

NOVEMBER 12, 2024

Efficient electrification workshop #4 – Part 2: Modelling HVAC with RETScreen Expert Hands-on Practice

Stephen Dixon, Knowenergy
Michel Parent, Technosim





Agenda

- Welcome and introductions
- Overview of RETScreen Expert
- Outline of how to model an HVAC system
- Hands-on activities with up to five (5) cases.
- 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



Natural Resources
Canada

REEEP®



The complete toolbox! Let's take a quick look

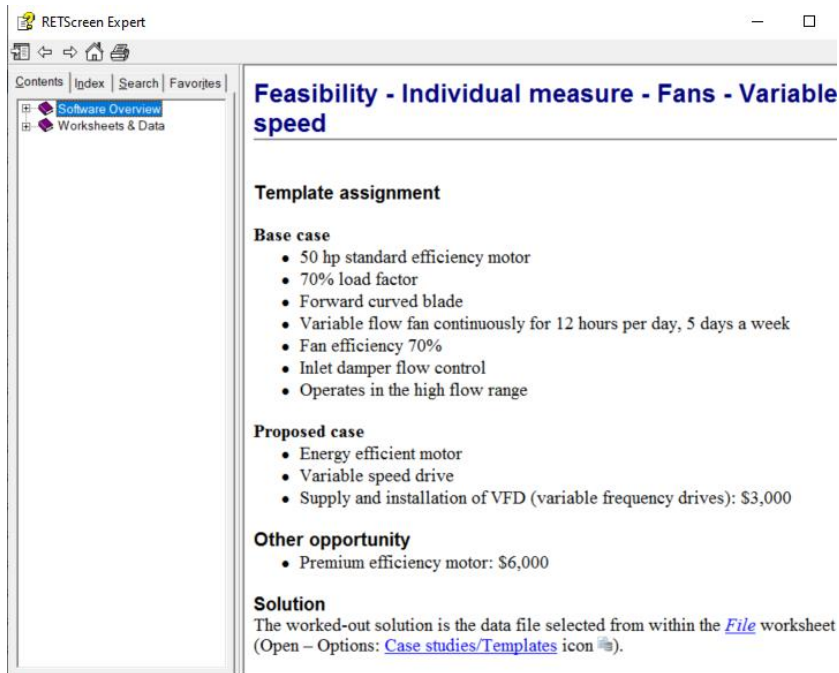
The screenshot displays the RETScreen Expert software interface. At the top, there is a menu bar with options: File, Location, Facility, Energy, Cost, Emission, Finance, Risk, Data, Analytics, Report, Custom. Below the menu bar is a header with the RETScreen Expert logo and the text "Clean Energy Management Software - Version 9.1".

The interface is divided into several sections:

- Getting started - Options:** Includes icons for Home, Open, Close, Settings, Help, Subscribe, Save, Save As, and Exit. Below these are options for Analysis type (Blank project, Benchmark, Feasibility, Performance, All) and Portfolio analysis (My portfolio, My portfolio - Example, Net zero plan - Example).
- Workflow - Per facility:** A central circular diagram showing a workflow. The cycle starts at "Start" and moves through "Performance" (Data, Analytics, Report), "Location" (Benchmark, Facility), "Energy" (Cost, Emission, Feasibility), and "Risk" (Finance, Risk). The central hub is labeled "RETScreen Expert Engine".
- Facility type - Examples:** Lists various facility types: Power plants, Power | Heating | Cooling, Power | Storage | Off-grid, Real property: Industrial | Agricultural, Commercial/Institutional, Residential, Military, Individual measure, Transportation, and User-defined.
- Integrated features:** Lists features such as User manual, eLearning, Databases, Dashboards, and About us (CanmetENERGY in Varennes, RETScreen Innovation Lab, RETScreen Data Onboarding, RETScreen Capacity Building).

At the bottom of the interface, there is a footer with the text: "RETScreen Expert - Professional - 9.1.0.90", "© Minister of Natural Resources Canada 1997-2024.", and "NRCCan/CanmetENERGY/Varennes".

Learning resource – case studies and templates



RETScreen Expert

Contents | Index | Search | Favorites

- Software Overview
- Worksheets & Data

Feasibility - Individual measure - Fans - Variable speed

Template assignment

Base case

- 50 hp standard efficiency motor
- 70% load factor
- Forward curved blade
- Variable flow fan continuously for 12 hours per day, 5 days a week
- Fan efficiency 70%
- Inlet damper flow control
- Operates in the high flow range

Proposed case

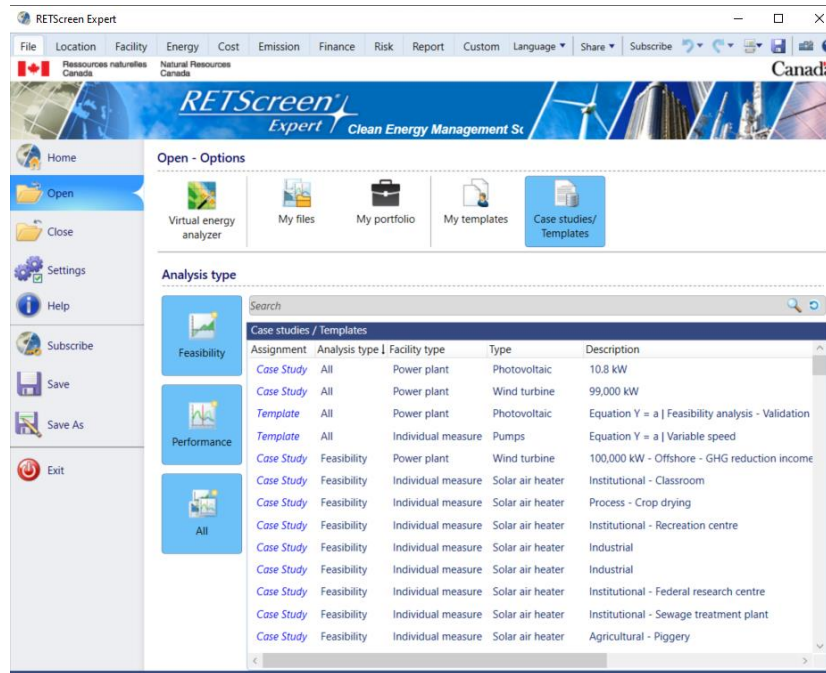
- Energy efficient motor
- Variable speed drive
- Supply and installation of VFD (variable frequency drives): \$3,000

Other opportunity

- Premium efficiency motor: \$6,000

Solution

The worked-out solution is the data file selected from within the [File](#) worksheet (Open – Options: [Case studies/Templates](#) icon).



RETScreen Expert

File Location Facility Energy Cost Emission Finance Risk Report Custom Language Share Subscribe

Resources naturelles Canada Natural Resources Canada

RETScreen Expert Clean Energy Management System

Home

Open

Close

Settings

Help

Subscribe

Save

Save As

Exit

Open - Options

Virtual energy analyzer | My files | My portfolio | My templates | **Case studies/Templates**

Analysis type

Search

Case studies / Templates	Assignment	Analysis type	Facility type	Type	Description
Case Study	All	Power plant	Photovoltaic	10.8 kW	
Case Study	All	Power plant	Wind turbine	99,000 kW	
Template	All	Power plant	Photovoltaic	Equation Y = a Feasibility analysis - Validation	
Case Study	Feasibility	Power plant	Wind turbine	100,000 kW - Offshore - GHG reduction income	
Case Study	Feasibility	Individual measure	Pumps	Equation Y = a Variable speed	
Case Study	Feasibility	Individual measure	Solar air heater	Institutional - Classroom	
Case Study	Feasibility	Individual measure	Solar air heater	Process - Crop drying	
Case Study	Feasibility	Individual measure	Solar air heater	Institutional - Recreation centre	
Case Study	Feasibility	Individual measure	Solar air heater	Industrial	
Case Study	Feasibility	Individual measure	Solar air heater	Industrial	
Case Study	Feasibility	Individual measure	Solar air heater	Institutional - Federal research centre	
Case Study	Feasibility	Individual measure	Solar air heater	Institutional - Sewage treatment plant	
Case Study	Feasibility	Individual measure	Solar air heater	Agricultural - Piggyery	

Learning resource – contextual text and video help

Subscriber: TdS Dixon Inc - Professional

Options

- eLearning
- RETScreen Connect

Motor

Type	
Capacity	
Efficiency - full load	%
Manufacturer	
Model	
Load factor	%
Efficiency - operating conditions	%
Motor shaft power load	kW
Efficiency	%
Fluid load - full flow	kW
Flow type	
Flow range	
Flow control type	
Operating hours	h/d
Incremental initial costs	\$
Incremental O&M savings	\$
Number of pumps	
Electricity	kWh

Capacity

The user enters the capacity of the motor. This value, also called "motor horsepower," "motor rated power" or "motor size," represents the motor rating or the motor rated shaft power load and can typically be found on the motor nameplate. The user can consult the RETScreen Product Database for more information.

Show figure:

[Pump-Motor System Schematic](#)

Pumps

CanmetENERGY

Feasibility Analysis with RETScreen Expert

Step-by-Step Energy Audits & Individual Energy Efficiency | ...more

1.2K views 4 years ago

Overview of RETScreen Expert Platform (20 min)



Modelling a basic HVAC system

The RETScreen HVAC models

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

Heating system

Description: Heating system

Note:

Method: Single fuel, Multiple fuels

Options: eLearning, RETScreen Connect

Heating system

	Base case	Proposed case
Technology	Heating system	Heating system
Fuel type	Natural gas - m ³	Natural gas - m ³
Fuel rate	0.30	0.30

Unit: \$/m³

Cooling system

Description: Cooling system

Note:

Options: eLearning, RETScreen Connect

Cooling system

	Base case	Proposed case
Technology	Cooling system	Cooling system
Fuel type	Natural gas - m ³	Natural gas - m ³
Fuel rate	0.30	0.30

Unit: \$/m³

Cooling equipment

Coefficient of performance - seasonal: kW/kW

Incremental initial costs: \$

Incremental O&M savings: \$

Refrigerant - Optional

Ventilation

Description: Dealed Ventilation

Note:

Method: Method 1, Method 2

Options: eLearning, RETScreen Connect

Ventilation - Method 1

	Base case	Proposed case	Energy saved
Schedule	24/7	24/7	
Flow	L/s		
Fresh air	%		
System reheat	Yes	Yes	
System selection	Heating	Heating	
Fan control	Constant	Constant	
Ventilation control	Constant	Constant	
Intake air damper leakage	Leaky	Leaky	
Heat recovery efficiency	%		
Costing method		Level 1	
Incremental initial costs	\$		
Incremental O&M savings	\$		
Number of ventilation units	1	1	
Heating system	Heating system	Heating system	
Heating	kWh		

Ventilation

Description: Simple Ventilation

Note:

Method: Method 1, Method 2

Options: eLearning, RETScreen Connect

Ventilation - Method 2

Description	Base case				Proposed case				Unit cost	Total cost
	System selection	Quantity	Schedule	Flow	System selection	Quantity	Schedule	Flow		
Heating	Heating		24/7	L/s	Heating		24/7	L/s	\$/L/s	\$
Total										0
Incremental initial costs - other	\$									
Incremental initial costs - total	\$									0
Incremental O&M savings	\$									
Heating system	Heating system				Heating system					
Heating	kWh									

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% of 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 nighttime 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

RETScreen - Energy Model Subscriber: TdS Dixon Inc - Professional

Commercial/Institutional - Office space with a warehouse - Services

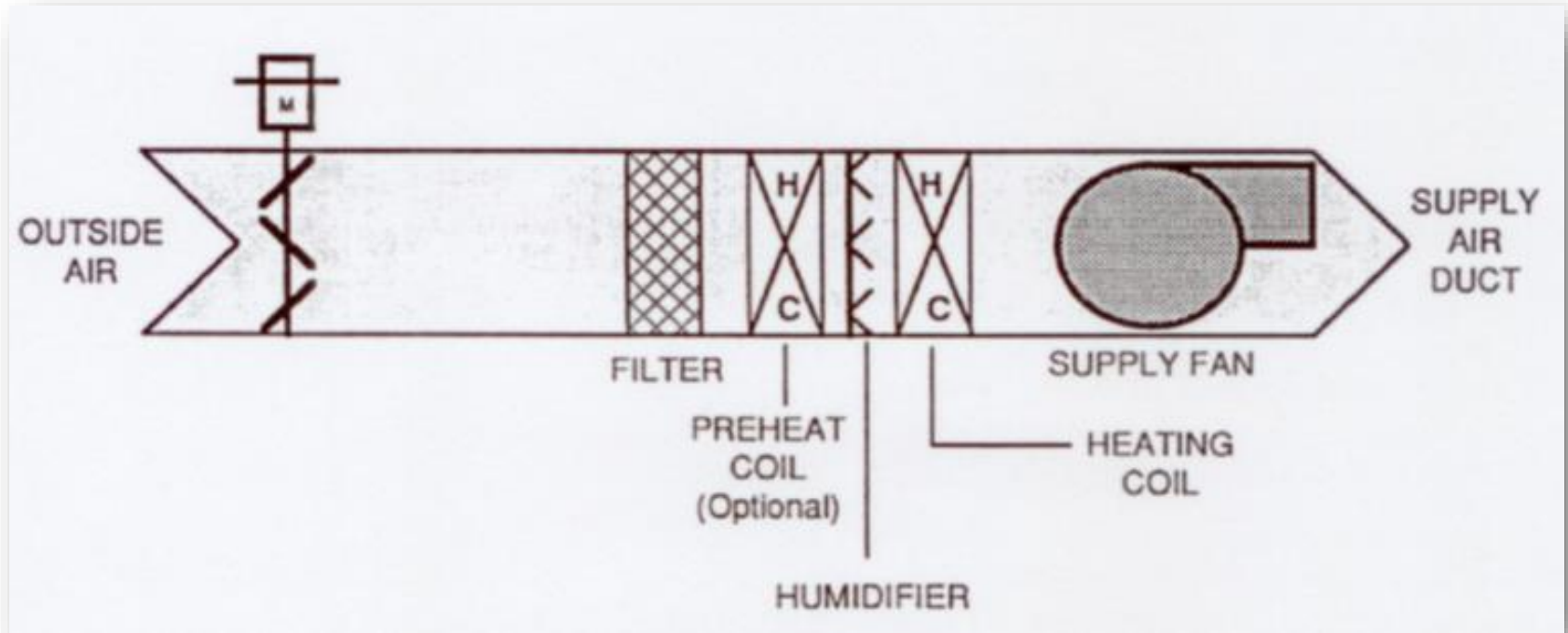
	Show: Energy	Heating	Cooling	Electricity	Simple payback	Include measure?
	Fuel saved	kWh	kWh	kWh	yr	<input checked="" type="checkbox"/>
Heating						
RTU Furnace	0					<input checked="" type="checkbox"/>
Cooling						
RTU A/C		0				<input checked="" type="checkbox"/>
Ventilation						
RTU Ventilation (HVAC)	34,499	1,540			Immediate	<input checked="" type="checkbox"/>
Electrical equipment						
RTU Fan Motor				19,710	1.1	<input checked="" type="checkbox"/>
Total	34,499	1,540	1,540	19,710	0.8	



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.

1. Make-up air (MUA) system

Overall

- Location is in Canada, Climate data location is Toronto, ON
- Marginal gas price of \$0.45/m³
- Marginal electricity price of \$0.12/kWh

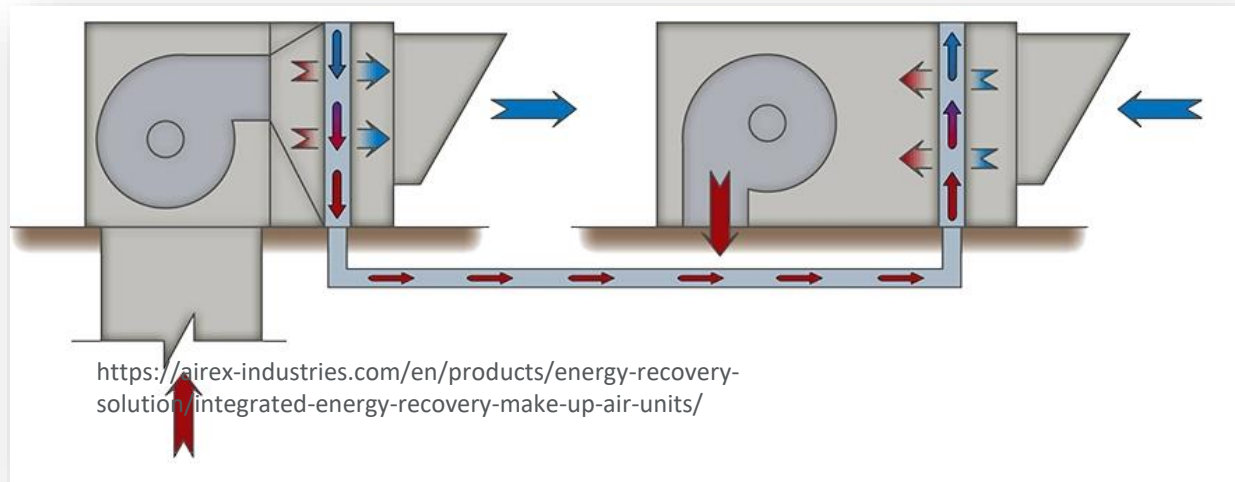
Base case conditions

- MUA providing outside air to perimeter fan-coils in an office building
- 22°C space temperature (during heating and cooling seasons)
- Hours of operation: 16 h/day, Monday to Friday
- Supply: 5,000 cfm, Supply fan motor: 5 brake horsepower
- Exhaust: 5,000 cfm, Exhaust fan motor: 3 brake horsepower
- Estimated motor efficiency: 92%
- Gas-fired heating section, nominal efficiency: 80%
- Gas heating controlled by a duct sensor, typical set point of 18 °C
- No cooling section

Now let's improve the system

Proposed case conditions

- Install a heat recovery system at 0.5 effectiveness, additional motor load of 20%
- Installed cost: \$30,000

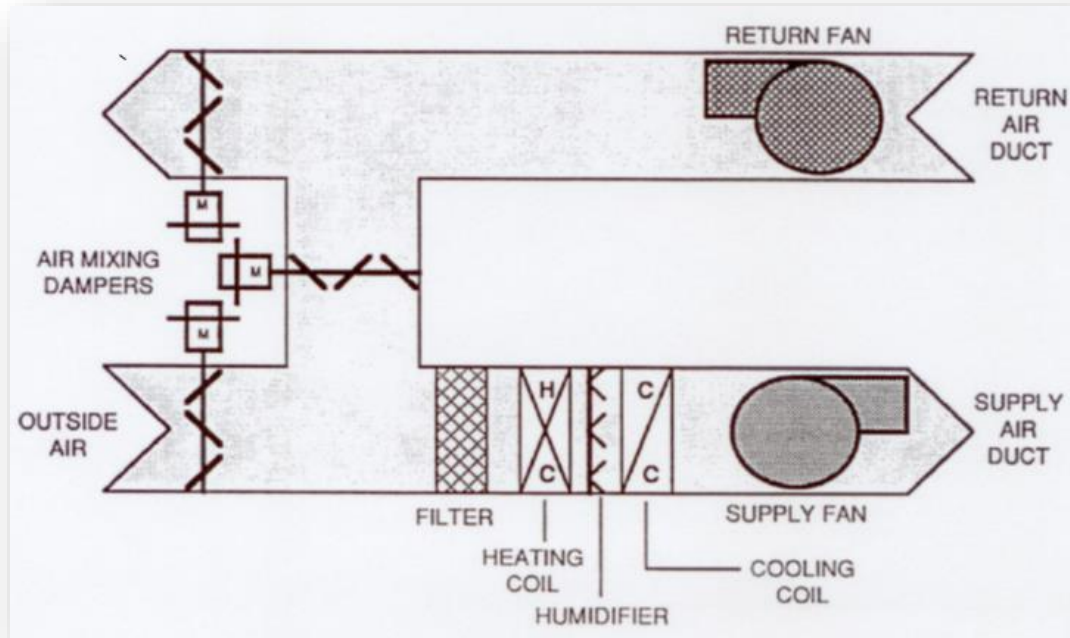




Circumstance/scenario 2

Case study situation

- Constant volume system – single zone



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

2. Constant volume system – single zone

Overall

- Location is in Canada, Climate data location is Guelph, ON
- Marginal gas price of \$0.45/m³
- Marginal electricity price of \$0.12/kWh

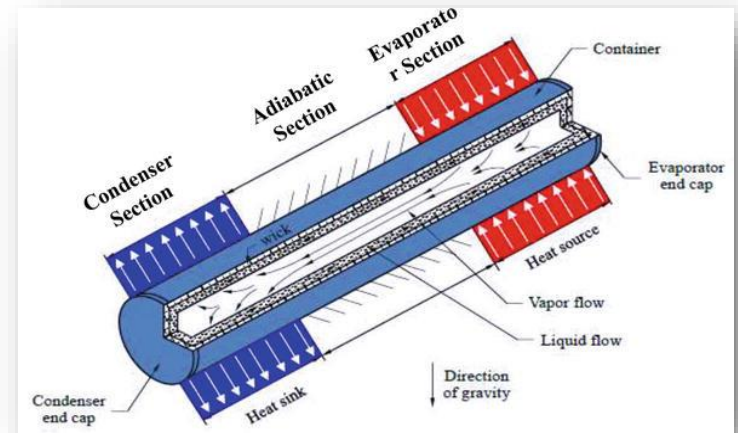
Base case conditions

- 22°C space temperature (during heating and cooling seasons)
- Hours of operation: 24h/day
- Heating/cooling changeover temperature is 16°C
- Supply: 10,000 cfm, Supply fan motor: 5 hp
- Minimum outside air: 15%
- Separate exhaust: 1,000 cfm, Exhaust fan motor: 1 hp
- No return fan
- Unit has hydronic heating and DX cooling with a gas efficiency of 75% annual and a cooling COP of 3.5 nominal
- Dampers are in adequate condition

Now let's improve the system

Proposed case conditions

- Install a heat recovery system at 0.6 effectiveness, additional motor load of 25%
- Note that no change is made to the existing separate exhaust
- Installed cost: \$15,000



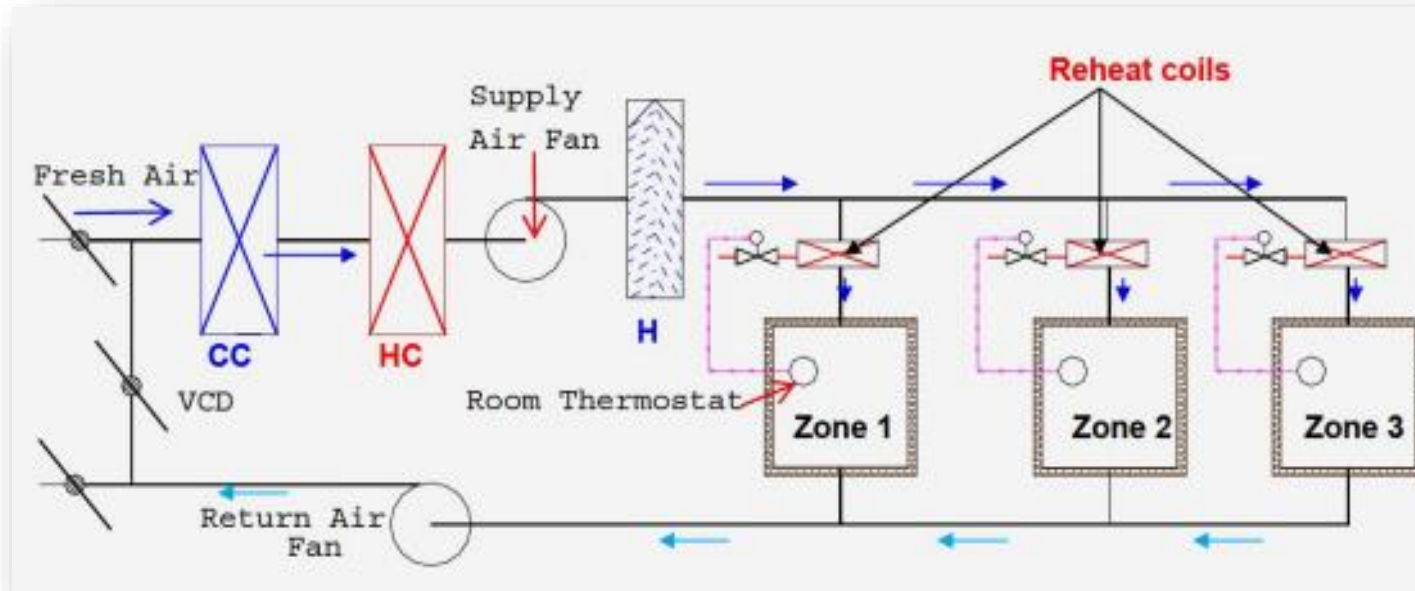
<https://www.intechopen.com/chapters/76428>



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)

3. Constant volume system with reheat

Base case conditions

- 22°C space temperature (during heating and cooling seasons)
- Hours of operation: 14h/day, Monday to Friday
- Heating/cooling changeover temperature is 16°C
- Supply: 15,000 cfm, Supply fan motor: 15 brake horsepower
- Return fan motor is 5 brake horsepower
- Estimated motor efficiency: 94%
- Minimum outside air: 15%
- Hydronic heating, boiler nominal efficiency of 80%
- Chilled water cooling, plant annual COP of 4.5
- New low-leakage dampers
- Supply set point for the air of 15 °C in the winter
- 20% of distribution has active reheat coils, boilers are off 5 months/year

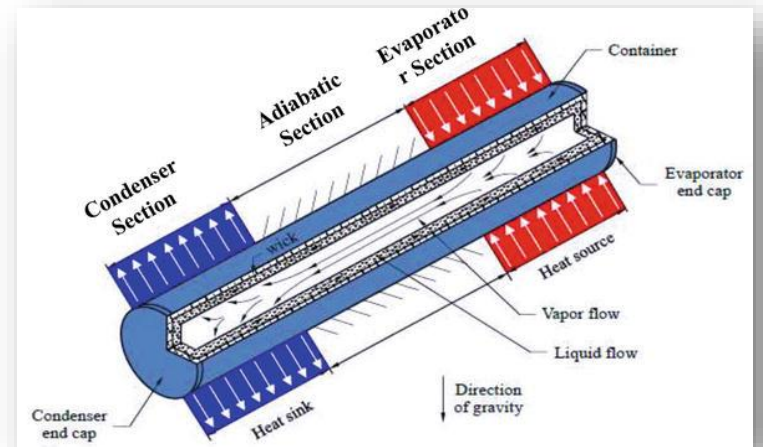
Overall

- Location is in Canada, Climate data location is Ottawa, ON
- Marginal gas price of \$0.45/m³
- Marginal electricity price of \$0.12/kWh

Now let's improve the system

Proposed case conditions

- Install a heat recovery system at 0.6 effectiveness, additional motor load of 25%
- Installed cost: \$21,000



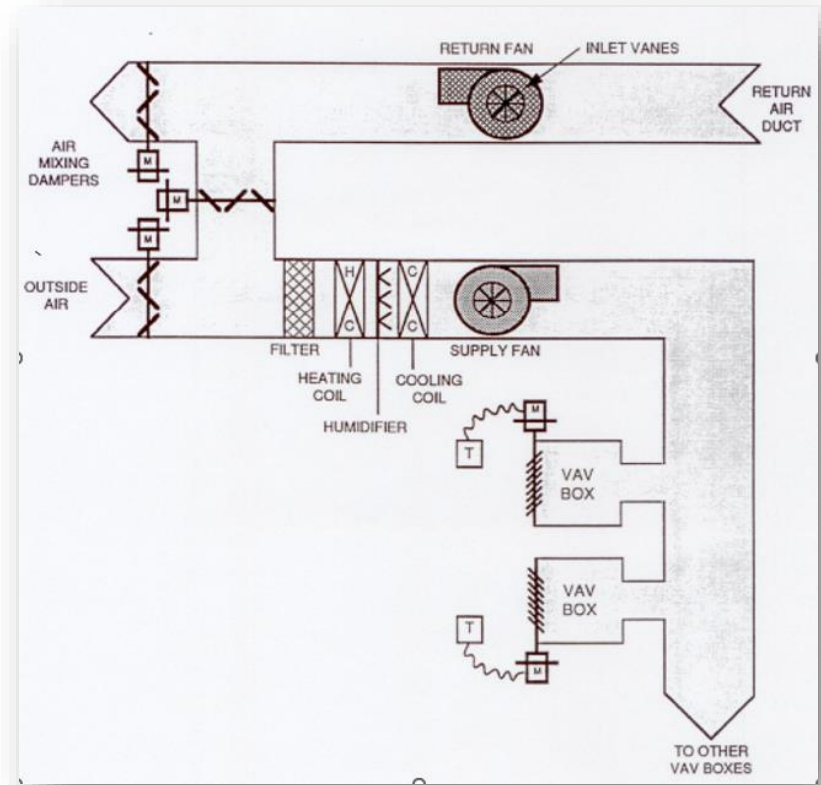
<https://www.intechopen.com/chapters/76428>



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)

4. Variable air volume (VAV) system

Base case conditions

- 22°C space temperature (during heating and cooling seasons)
- Hours of operation: 14h/day, Monday to Friday
- Heating/cooling changeover temperature is 16°C
- Supply: 15,000 cfm, Supply fan motor: 20 brake horsepower
- Return fan motor is 5 brake horsepower
- Estimated motor efficiency: 94%
- Minimum outside air: 15%
- Hydronic heating, boiler nominal efficiency of 80%, chilled water cooling, plant annual COP of 4.5
- Poor quality dampers
- Supply set point for the air of 15 °C in the winter
- VFDs on supply and return fans, average speed of 80% over the year
- 20% of distribution has active reheat coils, boilers are off 5 months/year

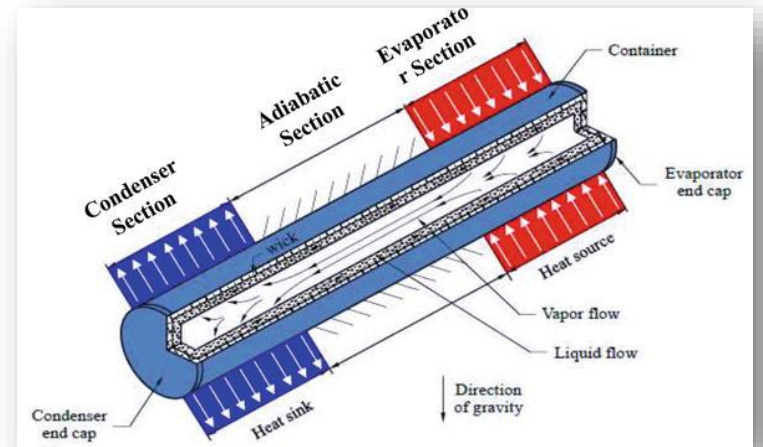
Overall

- Location is in Canada, Climate data location is Ottawa, ON
- Marginal gas price of \$0.45/m³
- Marginal electricity price of \$0.12/kWh

Now let's improve the system

Proposed case conditions

- Install a heat recovery system at 0.6 effectiveness, additional motor load of 25%
- Installed cost: \$21,000



<https://www.intechopen.com/chapters/76428>



Circumstance/scenario 5 - Optional Content

Case study situation

- Washroom, kitchen, process or general exhaust



5. Kitchen Demand Controlled Ventilation

Base case conditions

- Heating/cooling changeover temperature is 16°C
- Building heating temperature of 20°C and cooling of 21°C
- Exhaust: 10,000 CFM
- Exhaust fan motor is 5 horsepower

Overall

- Location is in Mississauga Canada, Climate data location is YYZ - Toronto International Airport
- Marginal gas price of \$0.45/m³
- Marginal electricity price of \$0.12/kWh

Now let's improve the system

Proposed case conditions

- A two-speed fan motor and controls are installed to deliver:
 - Low speed, 2,500 cfm operation for 12 hours/day
 - Full speed 10,000 cfm operation for 6 hours/day
 - Shut down for 6 hours/day
- Installed cost: \$8,000



<https://betterbuildingsolutioncenter.energy.gov/sites/default/files/attachments/Guidance-on-Demand-Controlled-Kitchen-Ventilation.pdf>



Q and A period

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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