Solar PV – The National Landscape and What’s Going on in Your Backyard

Andrew Owens
Overview of Entergy Corporation

- 30,000 MW electric generating capacity
- 2.9 million utility customers
- More than $10 billion annual revenues
- 13,000+ employees

Regulated Utilities
- 5 public utilities
- 4 contiguous states – AR, LA, MS, and TX
- 15,700 miles of high-voltage transmission
- 100,000+ miles of distribution
- ~200,000 natural gas customers in LA

Entergy Wholesale Commodities
- Owns 4 nuclear units located in the northern U.S. (currently shutting down and/or selling our merchant nuclear units)
- Owns all or partial interest in several natural gas and coal-fired power plants
- Sells electricity to wholesale customers

Source: SNL
**Average Electricity Rates in the Region**

- Major factor to Louisiana’s low electric rates is lower natural gas prices
- Other low cost states have larger percentage of legacy nuclear, coal, and hydro
- High cost states such as in the Northeast and California have:
  - More expensive to build new infrastructure
  - Higher labor & related costs
  - Regulatory and tax policies

### 2016 Average Electric Rates by State and by Customer Type

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<tr>
<th>Rank</th>
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<th>Industrial</th>
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</tbody>
</table>

Source: U.S. Dept. of Energy/Energy Information Agency (EIA) Data
Historical Generator Additions in the U.S.

Sources: EIA, GTM, AWEA, SEIA
Changing U.S. Electricity Generation Fuel Mix

So what’s changed since 2006?

Natural Gas ↑ 68%
Coal ↓ 38%
Nuclear and Hydro are flat
Renewables ↑ 254%
Wind up 749%
Solar up 7,109%

Source: EIA Data
Location of Solar Power Plants vs. Solar Irradiance

Source: SNL
Changing Dynamics of the Electric Grid

Today

Future

Integrated Grid

Evolving Customer Demand for New Technology, Products, and Services

Distributed Generation  Electric Vehicles  Home Services  Microgrids  Demand Response  Storage  Energy Management
Is New Technology a Threat ... or an Opportunity?
How Solar PV Market Factors Are Changing

Near-Term Drivers

- Falling costs (modules, balance-of-system, “soft”)
- 30% federal Investment Tax Credit (ITC) and other incentives
- New financing options (loans, 3rd-party ownership like leasing)
- Policies like Renewable Portfolio Standards (RPS), PURPA, net energy metering, EPA's Clean Power Plan
- Corporate and governmental sustainability initiatives
- Low cost of capital and yieldcos

Sources: SEIA, Lawrence Berkeley National Lab, Bloomberg New Energy Finance
Rooftop Solar PV Customers in New Orleans

Source: Company Data (Apr 2017)
Entergy’s Solar PV Projects and Pilots

• Entergy Arkansas
  – Stuttgart Project: 20-year PPA with NextEra Energy for new 81 MW\textsubscript{AC} solar farm approved in 2015 and expected to be on-line by end of 2017
  – 2016 Renewable RFP seeking up to 100 MW
  – Awaiting announcement of results

• Entergy Louisiana
  – 2010 renewable pilot (RFP and Standard Offer Tariff) yielded 5 PPAs (~60 MW) with biomass (rice hulls, sugarcane bagasse), landfill gas, and waste heat recovery resources
  – 2016 renewable RFP seeking up to 200 MW
  – Recently announced that two resources had been selected
Entergy’s Solar PV Projects and Pilots

- Entergy New Orleans
  - Patterson Solar+Storage Pilot:
    - ~1.1 MW_{AC} ground-mounted with single-axis tracking (June 2016)
    - 500 kWh 1-hour Li-ion battery
  - 2016 Renewable RFP seeking up to 20 MW (includes 5 MW self-build aggregated DG-scale solar PV)
  - Awaiting announcement of results

- Entergy Mississippi
  - Three 500 kW_{DC} solar pilot projects
  - Evaluating community solar

- Entergy Texas
  - Purchases wind Renewable Energy Credits (RECs) to comply with RPS
Entergy Arkansas Long-Term PPA with NextEra

• **Background**
  – Stuttgart Solar will build, own, operate the facility
  – Power sold to EAI under a fixed price, 20-year PPA
  – Project consists of fixed-tilt panels covering ~500 acres
  – Expected to be on-line by the end of 2017
  – Will be the largest solar PV facility in AR when complete

• **Regulatory Approval**
  – Came out of an RFP process that began February 2014
  – PPA announced April 2015 and approved by the Arkansas PSC in September 2015
  – Projected net benefits of ~$25m over the 20-year PPA (expected to reduce residential bills by ~11 ¢/month)

“Given the reasonably-projected net benefits of the project, the lack of substantial evidence that the PPA would produce net detriments, and a variety of environmental regulatory cost risks, including issuance by the U.S. Environmental Protection Agency of a Final Rule regulating carbon dioxide emissions for the first time, the PPA is required by public convenience and necessity.”

Source: Arkansas PSC Order No. 5; Docket No. 15-014-U
DeSoto Solar Station
- Located in DeSoto County, MS
- 3,720 fixed-tilt panels

Hinds Solar Station
- Located in Jackson, MS
- 3,768 single-axis tracking panels

Brookhaven Solar Station
- Located in Brookhaven, MS
- 3,720 fixed-tilt panels
Entergy New Orleans Solar Power Plant

- ~1.3 MW\textsubscript{DC} (~1.1 MW\textsubscript{AC}) single-axis tracker mounted panels
- 500 kWh one-hour advanced Li-ion battery
- Project operational June 2016
- Former site of a gas-fired peaking unit destroyed by Hurricane Katrina
Entergy New Orleans Solar Power Plant
Entergy New Orleans Solar Power Plant

- Solar Smoothing/Ramp Rate Control
- Deep Discharge/Energy Shift
- Frequency and Voltage Support
Aggregated Rooftop Solar PV Project

- Entergy Services, Inc. working with a solar company submitted a self-build proposal for Entergy New Orleans’ 2016 Renewable RFP, which sought up to 20 MW
- ENOI would own and operate the solar PV systems, which would be located on customer property under long-term leases
- 100% of the power would flow to the distribution system upstream of the meter
- Individual projects in the 100 kW to 1-2 MW range
- Focus on warehousing/storage, manufacturing, Federal/DoD sites, and possibly education (universities and K-12), hospitals, and other similar locations
Aggregated Rooftop Solar PV Project

• Potential benefits include:
  – real-world experience with DG-scale solar PV
  – influence over siting
  – clear visibility into operations
  – ability to add energy storage in the future
  – avoid time and cost of transmission-level interconnection
  – ability to partner with host sites to create win-win outcomes
  – increased local investment and use of local labor
  – visibly support renewables with associated PR/goodwill

Illustrative Rooftop Solar Project
Potential Challenges from Increased Solar PV

• Operational Issues
  – Intermittency and forecasting error
  – Load and frequency fluctuations; e.g., drops in frequency can disrupt system inertia (e.g., Hawaiian Electric)
  – Limited to no visibility into real-time performance
  – 2-way power flows on legacy radial distribution lines & equipment
  – Steeper ramping of traditional resources (California Duck Curve)

• Business Issues
  – Curtailments by system operators (e.g., CAISO)
  – Distortion of wholesale power prices and ultimately customer rates
  – Financial viability of existing merchant generators using conventional fuels (gas/oil, coal, and nuclear), which in turn may affect reliability
  – Policies like 1:1 full retail credit net metering can shift fixed infrastructure costs to other customers creating fairness issues
Potential Challenges from Increased Solar PV

- Distributed Solar
- Utility-Scale Solar
- Imports
- Other Renewables
- Thermal (Gas/Oil)
- Nuclear
- Hydro

Real-Time Average Hourly Price

Sources: EIA, CAISO
One Final Thought…

Next time you're afraid to share ideas, remember someone once said in a meeting, let's make a film with a tornado full of sharks.