

Best Practices for Energy Audits Using ASHRAE 211-2018 and RETScreen

Session F3: Energy Auditing

Javier Ojeda, P.Eng, CEM, REP, PMP, MBA

Agenda

1. Introduction

- What's ASHRAE 211-2018
- What's RETScreen

2. Planning the Audit

- Audit Scope and Objectives
- Info that you will need
- Preliminary Energy Use Analysis
- Tools
- Team

3. Conducting the Audit

- Site Visits
- Data Analysis – RETScreen + Excel + ASHRAE Forms
- Report Structure

4. After the audit

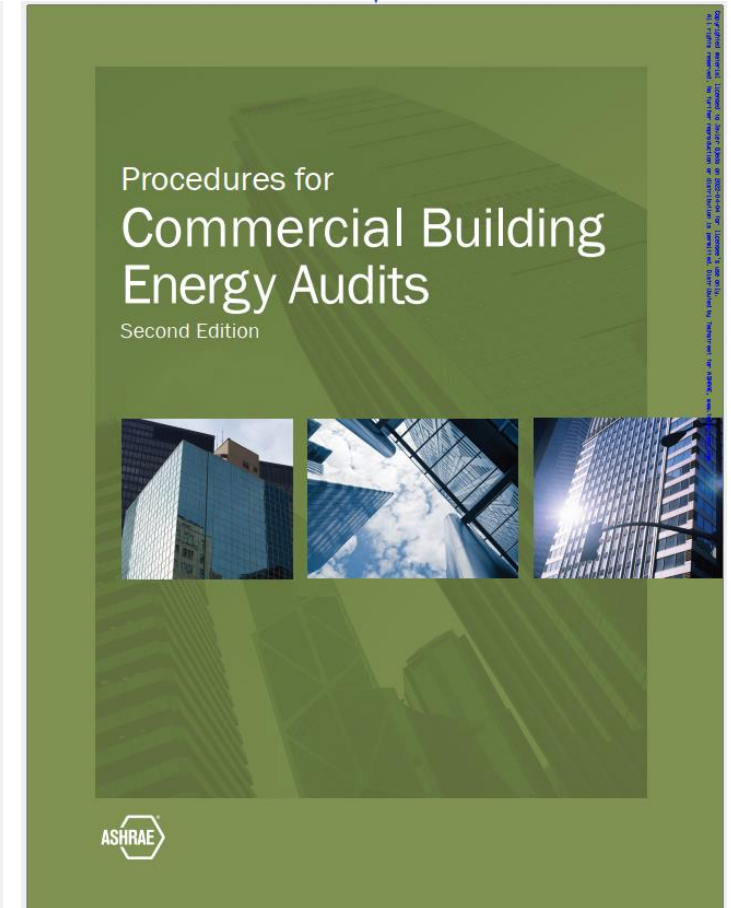
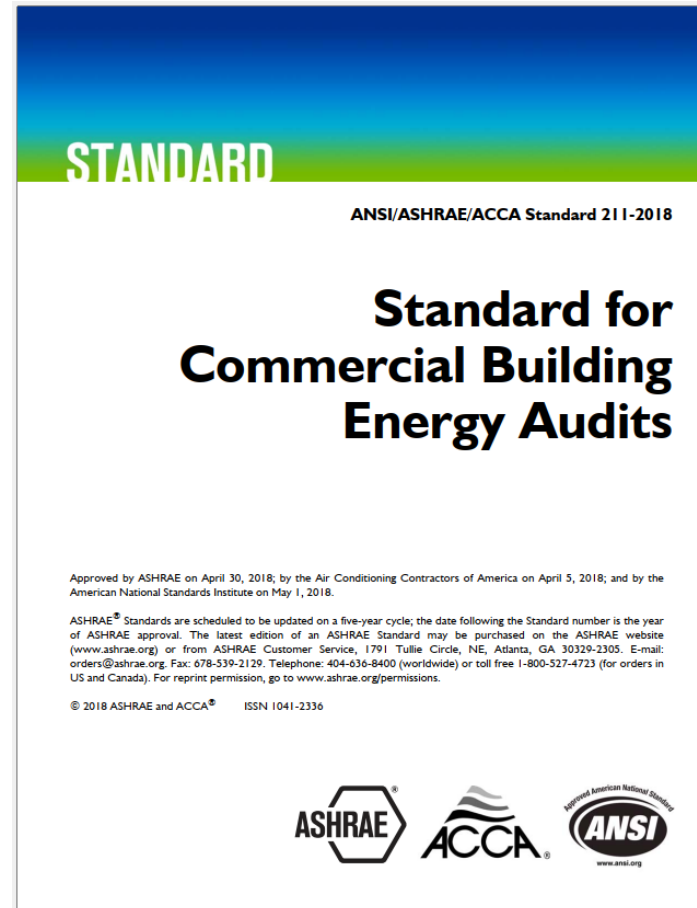
- RETScreen Energy Modeling
- Model Calibration
- EEM's and their simulation in RETScreen

5. Final Report

Introduction

- The ASHRAE 211-2018 Standard
 - A complement to the **PCBEA**
 - Brings order into chaos of Energy Audits
 - Establishes energy audit levels 1, 2, 3
 - Establishes Preliminary Energy Use Analysis Methods
 - Establishes a minimum performance standard for energy audits

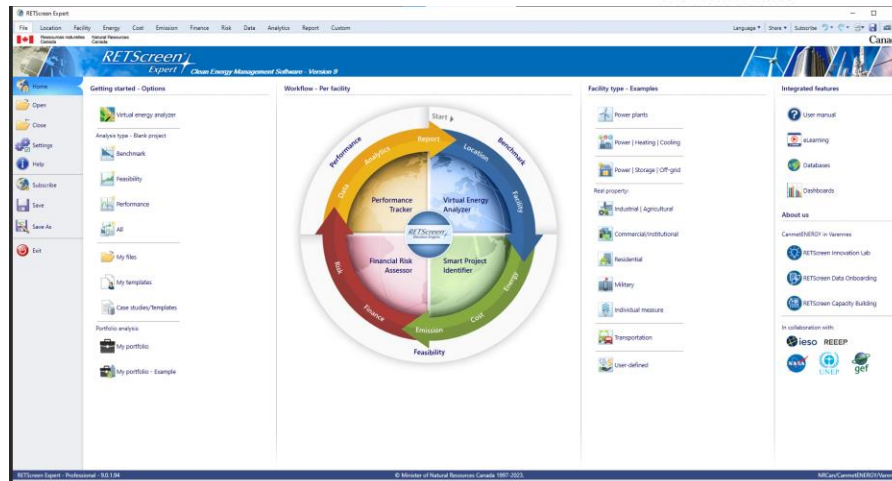
This is the
PCBEA!



Introduction



Canada

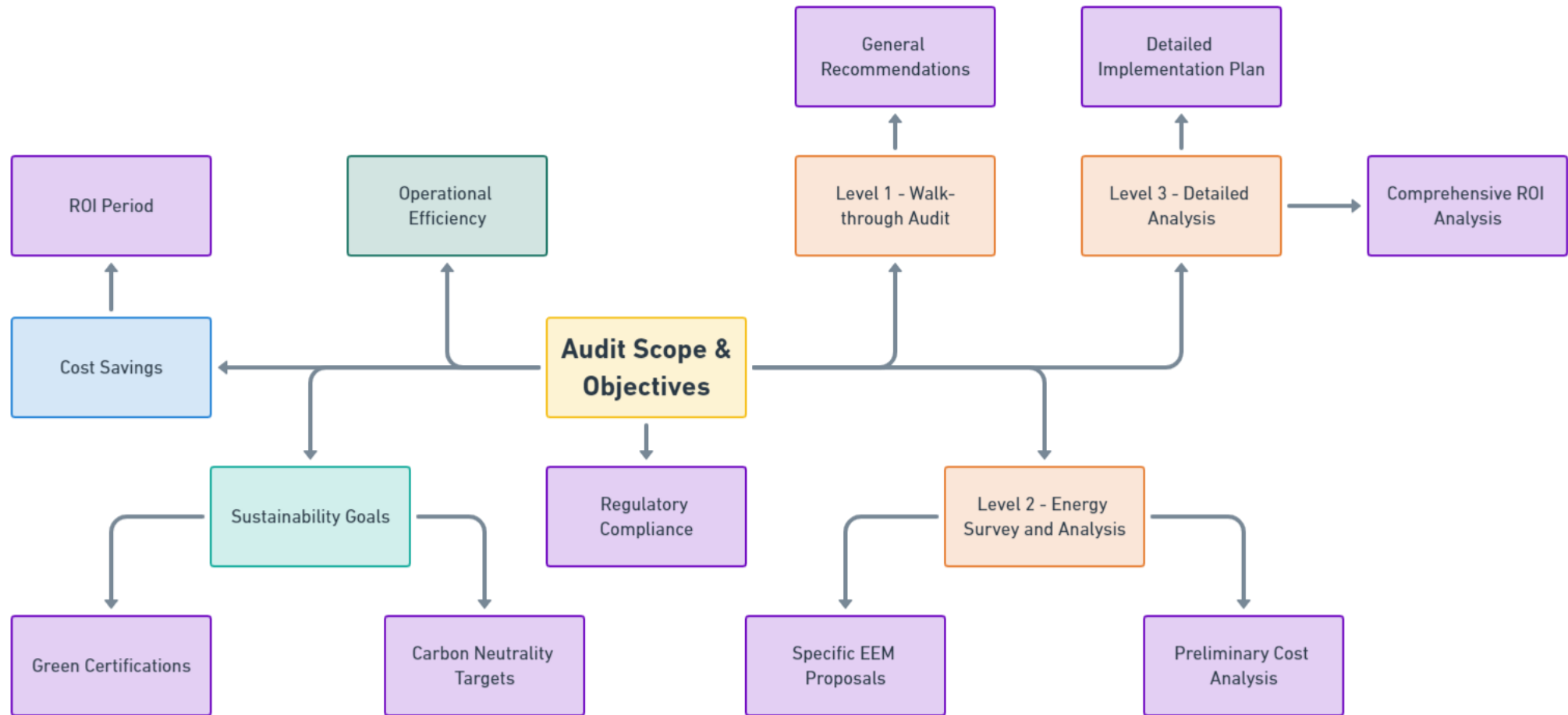


- What's RETScreen

- RETScreen is a free software tool developed by Natural Resources Canada (NRCAN) to assist in the evaluation of the viability and energy performance of renewable energy and energy efficiency projects.

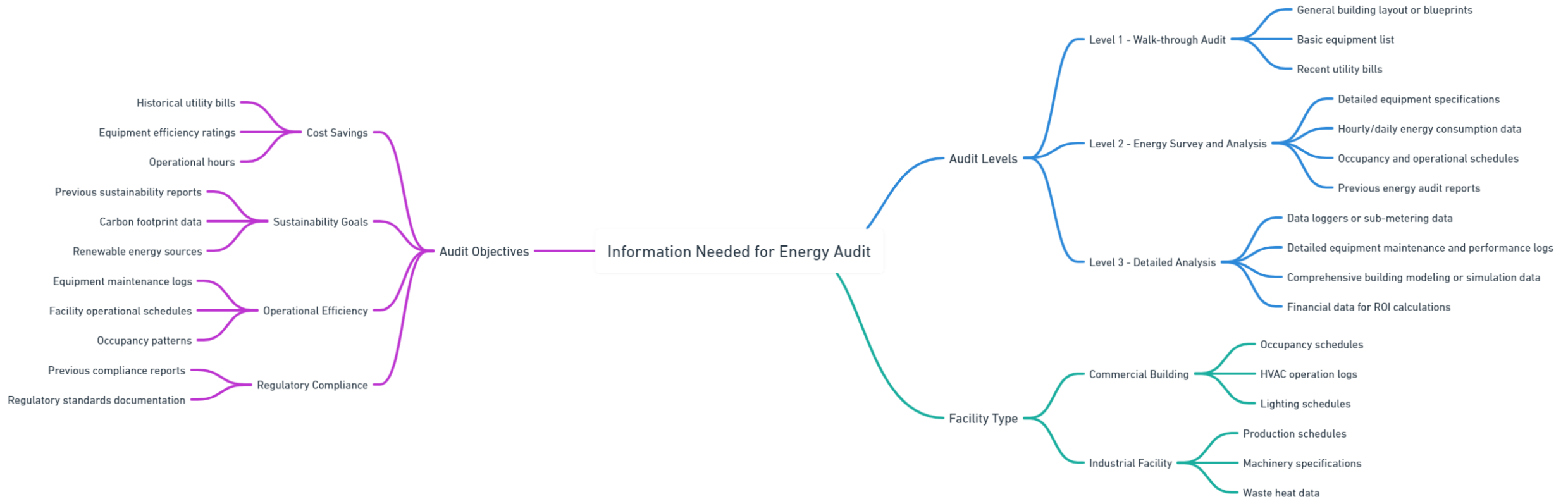
- Project Viability Analysis
 - Energy Modeling
 - Performance Analysis
 - Benchmarking

Planning the Audit



Made with Whimsical

Planning the Audit

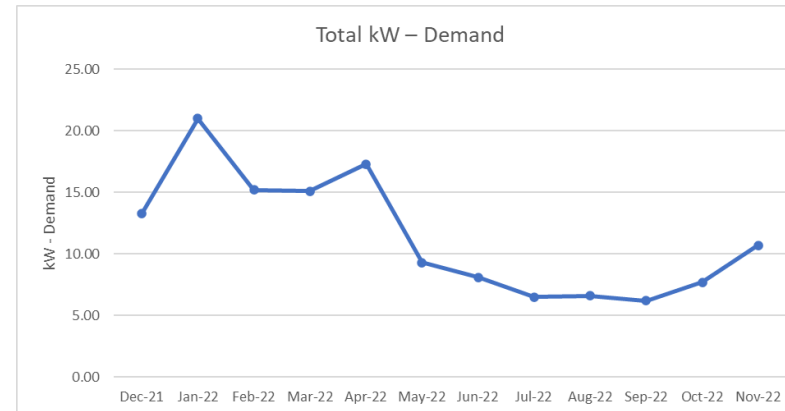
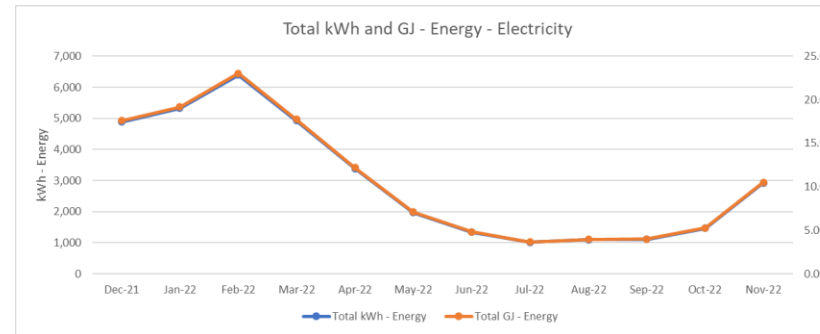


Made with Whimsical

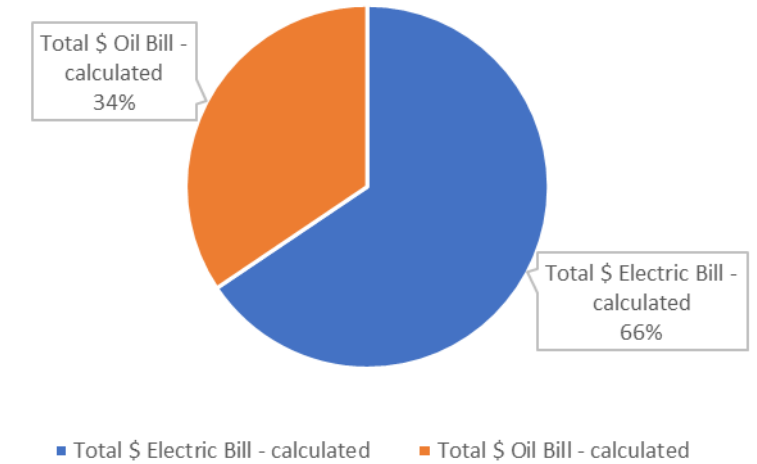
Planning the Audit

Preliminary Energy Use Analysis:

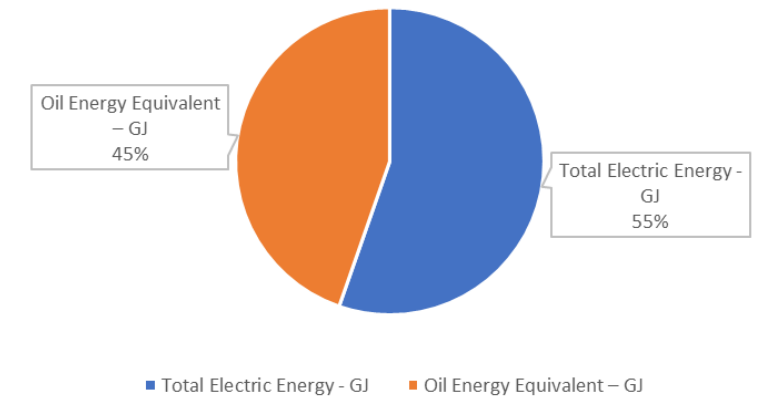
- Baseline overview of building's energy performance
- Early Stage Benchmarking
- Data Sources: utility bills, schedules (min. 1 calendar year)
- Key Metrics:
 - EUI
 - ECI
- Informs depth & focus of main audit



Energy Cost Distribution Per Source



Energy Distribution Per Source



Planning the Audit

Preliminary Energy Use Analysis:

- Baseline overview of building's energy performance
- Early Stage Benchmarking
- Data Sources: utility bills, schedules (min. 1 calendar year)
- Key Metrics:
 - EUI
 - ECI
- Informs depth & focus of main audit

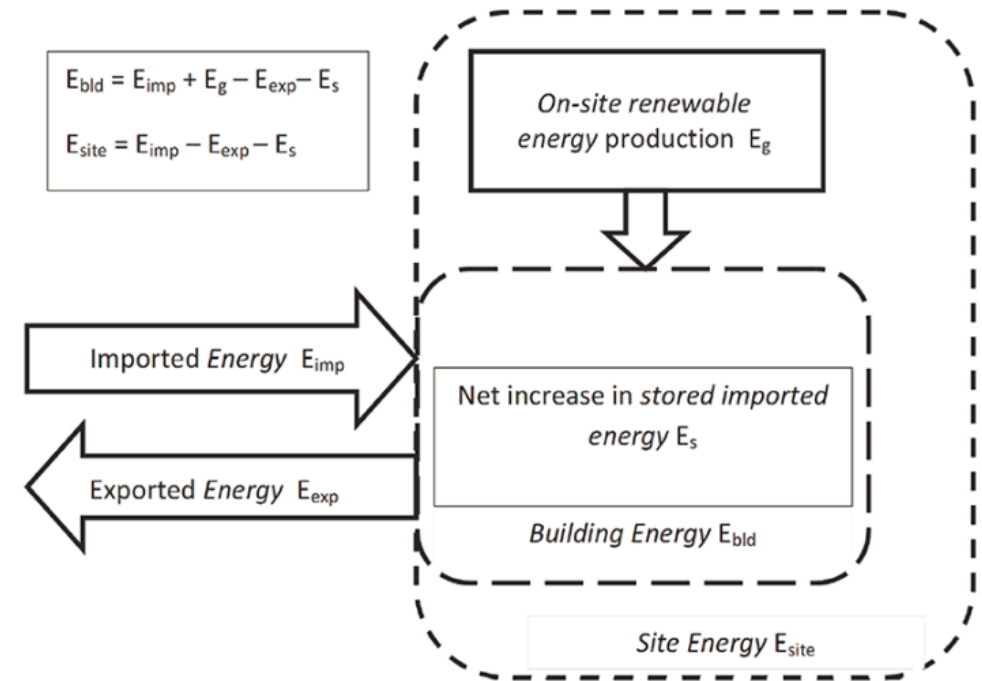


Figure 1 Relationship of site energy (E_{site}) and building energy (E_{bld}). From ASHRAE 211-2018, page 5

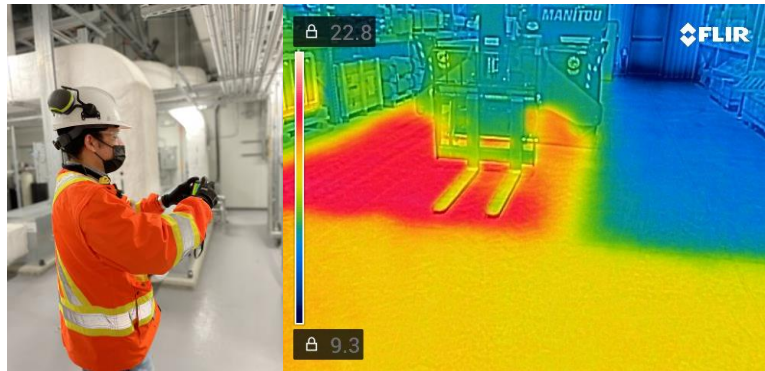
EUI: Energy Use Intensity

$$\frac{\text{total energy consumed by the building in one year (measured in kBtu or GJ)}}{\text{total gross floor area of the building (measured in square feet or square meters)}} = \left(\frac{\text{Kbtu}}{\text{SQft}} \right) \text{ or } \left(\frac{\text{GJ}}{\text{SQM}} \right)$$

ECI: Energy Cost Index

$$\frac{\text{total cost energy consumed by the building in one year (measured in \$)}}{\text{total gross floor area of the building (measured in square feet or square meters)}} = \left(\frac{\$}{\text{SQft}} \right) \text{ or } \left(\frac{\$}{\text{SQM}} \right)$$

Planning the Audit



TOOLS FOR THE
ENERGY AUDIT



Planning the Audit

The Audit Team

- I'll depend on how deep are you going in the energy audit, and what are the goals from it

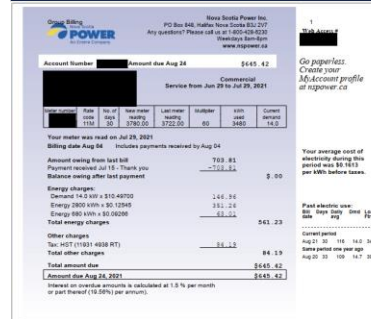


- **Basic Team – Level 1:**
 - The energy auditor (solo), level 1 and probably level 2 depending on the facility
 - Opt: Energy Analyst
- **For a level 2, consider adding:**
 - Surveyor / Drafter (if there are no drawings)
 - Energy modeler (if the auditor is not the energy modeler)
 - Opt: Discipline specialist:
 - Mechanical engineer
 - Electrical Engineer
 - Power Engineer
- **For a Level 3, consider adding:**
 - Second auditor, specialist in one specific aspect of the audit (i.e. LEED professional)
 - Electrician on site: to install data loggers and energy analyzers
 - Opt: Light specialist
 - Opt: Emissions Specialist
 - Any additional technician with specific specialization aligned with the scope of the audit

Conducting the Audit

- Site Visits
 - Stick to your plan... unless reality hits you in the face!

Documentation



SAFETY toolbox meeting



Preliminary Walkthrough

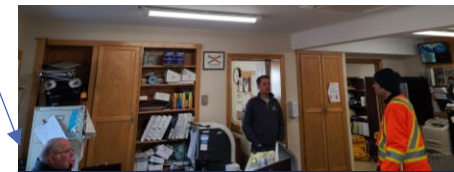
Equipment Checks



Data Collection



Interviews



Conducting the Audit

RETScreen Expert - Digby - 5 Bay Garage - NSDPW - COMBINED.rctx

File Location Facility Energy Cost Emission Finance Risk Report Custom

Benchmark Feasibility Performance All Level 1 Level 2 Hide benchmark Benchmark database... Show notes Show image Default image Select image... Adjust image... Keep aspect ratio Help eLearning Workflow... Colour coding...

Step 1 - Analysis type Step 2 - Benchmark Options Help

Subscriber: Hysovent Limited - Professional

RETScreen - Facility

Facility information

Facility type: Commercial/Institutional
Type: Other
Description: Commercial/Institutional - Maintenance Shop

Prepared for: Nova Scotia Department of Public Works
Prepared by: Hysovent Limited

Facility name: Digby - 5 Bay Garage
Address: 200 Robinson Weir Rd
City/Municipality: Digby
Province/State: NS
Country: Canada

Benchmark - Commercial/Institutional - Other

Facility size: 589 m²

Fuel consumption

Energy use intensity: GJ/m²
Reference unit: m²

Benchmark: 0.82 GJ/m²
Minimum (Typical): 0.62 GJ/m²
Maximum (Typical): 2.16 GJ/m²

Base case: 1.44 GJ/m²
Reference year: 2022

Set target: Target
Year: 2030
Target: -50%
Proposed case: 0.72 GJ/m²

Facility - Plan Annual

Energy use intensity (GJ/m²)

Plan

Base case

Target

Benchmark

Net zero

Let's go with Live Example!

- Data Analysis – RETScreen + Excel + ASHRAE Forms

All Audit Levels - Annual Summary

Summary for Existing Building

user input
calculated

Imported Energy (E_{imp})

Energy Type	Annual	Units	Conversion	Mass	Annual Cost
Electricity	47,071	kWh	3.4	172,235	\$ 7,873
	-				\$ -
	-				\$ -
	-				\$ -
	-				\$ -
Oil	17,276	Barrel (Fuel Oil #2)	39.3	672,441	\$ 15,211
	-				\$ -
	-				\$ -
E_{imp} Total					\$ 23,084

On-Site Renewable Energy Production (E_{rs})

Energy Type	Annual	Units	Conversion	Mass	Annual Cost
	-				\$ -
	-				\$ -
E_{rs} Total					\$ -

Exported Energy (E_{exp})

Energy Type	Annual	Units	Conversion	Mass	Annual Cost
	-				\$ -
	-				\$ -
E_{exp} Total					\$ -

Existing Building EUECI

Building Name	Digby 5 Bay Garage
Great Canadian Energy Meter	989
EUI (Building) (kWh/m ² /yr)	1,418.2
EUI (Site) (kWh/m ² /yr)	1,418.2
Site ECI (Energy cost index \$/m ² /yr)	\$ 44.41

EUI: Energy Use Intensity

Benchmarking & Target EUECI

Benchmark Source	Benchmark EUI (kWh/m ² /yr)	Target EUI (building) (kWh/m ² /yr)	Target EUI (site) (kWh/m ² /yr)	Target ECI (site) (\$/m ² /yr)	Annual Energy Savings to Reach Target	Annual Cost Savings to Reach Target
Benchmark Source						
Benchmark EUI (kWh/m ² /yr)						
Target EUI (building) (kWh/m ² /yr)						
Target EUI (site) (kWh/m ² /yr)						
Target ECI (site) (\$/m ² /yr)						
Annual Energy Savings to Reach Target						
Annual Cost Savings to Reach Target						

Notes

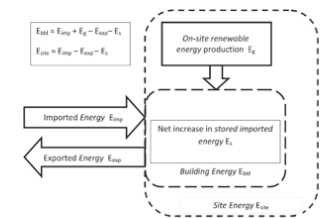
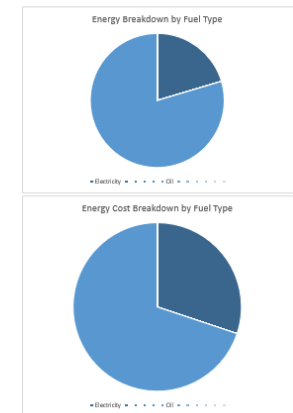


Figure 1 Relationship of site energy (E_{site}) and building energy (E_{buil})

Conducting the Audit – Report Structure

1. Executive Summary

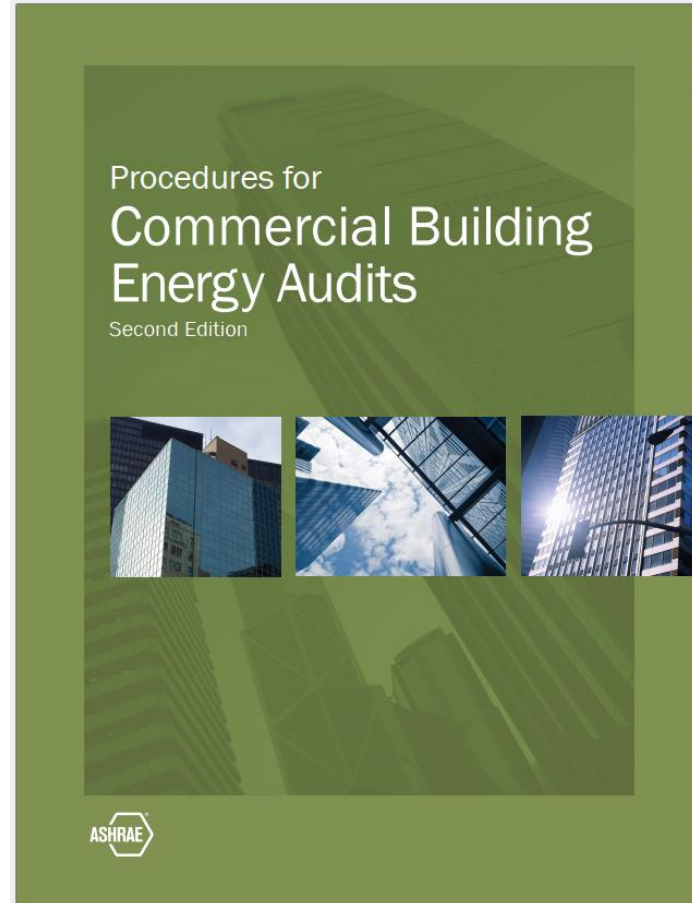
- Brief background and summary of scope
- EEM (Energy Efficiency Measures) summary table
- Summary of benchmarking results

2. Background Information

- Contact information for stakeholders
- Audit scope, methodology
- Description of the site and the building
- Historical energy consumption and costs
- Benchmarking results
- End-use analysis results
- Client motivations or mandates satisfied by this effort

3. Description of the Existing Building Systems

- Occupancy
- Building envelope
- Lighting systems
- Mechanical systems
- Security, oversight, or operational requirements impacting this effort
- Photographs



4. Energy Efficiency Measures

- No-cost/low-cost measures
- Capital investment measures
- Demand response measures
- Distributed generation/renewable energy measures
- O&M measures
- Impact of current financial market, utility incentives, federal tax or grant support, etc.

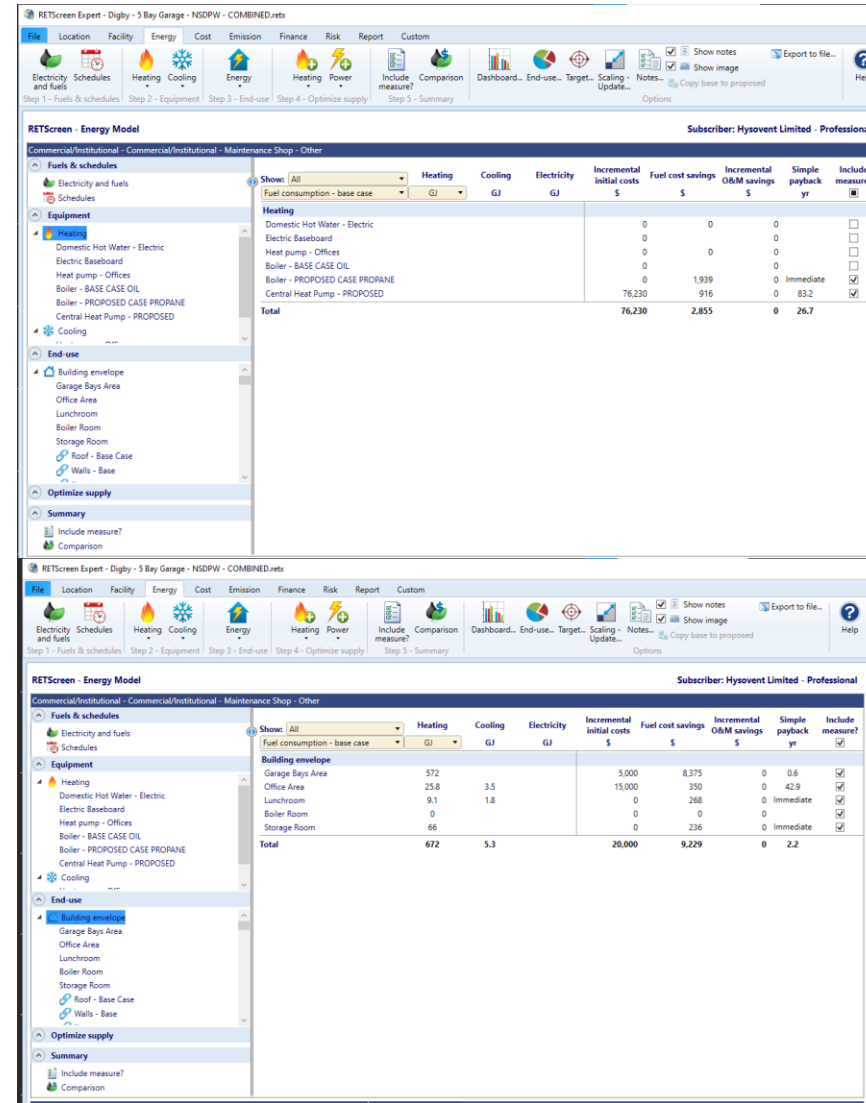
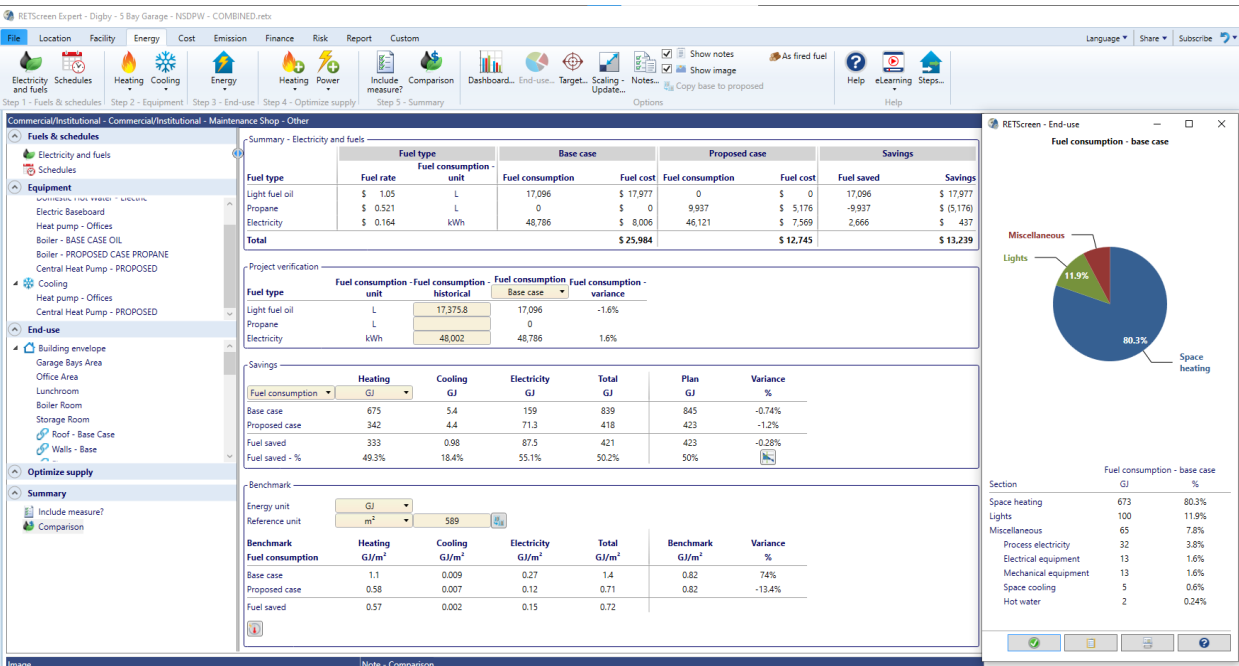
5. Supporting Information

- Analysis
- Measured data or monitoring results
- Manufacturers' information or "cut sheets"
- Plans and sketches
- Additional information or specifications

Let's go with Live Example!

After the Audit

- RETScreen Energy Modeling



Let's go with Live Example!

After the Audit

Project verification

Fuel type	Fuel consumption - unit	Fuel consumption - historical	Fuel consumption - Base case	Fuel consumption - variance
Light fuel oil	L	17,375.8	17,096	-1.6%
Propane	L		0	
Electricity	kWh	48,002	48,786	1.6%

Methods	ASHRAE Guideline 14, <i>Measurement of Energy and Demand Savings</i> (ASHRAE 2002) ASHRAE Research Project 1051 Final Report, "Procedures for Reconciling Computer-Calculated Results with Measured Energy Data" (Reddy and Maor 2006) ASHRAE Research Project 1404, <i>Measuring, Modeling, Analysis, and Reporting Protocols for Short-Term M&V of Whole Building Energy</i> (ASHRAE n.d.) <i>International Performance Measurement and Verification Protocol (IPMVP)</i> (EERE 2002) <i>M&V Guidelines: Measurement and Verification for Federal Energy Projects</i> (FEMP 2008)
Tools	ASHRAE Research Project 1050 Final Report, "Development of a Toolkit for Calculating Linear, Change-Point Linear and Multiple-Linear Inverse Building Energy Analysis Models" (Kissock et al. 2002) Universal Translator (UTOnline.org 2009) Energy Charting and Metrics (ECAM) Tool (CCC 2008) Building Optimization Analysis (BOA) Tool (CCC 2010) ASHRAE Research Project 1093 Final Report, "Compilation of Diversity Factors and Schedules for Energy and Cooling Load Calculations" (Abushakra et al. 2001) Building Energy Software Tools Directory (EERE 2011c)
Data Sources	Commercial Buildings Energy Consumption Survey (EIA 2003) EnergyIQ (LBNL 2011) ASHRAE/IES Standard 90.1 (ASHRAE 2010b) energy end-use schedules Title 24 energy end-use schedules (CEC 2008) Published reports and papers providing end-use loads and load shape data Historical weather data Design rules of thumb Performance metrics

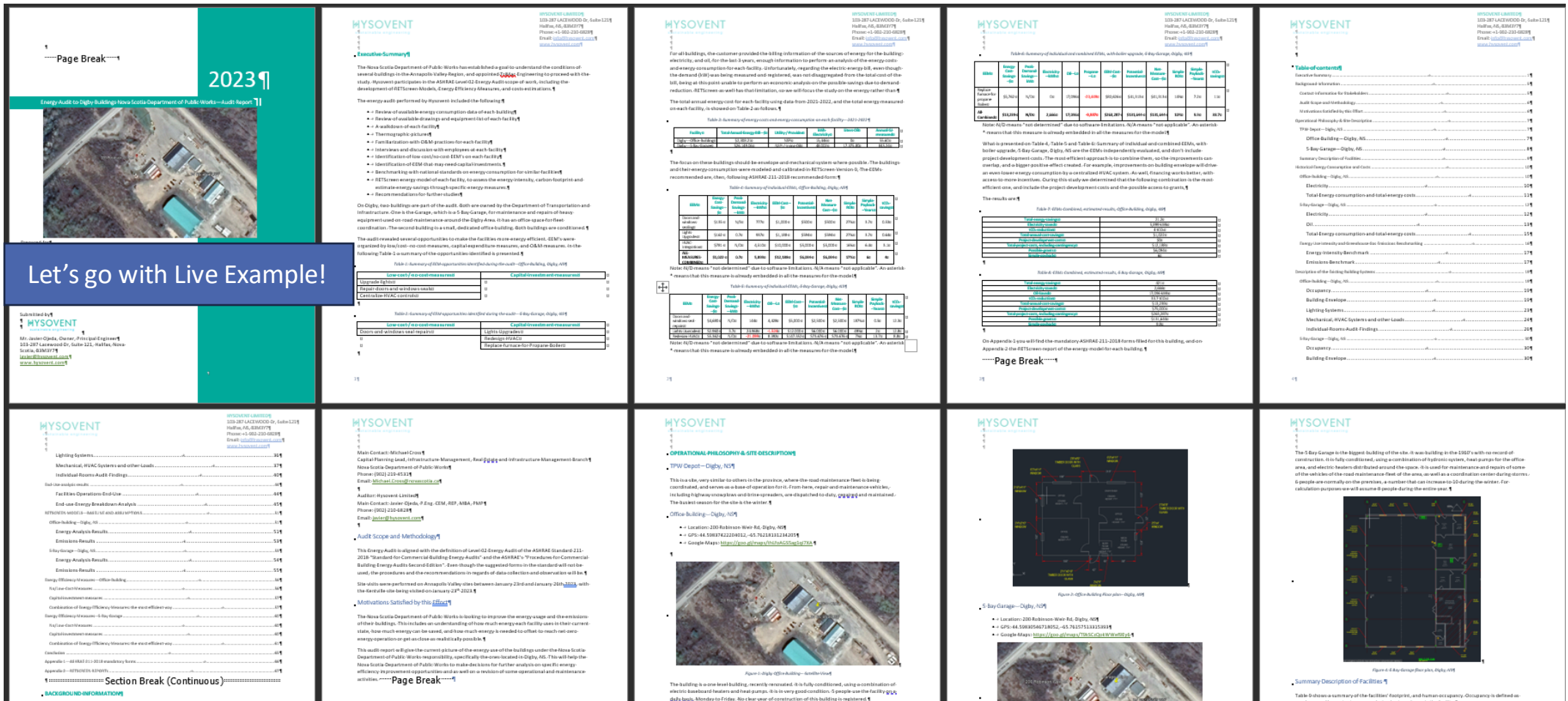
Some Resources
(particularly this one)

• Model Calibration

- Is the process that allows us to compare the energy consumption calculated by the model, with the real energy consumption.
- Good practice: it should be in the range of $\pm 10\%$
- Schedules are important to know, and be able to correctly put them on the model

Let's go with Live Example!

Final Report



Conclusion

- Energy audits are in certain way, unique, even when following a Standard like ASHRAE 211-2018
- Standards and Best practices help to guideline and streamline the audit process, but most importantly: THEY HELP TO PLAN
- Use of templates already available help to reduce time, effort, and homogenize as much as possible the audit processes and the way to show results
- RETScreen is an excellent tool, where a full energy audit can be put, and data analyzed right away.
- As well, it allows to streamline calculations, saving time and adding accuracy
- The large database, continuously being updated, is an excellent asset to have in hand
- You can add not just EEMs, but as well on-site energy generation, and simulate full substitution of systems, and measure the impact on energy consumption, energy costs, and emissions.

DANKE!
THANK YOU!
MERCI!
GRAZIE!
GRACIAS!
DANK JE WEL!

• • • • •

Photo by [Wilhelm Gunkel](#) on [Unsplash](#)

Javier Ojeda
P.Eng, MBA, PMP, CEM, REP
Owner, Principal Engineer
HYSOVENT Sustainable Engineering
Phone: [+1-902-2106828](#)
email: javier@hysovent.com

Hysovent Limited
[103-287 Lacewood Drive, Suite 121, Halifax, NS, B3M3Y7](#)
[Canada](#)
www.hysovent.com



HYSOVENT
sustainable engineering