BUILDING A WORLD OF DIFFERENCE®

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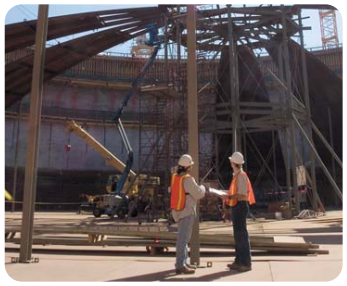




Western Renewable Energy Zones

Generation & Transmission Model Methodology & Assumptions

Version 1.2

March 2009

Introduction

The WREZ Generation & Transmission Model (GTM) is designed as a screening tool to assist load serving entities, regulators and renewable planners ("users") to identify and quantify the cost of delivering renewable resources to a variety of load zones throughout western North America.

The GTM includes resources defined by the WREZ Zone Identification and Technology Assessment (ZITA) Work Group, accessed by a conceptual transmission network developed by the Generation & Transmission Modeling Work Group (GTMWG).

The GTM is designed to be used as a screening tool. The model is Excel based, and has been designed to be flexible so that users may customize it to meet their specific requirements. That said, the model includes methodologies and data that has been developed and vetted by industry experts.

This document summarizes the methodology and assumptions used in the model. A companion document, the GTM Model User Guide, is designed to provide users with the information required to operate the model.

Generation & Transmission Model Methodology

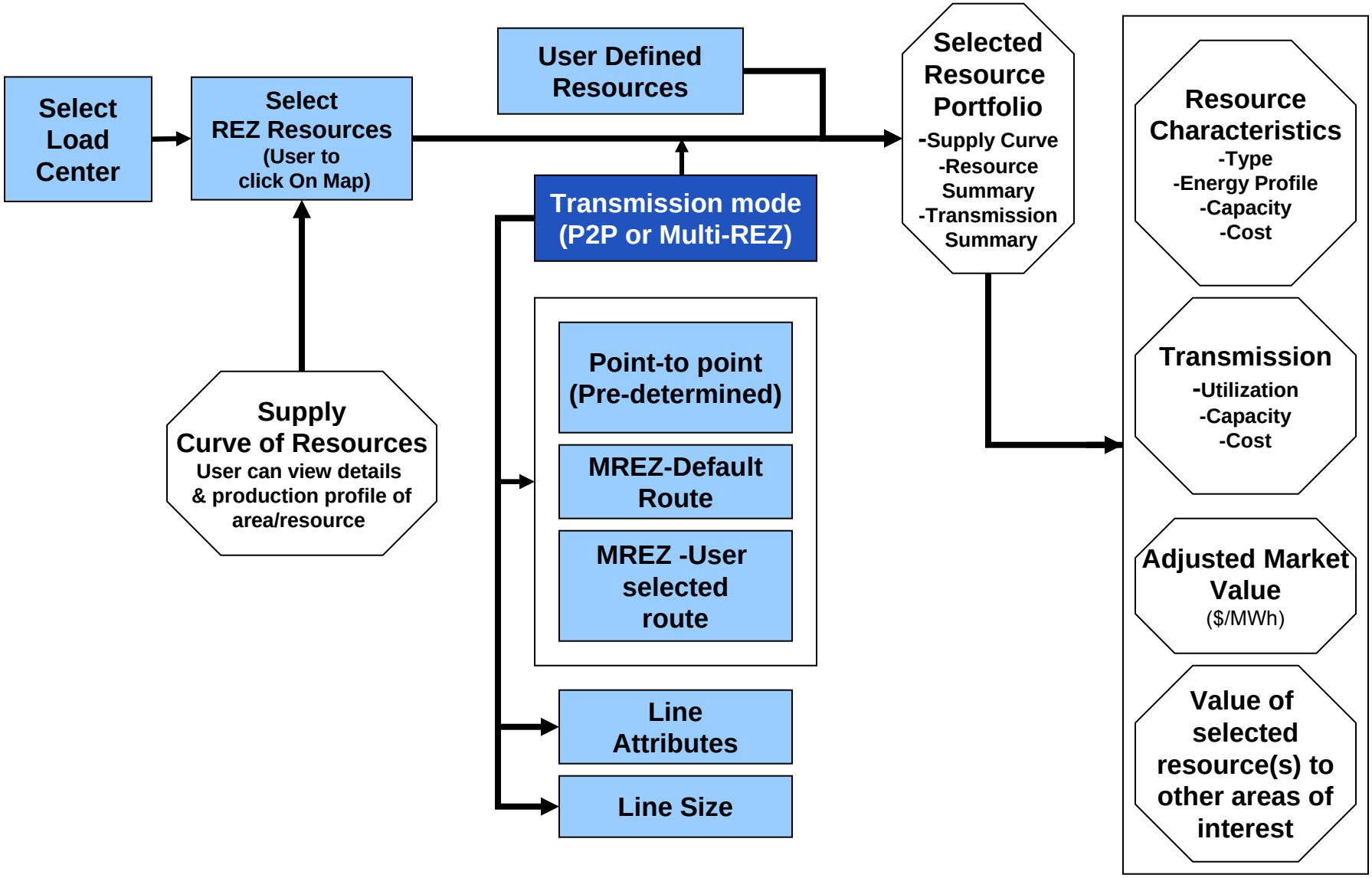
Model Overview

- Designed to allow users to develop portfolios of resources and deliver the energy to load zones
  - Users specify ZITA-defined resources or create own resources
  - Users may specify transmission lines and routes to deliver energy to load zones or can use model defined transmission path(s)
  - Model calculates a variety of cost information for resources and portfolios
- Model offers flexibility for all of these costs and assumptions

Model Overview (cont'd)

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

Model Overview



Renewable Resources and REZs

WREZ resource data is developed by the WREZ Zone Identification and Technology Assessment (ZITA) Workgroup. A discussion of the resources and zone identification process may be found at:

http://www.westgov.org/wga/initiatives/wrez/zita/index.htm

Important Note on Resource Data

GTM Version 1.2 contains Draft Resource data provided by the WREZ Zone Identification and Technical Analysis (ZITA) group. As of March 2009 this resource data is undergoing public review. An updated version of the model will be released when final resource data is provided by ZITA.

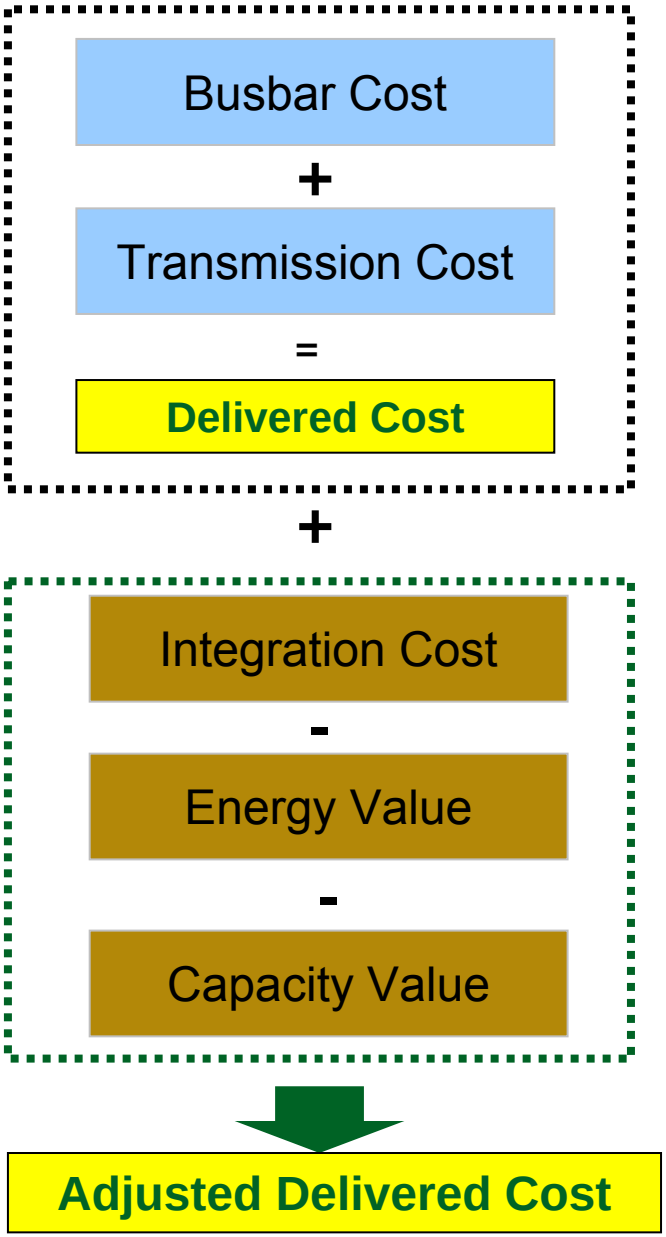
Resources

REZs, resources, and resource assumptions in model were developed by the WREZ ZITA working group

- Size and operational characteristics
- Cost of energy provided at bus-bar (levelized cost of energy – LCOE)
  - LCOE is total life-cycle cost of generating at a facility normalized by total generation from the facility ($/MWh)
  - Calculated using a pro forma model (input assumptions used to determine expected revenues, costs, and year-by-year after-tax cash flow over the project life)

Resource Cost Determination

- Resource cost information provided by model:
  - Busbar cost: “raw” cost of generation
  - Delivered cost: cost to deliver energy to load zone
  - Adjusted delivered cost: the *value* of a resource to a load zone, taking into consideration the energy and capacity benefit delivered by the resource



Generation Busbar Cost

Costs presented as levelized cost of energy (LCOE)

- LCOE is total life-cycle cost of generating at a facility normalized by total generation from the facility ($/MWh)
- Calculated using a pro forma model (input assumptions used to determine expected revenues, costs, and year-by-year after-tax cash flow over the project life)
- Includes expected gen-tie cost to allow facility to access bulk transmission system

Generation Costs (cont'd)

Technology – Specific Assumptions	
Capital Cost	Incentives
Fixed O&M	Net Plant Output
Variable O&M	Capacity Factor
Fuel Costs	Economic Life
Heat Rate	

General	
	Discount Rate
	Inflation

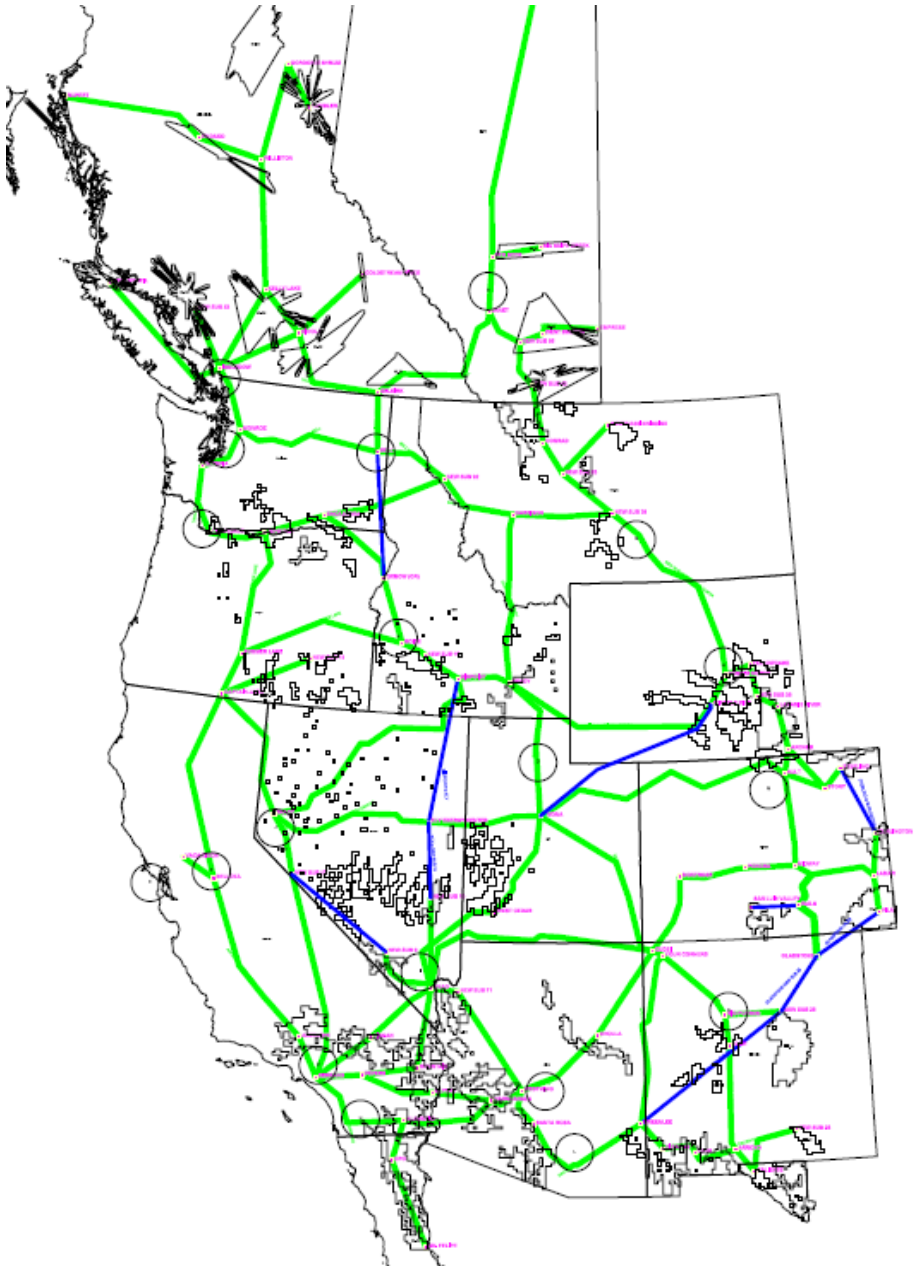
Transmission System Modeling

GTMWG Transmission Segments Working Group identified transmission paths, interconnection and delivery points

- Model mimics major transmission paths in WECC, with several segment additions
- Assumes all transmission incremental – model assumes substantially more than currently available transmission capacity is required to deliver WREZ power over the long term
- Default interstate transmission is single-circuit 500 kV, but user may specify alternative voltages for individual lines segments
- Distance – GIS and AutoCAD software used to calculate the distance over existing transmission paths, assuming that new transmission would augment existing paths

Transmission System

- WREZ modeled transmission system
  - Green lines approximate current system
  - Blue lines represent new transmission, but not specific proposed lines



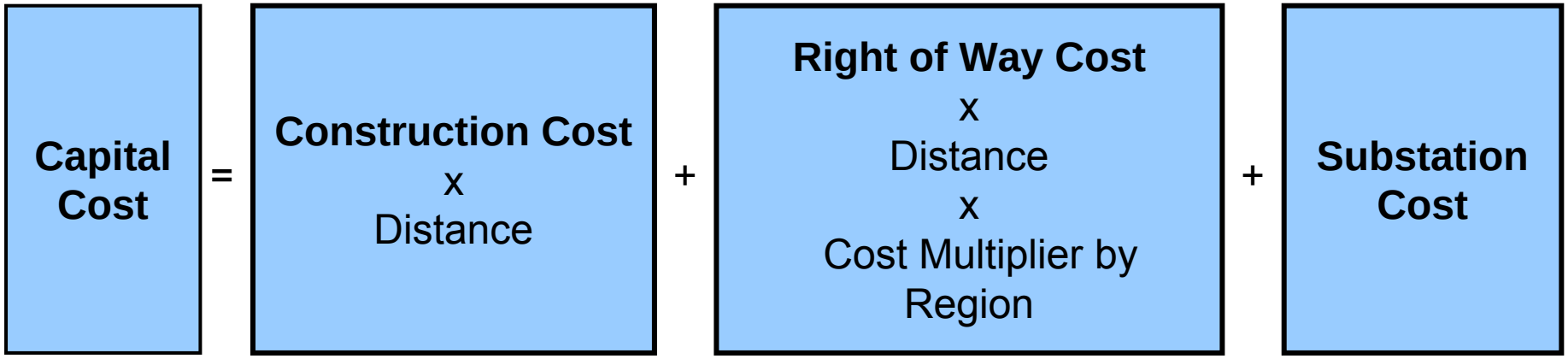
Transmission Line Assumptions

GTMWG Transmission Characteristics Working Group detailed operating characteristics and costs for lines

- Construction cost – The costs are assumed to be the same across regions in terms of $/mile
- Right of way cost – The RoW cost depends on the region. The transmission segments distances are categorized by region and are multiplied by appropriate regional rate to reflect land value differences in terms of $/acre
- Substation cost – The cost for one substation per segment is added to the capital cost, with cost varying by the substation voltage

Transmission Cost

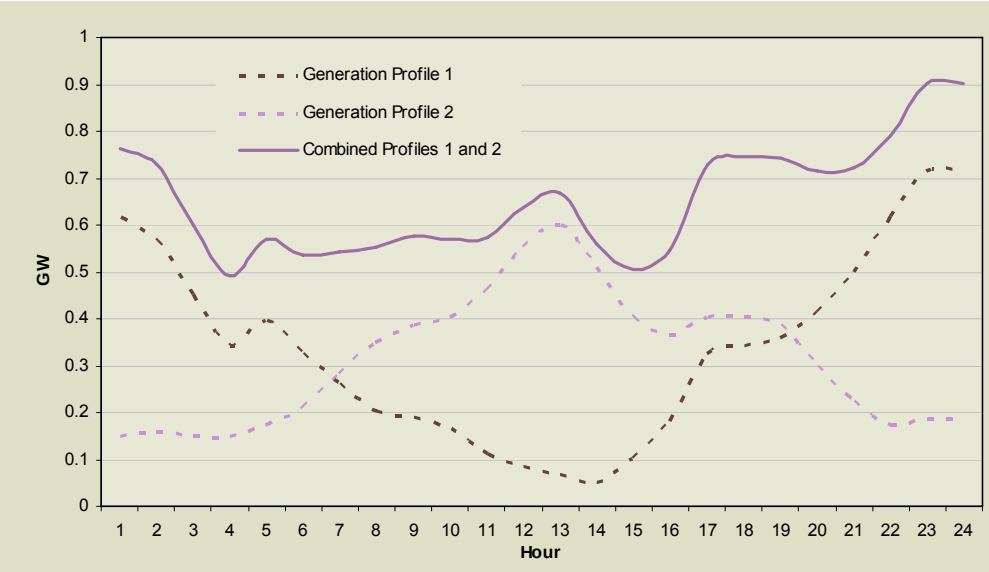
- Levelized Cost of Transmission (LCOT) - $/MWh
  - Costs include new substation and network costs required to interconnect resources to the grid
  - "Lumpy" investment – Line user(s) will pay full cost of the transmission line development



Transmission Cost (cont'd)

- Line utilization for lines with multiple projects are based on blended generation profiles using typical daily profile for each month of the year

Example Blended Resource Profile



- If multiple resources are on a single transmission line, the profiles are combined to produce a blended profile
- Transmission line utilization is based on the blended profile

Transmission Cost (cont'd)

- Pro Forma Financial Model used for transmission costs ($/MWh)
  - Simplistic tool to capture differences in cost of transmission between projects for the purpose of comparison and ranking
- Specific Pro Forma Inputs include:
  - Capital cost, including construction, substations & right of way
  - Transmission line capacity
  - Transmission line utilization factor
  - Fixed operation and maintenance cost

Transmission Losses

- Losses are based on distance from busbar to load zones 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 transmission system to accommodate the generation from the project into the grid. Starting point assumptions are provided in the model, but a user can change the integration cost for each technology
  - 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 marginal cost
- 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

Energy Value (cont'd)

Example of Energy Value Calculation

Load Pricing Profile

	12am	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm
Jan	$ 36	$ 35	$ 35	$ 35	$ 36	$ 42	$ 48	$ 53	$ 54	$ 55	$ 54	$ 53	$ 50	$ 49	$ 48	$ 48	$ 49	$ 62	$ 93	$ 72	$ 57	$ 51	$ 45	$ 39
Feb	$ 34	$ 33	$ 33	$ 33	$ 35	$ 41	$ 46	$ 50	$ 51	$ 51	$ 50	$ 49	$ 48	$ 48	$ 46	$ 45	$ 46	$ 50	$ 86	$ 73	$ 55	$ 48	$ 44	$ 36
Mar	$ 37	$ 36	$ 35	$ 36	$ 37	$ 42	$ 46	$ 49	$ 50	$ 52	$ 53	$ 53	$ 52	$ 56	$ 56	$ 53	$ 51	$ 50	$ 69	$ 82	$ 55	$ 50	$ 47	$ 40
Apr	$ 39	$ 38	$ 37	$ 37	$ 38	$ 41	$ 43	$ 46	$ 48	$ 50	$ 52	$ 55	$ 55	$ 58	$ 58	$ 56	$ 52	$ 49	$ 49	$ 53	$ 65	$ 51	$ 46	$ 42
May	$ 34	$ 32	$ 31	$ 3								$ 42	$ 48	$ 48	$ 57	$ 60	$ 49	$ 41	$ 39	$ 39	$ 44	$ 40	$ 37	$ 36
Jun	$ 35	$ 32	$ 31	$ 3								$ 50	$ 53	$ 58	$ 65	$ 67	$ 64	$ 54	$ 49	$ 47	$ 49	$ 47	$ 42	$ 38
Jul	$ 41	$ 38	$ 36	$ 3								$ 63	$ 66	$ 72	$ 76	$ 80	$ 78	$ 71	$ 63	$ 59	$ 59	$ 58	$ 53	$ 47
Aug	$ 38	$ 35	$ 34	$ 3								$ 56	$ 64	$ 64	$ 70	$ 77	$ 78	$ 65	$ 61	$ 58	$ 58	$ 56	$ 51	$ 45
Sep	$ 34	$ 33	$ 33	$ 3								$ 56	$ 58	$ 62	$ 68	$ 74	$ 71	$ 62	$ 58	$ 60	$ 58	$ 54	$ 47	$ 39
Oct	$ 40	$ 38	$ 37	$ 3								$ 58	$ 59	$ 60	$ 61	$ 64	$ 61	$ 57	$ 63	$ 73	$ 61	$ 56	$ 50	$ 44
Nov	$ 37	$ 35	$ 35	$ 35	$ 37	$ 45	$ 51	$ 55	$ 56	$ 57	$ 57	$ 57	$ 56	$ 56	$ 56	$ 56	$ 57	$ 70	$ 79	$ 65	$ 59	$ 56	$ 52	$ 42
Dec	$ 43	$ 40	$ 39	$ 39	$ 42	$ 50	$ 56	$ 59	$ 60	$ 61	$ 61	$ 60	$ 59	$ 58	$ 57	$ 57	$ 60	$ 73	$ 89	$ 75	$ 68	$ 61	$ 57	$ 48

Energy Price

X

Jan	50%	52%	54%	56%	55%	55%		%	58%	57%	55%	53%	51%	50%	49%	46%	42%	41%	42%	43%	43%	45%	48%
Feb	39%	37%	38%	41%	41%	40%	41%	39%	41%	41%	41%	40%	40%	40%	41%	39%	36%	33%	35%	36%	36%	37%	39%	42%
Mar	57%	55%	56%								3%	54%	53%	55%	56%	52%	49%	47%	46%	49%	53%	55%	58%	57%
Apr	57%	54%	52%								8%	47%	45%	47%	47%	45%	45%	47%	49%	52%	57%	61%	63%	62%
May	48%	49%	49%								9%	27%	27%	28%	25%	23%	25%	27%	31%	35%	39%	41%	43%	47%
Jun	33%	34%	35%								7%	23%	19%	18%	15%	12%	12%	16%	20%	24%	27%	30%	33%	33%
Jul	25%	26%	30%								0%	18%	17%	16%	12%	9%	8%	7%	8%	9%	13%	16%	17%	23%
Aug	23%	21%	23%								8%	15%	13%	12%	9%	6%	4%	4%	6%	8%	11%	13%	12%	16%
Sep	27%	26%	26%	27%	26%	27%	27%	27%	27%	26%	26%	27%	26%	27%	27%	23%	21%	21%	23%	26%	27%	28%	29%	27%
Oct	33%	31%	33%	36%	38%	38%	38%	37%	36%	35%	34%	33%	33%	33%	35%	35%	32%	31%	31%	31%	35%	36%	37%	39%
Nov	35%	37%	39%	38%	37%	38%	38%	37%	35%	32%	29%	27%	27%	27%	29%	30%	27%	25%	23%	23%	23%	25%	28%	34%
Dec	33%	35%	38%	39%	41%	37%	37%	37%	36%	34%	33%	32%	31%	30%	32%	30%	28%	28%	25%	26%	26%	26%	28%	31%

Hourly Capacity Factors

35% Average Capacity Factor

=

	$ 18	$ 18	$ 19	$ 20	$ 20	$ 23	$ 26	$ 28	$ 30	$ 32	$ 31	$ 29	$ 27	$ 25	$ 24	$ 23	$ 23	$ 26	$ 38	$ 30	$ 24	$ 22	$ 20	$ 19
	$ 13	$ 12	$ 13	$ 14	$ 14	$ 17	$ 19	$ 20	$ 21	$ 21	$ 20	$ 20	$ 19	$ 19	$ 19	$ 17	$ 17	$ 16	$ 30	$ 26	$ 20	$ 18	$ 17	$ 15
	$ 21	$ 20	$ 20	$ 20	$ 22	$ 25	$ 26	$ 28	$ 27	$ 27	$ 28	$ 29	$ 29	$ 31	$ 31	$ 28	$ 25	$ 24	$ 32	$ 40	$ 29	$ 27	$ 27	$ 23
	$ 22	$ 20	$ 19								25	$ 26	$ 25	$ 27	$ 28	$ 25	$ 24	$ 23	$ 24	$ 28	$ 37	$ 31	$ 29	$ 26
	$ 16	$ 16	$ 15								12	$ 11	$ 12	$ 13	$ 14	$ 14	$ 12	$ 11	$ 12	$ 14	$ 17	$ 16	$ 16	$ 17
	$ 11	$ 11	$ 11								13	$ 11	$ 10	$ 11	$ 9	$ 8	$ 8	$ 8	$ 10	$ 11	$ 13	$ 14	$ 14	$ 13
	$ 10	$ 10	$ 11								12	$ 11	$ 11	$ 11	$ 9	$ 7	$ 6	$ 5	$ 5	$ 5	$ 8	$ 9	$ 9	$ 11
	$ 9	$ 8	$ 8								10	$ 9	$ 8	$ 8	$ 7	$ 5	$ 3	$ 3	$ 4	$ 5	$ 7	$ 7	$ 6	$ 7
	$ 9	$ 9	$ 8								14	$ 15	$ 15	$ 17	$ 18	$ 17	$ 15	$ 13	$ 14	$ 16	$ 15	$ 15	$ 14	$ 11
	$ 13	$ 12	$ 12								20	$ 19	$ 20	$ 20	$ 21	$ 22	$ 19	$ 18	$ 20	$ 23	$ 21	$ 20	$ 19	$ 17
	$ 13	$ 13	$ 14	$ 13	$ 14	$ 17	$ 19	$ 20	$ 20	$ 18	$ 16	$ 16	$ 15	$ 15	$ 16	$ 16	$ 16	$ 17	$ 18	$ 15	$ 14	$ 14	$ 15	$ 14
	$ 14	$ 14	$ 15	$ 15	$ 17	$ 19	$ 21	$ 21	$ 22	$ 21	$ 20	$ 19	$ 18	$ 17	$ 18	$ 17	$ 17	$ 20	$ 23	$ 20	$ 18	$ 16	$ 16	$ 15

Weighted Energy Value Profile

$17/MWh Average Weighted Energy Value

Energy Value (cont'd)

Average Weighted Energy Value	$17/MWh
Average Capacity Factor	35%

$$\text{Energy Value (\$/MWh)} = \frac{\text{Average Weighted Energy Value}}{\text{Average Capacity Factor}}$$

$48/MWh = $17 / 35%

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

Capacity Value (cont'd)

Example of Capacity Value Calculation

	12am	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm
Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	0								0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0								0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0								0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0								0	0	0	0	1	1	1	1	1	1	0	0	0	0
Jul	0	0	0								0	0	1	1	1	1	1	1	1	1	1	1	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Top 10% (peak hours)

	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0							0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0							0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0							0%	0%	0%	0%	0%	15%	12%	12%	16%	20%	24%	0%	0%	0%	0%
	0%	0%	0							0%	0%	0%	17%	16%	12%	9%	8%	7%	8%	9%	13%	16%	0%	0%
	0%	0%	0							0%	0%	0%	0%	12%	9%	6%	4%	4%	6%	8%	11%	13%	0%	0%
	0%	0%	0							0%	0%	0%	0%	0%	0%	23%	21%	21%	23%	0%	0%	0%	0%	0%
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	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%										

Capacity Factor during top 10% (peak hours)

Average Capacity Factor during top 10% of load hours is the Capacity Credit

13% Capacity Credit

Capacity Value (cont'd)

Capacity Credit	13%
Resource Reserve Margin Cost: CT	$114/kW-yr
Project Capacity Factor	35%

$$\text{Capacity Value } (\$/\text{MWh}) = \frac{\text{Capacity Credit x Resource Reserve Margin Cost } (\$/\text{kW-yr})}{[\text{Project Capacity Factor x } (8760 \text{ hours in a year}/1000)]}$$

$5/MWh =
(13%) x ($114/kW-yr)
/ [(35%) x (8760 hours in a year / 1000)]

Adjusted Delivered Cost

Represents the *value* of a resource to a load zone, taking into consideration the energy and capacity benefit delivered by the resource

Generation Cost	$100	10% Loss	**$122** = $110 / (1 -10%)
Transmission Cost	$10		

	+
Integration Cost	$5
	-
Energy Value	$55
	-
Capacity Value	$15

Adjusted Delivered Cost	$57

Generation & Transmission Model Assumptions

Data Assumptions used in the Model

- Load Zones
- Renewable Resource Information and Data
- Gas-fired Generation Characteristics
- Transmission Segments
- Transmission & Substation Characteristics and Cost
- Transmission Financing Assumptions
- Capacity Value

Load Zones

Metro Area	Substation
VANCOUVER	Ingledow
SEATTLE	Monroe
SPOKANE	Bell
PORTLAND	Bethel
SAN FRANCISCO	Vaca-Dixon
SACRAMENTO	Bellota
LOS ANGELAS	Serrano
SAN DIEGO	Los Coches
LAS VEGAS	Mead
RENO	Tracy
PHEONIX	Westwing
TUCSON	Tortolita
DENVER	Ault
ALBUQUERQUE	Rio Puerco
SALT LAKE CITY	Mona
BOISE	Midpoint
BILLINGS	Broadview
CASPER	Casper North
El Paso	Caliente
CALGARY	Janet

Source: GTMWG Transmission Segments Working Group

Renewable Resource Information and Data

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http://www.westgov.org/wga/initiatives/wrez/zita/index.htm

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Source: WREZ ZITA Working Group

Renewable Resource Cost

- Project-specific inputs from ZITA include:
  - Nameplate capacity
  - Capacity factor
  - Energy generation profile
  - Capital costs including generation interconnection costs ("gen-tie")
  - Fixed and variable O&M (including insurance & ad valorem)
  - Heat rate & fuel costs (for biomass)

Source: WREZ ZITA Workgroup

Renewable Resource Cost

- Technology-specific inputs from ZITA include
  - Economic life
  - Debt/Equity ratio
  - Debt term
  - Interest rate
  - Equity cost
  - Tax life
  - Discount rate

Source: WREZ ZITA Workgroup

Gas Fired Generation Characteristics

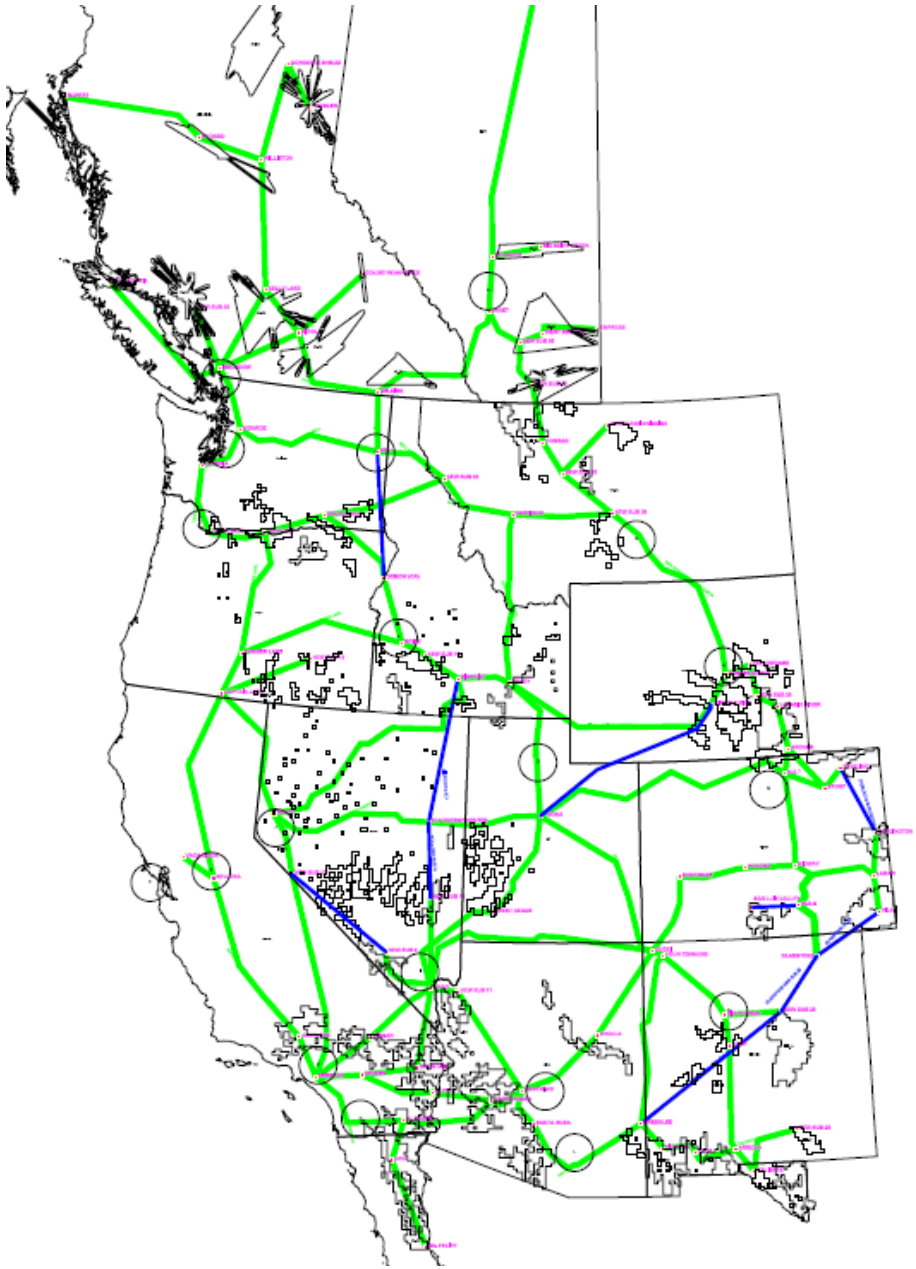
- Users have requested resource data for potential use in model
- Illustrative resource characteristics for new thermal generation
- Energy deliveries are location dependent and should be developed by user for specific zone where resource is located

Asset Type	Designation	Summer Ratings		Installed Costs (2009$/kW)	Levelized Capital Cost (2009$/kW-yr)	Assumed Capacity Factor	Busbar Costs (2009$/MWh)	
		Capacity (MW)	Full Load Average Heat Rate (Btu/kWh, HHV)				CO2 = $0/ton	CO2 = $35/ton
Combined Cycle	2 x 1 GE 7FB	500	6,870	1,280	129	85%	91	105
Combustion Turbine	GE 7 FA	150	11,000	750	79	10%	224	246
	LMS 100	86	9,350	1,090	114	10%	242	267

Source: Black & Veatch

Transmission Segments

- A comprehensive list of transmission segments and termination points is provided in the model



Transmission Characteristics

Transmission characteristics developed by Transmission Segments Work Group

	Capacity (MW)	Cap Cost $000/mile	ROW Width feet	Phase/Pole Current (amps)	Typical Conductors	No. of Conductor per phase	Resistance Per Cond (ohms/mile)	FLL* (MW/mile)	FLL* Per 100 miles	Losses at 60% Utilization % per 100 miles
765 kV AC Single	3000	2250	200	2383	957 ACSR	6	0.1086	0.30843	0.01028	0.00454
500 kV AC Single	1500	1800	175	1823	1590 ACSR	3	0.0666	0.22139	0.01476	0.00708
500 kV AC Double	3000	2880	175	1823	1590 ACSR	3	0.0666	0.44277	0.01476	0.00708
345 kV AC Single	750	1260	160	1321	795 ACSR	2	0.128	0.33513	0.04468	0.02145
345 kV AC Double	1500	2016	160	1321	795 ACSR	2	0.128	0.67027	0.04468	0.02145
230 kV AC Single	400	900	150	1057	1272 ACSR	1	0.0828	0.27749	0.06937	0.03330
230 kV AC Double	800	1440	150	1057	1272 ACSR	1	0.0828	0.55498	0.06937	0.03330
500 kV DC Bi-Pole	3000	1440	200	3000	1780 ACSR	3	0.0609	0.36540	0.01218	0.00585
800 kV DC Bi-Pole	TBD	TBD	TBD	2813	1780 ACSR	3	0.0609	0.32115	0.00714	0.00343

Source: GTMWG Transmission Characteristics Working Group

Transmission Cost

- Total Annual Non-Capital Costs are 3.0% of capital cost
  - O&M cost estimated to be 1.2% of capital cost
  - Property Tax and Insurance estimated to be 1.8% of capital cost

Source: GTMWG Transmission Segments Working Group

Note – Estimate is an average of values provided by PacifiCorp, PG&E and Trans-Elect

Transmission Financing Assumptions

AFUDC	10% percent of capital cost
Economic Life	20 years
Debt Percentage	60%
Debt Term	20 years
Interest Rate	7%
Equity Cost	11%
Tax Life	15%
Discount Rate	8.60%
Tax Rate	40%
ROW Cost	
California	**$27,500 per acre**
Baja, Mexico (CFE)	**$1,870 per acre**
Inland Rural (MT, NM, WY)	**$5,335 per acre**
All Other	**$9,478 per acre**

Source: GTMWG Modeling Working Group

Substation Costs

Line Size	Substation Capital Cost ($000s)
765 kV AC Single	62,500
500 kV AC Single	50,000
500 kV AC Double	80,000
345 kV AC Single	40,000
345 kV AC Double	64,000
230 kV AC Single	35,000
230 kV AC Double	56,000
500 kV DC Bi-Pole	250,000
800 kV DC Bi-Pole	TBD

Source: GTMWG Transmission Characteristics Working Group

Capacity Value Cost

- Based on the cost of combustion turbine (CT)
- Assumed avoided unit - GE LMS 100
  - Installed cost = $1,090/kW

Source: Black & Veatch estimate of installed cost