

# When is Heat Recovery Cost-Effective in Canadian Buildings?

Daniel Knapp, Arborus Consulting



Commissioned by Natural Resources Canada and  
the National Research Council of Canada

# NECB

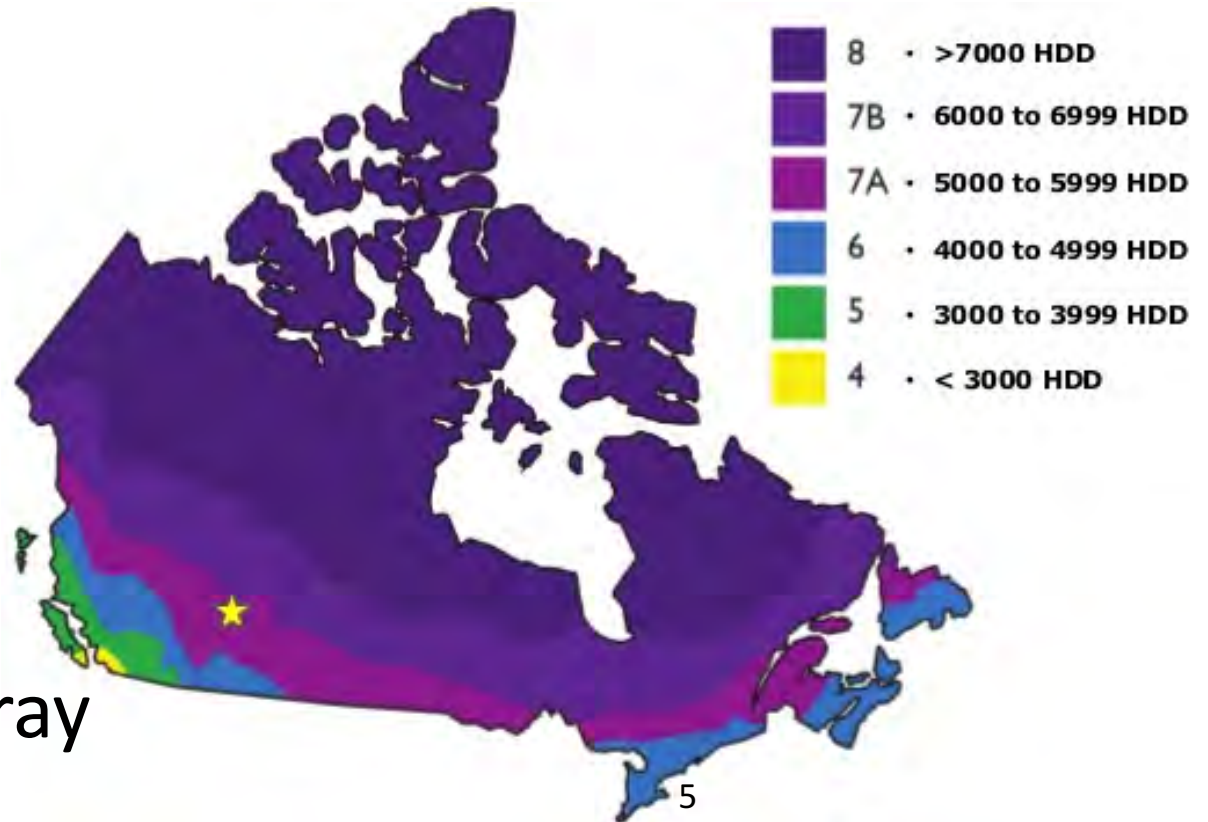
- National Energy Code of Canada for Buildings
- Ongoing improvement process
- NRCan and NRC commissioned study
- Cost benefit of exhaust air heat recovery
- Energy modelling study with CAN-QUEST

# Archetype Buildings

- 13 archetypes
- Retail, restaurants
- Hotels, multi-unit residential
- Long-term health care
- Offices, warehouse
- Primary and secondary schools

# Canadian Climate Zones

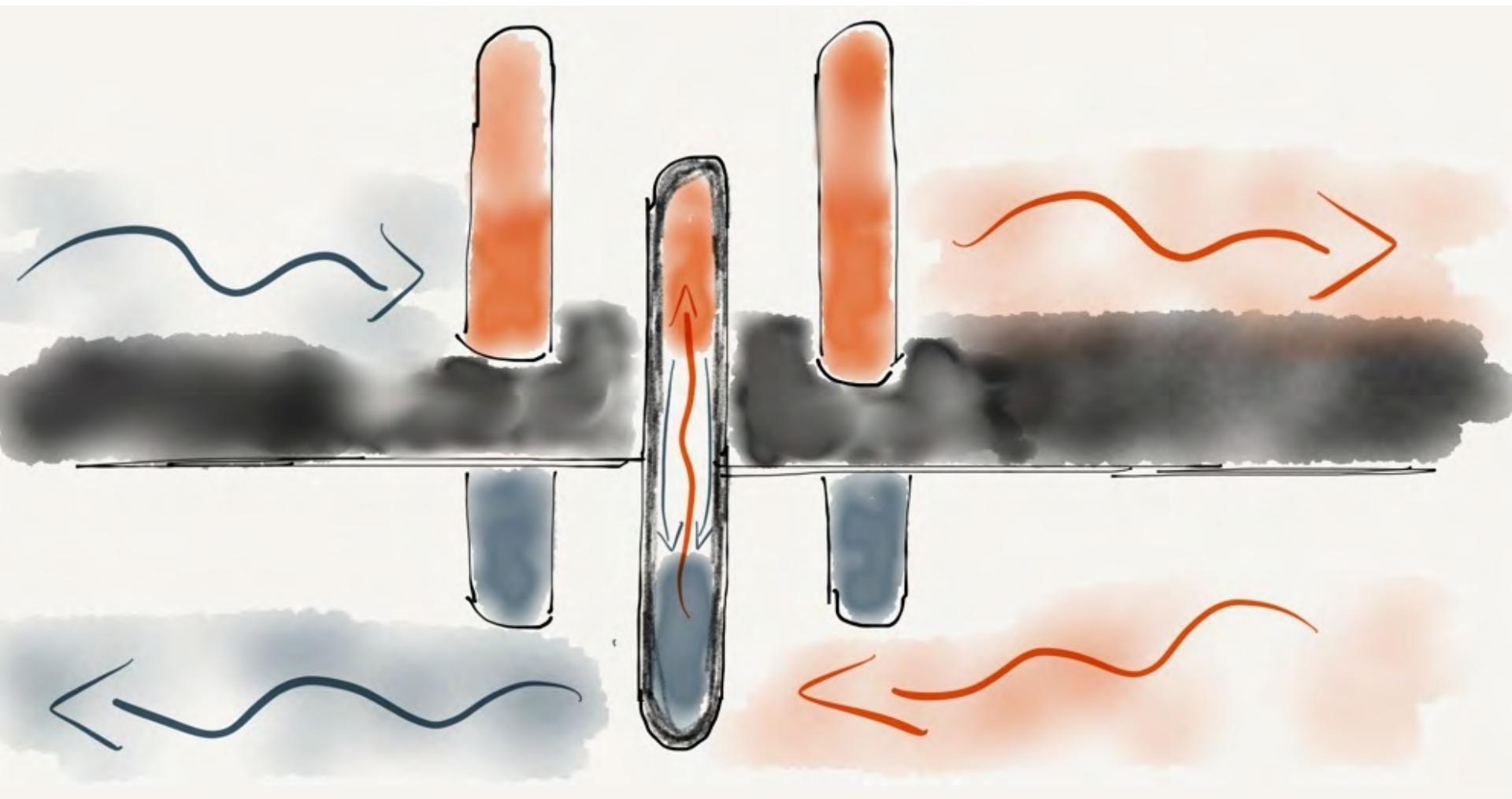
- Victoria
- Windsor
- Montreal
- Edmonton
- Fort McMurray
- Yellowknife



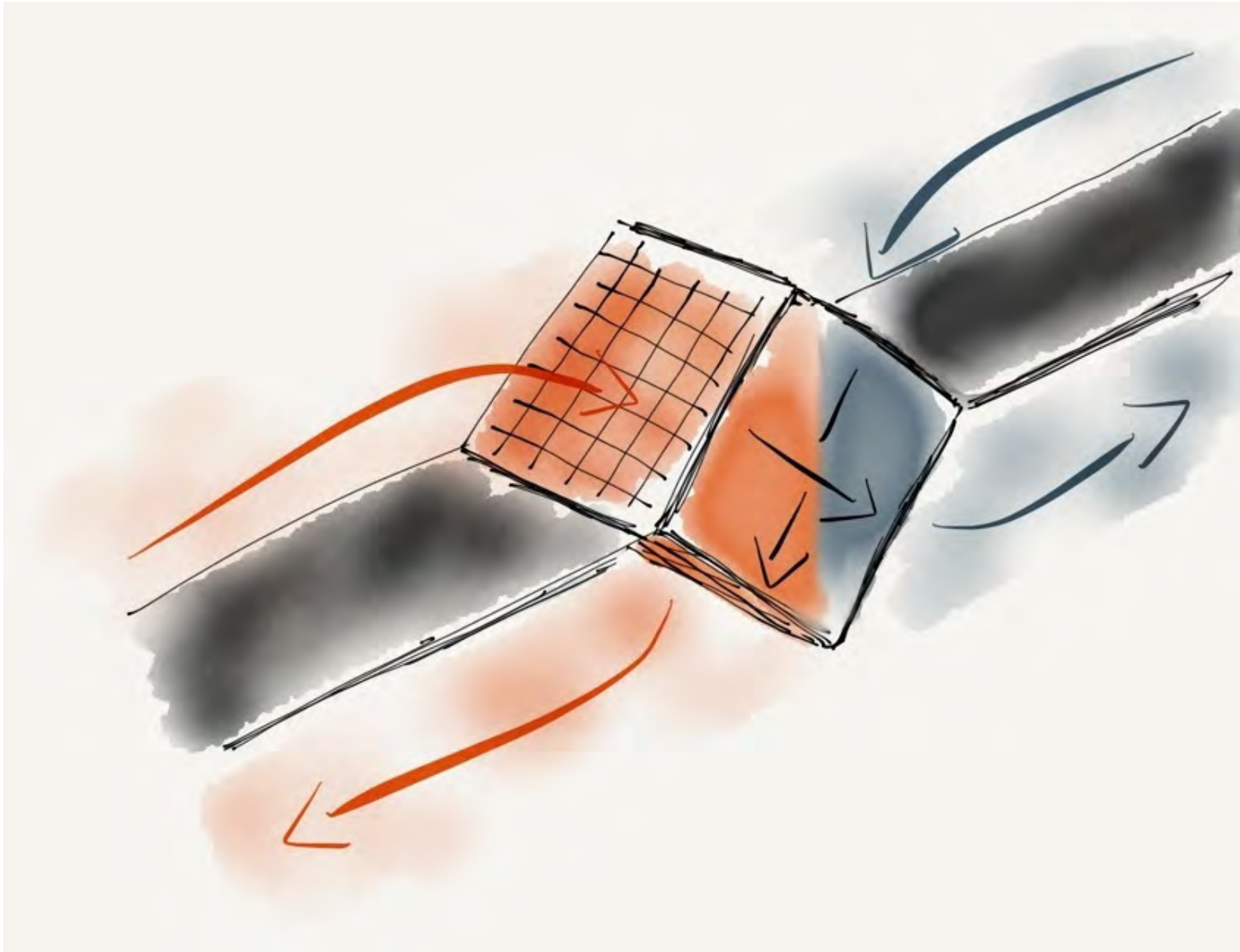
# Heat Recovery Technologies

Type	Options	Performance	Cost
Heat Pipe	Sensible only	50%	\$\$
Cross-flow	Sensible and enthalpy	55 to 65%	\$\$
Energy Wheel	Sensible and enthalpy	65 to 75%	\$
Reverse Flow	Enthalpy	80 to 90%	\$\$\$

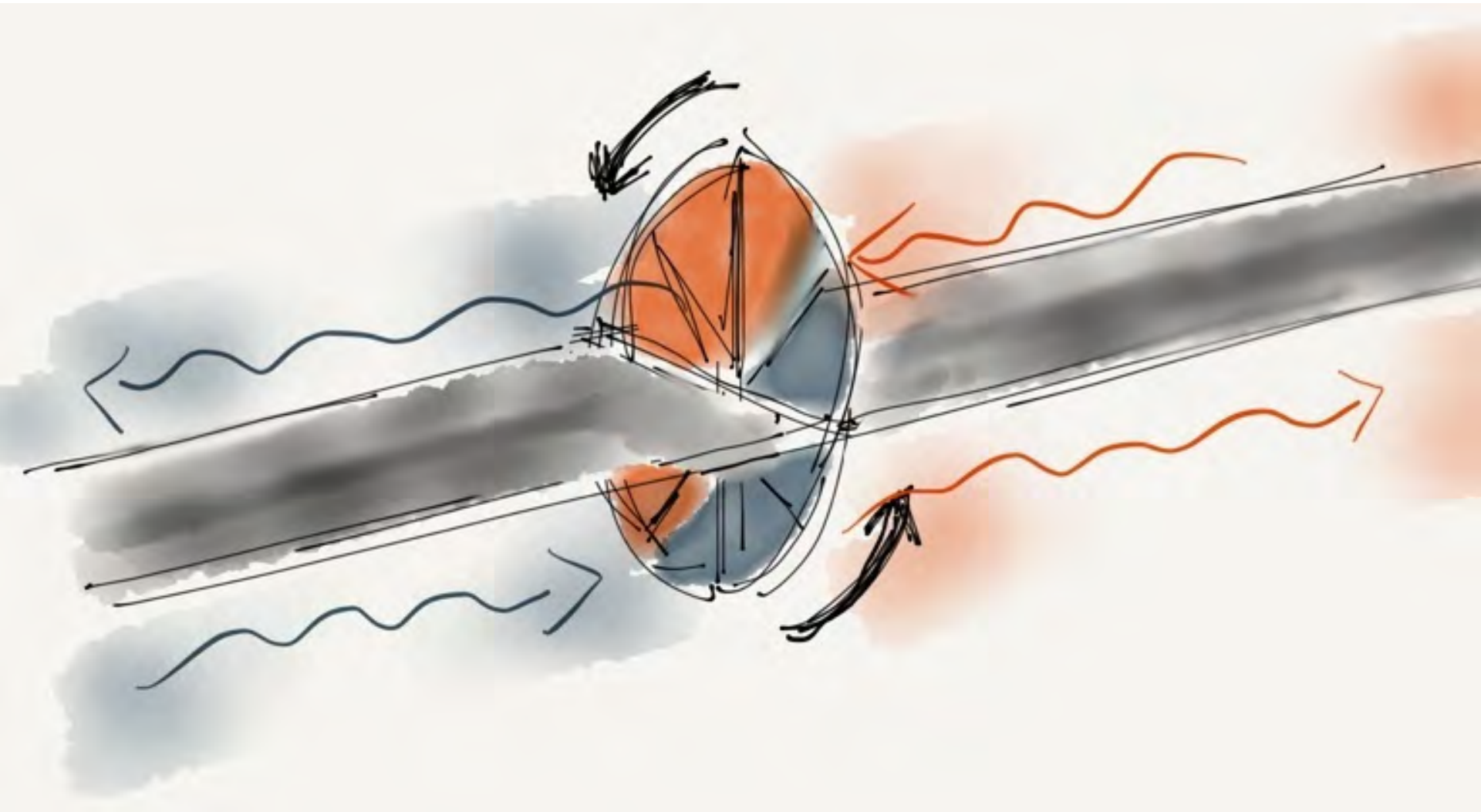
# Heat Pipe



# Cross-Flow or Heat Core

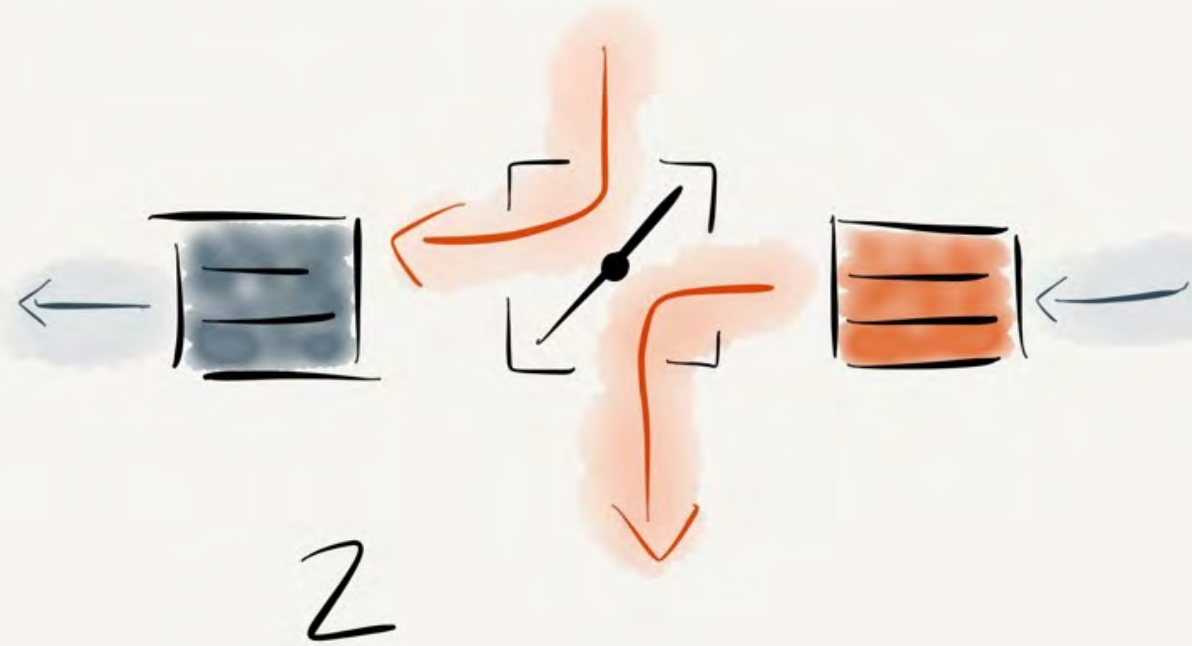
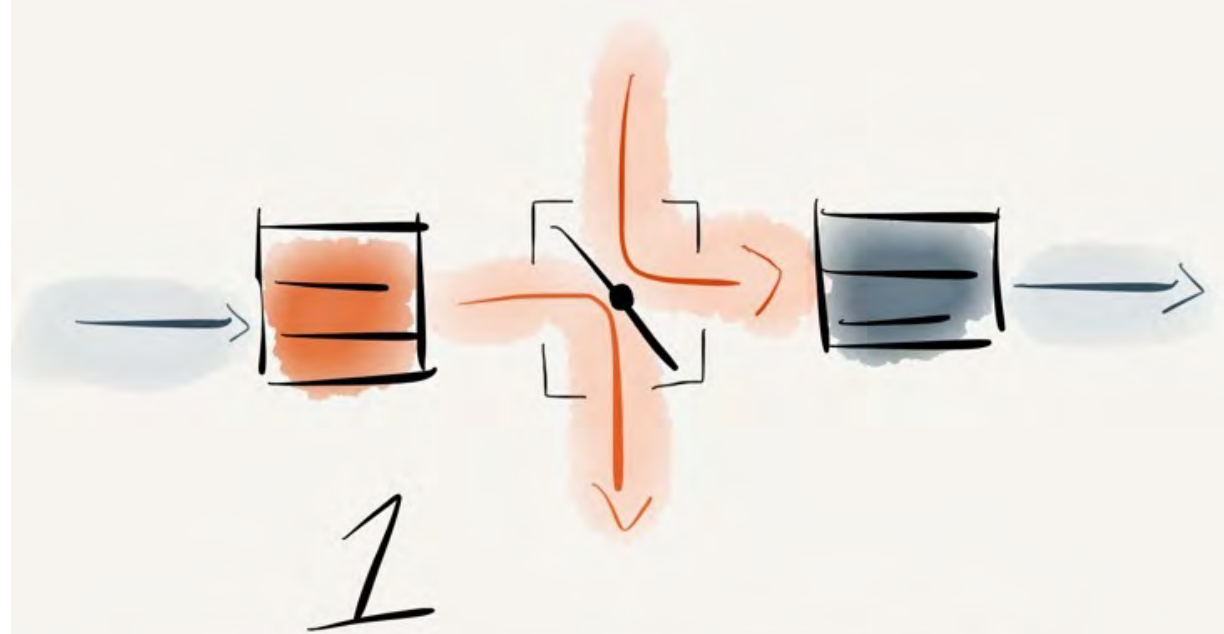


# Energy Wheel





# Reverse Flow



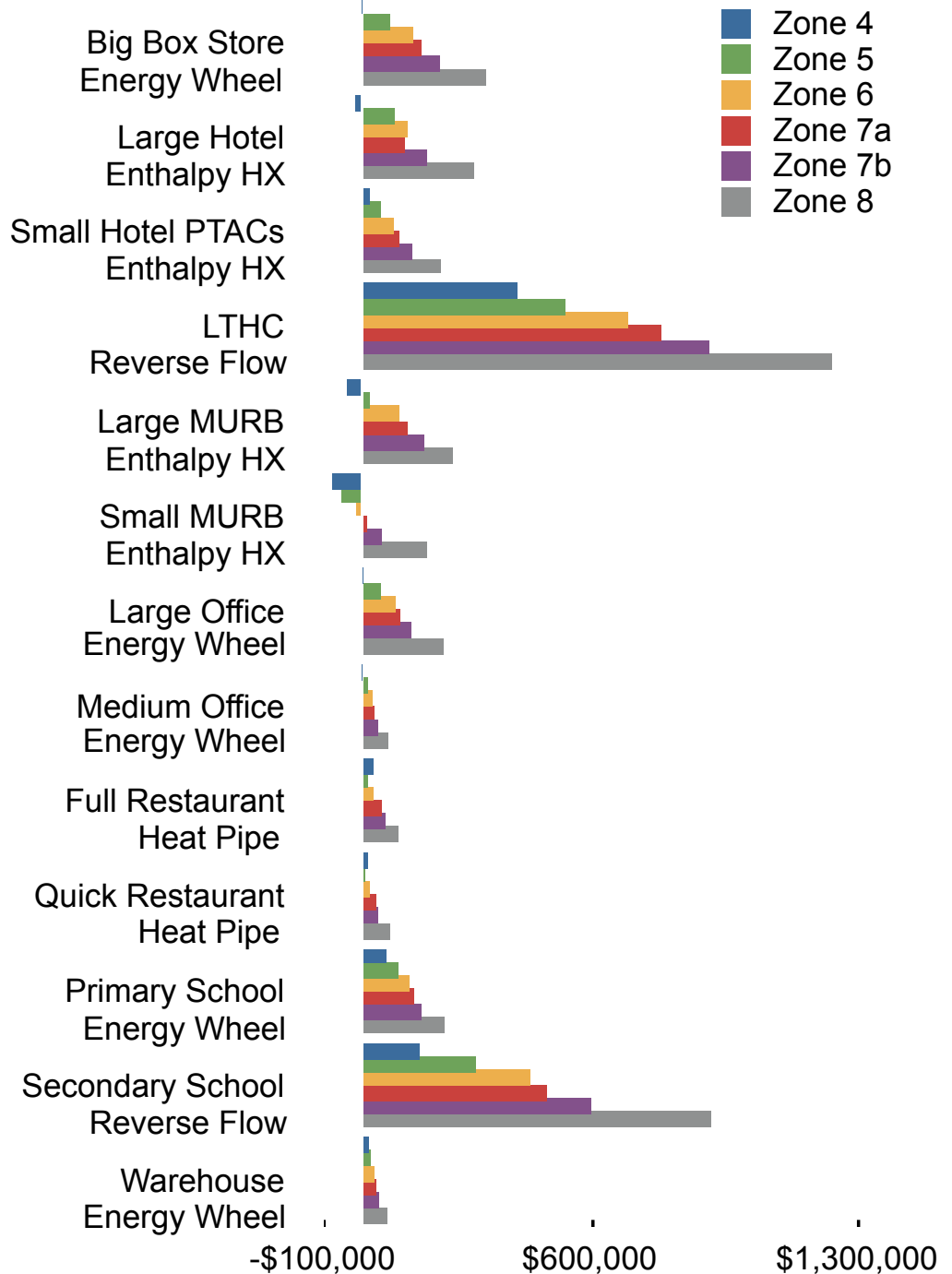
# Energy Modelling

- CAN-QUEST model of each building type
- Simulate with and without heat recovery
- Energy savings calculated
- 13 buildings, 6 climate zones
- 492 energy models simulated

# Cost Benefit Analysis

- Cost of equipment obtained from manufacturer's representatives
- Canadian average energy prices (2014) used to calculate energy cost savings
  - \$0.345/cubic metre for natural gas (\$0.033/ekWh)
  - \$0.113/kWh for electricity
- Simple payback or lifecycle cost savings

# Lifecycle Cost Benefit



# Payback Periods

	Zone 4	Zone 5	Zone 6	Zone 7a	Zone 7b	Zone 8	Payback Period
Big Box Store Energy Wheel	11.7	6.4	4.6	4.2	3.5	2.5	0-2
Large Hotel Enthalpy HX	24.5	3.4	2.6	2.8	2.0	1.2	2-5
Small Hotel PTACs Enthalpy HX	8.1	5.7	4.2	3.8	3.1	2.2	5-8
LTHC Reverse Flow	5.6	4.5	3.6	3.2	2.8	2.1	8-15
Large MURB Enthalpy HX	18.0	12.4	8.8	8.2	7.1	5.8	Over 15
Small MURB Enthalpy HX	335.2	40.0	17.3	12.1	8.7	4.6	Years
Large Office Energy Wheel	10.6	3.9	2.6	2.3	1.9	1.2	
Medium Office Energy Wheel	11.2	5.2	3.7	3.1	2.7	1.8	
Full Restaurant Heat Pipe	6.5	8.2	6.4	5.0	4.6	3.4	
Quick Restaurant Heat Pipe	7.2	8.5	6.8	5.3	4.8	3.5	
Primary School Energy Wheel	1.6	1.1	0.9	0.8	0.7	0.5	
Secondary School Energy Wheel	5.0	3.5	2.8	2.5	2.2	1.6	
Warehouse Energy Wheel	4.3	3.6	2.8	2.4	2.1	1.5	

# Discussion

- Almost all building types show good payback in climate zones 5 through 8
- Outdoor air fraction above 20%
- Longer run-times lead to shorter payback
- Bypass of heat recovery prevents overheating
- Higher supply air temperatures in winter to maximize heat recovery

# Maximize the cost benefit!

- Design systems to have higher outdoor air fraction with lower supply air flow rates in winter
- Right-size systems (especially VAV)
- Specify heat recovery devices with bypass control
- Supply air reset control – warmer temperatures in heating mode
- Energy wheels a good balance of cost and performance