National Renewable Energy Laboratory
Innovation for Our Energy Future

Assessing PV Potential on New York City's Network Distribution System

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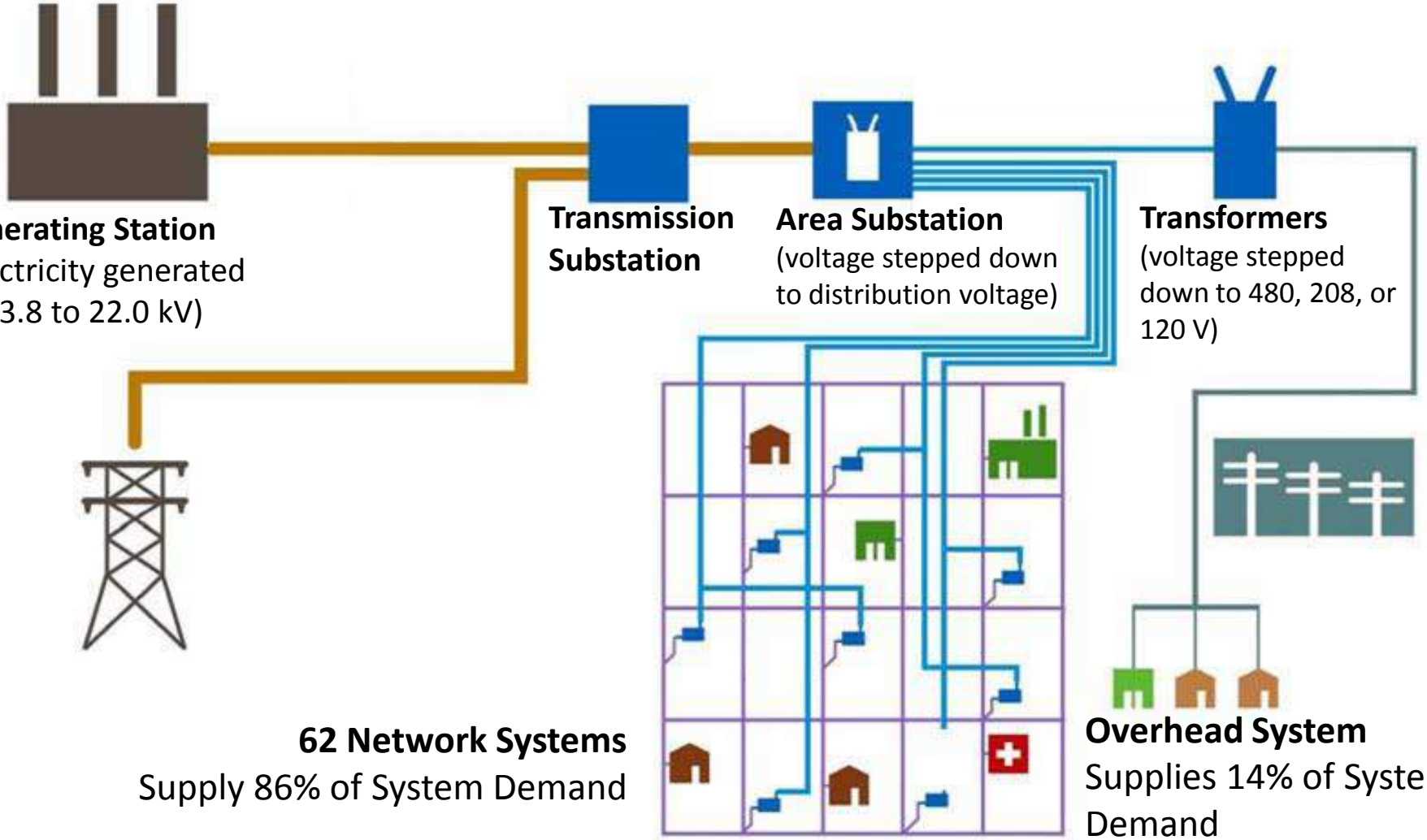
May 19, 2010

Background

- New York City goal: 600 MW of renewable electricity by 2030
- City uses a **secondary network** distribution system: each customer receives power through several parallel feeders and transformers
  - Network protectors open if power reverses
  - Ensures power does not backfeed from one transformer through another
- Utility concern: Distributed PV systems may disrupt network protection and reduce network reliability

New York City Distribution System



Generating Station
(electricity generated at 13.8 to 22.0 kV)

Transmission Substation

Area Substation
(voltage stepped down to distribution voltage)

Transformers
(voltage stepped down to 480, 208, or 120 V)

62 Network Systems
Supply 86% of System Demand

Overhead System
Supplies 14% of System Demand

Graphic courtesy of Con Ed

Objectives

- Assess potential electricity generation of rooftop photovoltaics in two utility networks
- Compare PV generation to network loads
- Analyze exporting energy trends & assess network impact

Approach

Analyze 2 utility networks:

- Herald: High density high-rise buildings

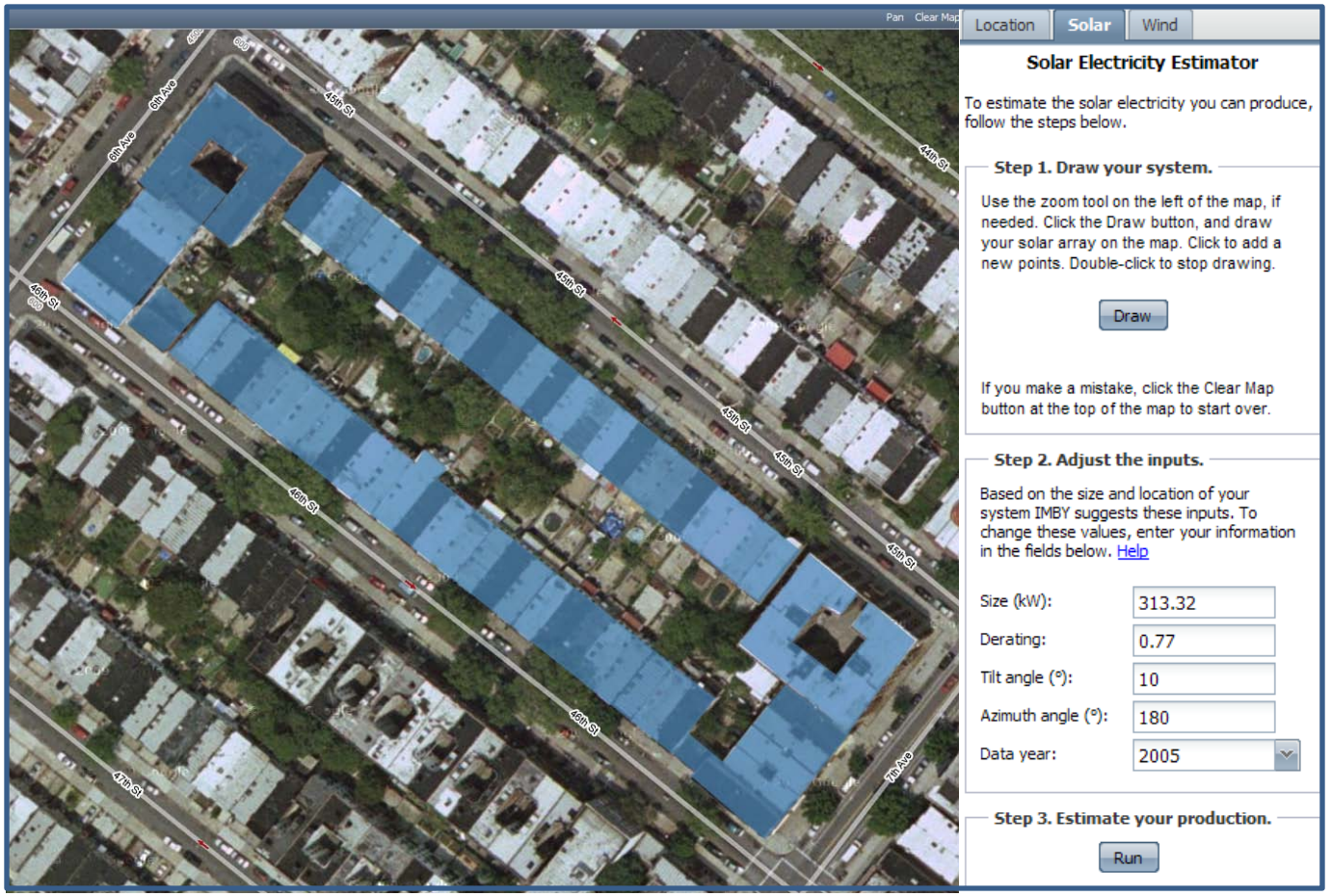
- Bay Ridge: High density low-rise buildings

Methodology

1. Calculate total roofspace
2. Estimate space suitable for PV
3. Calculate potential PV capacity
4. Calculate hourly energy production
5. Estimate shading losses
6. Compare PV generation to network loads

1. Calculate Total Rooftop Space

Methodology



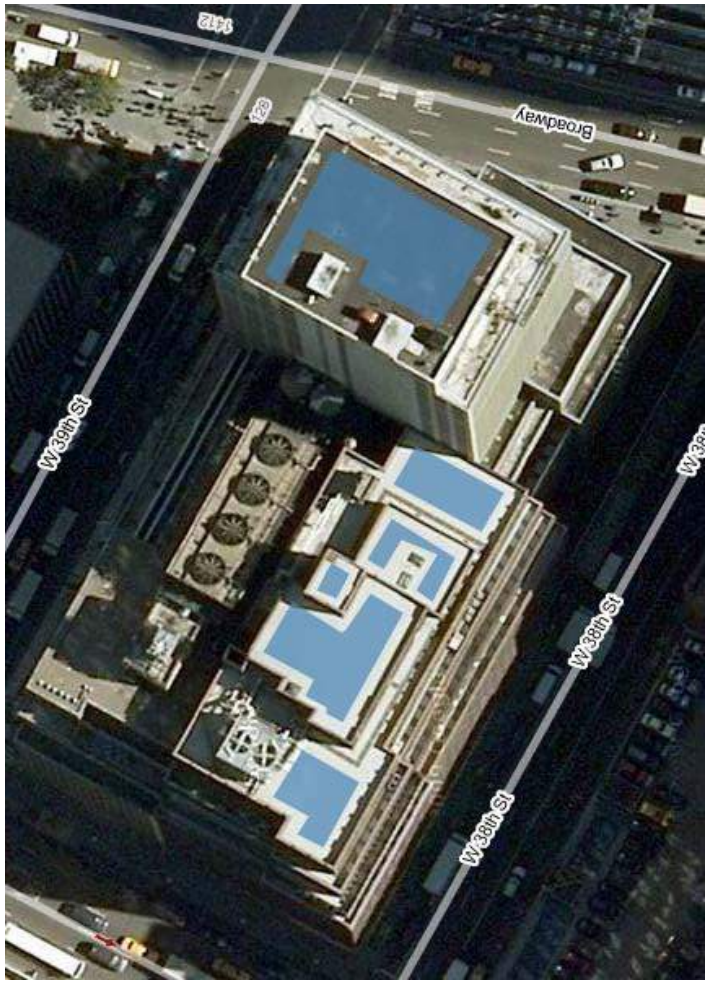
NREL's In My Backyard (IMBY) software

http://www.nrel.gov/eis/imby/

2. Estimate Suitable Space

Methodology

- Calculate reductions for:
  - Occupied Space
  - Shading from Rooftop Obstructions
  - Space for Access and Safety
  - Roof Orientation
  - Structural Adequacy
  - Historical Building Codes



3. Calculate Total Capacity

Methodology

	Herald (High-Rise)	Bay Ridge (Low-Rise)
Total Rooftop Area (m^2)	147,000	4,459,000
Percent Suitable Space	12%	40%
Total Suitable Rooftop Space (m^2)	17,640	1,819,600
Total Rooftop PV Capacity (MW DC)*	1.76	182

*100 W DC/m^2

4. Calculate Energy Production

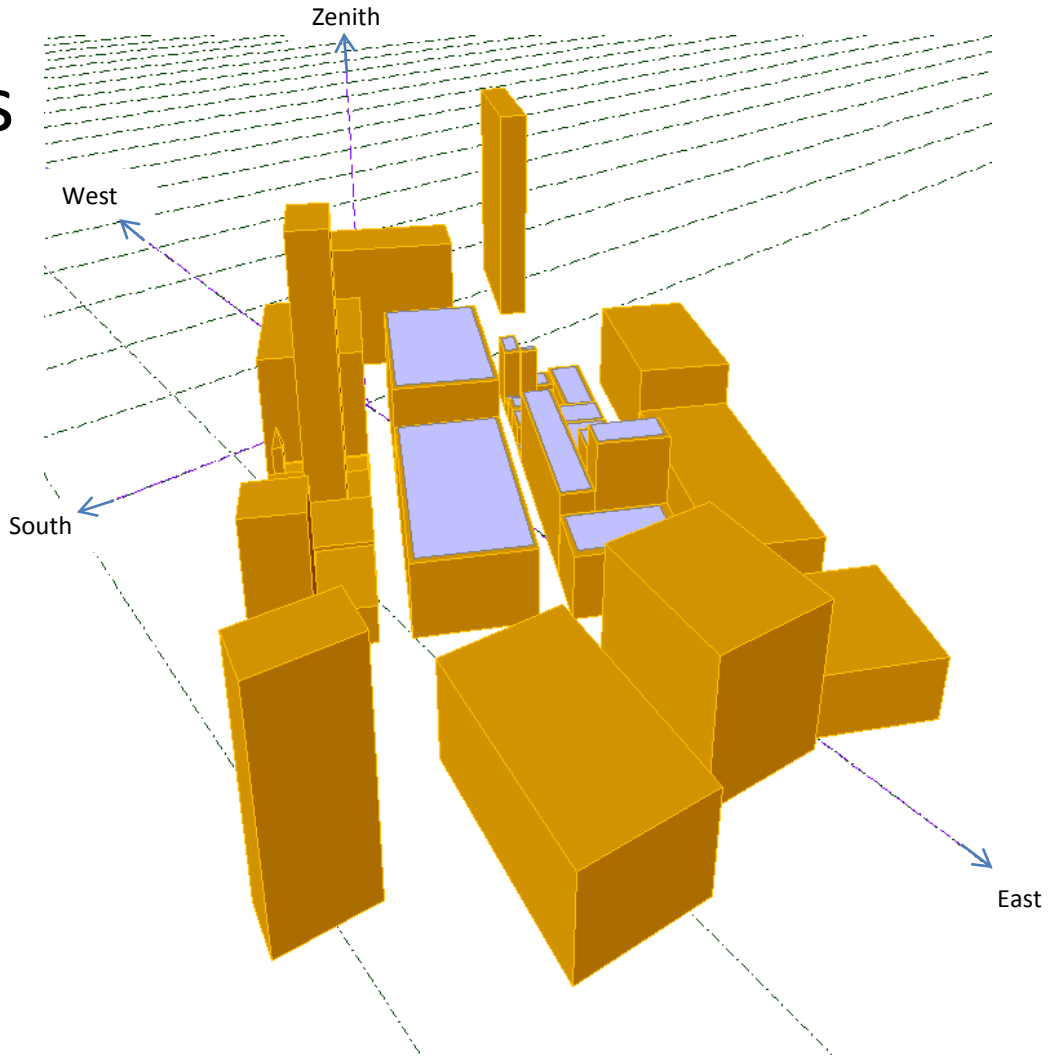
Methodology

- Use 2005 Perez satellite solar resource data and PVWatts model to estimate production
- Hourly AC energy production based on:
  - PV DC rating
  - PV azimuth and angle (assume horizontal mounting)
  - Incident solar radiation
  - PV cell temperature
  - Reflection losses
  - DC to AC derate factor

5. Apply Shading Losses

Methodology

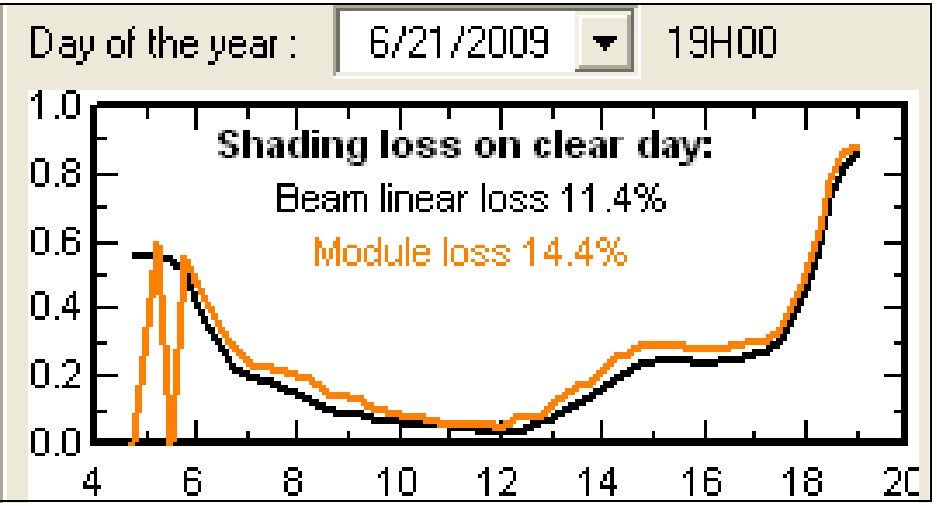
- Model typical areas in each network
- Calculate hourly shading factors
- Reduce PV generation

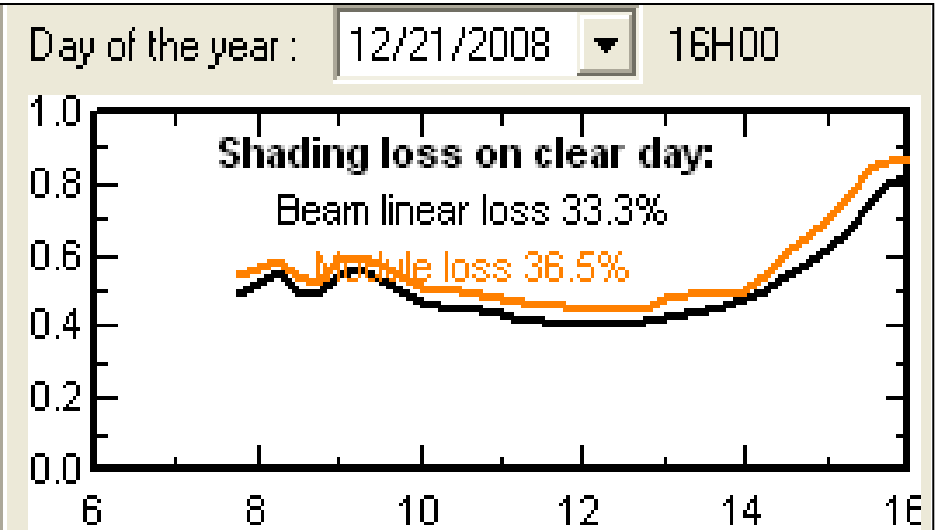


Hourly Shading Losses

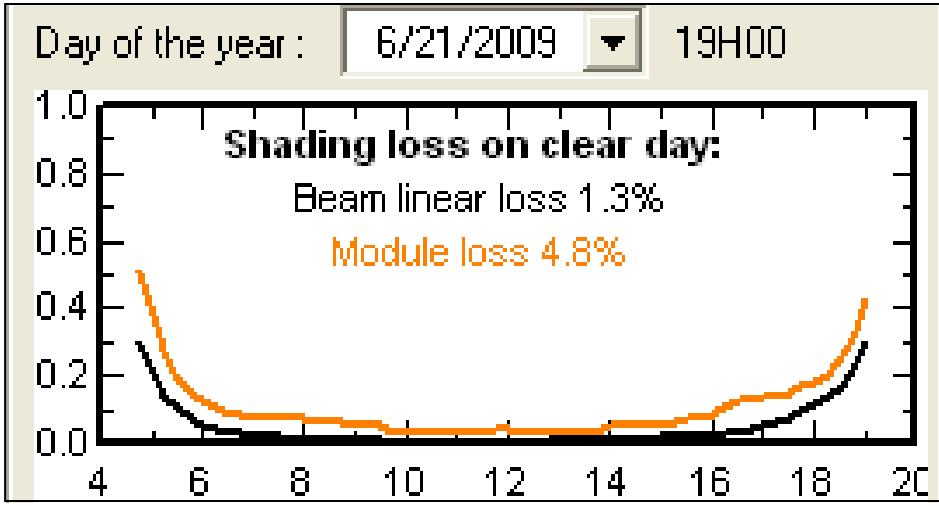
Results

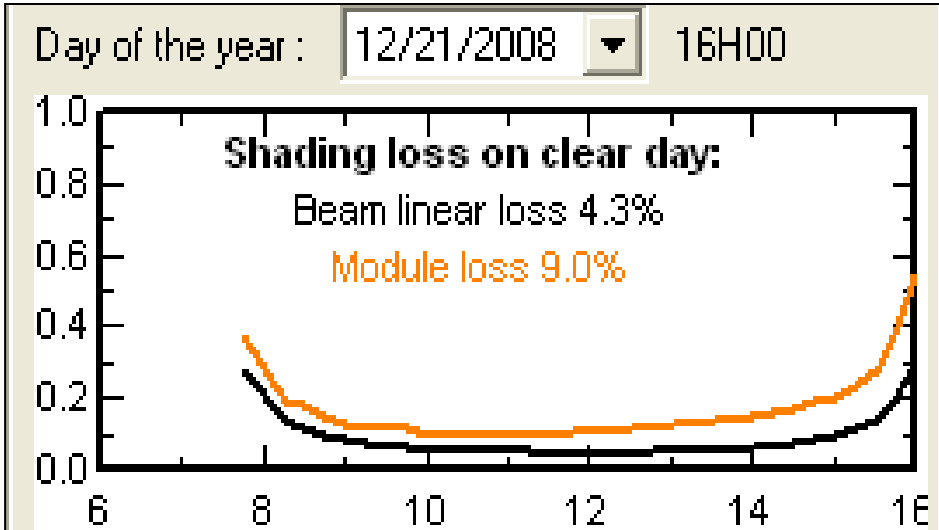
Herald Network (High-Rise)





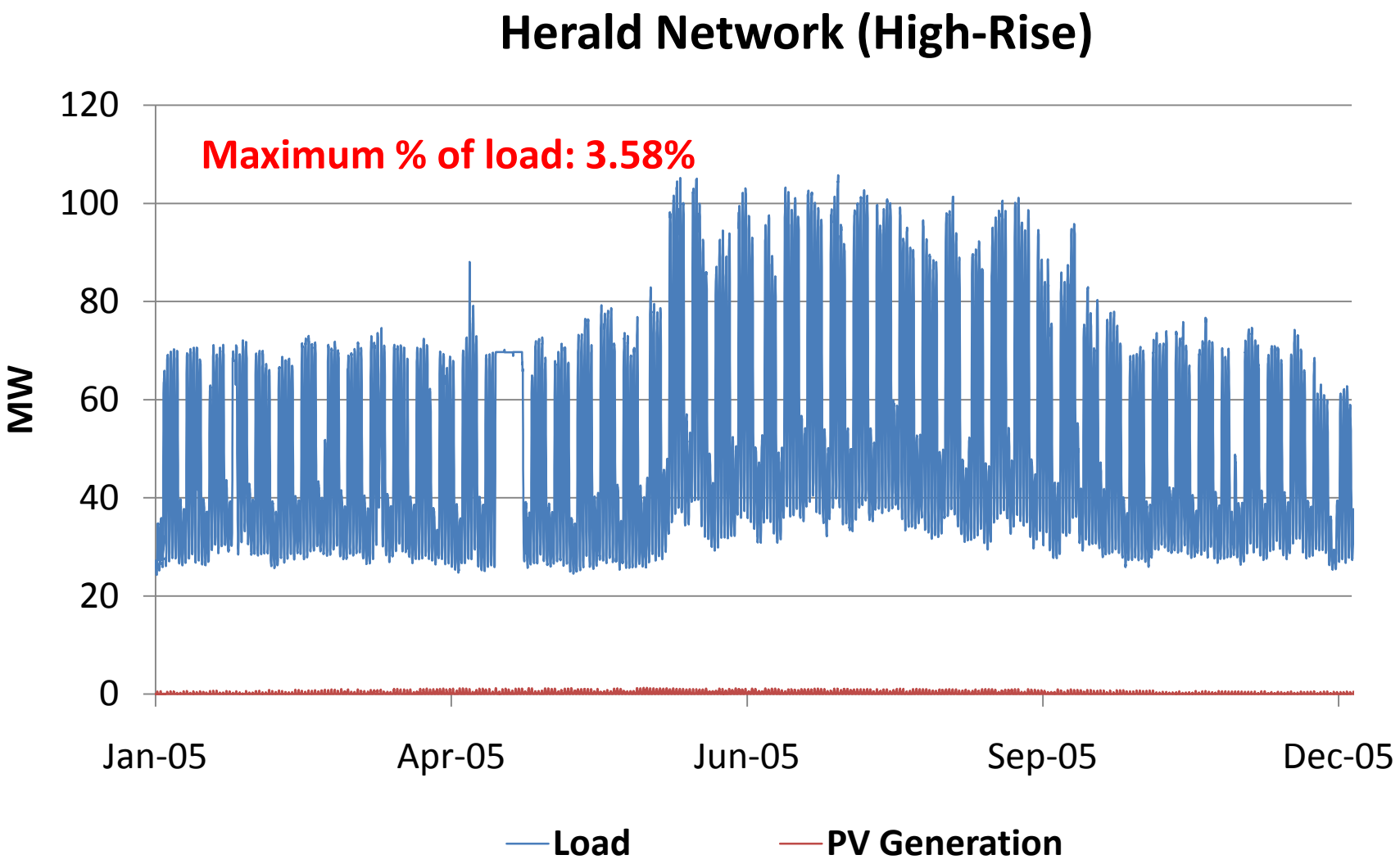
Bay Ridge Network (Low-Rise)





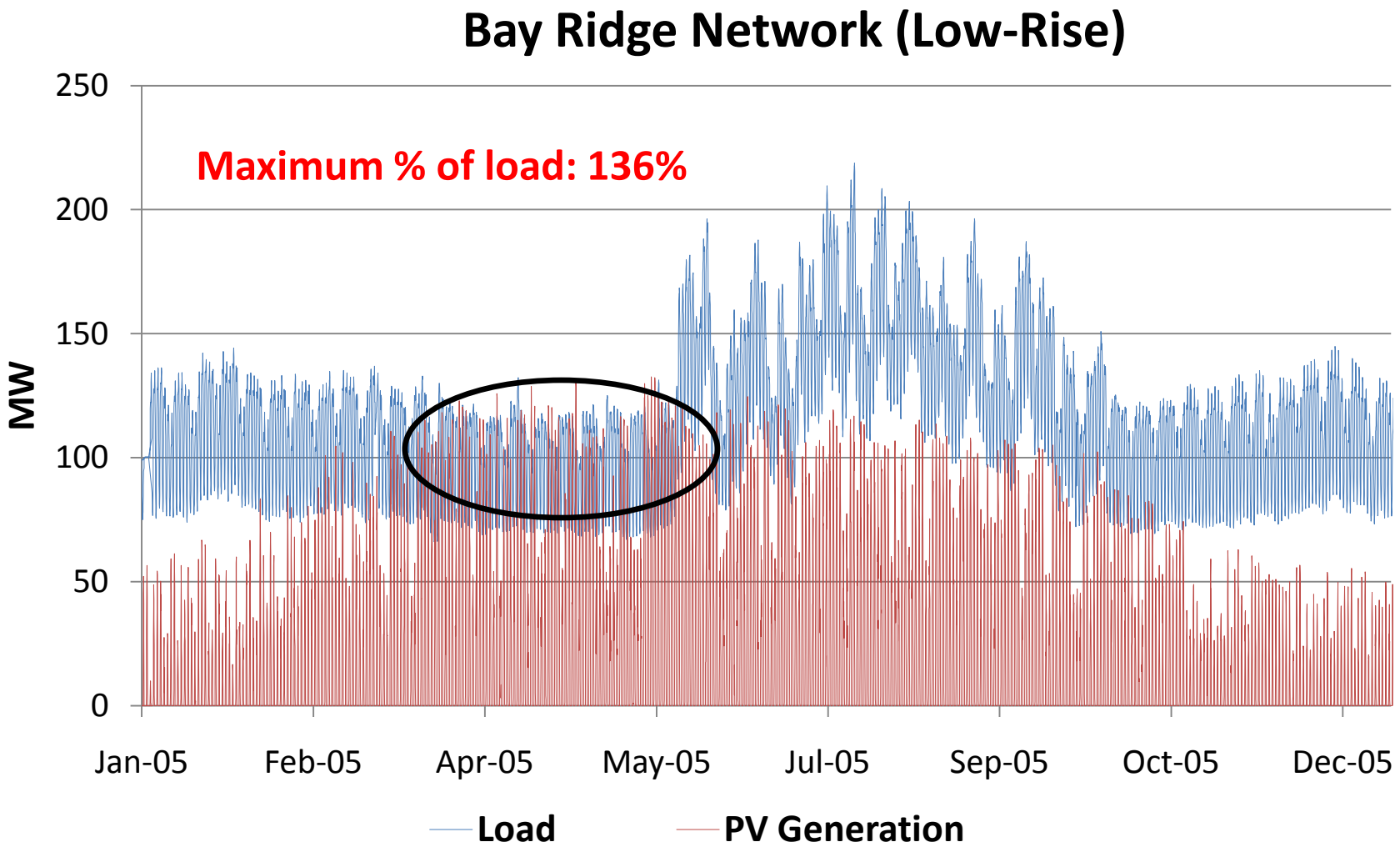
Compare PV Generation to Network Loads

Results



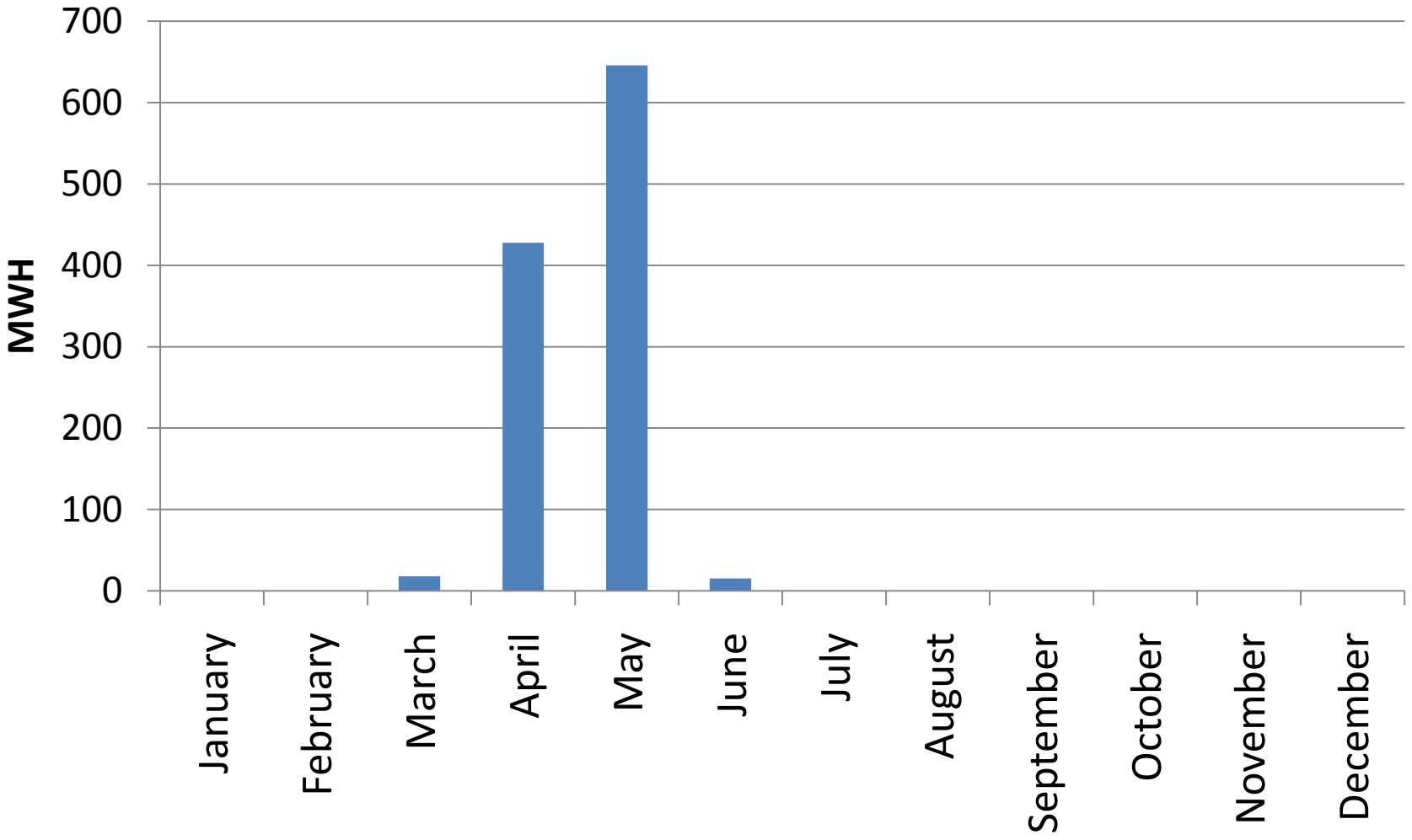
Compare PV Generation to Network Loads (continued)

Results



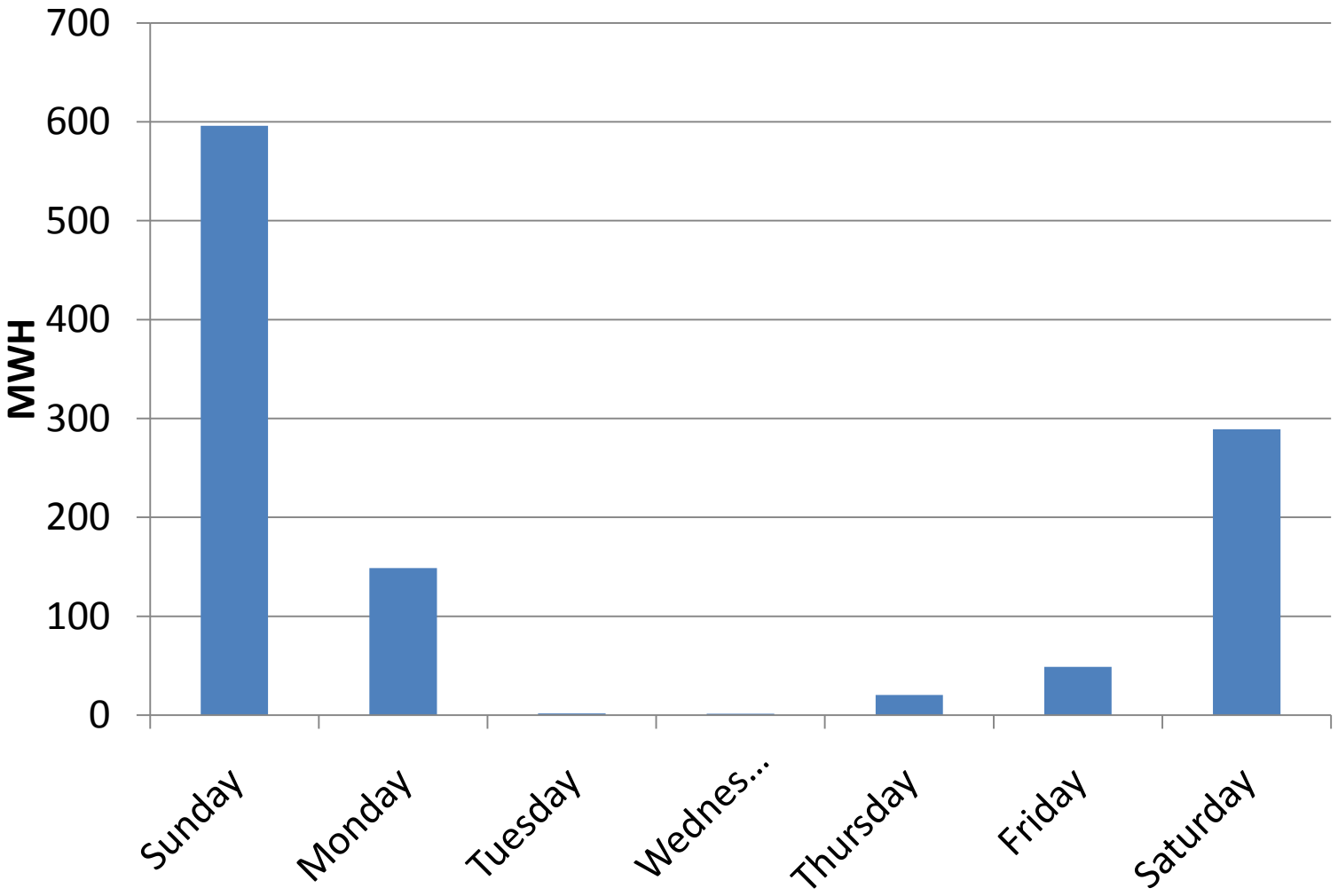
Energy Exporting Trends: Monthly

Results



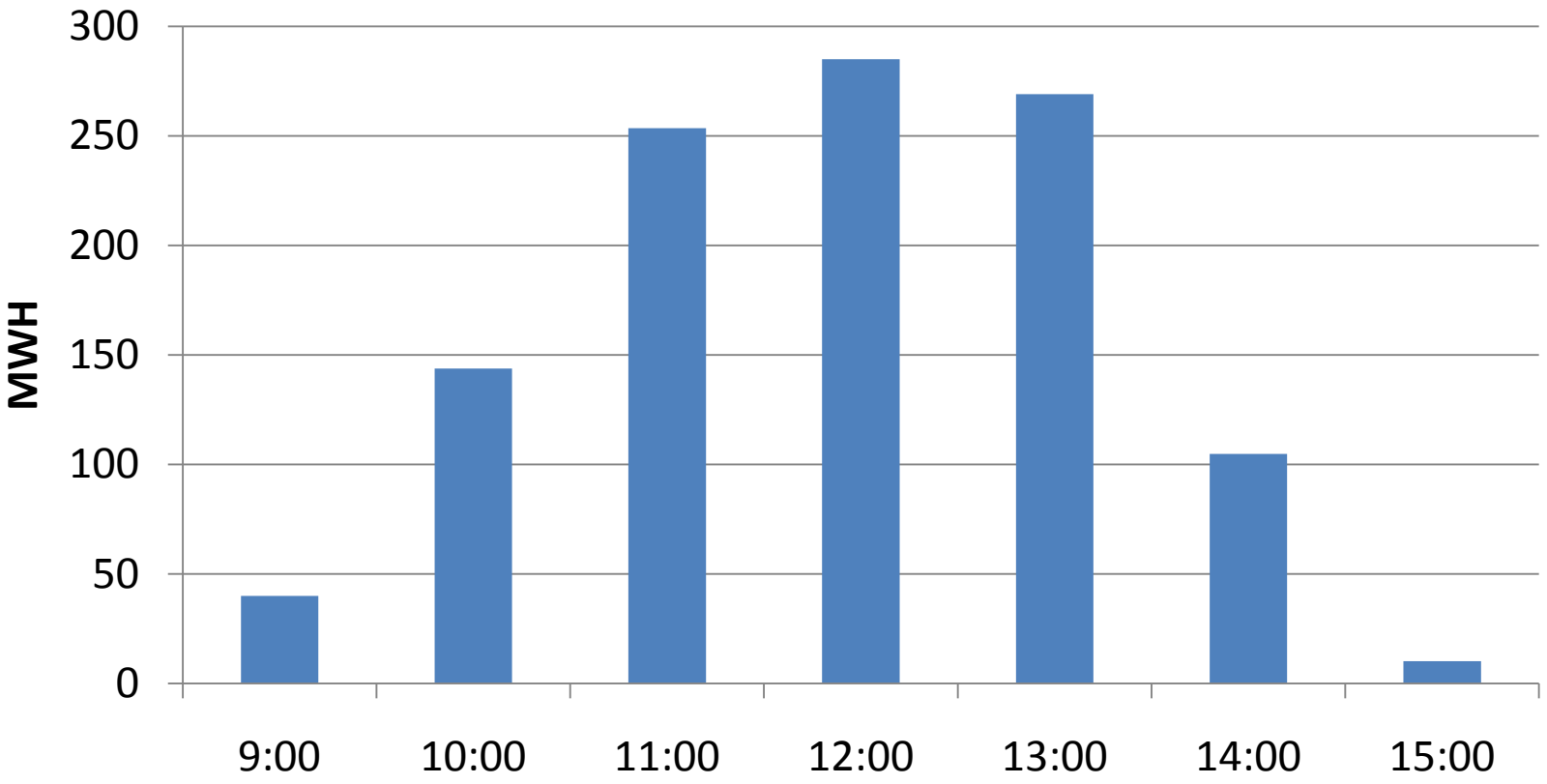
Energy Exporting Trends: Daily

Results



Energy Exporting Trends: Hourly

Results



Conclusions

- PV unlikely to export in areas of dense high-rise buildings
  - Limited roofspace, high shading losses, high loads
- PV generation can exceed loads in areas of dense low-rise buildings
  - Need to monitor installations more carefully
- Exporting most likely to occur during Spring weekends at mid-day
- Future research should study exporting at individual building level