Efficient and Sustainable Facility Design

Professional Development Webinar

Sustainable Labs Canada

February 18, 2015

Abstract

More than ever before, science based organizations and institutions are pursuing major facility upgrades with a key focus on sustainability and energy efficiency. There are many evolving reference points and guidance tools to assist project teams in the pursuit of these goals.

This presentation will benefit attendees by providing a guide to the sustainable rating systems applicable to new laboratory construction. It will also describe a holistic approach to sustainability which goes beyond any one rating system. Together, we will consider a systematic approach to the use of basic payback analysis and life cycle cost analysis. The presentation will outline the new technologies available to model the performance of engineering systems, and will use past project examples to illustrate passive and active approaches to overall building energy performance. Lastly, the presentation will give an overview of special products and technologies that can improve the performance of science facilities, laboratories and pharmaceutical production facilities.

Abstract

1. sustainable rating systems applicable to new laboratory construction
2. holistic approach to sustainability
3. basic payback analysis and life cycle cost analysis
4. technologies available to model the performance of engineering systems
5. approaches to overall building energy performance
6. products, concepts and technologies to improve your laboratory performance

LEED

Leadership in Energy & Environmental Design

USGBC

There are five rating systems that address multiple project types:

Building Design and Construction | Interior Design and Construction | Building Operations and Maintenance | Neighborhood Development | Homes

Building Design + Construction:

Interior Design + Construction:

Building Operations + Maintenance:

Neighborhood Development:

Homes:

LEED

Leadership in Energy & Environmental Design

USGBC

Integrative Process
requirements, while not a credit category, promote reaching across disciplines to incorporate diverse team members during the pre-design period.

Location and transportation
credits reward projects within relatively dense areas, near diverse uses, with access to a variety of transportation options, or on sites with development constraints.

Materials and Resources
credits encourage using sustainable building materials and reducing waste. Indoor environmental quality credits promote better indoor air quality and access to daylight and views.

Water efficiency
credits promote smarter use of water, inside and out, to reduce potable water consumption.

Energy and atmosphere
credits promote better building energy performance through innovative strategies.

Sustainable sites
credits encourage strategies that minimize the impact on ecosystems and water resources.

Indoor environmental quality
credits promote better indoor air quality and access to daylight and views.

Innovation
credits address sustainable building expertise as well as design measures not covered under the five LEED credit categories.

Regional priority credits
address regional environmental priorities for buildings in different geographic regions.

Labs21 (Our Friends)

Labs for the 21st Century

Co-sponsored by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE), Labs 21 is now transitioning to oversight by the International Institute for Sustainable Laboratories (I2SL).

The Labs21 Environmental Performance Criteria (EPC) complements the U.S. Green Building Council's widely used Leadership in Energy and Environmental Design for New Construction (LEED-NC) rating system, extending it to set appropriate and specific requirements for laboratories.

Core information resources:

- A Design Guide for Energy-Efficient Research Laboratories
- Best Practice Guides
- Technical Bulletins
- Case Studies
- Energy Benchmarking
- Laboratory Energy Efficiency Profiler (LEEP) Tool
- Energy-Efficient Laboratory Equipment Wiki
- Climate Neutral Research Campuses Website

Design process tools:

- Environmental Performance Criteria
- Labs21 Design Process Manual

Labs21

Labs for the 21st Century

At-a-glance comparison of the LEED versus EPC rating systems

LEED	Labs21 EPC
Criteria available for multiple building types	Specifically designed for laboratory facilities
Created to be used on its own	Created to work in conjunction with the LEED rating system
Provides certification	Does not provide certification
Produced by USGBC	Produced by a series of working groups that included more than 40 architects, engineers, facility managers, and health and safety professionals organized by Labs21

Green Globes

The genesis of Green Globes, similar to LEED and many other systems around the world was BREEAM, developed in the UK in the 1980's. Based on the 1996 CSA publication of BREEAM Canada, Green Globes for Existing Buildings was developed in 2000 as the first online system.

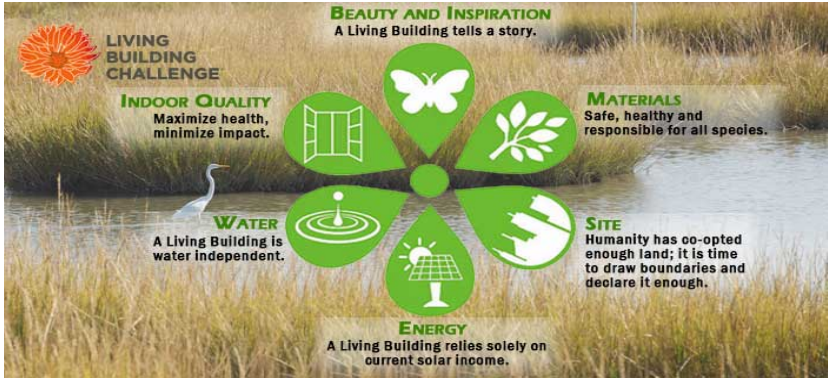
Green Globes for New Buildings Canada followed shortly thereafter, with the support of the Canadian Department of National Defense and Public Works and Government Services. In 2004, the system was adapted for the USA, where it is administered by the GBI (The Green Building Initiative), a standards developer through the American National Standards Institute (ANSI).

Core information resources:

- Rating System
- Program Summary
- Energy Modeling Expertise
- Plaques
- Water Calculator
- Performance Benchmarking Samples
- Case Studies

	Green Globes	LEED
Uses ANSI approved consensus development process	Yes	No
Nationally accepted program	Yes	Yes
Program delivery	Online interactive questionnaires	Online submission of templates
Total program points	1,000	110
Partial credits and recognizes that some criteria may be not applicable	Yes	Limited
Pre-requisites	No	Yes
Uses life cycle assessment and multiple attribute evaluations	Yes	No
Forest certifications accepted	FSC, SFI, ATFS, CSA	FSC
Time to complete documentation	◷	◷ ◷ ◷ ◷
Cost to certify a typical building	$	$ $ $ $

Living Building Challenge



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LIVING
BUILDING
CHALLENGE℠
3.0
A Visionary Path to a
Regenerative Future
INTERNATIONAL
LIVING FUTURE
INSTITUTE℠

Living Building Challenge

Projects can achieve three types of certification:

- Living Building Certification
- Petal Recognition
- Net Zero Energy Building Certification

The Living Building Challenge project certification process for projects pursuing Full Certification or Petal Recognition is intentionally straightforward, while still fostering an environment of support and collaboration. A project's path from inspired vision to inspirational achievement consists of three steps: Registration, Documentation + Operation and Audit + Certification.

The Net Zero Energy Building Certification follows a slightly different process.

Holistic Sustainability

How can we move toward a holistic approach to sustainability which goes beyond any one rating system?

Holistic Sustainability: Built Ecology

Holistic Sustainability: Built Ecology

DESIGN INTEGRATION

The timeline below shows the critical stages of involvement to establish, create and deliver high performance integrated project designs

ARCHITECTURAL INTEGRATION

- *Critical Stage to Inform the High Performance Design*
- Establishing Goals
- Research and Engineering Data to Inform Building Massing
- Integration of Systems Sizing & Facade Designs
- Inventing New Solutions

SYSTEM SYNERGIES

- *Critical Stage to Inform the High Performance Design*
- Designing Holistic Energy and Water Strategies
- Integrating Optimized Envelopes for Daylight with Electric Lighting Strategies
- District Energy Opportunities
- On-site Energy Generation Potentials

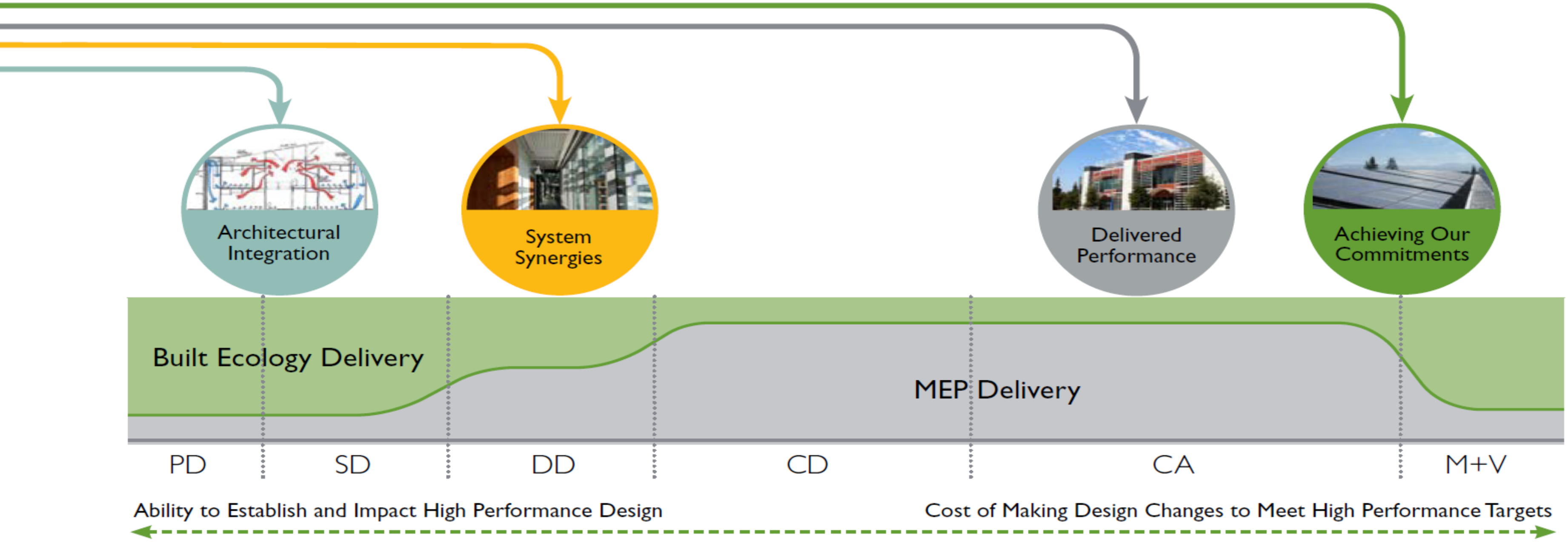
DELIVERED PERFORMANCE

- *Crucial Process to Ensure High Performance Designs Are Properly Coordinated & Executed*
- Custom Product Design Prototyping to Verify Performance
- Following Concepts Through Construction
- Measuring Actual Performance

ACHIEVING OUR COMMITMENTS

- *Essential Verification of Design Compared to High Performance Commitments*
- AIA Commitment & Architecture 2030 Challenge Reporting
- Net-Zero Building Design
- LEED Documentation and Reporting
- Living Building Challenge

Holistic Sustainability: Built Ecology



Approach to Sustainability

FRAME WORK OF UNDERSTANDING

NEED

[WHAT IS IMPORTANT TO ME?

PRIORITIES

COST EFFICIENCY OF CONSTRUCTION

COST EFFICIENCY OF OPERATIONS

FUNCTIONALITY

ENERGY EFFICIENT SYSTEMS

FLEXIBILITY TO MODIFY ENVIRONMENT

COMPUTER COMMUNICATIONS INFRASTRUCTURE

BUILDING CONTROL SYSTEMS

COLLABORATION AREAS

SUSTAINABILITY FEATURES

SAFETY FEATURES

ROOM FOR EXPANSION

STORAGE

NEED

[WHAT IS IMPORTANT TO ME?]

PRIORITIES

COST EFFICIENCY OF CONSTRUCTION	57%
COST EFFICIENCY OF OPERATIONS	68%
FUNCTIONALITY	70%
ENERGY EFFICIENT SYSTEMS	52%
FLEXIBILITY TO MODIFY ENVIRONMENT	44%
COMPUTER COMMUNICATIONS INFRASTRUCTURE	83%
BUILDING CONTROL SYSTEMS	36%
COLLABORATION AREAS	47%
SUSTAINABILITY FEATURES	$\boxed{33\%}$
SAFETY FEATURES	80%
ROOM FOR EXPANSION	48%
STORAGE	54%

LND and R & D Lab Design Survey, 2010

Why...

"...labs shy away from “green building” because they fear it will be significantly more expensive than conventional building design."

But...

"...if they had no budget constraints, they would place a “high” priority on energy-efficient HVAC (47%) and lighting (53%). These user-side respondents also rated energy-efficient systems (52%) as very important features in any lab environment."

Aspiration.

"... [sustainability] brings the need to be open-minded and experimental regarding new technologies that may not have been tried in laboratories before."

33% ?

Do Less. With Less. Get More.

Understand your Science. Know your resources. Build what you need.

Water. Power. Air.

*SOME TECH - ENGINEERED SYSTEMS

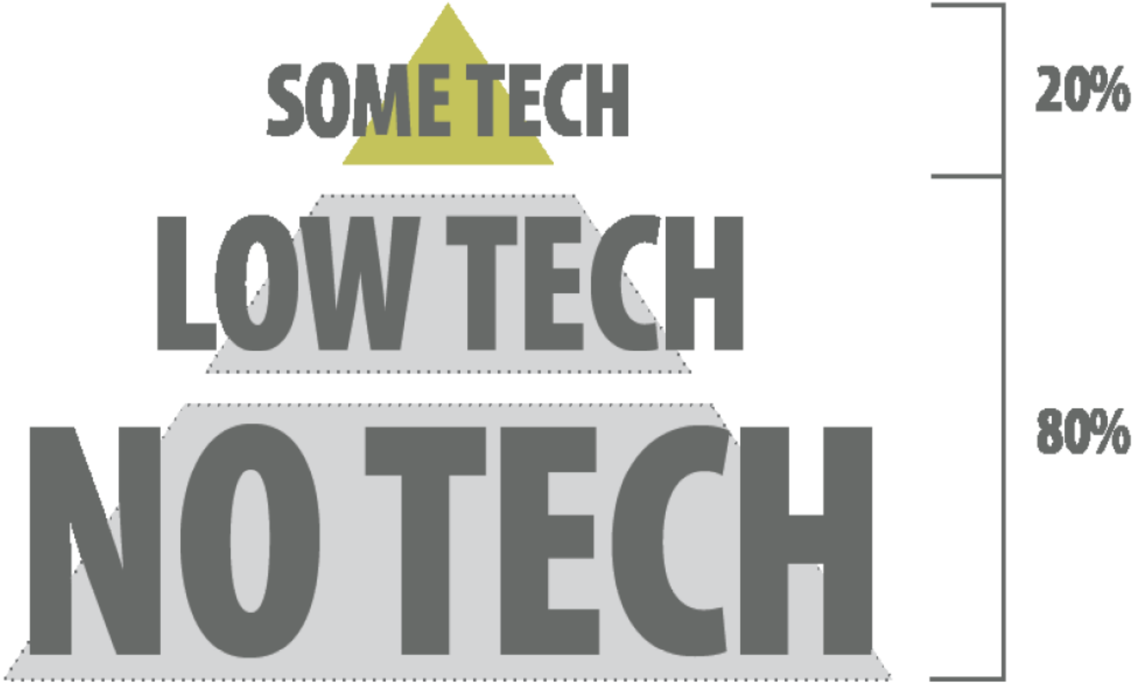
- Heating and Cooling Equipment
- Lighting Equipment

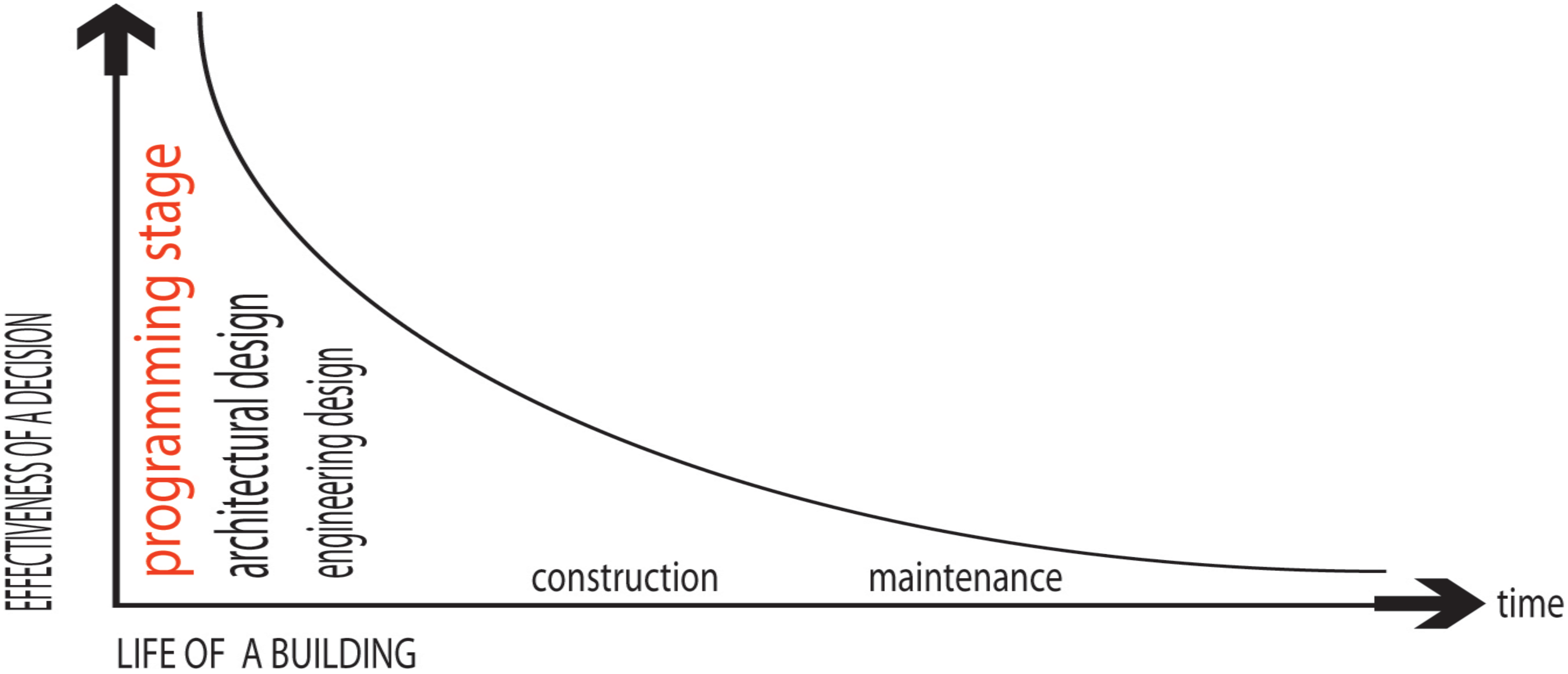
LOW TECH - PASSIVE SYSTEMS

- If you need energy, maximize what is available; wind and sunlight
- Building Orientation

NO TECH - LOAD AVOIDANCE

- Minimize Mechanical Engineering
- Minimize Electrical Engineering




EFFECTIVENESS OF A DECISION
programming stage
architectural design
engineering design
construction
maintenance
time
LIFE OF A BUILDING

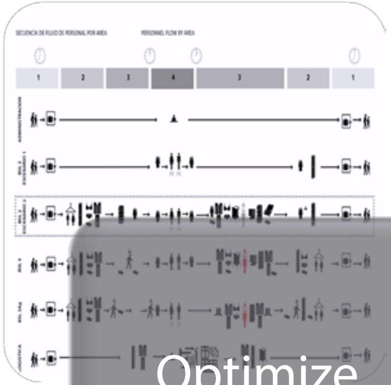
Sustainability System

Science and Procedures

UNDERSTAND YOUR SCIENCE.

People First

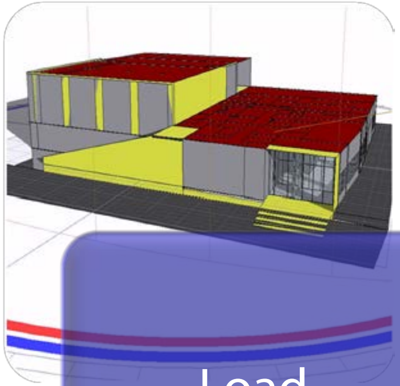
KNOW YOUR RESOURCES.



Optimize Work Flows

BUILD WHAT YOU NEED.

Sustainability System



Load Avoidance

NO TECHNOLOGY.

Passive Systems

LOW TECHNOLOGY.

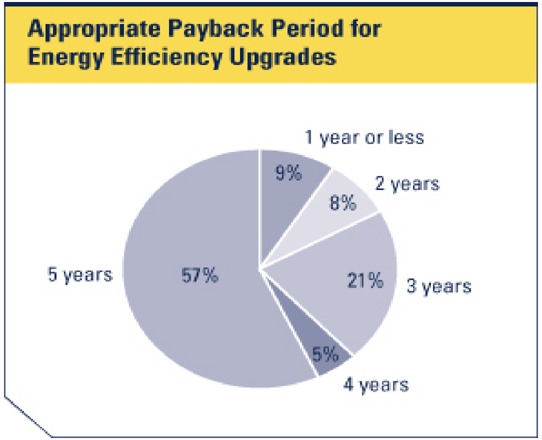
Engineered Systems

SOME TECHNOLOGY.

Basic Payback Analysis

A Systematic Approach

A survey company (CIBEUS) recently asked what an appropriate payback period would be for an organization to consider undertaking an energy efficiency retrofit of any kind. The average payback period considered appropriate for the commercial and institutional building sector as a whole is 4.8 years. Duration naturally depends on the type and content of work. Overall, 57% of owners would consider doing work with a payback period of 5 years or more. A mere 9% would consider it only if the payback period was 1 year or less.



Life Cycle Cost Analysis

Photo-voltaics, new appliances, and modern technologies tend to cost more money. Most green buildings cost a premium of <2%, but yield 10 times as much over the entire life of the building.
Kats, Greg, Leon Alevantis, Adam Berman, Evan Mills, Jeff Perlman. The Cost and Financial Benefits of Green Buildings, November 3rd, 2008

In regards to the financial benefits of green building, “Over 20 years, the financial payback typically exceeds the additional cost of greening by a factor of 4-6 times. And broader benefits, such as reductions in greenhouse gases (GHGs) and other pollutants have large positive impacts on surrounding communities and on the planet.”
Kats, Gregory. (September 24, 2010). Costs and Benefits of Green Buildings [Web Log Post].

Life Cycle ~~Cost~~ Analysis

A life cycle assessment (LCA) can help avoid a narrow outlook on environmental, social and economic concerns by assessing a full range of impacts associated with all cradle-to-grave stages of a process: from extraction of raw materials through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. Impacts taken into account include (among others) embodied energy, global warming potential, resource use, air pollution, water pollution, and waste.

New Modeling Technologies

New technologies available to model the performance of engineering systems.

EE4

New Modeling Technologies

EE4 MODELLING GUIDE VERSION 1.7

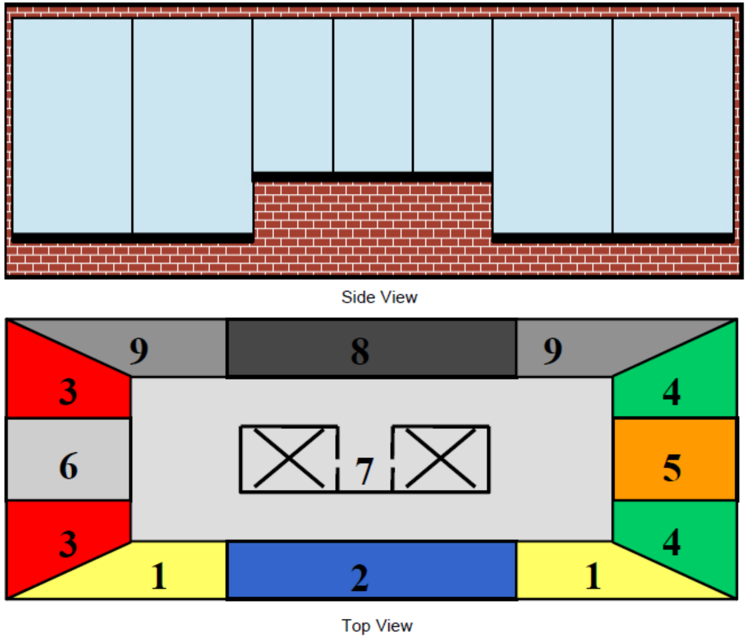


Figure 2-2 - Grouping Zones According to Heating and Cooling Loads

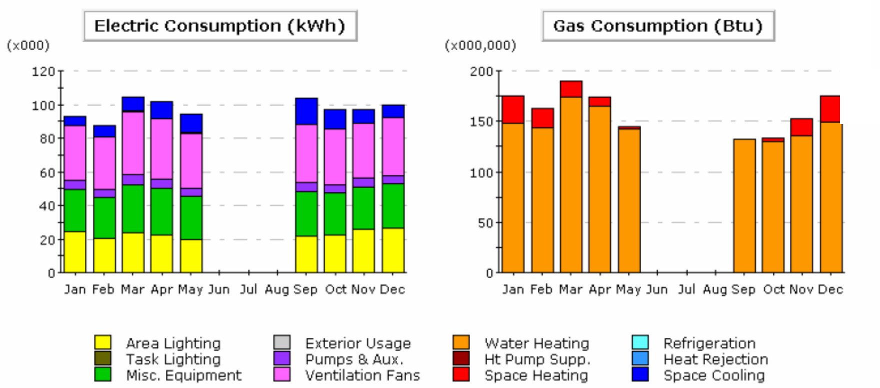
Natural Resources Canada
Ressources naturelles Canada

ecoENERGY
an ecoACTION Initiative

CAN-QUEST

New Modeling Technologies

Natural Resources Canada · Ressources naturelles Canada



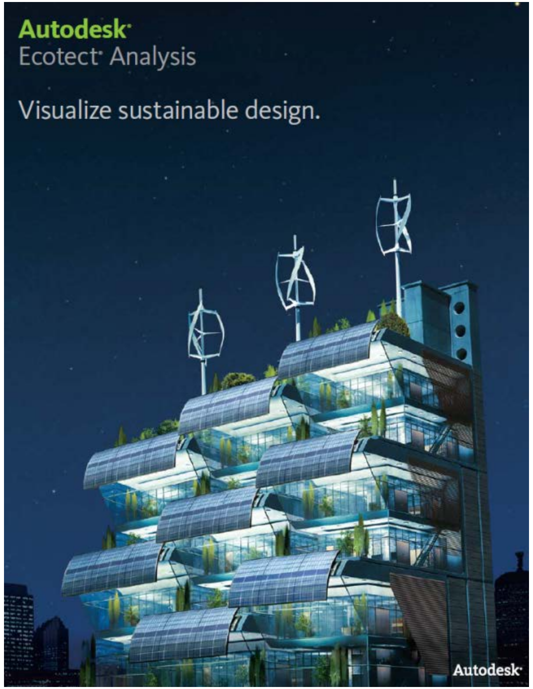
Electric Consumption (kWh x000)

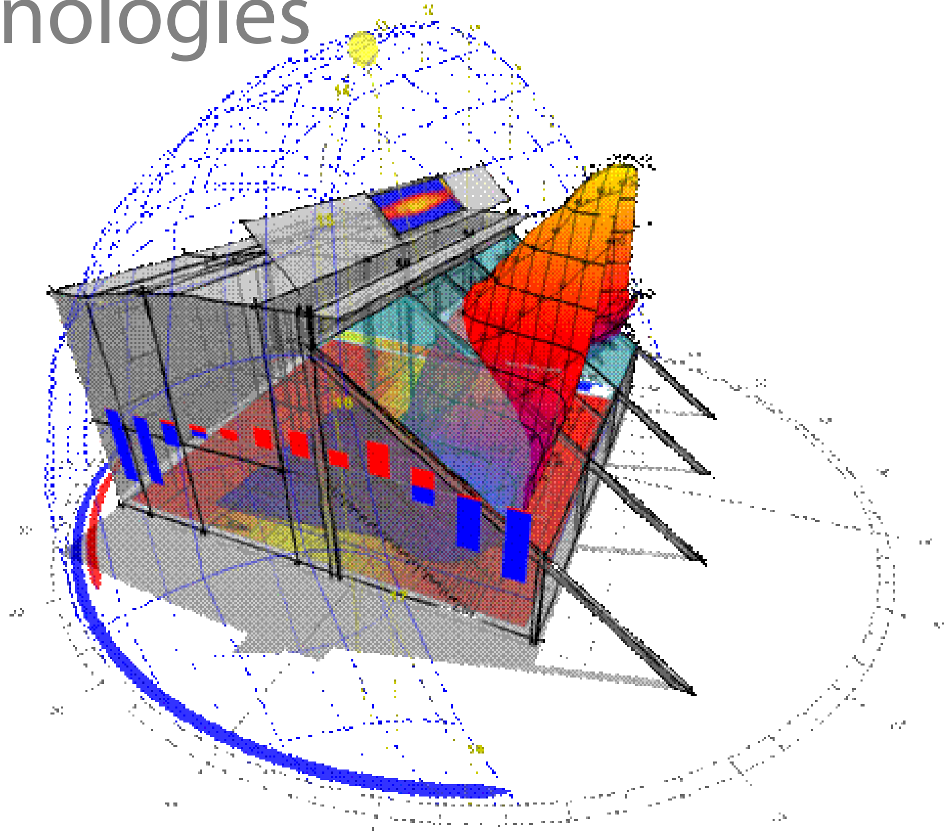
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	5.41	7.10	8.59	10.08	11.03	-	-	-	15.30	11.65	7.99	7.37	84.53
Heat Reject.	0.07	0.09	0.13	0.25	0.30	-	-	-	0.45	0.28	0.15	0.08	1.78
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	32.70	31.07	37.61	35.97	32.70	-	-	-	34.34	32.70	32.70	34.34	304.14
Pumps & Aux.	4.93	4.75	5.73	5.53	5.11	-	-	-	5.38	5.10	5.00	5.24	46.76
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	25.22	23.96	29.01	27.75	25.22	-	-	-	26.49	25.22	25.22	26.49	234.59
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	24.58	20.62	23.53	22.25	19.94	-	-	-	21.78	22.11	25.79	26.20	206.80
Total	92.92	87.59	104.60	101.82	94.30	-	-	-	103.73	97.07	96.86	99.70	878.59

CAN-QUEST is a Canadian adaptation of eQUEST, the popular building energy simulation software from the United States.

New Modeling Technologies

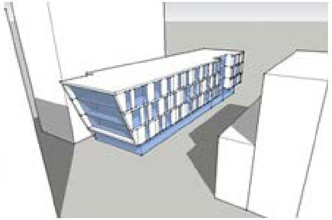
Ecotect Analysis





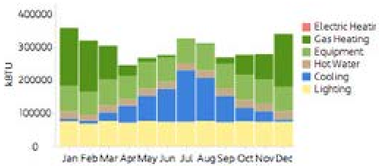
New Modeling Technologies

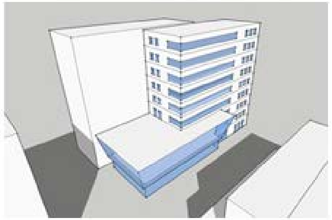
Sefaira



Energy Use	
3,825,008 kBTU	78 kBTU/ft2
Water Use	
712,880 gal	8 gal/person
CO_2 Use	
1,128,831 lbsCO_2	4,515 lbsCO_2/person

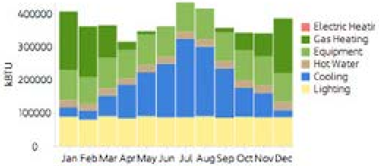
Energy Footprint (kBTU)

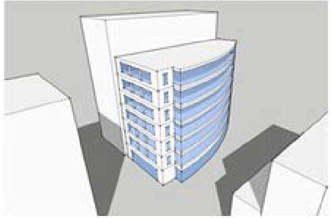




Energy Use	
4,740,160 kBTU	81 kBTU/ft2
Water Use	
712,880 gal	8 gal/person
CO_2 Use	
1,472,106 lbsCO_2	5,888 lbsCO_2/person

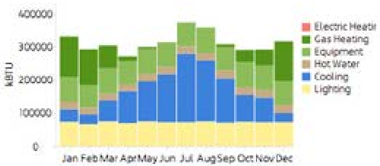
Energy Footprint (kBTU)





Energy Use	
4,005,299 kBTU	84 kBTU/ft2
Water Use	
712,880 gal	8 gal/person
CO_2 Use	
1,260,151 lbsCO_2	5,041 lbsCO_2/person

Energy Footprint (kBTU)



TRNSYS

New Modeling Technologies

New Modeling Technologies

Green Building Studio

Some Tech: Passive & Active Approaches

To Improve Overall Building Energy Performance

Scrutiny of Air Change Rates
Zone Definition & Control
Demand Based Ventilation
Heat Reclamation
Source Capture, Source Control – Ventilated Benches and Snorkels
Concentration of Heating & Cooling Loads for Better Control
Low Flow Fume Hoods
Energy Star Equipment
Chilled Beams
Open Concept Planning
Flexible Laboratory Casework and Overhead Service Distribution
Commissioning & Re-commissioning
Integrated Design Process

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Scrutiny of Air Change Rates

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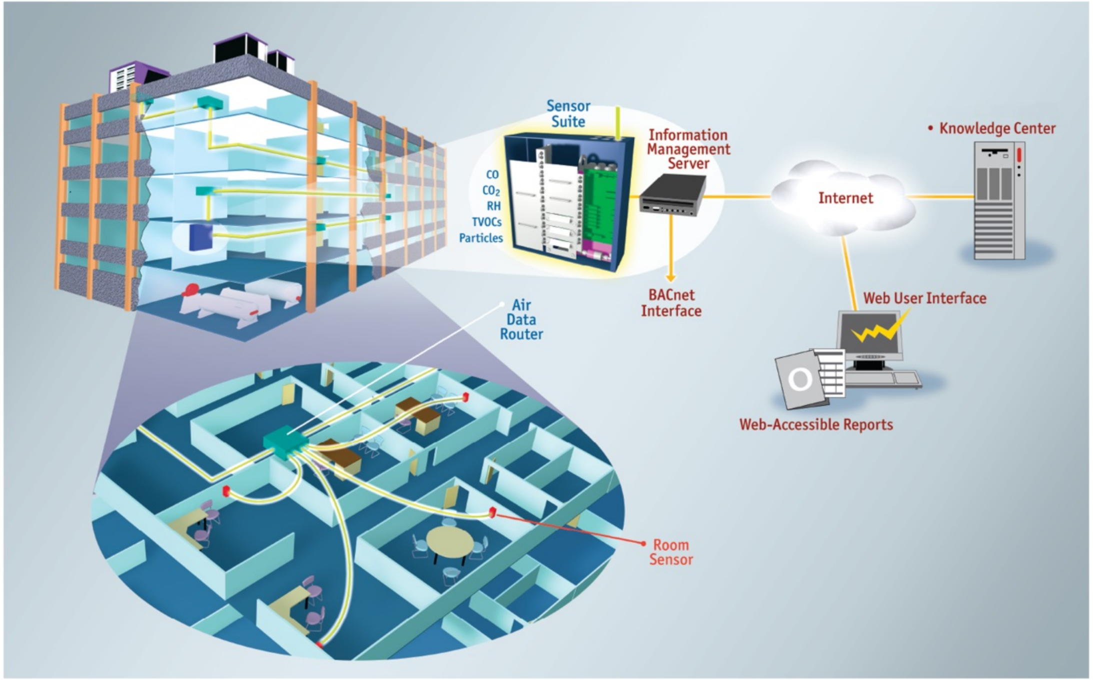
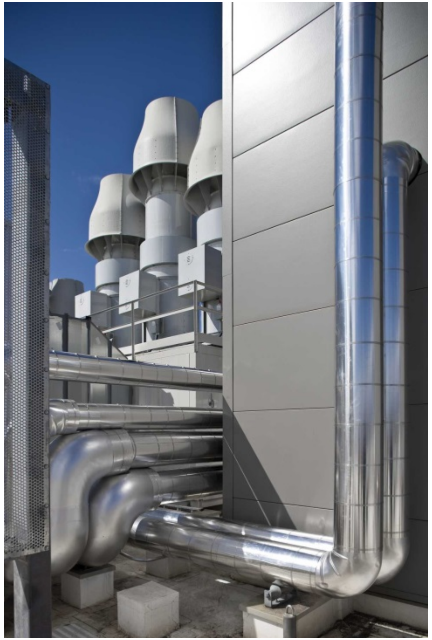
Demand Based Ventilation



Some Tech: Passive & Active Approaches

Heat Reclamation



Some Tech: Passive & Active Approaches

Source Capture, Source Control

Some Tech: Passive & Active Approaches

Concentration of Heating & Cooling Loads for Better Control

Some Tech: Passive & Active Approaches

Low Flow Fume Hoods

Some Tech: Passive & Active Approaches

Energy Star Equipment

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Some Tech: Passive & Active Approaches

Chilled Beams

Some Tech: Passive & Active Approaches

Open Concept Planning

Some Tech: Passive & Active Approaches

Flexible Laboratory Casework and Overhead Service Distribution

Some Tech: Passive & Active Approaches

Commissioning & Recommissioning

Some Tech: Passive & Active Approaches

Integrated Design Process

On the outside we are a design-forward national architecture practice with focused expertise.

Inside we embody the Canadian principles of honesty, diversity, practicality and regionalism.

12 LOCATIONS / 300 EMPLOYEES

National Sectors
Health Care
Science and Technology
Security and Defence
Sports and Entertainment
Hospitality
Transportation

Regional Sectors
Cultural
Commercial
Educational
Historical
Residential
Industrial