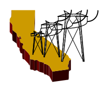
Transmission Research Program

Strategic Benefits Quantification for Transmission Projects

WECC TEPPC

June 12, 2008

Joe Eto, Lawrence Berkeley National Lab



Research Objective

- **Summarize research results on benefits of transmission projects**
- **Review methodologies being used for transmission project benefit quantification – *focus of today's presentation***
- **Review and summarize benefit analysis of recent transmission projects**
- **Present research results to improve benefit quantification methods – *focus of today's presentation***
- **Outline approaches to apply improved benefit quantification methods to:**
  - **Evaluate project cost effectiveness**
  - **Allocate transmission costs among participants**
  - **Develop framework for cost recovery**

Project Research Team

- CERTS/Lawrence Berkeley National Lab
  Joe Eto
- CERTS/Electric Power Group
  Vikram Budhraja, Fred Mobasheri, John Ballance, Jim Dyer
- CERTS Consultant – Alison Silverstein

Project Technical Advisory Committee

- DeDe Hapner, Vice President, FERC and ISO Relations, Pacific Gas & Electric
- Les Starck, Director of T & D Business Unit, Southern California Edison
- Caroline Winn, Director of T&D Asset Management, San Diego Gas & Electric
- Sean Gallagher, Director of Energy Division, California Public Utilities Commission
- Steve Ellenbecker, Energy Advisor to Wyoming Governor Freudenthal
- Jim Bushnell, Research Director, UC Energy Institute

Project Schedule

- Project Start -- October 2006
- Outreach–Frontier Line meetings -- Nov 06 & Jan 07
- CEC Technical Advisory Committee -- January 2007
- Public Presentation of Interim Findings -- May 2007
- Project Technical Advisory Committee [PTAC] -- September 2007
- Revision based on PTAC Input -- October 2007
- Outreach to CEC, CAISO, CPUC, IOUs -- November 2007 to April 2008
- Final Research Results and Report -- June 2008

Topics Addressed During Research

- Transmission Technologies – How do they impact benefits, influence cost allocation, impact stakeholders?
- Industry and Regulatory Changes – How have things changed and what does it mean for large regional transmission projects?
- Review of Other Regions and Industries – What can we learn and apply for transmission in California and the Western Interconnection?
- Benefit Quantification, Cost Allocation and Approval Processes

⇨ **Focus of today's briefing: Benefit Quantification**

Benefit Quantification Methods

- Production simulation models are generally used for transmission project benefit quantification
- CAISO developed the Transmission Economic Assessment Methodology (TEAM) for benefit analysis of major transmission projects
- In the TEAM approach, benefits are measured separately for consumers, producers, and transmission owners in different regions
- TEAM incorporates bid-cost markup in the analysis to reflect functioning of markets
- Uncertainties are considered through a wide range of future system conditions – dry and wet hydro, demand scenarios, gas price scenarios, generation addition scenarios
- Expected range of benefits is computed. Insurance and strategic value of transmission is discussed
- Methodology has been applied to evaluate Palo-Verde Devers No. 2 and other projects
- TEAM was filed with the CPUC in June 2004
- TEAM approach is comprehensive and incorporates many enhancements to traditional production simulation analysis

Assessment of Current Benefit Quantification Methods

- Models understate benefits of long life assets (50+years) by discounting future benefits using high interest rate based on cost of capital – essentially reducing the impact of benefits beyond the first 10-years
- Models utilize expected value approach that tends to minimize impact of high impact but low probability events
- Models are data intensive – require assumptions about future generation mix, fuel prices, and transmission network
- Models are static with no feedback – assume no change in investment for new generation resulting in a zero sum benefit distribution game, for example, Devers-Palo Verde No. 2
- Extreme market volatility and multiple contingency system events which can be very costly and risky to society are not captured in current models
  - 2001 California market dysfunction -- $20-40 billion
  - 2003 Northeast Blackout -- $5-10 billion

Research Building Blocks for Study

Benefits	Research to identify and quantify full range of benefits, including strategic benefits
Cost and Benefit Allocation and Cost Recovery	Utilization of improved benefit quantification methods for cost and benefit allocation and cost recovery
Planning Process	Improve transmission planning and approval process

Focus of this briefing: the first block

California Energy Commission - Public Interest Energy Research Program

Page 8

Transmission Benefits Can be Grouped into the Following Categories

- Primary Benefits
  - Improve network reliability – meet reliability standards and guidelines
  - Lower cost of energy and capacity adjusted for transmission losses as a result of reduced congestion, access to lower cost resources, and increased inter-regional power trading
- Strategic Benefits
  - Renewable resource development and integration
  - Fuel Diversity – lower natural gas consumption, gas prices
  - Emissions reduction/environmental
  - Market Power Mitigation
  - Insurance against contingencies
  - Development of new capacity and inter-regional trading
- Extreme Event Benefits
  - Reliability -- improve network load carrying capacity and ability to reduce or mitigate impact of extreme events resulting from multiple contingencies
  - Market volatility – societal benefit of reduced vulnerability to extreme price volatility due to long term outages and catastrophic events

In addition, there are secondary benefits related to infrastructure development, economic development, tax base, use of right-of-way, and new investment. However, the research did not address quantification of secondary benefits.

California

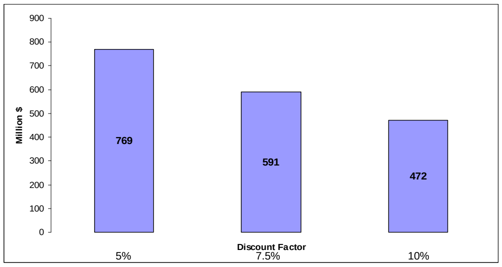
Page 9

Research Recommendations on Methods to Quantify Strategic Benefits of Transmission Projects

- Public Good **– long asset life benefit**
  - **Use social rate of discount to calculate the present value of benefits for the new transmission projects since transmission system is a "public good," assets are long life, and benefits accrue over time**
- Fuel Diversity Benefit
  - **Assess impact of significant renewable resources development upon price of natural gas**
- Reliability Improvement **from Extreme System Multiple Contingency Events**
  - **Assess impact of transmission project in mitigating N-3, N-4, N-5, N-6 events**
  - **Incorporate "transmission reserve margin" concept similar to spinning or planning reserves for generation**
- Risk Mitigation **for Low Probability/High Impact Extreme Market Events**
  - **Estimate risk mitigation benefit to society**
  - **Research use of value at risk, option value, and insurance premium approaches**
- Dynamic Analysis **-- construction of new generation**
  - **Recognize changing benefit streams over asset life due to construction of new generation in exporting region**

Public Good – Social Rate of Discount

- **In a restructured market, the high voltage transmission lines have become *Public Good*. The benefit from a new project cannot be denied to any retail customers nor generation owners.**
- **For calculating the present worth of a *Public Good* project, one should use the *social rate of discount* instead of regulated rate of return (opportunity cost of capital)**
- **For a project with 30-years of economic life and a constant annual benefit of $50 million, the present worth of benefits will be:**



Note: The social rate of discount is a function of per capital consumption growth, the elasticity of the marginal utility of consumption and the probability of survival of the *average consumer* from one period to the next. For U.S. the social rate of discount is around 5%.

Fuel Diversity Benefit -- Illustrative

- Integrate 4,500 MW of renewables (e.g., Tehachapi Wind)
- Estimated annual production ~ 13 Billion KWh (approximately 35% CF)
- Electricity production Using Gas in California
  - Base case ~ 107 Billion KWh
  - With Renewables ~ 94 Billion KWh
- Reduction in Gas for Power Plants ~ 12 %
- Price elasticity of natural gas 1% demand reduction equals 0.8 – 2% price reduction*
- Gas for electric production as a % of CA gas consumption ~ 40 %
- % Reduction in gas usage = .12 * .4 ~ 4.8%
- Gas Price Reduction (assume 1% for 1% reduction) = 4.8%
- Gas Price
  - Base Case $6/M²BTU
  - With Renewables $5.70/M²BTU
- Cost Savings for remaining 94 Billion KWh assuming average 9,000 BTU/KWh = 94 Billion KWh * 9,000 BTU/KWh X $0.30/M²BTU ~ $250 Million/year

Note: Including price impact on non-electric sector, benefit will be 2.5 times, or $625 million. Illustration ignores timing and present value for simplicity.

*Wiser, Bolinger, and St. Clair, January 2005, Easing the Natural Gas Crisis: Reducing Natural Gas Prices through Increased Deployment of Renewable Energy and Energy Efficiency

Quantification of Benefits of Mitigating Extreme Events

Extreme Reliability Events -- Multiple Contingency, Cascading Events

- **Transmission system performance is analyzed for N-1 and N-2 events but not for extreme events**
- **Methods to assess value of transmission in reducing magnitude and impact of multiple contingencies (N-3, 4, 5, 6) need to be researched and quantified**
- **Quantification approach should focus on network carrying capacity under multiple contingencies**
- **Alternatively, a policy or expert consensus approach can be used for "value equals xx% of cost" of project**

Extreme Market Volatility

- **Insurance industry utilizes extreme event probability distribution eg hurricane and earthquake insurance**
- **Such approaches are data dependent**
- **In the absence of such data to calculate insurance value of avoiding extreme price volatility, a policy consensus approach can be used**
- **Policy consensus can be encouraged via polling of policy makers or more formal approaches such as the Delphi method or risk tolerance and value at risk analysis**
- **Social rate of discount instead of cost of capital can be used to calculate the present value of the stream of future benefits for transmission project similar to other public projects**
- **Possible calculation "insurance value equals xx% of project cost"**

Incorporating Dynamic Planning Benefits

Analysis Method

- Define base case for studies
- Estimate benefits with proposed transmission project
- Modify future year base case to reflect dynamic impacts – for example new generation capacity construction
- Estimate change in benefits
- Assess other dynamic factors either individually or using scenarios and weights

Methods for Stakeholder and Policy Consensus to Value Strategic Benefits of Transmission Projects

- Stakeholder Consensus **to incorporate societal or strategic benefits**
  - **Utilize Delphi or other stakeholder consensus building approaches to develop an agreed "societal value" for transmission for example, a fixed percentage of transmission project cost**
- Resource Portfolio Analysis
  - **Methodologies to evaluate transmission project benefits using portfolio analysis**

Recommendations To Augment Benefit Quantification Methods

Public Good

- Use of social rate of discount to calculate the present value of benefits for the new transmission project

Fuel Diversity

- Include the benefit from potential decrease of natural gas price due to the construction of a new transmission project that integrates a significant amount of new renewable resources

Low Probability / High Impact Events

- Add risk mitigation benefit to society for low probability/high impact extreme market events and extreme system multiple contingency events – scenarios or Delphi method for stakeholder consensus

Recommendations for Benefit Quantification Methods Research

Dynamic Analysis

- Recognize the impact of new transmission projects on construction of new generation capacity in exporting regions

Portfolio Analysis

- Adapt portfolio analysis methods utilized in financial industry to transmission – construct and assess performance of portfolios including demand response, new generation (renewables and fuel based), new transmission, energy conservation

Quantification of Extreme Event Benefits (Insurance Value)

- Reliability – benefit of new transmission in reducing blackout footprint due to extreme (N-n) events and societal value of reduced vulnerability
- Market Volatility -- benefit of new transmission in reducing market volatility due to extreme (N-n) events and societal value of reduced vulnerability to run away market prices

Southwest Power Pool

Unintended Consequences for Base Plan Upgrades in the 2007 STEP

June 2008

Background

According to Attachment J of the SPP Tariff…

- **"For each SPP Transmission Expansion Plan, the Transmission Provider shall calculate the cost allocation impacts of the Base Plan Upgrades to each Transmission Customer within the SPP Region. The results will be reviewed for unintended consequences by the Regional Tariff Working Group and reported to the Markets and Operations Policy Committee and Regional State Committee."**

2008-2011 Base Plan Projects Summary

ZONE	Number of Projects: Direct Assigned	No MW-Mi	MW-Mi	Total	E&C $ Millions: Direct Assigned	No MW-Mi	MW-Mi	Total
AEP	4	7	14	**25**	$ 0.2	$ 8.5	$ 114.3	**$ 123.1**
GRDA	-	6	4	**10**	$ -	$ 2.6	$ 11.3	**$ 13.9**
OKGE	2	2	-	**4**	$ 0.1	$ 0.6	$ -	**$ 0.7**
WFEC	2	14	12	**28**	$ 0.2	$ 4.8	$ 41.1	**$ 46.1**
SPS	5	7	12	**24**	$ 0.2	$ 2.7	$ 177.4	**$ 180.3**
MIDW	-	-	-	**0**	$ -	$ -	$ -	**$ -**
SUNF	-	-	1	**1**	$ -	$ -	$ 2.0	**$ 2.0**
WESTAR	1	8	16	**25**	$ 0.0	$ 5.4	$ 42.0	**$ 47.4**
WEPL	-	3	-	**3**	$ -	$ 1.3	$ -	**$ 1.3**
MIPU	-	2	3	**5**	$ -	$ 0.6	$ 4.4	**$ 4.9**
KACP	-	4	2	**6**	$ -	$ 5.8	$ 10.8	**$ 16.6**
EMDE	3	6	6	**15**	$ 0.1	$ 7.0	$ 22.0	**$ 29.1**
SPRM	-	1	-	**1**	$ -	$ 1.9	$ -	**$ 1.9**
TOTAL	17	60	70	**147**	**$ 0.8**	**$ 41.4**	**$ 425.2**	**$ 467.4**

Commitment Horizon

2006 STEP

BOD approved reliability projects needing financial commitment within first two years.

2007 STEP

BOD approved reliability projects needing financial commitment within first four years

2008-2011 Base Plan Upgrades in STEP

- **Includes all base plan reliability projects in 2007 STEP**
  - **13 Base Plan Upgrades were not calculated because they were already evaluated in the 2006 STEP, 2 yr commitment horizon.**
- **147 Projects & $467.4M E&C Costs**
- **Project lists available in the following worksheet:**
  - **“Base Plan Upgrades – 2007 STEP.xls” in tabs:**
    - **“2008 Project List (Branch_Xfmr)”**
    - **“2008 Project List (Device)”**

Direct Assigned Projects

Allocation Methodology

- **All Base Plan Upgrades with an E&C cost of $100,000 or less.**
- **All ATRR assigned to host zone**

2008-2011 Subtotals

- **17 projects**
- **$0.8M E&C Costs**

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No MW-MI Impacts

Allocation Methodology
- **33% Regional and 67% to host zone**

2008-2011 Subtotals
- **60 projects**
- **$41.4M E&C Costs**

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MW-MI Impacts

Allocation Methodology
- **33% Regional and 67% to zones based on MW-MI Sum of Positive Impacts Only methodology with a $100k E&C minimum allocation**

2008-2011 Subtotals
- **70 Projects**
- **$425.2M E&C Costs**

Conclusions for Allocations

AEP and SPS received the largest allocations of these projects, but about 65% of the total E&C cost came from upgrades in these two zones.

2008 ATRR Allocations by Zone

	MW-Mi Impacts		No MW-Mi Impacts		Direct Assign	Totals
ZONE	33% Regional Allocations	67% MW-mi Allocations	33% Regional Allocations	67% MW-mi Allocations	Allocations	
CLECO	$ -	$ -	$ -	$ -	$ -	$ -
SWPA	$ -	$ -	$ -	$ -	$ -	$ -
AEP	$ 3,023,849	$ 6,085,058	$ 315,868	$ 415,164	$ 1,801	$ 9,841,740
GRDA	$ 263,141	$ 521,082	$ 27,487	$ -	$ -	$ 811,710
OKGE	$ 1,907,335	$ 1,208,559	$ 199,238	$ -	$ 2,825	$ 3,317,957
WFEC	$ 425,337	$ 2,069,380	$ 44,430	$ 247,516	$ 14,777	$ 2,801,440
SPS	$ 1,553,132	$ 7,487,178	$ 162,238	$ 251,587	$ 10,189	$ 9,464,324
MIDW	$ 96,784	$ 46,393	$ 10,110	$ -	$ -	$ 153,287
SUNF	$ 131,181	$ 285,934	$ 13,703	$ -	$ -	$ 430,817
WESTAR	$ 1,554,172	$ 1,484,341	$ 162,347	$ 197,733	$ 1,135	$ 3,399,728
WEPL	$ 163,334	$ 238,615	$ 17,062	$ 138,376	$ -	$ 557,387
MIPU	$ 544,521	$ 481,660	$ 56,880	$ 68,174	$ -	$ 1,151,235
KACP	$ 1,039,301	$ 773,594	$ 108,564	$ 537,473	$ -	$ 2,458,932
EMDE	$ 354,496	$ 2,037,085	$ 37,030	$ 251,396	$ 3,661	$ 2,683,668
SPRM	$ 208,491	$ 152,634	$ 21,779	$ 281,712	$ -	$ 664,615
TOTAL	**$ 11,265,073**	**$ 22,871,513**	**$ 1,176,736**	**$ 2,389,132**	**$ 34,388**	**$ 37,736,842**

2009 ATRR Allocations by Zone

ZONE	MW-Mi Impacts 33% Regional Allocations	MW-Mi Impacts 67% MW-mi Allocations	No MW-Mi Impacts 33% Regional Allocations	No MW-Mi Impacts 67% MW-mi Allocations	Direct Assign Allocations	Totals
CLECO	$ -	$ -	$ -	$ -	$ -	$ -
SWPA	$ -	$ -	$ -	$ -	$ -	$ -
AEP	$ 2,691,900	$ 6,758,716	$ 117,892	$ 30,172	$ 18,013	$ 9,616,694
GRDA	$ 234,254	$ 505,175	$ 10,259	$ 276,697	$ -	$ 1,026,385
OKGE	$ 1,697,954	$ 1,272,064	$ 74,362	$ 67,395	$ -	$ 3,111,775
WFEC	$ 378,645	$ 747,279	$ 16,583	$ 91,673	$ -	$ 1,234,179
SPS	$ 1,382,634	$ 9,613,363	$ 60,553	$ -	$ 1,670	$ 11,058,220
MIDW	$ 86,160	$ 27,421	$ 3,773	$ -	$ -	$ 117,354
SUNF	$ 116,780	$ 301,671	$ 5,114	$ -	$ -	$ 423,565
WESTAR	$ 1,383,560	$ 662,975	$ 60,593	$ -	$ -	$ 2,107,128
WEPL	$ 145,403	$ 263,996	$ 6,368	$ -	$ -	$ 415,768
MIPU	$ 484,745	$ 16,288	$ 21,229	$ -	$ -	$ 522,263
KACP	$ 925,210	$ 117,788	$ 40,520	$ 128,994	$ -	$ 1,212,511
EMDE	$ 315,581	$ 61,065	$ 13,821	$ 296,770	$ 915	$ 688,152
SPRM	$ 185,603	$ 12,950	$ 8,129	$ -	$ -	$ 206,682
TOTAL	**$ 10,028,430**	**$ 20,360,751**	**$ 439,196**	**$ 891,700**	**$ 20,599**	**$ 31,740,676**

2010 ATRR Allocations by Zone

ZONE	MW-Mi Impacts 33% Regional Allocations	MW-Mi Impacts 67% MW-mi Allocations	No MW-Mi Impacts 33% Regional Allocations	No MW-Mi Impacts 67% MW-mi Allocations	Direct Assign Allocations	Totals
CLECO	$ -	$ -	$ -	$ -	$ -	$ -
SWPA	$ -	$ -	$ -	$ -	$ -	$ -
AEP	$ 267,983	$ 443,437	$ 123,786	$ 524,998	$ 4,503	$ 1,364,707
GRDA	$ 23,320	$ 171,545	$ 10,772	$ -	$ -	$ 205,637
OKGE	$ 169,034	$ 98,893	$ 78,080	$ -	$ -	$ 346,007
WFEC	$ 37,695	$ -	$ 17,412	$ 77,738	$ -	$ 132,845
SPS	$ 137,644	$ -	$ 63,580	$ 55,956	$ -	$ 257,179
MIDW	$ 8,577	$ -	$ 3,962	$ -	$ -	$ 12,539
SUNF	$ 11,626	$ -	$ 5,370	$ -	$ -	$ 16,996
WESTAR	$ 137,736	$ 1,132,725	$ 63,622	$ 76,034	$ -	$ 1,410,117
WEPL	$ 14,475	$ -	$ 6,686	$ -	$ -	$ 21,161
MIPU	$ 48,257	$ 8,088	$ 22,291	$ -	$ -	$ 78,636
KACP	$ 92,106	$ 48,845	$ 42,545	$ 201,552	$ -	$ 385,049
EMDE	$ 31,417	$ 123,414	$ 14,512	$ -	$ -	$ 169,343
SPRM	$ 18,477	$ -	$ 8,535	$ -	$ -	$ 27,012
TOTAL	**$ 998,347**	**$ 2,026,948**	**$ 461,152**	**$ 936,278**	**$ 4,503**	**$ 4,427,229**

2011 ATRR Allocations by Zone

	MW-Mi Impacts		No MW-Mi Impacts		Direct Assign	Totals
ZONE	33% Regional Allocations	67% MW-mi Allocations	33% Regional Allocations	67% MW-mi Allocations	Allocations	
CLECO	$ -	$ -	$ -	$ -	$ -	$ -
SWPA	$ -	$ -	$ -	$ -	$ -	$ -
AEP	$ 272,858	$ 508,860	$ 105,051	$ 81,465	$ 18,013	$ 986,247
GRDA	$ 23,745	$ -	$ 9,142	$ 50,066	$ -	$ 82,953
OKGE	$ 172,109	$ 37,175	$ 66,262	$ -	$ 22,353	$ 297,899
WFEC	$ 38,380	$ 181,182	$ 14,776	$ 174,789	$ 18,243	$ 427,372
SPS	$ 140,147	$ -	$ 53,957	$ -	$ 16,703	$ 210,808
MIDW	$ 8,733	$ -	$ 3,362	$ -	$ -	$ 12,096
SUNF	$ 11,837	$ -	$ 4,557	$ -	$ -	$ 16,394
WESTAR	$ 140,241	$ 347,138	$ 53,993	$ 139,902	$ -	$ 681,274
WEPL	$ 14,738	$ -	$ 5,674	$ 33,185	$ -	$ 53,597
MIPU	$ 49,135	$ 46,943	$ 18,917	$ -	$ -	$ 114,995
KACP	$ 93,782	$ 671,681	$ 36,106	$ -	$ -	$ 801,569
EMDE	$ 31,988	$ 270,841	$ 12,315	$ 315,165	$ -	$ 630,309
SPRM	$ 18,813	$ -	$ 7,243	$ -	$ -	$ 26,056
TOTAL	**$ 1,016,508**	**$ 2,063,820**	**$ 391,356**	**$ 794,572**	**$ 75,313**	**$ 4,341,570**

Conclusion

Staff's analysis supports a finding of no "unintended consequences" with respect to the cost allocations associated with the 2008-2011 projects eligible for base plan funding in the STEP.

Results seem reasonable with host zone getting majority, if not all, of the 67% zonal allocations

Questions?