

# Steam System Operation & Distribution Optimization

Jayne Choi CNT Energy May 2, 2013



### **CNT Energy**

- A nonprofit organization dedicated to helping communities and consumers save energy and money
- An affiliate of the Center for Neighborhood Technology
- Other CNT affiliates include I-Go Car Sharing









### **CNT Energy**

- We help reduce energy usage and costs in households, buildings, and communities.
- Areas of expertise include:
  - Dynamic pricing and smart grid
  - Energy-efficient, green, and healthy buildings
  - Regional energy planning

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• We manage programs in Illinois and consult nationally and internationally





## PARR

- Current collaboration with GTI as a part of the PARR Building America team
  - Steam Systems Balancing and Tuning Study
  - Heating Season 2011-2012



The Partnership for Advanced Residential Retrofit







## Background

- In Chicago, heating is the focus of residential energy use
- Of the 470,000 multifamily units in the Chicago region, at least 70,000 are steam heated
- Old steam systems often suffer from temperature imbalances
  - Tenants must use supplemental heat or open their windows to cool their apartments during the heating season
- Buildings are often overheated

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- Steam heat was the best option for buildings constructed between 1900 and 1930
- Systems have been upgraded from coal to natural gas and many have undergone boiler replacement, but distribution systems remain largely the same
- Not designed for efficiency





(Peterson, 1985)

### **Steam Heating Basics**



























### **Boiler Cycles: In the Boiler Room**

In the boiler room:





8 min

Boiler turns on

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30 min

### Meanwhile, in a Unit:



This is what should happen during a boiler cycle; however, there are often problems...



### **Problems**











### **Problem Statement**

- Currently steam balancing is not commonly offered as a service or recommended as a measure
- Not tangible often requires time and dedication rather than basic equipment replacements
- Difficult to convince owners of its value
  - Balancing is a separate issue from boiler replacement
  - Natural gas is cheap, so it is not worth the time or effort



### **Previous Studies**



(Peterson, G., 1985)



- Biederman, N.; Katrakis, J. (1986). Space Heating Efficiency Improvements in Multifamily Buildings. Chicago: Gas Research Institute
- Peterson, G., (1985). Achieving Even Space Heating in Single Pipe Steam Buildings. Minneapolis: Center for Energy and Environment.
- Improving the balance of buildings provides
  - Opportunity for cost savings
  - 5-15% energy savings, 2-5 year payback
  - Increased resident comfort

### **Research Questions**

- How do steam balancing measures affect the temperature differences in a building?
- Will steam balancing affect the average length of boiler cycles?
- How do steam balancing measures affect natural gas usage?



### **Technical Approach**

#### Measures

- Replacing radiator vents
- Adding or upgrading main line air venting
- Boiler controls (4-6 sensors, indoor averaging)







#### Install steam balancing measures in 10 test buildings:

- Single-pipe steam
- 15-30 units
- Uneven temperatures throughout the building (based on observations from the building manager and/or tenants)





# **Energy Savers Program**

- A single point of contact to provide multifamily building owners with access to:
- **Technical Assistance** 
  - Utility bill analysis
  - Energy assessment
  - Cost-effective energy-saving recommendations
- Financing
  - Low-cost financing through our partner, the **Community Investment Corporation**
- **Construction Oversight**
- **Annual Performance Monitoring** 
  - Two years post-retrofit

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- Retrieve pre-upgrade measurements and data for monitoring
  - Building type and layout
  - Boiler information/pipe structure/condition of vents/type of existing controls
  - Temperature data from units
  - Boiler run-time data
  - Tenant survey/heat calls
- Develop detailed scopes for steam balancing work to be done
  - Measures included replacing radiator vents, adding or upgrading mainline air vents, and installing boiler controls
  - Scopes included price breakdowns for each measure





(http://www.onsetcomp.com/products/data-loggers/u10-003)

- Construction oversight
  - Inspection of work/quality control
  - Boiler control settings
- Collect post-upgrade data
  - Temperature data from units
  - Boiler run-time data
  - Tenant survey/heat calls
- Utility bill analysis comparing pre-upgrade and post-upgrade heating fuel use
  - Weather-normalized calculation of heating Energy Use Intensity (kBTU/sq ft/yr)



### **Post-Balancing Temperatures**

- Temperature results:
  - Changes in diurnal temperature patterns within units (different schedules of when the units were warmest and when they were coolest)
  - Smaller temperature differentials between the hottest and coldest units in some buildings





### **Tenant Comfort**

Tenant Survey Responses—Overall Temperature Comfort



Tenant survey responses rating overall temperature comfort. The tenants were asked to rate the overall temperature comfort within their unit on a scale from 1 = Uncomfortable to 5 = Comfortable.









### **Pre and Post Natural Gas Use**







### **Cost-effectiveness**

	% Savings	Balancing Cost (\$)	Simple Payback (years)
Measured (All buildings)	13.3%	9,434	3.4
Measured (Buildings without additional measures installed)	10.2%	9,875	5.1



### Rebates

- Through Peoples/North Shore Natural Gas Savings Program
- 3+ living units, Service Class 2 (Residential or C&I)
- October 1, 2012 May 31, 2013
- \$200/unit for central steam boiler controls, \$50/unit for improved venting

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Please submit the completed, signed application and required documentation one of three way **Option 3: Fax** Option 1: Mail Option 2: Scan and E-mail Peoples Gas/North Shore Gas For Peoples Gas customers: 773,853,2205 Steam Heating Controls peoplesgas@franklinenergy.com Attn: Peoples Gas/North Shore Gas Prescriptive Rebate Program For North Shore Gas customers: Single Pipe Steam Heating Controls 5450 N. Cumberland Ave., Suite 125 northshoregas@franklinenergy.com and Balancing Application Chicago, IL 60656

Single Pipe Steam Heating Controls and Balancing Prescriptive Rebate

8 2012 Peoples Gas and North Shore Gas

Valid Cictober 1, 2013 - May 31, 2013

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### Guidelines

 Developing further balancing guidelines and audit procedures ENERGY Energy Efficiency & Renewable Energy

Measure Guideline: Steam System Balancing and Tuning for Multifamily Residential Buildings

Jayne Choi, Peter Ludwig, and Larry Brand Partnership for Advanced Residential Retrofit

March 2013





### **Questions?**

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