Sustainable Campus Development in a Challenging Construction Environment

Presented by

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UNIVERSITY OF CALGARY

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Presentation Outline

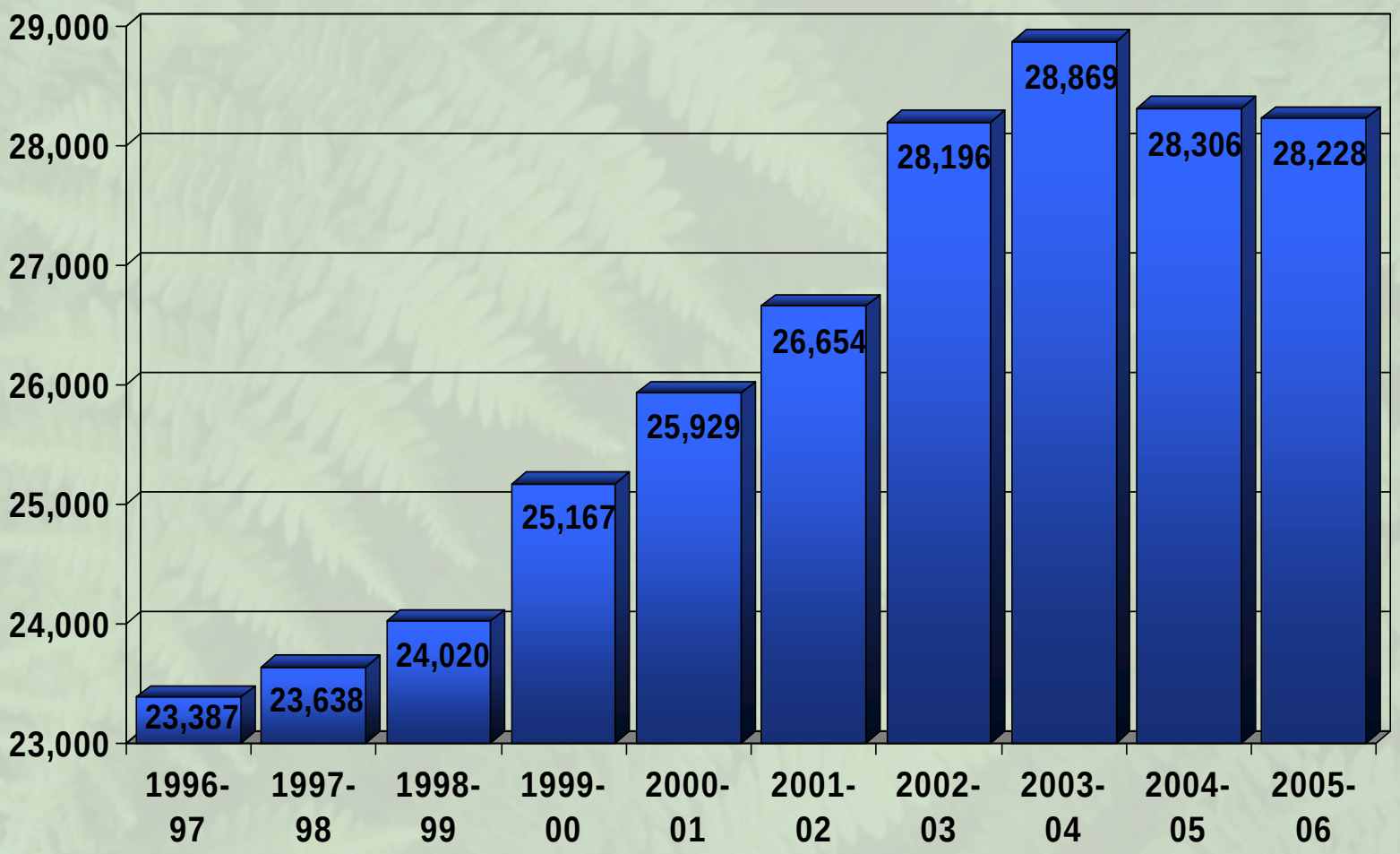
- The University of Calgary
  - The Campus & Utilities
  - Sustainability
    - Sharpening our Focus
    - Impact of Buildings
    - UofC Plan
  - Major Capital Plan
- "Real World" Issues
  - Central Plant Limitations
  - "Edifice" Complex
  - GHG Footprint
  - Electrical Deregulation
  - The Economy & Construction Escalation
- The Outcome
  - The Good News
  - The "Other" News
  - Lessons Learned

The University of Calgary – Overview

- 40th anniversary in 2006
- ~710 acres
- 8.5 million square feet
- ~115 structures on 8 sites
- 5,000+ faculty & staff

The Campus and Downtown Calgary

Enrollment:
Full Time Equivalent Students

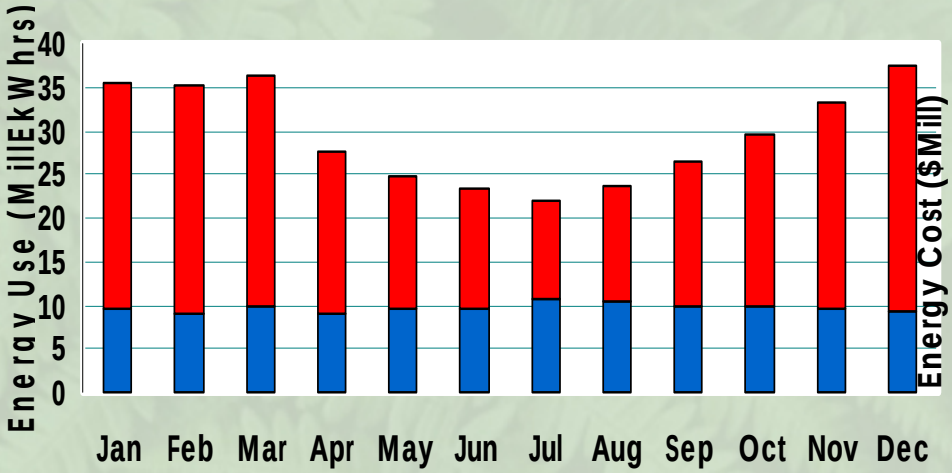


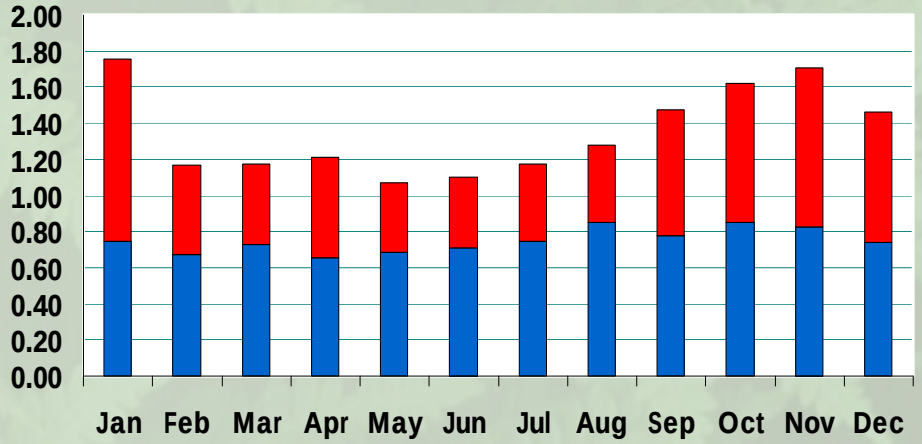
The University of Calgary - Utilities

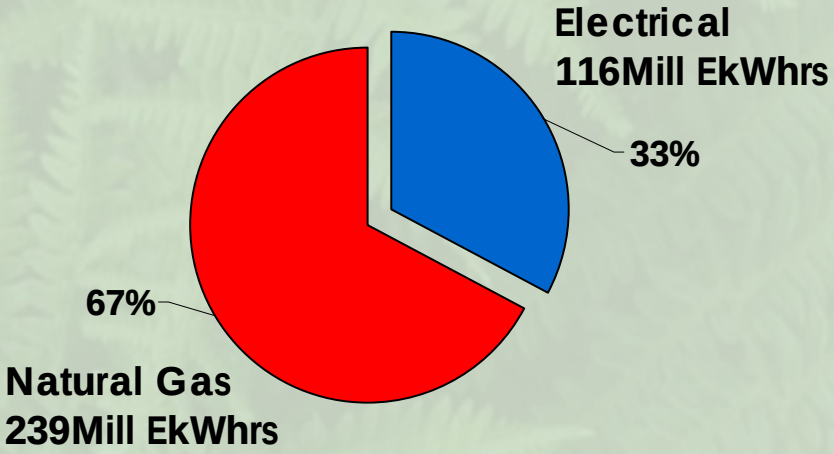
Central Heating & Cooling Plant (CHCP)

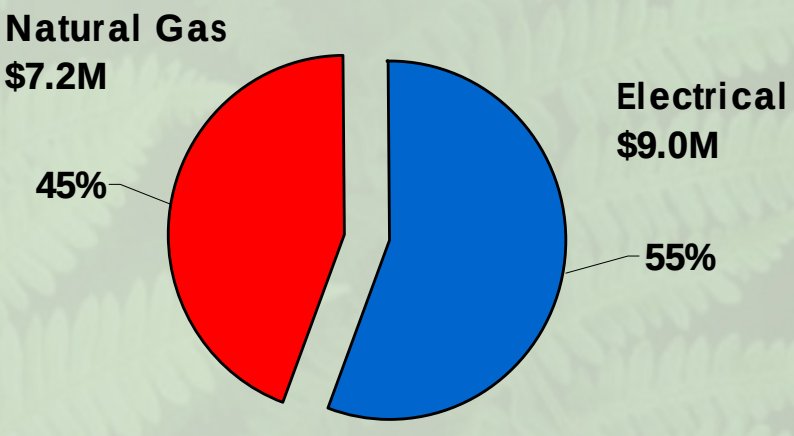
- 22 MW peak electric demand
- 210 MMBTU/hr peak thermal demand
- 4 gas boilers, 325 MMBTU/hr
- 4 chillers, 9000 tons
- 8km ‘walk-in’ utility tunnels

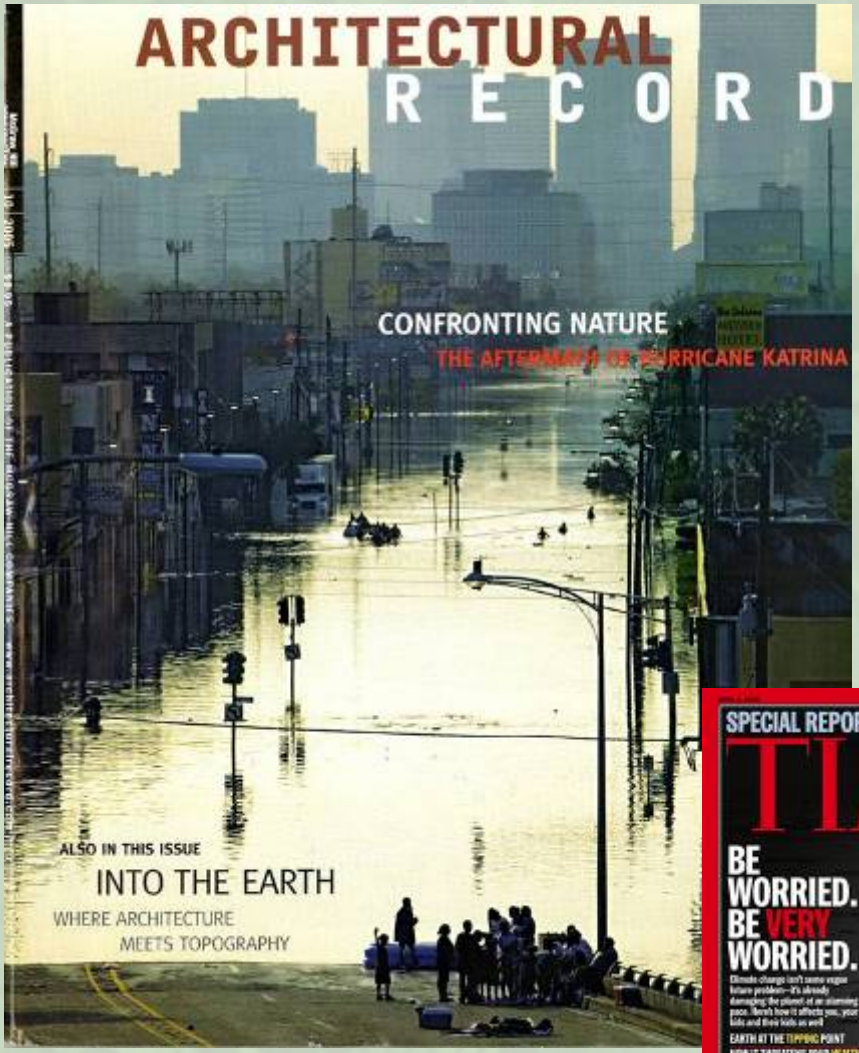
Annual Energy Use





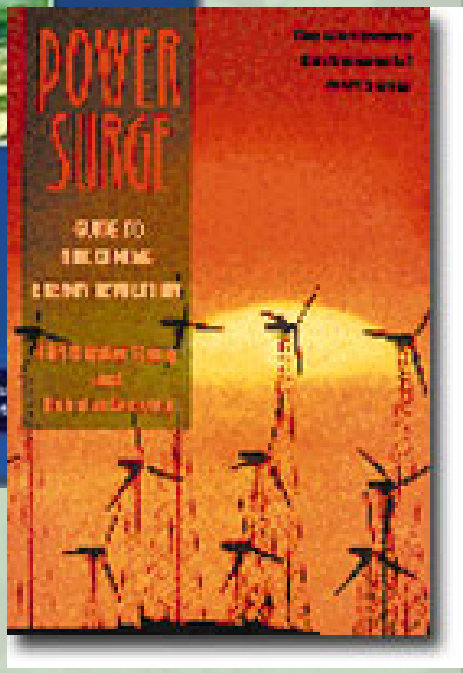





ARCHITECTURAL
RECORD
CONFRONTING NATURE
THE AFTERMATH OF HURRICANE KATRINA
ALSO IN THIS ISSUE
INTO THE EARTH
WHERE ARCHITECTURE
MEETS TOPOGRAPHY

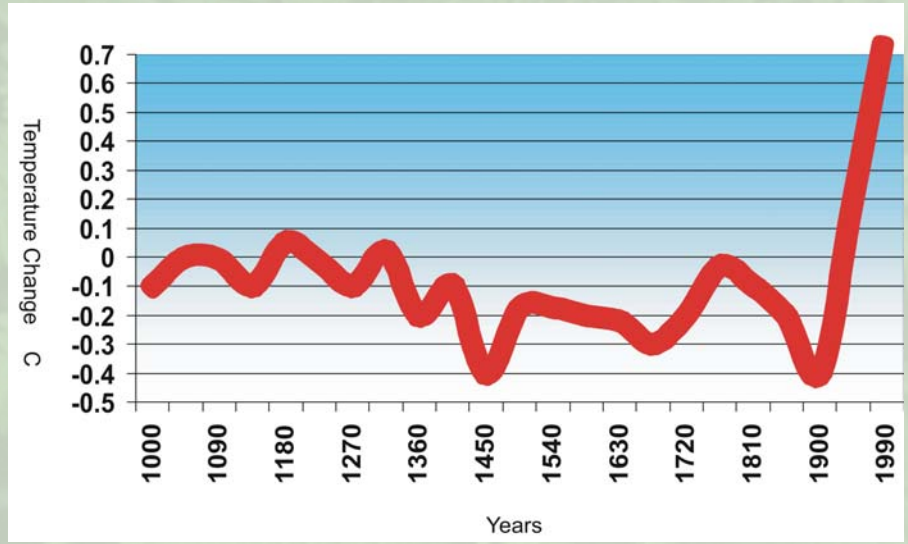

Climate Change 2001
The Scientific Basis

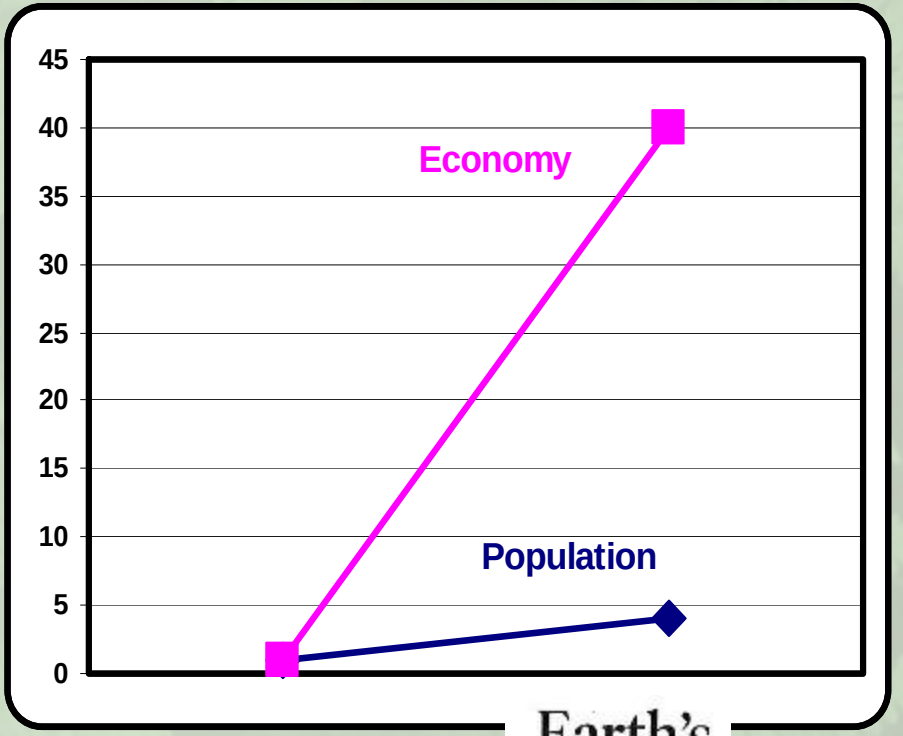

SPECIAL REPORT GLOBAL WARMING
TIME
BE WORRIED. BE VERY WORRIED.

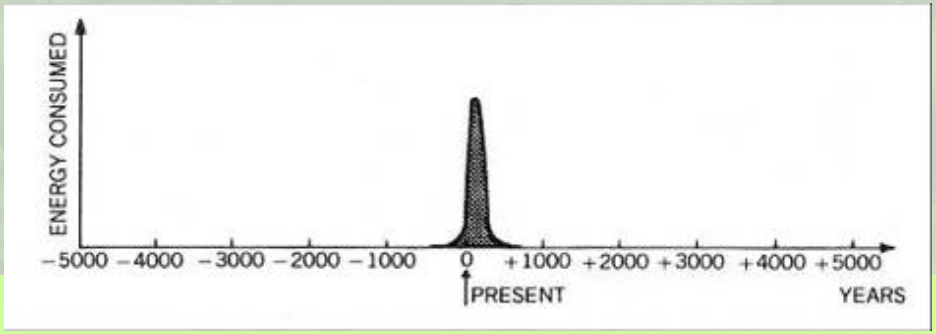

POWER SURGE

Sharpening our focus on global warming & sustainability

IPCC Clear on Human Contribution







Earth's CO_2 levels soaring

Greenhouse gases collecting faster than expected

Limits to Growth Analogy

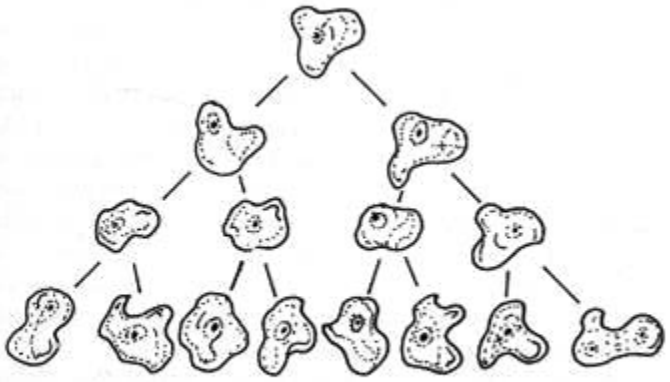


Figure 2.8a The exponential growth of amoeba.

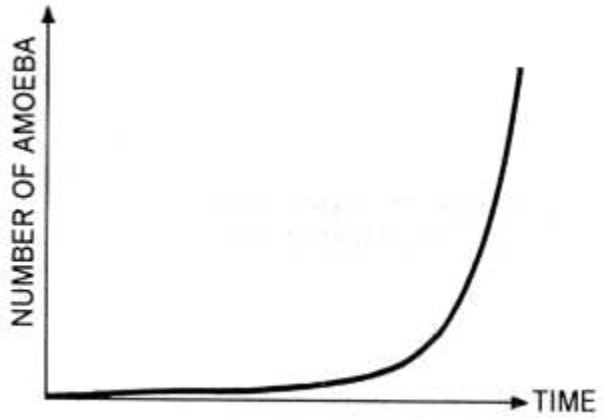


Figure 2.8b The theoretical exponential growth of amoeba.

If amoeba double every minute and we put them in a bottle (limited resource) that will take them 10 hours to fill, how long does it take to use up 3% of the bottle?

A. 18 minutes (3% of 10hrs)
B. About 1 hour
C. 5 hours and 30 minutes
D. About 8 hours
E. 9 hours and 55 minutes

Limits to Growth Analogy

Time	Percentage of bottle used up	
10:00	100 percent	
9:59	50 percent	
9:58	25 percent	
9:57	12 percent	
9:56	6 percent	
9:55	3 percent	Answer

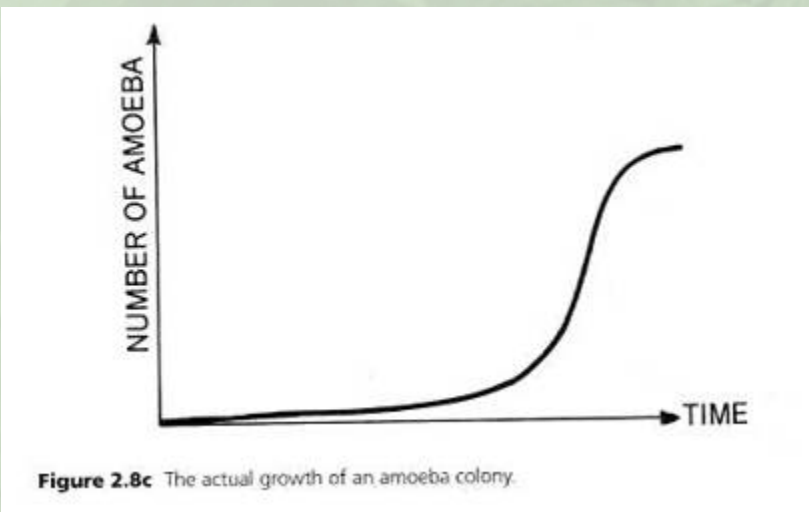


Figure 2.8c The actual growth of an amoeba colony.

If the amoeba find three more bottles then they increase their resource to 400%. How much additional time does this buy them?

Limits to Growth

"Our environmental appetite has potential to devastate civilization as we know it"

- Easter Island
- Sumer
- Rome
- Maya

"Civilizations often fall quite suddenly – a House of Cards effect.."

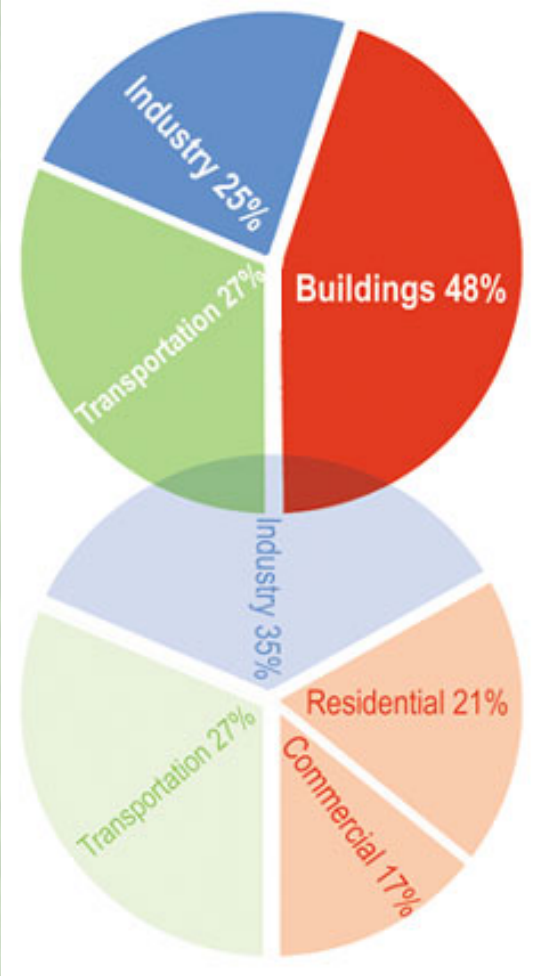
"Now is our last chance to get the future right"

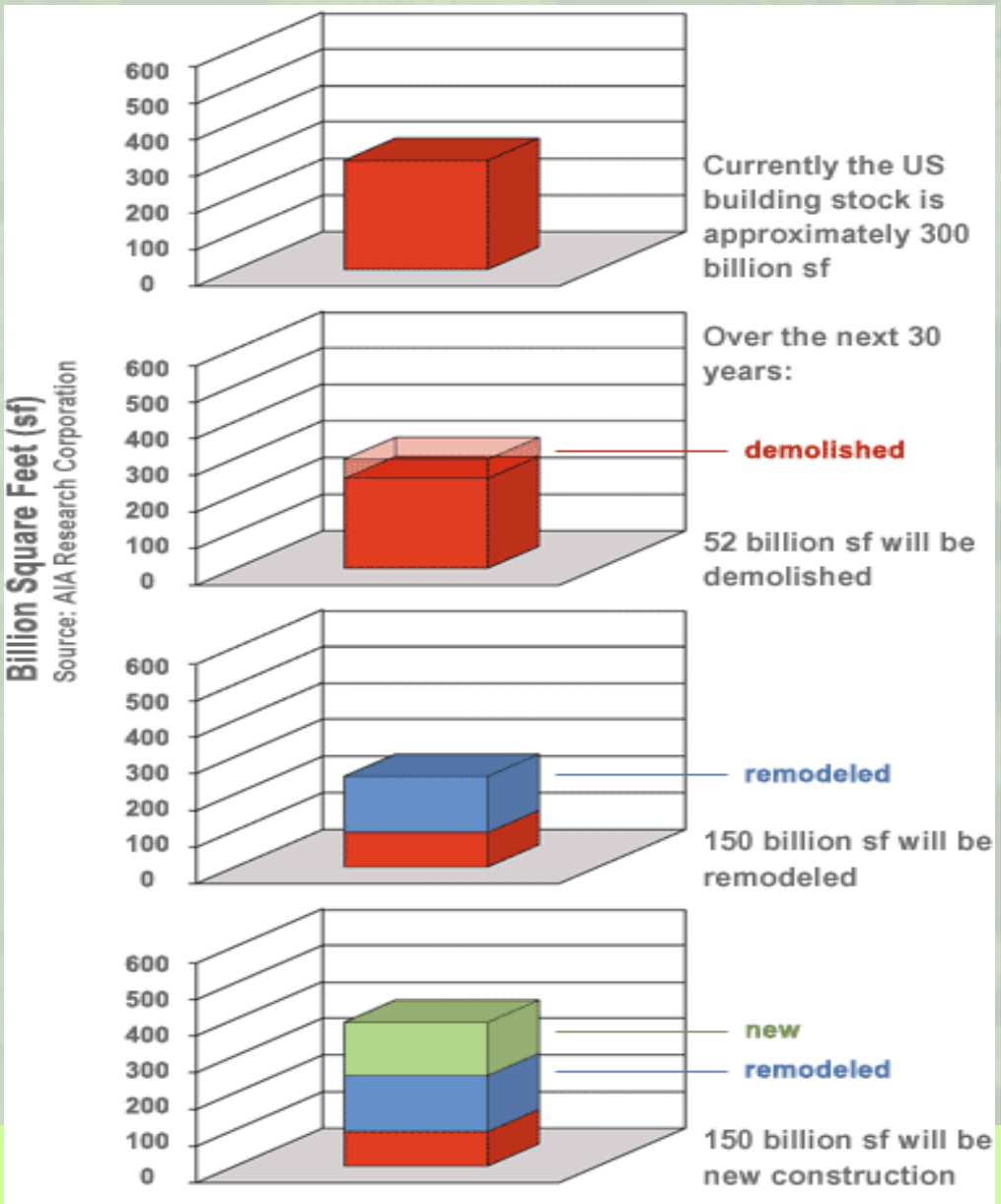
Environmental Impact of Buildings*

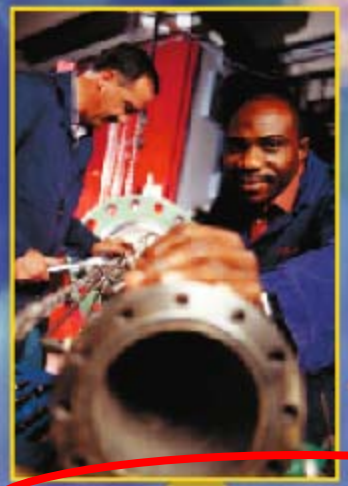
- 65.2% of total U.S. electricity consumption
- > 36% of total U.S. primary energy use
- 30% of total U.S. greenhouse gas emissions
- 136 million tons of construction and demolition waste in the U.S. (approx. 2.8 lbs/person/day)
- 12% of potable water in the U.S.
- 40% (3 billion tons annually) of raw materials use globally

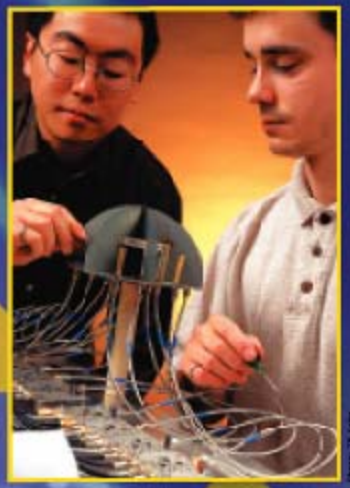
* Commercial and residential

The Impact of Buildings









Understanding Human Behaviour, Institutions and Cultures

- Public Policy Studies
- Strategic and International Studies
- Language Learning and Literacy
- Creativity and Innovation in the Arts

Advancing Health and Wellness

- Life and Medical Sciences
- [illegible]
- Health, Wellness and Human Performance
- Social Dimensions and Determinants of Health

Leading Innovation in Energy and the Environment

- Applied GeoScience
- Hydrocarbon Recovery and Upgrading
- Alternative Energy
- Energy and Environmental Systems and Modeling
- Business, Legal and Policy Aspects of Energy and the Environment

CORE PRINCIPLES

Enhancing the Learning Experience
Enhancing Research, Discovery and Creativity
Promotion of Multidisciplinary Inquiry
Return to Community

Creating Technologies and Managing Information for the Knowledge Society

- Quantum Information and Cryptography
- Wireless Communication, Location and Microelectronics
- Social Contexts for Technology

PROMINENCE & PROMISE

ACADEMIC PRIORITIES 2003/07

UNIVERSITY OF CALGARY

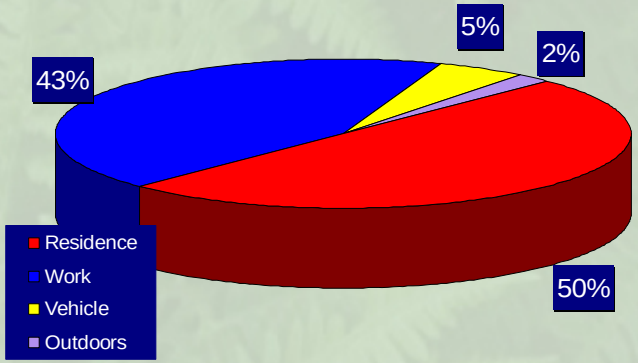
www.ucalgary.ca

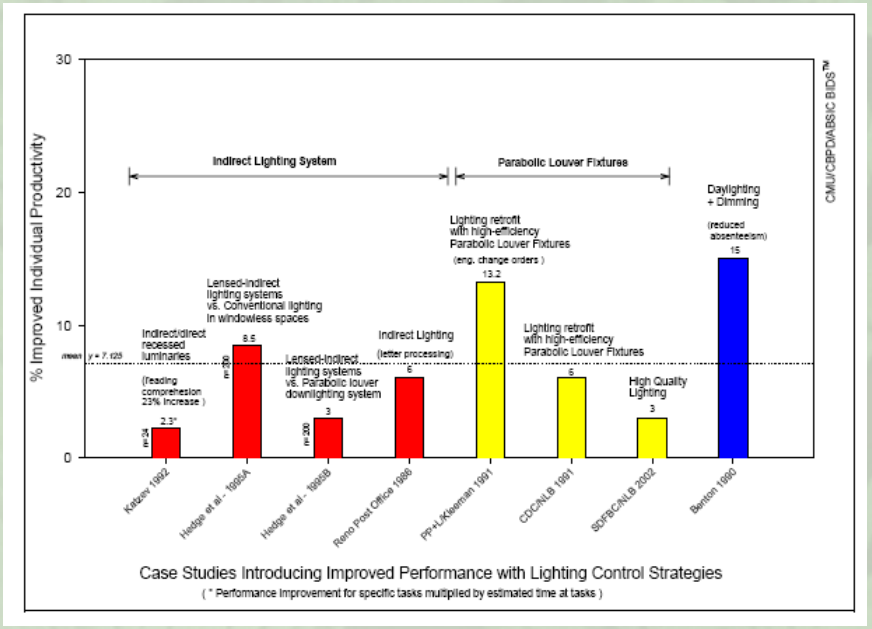
Cost Benefit for Improved Indoor Environmental Quality

Carnegie Mellon University
Center for Building Performance

Learning & Productivity gains:

- Lighting controls 7.1%
- Ventilation controls 1.8%
- Thermal controls 1.2%





Early Energy & Sustainability Initiatives

1995 - Environmental Policy adopted

1996 - Environmental Management Committee formed

First action plan to GHG Voluntary Challenge & Registry

1998 - Phase 1 of Energy Performance Contract

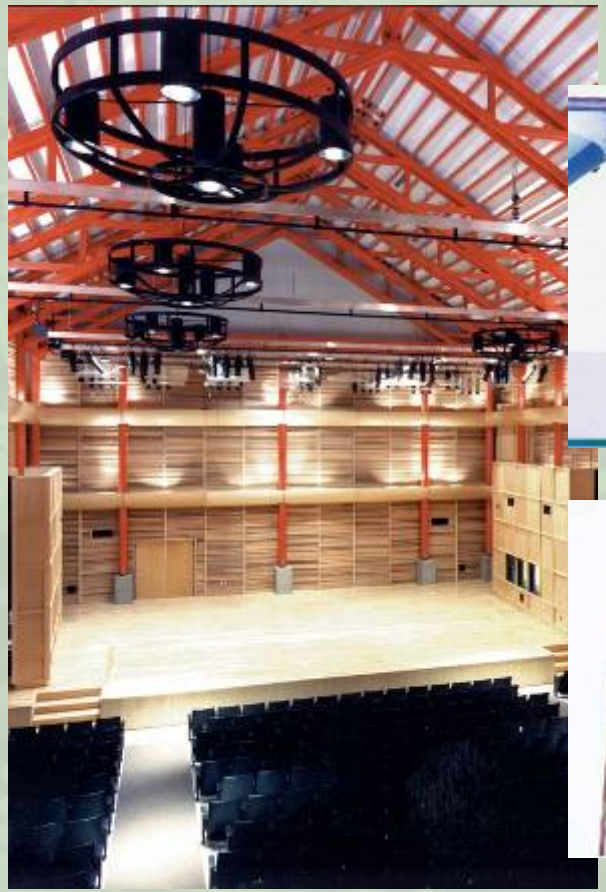
1999 - Consultant/benchmarking/guidelines/targets

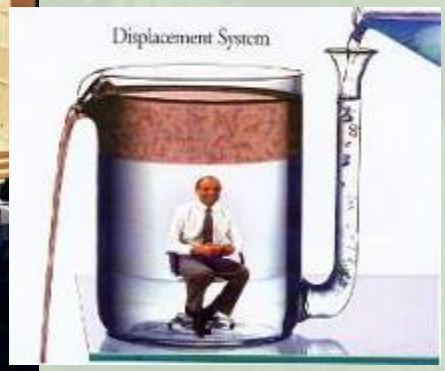
2000 - First annual environmental report

2001 - UofC ecological footprint established

http://www.ucalgary.ca/sustainability

Early Energy & Sustainability Initiatives





Rozsa Centre 2000
Displacement Ventilation

ICT 2001
In-Slab Radiant Cooling
Natural Ventilation

Project evolve

- Energy Sustainability & Building Technologies RFP
- 2 short listed proponents
- In place 2005
- 35% energy savings in 5 years, incl 8MW cogeneration
- Re-investment in energy & environment

Campus Sustainability

2005 - Launch of U-Bike free campus bicycling program

Launch of used cell phone and rechargeable battery recycling program

President commits to highest LEED Certification for all new projects

Completion of Phase I energy retrofits

2006 - Environment, Health, Safety and Sustainability Committee formed

Conclusion of one-year biodiesel pilot project

Creation of Sustainability Stewardship Working Group

Fumehood awareness program initiated

Bulb Eater purchased

2007 - Appointment of a Director of Sustainability

Establishment of an Office of Sustainability

Sustainability Gap Analysis – Business Plan

The Sustainability Portfolios


Land Planning & New Buildings


Existing Buildings


Water Management


Energy & Atmosphere


Operations & Maintenance


Transportation & Mobility


Participation, Collaboration & Communication


Solid Waste Management


Governance & Sr. Administration


Curriculum & Research


Health, Safety & Wellness


Procurement


Student Club Forum

Breadth of Involvement

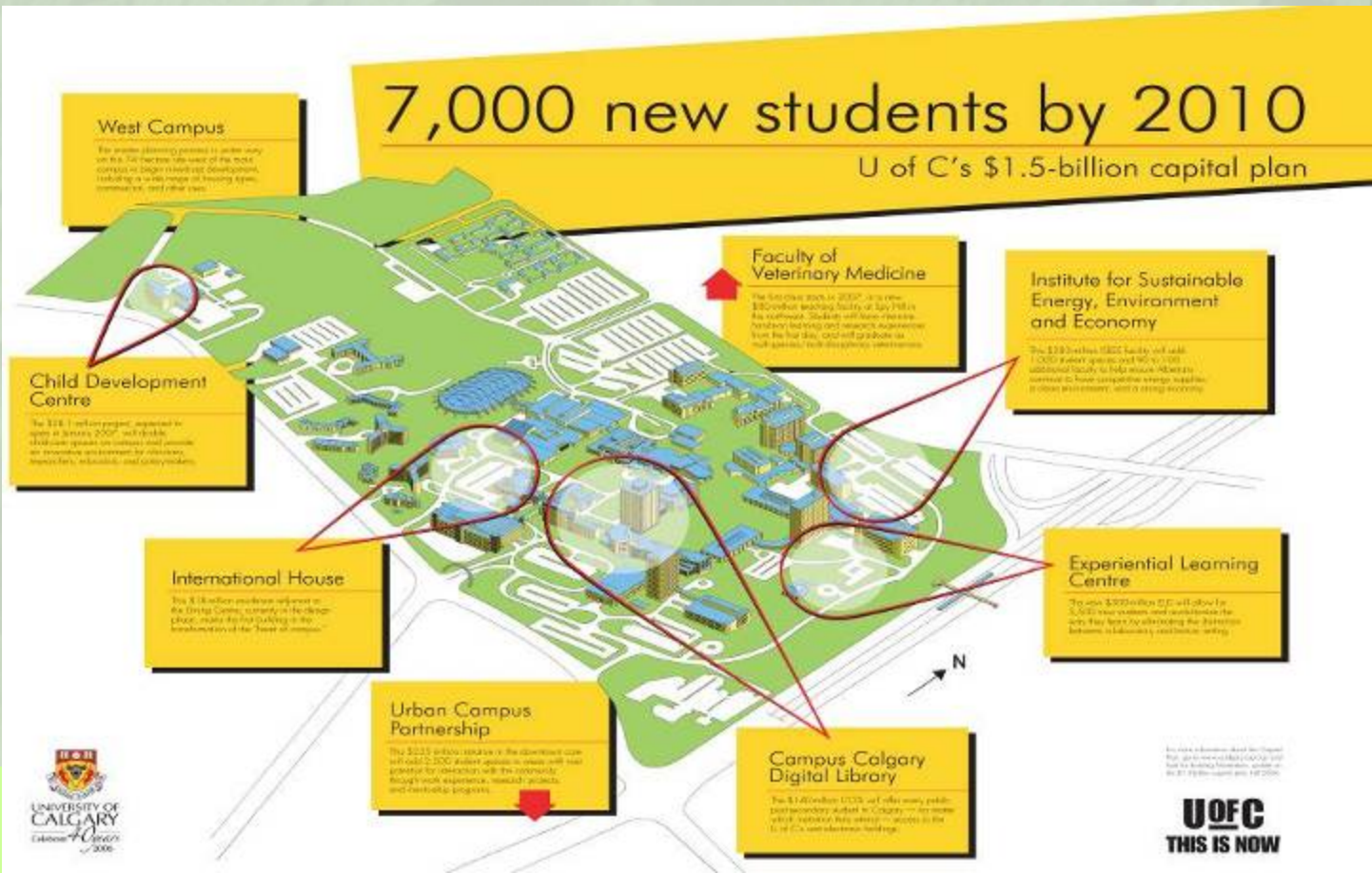
Sustainability Innovator Award
Received one of four Sustainability Innovator Awards by the 2008 College Sustainability Report Card. Sustainable Endowments Institute.

Why Does U of C Have a Platinum Objective?

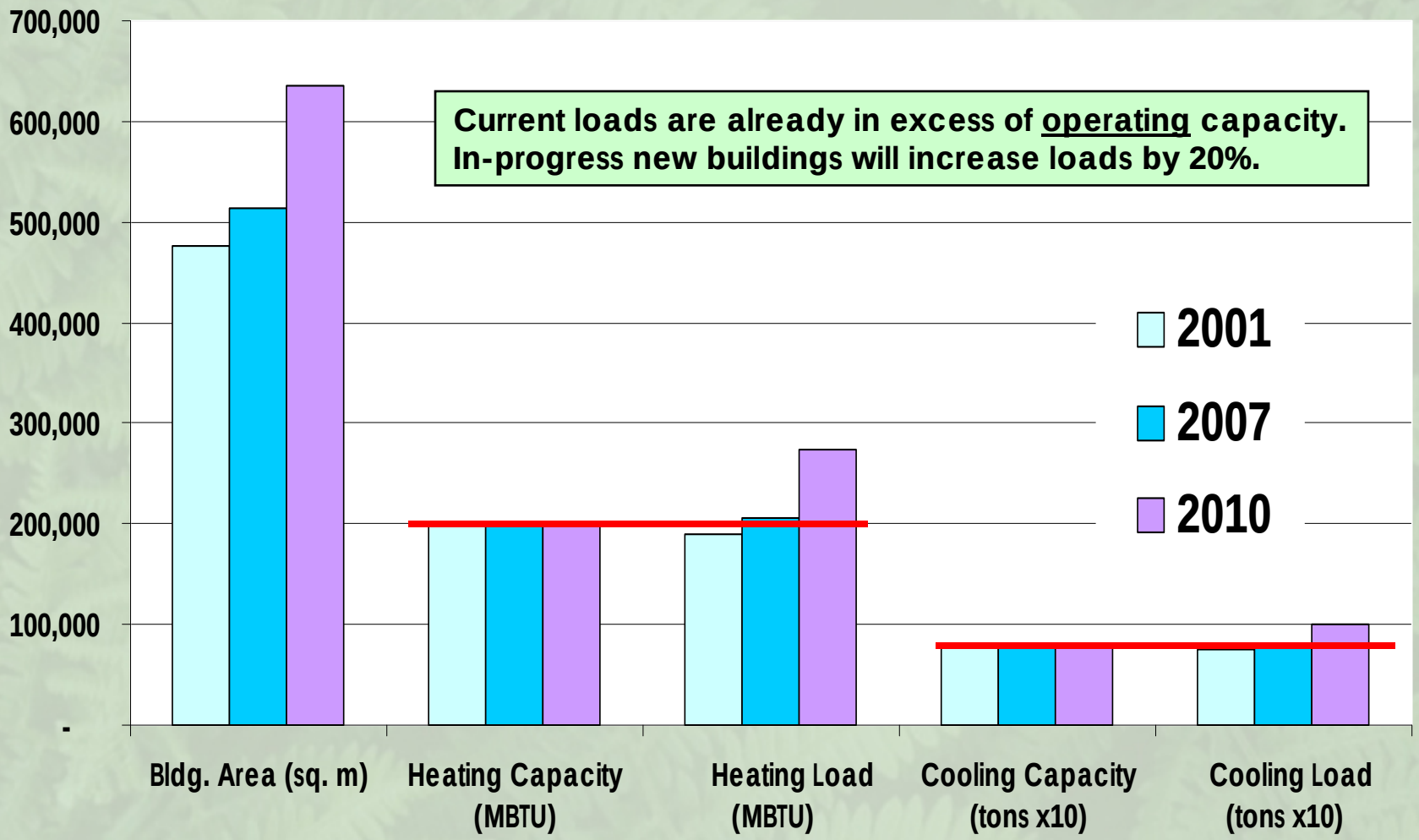
1. The University of Calgary, as a publicly funded institution, has a pivotal role to play in providing leadership in sustainability.
2. Investments in high performance LEED buildings provide:
    - Leading edge research and teaching opportunities for our faculty and students.
    - Reduced long term operating costs.
    - Improved indoor environments which dramatically enhance learning and productivity.

Major Capital Project Plan

- LEED® Platinum commitment
- “Design Matters” policy
  - Signature architects



Projected Thermal Loads



Equipment Life Cycle

Boiler #	Installed	**Age**
1	1966	**40**
2	1966	**40**
3	1966	**40**
4	1970	**36**

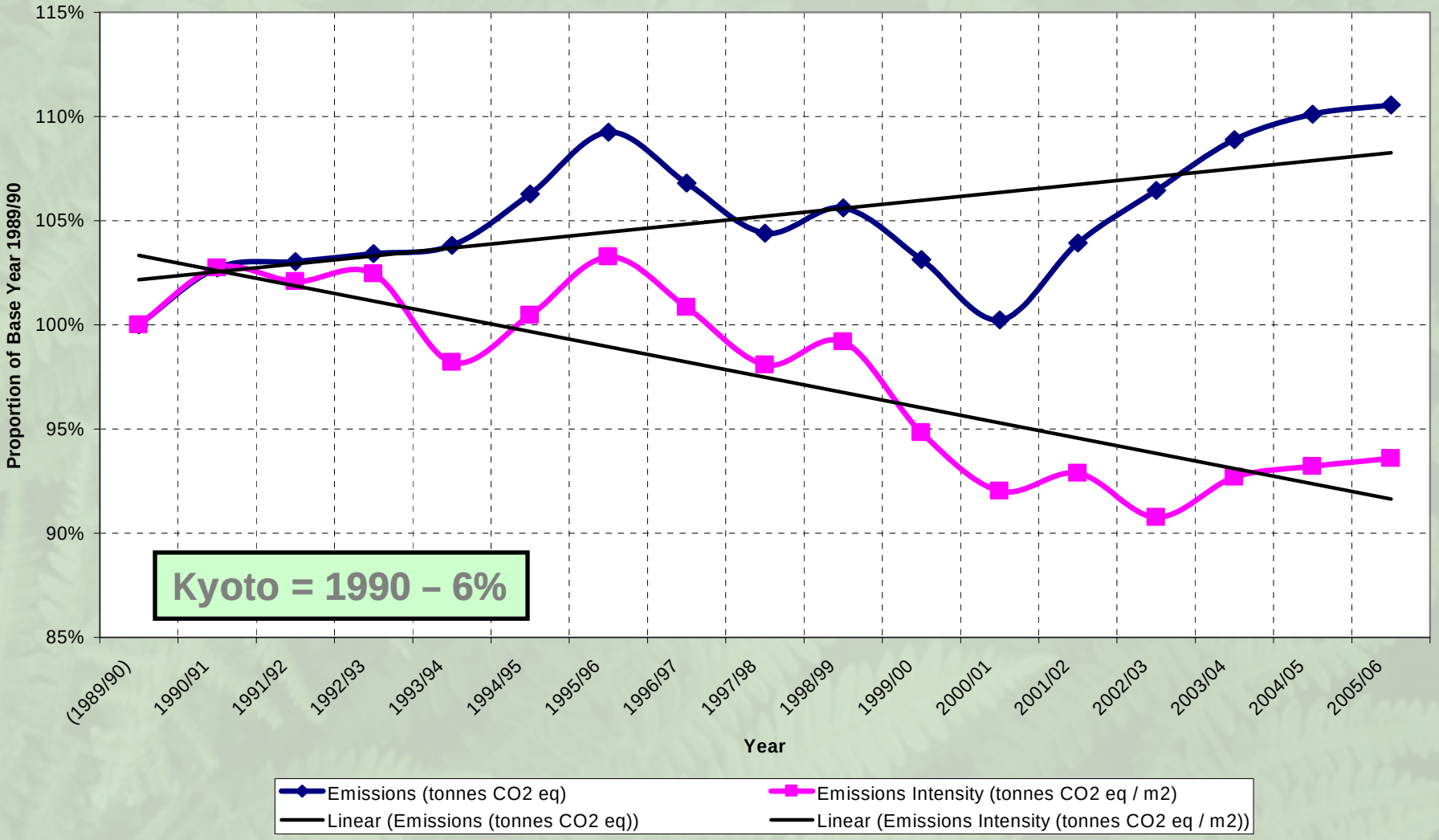
Chiller #	Installed	**Age**
1	1998	**8**
2	1998	**8**
3	1990	**16**
4	1972	**34**

“Edifice” Complex

- Space shortage
- Insufficient O&M funding
- Deteriorating FCIs
- Poor student satisfaction
- Limited terms for senior administration
- Separation of capital and O&M$

=>BUILD NEW BUILDINGS *!*

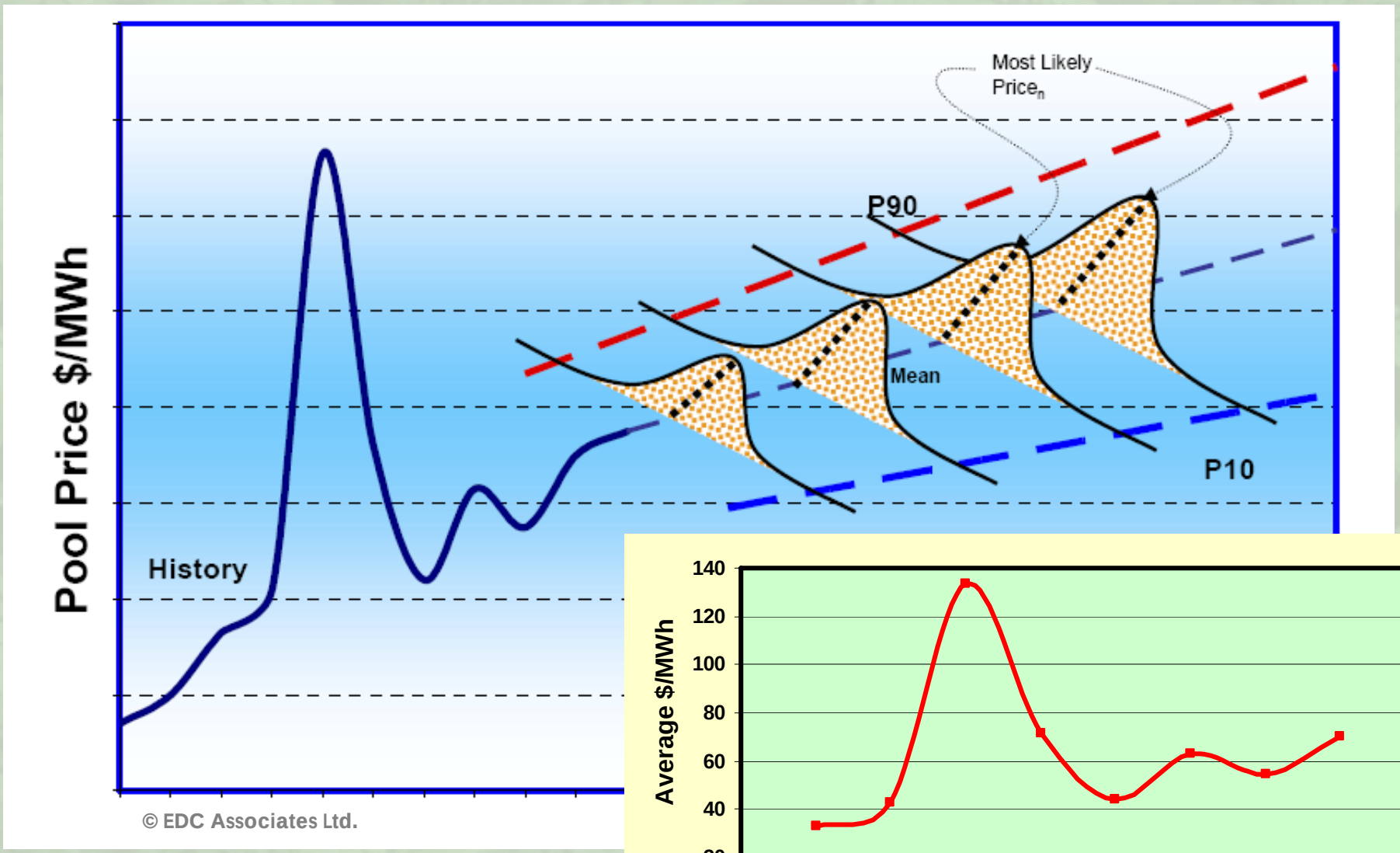
GHG Footprint - % Change



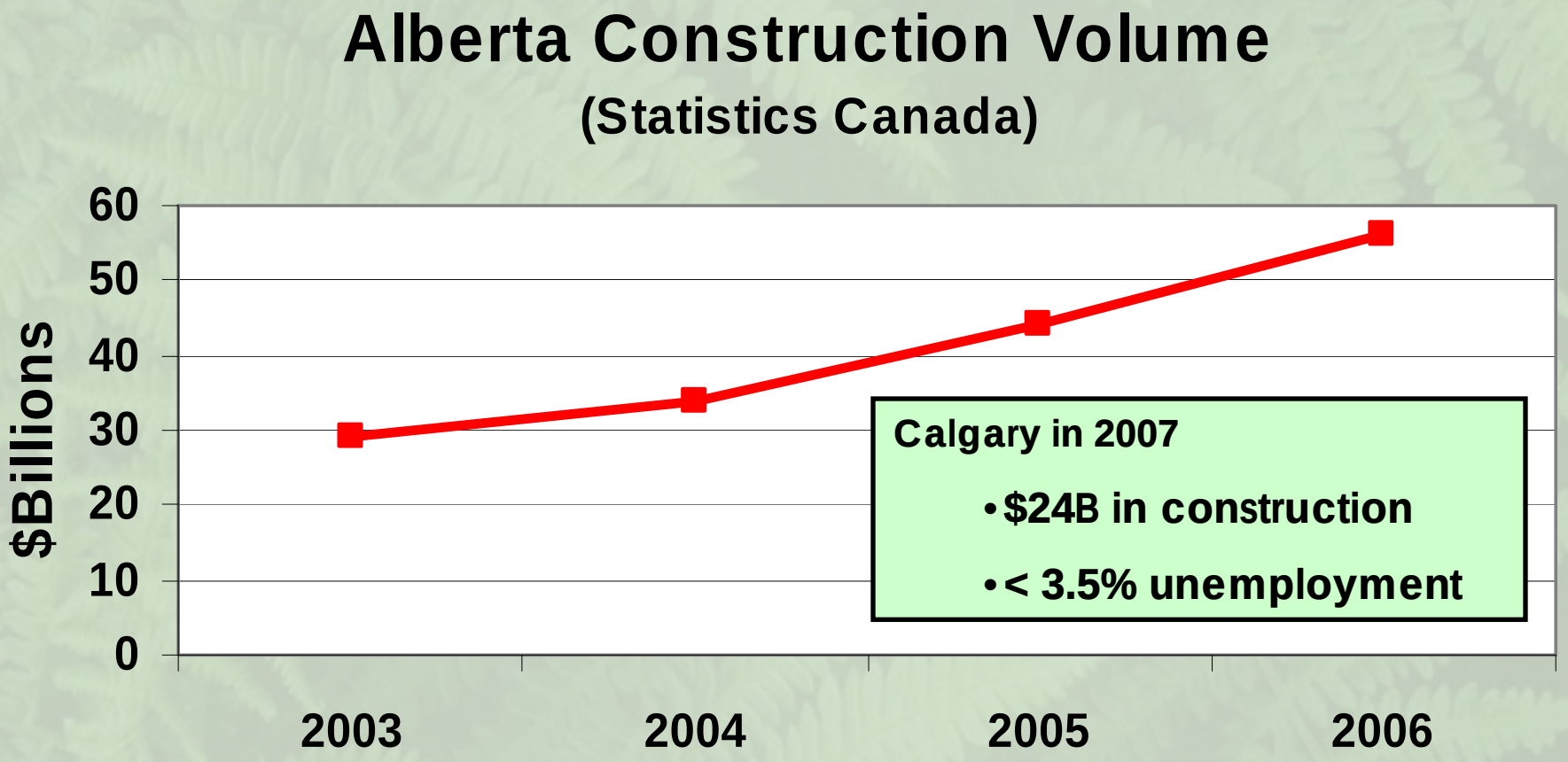
Electrical Deregulation

- Electric Utilities Act - effective Jan1, 2001
  - Deregulated
    - Generation (3 producers generate 90%)
    - Selling to consumers
  - Remains Regulated
    - Transmission & distribution
  - Alberta Electrical System Operator (AESO)
    - Acts as “power pool” between generators & retailers
    - Oversees operation of transmission system

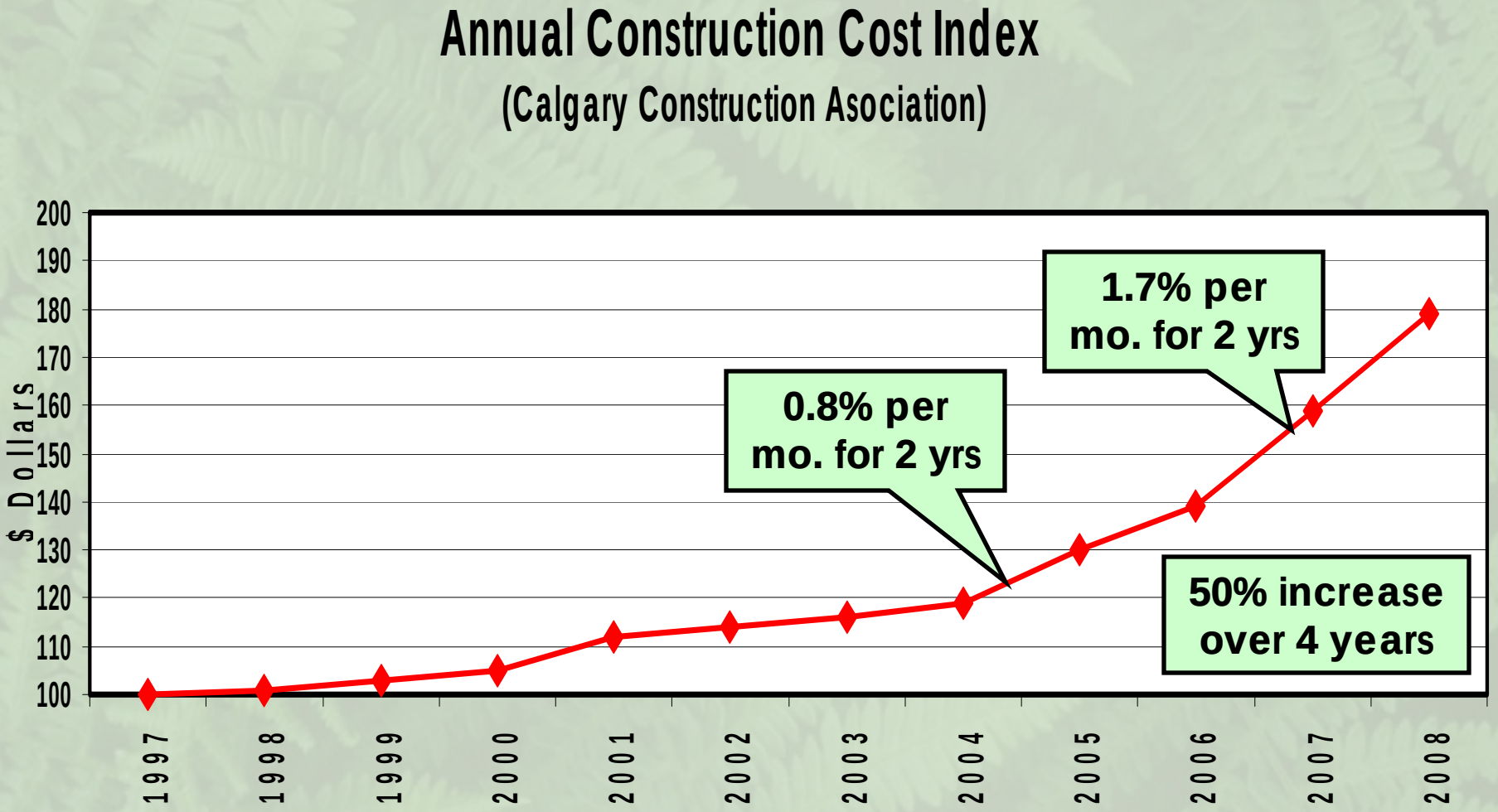
Electrical Deregulation



Economy & Construction Activity



Construction Costs & Escalation



Child Research Development Centre

a LEED® Platinum Building

- Occupancy sensors
- CO2 sensors
- Daylight sensors
- Underfloor air supply
- High-performance building envelope
- Storm water management
- Water efficient landscaping
- Photovoltaic array
- Energy consumption -60%
- All low-emitting materials
- Use of regional materials
- LEED tenant guidelines
- Green housekeeping
- Water reuse

BENEFITS

- $50,000 annual energy savings expected
- 59% Potable water conservation
- Fine tune building for optimized performance
- Living laboratory

Child Development & Research Centre

Water Use Sustainable Features

- **Water conservation & reuse**

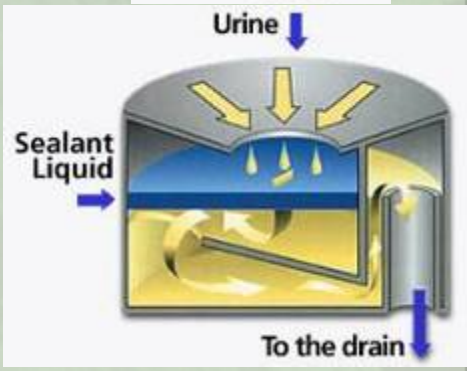
Fixtures;

Dual flush low flow toilets
Waterless urinal
Low flow faucets/showers
Infra-red sensors

Re-Use & Re-Cycling;

Non-potable water used in toilets

59% saving



CRDC Costs

LEED® Platinum
58 points achieved
Base building cost $23,000,000

LEED® Platinum premiums:

• **Access flooring**	**$745,000**
• **PV panels**	**$285,000**
• **High fly ash**	**$43,000**
• **Recycle bins**	**$12,000**
• **Certified wood**	**$42,000**
• Water reuse	$60,000
• Commissioning	$158,000
• **M & V**	**$100,000**
• **Mechanical misc.**	**$150,000**
TOTAL	**$1,595,000**

7% (6%)

Figure III-1. Level of Green Standard and Average Green Cost Premium

Level of Green Standard	Average Green Cost Premium
Level 1 – Certified	0.66%
Level 2 – Silver	2.11%
Level 3 – Gold	1.82%
Level 4 – Platinum	6.50%
Average of 33 Buildings	1.84%

Source: USGBC, Capital E Analysis

evolve "Evolves"

- Building Audits
  - Lighting retrofits/Bulb eater
  - HVAC retrofits
  - Controls retrofits
- Energy metering/M&V
- Lights-Out program
- Reporting tool
  - Energy & GHG reduction
  - Capital cost & savings

- 250,000 tubes, 38kg of mercury
- 10,000 tubes per year

Energy Management Plan

Energy Initiatives capital **cost $14.8M ($2.9M)**

Annual **savings $3.1M** per year **($0.9M)**

Simple **pay-back 4.8 years (3.2yr)**

WILL SAVE

24,000 Megawatt Hours of Electricity per year

99,000 Giga Joules of Natural Gas per year

33,000 Cubic Meters of Domestic Cold Water per year

Reduce Green House Gas (GHG) Emissions by 28,000 Tonnes per year

EQUIVALENT TO

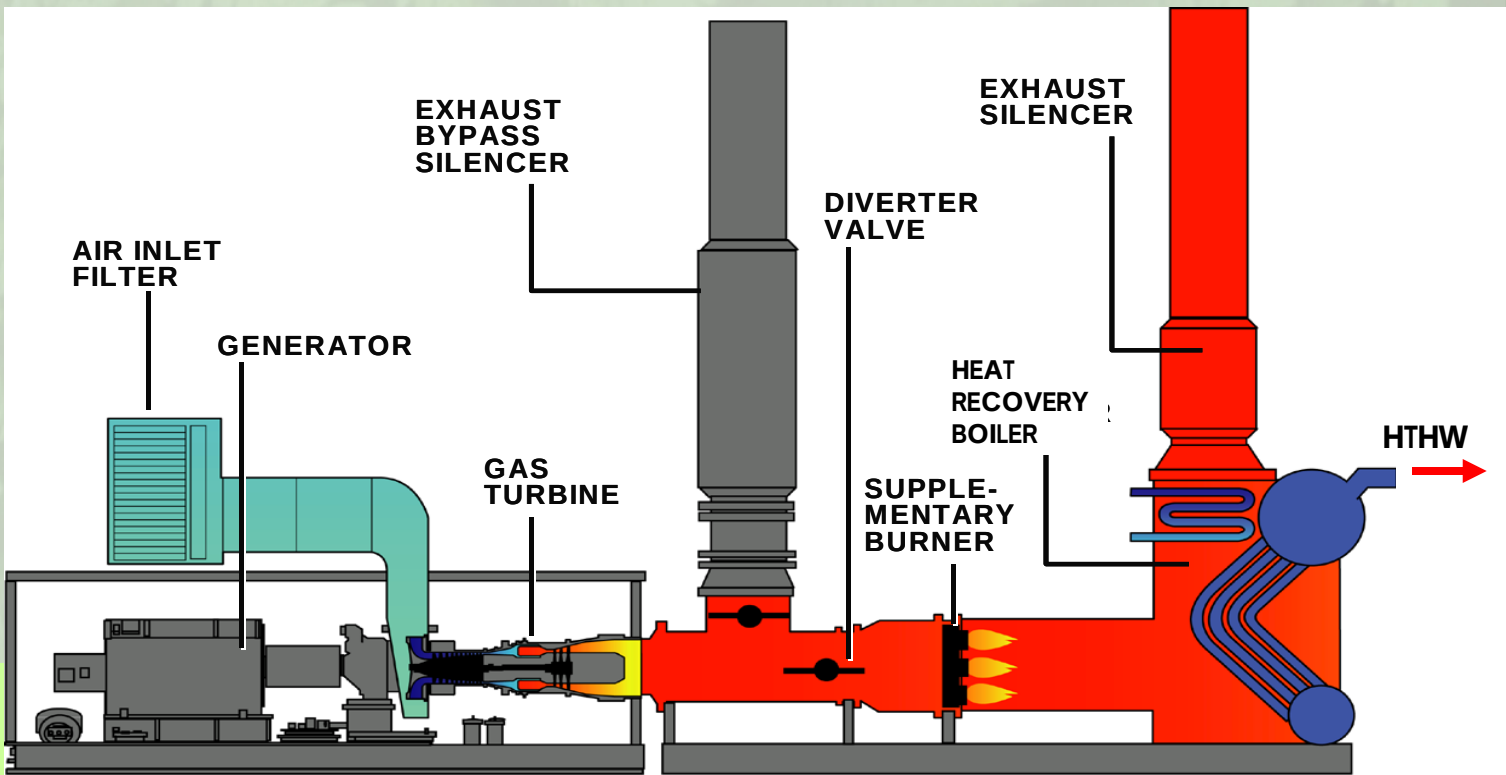
Removing 5,500 cars from the roads annually

Conserving 11,600,000 liters of gasoline yearly

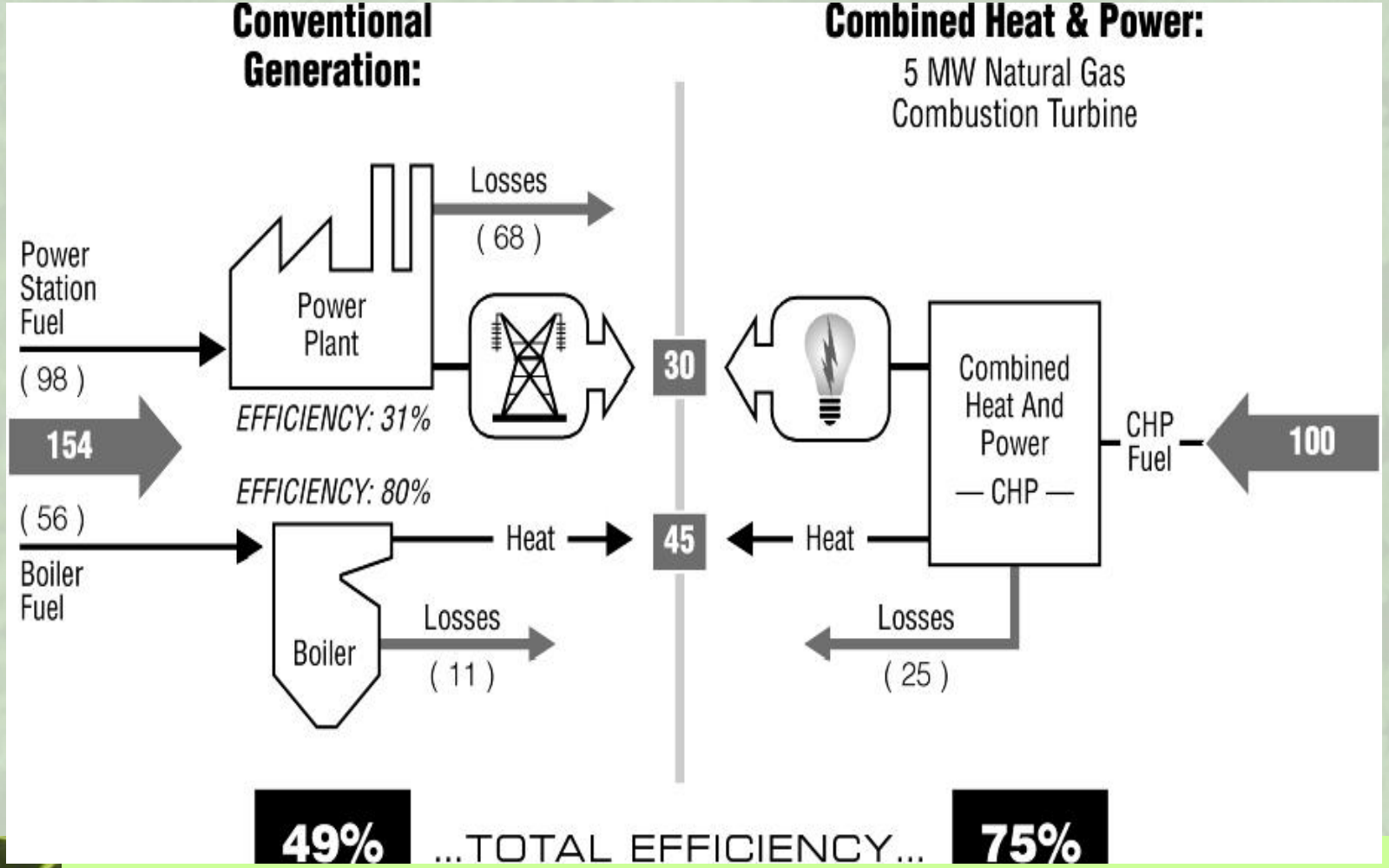
Planting 6,000,000 trees on 14,000 acres of land

CHCP Expansion

- "Combined Heat & Power," or CHP
- Heat produced from the electricity generating process is captured & used to heat buildings



Why Cogeneration?
Comparative Efficiency



Noise Control

Winter

Existing

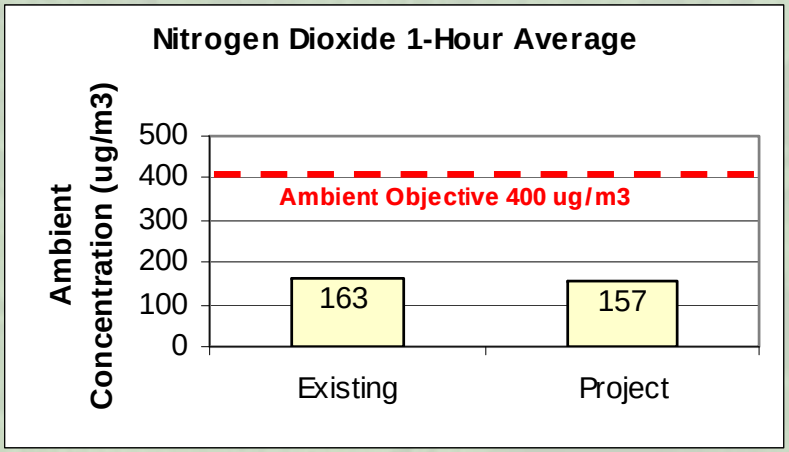
Winter

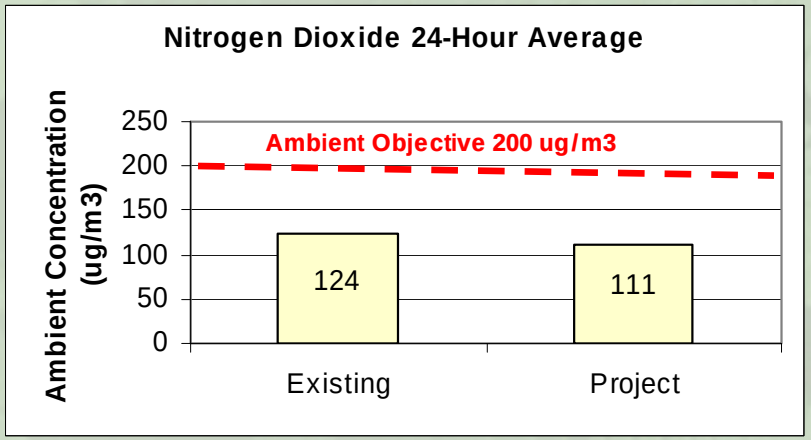
Cogen

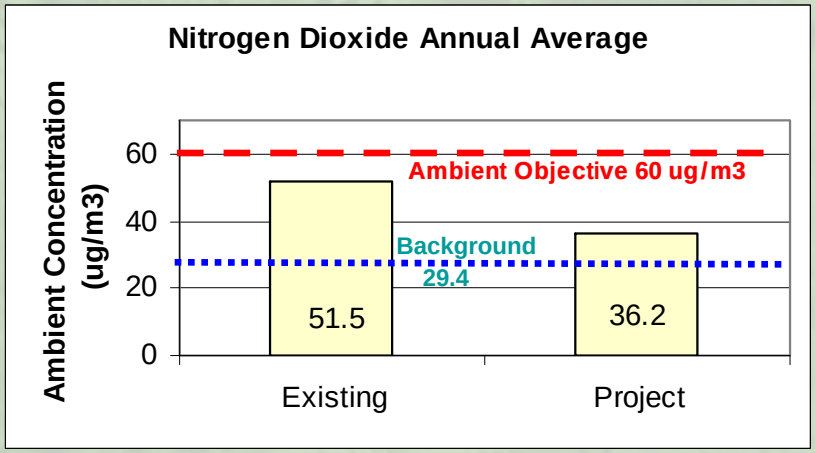
> 0.0 dBA
> 30.0 dBA
> 35.0 dBA
> 40.0 dBA
> 45.0 dBA
> 50.0 dBA
> 55.0 dBA
> 60.0 dBA
> 65.0 dBA
> 70.0 dBA
> 75.0 dBA
> 80.0 dBA

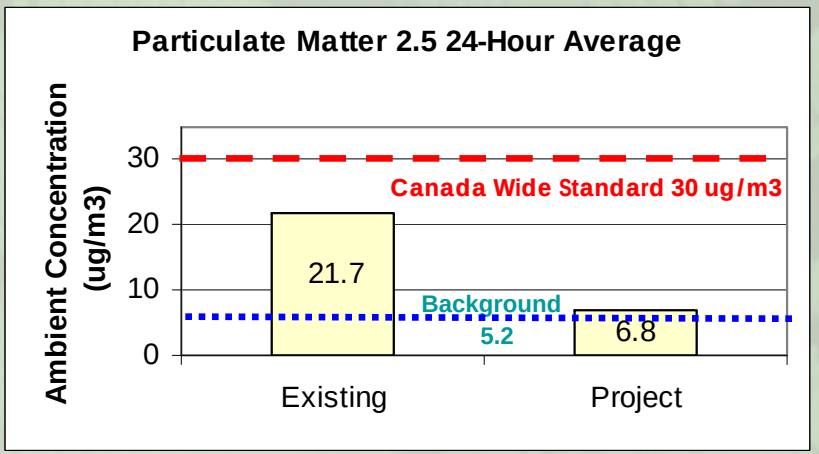
Emissions

Maximum Modeled Ground Level Concentrations



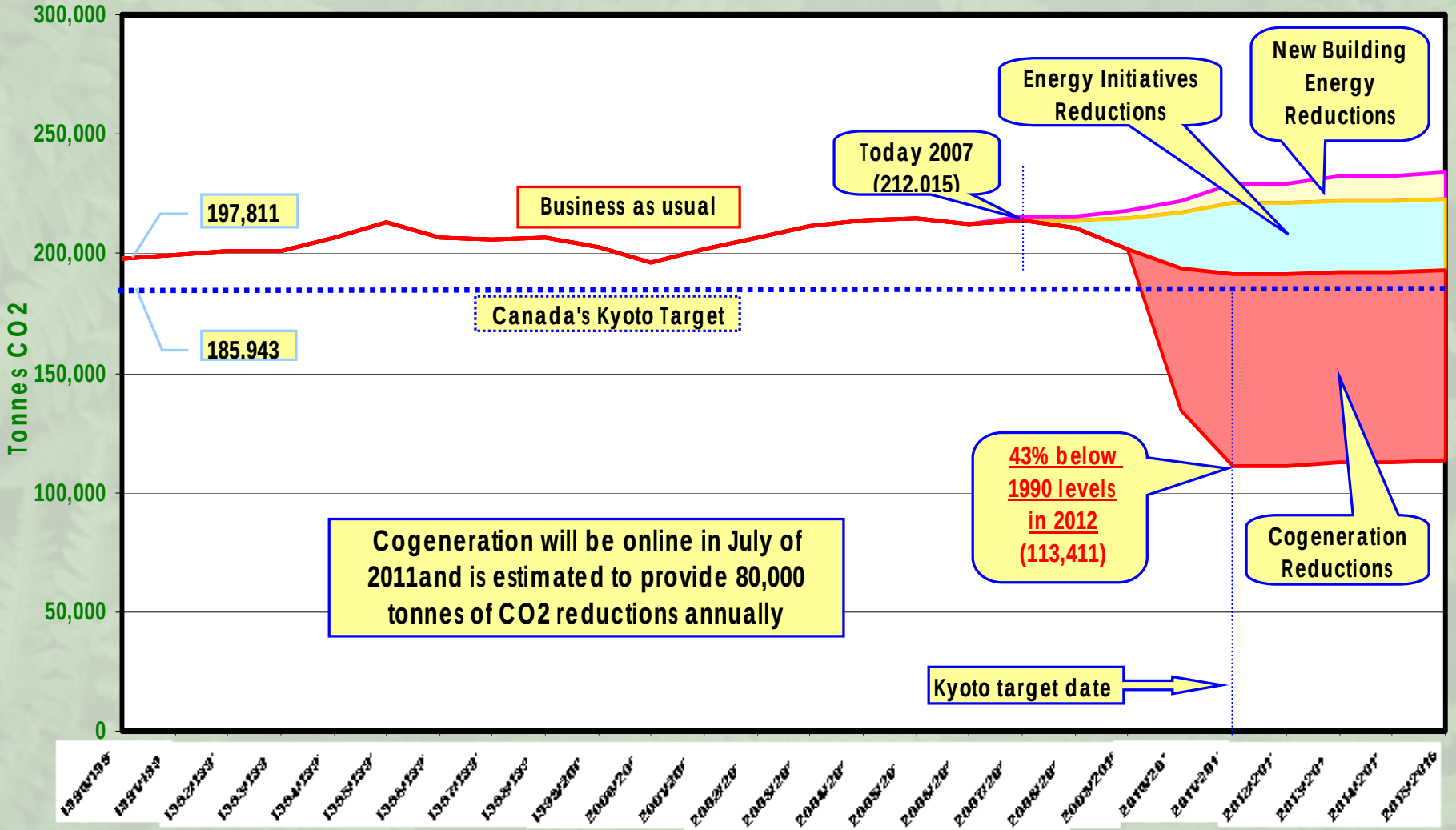






Building Design

GHG Reduction Projections



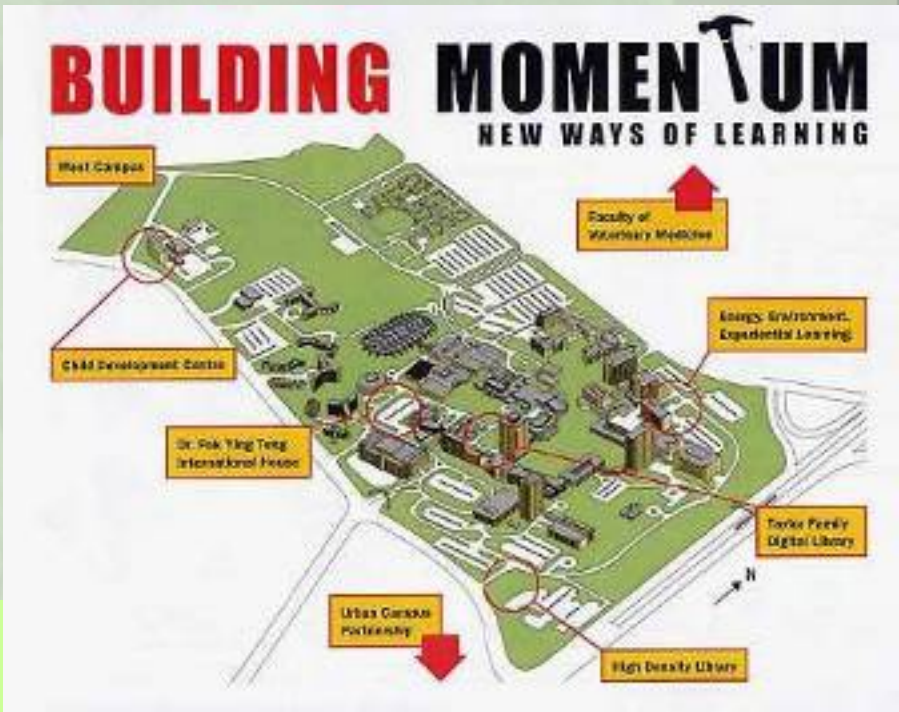
Major Capital Project Challenges

PROJECT	BUDGET	INITIAL COST	CURRENT COST
Digital Library (33,460m²)	$137.5	$266.1	$205.7
Residence Hall (7,710m²)	$20.5	$26.1	$31.9
Vet Med (7,739m²)	$39.3	$49.7	$45.8

Major Capital Project Casualties

"Re-Thinking"

- Signature architecture
  - 3 of 3 withdrawn from projects
- Projects/programs merged
- All project programs reduced substantially
- Sustainability features cut back



Platinum: From Concept to Practice
Challenges

Different building types:

- **Laboratories – Office - Housing - Animal**

Experience:

- **Consultants - Campus Planning/Campus Infrastructure**

Construction market conditions:

- **Escalation - Escalation - Escalation**

A larger priority:

- **Sustainable Campus - Sustainable Buildings**

Platinum Objective

- LEED® Platinum
  - CRDC achieved
  - Approach revised to best effort/Silver
  - Energy use target @ 2030 Challenge levels
- Doing the right thing for each project.
- Doing the right thing for the larger campus.
- Doing the right thing for research and teaching opportunities.

Sometimes Silver, Sometimes Gold

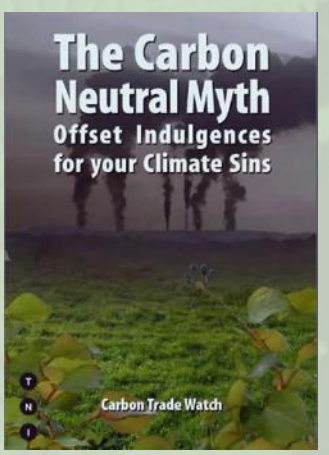
Lessons Learned – Project Management

- More rigorous initial project budget
  - QS now on each project with construction manager
- Match aspirations to budget
  - Signature architecture
  - LEED® Platinum
- Strategic partnerships are not “silver bullets”
- Select experienced team, internal & external
- Must “sell” infrastructure upgrade needs
- Maintain realistic contingencies
- Be realistic with escalation
- Build flexibility into design
- Keep a ‘bad news’ option in mind for every project

Lessons Learned – Goals

- 2030 Challenge (fossil fuel reduction)
  - Set & adopt targets
    - Progressive
    - Aggressive
  - Recognizes that current and emerging technology and behavior changes can not take us all the way to net zero
  - Allows 20% renewable energy or carbon credit purchase
  - Analogous to church indulgencies achieves nothing – <u>invest in technology & research</u>

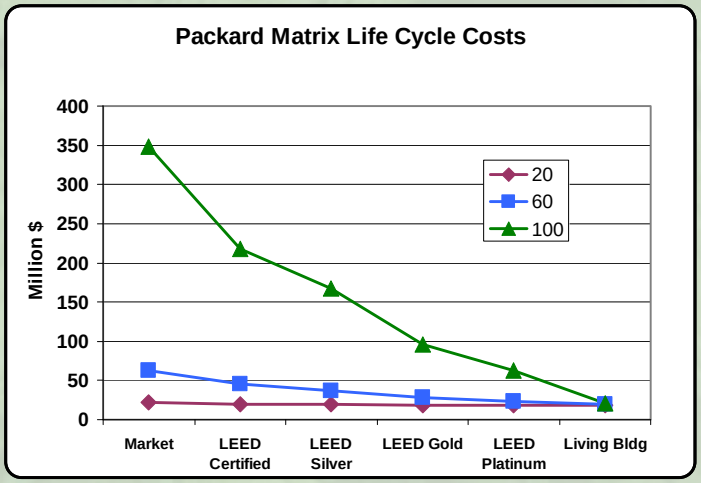
Now	50%
2010	60%
2015	70%
2020	80%
2025	90%
2030	CN



Lessons Learned – political

Longer term undertaking – LCC approach

- Packard Matrix
- Institutional challenges to be overcome;
  - Short term focus
  - Capital vs operating $
  - Limited O&M funding



Lessons Learned – Political

- Technical targets could be voluntary?
- HOT AIR….. By Jeffery Simpson
  - Need to legislate;
    - Increasingly lower targets (2030 Challenge)
    - Increasingly higher penalties (AB gov @ $15)
  - Provide framework for market forces to drive;
    - Transformation needed - LEED (City, UofC)
    - Technology further – Europe

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