Cost-Effectiveness Valuation Guidelines for DR Resources in the Pacific Northwest

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Overview of Talk

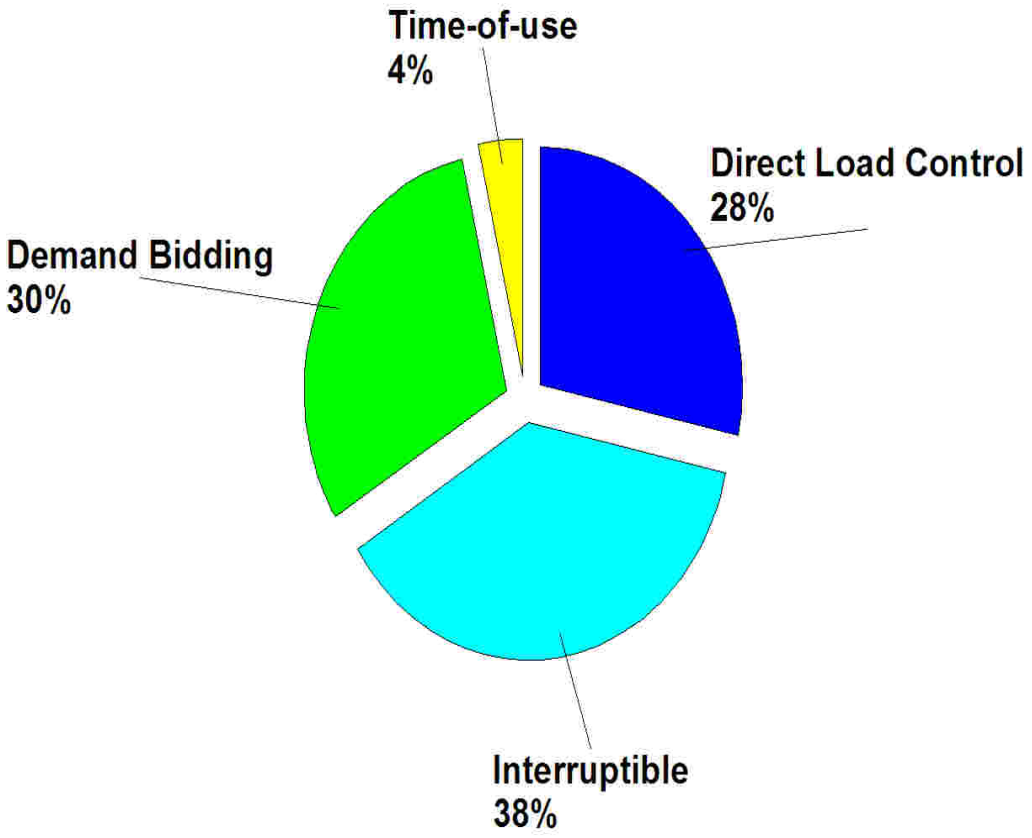
- **Existing DR Resources in the Pacific Northwest**
- **Regional DR Collaborative -- Pacific Northwest Demand Response Project (PNDRP)**
- **Cost-effectiveness Valuation Guidelines**
  - **Rationale/Need & Development Process**
  - **DR Benefits and Costs**
  - **Applying the C/E Screening Methodology to DR Programs: Spreadsheet Tool**

Pacific Northwest: Overview

- **Peak Demand = ~32700 MW in 2005**
  - **40% Res., 32% Comm., 23% Ind., 4% Irrigation**
- **Total DR resource ~720 MW**
  - **2% of 2005 Peak Demand**
  - **Largest Utility DR Programs: Idaho Power, Pacificorp, BPA, Portland General Electric, & Puget Sound Energy**
- **Why the interest in DR in the Pac NW?**
  - **Pac NW power system is running out of hydro, constrained, continuing load growth, environmental constraints, & need to integrate with other resources (e.g. wind)**
  - **Current/future situation changes the value for DR**
  - **Several recent pilot programs (e.g., BPA, Olympic Peninsula)**

Existing DR Resources in Pac NW

- Direct Load Control ~200 MW
- Interruptible ~265 MW
  - Irrigation Load Control ~208 MW
- Demand Bidding ~214 MW
- Time-of-use ~25 MW
- Resource potential data are not available on several DR programs



Pacific Northwest Demand Response Project (PNDRP): Regional Collaborative

- **PNDRP includes:**
  - **State PUCs (WA, OR, ID, MT)**
  - **Utilities and BPA**
  - **Northwest Power and Conservation Council (NPCC)**
  - **Other Stakeholders (DR providers, customer groups, consumer advocate, energy offices)**
- **Technical support and facilitation**
  - **Facilitated by RAP and NPCC; LBNL/RAP provides TA**
- **Working Groups:**
  - **(1) Cost Effectiveness, (2) Pricing and (3) Integrating DR into Distribution System Planning & Investment**

DR Cost Effectiveness Valuation Framework: Purpose & Development Process

- **Context**
  - **Lack of standardized methods to value DR resources, particularly "non-firm" resources (e.g. dynamic pricing, demand bidding)**
- **Purposes**
  - **Propose workable methods for state PUC and utilities to value benefits & costs of different types of DR resources**
  - **Use for ex ante screening of DR programs for C/E**
  - **Document value of DR for rate-setting purposes**
- **Development Process**
  - **Informational workshop (7/07); Workshops on draft guidelines (1/08 and 9/08) with comments/suggestions from members**
  - **Sources**
    - Review of Pac NW utility resource plans and current practices and guidance from state PUCs
    - CA Rulemaking on DR Cost-effectiveness; review, adapt, and simplify
    - DOE Report to Congress on Benefits of DR

Pac NW Guidelines and Principles

- Treat DR Resources on par with supply-side resources
- Distinguish among DR programs based on purpose, response time, dispatchability, & certainty of load response
- Account explicitly for all potential benefits
- Incorporate temporal and locational benefits of DR programs
- Include all DR program & participant costs
- Screen DR programs using multiple B/C tests; adapt B/C tests for distinctive features of DR programs
- Conduct DR pilots to assess market readiness, customer barriers and performance
  - Focus on “non-firm” DR resources (pricing) to identify resource value

DR Resources: Benefits & Costs

BENEFITS

- Avoided Generation Capacity Costs
- Avoided Energy Costs
- Avoid or Defer Investments in T&D System Capacity
- Environmental Benefits
- Reliability Benefits

COSTS

- Program Administration Costs
- Customer Costs
- Incentive Payments to participating customers

Benefits: Avoided Generation Capacity Costs

- **"Firm" DR resources which are directly integrated into IRP process can avoid need for some peaking capacity**
- **Use cost of new CT as benchmark proxy for market value of capacity avoided by "firm" DR resources**
  - **Costs have typically ranged between $50-85/kW-yr; recent increases have resulted in estimates over $100/kW-yr**
- **Allocate avoided capacity costs to specific time periods appropriate for Pac NW**
  - **Linked to relative need for generation capacity in each hour (e.g. LOLE)**
- **Adjusted "upward" for avoided T&D losses and reserve margin**
- **Adjusted "downward" to include DR program operational constraints compared to use of CT**

Benefits: Avoided Energy Costs

- Load shifting or curtailments enable utilities to avoid energy costs
- Expected wholesale market elect. price in each future time period is relevant opportunity cost for estimating value of elect. avoided by DR resource
- Adjust “upwards” to capture line losses avoided during events
- Likely necessary to further adjust “upwards” for “event-based” DR programs as likely to be called in hours when prices are higher than average peak period prices
- Two options to estimate avoided energy costs:
  - Wholesale energy prices averaged over highest prices hours of price forecast
  - Stochastic methods that analyze correlation between DR events and elect prices & which can explicitly address uncertainty in future loads, prices, hydro conditions

Benefits: Avoid or Defer T&D System Capacity

- **Key Elements of T&D System: Interties, Local Network Transmission, Local Distribution System**
- **DR resources that provide highly predictable load reductions on short notice in congested locations may allow utilities to defer T&D capacity investments**
- **Two options for setting value:**
  - **Estimate on a case-specific basis using geographically specific T&D studies**
  - **Develop a default value for DR programs (e.g., avoided cost of transformer capacity) that meet pre-established "right place" and "right certainty" criteria**

Benefits: Environmental & Reliability

- **Environmental**
  - DR resources may avoid emissions from peaking generation units and some potential conservation effects
  - Depends on emissions profile of utility generation mix and customer's DR strategy (e.g. shifting, curtailment, onsite generation)
  - For DR resources that yield load curtailments, emission rate characteristics of a new CT are reasonable proxy for estimating avoided GHG emissions
- **Reliability**
  - Joint consideration of economic and reliability benefits is challenging
  - Once "firm" DR incorporated into IRP process, resources become part of planned capacity
  - "Non-firm" DR (e.g., voluntary "emergency" programs) are not counted on as system resource and thus can provide reliability assurance
  - Reasonable proxy for monetizing value of "non-firm" load curtailments is VOLL ($3-5/kWh) * Expected Unserved Energy

DR Resource Costs

- **Program Administration costs**
  - **Pgm mgmt, marketing, onsite hardware, event notification system upgrades, payments to CSPs**
- **Customer costs**
  - **Investments in enabling technology, developing load response strategy, comfort/inconvenience costs, rescheduling costs, reduced product production**
- **Incentive payments to participating customers**
  - **Paid to encourage initial enrollment and/or ongoing participation**
  - **Compensate for reduction in value of service**

C/E Screening Methodology Example: Smart Thermostat A/C program

- **Smart Thermostat A/C Program**
  - Manage cycling and set-point of A/C system
  - Limited to 120 Summer peak hours
  - Assume 65% of households participate during events & 7% annual attrition rate
- **Participation Goal: 30,000 units within 7 years**
- **Peak Demand Savings: 1.1 kW/unit**
- **Annual Peak Energy Savings: 132 kWh/unit (with 66 kWh/unit increase in off-peak energy usage)**
- **A/C Energy: Peak=$75/MWh, Off-Peak=$45/MWh**
- **A/C Capacity: Gen=$80/kW-Yr., T&D=$3/kW-Yr.**
- **Environmental Benefits: $8/MWh**
- **Reliability Benefits: None (treated as firm)**

Smart Thermostat A/C Program
C/E Screening Analysis

Year	2008	2009	2010	2011	2012	2013	2014
Utility System Characteristics							
Forecasted Retail Sales (GWh)	23,000	23,460	23,929	24,408	24,896	25,394	25,902
Forecasted Peak Demand (MW)	4,000	4,088	4,178	4,270	4,364	4,460	4,558
Residential Retail Sales (GWh)	8,740	8,915	9,093	9,275	9,460	9,650	9,843
Residential Peak Demand (MW)	1,520	1,553	1,588	1,623	1,658	1,695	1,732
DR Program Characteristics							
Number of New Participants (Units)	4,286	4,586	4,886	5,186	5,486	5,786	6,086
Number of Returning Participants (Units)	0	3,986	7,971	11,957	15,943	19,929	23,914
Number of Total Participants (Units)	4,286	8,571	12,857	17,143	21,429	25,714	30,000
Peak Period Energy Reduction (MWh)	368	735	1103	1471	1839	2206	2574
Off-Peak Period Energy Increase (MWh)	184	368	552	735	919	1103	1287
Proportion of Class Retail Sales (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Capacity Reduction (MW)	3.06	6.13	9.19	12.26	15.32	18.39	21.45
Proportion of Class Peak Demand (%)	0.2%	0.4%	0.6%	0.8%	0.9%	1.1%	1.2%
Benefits							
Avoided Energy Cost Savings ($MM)	$0.02	$0.04	$0.06	$0.09	$0.11	$0.14	$0.16
Avoided Capacity Cost Savings ($MM)	$0.26	$0.54	$0.83	$1.14	$1.46	$1.81	$2.17
Avoided T&D System Cost Savings ($MM)	$0.01	$0.02	$0.03	$0.04	$0.05	$0.06	$0.08
Environmental Benefits ($MM)	$0.00	$0.00	$0.00	$0.01	$0.01	$0.01	$0.01
Reliability Benefits ($MM)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total ($MM)	***$0.29***	***$0.60***	***$0.92***	***$1.27***	***$1.63***	***$2.02***	***$2.42***
Benefits - Present Value ($MM)	**$19.91**						
Costs							
Program Development Costs ($MM)	$0.15	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Customer Acquisition Costs ($MM)	$0.90	$0.95	$1.00	$1.04	$1.08	$1.13	$1.17
Annual Program Administration Costs ($MM)	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07
Annual Program Variable costs ($MM)	$0.18	$0.36	$0.55	$0.75	$0.95	$1.16	$1.39
Total ($MM)	***$1.29***	***$1.37***	***$1.61***	***$1.86***	***$2.11***	***$2.36***	***$2.63***
Costs - Present Value ($MM)	**$19.28**						
Net Benefits ($MM)	***0.63***						
Benefit Cost Ratio	***1.03***						

- **7 years shown but full 20-years included in screening analysis**
- **Benefits exceed program costs (on PV basis) by $630,000**
- **Program is only marginally cost effective**

C/E Screening Methodology Example: DLC Water Heater program

- **DLC Water Heater Program**
  - Cycle Water Heater
  - Targeted to winter weekdays; 60 hrs/year
  - Assume 95% performance rate for households & 7% annual attrition rate
- **Participation Goal: 30,000 units within 7 years**
- **Peak Demand Savings: 1.0 kW/unit**
- **Annual Peak Energy Savings: 60 kWh/unit (with 60 kWh/unit increase in off-peak energy usage)**
- **A/C Energy: Peak=$75/MWh, Off-Peak=$45/MWh**
- **A/C Capacity: Gen=$80/kW-Yr., T&D=$3/kW-Yr.**
- **Reliability Benefits: None (treated as firm)**

DLC Water Heater Program
C/E Screening Analysis

Year	2008	2009	2010	2011	2012	2013	2014
Utility System Characteristics							
Forecasted Retail Sales (GWh)	23,000	23,460	23,929	24,408	24,896	25,394	25,902
Forecasted Peak Demand (MW)	4,000	4,088	4,178	4,270	4,364	4,460	4,558
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Residential Peak Demand (MW)	1,520	1,553	1,588	1,623	1,658	1,695	1,732
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Number of New Participants (Units)	4,286	4,586	4,886	5,186	5,486	5,786	6,086
Number of Returning Participants (Units)	0	3,986	7,971	11,957	15,943	19,929	23,914
Number of Total Participants (Units)	4,286	8,571	12,857	17,143	21,429	25,714	30,000
Peak Period Energy Reduction (MWh)	244	489	733	977	1221	1466	1710
Off-Peak Period Energy Increase (MWh)	244	489	733	977	1221	1466	1710
Proportion of Class Retail Sales (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Capacity Reduction (MW)	4.07	8.14	12.21	16.29	20.36	24.43	28.50
Proportion of Class Peak Demand (%)	0.3%	0.5%	0.8%	1.0%	1.2%	1.4%	1.6%
Benefits							
Avoided Energy Cost Savings ($MM)	$0.01	$0.02	$0.02	$0.03	$0.04	$0.05	$0.06
Avoided Capacity Cost Savings ($MM)	$0.35	$0.71	$1.10	$1.51	$1.94	$2.40	$2.89
Avoided T&D System Cost Savings ($MM)	$0.01	$0.03	$0.04	$0.05	$0.07	$0.08	$0.10
Environmental Benefits ($MM)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reliability Benefits ($MM)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total ($MM)	***$0.37***	***$0.75***	***$1.16***	***$1.60***	***$2.05***	***$2.54***	***$3.05***
Benefits - Present Value ($MM)	**$25.12**						
Costs							
Program Development Costs ($MM)	$0.10	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Customer Acquisition Costs ($MM)	$0.88	$0.96	$1.04	$1.13	$1.22	$1.31	$1.40
Annual Program Administration Costs ($MM)	$0.06	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07
Annual Program Variable costs ($MM)	$0.16	$0.32	$0.49	$0.67	$0.86	$1.05	$1.25
Total ($MM)	***$1.20***	***$1.34***	***$1.60***	***$1.86***	***$2.14***	***$2.43***	***$2.72***
Costs - Present Value ($MM)	**$19.63**						
Net Benefits ($MM)	***5.49***						
Benefit Cost Ratio	***1.28***						
Levelized Cost ($/kW-Year)	**$77.54**	**$92.73**					

- **7 years shown but full 20-years included in screening analysis**
- **Benefits exceed program costs (on PV basis) by $5.4M**
- **B/C Ratio = 1.28**

Summary and Next Steps

- **DR Cost-effectiveness guidelines supported by all participating PNDRP stakeholders (Sept 2008); recommendation that NPCC include in next Regional Plan**
- **NPCC will include DR C/E Guidelines in its 6th Northwest Electric Power and Conservation Plan (May 2009) as an Appendix**
- **Pac NW DR Cost-effectiveness guidelines are useful as a B/C SCREENING tool for DR Programs**

Questions?

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Pacific Northwest Demand Response Project documents can be downloaded at:

http://www.nwcouncil.org/energy/dr/Default.asp