

Levelized Cost of Solar Photovoltaics in North Carolina

A Parametric Analysis using System Advisor Model

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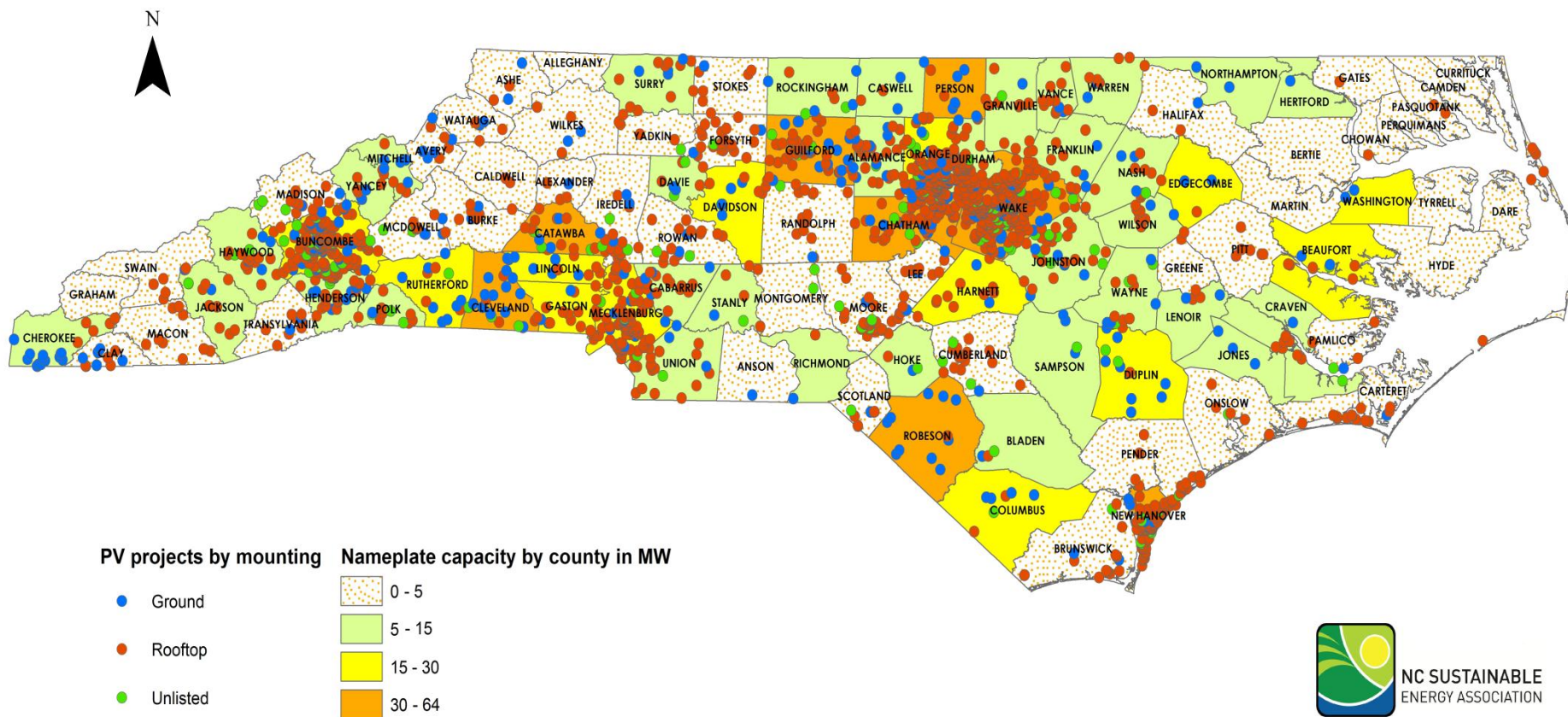
National Renewable Energy Laboratory
SAM Virtual Conference
July 23, 2013

North Carolina Leads in Solar

Ranked 5th for 2012 Installed Capacity and 6th for Cumulative Capacity by SEIA and GTM

Photovoltaic System Registration and Nameplate Capacity in North Carolina

January 2013



Registered Solar PV Capacity in NC from 2006-2012

| Cost Year | Capacity MW DC | No. of Systems | Solar PV System Capacity MW DC | | | | |
|--------------|----------------|----------------|--------------------------------|------------|------------|-------------|--------------|
| | | | 0-5 kW | 5-10 kW | 10-150 kW | 150-1000 kW | >1 MW |
| 2006 | 0.1 | 23 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2007 | 1.0 | 57 | 0.1 | 0.1 | 0.3 | 0.5 | 0.0 |
| 2008 | 11.7 | 133 | 0.3 | 0.1 | 0.6 | 8.5 | 2.3 |
| 2009 | 29.6 | 207 | 0.4 | 0.4 | 0.9 | 4.7 | 23.3 |
| 2010 | 42.9 | 374 | 0.6 | 0.7 | 2.4 | 11.4 | 27.8 |
| 2011 | 70.8 | 541 | 1.0 | 0.7 | 2.6 | 18.9 | 47.6 |
| 2012 | 477.9 | 725 | 1.3 | 1.1 | 1.6 | 22.3 | 451.7 |
| TOTAL | 634.1 | 2,060 | 3.6 | 3.1 | 8.5 | 66.2 | 552.6 |

Source: North Carolina Utilities Commission Small Power Producer Dockets

Notes: 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 systems reported in AC, an 84% DC to AC derate factor was applied.



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Methodology

LCOE, Avoided Cost, “Grid Parity” and Forecast to 2020

PV Levelized Cost of Energy (LCOE) Calculation

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

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

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

Note: The System Advisor Model (SAM), developed by the National Renewable Energy Laboratory, was used to generate the LCOE of PV using a parametric analysis for the application of tax credits and the evolving past and projected installed costs.



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Changing Policy Environment

Modeled:

- Reduction of federal investment tax credit at the end of 2016 from 30% to 10%
- Expiration state tax credit at the end of 2015

Not Modeled:

- The 2013 sequestration of tax credits issued by the Department of Treasury might also affect future solar PV development.
- County and city ordinances regulating solar may also play a role.



| SAM Fields | 0-5 kW; 5-10 kW | 10-150 kW; 150-1000kW; >1000 kW |
|---|---|---|
| SAM Financing Option | Residential | Commercial PPA |
| Federal Taxes Marginal Income Tax Rate | 28% | 34% |
| Federal Taxes Investment Tax Credit | 30% | 30% |
| North Carolina Taxes Marginal Income Tax Rate | 7% | 6.9% |
| North Carolina Taxes Tax Credit ^(a) | 25.2% (max = \$10,500) | 23.1% (max = \$2.5 million) |
| Property Tax County & City Tax Rate | 0.9075% | 0.9075% |
| Property Tax Assessed Percent | 0% | 20% |
| Depreciation | No Depreciation | 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 |
| Tilt of System | 36 degree tilt | 36 degree tilt |
| Derate Factor | 84% DC to AC | 84% DC to AC |
| System Degradation Rate | 0.5% per year | 0.5% per year |
| Economic Life of System | 20 years | 20 years |
| Geographic Location | Raleigh, North Carolina | Raleigh, North Carolina |

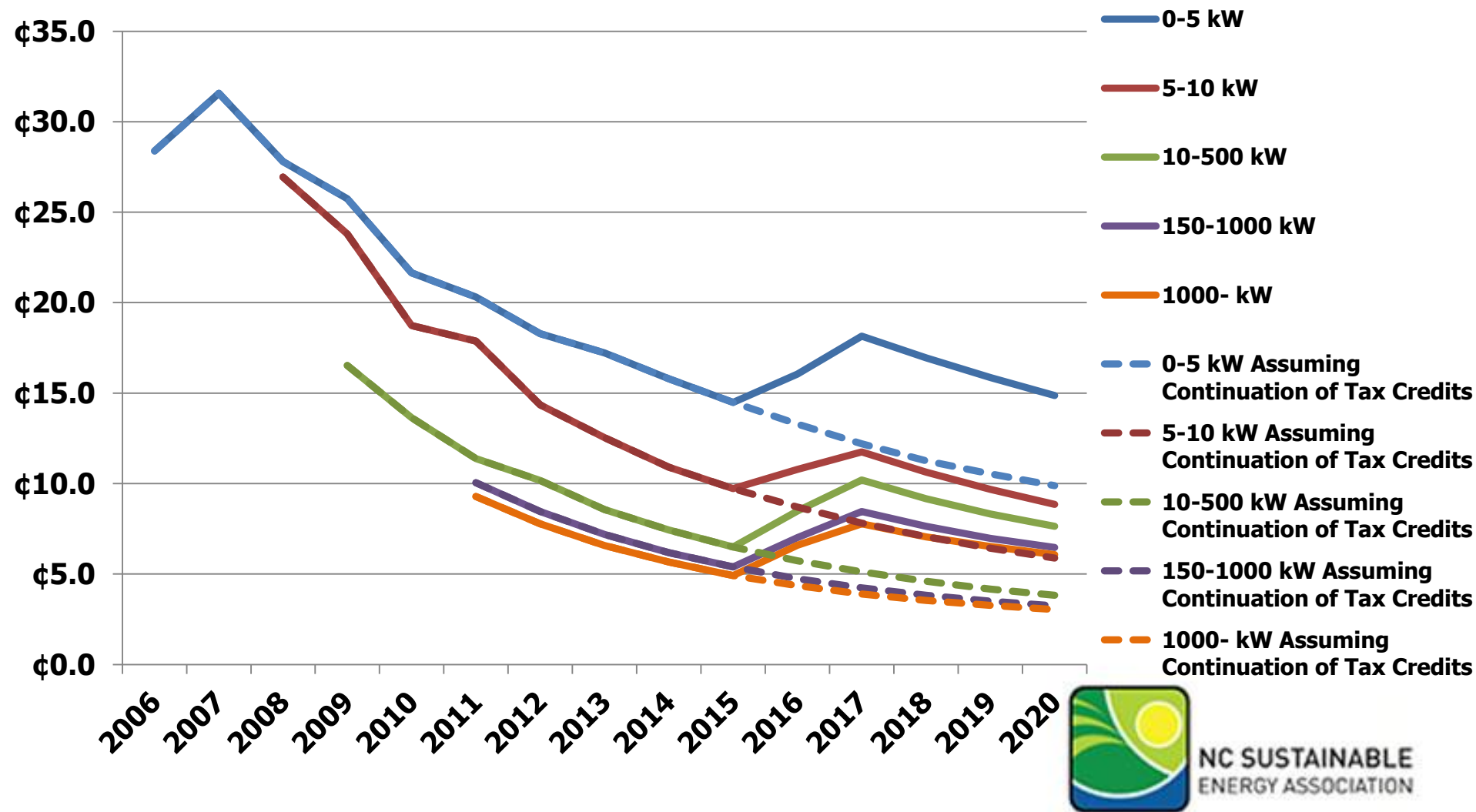
Market Performance

Solar LCOE Trends and Grid Parity with
Retail Electricity Prices and Avoided Cost

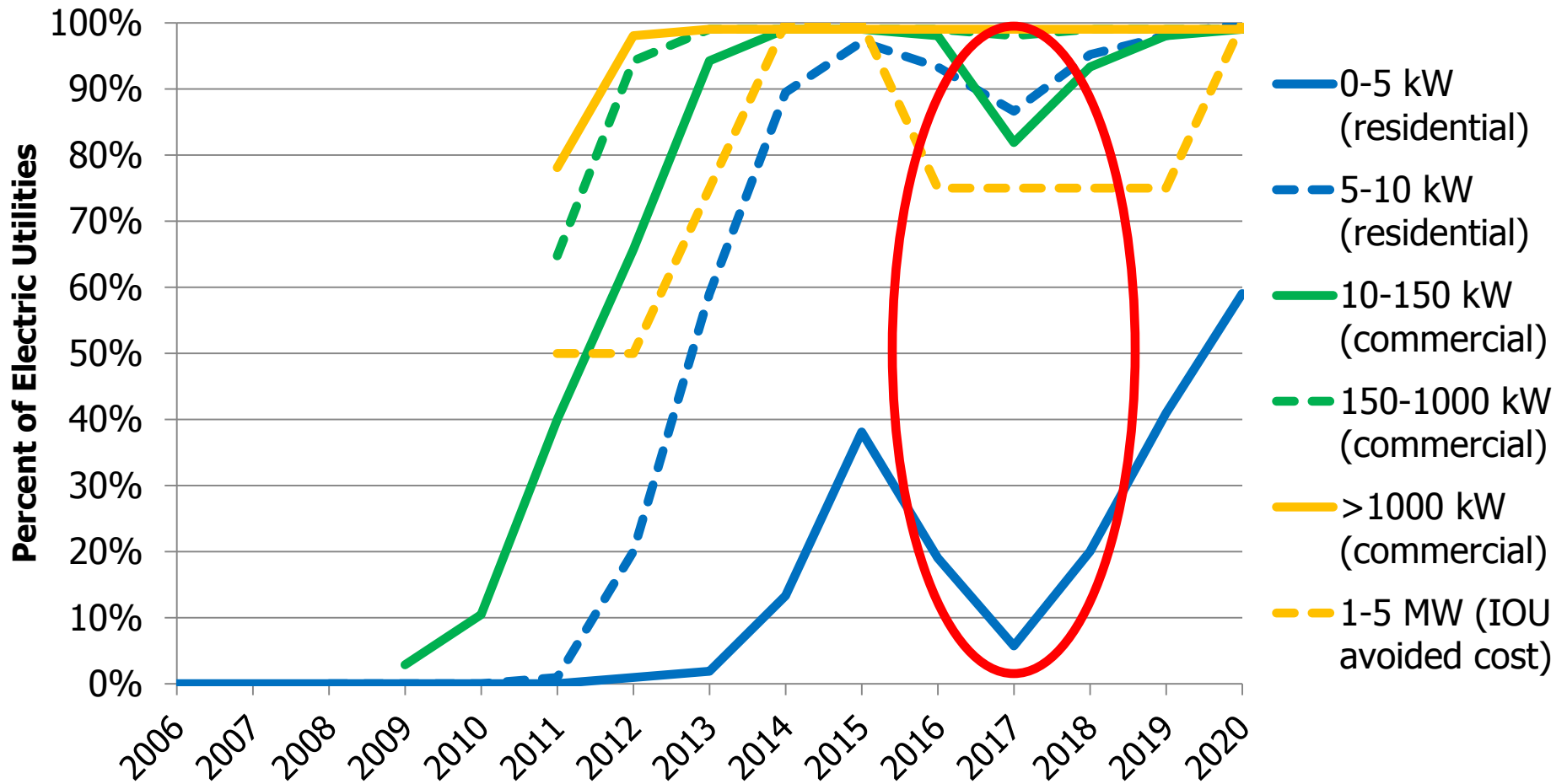
The Cost of Solar PV in NC is Dropping

NC Actual & Projected Solar LCOE ¢/kWh

Solar PV installed cost in NC decreased 52% from \$7.1/W in 2006 to \$3.4/W in 2012.



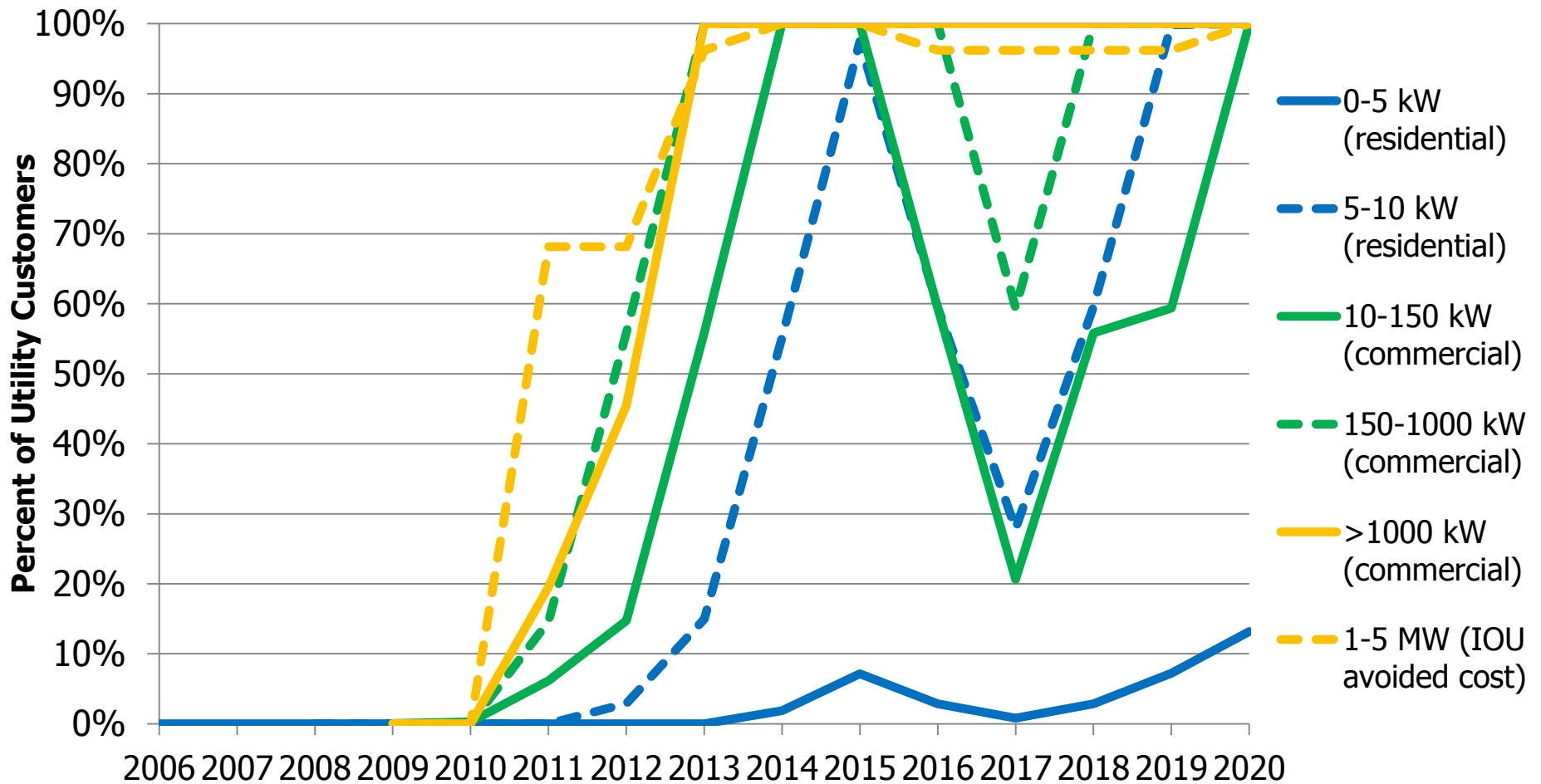
Percentage of Electric Utilities at Grid Parity with LCOE of Solar PV Systems from 2006-2020



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Source: NC Utilities Commission; "Levelized Cost of Solar PV in NC, 2013" report by NCSEA
Note: Systems of 10 kW or less are assumed to have residential ownership for tax purposes.

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, 2013" report by NCSEA
Note: Systems of 10 kW or less are assumed to have residential ownership for tax purposes.



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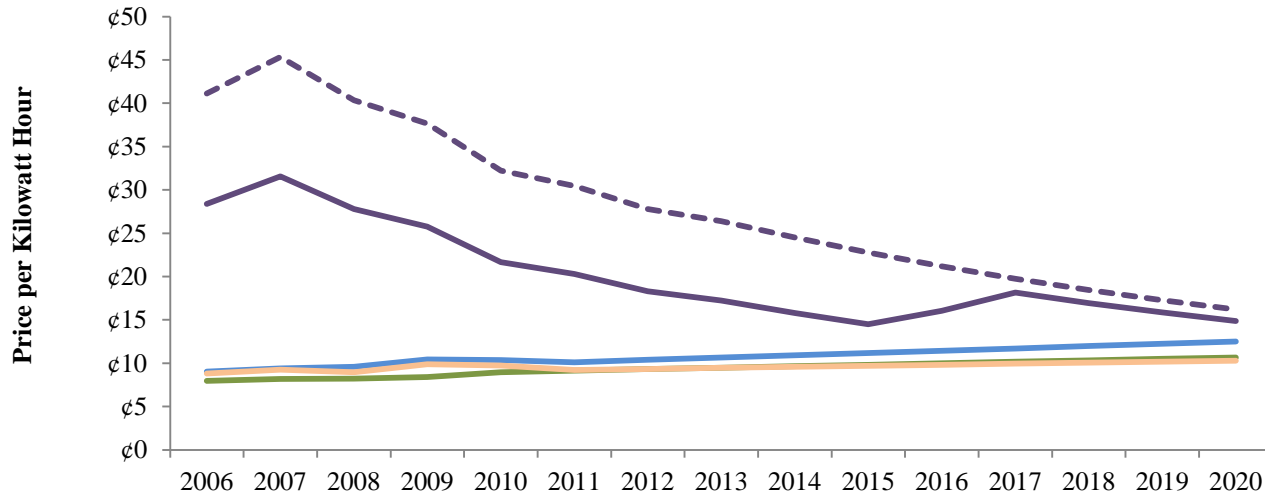
Conclusions

“Grid Parity” by Capacity Class in North Carolina

Grid Parity for NC PV Systems with Retail Price of Electricity and Avoided Cost for Investor-Owned Utilities (Tax Credits Applied)

| Capacity | Cooperatives | Municipals | Investor-Owned Utilities | | |
|-----------------------------------|--------------|------------|--------------------------|---------------|----------|
| | | | Progress | Duke | Dominion |
| 0-5 kW (residential) | 2019 | 2019 | N/A | N/A | N/A |
| 5-10 kW (residential) | 2013 | 2013 | 2015 | 2019 | 2019 |
| 10-150 kW (commercial) | 2013 | 2013 | 2014 | 2015 | 2014 |
| 150-1000 kW (commercial) | 2011 | 2011 | 2012 | 2013 | 2013 |
| >1000 kW (commercial) | 2011 | 2011 | 2012 | 2013 | 2012 |
| 1-5 MW 2012 (IOU avoided cost) | - | - | NO | YES(Option B) | NO |

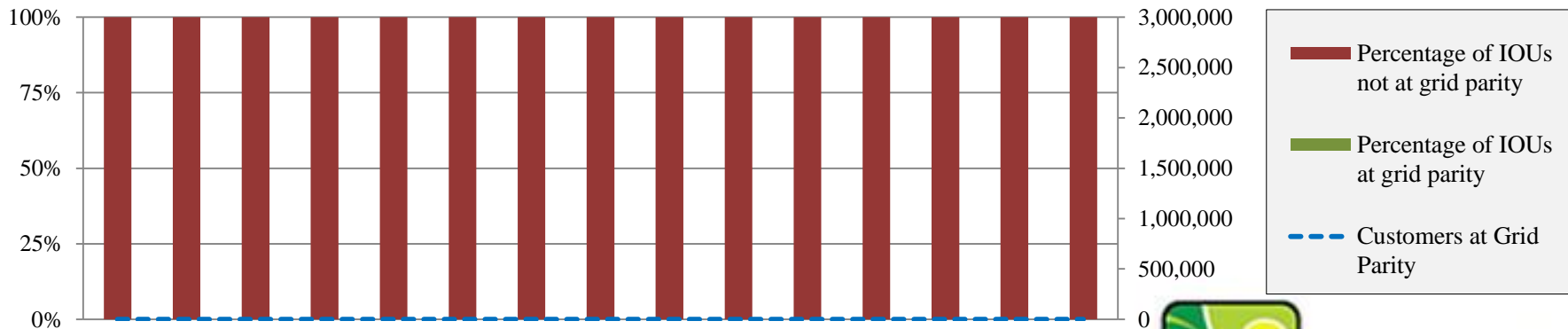
Residential PV Under 5 kW



Investor-Owned Utilities
Residential Electricity Prices
Residential Ownership of PV System 5 kW or Less

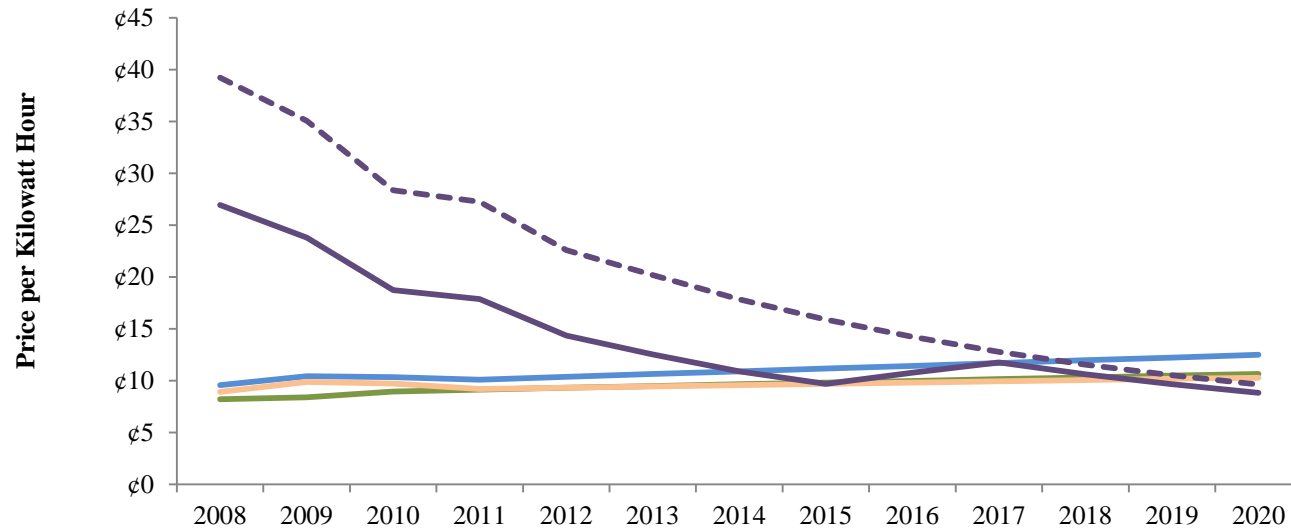
Progress Energy (Residential)
Duke Energy (Residential)
Dominion North Carolina (Residential)
5 kW or less (Residential with incentives)
5 kW or less (Residential without incentives)

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



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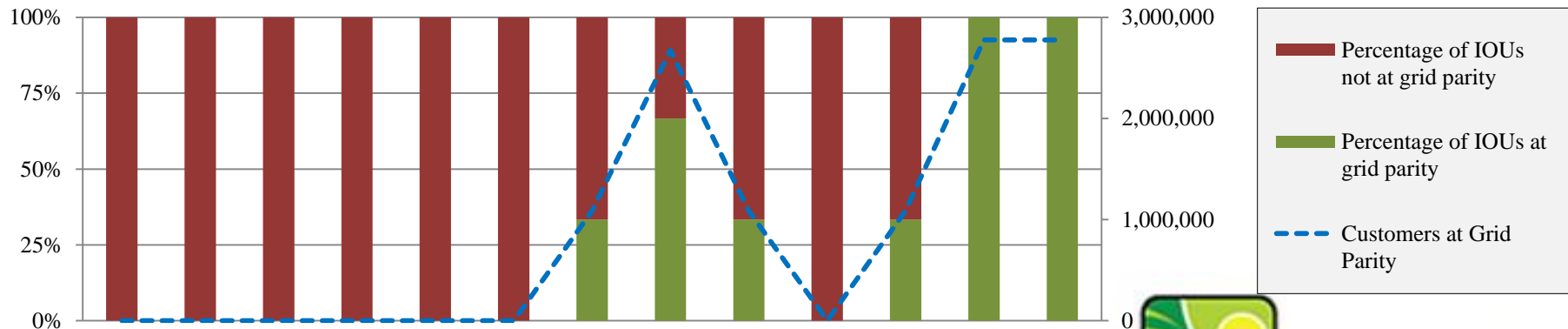
Residential PV 5-10 kW



Investor-Owned Utilities
Residential Electricity Prices
Residential Ownership of PV System 5 kW
through 10 kW

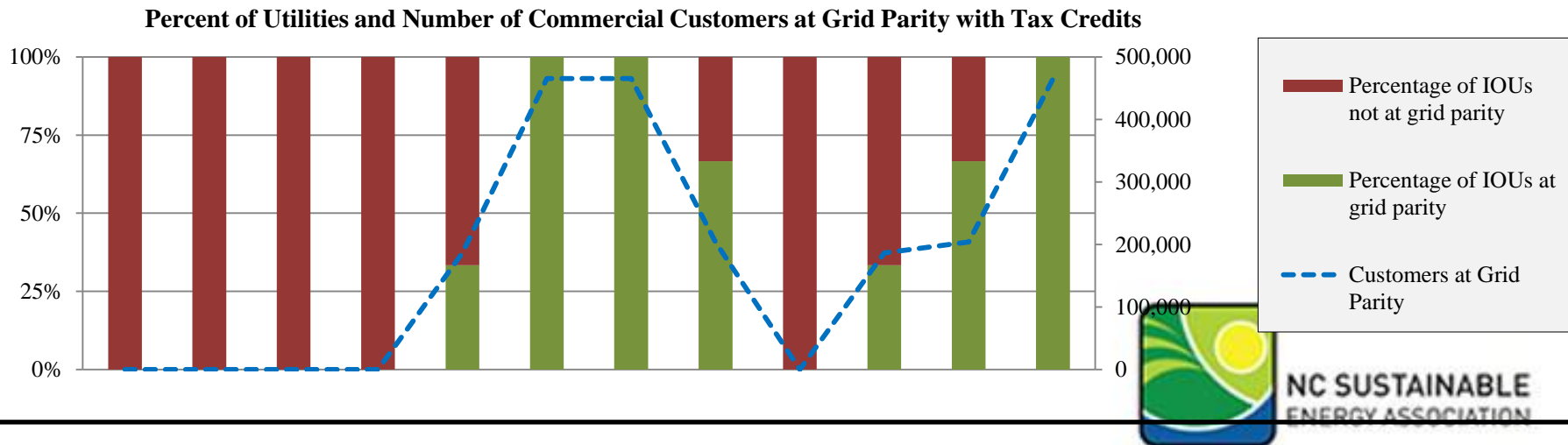
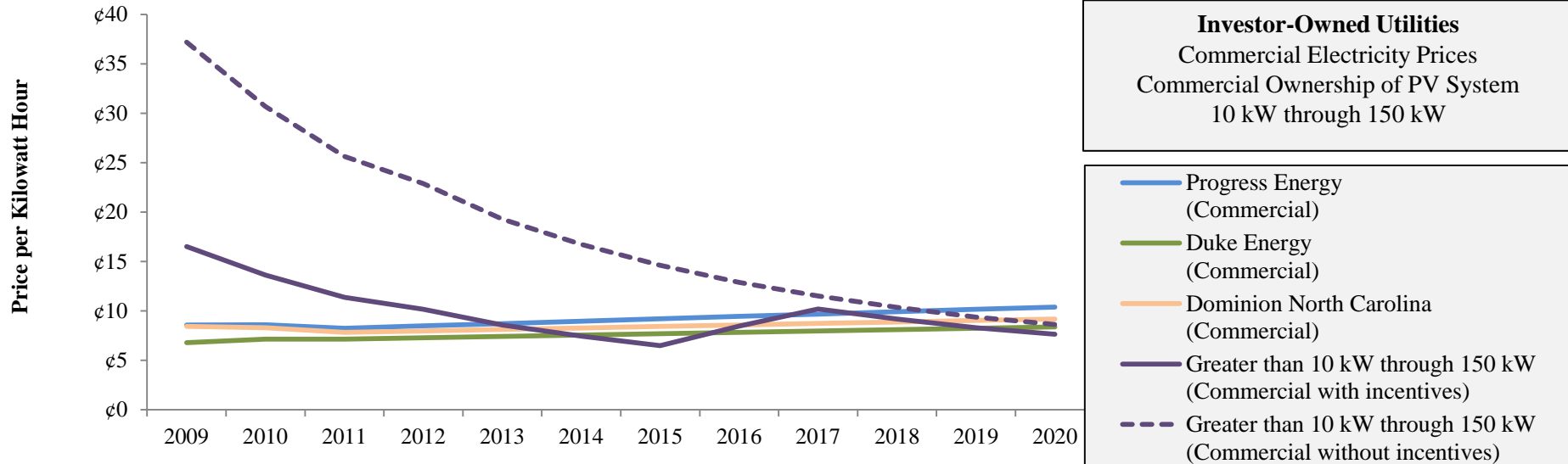
- Progress Energy (Residential)
- Duke Energy (Residential)
- Dominion North Carolina (Residential)
- Greater than 5 kW through 10 kW (Residential with incentives)
- Greater than 5 kW through 10 kW (Residential without incentives)

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

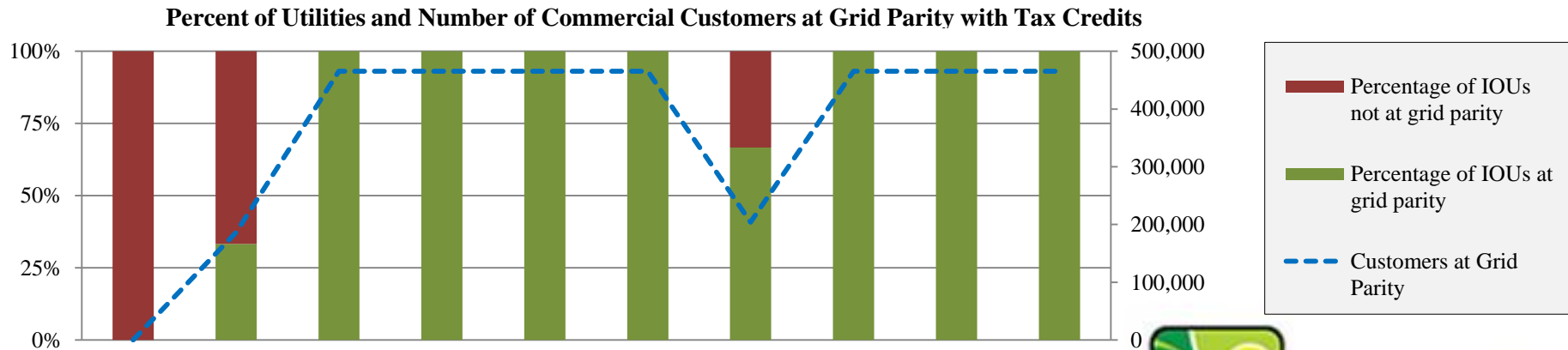
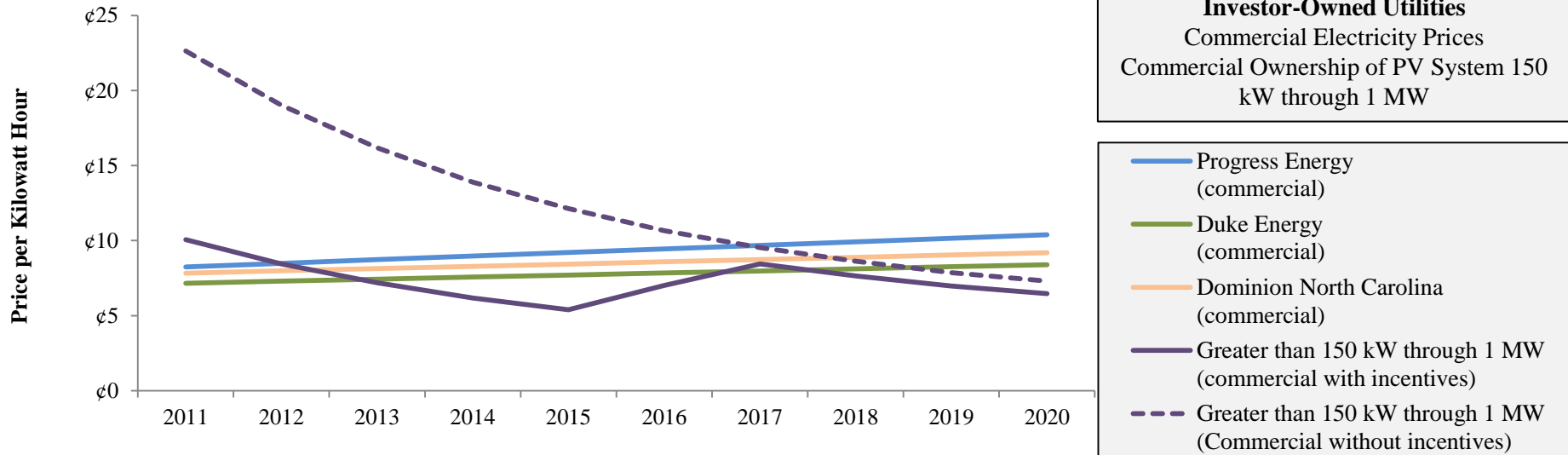


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Commercial PV 10-150 kW

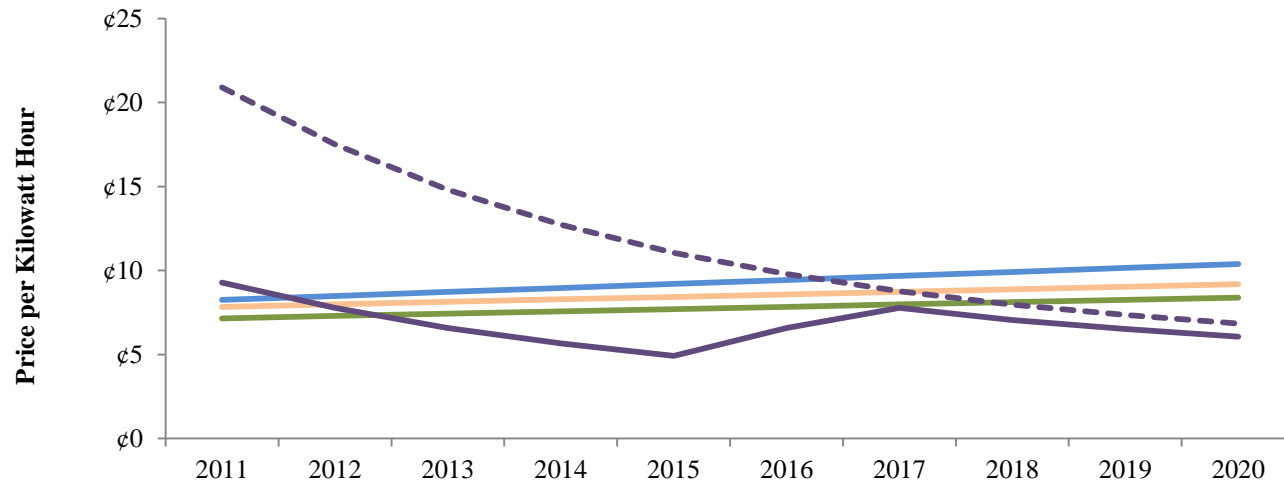


Commercial PV 150 kW- 1 MW



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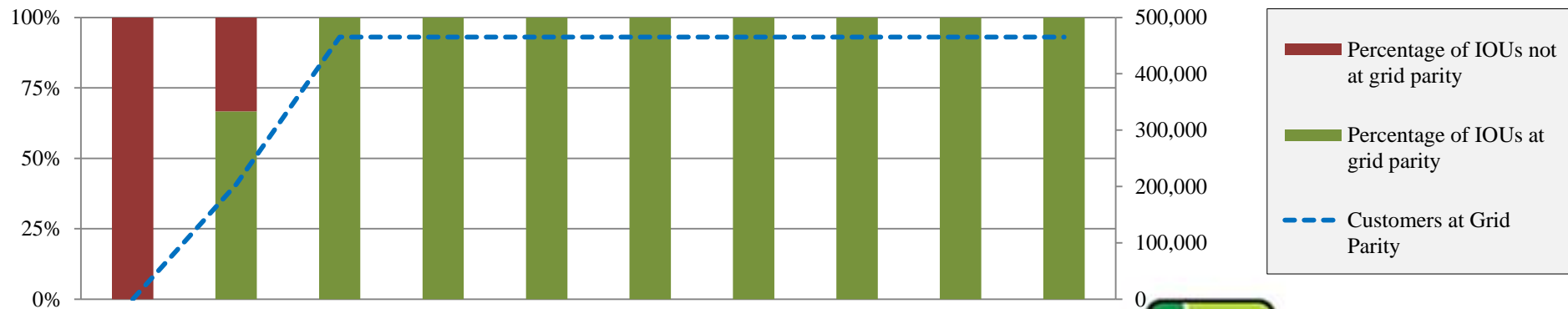
Commercial PV over 1 MW



Investor-Owned Utilities
 Commercial Electricity Prices
 Commercial Ownership of PV System
 Over 1 MW

- Progress Energy (Commercial)
- Duke Energy (Commercial)
- Dominion North Carolina (Commercial)
- Greater than 1 MW (Commercial with incentives)
- Greater than 1 MW (Commercial without incentives)

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



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Key Findings

- **PV systems greater than 10 kW will be at “grid parity” before 2015.**
- **All solar PV systems will be at “grid parity” before 2020 (except for systems under 5 kW with investor-owned utility prices).**
- **For solar PV systems larger than 1 MW and smaller than 5 MW, it is more difficult to reach “grid parity” with avoided costs than electricity prices.**
- **Systems larger than 150 kW are less affected by tax credit changes.**



Thank you

Questions?



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