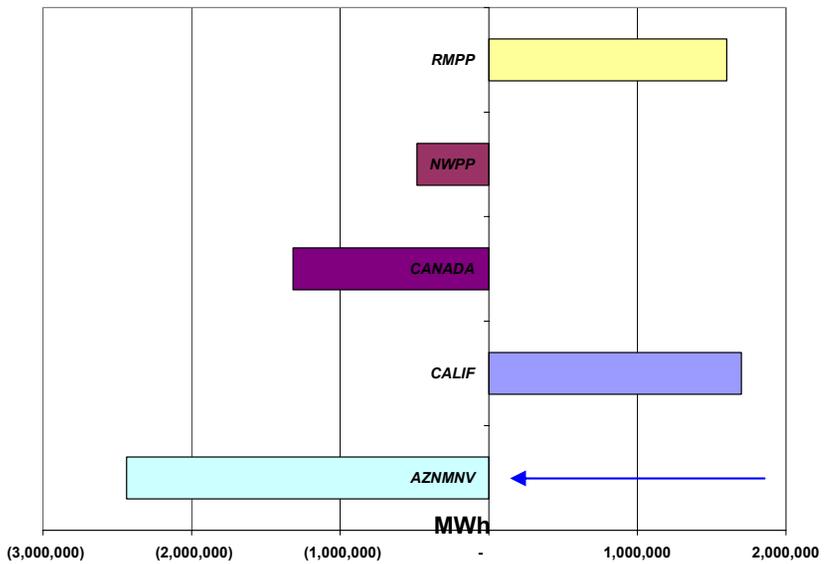
Hydro: Includes pumped storage

Other: Oil, Biomass, Geothermal, Solar

# Change in Generation by Region and Area

## Due to Gas Price Increase from \$5 to \$7/MMBtu

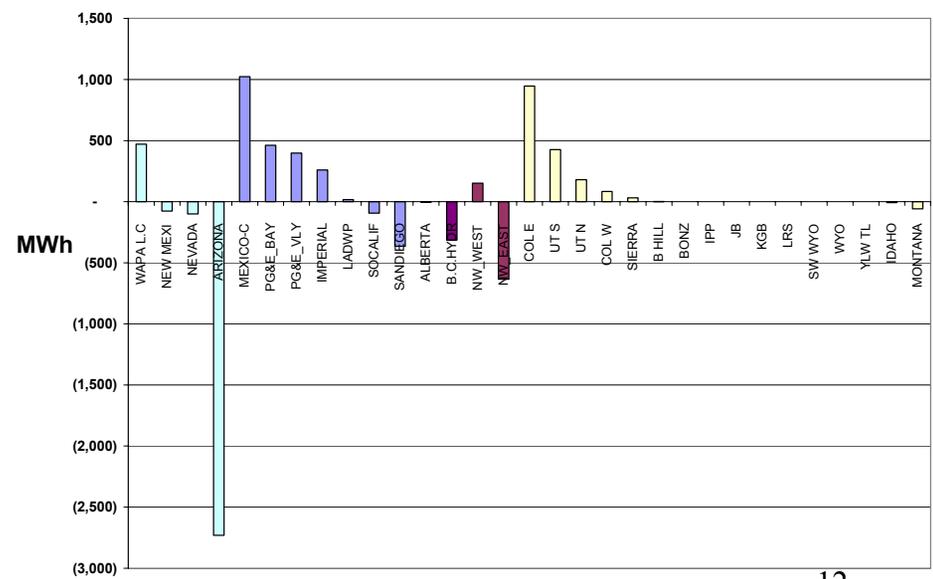
### Net Generation Change By Region



*Generation in Arizona shows the most dramatic reaction (reduction) to a change in Gas price from HH \$5 to \$7/MMBtu*

*Generation in Mexico-C and Colorado-East each show increases of approximately 1,000,000 MWh per year with the increased natural gas price*

### Net Generation Change By Area



# Change in Generation by Fuel Type

## Due to Gas Price Increase from \$5 to \$7/MMBtu

	GWh @ \$7 HH	GWh @ \$5 HH	Difference	Cap. Fact. @ \$7	Cap. Fact. @ \$5
Coal	295,132	295,130	0.0%	92.3%	92.3%
Gas	244,917	246,697	-0.7%	31.7%	31.9%
Hydro (Incl Pumped storage)	241,300	241,300	0.0%	42.7%	42.7%
Nuclear	78,407	78,407	0.0%	92.9%	92.9%
Wind	24,838	24,838	0.0%	44.8%	44.8%
Other	<u>23,955</u>	<u>22,114</u>	<u>8.3%</u>	<u>46.9%</u>	<u>43.3%</u>
	908,550	908,486	0.0%	49.1%	49.1%

*Minor reduction in gas generation after increase of gas price.*

*Most of the difference made up by dispatching plants using "Other" fuels*

### Breakdown of "Other" Fuel Category

GWh	GWh Gen @ \$7HH	GWh Gen @ \$5HH	Capacity GW	Cap. Factor @ \$7HH	Cap. Factor @ \$5HH
Solar	1,674	1,674	0.21	89.9%	89.9%
Bio	4,390	4,259	0.56	90.2%	87.0%
Geothermal	2,653	2,653	0.34	89.9%	89.9%
Oil-H	7,704	4,467	0.97	90.9%	51.3%
Oil-L	39	0	0.89	0.5%	0.0%
Petroleum Coke	2	2,261	0.31	0.1%	80.7%
Refuse	693	0	0.19	42.7%	0.0%
WH	229	229	0.03	96.5%	90.3%
Wood	6,572	6,572	0.82	91.5%	89.1%

*Oil-related fuels derivatives start dispatching at current oil price assumptions*

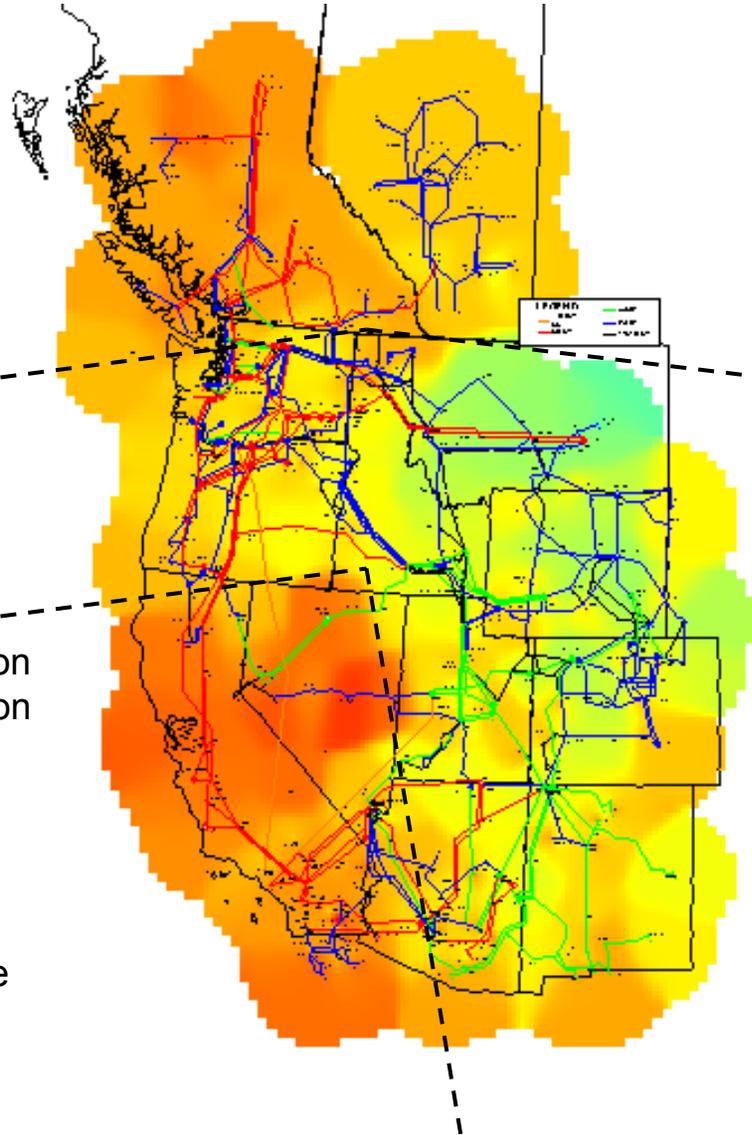
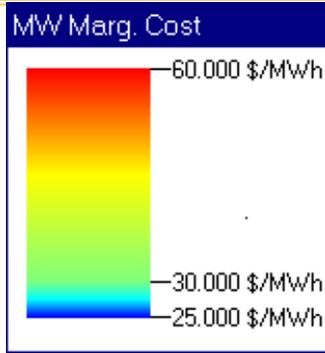
# Transmission Congestion via Locational Marginal Prices (LMPs)



# Transmission Congestion

Average for January 24, 2008

\$5 Gas



**Congested paths**

Contour maps can help identify opportunities for transmission expansion  
 Difference in colors indicates congestion

Congestion can be caused by transmission constraints and by transmission losses

A typical Winter and Summer day were chosen for this illustration

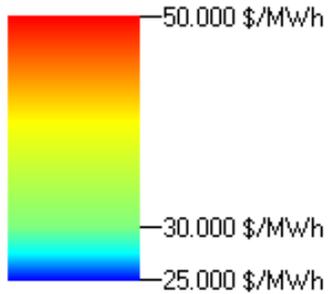
**2008 Base Case**  
 September 2005

# Transmission Congestion

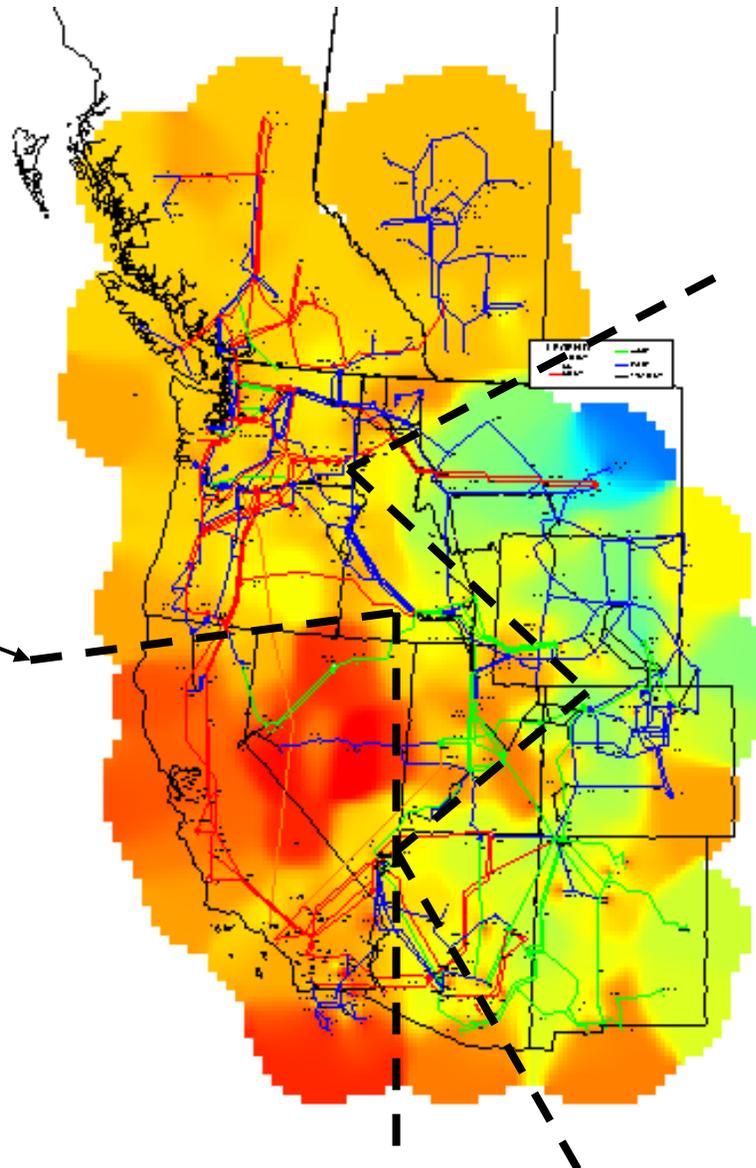
Average for August 11, 2008

\$5 Gas

MW Marg. Cost



Congested paths

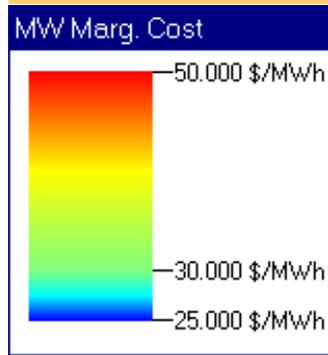


2008 Base Case  
September 2005

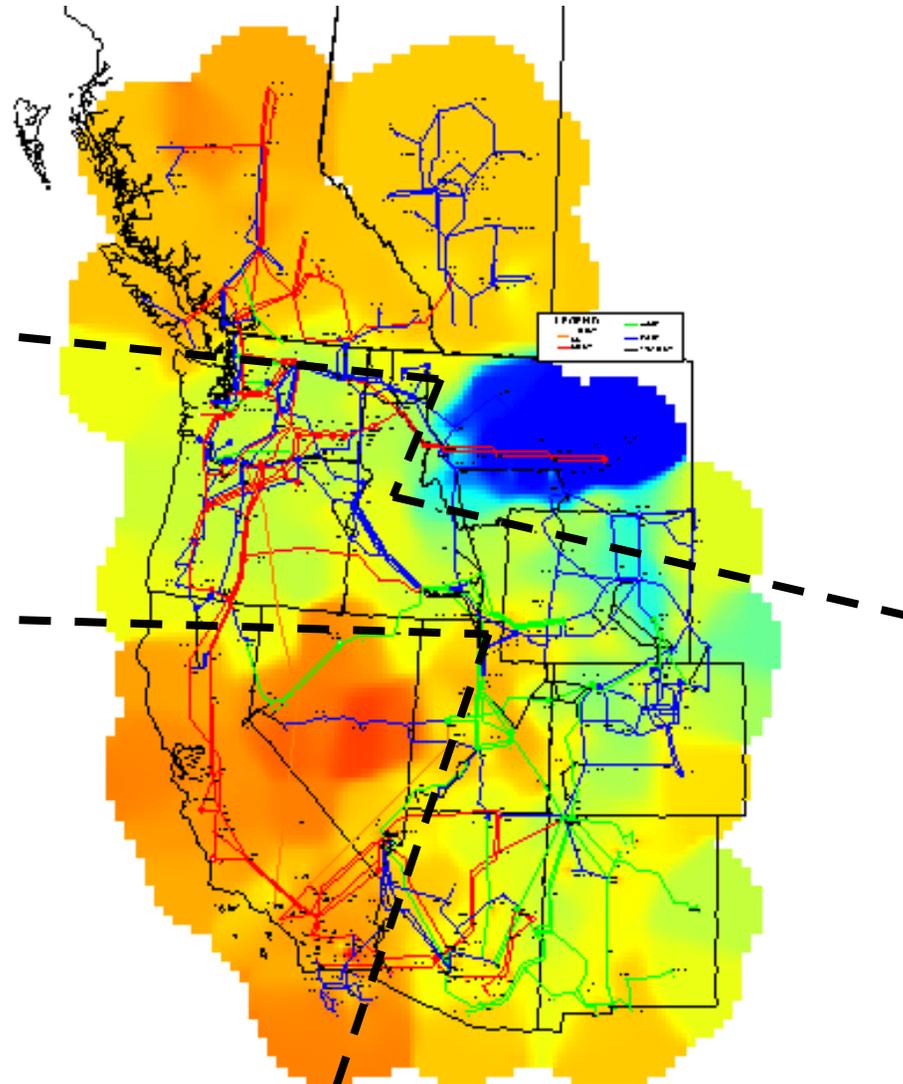
# Transmission Congestion

Average for June 16, 2008

\$5 Gas



Congested paths

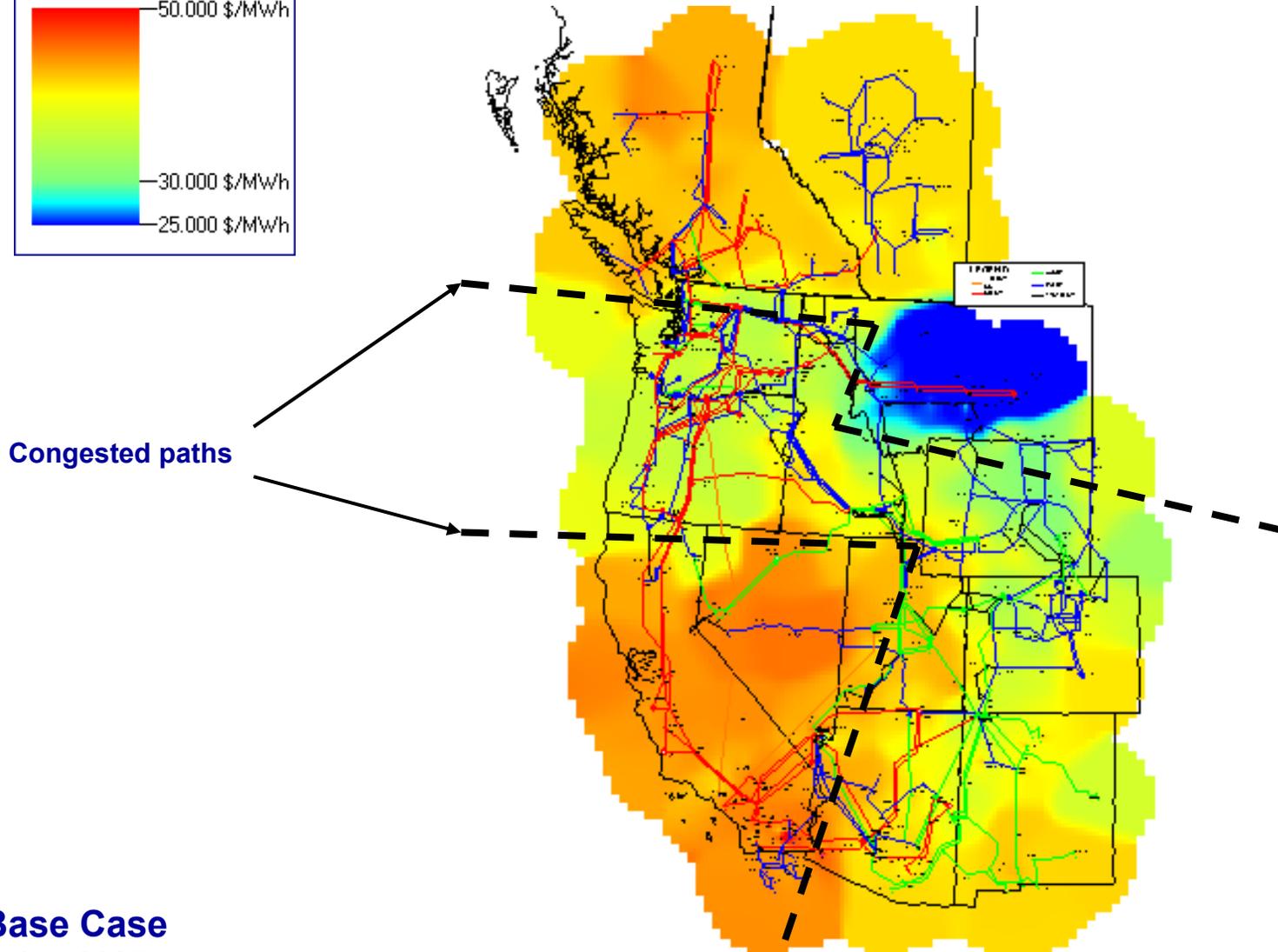
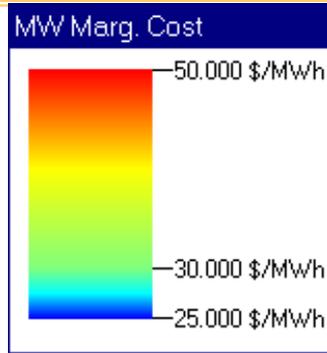


**2008 Base Case**  
September 2005

# Transmission Congestion

June 16, 2008 hr 10

\$5 Gas



**2008 Base Case**  
September 2005

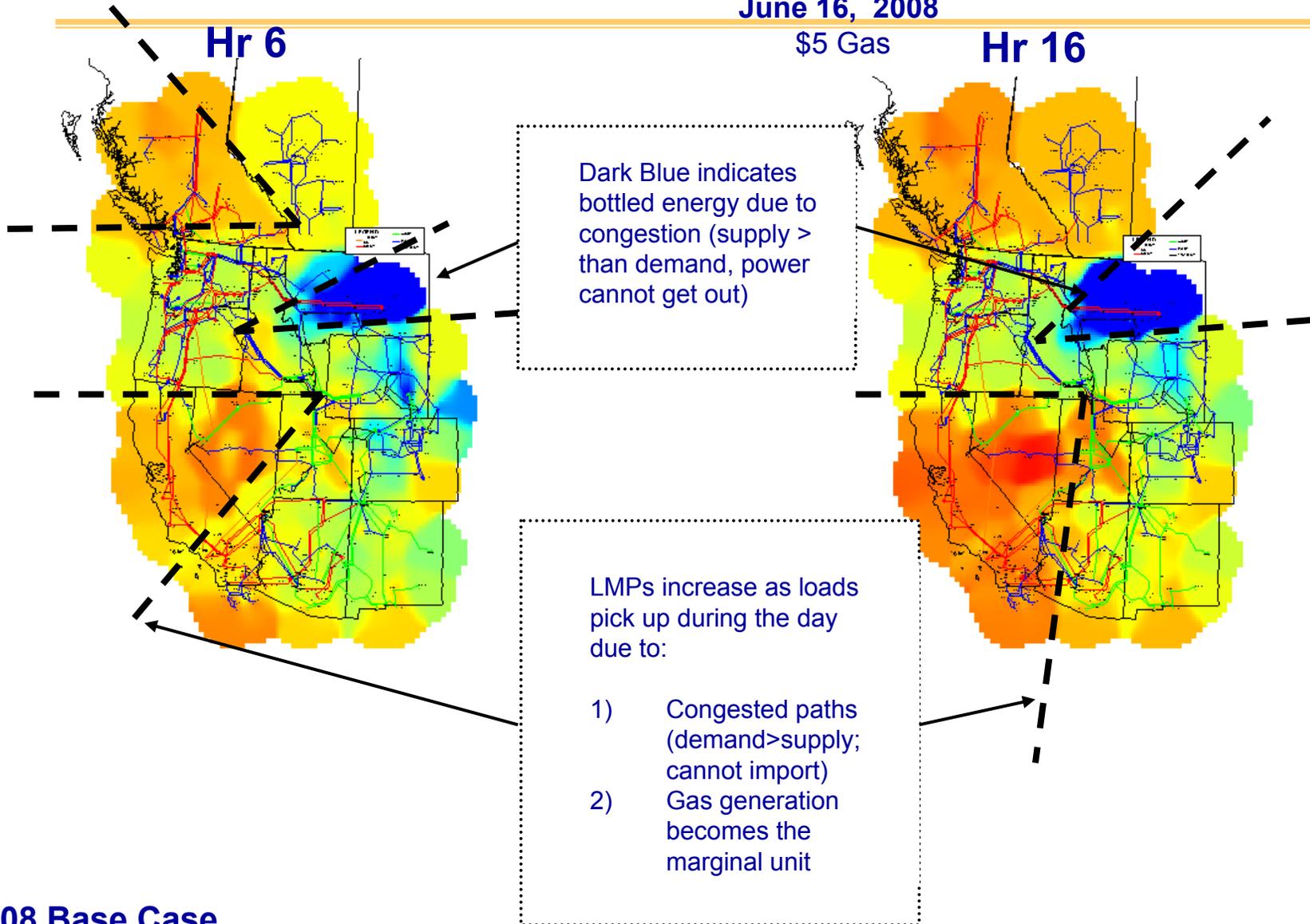
# Transmission Congestion

June 16, 2008

\$5 Gas

Hr 6

Hr 16



**2008 Base Case**  
September 2005

# Incremental Congestion Costs

Savings if capacity on congested paths increases by 1 MW

Interface Name	Forward Limit (MW)	Reverse Limit (MW)
IPP DC LINE	1920	-1400
PATH C	775	-850
Navajo - Crystal	1411	-1411
BONANZA WEST	785	
CORONADO - SILVER KING - KYRENE	1100	
NORTHWEST - CANADA	2000	-2800
ALBERTA - BRITISH COLUMBIA	700	-720
FOUR CORNERS 345_500	840	-840
SOUTHWEST OF FOUR CORNERS	2325	
TOT 2C	300	-300
BRIDGER WEST	2100	
TOT 1A	650	
PACIFICORP_PG&E 115 KV INTERCON.	80	-45
El Centro Bank	215	-215

Rank		
\$4 Gas	\$5 Gas	\$7 Gas
1	1	1
2	2	2
3	3	4
4	4	3
8	5	5
7	6	6
5	7	8
6	8	7
9	9	9
11	10	10
10	11	11
13	12	13
14	13	14
15	14	15

Congestion Cost (k\$) (Shadow Price X Path Flow)		
\$4 Gas	\$5 Gas	\$7 Gas
7,476	9,696	12,347
5,831	6,037	6,086
3,992	3,509	4,168
2,661	3,158	5,715
1,364	2,167	3,232
1,484	1,955	2,780
1,949	1,899	2,097
1,515	1,644	2,379
550	835	945
364	595	857
503	360	645
217	186	201
151	152	157
115	127	157

Incremental congestion costs, combined with line-loading data (see duration curves later in this package), help to focus potential investment.



# Key Assumptions

- Network representation
- Loads
- Resources
- Fuel Prices



# Network Representation and Topology

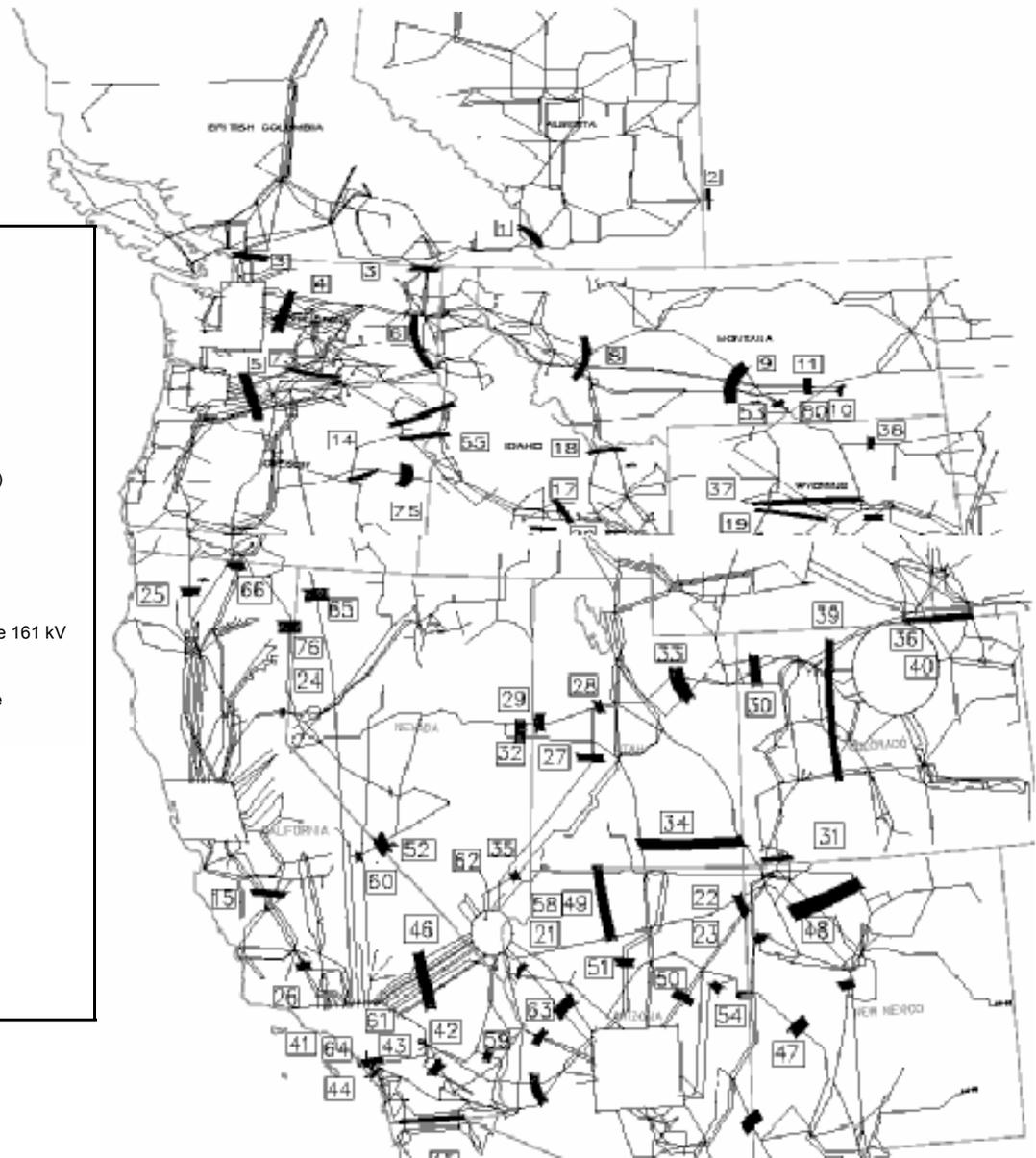
- **Used WECC Powerflow case (2008 HS2A) for network definition**
  - Powerflow case includes transmission assets and resources, and simulates power flows.
  - Case was rerun to net out station service capacity from Pmax and to include updates since the case was published.
  - Case was not rerun to reflect currently planned resources as revisions were applied direct in GridView.
  
- **Used WECC 22-bubble network topology, with these exceptions:**
  - The single NW bubble is split into west and east NW bubbles.
  - The single PG&E bubble is split into Bay Area and PG&E bubbles to accommodate variations in load shapes.
  - The RMATS topology is used for the Rocky Mountain states, except that the Montana bubbles are reduced from 2 to 1. The SSG\_WI topology includes a total of 33 bubbles.



# Western Interconnect

## Major Paths

- |  |   |
|--|---|
| 1. Alberta-British Columbia                | 38. TOT 4B                                |
| 2. Alberta-Saskatchewan                    | 39. TOT 5                                 |
| 3. Northwest-Canada                        | 40. TOT 7                                 |
| 4. West of Cascades-North                  | 41. Sylmar to SCE                         |
| 5. West of Cascades-South                  | 42. IID-SCE                               |
| 6. West of Hatwai                          | 43. North of San Onofre                   |
| 7. Intentionally Left Blank                | 44. South of San Onofre                   |
| 8. Montana to Northwest                    | 45. SDG&E-CFE                             |
| 9. West of Broadview                       | 46. West of Colorado River (WOR)          |
| 10. West of Colstrip                       | 47. Southern New Mexico (NM1)             |
| 11. West of Crossover                      | 48. Northern New Mexico (NM2)             |
| 12. Intentionally Left Blank               | 49. East of the Colorado River (EOR)      |
| 13. Intentionally Left Blank               | 50. Cholla-Pinnacle Peak                  |
| 14. Idaho to Northwest                     | 51. Southern Navajo                       |
| 15. Midway-Los Banos                       | 52. Silver Peak-Control 55 kV             |
| 16. Idaho-Sierra                           | 54. Coronado West                         |
| 17. Borah West                             | 55. Brownlee East                         |
| 18. Idaho-Montana                          | 58. Eldorado-Mead 230 kV Lines            |
| 19. Bridger West                           | 59. WALC Blythe 161 kV -SCE Blythe 161 kV |
| 20. Path C                                 | 60. Inyo-Control 115 kV Tie               |
| 21. Arizona to California                  | 61. Lugo-Victorville 500 kV Line          |
| 22. Southwest of Four Corners              | 62. Eldorado-McCullough 500 kV line       |
| 23. Four Corners 345/500 Qualified Path    | 63. Perkins-Mead-Marketplace 500 kV Line  |
| 24. PG&E-Sierra                            | 64. Marketplace-Adelanto                  |
| 25. PacifiCorp/PG&E 115 kV Interconnection | 65. Pacific DC Intertie (PDCI)            |
| 26. Northern-Southern California           | 66. COI                                   |
| 27. Intermountain Power Project DC Line    | 71. South of Allston                      |
| 28. Intermountain-Mona 345 kV              | 73. North of John Day                     |
| 29. Intermountain-Gonder 230 kV            | 75. Midpoint-Summer Lake                  |
| 30. TOT 1A                                 | 76. Alturas Project                       |
| 31. TOT 2A                                 | 77. Crystal-Allen                         |
| 32. Pavant-Gonder 230 kV                   | 78. TOT 2B1                               |
| 33. Bonanza West                           | 79. TOT 2B2                               |
| 35. TOT 2C                                 | 80. Montana Southeast                     |
| 36. TOT 3                                  |   |
| 37. TOT 4A                                 |   |



# SSG-WI Path Limits

## WECC Path Catalogue Operating Limits & Other Adjustments Made by SSG\_WI

Interface Name	Forward Limit (MW)	Reverse Limit (MW)
ALBERTA - BRITISH COLUMBIA	700	-720
ALBERTA - SASKATCHEWAN	150	-150
ALTURAS PROJECT	300	-300
BILLINGS - YELLOWTAIL	400	-400
BONANZA WEST	785	
BORAH WEST	2307	
BORAH WEST	2200	
BROWNLEE EAST	1850	
CHOLLA - PINNACLE PEAK	1200	
COI	4700	-3675
CORONADO - SILVER KING - KYRENE	1100	
Crystal - H Allen 500 kV PS	950	
Crystal - H Allen 230 kV PS	950	
Devers Bank No. 1	1120	-1120
EAGLE MTN 230_161 KV - BLYTHE 16		-218
EI Centro Bank	215	-215
EOR	8055	
FOUR CORNERS 345_500	840	-840
HA-Red Butte PS	300	-300
IDAHO - MONTANA	337	-337
IDAHO - NORTHWEST	2400	-1200
IDAHO - SIERRA	500	-360
IID - SCE	600	
INTERMOUNTAIN - GONDER 230 KV	220	
INTERMOUNTAIN - MONA 345 KV	1400	-1200
INYO - CONTROL 115 KV TIE	56	-56
IPP DC LINE	1920	-1400

Interface Name	Forward Limit (MW)	Reverse Limit (MW)
MIDPOINT - SUMMER LAKE	1500	-600
MIDWAY - LOS BANOS	5400	
MONTANA - NORTHWEST	2200	-1350
NORTH OF JOHN DAY	8600	-8600
North of Miguel	2000	
NORTH OF SAN ONOFRE	2440	
NORTHERN NEW MEXICO (NM2)	1665	-1450
NORTHWEST - CANADA	2000	-2800
NW to Canada East BC	400	-400
PACI vs PDCI	7300	
PACIFIC DC INTERTIE (PDCI)	3000	-2100
PACIFICORP_PG&E 115 KV INTERCON.	80	-45
Path 26	3700	-3000
Path 45	408	-800
PATH C	775	-850
PAVANT INTRMTN - GONDER 230 KV	440	-235
PERKINS - MEAD - MARKETPLACE 500	1400	
PG&E - SPP	160	-150
Pinto - 4 Corners PS	600	-600
PV West	3600	
SCIT	16700	-16700
SDGE Import Limit	2850	
Shiprock - Lost Canyon PS	400	-400
Sigurd - Glen Canyon PS	300	-300
SILVER PEAK - CONTROL 55 KV	17	-17
South of Lugo	6100	-6100
South of Navajo	2264	

Interface Name	Forward Limit (MW)	Reverse Limit (MW)
SOUTH OF SAN ONOFRE	2500	
SOUTHERN NEW MEXICO (NM1)	1048	-1048
SOUTHWEST OF FOUR CORNERS	2325	
SYLMAR - SCE	1600	-1600
TOT 4a 4b combined	1096	
TOT 1A	650	
TOT 2A	690	
Tot 2a 2b 2c Nomogram	1570	-1600
TOT 2B	780	-850
TOT 2B1	560	-600
TOT 2B2	265	-300
TOT 2C	300	-300
TOT 3	1450	
TOT 4A	810	
TOT 4B	680	
TOT 5	1675	
TOT 7	890	
WEST OF BROADVIEW	2573	
WEST OF CASCADES - NORTH	10500	-10500
WEST OF CASCADES - SOUTH	7000	-7000
WEST OF COLSTRIP	2598	
WEST OF CROSSOVER	2598	
WEST OF HATWAI	2750	
WOR	10623	
WOR - IID230	600	-600
WOR - N.Gila	1861	
WOR -n- El Dor to Lugo	2754	
WOR -n- Mc-Vic	2592	

# Wheeling Charges

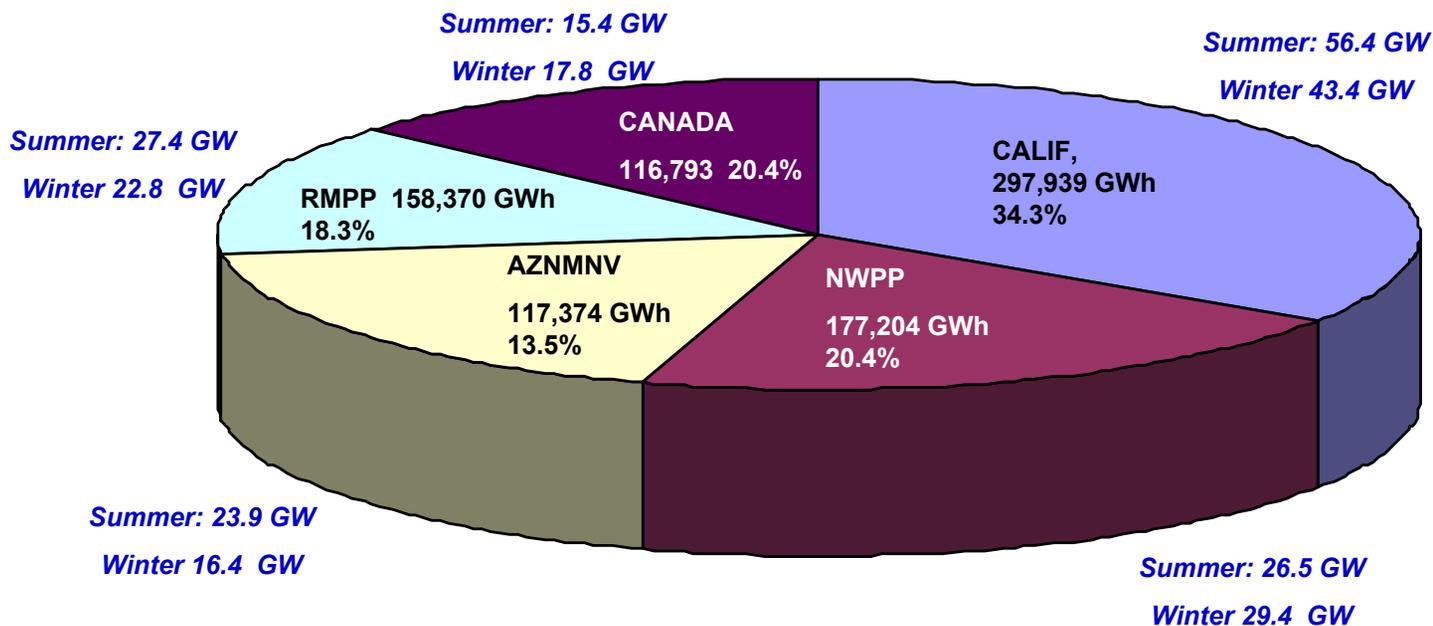
<b>INTERTIE</b>	<b>Forward, \$/MW</b>	<b>Based on Tariff for:</b>	<b>Reverse, \$/MW</b>	<b>Based on Tariff for:</b>
ALBERTA - BRITISH COLUMBIA	4.00	<i>Alberta</i>	5.00	<i>BC Hydro</i>
NORTHWEST - CANADA	2.96	<i>BPA Network</i>	5.00	<i>BC Hydro</i>
MONTANA - NORTHWEST	7.86	<i>BPA NT plus Mt Intertie</i>	2.96	<i>BPA Network</i>
IDAHO - NORTHWEST	2.07	<i>IDAHO</i>	3.60	<i>Ave Avista, BPA, PacifiCorp</i>
IDAHO - SIERRA	2.07	<i>IDAHO</i>	6.00	<i>SPPC</i>
IDAHO - MONTANA	2.07	<i>IDAHO</i>	4.25	<i>Northwestern</i>
PACIFICORP_PG&E 115 KV INTERCON.	5.84	<i>PacifiCorp</i>	3.20	<i>PG &amp; E</i>
INTERMOUNTAIN - MONA 345 KV	9.00	<i>LADWP</i>	5.84	<i>PacifiCorp</i>
INTERMOUNTAIN - GONDER 230 KV	9.00	<i>LADWP</i>	6.00	<i>SPPC</i>
TOT 1A	2.50	<i>WAPA UC</i>	7.42	<i>Deseret</i>
PAVANT INTRMTN - GONDER 230 KV	5.84	<i>PacifiCorp</i>	6.00	<i>SPPC</i>
TOT 2B	5.84	<i>PacifiCorp</i>	2.80	<i>ARIZONA</i>
TOT 2C	5.84	<i>PacifiCorp</i>	4.09	<i>NEVADA</i>
TOT 3	3.00	<i>Estimate</i>	3.00	<i>Estimate</i>
Z2-EOR	2.80	<i>ARIZONA</i>	3.10	<i>SOCALIF</i>
PACIFIC DC INTERTIE (PDCI)	6.35	<i>BPA NT plus Intertie</i>	12.39	<i>LADWP + Intertie</i>
Z6-COI	6.35	<i>BPA NT plus Intertie</i>	6.59	<i>PG &amp; E + Intertie</i>

- Charges above are based on published tariffs (Non-firm, on-peak hourly charge for originating utility)
- Because the charge is determined by the area's originating utility it may be different by direction (Forward/Reverse) on a path.
- The charges are modeled at a path, not line, level. Intent is to show friction between control areas, not all charges between the 33 SSG-Wi bubbles. This may make comparison of wheeling charge assumptions with some other studies difficult.
- Pacific DC Intertie Rate : Bonneville Power Administration (BPA) has two different types of tariff. The Intertie rate is used to bring power into the network. The Intertie rate itself is not a network tariff. Charges for transactions using the Intertie attract its charge as well as the originating utility's wheeling rate.

# 2008 Load Forecast:

## Annual Energy and Non-Coincident Peaks (GW)

Based on WECC L&R Forecast issued in 2004, with SSG-WI modifications



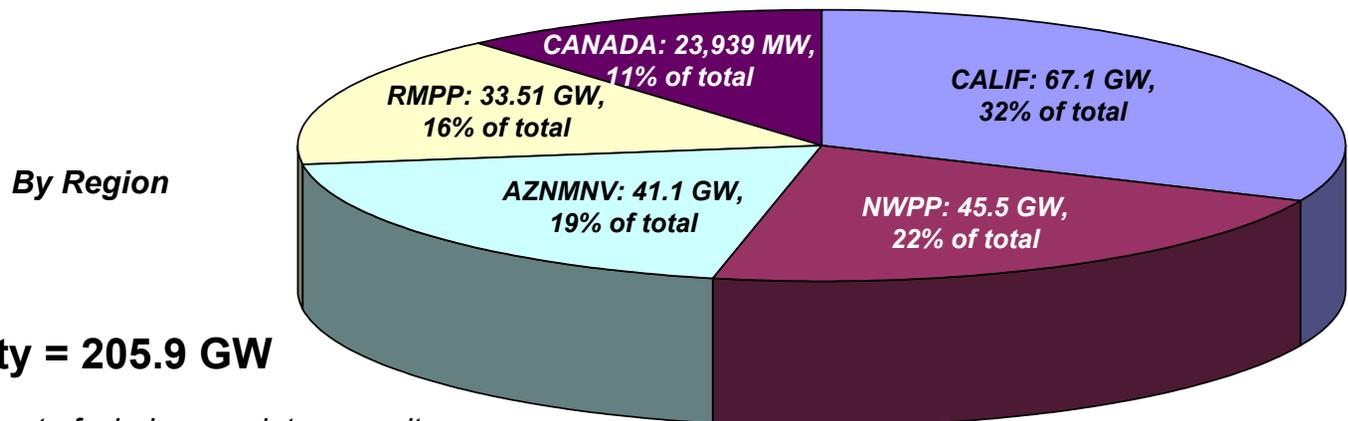
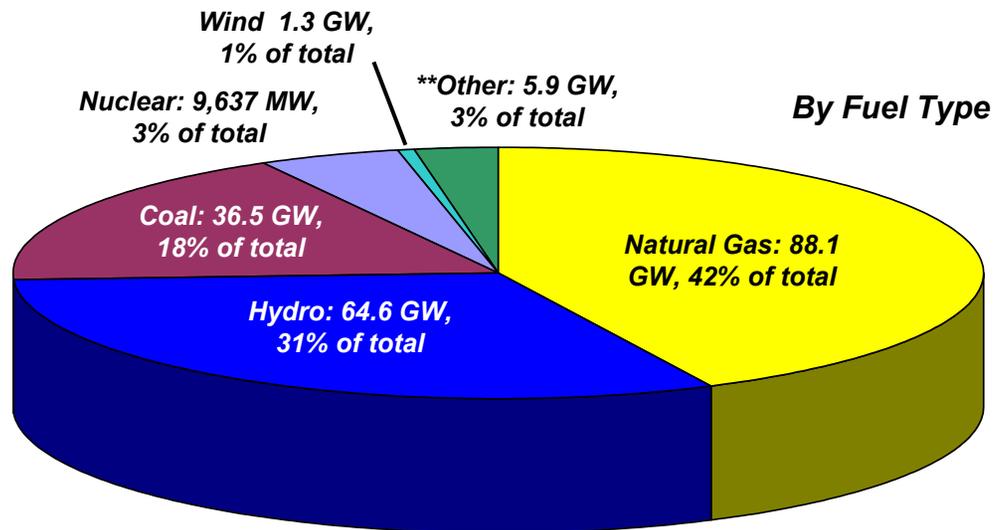
**Total Load (Energy): 867,680 GWh**  
**Total Non-Coincident Summer Peak: 149.5 GW**

# WECC Non-Coincident Peak Load by Area

		<i>Summer MW</i>	<i>Winter MW</i>			<i>Summer MW</i>	<i>Winter MW</i>
		<i>July-August</i>	<i>Dec-Jan</i>			<i>July-August</i>	<i>Dec-Jan</i>
		<i>Summer MW</i>	<i>Winter MW</i>			<i>Summer MW</i>	<i>Winter MW</i>
CAISO	IMPERIAL	740	351	RMPP	B HILL	851	835
CAISO	LADWP	5,396	4,059	RMPP	BHB	425	474
CAISO	MEXICO-C	1,631	1,223	RMPP	BONZ	197	147
CAISO	PG&E_BAY	7,998	6,887	RMPP	COL E	8,878	7,920
CAISO	PG&E_VLY	17,240	13,103	RMPP	COL W	871	913
CAISO	SANDIEGO	3,254	3,091	RMPP	IDAHO	3,025	2,311
CAISO	SOCALIF	20,106	14,652	RMPP	IPP	1	1
	<i>Total</i>	<b>56,365</b>	<b>43,366</b>	RMPP	JB	1	1
				RMPP	KGB	1,275	965
AZNMNV	ARIZONA	15,204	10,578	RMPP	LRS	531	520
AZNMNV	NEVADA	4,998	2,592	RMPP	MONTANA	1,611	1,620
AZNMNV	NEW MEXI	3,290	2,882	RMPP	SIERRA	1,737	1,439
AZNMNV	WAPA L.C	358	355	RMPP	SW WYO	481	400
	<i>Total</i>	<b>23,850</b>	<b>16,407</b>	RMPP	UT N	6,256	4,295
				RMPP	UT S	967	672
CANADA	ALBERTA	8,217	8,570	RMPP	WYO	338	289
CANADA	B.C.HYDR	7,199	9,187	RMPP	YLW TL	1	1
	<i>Total</i>	<b>15,416</b>	<b>17,757</b>		<i>Total</i>	<b>27,446</b>	<b>22,803</b>
NWPP	NW_EAST	10,955	12,017				
NWPP	NW_WEST	15,508	17,378				
	<i>Total</i>	<b>26,463</b>	<b>29,395</b>				
<b>Total West Non-Coincident Peak MW</b>						<b>149,540</b>	<b>129,728</b>

	<i>Summer MW</i>	<i>Winter MW</i>
	<i>July-August</i>	<i>Dec-Jan</i>
<b>Coincident West Peak MW</b>	<b>143,710</b>	<b>123,673</b>

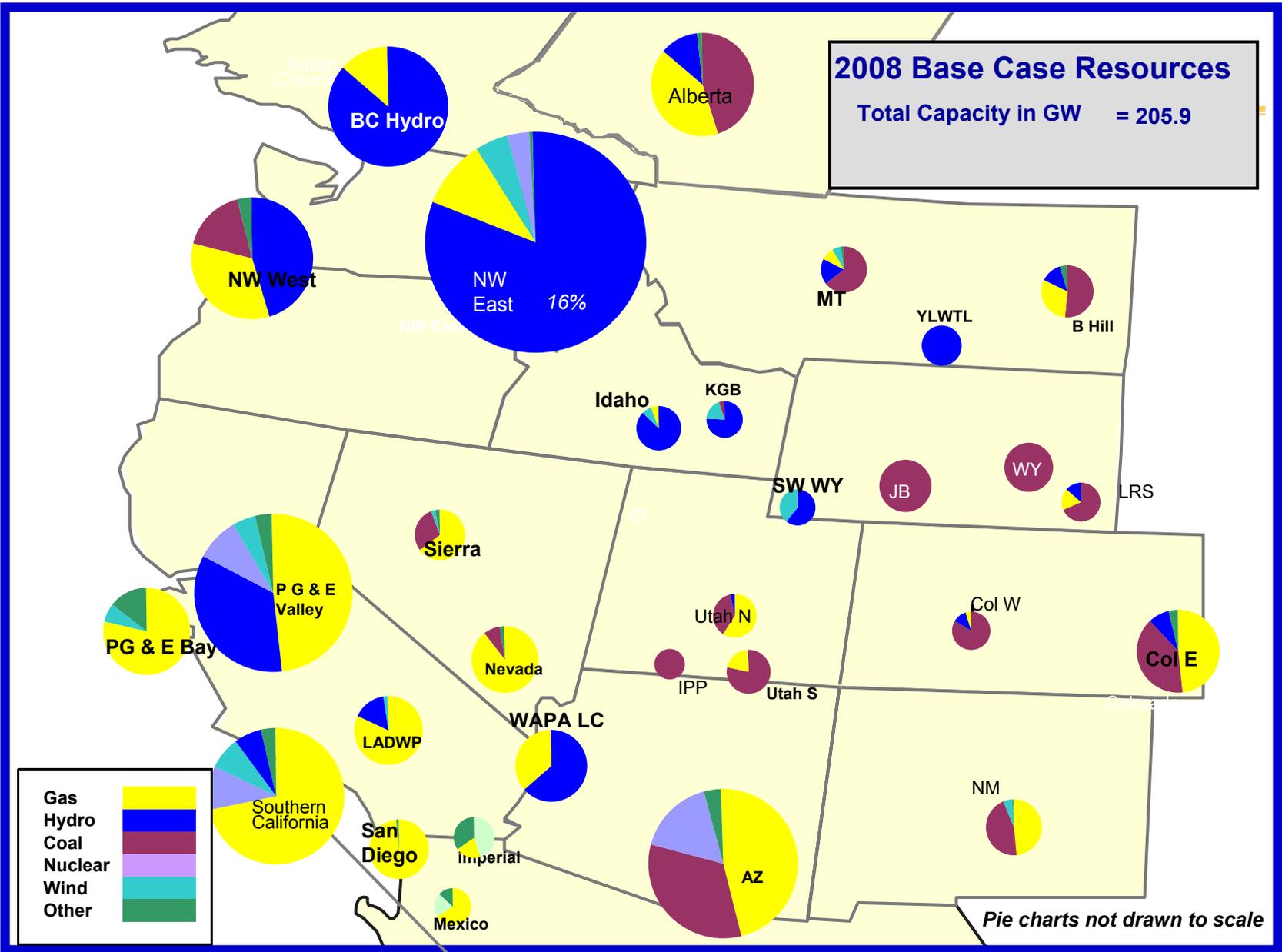
# WECC Resource Capacity by Fuel Type and Region



**Total WECC \*Capacity = 205.9 GW**

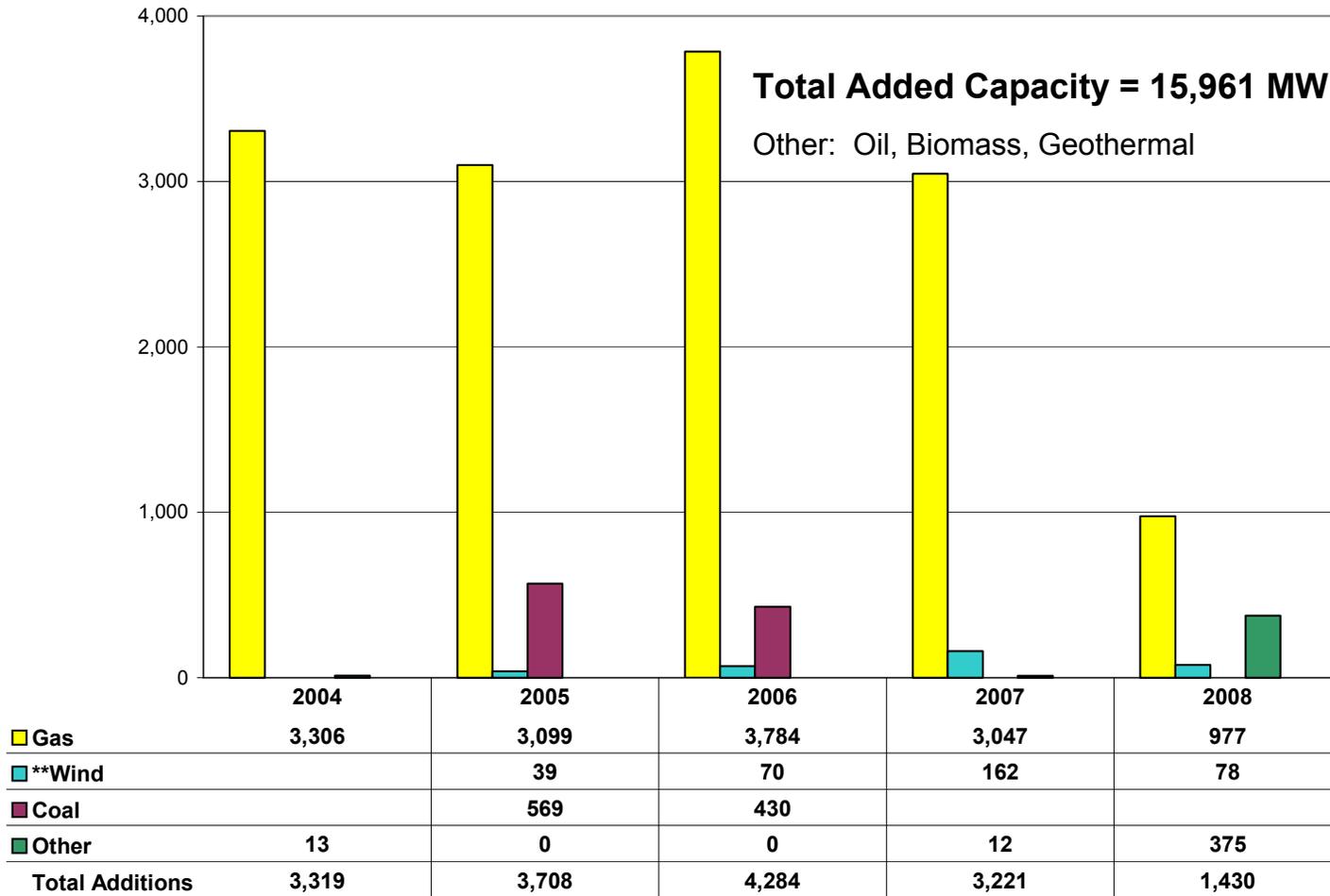
\*Capacity includes 80% discount of wind nameplate capacity

\*\*Other: Oil, Biomass, solar, oils



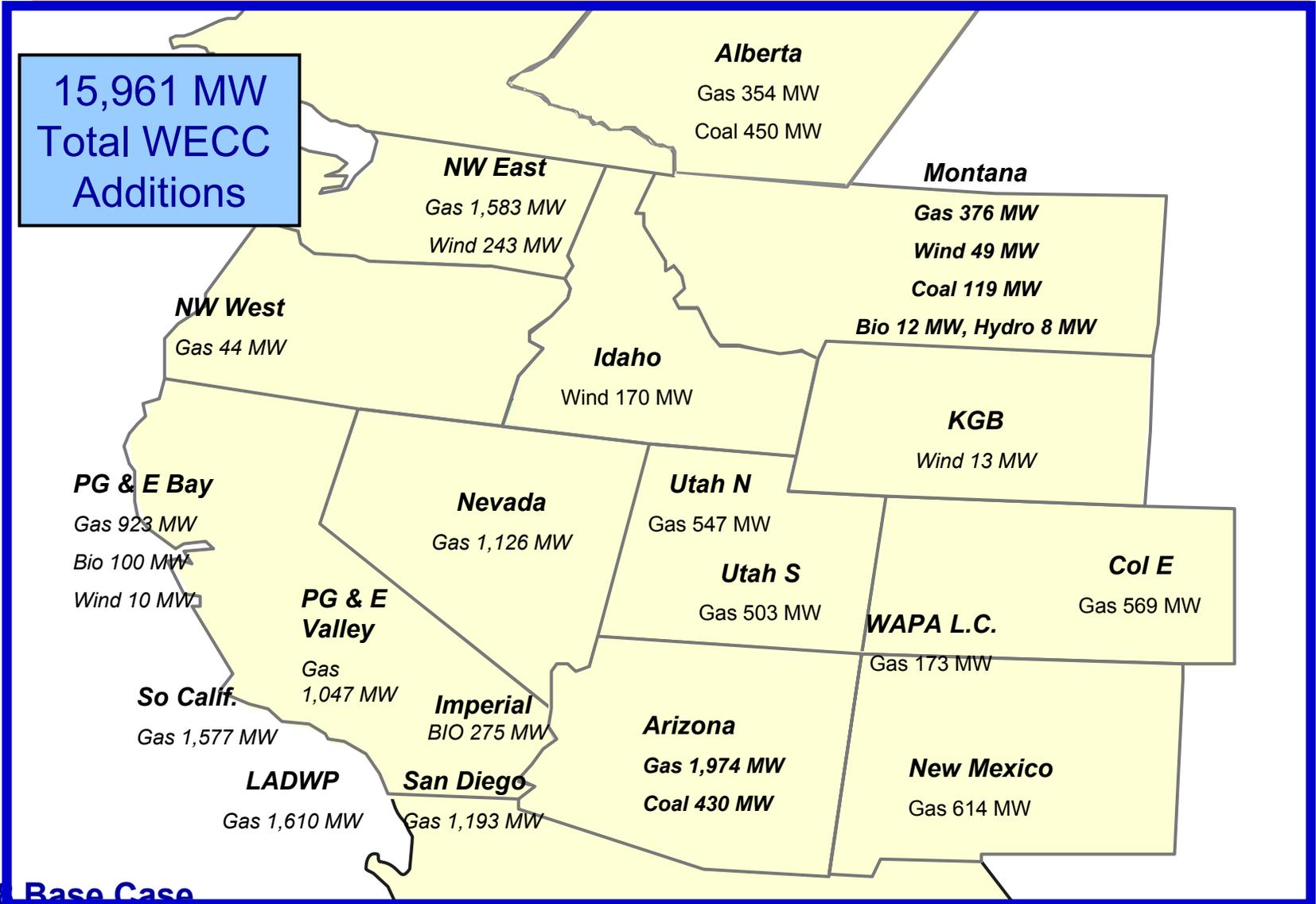
**2008 Base Case**  
September 2005

# New Capacity 2004-2008 by Fuel Type



*\*Wind is shown at 80% discount to installed capacity*

# NEW CAPACITY BY AREA 2004-2008



2008 Base Case

September 2005

\*Wind is shown at 80% discount to installed capacity

# **Modeling Assumptions for Hydro and Wind Units**

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## **Hydro:**

- Northwest hydro generation reflects on historical hourly generation for high (yr 1999), low (yr 2003) and medium (yr 2002) hydro years.
- California and British Columbia actual data were aggregated by river system

## **Wind:**

- Shapes applied to most wind generation was supplied by National Renewable Energy Lab
- CAISO provided wind shapes for its areas based on actual data

Both hydro and wind are treated as fixed inputs to model

## **Modeling Assumptions for Thermal Unit Operation**

### **Generic, unit-level operational assumptions were developed in a manner that:**

- allows dispatch and production costs to be simulated with reasonable accuracy
- takes into account technical expertise and views of States, SPGs and others
- protects commercial sensitivities
- ensures licensing agreements are respected

### **Generic, unit based assumptions include:**

- Heat rate curves, minimum and summer de-rated capacity
- Minimum up and down times, forced outage and planned maintenance rates
- Variable non-fuel O&M (operation & maintenance) and start-up costs

# Development of Generic Assumptions:

## Heat Rate Curve Example

Use publicly available information, previous studies (SSG-WI, RMATS), and input from states and experts to identify 1,200+ units.

Assign units to thermal unit “buckets” based on:

- Technology type
- Capacity
- Fuel
- Vintage

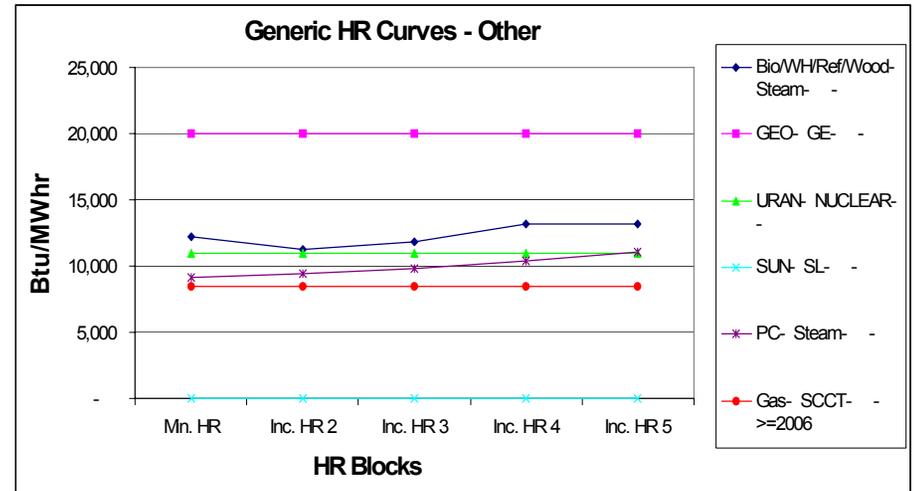
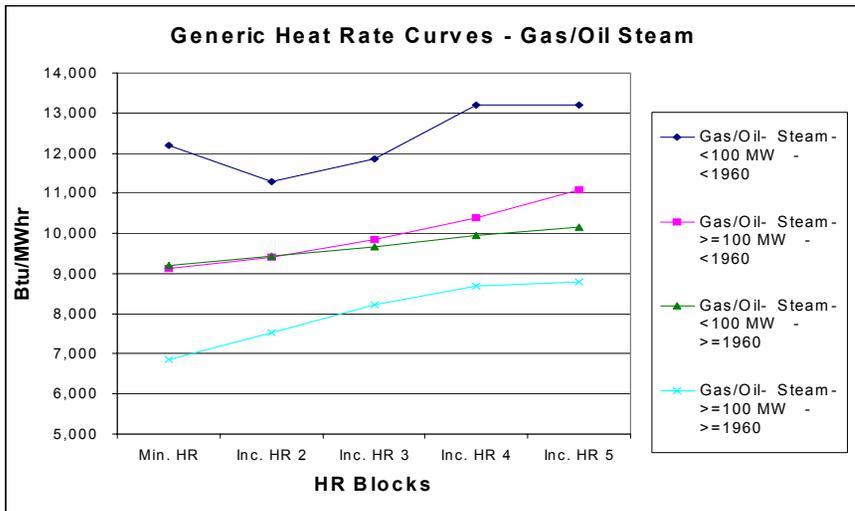
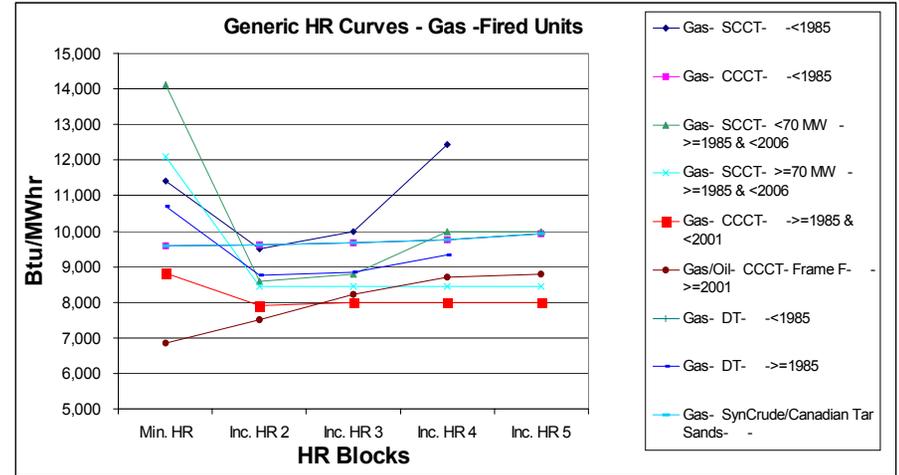
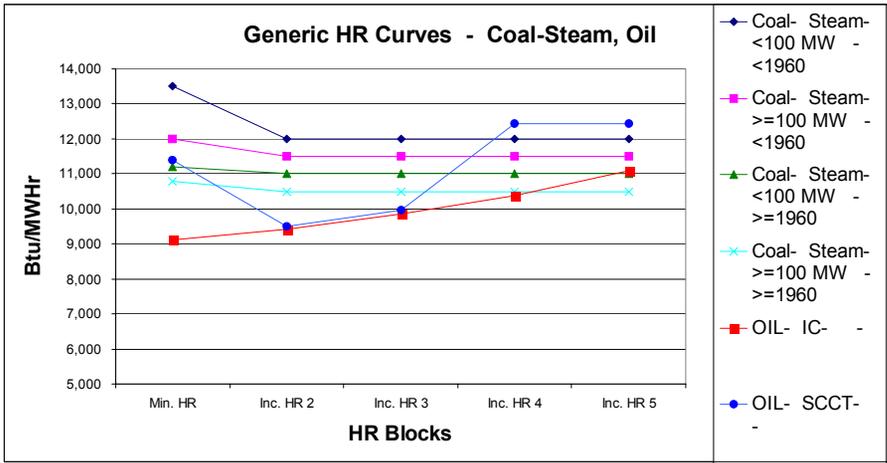
Use commercial database to supply unit-level data that best represents each thermal bucket.

### SSG-WI 2008 Database

Apply a generic curve to all units in a bucket.

Certain plants in California had heat rate curves published in a CEC paper. Those curves for the corresponding units in this study.

# Generic Heat Rate Curves by Fuel, Technology



# Thermal Unit Generic Assumptions

## (Non-Heat Rate Related)

Bucket	Fuel	Technology	Size	Vintage	Heatrate	Non-Fuel Var. O&M (\$/MWh)	Forced Outage Rate (FOR)	Forced Outage Duration Hrs	Planned Maint. Rate (PMR)	De-rate for Summer	Ave. Maint. Days	Ramp Rate (MW/Min)	Start-Up Costs \$/Start
1	Gas/Oil	Steam	<100 MW	<1960	12.5	5.00	0.071	55	0.105	0.973	38	1	-
2	Gas/Oil	Steam	>=100 MW	<1960	11.5	5.00	0.071	55	0.105	0.973	38	1	-
3	Gas/Oil	Steam	<100 MW	>=1960	10.5	5.00	0.071	55	0.105	0.973	38	1	-
4	Gas/Oil	Steam	>=100 MW	>=1960	9.500001	3.00	0.071	55	0.105	0.973	38	1	-
5	Gas	SCCT		<1985	13.5	8.00	0.036	89	0.041	0.88	15	1	7,000
6	Gas	CCCT		<1985	9.3	5.00	0.055	22	0.041	0.931	15	1	7,000
7	Gas	SCCT	<70 MW	>=1985 & <2006	10.5	5.00	0.036	89	0.041	0.88	15	1	7,000
8	Gas	SCCT	>=70 MW	>=1985 & <2006	10.7	5.00	0.036	89	0.041	0.88	15	1	7,000
9	Gas	CCCT		>=1985 & <2001	7.25	2.00	0.055	22	0.041	0.931	15	1	7,000
10	Gas/Oil	CCCT- Frame F		>=2001	7	2.00	0.055	22	0.041	0.931	15	1	7,000
11	Gas	DT		<1985	9.57	5.00	0.055	22	0.041	0.931	15	1	-
12	Gas	DT		>=1985	7.46	5.00	0.055	22	0.041	0.931	15	1	-
13	Gas	CCCT/SynCrude/Canadian Oil Sands			5.8	5.00	0.036	89	0.041	0.931	15	1	7,000
14	OIL	IC			11	13.25	0.036	55	0.105	0.973	38	1	7,000
15	OIL	SCCT			13.5	8.00	0.036	55	0.041	0.88	15	1	7,000
16	Coal	Steam	<100 MW	<1960	12	4.00	0.066	38	0.071	0.973	26	2.5	15,000
17	Coal	Steam	>=100 MW	<1960	11.5	2.00	0.066	38	0.071	0.973	26	2.5	15,000
18	Coal	Steam	<100 MW	>=1960	11	3.00	0.066	38	0.071	0.973	26	2.5	15,000
19	Coal	Steam	>=100 MW	>=1960	10.5	2.00	0.066	38	0.071	0.973	26	2.5	15,000
20	Bio/WH/Re	Steam			12.5	5.00	0.071	38	0.105	0.973	38	1	15,000
21	GEO	GE			20	4.00	0.071	16	0.105	1	38	1	-
22	URAN	NUCLEAR			11		0.07	298	0.075	1	27	1	-
23	SUN	SL						1	0.105		38	1	-
24	PC	Steam			11	21.00	0.071	55	0.105	0.973	38	1	-
25	Gas	SCCT		>=2006	8.5	5.00	0.036	55	0.041	0.88	15	1	7,000
26	Gas/Oil	CCCT- Frame G	>450 MW	>=2008	6.3	2.00	0.036	22	0.041	0.931	15	1	7,000

Buckets for generic assumptions were defined by Generation Sub-Group

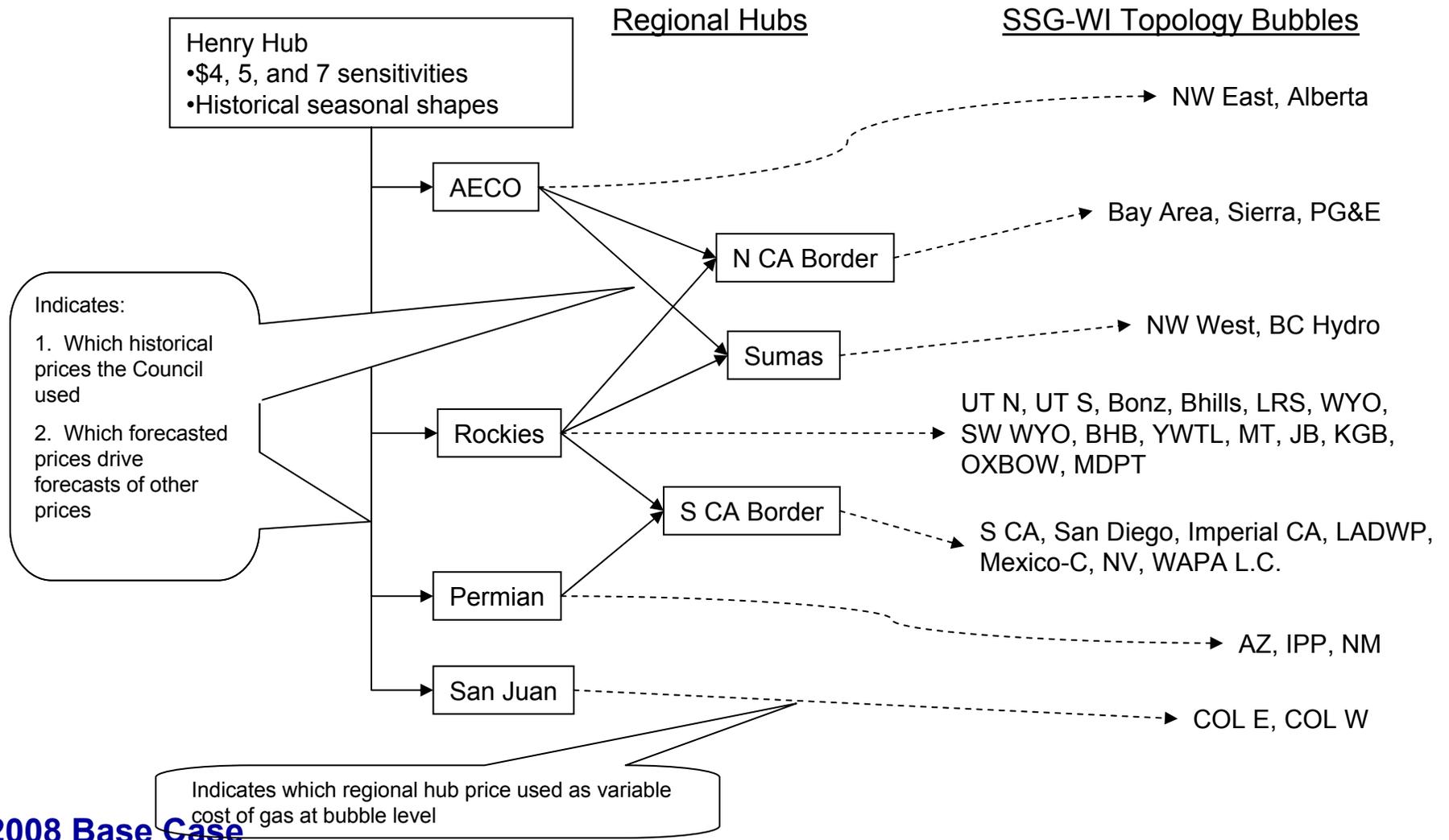
# Gas Price Assumptions

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- Objective was to estimate the variable component of gas prices for the SSG-WI topology
  - Based on Henry Hub annual average price scenarios (\$4, 5, and 7 in 2005 dollars)
  - Prices determine gas unit dispatch and fuel costs in each SSG-WI bubble
- Northwest Power and Conservation Council's data and methodology was used
  - As reflected in final version of *Fifth Northwest Electric Power and Conservation Plan*
  - Council employs historical hub price data from last 20+ years
  - Linear regression used to forecast prices at Henry Hub, other regional hubs, and some burner tip areas
- Seasonal patterns were added to Council's prices

# Gas Price Basis & Transportation:

## Drivers of the variable cost of gas



# Gas Prices by SSG-WI Topology

Based on \$5.00 2008 annual average Henry Hub - \$4 and \$7 sensitivities were also run  
 2008 gas price forecast (in 2005\$/MMBtu)

Area	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
ALBERTA	\$4.89	\$4.88	\$4.75	\$4.05	\$3.95	\$3.97	\$3.99	\$4.01	\$4.00	\$4.01	\$4.23	\$4.37
ARIZONA	\$5.42	\$5.40	\$5.26	\$4.53	\$4.43	\$4.45	\$4.47	\$4.49	\$4.48	\$4.49	\$4.73	\$4.87
B.C.HYDRO	\$5.01	\$4.99	\$4.86	\$4.17	\$4.08	\$4.10	\$4.12	\$4.14	\$4.12	\$4.14	\$4.36	\$4.49
BAY AREA	\$5.70	\$5.68	\$5.55	\$4.86	\$4.76	\$4.78	\$4.80	\$4.82	\$4.80	\$4.82	\$5.04	\$5.18
BHB	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
BHILLS	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
BONZ	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
COL E	\$4.84	\$4.83	\$4.71	\$4.09	\$4.01	\$4.03	\$4.04	\$4.06	\$4.05	\$4.06	\$4.26	\$4.38
COL W	\$4.84	\$4.83	\$4.71	\$4.09	\$4.01	\$4.03	\$4.04	\$4.06	\$4.05	\$4.06	\$4.26	\$4.38
IMPERIAL CA	\$5.67	\$5.66	\$5.52	\$4.82	\$4.73	\$4.75	\$4.77	\$4.79	\$4.77	\$4.79	\$5.01	\$5.15
IPP	\$5.42	\$5.40	\$5.26	\$4.53	\$4.43	\$4.45	\$4.47	\$4.49	\$4.48	\$4.49	\$4.73	\$4.87
JB	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
KGB	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
LADWP	\$5.67	\$5.66	\$5.52	\$4.82	\$4.73	\$4.75	\$4.77	\$4.79	\$4.77	\$4.79	\$5.01	\$5.15
LRS	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
MDPT BOISE & SNAKE	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
MEXICO-C	\$5.67	\$5.66	\$5.52	\$4.82	\$4.73	\$4.75	\$4.77	\$4.79	\$4.77	\$4.79	\$5.01	\$5.15
MONTANA	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
NEVADA	\$5.67	\$5.66	\$5.52	\$4.82	\$4.73	\$4.75	\$4.77	\$4.79	\$4.77	\$4.79	\$5.01	\$5.15
NEW MEXICO	\$5.42	\$5.40	\$5.26	\$4.53	\$4.43	\$4.45	\$4.47	\$4.49	\$4.48	\$4.49	\$4.73	\$4.87
NW EAST	\$4.89	\$4.88	\$4.75	\$4.05	\$3.95	\$3.97	\$3.99	\$4.01	\$4.00	\$4.01	\$4.23	\$4.37
NW WEST	\$5.01	\$4.99	\$4.86	\$4.17	\$4.08	\$4.10	\$4.12	\$4.14	\$4.12	\$4.14	\$4.36	\$4.49
OXBOW/HELLS CANYON	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
PG AND E	\$5.70	\$5.68	\$5.55	\$4.86	\$4.76	\$4.78	\$4.80	\$4.82	\$4.80	\$4.82	\$5.04	\$5.18
SAN DIEGO	\$5.67	\$5.66	\$5.52	\$4.82	\$4.73	\$4.75	\$4.77	\$4.79	\$4.77	\$4.79	\$5.01	\$5.15
SIERRA	\$5.70	\$5.68	\$5.55	\$4.86	\$4.76	\$4.78	\$4.80	\$4.82	\$4.80	\$4.82	\$5.04	\$5.18
SO CALIF	\$5.67	\$5.66	\$5.52	\$4.82	\$4.73	\$4.75	\$4.77	\$4.79	\$4.77	\$4.79	\$5.01	\$5.15
SW WYO	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
UT N	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
UT S	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
WAPA L.C.	\$5.67	\$5.66	\$5.52	\$4.82	\$4.73	\$4.75	\$4.77	\$4.79	\$4.77	\$4.79	\$5.01	\$5.15
WYO	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36
WYF	\$4.81	\$4.80	\$4.68	\$4.07	\$3.99	\$4.00	\$4.02	\$4.04	\$4.03	\$4.04	\$4.23	\$4.36

**2008 Base Case**  
 September 2005

# Coal Price Assumptions

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- **Source: EIA's 2005 Outlook**
- **Transportation costs are key uncertainty**
- **Distance, mode of transportation, source basin and demand region are drivers of transportation costs**
- **EIA employs two transportation price “tiers”:**
  - reflects historical averages/trends
  - captures higher cost of expanded shipping distances in large demand regions

# Coal Price by SSG-WI Topology

<b>SSG-WI Topology Bubble</b>	<b>2008 Coal Price</b> Includes Transportation adder in 2008\$/MMBtu, assuming 2.5% yearly inflation rate
ARIZONA	1.49
Big Horn Basin (BHB)	0.44
Colorado East (COL E)	0.97
Colorado West (COL W)	1.10
IPP	1.18
Jim Bridger (JB)	1.06
MONTANA	0.62
NEVADA	1.18
NEW MEXICO	1.47
Northwest West (NW WEST)	1.52
Utah North (UT N)	1.12
Wyoming (WYO)	0.53

# Other Fuel Price Assumptions

<b>FUEL</b>	<b>\$/MMBtu</b>	<b>Source</b>
Biomass	\$2.22	RMATS Study
Oil-L, Petroleum Coke	\$6.62	RMATS Study
Oil-H	\$4.42	
Geothermal, Waste Heat	\$1.105	RMATS Study
Refuse	\$4.41	RMATS Study
Uranium	\$0.60	RMATS Study

# Validation



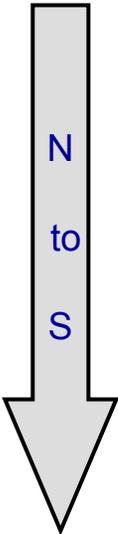
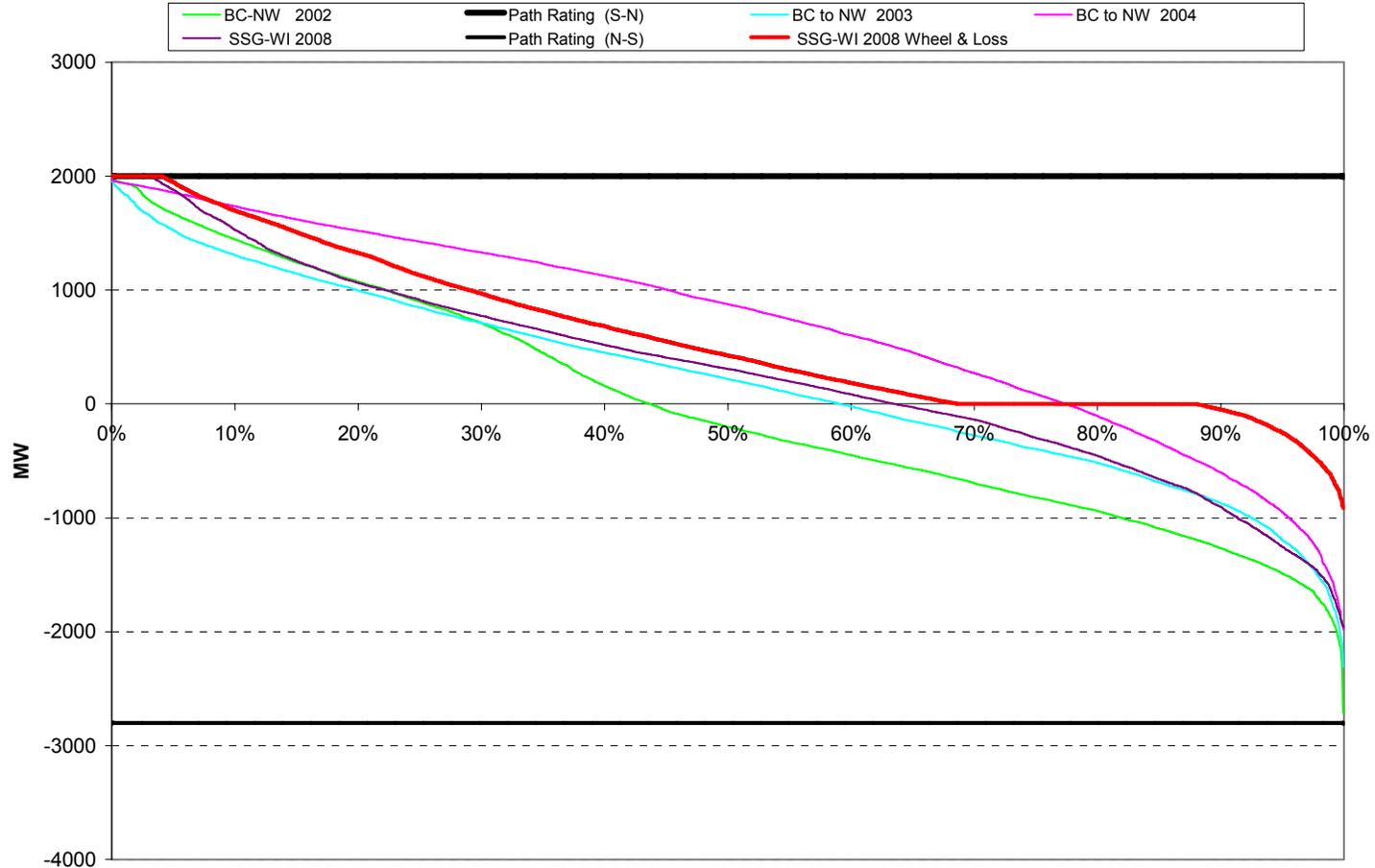
# Benchmarking modeling results to historical actual

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- **The objective is to compare patterns of path loading**
- **For all paths**
  - Historic actual loads are compared to 2008 base case
  - Based on \$5 Gas, transmission wheeling and losses
- **Must consider modeling limitations when drawing conclusions**
  - Comparing historic actual to a forecast
  - Incremental system additions

# Northwest to Canada

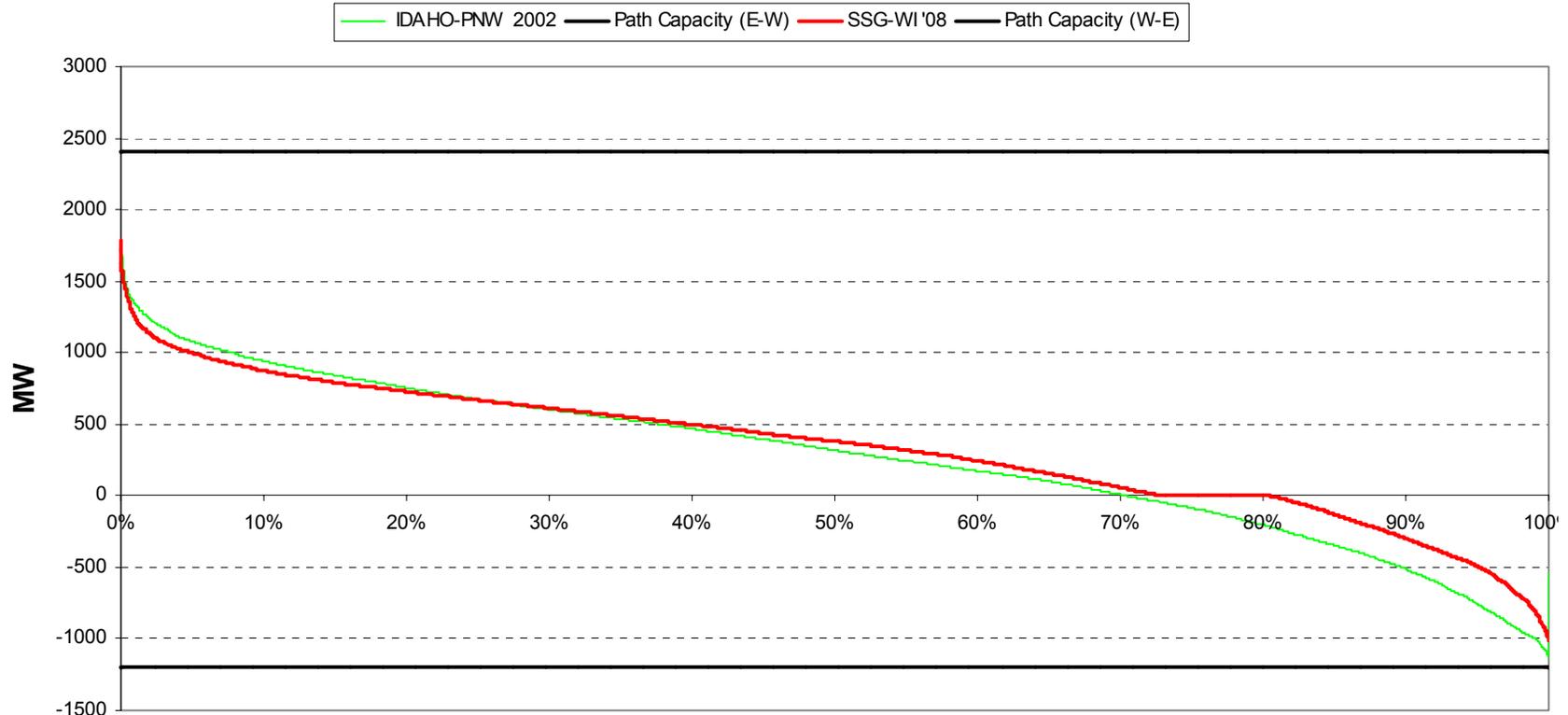
Historic vs SSG\_WI 2008 Flow - MW



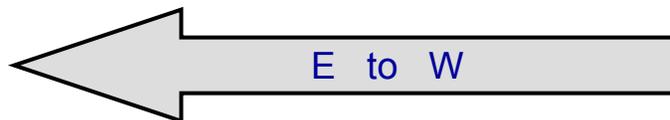
- This path (Washington and southern British Columbia) shows moderately high utilization; the 22% at zero flows is due to double application of wheeling charges (one counts is using 2002 actual Northwest to Canada flows to shape hydro; second count applied ~\$3 BPA network wheel)
- SSG\_WI 2008 with wheel and loss shows zero value between 70% to 90%; selecting to omit (paying \$2.96 BPA network wheel)

# Idaho to PNW Duration Curve

## Historic vs SSGWI Flow - MW



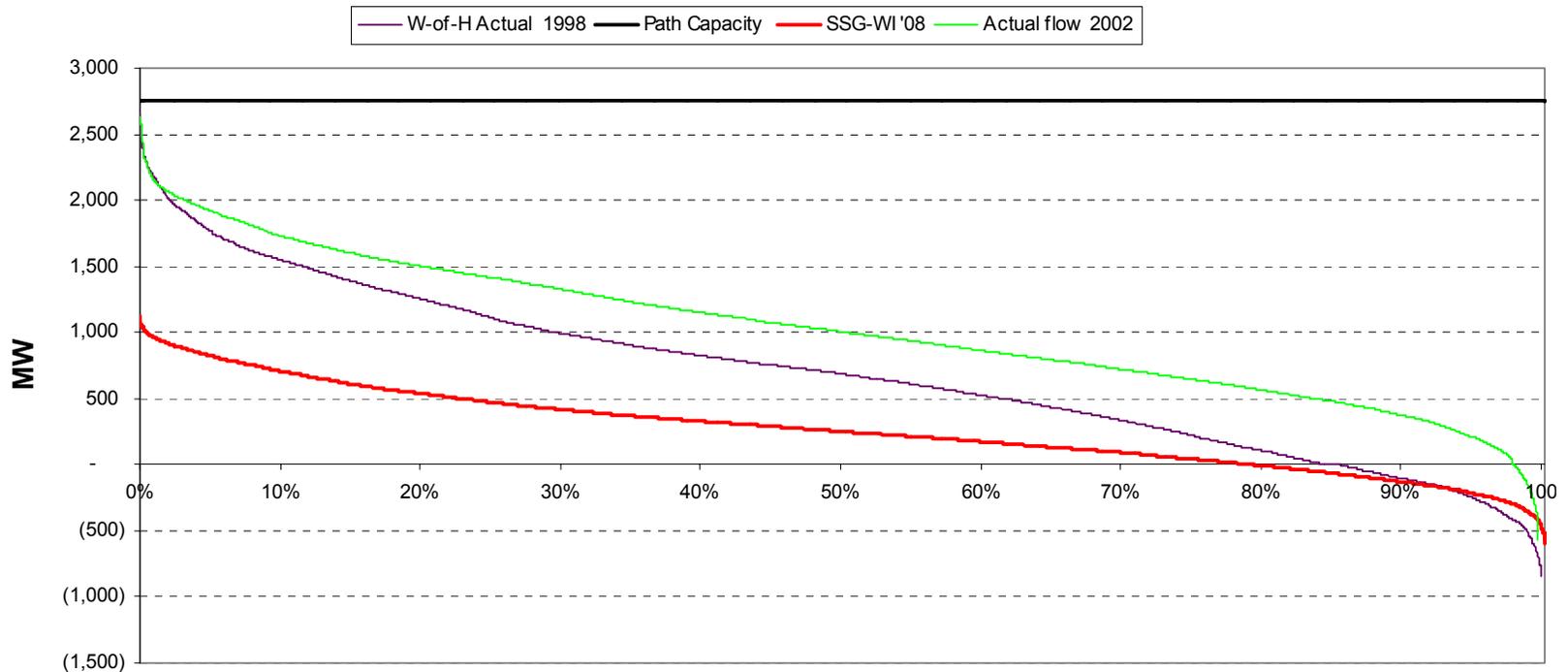
- This path (Southwest Idaho and Eastern Oregon/Washington and Northern Idaho) shows moderately high utilization
- SSG\_WI 2008 with wheel and loss shows close correlation with 2002 actual flow



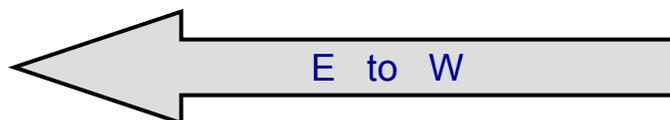
**2008 Base Case**  
September 2005

# West of Hatwai Duration Curve

**Historic vs SSGWI Flow - MW**

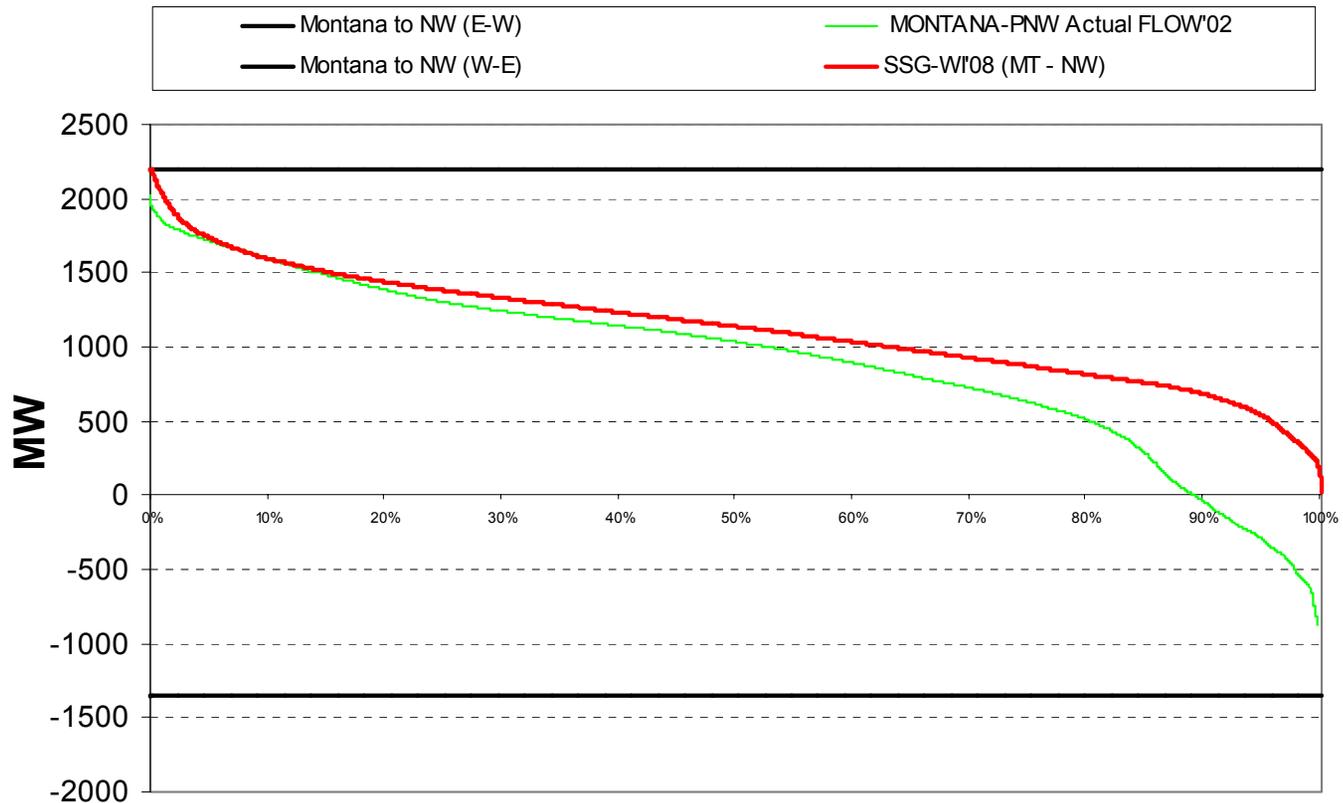


- This path (Eastern Washington) shows moderate utilization
- SSG\_WI 2008 with wheel and loss holds the shape but shows lower flow than historic



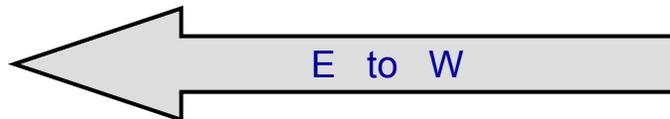
# Montana to PNW Duration Curve

## Historic vs SSGWI - MW



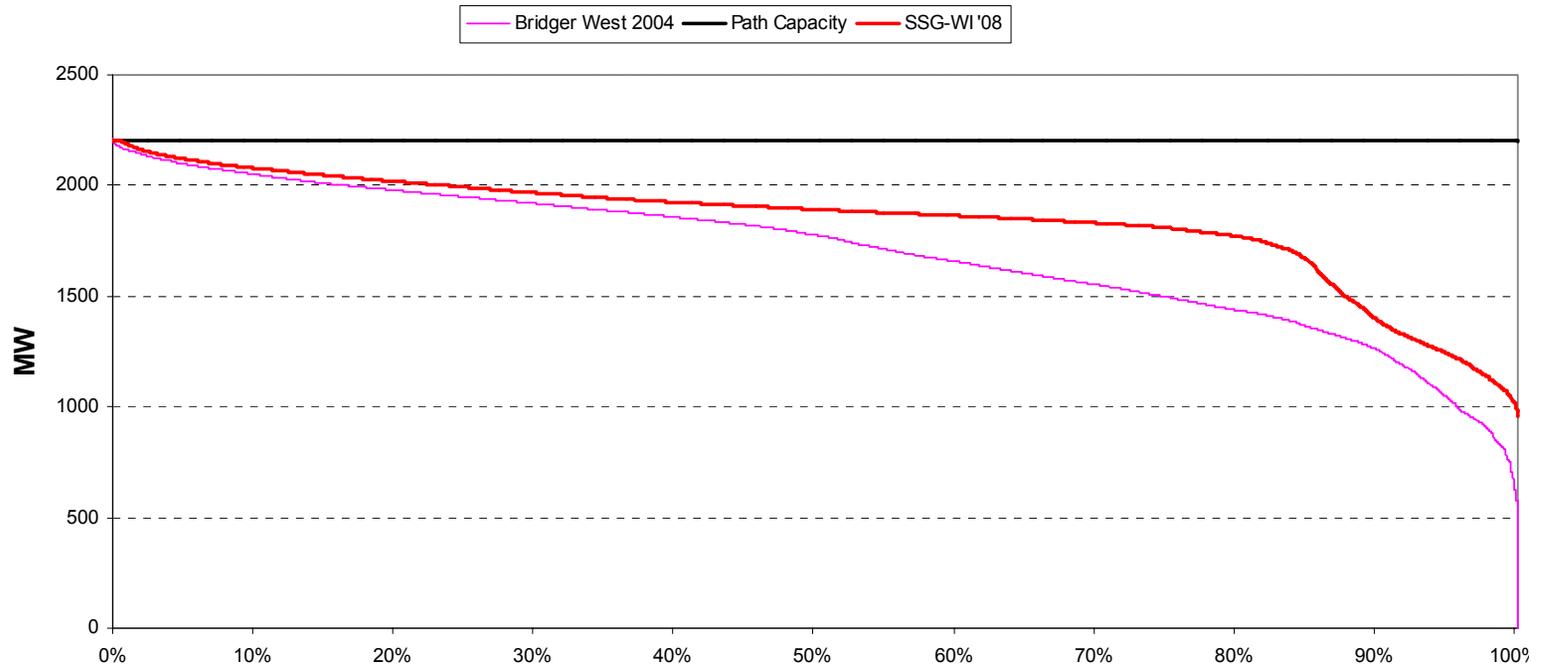
- This path (lines between western Montana and the Northwest) shows moderately high utilization
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic

**2008 Base Case**  
September 2005

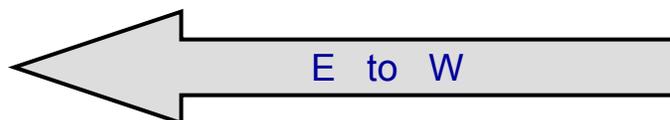


# Bridger West

**Historic vs SSGWI Flow - MW**



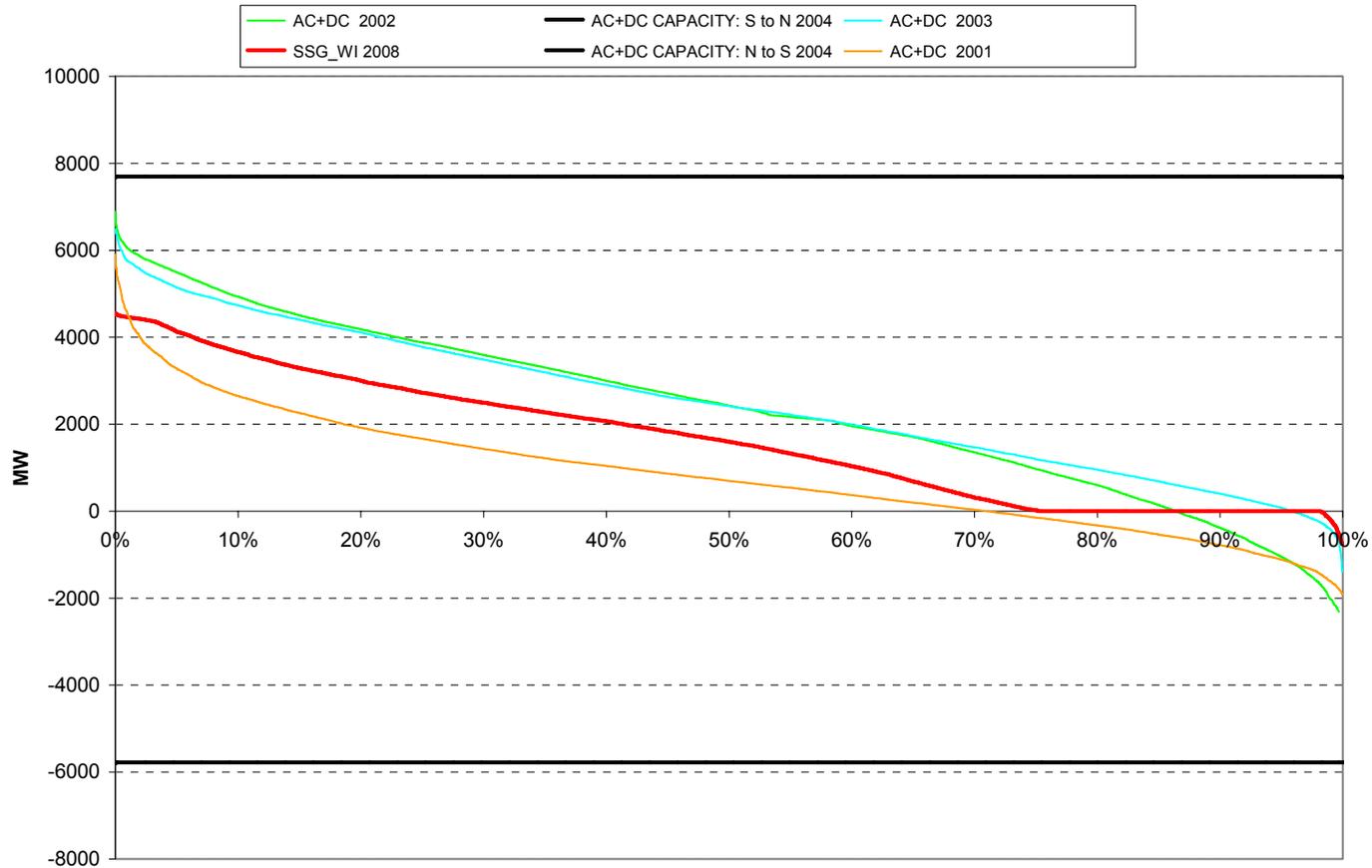
- This path (Border between Southeast Idaho and Southwest Wyoming) shows moderately high utilization
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic



**2008 Base Case**  
September 2005

# COI + PDCI Duration Curve

Historic vs SSG\_WI 2008 Flow - MW

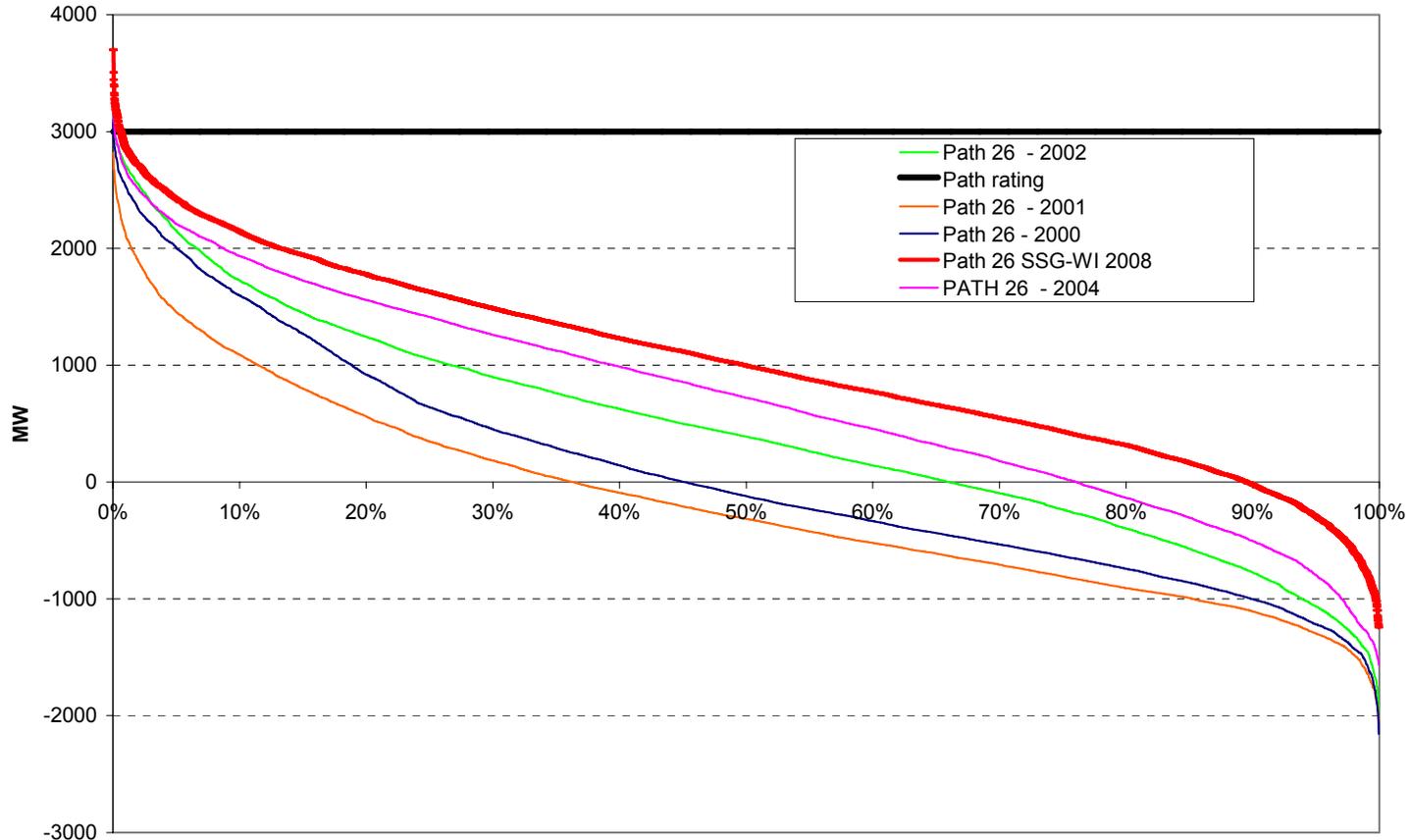


- This path (PACI in combination with PDCI) shows moderate utilization
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic

**2008 Base Case**  
 September 2005

# Path 26 Duration Curve

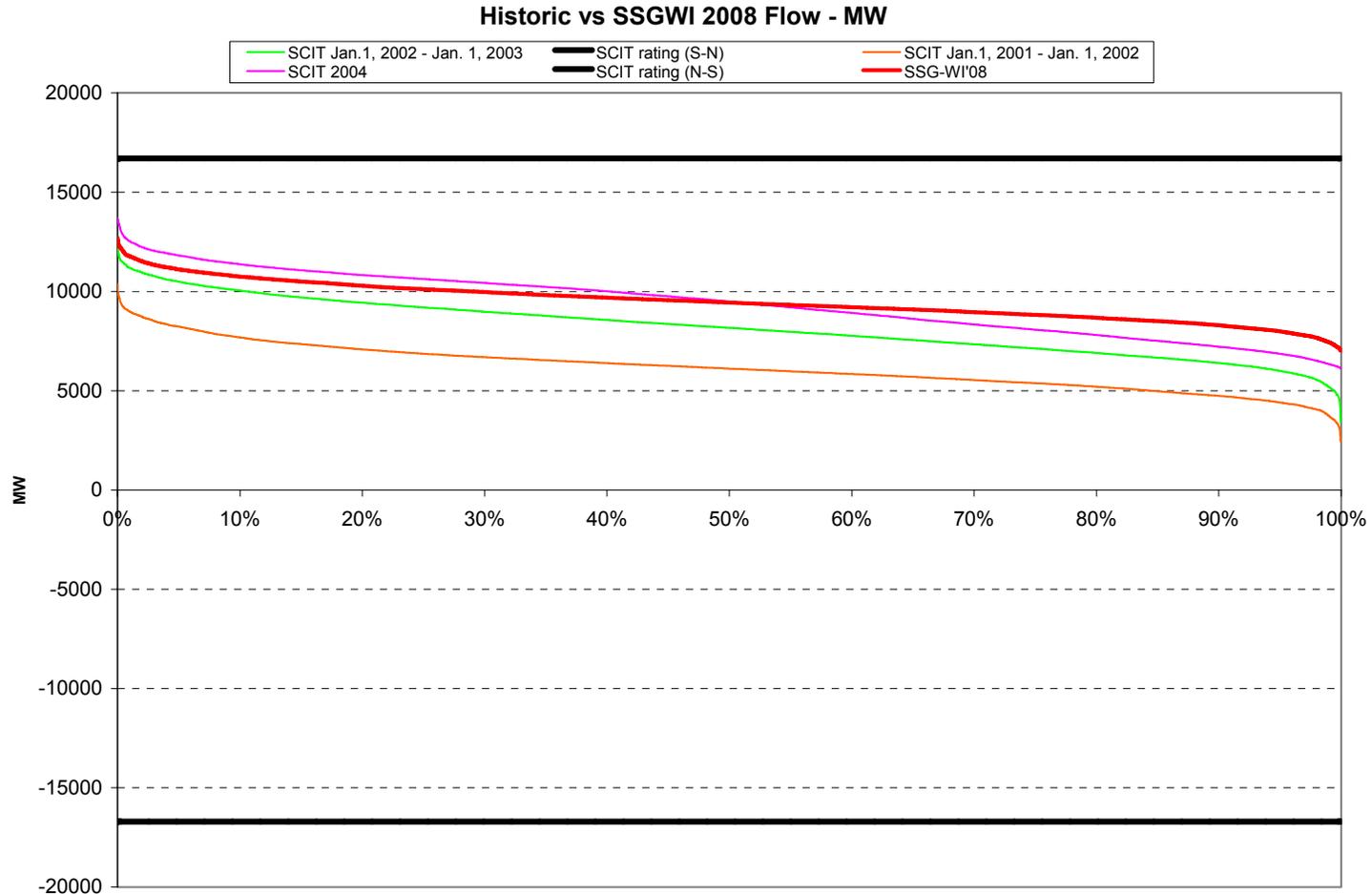
Historic vs SSGWI 2008 Flow - MW



- This path (Between PG&E and Southern California Edison; Midway to Vincent 3-500 kV lines) shows moderately high utilization
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic

**2008 Base Case**  
 September 2005

# SCIT Duration Curve

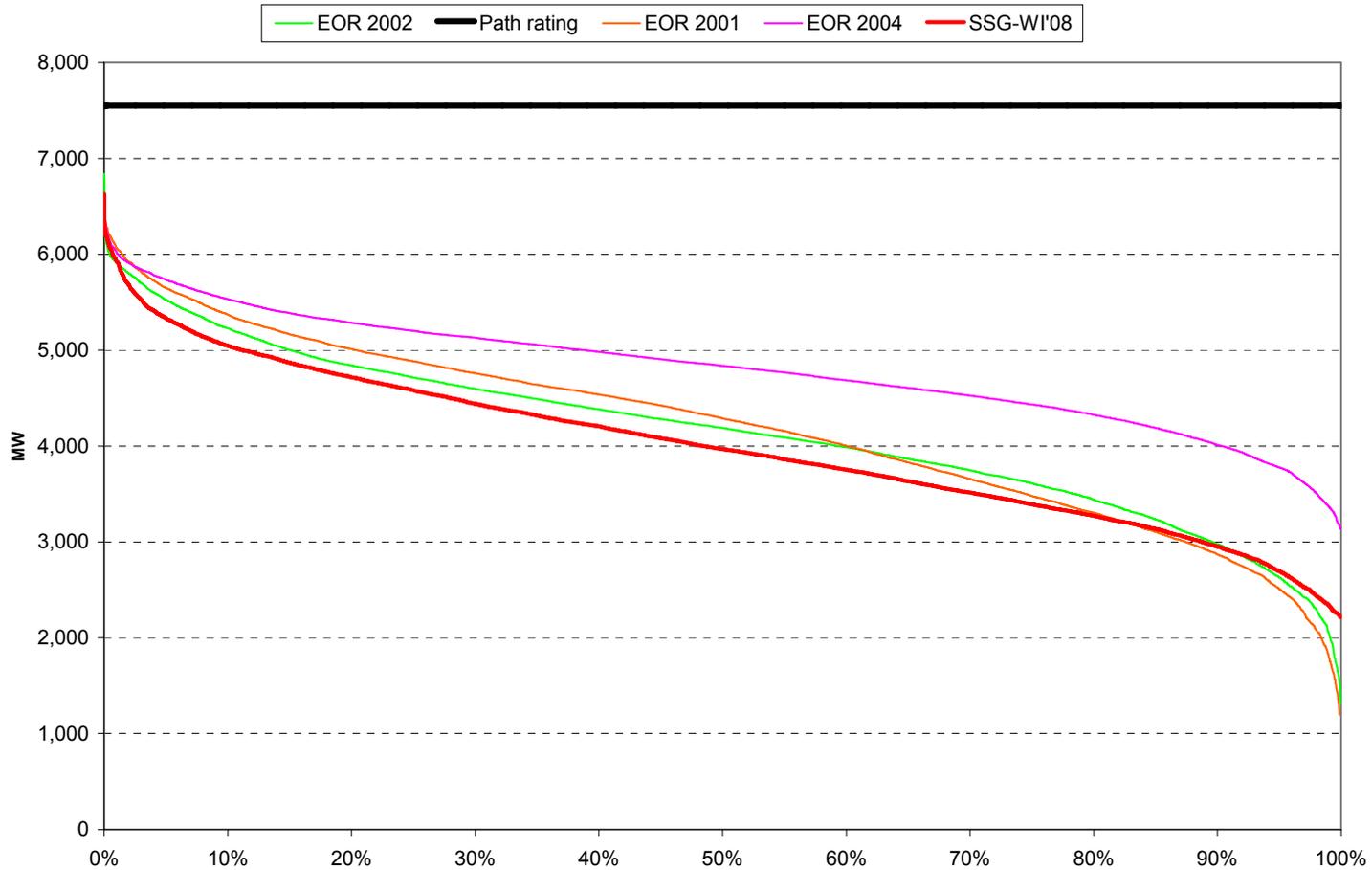


- This path (Sum of Midway, PDCI, IPP, North of Lugo, and WOR) shows moderate utilization
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic

**2008 Base Case**  
September 2005

# East of the River Duration Curve

**Historic vs SSGWI 2008 Flow - MW**

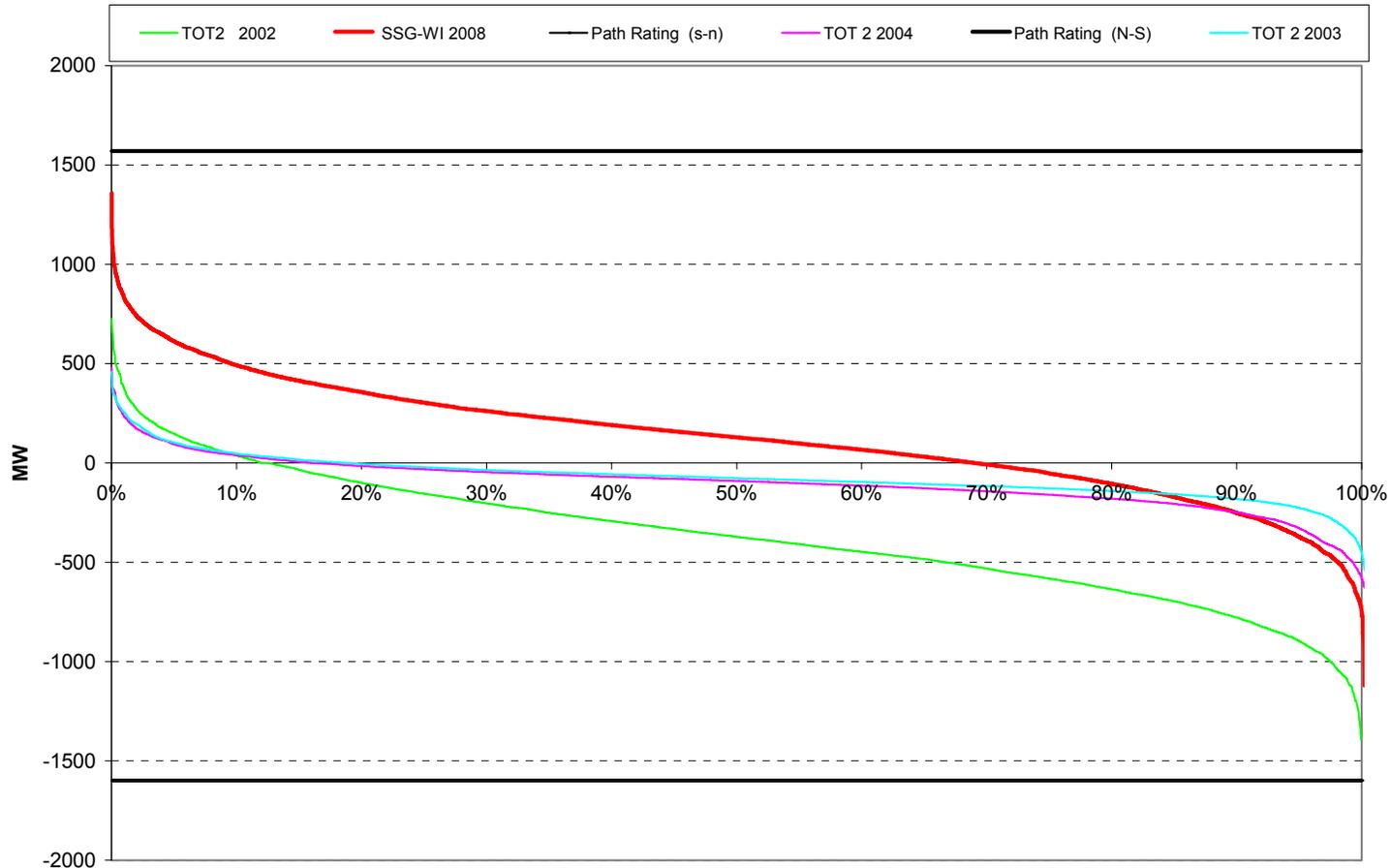


- This path (western Arizona) shows moderate utilization
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic

**2008 Base Case**  
September 2005

# TOT2 (A+B+C) Duration Curve

Historic vs SSG\_WI 2008 Flow - MW

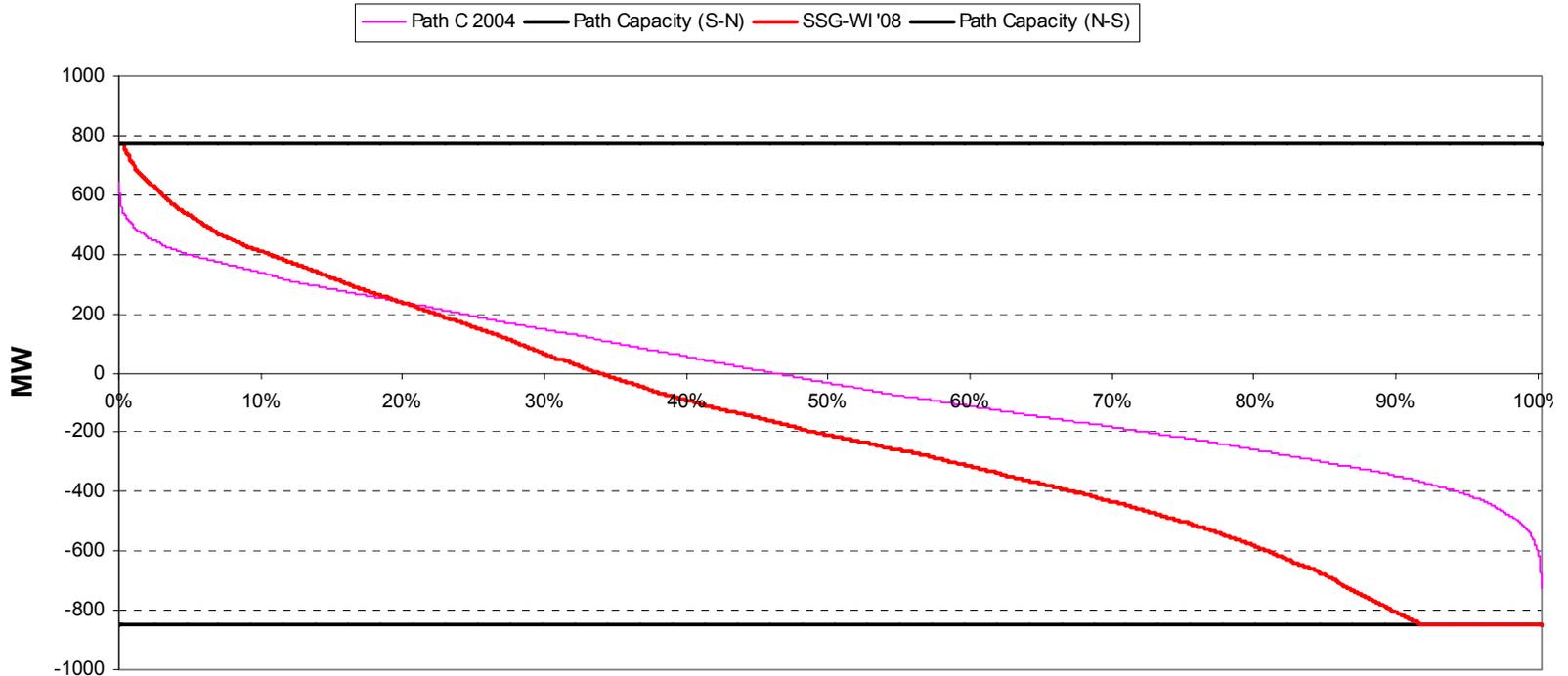


- This path (southern CO, southern Utah to N. Arizona and southern Utah to South-East Nevada ) shows moderate utilization
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic

**2008 Base Case**  
September 2005

# Path C

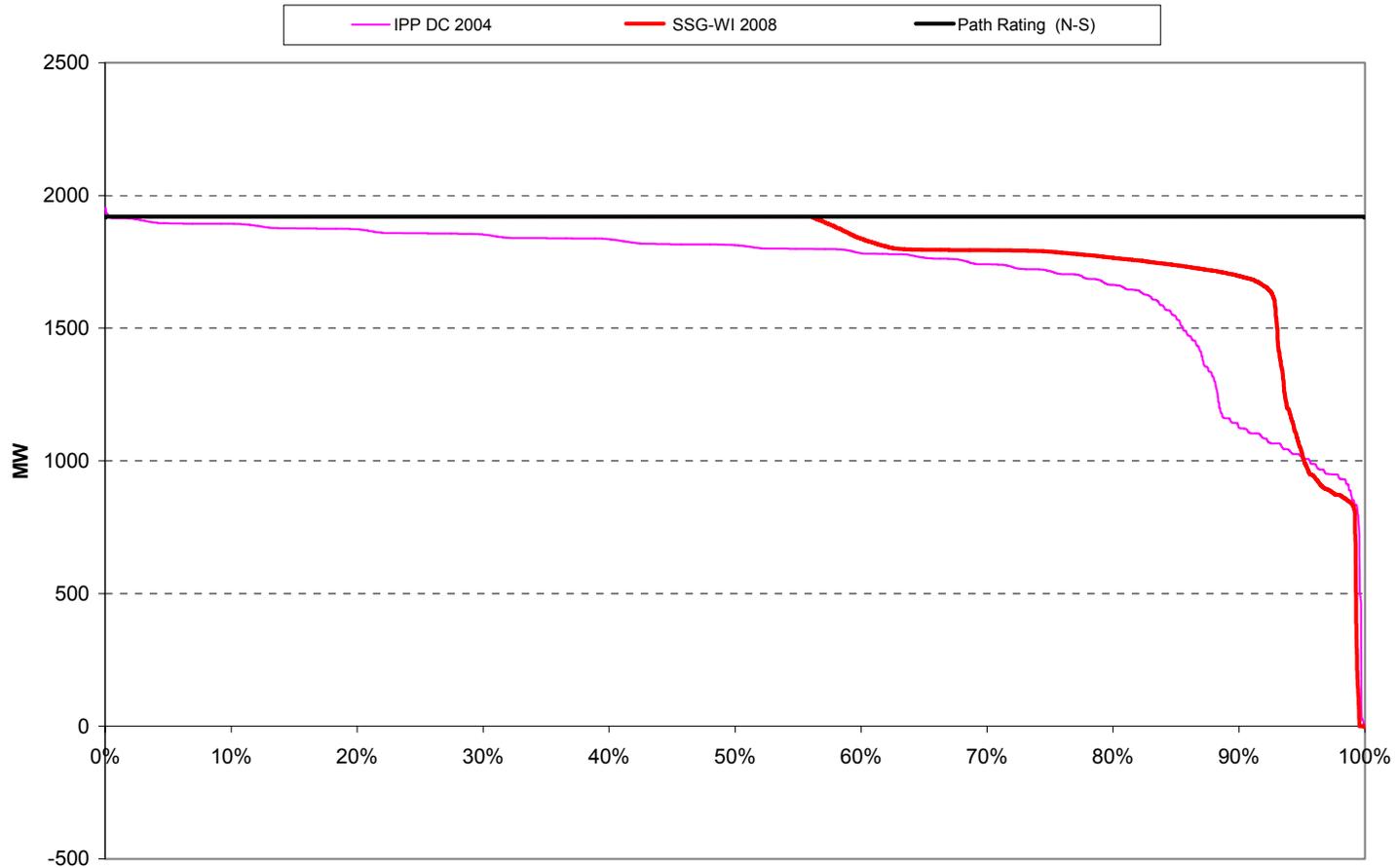
## Historic vs SSGWI Flow - MW



- This path (Northern Utah/southern Idaho ) shows moderately high utilization; 10% of the time at limit in the south to north direction
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic

# IPP DC

**Historic vs SSG\_WI 2008 Flow - MW**

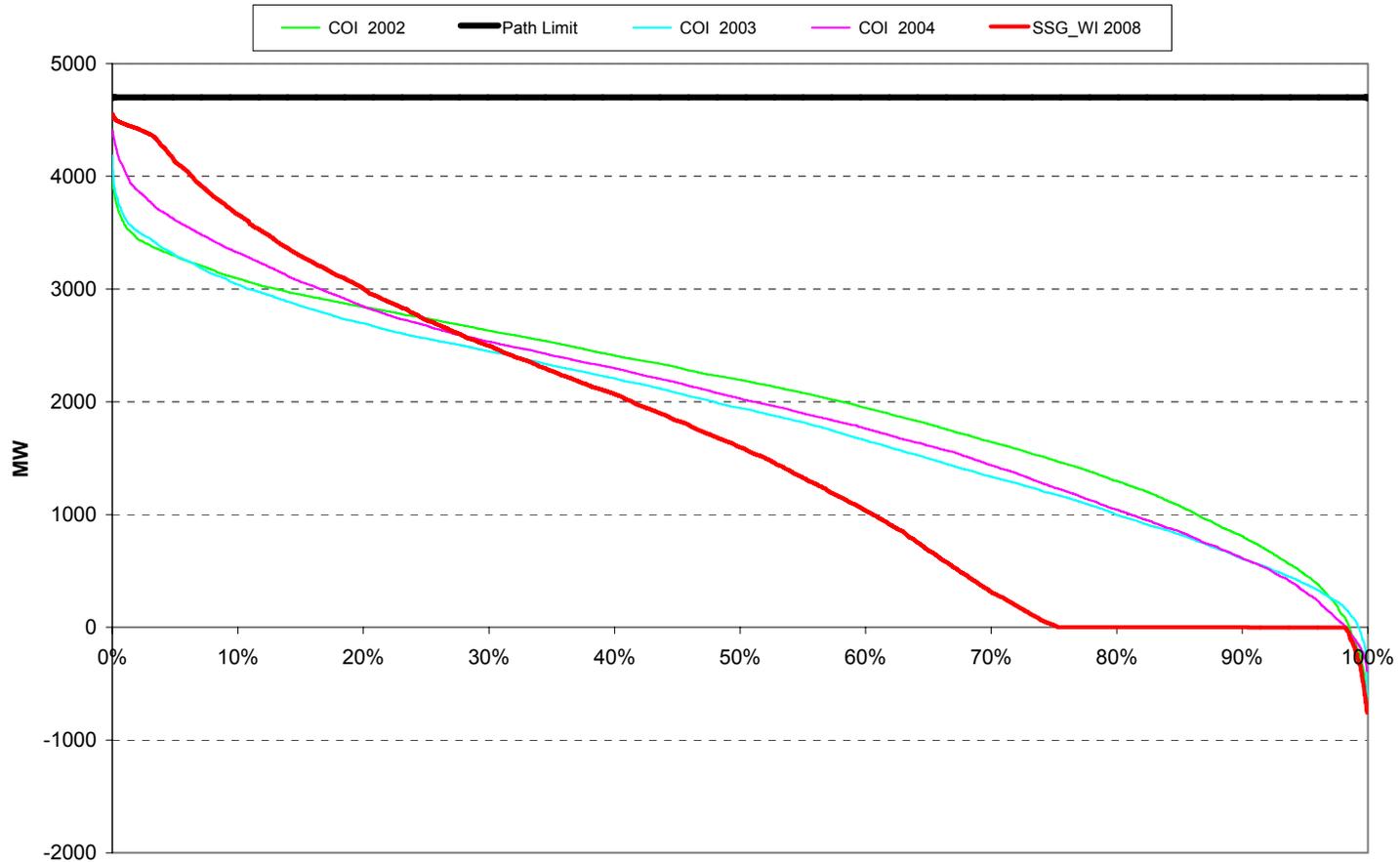


- This path (Intermountain to Adelanto station in southern California) shows moderately high utilization; 55% of the time at limit in the north to south direction.
- SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic

**2008 Base Case**  
 September 2005

# COI

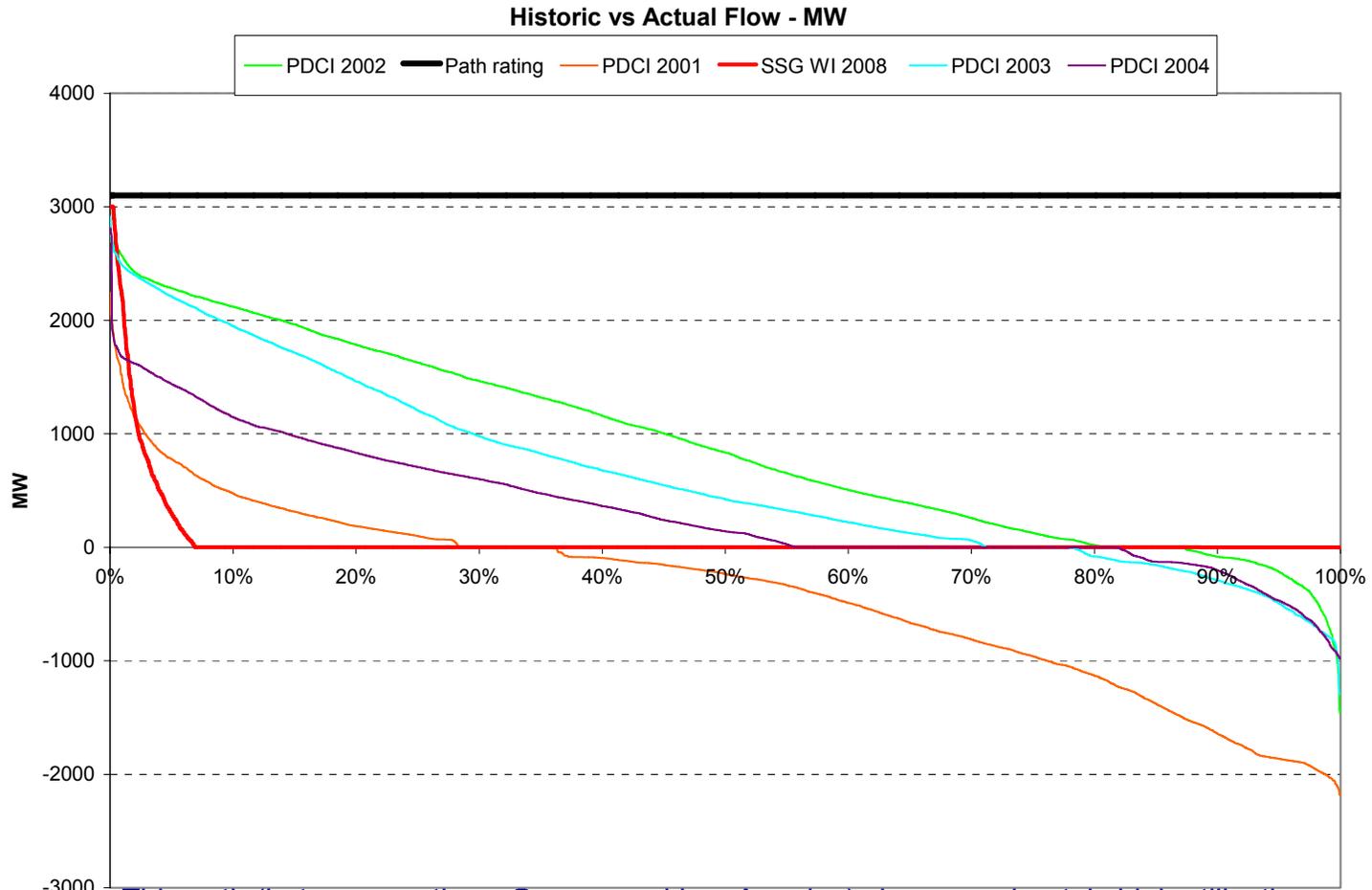
## Historic vs SSG-WI 2008 Flow - MW



- This path (between Oregon and northern California) shows moderately high utilization; the flow is 25% of the time at zero in the northern direction is due to an imbalance in modeling wheel charges.

**2008 Base Case** SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic  
 September 2005

# PDCI



- This path (between northern Oregon and Los Angeles) shows moderately high utilization; the flow is 90% of the time at zero is due to overstatement of wheel charges in the case between LADWP and southern California.

**2008 Base Case** SSG\_WI 2008 with wheel and loss holds the shape and correlates with historic.  
 September 2005