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Efficient electrification workshop #4 – Part 1: Modelling HVAC with RETScreen Expert

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Agenda

- Welcome and introductions
- Quick overview of RETScreen Expert
- Overview of how to use RETScreen Expert to model HVAC systems
- Presentation of HVAC circumstances
- HVAC circumstances
- Modelled results and solutions
- Cautions to avoid poor results
- Wrap-up and Q and A

Quick overview of RETScreen Expert

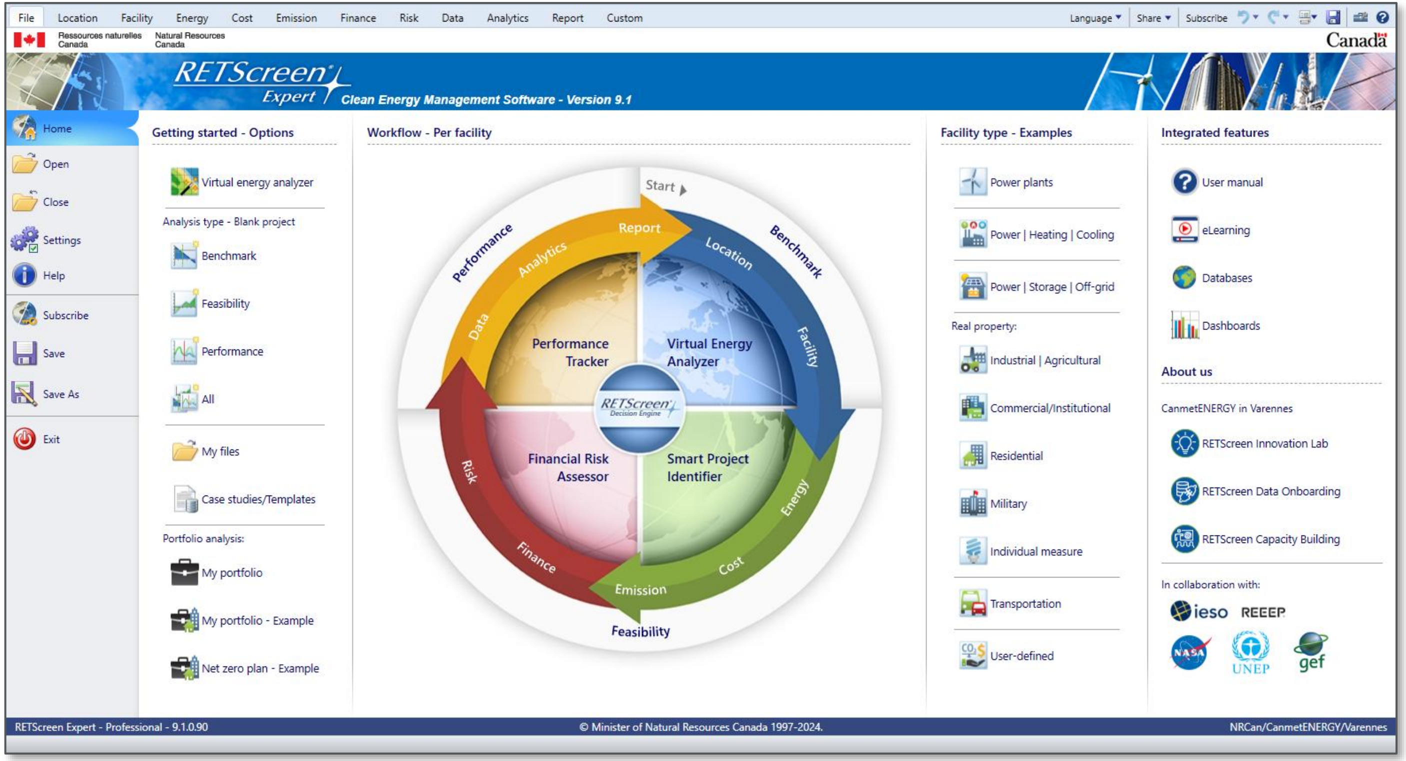
RETScreen Expert

- Intelligent decision support tool to enable stakeholders to rapidly identify, assess, optimize and track the performance of clean energy investments over the entire project life cycle
- 38 languages covering two thirds of the world's population

RETScreen development

- Natural Resources Canada (CanmetENERGY)
- Renewable Energy and Energy Efficiency Partnership
- Independent Electricity System Operator
- United Nations Environment Programme
- National Aeronautics and Space Administration
- Global Environment Facility

The complete toolbox! Let’s take a quick look



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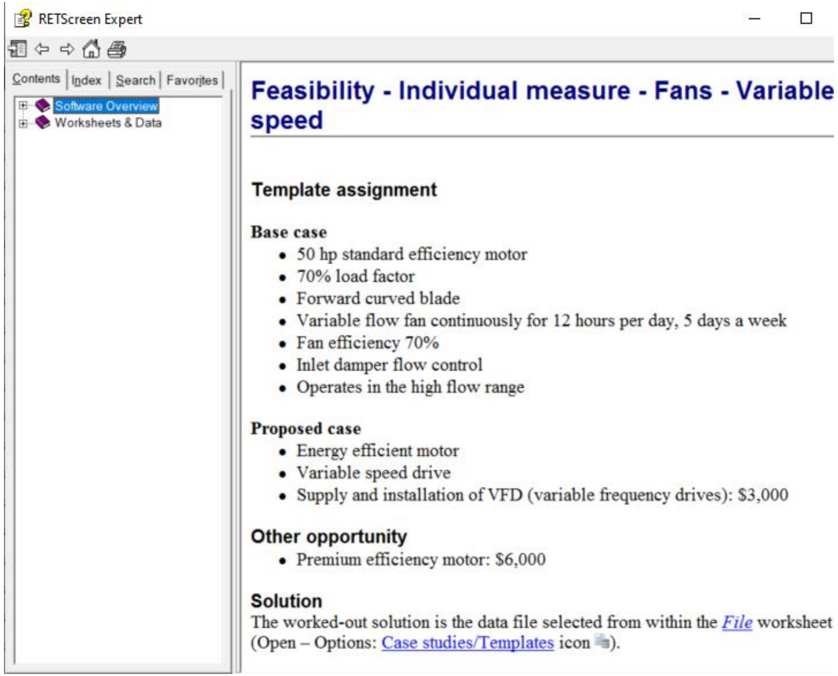
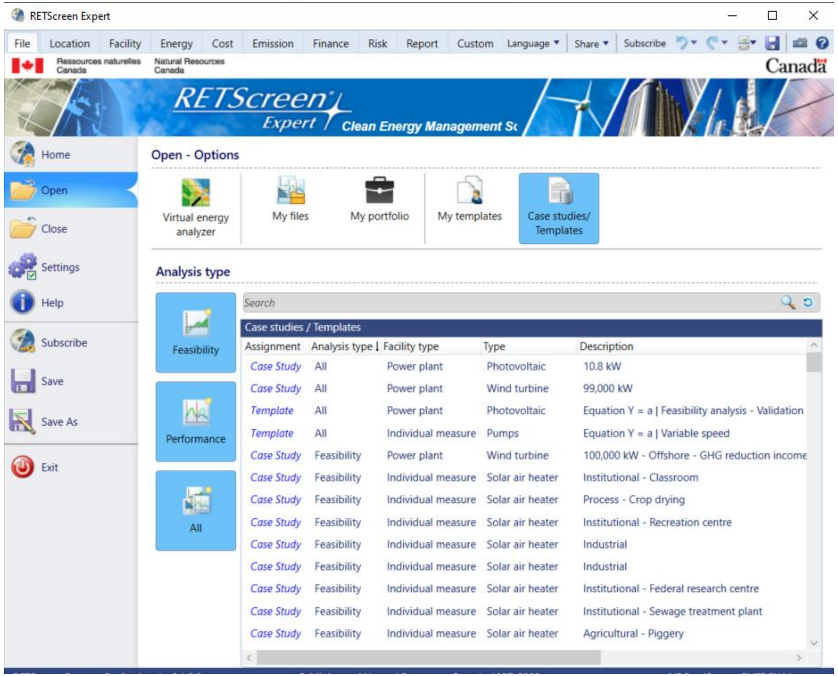
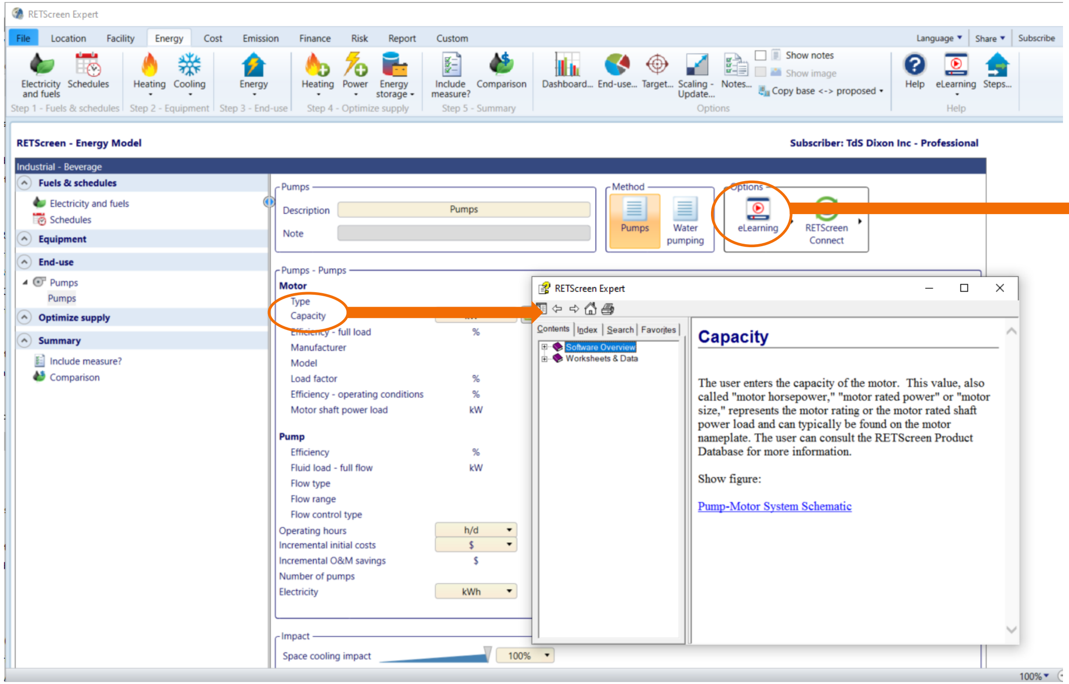
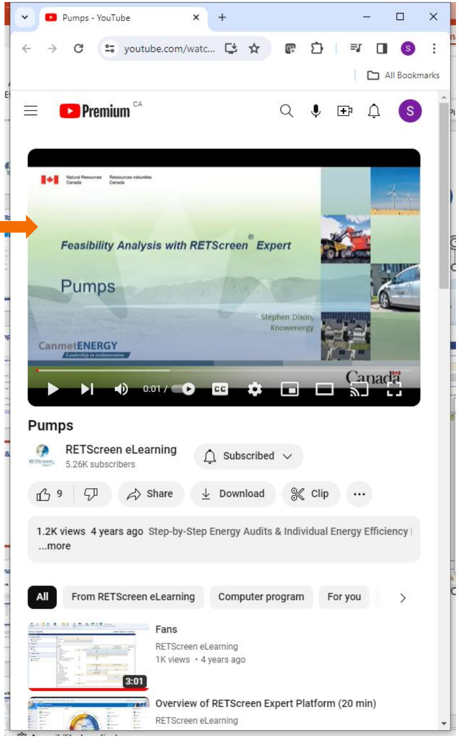
Learning resource – case studies and templates





Learning resource – contextual text and video help

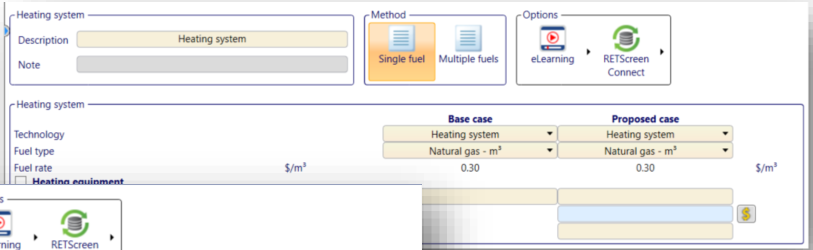


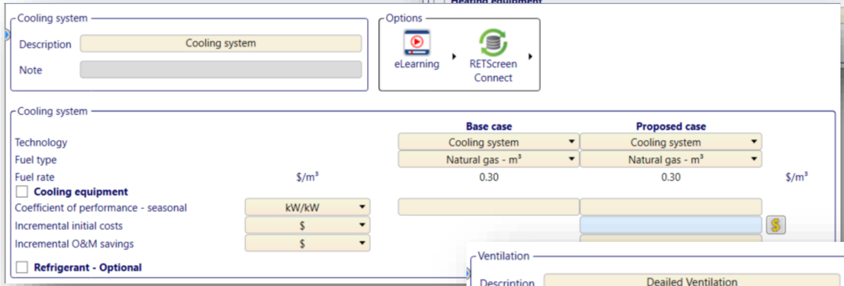


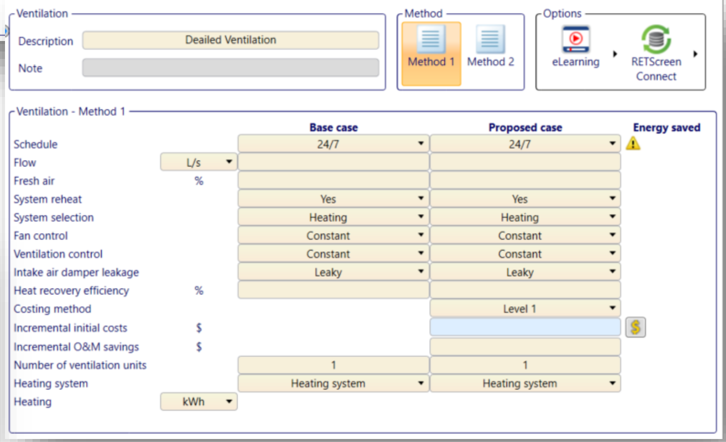
Modelling a basic HVAC system

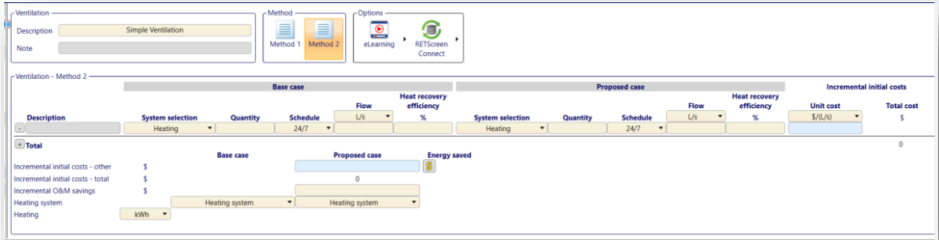
The RETScreen HVAC models

- Heating systems
- Cooling systems
- Ventilation models
  - Level 1: Detail
  - Level 2: Simple

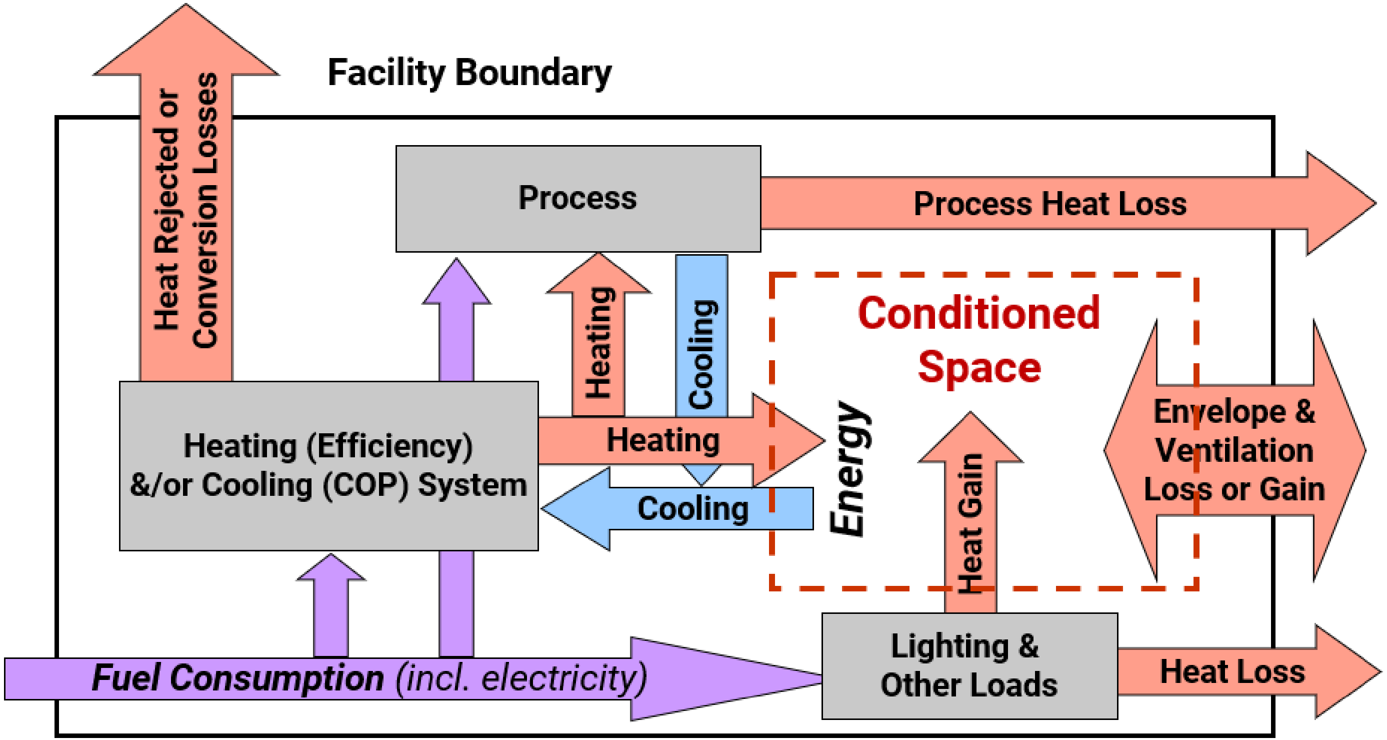




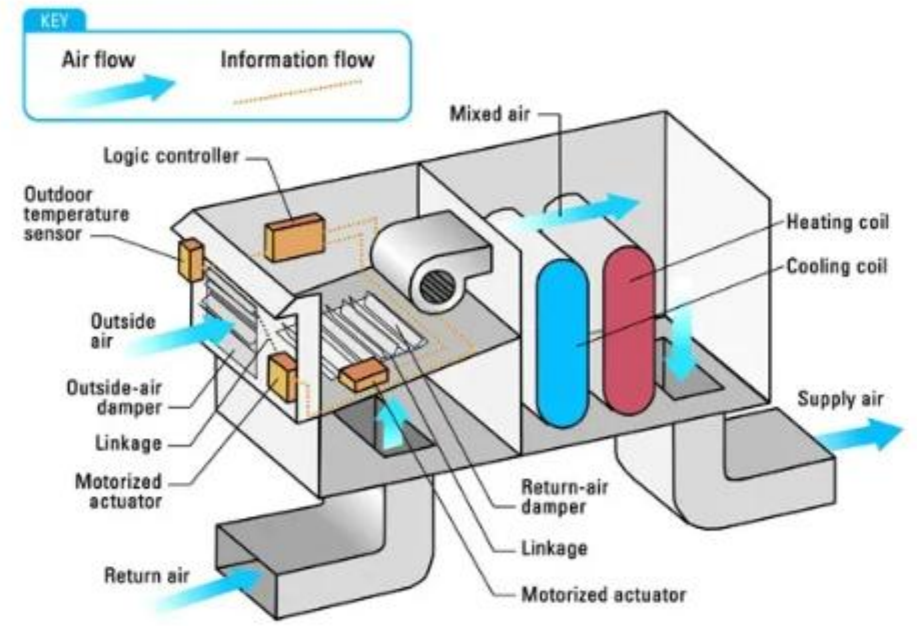




RETScreen and HVAC energy balances

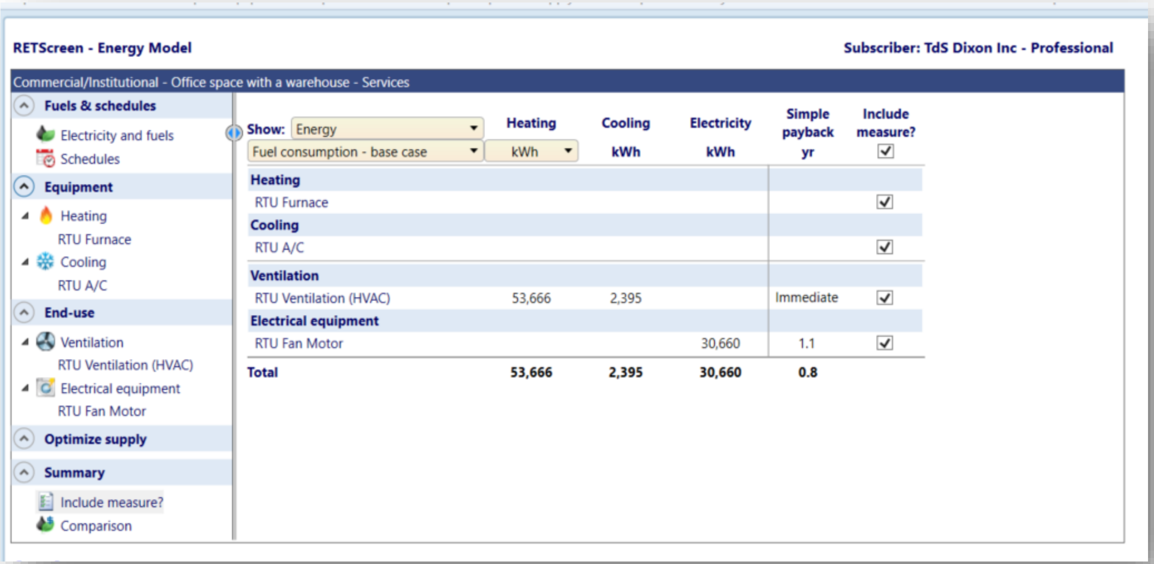


Heating, ventilation and cooling with a rooftop unit (RTU)



Models required

- Electricity and fuels
- Schedules
- Heating system
- Cooling system
- Ventilation
- Motor/fan



Demonstration – build the system

There is one rooftop unit providing space heating and cooling to the building:

- The heating equipment is a furnace with a seasonal efficiency of 80%
- The cooling equipment is a compressor unit with a seasonal COP of 3.0

Base Case – Office and Warehouse Ventilation (Method 1)

- Building is cooled to 21°C, on the same schedule as heating
- 5,000 cfm capacity rooftop unit provides ventilation, with heating and cooling as required
- Ventilation (fresh air) is 20% os system airflow
- The fan is driven by a 5hp motor (measured at 3.5 kW) (set heating and cooling impact to 0%)
- The ventilation system operates 24 hours 7 days a week (constant)
- Dampers have medium leakage
- The system does not have heat recovery

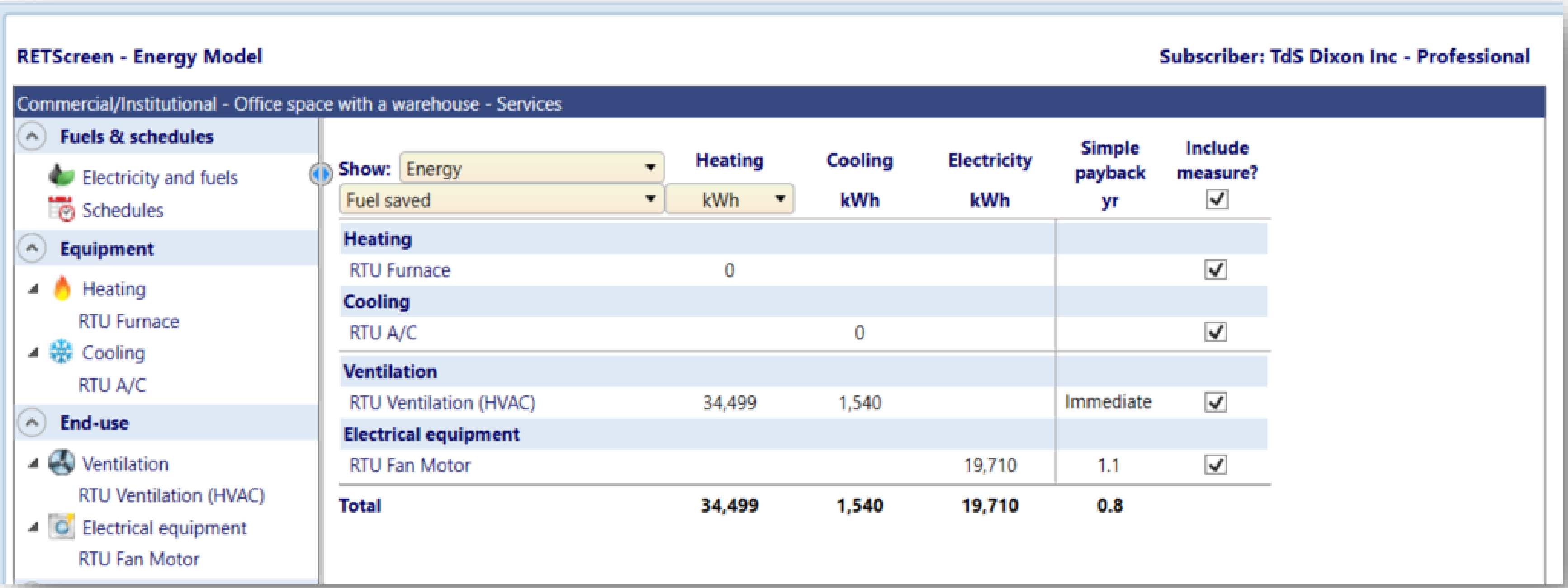
Now let's improve the system

Proposed Case

- The building is only occupied 10 hours per day, 6 days per week
- Modify the fan and ventilation control to operate according to the occupancy schedule
  - You will need to add a schedule in the model
- Implement a night time setback and set up of 4°C during unoccupied periods
- Cost of controls to implement fan, ventilation, and temperature control is $3,000

Hint: You need to define a new Schedule, Heating equipment, Cooling equipment, two Ventilation equipment sheets and a Fan motor sheet (under Electrical equipment)

Results of model



	Heating kWh	Cooling kWh	Electricity kWh	Simple payback yr	Include measure?
Heating					
RTU Furnace	0				✓
Cooling					
RTU A/C		0			✓
Ventilation					
RTU Ventilation (HVAC)	34,499	1,540		Immediate	✓
Electrical equipment					
RTU Fan Motor			19,710	1.1	✓
Total	**34,499**	**1,540**	**19,710**	**0.8**	

What have we modelled?

Key elements

1. RETScreen always models single zone systems.
2. Most RETScreen models consider the system to be able to provide both heating and cooling (i.e. switchover systems).
3. Economizer free cooling operation is not considered in RETScreen.

System type

Know your systems before modelling them in RETScreen

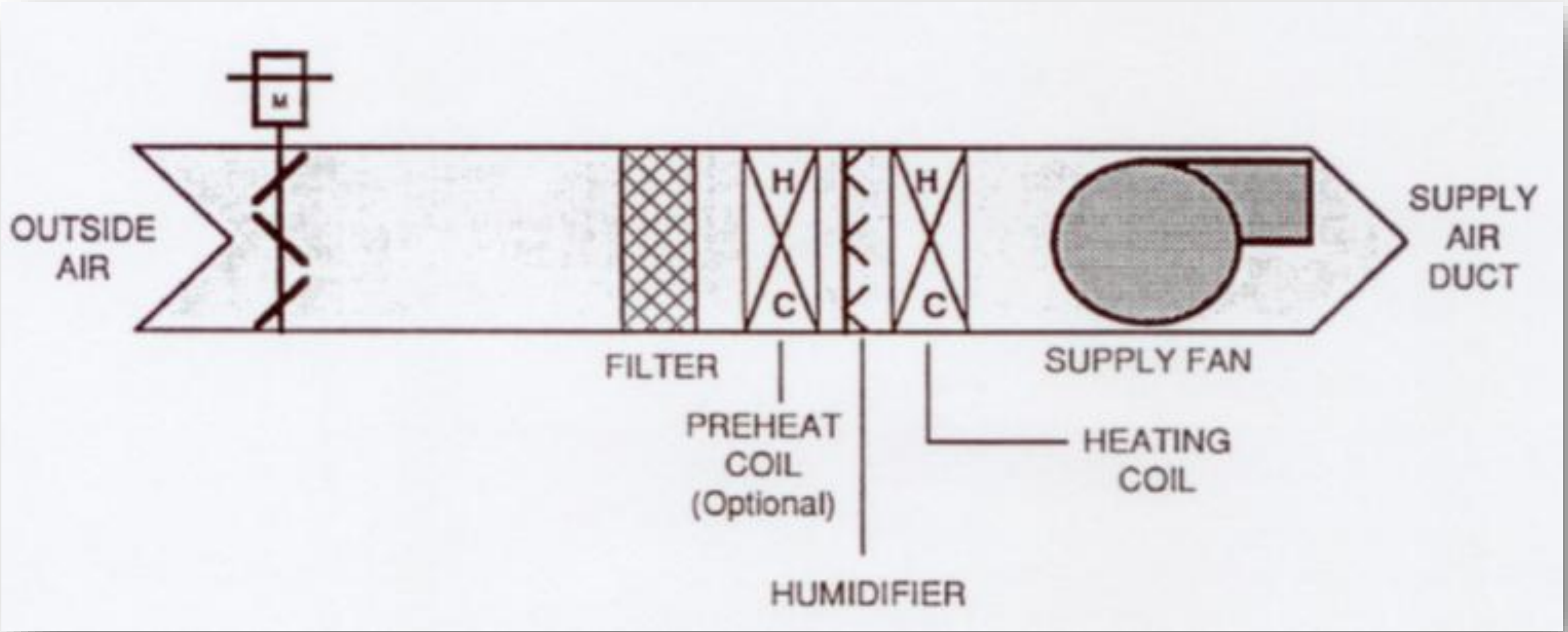
HVAC system services

- Always identify what services your HVAC system provides to spaces
- Typically, a system can provide the following, but most systems do NOT provide all these services:
  1. Space heating (in contrast to outdoor air heating)
  2. Space humidification
  3. Space cooling
  4. Space air filtration
  5. Ventilation (i.e. bringing in outdoor air)

Circumstance/scenario 1

Case study situation

- Make-up air (MUA) system



Services provided

- Ventilation only!
- MUA will pre-condition the outdoor air but does not provide space heating, cooling, humidification and filtration
  - The presence of filters, heating and cooling coils and a humidifier does not mean it is used for space air conditioning
  - It is a **cold-deck** system

Cold-deck system: A cold-deck system refers to a design whereby air is distributed to various zones or areas within a building at a temperature at or below a space temperature set point. Cold deck systems are often contrasted with hot-deck systems whereby air is heated and then distributed.

Case study situation results

Ventilation

Description	Makeup Air Unit
Note	

Method: Method 1, Method 2

Options: eLearning, RETScreen Connect

Ventilation - Method 2

	Base case					Proposed case				
Description	System selection	Quantity	Schedule	Flow (cfm)	Heat recovery efficiency %	System selection	Quantity	Schedule	Flow (cfm)	Heat recovery efficiency %
	Heating & cooling	1	24/7	10,000	0%	Heating & cooling	1	24/7	10,000	70%

Total

		Base case	Proposed case	Energy saved
Incremental initial costs - other	$			
Incremental initial costs - total	$		0	
Incremental O&M savings	$			
Heating system		Furnace	Furnace	
Heating	kWh	446,299	133,890	312,409
				70%
Cooling system		AC	AC	
Cooling	kWh	79,150	23,745	55,405
				70%

Cautions

- Only model the make-up <u>or</u> exhaust (relief) flows – not both
  - The exhaust fan is modelled but not its flow
- As it is a cold-deck system, be mindful of the associated schedule
- MUA Schedule should be set higher than space temperature, such as 2 ^{o}C higher

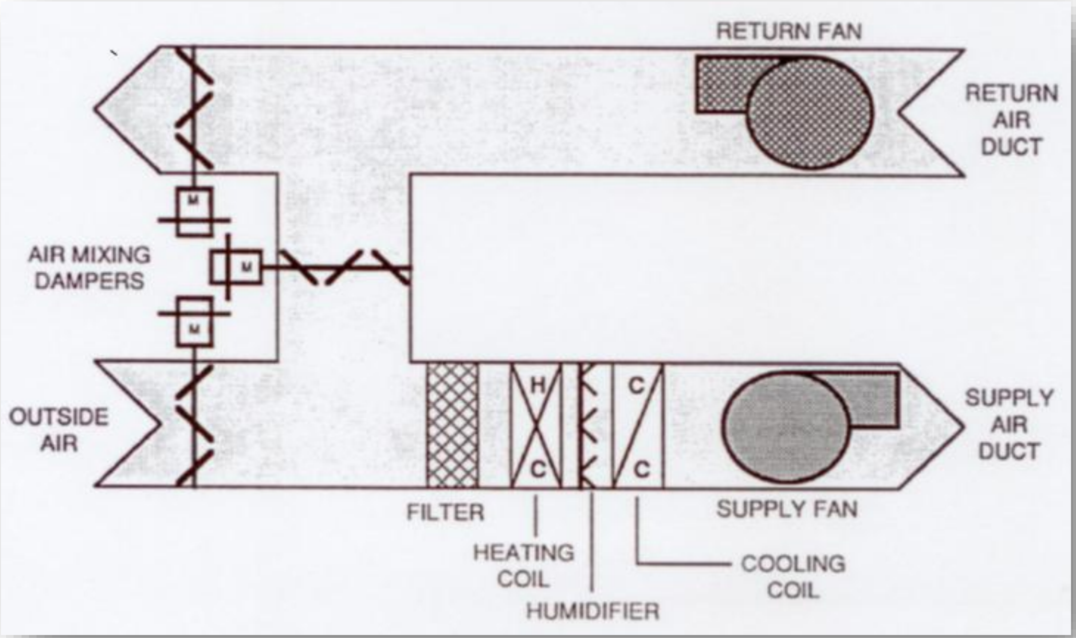
Schedules

Description		24/7	MUA
Occupied			
Temperature - space heating	°C	22	24
Temperature - space cooling	°C	22	24
Unoccupied			
Temperature - space heating	°C		18
Temperature - space cooling	°C		24
Occupancy rate - daily			
Monday	h/d	24	24
Tuesday	h/d	24	24
Wednesday	h/d	24	24
Thursday	h/d	24	24
Friday	h/d	24	24
Saturday	h/d	24	24
Sunday	h/d	24	24
Occupancy rate - annual	h/yr	8,760	8,760
	%	100%	100%
Heating/cooling changeover temperature	°C	16	
Length of heating season	d	240	
Length of cooling season	d	125	

Circumstance/scenario 2

Case study situation

- Constant volume system – single zone



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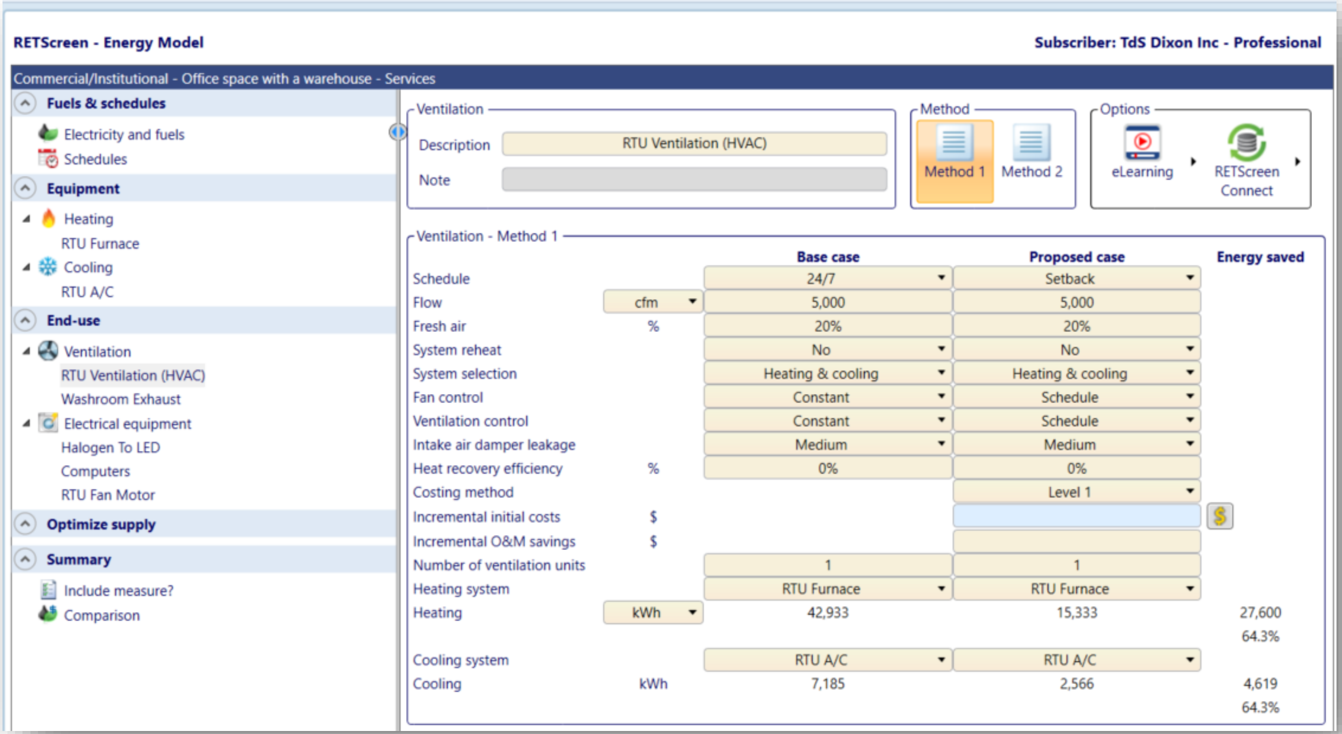
Services provided

- This system can provide all 5 services
- It is typically controlled by a space thermostat
  - It is a **switch-over** being cold-deck when there is a cooling call and hot-deck when there is a heating call
- This system is the basis for the ventilation element in RETScreen

Case study situation results



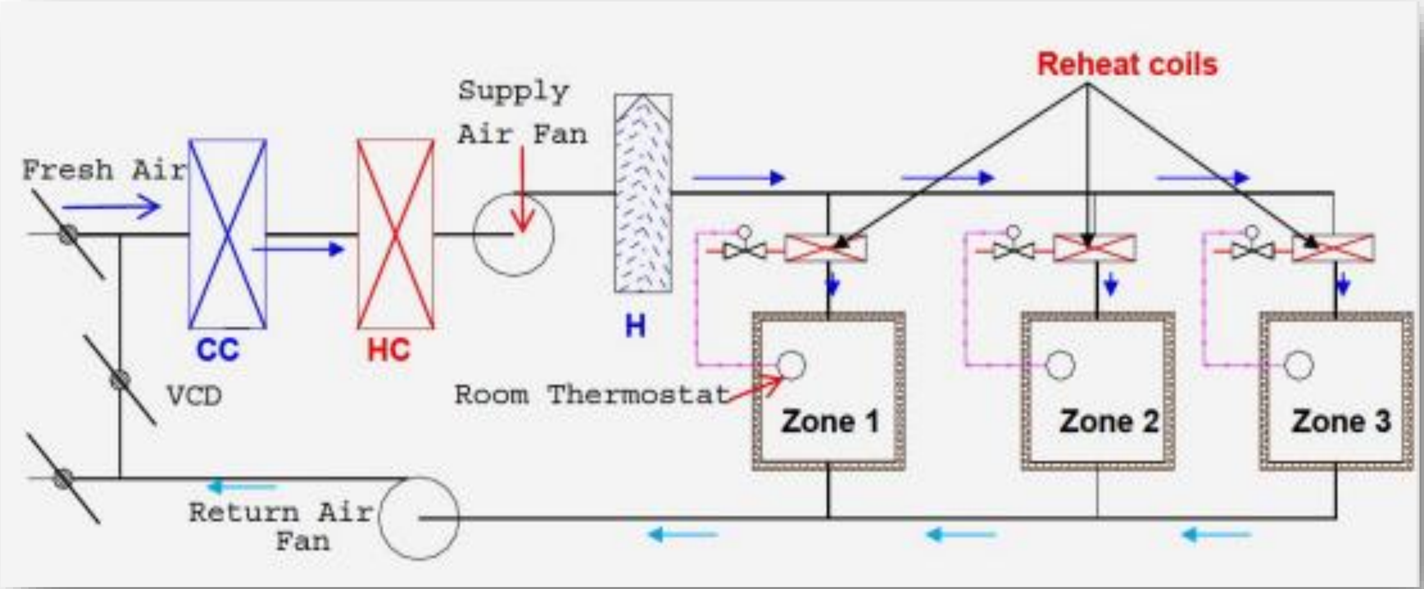
Cautions

- The system does not respond to a call from space heating and cooling
  - Heating and cooling are only for heating and/or cooling mixed air to the schedule set point
- Free cooling is not considered
- Associated exhaust flows are only defined if they are superior to the % defined in the ventilation element
  - Exhaust fan motors are still defined

Circumstance/scenario 3

Case study situation

- Constant volume system with reheat



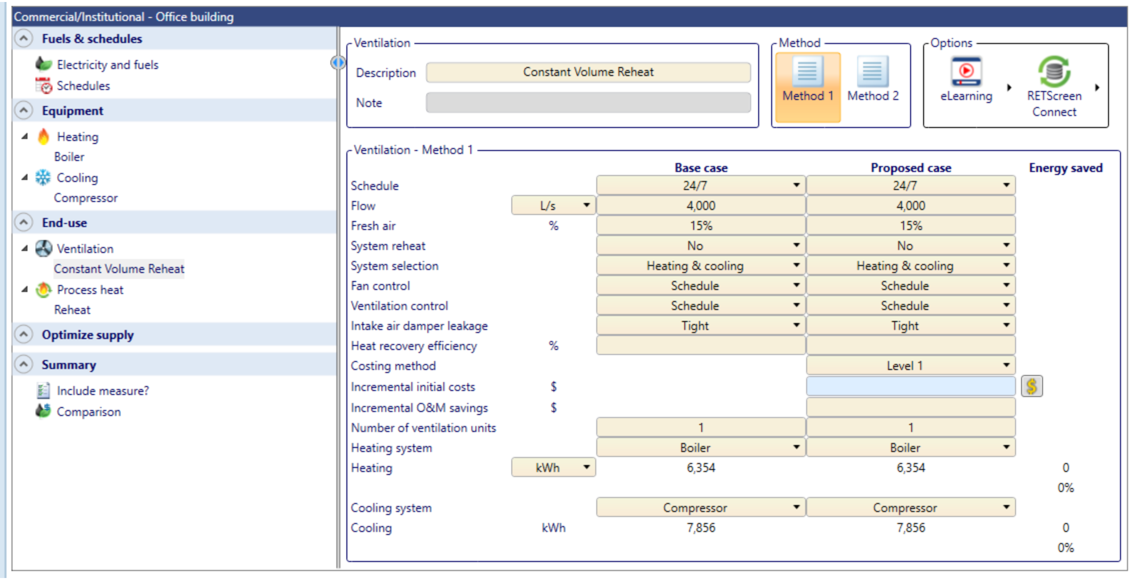
https://www.ijirset.com/upload/2016/april/242_68_Basic.pdf

Services provided

- This system provides 4 of the 5 services
    - It is not typically used for space heating
- It is typically controlled by a supply duct temperature sensor
    - It is a cold-deck system
- Reheat coils are typically not used as the primary source of space heating (excluding fan-powered boxes)

Case study situation results

- RETScreen screenshot of modelled scenario/circumstance



Cautions

- It is defined in an almost identical manner to the single zone system but:
  - Its schedule must account for its cold-deck nature
- System reheat should NOT be selected
  - Use a separate Process Load to capture reheat
- It is not assigned to specific zones or spaces; the system is independent of the building envelope defined in the model.

System Schedule and Reheat

- The schedule must be defined to a value of typically 5^{o}C or 1 ^{o}C above average yearly ambient, whichever is greater.
- Reheat should be defined as a process load using:

Load = System Flow (CFM) * 1.08 * (Room Temp. - Supply Temp.) (oF) * % with Reheat

- Note: Results are in BTU/hr.

Cold Deck Schedule and Reheat

Options: eLearning, RETScreen Connect

Schedules

Description		24/7	VAV
Occupied			
Temperature - space heating	°C	22	8.2
Temperature - space cooling	°C	22	24
Unoccupied			
Temperature - space heating	°C		5
Temperature - space cooling	°C		24
Occupancy rate - daily			
Monday	h/d	24	24
Tuesday	h/d	24	24
Wednesday	h/d	24	24
Thursday	h/d	24	24
Friday	h/d	24	24
Saturday	h/d	24	24
Sunday	h/d	24	24
Occupancy rate - annual	h/yr	8,760	8,760
	%	100%	100%
Heating/cooling changeover temperature	°C	16	
Length of heating season	d	240	
Length of cooling season	d	125	

Process heat

Description	Reheat
Note	

Options: RETScreen Connect

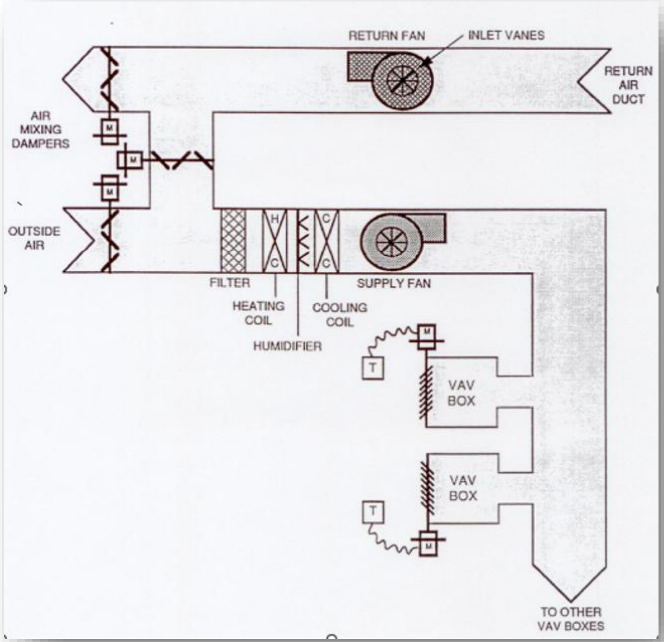
Process heat

		Base case	Proposed case	Energy saved
Level		Level 2		
Heating load	kW	0.23	0.23	
Duty cycle	%	100%	100%	
Operating hours	h/yr	1,500	1,500	
Incremental initial costs	$			
Incremental O&M savings	$			
Heating system		Boiler	Boiler	
Number of units		1	1	
Heating	kWh	345	345	0
				0%

Circumstance/scenario 4

Case study situation

- Variable air volume (VAV) systems

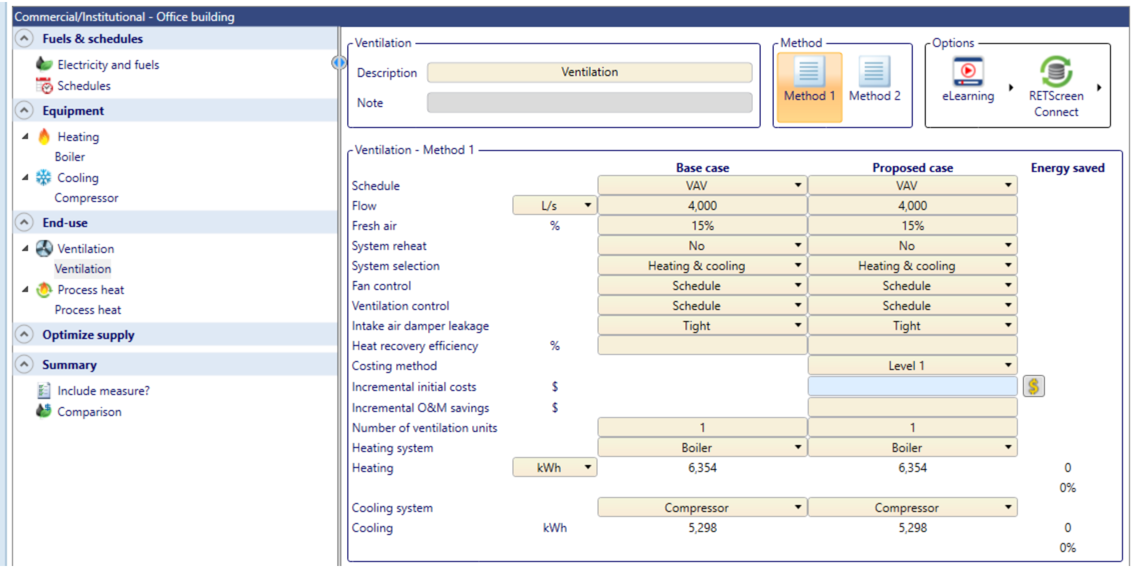


Services provided

- This system provides 4 of the 5 services
  - It is not typically used for space heating
- It is typically controlled by a supply duct temperature sensor
  - It is a cold-deck system
- Reheat coils can be used but are not the primary source of space heating (excluding fan-powered boxes)

Case study situation results

- RETScreen screenshot of modelled scenario/circumstance



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Cautions

- The flow modulation is not modelled and the flow entered must be the typical average yearly flow
- Its schedule must account for its cold-deck nature, as shown for the constant volume system – identical approach.
  - Do NOT select reheat but use the previous Process Load method:
    - Only difference is using the average flow.
  - It is not assigned to specific zones or spaces; the system is independent of the building envelope defined in the model

Circumstance/scenario 5

Case study situation

- Washroom, kitchen, process or general exhaust

Case study situation results

Ventilation

Description: Ventilation

Note:

Method: Method 1 | Method 2

Options: eLearning | RETScreen Connect

Ventilation - Method 2

	Base case					Proposed case				
Description	**System selection**	**Quantity**	**Schedule**	**Flow** cfm	**Heat recovery efficiency** %	**System selection**	**Quantity**	**Schedule**	**Flow** cfm	**Heat recovery efficiency** %
	Heating & cooling	1	24/7	10,000	0%	Heating & cooling	1	6 hours per da	10,000	0%
	Heating & cooling	1	24/7	0	0%	Heating & cooling	1	12 hours per d	2,500	0%
	Heating & cooling	1	24/7	0	0%	Heating & cooling	1	6 hours per da	0	0%

Total

		Base case	**Proposed case**	**Energy saved**
Incremental initial costs - other	$		8,000	
Incremental initial costs - total	$		8,000	
Incremental O&M savings	$			
Heating system		Furnace	Furnace	
Heating	kWh	446,299	167,362	278,937
				62.5%
Cooling system		AC	AC	
Cooling	kWh	79,150	29,681	49,469
				62.5%

Cautions

- Only model the exhaust or make-up flows – not both
- Be attentive to the schedule (temperature) defined as the associated flow from exhaust, even when no MUA is present, system is considered cold-deck.

Q and A period

Workshop 2 – hands on with RETScreen Expert HVAC

Tuesday, Nov 12

1:00 – 3:00 PM

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Efficient Electrification Toolkit and Helpdesk

The webinar materials will be shared with you by email.

The webinar recording can be accessed at SaveonEnergy.ca/Training-and-Support. Select your sector and then "Efficient Electrification".

For questions and technical support regarding the Efficient Electrification Toolkit, including RETScreen, contact trainingandsupport@ieso.ca.

Please use "EE toolkit helpdesk" as your email subject line. Requests will be triaged and addressed in the order they are received.

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