

ECONOMICS OF DISTRICT ENERGY FOR HVAC IN MULTI-FAMILY HOUSING – AN ECONOMIC EXPOSE

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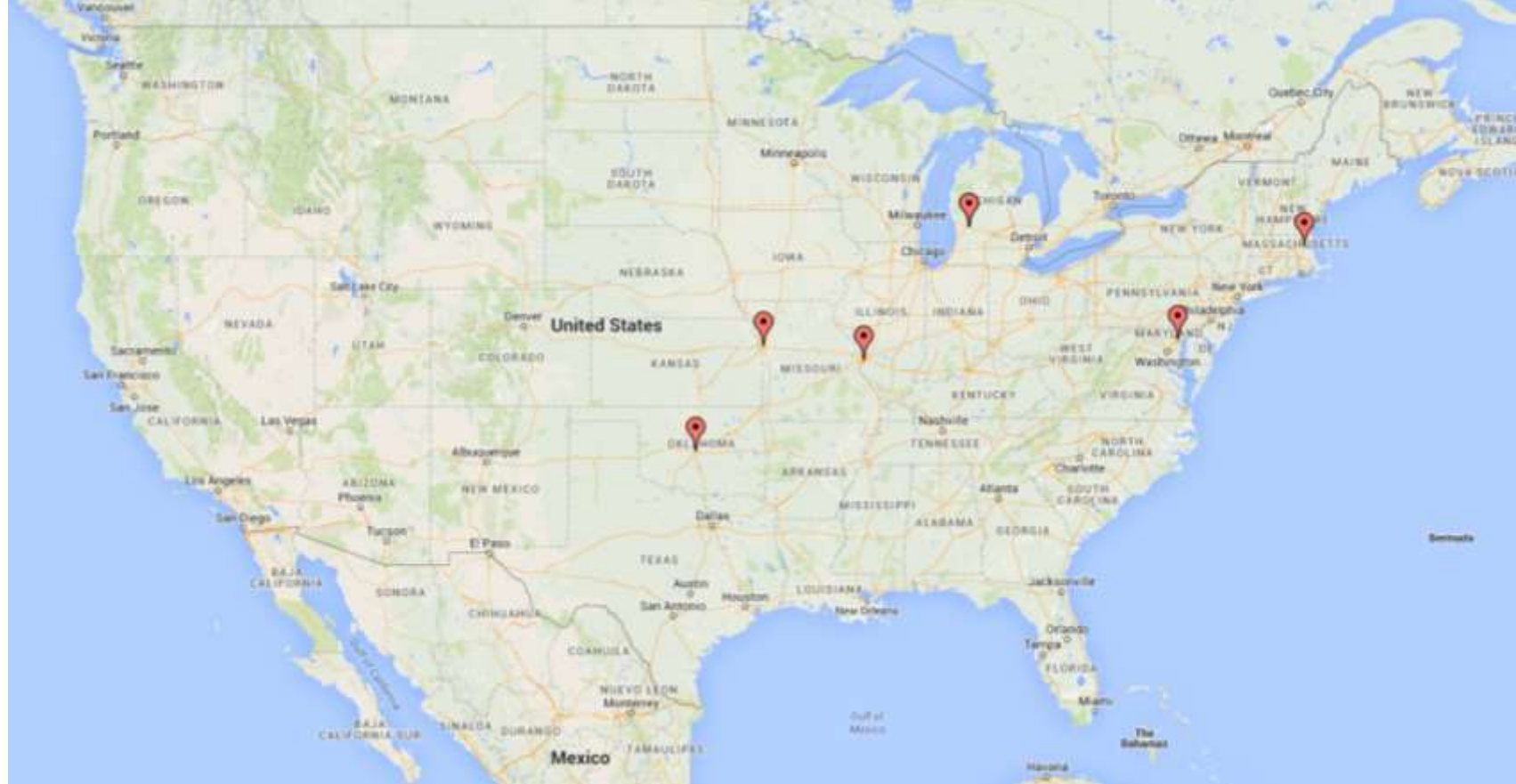
INTRODUCTION

An analysis was undertaken to evaluate the competitiveness of district energy compared to a variety of other competitive approaches.



CITIES MODELED WHICH INCLUDE DISTRICT ENERGY SYSTEMS

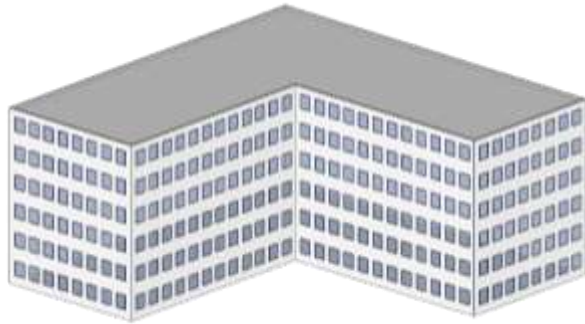
- Baltimore, MD
- Boston/Cambridge, MA
- Grand Rapids, MI
- Kansas City, MO
- St. Louis, MO
- Oklahoma City, OK



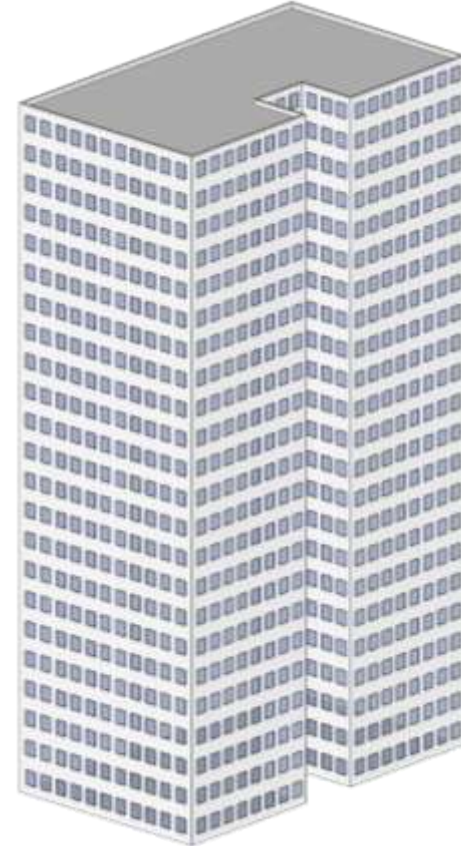
PROTOTYPICAL MODELED BUILDINGS



30 Unit

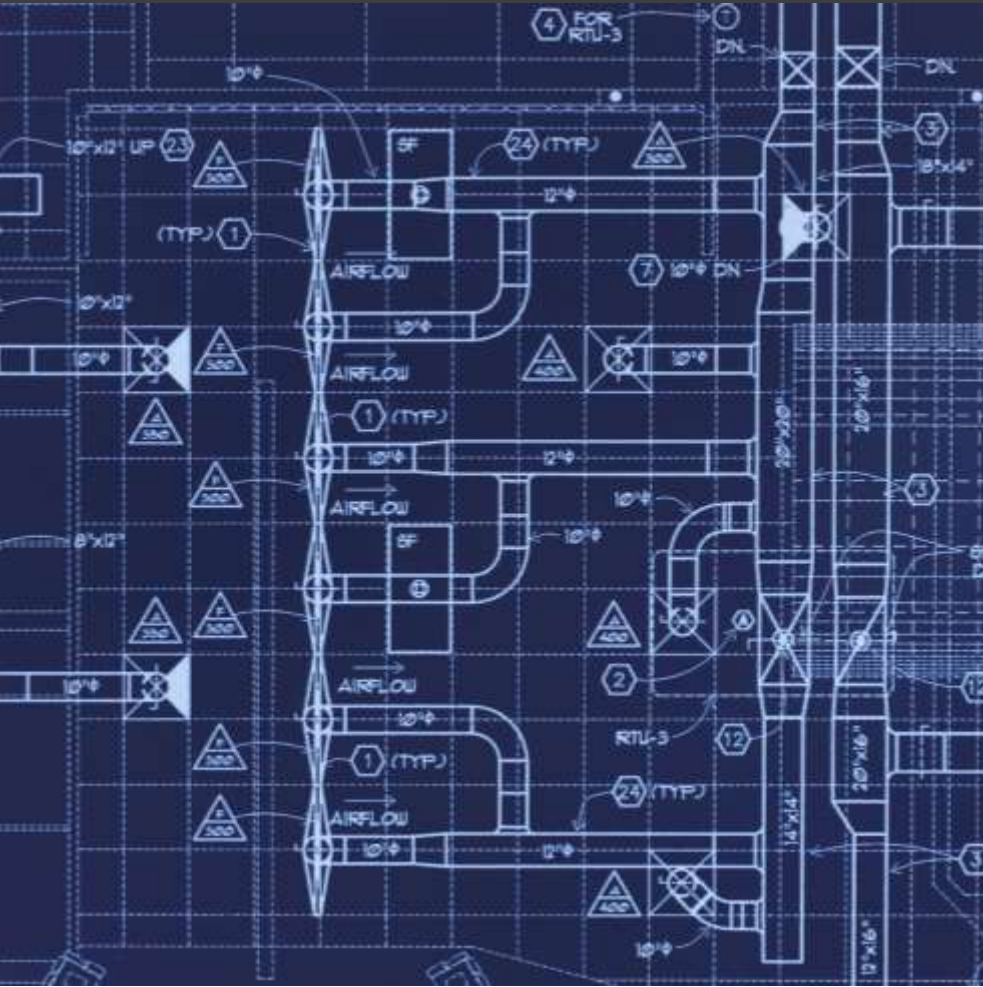


100 Unit



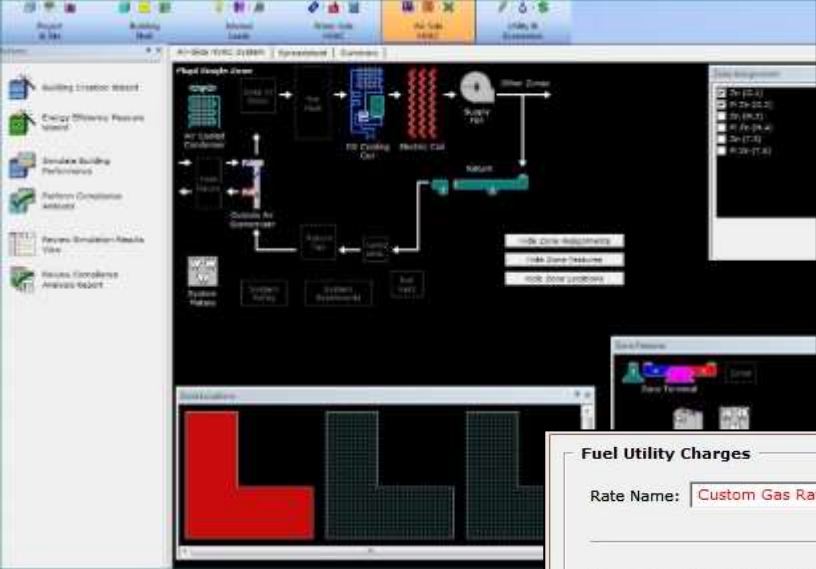
300 Unit

HVAC SYSTEMS MODELED



- Base Case
 - Split System DX / gas furnace (30)
 - Through-wall packaged electric (100 & 300)
- 4-Pipe Fan Coil with Local Boiler & Chiller (Building Self-Performed)
- Boiler-Tower heat pump
- Variable Refrigerant Flow
- District Energy with 4-Pipe Fan Coils





Residential Domestic Water Heating

Heater Specifications:

Heater Fuel: **Natural Gas** Efficiency Spec.: **Efficiency and Thermal Efficiency**

Heater Type: **Storage** Thermal Efficiency: **0.800**

Hot Water Use: **16.89** gal/person/day

Input Rating: **3,970.6** kBtu/h

Storage Tank:

Tank Capacity: **4,333** Gal Insulation R-value: **12.0**

Standby Loss: **1.32** %/hr

Water Temperatures:

Supply Water: **110.0** °F Inlet: **Equals Ground Temperature**

General Information

Project Name: **VENA 100 Boston Base** Code Analysis: **LEED-NC (Appendix G)**

Building Type: **Multifamily, Mid-Rise (interior entries)** Code Vintage: **version 3.0**

Location Set: **All eQUEST Locations**

State: **Massachusetts** Jurisdiction: **ASHRAE 90.1**

City: **Boston** Region/Zone: **SA - Cool, Humid**

Utility: **- custom -** Rate: **- custom -**

Electric: **- custom -**

Gas: **- custom -**

Area, HVAC Service & Other Data

Building Area: **100,000** ft² Number of Floors: Above Grade: **6** Below Grade: **0**

Cooling Equip: **DX Coils** Heating Equip: **Electric Resistance**

Analysis Year: **2015** Daylighting Controls: **Yes** Usage Details: **Hourly Enduse Profile**

Fuel Utility Charges

Rate Name: **Custom Gas Rate** Type: **Block Charges** Block Type: **Incremental Blk**

☒ Second Season:

Season 1: 1/1 - 5/31 & 9/1 - 12/31 Mon, Jun 01 thru Mon, Aug 31

Customer Charge: **10.00** \$ / Month

Uniform Charges: **0.0000** \$ / Therm/hr **0.000000** \$ / Therm

Energy Blocks	Blk Size	\$ / Therm
1 Therm Block	10	0.449600
2 Therm Block	99,999	0.534300
3 - select another -		

Demand Blocks	Blk Size	\$ / Thm/hr
1 Therm/hr Block	99,999	0.0000

Entire Year 1/1-12/31

On At	Off At
Mon: 5 pm	7 am
Tue: 5 pm	7 am
Wed: 5 pm	7 am
Thu: 5 pm	7 am
Fri: 5 pm	7 am
Sat: 4 pm	9 am
Sun: 4 pm	9 am
Hol: 4 pm	9 am

Window Area Specification

Window Area Specification Method: **Percent of Net Wall Area (Floor to ceiling)**

Describe Up To 3 Window Types:

Glass Category	Glass Type	Frame Type	Frame Uf (Btu/hr-ft ² -°F)
1: Double Low-E	1/2" Low-E (x3+2) Clear 1/8", 1/4" Air (2015)	1" Fiberglass/Insul. Oper	3.30
2: select another			

Window Dimensions, Positions and Quantities

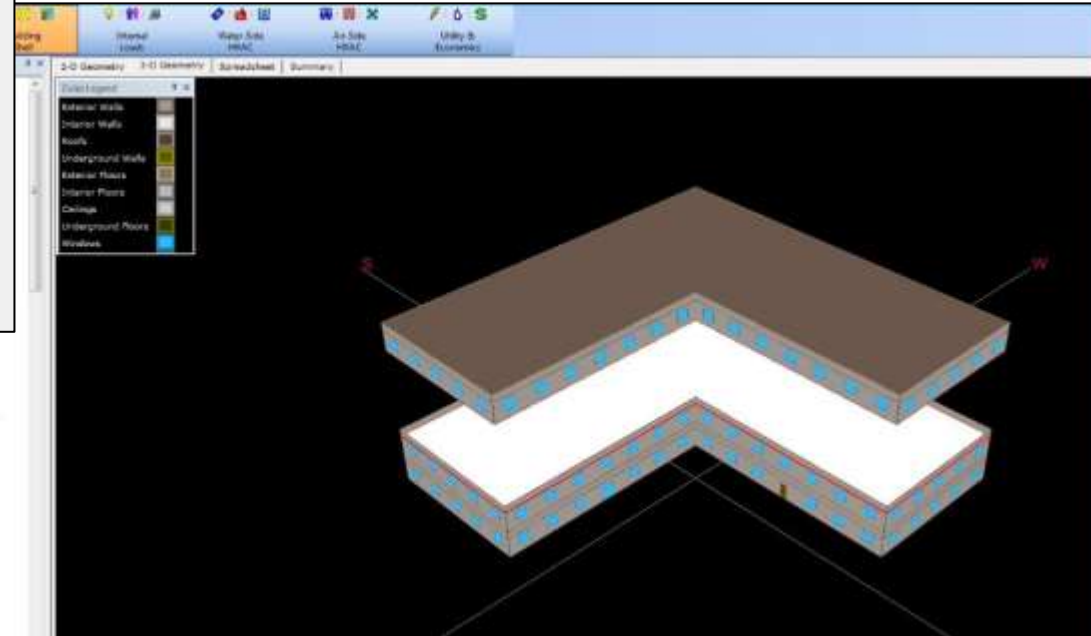
Type	Window Width (ft)	Window Ht (ft)	Uf (Btu/hr-ft ² -°F)	% Window (Floor to ceiling, including frame):
1:	8.00	4.25	3.30	17.7 17.7 17.7 17.7

Activity Areas Allocation

Area Type	Percent Area (%)	Design Flow Group (M/person)	Design Ventilation (CFM/person)
1: Residential (Multifamily Dwelling Unit)	77.8	205.0	20.0
2: Corridor	16.0	105.0	15.0
3: Storage (Combined)	7.0	333.3	50.0
4: Utility	6.0	305.0	15.0
5: - select another -			

Percent Area Sum: **100.0**

Consistency Profiles by Season: **Choose Profile (S1)**



ANNUAL UTILITY COSTS

		Base Case					
City	No. of Residential Units	Split System, DX clg, gas heat	Self-contained (packaged)	4-pipe fan coil (4P FC) local	Heat Pump (WSHP) local	Variable Refrigerant Flow (ASHP)	4-pipe fan coil (4P FC) district
Boston, MA	30	\$29,646		\$32,175	\$39,317	\$39,125	\$40,952
	100		\$180,402	\$132,363	\$133,013	\$135,253	\$141,179
	300		\$525,619	\$359,051	\$407,748	\$408,776	\$429,973
Grand Rapids, MI	30	\$26,823		\$28,681	\$33,611	\$36,416	\$36,573
	100		\$159,200	\$114,703	\$114,485	\$125,956	\$125,692
	300		\$467,598	\$316,990	\$353,078	\$380,440	\$376,694
Baltimore, MD	30	\$29,702		\$31,261	\$34,816	\$30,856	\$39,631
	100		\$130,965	\$122,887	\$118,158	\$106,649	\$125,333
	300		\$389,906	\$335,317	\$358,709	\$325,809	\$360,153

CONTRIBUTING FACTORS

- Factors considered beyond utility cost
 - System first cost
 - Regional cost adjustments
 - Equipment replacement schedule
 - Based on published estimates of equipment life
 - Maintenance costs
 - Based on published estimates for each system



20 YEAR LIFE CYCLE COSTS

		Base Case					
City	No. of Residential Units	Split System, DX clg, gas heat	Self-contained (packaged)	4-pipe fan coil (4P FC) local	Heat Pump (WSHP) local	Variable Refrigerant Flow (ASHP)	4-pipe fan coil (4P FC) district
Boston, MA	30	\$2,054,301		\$2,064,773	\$2,065,533	\$2,109,496	\$2,160,518
	100		\$7,281,495	\$5,158,073	\$4,569,074	\$4,978,822	\$5,144,704
	300		\$19,580,856	\$12,508,625	\$11,935,766	\$13,148,069	\$13,733,052
Grand Rapids, MI	30	\$1,772,263		\$1,908,534	\$1,892,029	\$2,001,995	\$2,009,417
	100		\$6,363,982	\$4,524,624	\$4,044,255	\$4,613,664	\$4,618,292
	300		\$16,970,985	\$10,914,447	\$10,412,401	\$12,041,229	\$11,979,653
Baltimore, MD	30	\$1,846,811		\$1,976,021	\$1,923,466	\$1,860,872	\$2,088,460
	100		\$5,651,609	\$4,737,989	\$4,139,298	\$4,123,489	\$4,612,211
	300		\$15,013,010	\$11,395,370	\$10,559,240	\$10,654,746	\$11,566,388

INITIAL AND LIFE CYCLE COSTS



Cost discussion

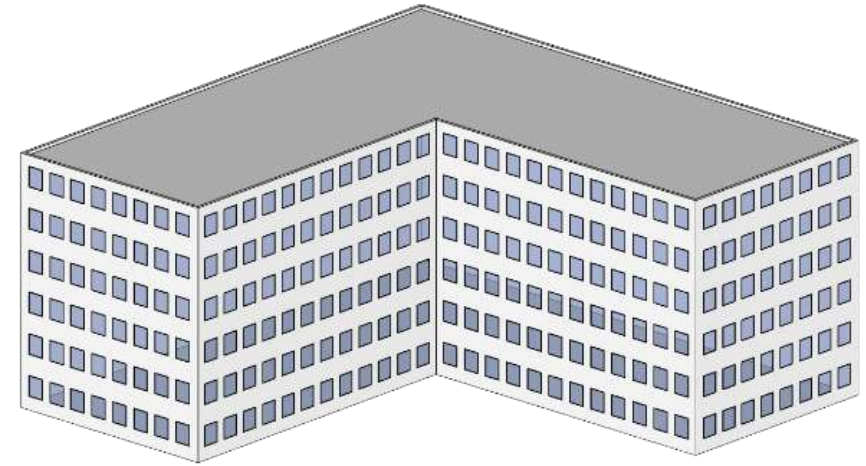
District Energy shows economic advantage:

- In northern climates
- Where utility rates are high
- In larger buildings
- Broad conclusions are difficult when considering total life-cycle costs

BASIS OF DISCUSSION

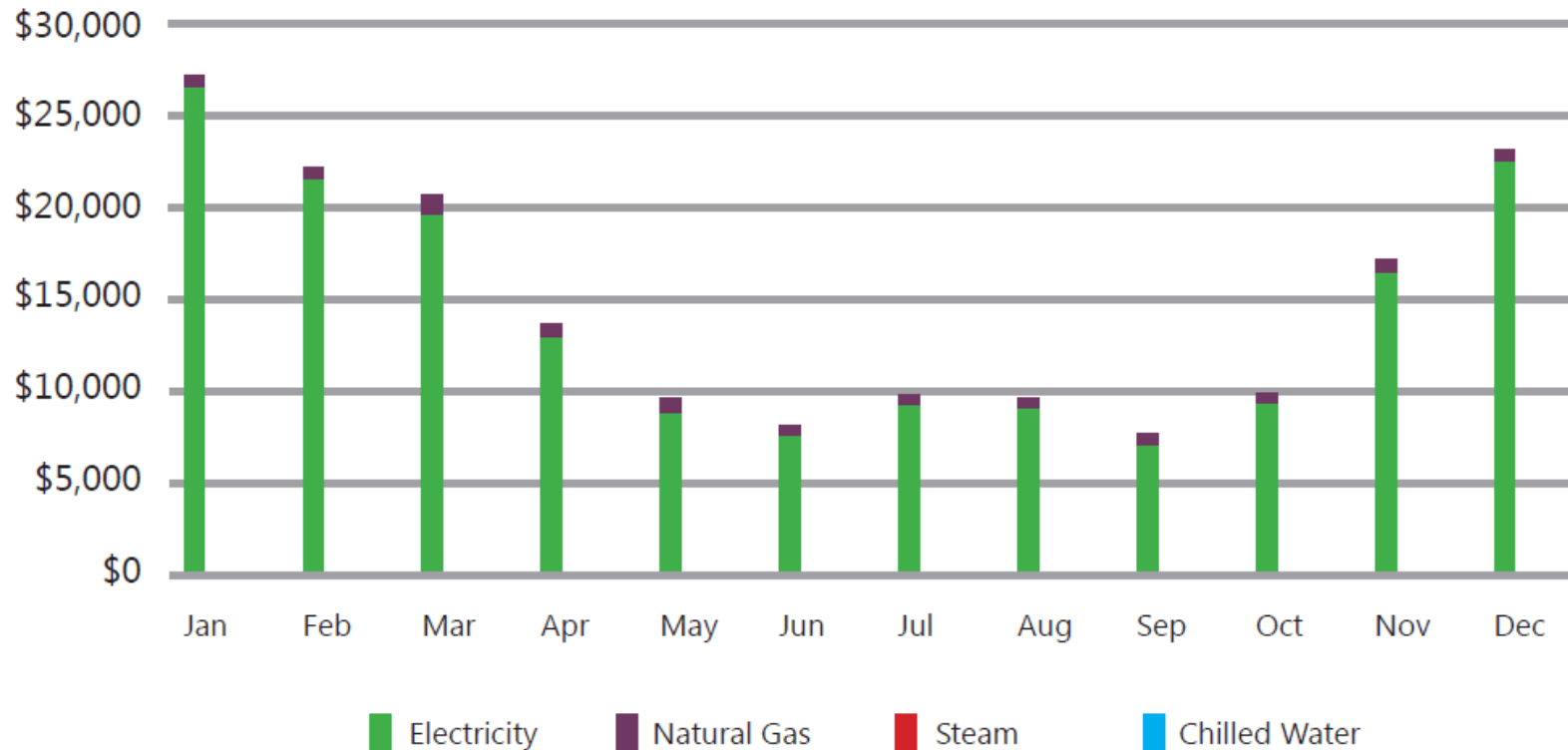
Closer look:

- Boston, MA
 - Representative of:
 - Steam heating distribution
 - Chilled water distribution
 - 100 unit building



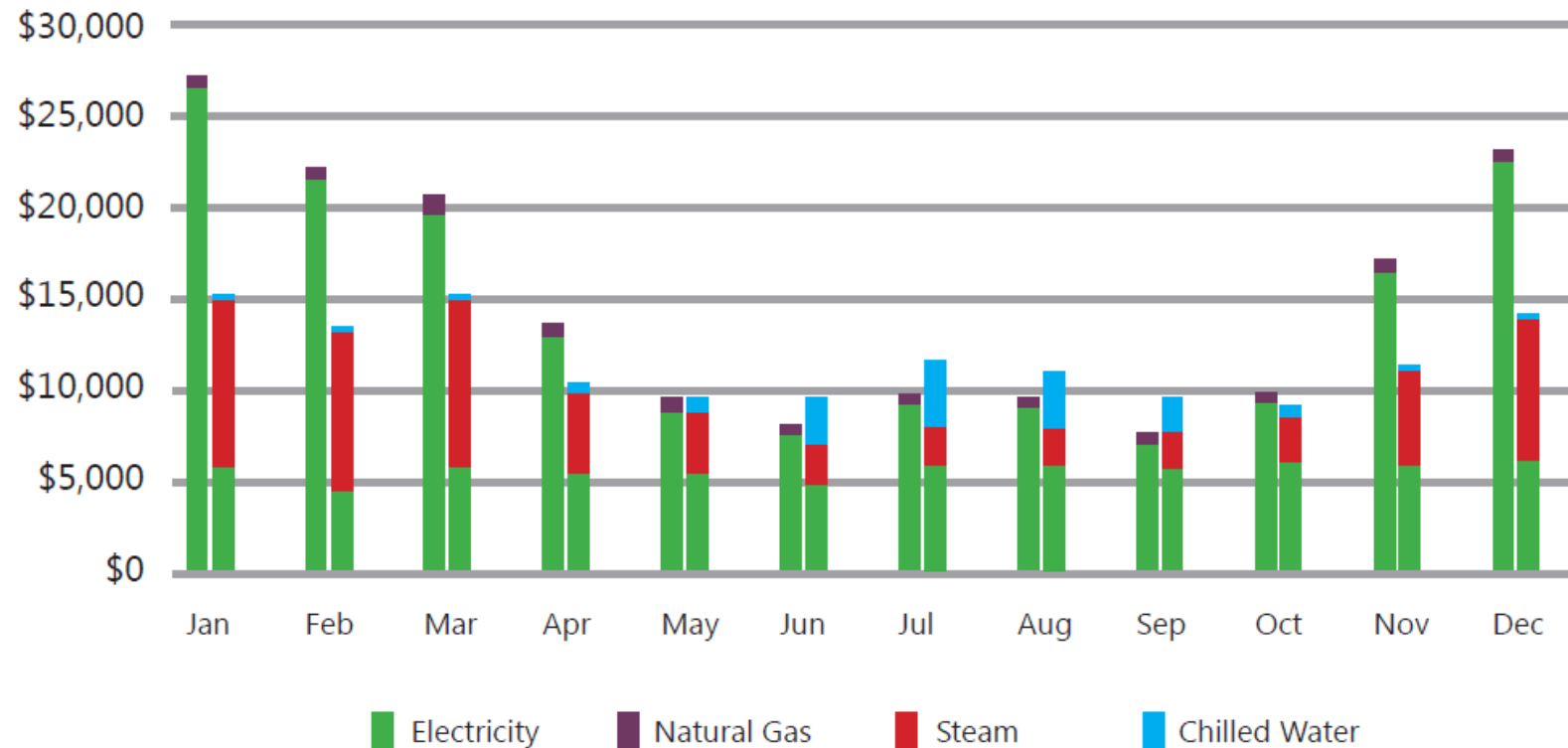
ANNUAL UTILITY COSTS

Boston: 100 Unit



ANNUAL UTILITY COSTS

Boston: 100 Unit



DEVELOPER'S PERSPECTIVE



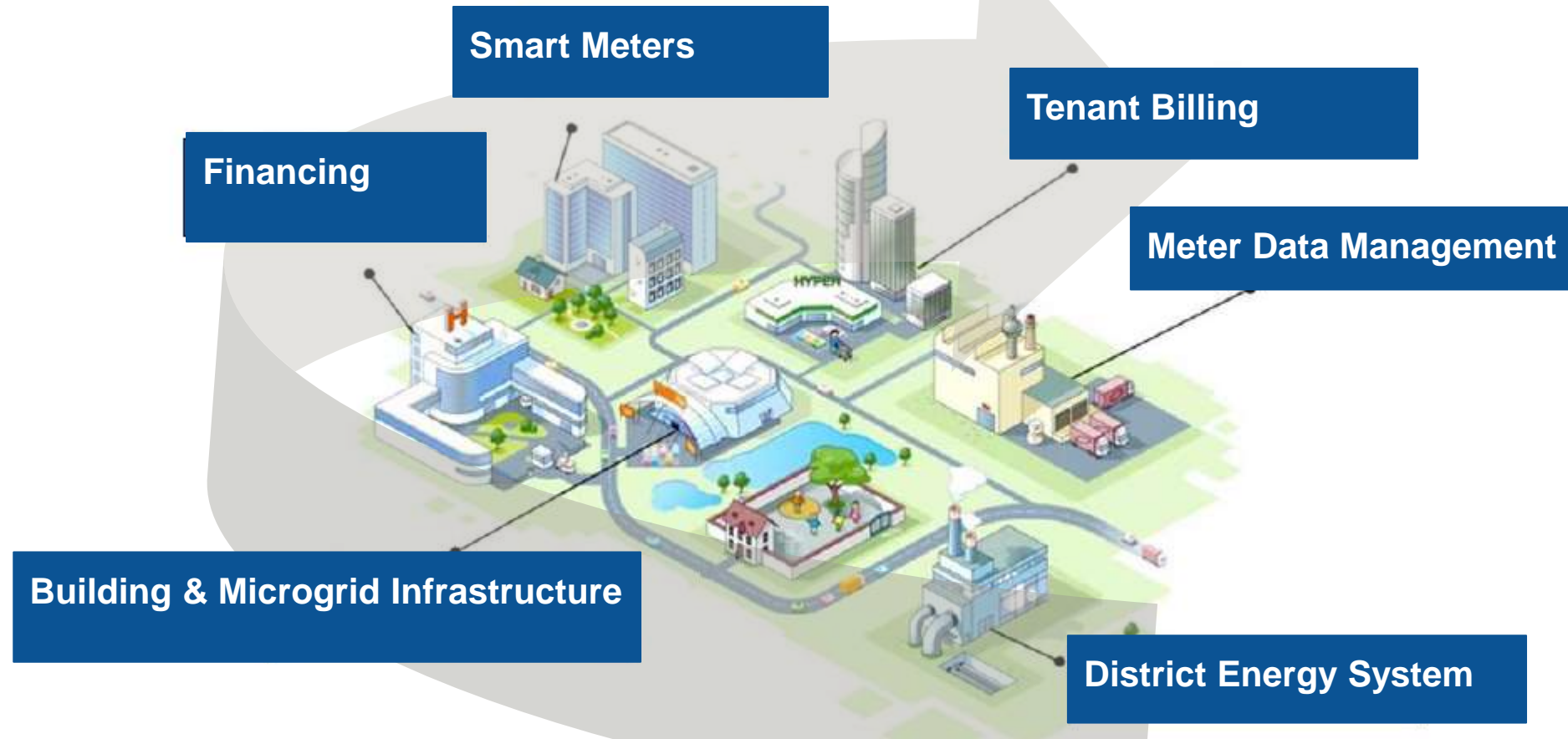
- The developer's time frame can dictate greater concern toward 1st cost than life cycle costs
- Can be insulated from D-E benefits by engineer/contractors
- The Building O&M labor cost for self-perform cases tend to be minimized by developers
- Long term financing options can include some capital costs

DISTRICT ENERGY STRATEGIES



- Win, win situations can be achieved by extending distribution to other potential customers or to increase system reliability
- Leverage sustainability opportunities that include DHW preheat, snowmelt, rooftop greenhouses
- Municipal WW boiler makeup in Grand Rapids
- Condensing economizers improve plant efficiency

DISTRICT ENERGY SOLUTION



ENERGY SUB-METERING

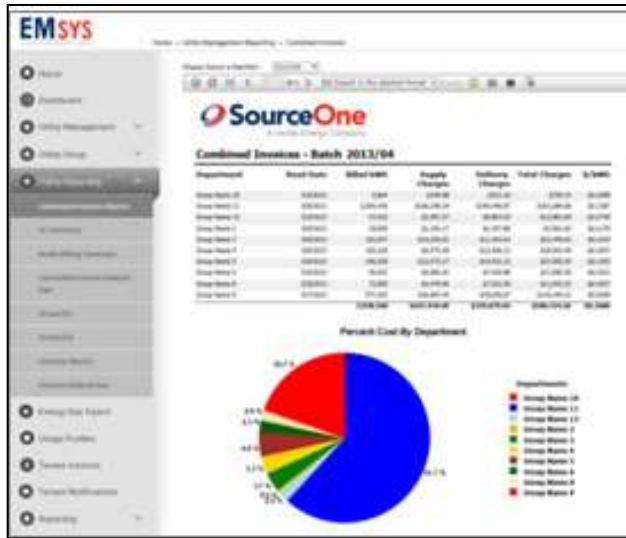
Developers prefer the simplicity of Energy Sub-metering and Direct Billing to tenants.

- Enables marketing actual energy use to tenants as portrays them as being energy conscious
- Compete with electric utilities that commonly bill direct
- They can avoid the billing process

Three approaches to allocating energy exist:

- Space allocation – proportionally allocate energy use by the ratio of square footage
- Hybrid – digital or temperature input to an algorithm
- Energy meters – direct via flow rate and delta T measurement

DATA MANAGEMENT



One method of data managing is the EMSYS system, by Source One. It gathers, reports and can generate billing.



Third party billing services are also available.

CONCLUSIONS



District energy does offer economic advantages for multi-family housing. It is important to understand the developers perspective and the specifics of each opportunity.

These findings are for specific locations in the USA. Results may differ in other locations.

QUESTIONS

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