Energy Management Workshop
Regina ASHRAE Chapter Technical Seminar – May 6, 2010

James Furlong, CEM, CET, LEED® AP, Principal
Agenda

- Basic Understanding
- History
- The Impact of buildings
- Performance Benchmarking
- The Need for Energy Management
- Energy Management Process
  - Audit Process
  - Levels of Audit
  - M&V
  - Typical Measures
- Project Management
- Project Financing
- Case Studies
- Carbon Emissions
- Discussion
Basic Understanding
Energy Management Basics

Energy Consumption = kWh
Energy Management Basics

\[ \text{kW} \times \text{h} = \text{kWh} \]
Energy Management Basics

\[\text{kW} = \text{Utility Load} \]

\[(\text{equipment load/efficiency})\]

\[h = \text{period of time}\]
Energy Management Basics

Save Energy?

Reduce Load
Increase Efficiency
Reduce Period of Operation
(ideally all three)
Energy Management History
## Evolution of the Buildings Energy Business

<table>
<thead>
<tr>
<th>Year</th>
<th>Event/Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970’s</td>
<td>Oil Crisis</td>
</tr>
<tr>
<td>1980</td>
<td>Simple Formula Invest /Share in Return</td>
</tr>
<tr>
<td>1985</td>
<td>Market Fails</td>
</tr>
<tr>
<td></td>
<td>- Profit Taking</td>
</tr>
<tr>
<td></td>
<td>- Owners Dissatisfied with Loss of Control</td>
</tr>
<tr>
<td></td>
<td>- Sick Building Syndrome</td>
</tr>
<tr>
<td>1987</td>
<td>Pressure for Solutions Returns</td>
</tr>
<tr>
<td></td>
<td>- Scarce Funding</td>
</tr>
<tr>
<td></td>
<td>- Deteriorating Infrastructure</td>
</tr>
<tr>
<td>1990’s</td>
<td>Consultants / ESCO’s Arrive</td>
</tr>
<tr>
<td></td>
<td>- Federal FBI Program in Full Swing</td>
</tr>
<tr>
<td></td>
<td>- Still no formal acknowledgement or programs at provincial levels</td>
</tr>
</tbody>
</table>
Evolution of the Buildings Energy Business

Mid 1990’s  Growth of Internal Solutions
- Concern that ESCO’s take too much profit?
- Identification of Infrastructure Deferred Maintenance

Late 1990’s  Increasing Pressure to do Something
- In a lot of instances Deferred Maintenance Account overwhelming
- Recognition that the process must start somewhere
- Increased activity in all classifications of approach

2000’s  Growth of Sustainability
- More serious uptake on Federal programs
- Well established design strategies for new facilities
  (ASHRAE 90.1, CBIP, IBIP, MNEC)
- Growth of Sustainability (LEED, USGBC, CaGBC)

Today  Sustainability & Energy Performance is Mainstream Business

Impact of Buildings and Energy
In Canada, Buildings are responsible for:

- 33% of all energy used
- 50% of natural resources consumed
- 12% of non-industrial water used
- 25% of landfill waste generation
- 10% of airborne particulates produced
- 35% of greenhouse gases emitted

Source: Commission for Environmental Cooperation, 2008
Energy used in the life of a building

- 20% embodied
- 80% Operational
Building Operating Costs

- Labour is the largest single cost in operating a building
Building Operating Costs – Salaries Removed

- Utilities = 45%
Performance Benchmarking
Facility Performance Benchmarking

Resources:
NRCan Database
CaGBC Green-Up
Energy Star Portfolio Manager

Typically expressed in e-kWh/m²-year

Factors:
• Age
• Climate
• Occupancy Class
## Facility Performance

<table>
<thead>
<tr>
<th></th>
<th>GJ/m²</th>
<th>kWh/m²</th>
<th>kWh/ft²</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>1.35</td>
<td>375</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>1.60</td>
<td>444</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>K-8</td>
<td>1.26</td>
<td>350</td>
<td>33</td>
<td>744</td>
</tr>
<tr>
<td>K-12</td>
<td>1.16</td>
<td>321</td>
<td>30</td>
<td>179</td>
</tr>
<tr>
<td>Offices</td>
<td>1.62</td>
<td>450</td>
<td>42</td>
<td>130</td>
</tr>
</tbody>
</table>

Sources: NRCan OEE (AB) and Stantec internal database (AB, SK, MB)

REALPac 20 x 15 challenge: Move to <20kWh/ft² by 2015
The Need for Energy Management
Simple Retrofit
## Consequences without Energy Management

<table>
<thead>
<tr>
<th>Today</th>
<th>5-years</th>
<th>10-years</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Facilities generally working</td>
<td>• Calls on emergency funding increasing</td>
<td>• Environmental taxing in effect</td>
</tr>
<tr>
<td>• Energy costs manageable</td>
<td>• Energy costs up 25%</td>
<td>• Large calls on emergency funding</td>
</tr>
<tr>
<td>• Operations budget perhaps 10% to 12% of total</td>
<td>• Operations budget perhaps 18% of total</td>
<td>• Energy costs up an additional 20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Operation standards compromised with indeterminate impact</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lack of functionality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Operations budget 30% of total</td>
</tr>
</tbody>
</table>
## Opportunities with Energy Management

<table>
<thead>
<tr>
<th>Today</th>
<th>5-years</th>
<th>10-years</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Facilities generally working</td>
<td>• Calls on emergency funding reduced</td>
<td>• Selling environmental (CO₂) credits</td>
</tr>
<tr>
<td>• Energy costs manageable</td>
<td>• Improvement in environmental and operating of facilities</td>
<td>• Still lower calls on emergency funding</td>
</tr>
<tr>
<td>• Operations budget perhaps 10% to 12% of total</td>
<td>• Energy costs down 10%</td>
<td>• Energy costs up 10%</td>
</tr>
<tr>
<td></td>
<td>• Operations budget neutral</td>
<td>• Operations budget neutral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reinvestment will be required soon to avoid spiral downwards</td>
</tr>
</tbody>
</table>
Timeline Related to Energy Management

- **0 Years**: Return on Investment Strategies
- **5 Years**: Infrastructure Renewal Strategies
- **10 Years**: Funds for other uses Strategies
- **15 Years**:
- **20 Years**:
Timeline Related to Energy Management

- Beyond the useful life expectancy of improvements
- Maximizing the value of an investment in infrastructure
- Under - realizing opportunity
Energy Management Process
Gathering Data

- High level break-out of end-uses from utility bills
  - Tools, how they work
- Spot Monitoring
  - Using electrical signatures to understand end-usage
- Detailed Monitoring
- Building Energy Assessment
  - Energy end-use
  - Envelope
  - Equipment
Energy End-use Breakdown

Typical High School

- Lighting: 26%
- Equipment: 10%
- Heating: 40%
- Cooling: 11%
- Pumps & Aux: 2%
- Fans: 5%
- DHW: 6%

Typical Office Building

- Lighting: 55%
- Equipment: 12%
- Heating: 15%
- Cooling: 4%
- Pumps & Aux: 4%
- Fans: 2%
- DHW: 8%
Understand your rate structure

Natural Gas

<table>
<thead>
<tr>
<th>Rate Class</th>
<th>Rate Code</th>
<th>Basic Monthly Charge ($/month)</th>
<th>Delivery Charge ($/m³)</th>
<th>Commodity Charge ($/1000 m³)</th>
<th>$/100 GJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Service II</td>
<td>G02</td>
<td>25.75</td>
<td>0.0631</td>
<td>$0.18</td>
<td>$5.21</td>
</tr>
<tr>
<td>(0 to 100,000 m³/year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Service III</td>
<td>G03</td>
<td>77.40</td>
<td>0.0551</td>
<td>$0.18</td>
<td></td>
</tr>
<tr>
<td>(100,000 to 600,000 m³/year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 GJ = 26.8 m³

Saskatchewan Rates

Electricity

<table>
<thead>
<tr>
<th>RATE CODE</th>
<th>URBAN E05</th>
<th>RURAL E06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Monthly Charge</td>
<td>$33.80</td>
<td>$47.65</td>
</tr>
<tr>
<td>Demand Charge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First 50 kW/Amo.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>- Balance $/kVA</td>
<td>$11.30</td>
<td>$12.25</td>
</tr>
<tr>
<td>Energy Charge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Block kW/h/mo.</td>
<td>16,750 kWh</td>
<td>15,500 kWh</td>
</tr>
<tr>
<td>- First Block ($/kW.h)</td>
<td>8.764¢</td>
<td>9.160¢</td>
</tr>
<tr>
<td>- Balance ($/kW.h)</td>
<td>5.425¢</td>
<td>4.997¢</td>
</tr>
</tbody>
</table>

Demand (kW) and Power Factor

Consumption (kWh)
Energy Audits

- Facility Auditing
- Energy and water billing review
- Recommendations and energy saving opportunities
- Lighting and HVAC Audit Analysis
- Power quality review and rate evaluation
- Electrical load monitoring
- Cost/benefit analysis
Energy Audits – Levels of Detail

- Energy Audit Scoping Exercise
  - BEPI comparison
- Level 1 – Walkthrough
  - Bi-annual “Checkup”
- Level 2 – Detailed
  - 5-year “Physical”
- Level 3 – Investment
  - Yikes - “Mayo Clinic/MRI”
Energy Audit Steps

- Gather background information (will need this to generate your scope of work):
  - Size of facility
  - Age of facility
  - Type/Occupancy
  - When was the last major retrofit to E/M systems?

- Review Utility Data (in advance if possible)
  - At least two years of data, if possible
  - What is the major use – gas or electric?
  - Compare to BEPI – much or little potential?
  - What does the prevailing rate structure promote?
Energy Audit Steps

• Conduct interview with key staff
  • Operations staff including electrician, engineer, maintenance supervisor if possible
  • Admin staff – those paying the bills (is this a priority?)
  • Occupants – the real story!

• Questions:
  • What is your biggest maintenance hassle?
  • What is working well? Not so well?
  • Frequent Cold/Hot or Headache complaints? Where?
  • Are there incentives in the organization for energy conservation?
  • What retrofits or upgrades would they like to see or have planned?
Energy Audit Steps

- **Staff Interview Cont:**
  - Have operators explain system: M&E
  - Procure O&M Manuals

- Review Lamps in storage room (you can’t always see the fixtures on your tour, reviewing gives a clue as to what you will likely encounter)

- Review primary plant & distribution rooms
  - Take photographs
  - Collect Name Plate (data, not the plates…ask James about the funny story)
  - Note age, number, service, condition, type, efficiency
  - Also note: clearances & room access (for new equipment)
Energy Audit Steps

Room by room lighting count and HVAC & lighting control review

- Lamp and ballast type (discriminator)
- Lamp count per Fixture
- Fixture count
- Lens condition
- Light levels adequate (light meter) – ECM = Delamping
- Color of room – dark or light?
- Access to daylight? – ECM = Daylighting
- Frequency of occupancy? – ECM = Occupancy Sensors
Energy Audit Steps

Review of Processes

- Pool:
  - Pool cover?
  - Heat reclaim opportunities?
  - Solar hot water heating?
- Ice Rinks
  - Low-e ceiling?
  - Heat recovery opportunities? (adjacent to a pool?)
- Laundromat:
  - Efficiency?
  - Stack Economiser?
- Commercial Kitchens
  - Demand controlled exhaust and make-up air?
Energy Audit Steps

Review Energy Conservation Measures (ECMs)

- Are there opportunities for energy savings and replacement of failing equipment?
- Chances to improve comfort? Reduce maintenance? (win/win)

Calculate Savings:

- Level 1: Typical payback potential, or sample hand-calc
- Level 2: Spreadsheets (kW * h before – kW * h after = savings)
- Level 3: Modelling Software – EE4, eQuest, RETScreen
Energy Audit Steps

Opinion of Probable Cost:

- Level 1 – Class D: Expected precision variance -25% to +75% or more
- L2 – C: Expected precision variance -15% to +25% or more
- L3 – B: Expected precision variance -10% to +10% or less

Sources:
- Call a contractor
- Call a supplier
- RS Means
- The last job

ROT: Equipment + 100% for labour +1% per month +12% design = Class C
Energy Audit Steps

Costing Cont:

Remember to consider ACE:

- Access (crane, scissor lift, helicopter, hole in the wall?)
- Cleanup /Disposal
- Environmental Remediation (asbestos)
Energy Improvement Strategies

- Energy Awareness Program
- Envelope improvements
- Lighting retrofits
- Ventilation improvements
- Primary equipment
- Secondary equipment
- HVAC conversions
- Re-commissioning
- Verification
Energy Saving Measures (low/no cost)

- Energy Awareness Program
Energy Saving Measures (low/no cost)

- Energy Awareness Program

Energy Saving Measures (low/no cost)

- Energy Awareness Program

Energy Saving Measures (low/no cost)

- LED exit signs (<2-years)
- Incandescent to CFL (2 – 3-years)
- Adjusting lighting sweep and AHU schedule to match occupancy (instant)
- Envelope improvements (< 1-year)
  - Replace weather stripping
  - Seal cracks and openings
  - Ensure doors close properly
- Water
  - Low flow aerator faucets
  - Efficient irrigation system/control
Energy Saving Measures (medium)

- T12 to T8 lighting retrofit (4 – 6-years)
- Controls upgrade (4 – 7-years)
  - Outdoor air reset schedules (air/hydranics)
  - CO₂ demand controlled ventilation
  - Daylighting & occupancy sensors
  - Space temperature setback
- Motor retrofits (2 – 6-years)
- Equipment procurement (3 – 5-years)
  - Energy Star Appliances
Energy Saving Measures (high)

- Chiller replacement (10-years)
- Near condensing boiler replacement (12-years)
- Constant Volume to VAV (10-years)
- AHU replacement (15-years)
- Envelope/fenestration upgrades (25-years +)
Energy Saving Measures (misc.)

- Stack economizer
- Eddy draft regulator
- Water-side economizer
- Addressable/Fixture specific lighting controls
- Condensing boilers
- Photovoltaics (20-years)
- Solar thermal (12-years)
- Exterior solar treatments
- Geoexchange
HVAC Systems Analysis Example - Office

Relative Installed vs. Relative Operating Costs

- WSHP Earth Coupled
- WSHP Boiler Tower
- VAV Central Station
- 2-Pipe Fan-Coil
- VAV Rooftop
- 4-Pipe Fan-Coil
- PTAC
- Air-Water Induction
- Double Duct
Measurement and Verification

Typically required for incentive procurement, financing, ESCOs

“You can save what you can’t measure”

Simple = “Normalized” annual utility consumption with existing utility meters

Detailed = IPMVP
  Submetering of primary ECMs
  Measurement and metering costs shouldn’t exceed the annual energy cost savings of the measure!
Measurement and Verification

Typical Submetering:

Spot metering – before and after

Flue gas analyzer for boiler efficiency

Flow and temperature output and gas input for efficiency (energy in/energy out = efficiency)

Lighting circuits

Control trend logs

Monitoring/Trending Frequency: hourly is usually enough (same as simulation time step)
Measurement and Verification

- Results Not Meeting Expectations?

- Identify variables to building performance: outdoor temperature or changes in occupancy
- Is it being operated as intended?
- How much occupant control? Are there operable windows?
Project Delivery Options & Risk Management

- **More**
  - Design Opportunities that are Cost-neutral or Cost-beneficial

- **Fewer**
  - “Inventive Activity”
    - Inventive activities vary in frequency & duration to suit project needs

- **More**
  - Cost Consequences of Design Changes

- **Less**
  - “Decisive Activity”
    - Decisive activities to maintain project schedule

TIME
## Sample Implementation Schedule (Level 3)

<table>
<thead>
<tr>
<th>Project Go-Ahead</th>
<th>Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility Walk-Through and Staff Interviews</td>
<td>Week 1</td>
</tr>
<tr>
<td>Preliminary List of Measures Presented</td>
<td>Week 3</td>
</tr>
<tr>
<td>Completion of Energy Measures/Model</td>
<td>Week 8</td>
</tr>
<tr>
<td>Completion of Report</td>
<td>Week 8 - 10</td>
</tr>
<tr>
<td>Report Presentation</td>
<td>Week 13</td>
</tr>
<tr>
<td>Client Review</td>
<td>Week 15</td>
</tr>
<tr>
<td>Report Submittal for Incentive Procurement</td>
<td>Week 16</td>
</tr>
<tr>
<td>Incentive Technical Review Process</td>
<td>Up to Four Weeks</td>
</tr>
<tr>
<td>Incentive Procurement</td>
<td>Week 24</td>
</tr>
<tr>
<td>Development of Design Documents</td>
<td>Week 20</td>
</tr>
<tr>
<td>Completion Of Design Documents</td>
<td>Week 28</td>
</tr>
<tr>
<td>Client Review</td>
<td>Week 29</td>
</tr>
<tr>
<td>Call for Tender</td>
<td>Week 30</td>
</tr>
<tr>
<td>Construction Commences</td>
<td>Week 38</td>
</tr>
<tr>
<td>Construction Completion</td>
<td>Week 52</td>
</tr>
<tr>
<td>Measurement and Verification</td>
<td>One Year After Construction</td>
</tr>
</tbody>
</table>
Finding the Right Fit

- Avoid “bleeding edge”
- Don’t cherry pick: low payback to finance long payback
- Equipment is step 1
- Education is step 2
Project Financing
Financing

- Internal Financing
- Direct loan or Lease
- Energy Performance Contractors (ESCO)
- Financial Incentives
Return on Investment

- Simple Payback
- Incremental Payback
- Simulations

Incentive Programs

- Utility Companies
  - SaskPower
  - SaskEnergy
- Rinks
- Lighting
- Boiler retrofit
- Municipalities
  - Federation of Canadian Municipalities (FCM)

Funding Opportunities

- **NRC ecoEnergy**

  $10 per gigajoule (277.8 kWh) of estimated annual energy savings; or

  25 percent of eligible project costs; or

  $50,000 per project ($250,000 per organization).

Energy Performance Company (ESCO)

- Opportunity Assessment
- Feasibility Study
- Go / No-go
- Request for Proposal Development
- Proposal Assessment
- Finalize design, Procurement, and construction
- Performance Period

Great option if you have no money, but….if you have $ can save up to 30%
Track and Reinvest Your Savings

- Quantify savings
- Identify further opportunities
- Identify operational irregularities
- Sustainability Tracking, Assessment and Rating System (STARS) AASHE
- LEED
- BOMA BESt

http://www.greencampus.harvard.edu/
Example & Case Studies
Example

You are a maintenance manager at a 150,000 ft² professional office building (the corporate HQ)

Approximate $390,000 / year in gas and electricity costs
Circa 1983
Increasing maintenance as equipment fails

You do your homework. BEPI = 500 ekWh/m²-year, NRCan benchmark = 400 in your region. BEPI is also highest of all buildings in portfolio.

There is potential for energy savings and you convince your CFO to engage a consultant for a Level 2 energy audit.
Example

A Level 2 audit uncovers the following energy conservation measures:

- Low flow aerators
- LED exit signs
- T12 to T8 retrofit
- Constant volume to VAV conversion
- 85% efficient near-condensing boilers
- High efficiency air cooled chiller
- Demand controlled ventilation

The total bundle of measures costs just under $300,000 and has a 6.3 year simple combined payback and will reduce your energy costs by 12%
Example

Problem: Cash is tight. Your CFO is visionary and is certain the company will last 5 years but can’t forecast any longer and as such won’t approve projects with >5 year simple payback. You could not afford a Level 3 audit at the time so nobody will provide you with incentives or long term loans to implement.

After consulting with your brilliant energy consultant you decide to self-finance/fund and implement over time.
Example

Implementation planning – your consultant’s napkin sketch

Reinvest cumulative energy savings in “mini” retrofit projects to facilitate self-funding
## Example Implementation

<table>
<thead>
<tr>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cost Rapid Payback</td>
<td>High Cost Long Payback</td>
</tr>
<tr>
<td>• T12 to T8 = $50k / 5 Yr</td>
<td>• Mid Eff. Boilers = $100k / 10 yr</td>
</tr>
<tr>
<td>• CV to VAV = $35k / 3 Yr</td>
<td>• High Eff. Chiller = $90k / 12 yr</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost, Rapid Simple Payback</td>
<td>Low Cost Long Payback</td>
</tr>
<tr>
<td>• Aerators = $1,500 / 1 Year SPB</td>
<td>• CO2 DCV = $10k / 8 yr</td>
</tr>
<tr>
<td>• LED Exits = $10K / 2 Yr</td>
<td></td>
</tr>
<tr>
<td>• Education = free</td>
<td></td>
</tr>
</tbody>
</table>
Example

Annual Utility Costs Through Retrofit

Year 0 | Year 1 | Year 2 | Year 3 | Year 4
---|---|---|---|---
$388,000 | $381,500 | $359,833 | $342,333 | $341,083
Example

Year 1 = $11,500 cost / $6,500 Savings
Year 2 = $85,000 cost / $28,167 Savings
Year 3 = $190,000 cost / $45,667 Savings
Year 4 = $10,000 Cost / $46,917 Savings
Case Study – Good Earth Building

Good Earth Building
- 25 year old facility (circa 1980)
- Infrastructure failing
- Losing tenants
- Operations and utility costs increasing
- Chronic occupant complaints
Case Study – Good Earth Building

- $1,000,000 Renovation
- Replace primary HVAC plant (boiler, chiller, cooling tower, pumps and motors)
- Controls upgrade
- Complete lighting retrofit
Case Study – Good Earth Building

- 10 year simple payback
- 25% decrease in energy costs
- 50% reduction in maintenance costs
- Reduced tenant turn-over
- Improved thermal comfort & lighting (reduced head-ache complaints)

Projected Performance Retrofit Energy Savings
Case Study – Joffre Place

Joffre Place Audit

$275,000/year utility costs

6-storey 9,600 m² Calgary facility with office, retail & parkade.

Circa 1980

- Lighting & controls upgrades identified
- $148,000 retrofit, $54,000 utility savings, 2.8 year payback.
- 584 tonnes of CO₂ saved per year
Case Study – Dundee

Dundee Commercial Portfolio

- National commercial building portfolio
- 12 million square feet
- Mandate to reduce operating costs, greenhouse gas emissions, and market to "green" tenants
- Identified the need to develop a plan
Case Study – Dundee

- Energy Performance Matrix
- Evaluate size, age, energy intensity, geographic location, retrofit history
- Develop Audit Protocol
  - Walk-through Audit (small, efficient, or new buildings)
  - Investment Grade Audit (large, inefficient, old buildings)
Case Study – Dundee

Dundee Commercial Portfolio

- 2007: Audited half of portfolio
- 2008: Audit remaining portfolio & started implementation of low cost measures
- 2009: On hold (recession)
- 2010: Implementation of high cost measures starts in select locations
Carbon and Energy
Carbon
Carbon Footprinting

- A carbon footprint is "the total set of GHG (greenhouse gas) emissions caused directly and indirectly by an individual, organization, event or product" (UK Carbon Trust 2008).

- GHGs measured in CO₂e
- Global Warming Potentials (GWP)
  - CO₂ = 1
  - CH₄ = 21
  - N₂O = 310
Carbon Footprinting

- **Decide what to include:**
  - Scope 1 – direct emissions (e.g. gas, oil, etc)
  - Scope 2 – indirect emissions (e.g. electricity)
  - Scope 3 – indirect off-site emissions (e.g. transport, waste disposal, etc)
- **Most buildings will do scope 1 and scope 2 (control)**

- **Convert fuel consumption into emissions**
- **Emission factors (CO$_2$e)*:**
  - Natural gas – 1,903 g/m$^3$
  - Propane – 1,544 g/l
  - Diesel – 2,790 g/l
  - Electricity (primary coal) – 960 g/kWh
  - ‘Green’ electricity e.g. Bullfrog Power – 0 g/kWh

From Carbon Footprinting to Carbon Management

- Footprint = baseline…what next?

- UNDERSTAND where you are going
  - Project your future emissions
  - Planned growth in floor area (use benchmarks)
  - Planned energy efficiency projects

- DECIDE where you want to be
  - Set a reduction target and year

- DECIDE how you are going to get there
  - Benchmark, audit results, capital spending program, etc
  - Make an action plan

- CHECK how you doing
  - Check energy use
The Carbon Market

- Offsets – can you sell your efficiency gains?
- In theory, yes…
  - Selling for $10-$13/tonne CO$_2$e
  - Energy Efficiency Protocol been developed
  - [http://carbonoffsetsolutions.climatechangecentral.com/](http://carbonoffsetsolutions.climatechangecentral.com/)

- In practice, this is more difficult
  - Would need aggregation; offsets must be verified
Thank You

Questions & Answers

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