ELECTRIC POWER RESEARCH INSTITUTE

Demand Response Triggers (DR Triggers) Project:

Conclusion and Next Steps

Enabling Technologies Development Workshop
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PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

Origins of Concept:
DR Triggers Decision Support Tool Needed

- California Energy Crisis
  - Dead of winter (2000 – 2001)
  - Supply shortages
  - Crisis of reliability
  - Bankruptcies and emptying of state coffers

- Financial shock to net buyers of electricity
  - Unprecedented charges on settlement statements
  - Revealed 45+ days after the fact

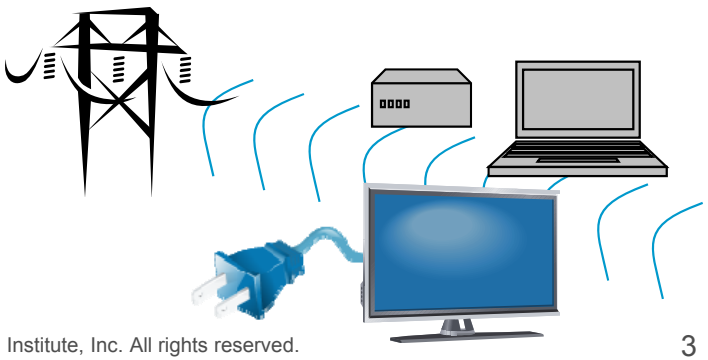
- Concept: Clarity on wholesale charges in time for demand-side to act
  - Financial connection between retail and wholesale markets through settlements
  - Assess charges by market product and charge code (premiums paid for what?)
  - Clarify financial impact of demand response (what charges can avoid?)

What is meant by Demand Response?

Dynamic change in electricity usage coordinated with system or market conditions

- Facilitated through **demand response programs** designed to coordinate electricity usage with power system or market needs

- Utilizes **demand-side resources**
  - on the end-use side of the meter
  - can be relied on to respond in coordinated fashion
  - distributed generation, storage, dispatchable load, etc.



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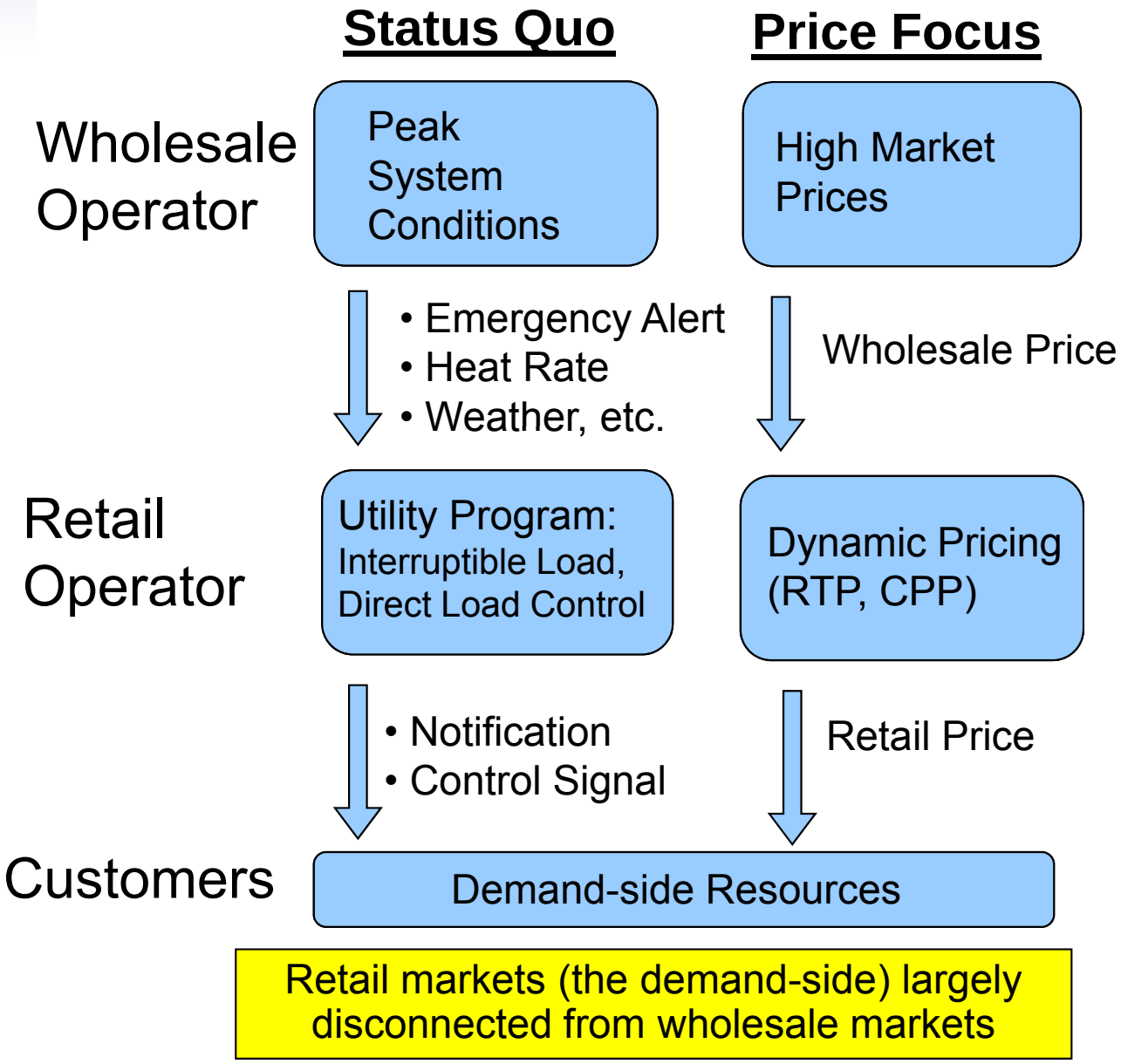
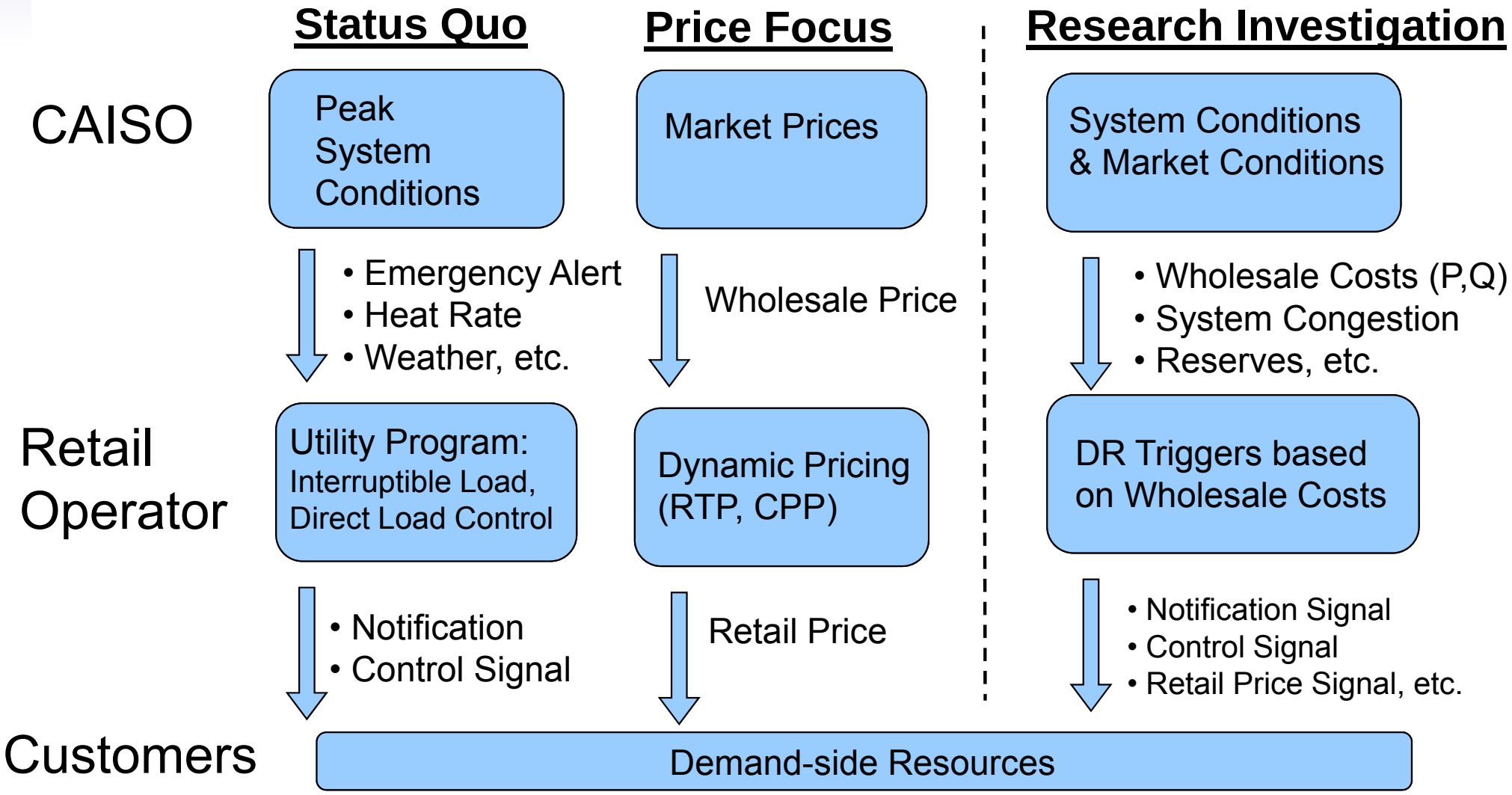
Background: Status Quo

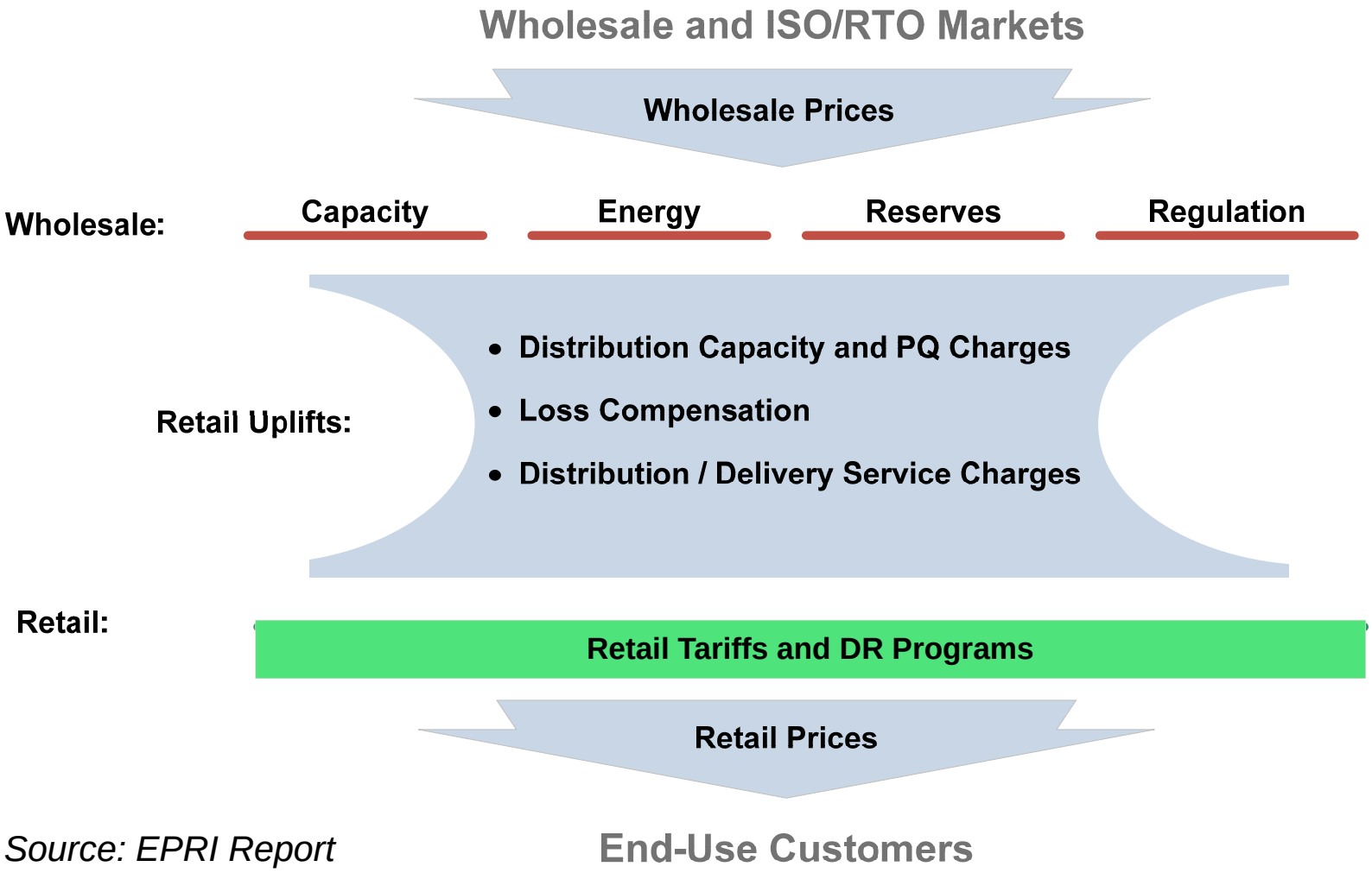


Background: Research Investigation



Retail load aware of the financial impact of wholesale markets in time to trigger DR to mitigate wholesale costs

Relationship of wholesale and retail market prices



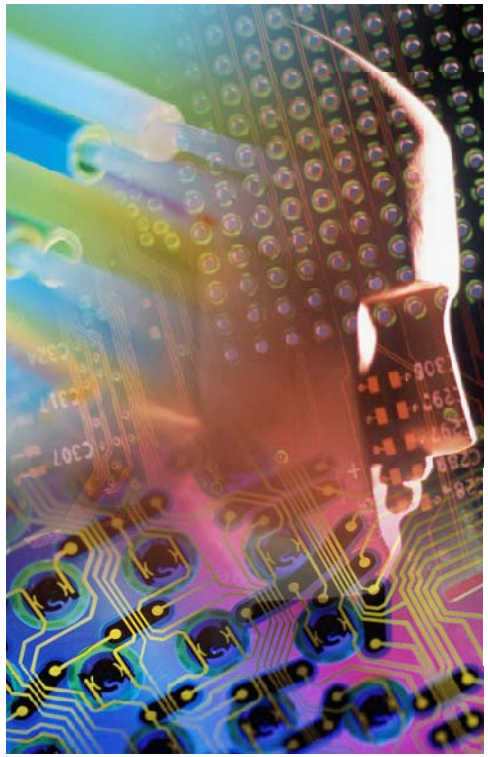
Source: EPRI Report

Question for pause: Real-time pricing of what?
(California Energy Crisis was a crisis of Reliability)[1]

1. Chuang, A., "Assessing the Impact of Resource Availability on Electric Service Reliability Cost", Electricity Journal, March 2004.

Project Tasks

- Trigger Methodology Development
- Information Technology Specification
- Proof-of-Concept Demonstration
- Reporting and Publication



Specify, develop, and demonstrate a method for energy retailers to trigger demand response in a fashion that financially links retail with wholesale electricity markets

Industry Collaborators

\+ Consultants

Proof-of-Concept Feasibility: Project Stages

- Identified Charge Codes sensitive to Demand Response
- Industry outreach
- Aggregated settlements to identify significant charge codes
- Prioritized charge codes (pre-MRTU and MRTU equivalents)

- Devise method for assessing DR impact on wholesale settlements
- Document assumptions
- Investigate input data availability
- Draft specification for envisioned tool to support short-term procurement personnel beyond status quo
- Vet with market participants to finalize and prioritize requirements

- Develop prototype of Day-ahead and Day-of screens
- Limited function proof-of-concept prototype demonstration

- Summarize findings in report and gather feedback
- Final Edits
- Publication

Priority Ranking: Top Charge Codes

- 16 Priority Charge Codes continued or were replaced under MRTU

* MD02 Charge Code Number	MD02 Charge Code Name	MRTU Charge Code Number	MRTU Charge Code Name	Priority
2	Day Ahead Non-Spinning Reserve due SC	6200	Day Ahead Non Spinning Reserve	1
52	Hour Ahead Non-Spinning Reserve due SC	6250	HASP Non-Spinning Reserve	1
111	Spinning Reserve due ISO	6194	Spinning Reserve Obligation Settlement	1
112	Non-Spinning Reserve due ISO	6294	Non-Spinning Reserve Obligation Settlement	1
115	Regulation Up Due ISO	6594	Regulation Up Obligation Settlement	1
116	Regulation Down Due ISO	6694	Regulation Down Obligation Settlement	1
372	High Voltage Access Charge due ISO	372	High Voltage Access Charge Allocation	2
550	FERC Fee	550	FERC Fee Settlement due Monthly	2
1401	Imbalance Energy Offset	6477	Real Time Imbalance Energy Offset	3
4401	Instructed Energy	6470	Real Time Instructed Imbalance Energy Settlement	1
4406	Unaccounted for Energy	6474	Real Time Unaccounted for Energy Settlement	1
4407	Uninstructed Energy	6475	Real Time Uninstructed Imbalance Energy Settlement	1
4487	Allocation of Excess Cost for Instructed Energy	6486	Real Time Excess Cost for Instructed Energy Allocation	3
4501	GMC-Core Reliability Services Non-Coincident Peak	4501	Core Reliability Services - CRS Peak Demand	2
4505	GMC-Energy Transmission Services Net Energy	4505	Energy Transmission Services - Net Energy	2
4534	GMC-Market Usage Ancillary Services	4534	Market Usage - Awarded AS	2

Highest priority for proof-of-concept are Ancillary Service and Imbalance Energy Charge Codes.

Approach for Developing Trigger Methodology

- Step1: Start with highest priority CCs and work down
- Step 2: Document CC formulations and identify input data
  - Understand billable quantity and Price as a function of Load
  - Charge = Price(Load) * BillableQuantity(Load)
- Step 3: Analyze CCs by impact of change in load on charge
  - Derive ΔCharge/ΔLoad "change in charge with respect to a change in load"
  - Identify assumptions
- Step 4: Analyze availability of input data
  - Timeframe available (operational timeframe desired)
  - Source of input data (systems)
  - Accessibility by market participants
- Step 5: Devise method of estimating data not available in operational timeframes
  - Historical data (e.g., from settlements or other input sources)
  - Fixed fees/prices by FERC/CAISO
  - Consider constancy of input data for accuracy
- Step 6: Summarize trigger method for a collection of charge codes
  - Simplify calculations (e.g. , treat charges in groups or compute impact by similar BQ)
  - Summarize assumptions

Potential Benefit: Triggering during Top 24 Priced Intervals (1/1/08-11/30/08)

Date	Hour	Delta_Reg Down_Charge / Delta_Load	(RegUpReq+ TotSelfProv)/ TotLoad	Delta_Reg Up_Charge / Delta_Load	(SpinReq+Tot SelfProv)/Tot BaseOpResReq	Delta_Spin _Charge / Delta_Load	(NspinReq+TotSelf Prov)/Tot BaseOpResReq	Delta_NonSpin_Charge / Delta_Load	Factor	Delta_CC4534_Charge / Detla_Load	Delta_AS_ChargeGroup / Delta_Load	Top 24 Interval?	Value of Trigger (during Top 24 Intervals)
11/29/2008	9	0.0161141	0.01842748	0.2029347	0.499996724	0.1359373	0.499997	0.043107	0.07	0.06415398	0.462247617		
11/29/2008	10	0.0223867	0.0159364	0.1289674	0.49999364	0.1264277	0.499994	0.047099	0.07	0.06398327	0.388863739		
11/29/2008	11	0.0243477	0.01600547	0.2162329	0.5	0.0688265	0.5	0.045584	0.07	0.06400516	0.418996277		
11/29/2008	12	0.0225561	0.01510108	0.1867445	0.499993693	0.0874563	0.499994	0.044751	0.07	0.06393366	0.405441715		
11/29/2008	13	0.013915	0.01537605	0.1902084	0.5	0.073834	0.5	0.047107	0.07	0.06395566	0.389019734		
11/29/2008	14	0.015273	0.01619876	0.2188293	0.500006376	0.0670259	0.500006	0.047737	0.07	0.0640236	0.412888523		
11/29/2008	15	0.0185965	0.01585847	0.1961673	0.500003209	0.0687013	0.500003	0.0462	0.07	0.06399026	0.393655761		
11/29/2008	16	0.024604	0.0157945	0.1953655	0.499993612	0.0687622	0.499994	0.045359	0.07	0.06399006	0.398081005		
11/29/2008	17	0.0180779	0.01420142	0.1756979	0.500002887	0.073109	0.500003	0.051021	0.07	0.06388138	0.381787465		
11/29/2008	18	0.0080859	0.01438266	0.4162167	0.499997131	0.3232901	0.499997	0.051828	0.07	0.06382445	0.863244693		
11/29/2008	19	0.0081658	0.0141992	0.3749168	0.499994157	0.3307369	0.499994	0.051347	0.07	0.06381351	0.828980204		
11/29/2008	20	0.0086262	0.01731128	0.3371634	0.5	0.0954718	0.5	0.051167	0.07	0.06401522	0.556443228		
11/29/2008	21	0.026365	0.01416703	0.3167917	0.500003265	0.2898097	0.500003	0.049983	0.07	0.06390814	0.746857835		
11/29/2008	22	0.0601742	0.0158289	0.5144441	0.500006748	0.2744363	0.500007	0.048585	0.07	0.06409938	0.961738551		
11/29/2008	23	0.0215956	0.01556682	0.3915481	0.499996546	0.2971299	0.499997	0.049981	0.07	0.06407699	0.824331242		
11/29/2008	24	0.0528538	0.01686871	0.3543364	0.500003661	0.0829144	0.500004	0.03756	0.07	0.06420038	0.591864811		0
11/30/2008	1	0.0173174	0.01814851	0.2929192	0.5	0.0732441	0.5	0.028727	0.07	0.06406149	0.476269298		0
11/30/2008	2	0.0184223	0.01860145	0.3002541	0.5	0.0275087	0.5	0.027982	0.07	0.06408877	0.438255453		0
11/30/2008	3	0.0231514	0.01863784	0.3007715	0.5	0.0275823	0.5	0.027953	0.07	0.06409466	0.443552517		0
11/30/2008	4	0.0289464	0.01860963	0.3002646	0.5	0.0275943	0.5	0.027952	0.07	0.06411914	0.448876931		0
11/30/2008	5	0.0286196	0.01841132	0.2971728	0.500007604	0.0275284	0.500008	0.028035	0.07	0.06410611	0.445461699		0
11/30/2008	6	0.0243934	0.0178338	0.2878573	0.499996344	0.0276945	0.499996	0.02819	0.07	0.06408334	0.432218738		0
11/30/2008	7	0.0401997	0.01929217	0.4543499	0.49999635	0.2737025	0.499996	0.036176	0.07	0.06420474	0.868633125		0
11/30/2008	8	0.0687394	0.01738759	0.2151141	0.499989471	0.0732315	0.499989	0.036112	0.07	0.06421992	0.457416615		0
11/30/2008	9	0.0460403	0.01633918	0.2697519	0.5	0.0730557	0.5	0.04266	0.07	0.06405478	0.49556307		0
11/30/2008	10	0.0285098	0.01584338	0.2991313	0.499996777	0.0715785	0.499997	0.044345	0.07	0.06394406	0.507509121		0
11/30/2008	11	0.0445404	0.01591222	0.3799558	0.499996816	0.0698725	0.499997	0.046341	0.07	0.06401083	0.604720537		0
11/30/2008	12	0.0595576	0.01527507	0.4417376	0.499996845	0.0728219	0.499997	0.046939	0.07	0.06400436	0.685060122		0
11/30/2008	13	0.0568312	0.01488242	0.4461265	0.499996847	0.0742054	0.499997	0.047466	0.07	0.06400261	0.688631832		0
11/30/2008	14	0.0571641	0.01487505	0.4494084	0.5	0.0742215	0.5	0.04796	0.07	0.06400252	0.692755995		0
11/30/2008	15	0.074458	0.0148763	0.3375215	0.500003211	0.0742101	0.500003	0.048311	0.07	0.06404029	0.598541121		0
11/30/2008	16	0.0475144	0.01477266	0.3368189	0.499996835	0.0741975	0.499997	0.048679	0.07	0.06402567	0.571235613		0
11/30/2008	17	0.0327491	0.01760865	0.2440432	0.499997084	0.2084063	0.499997	0.052347	0.07	0.06412072	0.601666709		0
11/30/2008	18	0.0066153	0.01718603	0.3561132	0.499991209	0.2130438	0.499991	0.046019	0.07	0.06395204	0.685742915		0
11/30/2008	19	0.0032526	0.01517627	0.4797026	0.499997045	0.256356	0.499997	0.046021	0.07	0.06380145	0.849134082		0
11/30/2008	20	0.0162344	0.01505155	0.3424057	0.500003006	0.250628	0.500003	0.045357	0.07	0.06385536	0.71848079		0
11/30/2008	21	0.0178264	0.01516274	0.5541564	0.499990831	0.2321718	0.499991	0.053173	0.07	0.06386946	0.921196905		0
11/30/2008	22	0.0106962	0.01438235	0.5276437	0.500003159	0.2621757	0.500003	0.048922	0.07	0.06378262	0.913219834		0
11/30/2008	23	0.0310788	0.01596061	0.3621086	0.499996649	0.0742245	0.499997	0.047553	0.07	0.06396044	0.578925181		0
11/30/2008	24	0.0548768	0.01784529	0.3951278	0.49999633	0.0717247	0.499996	0.046471	0.07	0.06418625	0.632386606		0
													2,155

15.5151525
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21.11828318
22.25749953
23.85866343
24.63045605
25.16193539
26.91920874
27.37883259
28.58108561

1MW operating reserve from DR can capture $1000's in avoided A/S Charges during top 317 hours

Potential Benefit: Triggering during Top Priced Intervals (1/1/08-1/31/09)

Algorithm 1: Trigger DR during top hours
(when imbalance energy prices exceed threshold)

Location	No. of Top Hrs	with Prices Above ($/MWh)	No. Dates top hours occur across	Trigger impact during top hours ($/MW)
NP15	100	244	58	$30,551
NP15	93	250	55	$28,827
NP15	78	260	47	$25,007
NP15	68	270	42	$22,368
NP15	55	280	36	$18,786
NP15	54	290	35	$18,504
NP15	49	300	33	$17,029
NP15	43	310	29	$15,206
SP15	100	235	56	$27,271
SP15	83	250	49	$25,792
SP15	71	260	42	$22,737
SP15	62	270	38	$20,366
SP15	51	280	32	$17,332
SP15	50	290	31	$17,050
SP15	43	300	27	$14,984
SP15	38	310	24	$13,469

Algorithm 2: Trigger DR during top hours
(when imbalance energy prices exceed threshold but only on days with multiple top hours)

Location	No. Top Hours	with Prices Above ($/MWh)	No. Days with multiple top hours	No. Top Intervals on these days	Trigger Impact during top intervals on these days ($/MW)
NP15	117	230	29	84	$25,557
NP15	93	250	24	60	$19,492
NP15	78	260	20	52	$17,125
SP15	105	230	24	71	$21,683
SP15	83	250	19	[illegible]	$16,902
SP15	71	260	[illegible]	46	$15,211

1MW DR can capture $10,000's in avoided imbalance energy charges during peak priced hours (for imbalance energy) on top two dozen or more days.

Requirements Specification: Guiding Principles

- Objective of decision support tool: Use DR for short-term procurement economics
  - decision support tool to determine impact of triggering DR on wholesale settlements
  - scope of functions is for decision support tool that gives information to know whether in the money or not
- Basic functions: Get data, do calculations, create report
  - Show current state, what amount of DR have available
  - Show information to inform the decision
- Specification: Specify Wish List of functions and then prioritize
- Prototype: Get something built quickly and then add more later

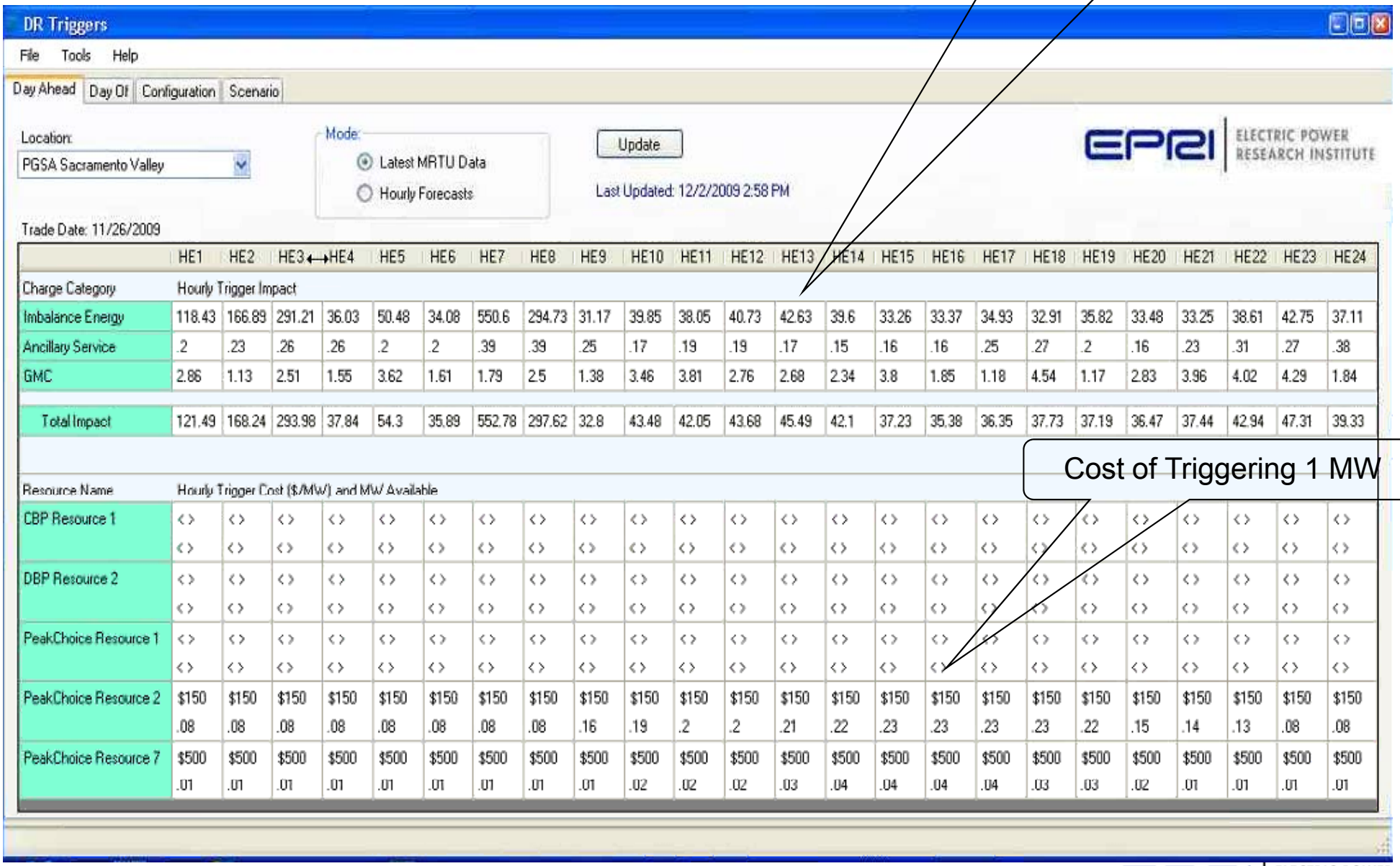
Proof-of-Concept Demonstration

Scenarios were illustrated through live demonstration.

- Scenario A: “when locations matter”
  - Trigger impact calculations varied substantially for select locations, so that it made sense to trigger DR resources in multiple locations but not other locations.
- Scenario B: “when trade dates matter”
  - On certain trade dates the tool indicated select hours that triggering demand response was estimated to be in the money. But for many other trade dates this was not the case.
- Scenario C: “when charge code matter”
  - On certain days the trigger impact calculations for ancillary services was on a greater order of magnitude than on average

Prototype: Day-Ahead Screen (Sacramento Valley)

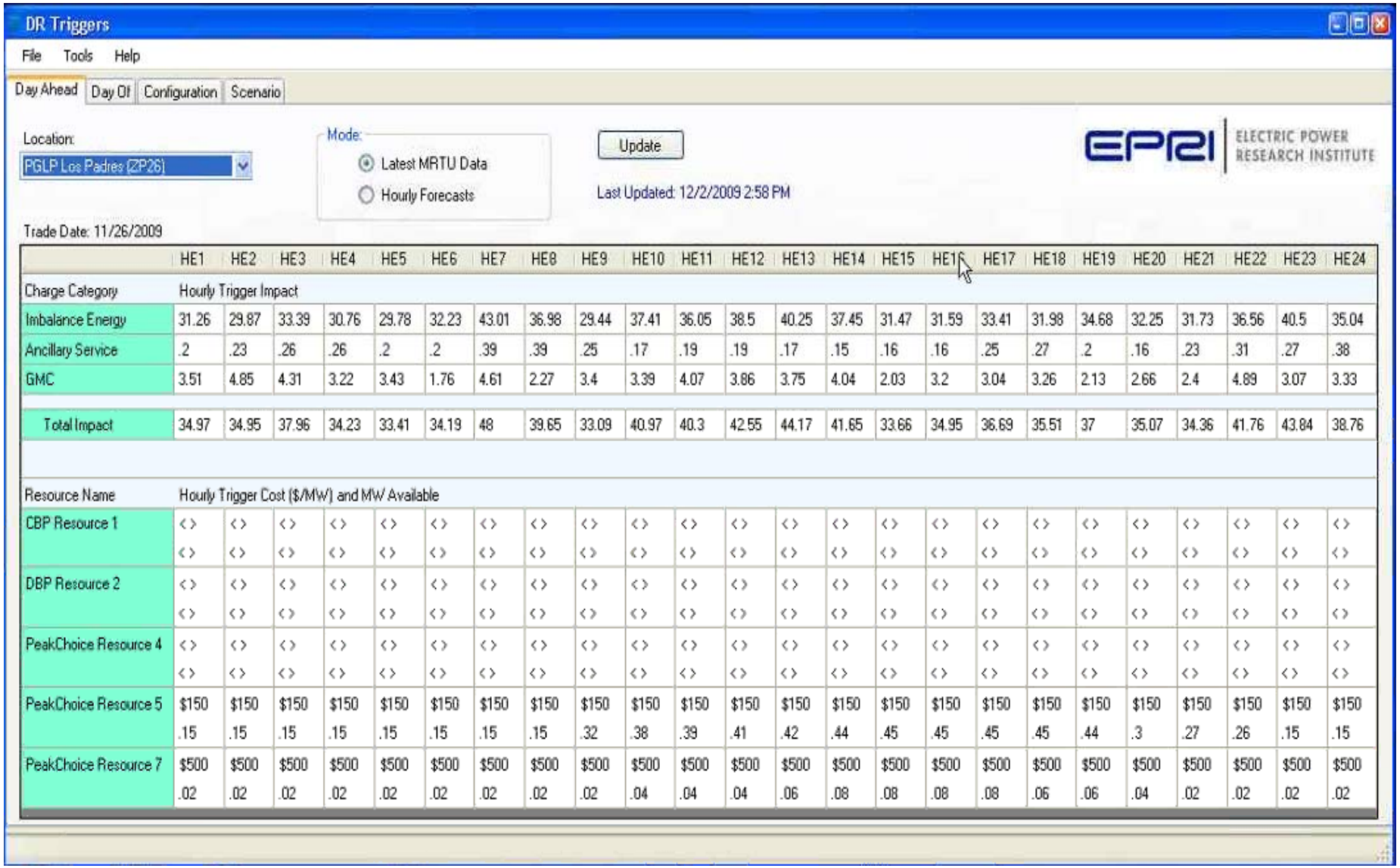
Change in charge estimated for 1 MW decrease in load scheduled DA, based on inputs/forecasts available DA



	HE1	HE2	HE3↔HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24
Charge Category	Hourly Trigger Impact																						
Imbalance Energy	118.43	166.89	291.21	36.03	50.48	34.08	550.6	294.73	31.17	39.85	38.05	40.73	42.63	39.6	33.26	33.37	34.93	32.91	35.82	33.48	33.25	38.61	42.75	37.11
Ancillary Service	.2	.23	.26	.26	.2	.2	.39	.39	.25	.17	.19	.19	.17	.15	.16	.16	.25	.27	.2	.16	.23	.31	.27	.38
GMC	2.86	1.13	2.51	1.55	3.62	1.61	1.79	2.5	1.38	3.46	3.81	2.76	2.68	2.34	3.8	1.85	1.18	4.54	1.17	2.83	3.96	4.02	4.29	1.84
Total Impact	121.49	168.24	293.98	37.84	54.3	35.89	552.78	297.62	32.8	43.48	42.05	43.68	45.49	42.1	37.23	35.38	36.35	37.73	37.19	36.47	37.44	42.94	47.31	39.33
Resource Name	Hourly Trigger Cost ($/MW) and MW Available																						
CBP Resource 1	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
DBP Resource 2	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
PeakChoice Resource 1	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
PeakChoice Resource 2	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150
	.08	.08	.08	.08	.08	.08	.08	.08	.16	.19	.2	.2	.21	.22	.23	.23	.23	.23	.22	.15	.14	.13	.08	.08
PeakChoice Resource 7	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02	.02	.02	.03	.04	.04	.04	.04	.03	.03	.02	.01	.01	.01	.01

Cost of Triggering 1 MW

Prototype: Day-Ahead Screen (Los Padres)



DR Triggers

File Tools Help

Day Ahead | Day Of | Configuration | Scenario

Location: PGLP Los Padres (ZP26)

Mode: Latest MRTU Data / Hourly Forecasts

Update

Last Updated: 12/2/2009 2:58 PM

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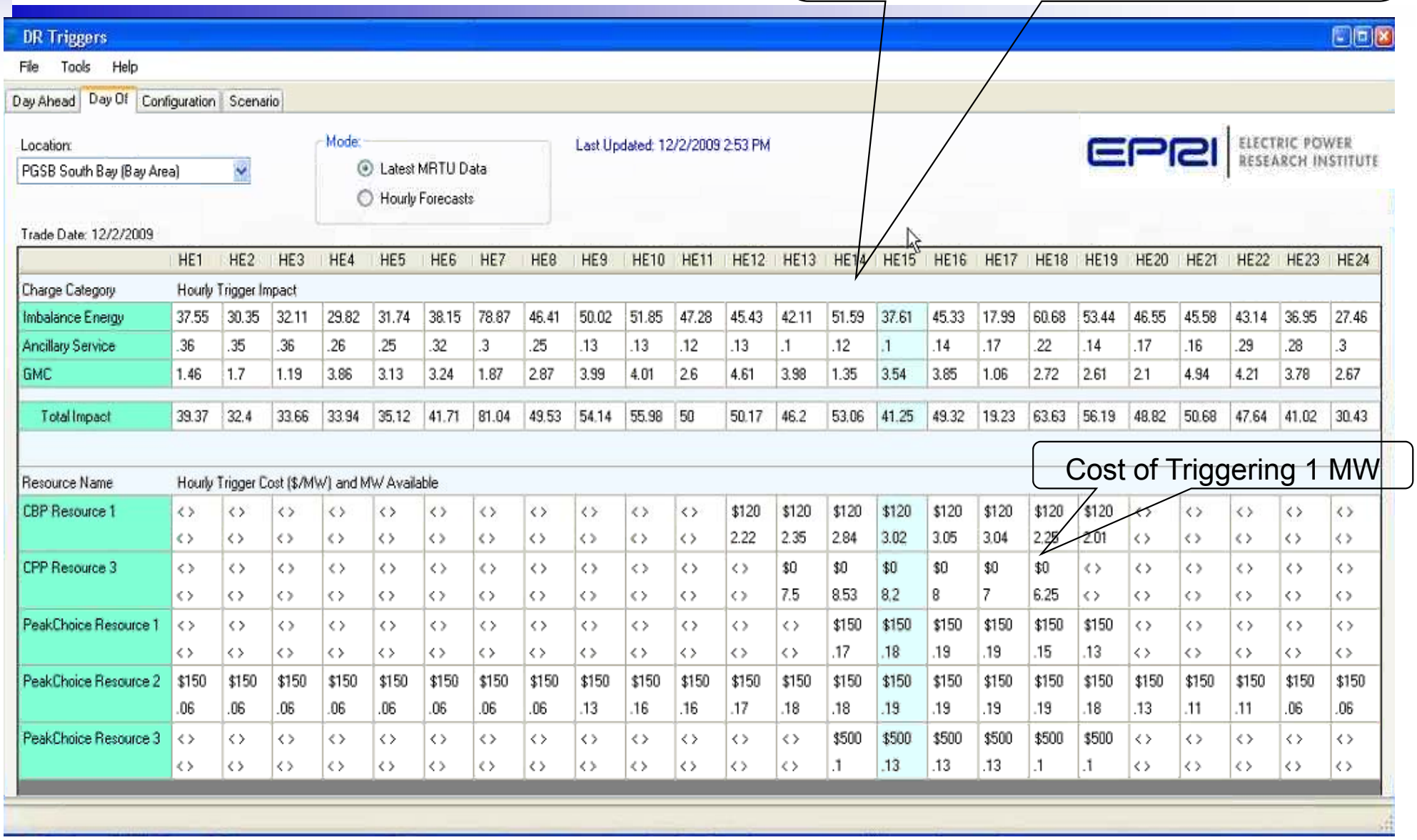
Trade Date: 11/26/2009

	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24
Charge Category	Hourly Trigger Impact																							
Imbalance Energy	31.26	29.87	33.39	30.76	29.78	32.23	43.01	36.98	29.44	37.41	36.05	38.5	40.25	37.45	31.47	31.59	33.41	31.98	34.68	32.25	31.73	36.56	40.5	35.04
Ancillary Service	.2	.23	.26	.26	.2	.2	.39	.39	.25	.17	.19	.19	.17	.15	.16	.16	.25	.27	.2	.16	.23	.31	.27	.38
GMC	3.51	4.85	4.31	3.22	3.43	1.76	4.61	2.27	3.4	3.39	4.07	3.86	3.75	4.04	2.03	3.2	3.04	3.26	2.13	2.66	2.4	4.89	3.07	3.33
Total Impact	34.97	34.95	37.96	34.23	33.41	34.19	48	39.65	33.09	40.97	40.3	42.55	44.17	41.65	33.66	34.95	36.69	35.51	37	35.07	34.36	41.76	43.84	38.76
Resource Name	Hourly Trigger Cost ($/MW) and MW Available																							
CBP Resource 1	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
DBP Resource 2	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
PeakChoice Resource 4	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>
PeakChoice Resource 5	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150
	.15	.15	.15	.15	.15	.15	.15	.15	.32	.38	.39	.41	.42	.44	.45	.45	.45	.45	.44	.3	.27	.26	.15	.15
PeakChoice Resource 7	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
	.02	.02	.02	.02	.02	.02	.02	.02	.02	.04	.04	.04	.06	.08	.08	.08	.08	.06	.06	.04	.02	.02	.02	.02

Prototype: Day-of Screen

Automatically polling to show: change in charge estimated for 1 MW decrease in load triggered Day-of, based on inputs/forecasts available day-of



DR Triggers

File Tools Help

Day Ahead | Day Of | Configuration | Scenario

Location: PGSB South Bay (Bay Area)

Mode: Latest MRTU Data / Hourly Forecasts

Last Updated: 12/2/2009 2:53 PM

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Trade Date: 12/2/2009

	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24
Charge Category	Hourly Trigger Impact																							
Imbalance Energy	37.55	30.35	32.11	29.82	31.74	38.15	78.87	46.41	50.02	51.85	47.28	45.43	42.11	51.59	37.61	45.33	17.99	60.68	53.44	46.55	45.58	43.14	36.95	27.46
Ancillary Service	.36	.35	.36	.26	.25	.32	.3	.25	.13	.13	.12	.13	.1	.12	.1	.14	.17	.22	.14	.17	.16	.29	.28	.3
GMC	1.46	1.7	1.19	3.86	3.13	3.24	1.87	2.87	3.99	4.01	2.6	4.61	3.98	1.35	3.54	3.85	1.06	2.72	2.61	2.1	4.94	4.21	3.78	2.67
Total Impact	39.37	32.4	33.66	33.94	35.12	41.71	81.04	49.53	54.14	55.98	50	50.17	46.2	53.06	41.25	49.32	19.23	63.63	56.19	48.82	50.68	47.64	41.02	30.43
Resource Name	Hourly Trigger Cost ($/MW) and MW Available																							
CBP Resource 1	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	$120	$120	$120	$120	$120	$120	$120	$120	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	2.22	2.35	2.84	3.02	3.05	3.04	2.25	2.01	<>	<>	<>	<>	<>
CPP Resource 3	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	$0	$0	$0	$0	$0	$0	<>	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	7.5	8.53	8.2	8	7	6.25	<>	<>	<>	<>	<>	<>
PeakChoice Resource 1	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	$150	$150	$150	$150	$150	$150	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	.17	.18	.19	.19	.15	.13	<>	<>	<>	<>	<>
PeakChoice Resource 2	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150	$150
	.06	.06	.06	.06	.06	.06	.06	.06	.13	.16	.16	.17	.18	.18	.19	.19	.19	.19	.18	.13	.11	.11	.06	.06
PeakChoice Resource 3	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	$500	$500	$500	$500	$500	$500	<>	<>	<>	<>	<>
	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	<>	.1	.13	.13	.13	.1	.1	<>	<>	<>	<>	<>

Cost of Triggering 1 MW

Future Work

- Develop “full picture” of charges
  - DA Energy, Capacity, AS Reliability, etc.
- Develop conceptual framework for demand-side integration
  - Consider added dimensions and facets available in markets
  - connection to retail rates
  - technology capabilities required
- Implement tool using latest available data
  - Operational constraints, timeframes, interfaces, “latest MRTU data” intelligence
- Demonstrate practical applications of tool
  - for connecting retail to wholesale electricity markets to support a variety of objectives

Conclusions

- DR Trigger Methodology assesses impact to wholesale settlements from a change in metered load (DR), by charge type.

- Importance of trigger flexibility for capturing value through DR
  - Depending on the cost-impacting situation (e.g., Reserves, Imbalance Energy, etc.)
  - System-level vs. localized distribution-level triggering (e.g., fast-charging PEV)

- **Collaborative team from industry** crossed traditional boundaries to bridge ***industry gap***
  - Industry collaborative investigation required to bring clarity to wholesale charges
  - Considerations beyond status quo
    - participating load “offers to supply” vs. “demand bids to buy”
    - Economic triggering of DR for reliability

- Further work needed to clarify retail/wholesale market connection
  - How DR programs can be linked to the DR Triggers Decision Support tool
  - Full continuum of requirements involving customers that provide the DR resources

Together…Shaping the Future of Electricity

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