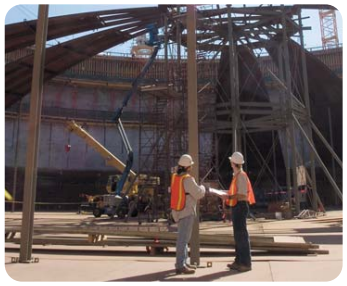
BUILDING A WORLD OF DIFFERENCE®

BLACK & VEATCH





Western Renewable Energy Zones

Peer Analysis Tool
User Guide and Methodology

Version 1.0

March 2009

Introduction

The Peer Analysis tool complements the Generation and Transmission Model (GTM), and is designed to assist load serving entities, regulators and renewable planners ("users") to easily identify the cost and value of renewable resources delivered to different load zones. This also provides the capability to identify possible partnership opportunities.

This tool mimics the GTM methodology for resource cost and value determination, assuming point-to-point transmission costs. The difference is this tool is designed to provide the comparative information for multiple load zones simultaneously, while the GTM provides only limited comparisons.

The tool is designed to be used as a resource analysis and comparison tool by users. It is not meant to be used to develop resource portfolios.

The model is Excel based and is flexible, allowing users to adapt it to meet their specific requirements.

Introduction (cont'd)

- Tool allows users to see supply curve of all WREZ resources available to a load zone
- Users may change supply curves by modifying limited number of assumptions
- Tool includes ranking of resources for each load zone
- Tool uses adjusted delivered costs of resources assuming point-to-point transmission service

PEER Analysis Tool

User Guide

! System Configuration Information

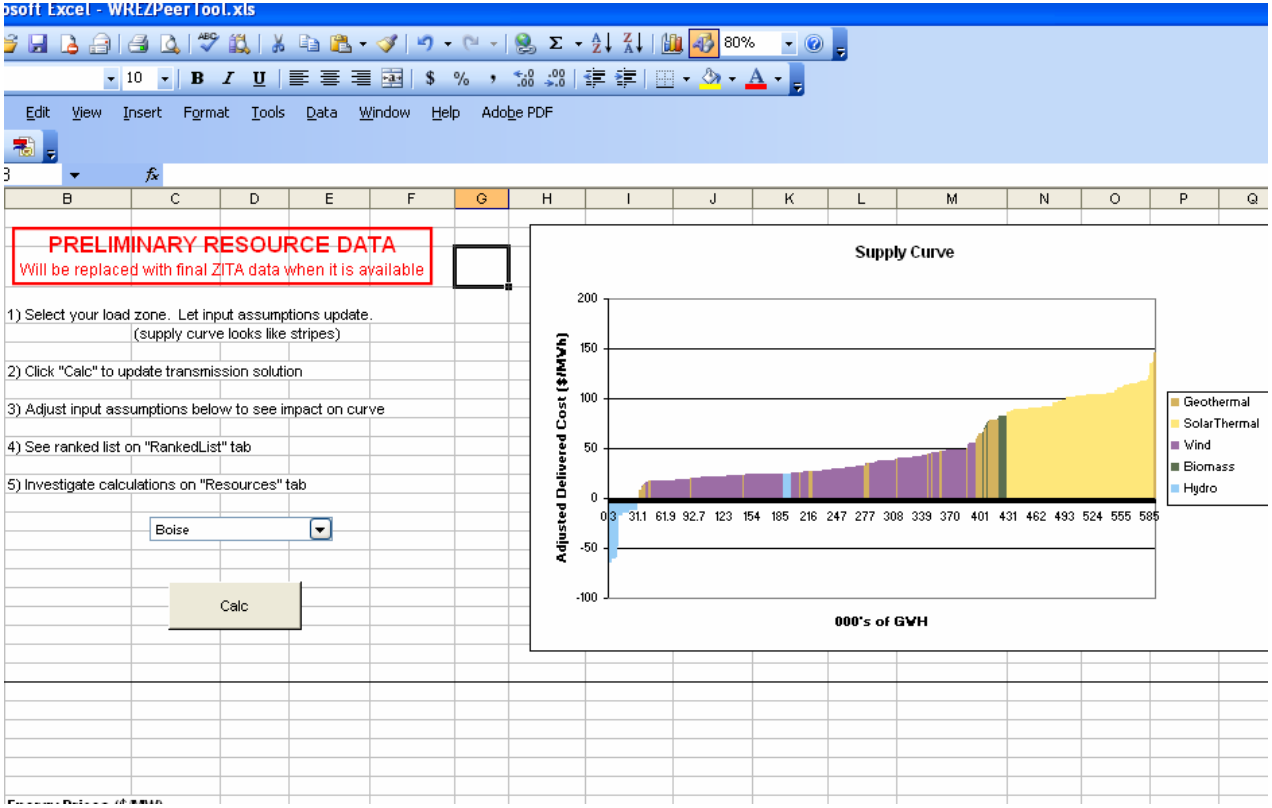
The GTM uses advanced macros and Excel must be configured to allow for use of these. When opening the GTM model the first time:

1. If "Security Warning" pops up on your screen; click "Enable Macros." The machine is properly configured
2. If the "Security Warning" *does not* appear on you screen, you will need to change the security level in Excel. Follow the instructions below (1)
   A. Go to "Tools" on the menu bar
   B. Select "Macros"
   C. Select "Security"
   D. A Security window will pop up on your screen
   E. Select "Medium" and click "Ok"
   F. Open WREZ Model and follow Step 2 above

1. These directions are for Office Version 2003 -- different versions of Office software may have security settings in different locations

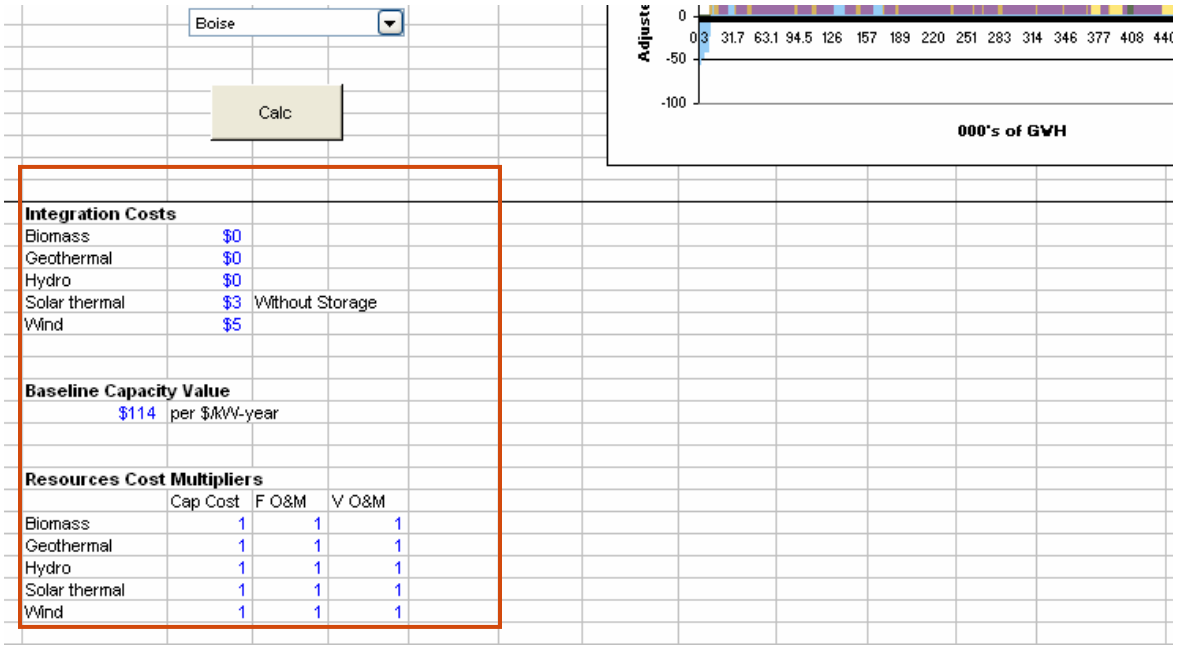
Developing a Supply Curve for a Load Zone

- Select a load zone from the drop down menu
- Click “Calc”
- A supply curve of all WREZ resources available to the selected load zone will be created



Modifying the Supply Curve

- User can adjust assumptions in blue and evaluate the effect on the supply curve. The following assumptions can be changed:
  - Integration costs
  - Capacity value
  - Resource cost multipliers



Integration Costs		
Biomass	$0	
Geothermal	$0	
Hydro	$0	
Solar thermal	$3	Without Storage
Wind	$5	

Baseline Capacity Value	
$114	per $/kW-year

Resources Cost Multipliers	Cap Cost	F O&M	V O&M
Biomass	1	1	1
Geothermal	1	1	1
Hydro	1	1	1
Solar thermal	1	1	1
Wind	1	1	1

Modifying the Supply Curve (cont'd)

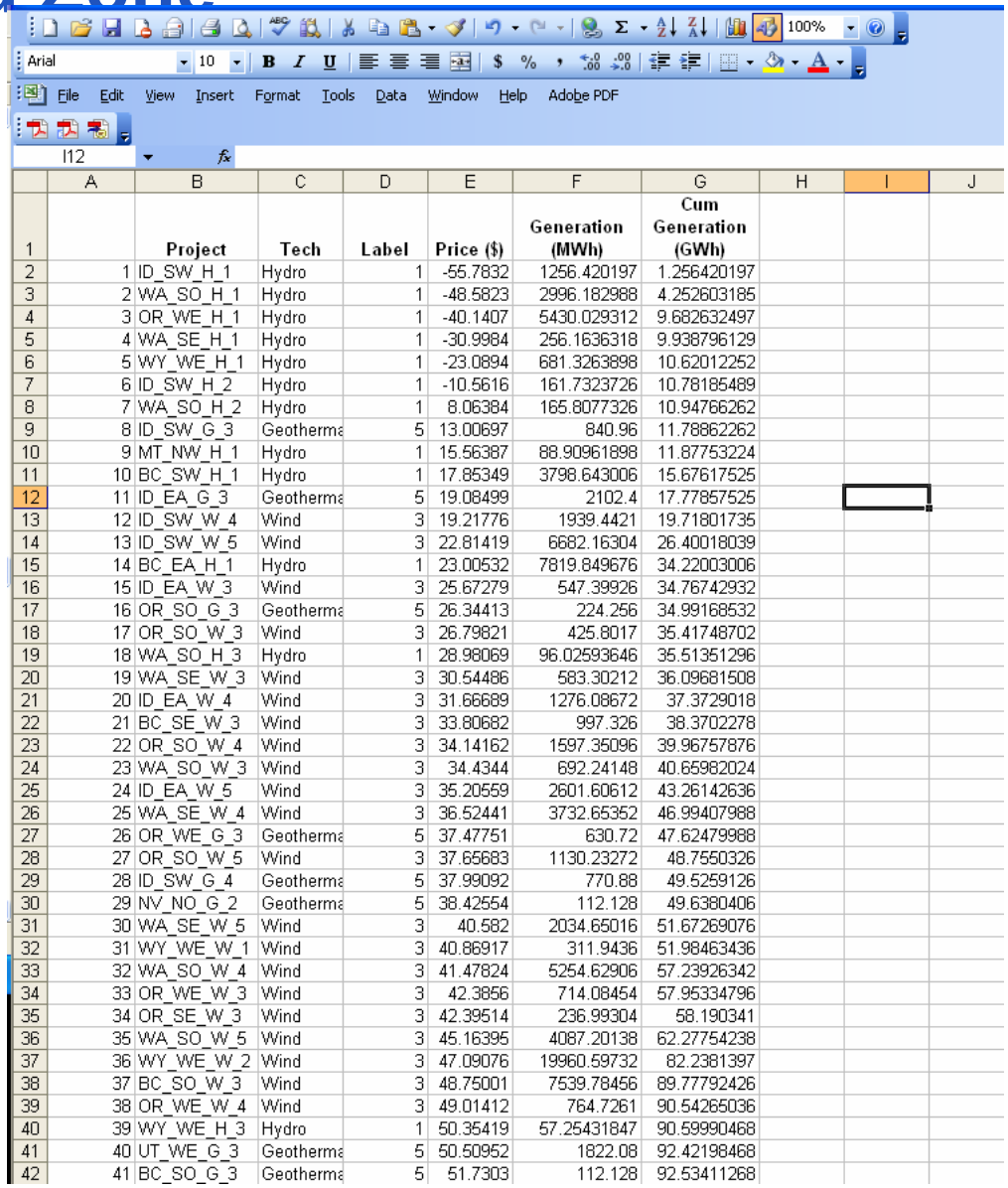
- Transmission assumptions
- Transmission financial assumptions

		500 kV AC Single				2						
		Line Utilization		100%								
Size		Capacity (MW)	le Cap Cost $000/mile	ROW Width feet	No. of Current (amps)	Resistance Typical Conductors	Conductors per phase	Per Cond (ohms/mile	FLL* (MW/mile)	FLL* per 100 miles	Losses at 60% Utilization % per 100 miles	Subt Costs thousands
765 kV AC Single		3000	2250	200	2383	957 ACSR	6	0.109	0.308	1.0%	0.5%	62500
500 kV AC Single		1500	1800	175	1823	1590 ACSR	3	0.067	0.221	1.5%	0.7%	50000
500 kV AC Double		3000	2880	175	1823	1590 ACSR	3	0.067	0.443	1.5%	0.7%	50000
345 kV AC Single		750	1260	160	1321	795 ACSR	2	0.128	0.335	4.5%	2.1%	40000
345 kV AC Double		1500	2016	160	1321	795 ACSR	2	0.128	0.670	4.5%	2.1%	40000
230 kV AC Single		400	900	150	1057	1272 ACSR	1	0.083	0.277	6.9%	3.3%	35000
230 kV AC Double		800	1440	150	1057	1272 ACSR	1	0.083	0.555	6.9%	3.3%	35000
500 kV DC Bi-Pole		3000	1440	200	3000	1780 ACSR	3	0.061	0.365	1.2%	0.6%	250000
800 kV DC Bi-Pole		TBD	TBD	TBD	2813	1780 ACSR	3	0.061	0.321	0.7%	0.3%	TBD

Transmission Financial Assumptions			
AFUDC	10%	of capital cost	-0
Economic Life	20	years	
Debt Percentage	60%		
Debt Term	20	years	
Interest Rate	7%		
Equity Cost	11%		
Tax Life	15	years	
Disount Rate	8.60%		
Tax Rate	40%		
Non-Capital Costs	3%		
ROW costs per acre		$10,700	

Ranking for Single Load Zone

- The tool ranks resources by delivered adjusted cost to the selected load zone (listed on RankedList sheet)
- The rankings are used to create the supply curve



	A	B	C	D	E	F	G	H	I	J
1		Project	Tech	Label	Price ($)	Generation (MWh)	Cum Generation (GWh)			
2	1	ID_SW_H_1	Hydro	1	-55.7832	1256.420197	1.256420197			
3	2	WA_SO_H_1	Hydro	1	-48.5823	2996.182988	4.252603185			
4	3	OR_WE_H_1	Hydro	1	-40.1407	5430.029312	9.682632497			
5	4	WA_SE_H_1	Hydro	1	-30.9984	256.1636318	9.938796129			
6	5	WY_WE_H_1	Hydro	1	-23.0894	681.3263898	10.62012252			
7	6	ID_SW_H_2	Hydro	1	-10.5616	161.7323726	10.78185489			
8	7	WA_SO_H_2	Hydro	1	8.06384	165.8077326	10.94766262			
9	8	ID_SW_G_3	Geotherma	5	13.00697	840.96	11.78862262			
10	9	MT_NW_H_1	Hydro	1	15.56387	88.90961898	11.87753224			
11	10	BC_SW_H_1	Hydro	1	17.85349	3798.643006	15.67617525			
12	11	ID_EA_G_3	Geotherma	5	19.08499	2102.4	17.77857525			
13	12	ID_SW_W_4	Wind	3	19.21776	1939.4421	19.71801735			
14	13	ID_SW_W_5	Wind	3	22.81419	6682.16304	26.40018039			
15	14	BC_EA_H_1	Hydro	1	23.00532	7819.849676	34.22003006			
16	15	ID_EA_W_3	Wind	3	25.67279	547.39926	34.76742932			
17	16	OR_SO_G_3	Geotherma	5	26.34413	224.256	34.99168532			
18	17	OR_SO_W_3	Wind	3	26.79821	425.8017	35.41748702			
19	18	WA_SO_H_3	Hydro	1	28.98069	96.02593646	35.51351296			
20	19	WA_SE_W_3	Wind	3	30.54486	583.30212	36.09681508			
21	20	ID_EA_W_4	Wind	3	31.66689	1276.08672	37.3729018			
22	21	BC_SE_W_3	Wind	3	33.80682	997.326	38.3702278			
23	22	OR_SO_W_4	Wind	3	34.14162	1597.35096	39.96757876			
24	23	WA_SO_W_3	Wind	3	34.4344	692.24148	40.65982024			
25	24	ID_EA_W_5	Wind	3	35.20559	2601.60612	43.26142636			
26	25	WA_SE_W_4	Wind	3	36.52441	3732.65352	46.99407988			
27	26	OR_WE_G_3	Geotherma	5	37.47751	630.72	47.62479988			
28	27	OR_SO_W_5	Wind	3	37.65683	1130.23272	48.7550326			
29	28	ID_SW_G_4	Geotherma	5	37.99092	770.88	49.5259126			
30	29	NV_NO_G_2	Geotherma	5	38.42554	112.128	49.6380406			
31	30	WA_SE_W_5	Wind	3	40.582	2034.65016	51.67269076			
32	31	WY_WE_W_1	Wind	3	40.86917	311.9436	51.98463436			
33	32	WA_SO_W_4	Wind	3	41.47824	5254.62906	57.23926342			
34	33	OR_WE_W_3	Wind	3	42.3856	714.08454	57.95334796			
35	34	OR_SE_W_3	Wind	3	42.39514	236.99304	58.190341			
36	35	WA_SO_W_5	Wind	3	45.16395	4087.20138	62.27754238			
37	36	WY_WE_W_2	Wind	3	47.09076	19960.59732	82.2381397			
38	37	BC_SO_W_3	Wind	3	48.75001	7539.78456	89.77792426			
39	38	OR_WE_W_4	Wind	3	49.01412	764.7261	90.54265036			
40	39	WY_WE_H_3	Hydro	1	50.35419	57.25431847	90.59990468			
41	40	UT_WE_G_3	Geotherma	5	50.50952	1822.08	92.42198468			
42	41	BC_SO_G_3	Geotherma	5	51.7303	112.128	92.53411268			

Resource Ranking for Multiple Load Zones

- Tool can help identify partnership opportunities
  - Compare top ranking projects with other load zones
  - Partnership should be considered for projects that rank highly for two or more load zones (highlighted in the example below)

	Seattle		Boise		Portland		Sacramento	
Rank	Project	Price	Project	Price	Project	Price	Project	Price
1	OR_WE_H_1	$ (33.18)	OR_WE_H_1	$ (27.59)	OR_WE_H_1	$ (35.07)	OR_WE_H_1	$ (25.34)
2	WA_SO_H_1	$ (27.48)	WA_SO_H_1	$ (24.95)	WA_SO_H_1	$ (29.38)	WA_SO_H_1	$ (21.99)
3	ID_SW_H_1	$ (16.57)	ID_SW_H_1	$ (23.59)	ID_SW_H_1	$ (17.20)	ID_SW_H_1	$ (17.89)
4	WA_SE_H_1	$ (9.61)	WY_WE_H_1	$ (9.40)	WA_SE_H_1	$ (6.27)	WY_WE_H_1	$ (4.32)
5	WY_WE_H_1	$ 0.80	WA_SE_H_1	$ (6.81)	WY_WE_H_1	$ 1.02	WA_SE_H_1	$ 1.71
6	MT_NW_H_1	$ 6.86	MT_NW_H_1	$ 6.31	MT_NW_H_1	$ 8.12	BC_SW_H_1	$ 6.24
7	BC_NE_H_2	$ 15.68	BC_SW_H_1	$ 11.50	AB_NO_H_1	$ 19.88	BC_EA_H_1	$ 10.17
8	AB_NO_H_1	$ 16.12	AB_NO_H_1	$ 11.97	BC_NE_H_2	$ 20.31	MT_NW_H_1	$ 11.82
9	BC_SW_H_1	$ 19.02	BC_EA_H_1	$ 12.77	BC_SW_H_1	$ 22.29	AB_NO_H_1	$ 16.09
10	BC_EA_H_1	$ 19.94	ID_SW_H_2	$ 21.24	WA_SO_H_2	$ 23.18	ID_SW_H_2	$ 26.94
11	WA_SO_H_2	$ 25.08	BC_NE_H_2	$ 21.71	BC_EA_H_1	$ 23.27	CA_WE_W_1	$ 27.67
12	BC_WC_H_2	$ 26.55	WA_SO_H_2	$ 27.61	ID_SW_H_2	$ 27.62	BC_NE_H_2	$ 30.14
13	ID_SW_H_2	$ 28.26	WY_WE_W_1	$ 30.02	BC_WC_H_2	$ 29.41	WA_SO_H_2	$ 30.57
14	WY_WE_W_1	$ 30.59	WY_EA_W_1	$ 32.49	WY_WE_W_1	$ 30.72	BC_WC_H_2	$ 32.49
15	WY_EA_W_1	$ 31.92	BC_WC_H_2	$ 33.36	CA_WE_W_1	$ 32.33	NV_NO_G_2	$ 37.93
16	OR_WE_G_3	$ 34.59	CA_WE_W_1	$ 35.09	OR_WE_G_3	$ 32.76	WY_WE_W_1	$ 40.21
17	CA_WE_W_1	$ 34.61	ID_EA_G_3	$ 37.57	WY_EA_W_1	$ 33.16	CA_SO_W_2	$ 40.50
18	BC_WC_G_3	$ 37.19	NV_NO_G_2	$ 38.60	NV_NO_G_2	$ 36.40	WY_EA_W_1	$ 42.80
19	BC_SO_G_3	$ 38.11	OR_WE_G_3	$ 41.28	ID_EA_G_3	$ 40.45	OR_WE_G_3	$ 43.82
20	NV_NO_G_2	$ 38.39	ID_SW_G_3	$ 41.51	BC_WC_G_3	$ 40.56	CA_WE_W_2	$ 44.30

Useful for identifying potential partnership opportunities!

Allocating Resources – Example Overview

- Not everyone can have the best resources
  - Some resources will be highly ranked for all the load zones
  - There will be competition for these limited best resources
- Tool can also be used to allocate resources
  - The user can create a cost matrix of adjusted delivered costs for all resource to each of the load zones
  - For example, allocate each resource to the top 3 load zones by cost

Allocating resources - Resource Cost Matrix

- By copying the results from the “Resources” sheet for each load zone and pasting into a new sheet, the user can create a resource cost matrix
- A resource cost matrix will show the cost of each project for each load zone

ID	Albuquerque	Billings	Boise	Calgary	Casper	Denver	El Paso	Las Vegas	Los Angeles	Northern California	Pheonix	Portland	Reno	Salt Lake City	San Francisco	San Diego	Seattle	Spokane	Tucson	Vancouver
WY_EA_B_5	$104	$100	$102	$101	$96	$93	$111	$104	$107	$115	$106	$113	$106	$98	$116	$110	$111	$105	$108	$105
WY_EA_H_3	$59	$54	$59	$62	$51	$48	$63	$59	$63	$69	$60	$72	$60	$52	$70	$64	$70	$65	$63	$65
WY_EA_W_1	$40	$35	$35	$29	$34	$32	$45	$40	$42	$48	$42	$37	$41	$36	$49	$45	$36	$31	$43	$31
WY_EA_W_2	$54	$49	$48	$42	$47	$45	$60	$54	$56	$62	$56	$50	$56	$49	$64	$59	$49	$44	$57	$44
WY_EA_W_3	$73	$68	$67	$60	$66	$64	$80	$74	$76	$83	$76	$69	$76	$69	$85	$80	$67	$61	$77	$61
WY_EC_B_5	$105	$99	$101	$100	$95	$93	$112	$105	$108	$114	$106	$113	$107	$99	$116	$111	$110	$105	$109	$105
WY_EC_W_2	$57	$51	$50	$44	$49	$48	$63	$57	$59	$65	$59	$52	$59	$53	$66	$63	$50	$45	$61	$45
WY_EC_W_3	$73	$66	$66	$58	$64	$64	$79	$73	$76	$81	$76	$67	$75	$69	$83	$80	$65	$60	$77	$60
WY_NO_W_2	$62	$54	$54	$47	$53	$54	$69	$63	$65	$68	$65	$55	$63	$58	$70	$69	$53	$48	$66	$48
WY_NO_W_3	$73	$64	$63	$56	$62	$64	$79	$73	$76	$79	$75	$64	$74	$68	$81	$80	$62	$57	$77	$57
WY_SO_B_5	$103	$101	$104	$102	$97	$91	$109	$102	$105	$116	$104	$115	$104	$96	$117	$108	$113	$107	$107	$107
WY_SO_W_2	$55	$53	$52	$46	$51	$47	$61	$55	$58	$66	$57	$54	$57	$51	$68	$61	$53	$48	$59	$48
WY_SO_W_3	$77	$74	$73	$66	$72	$68	$83	$77	$80	$89	$79	$75	$79	$72	$91	$84	$73	$67	$81	$67
WY_SO_W_4	$95	$93	$92	$83	$90	$86	$103	$96	$99	$109	$98	$92	$98	$91	$111	$103	$90	$84	$100	$84
WY_WE_B_5	$109	$98	$98	$99	$94	$97	$115	$106	$109	$110	$110	$110	$104	$100	$112	$112	$109	$104	$113	$104
WY_WE_H_1	($3)	($10)	($9)	($4)	($13)	($12)	$0	($5)	($2)	($2)	($3)	$3	($7)	($10)	($2)	($2)	$2	($1)	($0)	($1)
WY_WE_H_3	$66	$56	$59	$65	$53	$55	$71	$64	$69	$69	$68	$73	$62	$58	$69	$70	$72	$68	$71	$68
WY_WE_W_1	$43	$34	$32	$28	$33	$35	$49	$41	$43	$45	$45	$34	$40	$37	$46	$47	$34	$30	$46	$30
WY_WE_W_2	$60	$50	$48	$43	$49	$51	$66	$58	$61	$62	$62	$50	$57	$54	$63	$65	$49	$44	$64	$44
WY_WE_W_3	$73	$63	$60	$55	$61	$64	$80	$72	$74	$76	$76	$62	$71	$67	$77	$79	$62	$56	$77	$56

Allocating Resources - Relative Ranking

- For each project, by ranking each load zone from lowest to highest cost, the user can begin to see the relative attractiveness of resources to each zone
- In this example, each resource is allocated to the top 3 load zones where resource is most valuable

ID	4	Albuquerque	Billings	Boise	Calgary	Casper	Denver	El Paso	Las Vegas	Los Angeles	Northern California	Pheonix	Portland	Reno	Salt Lake City	San Francisco	San Diego	Seattle	Spokane	Tucson	Vancouver
WY_EA_B_5	Biomass	0	0	0	0	2	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0
WY_EA_H_3	Hydro	0	0	0	0	2	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0
WY_EA_W_1	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_EA_W_2	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_EA_W_3	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_EC_B_5	Biomass	0	0	0	0	2	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0
WY_EC_W_2	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_EC_W_3	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_NO_W_2	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_NO_W_3	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_SO_B_5	Biomass	0	0	0	0	3	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0
WY_SO_W_2	Wind	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	3
WY_SO_W_3	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_SO_W_4	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_WE_B_5	Biomass	0	3	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WY_WE_H_1	Hydro	0	3	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WY_WE_H_3	Hydro	0	3	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WY_WE_W_1	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_WE_W_2	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
WY_WE_W_3	Wind	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2

PEER Analysis Tool

Methodology

Methodology

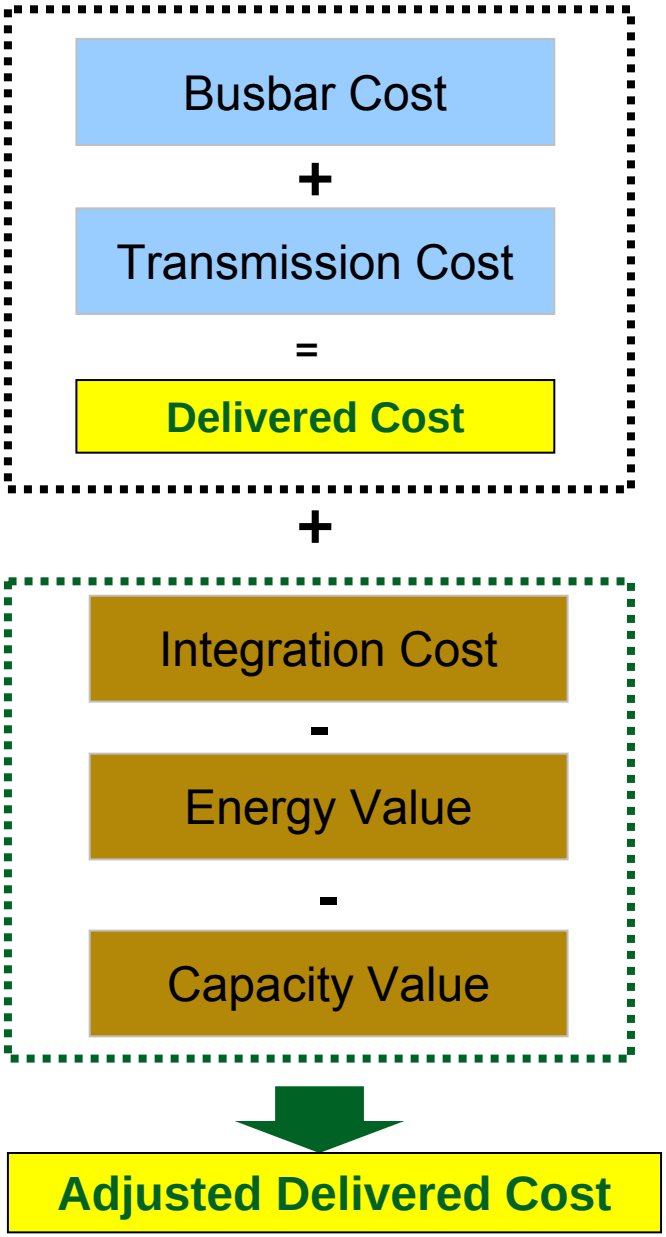
- Overview
- Adjusted Delivered Cost
- Transmission
- Transmission Losses
- Integration Costs
- Energy Value
- Capacity Value

Methodology Overview

- Model based on Year 2015 information
  - Loads
  - Costs
  - Resource technologies
- All cost inputs and outputs in $ 2009

Adjusted Delivered Cost

- Busbar cost – "raw" cost of generation
- Delivered cost – cost to deliver energy to load zones
- Adjusted Delivered cost – the *value* of a resource to a load zone, taking into consideration the energy and capacity benefit delivered by the resource



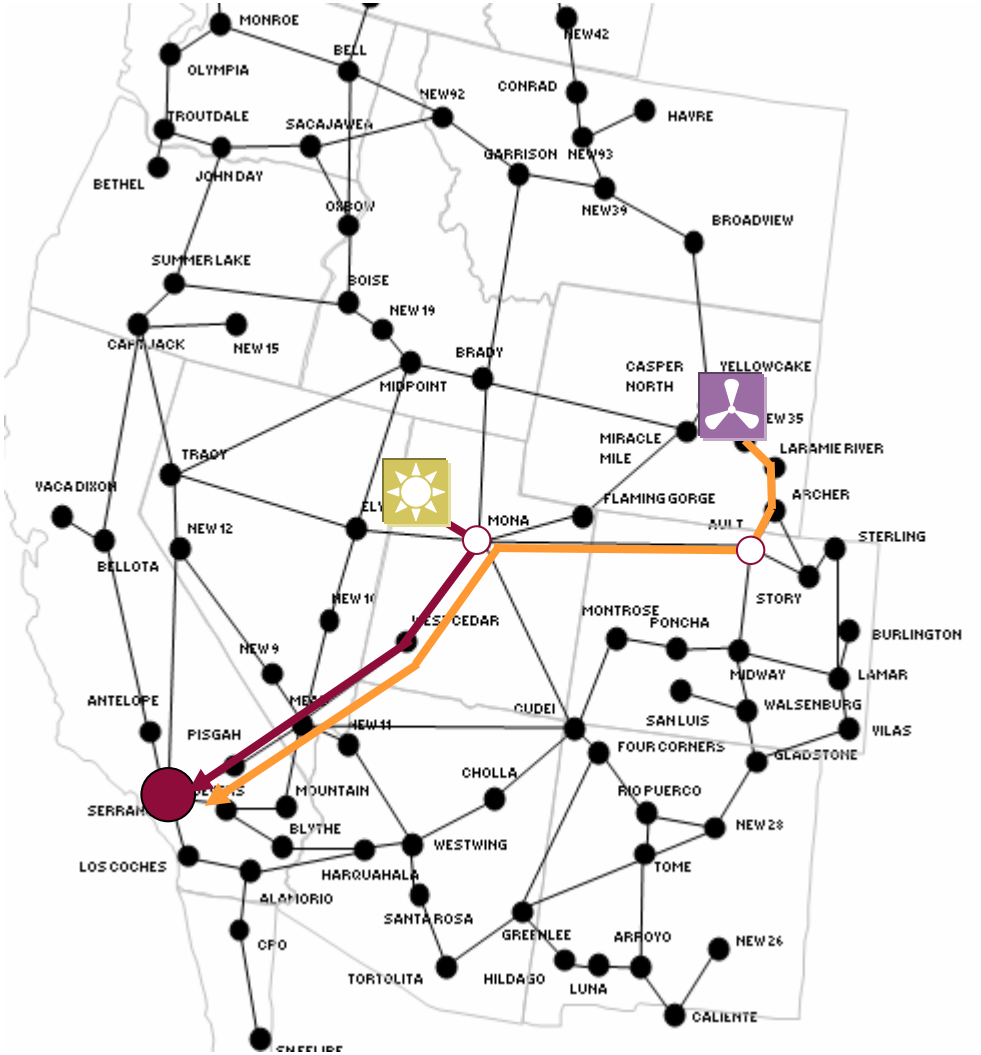
Transmission

- All transmission costs based on point-to-point routing over existing rights of way

!! NOTE: The transmission cost in the Peer Analysis Tool is fixed, and cannot be redefined by users within the tool as may be done in the GTM model

- Pro-rata costs for transmission of each resource to load zone is calculated using the user defined utilization (GTM model calculates utilization based on generation profiles of the resources on the transmission line)

Point-to-Point Transmission



- Each resource has a separate transmission route to the load zone
- Transmission routing is based on the shortest distance over existing Right of Ways

Transmission Losses

- Losses are based on distance from busbar to load zone and line voltage
- Losses applied to the delivered cost of the resource

$$\text{Delivered Cost after Losses} = \frac{\text{Cost at Busbar (\$/MWh)} + \text{Transmission Cost (\$/MWh)}}{(1 - \%\ \text{Transmission Loss})}$$

Integration Cost

- Integration cost of a project is the indirect operation cost to the grid to accommodate the generation from a project
- Integration costs are determined by resource type
  - Wind - $5/MWh
  - Solar thermal - $2.50/MWh
  - Biomass - $0.00/MWh
  - Geothermal - $0.00/MWh

Energy Value

- Energy value of a resource represents the value of its hourly output to the load zone – i.e. the load zone's energy price forecast value
- Energy values based on 2015 market forecast ($2009) developed using ProMod production cost model
- Average hourly energy prices by month are included in the price forecast for each load zone

$$\text{Energy Value (\$/MWh)} = \sum \frac{(\text{Energy Value in Time Period}) \times (\text{Energy Output in Time Period})}{\text{Total Energy Output}}$$

Energy Value (cont'd)

- 2015 Energy Price Forecast
  - Developed by B&V using ProMod production cost software
  - CO_2 at $35/ton
  - Fuel cost approximately $10/MMBtu
  - Zonal Transmission Model – Each market zone is connected to series of others with transmission links or interfaces that have been assigned bi-directional energy and capacity limits, wheeling charges (when applicable) and losses

Capacity Value

"Capacity Credit Factor" approach

- Each project's capacity value is based on its contribution to resource reserve margin requirements. The capacity value represents the avoided expense of purchasing an alternative source of capacity: a gas turbine generator
  - Avoided adequacy cost calculated from the levelized fixed costs of a gas turbine
- The contribution to resource reserve margin is based on a capacity credit factor calculated for each project
  - Capacity credit factor is defined as the capacity factor of the resource during the peak period (top 10% of load hours) over the entire year
  - Gas turbine capacity credit factor is assumed to be 100%
- Capacity Value ($/kW-yr) = capacity credit factor * avoided resource reserve margin costs

No WECC – wide standards exist for calculating capacity credit