Leveraging Mechanical CHP w/ Natural Gas Engine Driven Chillers

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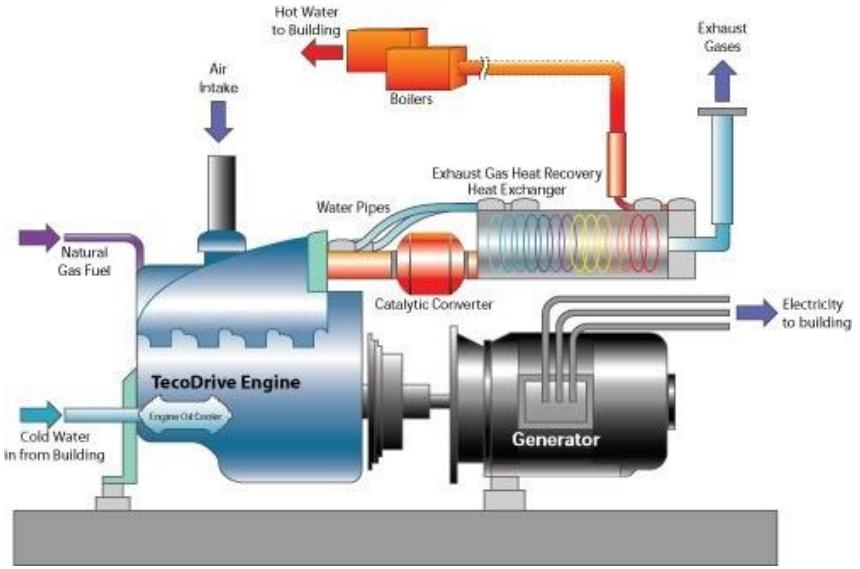
POINTS OF DISCUSSION

- What is CHP?
- Why Mechanical CHP?
- Natural Gas Engine Driven Chiller Offerings from Tecogen
- Benefits
- Retrofit Considerations
- Sample Economics
- Greenhouse Gas Savings Comparison
- Sample Installations
- Cloud Based Remote Monitoring
- Service and Maintenance

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 ("cogeneration")**
  - Shaft work turns a generator to create electricity, heat is recovered from prime mover
- **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"



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Mechanical CHP – WHY?

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The Driving Force in Cooling

- Natural gas much cheaper than electricity
- Electric tariffs remain high and generally increasing
  - High demand charges and TOU rates!!
- Long-term pressure for infrastructure upgrades
- Heavily incentivized
- **Traditional Cogen/CHP typically not allowed in Downtown Boston**
- No need for costly grid interconnection, anti-cogen tariffs, or expensive ongoing metering equipment
- Take advantage of all CHP benefits (free hot water!) with much lower cost of deployment

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Tecochill Natural Gas Engine Driven Chillers

- TecoChill STx Series
  - 150-200 tons water-cooled
  - Single engine/single compressor
  - Up to 700,000 Btu/hr of free hot water for DHW, Pool/Spa, Laundry, etc.

- TecoChill DTx Series
  - 250-400 tons water-cooled
  - Dual engine/dual compressor
  - Multiple engines and compressors allow for built in redundancy and great turn-down
  - Up to 1,500,000 Btu/hr of free hot water for DHW, Pool/Spa, Laundry, etc.

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The Driving Force in Cooling

TecoChill STx Series

TecoChill DTx Series

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Benefits of Natural Gas Engine Driven Chillers

- Major operating cost reduction due to cheaper input fuel (natural gas is 3-4X cheaper on a per BTU basis compared to electricity
- Additional operating cost reduction by significantly reducing peak demand charges
  - TecoChill chillers only require a few kW of single phase power, removing hundreds of kW of peak demand
- Once free hot water is recovered from the engine(s), the system turns into a Combined Heat and Power (CHP) system
  - The free recovered hot water offsets boiler gas-providing furthering savings
  - A “CHP” system results in significant greenhouse gas savings because the overall efficiency of these systems are much higher than the central electric generating plant which is powering the electric chillers-**REDUCED CARBON FOOTPRINT!**
- Since only a few kW of single phase power is needed to power these chillers the also offer the following ancillary benefits:
  - Can back-up the cooling system with a very small amount of emergency generator capacity such that guests will never be left uncomfortable in the event of an outage or brown-out in the middle of the summer.
  - Can make expanding the chiller plant very easy whereas adding more electric chiller capacity could be very costly (upgrading electrical infastructure = $$$)

Retrofit Considerations

- Footprint comparable to an electric chiller
- Easy disassembly for access to mechanical room
- Quiet operation
- Able to utilize existing cooling tower, pumps, and piping in most cases
- Only 2.7 kW single-phase power required for water-cooled units
- Free heat recovery built-in to chiller
- High-temperature heat recovery (up to 225°F) with no additional fuel input
  - Excellent economic bonus
- Low temperature exhaust similar to a boiler (< 500F)
  - Typical diameter 4”-6”
  - Very low noise at exit of exhaust-similar to boiler accomplished by using very large hospital grade silencers

Disassembly for Installation

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Factors Affecting Chiller Economics

- Equipment Operating Efficiency (IPLV) & Full Load Efficiency
- Gas and Electric Rates (**Including Demand**)
- Use of Heat Recovery
- Utility Incentives
- Equipment and Installation Costs
- Electric Power Requirements
  - Electric chillers require expensive transformers and switchgear
- Stand-by generator requirements
  - Facilities can keep their cooling plant online with minimal load on emergency generators

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The Driving Force in Cooling

TecoChill Sample Economics

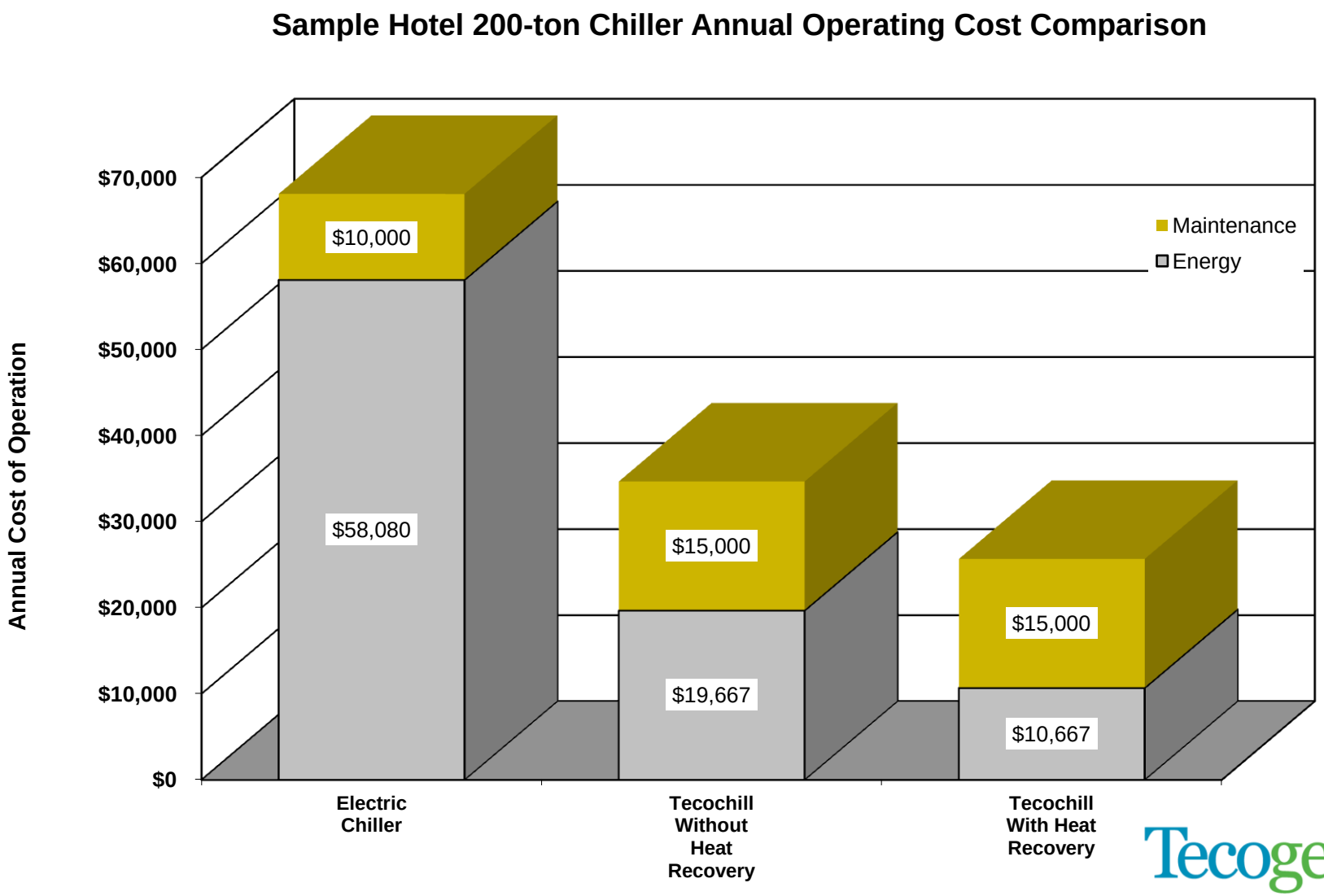
- **Assumptions:**
  - 200-ton natural gas engine driven chiller vs. status quo electric chiller
  - 3,000 annual operating hours @ 50% average chiller loading

  - **Utility Rates-typical for Boston Hotel**
    - Natural Gas: $0.90/therm
    - Electricity (Energy): $0.12/kwh
    - Electricity (Demand): $28/kW peak, $10/kW off peak

  - **Free Hot Water from TecoChill Assumptions**
    - **500,000 Btu/hr available**
    - **Offsetting existing natural gas boiler (75% efficiency)**

  - **Incentive from Eversource via Custom Electric Incentive Program**
    - Up to 75% of incremental cost

Tecochill Operating Cost Savings



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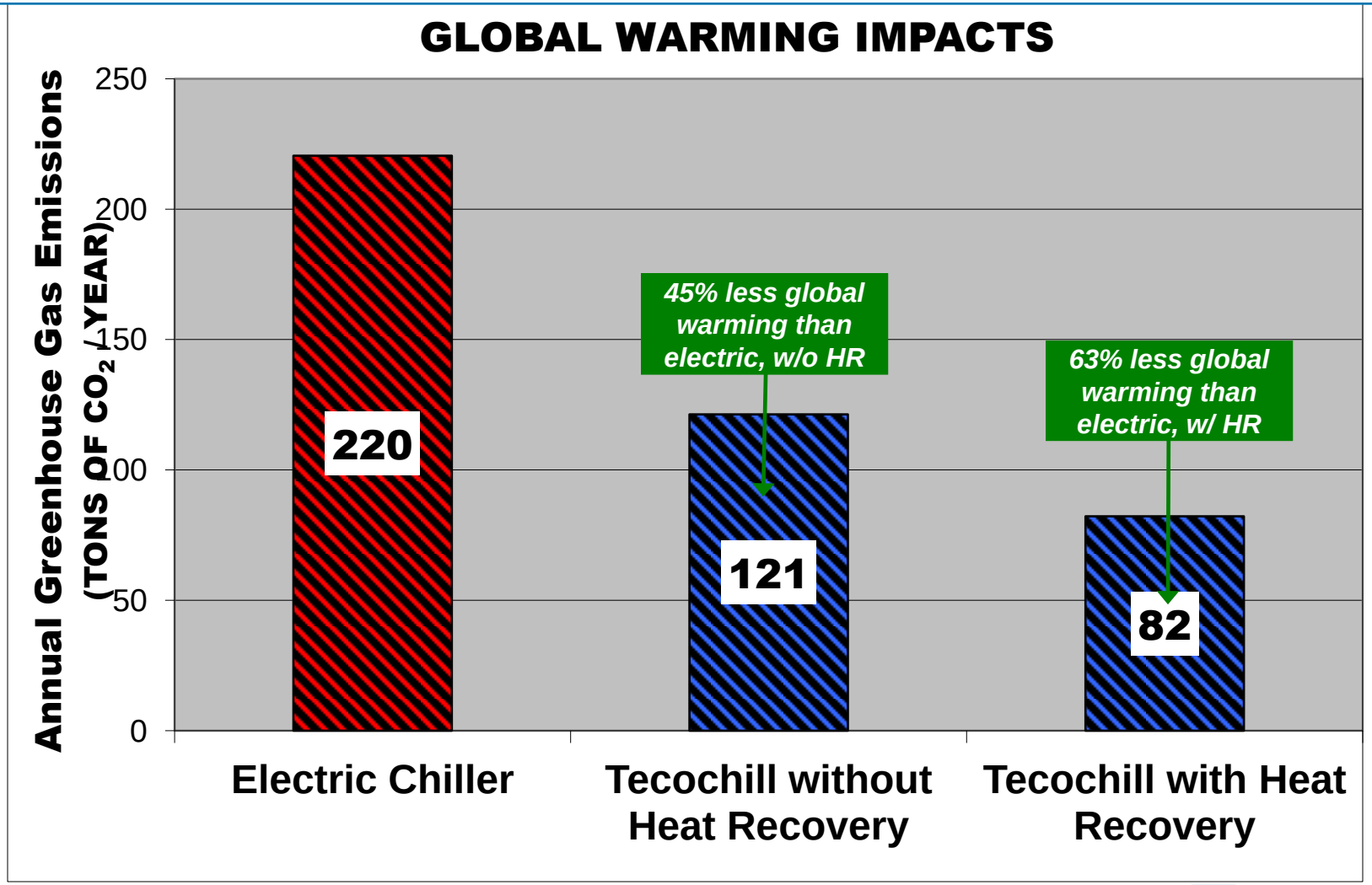
TecoChill Sample Economics Summary

- Electric Chiller Annual Operating Cost =$68,080/year
- **TecoChill Chiller assuming zero heat recovery utilized**
  - Annual Savings (inclusive of incremental maintenance)= **$33,413/year**
- **TecoChill Chiller assuming all heat recovery utilized**
  - Annual Savings (inclusive of incremental maintenance)= **$42,413/year**
  - **Results: Annual savings between $33,413-42,413/ year**
  - **So what is the payback/ROI?**
  - **New Electric 200-ton Chiller = $90,000**
  - **TecoChill Natural Gas 200-ton Chiller = $200,000**
  - **Eversource Incentive (75% of incremental cost)= $82,500**
  - **Assume incremental cost net of incentive = $27,500**
  - **Assume annual savings of $35,000/year (conservative)**
  - **ROI = < 1 year payback**

Tecochill Greenhouse Gas Comparison



1,200 Ton Plant Example-Kohler Manufacturing

Hybrid Plant Example-Barnes Building-Boston Seaport

EXPERT SERVICE

Fast, **S**imple, **P**redictable

100% remote monitoring system ensure automatic dispatch

- Units notify technicians via internet or cell when they need scheduled or unscheduled service

Full service of all installed components included.

- Essentially a full parts and labor warranty in perpetuity

Inexpensive relative to savings

24/7 support from TECOGEN

- Fully customizable factory service programs available
- 8 Fully staffed local service offices
- **3 service centers in Greater NYC Area**
- **1 service center in CT**
- **1 service center in MA**
- Detailed O&M training available
- Sole source accountability

Typical TecoChill Applications

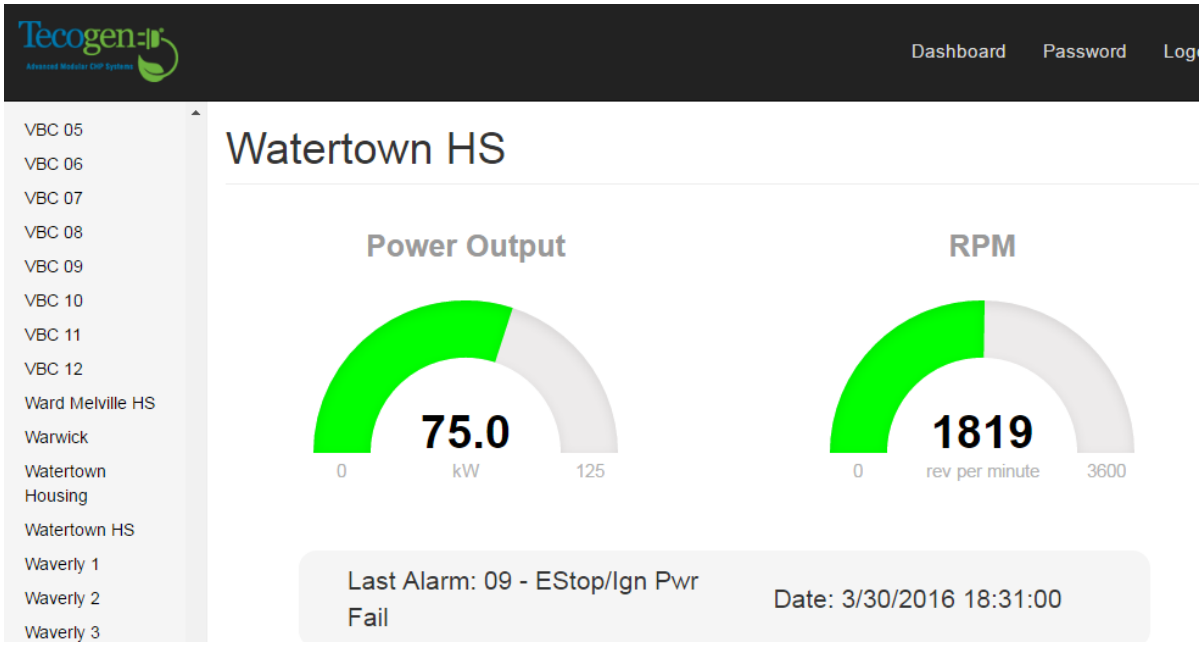
- Ice Rinks
  - TecoChill units make AHL and NHL ice
  - (2) Stanley Cups have been won on TecoChill ice
- Bio-Labs/Big Pharma
  - TecoChill units utilized at Pfizer plant
  - Marine Bio Labs in Woods Hole has (5) TecoChill units
- Hospitals
  - Jamaica Hospital in Queens, NY-entirely cooled by TecoChill units.
- Manufacturing
  - Large Blue-Chip Companies, many in the NAFTA Region of Mexico use TecoChill
  - Kohler, Black & Decker, Spellman Electric, etc.

- **All of the above applications are absolutely critical cooling environments-if we can keep these places cool, we can certainly keep your hotel cool.**

Cloud Based Monitoring Capability

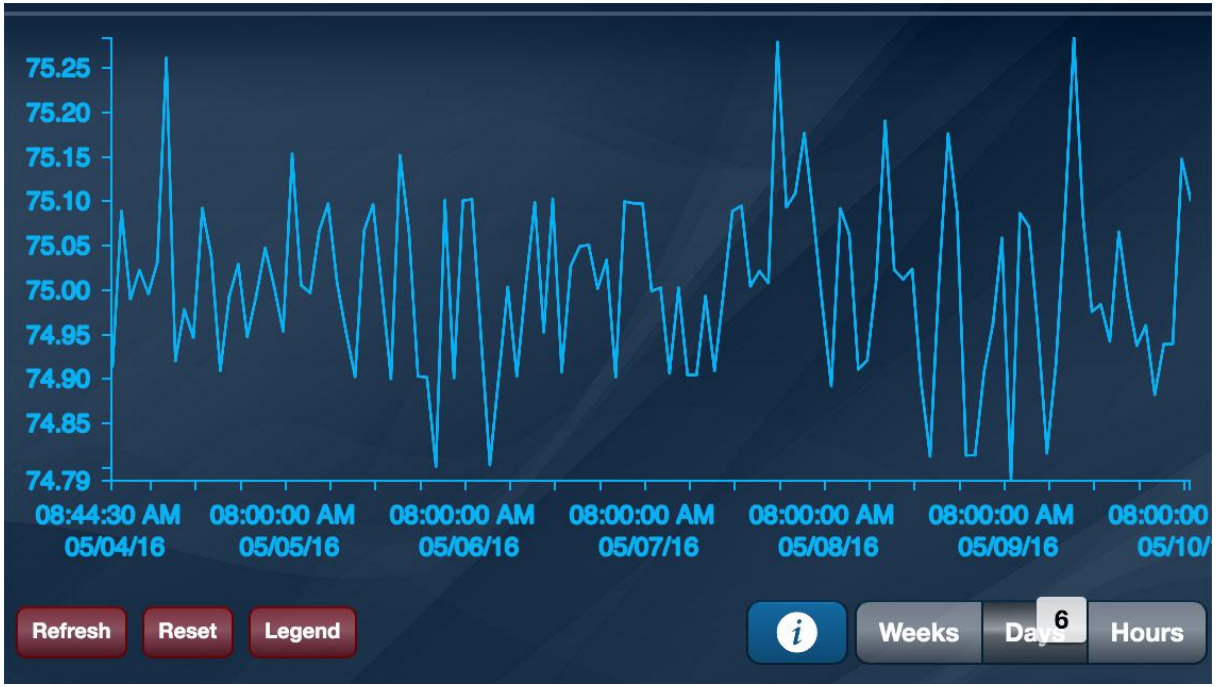
Instant access to any machine via dashboard

- Access customizable so engineers can only see jobs they were involved with
- Owners can see only their equipment
- View KPI's such as savings, power production, utilization



Data Analytics

- Tecogen partnered with GE Equipment Insight to provide cloud based data analytics, real-time data and historical data being stored
- Customers and engineers can review operational history, predict savings, “M&V” package built right in…



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GE Equipment Insight

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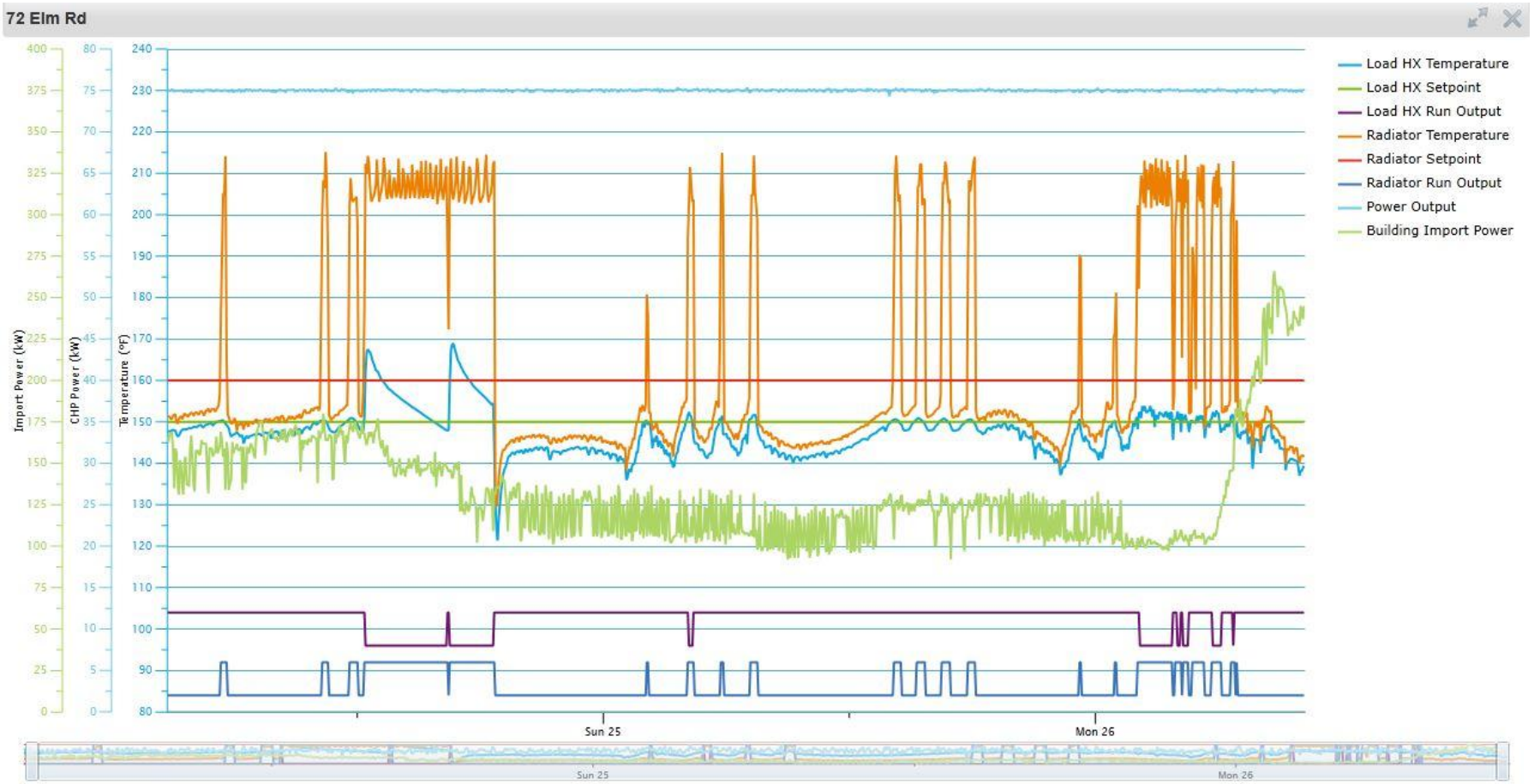
Data Analytics



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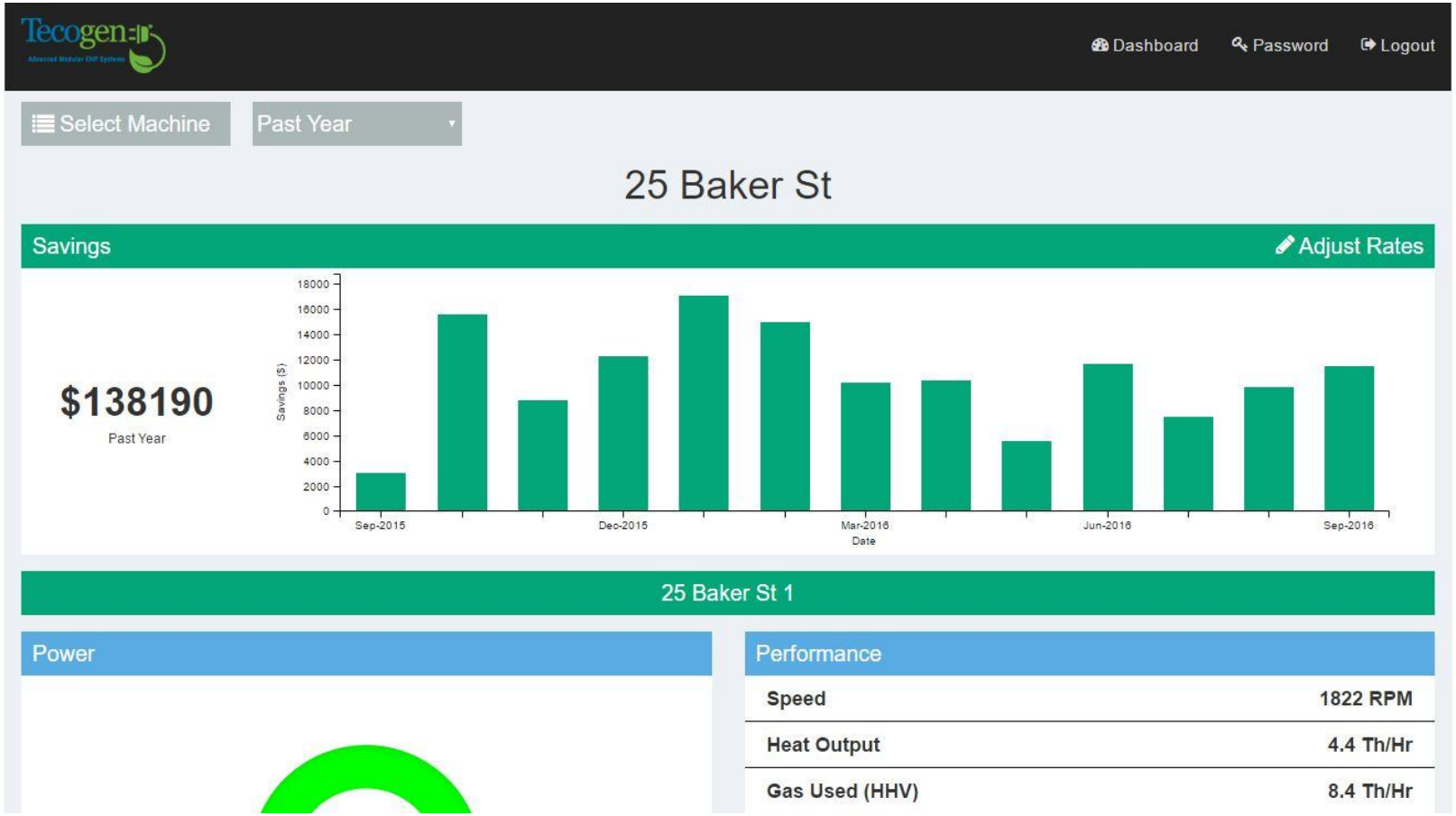
CHPInsight™



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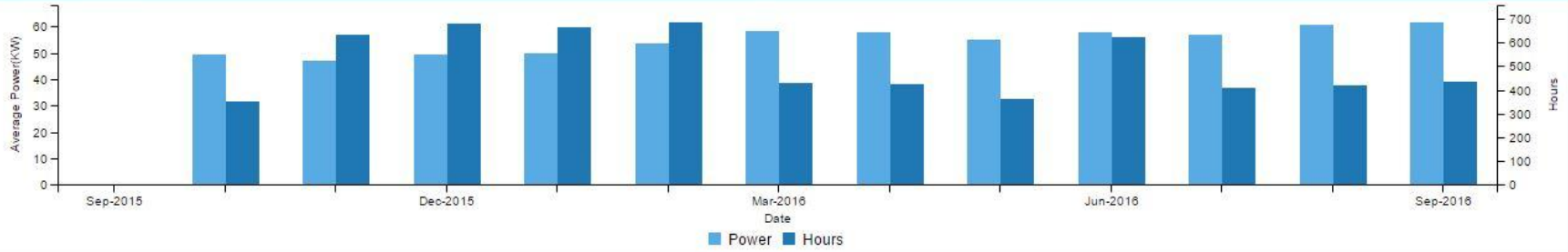
25 Baker St 1

Power

Performance

Speed	1822 RPM
Heat Output	4.4 Th/Hr
Gas Used (HHV)	8.4 Th/Hr
Electrical Eff (HHV)	26.4 %
Overall Eff (HHV)	78.8 %

Power Output



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Fleet Monitoring Capability

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TECOGEN IS THE PERFECT FIT

- All equipment manufactured locally in MA
- All equipment UL certified and fast tracked and accepted by all utilities.
- Over 30 years experience with cogeneration
- Over 25 years experience producing natural gas chillers
- Emissions controls **on par with Fuel Cell on a reliable basis**. No complicated and unreliable emissions system like SCR found on large scale CHP units. No consumable fluids to maintain emissions.
- Our systems are **reliable**, **redundant**, **easily serviced** with no end of life projection.

Take Away

- **If you are planning a chiller replacement in the coming years, there is an alternative to using expensive electricity to cool your building**

- **Make sure you consider a natural gas engine driven chiller, the decision to replace what you have with another electric chiller should not be automatic**

- **Consider your options!**

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