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# ECM Surveys and C-PACE Applications for the City of Philadelphia Energy Authority

PRACTICAL ENERGY SOLUTIONS

*a Division of Spotts, Stevens and McCoy*

[practicalenergy.net](http://practicalenergy.net) | [ssmgroup.com](http://ssmgroup.com)





## QUALIFICATIONS AND EXPERIENCE

### Practical Energy Solutions/Spotts, Stevens and McCoy

- Companies merged in July 2020, worked together and shared office space in West Chester prior to merger
- PES focus was 100% on energy, primarily commercial and municipal buildings
- SSM provides wide range of engineering services to the same client base
  - Building Engineering
  - Site Planning and Design
  - Survey and Data Capture
  - Infrastructure Planning, Engineering and Design
  - GIS, Building, Infrastructure and Environmental Modeling
  - Wastewater Planning, Engineering, Design and Operations
  - Water Planning, Engineering, Design and Operations
  - Construction Phase Services





PES INDEPENDENT EXPERTISE AND PROJECT EXPERIENCE

## Energy Consulting since 2006

- Energy Audits (ASHRAE I, II, and III)
- Benchmarking Studies
- Building Energy Modeling
- Operational/System Assessments
- Re-tuning HVAC and Central Utility Plant Operations
- Strategic Energy Planning and Implementation
- Technical Support for Rebate, Grant, and Financing Programs
- ROI/Feasibility Studies for Capital Projects and Renewable Energy Systems
- HVAC Design and Control Sequence Consulting
- Carbon and GHG Inventories and Climate Action Plans



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PHILADELPHIA C-PACE

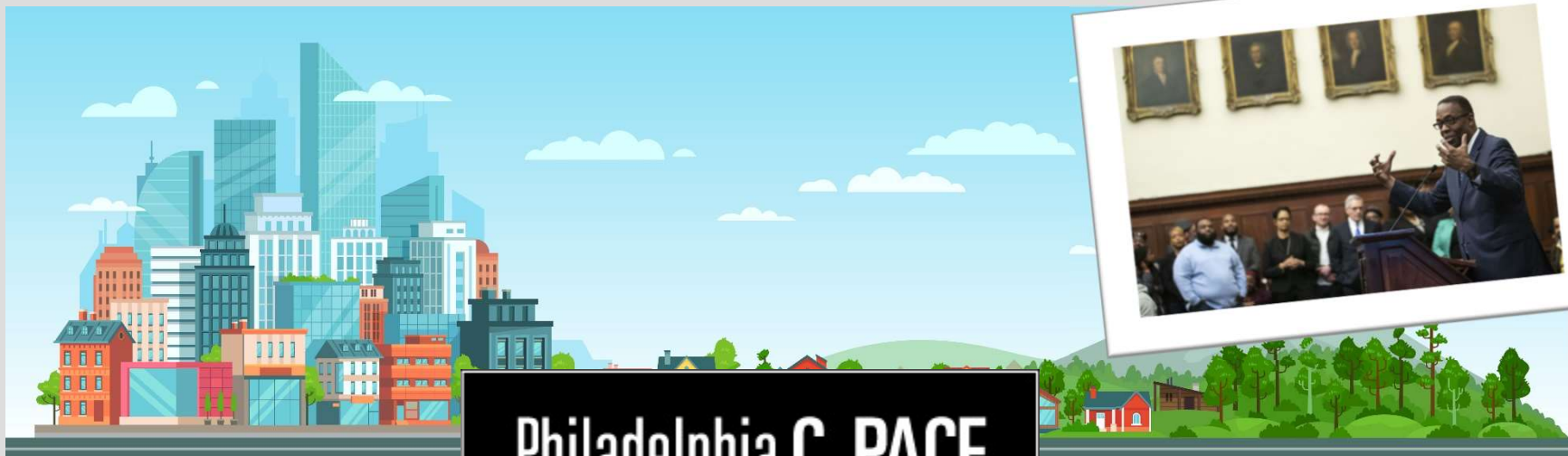
## PES Relevant Experience

- Technical Support for Energy Efficiency Financing Programs
  - Energyworks (5 county SE PA region)
  - Green Energy Loan Fund (statewide PA)
  - Baltimore Energy Efficiency Fund
  - C-PACE Philadelphia
- Technical Support for Grant and Rebate Programs
  - PGW EnergySense – Commercial and Industrial rebates
  - Delaware County Municipal Energy Grant Program
  - PECO rebate program Trade Ally



## Why Are We Here Today?

- To learn about C-PACE financing, a program approved by the state legislature and Philadelphia City Council, which can be used for energy efficiency, renewable energy projects, and water efficiency projects.
- Our focus: Energy Conservation Measure (ECM) Survey



Philadelphia C-PACE



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## PHILADELPHIA C-PACE

# Why is the City promoting this?

- We need a multi-faceted approach to reach the carbon reduction targets established by the City of Philadelphia
- *Powering Our Future: A Clean Energy Vision for Philadelphia*



Cut citywide carbon pollution 25 percent by 2025 from 2006 levels



Reduce carbon pollution from the City-owned buildings and streetlights 50 percent by 2030



Cut citywide carbon pollution 80 percent by 2050 from 2006 levels



Achieve a 100 percent carbon-free electricity grid by 2050



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## PHILADELPHIA C-PACE

# What is required to apply for financing?

- Pre-application
  - Starts the review process where Philadelphia Energy Authority can provide feedback on your submittal
- Energy Conservation Measure (ECM) Survey or Renewable Energy Feasibility Survey
- The ECM survey is a key element of the application
  - Must be prepared by a Qualified Engineering Professional
  - Must cover all elements of the building that are being financed using C-PACE
  - If subject to code compliance, may need additional measures





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## Who can complete the ECM Survey?

- Certified Building Energy Assessment Professional (BEAP - ASHRAE)
- Certified Energy Auditor (CEA - AEE)
- Certified Energy Manager (CEM - AEE)
- Certified High-Performance Building Design Professional (HBDP - ASHRAE)
- Certified Measurement and Verification Professional (CMVP - offered by AEE and Efficiency Valuation Organization)
- Licensed Professional Engineer (P.E.)
- Investor Confidence Project (ICP) Quality Assurance Assessor
- Investor Confidence Project (ICP) Project Developer
- Certified Passive House Consultant (CPHC)



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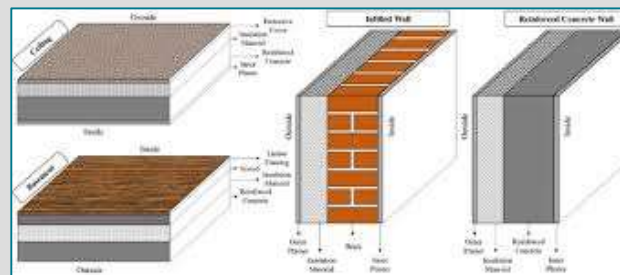




## PHILADELPHIA C-PACE

# What kind of ECMs are eligible?

- HVAC
  - And associated equipment
- Lighting
- Building envelope
- Energy recovery
- Controls
- Renewable energy systems
- Other measures that save energy
  - Better than code
  - Better than previous performance





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## What information is required in the ECM Survey?

That depends....

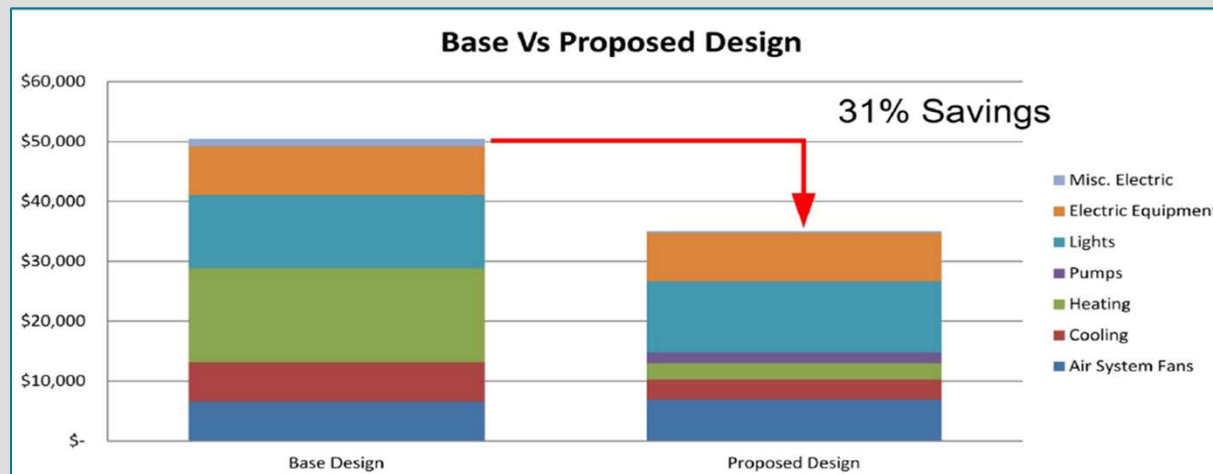
- For all projects:
  - Baseline energy performance (and/or water, as applicable)
  - Proposed project energy performance
  - Savings calculations
- Prescriptive v. whole building
- Code required elements must be included



## PHILADELPHIA C-PACE

# What information is required in the ECM Survey?

- For new construction:
  - Baseline energy performance
    - Energy model of the project designed as a minimum code compliant building, based on applicable code for the project
  - Proposed project energy performance
    - Energy model of the actual project design
  - Savings calculations

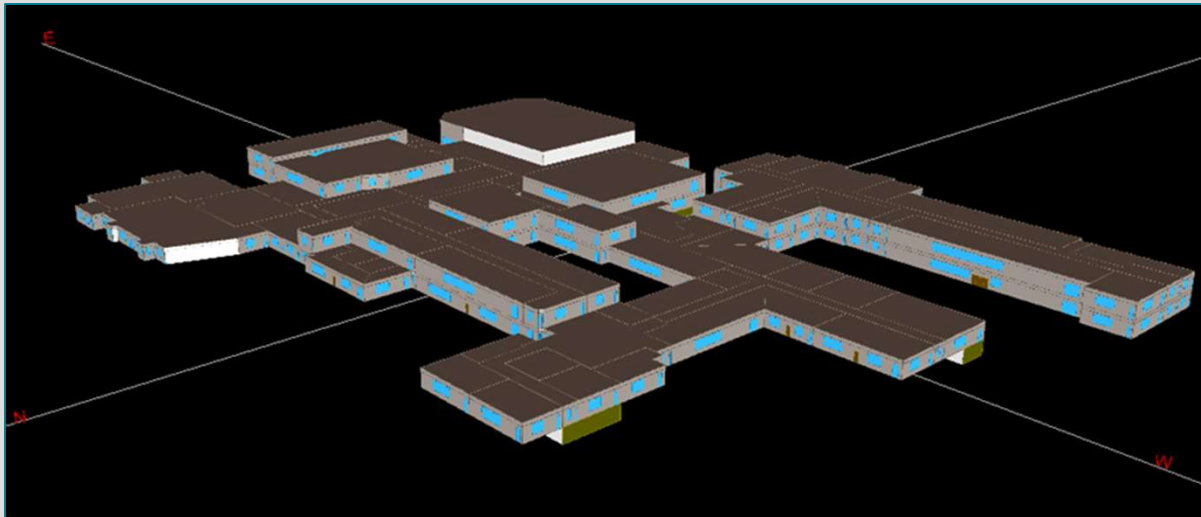




## PHILADELPHIA C-PACE

# What information is required in the ECM Survey?

- For gut/rehab, or major renovation, including change of use :
  - Baseline energy performance
    - Energy model of the project designed as a minimum code compliant building
  - Proposed project energy performance
    - Energy model of the actual project design
  - Savings calculations

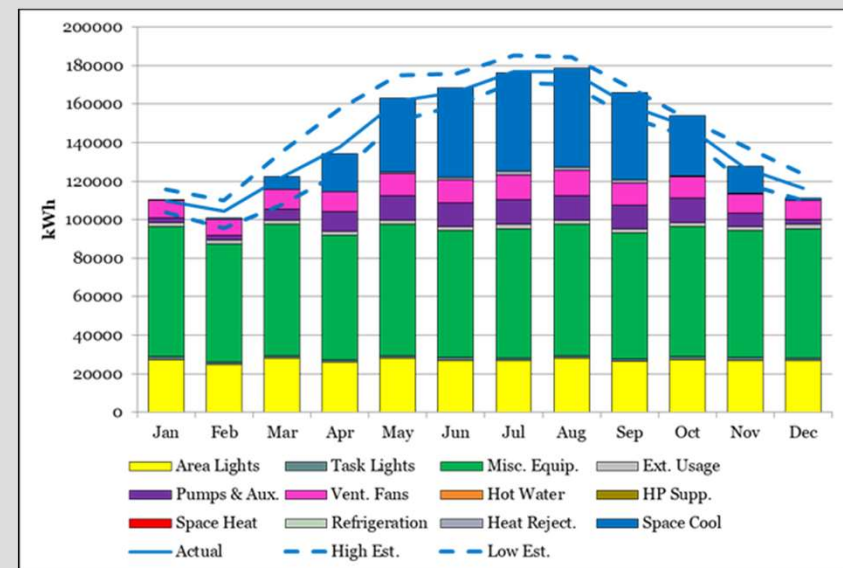




## PHILADELPHIA C-PACE

# What information is required in the ECM Survey?

- Existing building retrofit, no change in use:
  - Baseline energy performance
    - Actual utility use from previous 12 – 24 months, and or:
    - Energy model of existing building, calibrated to energy bills
  - Proposed project energy performance
  - Manual calculations of future energy use
  - Energy model of the actual project design
- Savings calculations





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## What supporting information should be provided with the ECM Survey?

- Full set of drawings and specs
- An ECM summary table
- Energy model files with list of assumptions
- Energy audit with details of calculations on each ECM
- A narrative description of the baseline building
- A narrative of the proposed building features, noting differences from baseline
- 12 – 24 months of utility bills if applicable
- Cut sheets for energy saving equipment



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# What supporting information should be provided with the ECM Survey?

Energy Consumption Estimates:

Electricity Use (kWh/yr)			
	Baseline	Proposed	Savings
Interior Lighting	749,583	631,738	117,845
Space Heating - Elec	307,576	132,206	175,370
Space Cooling	1,134,549	306,960	827,589
Pumps	3,185	67	3,118
Heat Rejection	0	0	0
Fans-Interior	218,842	604,862	-386,020*
Service Hot Water	29,869	25,541	4,328
Receptacle Equipment	374,979	374,979	0
Process Exhaust Fans	24,982	24,982	0
Elevators	13,237	9,926	3,311
Stage Process Lighting	226,884	226,884	0
Total Electricity	3,083,686	2,338,145	745,541

\* Note 1: Fan-Interior savings are negative as ASHRAE 90.1-2007 requires the Baseline model to use Variable Speed fans while the Proposed design uses Constant Volume fans. This negative savings is offset by the superior savings of the Proposed cooling equipment in the Space Cooling category.



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# What type of review is done?

- Compare baseline parameters to design
- Occupancy, use, must be the same in baseline and design

Gas Utility Rate	Same as Design			\$1.020/therm		
Other Utility Rate	Same as Design			None		
Space Uses	Space Type	Area (SF)	SF/Person	Space Type	Area (SF)	Occupants
Space Type 1	Same as Design			Retail	27,221	75 sf/per
Space Type 2				Stairs	1,139	1 per/ea
Space Type 3				Restrooms	582	4 ppl/ea
Space Type 4				Storage	1,187	1 per/ea
Space Type 5				Corridor	5,579	10 ppl/ea
Space Type 6				Mechanical	1,244	1 per/ea
Space Type 7				Fitness Area	1,406	5 ppl/ea
Space Type 8				Computer Room	154	1 per/ea
Total				Total	38,512	
Building Envelope	Description	Insulation R-Value	Assembly U-factor/ C-factor/F-factor	Description	Insulation R-Value	Assembly U-factor/ C-factor/F-factor
Roof	Same as Design		Same as Design	None		n/a
Walls - Above Grade	Steel-framed		U-0.124	40" Masonry		U-0.112
Walls - Below Grade	Same as Design		Same as Design	None		n/a
Semiheated Exterior Envelope	Same as Design		Same as Design	None		n/a
Floors	Same as Design		Same as Design	None		n/a
Slab-On-Grade Floors	Same as Design		Same as Design	4" LW Concrete		F-0.73
Fenestration and Shading	U-factor	SHGC	VT	U-factor	SHGC	VT
Vertical Glazing	U-0.57	SHGC-0.49	VT-0.44	U-0.38	SHGC-0.38	VT-0.44
Skylights	n/a	n/a	n/a	n/a	n/a	n/a
Other Fenestration	U-0.41	SHGC-0.69	n/a	U-0.41	SHGC-0.69	n/a
Vertical Glazing Description	90.1-16 Zone 4			Low-E insulated glazing		
Vertical Glazing % Wall Area	Same as Design			8.6%		
Vertical Glazing Shading Devices	Same as Design			None		
Skylight Glazing Description	Same as Design			None		
Skylight % Roof Area	Same as Design			0%		
Other Fenestration Description	HGI Glass Door			HGI Glass Door		
Other Exterior Shading	Same as Design			None		
Lighting	Same as Design			Scheduled		
Automatic Lighting Shutoff Method	None			None		
Daylight Dimming Controls	Same as Design			Space-by-Space Method		
Interior Lighting Allowance Method	Space Type	Area (SF)	LPD (W/SF)	Space Type	Area (SF)	LPD (W/SF)
Space Type 1	Retail	27,221	1.70	Retail	27,221	1.06
Space Type 2	Stairs	1,139	0.60	Stairs	1,139	0.30
Space Type 3	Restrooms	582	0.90	Restrooms	582	0.55
Space Type 4	Storage	1,187	0.80	Storage	1,187	0.28
Space Type 5	Corridor	5,579	0.50	Corridor	5,579	0.47
Space Type 6	Mechanical	1,244	1.50	Mechanical	1,244	0.27
Space Type 7	Fitness Area	1,406	0.90	Fitness Area	1,406	0.19
Space Type 8	Computer Room	154	2.14	Computer Room	154	0.45
Total LPD	Total	38,512	1.42	Total	38,512	0.86
Automatic Exterior Lighting Control	None			None		

Baseline: not modeled according to Appx A, modeler simply overwrote U-value which may lead to inaccurate calculations re thermal mass, heat storage, and delayed release. LEED report modeled U-value do not match narrative summary table. Proprietary presumably includes insulation, but not shown in layer-by-layer construction. Provide more detail post-renovation wall construction.

Baseline: SHGC should match Appx G table G3.4-4

Baseline: U-value and SHGC should match Appx G table G3.4-4

Baseline: should match Appx G table G3.4-4

Proposed: actual wattage modeled for each space  
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If exterior lighting exists it must be included in the model







## PHILADELPHIA C-PACE

# What type of review is done?

- Make sure that all energy using equipment is modeled in baseline and proposed design

Other Fenestration Description		HGI Glass Door		HGI Glass Door		Baseline: should match Appx G table G3.4-4		
Other Exterior Shading		Same as Design		None				
<b>Lighting</b>								
Automatic Lighting Shutoff Method		Same as Design		Scheduled				
Daylight Dimming Controls		None		None				
Interior Lighting Allowance Method		Same as Design		Space-by-Space Method				
Interior Lighting Power Density		Space Type	Area (SF)	LPD (W/SF)	Space Type	Area (SF)	LPD (W/SF)	
Space Type 1	Retail	27,221	1.70		Retail	27,221	1.06	
Space Type 2	Stairs	1,139	0.60		Stairs	1,139	0.30	Proposed: actual wattage modeled for each space
Space Type 3	Restrooms	582	0.90		Restrooms	582	0.55	Proposed: actual wattage modeled for each space
Space Type 4	Storage	1,187	0.80		Storage	1,187	0.28	Proposed: actual wattage modeled for each space
Space Type 5	Corridor	5,579	0.50		Corridor	5,579	0.47	Proposed: actual wattage modeled for each space
Space Type 6	Mechanical	1,244	1.50		Mechanical	1,244	0.27	Proposed: actual wattage modeled for each space
Space Type 7	Fitness Area	1,406	0.90		Fitness Area	1,406	0.19	Proposed: actual wattage modeled for each space
Space Type 8	Computer Room	154	2.14		Computer Room	154	0.45	Proposed: actual wattage modeled for each space
Total LPD	Total	38,512	1.42		Total	38,512	0.86	Proposed: actual wattage modeled for each space
Automatic Exterior Lighting Control		None		None		If exterior lighting exists it must be included in the model		
Tradable Surfaces		None		None		If exterior lighting exists it must be included in the model		
Non-Tradable Surfaces		None		None		If exterior lighting exists it must be included in the model		
Other		Same as Design		Exit Signs: 0.01 kW				
<b>Internal Loads</b>								
Occupant Activity		Same as Design		Retail				
Occupant Density		Same as Design		See Space Uses				
Receptacle Equipment		Space Type	Area (SF)	EPD (W/SF)	Space Type	Area (SF)	EPD (W/SF)	
Space Type 1					Retail	27,221	1.0	
Space Type 2					Stairs	1,139	0.0	
Space Type 3					Restrooms	582	0.0	
Space Type 4					Storage	1,187	0.0	
Space Type 5	Same as Design				Corridor	5,579	0.0	
Space Type 6					Mechanical	1,244	0.0	
Space Type 7					Fitness Area	1,406	3.0	
Space Type 8					Computer Room	154	500 W	
Total EPD					Total	38,512	0.84	
Elevators and Escalators		Same as Design		25 kW				
Refrigeration Equipment		Same as Design		None				
Cooking Equipment		Same as Design		None				
Data Center & Server Room Loads		Same as Design		None				
Process Loads		Same as Design		None				
Other		Same as Design		None				
<b>Air-Side HVAC</b>								
Primary HVAC Type		System 3 - PSZ AC		VRF w/ DOAS				
Other HVAC Type		System 9 - Gas Unit Heaters		Electric unit heaters		Baseline: fuel type should match Proposed (System 10)		
Total Cooling Capacity		115% autosized		VRF: 70 tons DOAS: 30 tons				
Total Heating Capacity		125% autosized		VRF: 945 MBH DOAS: 480 MBH				
Cooling Efficiency		9.0-10.1 EER		VRF: 0.85 kW/ton DOAS: 10.5 EER				
Heating Efficiency		80% Et		VRF: 0.85-0.87 kW/ton DOAS: 78% Et				
IT Cooling Capacity		Same as Design		None				
IT Cooling Efficiency		Same as Design		None				
Reheat Type		Same as Design		None				
Air-Side Economizer		Not Required		None				
Economizer High Limit Shutoff		Not Required		None				
Design Airflow Rates		Autosized for 20F dT		440-1,800 cfm/cassette				
Design Min Ventilation		Same as Design		6,500 cfm				
Fan System Operation		Constant Speed		Variable Speed				
System Fan Power		Sized per Appx G: 21.2 kW		VRF: 150-450W/cassette DOAS: 2 x 7.5 HP Exhaust: 2 x 2 HP				
Zone Fan Power		See System Fan Power		See System Fan Power				
Return/Relief Fan Power		See System Fan Power		See System Fan Power				





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# What type of review is done?

- Solar:
  - Building characteristics
  - Size of array
  - Current utility usage
  - Production expected (Include calculations)
  - Financial analysis:
    - Rate escalation
    - Tax benefits
    - SREC sale
    - Project cost
  - Commissioning plan
  - Performance monitoring
  - Service life
  - Annual maintenance
  - Confirmation of interconnection approval

4	Energy System Foundation	Roof mount, Everst Racking system	No information provided.
5	Building Characteristics	Multi level brick, commercial building. Using for office space, teaching and worship. See Attached #6 for appraisal report.	Roof specified as rubber membrane and is in good condition. No comment.
6	Utility consumption profile of the site, including the site's historic energy use and cost;	See Attached #1	Utility consumption profile is not included – except a single value for annual electricity usage. Total building electricity usage for all tenants should be included in utility consumption.
7	Description of the proposed Renewable Energy Improvement	Installation of a 212.12 kw roof top solar PV system	Request for additional system design details, such as model number and quantity for invertors and solar panels. Request a single line diagram or site layout.
8	Projected Annual Energy Production	266,673 kwh	Annual degradation rate is about 0.5%, which is appropriate based on the current solar panel technology.
9	Projected energy cost and levelized financial cost inclusive of financing of energy to be generated by the Renewable Energy Improvement, including assumptions effective the levelized cost;	See Attached #2	<ul style="list-style-type: none"> <li>• Electricity rate is \$0.14 per kWh for Year 1. This value cannot be confirm as utility bills were not provided.</li> <li>• The electricity savings is based on the total electricity rate. However, as outlined the PECO Tariff, PECO will provide a credit based on the total amount of electricity generated at the full retail rate. The customer will still be accountable for monthly customer charges, demand charges (which can account for a large portion of the bill), and other charges applicable to the rate schedule. As such, the estimation that 100% of the electricity costs will be saved may overestimate the potential savings.</li> </ul>
10	Weighted cost of energy saved and generated by the project;	See Attached #1	See comment above.
11	Breakdown of cost savings to be realized, if any	See Attached #1	See comment above.
12	Utility tariff to be applied to the site and/or system following installation;	None	No comment, included in Attached #5.
13	Utility escalation rate assumptions;	3%	This escalation rate in the area is higher than anticipated, which may overestimate annual utility savings.
14	Tax benefits;	ITC, MACRS	Appears appropriate. Confirm the source of the MACRS benefits.
15	Expected Useful Life of the Renewable Energy System;	30 years	No comment.
16	Maintenance expenses;	\$63,000 over the lifetime of the system	No clarification provided, not included in the cash flow analysis in Attached #1.
17	Alternative Energy Credits (AECs) or other ongoing sources of revenue as applicable	Pennsylvania SRECs	SREC price is estimated at \$50/SREC in the financial analysis in Attachment #1. This estimation is conservative and may not accurately reflect the potential revenue from SRECs, as the cost fluctuates with the market ranging from a low of \$18/SREC to a high of \$45/SREC. Additionally, the SREC revenue is captured for 15 years following the installation of the system. However, the useful life in Pennsylvania is only 3 years.
18	Survey of total project capital cost, utility tariffs, and interconnection issues, including analysis of impacts of surplus energy generation by the Renewable Energy Improvement;	Total cost of project construction is \$449,694.40.	Aside from total project costs, the utility tariffs and interconnection issues, including analysis of impacts of surplus energy generation by the Renewable Energy Improvement, were not addressed.
19	Identification of an appropriate commissioning plan for monitoring the system functionality and performance;	See Attached #4	Checklist appears to be acceptable, no comment.
20	Verification of the availability of net metering if the system generates excess power that is delivered to the utility grid at any time. Systems are not required to be grid connected.	PECO approved net metering paperwork, see attached #4	Not addressed in application.
21	The Renewable Energy Feasibility Survey should be prepared based on the Property Owners' intended use of the Renewable Energy Improvement. Allowable uses of a Renewable Energy Improvement include:	Generation of electricity to supply the on-site demand of the Property Owner;	No comment.
22	Baseline: The energy generation baseline for all Renewable Energy Improvements is assumed to be zero energy generation; provided, however, if a Renewable Energy Improvement is a replacement of an existing renewable energy system, the	No comment	The energy generation baseline is assumed to be zero energy generation, as an



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## Final Whole Building Energy Summary

Table 1: Energy Comparison

	Total Energy (MBtu/yr)	Electricity (kWh/yr)	Natural Gas (Therm/yr)	Utility Cost (\$/yr)
Baseline Model	11,792	2,965,041	16,756	\$ 314,617
Proposed Model	7,622	2,191,157	1,454	\$ 222,621
Savings	4,171	773,884	15,302	\$ 91,996
% Savings	35%	26%	91%	29%

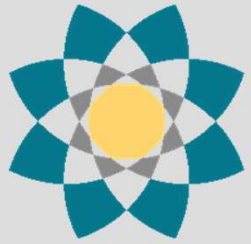


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# Summary – ECM Survey

- Significant detail is required
- For multi-measure projects, all energy using elements of the building need to be assessed
- Energy modeling is the most efficient path in most cases
  - Follow all requirements of ASHRAE 90.1, Appendix G
  - Allows trade-offs between different building elements
- Assumptions and calculations need to be explicitly stated
- For retrofits, building envelope can be an issue
- The Program Managers want your project to qualify, and will provide support/feedback as needed





**We're here to help.**



**PAUL SPIEGEL, PE, LEED AP**

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