The Fairview: Deep Retrofits in Multifamily Residences

Presented by:
Greg Carlson
Property Manager
Fairview Owner’s Corporation

May 8, 2018
Property Profile

- Location: Forest Hills, New York
- Square Footage: 428,800
- Units: 424
- Year Built: 1966
- Building Style: Cooperative Residence
- Residents: ~1,400 residents, predominantly comprised of middle income families with children
• Original chiller had reached end of life, was not providing sufficient cooling capacity, and was consuming significant steam
• Boilers ran year-round to make domestic hot water and steam for heating and cooling
• Mechanical equipment nearing end of life
  • 20-30+ years old
• Oil #6 equipment was on the horizon for phase out by NYC
• Overall high utility costs
• Improve building comfort and performance
• Decrease utility costs
• Identify cost-effective equipment upgrades
• Incentives and/or low cost loans
• Board of Directors reached out to professional engineering consultant to discuss options
• Participating in NYSERDA’s Multifamily Performance Program (MPP) was recommended
• Received energy reduction plan outlining upgrade options
  • Included cost to implement, annual projected savings, and projected payback
• Board of Directors selected measures
• Some residents were skeptical:
  • Will the upgrades really make that much of a difference?
  • How noisy is construction going to be?
  • How long is this process going to take?
  • Will the work be completed in time before the cooling/heating seasons start?
  • How much is this work going to cost us?
The Board voted to approve MPP energy reduction plan
  • Upgraded the heating, cooling, domestic hot water, and lighting equipment

The MPP project was a success
  • Upgrades have saved $333,400 annually on utility bills

Residents were interested in additional measures to improve energy independence and resilience
After Superstorm Sandy, residents became more aware of energy security and building resilience.

Residents wanted to be less dependent on the main power grid.

The Board worked with EN-POWER GROUP again to assess the feasibility of on-site generation options:
- Cogeneration (CHP)
- Solar photovoltaic (PV) system

Both technologies were installed successfully and the Board is currently discussing battery storage opportunities.
The Fairview:
Deep Retrofits in Multifamily Residences
May 8, 2018

Michael Scorrano, PE, MBA
Managing Director & Founder
EN-POWER GROUP

Company Overview

EN-POWER GROUP is an energy engineering firm that designs, develops, and delivers comprehensive solutions from concept to completion for any type of building.

Our services include:

- Engineering design and implementation
- Energy consulting, management, and financing
- Compliance and certifications
- Resiliency, on-site generation, and renewable energy
EN-POWER GROUP

Company Overview

- 150,000,000 square feet audited
- 2,000+ buildings audited
- 2,500+ buildings benchmarked
- $25,000,000 in incentives recovered for our clients
- 2013 and 2015 winner of NYSERDA Installer Award for achieving the “Highest Portfolio Wide Installed Energy Savings” of any NYSERDA MPP partner
The Fairview: Phase I
Equipment Modernization Focusing on Efficiency

➢ Development of a comprehensive Energy Reduction Plan that included detailed on-site energy study & energy modeling
➢ Evaluation of potential measures
  • Capital costs, energy and cost savings, payback periods, return on investment (ROI), available incentives, etc.
➢ Measures selected and installed:
  • Duel fuel boiler burners / conversion to natural gas
  • Direct-fired chiller / elimination of summer boiler steam production
  • Separate domestic hot water (DHW) heaters
  • High efficiency pump motors
  • Variable frequency drives (VFDs) on pump and fan motors
  • All new interior and exterior lighting
The Fairview: Phase I
Design Considerations

➢ Challenges
  • Original building equipment with tight access for rigging new equipment
  • Large number of residences and the need to maintain continuous operation
  • Cost consideration and return on investment

➢ Solutions
  • Careful design and construction sequencing
  • Selection of equipment that could be integrated into the building
    • Direct-fired heaters and DHW heaters
    • Equipment redundancy benefits
  • Selection of only cost-effective measures
The Fairview: Phase I
Achievements

➢ Reduced energy consumption:
  • 23% source energy savings
  • Energy Use Index (EUI)
    • Pre-retrofit: 224.5 kBtu/sqft per year
    • Post-retrofit: 169.6 kBtu/sqft per year
  • Carbon emission reduction: ~1,890 tons annually
➢ Reduced staff maintenance needs:
  • Early compliance to oil #6 ban in favor of lower cost, cleaner natural gas
  • Elimination of summer boiler steam production
  • Increased resident comfort
The Fairview: Phase I

Achievements

➢ Reduced energy costs:
  • Actual energy cost savings: $333,000 annually
  • Total project cost: $2,046,000
  • Payback period: 6.1 years
  • Net life cycle savings: $3,431,000
  • Lifetime return on investment (ROI): 68%

➢ Rebates & Financing:
  • NYSERDA MPP Grant: $263,000
  • NYSERDA Energy $mart Loan Fund: $2,120,000
  • NYSERDA Peak Load Reduction: $200,000
  • NYSERDA Building Operator Training: $3,000
  • Others: $250,000 from local utility funds
The Fairview: Phase II
New Equipment Focusing on Resiliency

➢ Concerns about energy resiliency after Superstorm Sandy
  • How to better prepare The Fairview for the next extreme weather event or natural disaster?
  • How to maintain vital utility services such as water and energy supply critical to The Fairview to protect the health and welfare of all residents?
The Fairview: Phase II
New Equipment Focusing on Resiliency

➢ At the building level, major components of resiliency include:
  • Emergency planning
  • Capital/long-term planning
➢ Resiliency is ultimately about RISK assessment, planning, and prevention
➢ Current technologies that enhance building resiliency:
  • Emergency Power Generation
  • Cogeneration / Combined Heat & Power (cogen or CHP)
  • Solar Power
  • Battery Storage
The Fairview: Phase II  
Cogeneration / Combined Heat and Power

➢ Cogeneration uses one fuel source to generate electricity and recycles thermal energy for heating, domestic hot water, and cooling
  • More energy efficient than conventional generation (60% to 90% efficiency)
➢ Can be designed to maintain electricity supplies during emergencies
➢ Provides significant savings compared to purchased electricity and self generated thermal energy, allowing for a return on investment
The Fairview: Phase II
Design Considerations

➢ Challenges
• Integration of both CHP and solar PV systems with one another and with existing building systems
• Building located in floodplain (post-Sandy requirements)
• Significant wind loads on rooftop (16 floors)
• NYDOB/NYFD criteria
• New roof / warranty
• Rigging of CHP system and physical space requirements

➢ Solutions
• 82-kW solar PV system:
  • Racking structure to elevate and tilt panels
  • Pitch pockets for physical attachments
• 300-kW CHP system (InVerde Ultra, M/N INV-300):
  • Units all located above floodplain
  • Required some demolition of wall to fit units into building
  • Scheduled shutdowns for building tie-in
The Fairview: Phase II
Achievements

➢ CHP System Installation
  • Projected annual generation: 1,369,500 kWh of electricity and save 110,800 therms
  • Annual energy cost savings: $159,000

➢ Rebates & Financing:
  • NYSERDA CHP Program rebate: $510,000
  • With rebate, the simple payback was 5.5 years, and return on investment (ROI) was 18%
The Fairview: Phase II
Achievements

➢ Solar Photovoltaic (PV) System Installation
  • The solar PV system is projected to generate 105,600 kWh of electricity annually
  • Annual energy cost savings: $11,000
  • Tax benefits attributed to co-op shareholders

➢ Solar PV System
  • Coordinated rebate application of the NYSERDA’s NY-SUN Program, and total amount of rebate is $51,000
Multifamily Performance Program

The Fairview: Deep Energy Retrofits in Multifamily Residences - New MPP Incentives
Building Energy Exchange

May 8, 2018
Agenda

1 – Multifamily Building Solutions Network

2 – MPP Comprehensive Option

4 – MPP High Performance Offering

5 – Energy Use Snapshot
Reforming the Energy Vision (REV)

Governor Cuomo’s strategy to build a clean, resilient and affordable energy system for all New Yorkers.
Clean Energy Fund (CEF)

- 10-year, $5 billion State funding commitment that supports REV
- Reshapes New York’s energy efficiency, clean energy and energy innovation programs
- Reduced cost of clean energy
- Accelerates adoption of energy efficiency to reduce load
- Increases renewable energy to meet demand
- Mobilizes private investment in clean energy
Multifamily Building Solutions Network

Providing solutions to improve your building
Multifamily Building Solutions Providers

• New Network of Energy Service Professionals
• Replaces the Multifamily Performance Partners
• Taking applications on an on-going basis
• NYSERDA vets Providers on criteria that a diligent building owner would use
• Minimizes the effort a building owner needs to undertake to select a qualified professional
Provider Qualifications

• Certified
  – AEE, BPI, RA, and/or PE

• Experienced
  – Case studies on at least 3 projects
  – References

• Local

• Sound
  – Customer Service and Quality Control plans
  – Staffing detail
Provider Oversight – Annual Report

• General Information

• Market Activity

• Market Intelligence

• Customer Satisfaction
MPP Version 8 - Comprehensive Option

A whole-building approach
Comprehensive Option - Overview

• Find a Multifamily Building Solutions Provider.
• Only available to eligible affordable buildings:
  – Existing buildings
  – 5+ residential units
  – Pay into electric Systems Benefits Charge
  – At least 50% residential space
  – Meets Low-to-Moderate Income definition
• Work with Provider to identify a minimum 20% projected energy savings.
Comprehensive Option – Affordability

• Minimum of 25% of the units are occupied by households earning not more than 80% of the area or state median income, whichever is higher.
• All other properties are considered market rate and ineligible for the Comprehensive Option.

Forms of Proof:
• Proxy Program (HUD, WAP, NYSHCR, NYCHPD)
• Rent Roll
• Resident Income
Comprehensive Option Incentives

<table>
<thead>
<tr>
<th>Projected Energy Savings Target</th>
<th>Total Incentive* (per unit)</th>
<th>Construction Incentive* (per unit)</th>
<th>Performance Incentive (per unit)</th>
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<tbody>
<tr>
<td>20% - 24%</td>
<td>$700</td>
<td>$600</td>
<td>$100</td>
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<tr>
<td>25% - 29%</td>
<td>$800</td>
<td>$700</td>
<td>$100</td>
</tr>
<tr>
<td>30% - 35%</td>
<td>$1,000</td>
<td>$800</td>
<td>$200</td>
</tr>
<tr>
<td>36%+</td>
<td>$1,500</td>
<td>$1,000</td>
<td>$500</td>
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</table>

*Construction incentive is typically paid out at 100% construction completion. Projects that use a construction manager to oversee the project, however, may qualify for a payment of one-half of the construction incentive at 50% completion.
Comprehensive Option – Incentive Cap

• NYSERDA incentives will not exceed 50% of the total costs of eligible measures.
• Total project costs includes the cost of improvements in the proposed SAV-IT.
• The following are **not** included in the total project costs for the purposes of calculating the incentive cap:
  – Cost of previously installed measures
  – Provider fees
  – Construction management fees
Incentive Cap

40-unit building projecting 28% energy savings

Incentive Eligibility: $28,000
Cost of Improvements: $80,000
Incentive Cap: $40,000
Incentives Received for Previously Installed Measure(s): $5,000
New Incentive Cap: $35,000

Updated Incentive Cap:

Base Incentive  Performance Incentive
<table>
<thead>
<tr>
<th>Previously Installed Measures, including previous WAP*</th>
<th>Measure savings may be used to reach Performance Target</th>
<th>Measure costs may be included in Incentive Cap</th>
<th>Incentive Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Utility Programs</th>
<th>Yes</th>
<th>Yes</th>
<th>Utility incentives deducted from eligible MPP Incentive</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Other NYSERDA Programs (renewables, Targeted Option)</th>
<th>Yes</th>
<th>Yes</th>
<th>Other Program incentives deducted from eligible MPP Incentive</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>WAP concurrently with MPP</th>
<th>Yes</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
</table>

*Previously installed measures are those installed and operating up to one year prior to MPP Application Approval.
Comprehensive Option – Process

1. NYSERDA Energy Use Snapshot Service

2. Provider submits customer’s application

3. NYSERDA reviews & approves application

4. Provider performs energy assessment

5. Provider completes SAV-IT and submits to NYSERDA

6. NYSERDA reviews and approves scope of work

7. Building installs improvements

8. Provider requests 100% completion incentive

9. Provider verifies project performance
Savings Verification and Information Tool

(SAV-IT)
High Performance Component

The next generation of deep energy savings
High Performance Component – Overview

• Applications to achieve significant energy savings by:
  – 40% Source Energy Savings from EE only, and 100 EUI (kBtu/sf/year) with the aid of Renewables or CHP option
  – Or Passive House Standard

• Incentives of $3,500/unit for affordable existing multifamily projects only
High Performance Component – Overview

- Applicable to Affordable Existing MF Buildings only

- Applications submitted exclusively through a Multifamily Building Solutions Provider (MFBS-P)
High Performance Component – Overview

• The High Performance Component allows for the integration of Renewables and Conservation Measures to reach 100EUI
  o PV
  o Real Time Energy Management (RTEM)
  o Co-Generation (CHP)
  o Renewable Heating and Cooling
Energy Use Snapshot
Energy Use Snapshot – Overview

A free report and a complete and accurate snapshot of:

- Heating
- Cooling
- Baseload

### Regression Model Results

- Winter (Heating) Slope: 8.11 Therms/day per °F
- Winter changepoint temp: 63.8 °F
- Summer (Cooling) Slope: 0.00 Therms/day per °F
- Summer changepoint temp: 85 °F
- Baseload Slope: 0.50 Therms/day
- # of baseline data points (n): 12
- # of parameters (p): 4
- Coefficient of Variation: 5.1%

### Source for Typical Weather Information

- Weather Station Locality: Syracuse
- Weather Data Publication Source: NOAA 1981-2010 Climate Normals

### Energy Usage Correlation to Weather

#### Regression Model Results

- Winter (Heating) Slope: 8.11 Therms/day per °F
- Winter changepoint temp: 63.8 °F
- Summer (Cooling) Slope: 0.00 Therms/day per °F
- Summer changepoint temp: 85 °F
- Baseload Slope: 0.50 Therms/day
- # of baseline data points (n): 12
- # of parameters (p): 4
- Coefficient of Variation: 5.1%

### Time Series Comparison to Regression Model

#### Utility Data (Actual)

- Heating (Therms)
- Cooling (Therms)
- Baseload (Therms)

#### Regression Model Predictions

- Total Therms (Day)

### Energy Usage Normalized to a Typical Weather Year

- Heating (Therms)
- Cooling (Therms)
- Baseload (Therms)

#### Energy Usage for a Typical Weather Year

- Total Therms (Day)
- Total HDD (Therms)
- Total CDD (Therms)
Energy Use Snapshot – Quick Overview

The Snapshot shows two types of energy totals:

- Actual historic usage
  - up to two years
- Predicted usage during typical weather conditions
  - annual and monthly
Energy Use Snapshot – Quick Overview

Free for eligible MPP multifamily buildings
- Participation in MPP is required
- Must pay into the electric System Benefits Charge

Required for Comprehensive Option & High Performance Component
- But still free
Energy Use Snapshot – Quick Overview

Cuts your project costs because NYSERDA does these tasks:

- Obtains electricity and gas usage histories from utility companies
- Compiles all billing data into a single workbook
- Scales up sampled apartment meters
- Disaggregates heating, cooling and baseload usage
- Weather-normalizes per industry standards
- Graphs usage patterns
- Calculates useful metrics
Energy Use Snapshot – Quick Overview

Some up-front effort on your part:

- You provide to NYSERDA:
  - Signed Data Release Authorization Forms (DRAFs)
  - Oil delivery records
  - District Steam billing data
  - Some building info (sq. ft., number of apts., etc.)
Thank You!

Dean Zias
NYSERDA – Multifamily Performance Program
Project Manager, New York City Office
(212) 971-5342x3019
dean.zias@nyserda.ny.gov
Combined Heat and Power Basics
Advanced Inverter Based CHP Systems
COMPANY OVERVIEW

Tecogen Key Stats

- Headquartered in Massachusetts
- >30 Years of Manufacturing CHP
- Nine USA service centers
- 2300+ units shipped
- Largest and most tenured CHP provider in the USA

2300 MANUFACTURED UNITS

9 SERVICE CENTERS
WHAT IS CHP?

- Simultaneous production of shaft power and heat
- A prime mover (in many cases an internal combustion engine) turns a shaft to produce shaft work, and heat is recovered from the prime mover and purposefully reused.

**Electrical CHP**
- Shaft work turns a generator to create electricity, heat is recovered from prime mover
- Tecogen’s Inverde® & TecoPower® products are Electrical CHP Systems

**Mechanical CHP**
- Shaft work turns a device such as a refrigeration compressor to drive a vapor-compression cycle, heat is recovered from prime mover
- Tecogen’s TecoChill® and Ilios® products are Mechanical CHP systems

Traditional “cogen” “Electrical CHP”

Note: Typically most people associate “cogeneration” with electrical CHP, all types of CHP products are also cogeneration products, don’t get caught up in the semantics!
TECOGEN’S CHP PRODUCT SUITE

Cogen Modules

Ilios Water Heaters

TECOCHILL Chillers

Electricity & Heat

2x Heat Efficiency

Cooling & Heat

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Understanding the benefits

- Tecogen installations utilize a multiple unit approach to serve larger loads
  - Install units in groups on a large campus close to the thermal loads
  - Load following the building, turn units off as building loads decrease, saving on service costs.

- No synchronous generators means easy interconnection, anywhere, inverter based just like a solar panel
  - No paralleling switchgear needed for multiple units, all paralleling done via software

- In most cases several low cost Tecogen units will be much cheaper to install than large industrial engine based platforms
  - With a “plug and play” approach, everything is standardized and pre-packaged, reducing cost.

- Provides a greater degree of redundancy, can take a small portion of the plant off line to service, keeping the majority of the plant up and running at all times.
  - Greater ability to actually capture demand savings for the customer

- Small units allow use of low-cost, reliable automotive based engine, with widespread parts availability, quick and easy to repair, a complete engine can be replaced in a matter of a few hours.

- Standardized design allows safety certification on entire package for all products
- 33% Electrical Efficiency-Highest in class
- Widest operating range 10kW-125kW
- Patented variable speed operation for highest part load efficiency
- Low gas pressure requirement, 4” WC
- Quiet Operation (65 dBA @ 20’)
- Seamless energy storage integration via DC input feature
  - Can charge and discharge batteries
  - Allows for time-shifting and peak demand shaving strategies
  - Can also integrate solar PV directly into Inverde for seamless integration between renewables and CHP
- Ultra-clean emissions on par w/ fuel cell
- 25kW peaking ability for added savings
  - Demand response programs
  - Winter thermal load following
  - Summer electrical load following(demand capture)
- CERTS Microgrid Technology
Combined Heat & Power (aka cogeneration)

Definition: The simultaneous production of two useful outputs (electricity + heat) from a single fuel source

- Gas in: 1,042,560 Btu
- Electricity out: 100 kW (32.7% efficiency)
- Thermal out: 613,000 Btu/hr (58.8% efficiency)
- Total efficiency: >91.5% (LHV basis)

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Excellent part-load efficiency
Inverde e+ Ultra Part Load Performance

All other cogen units are inferior when it comes to part load efficiency, this is solely a result of Tecogen’s patented inverter technology and variable speed operation.

<table>
<thead>
<tr>
<th>Electrical Output (kW)</th>
<th>Fuel Usage (BTU/hr)</th>
<th>Heat Recovery (BTU/hr)</th>
<th>Electrical Efficiency (%)</th>
<th>Overall Efficiency (%)</th>
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</thead>
<tbody>
<tr>
<td>125</td>
<td>1,316,775</td>
<td>780,000</td>
<td>32.39</td>
<td>91.63</td>
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<td>290,000</td>
<td>30.34</td>
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<td>20</td>
<td>259,378</td>
<td>147,175</td>
<td>26.31</td>
<td>83.05</td>
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Advanced Modular CHP Systems
Inverter Interface

**Engine/Generator Output**

<table>
<thead>
<tr>
<th>RPM</th>
<th>Volts</th>
<th>Freq (hz)</th>
<th>KW</th>
</tr>
</thead>
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<tr>
<td>1000</td>
<td>98</td>
<td>135</td>
<td>39</td>
</tr>
<tr>
<td>2200</td>
<td>207</td>
<td>297</td>
<td>93</td>
</tr>
<tr>
<td>3000</td>
<td>258</td>
<td>405</td>
<td>130</td>
</tr>
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</table>

**Delivered kW**

<table>
<thead>
<tr>
<th>Volts</th>
<th>Freq (hz)</th>
<th>KW</th>
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</thead>
<tbody>
<tr>
<td>480</td>
<td>60</td>
<td>37</td>
</tr>
<tr>
<td>480</td>
<td>60</td>
<td>88</td>
</tr>
<tr>
<td>480</td>
<td>60</td>
<td>123</td>
</tr>
</tbody>
</table>
WHAT ARE THE BEST APPLICATIONS FOR CHP?

- Buildings
  - Hospitals
  - Nursing Homes
  - Colleges/Schools
  - Hotels
  - Industrial/Process
  - Multi-Family Residential
  - Department Stores
  - Ice Rinks

- Gas usage – at least 50,000 therms annually
  - Ideally have centralized hot water system

- Electric usage – at least 876,000 kWh annually
HOW CAN CHP BENEFIT A DEEP ENERGY RETROFIT PROJECT?

• Waste heat can be used for other applications
  • Domestic Hot Water Production

• Improved Resiliency
  • Decentralized power source can provide electricity during blackouts and extreme weather events
  • Equipment redundancy
Company Information

Tecogen Inc.
45 First Avenue
Waltham, MA 02451

www.tecogen.com

Contact

Jeffrey Glick, VP Sales - Tecogen Inc.
781.466.6481
Jeffrey.Glick@Tecogen.com