



**WECC Regional Planning
Pacific Northwest/Canada to Northern California Project**

Steering Committee Meeting of April 20, 2007

Technical Analysis Committee

Presentation

Ben Morris

Topics Covered

- Committee Interactions
- Study Plan
- Cost Development
- Base Case Development
- Upcoming Work/Schedule

Committee Interactions

- Approximately 30-members of TAC
- Hosted three web meetings since January
- Many meetings/phone call with individual members of the TAC
- Periodic emails sent to TAC members appraising TAC members of project cost development and base case development
- Another Web Meeting will be coming up by end of April 2007

Study Plan

- Completed Study plan development incorporating the comments received from members of Technical Analysis Committee.

- Study Plan covers
 - Alternatives/scenarios to be considered
 - Transmission Facility Cost Estimates
 - Assumptions and Base Case Development
 - 3 n-s study cases representative of three of the major resource/transmission development scenarios
 - 1-s-n case
 - Power flow and stability cases for 15 critical outages in the West
 - Documentation of results
 - Schedule and hand-offs to stakeholders

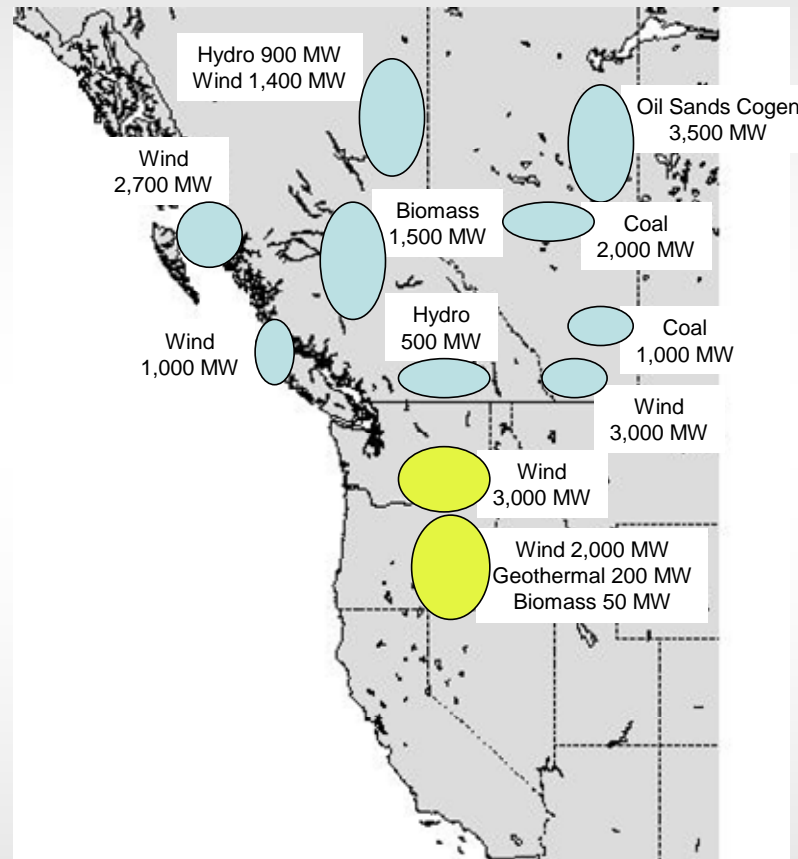


Transmission Facility Costs

Transmission Facility Cost Estimates

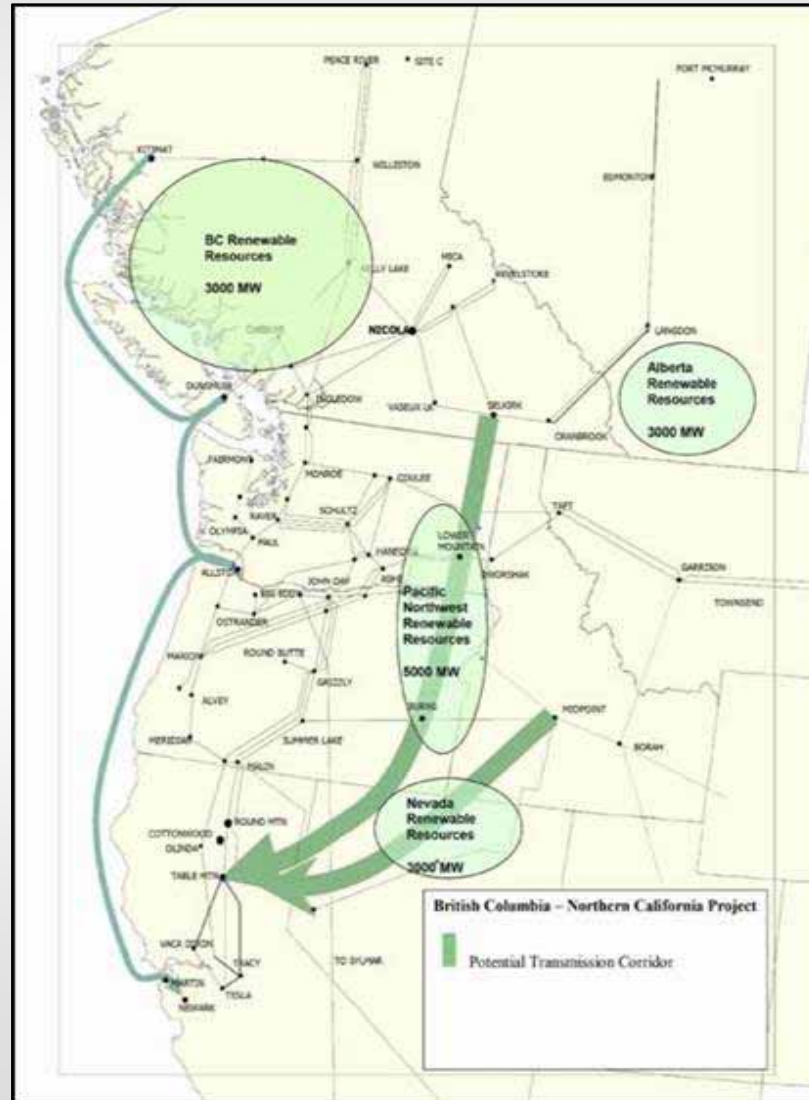
- Presented by scenario, where a scenario is a combination of resources and transmission facilities necessary to receive and deliver those resources
- Basis:
 - The potential development (MW) for various resource areas in Canada and the Northwest provided by the L&R Committee
 - The major inland and submarine cable options between Canada and California under consideration

Loads and Resources Working Group Proposed Scenarios



- Scenario 1: Canada Resources
- Scenario 2: Northwest U.S. Renewables

Major Transmission Alternatives



Preliminary Draft for Discussion Purpose
WECC Regional Planning Review
Pacific Northwest/Canada- Northern California Transmission project

Scenario Description

Based on Resource Development in BC, Alberta, Pacific Northwest and Eastern Nevada

Scenario Development

- AC-S1** 3000 MW from Canada (BC and Alberta) 500 kV DCTL
- AC-S2** 1500 MW from Canada (BC and Alberta) and
1500 MW from Pacific Northwest (750MW WA State-MID C Area, 750 MW from
Burns OR) 500 kV DCTL
- AC-S3** 1500 MW from Canada (BC and Alberta) Via 500 kV SCTL and
1500 MW from Eastern Nevada /Idaho- 500 kV SCTL
- AC-S4** 1500 MW from Canada (BC and Alberta) via 765 kV SCTL
and 1500 MW from Eastern Nevada/Idaho - 500 kV SCTL
- AC-S5** 3000 MW from Pacific Northwest (1500MW WA State-Mid C Area, 1500 MW)
from Burns OR) 500 kV DCTL
- AC-S6** 3000 MW from Canada (BC and Alberta) Two 500 kV SCTL
- DC-S10** 1600 MW from Allston OR to San Francisco CA with DC Terminal at Allston, Martin and
Newark with AC with connection to BC to access renewable resources
- DC-S11** 3000 MW import via +/- 500 kV Bi Pole HVDC line from Selkirk BC to Ravens Sub in Norther California

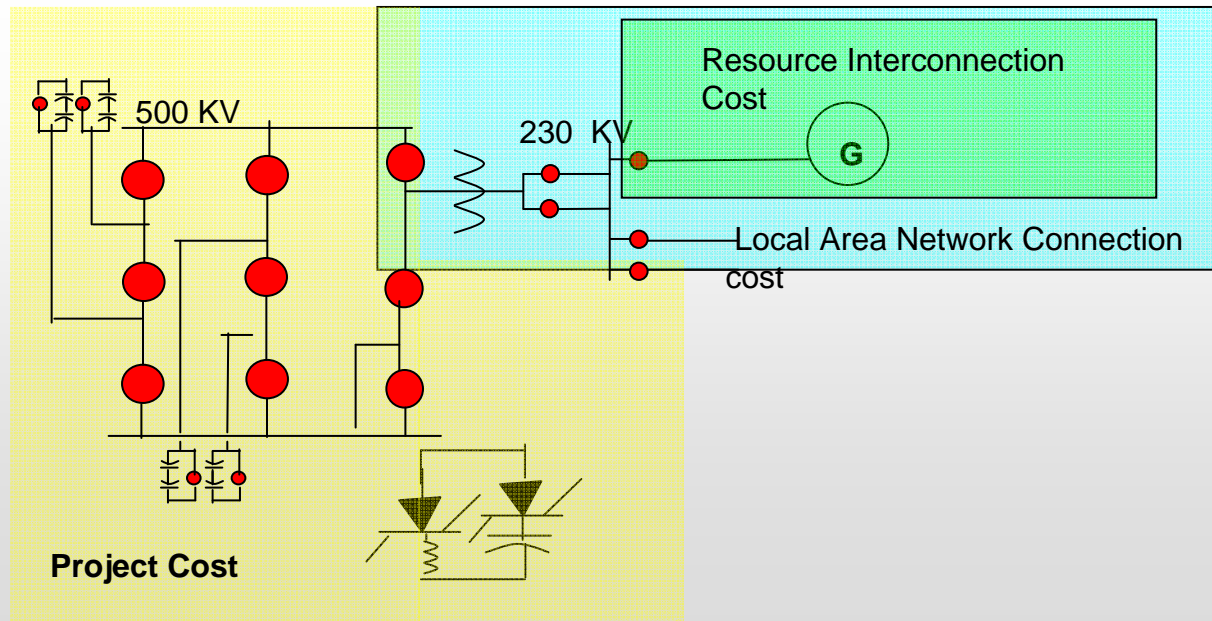
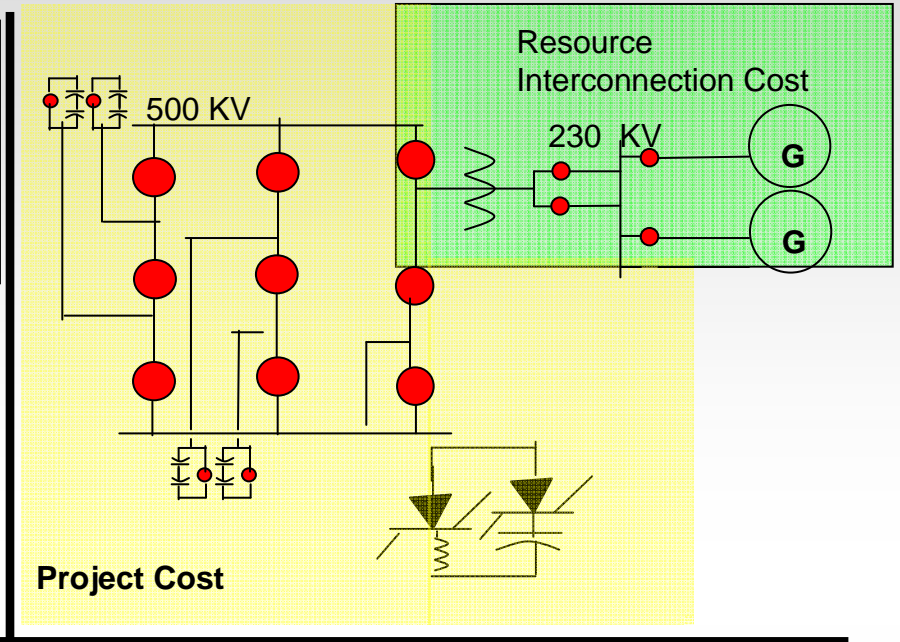
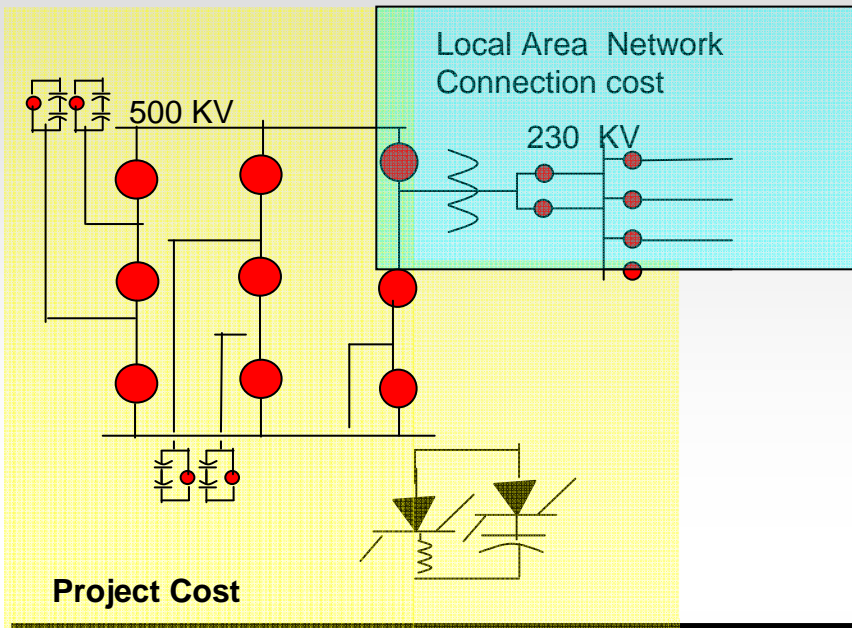


Transmission Facility Cost Aggregation

For each scenario, transmission facility costs are aggregated in:

- **Project costs:** Includes components for new lines and substations required to transfer 3000 MW Canada/Pacific Northwest or Eastern Nevada or Idaho to Northern California.
- **Local transmission reinforcement costs:** Includes local transmission upgrade cost associated with interconnection to the project (receipt/delivery of resources)
- **Generation interconnection costs:** Includes the cost of gen-tie/collector system costs to connect the resources to the local transmission system or directly to the project.

Examples of various cost component used in cost development



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Pacific Northwest/Canada- Northern California Transmission project

Cost estimate for transmission scenario based on unit cost figures

*Disclaimer The project and transmission upgrade cost is based on publicly available unit cost figures and is not based on engineering estimates
Actual cost will depend upon engineering estimates for specific transmission element which can vary from region to region.*

Assumptions:

- 1) Uniform cost for ROW for 500 KV lines in Canada/Pacific Northwest/Nevada
- 2) Cost of ROW in CA 1.5 time the cost of ROW in Canada/Pacific Northwest/Nevada
- 3) For over land transmission line assume homogenous line construction throughout the transmission corridor
- 4) Cost for ROW for 765 kV row 1.0 times the cost of 500 KV line ROW
- 5) Maximum rating for Single Circuit Transmission Line (SCTL)-500 kV is 1500 MW
- 6) Maximum rating for Double Circuit Transmission line (DCTL)-500 kV is 3000 MW
- 7) Maximum rating for a single circuit 765 kV line is 3000 MW
- 8) Bi Pole DC Line Voltage rating +/- 500 kV
- 9) Bi Pole DC line capacity 1500 or 3000 MW
- 10) Mileage for the new transmission line to California were based on straight line measurement and increased by 30 % to accommodate routing issues.
- 11) Cost for 500 kV Double Circuit Tower Line is 160 % the cost of single circuit tower line
- 12) Cost for 765 kV Single Circuit Tower line is 130 % the cost for 500 kV DCTL
- 13) The new transmission lines will be series compensated assume one bank per terminal bank per line segment with normal rating of 2667 Amps
- 14) Each 500/230 kV or 765/230 kV transformer bank 1134 MVA bank comprises of three single phase units (Non Firm Bank)
- 15) Static Var Compensator for 500 and 765 kV.
- 16) Cost for other 765 kV station equipment 130 % the cost of 500 kV equipment
- 17) Transmission cost plans based on resource scenario development
- 18) The project cost represented here does not include the permitting and environmental mitigation and cost.
- 19) For inland AC options a switching station or substation is assumed every 175-225 miles
- 20) The local transmission upgrade cost does not include the cost to connect generation resources to the grid..

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WECC Regional Planning Review

Pacific Northwest/Canada- Northern California Transmission project- Transmission Asset Cost Analysis

Overall Cost : To include project cost, local area transmission reinforcement cost and generation resource interconnection cost

	AC-S1 500 KV AC	AC-S2 500 KV AC	AC-S3 500 KV AC	AC-S4 765& 500 KV A	AC-S5 500 KV AC	AC-S6 500 KV AC	DC-S10 500 KV HVDC	DC S11 500 KV HVDC
<i>Import Capablity MW</i>	3,000	3,000	3,000	3,000	3,000	3,000	1,600	3,000

Transmission project Cost in \$,000 to CA Border (Raven) Sub

Transmission Line	\$2,426,996	\$2,156,492	\$2,726,524	\$4,261,429	\$1,637,012	\$3,203,200	\$1,699,750	\$1,429,900
Substation	\$390,700	\$347,800	\$403,300	\$442,570	\$257,800	\$396,100	\$440,000	\$1,000,000
Sub Total	2,817,696	2,504,292	3,129,824	4,703,999	1,894,812	3,599,300	2,139,750	2,429,900

Local Area Transmission Reinforcement Cost in \$,000 for Canada, WA, NV and Idaho

Transmission Line	\$0	\$0	\$0	\$0	\$0	\$0	\$736,000	\$377,325
Substation	\$93,500	\$158,100	\$124,800	\$328,790	\$128,000	\$93,500	\$31,500	\$154,400
Sub Total	\$93,500	\$158,100	\$124,800	\$328,790	\$128,000	\$93,500	\$767,500	\$531,725

Generation Resource Interconnection Cost in \$,000

Transmission Line								
Substation								
Sub Total								

Total Cost in \$,000 to CA Border (Raven) Sub

Transmission Line	\$2,426,996	\$2,156,492	\$2,726,524	\$4,261,429	\$1,637,012	\$3,203,200	\$2,435,750	\$1,807,225
Substation	\$484,200	\$505,900	\$528,100	\$771,360	\$385,800	\$489,600	\$471,500	\$1,154,400
Total	\$2,911,196	\$2,662,392	\$3,254,624	\$5,032,789	\$2,022,812	\$3,692,800	\$2,907,250	\$2,961,625

California Interconnection Options

- CA 1 500 kV DCTL from Raven to Elverta(Zeta1) with SCTL bypassing Elverta to Tesla.
The DCTL portion of the line from Raven Sub will be routed close to Round Mountain-Cottonwood substation
No connection will be established at Round Mountain or Cottonwood.

- CA 2 500 KV line from Raven to Elverta (Zeta1) and 500 kV line from Raven-Table Mountain-Tesla
with connection at Table Mountain. The route will be to east of existing 500 kV line between
Table Mountain and Tesla Sub.

- CA 3 Raven- Elverta (Zeta1) and Raven-Bellota-Sunol- Tesla 500 kv lines.
The route is in the foot hills of Sierra Mountain range.

- CA 4 500 kV line fro Raven-Elverta (Zeta1) and 500 kV line from Raven to Tesla bypass Table Mountain.

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WECC Regional Planning Review

**Pacific Northwest/Canada- Northern California Transmission project:
Transmission Asset Cost Analysis-California Interconnection Options**

**Transmission project Cost in \$,000 from CA Border (Raven) Sub
to other substations within Northern California**

	CA 1 500 KV AC	CA 2 500 kV AC	CA 3 500 KV AC	CA 4 500 kV
<i>Import Capablity MW</i>	3,000	3,000	3,000	3,000
Transmission Line	\$1,248,420	\$1,137,565	\$1,075,000	\$806,410
Substation	\$228,000	\$279,400	\$298,800	\$226,000
Total	1,476,420	1,416,965	1,373,800	1,032,410

WECC Regional Planning Review

Pacific Northwest/Canada- Northern California Transmission project- Transmission Asset Cost Analysis

Overall Cost : To include project cost, local area transmission reinforcement cost and generation resource interconnection cost

Total Cost in \$,000 Including California interconnection options CA 1-CA 4

Total with CA 1	\$4,387,616	\$4,138,812	\$4,731,044	\$6,509,209	\$3,499,232	\$5,169,220	\$2,907,250	\$4,438,045
Total with CA 2	\$4,328,161	\$4,079,357	\$4,671,589	\$6,449,754	\$3,439,777	\$5,109,765	\$2,907,250	\$4,378,590
Total with CA 3	\$4,284,996	\$4,036,192	\$4,628,424	\$6,406,589	\$3,396,612	\$5,066,600	\$2,907,250	\$4,335,425
Total with CA 4	\$3,943,606	\$3,694,802	\$4,287,034	\$6,065,199	\$3,055,222	\$4,725,210	\$2,907,250	\$3,994,035



Base Case Development

Base Case Development

- Benchmark case developed from WECC 2016 HS1A base case with North-to-South flows
- Major path flows represent corner point on NOPSG 2006 NJD Nomogram
- Develop Study Case 1:
 - 500 kV DCTL inserted between Selkirk (BC) and Raven Sub (California) with connections to Tesla and Elverta
 - 3000 MW additional renewable resources added in Canada to fill the line
 - Resources backed down in northern California

Resource Additions Modeled in Canada

- 600 MW BC Coastal Wind at Skeena 500 kV
- 250 MW Vancouver Island Wind at Dunsmuir 500 kV
- 1100 MW Wind and Site C Hydro at Peace Canyon 500 kV
- 300 MW Small Hydro at Ashton Creek 500 kV
- 750 MW Alberta Wind, Coal, and Oil Sands Cogeneration represented at Cranbrook 500 kV

500 kV DCTL Model

- Approximately 50% series compensation
- Base Cases with and without network connections between Selkirk and Raven initially
- Intermediate 500 kV stations at Spokane, Mid-C, and Burns to collect generation
- Synchronous condensers modeled at intermediate 500 kV stations for voltage control (to be replaced later with static var devices)
- Line shunt reactors for light load conditions

Major Path Flows for Benchmark and Project Base Cases

#	Path Name	Path Rating	2016 HS1A	Benchmark Case	Project Case
3	Northwest – Canada	3150 MW (n2s)	2302 MW (n2s)	3150 MW (n2s)	3150 MW (n2s)
26	Northern – Southern Calif.	4000 MW (n2s)	2185 MW (n2s)	4000 MW (n2s)	4000 MW (n2s)
65	PDCI	3100 MW (n2s)	2980 MW (n2s)	2850 MW (n2s)	2850 MW (n2s)
66	COI	4800 MW (n2s)	3776 MW (n2s)	4400 MW (n2s)	4400 MW (n2s)
73	North of John Day	8400 MW (n2s)	7949 MW (n2s)	7800 MW (n2s)	7808 MW (n2s)
75	Midpoint – Summer Lake	1500 MW (e2w)	85 MW (w2e)	236 MW (w2e)	247 MW (w2e)
76	Alturas Project	300 MW (n2s)	263 MW (n2s)	264 MW (n2s)	259 MW (n2s)
X	BC – California	3000 MW (n2s)	N/A	N/A	3000 MW (n2s)



Upcoming Work/Schedule

■ Project Cost Development

- Develop estimate for resource interconnection cost (gen-tie)
- Develop preliminary cost for the local area transmission upgrade cost in BC, Washington, Oregon and Nevada
 - Transmission upgrade cost on BCTC system with potential resource connection along BC coast or other location within BCTC system for delivery to Selkirk BC.
- Review preliminary project costs
- Provide update to Economic Analysis Committee (May 2007)
- Engineering review of unit cost estimates (May-June)
- Final update to Economic Analysis Committee (July 1, 2007)

■ Base Cases

- Develop Study Case 2: Model tie to Midpoint with resource adjustments.
- Develop Study 3: Model intermediate resource on-ramps and network connections between Selkirk and Raven (Study Case 2)
- Develop Study Case 4: Winter base case modeling heavy south-to-north flows



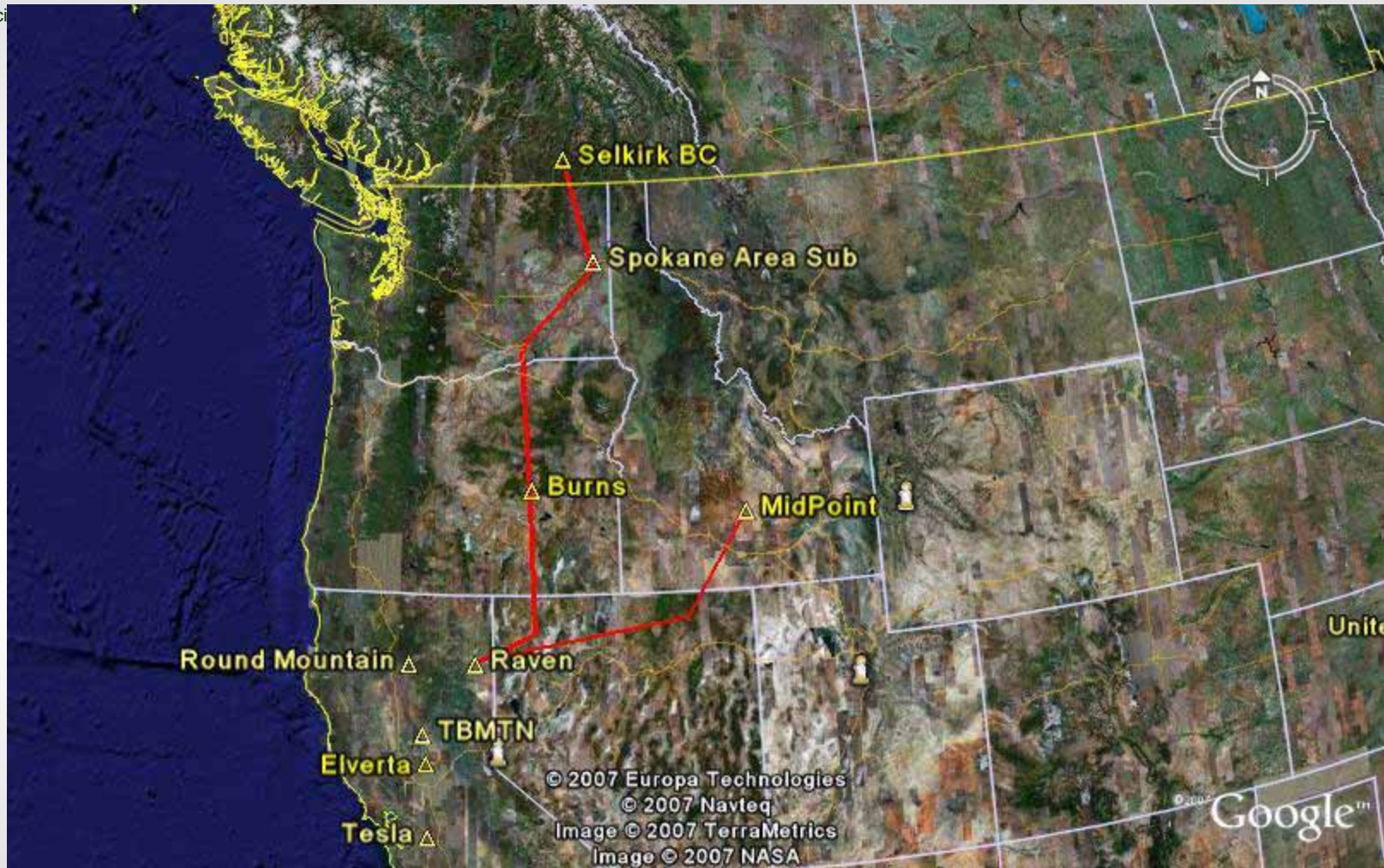
- Power System Analysis

- three n-s study cases (May-June)
- Power System Analysis of one s-n study case (July)
- Present results to Steering Team (July)

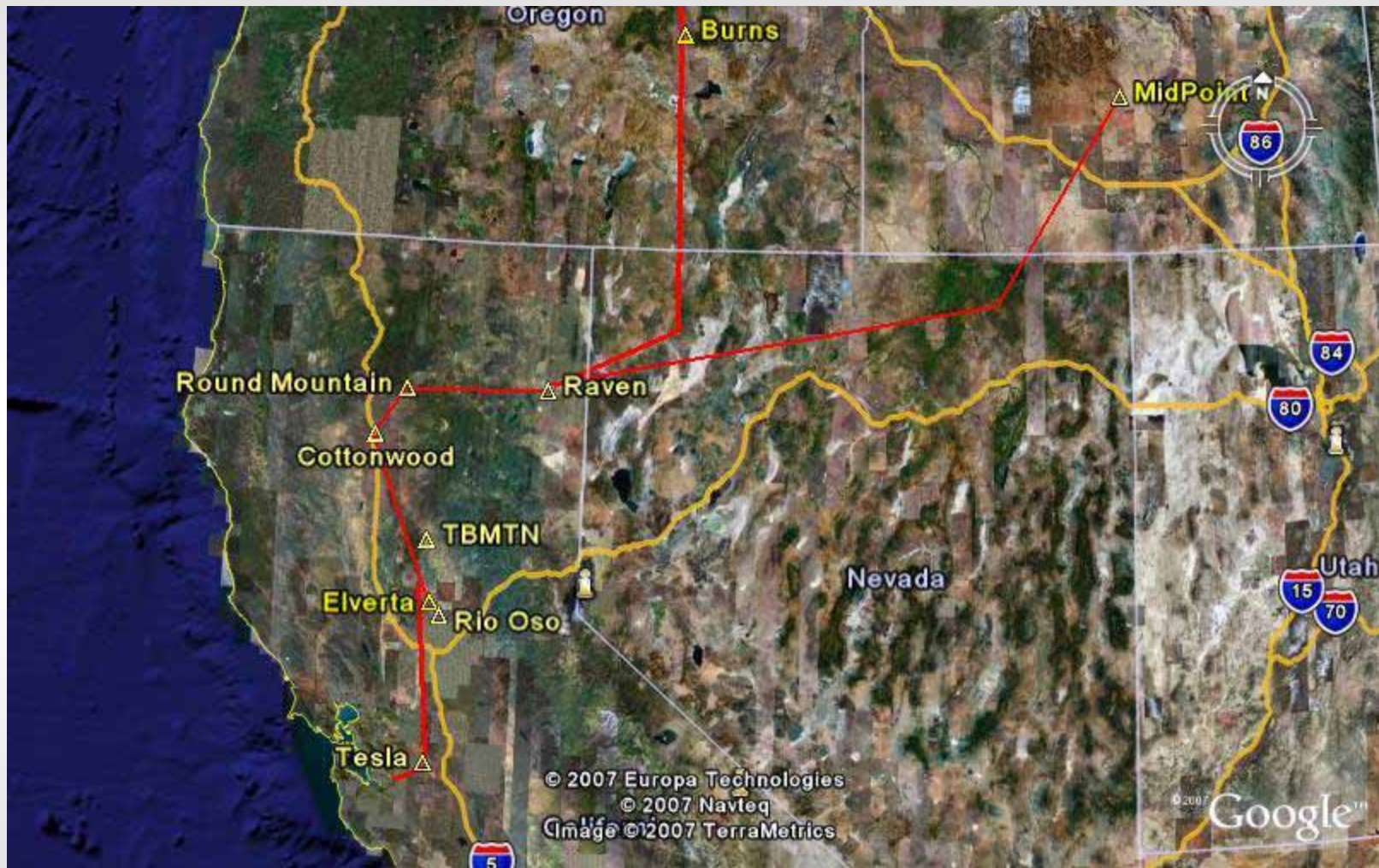
BCTC, PG&E, Sea Breeze and TANC are the primary leads on performing the studies. Additional support from Avista, PacifiCorp, and SPP will be needed for analysis of network connection within their service territories.

- Prepare TAC report (Aug)

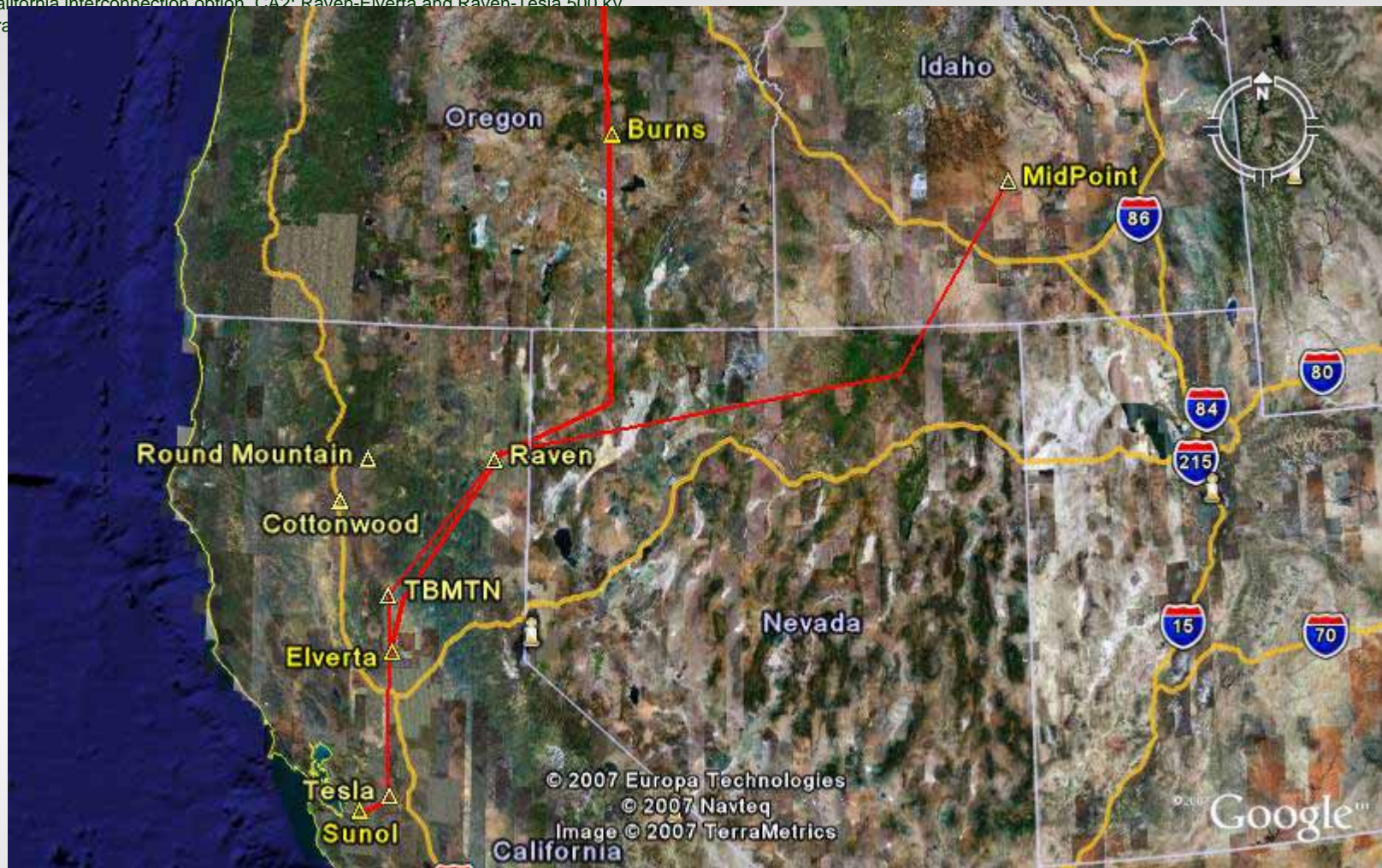
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Pacific Northwest/Canada-Northern California Transmission Project Review:
California interconnection option CA1: Raven-Round Mountain-Cottonwood-Elverta - Tesla 500 kV
Draft Conceptual Plan



Pacific Northwest/Canada-Northern California Transmission Project Review:
California interconnection option CA2: Raven-Elverta and Raven-Tesla 500 kV
Draft



Pacific Northwest/Canada-Northern California Transmission Project Review:
California interconnection option CA3- Raven-Elverta and Raven-Bellota-Tesla 500 kV
Draft Conceptual Plan



Pacific Northwest/Canada-Northern California Transmission Project Review:
California interconnection option CA4- Raven-Elverta and Raven-Tesla- 500 kV
Draft Conceptual Plan

