CONNECTICUT GREEN BANK

# *Lessons Learned in C-PACE Energy Efficiency and Renewable Energy Project Development*

***June 23, 2016***

**Presented by:**
**Anthony J. Buonicore, PE**
**Director of Engineering**

SRS
accelerating clean energy

# Overview

- **C-PACE Project Technical Review (TR)**
  - Benefits to Stakeholders
  - TR Process Focus
- **Lessons Learned in Technical Review**
  - Energy Conservation Measures (ECMs)
  - Solar PV Systems
- **How Contractors Can Expedite the TR Process**

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Benefits of 3rd Party Technical Review for Project Stakeholders

***Building Owners and Mortgage Holders***


- **Virtually every building owner survey seeking to identify the barriers to energy efficiency investment identified as a major barrier: *lack of confidence in the energy savings projections***
  - Perceived inherent bias of energy auditors and energy service companies
  - The fact that energy savings can't be measured
- **3rd Party Technical Review provides confidence that the project has been vetted by experienced engineers, trained and certified on ICP protocols, qualified to conduct the review**

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Benefits of 3rd Party Technical Review for Project Stakeholders

***Contractors***

- **Ability to present to an often skeptical building owner validation that energy savings and cash flow projections have been reviewed by an independent third party**
- **Result…**
  - Provides contractor with a sales advantage and differentiator
  - Can improve proposal-to-project conversion rate
  - Can increase business

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# C-PACE Technical Review Focus

- **Savings-to-Investment Ratio (SIR)**
  (CGB legislative mandate in Gen. Stat. 16a-40g)

- **Projected Savings ("S")**
  - Energy Savings
    - 1st Year and over the EUL of the ECMs
    - Are the projected energy savings reasonable?

  - Use of utility incentives, if available (e.g., ZREC for 15 years)
  - Use of tax incentives, if available (e.g., investment tax credit)

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# C-PACE Technical Review Focus

- **Total Investment (“I”)**
  - Project Capital Cost Less Utility One-time Rebates
  - Upfront Contractor Costs (e.g., energy audit, feasibility study, etc.)
  - Related ECM/RE Costs (e.g., new roof, asbestos removal, etc.)
  - Financing Costs (i.e., closing fee, interest payments over term)

SRS accelerating clean energy

cpace



CONNECTICUT GREEN BANK

# Technical Review Focus for ECMs

- **Technical review elements (focus on energy audit, the extent of which is typically a function of project complexity)**
  - Building utility bills – rate schedule, costs
  - Building baseline energy consumption (actual / weather normalized)
  - Recommended ECMs / eligibility
  - ECM EULs
  - First year energy savings (kWh, MM Btu, dollars)
  - Savings projection over project lifetime (energy price escalation, performance degradation, etc.) – “S”
  - ECM total project cost – “I”
  - SIR > 1
  - Cx and M&V plan

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# LESSONS LEARNED FROM CONTRACTOR ECM PROJECT SUBMISSIONS

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Utility Bills

- **Actual rate structure in utility bills for the baseline period were not reviewed to determine how both electricity generation and demand/ delivery is priced,** e.g., failure to calculate and factor in demand savings of RTUs

- **Use of aggregated** (generation plus demand/delivery) **electricity cost used to determine savings when ECMs do not reduce both similarly**

- **Use of aggregated** (supply plus demand/delivery) **natural gas cost used to determine savings when ECMs do not reduce both similarly**

- **Fuel oil use for heating not allocated properly when deliveries crossed months** – average/day can be misleading – allocate by HDDs

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Baseline Energy Consumption

- **Baseline period selected not "representative"**
  - Baseline period was less than 1 year
  - Major renovation took place during baseline period
  - Building occupancy rate in baseline period not typical
  - Change in building operating hours during baseline period
  - Removal of major equipment in baseline period, e.g., data center, that impacts energy use
  - Addition of ECMs, e.g., lighting upgrade, in baseline period
- **Baseline period actual energy consumption not weather normalized**

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Recommended ECMs

- **Non-eligible ECMs were included**
  - Not “permanently fixed” ECMs, e.g., Energy Star appliances or window shades that are removable
  - Non-documentable maintenance measures that save energy, e.g., cleaning of HX tubes
- **Recommended ECM package did not meet building owner’s financial return criteria, e.g., payback, ROI, NPV, cash flow**
- **Recommended ECMs were directed solely at equipment replacement –** ***ignoring other energy savings opportunities that could get the SIR > 1 and make the project economics more compelling***

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# ECM EULs

- **EUL exceeded industry norms**
  - C-PACE Technical Review Team manages a comprehensive database of several hundred ECMs with industry best practice EULs that is accessible by contractors, including
    - DEER Database (CA PUC) – updated ~ every 2 years
    - U.S. DOE Clean Energy Finance Guide, March 2013
    - Local utility EULs found in ECM Incentives Document
- **Most Up-to-date EUL not used, e.g.,**
  - LED lighting: 50,000-100,000 hours today, up from 30,000–50,000 hours

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Energy Savings Projections

- **Energy savings based on projected energy consumption with ECMs installed under normalized (e.g., weather) conditions to actual energy consumption in the baseline period** (rather than under normalized conditions)

- **Building energy use model/spreadsheets issues typically involved**
  - Oversimplified building shape and too great a reliance on “defaults” with many assumptions
  - Not calibrated against actual utility data or when calibrated, arbitrary tweeking to “make it look good”
  - Uncertainty (+/-) not identified

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Energy Savings Projections cont'd

- **Savings did not factor in ECM interactive effects – e.g., high efficiency lighting can decrease A/C load in summer, but increase heating load in winter**
- **Aggressive savings projections over EUL**
  - Too aggressive annual energy cost escalation
  - Failure to consider annual performance degradation

- **Inclusion of non-documentable maintenance savings**
- **Utility rebates not pursued**
- **Too aggressive estimation of utility rebates**

SRS accelerating clean energy

cpace



CONNECTICUT GREEN BANK

# Project Costs

- **Failure to include ECM-related costs, e.g.,**
  - Boiler Conversion (oil to gas) – did not consider…
    - Fuel oil tank removal / remediation
    - Asbestos removal
    - Gas line extension from street
    - Gas service availability in the main header

- **Non-ECM related costs included in the project cost, e.g.,**
  - Building re-wiring not associated with ECMs
  - Building envelope repairs having nothing to do with the ECMs

SRS accelerating clean energy

cpace



CONNECTICUT GREEN BANK

# Other

- **Incomplete project documentation, e.g.,**
  - cut sheets of equipment to be installed (e.g., corroborate projected efficiencies, i.e., AHRI performance certificates)
  - cost proposal(s)/contract(s) supporting project cost
  - equipment warranties
  - Cx plan (C-PACE Technical Review team has a template available)

SRS accelerating clean energy

cpace



CONNECTICUT GREEN BANK

# LESSONS LEARNED FROM CONTRACTOR SOLAR PV PROJECT SUBMISSIONS

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Technical Review Focus for Solar PV

- **Technical review elements** (focus on Feasibility Study)
  - Building utility bills – rate schedule, costs
  - Building baseline energy consumption (actual / normalized)
  - Solar PV feasibility
  - First year energy savings (kWh, dollars)
  - Savings projection over project lifetime (energy price escalation, performance degradation, etc.) – “S”
  - Solar PV total project cost – “I”
  - SIR > 1
  - Cx and M&V plan

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Utility Bills

- **Actual rate structure in utility bills for the baseline period were not reviewed to determine how electricity generation and demand/delivery is priced** (on a kWh and kW basis)

- **Use of aggregated** (generation plus demand/delivery) **electricity cost used to determine savings when Solar PV cannot be assumed to reduce demand / delivery charges** (unless energy storage included)

SRS accelerating clean energy

cpace



CONNECTICUT GREEN BANK

# Baseline Energy Consumption

- **Baseline period selected not "representative"**
  - Baseline period was less than 1 year
  - Major renovation took place during baseline period
  - Building occupancy rate in baseline period not typical
  - Change in building operating hours during baseline period
  - Removal of major equipment in baseline period, e.g., data center, that impacts energy use
  - Addition of ECMs, e.g., lighting upgrade, in baseline period


- **Baseline period actual energy consumption not weather normalized**
- **Baseline energy consumption for Solar PV sizing fails to account for electricity reduction of planned ECMs** (such as a lighting upgrade under separate contract) – resulting in an oversized Solar PV system

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Solar PV Feasibility Study

- **Shading study not included**
- **Estimated remaining useful life of the roof not evaluated** (for roof-top Solar PV)
- **Inverter projected lifetime does not cover the financing term or EUL of the Solar PV system** (25 years)

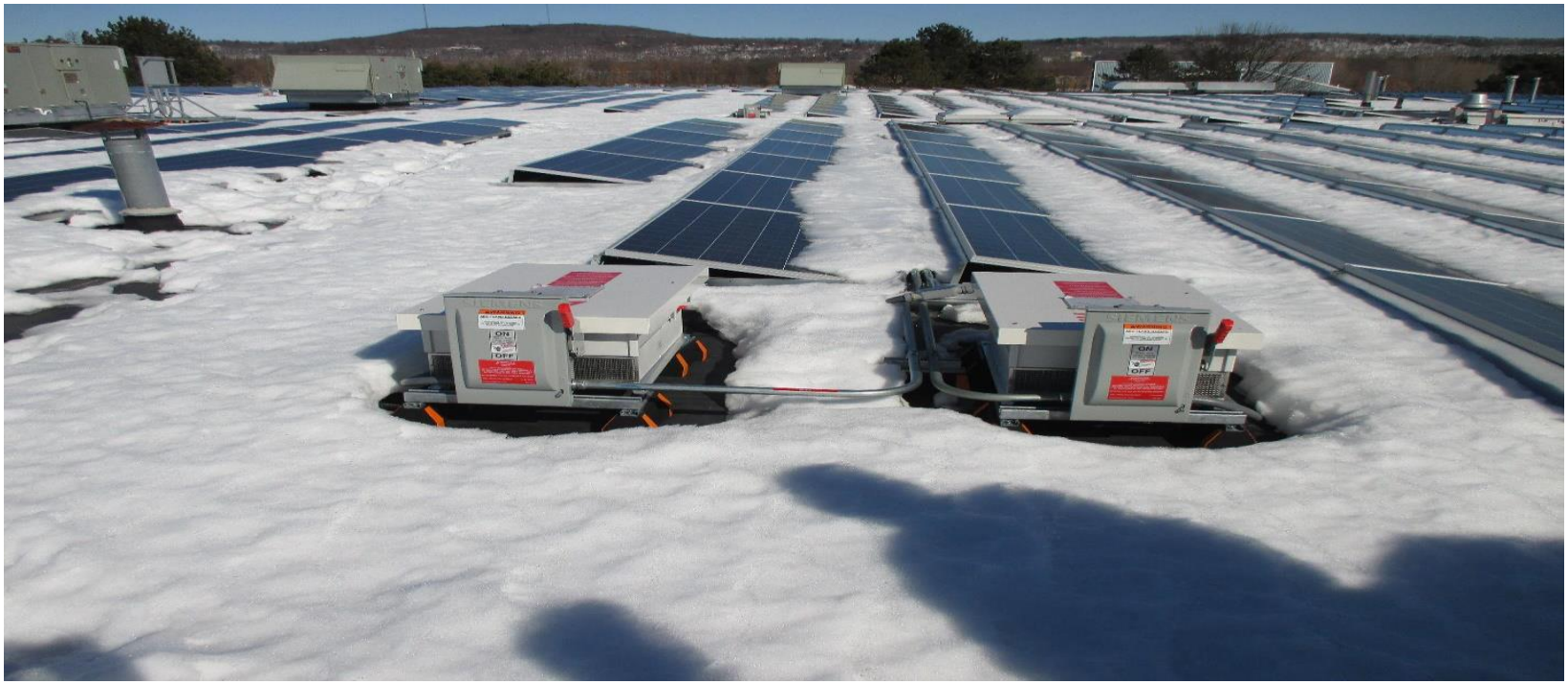
SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Solar PV Feasibility Study cont'd

- **Building structural ability to support roof-top Solar PV including snow and wind loading not evaluated**



SRS accelerating clean energy

cpace



CONNECTICUT GREEN BANK

# Upfront Solar PV Assessment cont'd

- **Assumed system losses** – DC to AC de-rate (nameplate DC rating, mismatch, diodes and connections, DC wiring, AC wiring, soiling, shading) **too low** (flagged if < 10%)


SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Upfront Solar PV Assessment cont'd

- **Assumed inverter efficiency too high** (flagged if > 98% for a string inverter and if > 96% for a microinverter)


SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Upfront Solar PV Assessment cont'd

- **Solar irradiation database (TMY2 or TMY3) used is not representative of the location where the Solar PV system will be installed, e.g., Hartford data** (interior CT) **not representative for New London** (coastal)

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Upfront Solar PV Assessment cont'd

- **Failure to obtain Fire Marshal approval** (e.g., 2015 National Fire Code no longer allows "wall-to-wall" PV module coverage; borders and walkways must be provided)

- **Failure to include system annual performance degradation** (typically 0.5 – 1%)

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Energy Savings Projections

- **Including the utility's demand component in determining electricity savings - should be based only on generation $/kWh savings *assuming no impact on demand component***
- **Failure to obtain an LOA from the utility for the ZRECs**
- **If Solar PV system installation delayed – failure to re-calculate ZREC value** (utility has a start date for the beginning of the 15 year time period in CT)

accelerating clean energy



CONNECTICUT GREEN BANK

# Energy Savings Projections cont'd

- **Uncertainty surrounding electricity production not addressed**

  (PV performance projected by PVwatts may vary from the long term average and electricity costs may not escalate as projected – need to manage client expectations)

- **Aggressive savings projections over EUL resulting from**
  - Too aggressive annual energy cost escalation
  - Failure to consider annual system performance degradation
- **Unsubstantiated tax rate used to take advantage of Bonus Depreciation and MACRS**
- **Applying the retail rate for electricity rather than the wholesale rate to "excess electricity" sent to the grid**

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Project Costs

- **Failure to include Solar PV-related costs, such as:**
  - Roof upgrade to be consistent with Solar PV (roof-top) life

  - Building structural support to handle anticipated Solar PV (roof-top) loading - including wind and snow loading

- **Non Solar-related costs included, such as:**
  - Building re-wiring
  - Building envelope repairs

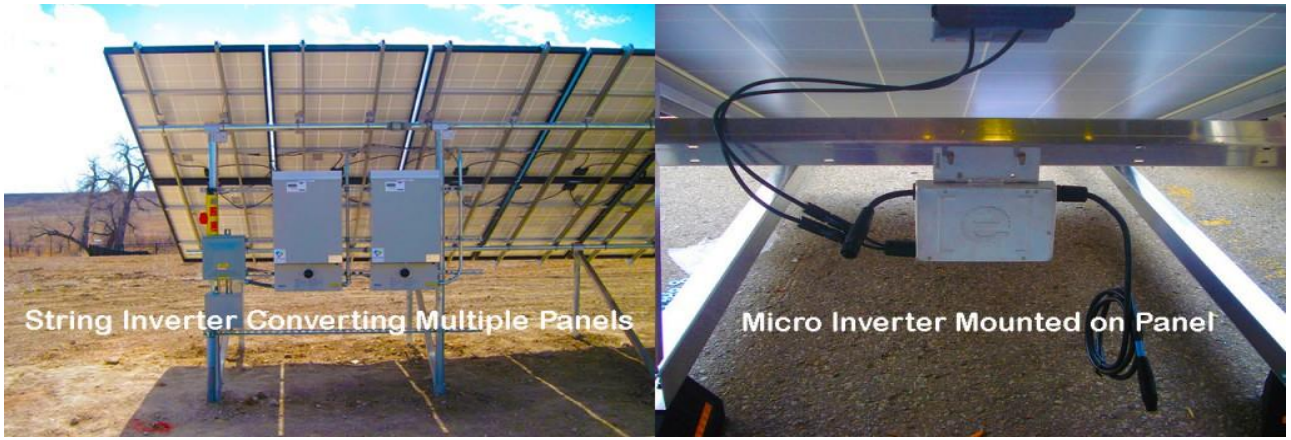
accelerating clean energy



CONNECTICUT GREEN BANK

# Project Costs cont'd

- **Failure to include the cost of an extended warranty on the string inverters covering the full finance term or EUL**




- **Including more than what is IRS allowable in the "project cost" for the ITC** (e.g., cost of roof upgrade is not allowable)

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

# Other

- **Incomplete project documentation, e.g.,**
  - cut sheets of equipment to be installed
  - cost proposal(s)/contract(s)
  - equipment warranties
  - Cx plan (C-PACE Technical Review team has a template available)
  - Failure to include an M&V plan (C-PACE Technical Review team has a template available)

# How Contractors Can Expedite the TR Process

- **Coordinate and begin working with the C-PACE technical team as soon as a project begins to develop to avoid 11th hour changes**
- **Prepare a complete project package "ready for financing" with energy audit or renewable energy feasibility study, including**
  - Project description
  - Baseline utility bills
  - Energy savings calculations
  - Disaggregated project costs (with support documentation)
  - Cut-sheets of ECM / RE equipment to be installed
  - ***Tap C-PACE technical team for support where needed***

SRS accelerating clean energy

cpace

CONNECTICUT GREEN BANK

CONNECTICUT
GREEN BANK




SRS
accelerating clean energy

**Biographical Sketch**

# Anthony J. Buonicore, P.E.

Anthony Buonicore is Chairman and Director of Engineering at Sustainable Real Estate Solutions, Inc. (SRS). Mr. Buonicore previously served as CEO of Buonicore Partners, Inc., an energy risk management consulting firm and publisher of the daily energy news service, *Building Energy Performance Assessment News*, prior to the firm being acquired by SRS. He is a past president and Fellow Member of the Air & Waste Management Association, a Diplomat in the American Academy of Environmental Engineers, a certified Investor Confidence Project Quality Assurance Provider and a licensed professional engineer. He is chairman of ASTM's Building Energy Performance Assessment (BEPA) Task Group, which developed the E2797 BEPA standard, and is a member of the Zero Energy Commercial Buildings Consortium. Mr. Buonicore has been a leader in the energy-environmental industry since the early 1970s, serving as General Chairman of the American Institute of Chemical Engineers' First National Conference on Energy and the Environment in 1973 and as founder and first chairman of the Air & Waste Management Association's Energy-Environmental Interactions Technical Committee in 1974. Mr. Buonicore holds both bachelor's and master's degrees in chemical engineering from Manhattan College.

Mr. Buonicore can be reached at 203-635-6665 or ajb@paceworx.com