SSG-WI Modeling

- **SSG-WI 2015 Reference Case**
  - Key Assumptions
  - “Do Nothing” Case Findings – Congestion Areas
  - “Add Resources and Minimal Transmission” Case Findings
  - Assumptions Requiring Resolution

- **SSG-WI 2008 Study – Summary of Congestion Areas**

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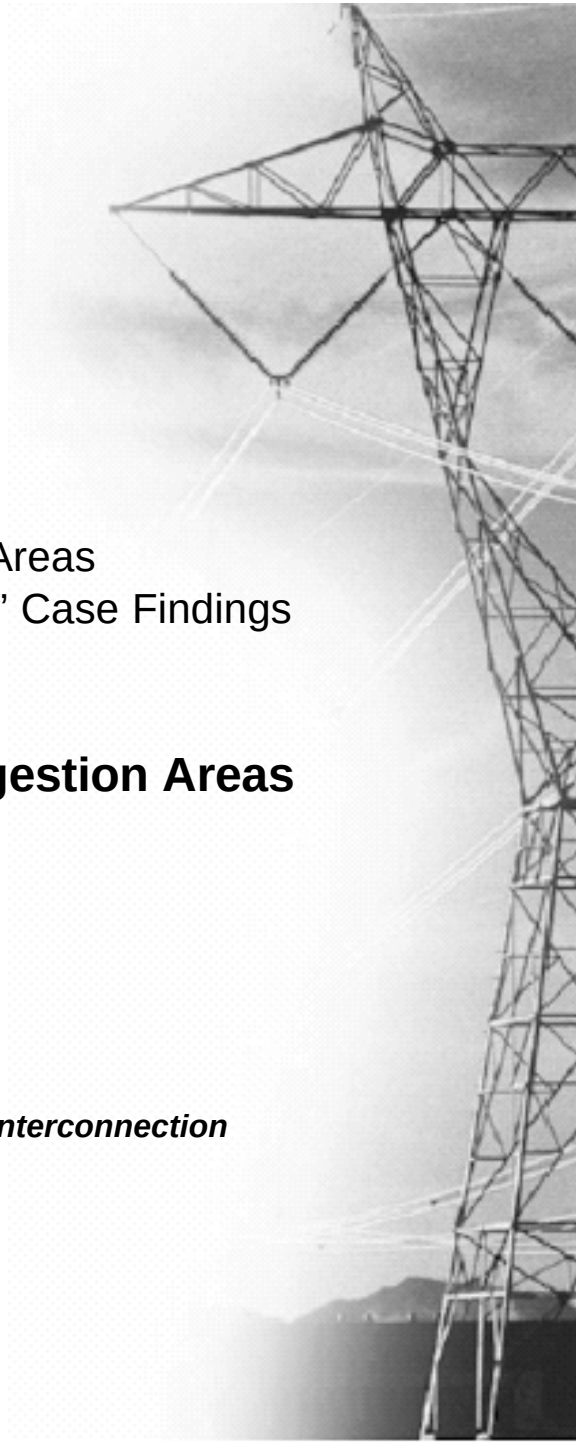

How SSG-WI Evaluates Transmission Expansions

Steps to Quantify Costs

- **Production cost modeling**
  - West-wide scope
  - Detailed transmission representation
  - Simulates dispatch of power system
  - Determines fuel and other variable O&M – with sensitivities
  - Focus: as loads grow, transmission congestion occurs, and new resources and new transmission are added

- **Fixed cost analysis**
  - Estimates capital investment costs of resource and transmission additions
  - Converts capital investment costs to annual capital charges
  - Then adds annual fixed O&M

- **Production costs and fixed costs added together**
  - Then compared to totals for other scenarios

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Methodology for Economic Comparisons

See handout for detailed explanation of this table

	Hypothetical Example	2015			
	Sample Economic Comparison Table	Reference Case		Scenario Name	
		Initial Investment	Annual Costs	Initial Investment	Annual Costs
1	**Production Costs (Fuel & Other VOM)**		**16,121**		**15,923**
2	Change from Reference Case				(198)
3					
4	**Resource Costs:**				
5	**Resource Additions Investment**				
6	Wind	1,957		2,246	
7	Gas thermal	444		198	
8	Coal thermal	3,453		3,985	
9	Incremental Transmission Integration Investment	159		175	
10	**Resource Capex Sub Total**	**6,012**		**6,604**	
11					
12	**Other Resource Costs**				
13	Incremental Capital Charge @ 10%		601		660
14	Incremental Fixed O&M		116		128
15	Wind "wear and tear"		39		56
16	**Subtotal Other Costs**		**756**		**845**
18	**Total Resource Costs**	**6,012**		**6,604**	**845**
19					
20	**Incremental Fixed Gas Transportation Costs**				
21					
22	**Transmission Costs:**				
23	Incremental Line Investment			777	
24	Customized Equipment Investment			193	
25	**Transmission Capex Sub Total**	**-**		**970**	
26					
27	**Other Transmission Costs**				
28	Incremental Fixed O&M				19
29	Incremental Capital Charge @ 10%				97
30	**RM Transmission Costs**		**-**	**970**	**116**
31					
32	**Annualized Costs**		**756**		**961**
33	Change from Reference Case				205
34					
35	**Total Initial Investment**	**6,012**		**7,574**	
36	**Annual Net (Savings)/Cost from Reference Case**				**7**

Economic Gains and Losses

Hypothetical Example

LMP is the Load Cost divided by GWh- Essentially this is the average regional LMP for the year

LMP is the Generator Revenue divided by GWh- Essentially this is the average regional LMP for the year

Total generator production cost- includes fuel and other VOM

	Load			Generator					
Region	*GWh*	*LMP*	*Cost (MM)*	*GWh*	*LMP*	*Revenue (MM)*	*VOM (MM)*	*Gross Margin (MM)*	*Load Minus Generator*
Rocky Mountain	161,635	48.24	7,797	195,545	47.10	9,209	2,361	6,848	949
Northwest	193,131	49.22	9,505	201,812	48.67	9,821	2,404	7,418	2,088
Canada	142,702	48.83	6,968	146,257	48.63	7,113	1,996	5,117	1,850
Mexico	19,848	48.20	957	25,404	47.75	1,213	879	334	623
California	335,938	51.47	17,291	221,372	52.04	11,521	6,117	5,404	11,887
Desert Southwest	162,512	49.02	7,967	225,373	48.36	10,899	6,024	4,875	3,091
Total	1,015,766	49.70	50,484	1,015,763	49.00	49,777	19,780	29,997	20,488

Total energy demanded by loads represented in GWh

The hourly demand at each load node times the hourly LMP ($), summed for the year.

Total energy generated in GWh

The hourly generation at each generator node times the hourly LMP, summed for the year.

Revenues minus VOM= Generator Gross Margin

Load Cost minus Generator Gross Margin, used to calculate total benefits in Chapter 3

- Regional (societal) perspective
- Calculated for each scenario
- Results are compared across scenarios - to determine gains and losses

2015 Reference Case

- **Represents region's current planning path**
  - Starting point: 2008 base case (existing system)
  - Adds resources planned in IRPs and renewable to conform with RPS
  - Also adds resources per CEC
  - Minimal transmission added

- **Includes range of fuel assumptions**
  - Gas prices $4, $5, and $7 (HH in 2005 dollars)
  - Coal prices per EIA's 2005 Outlook
  - Wind shapes per NREL, CAISO
  - "Average" hydro year – 2002

- **Identifies, addresses areas of transmission congestion**
  - Fairly rough cut

2015 Key Assumptions

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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 Allen230 kV PS	950	
Devers Bank No. 1	1120	-1120
EAGLE MTN 230_161 KV - BLYTHE 16		-218
El 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	

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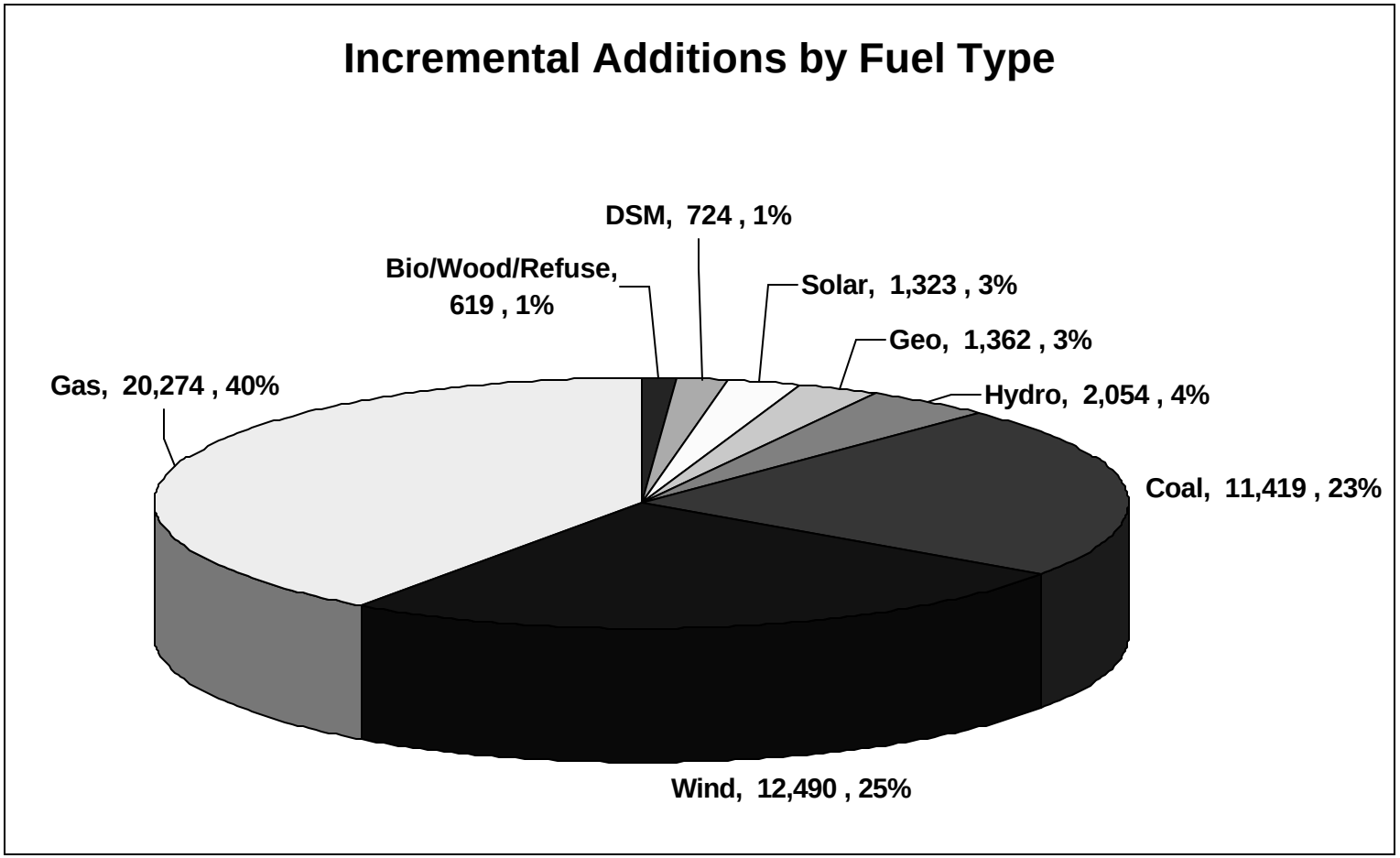
Incremental Resources by Area and Fuel Type

Sum of PSSEMaxCap(MW)		Fuel								
Region Name	**Area Name**	**Bio/Wood/Refuse**	**Coal**	**DSM**	**Gas**	**Geo**	**Hydro**	**Solar**	**Wind**	**Grand Total**
AZNMNV	ARIZONA		3,400		2,700				1,500	7,600
	NEVADA				1,446					1,446
	NEW MEXI	64	-		1,406					1,470
	WAPA L.C		400					50		450
AZNMNV Total		64	3,800		5,552			50	1,500	10,966
CAISO	IMPERIAL	75			50	425		175		725
	LADWP				300			310	1,030	1,640
	MEXICO-C				1,619	86				1,704
	PG&E_BAY				565					565
	PG&E_VLY	190			2,666	410		280	900	4,446
	SANDIEGO				500		40		163	703
	SOCALIF	290			1,768			500	3,500	6,058
CAISO Total		555			7,467	921	40	1,265	5,593	15,841
CANADA	ALBERTA		2,223		1,999				334	4,557
	B.C.HYDR				1,173		1,754		897	3,823
CANADA Total			2,223		3,172		1,754		1,231	8,380
NWPP	NW_EAST			144	723		260		1,590	2,717
	NW_WEST			384	400				150	934
NWPP Total				528	1,123		260		1,740	3,651
RMPP	B HILL		100							100
	COL E		1,750		1,282			8	835	3,875
	IDAHO			152	30					182
	JB		500							500
	KGB		500		62				590	1,152
	MONTANA		1,268						400	1,668
	SIERRA		703		514	441			601	2,259
	UT N			44	547					591
	UT S		575		525					1,100
RMPP Total			5,396	196	2,960	441		8	2,426	11,427
Grand Total		**619**	**11,419**	**724**	**20,274**	**1,362**	**2,054**	**1,323**	**12,490**	**50,264**

Incremental Resources by Fuel Type



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2015 Resources by Area and Fuel Type

		2015 Resources		Resources (Capacity) MW by Fuel Type										
REGION	**AREA**	**Installed Capacity MW**	**Discounted Capacity MW**	**Coal**	**Nat. Gas**	**Oil**	**Hydro + Pumped**	**Wind**	**DR/DSM**	****Biomass (thermal)**	**Solar**	**GEO**	**Nuclear**	***Other**
CALIF ("CAISO")	IMPERIAL	2,266	2,263	0	357	32	176	4	0	350	175	1,117	0	55
CALIF ("CAISO")	LADWP	7,566	6,776	0	5,199	0	1,003	1,054	0	0	310	0	0	0
CALIF ("CAISO")	MEXICO-C	4,731	4,731	0	3,793	153	0	0	0	0	0	785	0	0
CALIF ("CAISO")	PG&E_BAY	7,464	7,388	20	6,291	860	0	102	0	112	0	0	0	80
CALIF ("CAISO")	PG&E_VLY	28,016	27,154	50	14,389	174	8,579	1,149	0	611	280	430	2,190	165
CALIF ("CAISO")	SANDIEGO	5,312	5,190	0	5,061	48	40	163	0	0	0	0	0	0
CALIF ("CAISO")	SOCALIF	24,589	21,744	108	15,848	50	1,315	3,794	0	505	713	0	2,150	107
AZNMNV	ARIZONA	31,164	31,164	11,179	15,008	140	700	0	0	0	0	0	4,137	0
AZNMNV	NEVADA	9,028	9,028	605	8,246	0	0	0			0	0	0	177
AZNMNV	NEW MEXI	5,750	5,712	2,037	3,567	20	14	48		64	0	0	0	0
AZNMNV	WAPA L.C	5,939	5,939	0	2,197	0	3,742	0	0	0	0	0	0	0
CANADA	ALBERTA	16,416	16,132	7,603	6,903	0	1,493	355	0	62	0	0	0	0
CANADA	B.C.HYDR	15,818	5,906	0	2,811	0	12,110	897	0	0	0	0	0	0
NWPP	NW_EAST	35,638	34,094	0	4,351	24	27,899	1,929	144	107	0	0	1,160	23
NWPP	NW_WEST	12,136	12,002	1,966	4,158	74	5,067	168	473	215	0	0	0	15
RMPP	B HILL	1,120	1,120	622	317	42	139	0	0	0	0	0	0	0
RMPP	BHB	0	0	0	0	0	0	0	0	0	0	0	0	0
RMPP	BONZ	468	468	468	0	0	0	0	0	0	0	0	0	0
RMPP	COL E	12,583	11,795	5,267	5,569	120	744	875	0	0	8	0	0	0
RMPP	COL W	2,294	2,294	1,904	104	0	286	0	0	0	0	0	0	0
RMPP	IDAHO	2,439	2,412	0	165	0	2,088	34	152	0	0	0	0	0
RMPP	IPP	1,847	1,847	1,847	0	0	0	0	0	0	0	0	0	0
RMPP	JB	2,628	2,628	2,628	0	0	0	0	0	0	0	0	0	0
RMPP	KGB	272	262	15	0	0	244	13	0	0	0	0	0	0
RMPP	LRS	1,628	1,628	1,107	300	0	221	0	0	0	0	0	0	0
RMPP	MONTANA	5,381	5,022	3,779	376	0	700	449	0	12	0	0	0	65
RMPP	SIERRA	4,095	3,605	1,268	1,720	0	0	612	0	23	0	471	0	0
RMPP	SW WYO	181	164	0	0	0	160	21	0	0	0	0	0	0
RMPP	UT N	3,048	3,048	929	1,991	0	84	0	44	0	0	0	0	0
RMPP	UT S	4,011	4,011	2,849	1,138	0	0	0	0	0	0	24	0	0
RMPP	WYO	775	775	775	0	0	0	0	0	0	0	0	0	0
RMPP	YLW TL	288	288	0	0	0	288	0	0	0	0	0	0	0
	Total Capacity	**254,888**	**236,587**	**47,026**	**109,860**	**1,737**	**67,090**	**11,666**	**813**	**2,061**	**1,486**	**2,827**	**9,637**	**687**

Capacity Discounts
(Per M. Johannis)

25% BC Hydro - Hydro Resources
7.5% BC Hydro - Wind Resources
20% Capacity MW for Wind - General
25% California Wind Resources
10% Colorado Wind Resources

*Other: Petroleum coke, refuse
** Biomass (thermal): includes units using wood as fuel.

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2015 Loads and Resources

		2015 Resources		2015 Load			
REGION	**AREA**	**Installed Capacity MW**	**Discounted Capacity MW**	**ANNUAL ENERGY MWh**	**SUMMER PEAK MW (Jul-Aug)**	**WINTER PEAK MW (Dec-Jan)**	**Load Coverage by SSG-Wi Bubble (using discounted capacity)**
CALIF ("CAISO")	IMPERIAL	2,266	2,263	4,212,776	1,091	501	107%
CALIF ("CAISO")	LADWP	7,566	6,776	33,314,726	6,249	5,060	8%
CALIF ("CAISO")	MEXICO-C	4,731	4,731	15,278,260	3,209	2,405	47%
CALIF ("CAISO")	PG&E_BAY	7,464	7,388	51,987,840	10,919	10,017	-32%
CALIF ("CAISO")	PG&E_VLY	28,016	27,154	79,993,555	19,549	10,870	39%
CALIF ("CAISO")	SANDIEGO	5,312	5,190	22,962,706	5,058	3,912	3%
CALIF ("CAISO")	SOCALIF	24,589	21,744	134,936,173	25,462	19,491	-15%
AZNMNV	ARIZONA	31,164	31,164	104,761,526	22,626	14,464	38%
AZNMNV	NEVADA	9,028	9,028	29,345,006	7,276	3,648	24%
AZNMNV	NEW MEXI	5,750	5,712	27,245,822	4,730	4,001	21%
AZNMNV	WAPA L.C	5,939	5,939	1,590,561	252	235	2261%
CANADA	ALBERTA	16,416	16,132	77,291,069	10,362	10,794	56%
CANADA	B.C.HYDR	15,818	5,906	74,158,753	9,248	12,457	-36%
NWPP	NW_EAST	35,638	34,094	74,310,368	11,270	12,355	203%
NWPP	NW_WEST	12,136	12,002	107,629,066	15,979	17,913	-25%
RMPP	B HILL	1,120	1,120	6,588,272	972	955	15%
RMPP	BHB	0	0	3,695,185	457	506	-100%
RMPP	BONZ	468	468	1,242,519	237	176	97%
RMPP	COL E	12,583	11,795	62,135,625	10,727	9,521	10%
RMPP	COL W	2,294	2,294	6,440,916	951	993	141%
RMPP	IDAHO	2,439	2,412	18,631,181	3,694	2,850	-35%
RMPP	IPP	1,847	1,847	0	1	1	N/A
RMPP	JB	2,628	2,628	0	1	1	N/A
RMPP	KGB	272	262	6,826,263	1,429	1,081	-82%
RMPP	LRS	1,628	1,628	3,996,419	581	567	180%
RMPP	MONTANA	5,381	5,022	10,807,468	1,689	1,698	197%
RMPP	SIERRA	4,095	3,605	11,728,413	1,995	1,642	81%
RMPP	SW WYO	181	164	4,553,805	596	547	-72%
RMPP	UT N	3,048	3,048	42,173,311	7,999	5,368	-62%
RMPP	UT S	4,011	4,011	6,057,463	1,189	819	237%
RMPP	WYO	775	775	2,454,859	331	304	134%
RMPP	YLW TL	288	288	0	1	1	28700%
	Total Capacity	**254,888**	**236,587**	**1,026,349,907**	**186,130**	**155,151**	**27%**

Capacity Discounts
(Per M. Johannis)

25%	BC Hydro - Hydro Resources
7.5%	BC Hydro - Wind Resources
20%	Capacity MW for Wind - General
25%	California Wind Resources
10%	Colorado Wind Resources

2015 Reference Case
November 9, 2005

Thermal Generator Data

- **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**:
  - Minimum up and down times
  - Variable non-fuel O&M (operation & maintenance) and start-up costs
  - Fuel type
  - Fuel cost and availability
    - Also subject to laws of supply and demand
  - Heat rate curves – generic, specific for California units
  - Forced outage rate (EIA - Monte Carlo distribution)
  - Scheduled outages (EIA maintenance rates – GridView optimizes scheduling)
  - Ramp rates
  - Energy limits (pollution, fuel availability)

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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

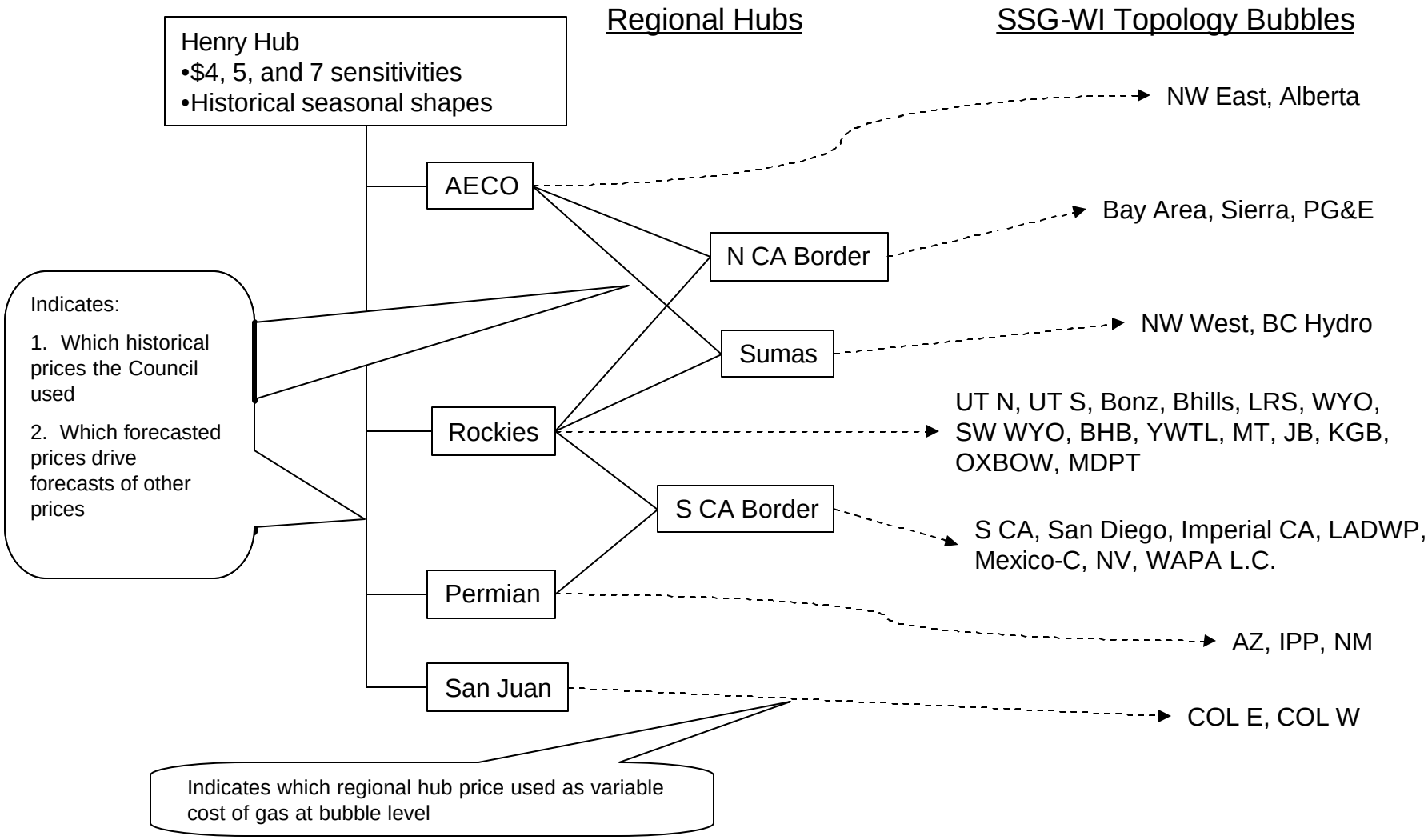
Buckets for generic assumptions were defined by Generation Sub-Group

Gas Price Assumptions

- **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**
- **Fixed transportation cost (capacity charge) of delivering gas from regional hubs to burner tip was included with other fixed costs of the scenario**

Gas Price Basis & Transportation:

Drivers of the variable cost of gas



“Do Nothing” Case

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Seams Steering Group of the Western Interconnection

Total Annual Fuel and Other Variable O&M by Area

$5 Gas

Area	Generation Cost (M$ - 2015)
NEW MEXI	772
ALBERTA	2,543
IDAHO	28
MONTANA	352
SIERRA	280
NW_EAST	1,091
NW_WEST	1,506
PG&E_VLY	2,551
PG&E_BAY	1,491
B HILL	133
BHB	-
ARIZONA	4,093
BONZ	53
COL E	1,517
COL W	284
IPP	256
JB	269
KGB	2
LRS	132
SW WYO	-
UT N	512
UT S	497
NEVADA	1,141
WYO	57
WAPA L.C	567
YLW TL	-
MEXICO-C	620
IMPERIAL	127
SANDIEGO	829
SOCALIF	2,361
LADWP	991
B.C.HYDR	530
Western Interconnect	25,587

"Do Nothing" case includes 2015 loads -- but no resource or transmission additions

Intent: to help target new resources and transmission to relieve congestion

Opportunity Costs: "Do Nothing" Case

Savings if capacity on congested paths increases by 1 MW

Interface Name	Congestion Cost (k$)	Congestion Hours (Hrs)
NORTHWEST - CANADA	188373	5494
Navajo - Crystal	95964	6296
MONTANA - NORTHWEST	75853	3424
BRIDGER WEST	75751	2948
Z7-Path 45	51576	945
BONANZA WEST	45618	3270
TOT 1A	33964	3145
COI	25334	185
ALBERTA - BRITISH COLUMBIA	22121	2378
PATH C	20071	1023
SOUTHWEST OF FOUR CORNERS	18425	253
CORONADO - SILVER KING - KYRE	15785	887
INTERMOUNTAIN - MONA 345 KV	15668	1268
Imperial Valley - La Rosita	13771	349
PACIFIC DC INTERTIE (PDCI)	12285	1798
CHOLLA - PINNACLE PEAK	12163	11
NORTH OF SAN ONOFRE	6910	454
EOR	6010	496
Jojoba - Kyrene	5350	3
Peacock - Mead	4541	4706
SOUTHERN NEW MEXICO (NM1)	4135	24
WOR -n- El Dor to Lugo	4125	561
IPP DC LINE	3257	1166
Path 26	3122	786
TOT 2C	3061	2708
TOT 2A	2664	604
SCIT	2475	156
IID - SCE	2191	2598
NW to Canada East BC	2095	9
TOT 4B	2073	505
NORTHERN NEW MEXICO (NM2)	2072	16
MARKETPLACE - ADELANTO	1871	287
TOT 2B1	1866	18
IDAHO - SIERRA	1665	140
El Centro Bank	1599	4655
TOT 3	1306	30
BROWNLEE EAST	899	22
INTERMOUNTAIN - GONDER 230 K	899	3377

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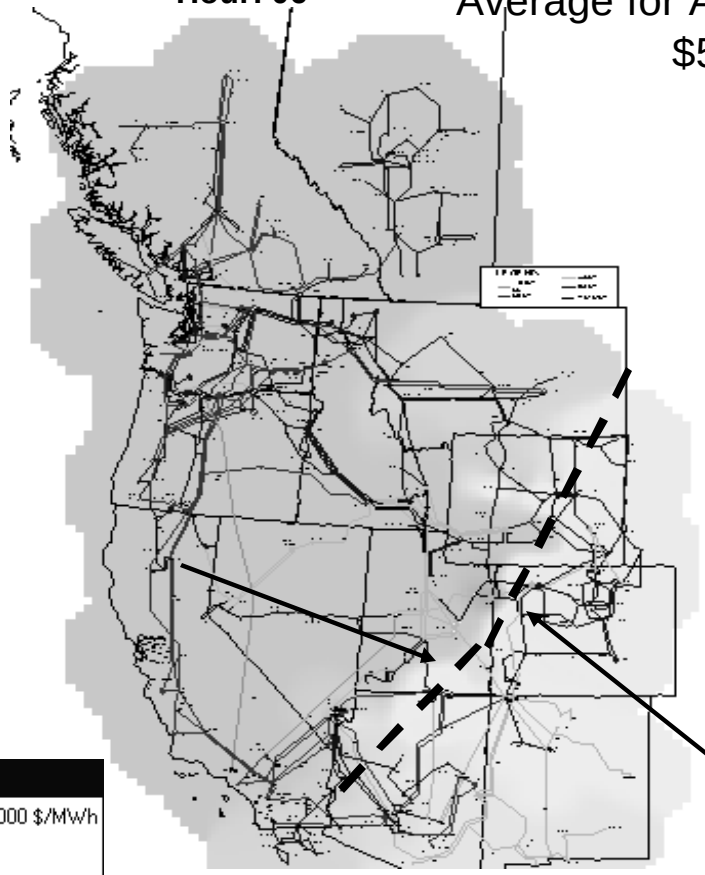
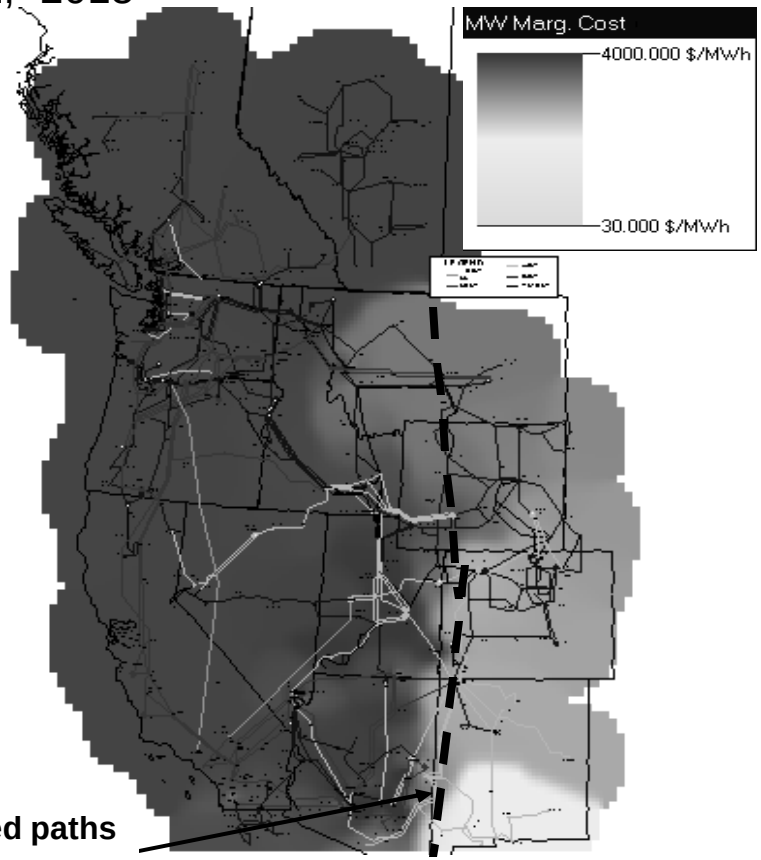
Congestion Prices

Average for August 11, 2015
$5 Gas

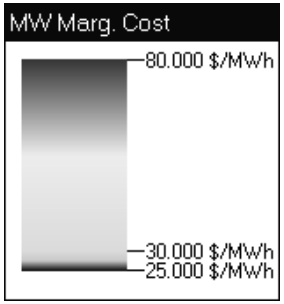
Hour: 06



Hour: 15



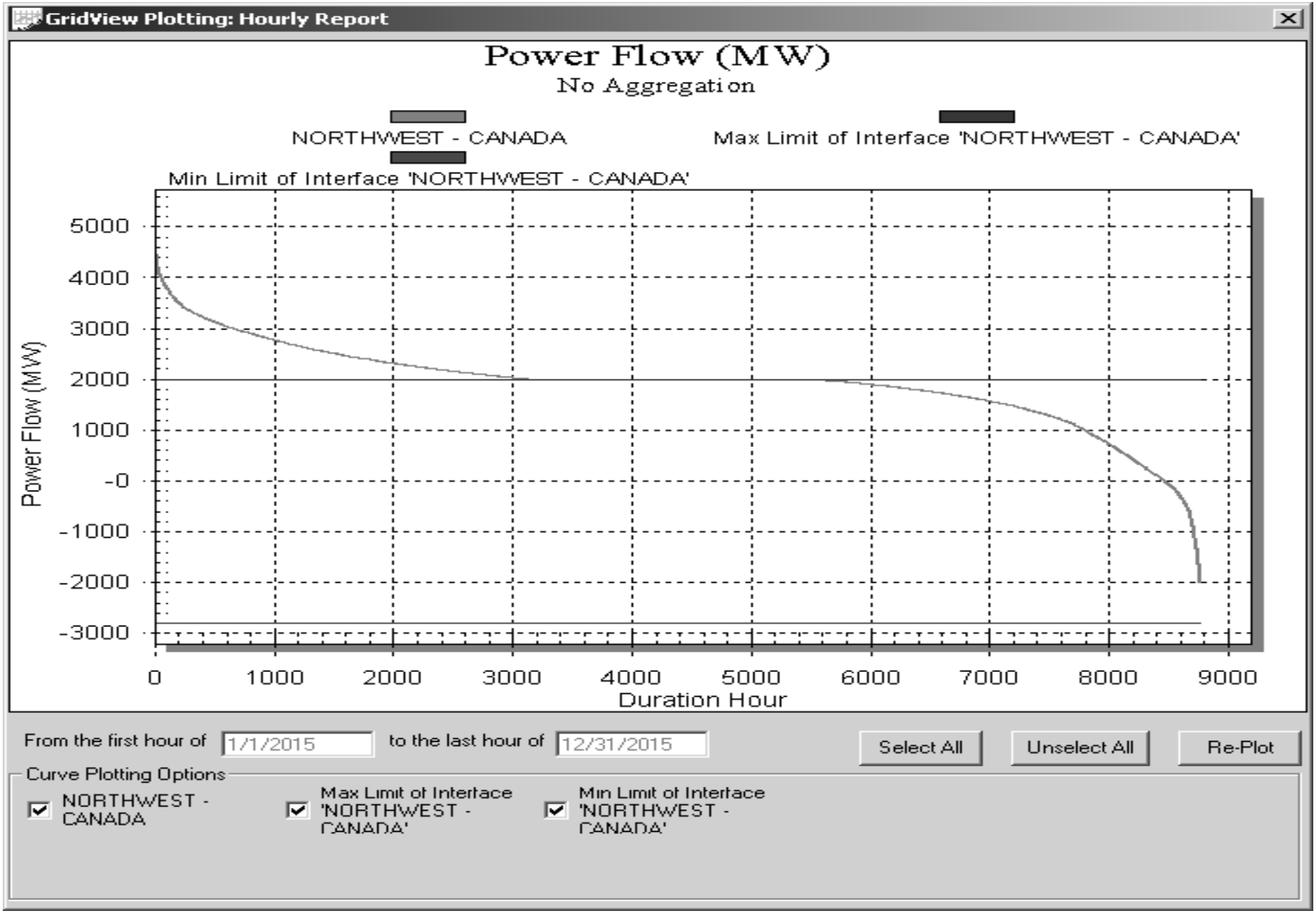
Congested paths



***Differences* in colors indicate congestion**

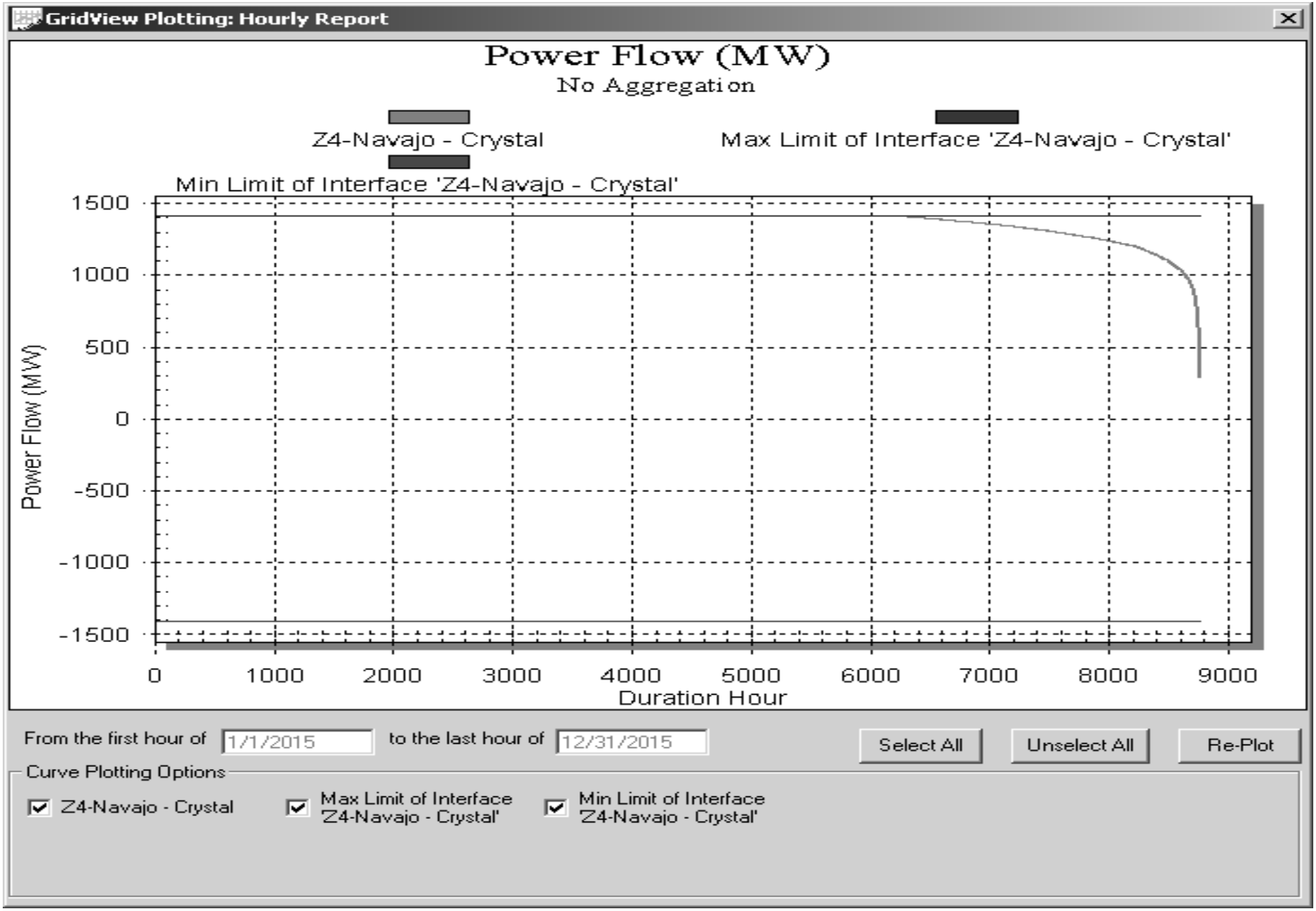
Congestion can be caused by transmission constraints or by transmission losses

2015 Reference Case
November 9, 2005



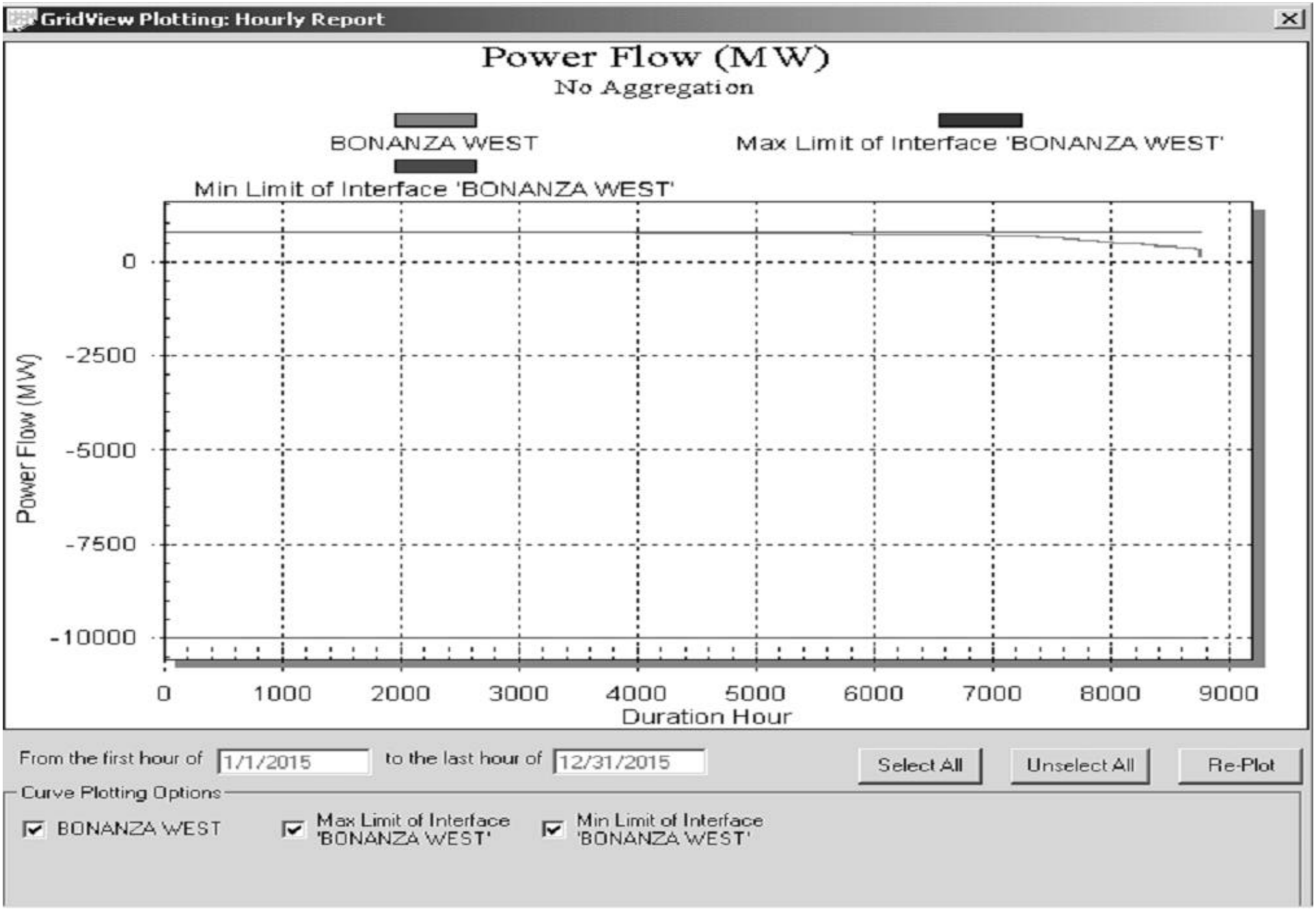
2015 Reference Case

November 9, 2005



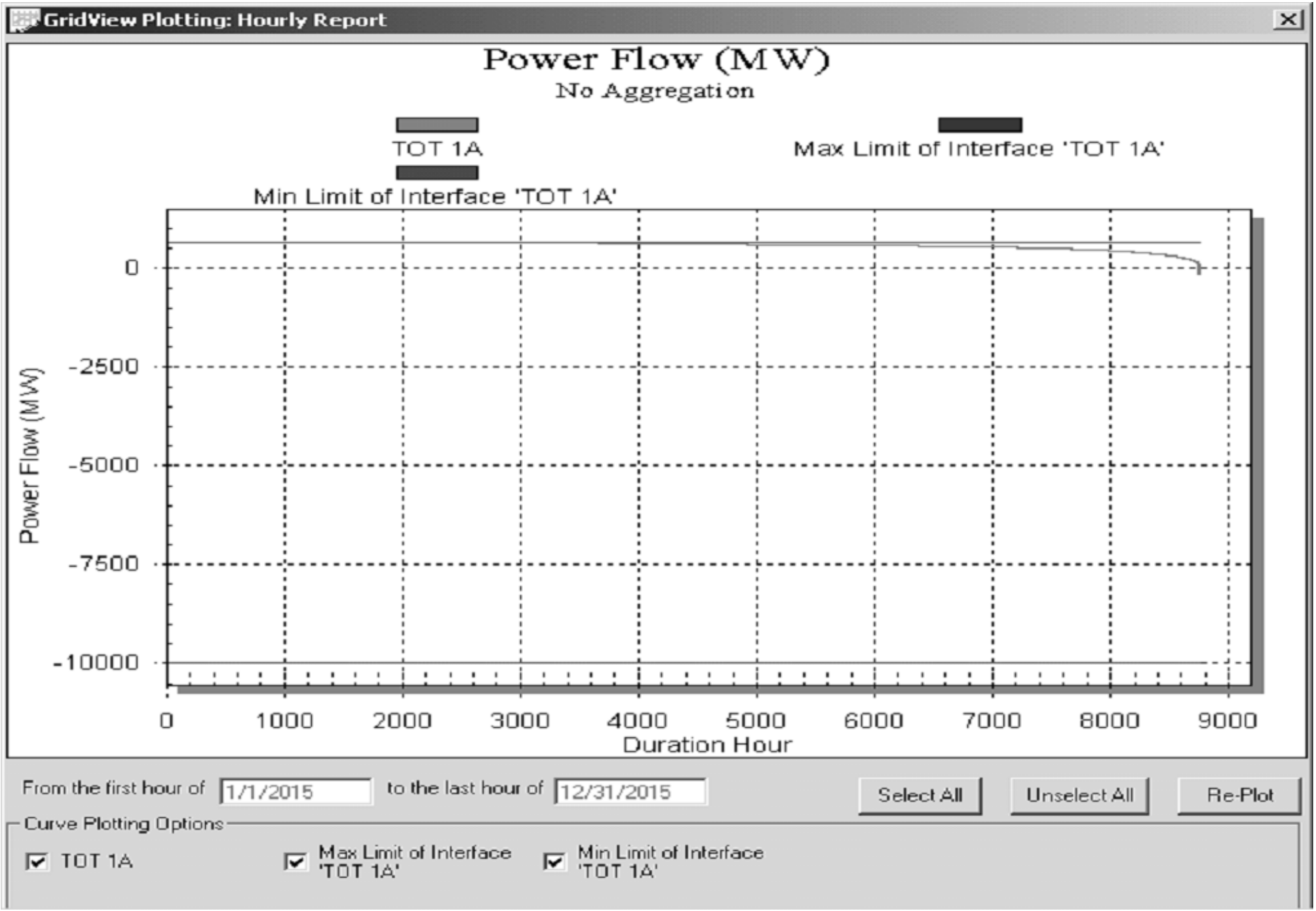
2015 Reference Case

November 9, 2005



2015 Reference Case

November 9, 2005



2015 Reference Case

November 9, 2005

2015 Reference Case

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Findings

- **If loads grow to 2015 levels, and no resources or transmission are added, congestion is widespread and production costs rise by $11.5 billion from 2008 Base Case**

- **Addition of resources and minimum transmission results in reduction in production costs of $6.34 billion from the 2015 "Do Nothing" Case to 2015 Reference Case**

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Total Annual Fuel and Other Variable O&M by Area

$5 Gas

Area	Generation Cost (M$)			Deltas (M$)		
	a	b	c			
	2008 Base Case	Do Nothing Case	Reference Case	b-a	c-a	b-c
ALBERTA	1467	2543	2042	1076	575	501
ARIZONA	2410	4093	3445	1683	1034	648
B HILL	60	133	75	73	14	58
B.C.HYDR	135	530	378	395	243	152
BHB	0	0	0	0	0	0
BONZ	45	53	51	8	6	3
COL E	856	1517	807	661	-49	711
COL W	230	284	269	54	39	15
IDAHO	9	28	12	19	3	16
IMPERIAL	109	127	90	18	-19	37
IPP	216	256	256	40	40	0
JB	227	269	310	42	83	-41
KGB	2	2	74	0	72	-72
LADWP	500	991	601	491	102	390
LRS	72	132	83	59	11	48
MEXICO-C	181	620	475	439	294	145
MONTANA	304	352	358	47	54	-6
NEVADA	727	1141	1166	414	439	-24
NEW MEXI	352	772	488	420	136	284
NW_EAST	879	1091	1162	211	283	-71
NW_WEST	1183	1506	1415	323	232	91
PG&E_BAY	863	1491	949	628	86	543
PG&E_VLY	1181	2551	1438	1371	257	1113
SANDIEGO	239	829	415	590	175	414
SIERRA	101	280	235	179	135	44
SOCALIF	843	2361	1466	1518	623	895
SW WYO	0	0	0	0	0	0
UT N	353	512	472	160	119	41
UT S	401	497	462	96	61	35
WAPA L.C	116	567	199	451	83	368
WYO	48	57	57	9	9	0
YLW TL	0	0	0	0	0	0
	14,110	25,587	19,250	11,477	5,140	6,337

2015 Reference Case

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Capacity Factors by Generator Type, $5 Gas

AVERAGE CAPACITY FACTOR OF DISPATCHED UNITS (Total Gen/8760)/Capacity

		Unit Type			
Region	**Load Area**	**Hourly Resource**	**Hydro**	**Thermal**	**Average CF**
AZNMNV	**ARIZONA**	**28%**	**48%**	**57%**	**55%**
	NEVADA	**30%**	**0%**	**33%**	**33%**
	NEW MEXI	**40%**	**0%**	**46%**	**46%**
	WAPA L.C	**22%**	**41%**	**25%**	**34%**
AZNMNV Total		**29%**	**42%**	**49%**	**48%**
CALIF	**IMPERIAL**	**48%**	**48%**	**46%**	**47%**
	LADWP	**32%**	**22%**	**25%**	**25%**
	MEXICO-C	**40%**	**0%**	**24%**	**27%**
	PG&E_BAY	**23%**	**0%**	**30%**	**29%**
	PG&E_VLY	**63%**	**36%**	**33%**	**36%**
	SANDIEGO	**1%**	**0%**	**19%**	**19%**
	SOCALIF	**41%**	**47%**	**30%**	**32%**
CALIF Total		**45%**	**36%**	**29%**	**32%**
CANADA	**ALBERTA**	**43%**	**37%**	**60%**	**57%**
	B.C.HYDR	**0%**	**25%**	**31%**	**25%**
CANADA Total		**43%**	**25%**	**55%**	**37%**
NWPP	**NW_EAST**	**34%**	**42%**	**70%**	**45%**
	NW_WEST	**34%**	**43%**	**66%**	**56%**
NWPP Total		**34%**	**42%**	**68%**	**48%**
RMPP	**B HILL**	**0%**	**48%**	**57%**	**56%**
	BONZ	**0%**	**0%**	**88%**	**88%**
	COL E	**43%**	**46%**	**53%**	**52%**
	COL W	**0%**	**37%**	**82%**	**76%**
	IDAHO	**35%**	**49%**	**6%**	**43%**
	IPP	**0%**	**0%**	**92%**	**92%**
	JB	**0%**	**0%**	**87%**	**87%**
	KGB	**30%**	**49%**	**82%**	**54%**
	LRS	**0%**	**48%**	**73%**	**69%**
	MONTANA	**40%**	**52%**	**78%**	**71%**
	SIERRA	**47%**	**0%**	**47%**	**47%**
	SW WYO	**39%**	**37%**	**0%**	**38%**
	UT N	**0%**	**21%**	**56%**	**54%**
	UT S	**0%**	**0%**	**80%**	**80%**
	WYO	**0%**	**0%**	**92%**	**92%**
	YLW TL	**0%**	**48%**	**0%**	**48%**
RMPP Total		**40%**	**47%**	**67%**	**62%**
AVE. CAPACITY FACTOR		**40%**	**36%**	**47%**	**43%**

Hourly resource includes wind, geothermal, solar and DSM

CAPACITY FACTOR OF THERMAL UNITS

Region	**Load Area**	**Sun**	**Bio**	**Coal**	**Gas**	**Geo**	**Oil**	**PC**	**Uran**
AZNMNV	ARIZONA			83%	28%		0%		93%
	NEVADA			92%	29%		0%		
	NEW MEXI			92%	9%				
	WAPA L.C			89%	13%				
AZNMNV Total				85%	25%		0%		93%
CAISO	IMPERIAL		56%		6%	90%	0%		
	LADWP				25%				
	MEXICO-C				21%		54%		
	PG&E_BAY		90%	92%	24%		63%	0%	
	PG&E_VLY		80%	92%	21%	90%	4%	0%	93%
	SANDIEGO				19%		0%		
	SOCALIF	90%	82%	92%	19%		0%	0%	93%
CAISO Total		90%	76%	92%	21%	90%	49%	0%	93%
CANADA	ALBERTA		74%	87%	29%				
	B.C.HYDR				31%				
CANADA Total			74%	87%	30%				
NWPP	NW_EAST		73%		66%		0%		93%
	NW_WEST		83%	92%	60%		0%		
NWPP Total			80%	92%	63%		0%		93%
RMPP	B HILL			89%	2%		0%		
	BONZ			88%					
	COL E			89%	13%		0%		
	COL W			86%	9%				
	IDAHO				11%				
	IPP			92%					
	JB			87%					
	KGB			89%	32%				
	LRS			92%	2%				
	MONTANA			87%	29%			0%	
	SIERRA		89%	90%	1%	90%			
	UT N			92%	33%				
	UT S			92%	36%	90%			
	WYO			92%					
RMPP Total			89%	89%	16%	90%	0%	0%	
Total Capacity Factor		**90%**	**76%**	**88%**	**26%**	**90%**	**36%**	**0%**	**93%**

Opportunity Costs: Reference Case

Savings if capacity on congested paths increases by 1 MW

Interface Name	Congestion Cost (k$)	Congestion Hours (Hrs)
CHOLLA - PINNACLE PEAK	1028282	7756
MONTANA - NORTHWEST	503127	7355
BRIDGER WEST	410832	6050
Navajo - Crystal	345801	8118
WOR - IID230	207484	6283
IPP DC LINE	143249	6799
IID - SCE	120852	2323
WEST OF BROADVIEW	120374	2137
WEST OF COLSTRIP	102440	4001
BONANZA WEST	94565	3982
FOUR CORNERS 345_500	78406	3298
PACIFIC DC INTERTIE (PDCI)	66423	4196
SOUTHERN NEW MEXICO (NM1)	65287	4606
PATH C	47916	2180
CORONADO - SILVER KING - KYRENE	46719	4093
El Centro Bank	46605	4072
SCIT	41929	1270
ALBERTA - BRITISH COLUMBIA	41128	6578
BORAH WEST	29894	971
TOT 2C	15651	6005
HA-Red Butte PS	6651	1873
TOT 1A	6074	1390
Path 45	4355	2194
WOR - N.Gila	1937	82
WOR	1884	188
PAVANT INTRMTN - GONDER 230 KV	1781	842
PACIFICORP_PG&E 115 KV INTERCON.	1436	6237
NORTHWEST - CANADA	1249	208

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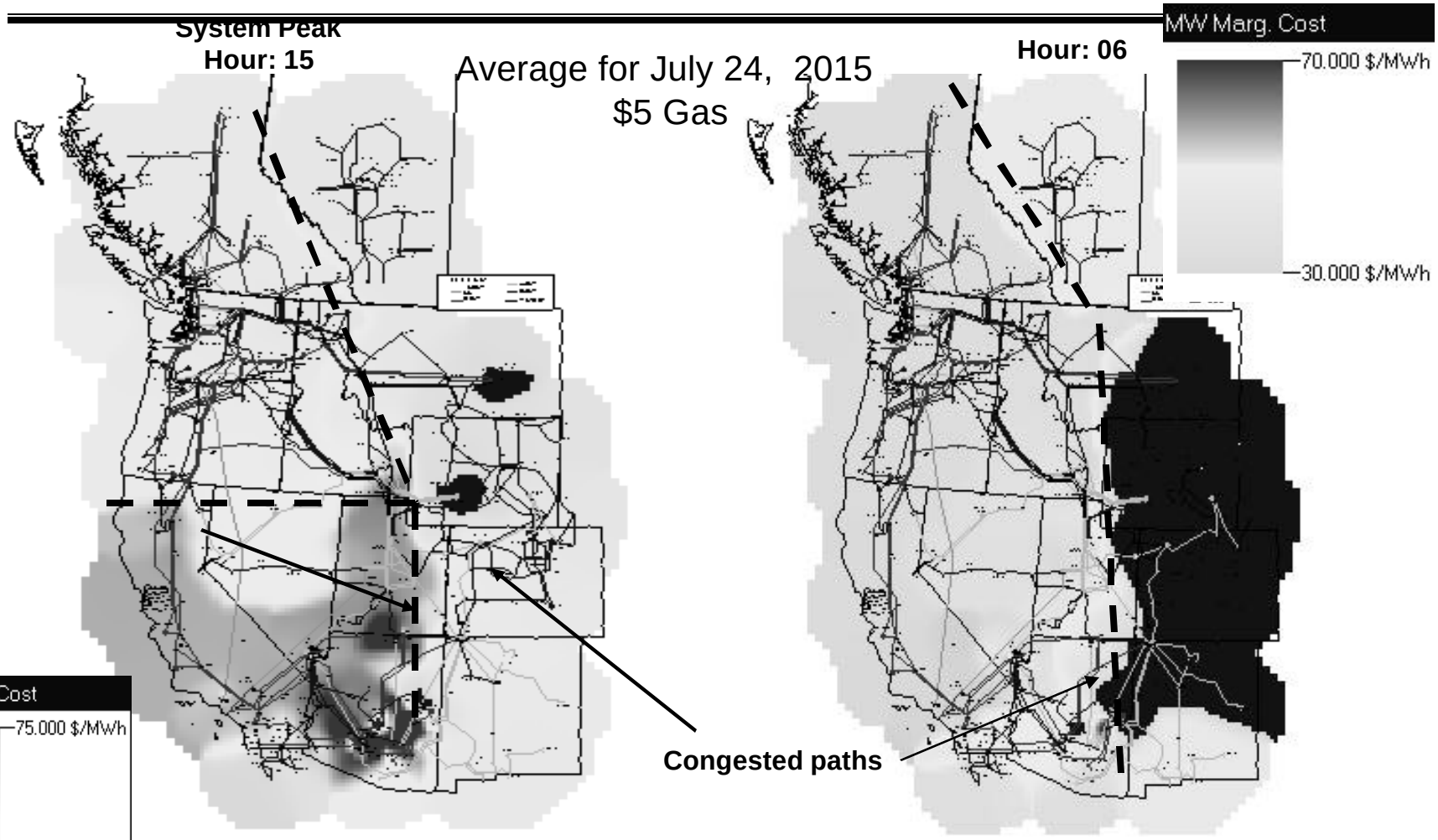
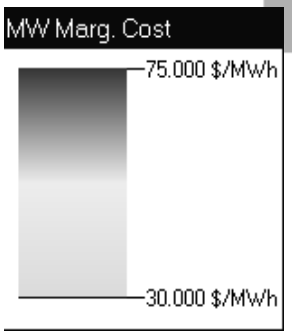
Congestion Prices





Differences **in colors indicate congestion**

Congestion can be caused by transmission constraints or by transmission losses

2015 Reference Case
November 9, 2005

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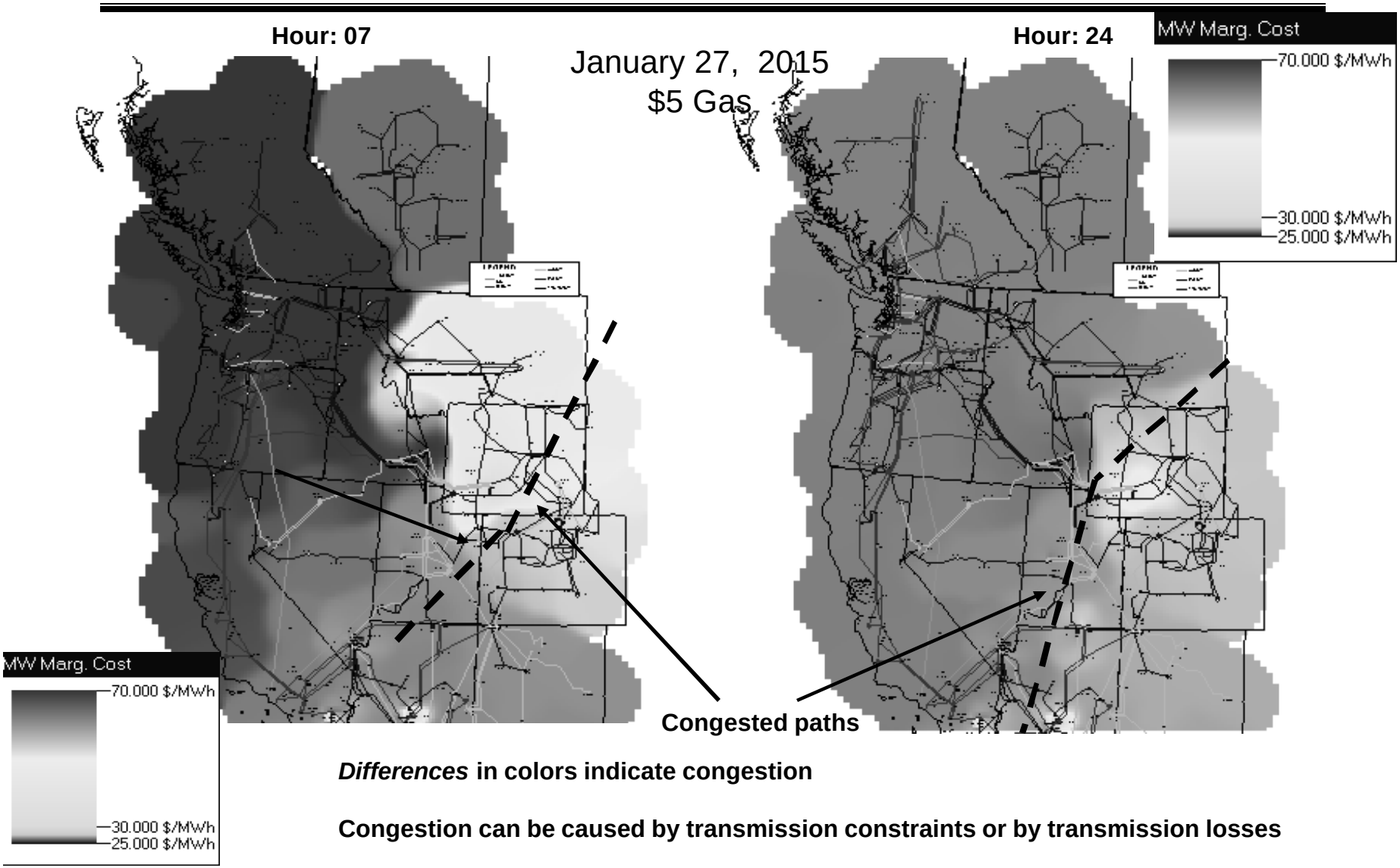
Congestion Prices



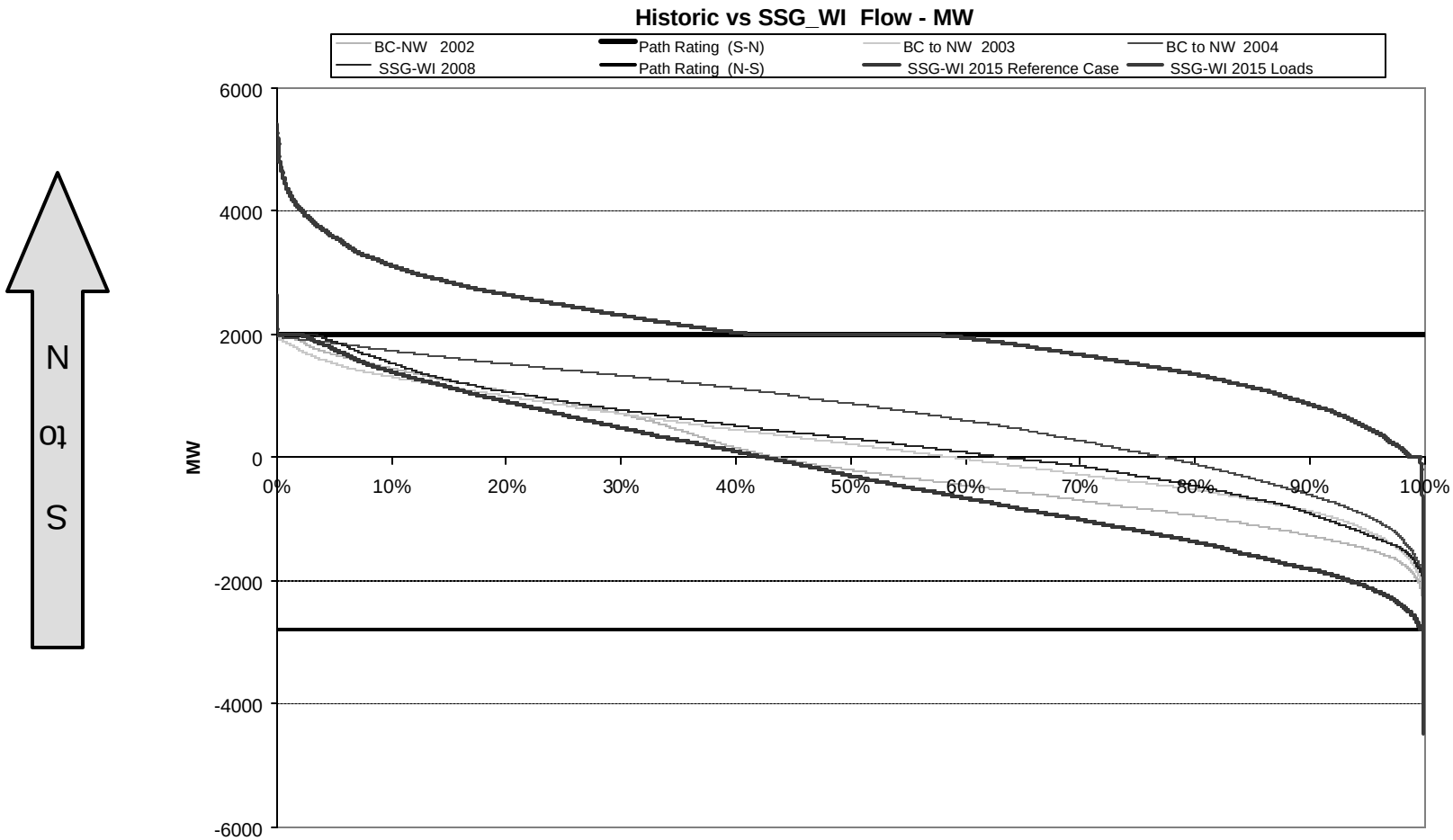
Differences **in colors indicate congestion**

Congestion can be caused by transmission constraints or by transmission losses

2015 Reference Case

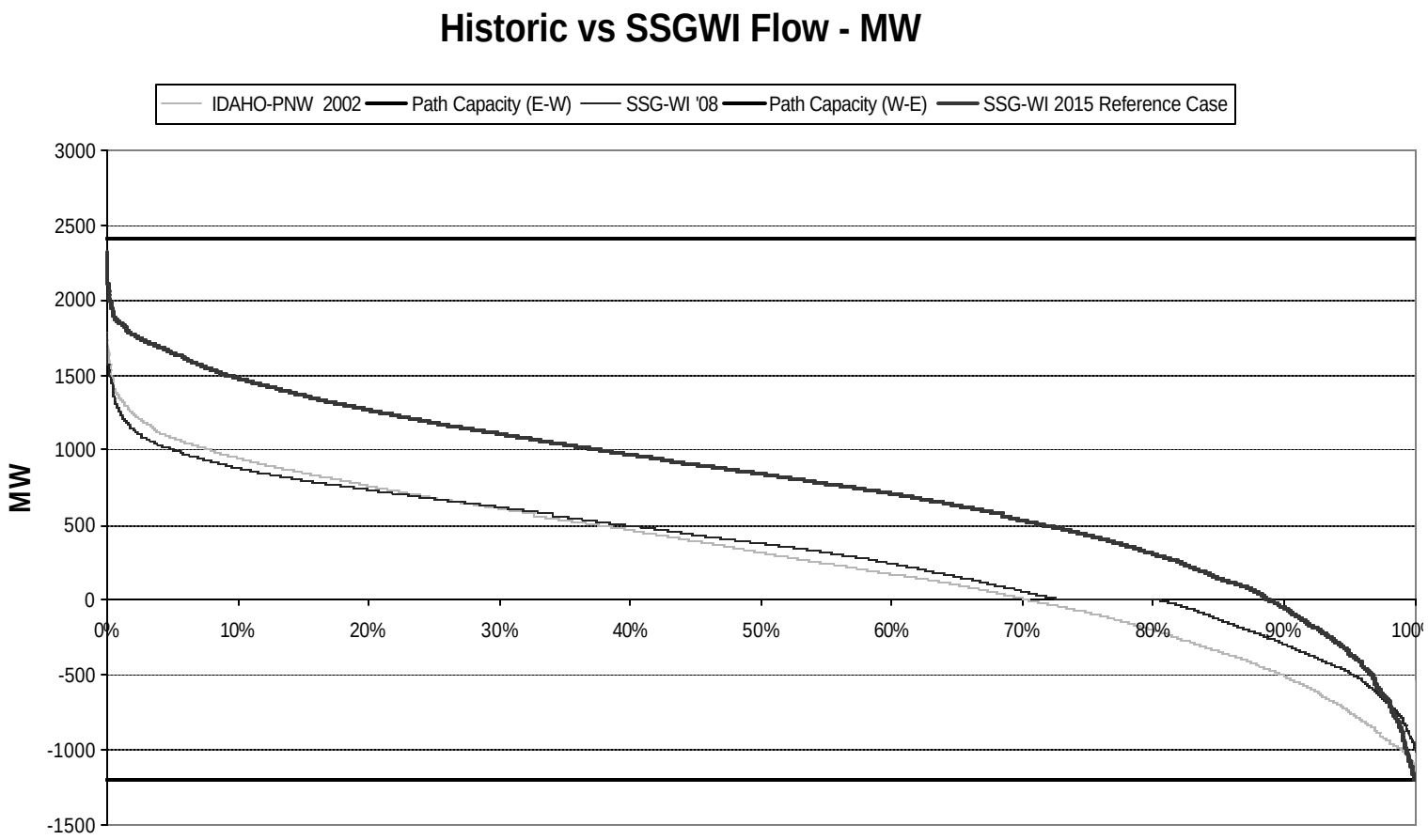
November 9, 2005

Northwest to Canada



• This path (Washington and southern British Columbia) shows high utilization;

Idaho to PNW Duration Curve

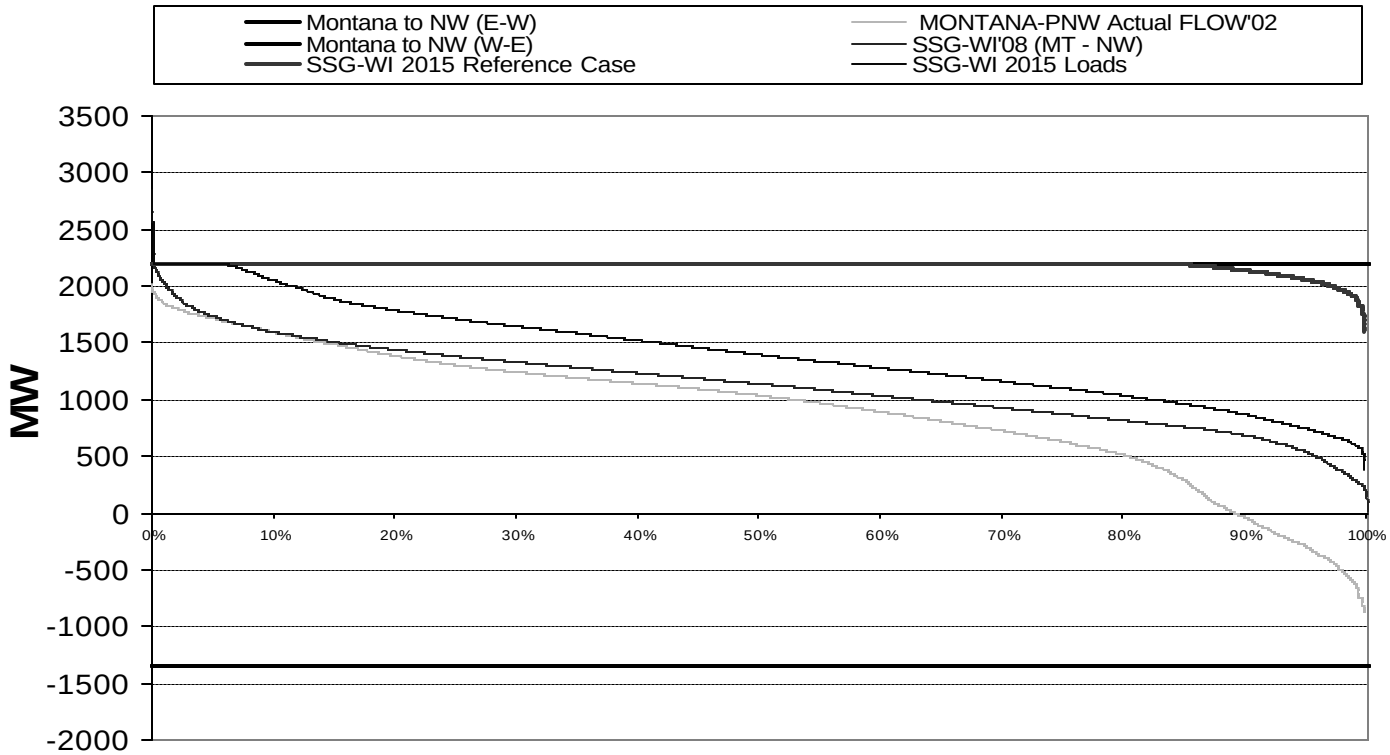


- This path (Southwest Idaho and Eastern Oregon/Washington and Northern Idaho) shows high utilization

E to W

Montana to PNW Duration Curve

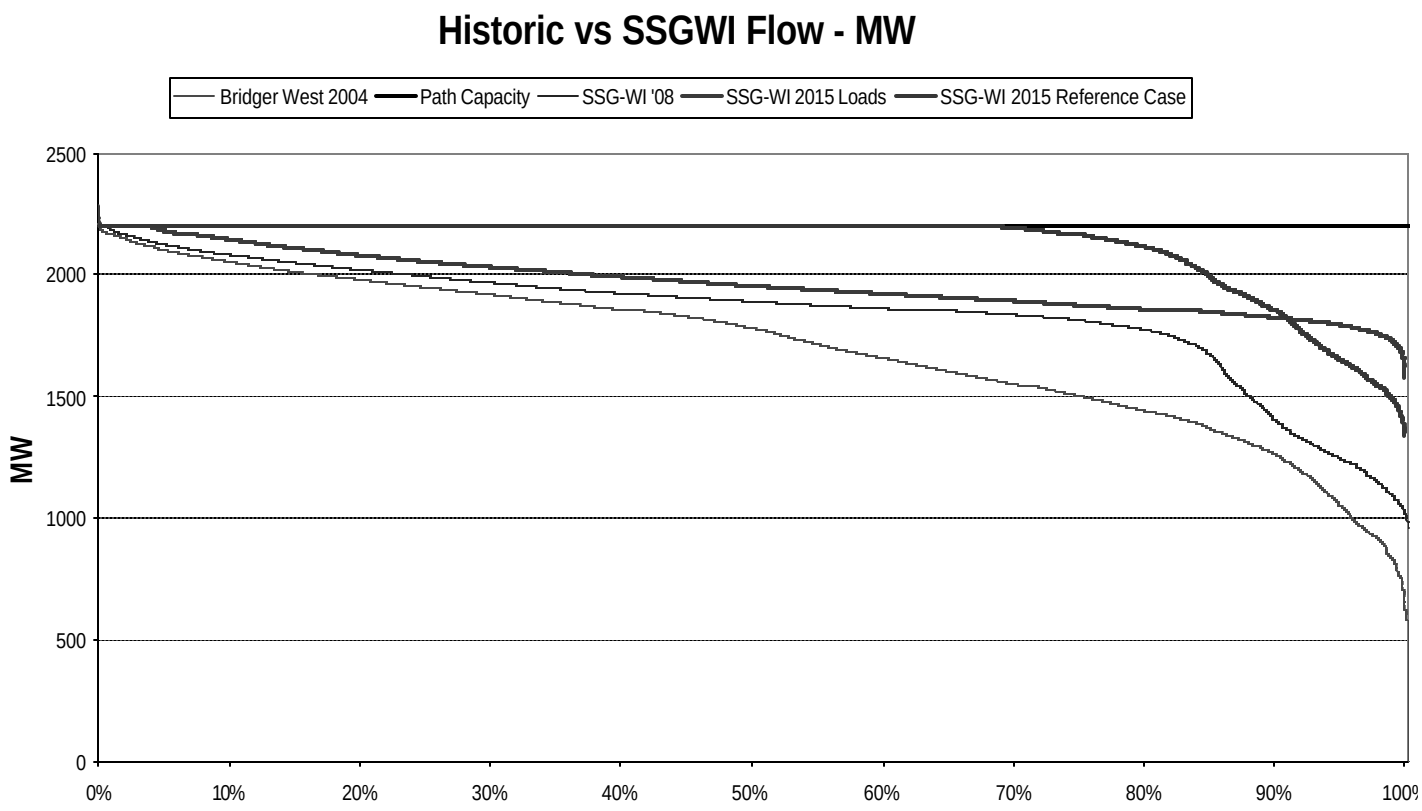
Historic vs SSGWI - MW



• This path (lines between western Montana and the Northwest) shows moderately high utilization

E to W

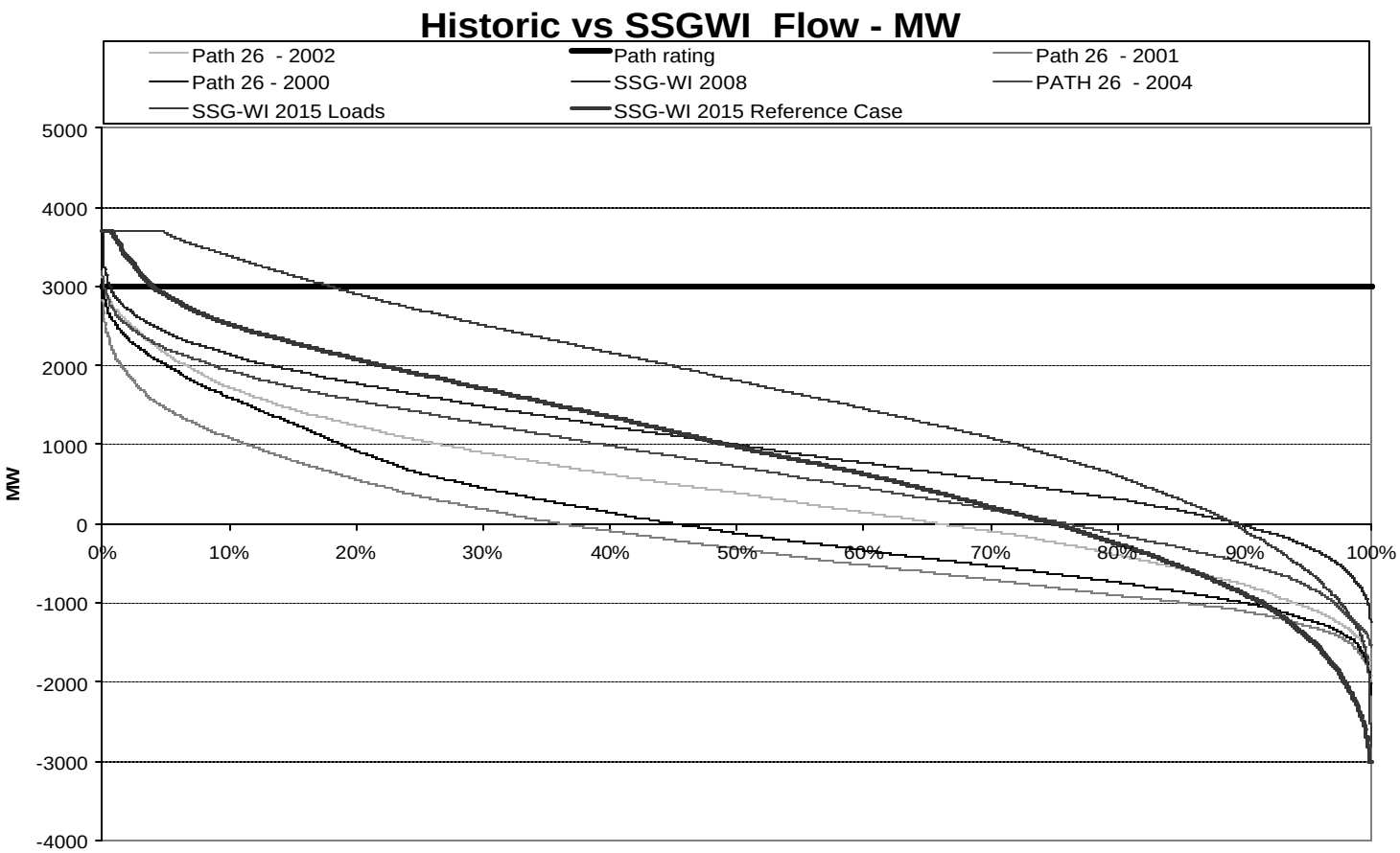
Bridger West



- This path (Border between Southeast Idaho and Southwest Wyoming) shows high utilization

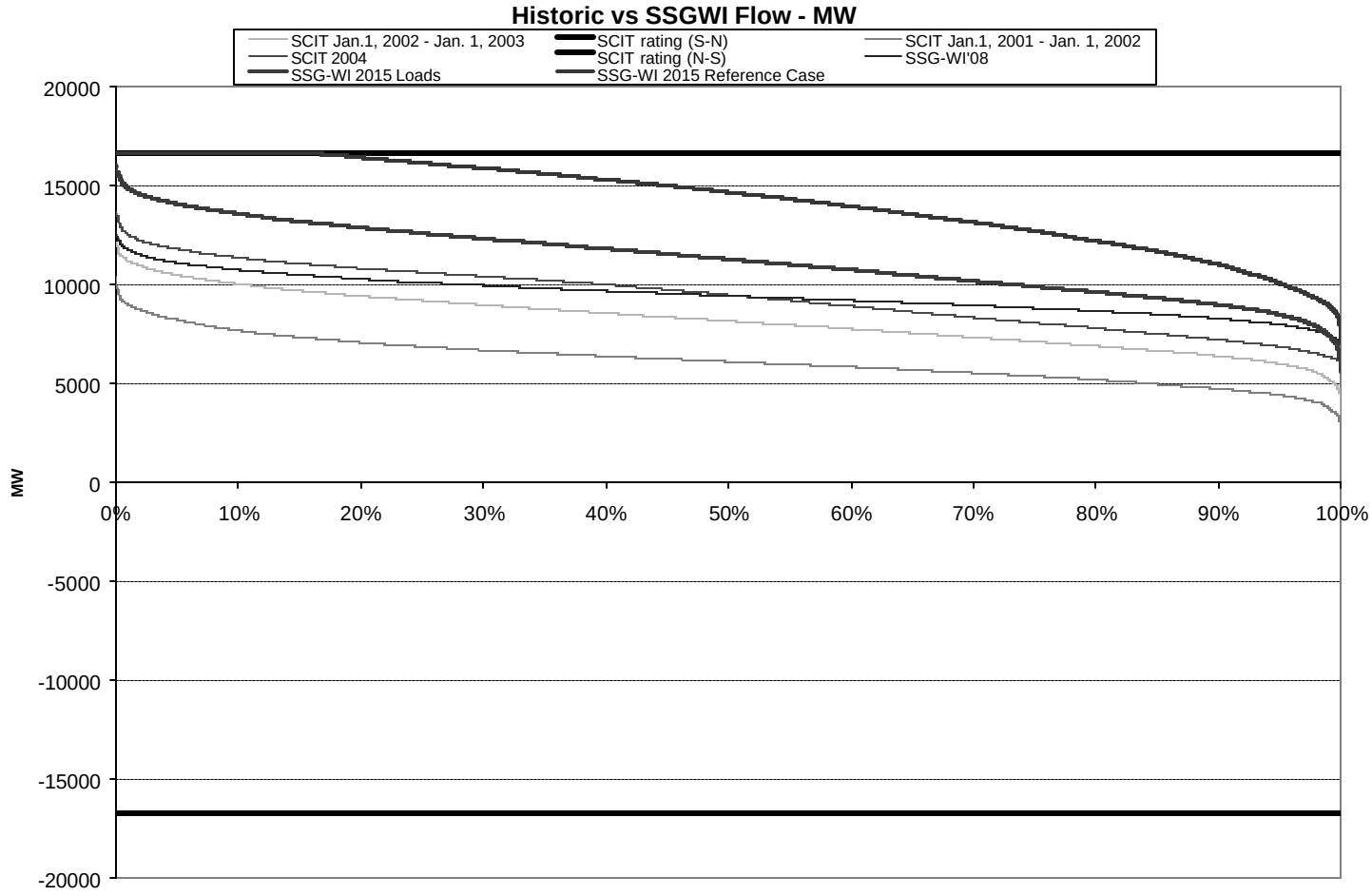
E to W

Path 26 Duration Curve



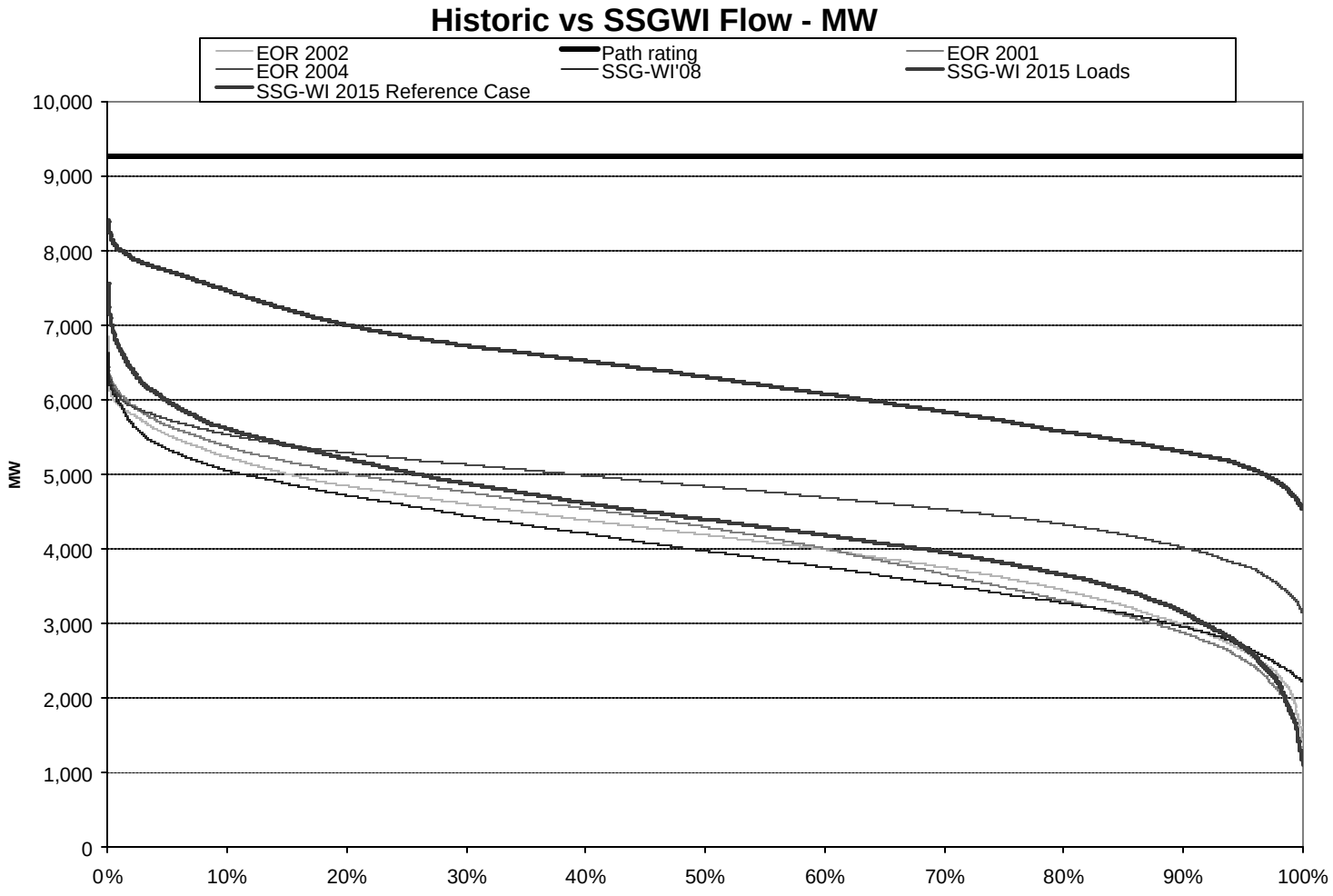
- This path (**Between PG&E and Southern California Edison; Midway to Vincent 3-500 kV lines)** shows moderately high utilization

SCIT Duration Curve



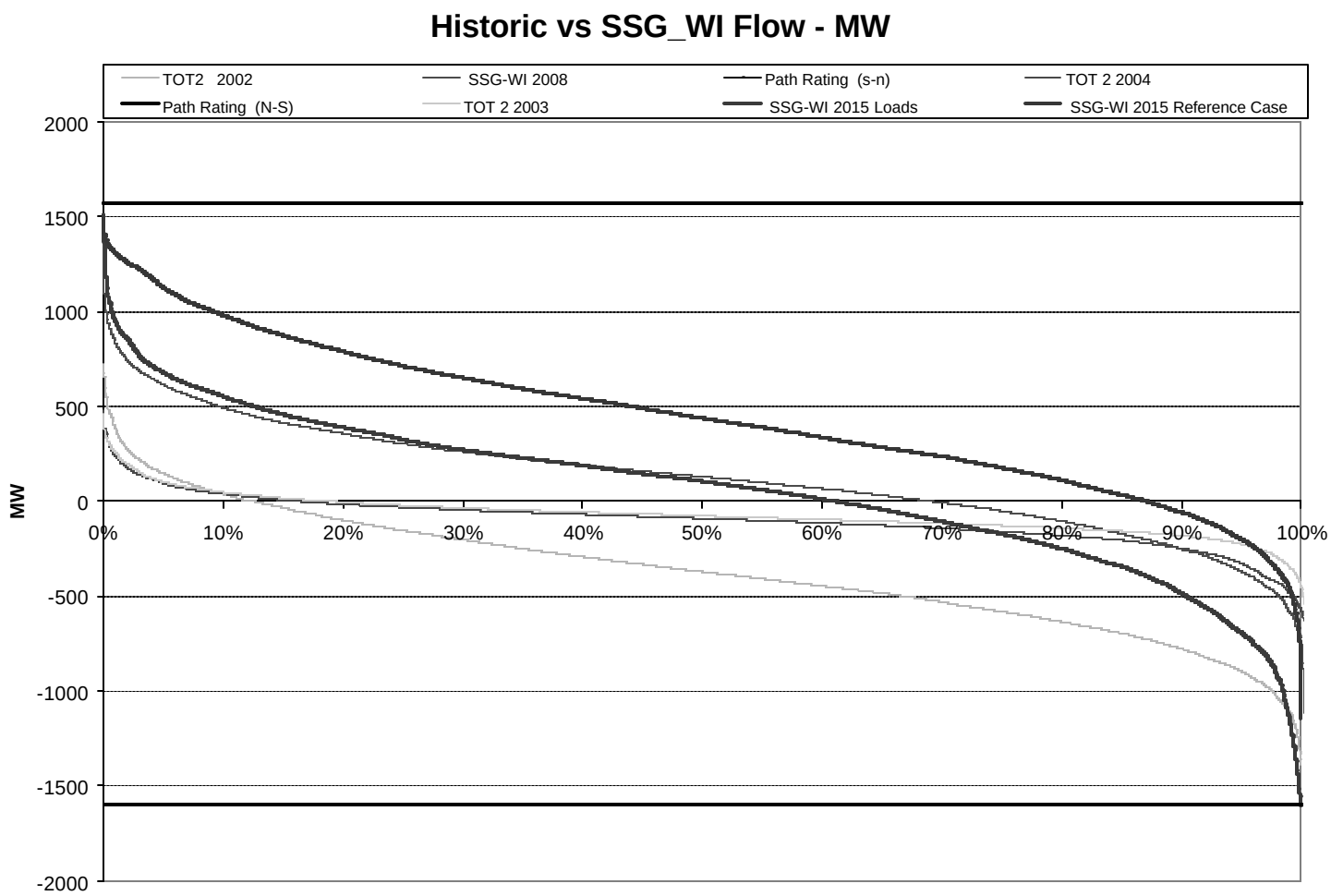
- This path (Sum of Midway, PDCI, IPP, North of Lugo, and WOR) shows moderate utilization

East of the River Duration Curve



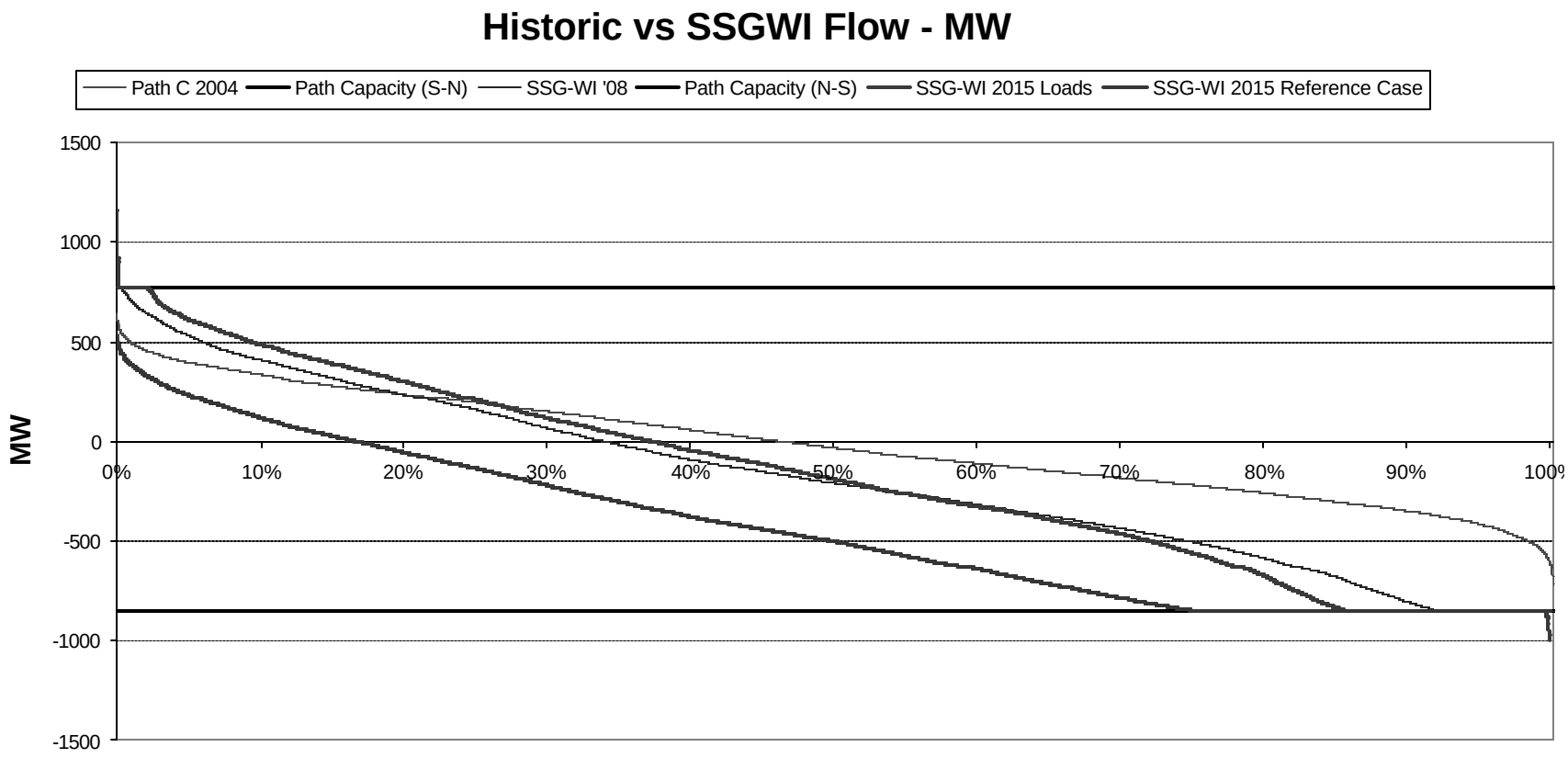
- This path (western Arizona) shows moderate utilization

TOT2 (A+B+C) Duration Curve



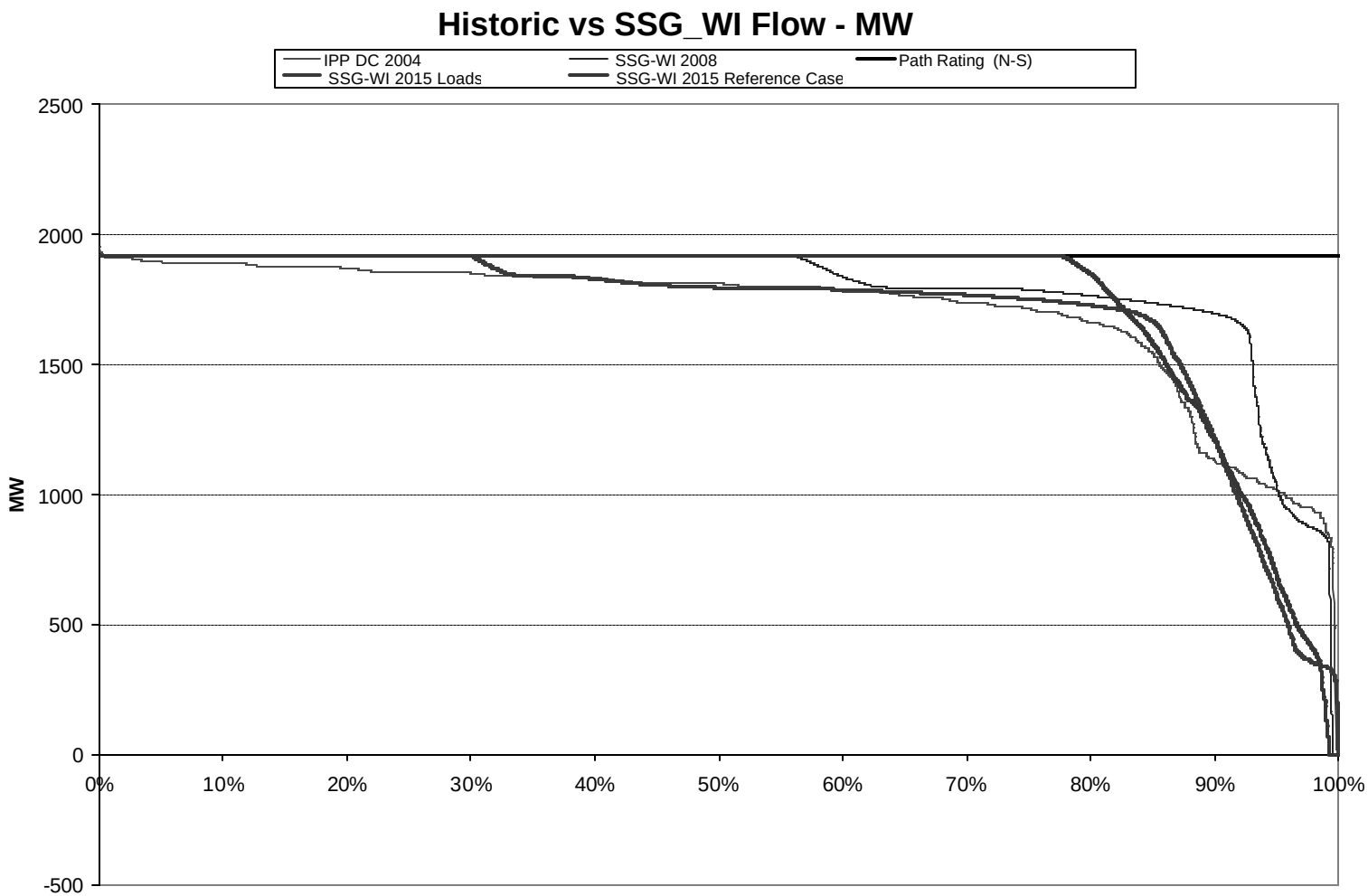
- This path (southern CO, southern Utah to N. Arizona and southern Utah to South-East Nevada) shows moderate utilization

Path C



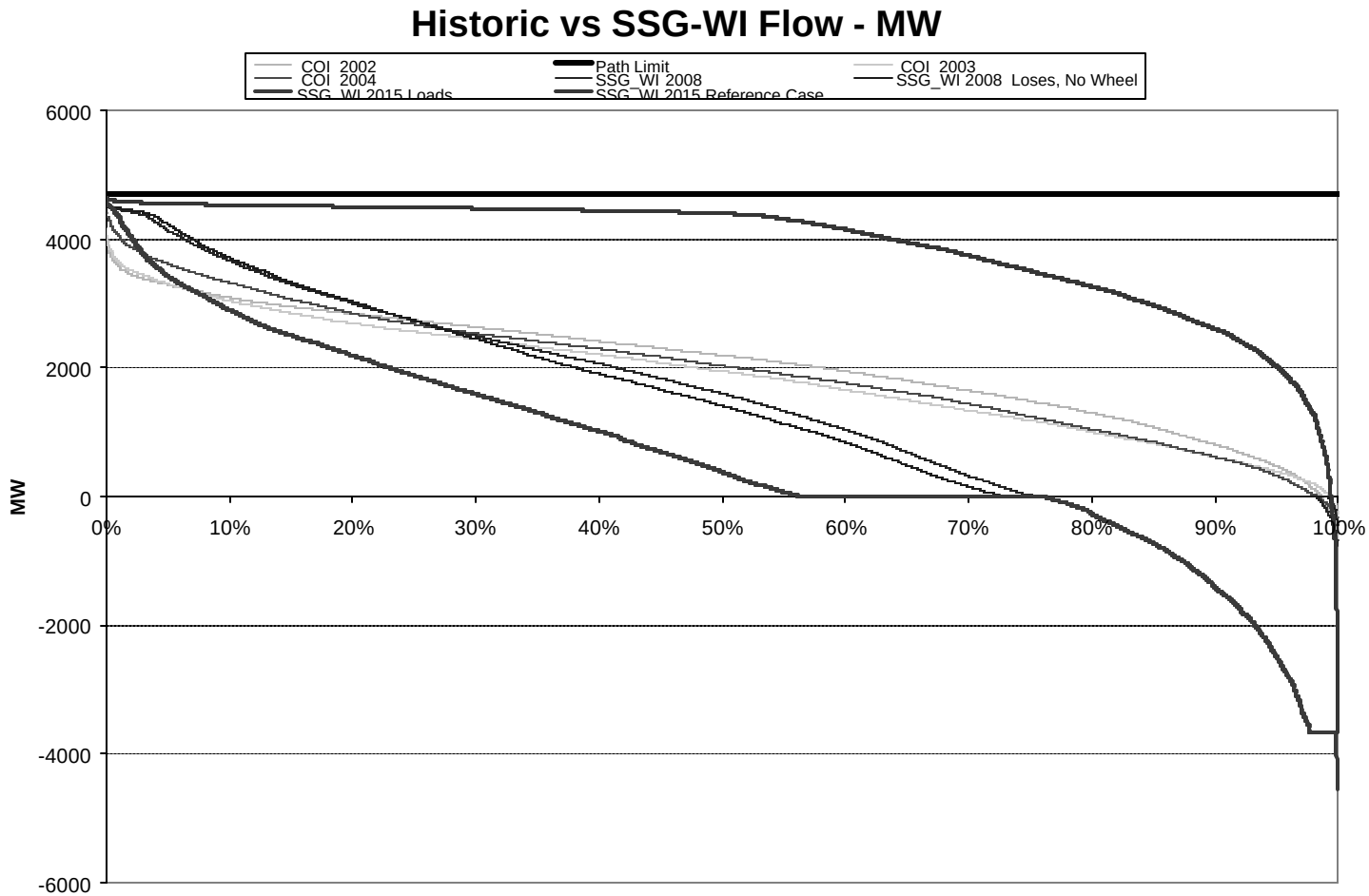
- This path (Northern Utah/southern Idaho) shows moderately high utilization; 10% of the time at limit in the south to north direction

IPP DC



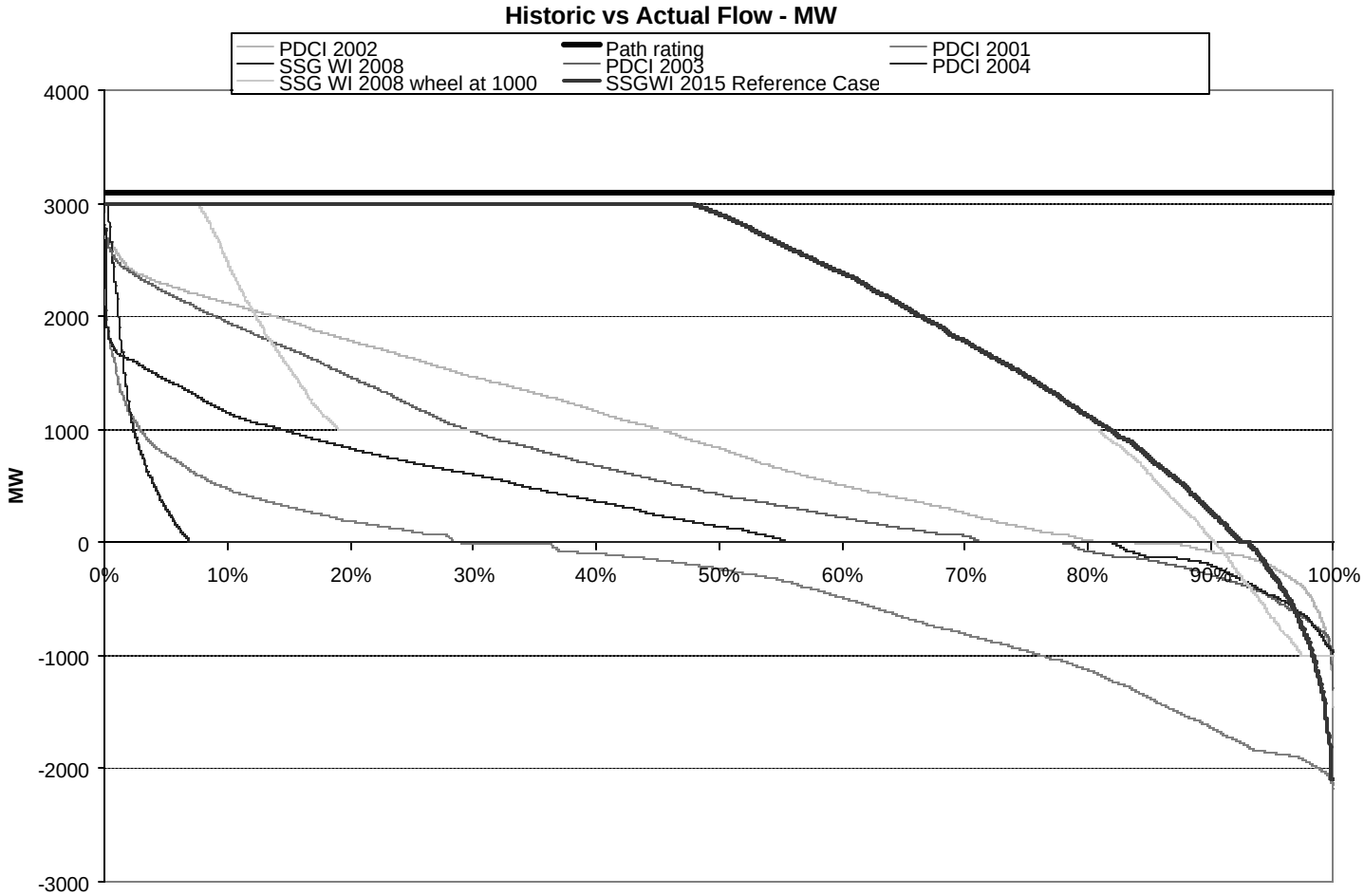
- This path (Intermountain to Adelanto station in southern California) shows moderately high utilization; 55% of the time at limit in the north to south direction.

COI



• This path (between Oregon and northern California) shows high utilization;

PDCI



• This path (between northern Oregon and Los Angeles) shows high utilization

Assumptions Requiring Resolution

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Assumptions Requiring Resolution

Assumption	Issue
Escalation rate	Analysis will be done in 2005 dollars
Capital charge rate for resources and transmission	10% - excludes fixed O&M
Fixed O&M rate - Resources	Per type of resource (RMATS: Gas - $7.25, Coal - $25, Wind - $17.5, Solar -?, Biomass -?, Geo -?, DSM -?)
Fixed O&M rate - Transmission	20% of the capital charge (source RMATS)
Wind “wear and tear” on non-wind resources	$5.5/MWh (source RMATS) – or less, because we now include thermal unit commitment?
Fixed transportation cost of gas from regional hubs to burner tip areas (capacity charge)	$?/kw/yr
Percent of installed capacity of wind, hydro, solar, etc. that counts towards meeting peak load	Same throughout region or wind @20% except in CA @ 38 to 40%?
Planning margin assumption	?

Assumptions Requiring Resolution

(Continued)

Assumption	Issue
DSM – The Council's forecast has DSM & Efficiencies. In addition, we are modeling incremental DSM submitted by the Resource Addition Subcommittee.	DSM double counted in NW?
Pump loads in California – Modeling pumps and using the 2008 load shapes generated by CAISO for the 2015 Reference Case. Also using the CEC Load forecast, which includes pump loads.	Pumps double counted in CA?
Transmission Nomograms: simplify North of John Day	
Thermal unit commitment data for Frame "F"	If received by 11/11/05