The Fairview: Deep Retrofits in Multifamily Residences

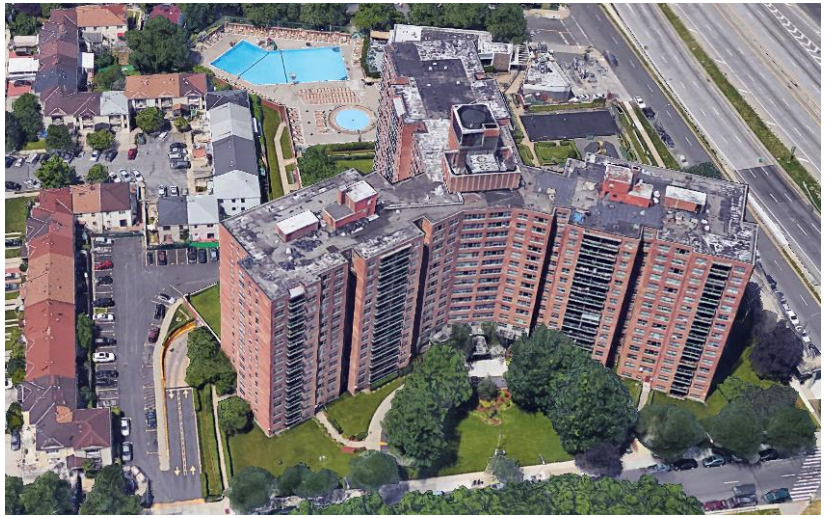
Presented by:

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



Property's Existing Conditions

- 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

Project Wish List

- Improve building comfort and performance
- Decrease utility costs
- Identify cost-effective equipment upgrades
- Incentives and/or low cost loans

Project Scoping

- 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

Project Concerns

- 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?

Next Steps

- 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

On-Site Generation

- 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 Board is currently discussing battery storage opportunities

EN-POWER GROUP

The Fairview:

Deep Retrofits in Multifamily Residences

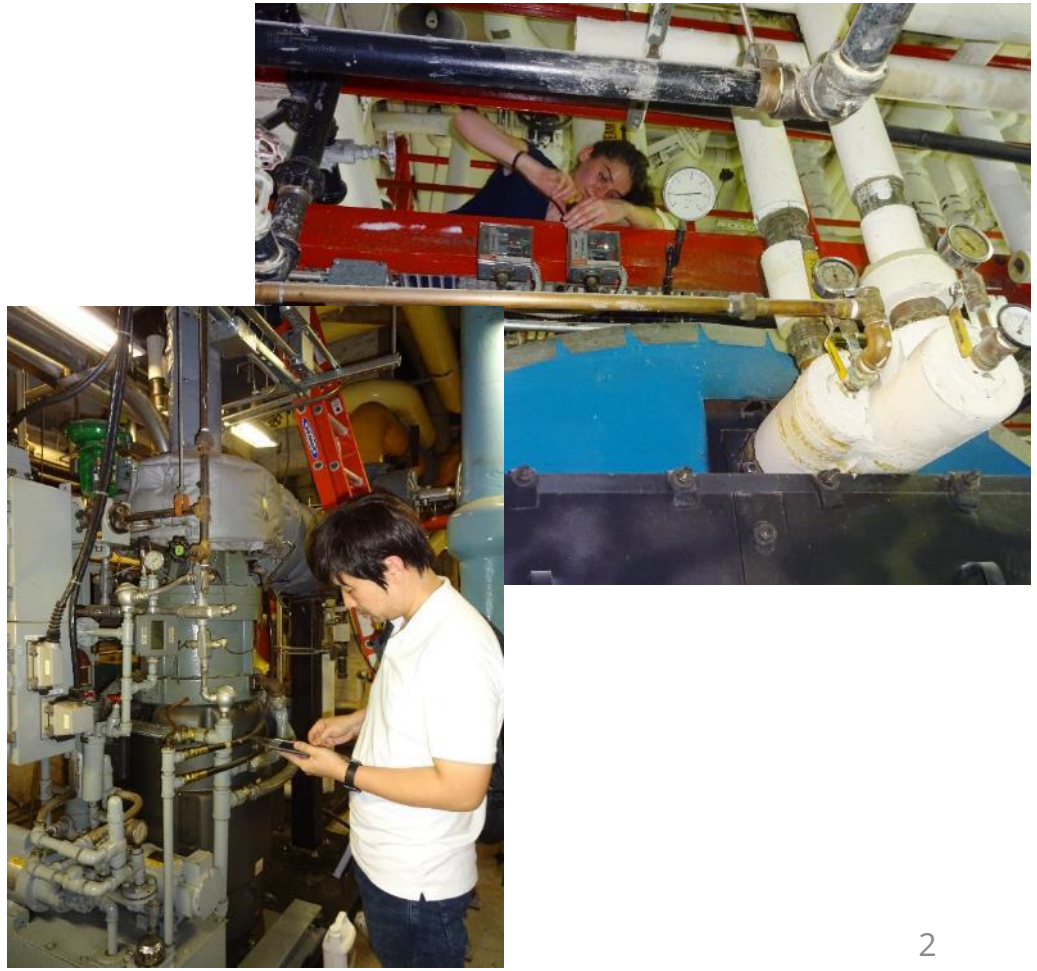
May 8, 2018

Michael Scorrano, PE, MBA
Managing Director & Founder

EN-POWER GROUP

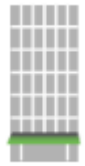
Company Overview

- 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


Commercial


Multifamily


Educational


Healthcare


Hospitality


Municipal


Data Center


Industrial

- 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

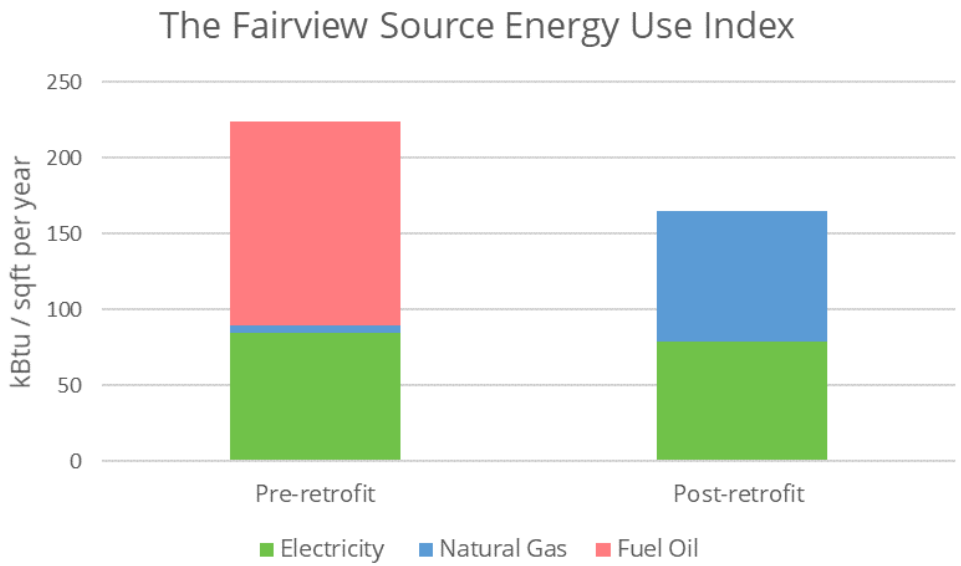
Design Considerations

- 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

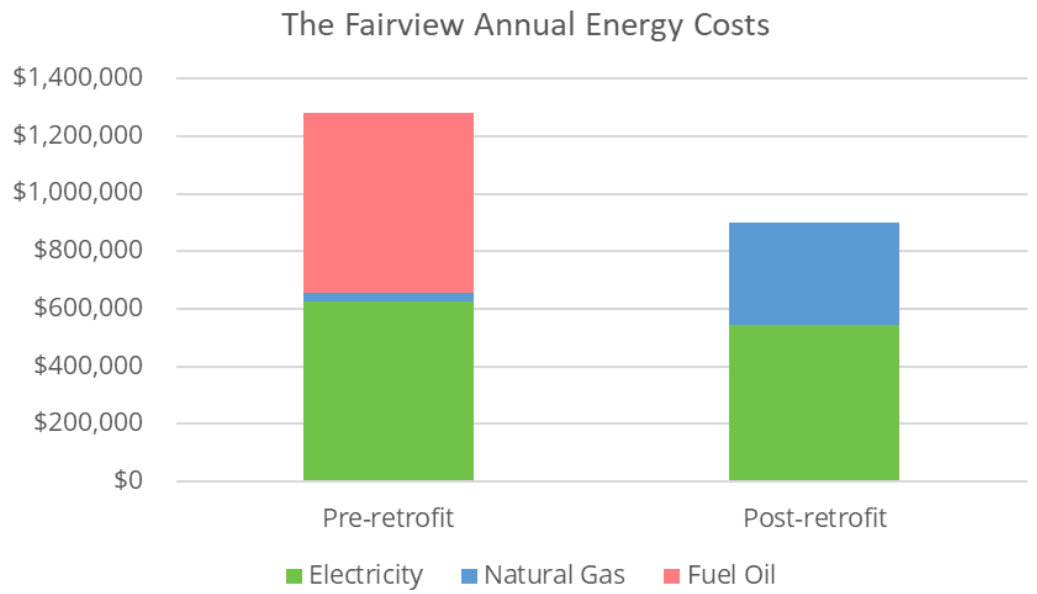
- Reduced energy consumption:
  - 23% source energy savings
  - Energy Use Index (EUI)
    - Pre-retrofit: 224.5 kBtu/sqft per year
    - Post-retrofit: 169.6 kBtu/sqft per year
  - Carbon emission reduction: ~1,890 tons annually
- Reduced staff maintenance needs:
  - Early compliance to oil #6 ban in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



The Fairview: Phase I

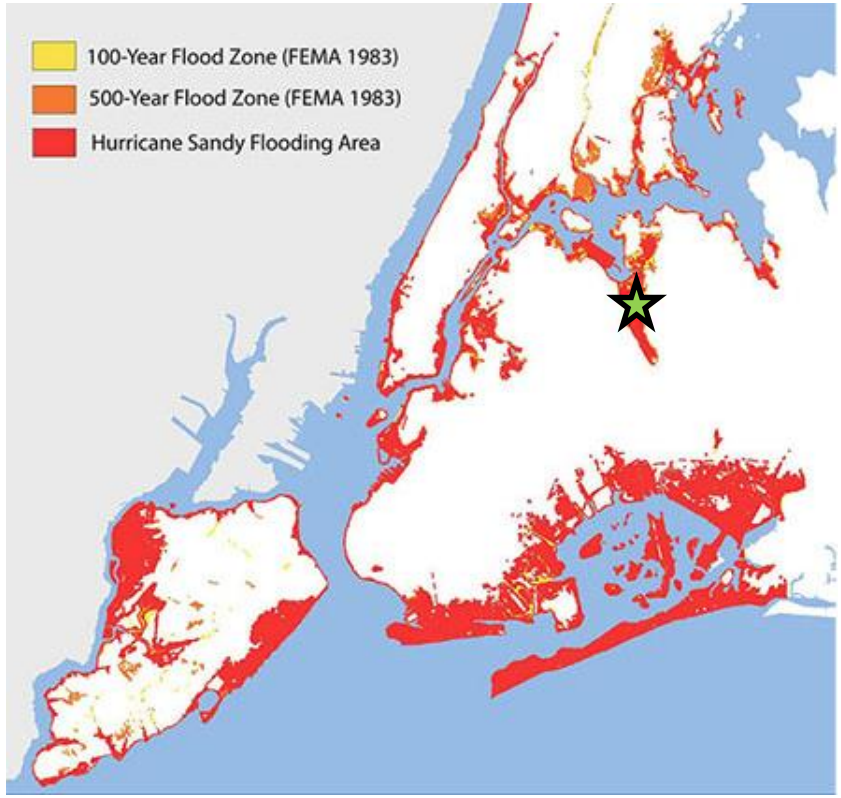
Achievements

- 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

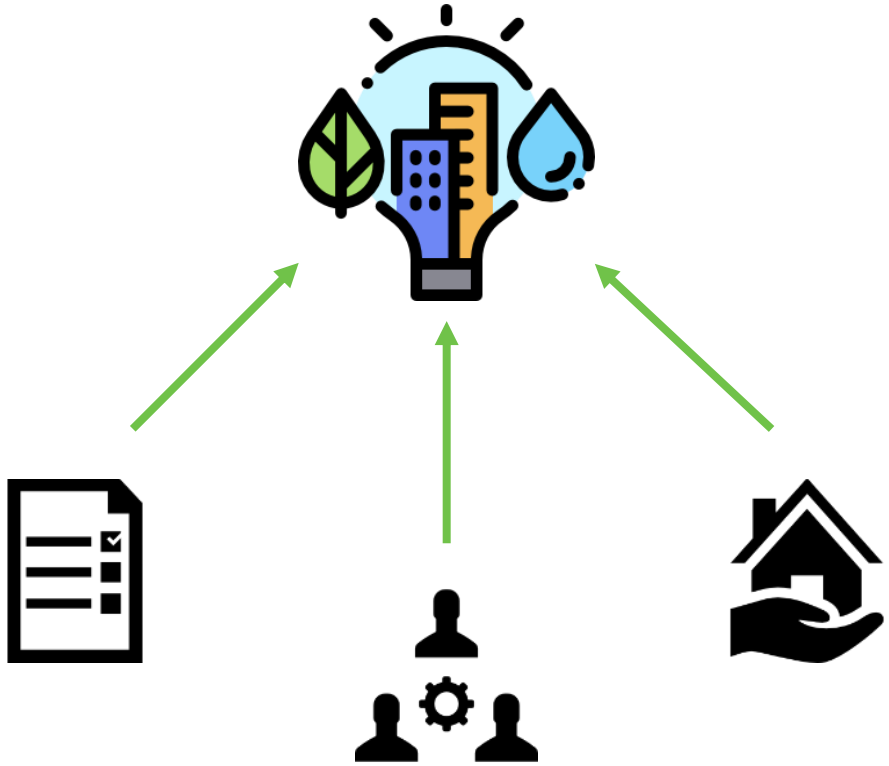


Courtesy NYC Mayor's Office

- 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

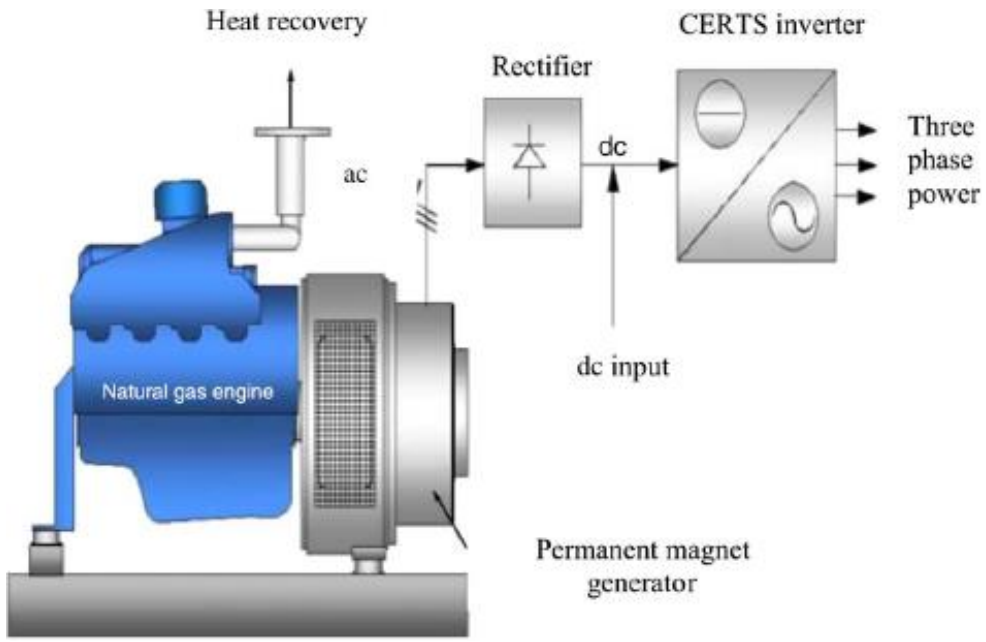
New Equipment Focusing on Resiliency



- 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

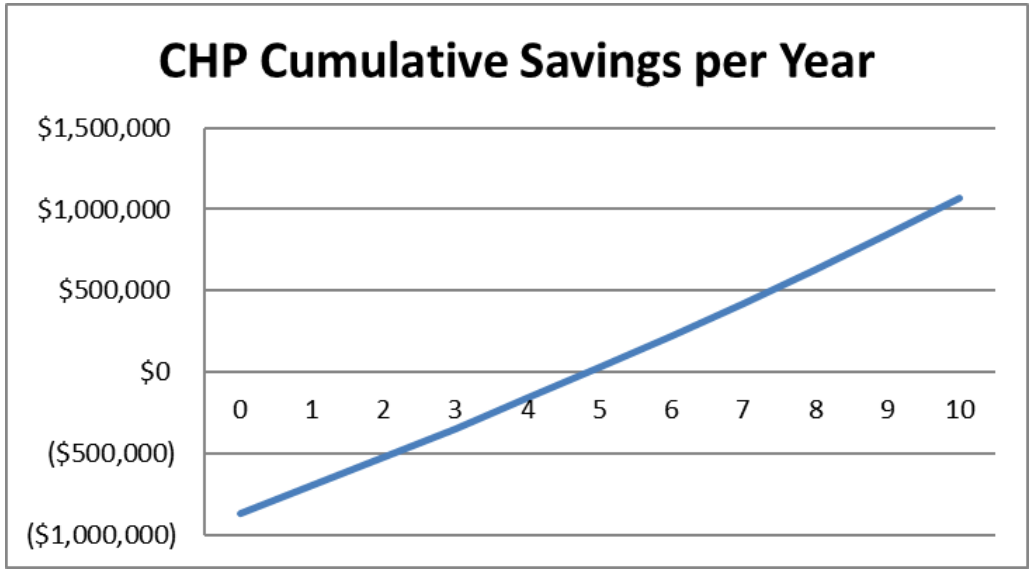
The Fairview: Phase II

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

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

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

NEW YORK STATE OF OPPORTUNITY. NYSERDA

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

Projected Energy Savings Target	Total Incentive* (per unit)	Construction Incentive* (per unit)	Performance Incentive (per unit)
20% - 24%	$700	$600	$100
25% - 29%	$800	$700	$100
30% - 35%	$1,000	$800	$200
36%+	$1,500	$1,000	$500

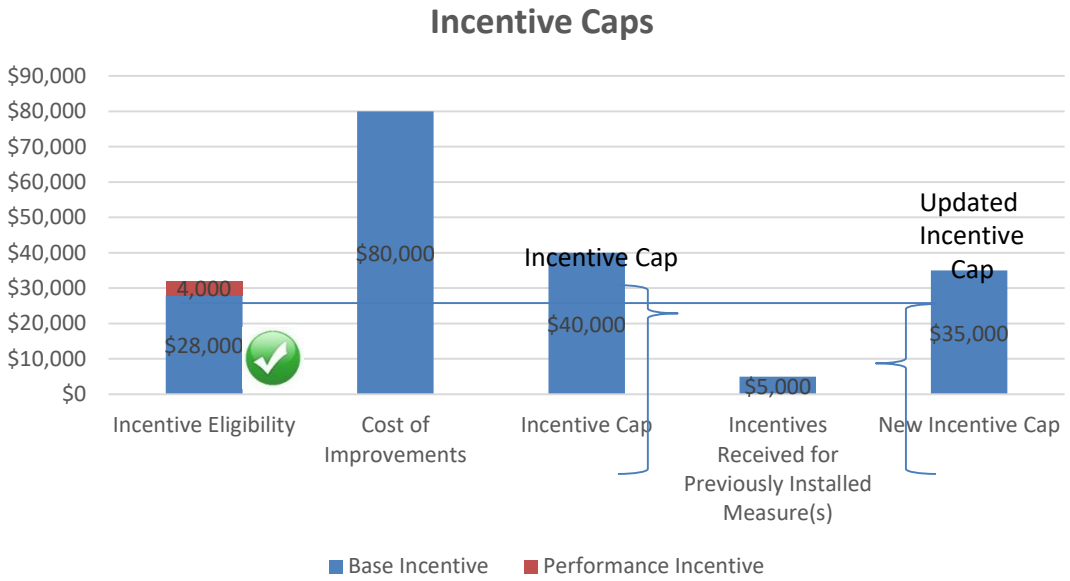
*Construction incentive is typically paid out at 100% construction completion. Projects that use a construction manager to oversee the project, however, may qualify for a payment of one-half of the construction incentive at 50% completion.

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



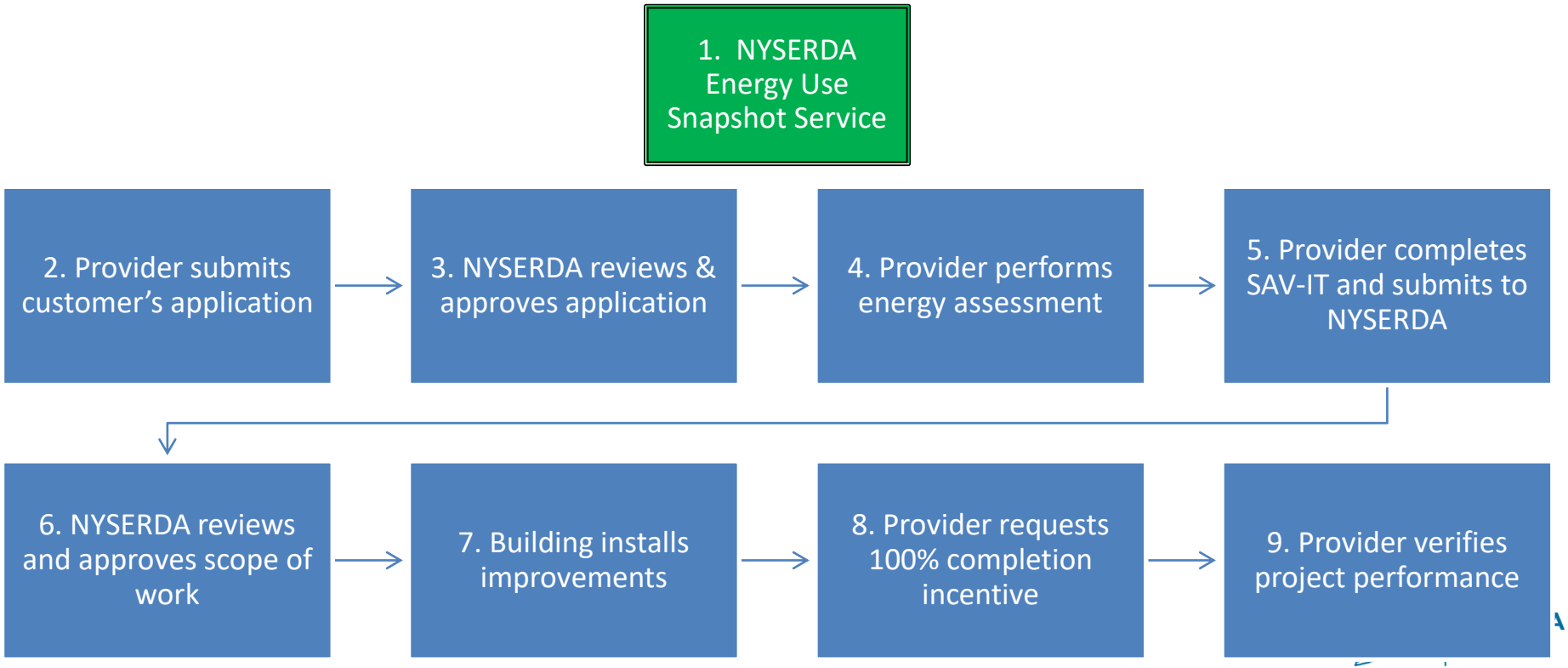
NEW YORK STATE OF OPPORTUNITY. NYSERDA

Coordination with Previously Installed Measures and Other Energy Efficiency Programs including WAP

	Measure savings may be used to reach Performance Target	Measure costs may be included in Incentive Cap	Incentive Adjustments
Previously Installed Measures, including previous WAP*	Yes	No	N/A
Utility Programs	Yes	Yes	Utility incentives deducted from eligible MPP Incentive
Other NYSERDA Programs (renewables, Targeted Option)	Yes	Yes	Other Program incentives deducted from eligible MPP Incentive
WAP concurrently with MPP	Yes	Yes	N/A

*Previously installed measures are those installed and operating up to one year prior to MPP Application Approval

Comprehensive Option – Process



NEW

Savings Verification and Information Tool

(SAV-IT)

NEW YORK STATE OF OPPORTUNITY. NYSERDA

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

NEW YORK STATE OF OPPORTUNITY. NYSERDA

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**
  - PV
  - Real Time Energy Management (RTEM)
  - Co-Generation (CHP)
  - Renewable Heating and Cooling

Energy Use Snapshot

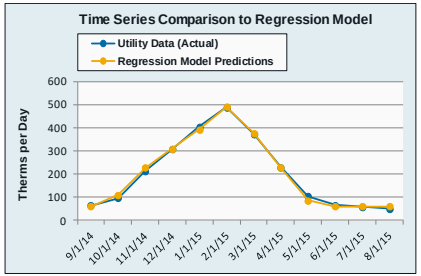
Energy Use Snapshot – Overview

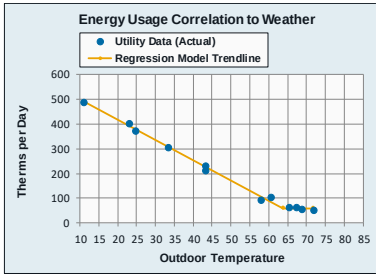
A free report and a complete and accurate snapshot of:

- 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	63.8	°F
Baseload	60.1	Therms/day
# of baseline data points (n)	12	
# of parameters (p)	3	
r-squared:	1.00	
Coefficient of Variation	5.1%	

Source for Typical Weather Information	
Weather Station Locality	Weather File Publication Source
Syracuse	NOAA 1981-2010 Climate Normals





Utility Billing Data (Actual)					Actual Weather		
From	To	Days	Therms	Therms/ Day	Average Temp (°F)	HDD ref 65°F	CDD ref 65°F
8/23/14	9/24/14	33	2,097.0	64	65.4	108	118
9/25/14	10/23/14	29	2,769.0	95	57.8	224	14
10/24/14	11/21/14	29	6,218.0	214	43.2	632	0
11/22/14	12/23/14	32	9,845.0	308	33.3	1,015	0
12/24/14	1/26/15	34	13,744.0	404	22.9	1,431	0
1/27/15	2/24/15	29	14,124.0	487	11.0	1,566	0
2/25/15	3/25/15	29	10,788.0	372	24.8	1,166	0
3/26/15	4/24/15	30	6,910.0	230	43.2	655	0
4/25/15	5/26/15	32	3,328.0	104	60.6	211	69
5/27/15	6/24/15	29	1,911.0	66	67.2	45	112
6/25/15	7/24/15	30	1,751.0	58	68.8	20	134
7/25/15	8/25/15	32	1,644.0	51	71.9	0	223
		Total Days	Total (Therms)			Total HDD	Total CDD
		368	**75,129**			7,074	670

Regression Model Projected to Actual Weather				
Heating (Therms)	Cooling (Therms)	Baseload (Therms)	Total (Therms)	Total Therms/ Day
0	0	1,983	1,983	60
1,428	0	1,742	3,170	109
4,858	0	1,742	6,601	228
7,934	0	1,923	9,856	308
11,294	0	2,043	13,337	392
12,435	0	1,742	14,177	489
9,191	0	1,742	10,933	377
5,034	0	1,802	6,837	228
846	0	1,923	2,768	87
0	0	1,742	1,742	60
0	0	1,802	1,802	60
0	0	1,923	1,923	60
Heating (Therms)	Cooling (Therms)	Baseload (Therms)	Total (Therms)	
53,018	0	22,111	**75,129**	

These totals are not normalized to a typical weather year.

Energy Usage Normalized to a Typical Weather Year					
From	To	Days	Typical Average Temp (°F)	Typical HDD ref 65°F	Typical CDD ref 65°F
1/1/10	1/31/10	31	26.0	1,209	0
2/1/10	2/28/10	28	25.4	1,110	0
3/1/10	3/31/10	31	37.4	860	6
4/1/10	4/30/10	30	47.9	518	6
5/1/10	5/31/10	31	59.9	191	32
6/1/10	6/30/10	30	66.4	66	112
7/1/10	7/31/10	31	71.8	4	213
8/1/10	8/31/10	31	68.0	31	123
9/1/10	9/30/10	30	60.7	181	53
10/1/10	10/31/10	31	49.5	481	0
11/1/10	11/30/10	30	40.9	723	0
12/1/10	12/31/10	31	27.7	1,155	0
		Total Days		Total HDD	Total CDD
		365		6,529	545

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

FAIRVIEW CHP PRESENTATION
NEW YORK, NY
MAY 8, 2018

Tecogen®
Advanced Modular CHP Systems

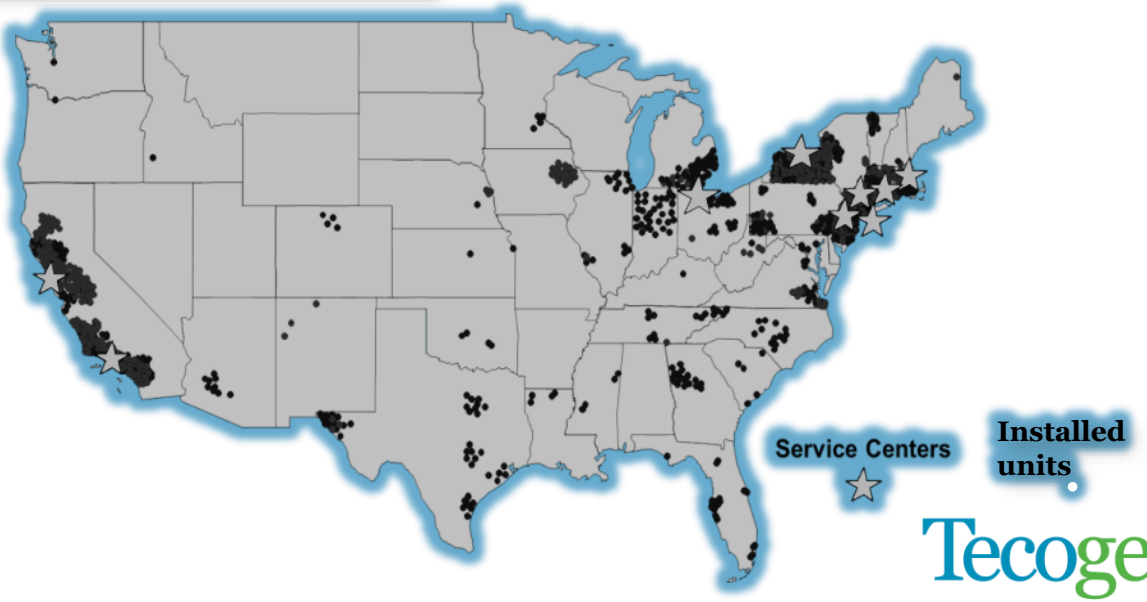
COMPANY OVERVIEW

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

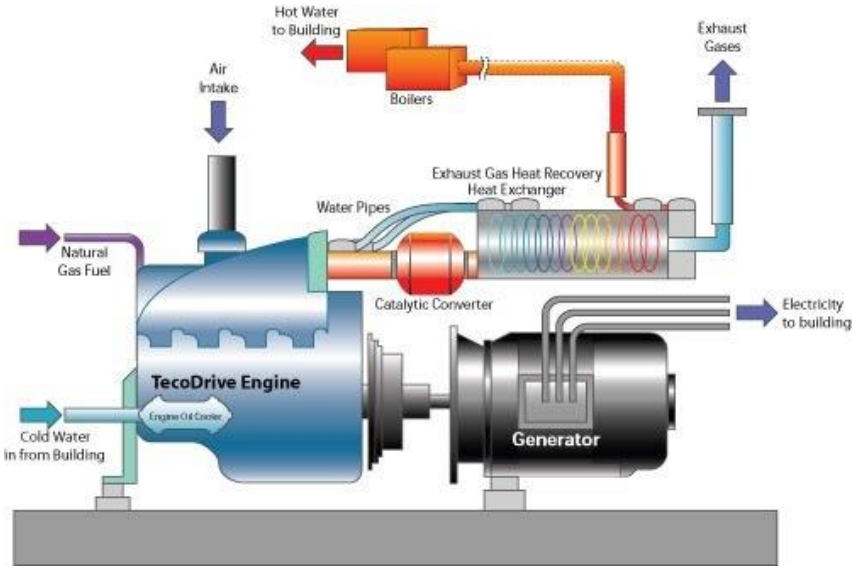


Tecogen®
Advanced Modular CHP Systems

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®
Advanced Modular CHP Systems

TECOGEN'S CHP PRODUCT SUITE

Cogen Modules

Electricity & Heat

Ilios Water Heaters

2x Heat Efficiency

TECOCHILL Chillers

Cooling & Heat

Tecogen

Advanced Modular
CHP Systems

A Modular Approach…

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

InVerde®

Inverter-Based Cogeneration

- 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

UL 2200 Certified & TYPE 10 EPSS Rated for Emergency Power

INTERTEK ETL LISTED C US

CA Rule 21 - Certified
NJDEP - Air Permit Exempt
NYSIR - Certified

Tecogen®

Advanced Modular CHP Systems

Combined Heat & Power (aka cogeneration)

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

100.0%

Gas in

1,042,560 Btu

32.7%

Electricity out

100 kW

58.8%

Thermal out

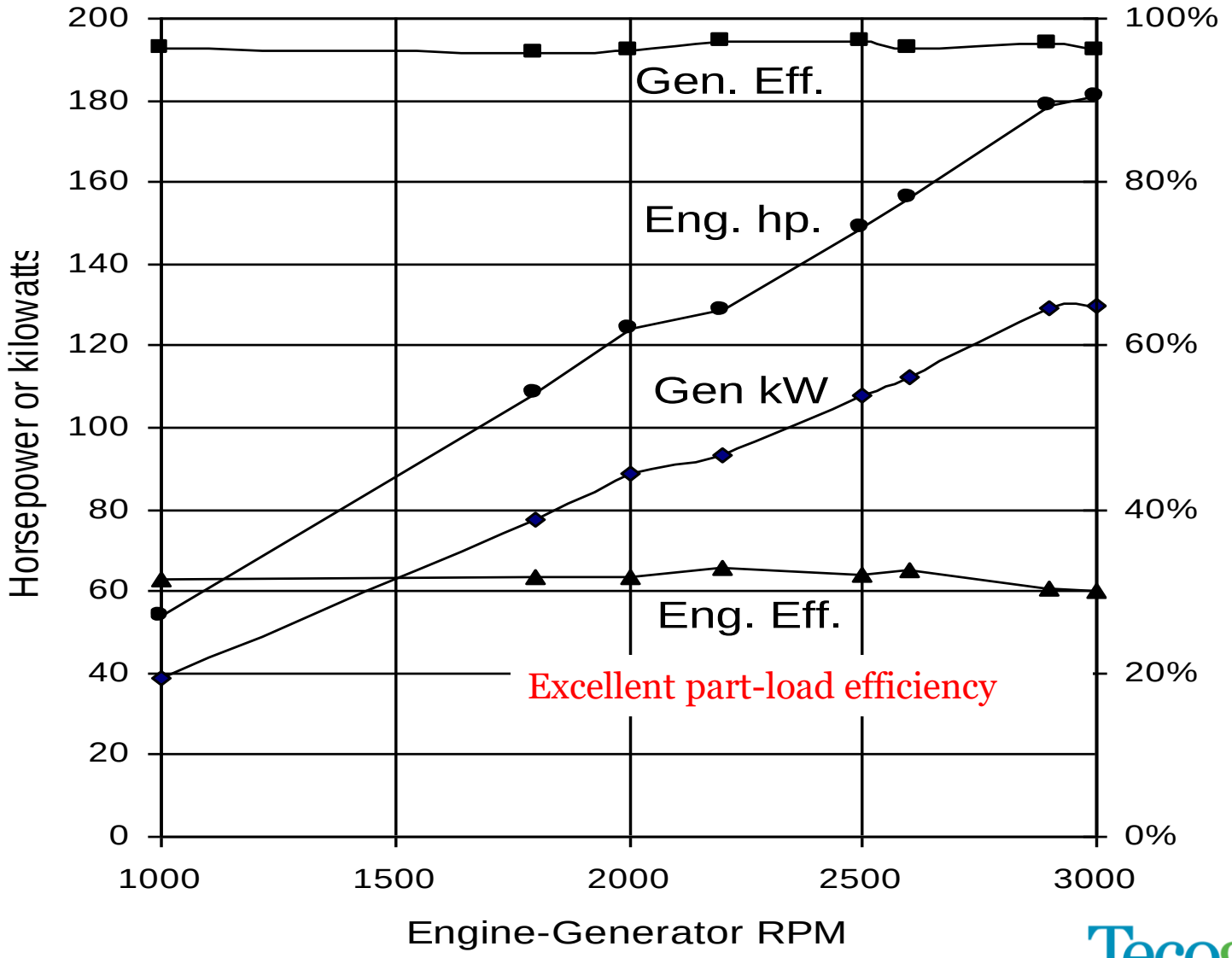
613,000 Btu/hr

>91.5% total (LHV basis)

Tecogen

Advanced Modular CHP Systems

Performance

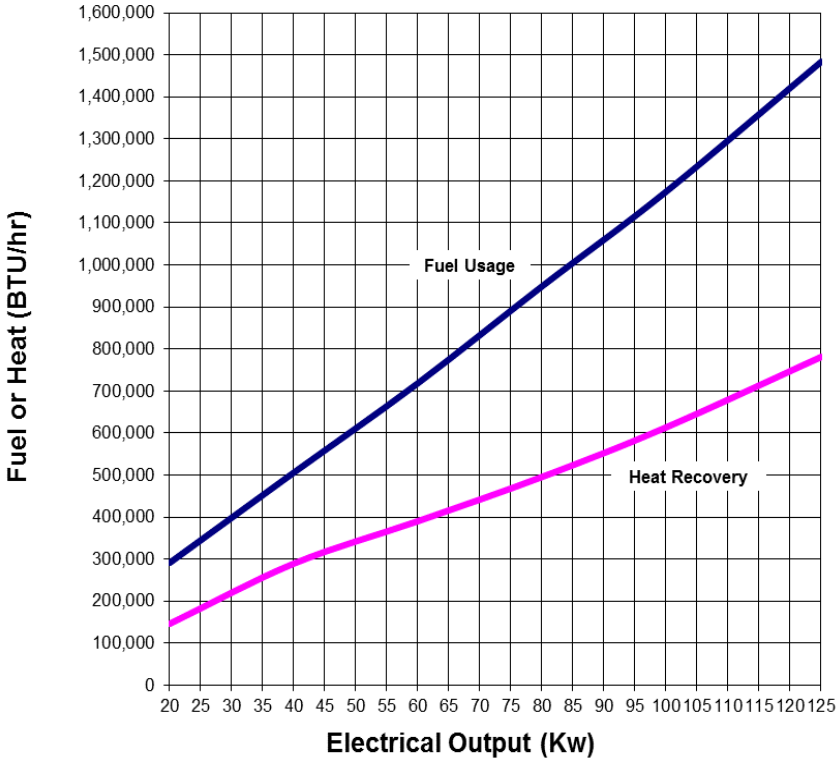


Tecogen

Advanced Modular CHP Systems

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

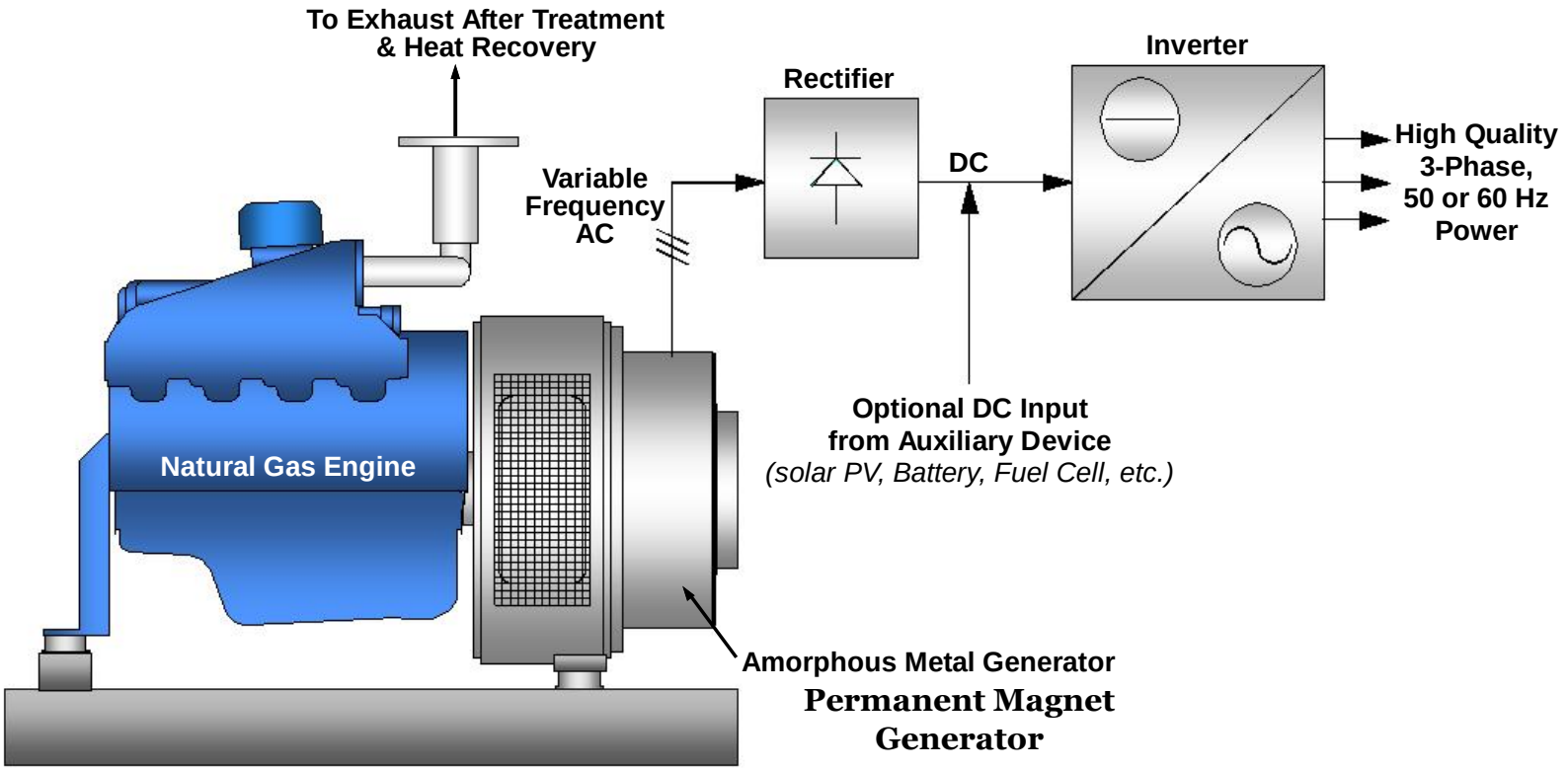


INV-100 Modulation

Electrical Output (kW)	Fuel Usage (BTU/hr)	Heat Recovery (BTU/hr)	Electrical Efficiency (%)	Overall Efficiency (%)
125	1,316,775	780,000	32.39	91.63
100	1,042,560	613,000	32.73	91.52
80	842,910	495,400	32.38	91.16
60	638,392	390,571	32.07	93.25
40	449,767	290,000	30.34	94.82
20	259,378	147,175	26.31	83.05

Tecogen®
Advanced Modular CHP Systems

Inverter Interface



Engine/Generator Output

RPM	Volts	Freq (hz)	KW
1000	98	135	39
2200	207	297	93
3000	258	405	130

Power Conversion

Delivered kW

Volts	Freq (hz)	KW
480	60	37
480	60	88
480	60	123

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

Tecogen®
Advanced Modular CHP Systems

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

Tecogen
Advanced Modular CHP Systems

InVerde
Inverter-Based Cogeneration

Tecopower
The pioneer in CHP

Tecochill
The Driving Force in Cooling

Ilios
High Efficiency Water Heater

Ultera
EMISSION CONTROL

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