Successful Integration of CHP at Novartis Institute's Cambridge R&D Campus

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Annual Conference

February 20, 2014

Presented By:

SourceOne
A Veolia Energy Company

and

NOVARTIS

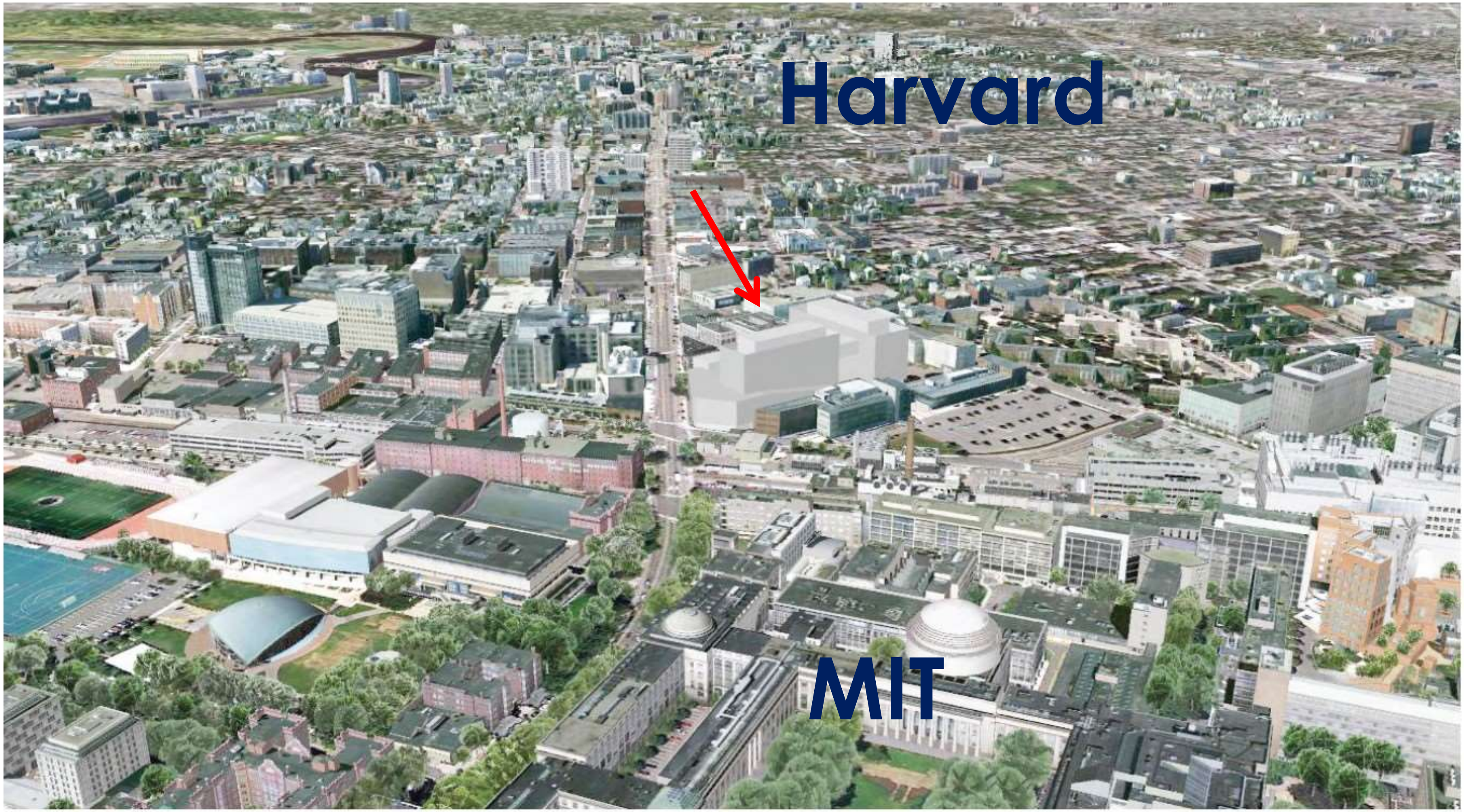
Overview

- Novartis plans Cambridge Campus expansion.
- Context for campus expansion.
- Novartis' Energy Challenge:
  - Sustainable management of energy and related greenhouse gas (GHG) emissions.
  - Corporate initiatives focused on life cycle analysis vs. short term payback.
- Meeting Novartis' Energy Requirements.
- Historical Energy Use.
- Energy Conservation Measures
- Energy Saving Applications & Technologies
- Drivers for CHP
- The Path Taken
- Q&A

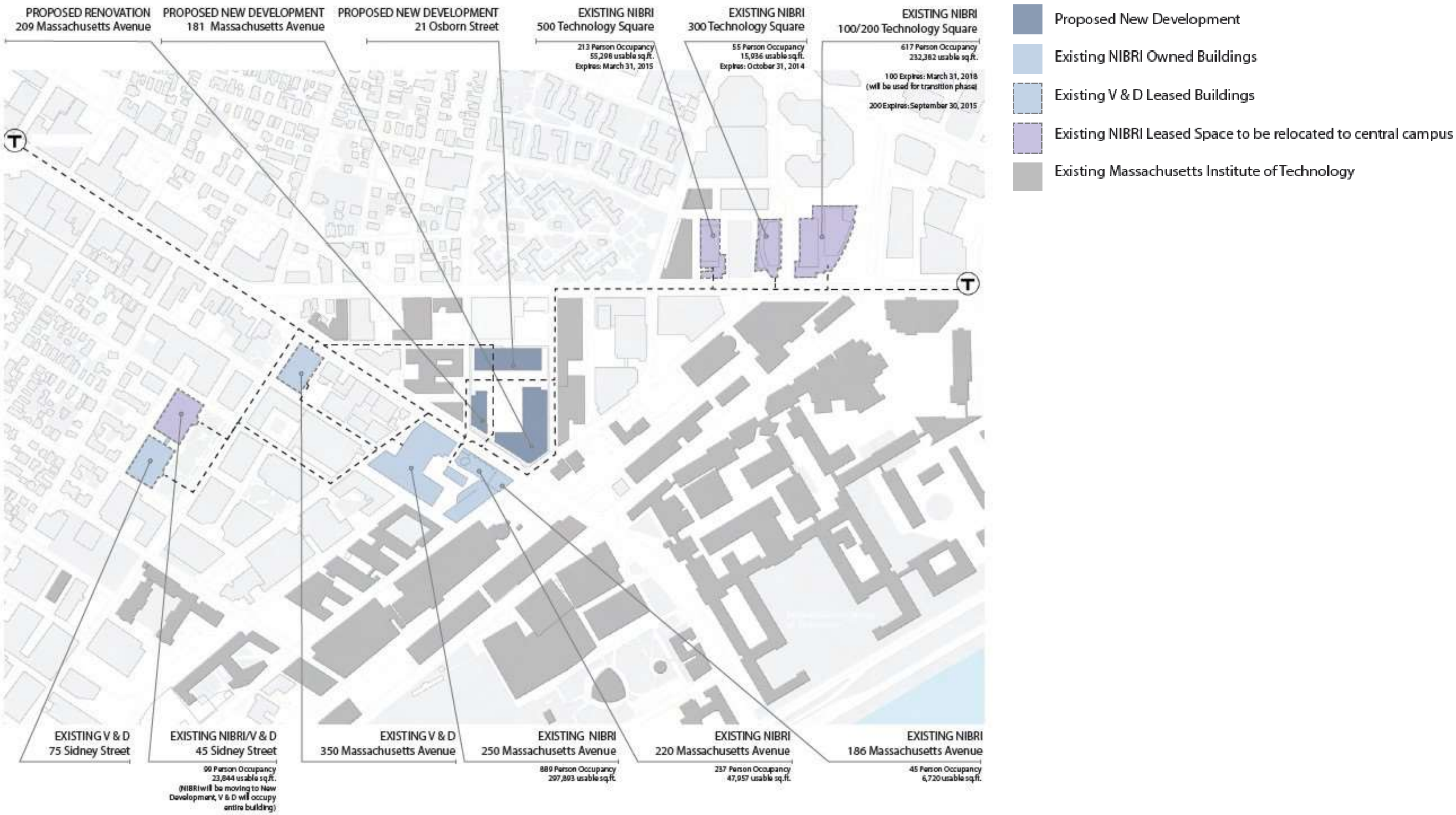
Context for Novartis' Campus Expansion

- Headquartered in Cambridge, MA.
- New 550,000 square foot campus of lab, office and retail space.
- New energy needs emerge with campus growth:
  - Total energy requirements increasing beyond capabilities.
  - Energy requirement types and density changed with expansion.
- Determining the feasibility of CHP.

Cambridge Campus Expansion

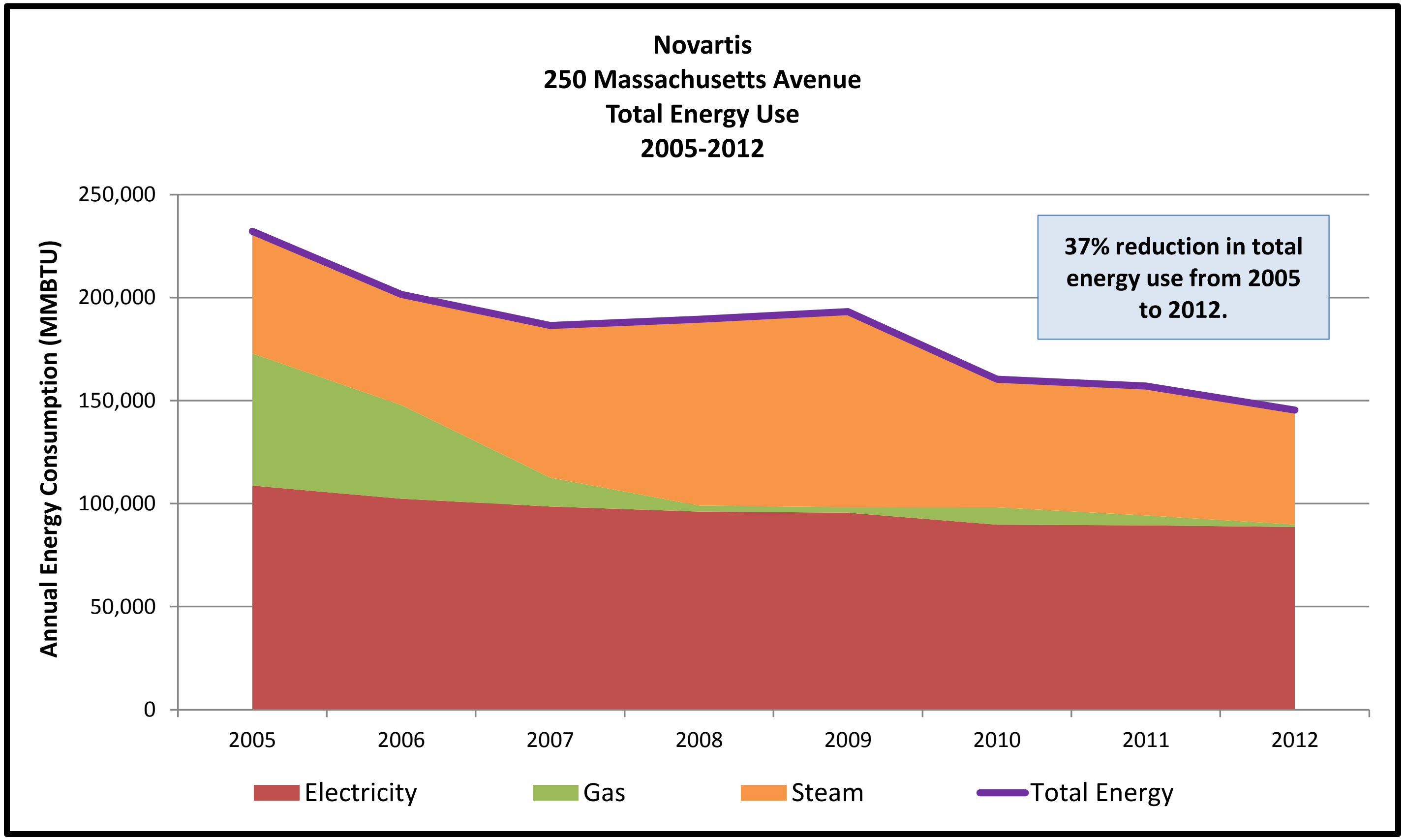


Cambridge Campus Expansion



Historical Energy Use
250 Massachusetts Avenue – 2005 through 2012

- 20% increase in square footage and 37% energy reduction since 2005.



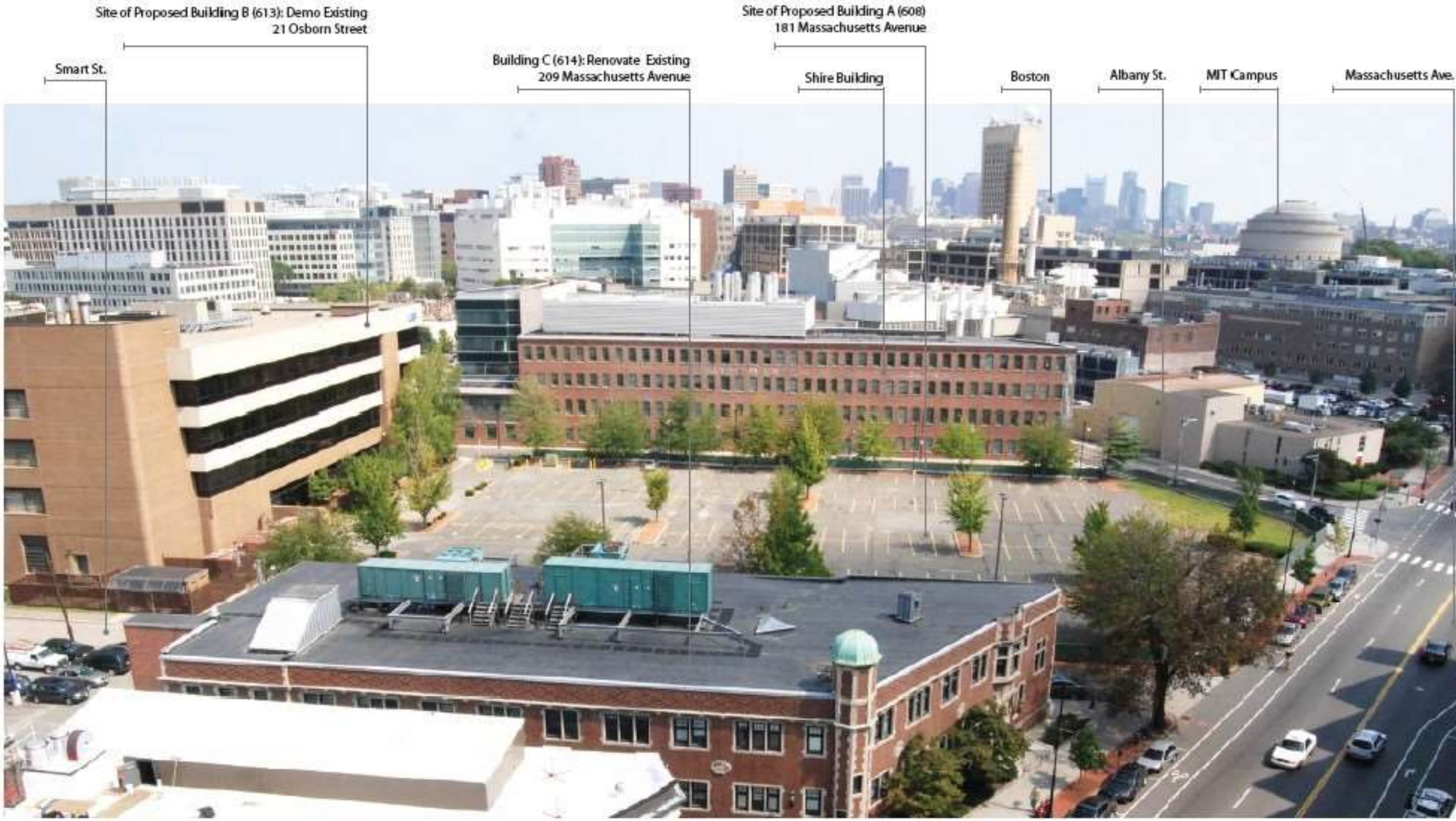
Energy Conservation Measures

250 Massachusetts Avenue – Projects 2009 through 2012

- Air Compressor upgrades.
- Vacuum pump replacement/upgrades.
- Rooftop unit upgrades.
- Cold rooms energy efficient retrofit.
- Chilled water loop optimization.
- Steam trap repairs.
- Lighting upgrades.
- Laboratory and Vivarium air rate reductions.

$1.5+ Million Annual Cost Savings!

Cambridge Campus Expansion



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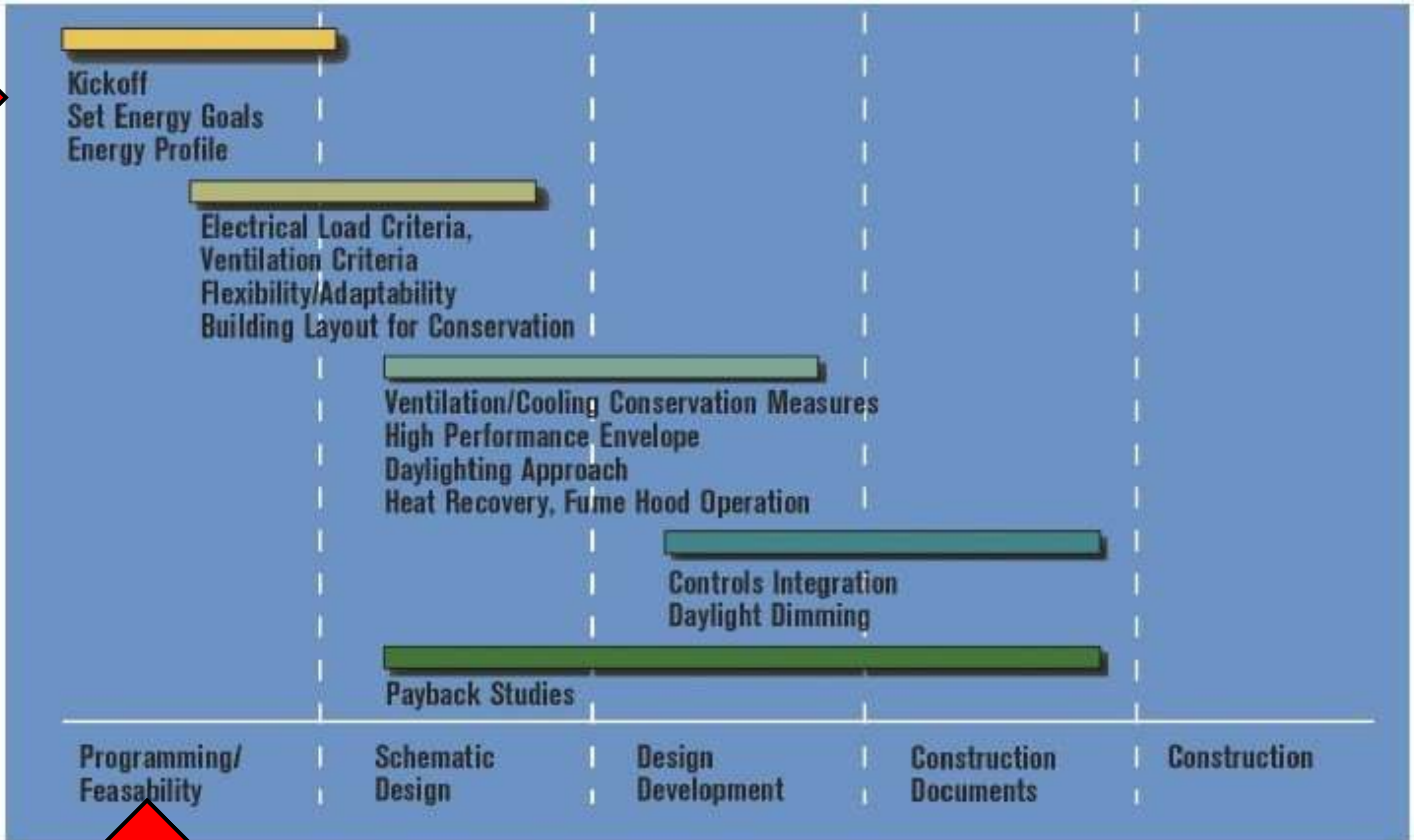
Novartis' Energy Challenge

- Early Involvement



www.labdesignnews.com

Novartis' Energy Challenge

- Clear Vision...Documented Goals

EXECUTIVE SUMMARY
NIBRI CAMBRIDGE CAMPUS EXPANSION

Environmentally responsible and sustainable c
uphold the highest standards for sustainability
passive and active design solutions will be util
age building type. It is NIBRI's goal that the prc
tion from USGBC.

The project cost objective will be to design to t
this objective, it is expected that the team will
lowest possible first cost of construction balan

1.3 PROJECT GOALS

The Project Goals were defined at the beginning of the project, and are included in this Project Procedures Manual as a reference to the desires of NIBRI Institutes for Biomedical Research, Inc (NIBRI). Changes to these goals may only be made by the Project Executive Team (PET). Team members will be notified via e-mail when updates have been made to the Project Goals. Recommendations for revisions should be directed to NIBRI Project Controls Manager, for consideration by the PET.

Sustainability
Consistent with NIBRI's corporate goals, this project is expected to meet high standards of sustainability and building performance. Although the minimum LEED rating of silver has been established, the project team is expected to push to exceed this rating with focus on optimizing actual performance of the project though measurable ways established ... ation and the involvement of a whole

1.4 SUSTAINABILITY GOALS

The Cambridge Campus Expansion Project will conform to the following sustainability guidelines:

- LEED v3.0 (Gold level certification)
- Labs 21 (EPC 22 Checklist)

Sustainability strategies will be developed during the Concept Design phase of the project. Meetings, chaired by the project Sustainability Leader, will be held on a bi-weekly basis to identify project sustainability goals, and to confirm the project is adhering to these goals. The sustainability goals require ratification by the team before they are considered final. Any changes to the project sustainability goals must be approved by the Project Executive Team (PET). When changes to the Sustainability Goals have been enacted, they will be uploaded to Gateway and the Project Team will be notified via e-mail.

Novartis' Energy Challenge

- Clear Vision…Documented Goals

D. ENERGY PERFORMANCE GOALS

Baseline Standard	Metric	Goal
Architecture 2030 Challenge	Design Year Goal	60% better than avg CBEC's standard
ASHRAE 90.1-2007	Percent of optimization as compared to baseline	30%-40% better
Design to Earn ENERGY STAR	EPA Energy Performance Rating (must be greater than 75)	Rating of 90 or greater
Local Energy Code Requirements	IEC	Comply with "stretch" code of 20% better than compliance
NIBRI Goals	HSE Guidelines 13 and 14	212kBtu/SF-yr*

*The NIBRI target was identified to be 264 kBtu/SF-yr during the Criteria Design Phase. A more comprehensive and detailed target calculation methodology was requested at the end of 2011. The calculation resulted in a memo issued on 1/6/12 with an updated target of 212kBtu/SF-yr.

Novartis' Energy Challenge

- **GL13: Energy Management** - Defines what energy management means for Novartis. It is the link between energy use and GHG emissions; **management principles and processes**.

"This guideline supports and implements the Novartis Policy on Corporate Citizenship (CC). Its aim is a ***sustainable management of energy and related greenhouse gas (GHG) emissions*** *throughout Novartis for all types of energy and on all its activities."*

Novartis' Energy Challenge

GL14: Energy Standards for Buildings and Equipment

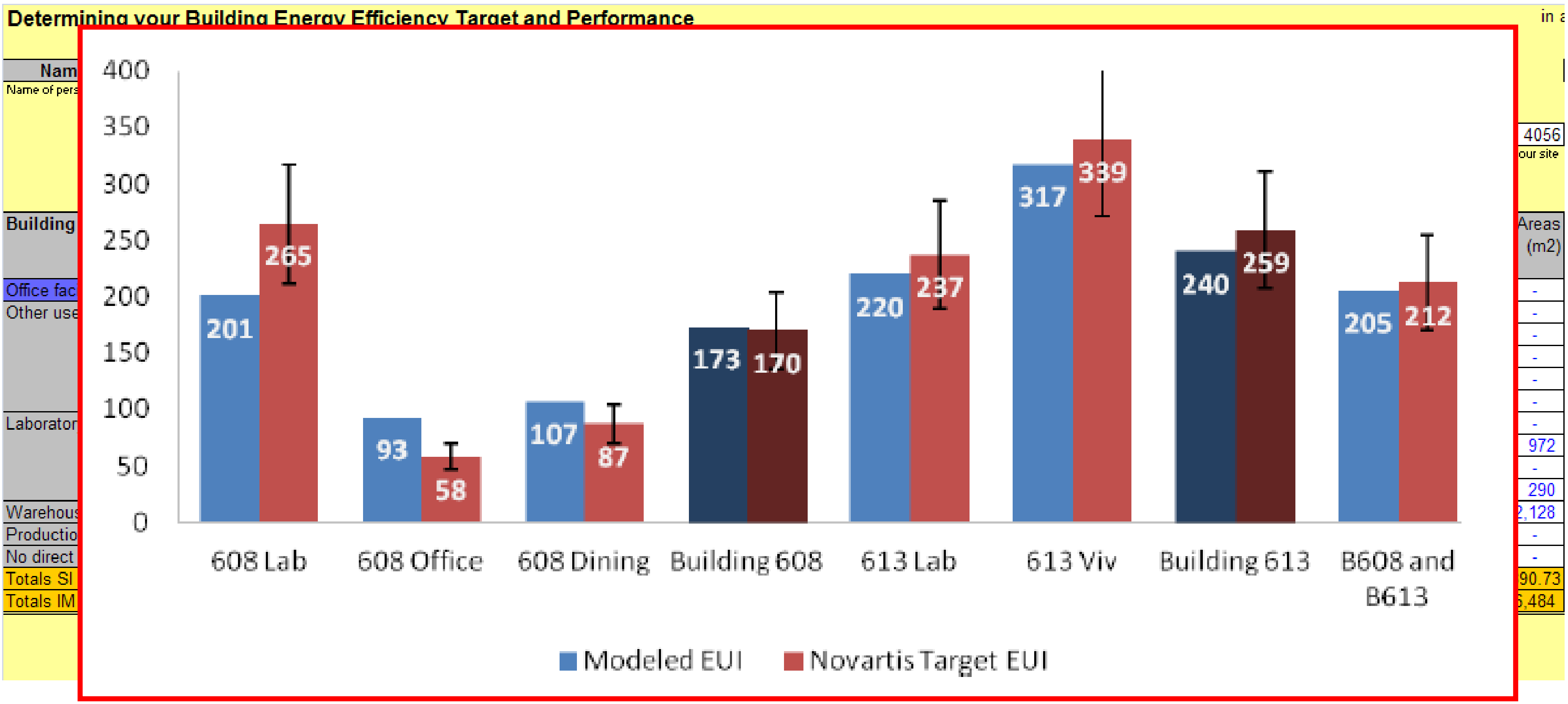
Specifies Novartis' requirements on energy efficiency and related GHG performance of buildings and equipment.

*"This guideline follows and implements the Novartis Policy on Corporate Citizenship (CC). Its aim is achieving **energy excellence** in the operation of all Novartis buildings and equipment worldwide.*

*"It serves as a **minimum standard** in the evaluation and selection of new design and for the upgrade or replacement of existing equipment in applying **full life cycle cost**, including energy cost, maintenance cost, and **not lowest first cost**."*

Novartis' Energy Challenge

- Clear Vision…Documented Goals



Novartis' Energy Challenge


Option 1

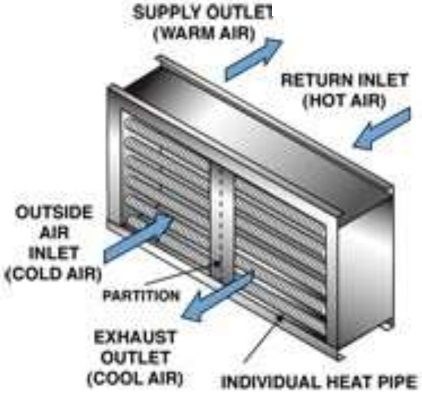

Option 2


Option 3


Option 4

Energy Saving Applications & Technologies
181 Mass Ave – Design Improvements

- Building
  - High Performance Glass/Façade.
- Airside
  - VAV Supply and Exhaust.
  - Displacement Ventilation.
  - FanWall® Technology.
  - Heat Pipe Energy Recovery
  - Low Pressure Drop Design
  - EF Optimization.



Energy Saving Applications & Technologies

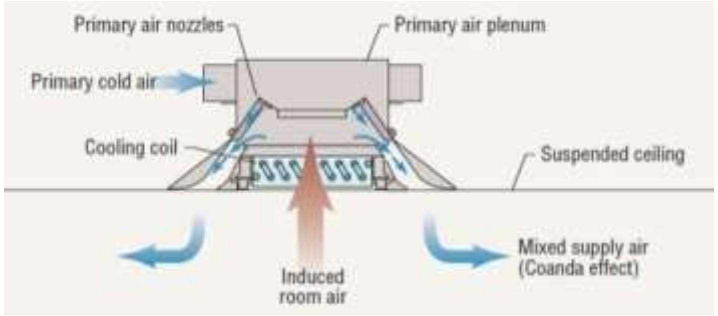
181 Mass Ave – Design Improvements

- Waterside:
  - Rain, Grey, Condensate Water Collection/Reuse.
  - Pressure Independent Control Valves.
  - Chilled Beams - Radiant Heating.
  - Water Cooled Freezers.
  - Tower Economizer.
  - Chemical Free Tower.


LABORATORIES FOR THE 21ST CENTURY:
AN INTRODUCTION TO LOW-ENERGY DESIGN

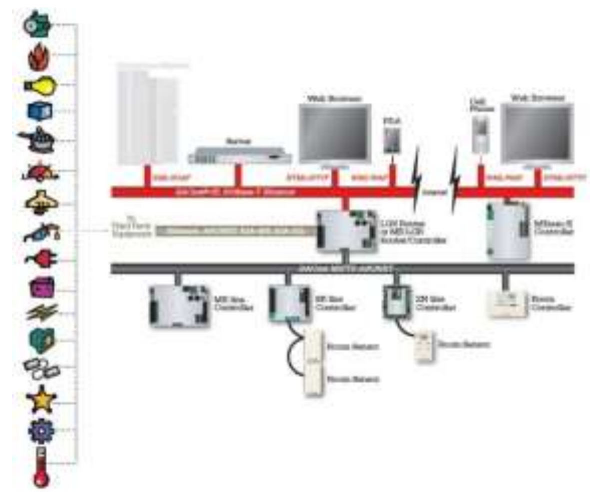
EPA United States Environmental Protection Agency

FEDERAL ENERGY MANAGEMENT PROGRAM



Energy Saving Applications & Technologies
181 Mass Ave – Design Improvements

- Lighting:
  - High Efficiency Lighting Design.
  - Daylight Sensor Control.
  - Occupancy Sensor Control.
- Building Automation:
  - Integrated Design Assist Partner.
  - Traditional Low Voltage Systems.



The Path Taken

- Utility costs per Square foot

181 Massachusetts Avenue	
Utilities	**Cost/sf**
Electricity	2.33
Gas	1.72
Steam	0.31
Water - Building	0.02
Sewer - Building	0.05
Water - Cooling Tower	0.09
Sewer - Cooling Tower	0.00
Credit - storm	-0.03
TOTAL	4.50

250 Massachusetts Avenue	
Utilities	**Cost/sf**
Gas	0.02
Electricity	6.4
Oil / Steam	2.03
Water & Sewer	0.74
TOTAL	9.37

Novartis Mission: To Care and Cure

We want to discover, develop and successfully market innovative products to prevent and cure diseases, to ease suffering and to enhance the quality of life.

We also want to provide a shareholder return that reflects outstanding performance and to adequately reward those who invest their money, their time and their ideas in our company.

External Energy Infrastructure → Energy Infrastructure To Support Operations

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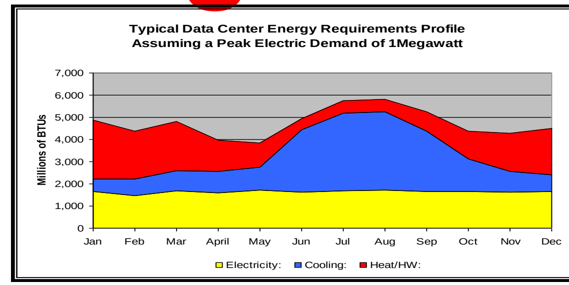
The Campus's Energy Infrastructure Goals

- ✓ Satisfy 24/7 thermal and electric energy requirements.
- ✓ Assure reliability of energy supplies.
- ✓ Maintain price stability and minimize future energy cost risk.
- ✓ Minimize environmental impact

Can self-generation help Novartis achieve the four goals?

Initial Assessment (Screening)

a) Develop Energy Requirements Profile
b) Assess Utility Infrastructure Needs
c) Evaluate Fatal Flaws

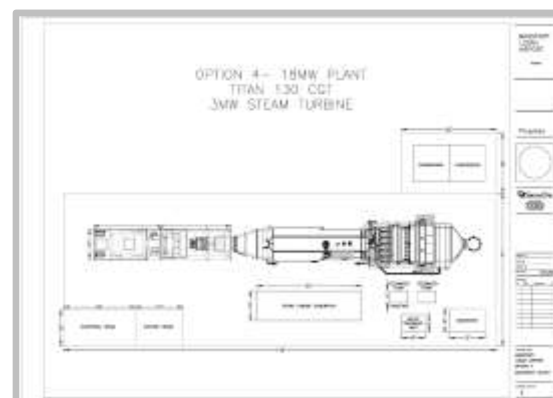


Detailed Feasibility Analyses

a) Major Component Selection
b) Detailed Planning Cost Estimate
c) Detailed Financial Analysis

Schematic Design thru Construction

a) Finalize Component Selection
b) Engineering & Construction Plans
c) Project Construction Program
d) Updated Financial Analysis



Assessment Process

Gather Information

- Building use & hours of Operation
- Internal & external supporting Infrastructure
- Energy use & cost via utility invoices
- Owner's Future Plans

Evaluate and Validate

- Calculate Total Energy Requirements Model (TERM)
- Assess condition of existing infrastructure
- Model range of CHP system classes to provide energy to serve the TERM.
- Perform Summary Financial Analysis

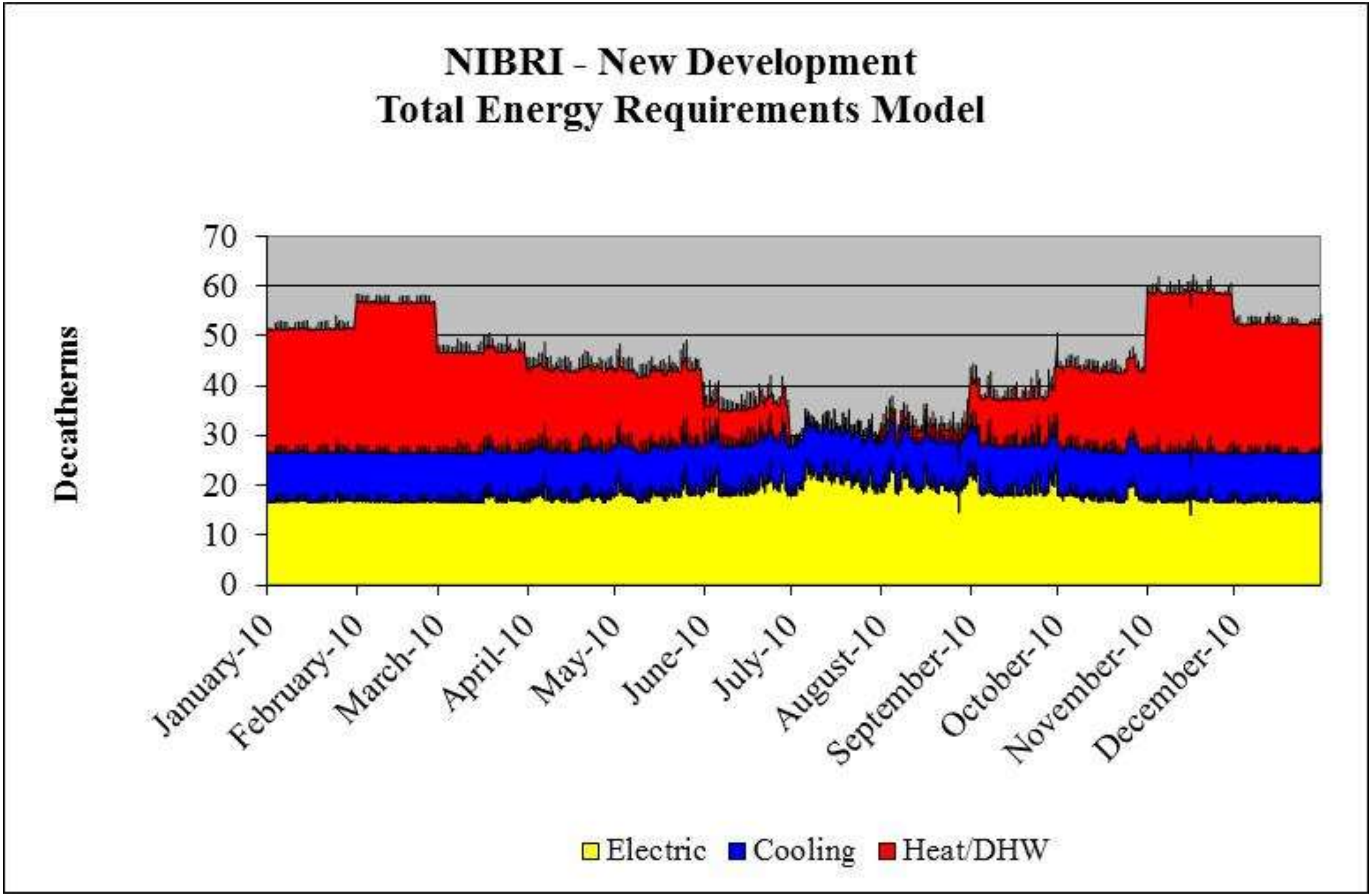
Conclude and Present

- Provide Report & Recommendations
  - Other EE Items
  - Proceed or not

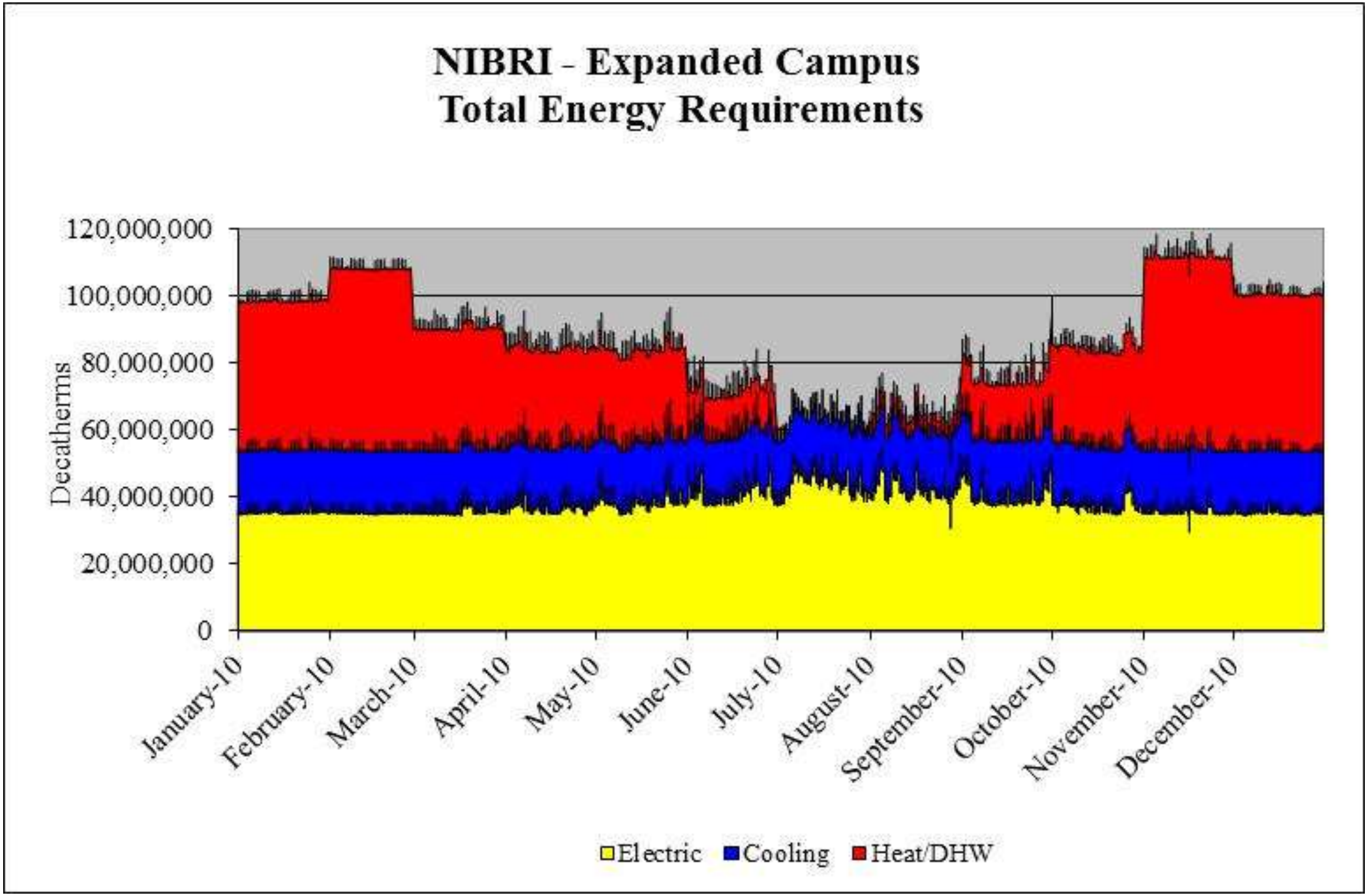
Uncovering Fatal Flaws

- Fuel Availability
- Site Restrictions
- NIBRI Schedule Risk
- Utility Infrastructure
- Constructability
- Capital Cost
- Regulatory Issues
- Thermal & Electric Profile Densities
- Financial Analysis

Screening Study Results



Screening Study Results

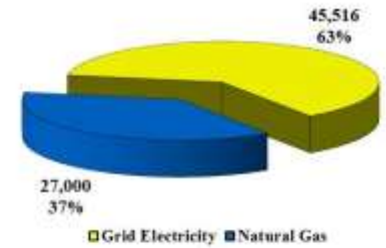


Screening Study Results

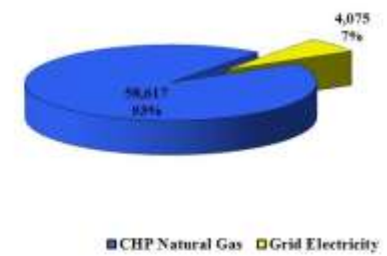
Option Prime Mover	NIBRI Mercury 50	Campus Twin Mercury 50
Electric (kW)	4,600	9,200
Unfired Steam (lbs/hr)	13,000	26,000
Electricity Generated (MWhs)	37,212	62,060
% of Load	90%	89%
Steam Production (MMlbs)	233,719	533,508
% of Load	100%	100%
% Total Energy Needs	**96.4%**	**91.5%**
CHP Plant Efficiency	**72.1%**	**81.9%**
Capital Cost Estimate	$14,311,092	$19,588,851
Cost per Kilowatt Installed	$3,111	$2,129
Annual Utility Cost Savings	$3,141,417	$7,158,262
Simple Payback (Yrs)	**4.6**	**2.7**

Carbon Footprint

Traditional Deployment
72,516 tons/year



CHP Environment
62,692 tons/year



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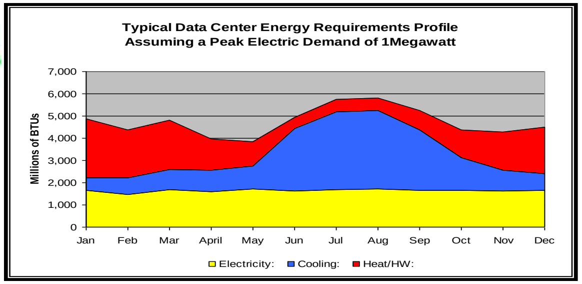

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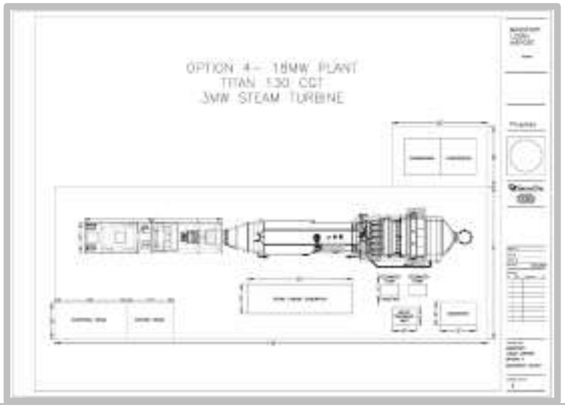

Assessment Process - *Again*

Gather Information

- Building use & hours of Operation
- Internal & external supporting Infrastructure
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Evaluate and Validate

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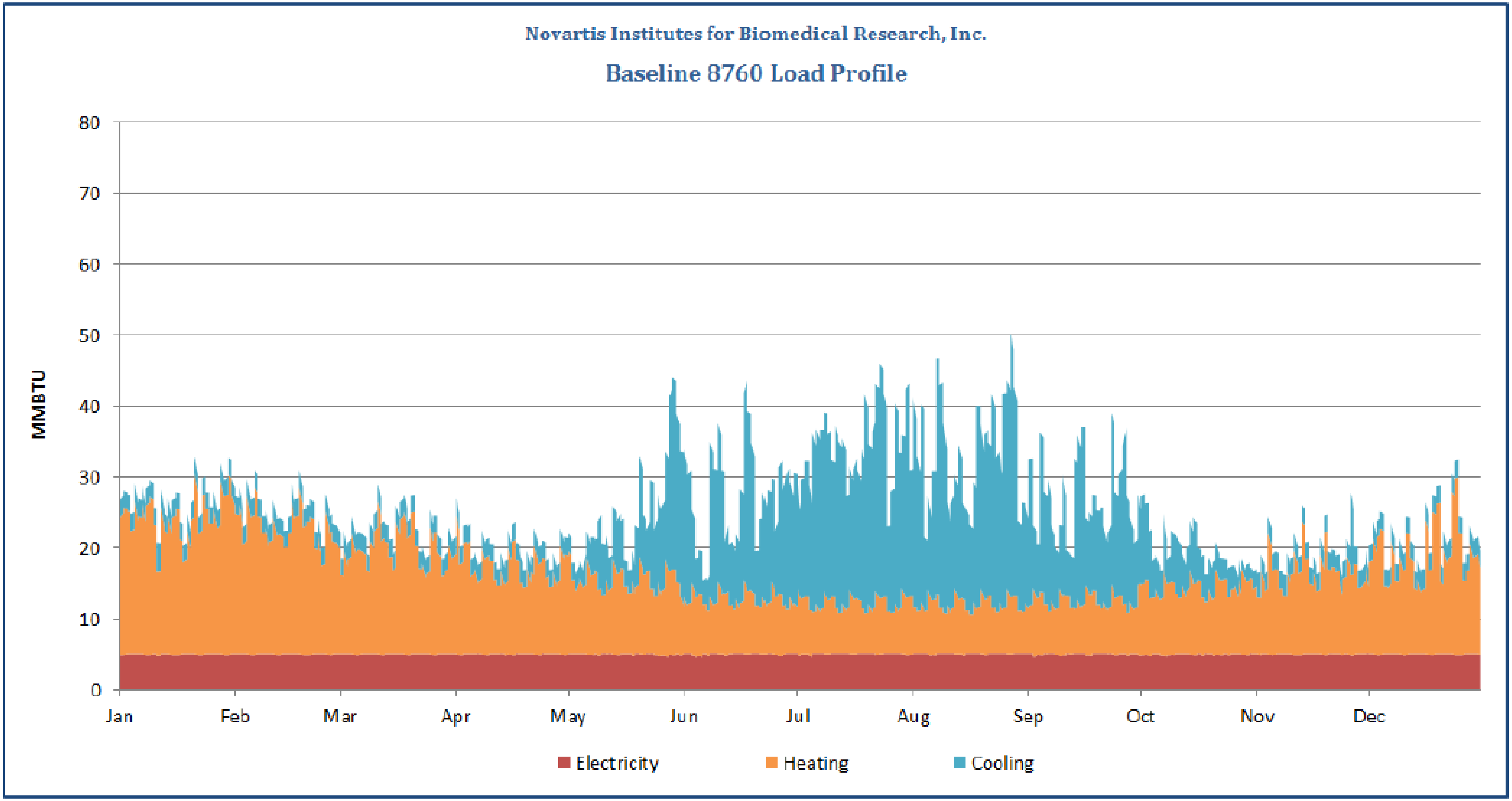
  - Proceed or not

Test & *Refine Assumptions*

So What Changed?

- 181 Mass ave complex becomes more efficient through design optimization
- Thermal needs @ 250 Mass Ave reduce at a faster rate than electrical
- Resulting electric to heat ratio challenges technology selection
- Novartis chooses not to power both facilities from one central plant because of project schedule & regulatory risk

Resulting Energy Profile



Summary Performance Statistics

Novartis Institutes for Biomedical Research, Inc.

At-a-Glance Load Statistics

Energy Demand

	Base Load[1]	Average	Peak	
Electrical Load	1,485	1,871	2,732	kW
Heating Load	8	13	31	MMBTU/hr
Chilling Load	201	879	4,090	Ton/hr

Average Heat-to-Power Ratio

1	:	2.0

Energy Consumption

	Consumption	
Electrical	16,392,289	kWh
Heating	112,664	MMBTU
Chilling	7,699,760	Tons

Average Power-to-Heat Ratio

1	:	0.5

Ideal Chiller Sizing

Steam Absorption	0	Tons
High Temperature Hot Water	90	Tons

☑ Include Proposed Load Curves

[1] *"Base load" is defined as the minimum load for at least 90% of the year.*

Summary Financial Statistics

Option	Additional Installed Cost	Annual Operating Cost	Annual Cost Savings	Annual APS Credit	Simple Payback (years)		20 Year Net Present Value		IRR
					W/O Rebate	With Rebate	4%	9%	
Option 1: Central Plant Serving 181 Mass Ave Electric and Thermal Only (Centaur 40; 3,360 kWe)									
Base Case		$4.0M							
Tri-Gen	$8.8M	$3.7M	$0.3M	$80K	22.6	--	($1.4M)	($3.9M)	2.3%
Option 2A: Central Plant Serving 181 Mass Ave Electric and Thermal, 250 Mass Ave Thermal (Two Jenbacher JMS 420; 1,430 kWe)									
Base Case		$5.1M							
Tri-Gen	$9.4M	$4.0M	$1.1M	$395K	6.1	5.2	$15.7M	$7.1M	17.9%
Option 3: Central Plant Serving 181 and 250 Mass Ave Electric and Thermal (Mercury 50; 4,420 kWe)									
Base Case		$8.2M							
Tri-Gen	$11.2M	$6.4M	$1.9M	$656K	4.4	3.6	$30.3M	$16.0M	25.1%

Notes:
1. NPV assumes 2% inflation rate.
2. NPV and IRR are calculated without rebate.
3. Annual cost savings does not include APS Credit.

Assessing The Value Streams

Green Communities Act of 2008:
Utility Program Administrators will evaluate CHP projects as an Energy Efficiency Measure eligible for Incentive Funding

Cape Light Compact · Western Massachusetts Electric (The Northeast Utilities System) · Unitil · nationalgrid · NSTAR

What this has created:
A systematic, merit-based evaluation of potential CHP system deployments

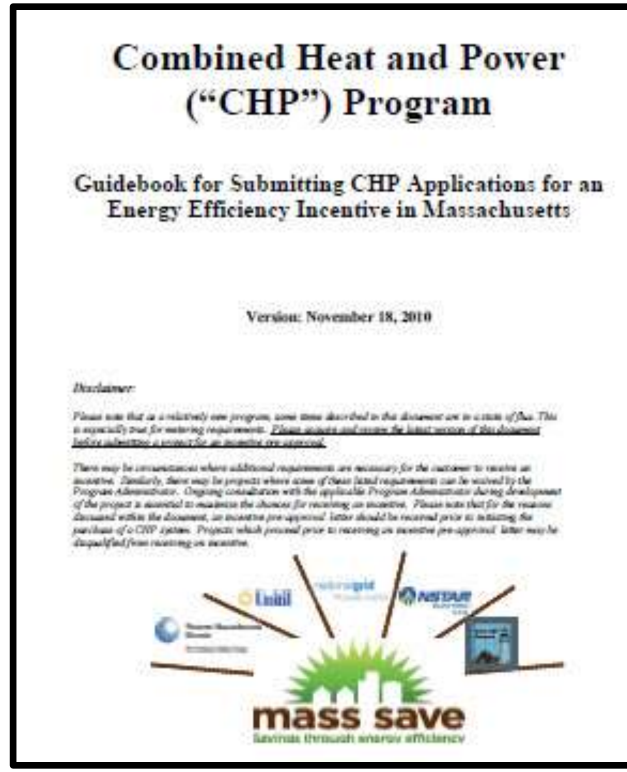
MA State Policy: CHP Incentives

Study Co-Funding

Incentives based on up to 50% of CapEx or one of three Tiers:

- $750/kW
- $950/kW
- $1,100/kW

Incentive offered will consider the overall added value of the CHP project to the PA's EE portfolio considering factors such as the overall building energy efficiency, BCR ratio and project risk. May be subject to Program Administrator Budget Limitations



Combined Heat and Power ("CHP") Program

Guidebook for Submitting CHP Applications for an Energy Efficiency Incentive in Massachusetts

Version: November 18, 2010

Disclaimer:

mass save

MA State Policy Impact: Funding

Investor Owned Utilities collect $0.0025/kWh from all customers to fund Demand Side Management programs.

1,931 kWhs
$4.83 charge

Cost of Electricity						
Delivery Services						
Customer Charge						6.43
Distribution	.05345	X	1931	KWH		103.21
Transition *	.00944	X	1931	KWH		18.23
Transmission	.01513	X	1931	KWH		29.22
Renewable Energy	.00050	X	1931	KWH		0.97
Energy Conservation	.00250	X	1931	KWH		4.83
Delivery Services Total					162.89	
Supplier Services						
Generation Charge						
Basic Svc Fixed	.07306	X		1931KWH	141.08	
Total Cost of Electricity					303.97	

Medium Sized Hospital

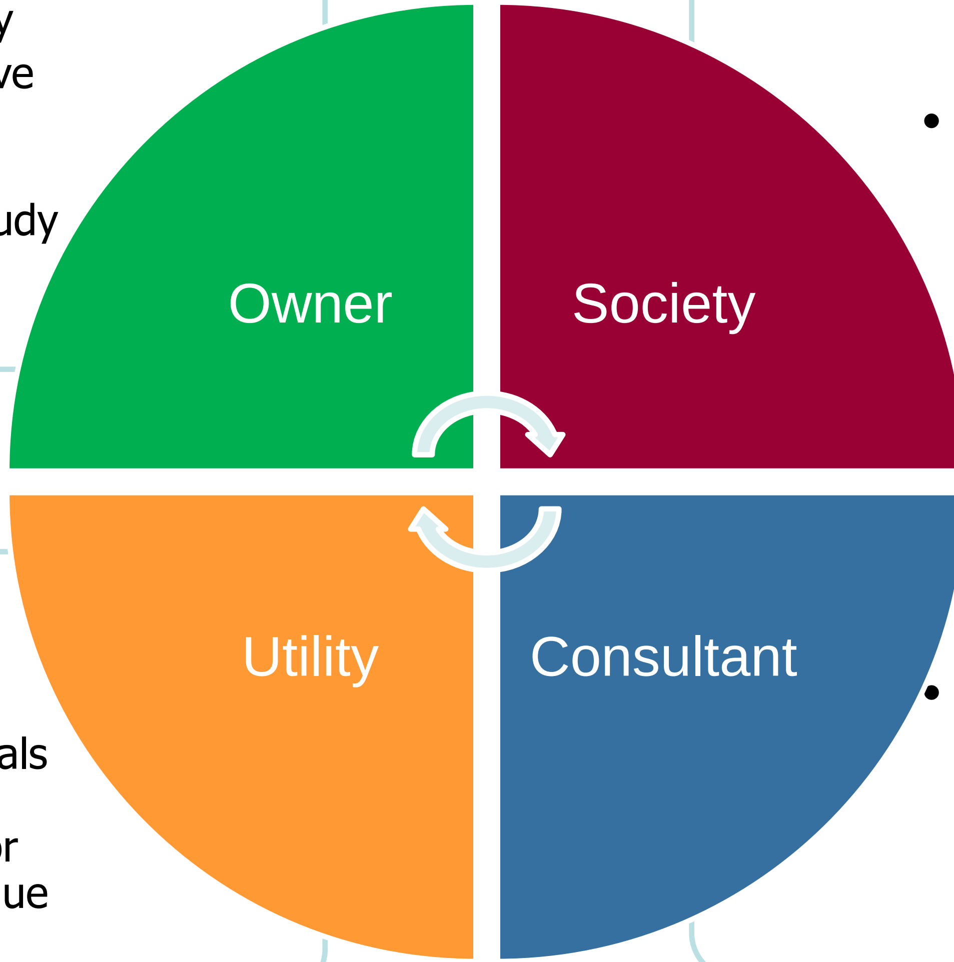
4,000 kWhs x 8760 x LF~0.82

$71,832 Annually

Value In the Policy

- Obtain partial funding for study
- Potential incentive for installation
- Obtain 3rd Party review of the Study

- EE funds projects that are highly efficient.
- Translates to less fuel used and lower need for new central plants



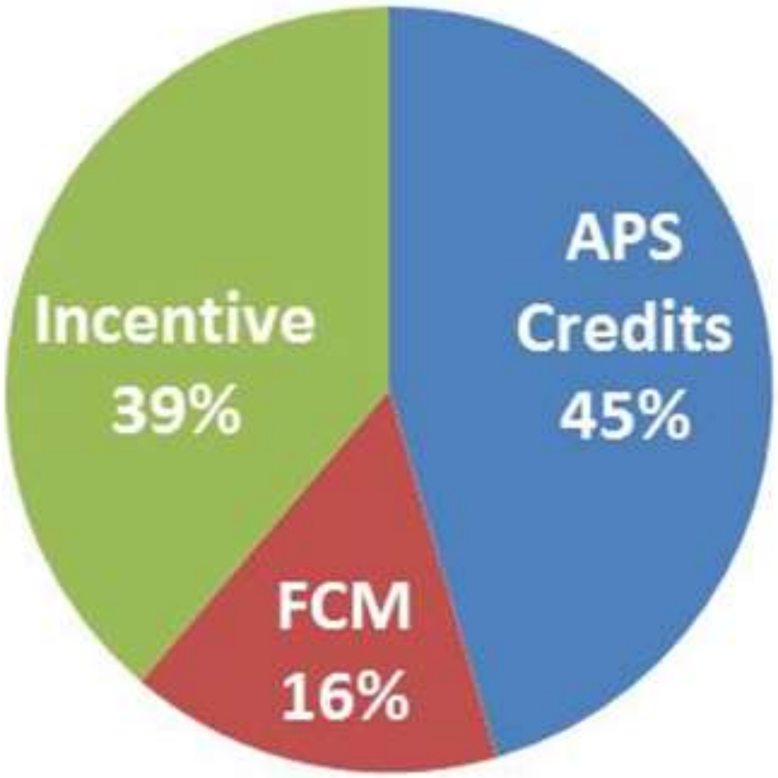
- Obtains projects that meet EE goals and enables compensation for lost future revenue

- Built-in QA process for deliverables that improves validity of work-product & heightens client confidence

Value In the Policy

<u>NPV Comparison</u>

Incentive: Year 1
APS Credits: 10 Years
FCM: 10 Years



- **As of April 2013, demand for APS far outpaced supply by about 130 MW, but this could change if large new units come online**
- **Long-term FCM price is $5.25 kW-month (the est. cost of new entry), but a large new generator in NEMA and the removal of the floor price in Auction 8 will likely result in suppressed prices over the next couple of years**

The Path Taken

- New Central Utility Plant:
  - Tri-Gen – Power, Heat, Cooling.
  - Variable Flow Pumping.
  - High Efficiency Frictionless Variable Speed Chillers.
  - Two Jenbacher Reciprocating Engines (2x 1,488 kW) matched with Hot Water Generators.
  - 150 Ton HW absorption Chiller
- Central plant will serve all requirements for the new facility and some of the heating requirements for the existing 250 Massachusetts Avenue facility.
- Results? – Stand by

Key Take-Aways

- ✓ MA Green Communities Program enables CHP as a viable technology
- ✓ CHP Evaluation needs an **organized** & **structured** approach
- ✓ **Validate** assumptions at each **Decision Point** in the process
- ✓ Engage internal and external expertise to ensure effective and efficient evaluation & decision making

Stay focused

Questions?