A Few Select Estimates of Generation Side Benefits Effects on Electricity Customer Costs

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1. Synchrophasor related research

2. Automated demand response (autoDR and OpenADR)

Synchrophasors → *Reliability*

Grid reliability is at greater risk with intermittent renewables and electric vehicle charging

Synchrophasor technology and applications let grid operators visualize grid activity much better

PIER has long history funding synchrophasor related research

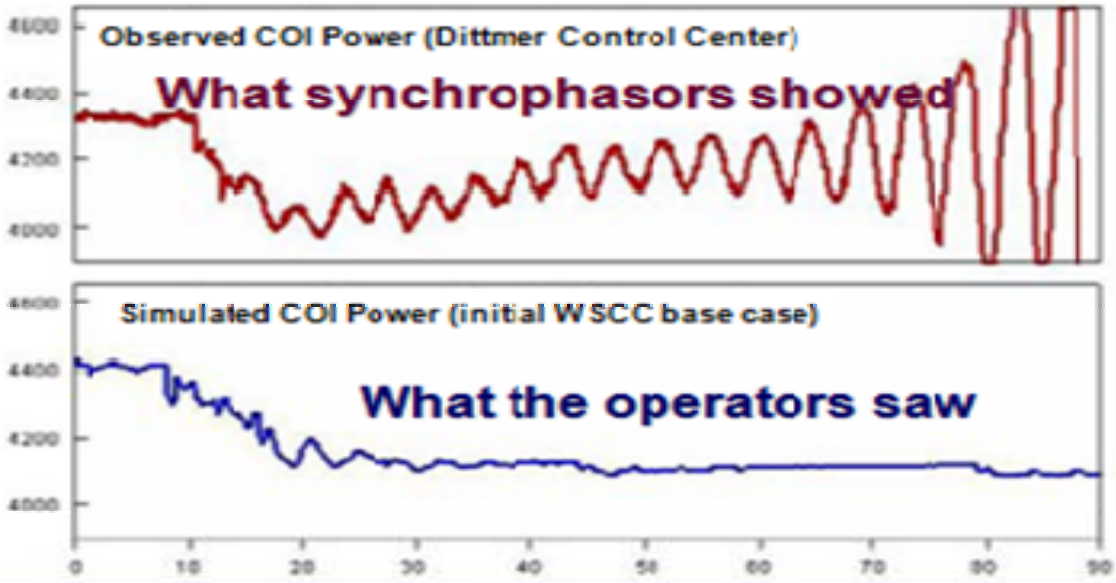
Considered instrumental in bringing synchrophasors from the laboratory to the field

Work continues, including applications for automated grid responses where appropriate.

Synchrophasors → *Reliability*

California-Oregon Intertie before West-wide Outage

August 10th, 1996, Power Flow During Generator Trip



This event triggered an inter-area power oscillation and ended in a wide-area power outage in western US.

ciee

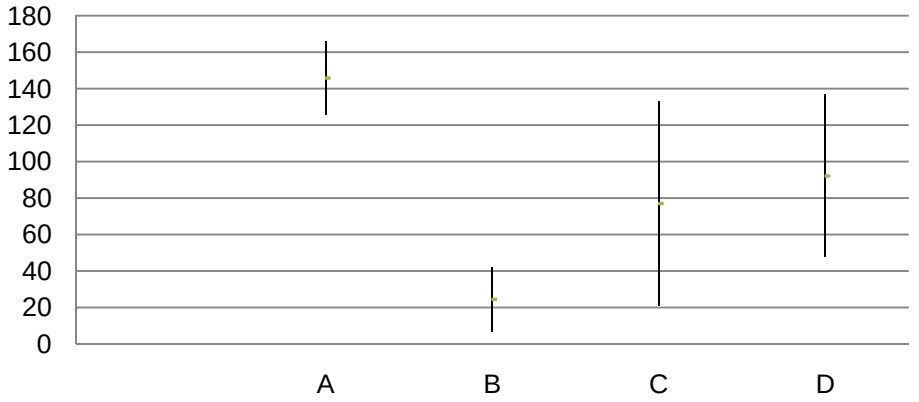
Synchrophasors

Reduced Outage Costs

Expected annual reliability benefits by year 2020, when grid must accept 33% renewables.

Estimates average to $85M/year

Four Estimates of Avoided Outage Costs ($millions)



Reliability value depends on

Probability and types of outages (duration) x Costs of those outages

Uncertain numbers: PIER used various estimates and expert judgments of probability and cost → 4 different estimate ranges

Synchrophasors

Reduced Electricity Cost

More full use of transmission lines

California- Oregon Intertie was de-rated after 1996 power outage (to carry less electricity)

With better ability to prevent outages may be able to re-rate by 200 MW

Value of additional transmission has been estimated as difference between prices at north and south ends of Intertie.

→ $8.2 million to $18.4 million = value of 200 additional MW

Synchrophasors

Reduced Electricity Cost

More full use of renewable electricity

Expect reduced time that intermittent renewable electricity is refused by grid operators - operator can better tell when grid is at risk.

- 1% to 5% increase in hours of wind accepted into the grid.
  → average cost of wind electricity drops 0.3 to 1.6 cents/kWh
- 9.2 million GWh of wind energy expected to be supplied to California in 2020.
- 9.2 million GWh x 0.3 - 1.6 cents/kWh can save ratepayers **$26 million to $150 million/yr**

Synchrophasors

Attribution

To evaluate attribution for the Real-Time Display Monitoring System, KEMA conducted structured interviews of 3 key players – 2 researchers, one CAISO (user) industry rep

Trade-off: expertise, familiarity ←→ potential for bias

- Careful question design, counterfactual scenarios

→Without PIER, work would be less sophisticated and useful, not tailored to California, reliability not ensured, at least 7 year delay

KEMA gave 70% attribution of a 10-year stream of benefits.

How would you translate a 7-year delay into attribution?

Attribution

General question about shared research:

If CEC and an outside state had shared research, and each achieved benefits of $250 million for their own state, would you give each state organization full attribution of its $250 million benefit?

- Public good, not excludable, total benefit is sum of individual benefits ($500 million)
- Only happens when different groups chip in: Should you only take credit when free ridership is not possible?

Here more complicated: DOE and PIER research both were needed. California is part of U.S. Both California and the U.S. received benefits. Thoughts?

Automated Demand Response

Reducing demand automatically, at customer command, in response to price signal.

--To reduce peak demand

--To help balance intermittent renewable energy

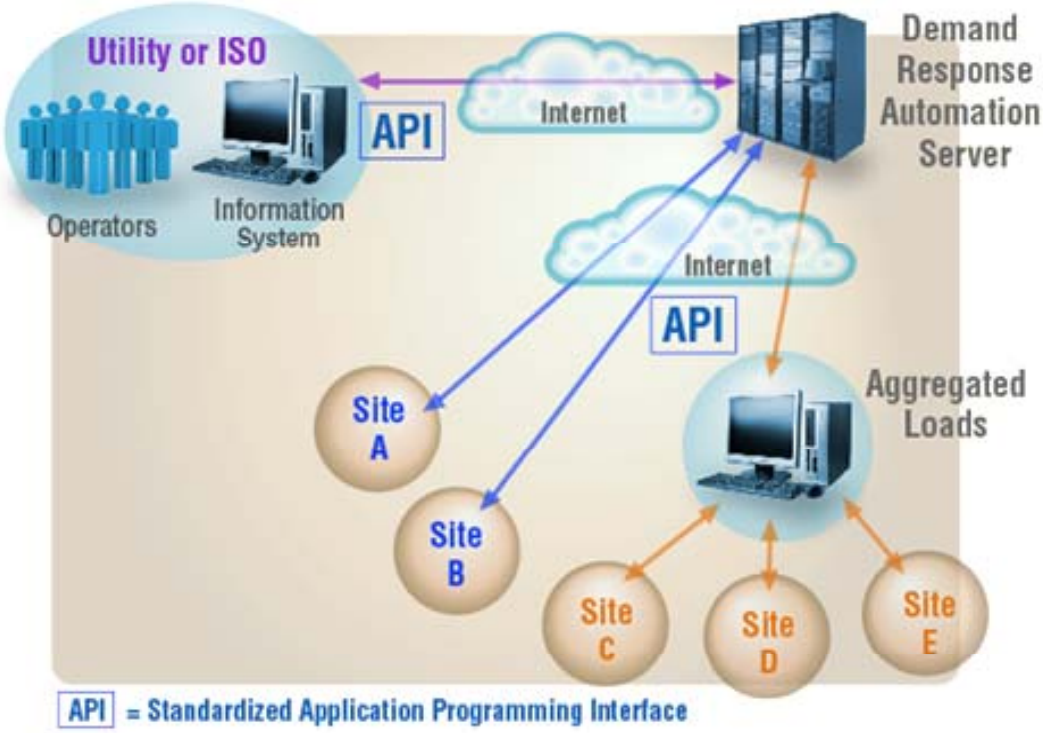


Image Courtesy of Demand Response Resource Center

Automated Demand Response

Peak Reduction

To estimate benefits:

1. How much is peak reduced?

   - 160 MW by end of 2011, commercial and industrial

2. How much would be reduced without ADR?

   - ADR users reducing peak 24%. Non automatic DR reduces ¼ as much (5-6%). So only ¾ or reduction attributable to ADR. 123 MW.

3. Savings = avoided new peak generation = $35 M/year

   = 123 MW x $285/kW-year for merchant gas peaker

4. Annualized installation cost to utilities = $4 M/year

5. Net savings = $31 million/year , as lower price per kWh

Automated Demand Response

Load Balancing

PIER funded modeling and follow-up interviews find:

- electricity storage (3000-5000 MW) will balance load for intermittent renewables more cost effectively than gas fired plants
  - Instant adjustment, don't need to keep gas-powered plants running
- OpenADR can replace an estimated1000 to 2000 MW of storage
- So value OpenADR by the price of the storage it replaces
  - Cheapest storage costs $155/kW-year (lead acid batteries, not best choice) while OpenADR installation costs $16.50/kW-year,
    - *Preliminary estimate: 155-16.5 = $138 saved/ kW-year*

→ (1000 to 2000 MW) x $.138/MW-year = $140-280 M/ year

Halve low estimate in case of storage cost drop: $70-280 M/yr

Automated Demand Response
Attribution

PIER major promoter and funder from inception, through PIER-funded Demand Response Research Center.

Should attribution be on percent of research funding?

On percent of California research funding since we're looking at California benefits?

On influence of CEC in making autoDR and OpenADR happen?

In this case, all questions reach similar conclusion –
High attribution to PIER.

Thank you.

Extra slides in case people request more details.

Synchrophasors

Reduced Outage Costs

4 Estimates of Reduced Outage Cost: overview

1. $145 million/year considering expert judgment of coming risks to reliability, LBNL outage cost estimates
2. $7M to $43M/ year if take historic outage rate as upper bound, very low outage cost estimates
3. $21M to $133M/ only increasing outage cost estimates per CA-specific study, still less than later LBNL meta-analysis of survey data
4. $47 to $137 M/year as CA share of WECC estimate

Reduced Outage Costs

4 Estimates of Reduced Outage Cost: details

(1) $145 million/year

- CA faces $8.1 billion/year in outage costs (LBL study)
- We can avoid 31 to 41% of these (inferred from Amin)
- 10% of costs are in transmission (LBL)
- Half of preventable transmission failures can be prevented by synchrophasor work (business case interviewee halved all outages)

$8.1 B x 36% x 10% x 50% = $145 million (midpoint)

Reduced Outage Costs

(2) Lowest estimate: $7M to $43M million/year

- expect 0.2 to 1.6 large outages a year (KEMA)
  - (1.56 is WECC average)
- cost per unserved kWh = $13 (based on 2003 Northeast blackout estimates, not survey-based)
- 50% of outages avoided

(3) Conservative estimate: $21M to $133M /year

- $42/unserved kWh (CA summer peak, E3-H-M)
  - LBL reviewing multiple surveys found $300-$600/kWh for small business, $11 -$97/kWh for large business

(4) $47 to $137M/year CA share of WECC estimate

- Higher outage risk (50%/year), lower reduction (10%)

Attribution

Survey: overview

"The key finding of the survey was that all respondents believed PIER support was essential to the development of RTDMS" (KEMA)

Respondents said without PIER

- Much less synchrophasor funding
- Delayed at least 7 years
- DOE might have chosen Eastern development partner rather than CAISO, avoiding Western-critical applications like oscillation damping

Western Interconnect Synchrophasor management says program benefits today from PIER's imagination, guided by PIER R&D

Synchrophasors

Attribution

Survey: synopsis of questions and answers

1. If PIER hadn't funded as much, how much would other organizations have filled need? → not nearly as much
2. Would CAISO have funded through market levies? → No, not its mandate
3. Did PIER provide technical assistance? → No, but provided much facilitation, catalyzing, support, training,…
4. Where would product development be now without PIER? → Not useful to CA, experimental, backroom, reliability not ensured.

→ Concludes results delayed at least 7 years without PIER. Gives 70% attribution to PIER of its 10-year estimated benefits stream.