Solar Soars Above & Beyond the Rooftop

Ron Celentano of Celentano Energy Services (CES)

Ron Celentano - Solar Industry Consultant – Design; Project Oversight; Installation; Inspection; Technical Training & Support; Policy Issues; Interconnection/Net Metering, SRECs; Pres. Of Pennsylvania Solar Energy Industries Assoc. (PASEIA); VP of MSEIA

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Brief Overview of Solar Canopies over Rooftops in Philadelphia

- Progression of five Onion Flats construction projects, with integrating solar PV into their buildings over the last 14 years (Onion Flats has been practicing in Philadelphia as developers, architects and builders since 1997)
- Couple of other examples of solar rooftop canopies in Philadelphia
Onion Flats – Rag Flats Project

- 2005 – 2006: 11 PV systems installed for Rag Flats Condominium (part reconstruction/part new construction)
Rag Flats Project
Belfield Passive House Project

FIRST CERTIFIED PASSIVE HOUSE IN PENNSYLVANIA

START: APRIL 20, 2012
CERTIFICATE OF OCCUPANCY: JULY 20, 2012

RECIPIENT OF THE 2014 INTERNATIONAL PASSIVE HOUSE AWARD
SECOND PLACE WINNER 2015 PHIUS AWARD “AFFORDABLE HOUSING”

2013 AIA HONOR AWARD
Stable Flats Passive House Project
Stable Flats Passive House Project
Onion Flats – Stable Flats Passive Home Project
Capital Flats Multi-Family Passive House Project

CAPITAL FLATS: 3 PHASES, 42 UNITS, 18 YEARS
Capital Flats Multi-Family Passive House Project
Characteristics and Modeling Results

- 25 Apartments (500-1000sf)
- 17,400 sf
- R34 walls
- R 54 roof/floors
- .13 Uvalue windows
- .6 SHGC
- Centralized VentilationERV, 82% efficient
- Centralized Hot Water: Geothermal
- Centralized heating/cooling: Geothermal VRF
- Centralized Electric Metering
- 77 kw PV array to get to Net Zero

**210 mods x 370 watts = 77 kW system**

**PHIUS+ 2015 Multi-Family Calculator**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results in green</td>
<td></td>
</tr>
<tr>
<td>iCFA TOTAL (ft³)</td>
<td>16,782</td>
</tr>
</tbody>
</table>

**PV Utilization**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site electricity (kWh/yr)</td>
<td>84085</td>
</tr>
<tr>
<td>Output from PV Watts (kWh/yr)</td>
<td>98554</td>
</tr>
<tr>
<td>Annual PV Output/Annual Electricity Demand</td>
<td>1.17</td>
</tr>
<tr>
<td>Utilization fraction from utilization curve</td>
<td>0.334</td>
</tr>
<tr>
<td>Primary Energy offset by PV (kBTU/ft³/yr)</td>
<td>21.15</td>
</tr>
</tbody>
</table>

**Primary Energy**

45 kBTU/sf/yr

Site Energy: 84,085 kWh/yr
Output from PV: 98,554 kWh/yr

**NET-POSITIVE!**
77 kW$_{DC}$ PV Array Layout & Rack Support

DPW / Preformed Line Products
P14 Rails; 10", 8" & 7" Stanchions
Balance of System Layout & String Map

Capital Flats II
Laurel St. & Hancock St, Philadelphia
210 - Sunpreme 370 W mods
5 - SolarEdge 14.4 Inverters

Array 1: Inverter 1
(3 Strings - 14 mods/String)

Array 2: Inverter 2
(3 Strings - 14 mods/String)

Array 3: Inverter 3
(3 Strings - 14 mods/String)

Array 4: Inverter 4
(3 Strings - 14 mods/String)

Array 5: Inverter 5
(3 Strings - 14 mods/String)
Efficient Wall Panels / Canopy Post Support Structure
Canopy Beam Support Structure / PV Modules Staged
- PV Racking on Support Structure -
- Thinking Out DC Optimizer Locations -
- Mounting PV Mods Onto Racking
Care Taken Spacing Mods and Torquing Them Down
DC Optimizers Installed After Mounting PV Mods
Wire Management of Homeruns and Bonding Detail
Installing Inverters & Accumulation Panel On Roof
Inverter Installation Completed
Main Electric Panel and Point of Interconnection
Completed Construction
Dark Truth About Building Energy Performance & Behavior

<table>
<thead>
<tr>
<th>Capital Flats</th>
<th>PECO Bills</th>
<th>2018</th>
<th>Meter In</th>
<th>Meter Out</th>
<th>Net kWh</th>
<th>Solar Generation</th>
<th>Total Usage</th>
<th>Solar Offset by Solar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 1/6 - 1/31</td>
<td>10,400</td>
<td>960</td>
<td>9,440</td>
<td>2018 Meter In</td>
<td>2018 Meter Out</td>
<td>2018 Net kWh</td>
<td>2018 Solar Generation</td>
<td>2018 Total Usage</td>
</tr>
<tr>
<td>Mar 3/2 - 3/30</td>
<td>9,520</td>
<td>4,880</td>
<td>4,640</td>
<td>3/30 - 5/1</td>
<td>9,600</td>
<td>3,920</td>
<td>5,680</td>
<td>3/30 - 5/1</td>
</tr>
<tr>
<td>Apr 3/30 - 5/1</td>
<td>10,880</td>
<td>2,960</td>
<td>7,920</td>
<td>5/1 - 5/28</td>
<td>12,320</td>
<td>4,160</td>
<td>8,160</td>
<td>5/1 - 5/28</td>
</tr>
<tr>
<td>Jul 6/29 - 7/30</td>
<td>13,280</td>
<td>2,800</td>
<td>10,800</td>
<td>7/30 - 8/25</td>
<td>9,920</td>
<td>2,800</td>
<td>7,120</td>
<td>7/30 - 8/25</td>
</tr>
<tr>
<td>Sep 8/25 - 9/28</td>
<td>84,085</td>
<td>98,554</td>
<td>14,469</td>
<td>Subtotal</td>
<td>100,400</td>
<td>28,400</td>
<td>72,000</td>
<td>78,191</td>
</tr>
</tbody>
</table>

Estimated projection on actual total building electric usage is about 200,255 kWh/yr, or 2.4X more than what was modeled!! Under investigation……..Some of it is technical that can be fixed, while some of it is behavioral, which is more challenging…. 
Energy Monitoring
Behavior Energy Management

Meeting the Energy Budget
Passive House Certified

FINAL BLOWER DOOR TEST  
Sept 29, 2017  
.53 ACH50

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**Capitol Flats II**  
152-154 W. Laurel Street  
Philadelphia, PA 19123

<table>
<thead>
<tr>
<th>Details</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERIOR CONDITIONED FLOOR AREA</td>
<td>18,782 ft²</td>
</tr>
<tr>
<td>ANNUAL HEATING DEMAND</td>
<td>3.0 kBtu/yr</td>
</tr>
<tr>
<td>ANNUAL COOLING DEMAND</td>
<td>6.2 kBtu/yr</td>
</tr>
<tr>
<td>PEAK HEATING LOAD</td>
<td>3.3 BTU/hr</td>
</tr>
<tr>
<td>PEAK COOLING LOAD</td>
<td>2.8 BTU/hr</td>
</tr>
<tr>
<td>AIR-TIGHTNESS TEST RESULTS</td>
<td>0.05 CFM60/sf²</td>
</tr>
<tr>
<td>SOURCE ENERGY</td>
<td>4,788 kWh/yr</td>
</tr>
<tr>
<td>SITE ENERGY USE INDEX (EUI)</td>
<td>17.0 kBtu/ft²/yr</td>
</tr>
</tbody>
</table>

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*Image of a group of people posing for a picture.*
# Capital Flats Multi-Family Passive House Project - Costs

## Actual Rents Achieved

<table>
<thead>
<tr>
<th>Rent</th>
<th>Category</th>
<th>Average Rent</th>
<th>$2.77/sf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## As-Built Expenses

<table>
<thead>
<tr>
<th>Description of Work</th>
<th>Actual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete/Steel/Excavation</td>
<td>$172,000.00</td>
</tr>
<tr>
<td>Windows/Doors/Panelized</td>
<td>$336,778.76</td>
</tr>
<tr>
<td>Rough Carpentry</td>
<td>$195,032.69</td>
</tr>
<tr>
<td>Finish Carpentry</td>
<td>$37,296.00</td>
</tr>
<tr>
<td>Cabinetry/Appliances/Fixtures</td>
<td>$284,284.77</td>
</tr>
<tr>
<td>Insulation</td>
<td>$39,500.00</td>
</tr>
<tr>
<td>Roofing Greenroof</td>
<td>$119,400.00</td>
</tr>
<tr>
<td>Exterior Cladding</td>
<td>$221,619.51</td>
</tr>
<tr>
<td>Drywall, Metal Studs</td>
<td>$116,630.95</td>
</tr>
<tr>
<td>Interior Doors/Frames/Hardware</td>
<td>$43,142.96</td>
</tr>
<tr>
<td>Flooring</td>
<td>$151,625.40</td>
</tr>
<tr>
<td>Paint</td>
<td>$48,000.00</td>
</tr>
<tr>
<td>Specialties: Steel</td>
<td>$55,500.00</td>
</tr>
<tr>
<td>Fire Sprinklers</td>
<td>$44,000.00</td>
</tr>
<tr>
<td>Plumbing</td>
<td>$130,000.00</td>
</tr>
<tr>
<td>HVAC: Air-source</td>
<td>$0.00</td>
</tr>
<tr>
<td>HVAC Geothermal, VRF</td>
<td>$312,208.00</td>
</tr>
<tr>
<td>Electric</td>
<td>$158,379.00</td>
</tr>
<tr>
<td>General Req's</td>
<td>$234,860.00</td>
</tr>
<tr>
<td>O&amp;H &amp; Profit</td>
<td>$176,227.23</td>
</tr>
<tr>
<td>Soft Costs</td>
<td>$314,560.77</td>
</tr>
<tr>
<td>Contingencies</td>
<td>$221,940.50</td>
</tr>
<tr>
<td>SOLAR: Structure, Panels, Racking</td>
<td>$250,000.00</td>
</tr>
</tbody>
</table>

**Total**                                | **$3,664,986.44** |

**Total Sf:**                             | **17,910 sf**     |

**Costs:**                                | **Hard**          |

**Average Rent:**                         | **$2.77/sf**      |

**Costs:**                                | **$169/sf**       |
Onion Flats Won 4 Awards: Capital Flats Multi-Family Passive House Project

Green Building United – 2018 Groundbreaker Award: Capital Flats – The Battery

https://greenbuildingunited.org/newsroom/cheers-to-more-than-a-year-of-green-building-celebration

Urban Land Institute (ULI) - Philadelphia Willard Rouse Award of Excellence 2018: For Capital Flats Phases 1, 2 & 3


PHIUS Multifamily Project of the Year Award 2018:


Design Philadelphia 2018: 2nd Place - Onion Flats: The Battery

https://www.designphiladelphiaphila.org/best-design-competition
Next Onion Flats Project

BANK FLATS
BANKS
COPPER FLATS

FRONT FLATS 2018: 28 units and retail
COPPER FLATS 2020: 68 units
FRONT FLATS 2018: 28 units and retail

COPPER FLATS 2020: 68 units
FRONT FLATS  2018: 28 units and retail
- 28 Apartments (300-500sf)
- 24,141 sf
- R34 walls, Buildsmart system
- R 54 roof/floors
- .13 Uvalue windows
- .28 SHGC
- **DE-Centralized Ventilation**
- **SEMI-DE-Centralized** Hot Water
- **DE-Centralized** heating/cooling
- **DE-Centralized** Electric Metering
- 174 kw PV array to get to Net Zero

BANK FLATS 2018: 28 units and retail

$152/sf
Other Solar Rooftop Canopy Projects in Philadelphia Installed by Solar States

LUIS MORA PERGOLA/ROOFDECK:
Address: 744 S. Warnock St.
Philadelphia, PA 19147
- 24 x Lumos LSX 250 (250 Watt solar modules)
- 6 kW solar array
- SMA SB 5.0 (5 kW inverter)
Other Solar Rooftop Canopy Projects in Philadelphia
Installed by Solar States

FINANTA:
Address: 1301 N. 2nd St.
Philadelphia, PA 19122
- 81 x Renogy 260W Modules (21.06 kW)
- 91 x Renogy 245W Modules (22.295 kW)
Total: 43.355 kW array
- Enphase M215 inverters
Thank You!!