

Modeling Levelized Cost of Renewable Energy with and without Tax Credits Compared with Retail Electricity Prices

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Let's Talk about "Grid Parity"

The point at which the amortized cost of a solar PV system becomes equal to retail electricity prices

Using North Carolina and Solar Photovoltaics (PV) as a Case Study and the System Advisor Model (SAM) to model the Levelized Cost of Energy (LCOE) to compare with Retail Electricity Prices



North Carolina

Policy Scorecard

Policies	NC
Federal Tax Credit	30%
State Tax Credit	35%
Renewable Energy Portfolio Standard	Yes
Rebates	No
Commercial Property Tax Abatement	80%
3rd Party Sales	No
Net Metering Grade (IREC, 2011)	D
Interconnection Grade (IREC, 2011)	B
Community Energy	No



North Carolina

Residential and Commercial Customers

Utility Ownership	Utilities	Residential Accounts	Commercial Accounts	% Total Accounts
Cooperative	31	926,727	88,676	21%
Municipal	71	488,743	89,284	12%
Investor	3	2,764,395	464,754	67%
Total	105	4,179,865	642,714	4,822,579

Source: U.S. Energy Information Administration, Form 2, File 861, 2010



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North Carolina

Electricity Prices (2010)

Avg. Electricity Price	Residential	Commercial
Cooperative	\$0.12	\$0.10
Municipal	\$0.12	\$0.11
Investor	\$0.10	\$0.08
Total	\$0.11	\$0.10

Source: U.S. Energy Information Administration, Form 2, File 861, 2010

**Demand charges and other fees are not included*



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Opportunities in North Carolina

Current policies benefitting local development



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North Carolina State Tax Credit

- 35% of the installed cost of the system taken in five equal installments with carryover if not used during the five years. There is a federal adjustment equivalent to the marginal tax bracket.
- The maximum credit for residential PV is \$10,500. The maximum credit for businesses is \$2,500,000 for all types of renewable energy technologies.



Property Tax Abatement for Commercial Solar Electric Systems and 100% Exemption for Residences

- 80% of the appraised value of a solar energy electric system is exempt from property tax.
- 100% exemption from property taxes for residences

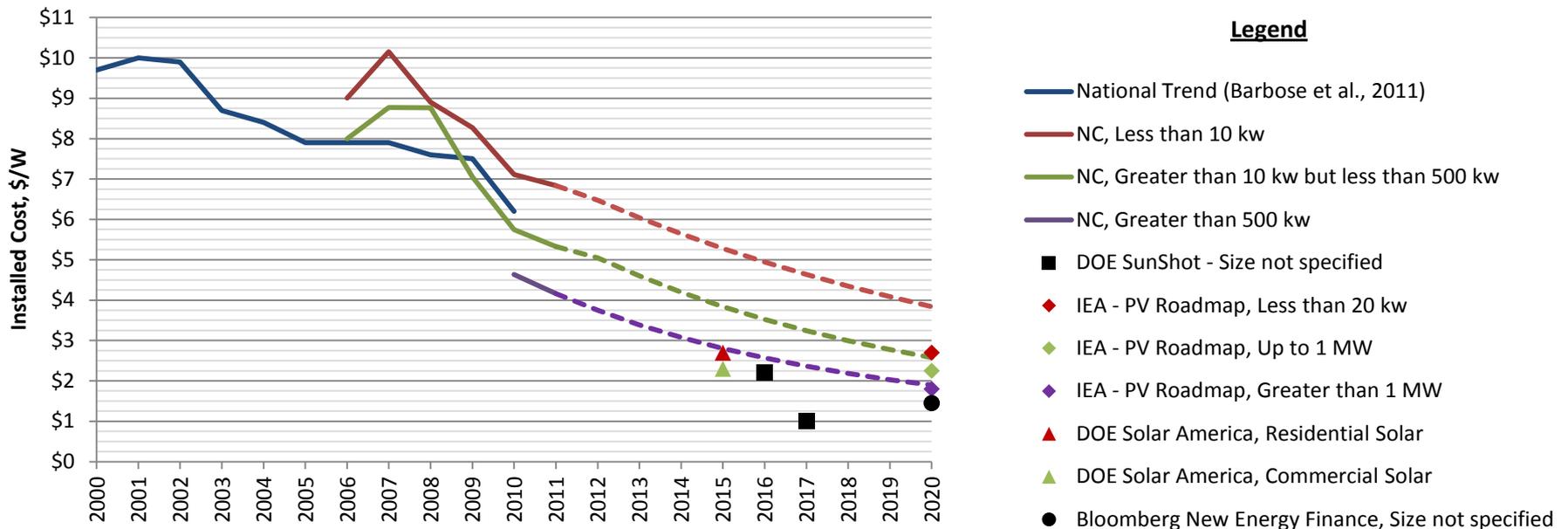
Applies to the following:

- Commercial
- Industrial
- Agricultural



Market Dynamics

The Cost of Solar PV in NC is Dropping NC Actual & Projected Solar Cost \$/W



Solar PV in North Carolina decreased 36% from \$8.50/W in 2006 to \$5.44/W in 2011.

Source: NC Utilities Commission; "Levelized Cost of Solar PV in NC, 2012" report by NCSEA



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Solar PV Installations:

Megawatts (MW) of Registered Solar PV Capacity in North Carolina Expected Online from 2006-2011

Expected Year Online	Capacity MW DC (a)	Number of Systems	Solar PV System Capacity		
			10 kW or Less	Greater than 10 kW through 500 kW	Greater than 500 kW
2006	0.26	24	22	2	0
2007	0.32	54	50	4	0
2008	5.49	116	105	7	4
2009	25.88	199	167	24	8
2010	28.43	352	283	57	12
2011	91.59	519	379	107	33
TOTAL	151.97	1,264	1006	201	57

Sources: NC Sustainable Energy Association, NC Utilities Commission

Notes: (a) Solar PV systems produce electricity in direct current (DC), which is converted by inverters to alternating current (AC), the typical current used throughout the U.S. electric grid. As a result, it is normal industry practice to report solar PV capacity in DC units. For the purpose of this report, 15.5 MW of reported AC capacity in 2010 and 19.5 MW of reported AC capacity in 2011 were converted to the equivalent DC capacity.

Given a 16% AC Capacity Factor, 152 MW DC produces 218,059 MWh a year—enough to power over 18,000 homes!

Source: National Renewable Energy Laboratory System Advisor Model



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Scenarios for LCOE Study

LCOE Trend Lines Modeled for Solar PV Systems in North Carolina.

System Capacity	System Ownership	Tax Credits	Timeframe
10 kW or Less	Residential	With Tax Credits	2006 to 2020
10 kW or Less	Residential	Without Tax Credits	2006 to 2020
Greater than 10 kW through 500 kW	Commercial	With Tax Credits	2006 to 2020
Greater than 10 kW through 500 kW	Commercial	Without Tax Credits	2006 to 2020
Greater than 500 kW	Commercial	With Tax Credits	2010 to 2020
Greater than 500 kW	Commercial	Without Tax Credits	2010 to 2020

Source: "Levelized Cost of Solar PV in NC, 2012" report by NCSEA

Note: Systems of 10 kW or less are assumed to have residential ownership for tax purposes.



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Calculating the Levelized Cost of Energy (LCOE) of Solar PV Systems

This equation yields a net present value in the familiar cents per kilowatt-hour (kWh) of electricity generated based on the following:

- System cost
- Financing
- Insurance
- Operations and Maintenance
- Depreciation
- Incentives

$$LCOE = \frac{\textit{Lifetime Cost}}{\textit{Lifetime Energy Production}}$$

Source: "Levelized Cost of Solar PV in NC, 2012" report by NCSEA

Note: The System Advisor Model (SAM) developed by the National Renewable Energy Laboratory was used to generate the LCOE.



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Inputs into System Advisor Model (SAM): Parametric Analysis

		10 kW or Less	Greater than 10 kW through 500 kW	Greater than 500 kW
Historical \$/W	2006	\$9.00	\$8.00	-
	2007	\$10.15	\$8.77	-
	2008	\$8.91	\$8.77	-
	2009	\$8.27	\$7.05	-
	2010	\$7.11	\$5.75	\$4.63
	2011	\$6.84	\$5.33	\$4.16
Projected \$/W	2012	\$6.47	\$5.05	\$3.75
	2013	\$6.04	\$4.60	\$3.39
	2014	\$5.65	\$4.20	\$3.08
	2015	\$5.28	\$3.84	\$2.80
	2016	\$4.94	\$3.53	\$2.57
	2017	\$4.63	\$3.24	\$2.36
	2018	\$4.35	\$2.99	\$2.19
	2019	\$4.08	\$2.77	\$2.03
	2020	\$3.84	\$2.58	\$1.90

Source: NC Utilities Commission; "Levelized Cost of Solar PV in NC, 2012" report by NCSEA



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SAM Fields	10 kW or less	Greater than 10 kW through 500 kW	Greater than 500 kW
SAM Financing Option	Residential	Commercial PPA	Commercial PPA
Federal Taxes Marginal Income Tax Rate	28%	34%	34%
Federal Taxes Investment Tax Credit	30%	30%	30%
North Carolina Taxes Marginal Income Tax Rate	7%	6.9%	6.9%
North Carolina Taxes Tax Credit ^(a)	25.2% (max = \$10,500)	23.1% (max = \$2.5 million)	23.1% (max = \$2.5 million)
Property Tax County & City Tax Rate	0.9075%	0.9075%	0.9075%
Property Tax Assessed Percent	0%	20%	20%
Depreciation	No Depreciation	5-year modified accelerated cost recovery system	5-year modified accelerated cost recovery system
Loan	7.75% for 10 years for 50% of the total cost	6% interest for 10 years for 50% of the total cost	6% interest for 10 years for 50% of the total cost
Tilt of System	36 degree tilt (fixed system)	36 degree tilt (fixed system)	36 degree tilt (fixed system)
Azimuth	180 Degrees	180 Degrees	180 Degrees
Derate Factor	84% DC to AC	84% DC to AC	84% DC to AC
System Degradation Rate	0.5% per year	0.5% per year	0.5% per year
Economic Life of System	20 years	20 years	20 years
Geographic Location	Raleigh, North Carolina	Raleigh, North Carolina	Raleigh, North Carolina
Real or Nominal Dollars	Nominal	Nominal	Nominal

The figures entered into the SAM model are adjusted downward to reflect the effective tax credit after accounting for interactions between federal and state taxes. However, the figure and results do not correct for the time value of money as the North Carolina tax credit is received over multiple years.

Source: "Levelized Cost of Solar PV in NC, 2012" report by NCSEA

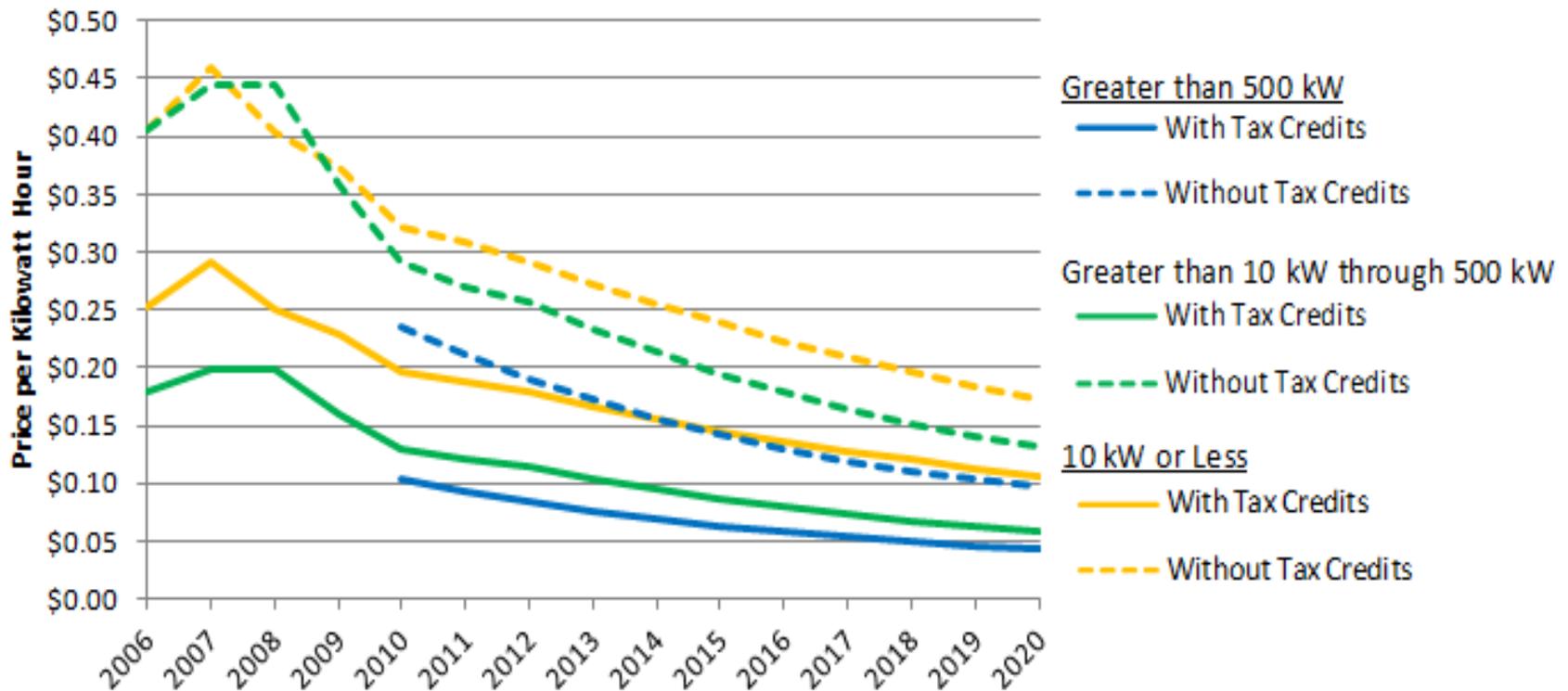


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Realignment of energy cost dynamics

Solar Prices in NC are Dropping

NC Actual & Projected Solar Cost (LCOE)

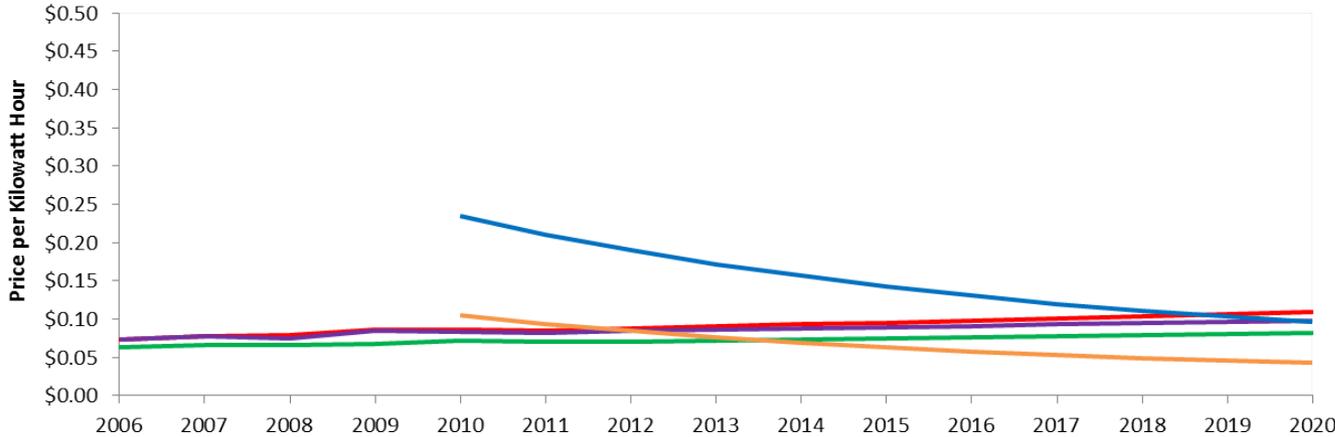


Source: NC Utilities Commission; "Levelized Cost of Solar PV in NC, 2012" report by NCSEA
Note: Systems of 10 kW or less are assumed to have residential ownership for tax purposes.



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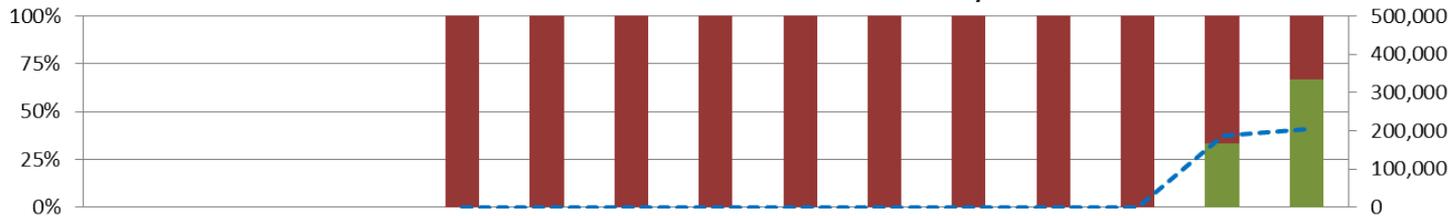
Commercial PV LCOE Compared with Retail Electricity Prices from 2006-2020



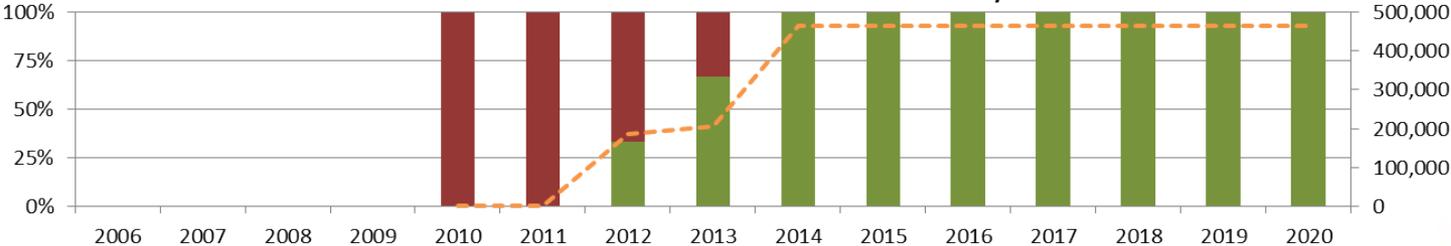
Investor-Owned Utilities
Commercial Electricity Prices
Commercial Ownership of PV System
Greater than 500 kW

- Progress Energy
- Dominion North Carolina
- Duke Energy
- Solar LCOE without Tax Credits
- Solar LCOE with Tax Credits

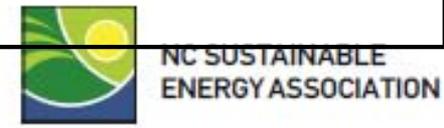
Percent of Utilities and Number of Commercial Customers at Grid Parity without Tax Credits



Percent of Utilities and Number of Commercial Customers at Grid Parity with Tax Credits

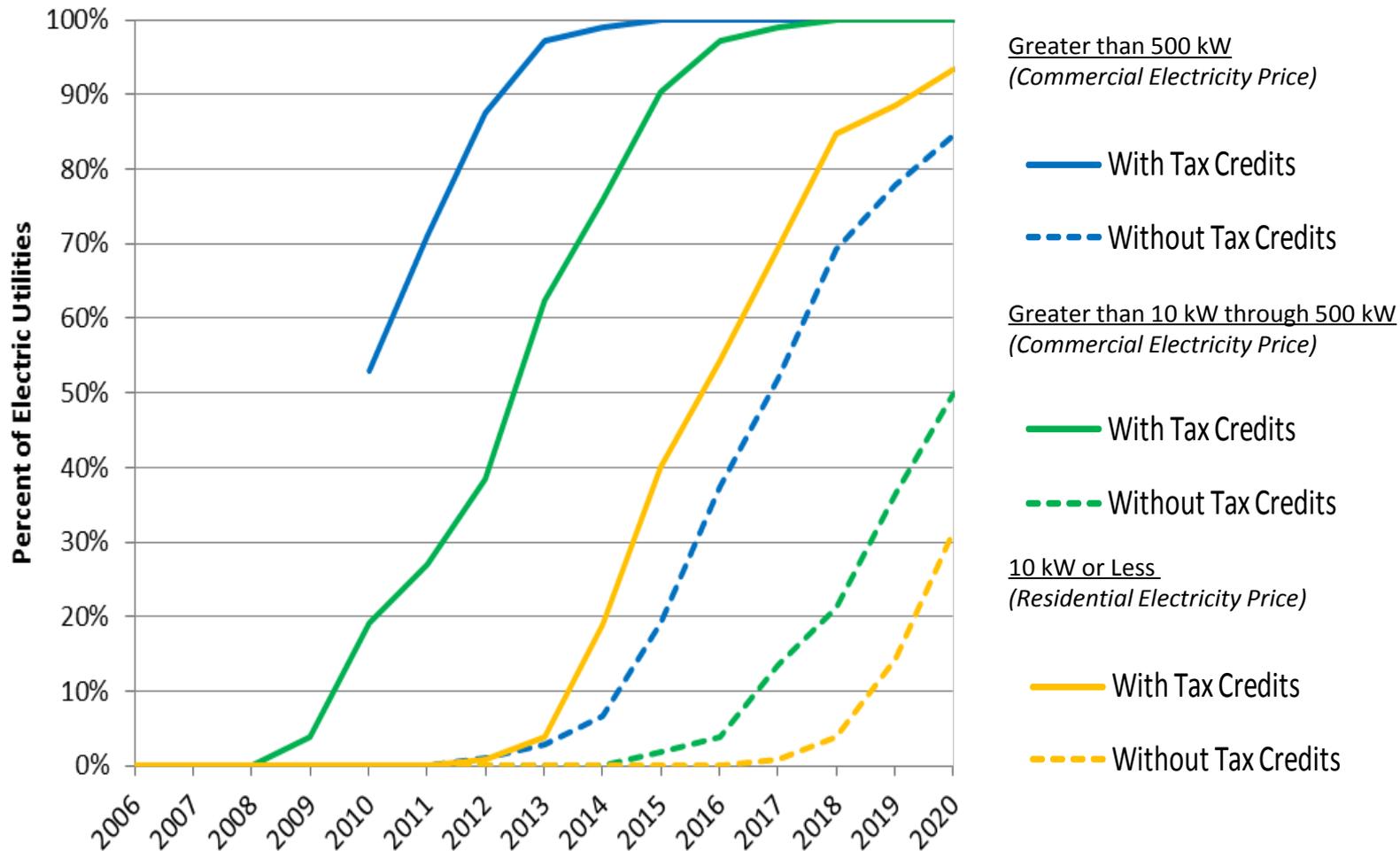


- Utilities not at Grid Parity
- Utilities at Grid Parity
- Customers at Grid Parity without Tax Credits
- Customers at Grid Parity with Tax Credits



Source: NC Utilities Commission; "Levelized Cost of Solar PV in NC, 2012" report by NCSEA
 Note: Systems of 10 kW or less are assumed to have residential ownership for tax purposes.

Percentage of Electric Utilities at Grid Parity with LCOE of Solar PV Systems from 2006-2020

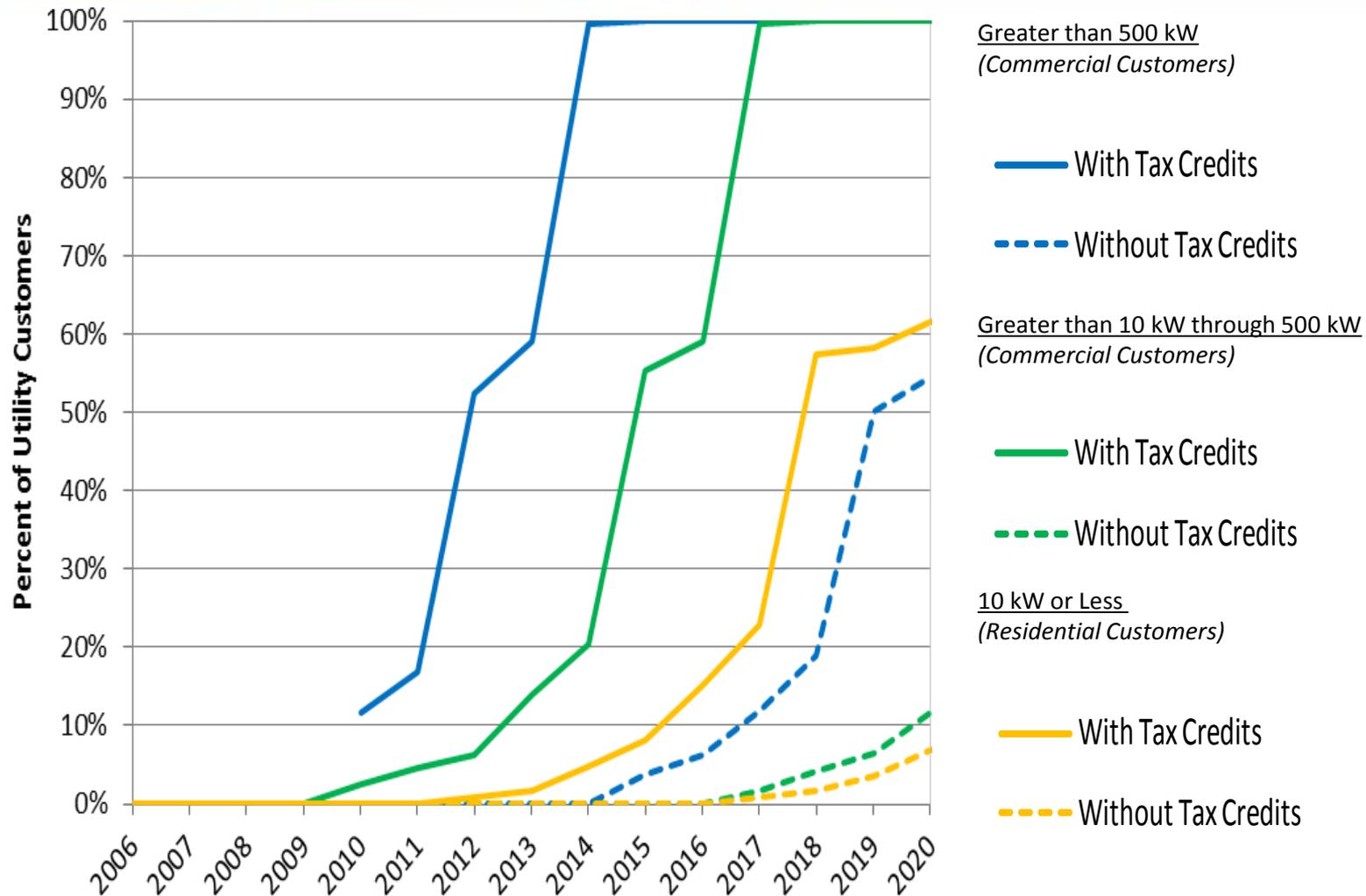


Source: NC Utilities Commission; "Levelized Cost of Solar PV in NC, 2012" report by NCSEA
 Note: Systems of 10 kW or less are assumed to have residential ownership for tax purposes.



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Percentage of Electric Customers at Grid Parity with LCOE of Solar PV Systems from 2006-2020



Source: NC Utilities Commission; "Levelized Cost of Solar PV in NC, 2012" report by NCSEA
 Note: Systems of 10 kW or less are assumed to have residential ownership for tax purposes.



Key Findings from LCOE Report

- For **many** electric utilities, solar PV systems **greater than 10 kW** with federal and state tax credits were at grid parity or cost competitive with commercial retail electricity prices in North Carolina in **2011**.
- For **all** North Carolina electric utilities, solar PV systems **greater than 500 kW** with federal and state tax credits achieve grid parity or become cost competitive with commercial retail electricity prices in **2015**.
- For **all** North Carolina electric utilities, solar PV systems **greater than 10 kW through 500 kW** with federal and state tax credits achieve grid parity or become cost competitive with commercial retail electricity prices in **2018**.
- For the **majority** of North Carolina electric utilities, solar PV systems **10 kW or less** taking federal and state tax credits achieve grid parity or become cost competitive with residential retail electricity prices in **2020**.
- For **many** electric utilities, solar PV **without federal and state tax credits** will be at grid parity or cost competitive with retail electricity prices in North Carolina in **2020**.



Thank You!

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Miriam Makhyoun is the Solar & Renewable Energy Industry Specialist for the NC Sustainable Energy Association (NCSEA), where she works fluidly with NCSEA's public policy and market intelligence teams to facilitate solar and renewable energy industry growth and development. She is also the Director for Development of Energy Systems for em[POWER] Energy Group, Inc. Prior to joining NCSEA, Miriam was an Assistant Project Manager Intern at Strata Solar in Chapel Hill, NC, where she managed a 5.1 MW PV installation in Kings Mountain, NC, and a 900 kW PV system in Newland, NC, arranged procurement, delivery, and labor schedules using Gantt Charts, facilitated contracts and certifications and drafted requests for quotes with scopes of work and evaluated corresponding bids from subcontractors. She was an Energy Analyst and a Landfill Gas Program Researcher for the Appalachian Energy Center and the former Financial Manager for Flip Model for Solar Power at the Hospitality House. Miriam holds a Master of Science in Technology with a concentration in Appropriate Technology, a Master of Business Administration with a concentration in Sustainable Business, a B.S. in International and Comparative Politics, and a B.A. in French from Appalachian State University. She is fluent in French and also speaks Spanish.



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