Energy Tariff Experts LLC

Understand Cost, Make Better Decisions

Presentation to ISO-NE CLG

October 9, 2015

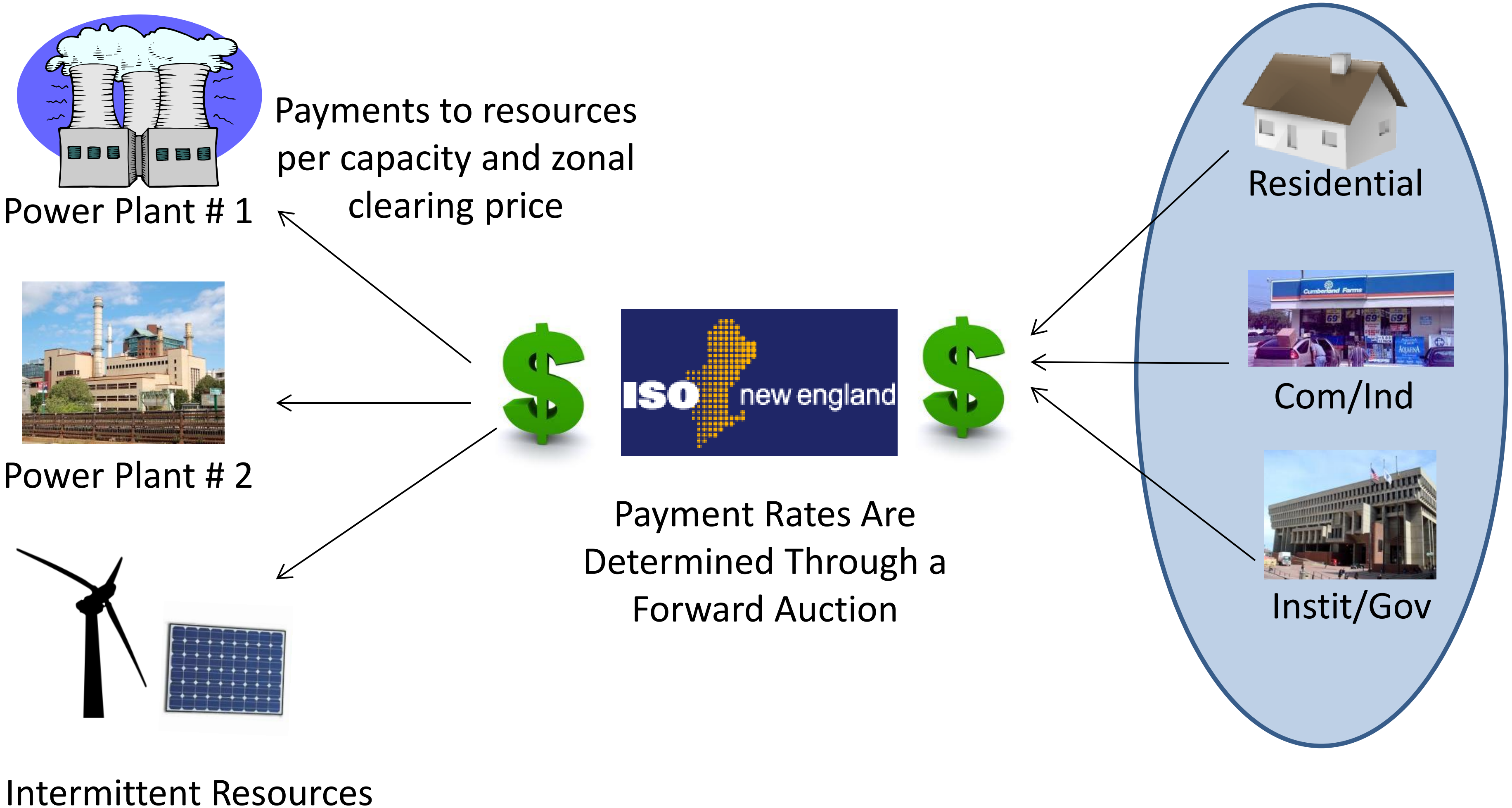
Agenda

- Brief Overview of Capacity Markets
- ISO-NE Historic Peak Load Days
- Customer ICAP Tags
- Capacity Charges to End Use Customers
- Output Profiles for Wind & Solar
- ISO-NE Forecast Growth of Renewables
- Assignment of Capacity Ratings to Intermittent Renewables
- Missing Money & Cost Impact of Increasing Intermittent Renewables
- Summary

How Do Deregulated Markets Incent New Generation?

(and keep existing generation)

Capacity Gets Paid **Load Pays**



Highly Abridged History of the FCM

- 2003 — Standard Market Design
- 2004
- 2005
- 2006 — LICAP Settlement Agreement; Transitional Capacity Pricing
- 2007
- 2008 — First Forward Capacity Auction
- 2009
- 2010 — Commencement of operations under FCM rules
- 2011
- 2012
- 2013 — FCA 7 4 zones, NEMA price separation, & Footprint Power entry
- 2014 — FCA 8 No floor price, Market tightens, Brayton retirement
- 2015 — FCA 9 Sloped demand curve

Capacity procured via self supply, bilaterals, and monthly auction

Market in oversupply, auctions clear at floor prices, pro-rated payments

Historical Capacity Prices

Delivery Periods	Rest of Pool Prices $/kW/mo
12/06 – 5/08	$3.05
6/08 – 5/09	$3.75
6/09 – 5/10	$4.10
6/10 – 5/11	$4.50
6/11 – 5/12	$3.60
6/12 – 5/13	$2.95
6/13 – 5/14	$2.95
6/14 – 5/15	$3.209

Installed Capacity Requirement

ICR = Installed Capacity Requirement

CONE = Cost of New Entry

NICR = Net Installed Capacity Requirement

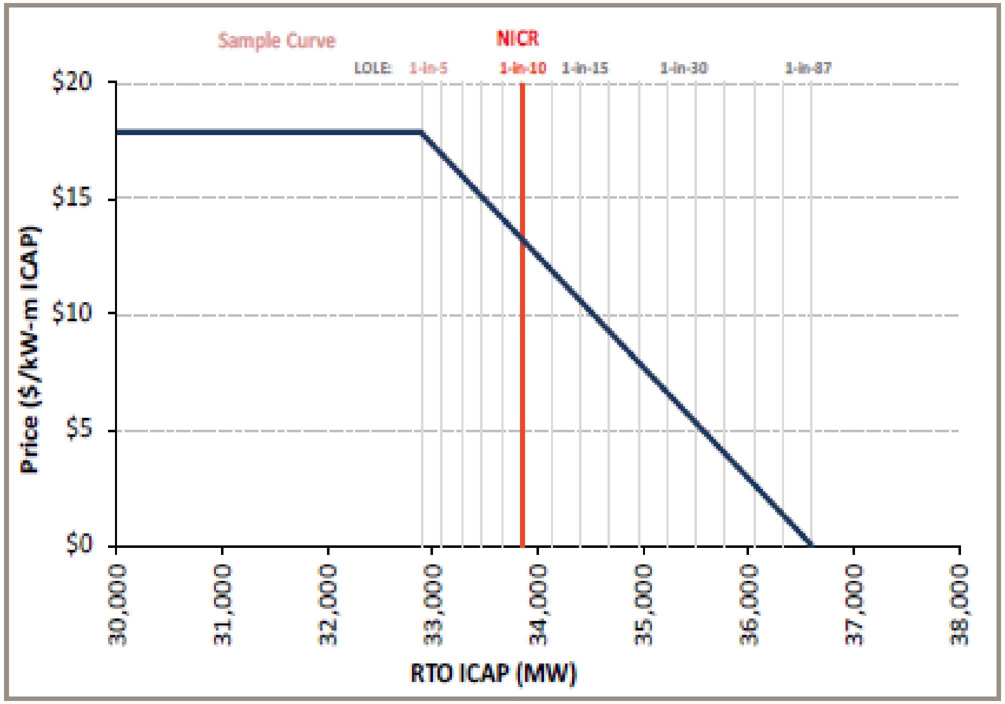
LOLE = Loss of Load Event

- Cap 1-in-5 = Net Cone x 1.6
  - Net Cone = $11.08 FCA9
  - Cap = $17.7
- At 1-in-87 price = $0
- At 1-in-10 (NICR) price = $13.2

Zonal sloped demand curves are likely for FCA 11

Technology specific Offer Review Trigger Price (ORTP) prevents subsidized resources from depressing prices (200 MW/yr exemption for renewables)

Example Sloped Demand Curve



Source: Graphic from ISO-NE FCM Training

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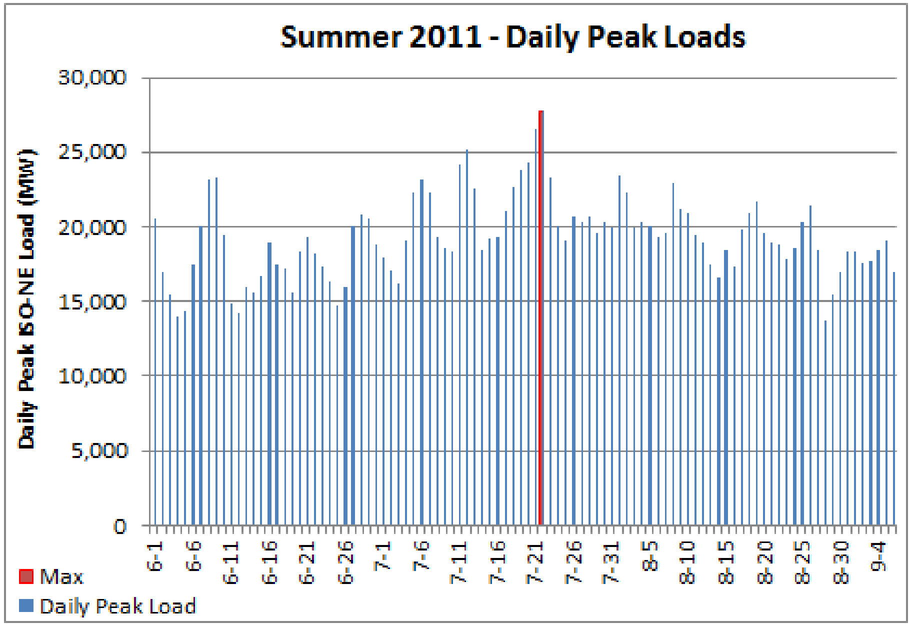
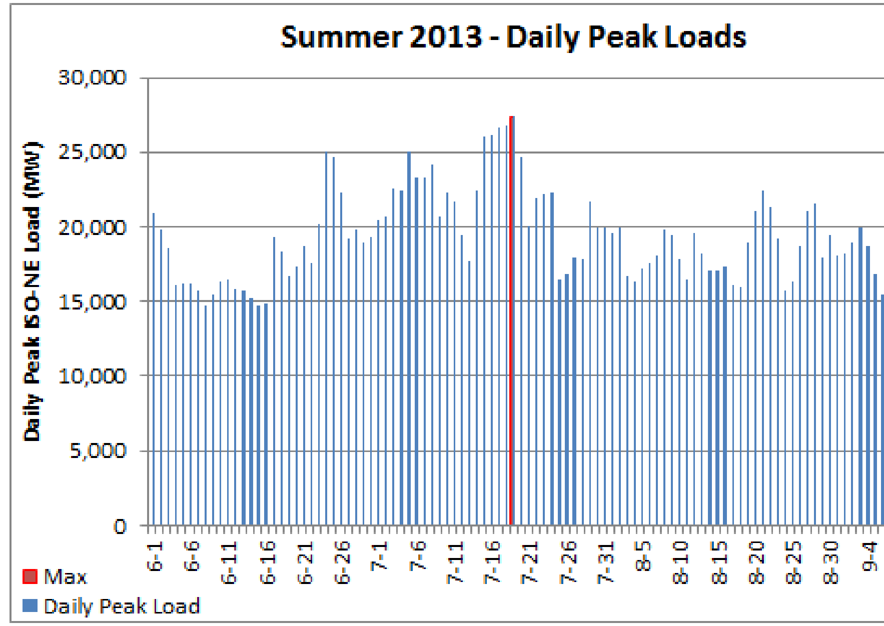
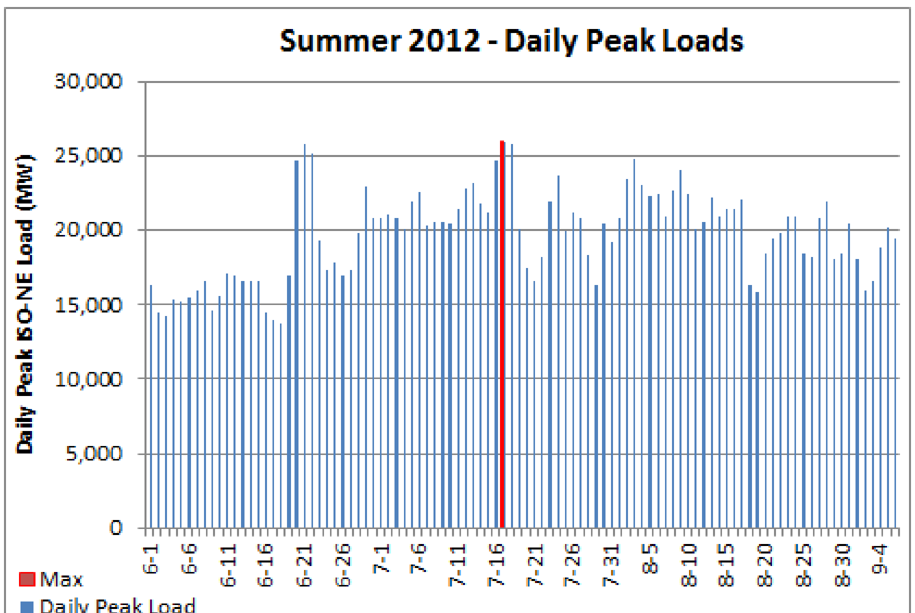
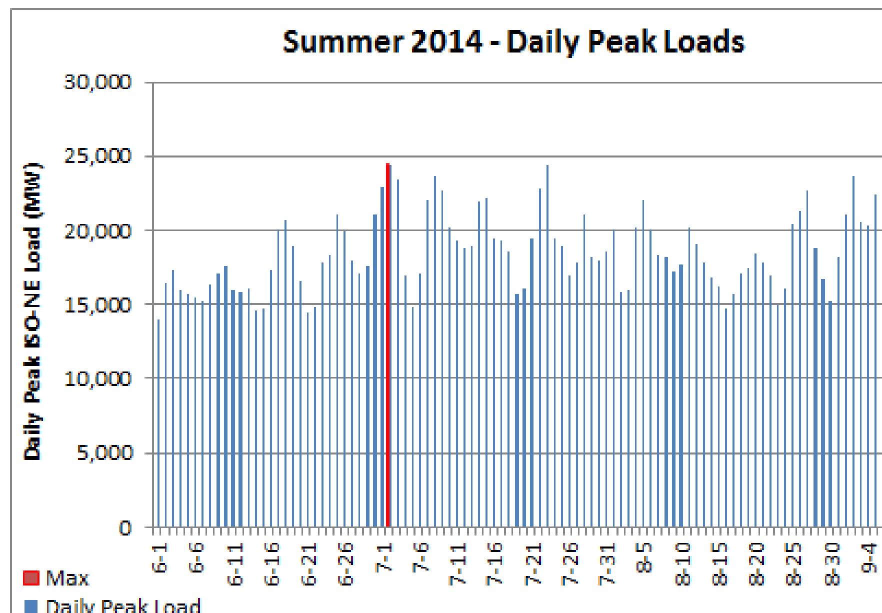
Historical ISO-NE Summer Peaks

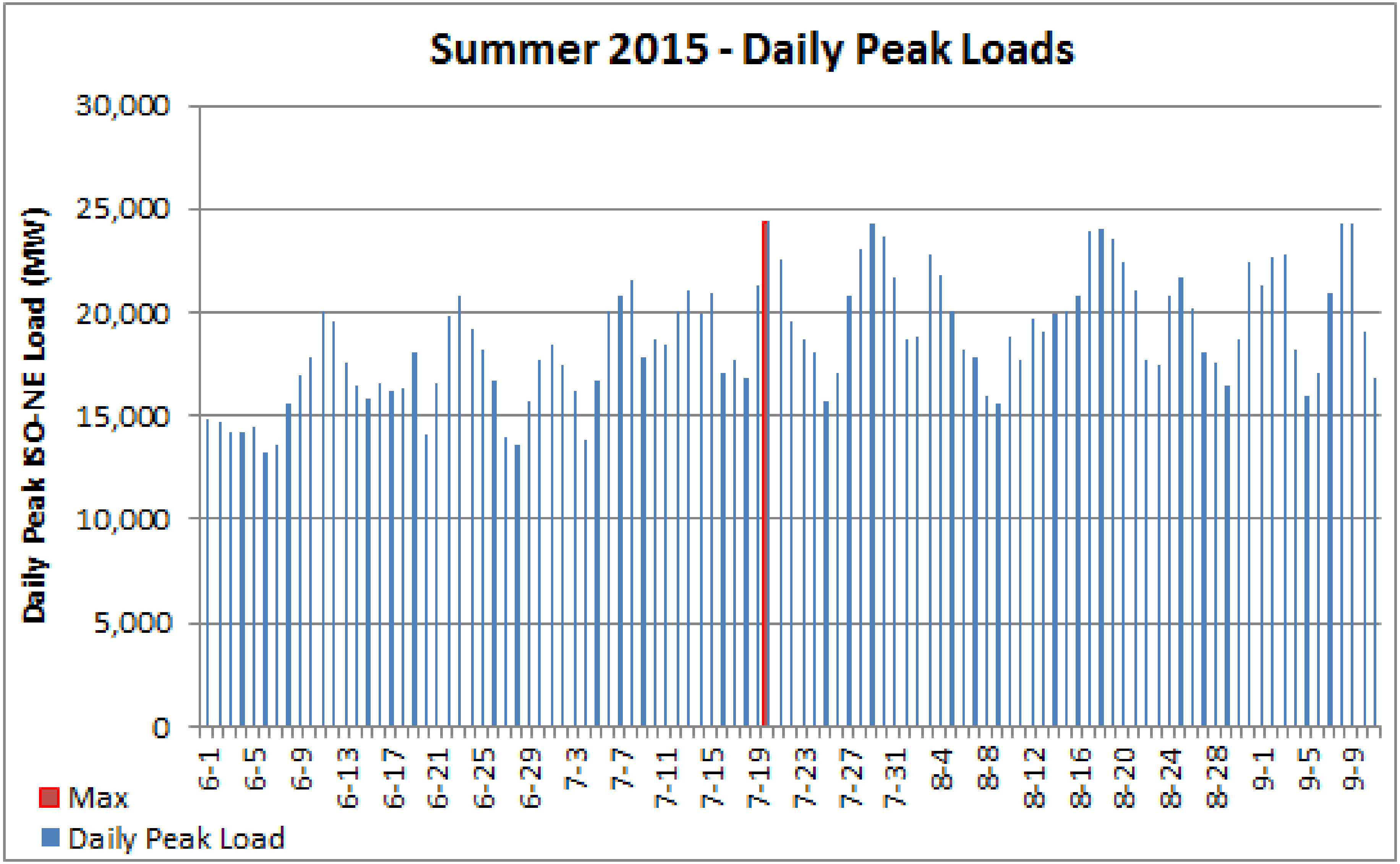








ISO-NE Peak Loads Summer 2015



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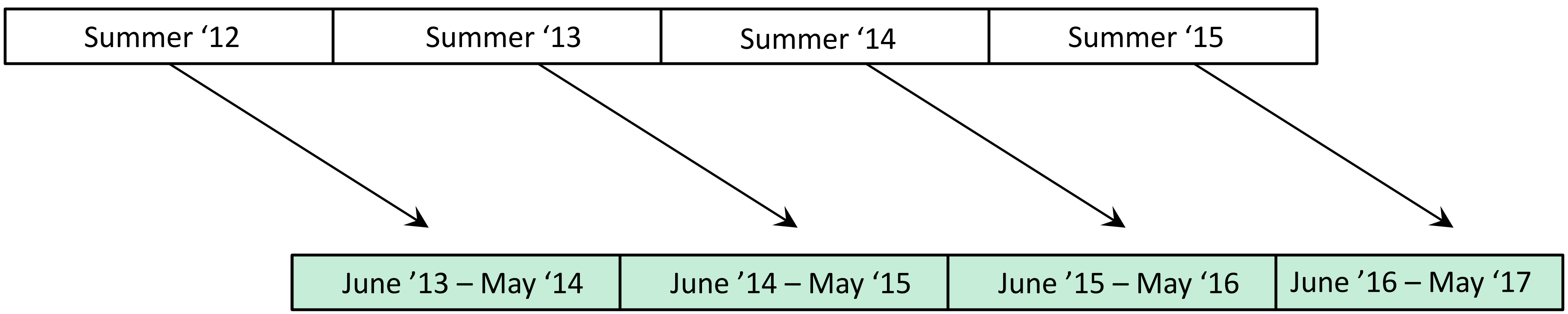
ICAP Tags Take Effect With a One Year Lag

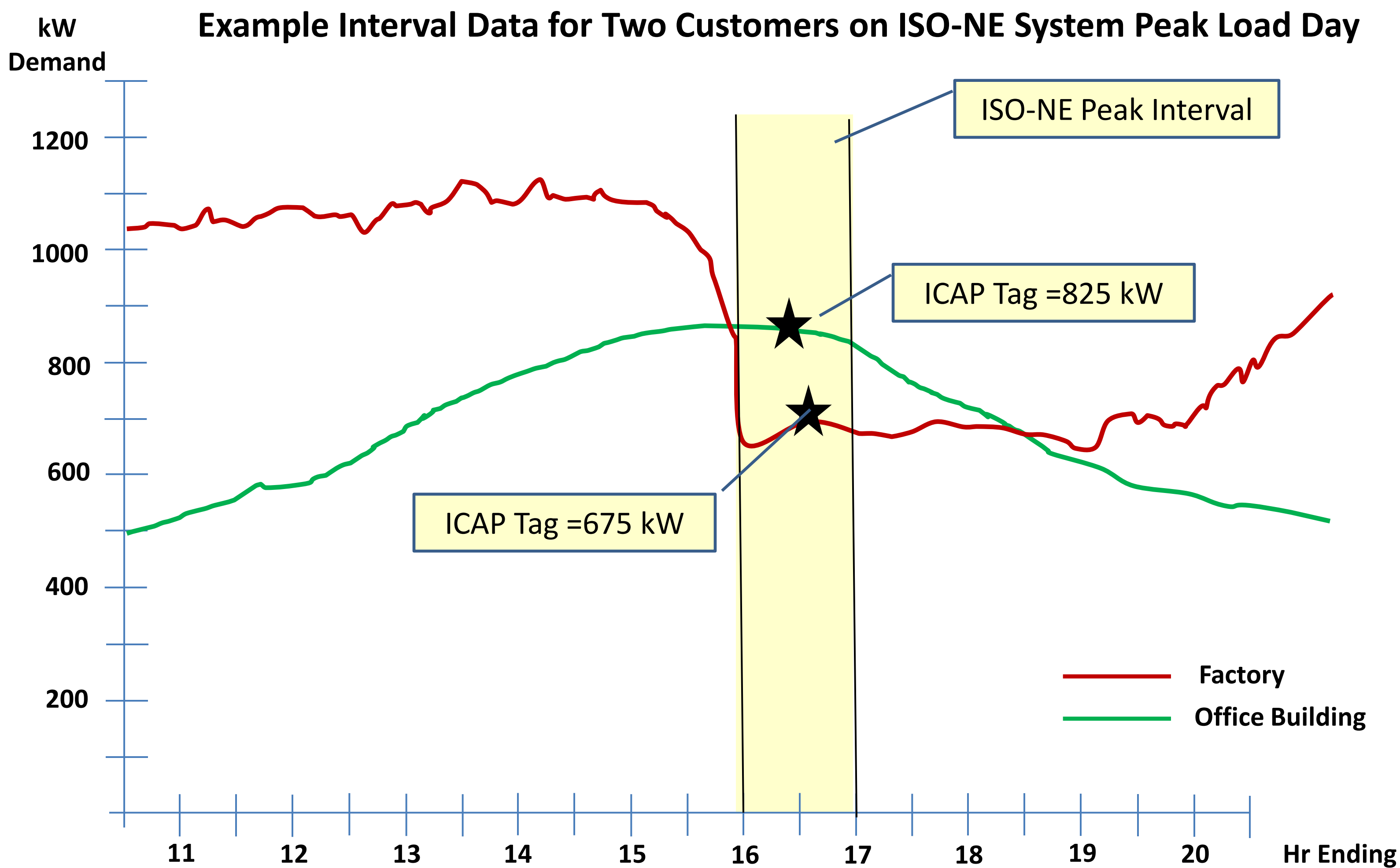
Customer ICAP Tag Set Per Interval Meter Data



Customer Payment Period for Associated ICAP Tag

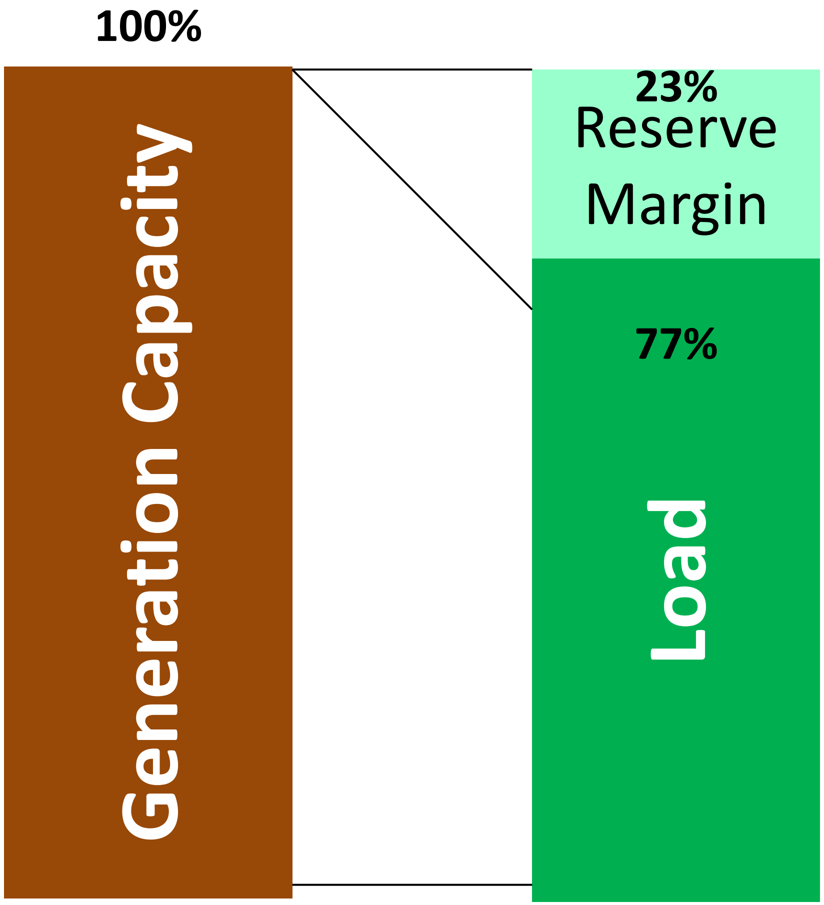
- This lag can be material for some customers (e.g., a factory that is idled could still owe capacity payments)
- Delayed payback for reducing ICAP tag

Customer ICAP Tag Determination



ISO-NE does not reconstitute loads for customers who reduce consumption during ISO-NE system peak hour so flexible customers have a cost reduction opportunity

Going From ICAP Tag to Customer Cost



- At any given time, there has to be more capacity than load
- Capacity receives a fixed price pre-determined by the FCM auctions
- The total amount required to be paid to generators must be collected from load
- The ratio between available generation and load is called the reserve margin

Customer Payment Calculation

$$\text{ICAP Tag} \times \text{Capacity Price} \times \frac{1}{(1 - \text{Reserve Margin})} = \text{Customer Capacity Payment Obligation}$$

Customer Capacity Charges Can Be Broken Out or Baked into Supply Price

Deregulated Supplier Invoice Excerpt Showing Capacity Pass-Through Charges for a Commercial Customer

Market Charges

Capacity Charge $/kW Day 09/15/2012 - 09/30/2012 (Capacity Tag 468.864 kW x Reserve Margin 1.23707 x Residual Adj 1 x 16 Days x Capacity Price)	9,280.31 kW Days at 0.0983667	$/kW Days	$912.87	
Capacity Charge $/kW Day 10/01/2012 - 10/15/2012 (Capacity Tag 468.864 kW x Reserve Margin 1.24345 x Residual Adj 1 x 15 Days x Capacity Price)	8,745.12 kW Days at 0.0951935	$/kW Days	$832.48	
Subtotal Market Charges				**$1,745.35**

- Many Commercial/Industrial customers elect to have capacity broken out in deregulated supplier pricing
- For Basic/Default Service customers, capacity charges are there and calculated on a portfolio basis

Current & Future ISO-NE Capacity Charges to Load

Auction	Acquired MW	Needed MW	Non Separating Zone Closing Prices ($/kW-mo)	Non-Separating Zone ~ Unit Cost to Load $/kWh[1]
FCA 5 (2014/'15)	36,918	33,200	$3.21[2]	$0.00891
FCA 6 (2015/'16)	36,309	33,456	$3.43[2]	$0.00952
FCA 7 (2016/'17)	36,220	32,968	$3.15[2]	$0.00874
FCA 8 (2017/'18)	33,702	33,855	$7.02	$0.01948
FCA 9 (2018/'19)	34,695	34,189	$9.55	$0.02650

[1] Presumes 23% reserve margin & customer load factor of 65%

[2] Generator payment rates pro-rated due to oversupply

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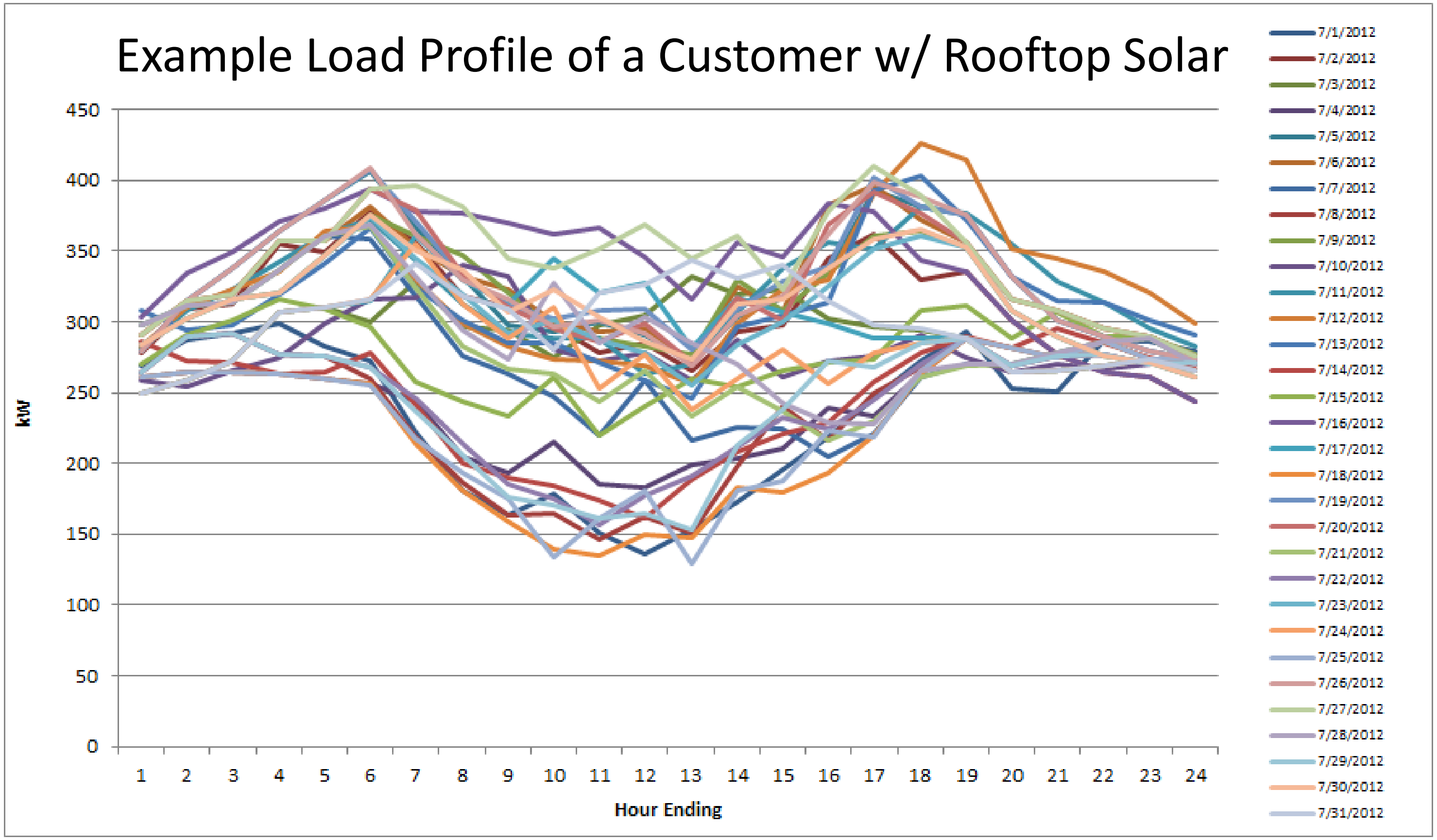
Impact of Behind the Meter Solar for an Interval Metered Customer

BTM PV reduces the ICAP tag of a customer by changing the load shape……for now



If high PV adoption shifts the peak load hour back, then BTM PV's effectiveness in lowering ICAP tag will be reduced

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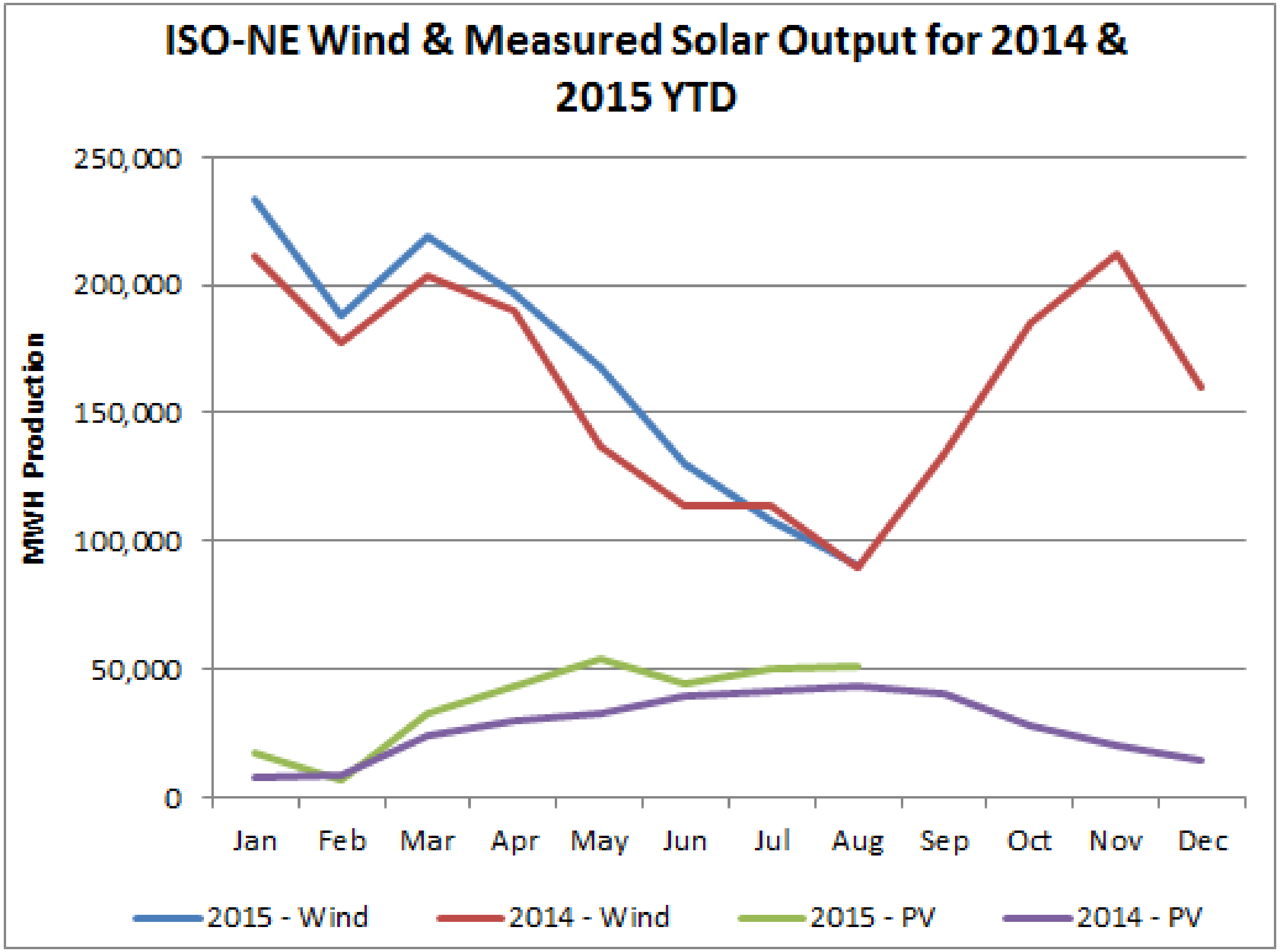
Wind & Solar Monthly Output Profiles



Source: ISO-NE Net Energy & Peak Load Report, Oct 2015

* Only includes the Solar PV that ISO-NE can "see"

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ISO-NE is Actively Planning for More Renewables

ISO-NE Forecast for Solar PV Additions[1]

States	Cumulative Total MW (AC nameplate rating)										
	Thru 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
CT	118.8	189.7	279.5	325.3	368.3	408.7	449.1	476.0	502.9	529.8	556.8
MA	666.8	863.8	1093.6	1145.0	1193.4	1238.8	1284.1	1314.4	1344.6	1374.8	1405.1
ME	10.4	12.6	14.8	16.7	18.5	20.3	22.0	23.7	25.4	27.2	28.9
NH	12.7	17.0	21.3	25.1	28.7	32.1	35.4	37.7	39.9	42.2	44.4
RI	18.2	27.9	48.3	75.4	106.4	135.4	156.0	163.1	168.5	173.9	179.3
VT	81.9	122.2	162.6	184.9	198.7	205.1	211.4	217.7	224.1	230.4	234.7
Regional - Cumulative (MW)	**908.8**	**1233.1**	**1620.0**	**1772.4**	**1914.1**	**2040.3**	**2158.1**	**2232.6**	**2305.5**	**2378.4**	**2449.1**

Notes:

(1) Forecast values include FCM Resources, non-FCM Energy Only Generators, and behind-the-meter PV resources
(2) The forecast reflects discount factors described on slides 4
(3) All values represent end-of-year installed capacities
(4) ISO is working with stakeholders to determine the appropriate use of the forecast

- In Spring 2015, ISO-NE completed a study of PV to classify types (e.g., FCM, SOR, BTM) to allow for rigorous analysis & inclusion in the CELT
- There is currently ~ 800 MW of wind in the system & 4,000 MW in the interconnection queue

[1] Source: ISO-NE Distributed Generation Forecast Working Group, “Classification of PV Forecast into Four Types”, April 14th, 2015

ISO-NE CELT Forecast

CELT = Capacity, Energy, Loads, and Transmission

1.6 - Seasonal Peak Load Forecast Distributions (Forecast is Reference with reduction for BTM PV)

		Peak Load Forecast at Milder Than Expected Weather				Reference Forecast at Expected Weather	Peak Load Forecast at More Extreme Than Expected Weather				
Summer (MW)	2015	27145	27395	27440	27825	28251	28700	29165	29825	30600	31270
	2016	27548	27803	27848	28238	28673	29133	29603	30278	31053	31733
	2017	27921	28181	28226	28626	29066	29531	30011	30696	31481	32171
	2018	28323	28583	28633	29033	29483	29958	30443	31138	31933	32628
	2019	28686	28951	28996	29406	29861	30341	30831	31541	32341	33051
	2020	28992	29262	29307	29722	30182	30667	31167	31877	32697	33417
	2021	29287	29557	29607	30022	30487	30977	31482	32202	33037	33762
	2022	29589	29864	29914	30334	30804	31299	31809	32539	33389	34124
	2023	29901	30181	30231	30656	31131	31631	32146	32886	33746	34491
	2024	30214	30494	30544	30974	31455	31964	32479	33224	34104	34859
WTHI (1)		78.49	78.73	79.00	79.39	79.88	80.30	80.72	81.14	81.96	82.33
Dry-Bulb Temperature (2)		88.50	88.90	89.20	89.90	90.20	91.20	92.20	92.90	94.20	95.40
Probability of Forecast Being Exceeded		90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
Winter (MW)	2015/16	22325	22440	22535	22595	22740	22890	23050	23150	23400	23755
	2016/17	22500	22620	22715	22775	22920	23070	23230	23335	23580	23935
	2017/18	22685	22800	22895	22960	23105	23255	23420	23520	23765	24120
	2018/19	22855	22975	23070	23130	23280	23435	23595	23700	23935	24295
	2019/20	23000	23120	23220	23280	23430	23585	23750	23850	24085	24445
	2020/21	23140	23260	23360	23420	23570	23725	23890	23995	24225	24585
	2021/22	23280	23400	23500	23565	23715	23870	24040	24145	24370	24730
	2022/23	23430	23550	23650	23715	23865	24020	24190	24295	24520	24880
	2023/24	23580	23705	23805	23865	24020	24180	24345	24455	24680	25035
	2024/25	23735	23855	23955	24020	24175	24335	24505	24610	24835	25190
Dry-Bulb Temperature (3)		10.72	9.66	8.84	8.30	7.03	5.77	4.40	3.58	1.61	(1.15)

Source: 2015 CELT Report, page 1.6.1

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Assignment of Capacity Ratings to Intermittent Renewables

Seasonal Claimed Capability (SCC) Based on

- Actual historical or modeled performance during "Reliability" hours
- Performance during any system wide or zonal Shortage Event

ISO-NE Intermittent Reliability Hours

Summer (June - Sept.)

Hr Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
All Days																								

Winter (Oct. - May)

Hr Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
All Days																								

- Other Hours - Reliability Hours

Total SCCs of intermittent resources 578 (Winter) and 365 (Summer) as of Oct 2015. Wind & solar is about 50% of this, rest is ROR hydro

Sources: Market Rule 1, Section III.13.1.2.2.2.1

SCC Report, Oct 2015

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Capacity Values for Selected Intermittent Assets

2.1 Existing Seasonal Claimed Capability (SCC) by Lead Participant

Generator Information as of January 1, 2015

Summer and Winter SCC as of January 1, 2015, and as of the 2014/15 Winter and 2015 Summer Peaks

LEAD PARTICIPANT	ASSET ID	ASSET NAME	UNIT TYPE	SUMMER SCC (MW)	WINTER SCC (MW)	PRIMARY FUEL TYPE	ALTERNATE FUEL TYPE	EIA PLANT NUMBER	IN-SERVICE DATE
				Massachusetts Electric Company					
MEC	857	OAKDALE HYDRO	HDR	2.895	1.137	WAT		10824	7/1/1994
MEC	947	RIVERDALE MILLS - QF	HDR	0.000	0.000	WAT		50601	7/1/1985
MEC	950	LP ATHOL - QF	HDR	0.055	0.049	WAT			1/1/1931
MEC	953	ATTLEBORO LANDFILL - QF	IC	0.119	0.105	OBG			11/1/1997
MEC	954	MM LOWELL LANDFILL - QF	IC	0.077	0.099	LFG		55095	8/1/1997
MEC	970	DUDLEY HYDRO	HDR	0.000	0.106	WAT			10/1/1987
MEC	1062	MWRA COSGROVE	HW	0.834	0.148	WAT		10825	10/1/1995
MEC	1122	CASCADE-DIAMOND-QF	HDR	0.036	0.216	WAT			12/31/1919
MEC	1225	TANNERY DAM	HDR	0.000	0.000	WAT		55924	4/1/2000
MEC	2462	PLAINVILLE GEN QF U5	IC	2.106	2.287	OBG			3/24/2003
MEC	13933	JIMINY PEAK WIND QF	WT	0.000	0.020	WND			7/1/2007
MEC	15462	HOLY NAME CC JR SR HIGH SCHOOL	WT	0.000	0.000	WND			9/1/2008
MEC	16183	RICHEY WOODWORKING WIND QF	WT	0.000	0.000	WND			2/18/2009
MEC	16188	WILSON HOLDINGS LLC - PV QF	PV	0.000	0.000	SUN			2/24/2009
MEC	16233	CITY OF MEDFORD WIND QF	WT	0.000	0.000	WND			2/27/2009
MEC	16234	CONSTELLATION-MAJILITE PV QF	PV	0.000	0.000	SUN			2/27/2009
MEC	16331	QUARRY ENERGY PROJECT	IC	0.379	0.380	LFG			4/3/2009
MEC	16332	BARTLETTS OCEAN VIEW FARM WIND	WT	0.000	0.000	WND			4/3/2009
MEC	16386	NATURE'SCLASSROOM-01507WT100NM	WT	0.006	0.000	WND			4/24/2009
MEC	16631	VICTORY ROAD DORCHESTER PV	PV	0.469	0.000	SUN		57265	12/22/2011
MEC	16640	HILLDALE AVE HAVERHILL PV	PV	0.300	0.000	SUN		57269	2/15/2011
MEC	16642	RAILROAD AVENUE REVERE PV	PV	0.337	0.000	SUN		57266	2/16/2011
MEC	16643	ROVER STREET EVERETT PV	PV	0.258	0.000	SUN			2/18/2011

Source: 2015 CELT Report, page 2.1.24

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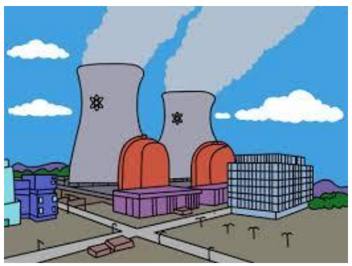
What is the Missing Money?

A Proper Market Construct Must Ensure

- Generation adequacy
- Financial adequacy for generation units……at least up to the ICR

Base Load Units

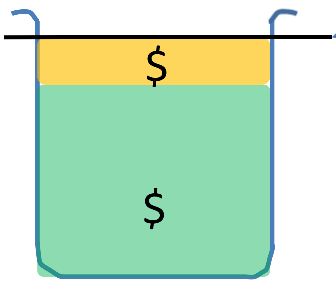


High Fixed Costs ⟷ Lower Fixed Costs

Low Variable Costs ⟷ Higher Variable Costs

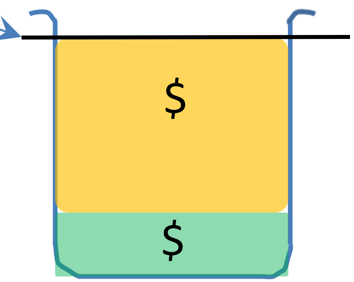
Peakers

Required $ for Financial Adequacy



Market Revenue Bucket

If the energy market doesn't supply enough revenue to provide financial adequacy to a unit, the delta is referred to as the "missing money"



Market Revenue Bucket

- Energy Market Revenues

- Capacity Market Revenues

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Impact of Increase in Renewables on ISO-NE Market

Wholesale Energy Prices

- No fuel costs
- Displacement of higher cost units
- PTC provides incentive to ignore negative prices

Capacity Prices

- Lower Wholesale prices create financial adequacy issues for some baseload units
  - Amount of “missing money” increases
  - Along w/ increased PFP risk
- Capacity prices must increase to ensure units stay in market & generation adequacy maintained

Good discussion of this issue in ISO-NE Discussion Paper from June 2015
“The Importance of a Performance-Based Capacity Market to Ensure Reliability as the Grid Adapts to a Renewable Energy Future”

Getting the Renewables to Market is a Challenge

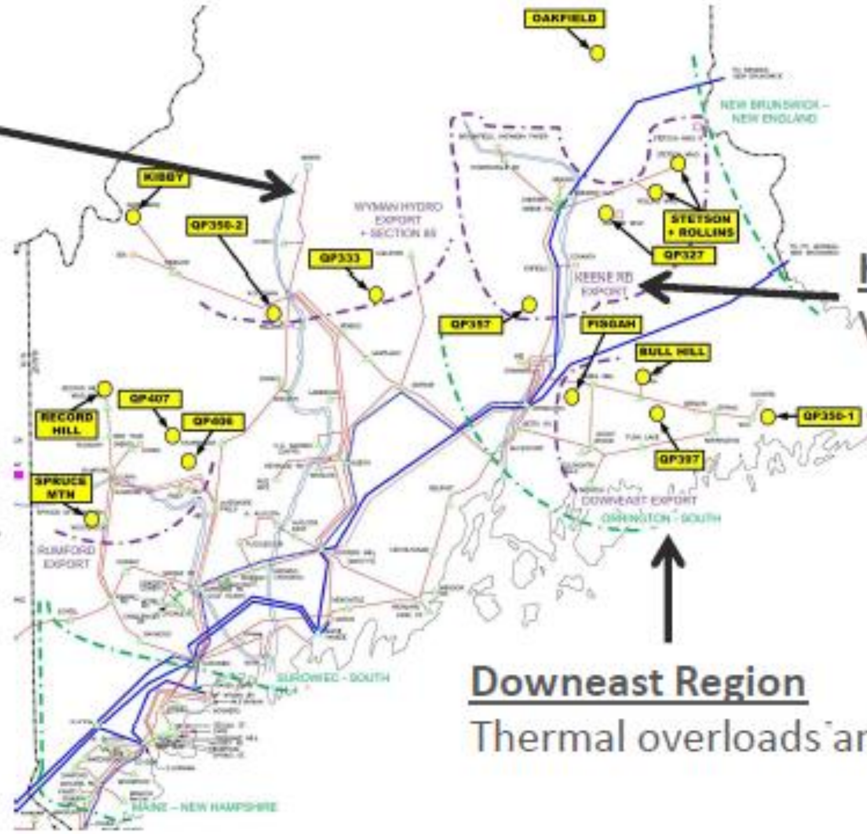
ISO-NE Identified Challenges w/ Wind Integration in Maine, by Region

Wyman Hydro Region

Local thermal and voltage problems; vulnerability to stability problems for extreme contingencies in southern New England

Rumford Region

Low voltage and BPS performance degradation



Keene Road Region

Voltage stability issues

Downeast Region

Thermal overloads and low 115 kV voltage

State-Wide

Replacement of large synchronous machines with wind degrades system dynamic performance

Source: "Strategic Transmission Analysis: Wind Integration Study: Maine and Northern Vermont Updates", Planning Advisory Committee, 12/18/2014

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ISO-NE is a Dynamic System & Constraints Can Shift

FERC Ruled in June 2015 That FCA 10 May Have Two Capacity Zones

Proposed Potential Import Constrained Zone Boundary

- The proposed boundary of the Southeast New England Zone would be made up of
  - The northern and western borders of the NEMA/Boston zone and the western border of the SEMA/RI zone

Constrained zones have local sourcing requirements so location of renewable resources matter

Graphic Source: Alan McBride Testimony, Appendix 1 ER15-1462-000, April 6th, 2015

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Summary

Rapid Scale up of Renewables in ISO-NE

- Helps New England States achieve public policy goals
- Decarbonizes the grid
- Advances new technologies and spurs innovation

But….

- There is no free lunch. Resource and financial adequacy must be maintained for existing baseload & economic dispatchable units.
- Suppression of wholesale prices will put upward pressure on capacity prices
- Consumer education required to facilitate understanding of the market and price signals
- A changing system may warrant further changes to capacity cost allocation formulas
- Regional political leadership's apparent loss of faith in market mechanisms is worrisome

Thank You

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