

Competitive Energy Services

Sustainability on Campus

Andrew Price, Senior Vice President, Competitive Energy Services

February 12, 2015

Topic Board

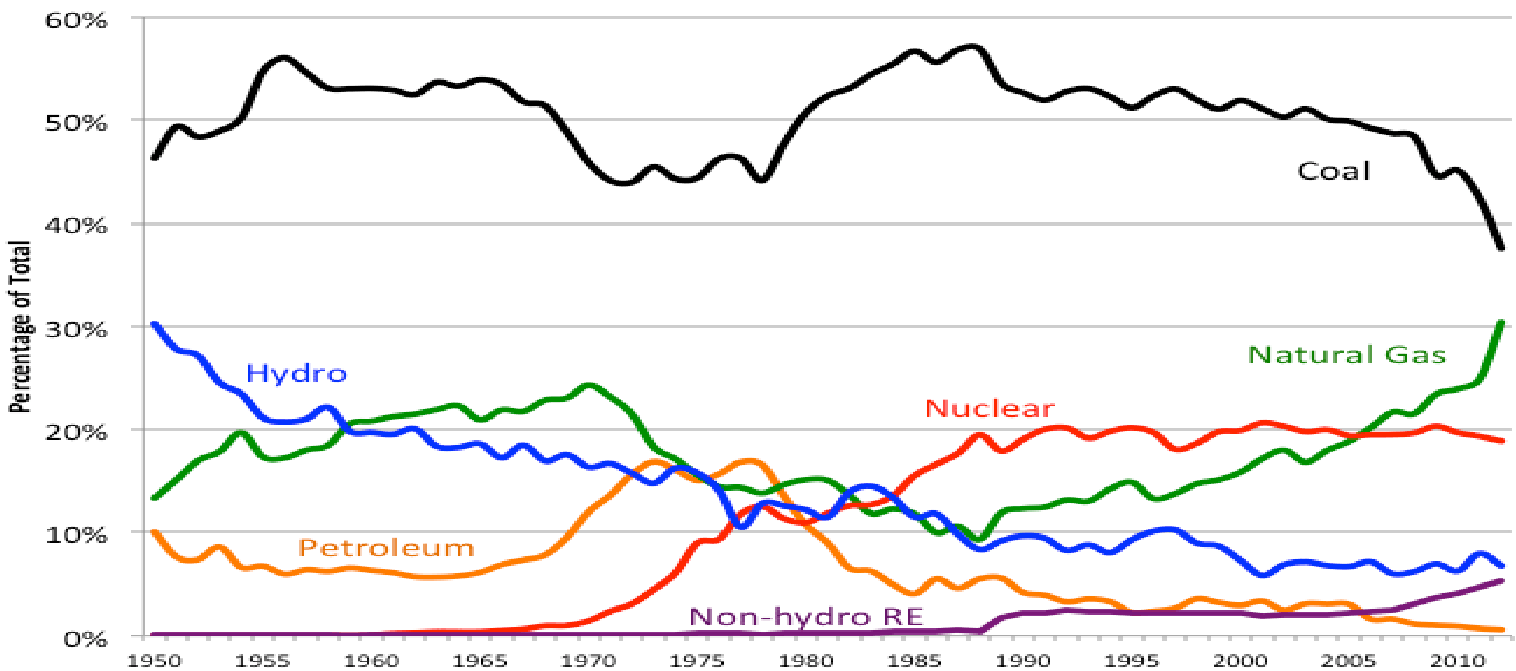
Gas/Biomass /Wind /Hydro	GHG	Solar PV & Thermal	Other
Natural Gas	Bowdoin CS	Solar Trends	Fuel Arbitrage
Canadian Hydro	Colby CS	Williams College CS	Renewable Portfolio (RPS)
Biomass	RGGI	UMass CS	Bowdoin Geothermal
Wind Trends	Carbon Cost	Bowdoin PV & Thermal	UMaine CS

* CS = Case Study

Natural Gas

- **Pros**
  - **Vast US Reserves**
  - **GHG Reduction At Burner Tip**
    - 50% vs coal
    - 30% vs oil
    - 17% vs propane
  - **Bridge Fuel To Renewables**
  - **Save $ and GHG**
- **Cons**
  - **Fracking**
  - **Pipelines**
  - **Cheap Gas Is Delaying Renewables**
  - **Leakage During Extraction**
    - 1% to 9%
    - 3% leakage rate is enough for natural gas to become as polluting as coal
  - **21 Global Warming Potential (100 yr)**

Natural Gas: US Power Mix



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Canadian Hydro

- **Northeast Issue**
  - **Large Canadian Hydro Vs Local Renewables**
  - **Power Lines Vs Distributed Generation**
  - **Is Large Hydro Renewable?**
  - **Necessary To Satisfy State RPS?**
  - **Hydro Quebec**
    - 4,000 MW New Wind
    - 4,000 MW New Hydro
  - **Nalcor Energy**
    - 5,000 MW New Hydro
  - **Proposed Power lines into ME, NH, VT, NY**

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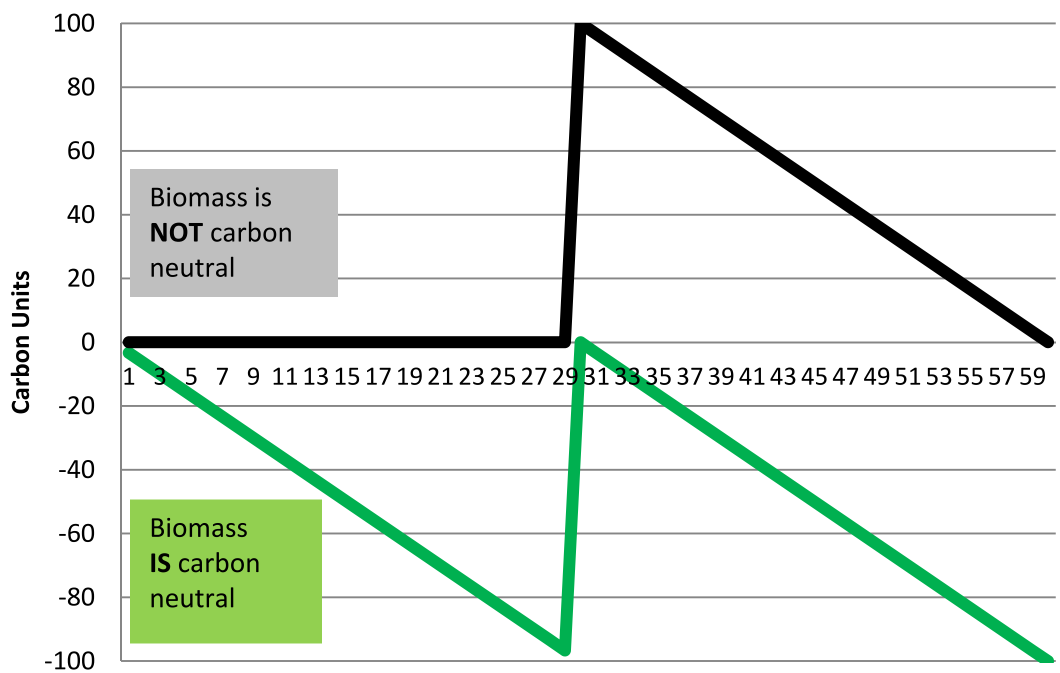
Biomass

- **Pellets**
  - High Fuel / Low Capx
  - $150 - $180 per ton
  - $15 - $25 per ton delivery
  - $10 - $13 per MMBtu
- **Chips**
  - Low Fuel / High Capx
  - $45 - $65 per ton
  - $10 - $30 per ton delivery
  - $4 - $6 per MMBtu

Colby College – Wood Chips

The Jackson Lab – Wood Pellets

Biomass (2)



What do carbon neutrality and the theory of relativity have in common?

Adapted from work done by William Strauss, Ph.D. President of FutureMetrics

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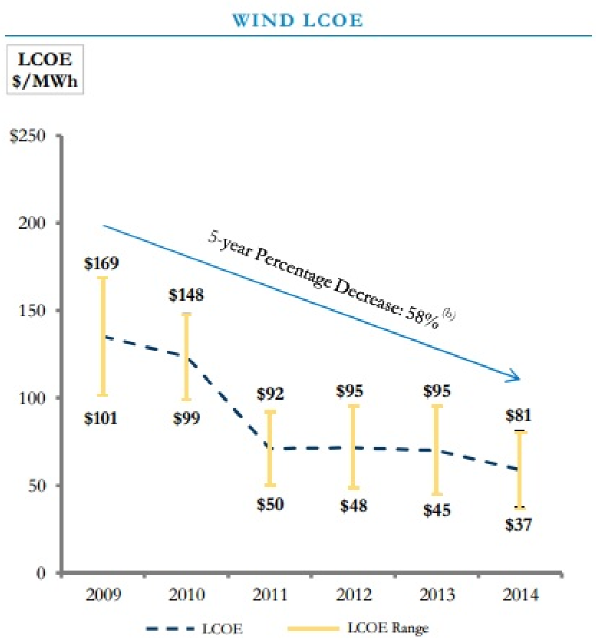
Wind Power Trends (1)



Lazard, LCOE v.8, Sep 2014

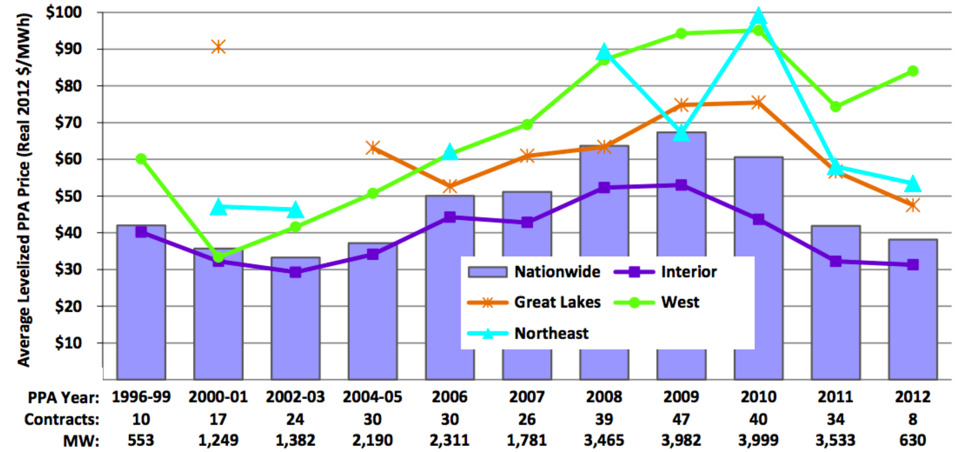
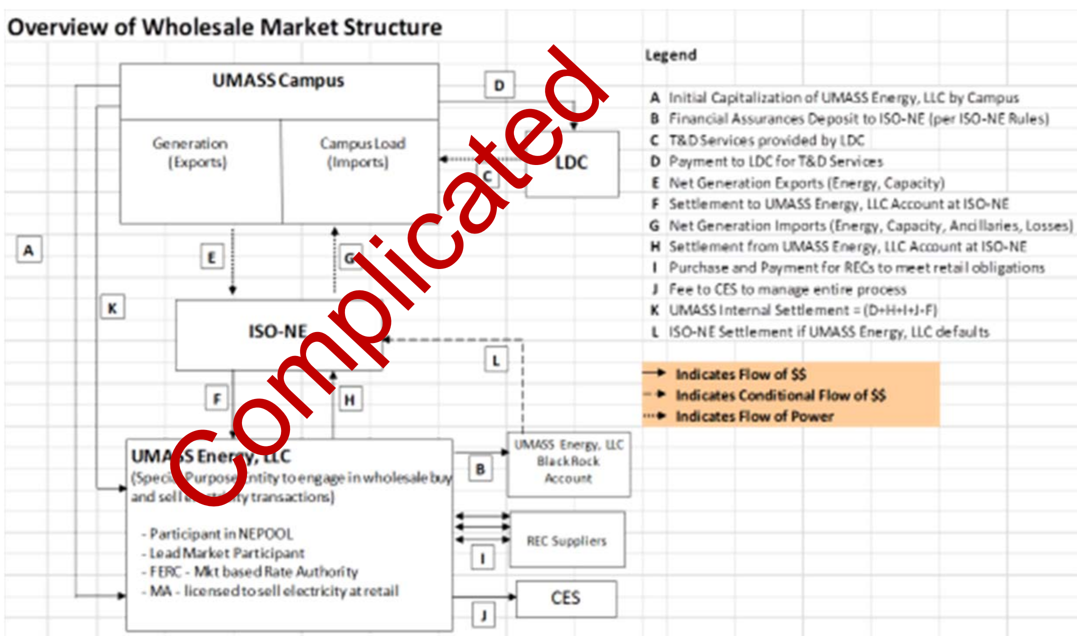


Figure 33. Generation-Weighted Average Levelized Wind PPA Prices by PPA Execution Date and Region

DOE 2013 Wind Technologies Report, Aug 2014

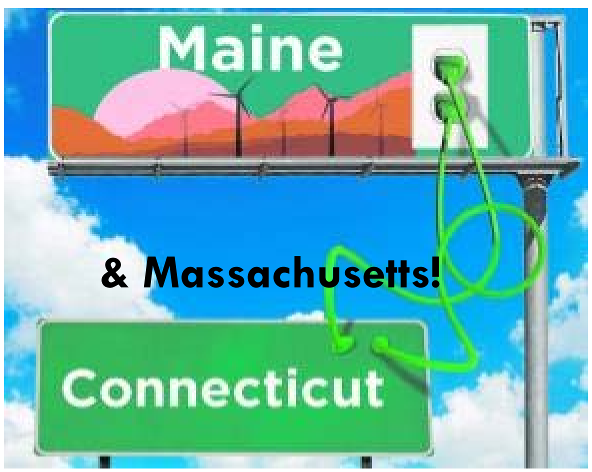
Wind Power (2)

- **Difficult To Buy Direct From Generator**

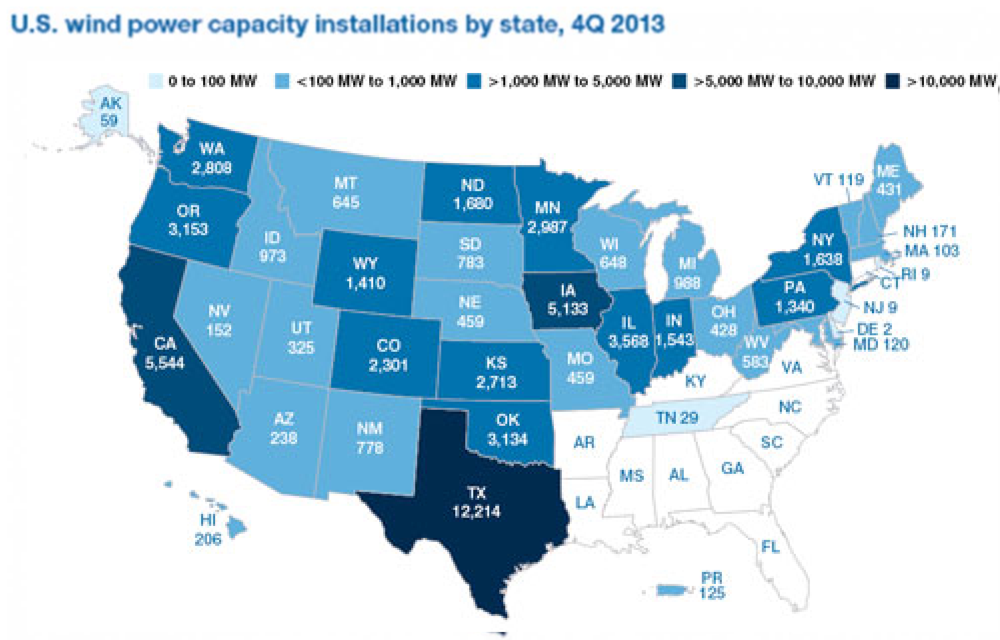


Wind Power (3)

- **Wind Exports**
- **500 MW Proposed from ME**
  - $1B Investment
  - Utilities Not Institutions
  - Using wind to meet RPS



Portland Press Herald, Oct 6, 2013

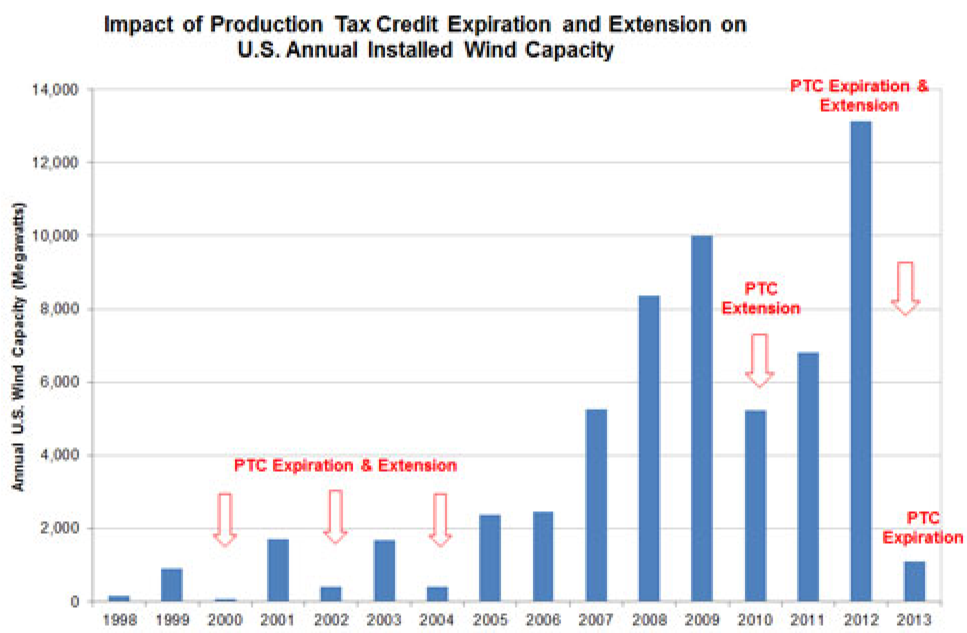


ACORE: The Outlook For Renewable Energy In America 2014

Wind Power (4)

- **Federal PTC**
  - **2.3 cents / kwh**
  - **1st 10 years**
  - **Expired 1/1/2014**
  - **2013 start allows Up to 24 months**
  - **Renewal?**

- **Offshore**
  - **Cost**



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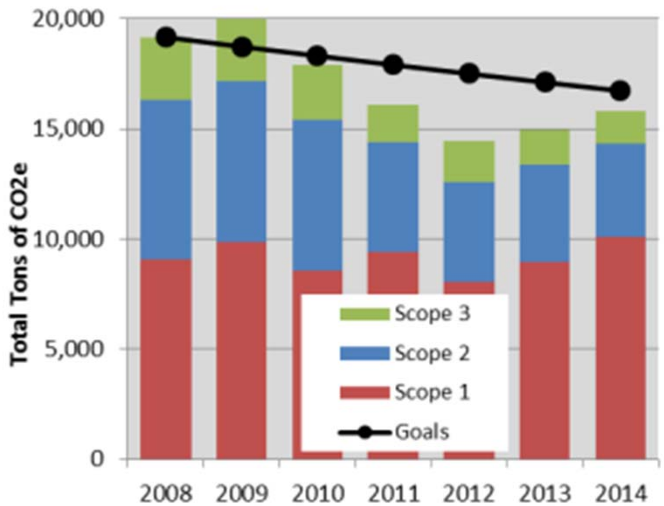
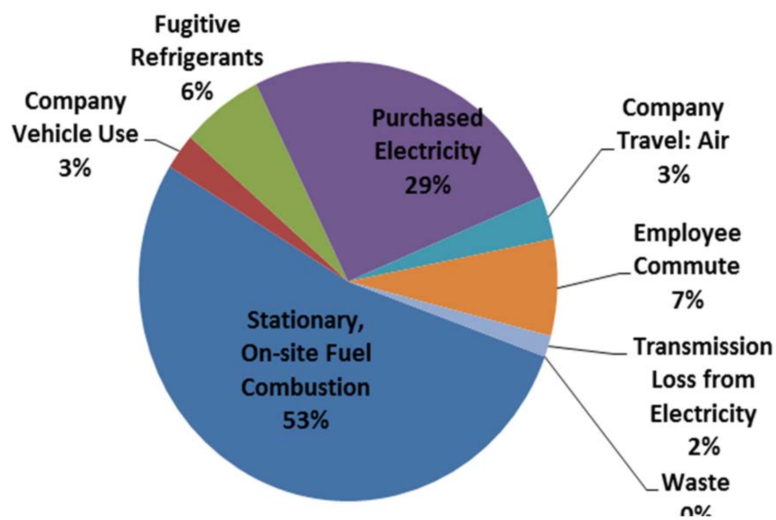
Case Study
Bowdoin GHG Inventory

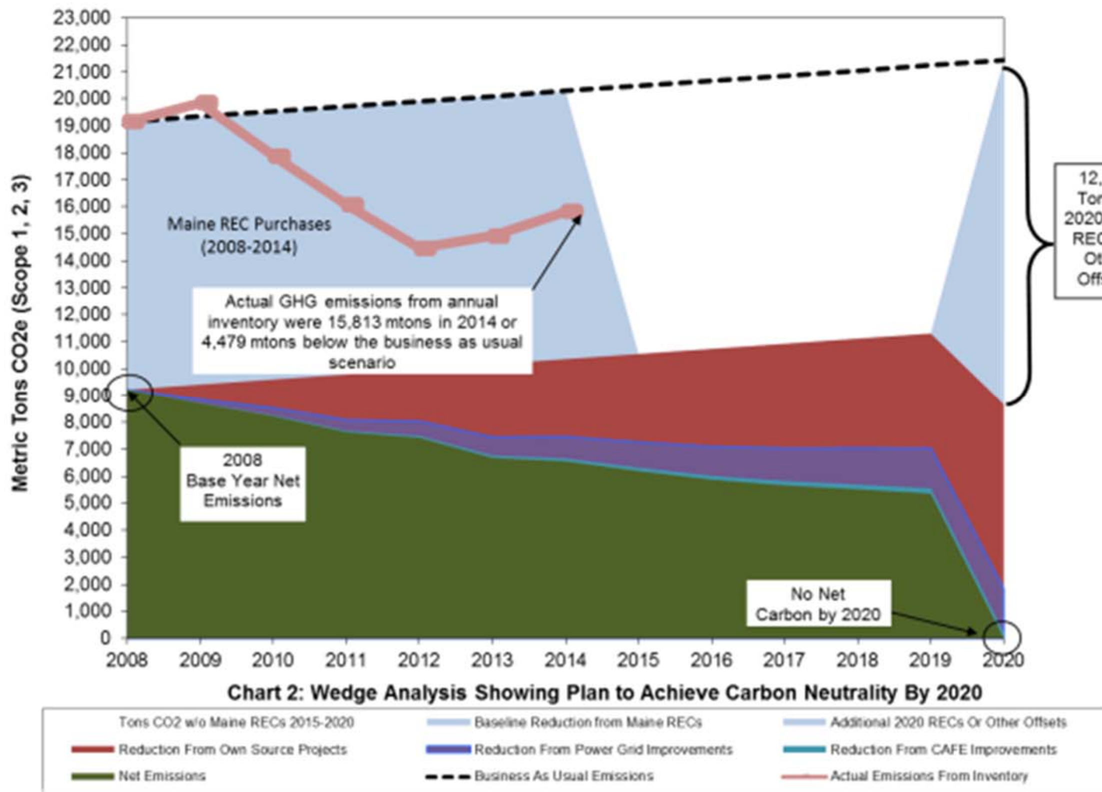
- **2008 Baseline** Greenhouse Gas (GHG) Emissions
- **Track GHG Emission Each Year**
- **Climate Action Plan Updates** & ACUPCC Submissions





Bowdoin ACUPCC

- ACUPCC
  - 2007 Pledge by President Mills
  - 2008 Base Year
  - 2020 Carbon Neutral Target
  - Onsite Is Priority
  - Offsets Are "Last Resort"



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Case Study
Colby College GHG

Competitive Energy Services

- **Independent verification of GHG Inventory**
- **Carbon Offset Strategy**
  - Optimize:
    - Cost ($1 to $20 per ton)
    - Project Type / Provider
    - Geographic Location
- **Competitive Bid**
- **Implementation**
- **Carbon Neutrality FY13**

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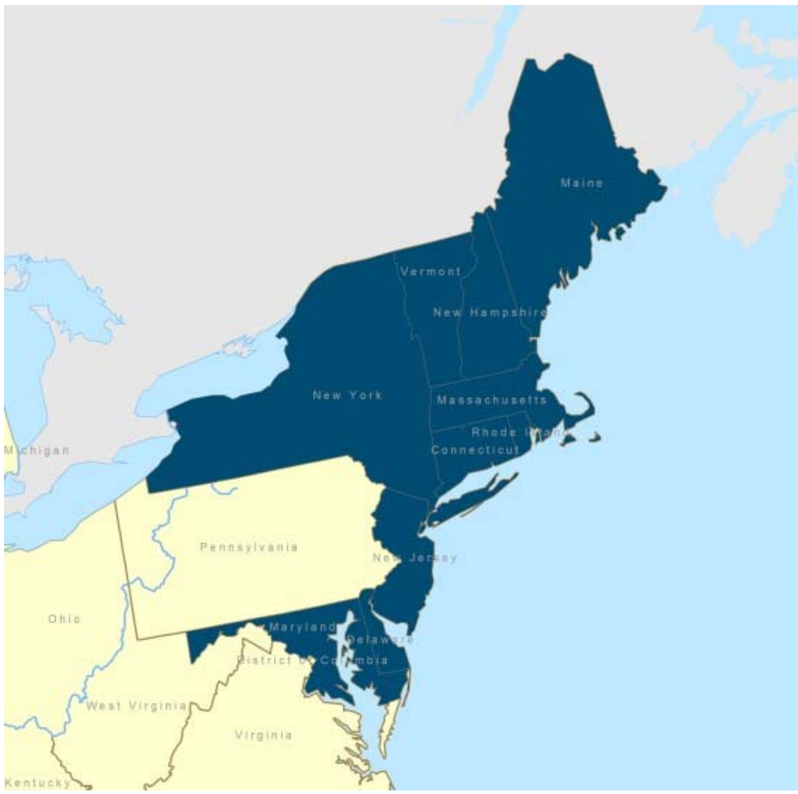
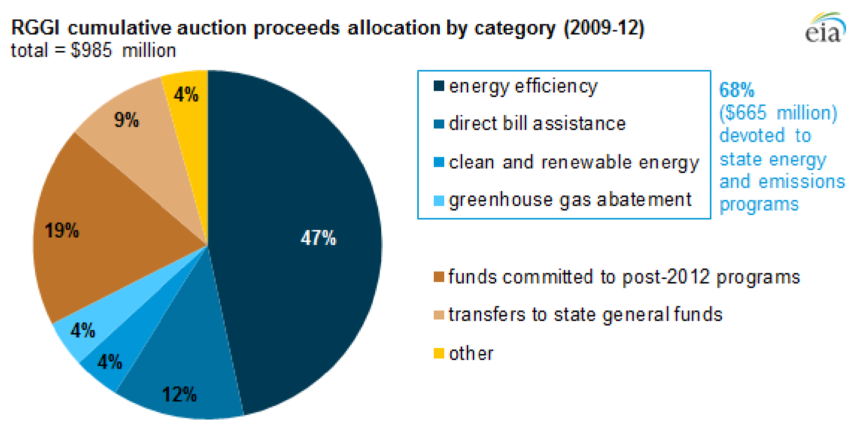
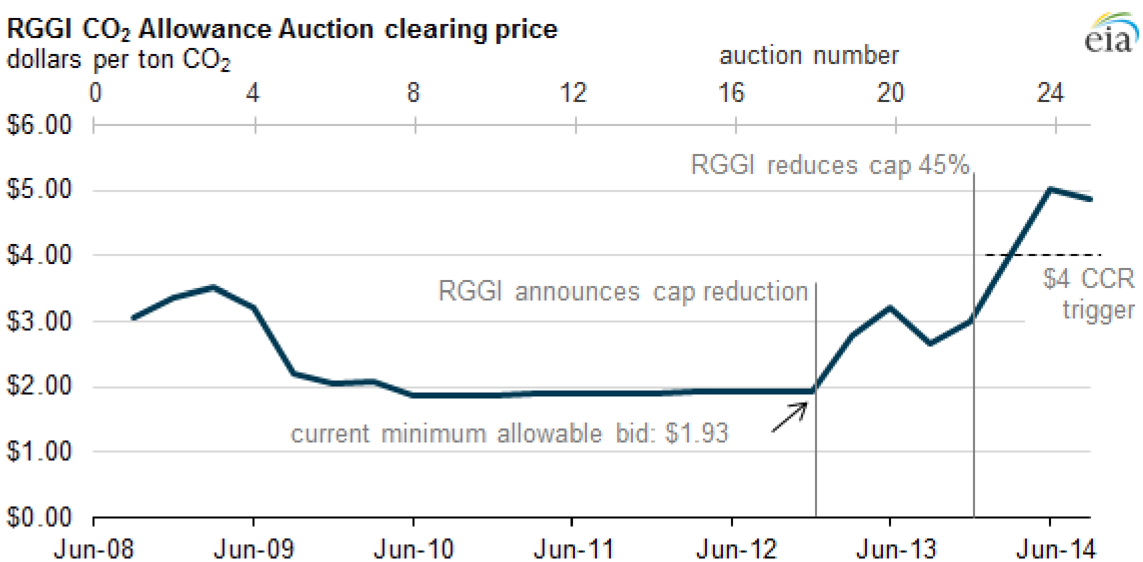
Regional Greenhouse Gas Initiative (RGGI)



- **Carbon Cap & Trade Program**
- **9 States**
  - **NJ Terminated 2011**
- **25 Auctions Through Sep 3, 2014**



RGGI - Changes



- **Power Plant Cap**
- **2014: Cap reduced 40%**
  - **165 Million Tons**
  - **91 Million Tons**
- **2015: 2.5% / yr reduction**
- **$2 / ton increase:**
  - **$0.8 / MWh from nat gas**
  - **$1.1 / MWh from oil**
  - **$2.0 / MWh from coal**
- **Opportunities:**
  - **Improves Renewables**
  - **Efficiency Investment**

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Carbon Offset Options And Prices

The costs of various green options range from insignificant to very expensive – understanding the costs is essential for informed decision making.

Cons: Confusing, Few Rules

Pros: Flexibility, Choice, Economic Efficiency

Carbon Offset Options and Prices		
Renewable Energy Certificates	2015 offer	
Compliance Market	$/metric ton	
ME Class I	$	11.03
ME Class II	$	0.99
MA Class I	$	110.25
MA Class II	$	57.33
MA W-E	$	21.50
MA Solar	$	870.98
CT Class I	$	110.25
CT Class II	$	1.65
CT Class III	$	55.13
MD Tier I	$	33.08
MD Tier II	$	12.13
MD Solar	$	308.70
NJ Class I	$	40.79
NJ Class II	$	12.13
NJ Solar	$	402.41
Voluntary Market		
US Green-E Wind	$	2.65
Low Impact Hydro	$	2.21
Nuclear Power	$	-
Carbon Offsets		
Compliance Market		
New England Regional Greenhouse Gas (RGGI)		4.43
California		12.65
Europe EUA (Euros)		5.78
Voluntary Market		
Generic National Blend		3.15
*All RECs converted using (lbs/MWh)		1000
(mt/MWh)		0.454

Carbon Abatement Cost

Cost of Carbon Abatement Comparison

As policymakers consider the best and most cost-effective ways to limit carbon emissions (including in the U.S., in respect of Section 111(d) regulations), they should consider the implicit costs of carbon abatement of various Alternative Energy generation technologies; an analysis of such implicit costs suggests that policies designed to promote wind and utility-scale solar development could be a particularly cost effective way of limiting carbon emissions; rooftop solar and solar thermal remain expensive, by comparison

- Such observation does not take into account potential social and environmental externalities or reliability-related considerations

		CONVENTIONAL GENERATION			ALTERNATIVE ENERGY RESOURCES			
	Units	Coal[(b)]	Gas Combined Cycle	Nuclear	Wind	Solar PV Rooftop	Solar PV Utility Scale[(c)]	Solar Thermal [(d)] with Storage
Capital Investment/KW of Capacity[(a)]	$/kW	$3,000	$1,006	$5,385	$1,400	$3,500	$1,750	$9,800
Total Capital Investment	**$mm**	**$1,800**	**$805**	**$3,339**	**$1,498**	**$8,505**	**$3,255**	**$6,860**
Memo: Total ITC/PTC Tax Subsidization	$mm	—	—	—	$449	$2,552	$977	$2,058
Facility Output	**MW**	**600**	**800**	**620**	**1,070**	**2,430**	**1,860**	**700**
Capacity Factor	%	93%	70%	90%	52%	23%	30%	80%
Effective Facility Output	**MW**	**558**	**558**	**558**	**558**	**558**	**558**	**558**
MWh/Year Produced[(e)]	GWh/yr	4,888	4,888	4,888	4,888	4,888	4,888	4,888
Levelized Cost of Energy	$/MWh	$66	$61	$92	$37	$180	$72	$118
Total Cost of Energy Produced	**$mm/yr**	**$324** ❷	**$298**	**$452**	**$183**	**$880**	**$354** ❶	**$579**
Carbon Emitted	mm Tons/yr	4.54	1.92	—	—	—	—	—
Difference in Carbon Emissions	mm Tons/yr							
vs. Coal		—	2.62	4.54	4.54	4.54	4.54 ❸	4.54
vs. Gas		—	—	1.92	1.92	1.92	1.92	1.92
Difference in Total Energy Cost	$mm/yr							
vs. Coal		—	($26)	$128	($141)	$557	$31 ❹	$255
vs. Gas		—	—	$154	($115)	$582	$57	$281
Implied Abatement Cost/(Saving)	$/Ton							
vs. Coal		—	($10)	$28	($31)	$123	$7 ❺	$56
vs. Gas		—	—	$80	($60)	$304	$30	$147

Source: Lazard estimates.

Note: Does not reflect production tax credit or investment tax credit. Assumes 2014 dollars, 20 – 40 year economic life, 40% tax rate and 5 – 40 year tax life. Assumes 2.5% annual escalation for O&M costs and fuel prices. Inputs for each of the various technologies are those associated with the low end levelized cost of energy.

(a) Includes capitalized financing costs during construction for generation types with over 24 months construction time.

(b) Based on advanced supercritical pulverized coal. Does not incorporate carbon capture and compression.

(c) Represents single-axis tracking.

(d) Low end represents concentrating solar tower with 18-hour storage capability.

(e) All facilities sized to produce 4,888 GWh/yr.

Illustrative Implied Carbon Abatement Cost Calculation:

❹ Difference in Total Energy Cost vs. Coal = ❶ – ❷
= $354 mm/yr (solar) – $324 mm/yr (coal) = $31 mm/yr

❺ Implied Abatement Cost vs. Coal = ❹ ÷ ❸
= $31 mm/yr ÷ 4.54 mm Tons/yr = $7/Ton

- **Cost Per Avoided Ton of Carbon**
- **Wind**
  - - vs Coal
  - - vs Nat Gas
- **Large Solar**
  - $7 vs Coal
  - $30 vs Nat Gas
- **Nuclear**
  - $28 vs Coal
  - $80 vs Nat Gas

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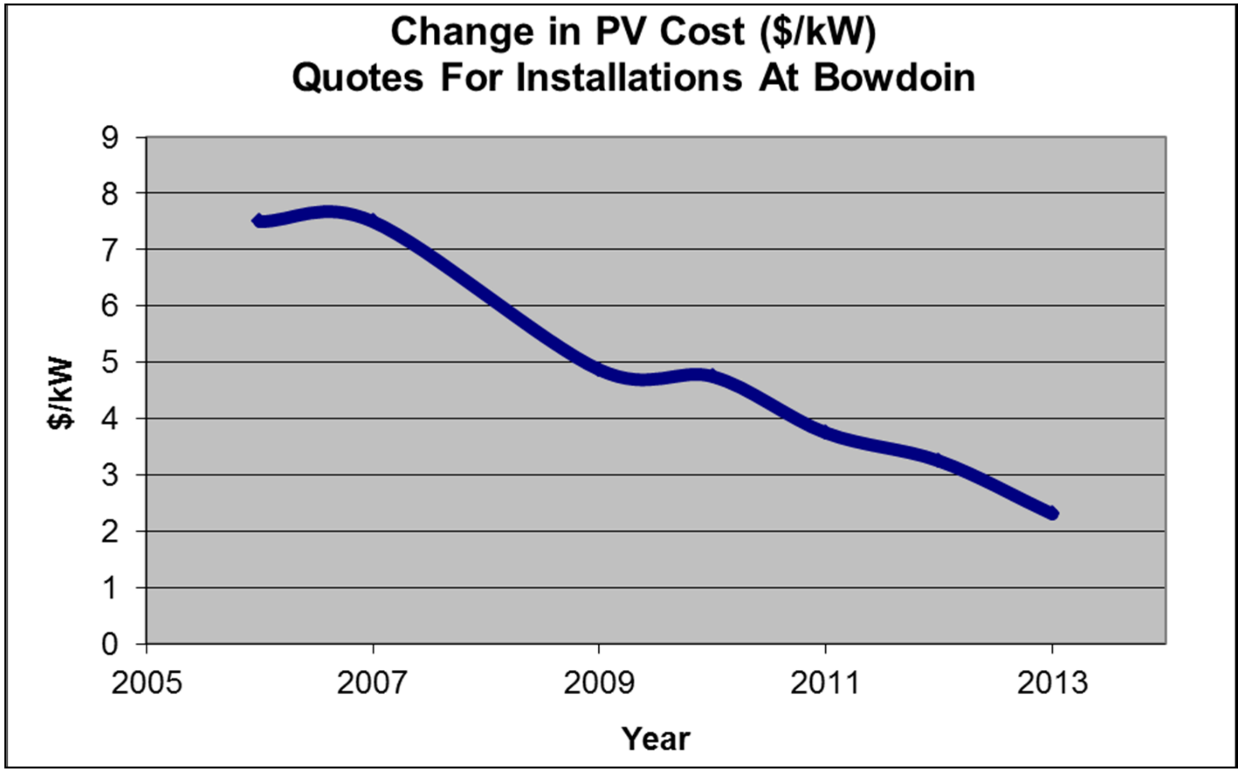
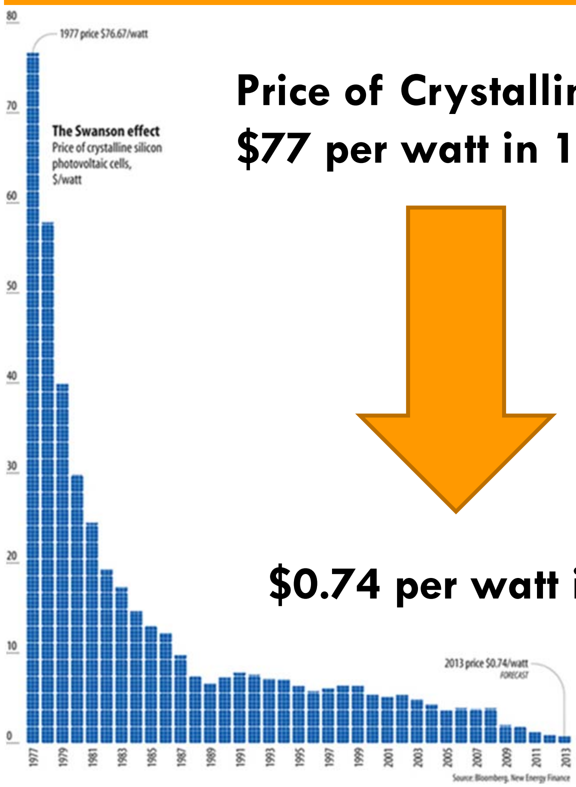
Solar PV Trends

Early
Adopter
Risk

Solar PV Trends (2)

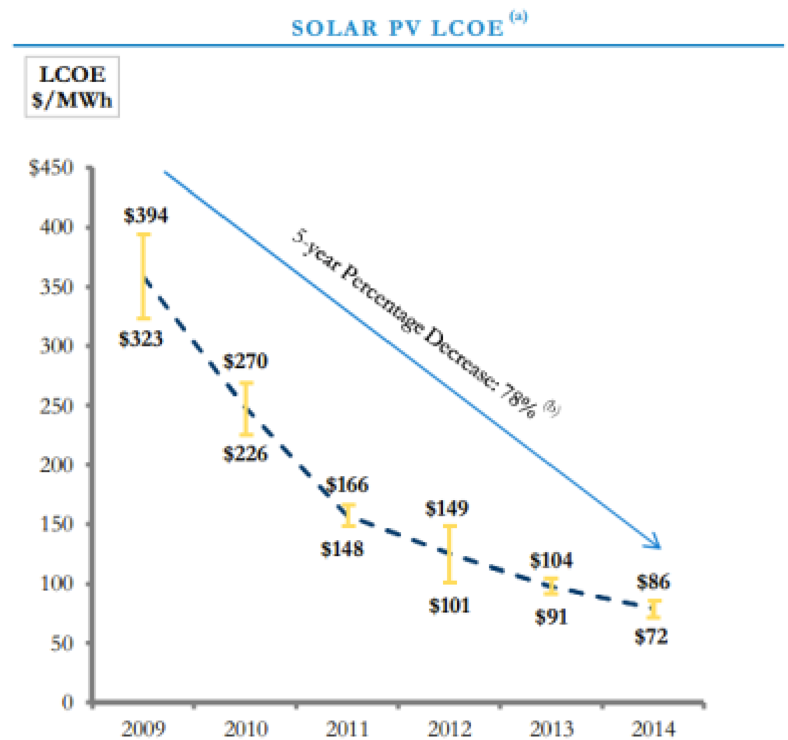


Solar PV Trends (3)



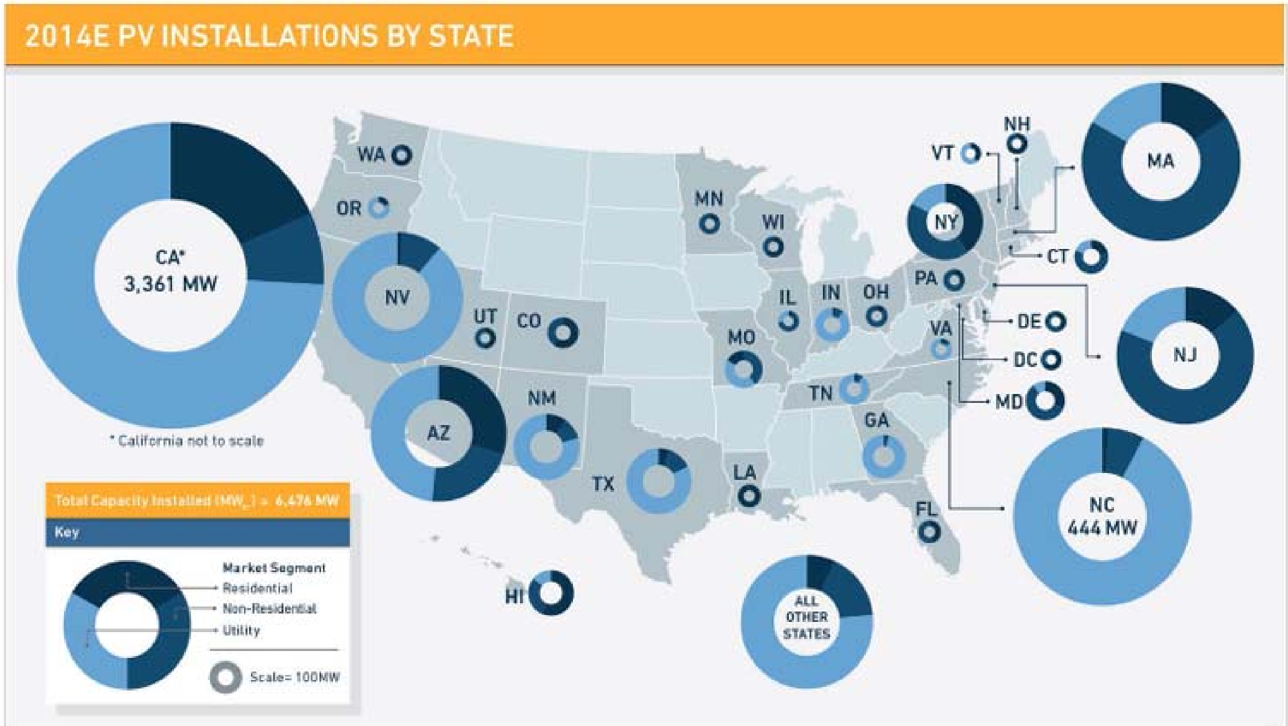
Price of Crystalline Silicon
$77 per watt in 1977

$0.74 per watt in 2013



Solar PV Trends (4)

Figure 2.11 PV Installation Forecast Map, 2014E



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Case Study
Williams College Solar PV

- **New Onsite Solar PV – 785 kW**
  - Kellogg – 39 kw
    - Living Building Challenge Requires Net Zero Energy
    - Flat Roof, Sloped Roof & Ground Mounted Dual Axis Solar
  - Stetson – 80 kW
    - LEED Gold Renovation
  - Weston – 45 kW
    - LEED Gold New Construction
  - Library Shelving – 621 kW
    - Ground Mount. Integration with existing roof solar PV project
- **Remote Solar PV**
  - Remote Net Metering Project (s)
  - Multi 1 MW Projects Located Remotely

Kellogg: Credit Black River Design

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Case Study
Solar PV: UMass System

- **MA Incentives: 25 - 55 cents / kwh**
  - SRECs (40 cents currently for 2015)
  - Net Metering (15+ cents currently)
- **CES Administered Procurement of Net Metering Credits**
- **UMass: “Renting” Utility Liability – low risk**
- **SRECs (Green Benefits) owned by others**
- **Within 2 years:**
  - 50 MW Solar PV Under Contract
  - All 5 campuses
  - $150 MM in project development Costs
- **Estimated Savings: $70 MM over 20 yrs**

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Case Study: Bowdoin Solar

- SolarCity Selected
- SolarCity Constructs, Owns & Operates
  - Federal Tax & Depreciation
- All electricity sold to Bowdoin
- 20 yr fixed price
- SolarCity keeps RECs (greenhouse gas benefit)
- Online Sep/Oct 2014

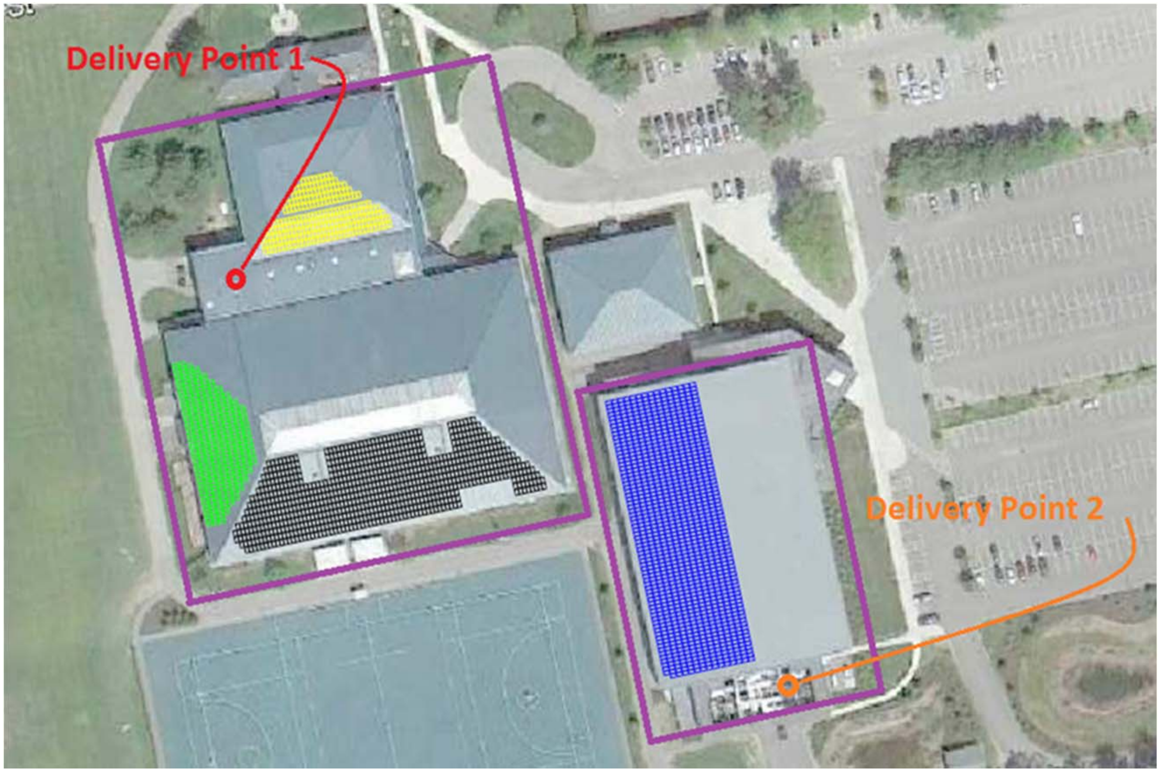
Solar Project Details (1)

- 4,690 solar panels
- 1,273 kW peak
- 1,600,000 kWh
- 8% of annual usage
- 20-30+ yrs
- 8 times the next largest solar system in Maine

Project Details (2)

- BNAS
  - Ground-mount
  - 660 kW
  - 850,000 kWh
  - Connected to campus with new underground distribution line

Project Details (3)



- Athletic Complex
  - Roof-mount
  - 614 kW
  - 720,000 kWh

Bowdoin Solar Thermal

- Thorne Dining
  - 1.75 million gallons water
    - Per year @ 180 degF
  - Project
    - 48 solar thermal panels
    - 1,920 square feet
    - Phase I: 9/23/10
    - Phase II: 4/30/11
    - $100k In ARRA grant funding
    - $247,000 total cost
  - Designed to offset
    - 56% of summer DHW load
    - 42% of winter DHW load

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Case Study LNG
Fuel Switching: UMass Amherst

- **Problem**
  - LDC pipeline natural gas curtailments
  - 1 to 2 million gallons ULSD
- **Solution**
  - Displace ULSD with LNG
  - Yr 1&2 Distrigas: 120 miles
  - Yr 3&4 Philadelphia Gas Works: 754 miles
- **Results**
  - COD Dec 10, 2012
  - Concept to COD: 8 mo.
  - 1st Temp Facility in MA
  - Estimated Savings
    - $1 to $3 MM over life
    - 30% reduction
    - 3,000 to 6,000 mtCO2e per yr

Obstacle: One Local LNG Supplier, Safety, Road Limitations

Opportunity: lower cost, lower emissions, quick implementation

Case Study CNG
Fuel Switching: UMaine Machias

- **Problem**
  - No pipeline natural gas
  - 150,000 gallons #2 Oil
- **Solution**
  - Displace ULSD with CNG
  - CNG is pipeline gas compressed to 3,500 psi and trucked 50 miles to campus
- **Results (Expected)**
  - Selected XNG
  - COD Oct 2015
  - Fuel savings used to pay for critical campus infrastructure upgrades.
  - 20% efficiency improvement
  - 30% reduction in GHG

Photo by XNG. Published by www.bizjournals.com/

Fuel Conversions

- **Conversion Opportunities**
  - #2 Oil to Propane: 14%
  - #2 Oil to Nat Gas: 27%
  - Propane to nat gas: 17%
  - Oil to Biomass: ???
- **CES Role Includes:**
  - Unbiased evaluation of conversion economics
    - Fuel Costs
    - Capital Costs
  - Forward price forecasts
    - Short, Medium, Long Terms
  - GHG emissions calculations

Fuel	Pounds CO2 Released per Million BTU
Natural Gas	116
Propane	139
Gasoline	157
#2 Home Heating Oil	161
#6 Residual Oil	172
Coal (Bituminous)	206

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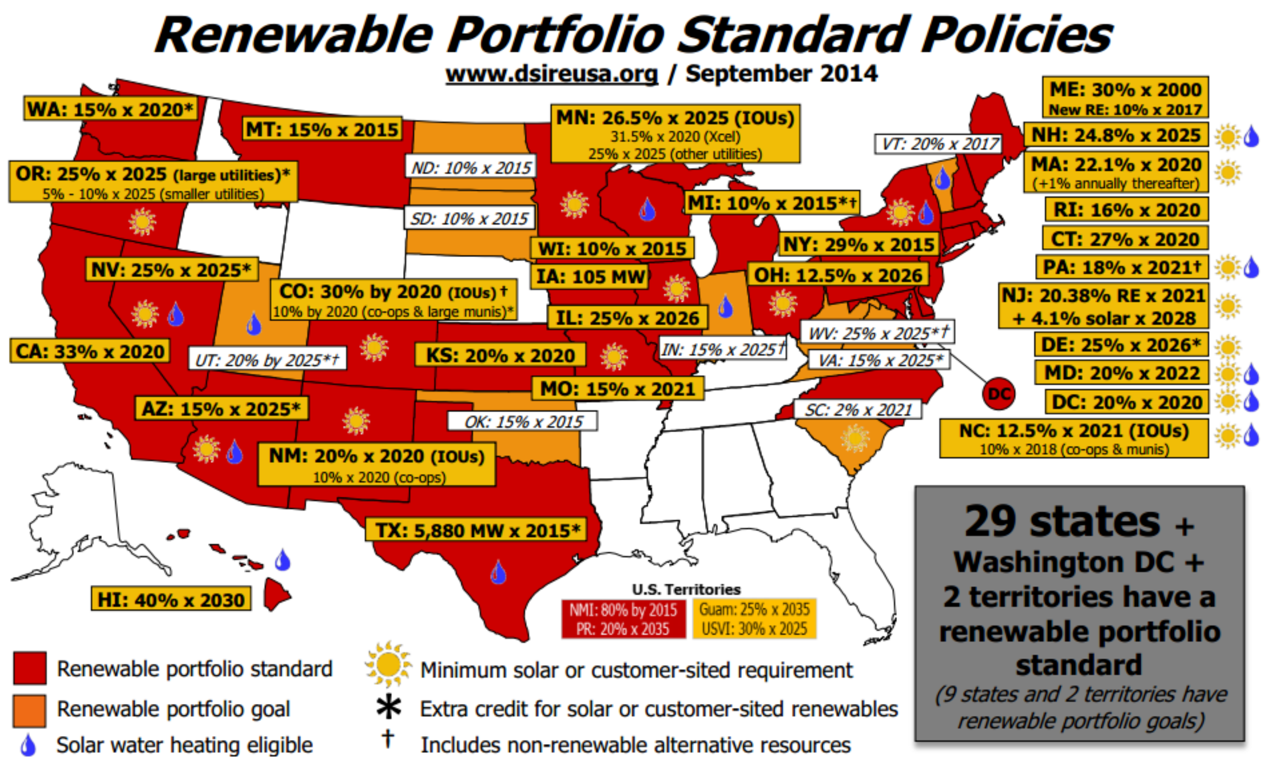
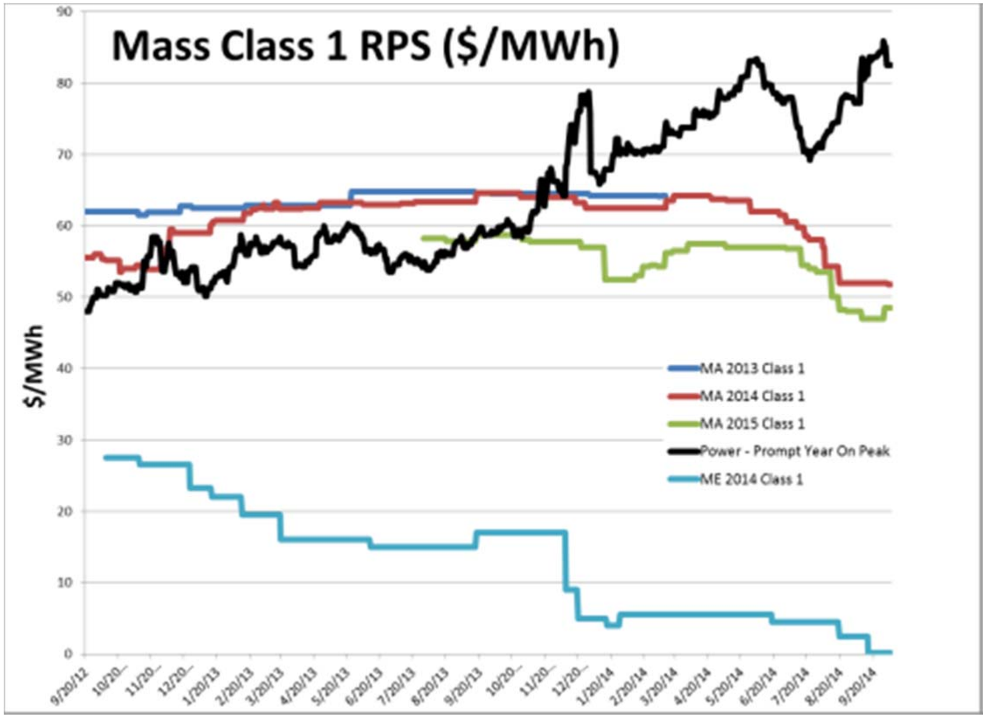
RECs Driven by Renewable Portfolio Standards



RPS & Power Pricing



Data Source: Bloomberg

- **Higher Power Prices Can Result in Lower RPS Prices**
- **RPS Prices In One State Can Impact Both RPS and Power Prices In Another State**
- **RPS Requirements (And Prices) Are Highly Political**

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Bowdoin Geothermal & Heat Pumps

- Geothermal
  - Osher & West Residence Halls
  - Studzinski Recital Hall
- Heat Pumps
- Overall Success With a Few Challenges

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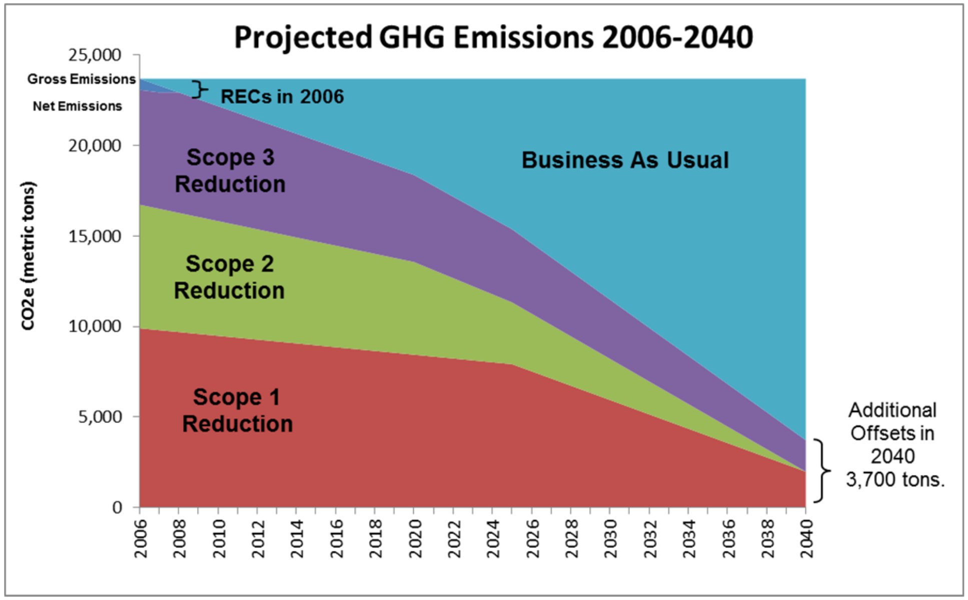
Case Study
University Maine System

- Selected Projects:
  - Fuel conversions:
    - Oil to biomass (ongoing)
    - Oil to CNG (ongoing)
    - Oil to pipeline natural gas
    - Pipeline gas to landfill gas (evaluated)
    - No one solution
  - GHG Inventory
  - Onsite Renewables
  - REC procurement



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Thank You

- **Competitive Energy Services**
  - **Andrew Price**
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  - **www.competitive-energy.com**

Bowdoin's
600 kW
Backpressure
Steam Turbine

Competitive Energy Services

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