Searching for Best Practices for Modeling Energy Efficiency in Integrated Resource Planning

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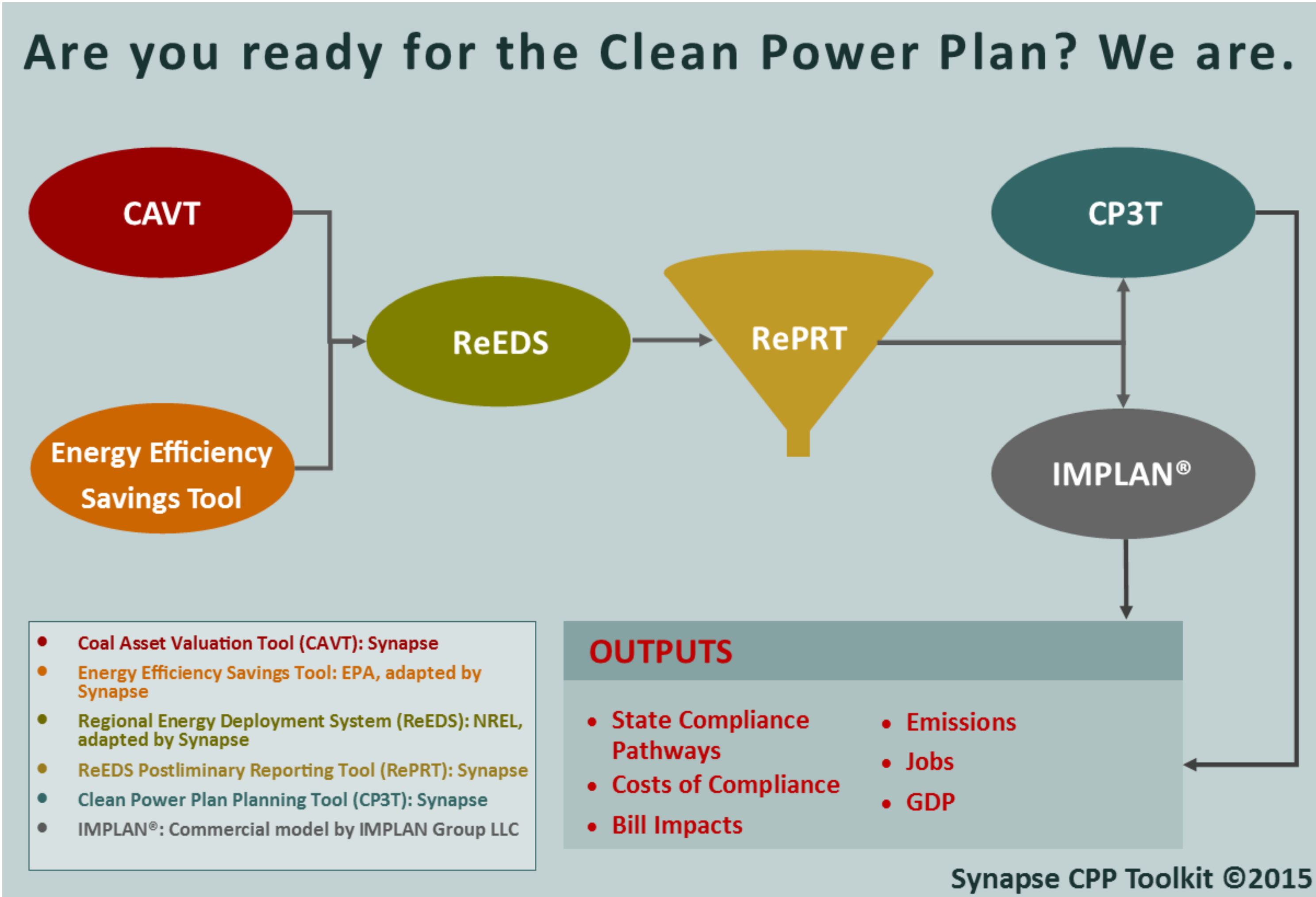
Synapse Energy Economics

- Founded in 1996 by CEO Bruce Biewald
- Leader for public interest and government clients in providing rigorous analysis of the electric power sector
- Staff of 30 includes experts in energy and environmental economics and environmental compliance
- Developer of open-source tools for Clean Power Plan and other electricity planning

Synapse Clean Power Plan Toolkit



Contents

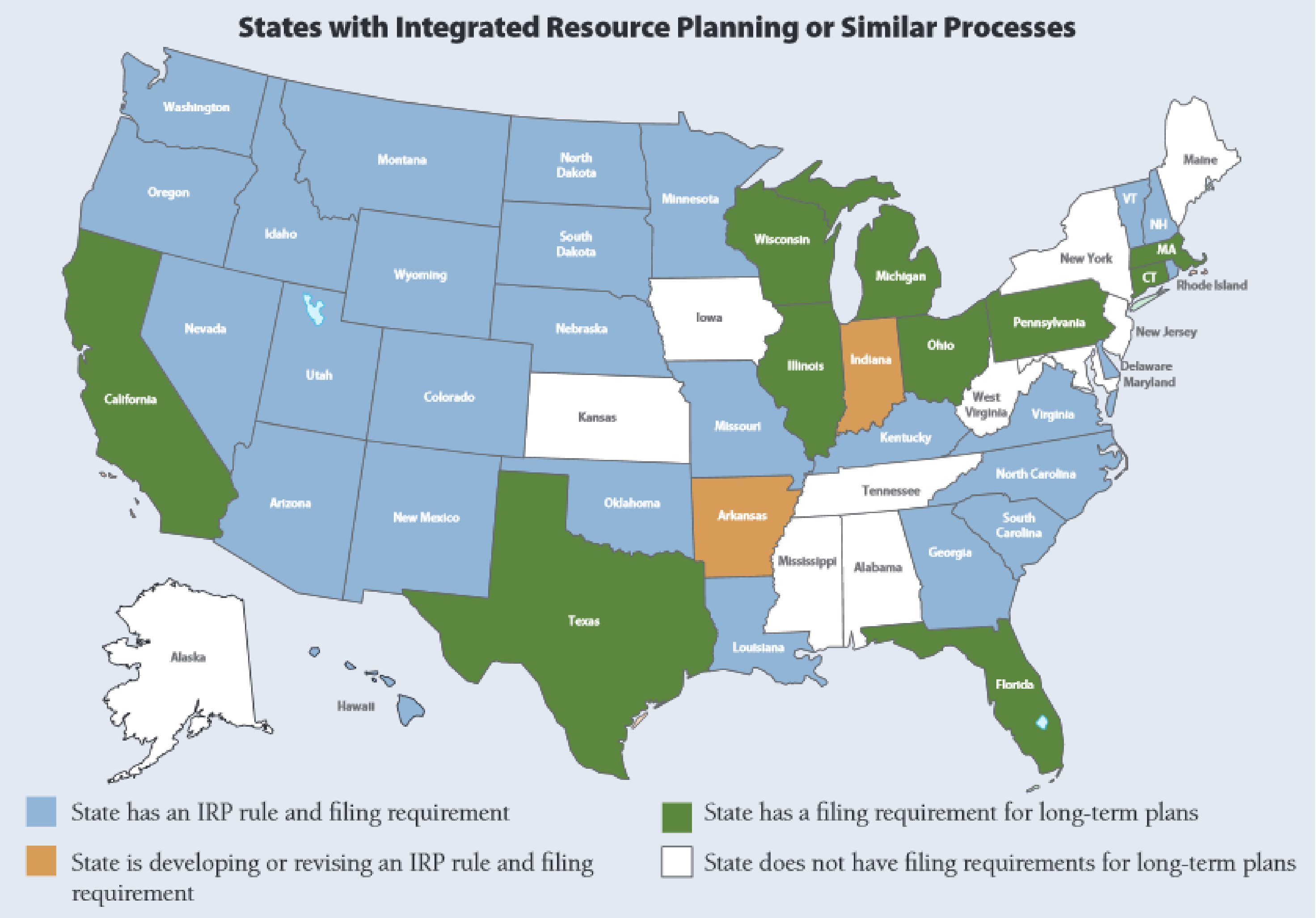
1. What is integrated resource planning, and how is it typically done?
2. How is energy efficiency typically modeled?
3. Pros and cons of different approaches
4. Lessons learned from IRP examples

Key Takeaways

1) Integrated resource planning (IRP) is an important tool, but it can be used badly.
2) Input assumptions and modeling constraints are key to success.
3) Energy efficiency modeling in IRP is only as good as the input assumptions used to generate the portfolio.
4) Two approaches (**load side** and **supply side**) can produce similar results given that key constraints (other than costs) are typically very stringent.
5) It is essential to understand and acknowledge the limitations of a model.
6) Modelers should run a range of EE scenarios to capture a full EE picture.
7) Modelers should not be overly constrained by EE potential studies for developing long-term EE savings in IRP.

Integrated Resource Planning and Energy Efficiency

States with IRP-type Processes



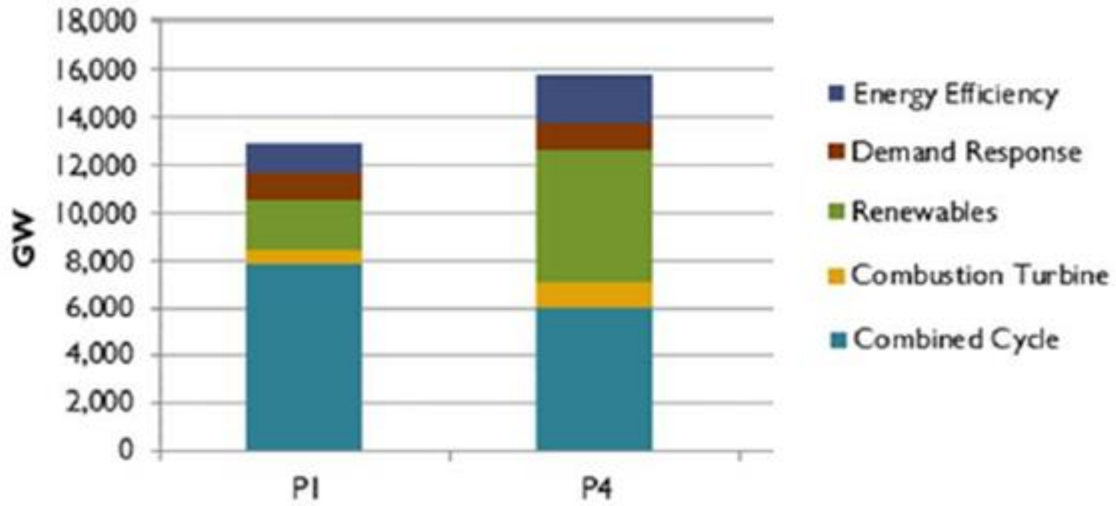
Source: Wilson & Biewald (2013) Best Practices in Electric Utility Resource Planning. Synapse Energy Economics.

What is IRP?

- IRP is a utility plan to examine various short- and long-term resource options for meeting forecasted energy demand in a least cost manner.
- A good IRP also tests robustness of planning options under a variety of uncertain futures.
- How does EE factor into IRP?
  - EE will change the amount and the mix of supply-side resources over time.
  - EE can help avoid or defer the cost of current and future environmental requirements.
  - EE can reduce long-term risks (i.e., fuel costs, environmental costs).

IRP Results Example

New energy resource mix for two portfolios in DEC's 2014 IRP, 2034



Source: Synapse Energy Economics (2015) Air Emissions Displacement by Energy Efficiency and Renewable Energy – A Survey of Data, Methods, and Results; Duke Energy Carolinas (2014) Duke Energy Carolinas Integrated Resource Plan (Annual Report), September 1, 2014.

EE Savings Performance under IRP

- No significant additional impacts are found among states with IRP compared with states w/o IRP

Policy	No. of states	Average EE investments as % of revenues	Average EE savings as % of sales
No IRP	10	1.5	0.5
Yes IRP	40	1.8	0.8
No EERS, no IRP	6	0.8	0.2
No EERS, yes IRP	18	0.8	0.3
Yes EERS, no IRP	4	2.7	1.0
Yes EERS, yes IRP	22	2.6	1.1

Source: Molina & Kushler (2015) Policies Matter: Creating a Foundation for an Energy-Efficient Utility of the Future, Table 6. ACEEE.

What are the Barriers to Modeling EE Right in IRP?

- IRP itself is not a policy to drive EE - unlike EERS, decoupling, and shareholder incentives. Policies matter for EE achievement (Molina & Kushler 2015).
- Modelers often take conservative approaches to incorporating non-traditional resources such as EE and renewables.
- IRP typically does not fully capture some important EE benefits, such as avoided T&D costs, environmental costs, and non-energy costs.

How EE is Modeled in IRP?

Modeling EE Approaches and Examples

Competitive Resource

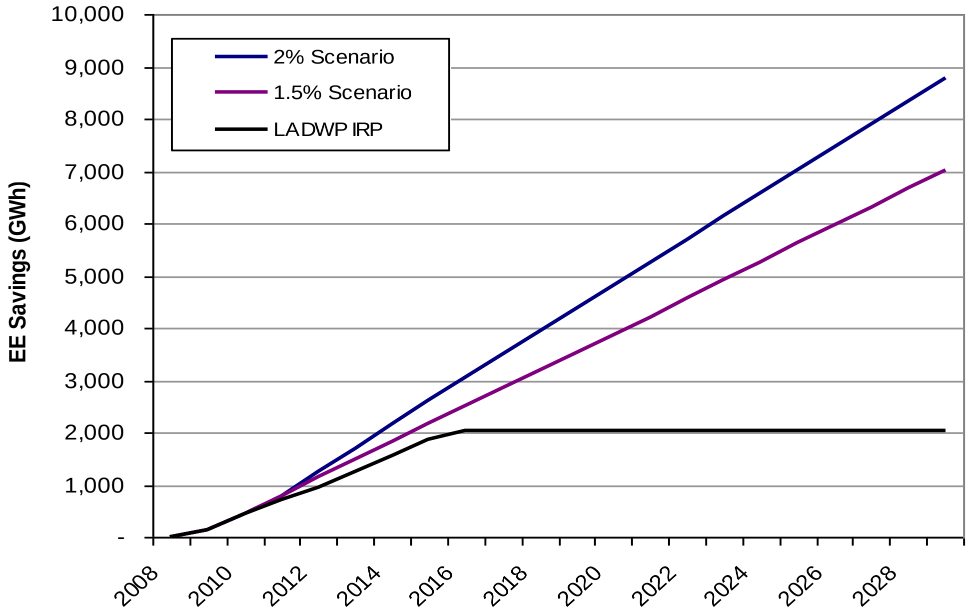
- TVA IRP 2015
- PGE IRP
- PacifiCorp IRP
- NWPCC
- Florida IOUs IRP

Load Modifier

- TVA IRP 2012
- IPL IRP 2014
- Duke Indiana IRP 2014
- LADWAP IRP 2010
- Vermont 2010
- SWEPCO IRP 2012

Load-Side Approach – Load Modifier

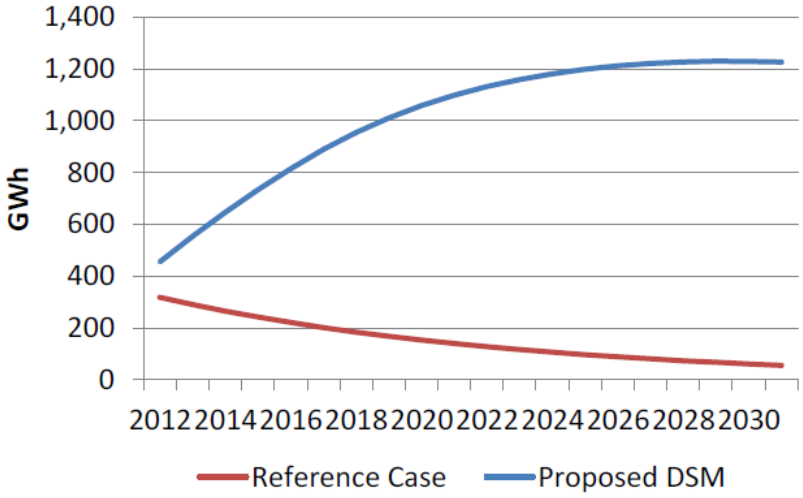
- The amount of EE in each year will be fixed in advance and used to modify load forecasts.
- This approach develops annual energy savings based on potential studies or utility's own assumptions.



Vermont Comprehensive Energy Plan 2010

- EE was modeled on the load side and mostly based on GDS potential study with minimal modifications.
- Three scenarios (i.e., Reference, Proposed DSM, and High Renewable) were modeled in an hourly dispatch model called Market Analytics.

Annual Energy Savings under the Reference Case and Proposed DSM Case



Sources: Synapse Energy Economics (2011). Electricity Scenario Analysis for the Vermont Comprehensive Energy Plan 2010.

Load-Side Approach: Key Features/Issues

Simple implementation	• EE is used to modify load
Simple stakeholder review	• A limited number of key variables for stakeholder review • Key assumptions are easier to audit
Modeling results	• EE resource is neither dynamic nor optimized

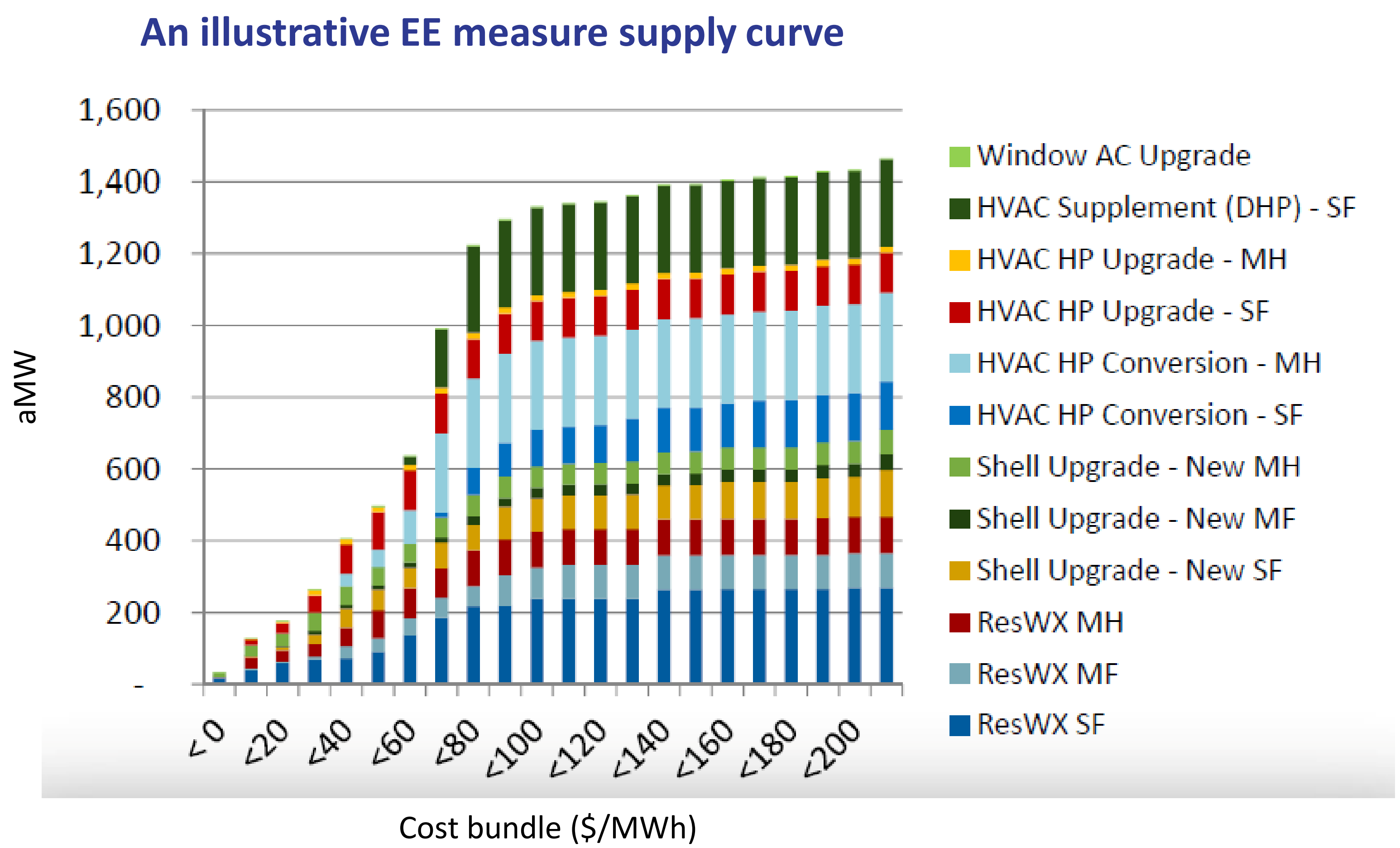
Competitive Resource Approach

- EE is analyzed endogenously in the model.
  - EE competes with other resources, and is selected optimally in a least cost fashion
  - Key constraints, such as EE ramp rates and penetration, are important
- This approach:
  - models EE resources as individual measures or bundled measures;
  - typically imposes additional constraints besides costs to estimate achievable savings; and
  - can be seen as another way of estimating achievable potential, but is more dynamic than typical potential studies.

Competitive Resource Approach: Key Features/Issues

Complex implementation	• Define individual bundles • Data difficult to obtain
Complex stakeholder review	• Implementation in IRP models is difficult to audit • Numerous variables for stakeholder review
EE model constraints critical	• Given no constraints, models would choose all cost-effective EE. • Model results closely mirror user constraints. Not necessarily "competitive" modeling
Resource mix realism	• Selected measures may not reflect a realistic measure and program mix

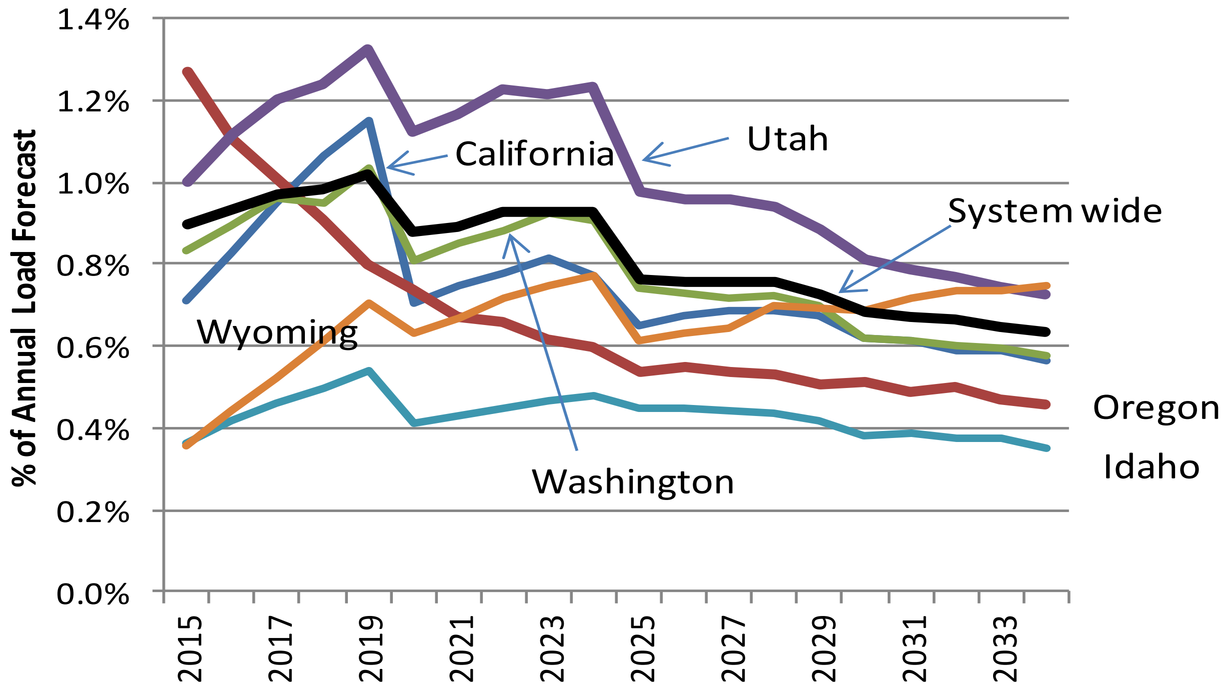
Competitive Resource Approach



Source: NWPCC (2014) Primer on Energy Efficiency Assessment Methodology.

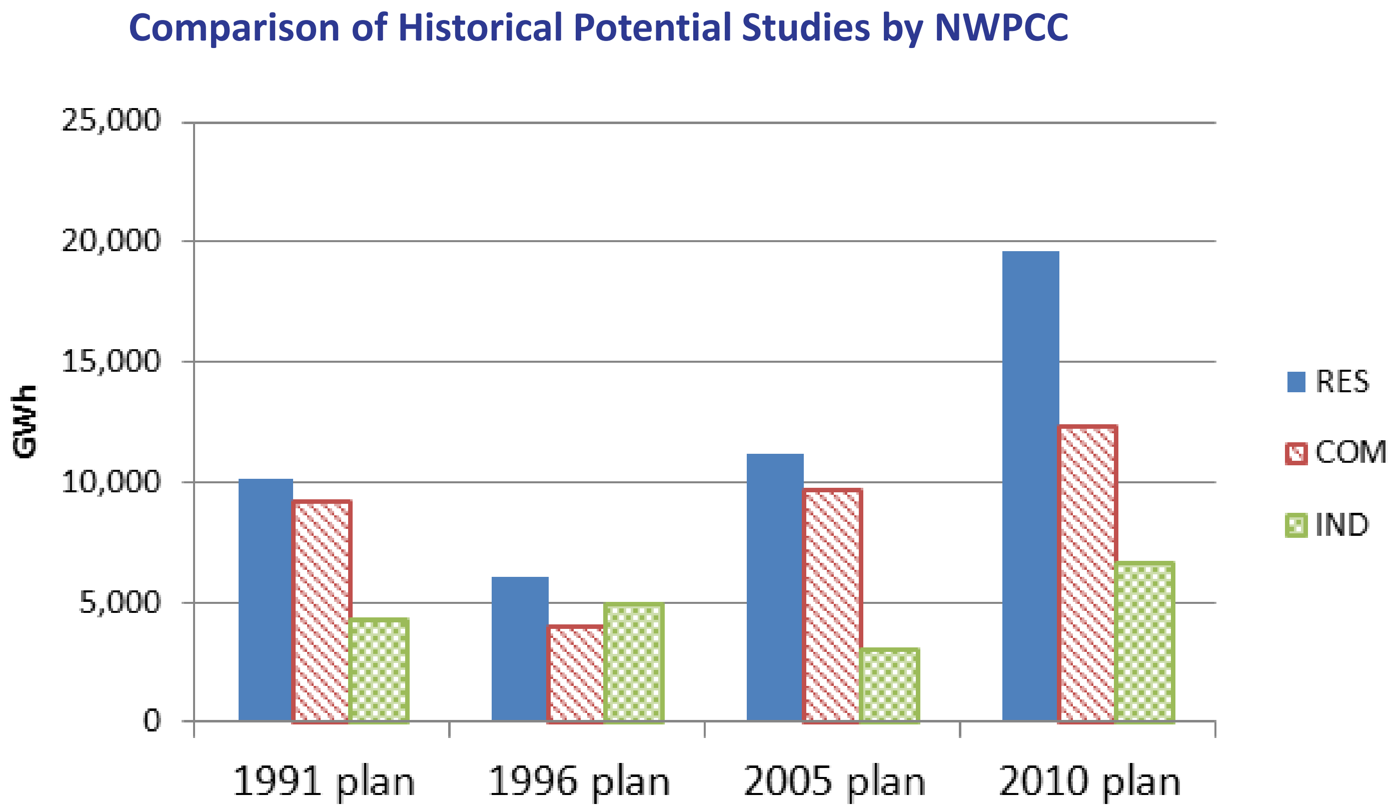
PacifiCorp 2015 IRP

Diminishing Savings over Time - Projected Annual Incremental Savings under PacifiCorp IRP



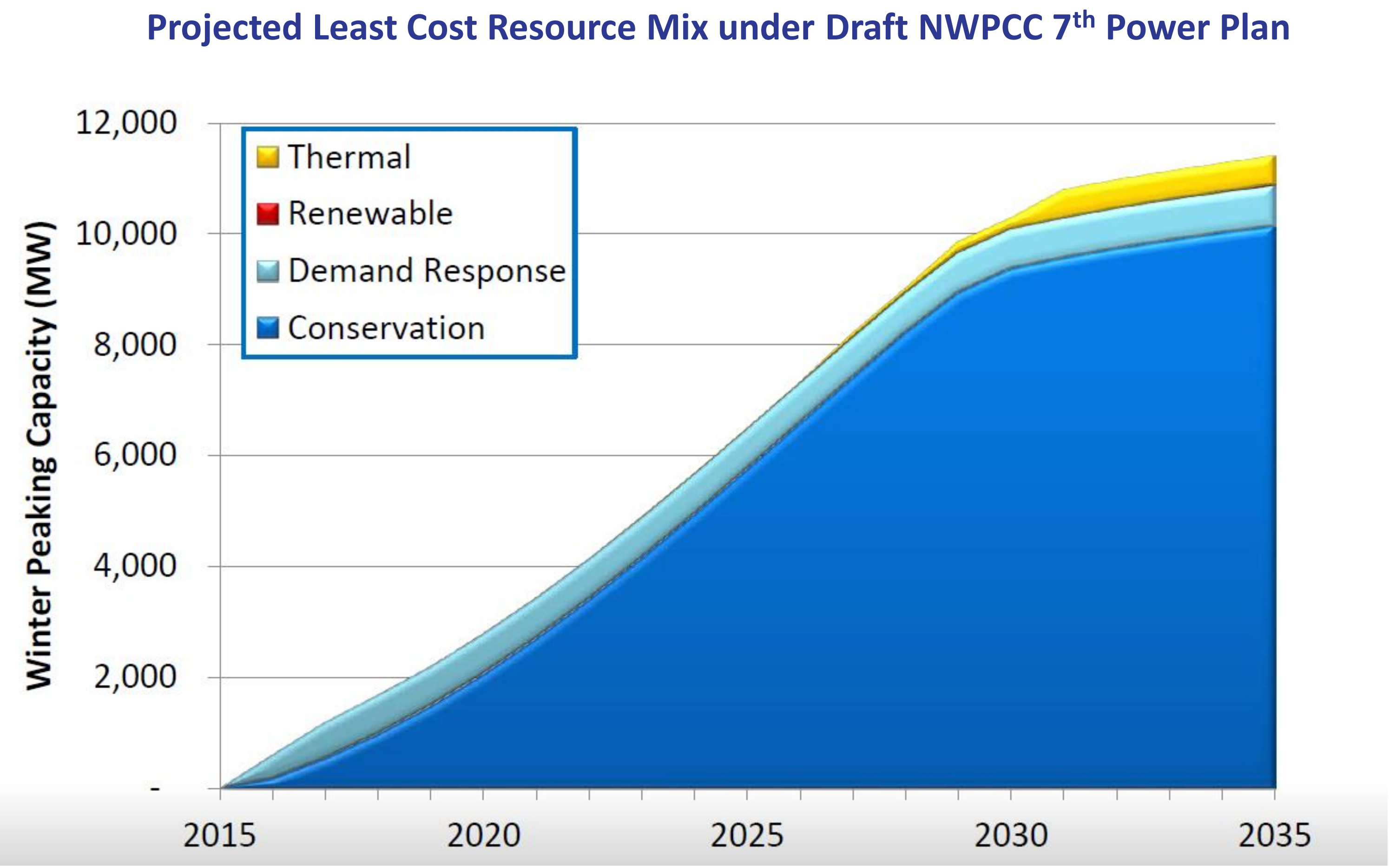
Source: PacifiCorp (2015) 2015 Integrated Resource Plan, Volume 1, Table A.1 – Forecasted Annual Load Growth, 2015 through 2024 (Megawatt-hours).

NWPCC Historical Potential Studies



Sources: Gordon et al. (2008) "Beyond Supply Curves" Proceedings of 2008 ACEEE Summer Study on Energy Efficiency in Buildings; NWPCC (2010) Sixth Northwest Conservation and Electric Power Plan.

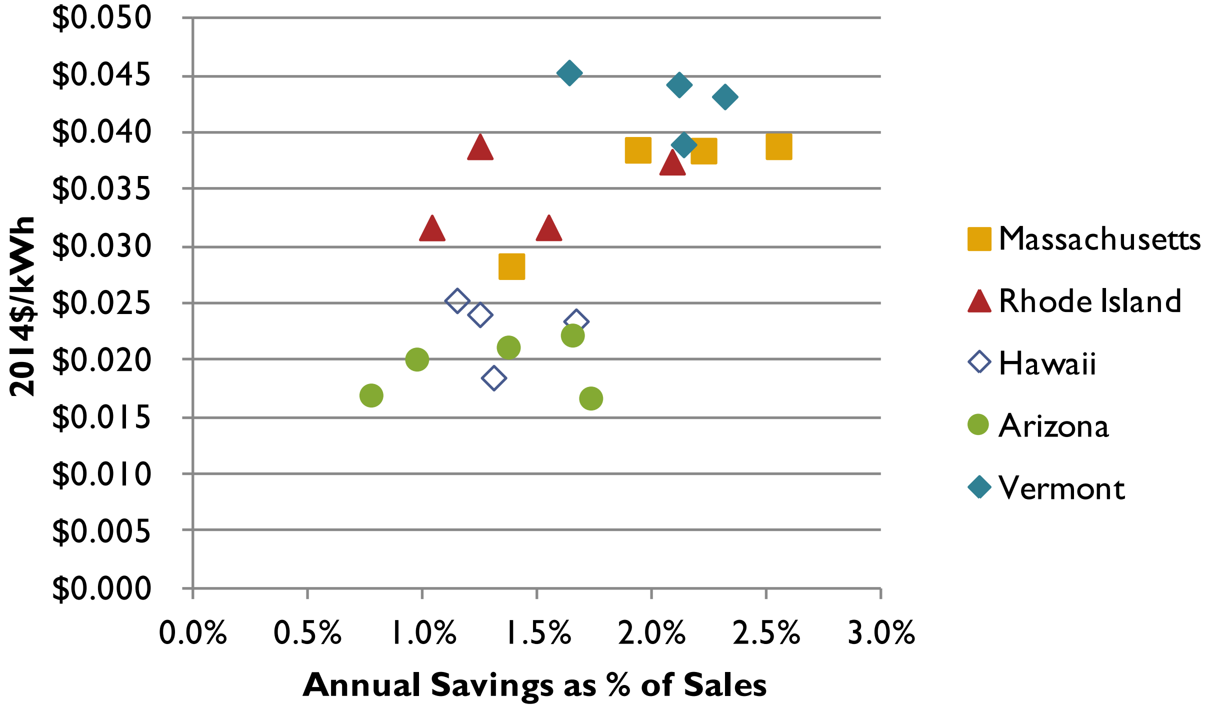
NWPCC 7th Power Plan (Draft)



Sources: NWPCC (July 2015) "Proposed Scope and Schedule for Scenario and Sensitivity Analysis", available at http://www.nwcouncil.org/media/7149376/p3.pdf.

Example from Leading States on Costs and Savings Over Time

Energy Efficiency Cost of Saved Energy ($/kWh) and Annual Savings (% of Sales) from 2009 to 2014



Sources: (1) Molina. (2014). The Best Value for America's Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs, ACEEE (2) ACEEE State Energy Efficiency Scorecard reports in 2011, 2012, and 2013. (2) Geller, et al. (2014). Maintaining High Levels of Energy Savings from Utility Energy Efficiency Programs: Strategies from the Southwest. (3) Hawaii Energy Annual Reports in 2012 to 2014 National Grid Electric and Gas Energy Efficiency Programs Year-End reports in 2010 to 2013. (4) Massachusetts program administrators' data obtained from Jeff Loiter, a member of the Massachusetts Energy Efficiency Advisory Council consultant team on April 2, 2015.

TVA 2015 IRP

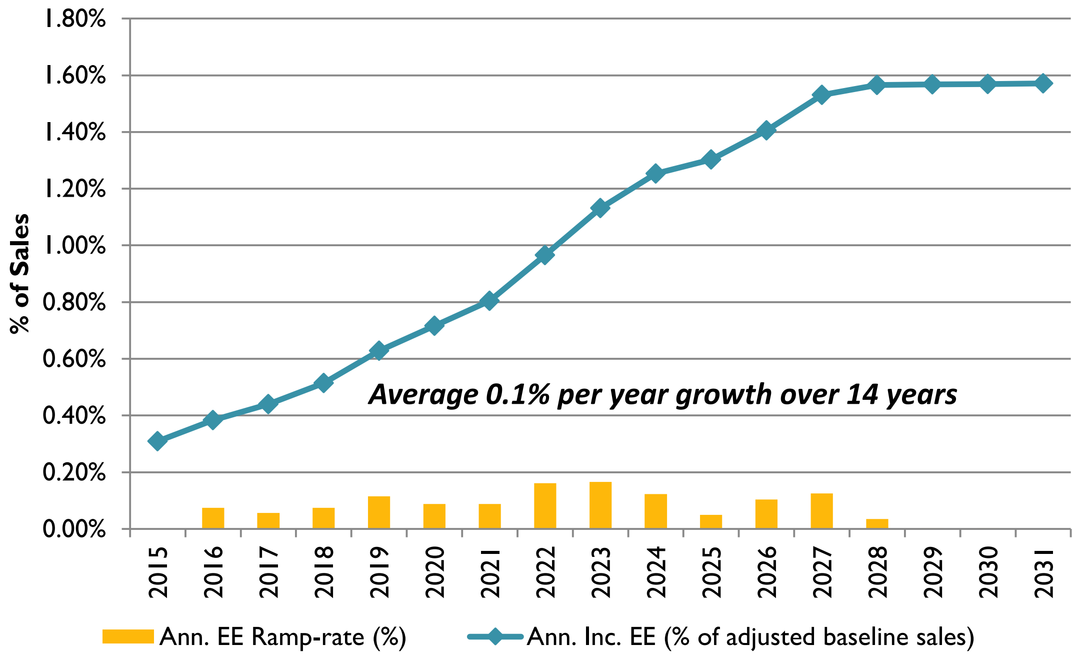
- EE as a competitive resource in System Optimizer. Modeled in three blocks.
- Results are suboptimal due to several conservative constraints.
  - Constraint #1: ann. growth, ann. energy and capacity savings, and unit availability schedules.

	RES	COM	IND
MW per Block	10	10	10
GWh per Block	50	59	72
Growth Rate (Yr 1 - 5)	25%	25%	25%
Growth Rate (Yr 6 - 15)	20%	20%	20%
Growth Rate (Yr ≥ 16)	15%	15%	15%
Max Inc. Block per Yr. Tier 1	9	4	4
Max Inc. Block per Yr. Tier 2	7	4	2
Max Inc. Block per Yr. Tier 3	8	4	2
Max Inc. Block per Yr. Total	24	12	8

Source: TVA (2015a) Integrated Resource Plan – 2015 Draft Report, p. 131.

TVA 2015 IRP

Implied, maximum annual incremental savings (% of sales) for “Strategy D - Maximize EE”

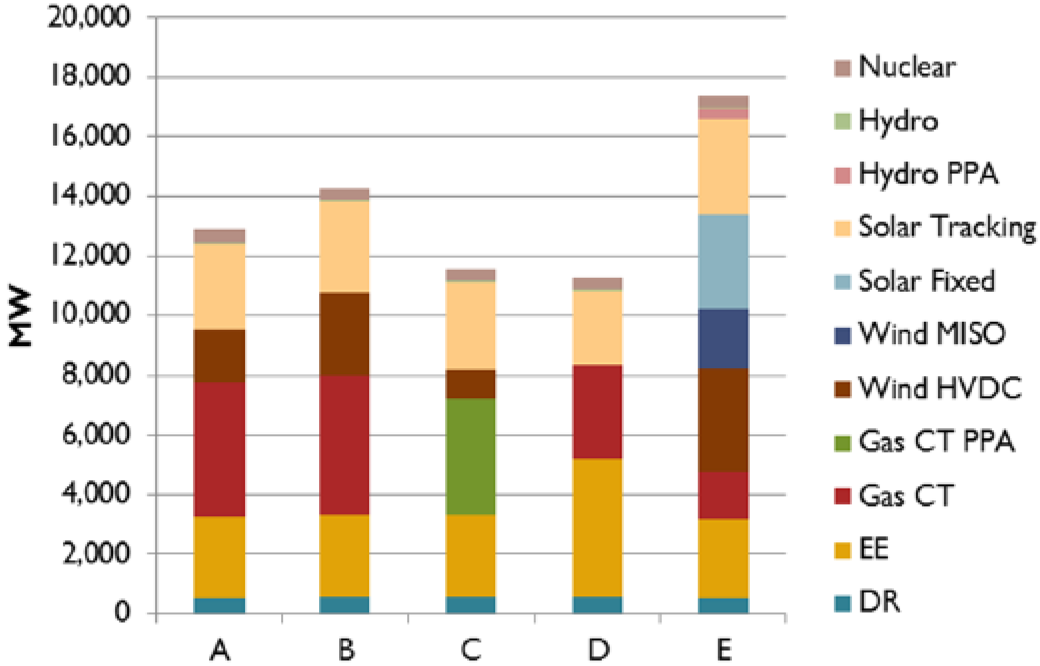


Source: Takahashi et al. (2015) Review of TVA’s Draft 2015 Integrated Resource Plan. p. 12. Synapse Energy Economics.

TVA 2015 IRP

- Constraint 2: Expensive measure costs. Future measures (Tier 2 and 3) are overly expensive up to 200% of the current measures (Tier 1)

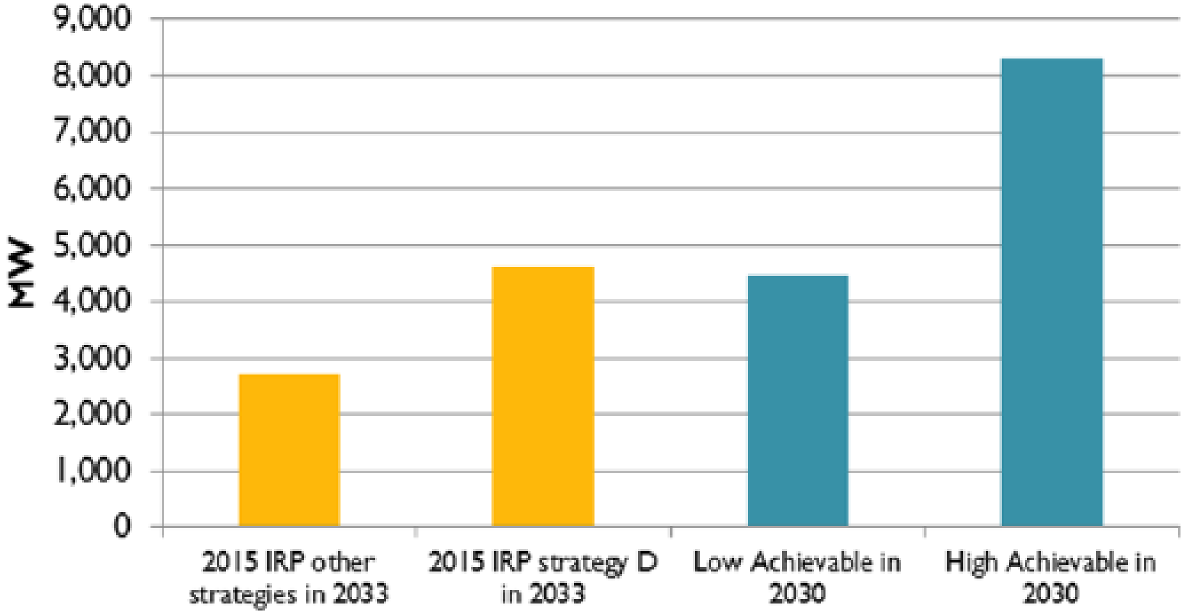
TVA DRAFT IRP Capacity Expansion Results under the Reference Scenario by Strategy



Source: TVA (2015b) Integrated Resource Plan - 2015 Draft Supplemental Environmental Impact Statement, Chapter 6.

TVA 2015 IRP

- Comparison of TVA Draft IRP Modeling Results on Efficiency with EnerNOC 2012 potential study for TVA



Source: Takahashi et al. (2015) Review of TVA's Draft 2015 Integrated Resource Plan. p. 14. Synapse Energy Economics.

NWPCC 2010. Sixth Power Plan

- NWPCC:
  - Has a long history of developing comprehensive IRPs
  - Runs an extensive but relatively transparent process to model resources
  - Models EE as a competitive resource in the Regional Portfolio Model
- NWPCC comprehensively values the benefits of energy efficiency including:
  - Value of avoided T&D
  - Risk avoidance value
  - 10% conservation credit (relative to avoided generation, and T&D)
  - Carbon costs
- NWPCC actively seeks new information and incorporates emerging measures:
  - Consumer electronics and LED
  - Heat pump water heater and mini-split heat pump
  - Utility distribution measures

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Questions?

Contact

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