Solar Microgrid Feasibility Study

City of Ann Arbor

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Introduction

- City primary objectives:
  - Resiliency of smaller critical assets
  - Reduction of GHG emissions
    - 25% city-wide by 2025 = 568,000 Metric tonnes CO_2e/yr
- Today's presentation:
  - Survey and selection of potential sites
  - Explanation of assumptions and methodology
  - Assessment of production, emissions, cost
  - Significant opportunities for renewable energy
  - Policy concerns
  - Final recommendations and ongoing work

Site Selection

- Total City-owned Sites: 212
- Sites selected for further consideration: 60
- Sites selected for microgrids for resiliency:
  - Fire Stations 1, 2, 3, 4
- Sites with significant solar potential:
  - Maynard Parking Structure
  - Landfill
  - Ann Arbor Public Schools

Important Takeaways

- Microgrids for Fire Stations
  - Opportunities to provide resiliency
  - Small emissions reductions
- Solar PV for Landfill and Schools
  - Significant opportunities to reduce city-wide emissions and meet climate goals

Methods

- ArcGIS for site assessment
  - Building area footprints from City of Ann Arbor Data Catalog
- NREL PVWatts model for solar PV production ratios
  - TMY3 weather data for Ann Arbor
  - Validated with production data from operating solar projects in southeast Michigan
- NREL System Advisory Model (SAM) for battery storage
- NREL LCA values to estimate total life-cycle emissions reductions

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Assumptions

- Solar Arrays
  - 34º tilt, south-facing
  - Standard (15%) efficiency
  - Fixed Rooftop – buildings
    - 177 kWh/m^2/yr
  - Fixed Open Rack – parking lots/structures, open space
    - 179 kWh/m^2/yr
- Solar Array O&M Coverage
  - 50% Landfill & Parking
  - 62.5% Rooftop (NREL 2016)
- SAM
  - System sized for storage & resiliency cases, 6hr peak load
  - Li-ion battery
- System Cost
  - $1.75/Watt installed
- Battery Cost
  - $600/kWh installed (Bloomberg)
- Emissions
  - DTE 2016 Fuel Mix
  - NREL 2013 Emission Factors

Location: Fire Stations 2, 3, 4

Site	Load (MWh/yr)	Solar Generation (MWh/yr)	Avoided Electricity Cost ($/yr)	PV Cost ($)	Payback Period (yrs)
2	22.2	39.4	5,910	58,400	10
3	37.7	66.1	9,920	98,100	10
4	40.0	56.8	8,520	84,300	10

- General payback for rooftop solar PV systems: 10 years

Location: Fire Stations 2, 3, 4

Site	Load (MWh/yr)	Solar Generation (MWh/yr)	Avoided Electricity Cost ($/yr)	PV Cost ($)	Battery Size (kWh)	Total Cost ($)	Payback Period (yrs)
2	22.2	39.4	5,910	58,400	26.3	74,200	13
3	37.7	66.1	9,920	98,100	45.2	125,000	13
4	40.0	56.8	8,520	84,300	38.5	107,000	13

- General payback for systems with batteries: 13 years
- Sized for 6 hour storage
- **Total LCA emissions reductions:** 81.4 tonnes CO_2e/year

Battery Operating Scenarios

- Emergency Discharge vs. Load Leveling
  - Financially equal if purchase/sale price are equal
  - Ability to load level – benefit if purchase/sell prices diverge
    - Shorter payback period

Location: Fire Station 1

Site	Load (MWh/yr)	Solar Generation (MWh/yr)	Avoided Electricity Cost ($/yr)	PV Cost ($)	Payback Period (yrs)
1	377	186	28,000	276,000	10

- High load – large battery required
  - **Battery Size:** 628 kWh
  - **Total Cost (Battery Cost):** $653,000 ($377,000)
  - **Payback Period:** 23 years
- LCA emissions reduction: 93.4 tonnes CO_2e/year

Locations evaluated for solar potential only; i.e., no battery

- Maynard Parking Structure
- Landfill
- Ann Arbor Public Schools

Location: Maynard Parking Structure

Site	Solar Generation (MWh/yr)	LCA CO_2e Reductions (tonnes/yr)	Avoided Electricity Cost ($/yr)	PV Cost ($)	Payback Period (yrs)
Maynard	497	249	74,500	737,000	10

- Does not reduce parking capacity

Location: Landfill

Site	Solar Generation (MWh/yr)	LCA CO_2e Reductions (tonnes/yr)	Avoided Electricity Cost ($/yr)	PV Cost ($)	Payback Period (yrs)
Landfill	40,600	20,300	6,080,000	59,500,000	10

- Land footprint: 120 acres
  - Solar array area: 56 acres
- Can generate 90% of annual electricity consumption for city-owned properties with solar PV
- Potential for a pilot community solar program
- Partnership with University of Michigan

Location: Ann Arbor Public Schools

Site	Solar Generation (MWh/yr)	LCA CO_2e Reductions (tonnes/yr)	Avoided Electricity Cost ($/yr)	PV Cost ($)	Payback Period (yrs)
Huron	4,120	2,060	618,000	6,070,000	10
Pioneer	4,920	2,460	737,000	7,260,000	10
Skyline	3,940	1,980	591,000	5,810,000	10
Clague	1,250	624	187,000	1,840,000	10

- All Ann Arbor Public Schools (32 total):
  - **Total rooftop potential:** 22,800 MWh/year
  - **Total parking lot potential:** 12,400 MWh/year
  - **Total LCA emissions reductions:** 17,600 tonnes CO_2e/year

Significant Opportunities

- Solar plus storage for resiliency of some city-owned sites
- On-site natural gas generator at any site as an additional non-spinning reserve (for backup power and load leveling)
- Large-scale solar to grid for parking structures and landfill
  - **Landfill represents opportunity for large-scale solar farm**
  - Pilot Community Solar projects can be possible with further negotiation
    - Power Purchase Agreements have enabled landfill solar farms in other states
      - Examples: Rochester, NY; Brooklyn, OH
- School partnerships for community solar or microgrid sites

Policy Issues

- Generic barriers to microgrids and solar PV include:
  - Local zoning laws
  - Lack of tax incentives
  - Lack of solar access laws/easements
- Michigan/Local barriers
  - Vague or restrictive zoning laws, tax status can limit investment in PV and microgrids
  - Regulatory changes may be seen within the next year
  - No state laws directly enabling community solar
- Conclusion: behind-the-meter or utility-connected?

Policy Considerations

- Public Schools have potential for community solar or microgrids
  - Currently no state laws directly enable community solar
- Landfill is a potential site for community solar or third-party development with Power Purchase Agreement
- Buying or selling power requires interconnection with grid
- DTE's MIGreenPower Plan expresses support for participation in green pricing programs under the present regulatory environment
  - Another option for green power if resiliency is not a main goal

Final Recommendations

- Evaluate additional cases that can contribute to resiliency and/or significant renewable generation
- Explore investment options for large-scale solar farms
  - Potential partnerships between Public Schools, City, and U of M
  - Enable public participation via community solar
  - Explore financing using Power Purchase Agreement
  - Revise zoning laws that are ill-defined or vague to prevent unintended obstacles to solar, microgrid, and battery installations

Suggested Ongoing Work

- Create a robust project template for use in future assessments
- Conduct a detailed assessment of school properties
- Further investigation of:
  - Additional generation sources
  - Wheeler Center
  - Water Treatment Plant
  - Conversion of diesel generators to natural gas (decreases CO_2e)
  - Core downtown microgrid of city-owned assets

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