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

Session F3: Energy Auditing

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Association of Energy Engineers

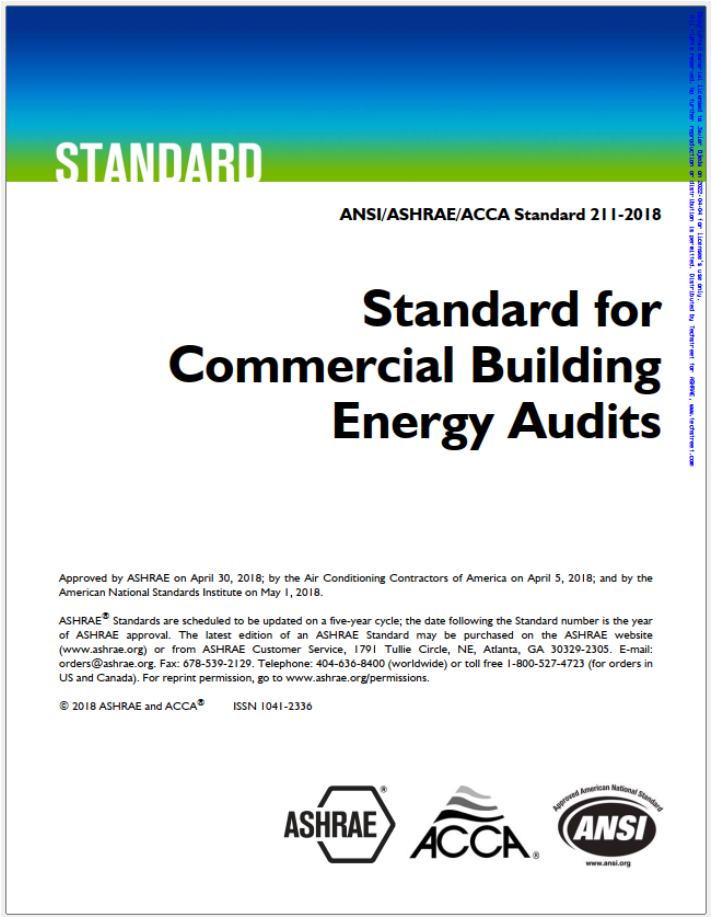
Agenda

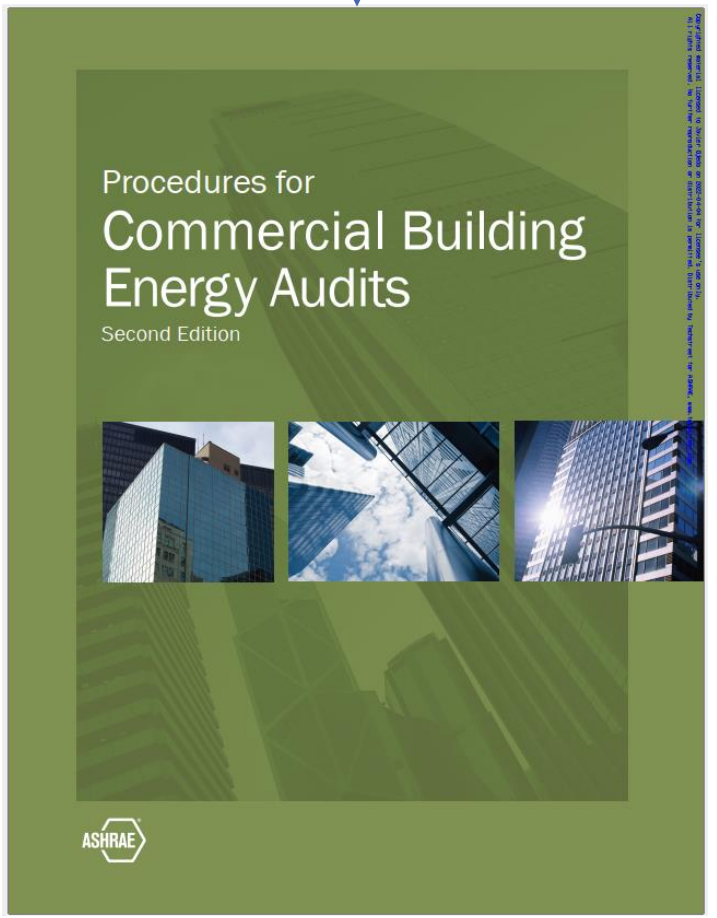
1. Introduction
   - What's ASHRAE 211-2018
   - What's RETSCreen
2. Planning the Audit
   - Audit Scope and Objectives
   - Info that you will need
   - Preliminary Energy Use Analysis
   - Tools
   - Team
3. Conducting the Audit
   - Site Visits
   - Data Analysis – RETScreen + Excel + ASHRAE Forms
   - Report Structure
4. After the audit
   - RETScreen Energy Modeling
   - Model Calibration
   - EEM's and their simulation in RETScreen
5. Final Report

Introduction

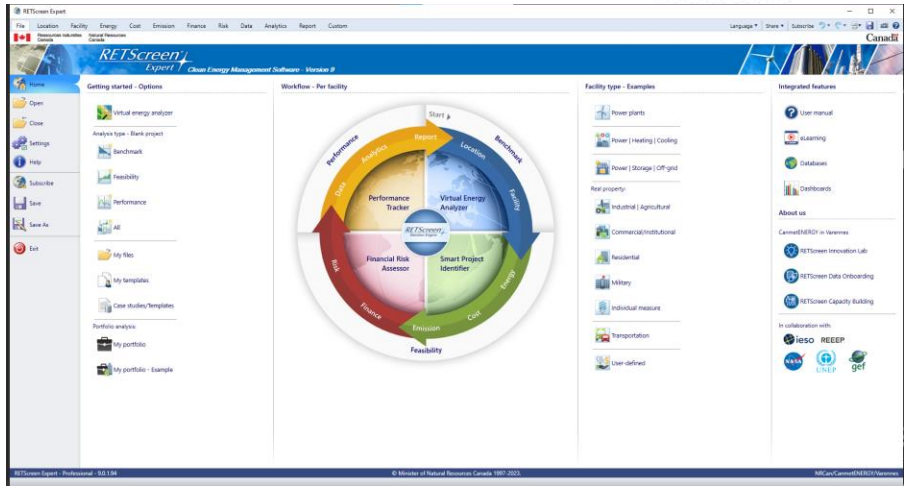
- The ASHRAE 211-2018 Standard
  - A complement to the **PCBEA**
  - Brings order into chaos of Energy Audits
  - Establishes energy audit levels 1, 2, 3
  - Establishes Preliminary Energy Use Analysis Methods
  - Establishes a minimum performance standard for energy audits

This is the PCBEA!



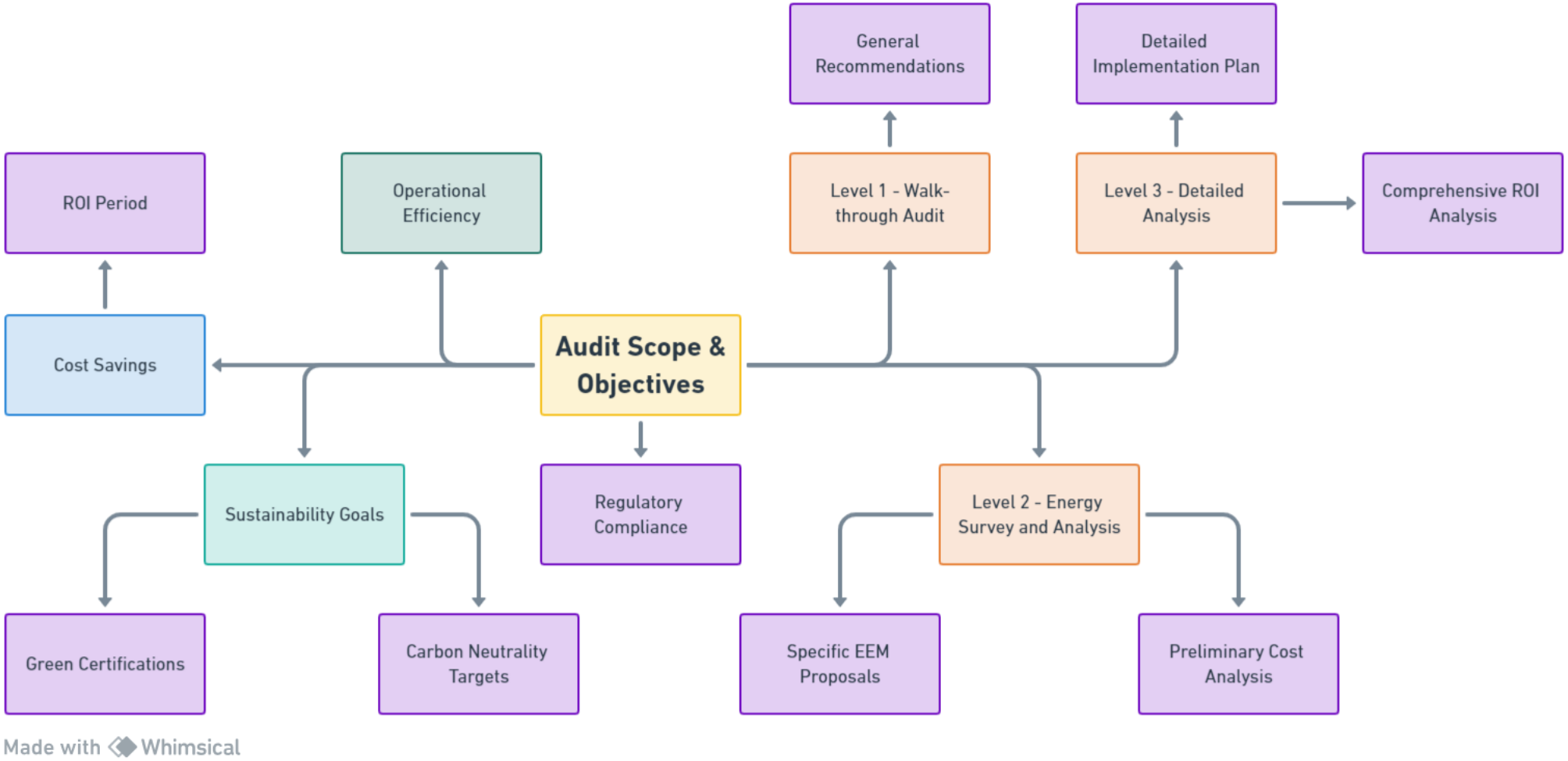


Introduction

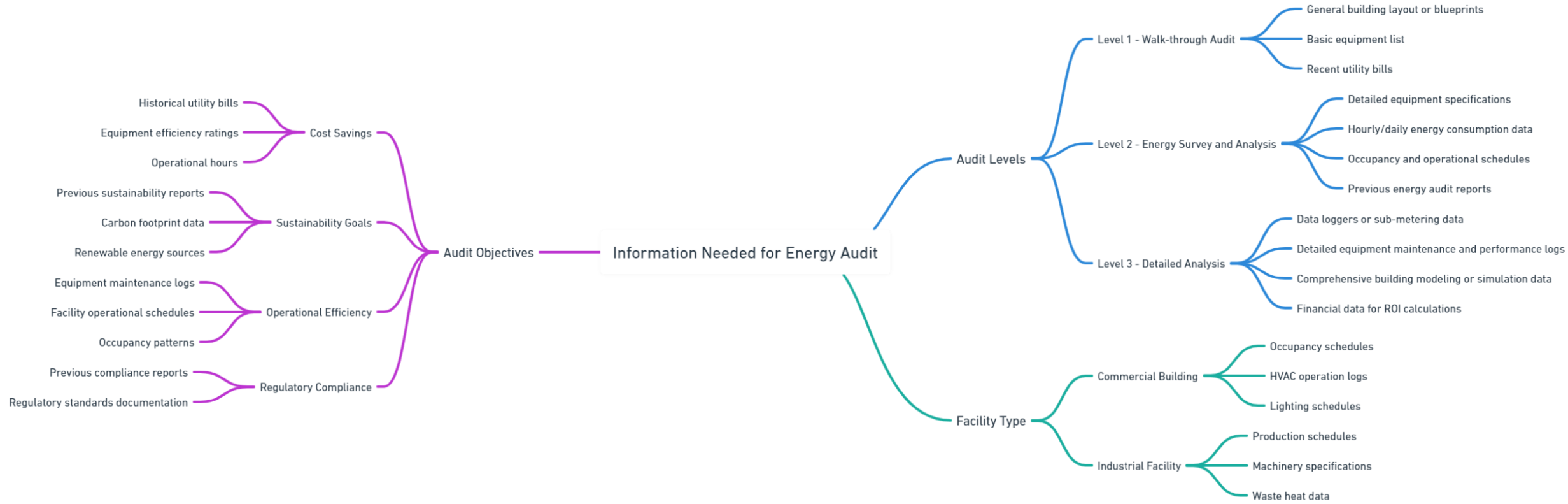


- What's RETScreen
  - RETScreen is a free software tool developed by Natural Resources Canada (NRCan) to assist in the evaluation of the viability and energy performance of renewable energy and energy efficiency projects.
  - Project Viability Analysis
  - Energy Modeling
  - Performance Analysis
  - Benchmarking

Planning the Audit



Planning the Audit

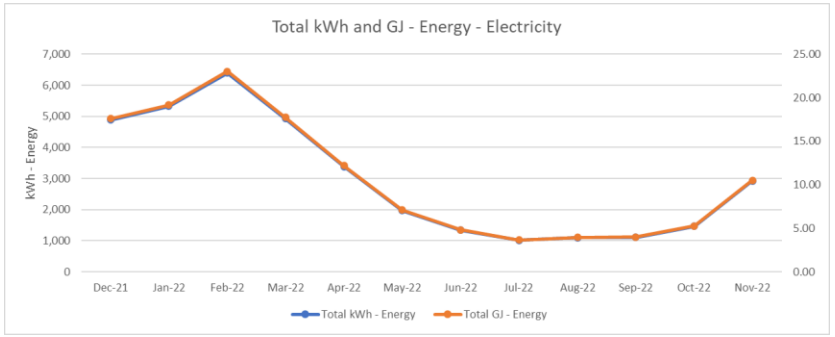


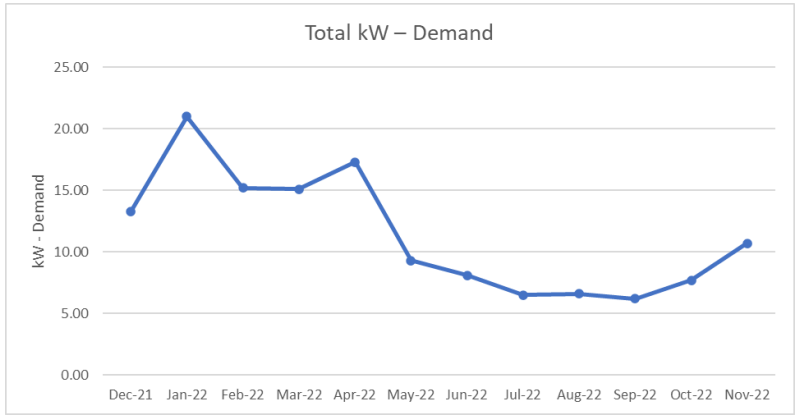
Made with Whimsical

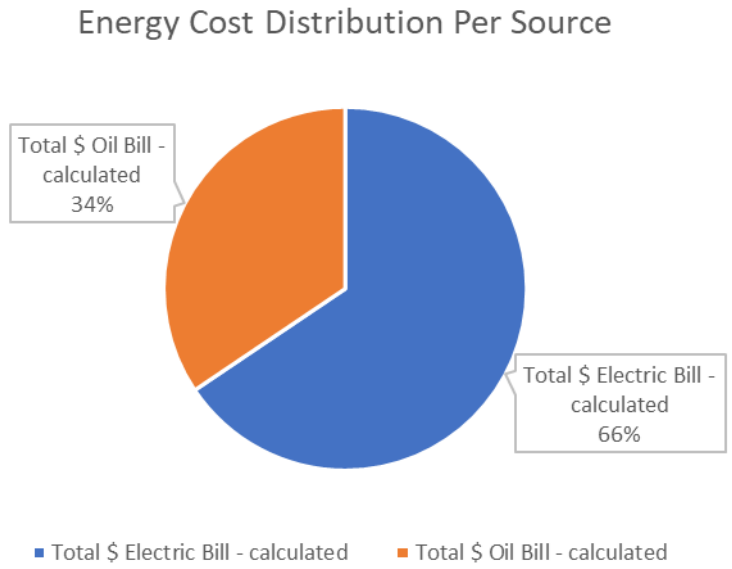
Planning the Audit

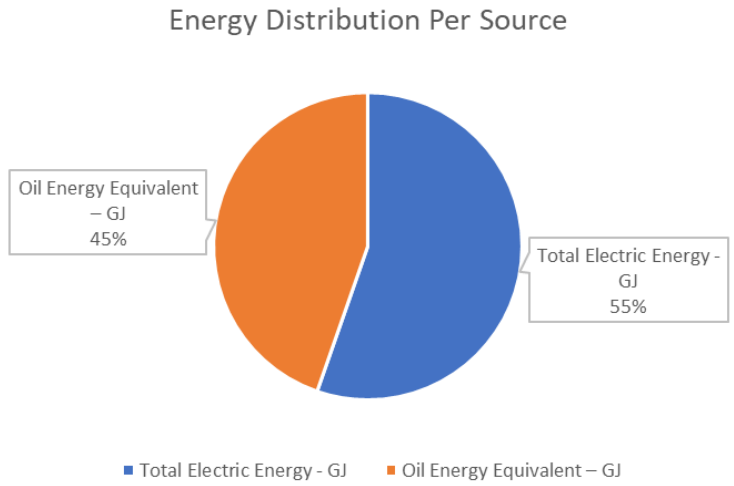
Preliminary Energy Use Analysis:

- 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









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ASHRAE Free Templates

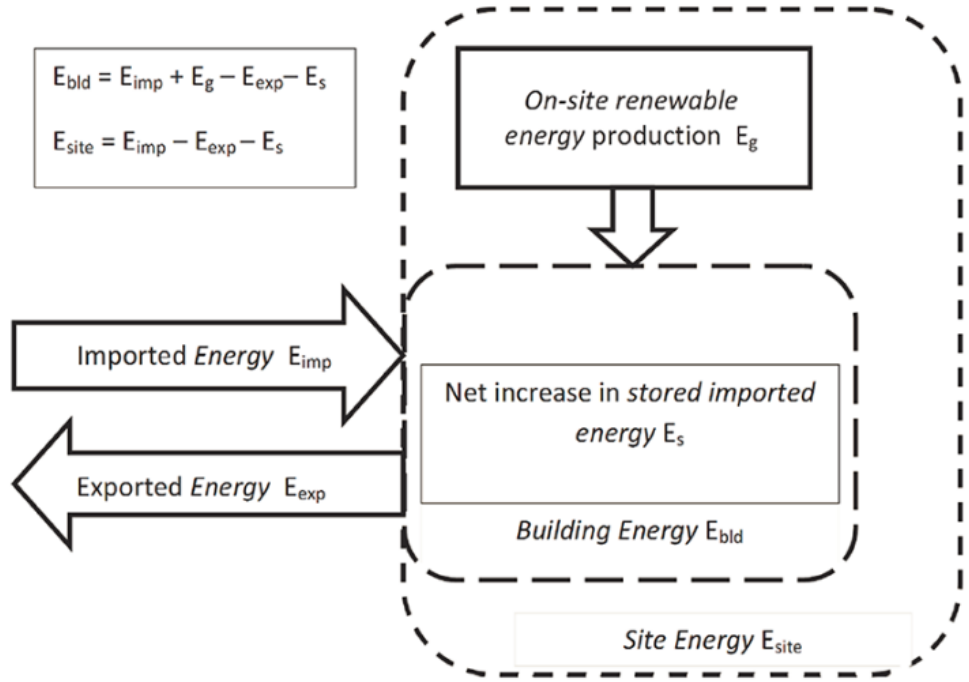


Figure 1 Relationship of site energy (E_{site}) and building energy (E_{bld}). From ASHRAE 211-2018, page 5

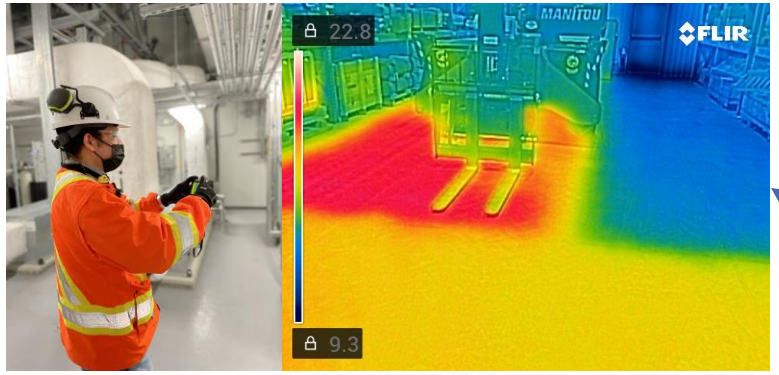
EUI: Energy Use Intensity

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

ECI: Energy Cost Index

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

Planning the Audit



TOOLS FOR THE ENERGY AUDIT

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ASHRAE **Free Templates**

Planning the Audit

The Audit Team

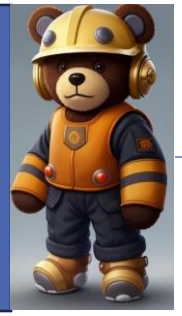
- I'll depend on how deep are you going in the energy audit, and what are the goals from it

- **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

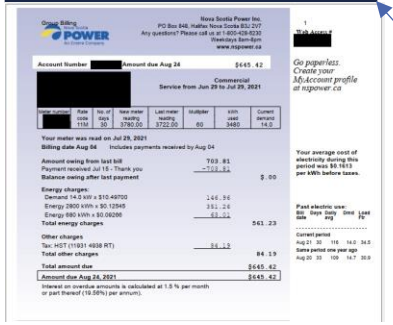
- Site Visits
  - Stick to your plan… unless reality hits you in the face!

SAFETY toolbox meeting



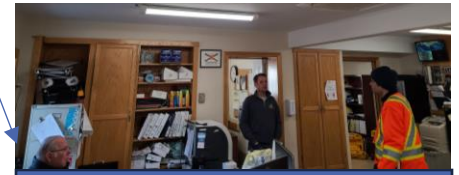
Preliminary Walkthrough

Documentation



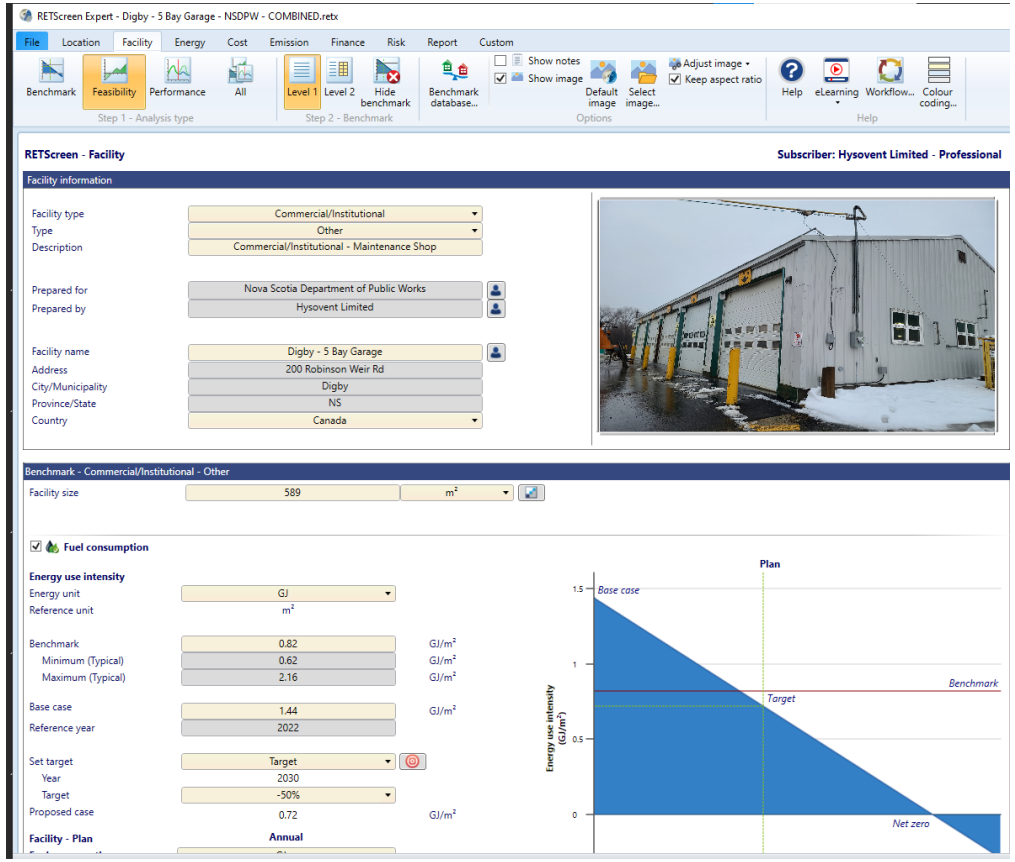
Equipment Checks

Data Collection



Interviews

Conducting the Audit



Let's go with Live Example!

- Data Analysis – RETScreen + Excel + ASHRAE Forms

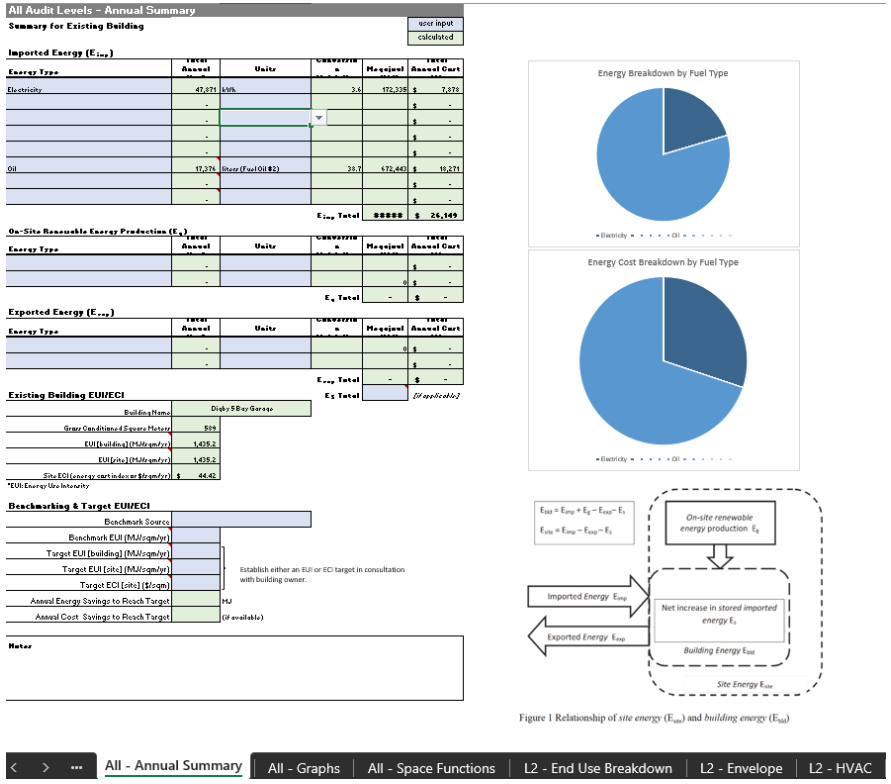


Figure 1 Relationship of *site energy* (E_{site}) and *building energy* (E_{bld})

Conducting the Audit – Report Structure

1. Executive Summary

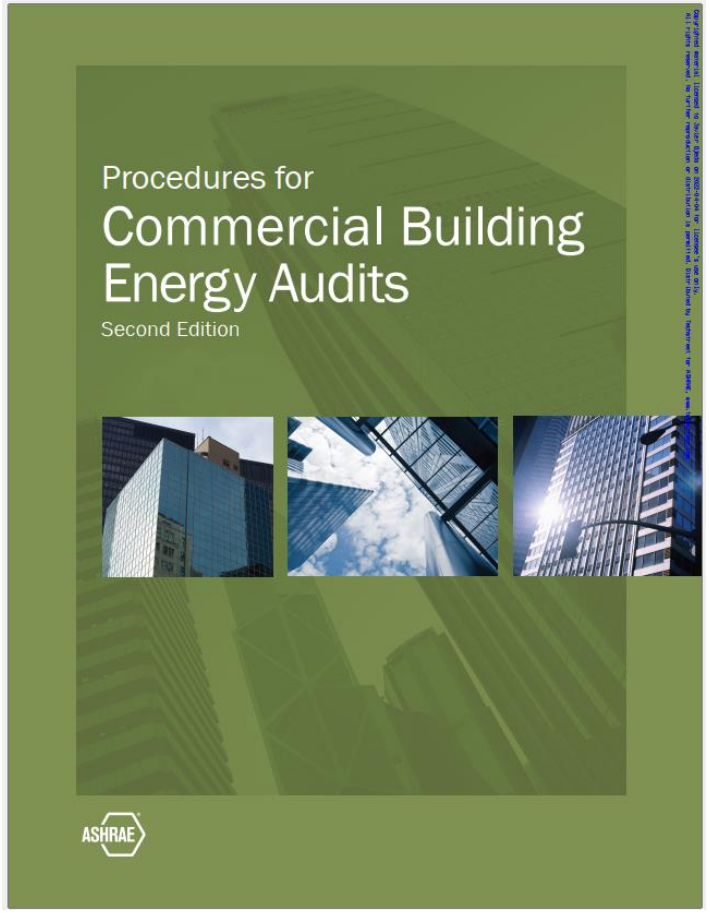
- Brief background and summary of scope
- EEM (Energy Efficiency Measures) summary table
- Summary of benchmarking results

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.

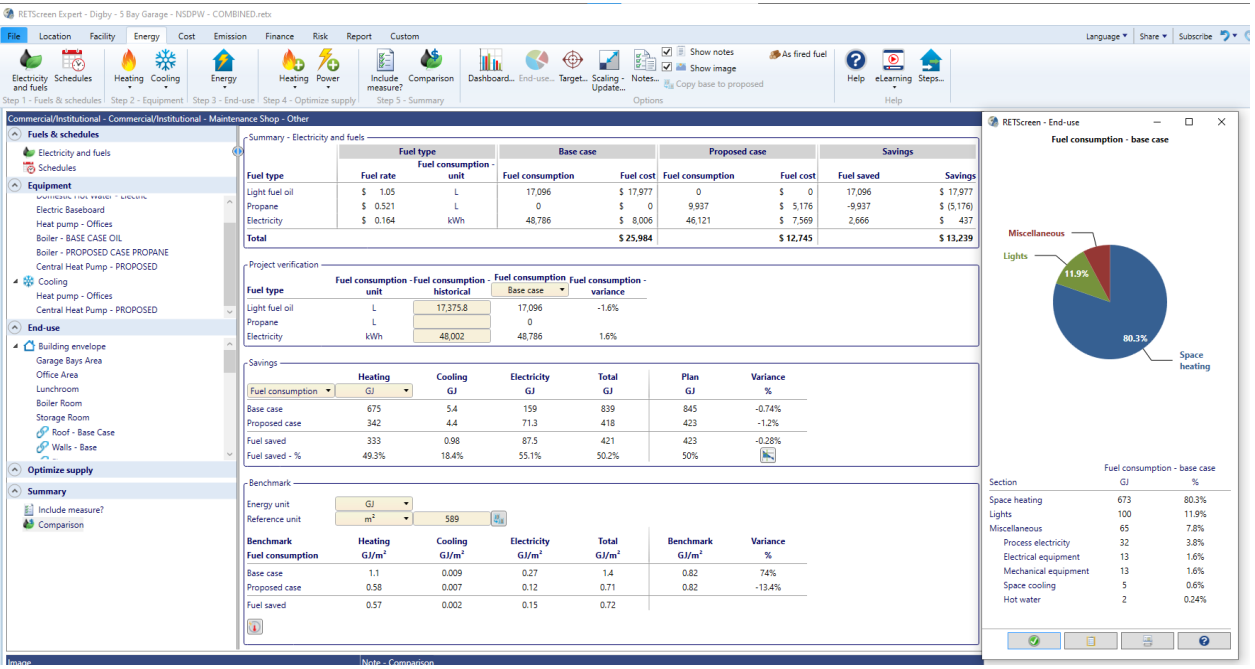
5. Supporting Information

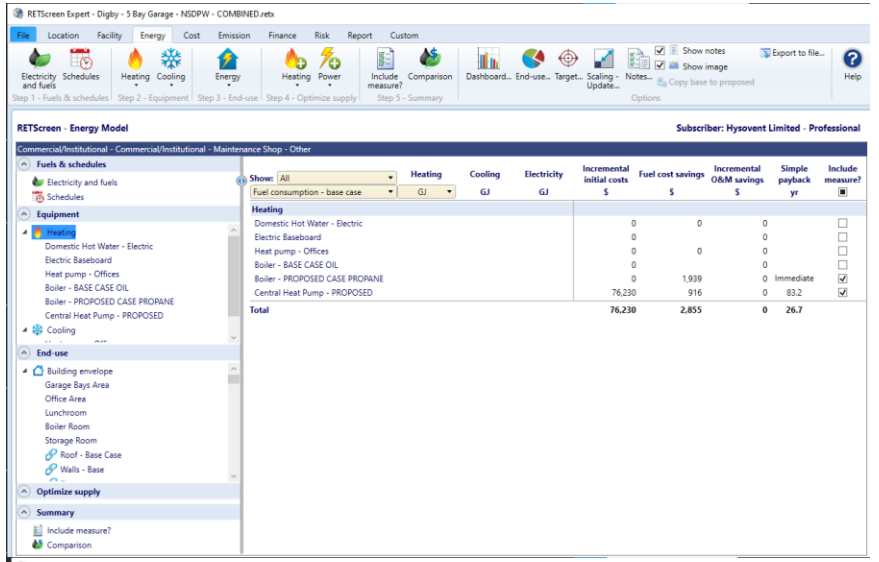
- Analysis
- Measured data or monitoring results
- Manufacturers' information or "cut sheets"
- Plans and sketches
- Additional information or specifications

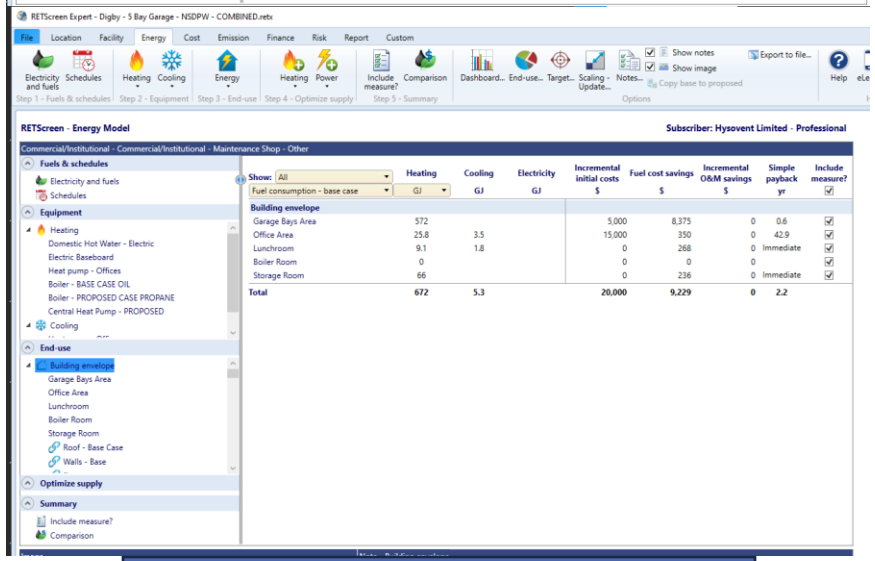
Let's go with Live Example!

After the Audit

- RETScreen Energy Modeling







Let’s go with Live Example!

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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, *Measurement of Energy and Demand Savings* (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, Measuring, Modeling, Analysis, and Reporting Protocols for Short-Term M&V of Whole Building Energy (ASHRAE n.d.) *International Performance Measurement and Verification Protocol* (IPMVP) (EERE 2002) *M&V Guidelines: Measurement and Verification for Federal Energy Projects* (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 ±10%
  - Schedules are important to know, and be able to correctly put them on the model

Let's go with Live Example!

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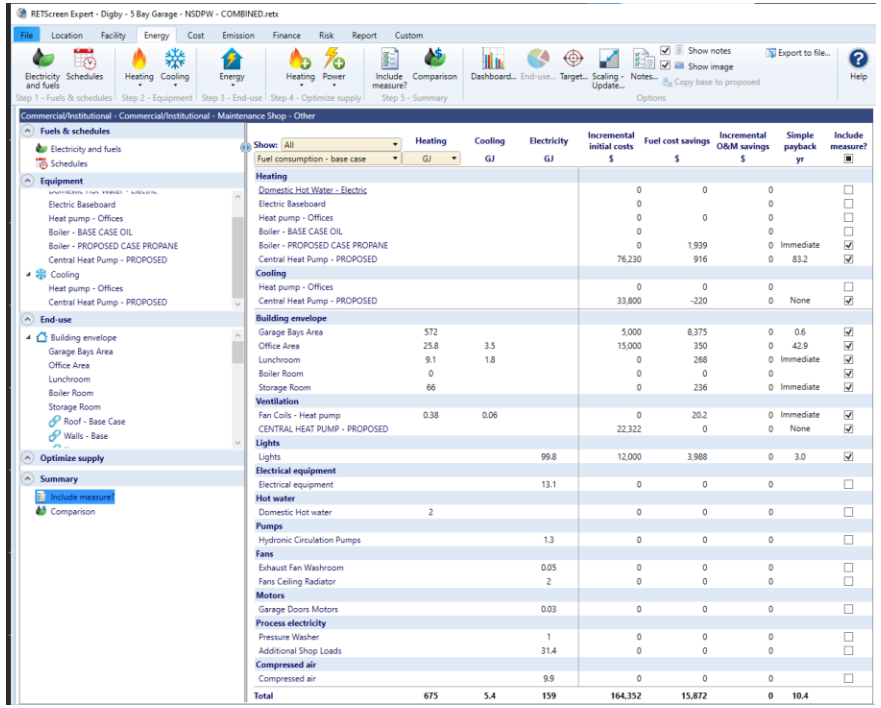
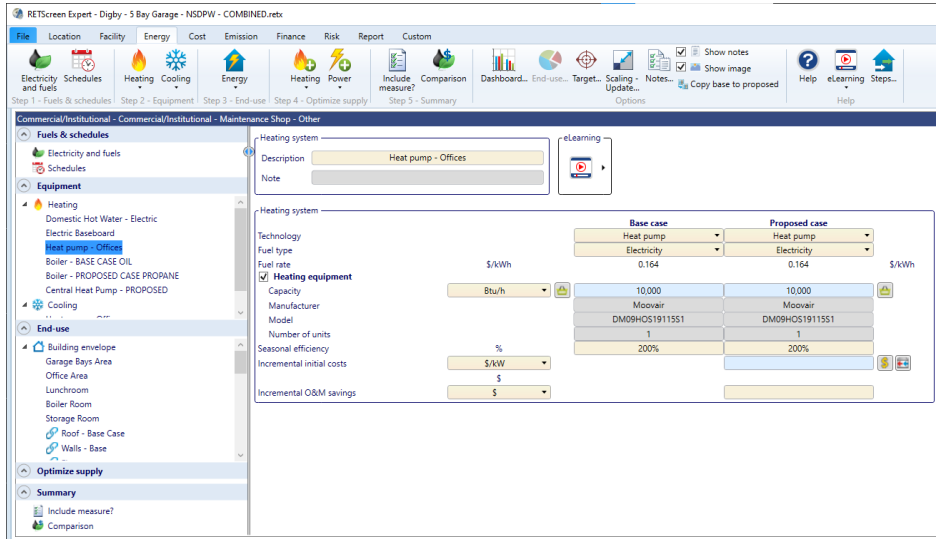
After the Audit

- EEM's and their simulation in RETScreen





Let's go with Live Example!

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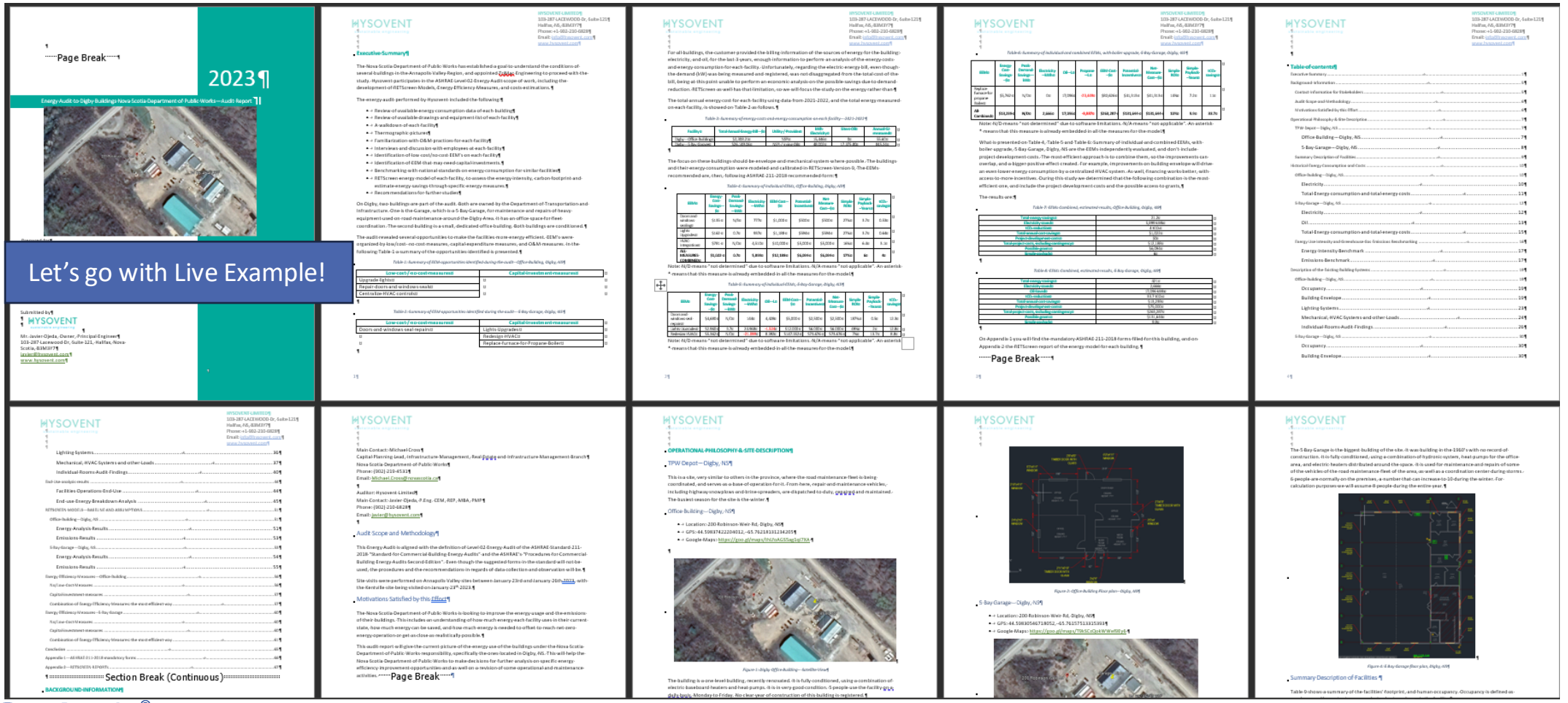
Final Report



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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.

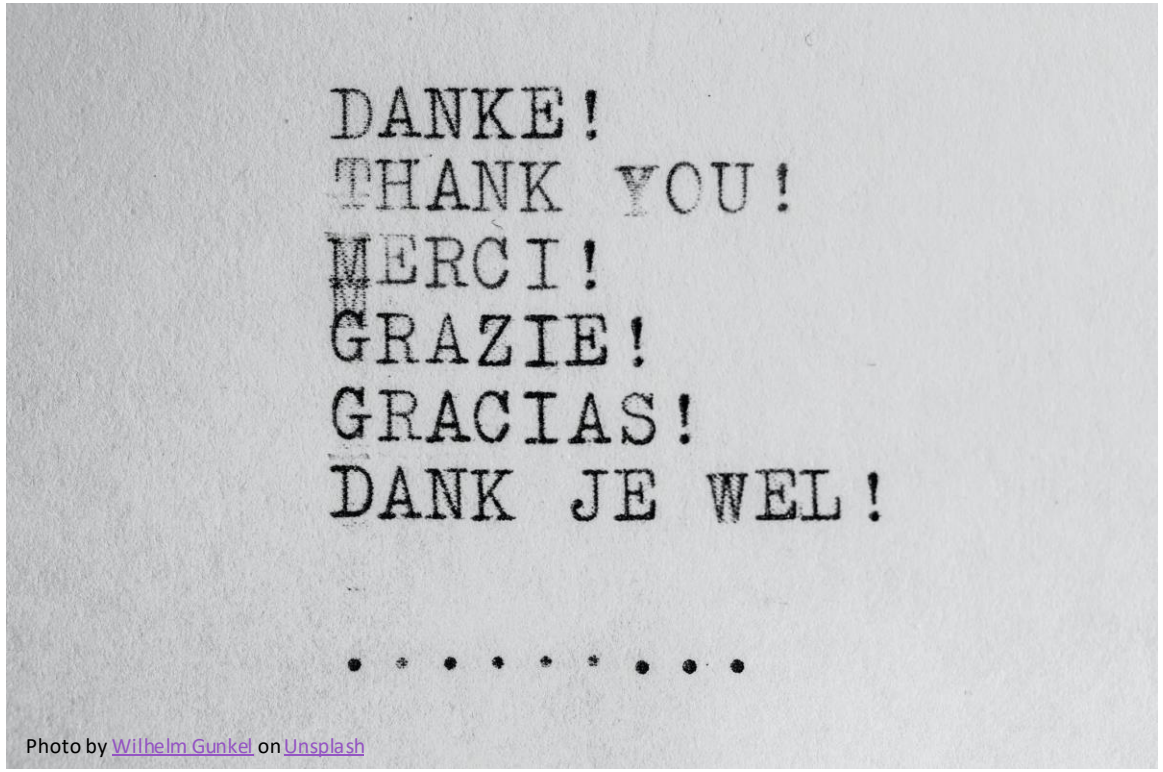
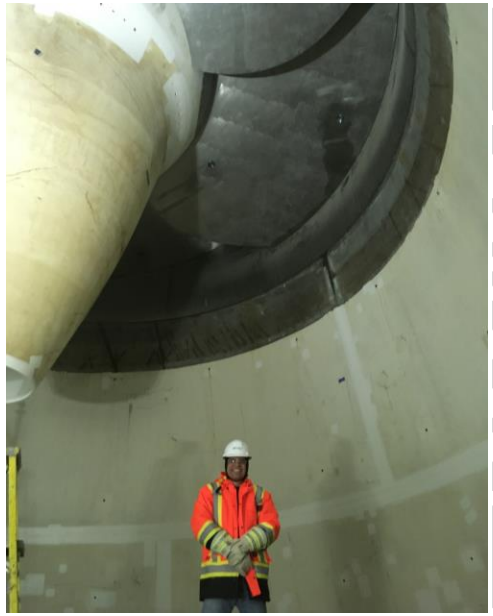


Photo by Wilhelm Gunkel on Unsplash



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