RAP® Energy solutions for a changing world

Value of Solar and Grid Benefits Studies

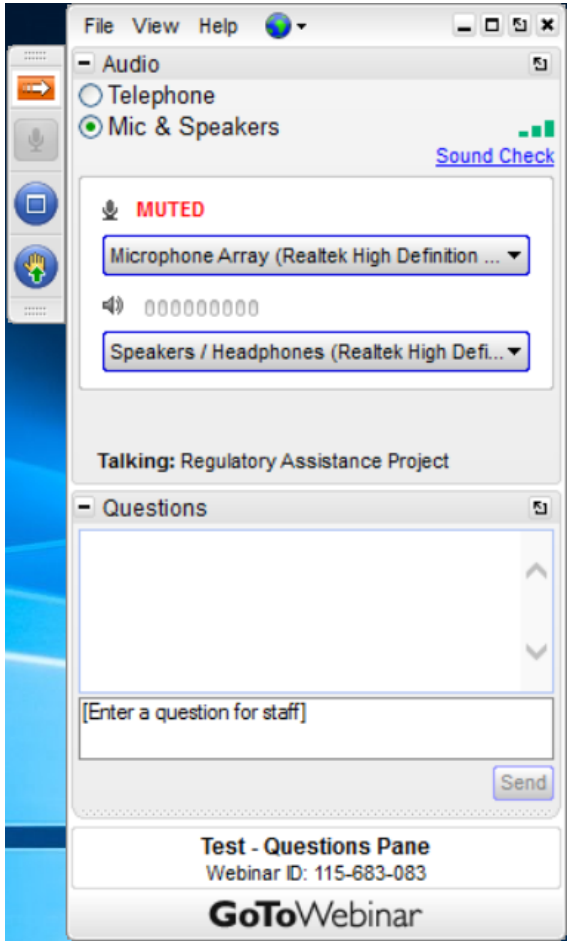
Alternative Approaches and Results

Presented by Jim Lazar, RAP Senior Advisor
and
Dr. Thomas Vitolo, Synapse Energy Economics Senior Associate

September 22, 2016

Questions?

Please send questions through the Questions pane



Our Experts

Jim Lazar

- RAP Senior Advisor (since 1998)
- Author of *Electricity Regulation in the US: A Guide,* and 11 other handbooks.

Dr. Thomas Vitolo

- Synapse Energy Economics Senior Associate
- PhD, System Engineering
- Expertise in VoS, PURPA, intermittent integration, munis

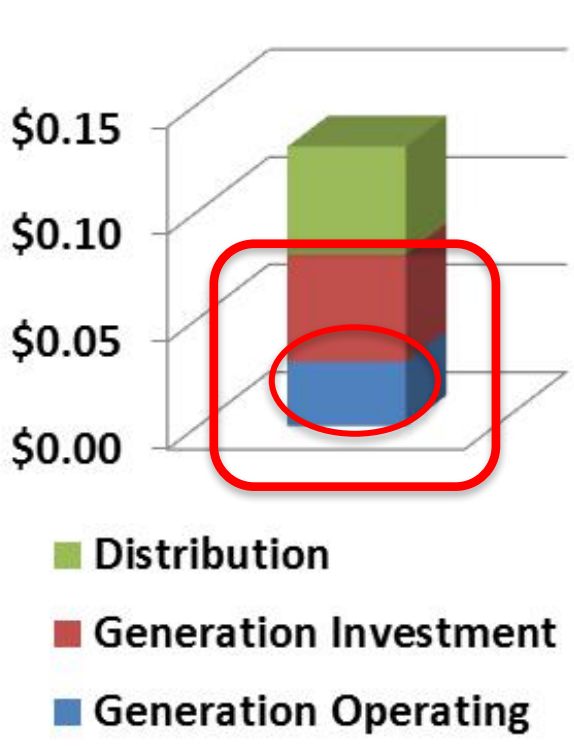
Overview of Net Metering and Value of Solar Ratemaking

- Net-Metering:
  - Simple
  - No new metering required
  - Typically not TOU based
  - Considered an infant-industry subsidy by many
- Value of Solar Analysis
  - Can be narrow (short-run) or broad in scope

Two Views of Cost Recovery

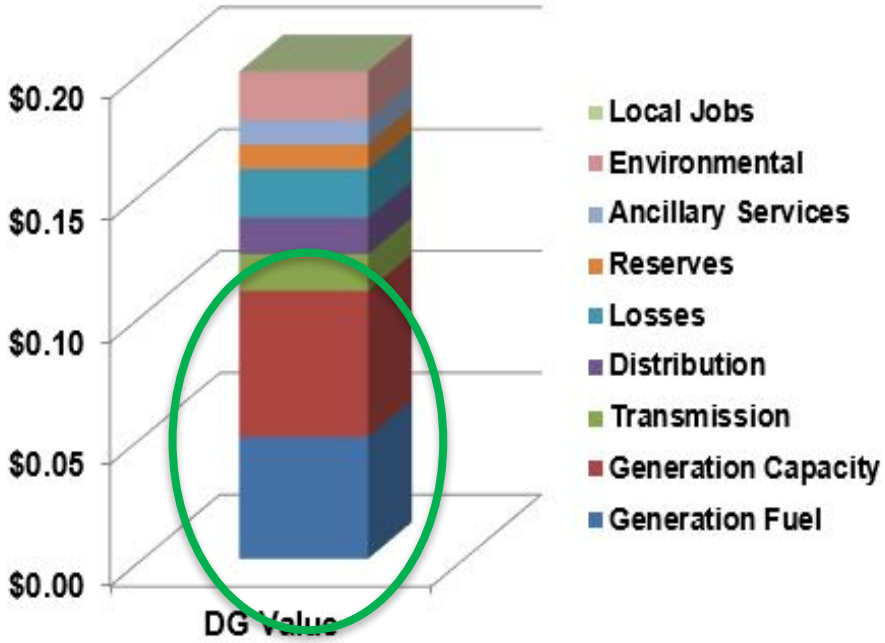
Traditional Utility View

- DG customer "uses" the grid and should pay for it;



Solar Advocate View

- Value of distributed resource is greater than the than retail rate;



Range of Solar Valuation Studies

- Narrow studies
  - Short-run cost savings from solar additions
- Long-Run studies
  - Generation capacity and energy value
- Broad Utility Sector Studies
  - Generation, transmission, distribution, and other utility system values.
- Extensive Societal Studies
  - Utility system and societal benefits

Categories of Costs Considered

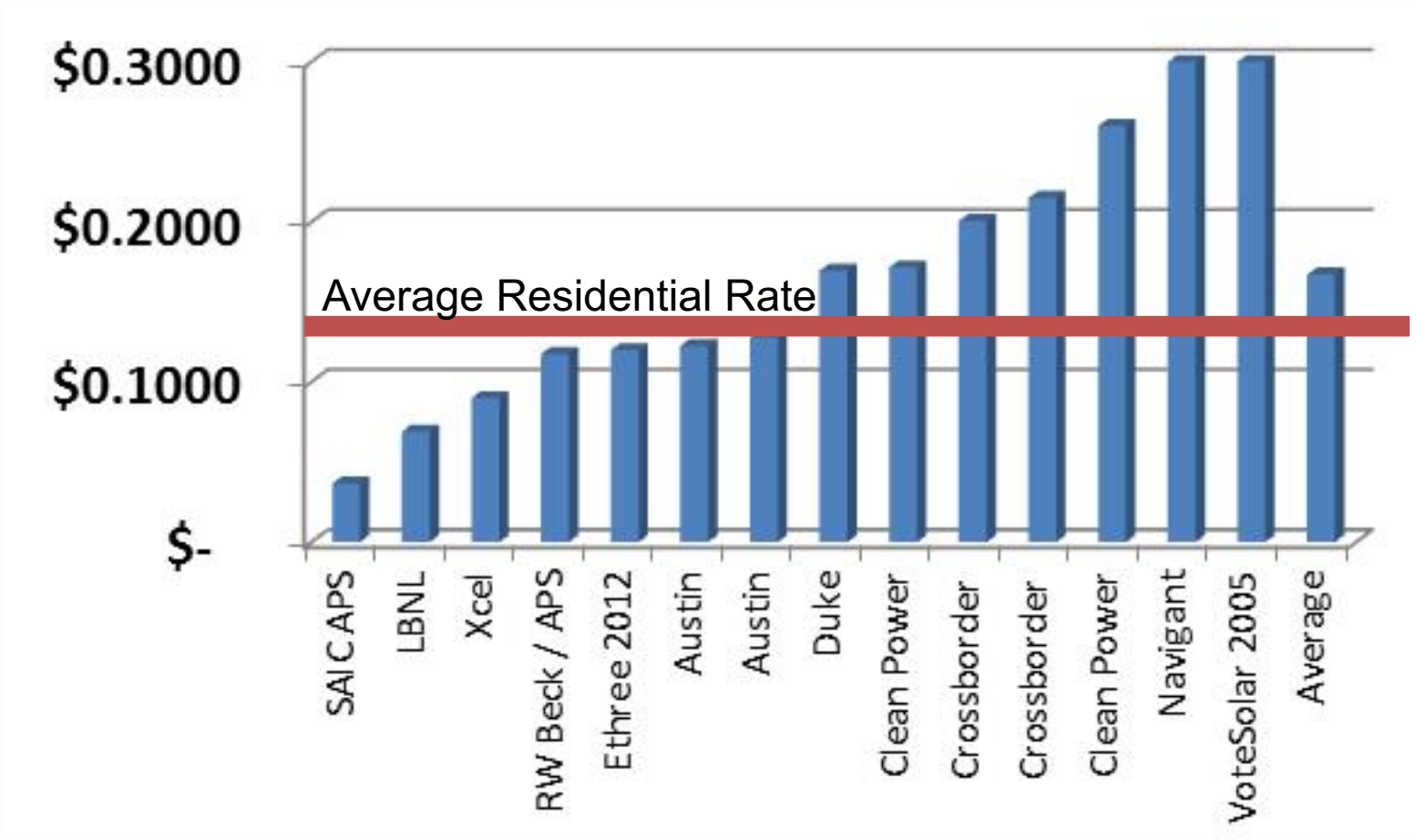
Type*	Variable	Capital	Externalities	Societal
Narrow	X			
Long-Run	X	X		
Broad Utility	X	X	x*	
Extensive	X	X	X	X

* Most utility studies consider only a subset of externalities, those that affect the utility sector.

Some Costs Treated Very Differently

- Production Capital Costs
- Transmission Capital Costs
- Distribution Capacity Credit
- Marginal or Average Line Losses
- Current or Future Environmental Costs
- Fuel Cost and Fuel Supply Risk
- Macroeconomic Effects

RMI Survey Of Multiple Studies: Range: $0.04 - $0.30/kWh



Narrow Studies

- Consider short-run marginal cost avoidance only
  - Fuel and purchased power
  - Line losses
  - Out of pocket environmental compliance
- Some look only at power supply

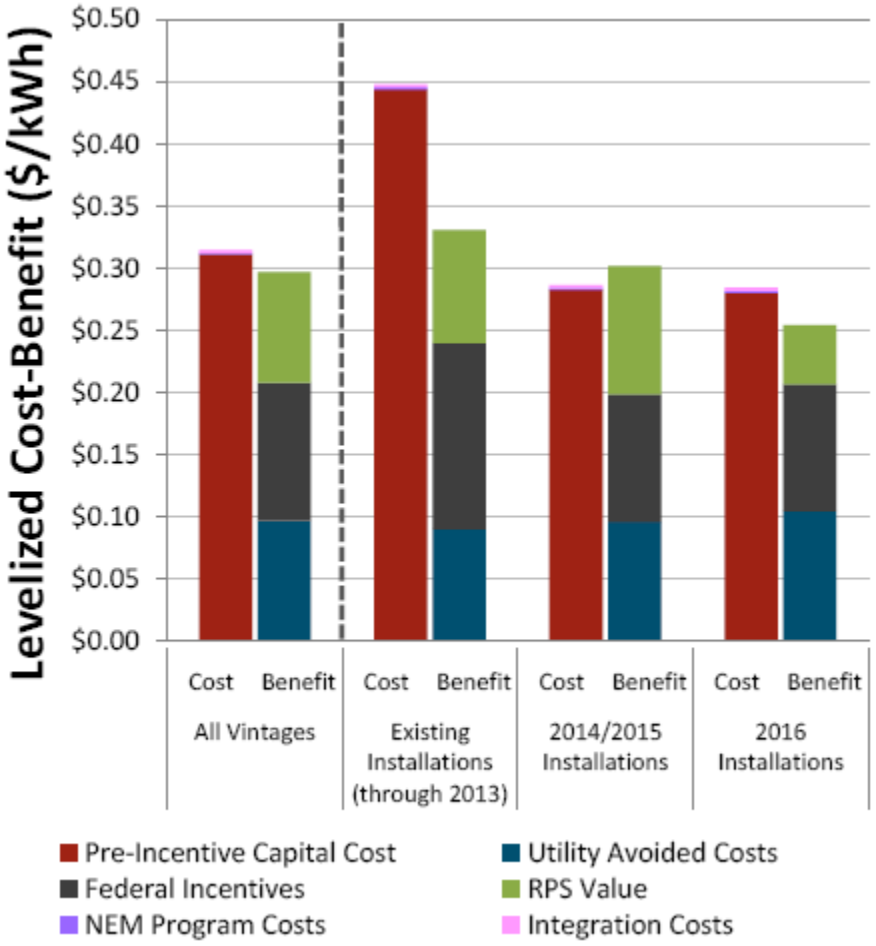
Example Narrow Study
NV Energy 2015

- Utility has adequate capacity
- Fuel savings are primary short-run benefit
- Commission ordered 8-year phase-down of NEM pricing
- Modified rate design for existing solar:
  - Higher fixed charge
  - Lower variable charge
- Update: Existing customers to be grandfathered

Broad Utility Sector Studies

- Nevada (E3)
- Mississippi (Synapse)
- Maine (Clean Power Research)
- Austin (Austin Energy)
- Minnesota (State Energy Office)

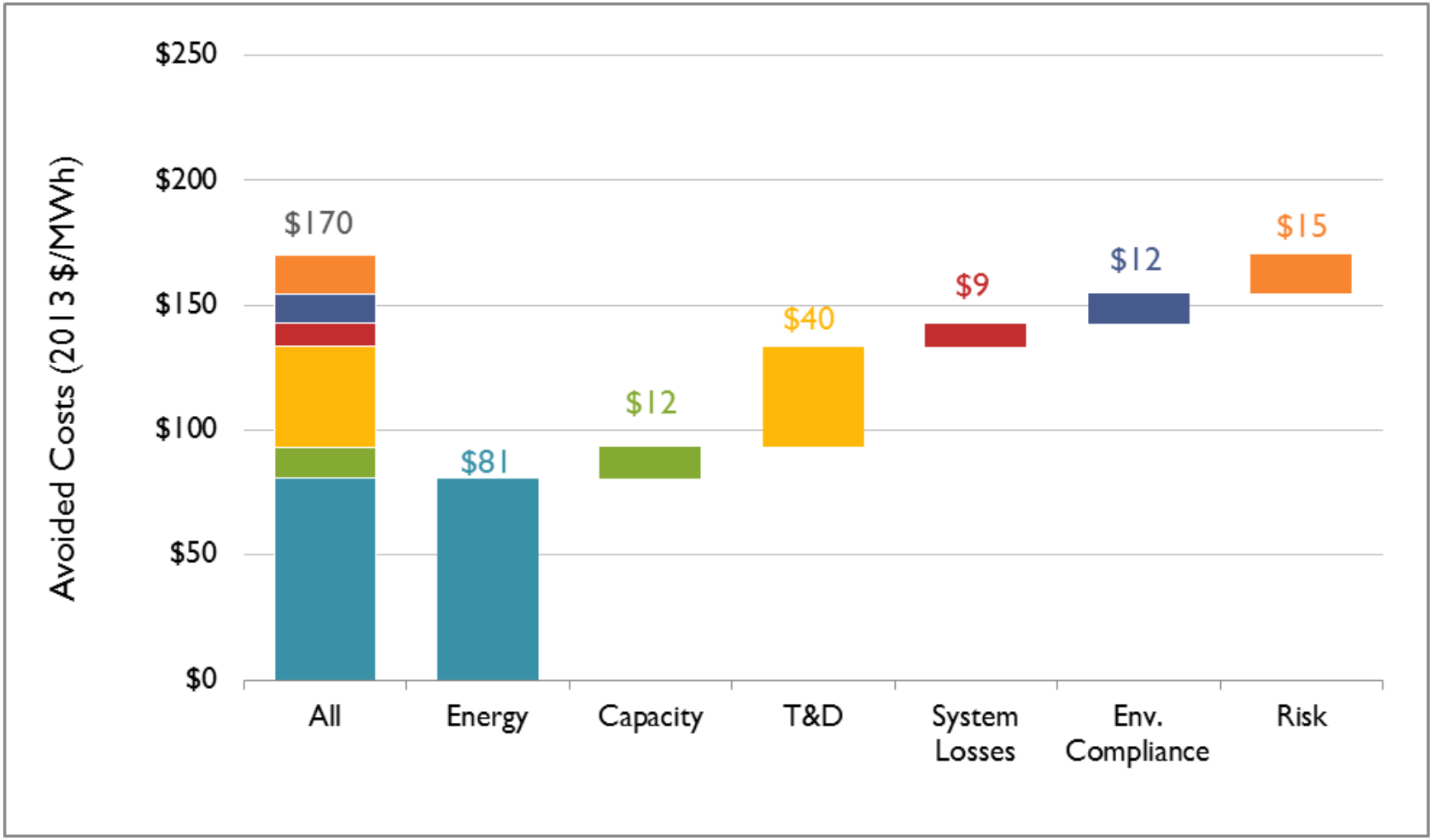
Long Run Studies: E3 for Nevada Costs and Benefits Very Close



Net Metering in Mississippi

- Synapse Energy Economics prepared the analysis for the Mississippi Public Service Commission, Docket No. 2011-AD-2
- Released September 19, 2014
- http://www.synapse-energy.com/project/mississippi-net-metering-study

Mississippi: 25-Year Levelized Avoided Costs



Mississippi VoS: 2014 and 2016

Energy

- 2014: Avoided costs dominated by oil CTs in early years
- 2016: Fuel forecasts likely lower than 2014, two fewer years of oil-fired CTs

Generation Capacity

- 2014: Linear increase from $6 kW-yr to net CONE over 25 years
- 2016: MISO South Zones 8-10 cleared at $1.09 kW-yr

Mississippi VoS: 2014 and 2016

Transmission & Distribution Capacity

- 2014: In-house estimation of $33 kW-yr transmission + $55 kW-yr distribution, adjusted for capacity credit
- 2016: Still no MS utility-specific studies to my knowledge

System Losses

- 2014: weighted average system losses using Entergy- and MS Power-specific data and national average for rest-of-state
- 2016: Using 2014 marginal line losses bumps benefit from $9 MWh to $16/MWh. Still no MS utility-specific PV-temporal utility-specific studies to my knowledge

Fn 1: Mississippi PSC, *Comments of the Mississippi Public Service Commission,* Dec 1, 2014.
http://watchdog.wpengine.netdna-cdn.com/wp-content/blogs.dir/1/files/2015/08/Comment-MS-PSC.pdf

Mississippi VoS: 2014 and 2016

Environmental Compliance

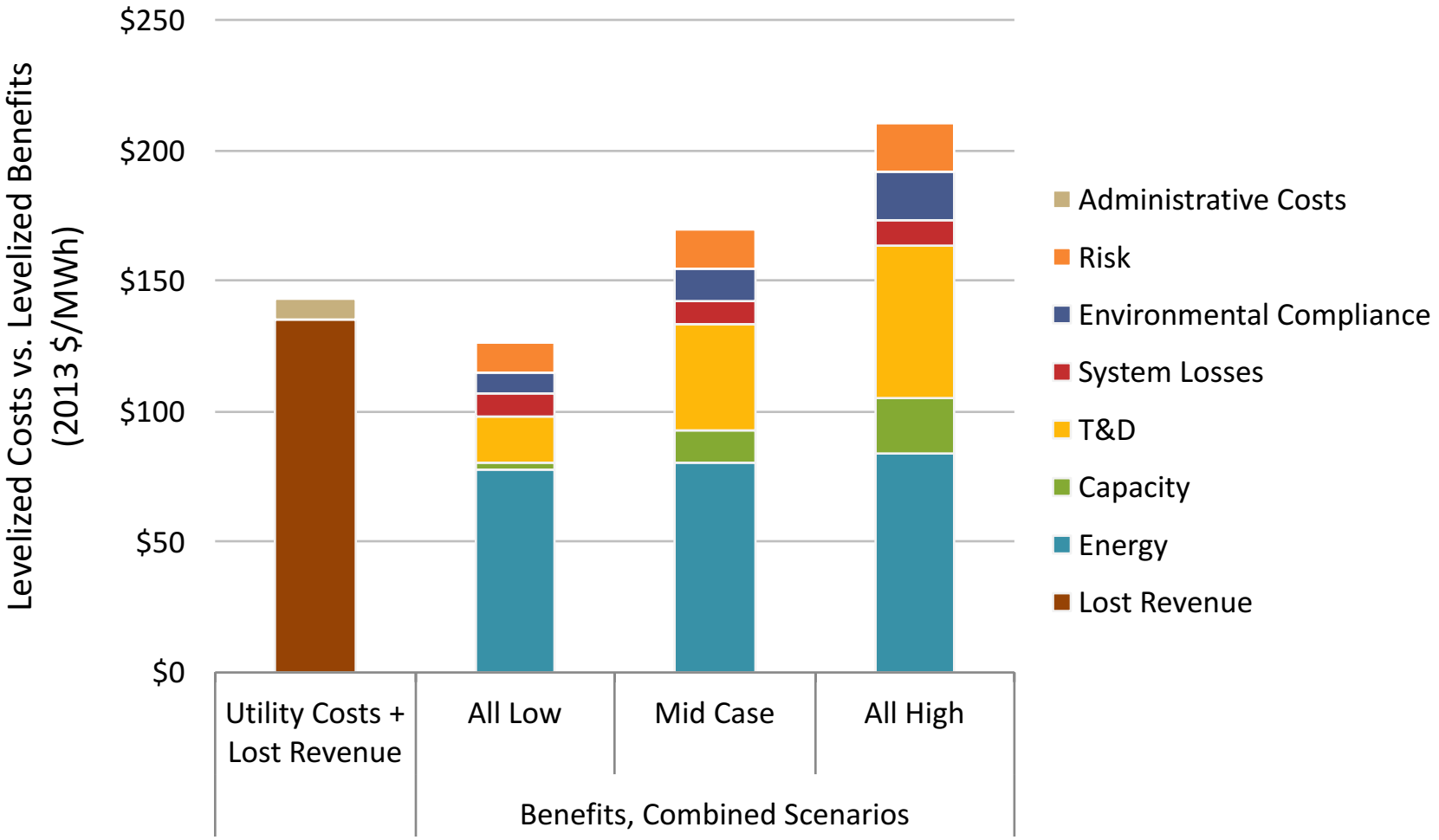
- 2014: CO_2 price only – Synapse Mid case ($15/ton in 2020, increasing linearly to $60/ton in 2040). SOx and NOx allowances embedded in avoided energy benefits.
- Dec 2014: MS PSC, citing Energy Ventures Analysis, stated residential bills to go up 35%, industrial rates 69% due to CPP.[1] Other predictions nowhere near as dire.

Avoided Risk

- 2014: 10% adder to all five other benefit categories
- 2016: A more finely tuned analysis perhaps more appropriate

Fn 1: Mississippi PSC, *Comments of the Mississippi Public Service Commission,* Dec 1, 2014.
http://watchdog.wpengine.netdna-cdn.com/wp-content/blogs.dir/1/files/2015/08/Comment-MS-PSC.pdf

Mississippi VoS: NEM Impact on Rates



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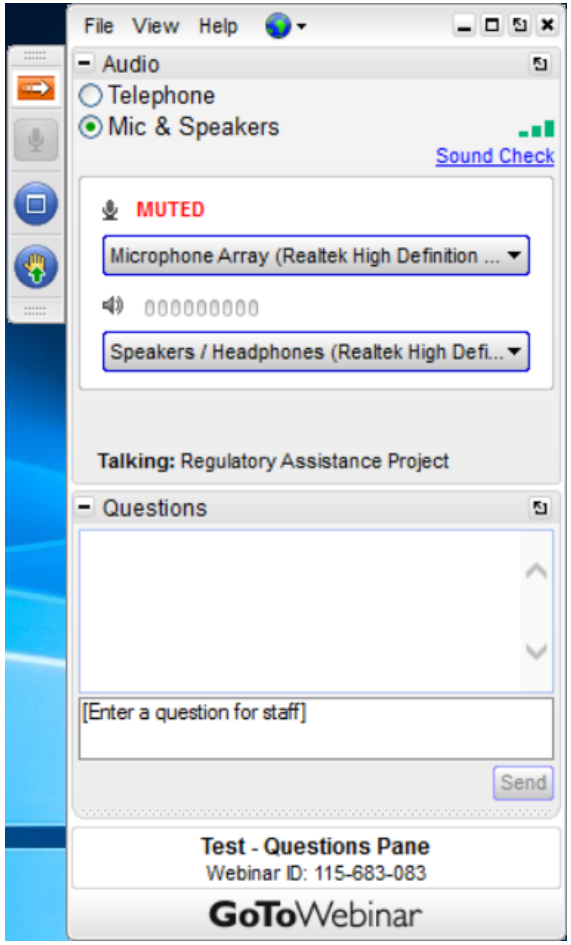
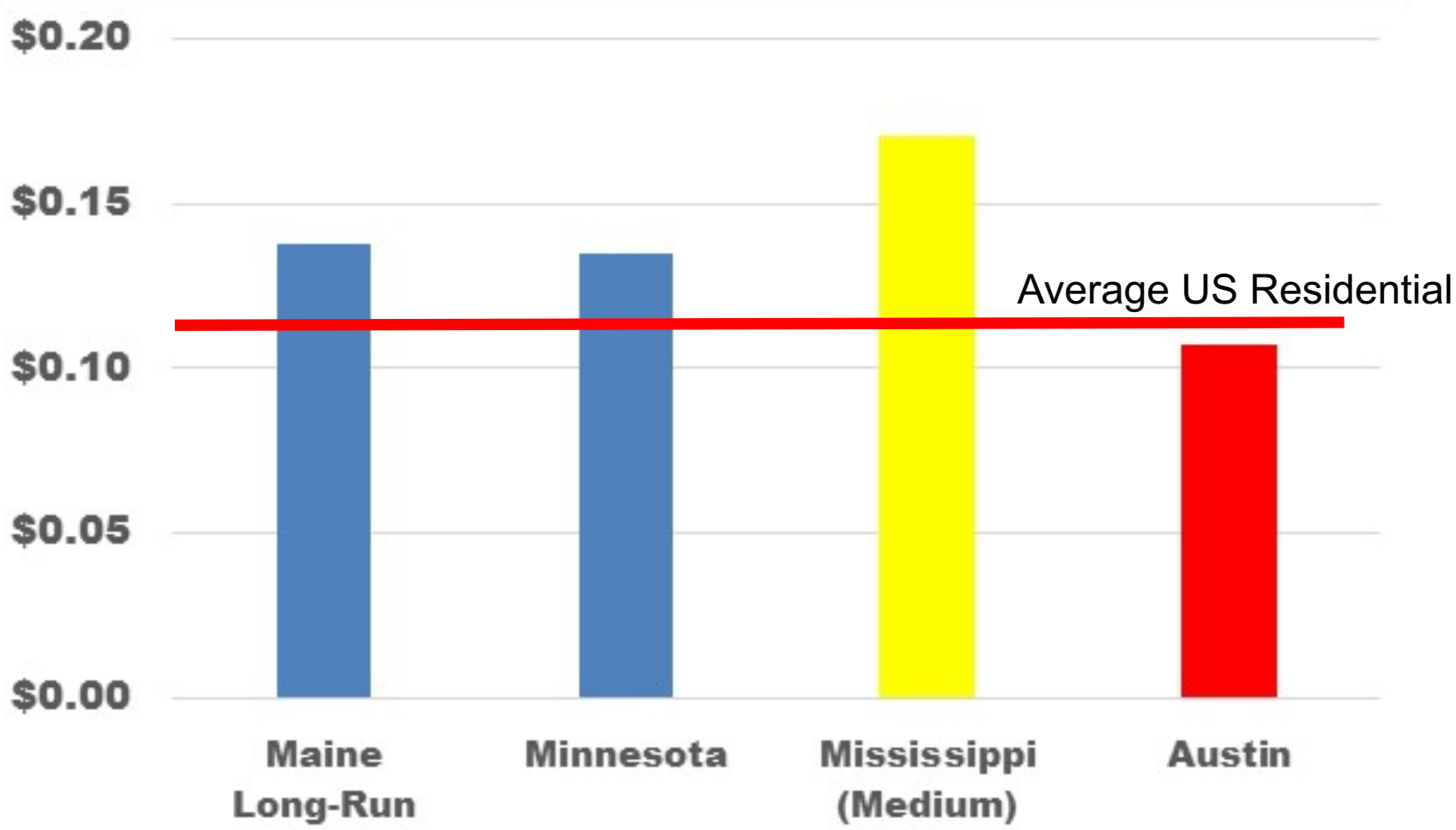


Broad: E3 Nevada vs Synapse Mississippi

- Included in E3
  - Generation
  - Transmission
  - Distribution
  - Losses
  - Avoided RPS
- Not Included in E3
  - Solar admin costs
  - Market Price Effects
  - Price Risk
  - Grid Support Services
  - Outage costs
  - Non-energy benefits

Broad Utility Sector Studies



Expansive Societal Studies

- Consider values in addition to those in the utility revenue requirement
  - Environmental benefit including future carbon costs
  - Local economic development
  - Value of energy independence
- Often show significant value generated for public even with full net-metering.

Crossborder Energy / Colorado

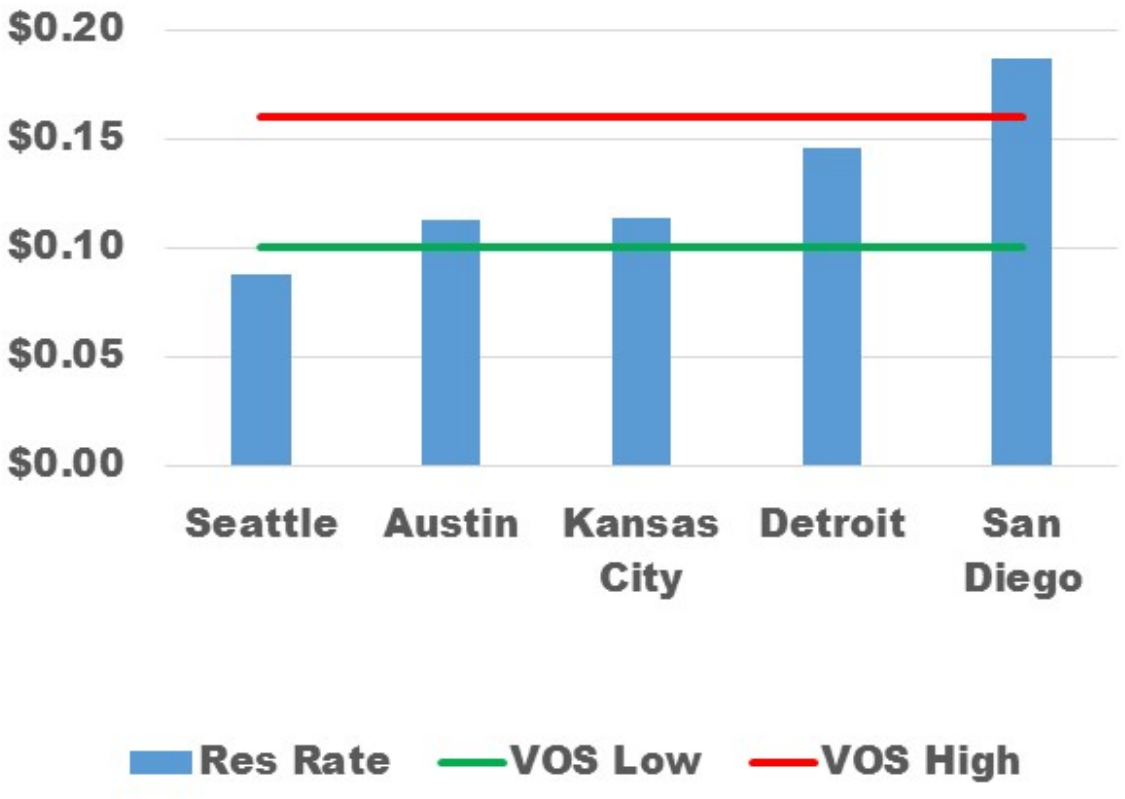
Benefits to PSCo Ratepayers	Fully Valued	Undervalued	Not Included
Energy			
Avoided energy (including fuel)	✓		
Avoided T&D line losses	✓		
Capacity			
Avoided generation capacity		✓	
Avoided T&D capacity and fixed O&M		✓	
Grid support services			✓
Financial			
Fuel Hedging	✓		
Avoided RPS or renewables costs			✓
Grid security and resiliency			✓
Environmental			
Air pollutants (NO_x, SO_x, PM, & CO_2)		✓	
Reduced water usage in power production			✓
Avoided land costs for generation or T&D			✓
Societal benefits (not direct ratepayer benefits)			
Job creation benefits			✓
Economic development, including local taxes			✓
Avoided health impacts			✓

Expansive Study: Colorado

Benefit/(Cost)	Low Gas	Base Gas	High Gas
	$/MWh	$/MWh	$/MWh
Avoided Energy Costs	35.80	52.10	76.10
Fuel Hedge Value	6.60	6.60	6.60
Avoided Emissions	27.40	27.40	27.40
Avoided Generation Capacity	50.60	50.60	50.60
Avoided Distribution	6.00	6.00	6.00
Avoided Transmission	18.00	18.00	18.00
Avoided Line Losses	4.70	6.20	8.30
(Solar Integration Costs)	(0.50)	(1.80)	(4.40)
+10% for Societal Benefits	14.90	16.50	18.90
Total Net Benefits/(Costs)	163.50	181.60	207.50

An Important Difference: High-Cost vs. Low-Cost Utilities

- Many utilities have low rates due to embedded low-cost resources.
- The marginal costs may be similar to those for higher cost utilities.



Things are a Little Different in Hawaii

Hawaii: Changing Value As Solar Installations Become More Prevalent

- Net metering until 2015 @ ~$.30/kWh
- Shifted to a marginal fuel credit @ ~$.15/kWh for limited **new** "grid supply" installations.
- By 3rd Quarter 2016, no new grid-supply systems permitted – only "self-supply" w/o backfeed.

Half of System Peak in Maui

Table 3. HECO Companies' Net Energy Metering Program Capacity and Enrollment

Capacity (MW)	**HECO**	**HELCO**	**MECO**
Installed or Approved	327.9	73.3	88.8
In the Queue	17.3	5.1	11.9
Total	**345.2**	**78.4**	**100.7**
Total NEM Customers	51,680	11,549	12,893
System Peak Load (MW)	1,165	188	191
NEM % of All Customers	17%	14%	18%
NEM % of System Peak	**30%**	**42%**	**53%**

Peak Load Impacts May Be Limited

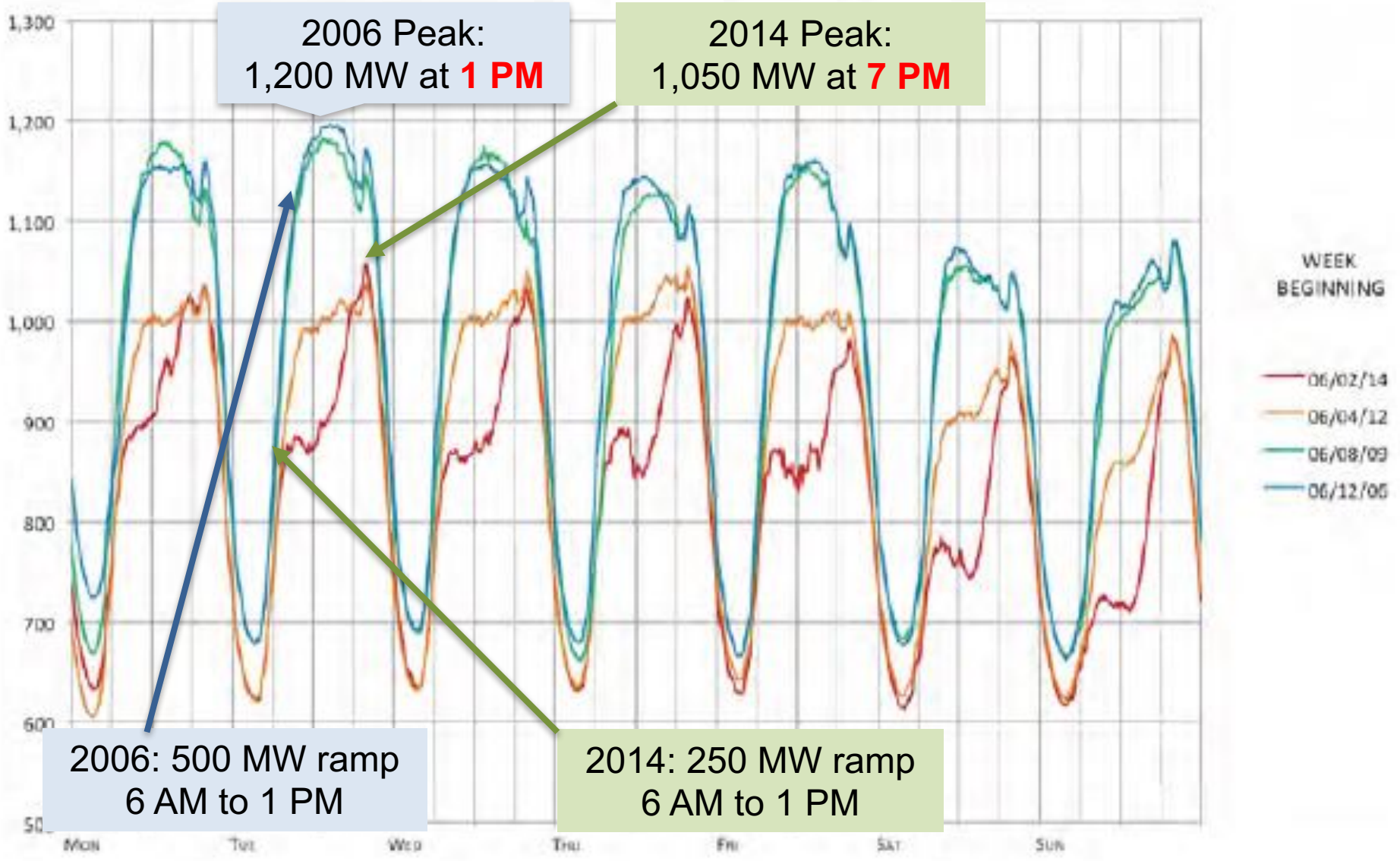
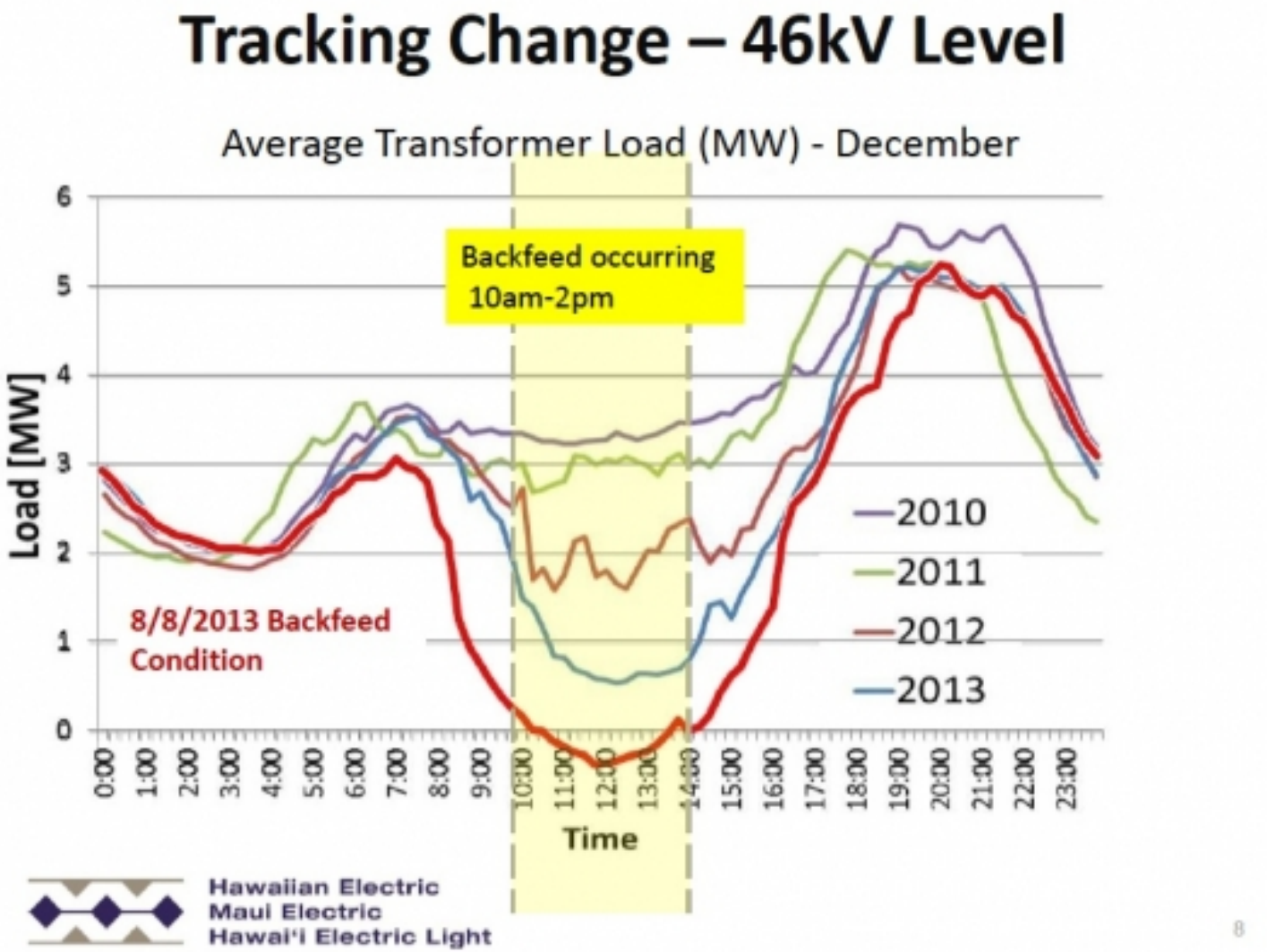


Figure 1-7. O'ahu System Load Profiles, 2006–2014

Source: Hawaiian Electric Co

Circuits and Substations "Running Backwards"



Discussion / Q&A

Key Takeaways

- The answer you get depends on the question you ask.
  - Short-run or long-run?
  - Utility direct effects only?
  - Utility direct and future utility effects?
  - All societal effects?
  - High PV saturation utilities are different
  - Low-cost utilities: >NEM may be needed
- Valuation of T&D, risk avoidance and environmental costs are important.

Additional Resources at
Value of Solar Center for Excellence
http://voscoe.pace.edu

About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power sector. RAP has deep expertise in regulatory and market policies that:

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- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

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- 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