Municipal Utilities Exploring Solar Options for Communities

Emerson Reiter, NREL Project Lead
Amanda Stephens, Pasadena Energy Programs Manager
Donald Chung, NREL Senior Project Lead
Brian Newton, Utility Manager for Fremont, Nebraska

Distributed Generation Interconnection Collaborative (DGIC)
December 8, 2016
Agenda

Introduction - Emerson Reiter, NREL

Solar + Storage in Pasadena, CA
  - Introduction - Amanda Stevens, Pasadena Water and Power
  - Analysis and Results - Donald Chung, NREL

Community Solar in Fremont, NE
  - Introduction - Brian Newton, Fremont Department of Utilities
  - Analysis and Results - Emerson Reiter, NREL

Question & Answer
Distributed Generation Interconnection Collaborative (DGIC)

- Supported by the U.S. DOE SunShot initiative
- Launched following a stakeholder workshop in Oct 2013
- Has executed 15 webinars to date

**Area 1: Practices and Protocols**
- Document current best practices and standards
- Identify replicable innovation and consistency

**Area 2: Peer Exchange**
- Facilitate data and information exchange amongst stakeholders
- Provide platform for peer learning and outreach
DGIC Planned 2017 Activities

**Area 1: Practices and Protocols**
- Develop case studies on leading interconnection practices based on peer nomination
- Execute data analysis on pre-application reporting for interconnection applicants
- Curate and share cutting-edge DG research from DOE programs

**Area 2: Peer Exchange**
- Publish “lessons learned” on community solar for municipal utilities (late 2016)
- Redesign DGIC website (go-live in January 2017)
- Hold four quarterly webinars with utility & industry experts
Participants are joined in listen-only mode.

Use the Q&A panel to ask questions during the webinar.

To ask a question: Type your question in the Q&A GoToWebinar toolbar.

The webinar is being recorded and will be posted on the DGIC site: [http://www.nrel.gov/tech_deployment/dgic.html](http://www.nrel.gov/tech_deployment/dgic.html)
Speakers

Amanda Stevens
Energy Programs Manager
Pasadena Water and Power
California

Donald Chung
Senior Project Lead
NREL
Colorado

Emerson Reiter
Project Lead (DGIC
Moderator and
Presenter)
NREL

Brian Newton
Utility General Manager for the
City of Fremont
Nebraska
Webinar - DGIC: Key Outcomes of NREL’s Utility Technical Assistance Program

Introduction to Pasadena Water and Power

Amanda Stevens
Manager, Energy Programs
December 8, 2016
Background on Pasadena Water and Power

- Community-owned utility since 1906, providing electric and water to the Pasadena service territory
  - Population of 141,510
- 23 square miles of service territory
- 678 miles of distribution
- 1,130,000 MWh in annual retail sales
- 320 MW system peak (2010)
- 65,569 retail energy services
• RPS goal of 40% renewable energy by 2020
  > Currently at 30%

• Ongoing support for local, distributed solar generation:
  > Pasadena Solar Initiative launched in 2008
    ▪ Rebates and education
    ▪ Net energy metering compensation for net surplus
  > Goal of 14 MW by 2017
  > Rebates have been gradually reduced; now at $0.30/Watt (vary by customer class/system size)
Distributed PV Capacity Installed in Pasadena

Annual PV Capacity Installed under PSI

Cumulative PV Capacity

Non Residential
Residential
Cumulative

Prior to PSI

Forecasted

0 1000 2000 3000 4000 5000 6000 7000 8000

200 400 600 800 1000 1200 1400 1600

0 200 400 600 800 1000

Pasadena Water and Power
Support PWP customers’ interest in local solar power.

- Design a program that is attractive for customers while being viable and sustainable for PWP.
- **Simplicity is important**, both for customers and program administrator.

Fulfill PWP commitment to develop a community solar program made in the 2015 Integrated Resource Plan.

Advance Pasadena’s renewable energy (14 MW solar under Pasadena Solar Initiative) and GHG goals.

Program is funded by participants.
Late-2015 thru 2016

- Research options and project economics
- Develop program design with input from Pasadena community
- Select site & issue RFP \( \rightarrow \) We are here

2017 (tentative)

- Receive final approval for contract and program
- Build PV system
- Market program and enroll customers
- Administer program & evaluate
• What are the economics for a locally-sited community solar PV system?

• Several potential Pasadena sites identified for NREL analytical team
  > solar carport or rooftop
  > 0.3 - 1.0 MW (per site)
  > Opportunity for adding battery storage??

• More specifically - could battery storage be integrated to provide additional benefits to the host site (peak shaving), in lieu of a lease payment?
Utility Technical Assistance
Pasadena Water and Power

Donald Chung
NREL Senior Project Lead

December 8, 2016
• Analyze potential for a community solar system hosted at several City of Pasadena sites.
  o Rooftop and carport systems are both possible at the sites under consideration.
  o Rooftop and carport systems were analyzed separately, due to a large difference in installed cost.
  o Sensitivity analysis was performed for key assumption values, including system cost, escalation rates, and developer IRR.

• Analyze the potential for a community solar developer to provide BTM storage systems to landlords or building tenants in lieu of lease payments for use of rooftops/parking areas.
Analysis Approach

- **Community solar potential is analyzed by modeling LCOE and potential year-1 PPA pricing from a third-party owned (TPO) system using SAM**
  - Analysis assumes that a developer will finance and construct a system, and earn a return by selling power produced to community solar subscribers.
  - The analysis produces a range of possible PPA pricing, which can be compared to the retail rates of potential subscribers to give a preliminary indication of financial feasibility.
  - Given the desktop nature of the modeling, sensitivity analysis was also performed for key assumption values, including system cost, escalation rates, and developer IRR.

- **Economics of a BTM storage system are analyzed from the tenant perspective using REopt, and compared to the potential income from a roof/parking area lease.**
Rooftop Community System Parametric Analysis

### Baseline Assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>TPO IRR (after tax)</td>
<td>8.9%</td>
</tr>
<tr>
<td>TPO Federal tax rate</td>
<td>35%</td>
</tr>
<tr>
<td>TPO State tax rate</td>
<td>6%</td>
</tr>
<tr>
<td>TPO combined tax rate</td>
<td>38.9%</td>
</tr>
<tr>
<td>PPA/Utility rate escalator</td>
<td>4.5%</td>
</tr>
<tr>
<td>Analysis period, years</td>
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<tr>
<td>Array tilt, degrees</td>
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<tr>
<td>Array azimuth, degrees</td>
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</tr>
<tr>
<td>System size, kW</td>
<td>1,355</td>
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<tr>
<td>Capital cost, $/W</td>
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<tr>
<td>O&amp;M cost, $/kW-yr</td>
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<td>Roof lease rate, $/kW-yr</td>
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<td>Roof lease, $/yr</td>
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<td>PBI, $/kWh</td>
<td>$0.096</td>
</tr>
<tr>
<td>PBI term, years</td>
<td>2</td>
</tr>
</tbody>
</table>

- Rooftop systems are preferred due to their lower capital cost ($1/W less than typical carport installed costs)
- Buildings B and D are assumed to be capable of supporting a total of 1.355 MW
- The rooftop system is modeled as a single, 1.355 MW system
- Modeling and sensitivity analysis was conducted using NREL’s SAM tool
Rooftop System Results

**Levelized PPA, Yr-1 PPA vs. Installed Cost**

- **PPA pricing** is most sensitive to **System Cost and Developer IRR**
  - Baselines: Cost = $2.15/W; IRR = 8.9%; Escalation = 4.5%
  - Sensitivity = pct change in Year 1 PPA/pct change in independent variable
  - **Cost sensitivity:**
    - 0.93% with PBI
    - 0.81% without PBI
  - **IRR sensitivity:**
    - 0.90% with PBI
    - 0.89% without PBI
  - **Escalator sensitivity:**
    - -0.36% with PBI
    - -0.36% without PBI

**Levelized and Yr-1 PPA vs. TPO IRR**

**Levelized and Yr-1 PPA vs. PPA Escalator**
### BASELINE ASSUMPTIONS

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<td>$0.096</td>
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<td>PBI term, years</td>
<td>2</td>
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- Parking areas for buildings A and C are assumed to be capable of supporting a total of 1.5 MW of carports.
- The carport system is modeled as a single, 1.355 MW system – the lower capacity compared to actual potential hosting capacity has no effect on these results.
- Modeling and sensitivity analysis was conducted using NREL’s SAM tool.
Carport System Results

- **PPA pricing** is most sensitive to System Cost and Developer IRR
  - Baselines: Cost = $3.15/W; IRR = 8.9%; Escalation = 4.5%
  - Sensitivity = pct change in Year 1 PPA/pct change in independent variable
  - Cost sensitivity:
    - 0.93% with PBI
    - 0.81% without PBI
  - IRR sensitivity:
    - 0.95% with PBI
    - 0.93% without PBI
  - Escalator sensitivity:
    - -0.36% with PBI
    - -0.36% without PBI
Storage In Lieu of Lease Concept: What to Compare?

**Developer**

- Max Willingess to Pay = lease of $25/kW-yr
- This is also the max spend on a storage system

**Lessor**

- Lease payments vs. avoided energy costs?
- Modeling needed to determine avoided energy cost

**Lease Payment?**

**Storage System?**
### Storage In Lieu of Lease Payment Analysis Steps

1. **Determine kW hosting capacity for each building**
   - Assumes all buildings within each grouping are equal
   - e.g., the 4 “B” buildings can each host 25% of the estimated 355kW total

2. **Compute lease payments to Tenant**
   - Assume $25/kW-yr is market rate
   - Determine the present value of 25 year lease payments from Developer and Tenant perspectives
   - This is the maximum cost a Developer would be willing to pay for a storage system in lieu of lease
   - This is also the minimum value the Tenant should expect from either a storage system, or from lease income

3. **Run TPO storage analysis in REopt for each building**
   - Constrain the present value of all storage capital and operating costs to equal the present value of the developer’s lifetime lease payments

4. **Analyze resulting storage system**
   - If a storage system is selected by REopt, compute the resulting avoided costs to the Tenant
   - If the avoided cost is greater than the lease payment, then a Tenant would prefer a storage system to lease payments
   - If the avoided cost is less than the lease payment, the Tenant would prefer the lease payments
Storage In Lieu of Lease Payments Do Not Appear Feasible

- For all buildings analyzed, Tenants realize better value from a lease payment of $25/kW-yr as compared to the avoided costs generated by a storage system.
- Conversely, a Developer may prefer providing systems in lieu of making lease payments as this could result in a lower lifetime cost.
- However, practicalities of owning/operating a storage system may limit Developer enthusiasm for this type of solution, unless additional revenues can be realized from the storage systems.

<table>
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<tr>
<th></th>
<th>A1516</th>
<th>B11516</th>
<th>B21516</th>
<th>B M1 31516</th>
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<th>C1516</th>
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<td>Max PV hosting capacity, kW</td>
<td>1,000</td>
<td>88.75</td>
<td>88.75</td>
<td>88.75</td>
<td>88.75</td>
<td>250</td>
<td>250</td>
<td>1,000</td>
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<tr>
<td>Annual Roof Lease, Cost to Developer/Income to Tenant</td>
<td>$25,000</td>
<td>$2,219</td>
<td>$2,219</td>
<td>$2,219</td>
<td>$2,219</td>
<td>$6,250</td>
<td>$6,250</td>
<td>$25,000</td>
</tr>
<tr>
<td>Present Value to Developer, 25 yr Roof Lease Cost</td>
<td>$(247,568)</td>
<td>$(21,972)</td>
<td>$(21,972)</td>
<td>$(21,972)</td>
<td>$(21,972)</td>
<td>$(61,892)</td>
<td>$(61,892)</td>
<td>$(247,568)</td>
</tr>
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</table>

**REOPT RESULTS**

<table>
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<tr>
<th></th>
<th></th>
<th>8.1</th>
<th>4.5</th>
<th>7.5</th>
<th>8.1</th>
<th></th>
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<th>70.4</th>
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<tbody>
<tr>
<td>Storage Power, kW</td>
<td>-</td>
<td>8.1</td>
<td>4.5</td>
<td>7.5</td>
<td>8.1</td>
<td>-</td>
<td>-</td>
<td>70.4</td>
</tr>
<tr>
<td>Storage Capacity, kWh</td>
<td>-</td>
<td>8.1</td>
<td>6.1</td>
<td>9.6</td>
<td>8.1</td>
<td>-</td>
<td>-</td>
<td>123.7</td>
</tr>
<tr>
<td>Tenant’s Year 1 Avoided Cost from Storage</td>
<td>-</td>
<td>$1,478</td>
<td>$814</td>
<td>$1,376</td>
<td>$1,529</td>
<td>-</td>
<td>-</td>
<td>$14,971</td>
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<tr>
<td>Tenant's Annual Lease Income</td>
<td>$25,000</td>
<td>$2,219</td>
<td>$2,219</td>
<td>$2,219</td>
<td>$2,219</td>
<td>$6,250</td>
<td>$6,250</td>
<td>$25,000</td>
</tr>
<tr>
<td>Makes Sense for Tenant?</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>
Brian Newton
Interim City Administrator/
Dept. of Utilities GM
City of Fremont Utilities – What we provide.

Customer owned:

- Electricity
  - 15,200 customers
- Natural Gas
  - 11,000 customers
- Water
  - 11,200 customers
- Wastewater
  - 11,000 customers
Electric Power

- **Baseload Power Plants**
  - Lon D Wright – coal-fired generating station
    - Unit #6 – 16.5 MW
    - Unit #7 – 21 MW
    - Unit #8 – 91.5 MW
  - Derril G Marshall Generating Station – gas-fired
    - 41.6 MW of peaking power

- **Grid Power**
  - Southwest Power Pool (SPP) – Market-based rates
    - 60MW limit

- **Renewable**
  - Cottonwood Wind Farm – 40 MW (November 2017)
  - **Community Solar – 1 – 3 MW (Summer 2017???)**
DOE - Solar Program Technical Assistance Grant

• Why ask for help?
• Request:
  • Look at various pricing models
    • Municipal-owned
    • Customer-owned
    • Power Purchase Agreement
  • Tax incentives
    • Clean Renewable Energy Bonds
    • Investment/production tax credit
  • Customer survey
    • Listen to customers
    • Educate
Community Solar Survey
(Smart Energy Power Alliance)

• Surveyed:
  • Residential accounts (+/-10,000 households)
  • July 18 through August 31, 2016

• Survey instrument:
  • Web-based (Survey Monkey administered by SEPA) – 184 completed
  • Paper-based (bill stuffers) – 236 completed

• Survey format:
  • Explanation of community solar
  • Eleven survey questions about solar interest
  • Three demographic questions
Community Solar Survey Results

• 70% interested in community solar
• Most appealing aspects of community solar:
  | Reduces dependence on fossil fuels (61%)
  | Good for the environment (57%)
  | Potential to provide subscribers financial benefits (52%)
  | Doesn’t require a rooftop (29%)
  | Employment for local worker (27%)
  | No maintenance and minimal upfront costs (22%)
  | Located within the community (15%)
  | Uses new solar technology (11%)
Community Solar Survey Results

• Most important
  | Initial cost (90%)
  | Long-term savings (82%)
  | Contract length (69%)
  | Who owns Renewable Energy Credits (43%)
  | Location of solar farm (36%)

• Payments – monthly versus upfront?
  • 58% need more information
  • 32% willing to pay monthly
  • 10% willing to pay one-time
Community Solar Survey Results

- What percentage of your monthly bill would you supplement with solar?

- No preference
- Less than 25%
- At least 25%
- At least 50%
- At least 75%
- 100%
Community Solar Survey Recommendations

- Education, education, education
  - 35% do not understand community solar

- Payment
  - Survey respondents are price sensitive

- Billing
  - Virtual net metering
  - Fixed blocks of solar energy

- Length of term
  - Minimum, but as short as possible
Brian Newton
Interim City Administrator/
Dept. of Utilities GM

Fremont, Nebraska
Community Solar Project
Finance for Municipal Utilities

Emerson Reiter (presenting for Jason Coughlin)

December 8, 2016
Analysis

• Based on local utility retail rates and the local cost of solar, can a municipally-owned community solar project be attractive to potential subscribers (i.e. competitive with retail rates)?

• Can municipal ownership with access to low cost of debt offset the benefits of the Investment Tax Credit (ITC) and accelerated depreciation via MACRS?
Assumptions:

- 1000 kW Community Solar Farm
- $2.50/W
- 100% debt financed at 4% for 20 years
- Retail residential utility rates = $0.09/kWh but excess generation credited at $0.04/kWh
- PPA bid at approximately $0.08/kWh
- Utility preference to own system if possible

Results if utility-owned:

- Nominal LCOE of $0.15/kWh (includes O&M)
- Monthly cost per 1 kW subscription = $16.58 (111 kWh)
- Monthly premium above retail rates for community solar = $6.62
- One time upfront payment: $2,512 ($2.51/W)
Key decision: access the ITC or own using low-cost bonds?

- Access ITC
  - PPA (via developer/tax equity partner)
  - Customer-Owned (via customer-controlled LLC)
- Own Directly
  - Low-Cost Financing (via municipal bonds)
Follow-On Considerations

• Power Purchase Agreement (PPA)
  o Will developers bid on the project?
  o Is rate competitive with other wholesale power?
  o Can utility absorb ancillary costs?

• Customer-Owned Limited Liability Corporation (LLC)
  o Do customers have tax appetite for ITC share?
  o Do customers have capital to put into LLC?
  o Are customers comfortable with tax credit issues?

• Utility-Owned System
  o Can utility offer additional savings (land, O&M, etc.)?
  o Is there operational value to utility ownership?
• NREL Lessons Learned on Community Solar for Municipal Utilities (coming soon!)

• NREL Community Solar Scenario Tool: a “first cut” financial analysis of various community solar program models
  http://www.nrel.gov/tech_deployment/tools_community_solar.html

• Solar Market Pathways Community Solar Toolkit: resources on financial structures, private letter rulings, securities law
  http://solarmarketpathways.org/toolkit/community-solar/
  o Coming soon: Community Solar Costing Tool (from Cook County project team)
Questions

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- Shape the discussion and signup for DGIC alerts: [http://www.nrel.gov/tech_deployment/dgic.html](http://www.nrel.gov/tech_deployment/dgic.html)
- Webinar slides and recording available here also!