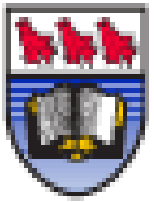
Weather Files

26 November 2019
8th Annual Public Sector Climate Leadership Symposium
Vancouver, BC



University of Victoria

Trevor Murdock

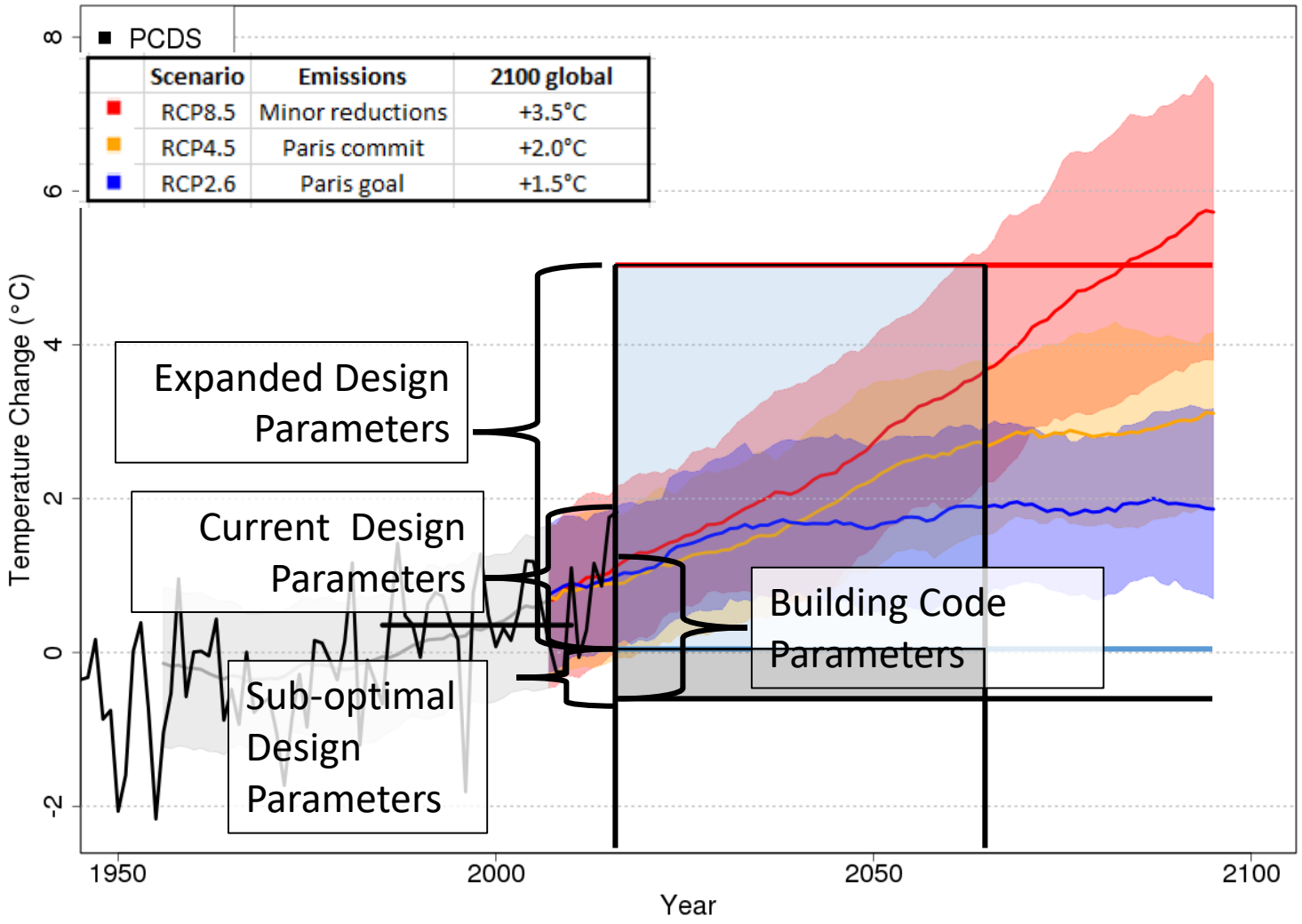
Assessing risk based on future climate

is necessary,

and possible,

and requires change.

Climate Design Parameters



1. Past conditions not a good guide for future
2. Past conditions don't even represent today
3. Building code values use past → inadequate
4. Conditions keep changing with time in all but best case
5. Must accommodate wider range of conditions in all cases
6. 2050s cautious roughly equals 2070s optimistic


2017
2032
5
netzero readyhome
Passive House
NET ZERO READY
NEW CONSTRUCTION
4
R-2000
40% BETTER
3
BuiltGreen
energy
20% BETTER
2
BuiltGreen
10% BETTER
STEP 1
BuiltGreen
ENHANCED COMPLIANCE
IMPROVED
BC BUILDING CODE
AVERAGE
ENERGY EFFICIENCY

Energy modelling

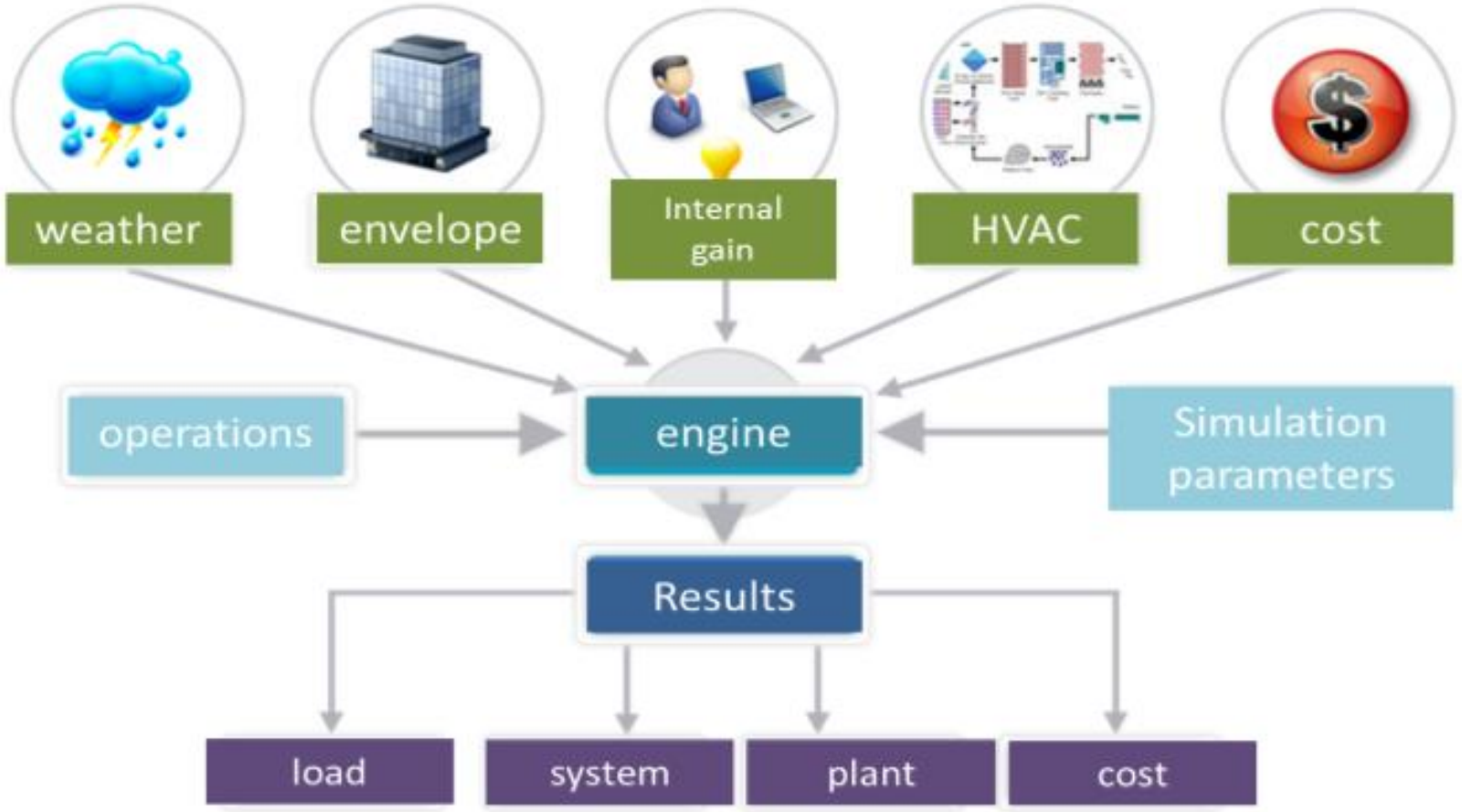


Image from: sustainablesv

Energy modelling – simple adjustmen

=H9+I$4

A	B	C	D	E	F	G	H	I	J	K	L	M
LOCATION	Vancouver I	BC	CAN	WYEC2-B-	718920	49.18	-123.17		-8	2	-9.6	1.7
DESIGN CON	1	Climate Design Data		Heating	12	-7	-4		-13.9	1.1	Extreme	01-Jan
TYPICAL/EXT	6	Summer -	Extreme	29-Jul	04-Aug	Summer -	Typical	2050s	09-Sep	15-Sep	W 15.98	14.95
GROUND TEM	3	0.5				4.57	7.13	2.9	10.08	12.27		
HOLIDAYS/D	No	0	0	0								
COMMENTS :	WYEC2-Canadian Weather year for Energy Calculations (CWEC) -- WMO#718920											
COMMENTS :	-- Ground temps produced with a standard soil diffusivity of 2.3225760E-03 {m**2/day}											
DATA PERIOD	1	1	Data	Sunday	1/ 1	31-Dec						9
1970	1	1	1	60	A_A__*A_	1.1	1.1	4	100	103210		9
1970	1	1	2	60	A_A__*A_	0.5	0.4	3.3	99	103340		9
1970	1	1	3	60	A_A__*A_	0.2	0	2.9	99	103420		9
1970	1	1	4	60	A_A__*A_	0	-0.2	2.7	98	103460		9
1970	1	1	5	60	A_A__*A_	-0.2	-0.4	2.5	98	103460		9
1970	1	1	6	60	A_A__*A_	-0.5	-0.7	2.2	98	103460		9
1970	1	1	7	60	_____*__9	-0.6	-0.6	2.3	100	103430		9
1970	1	1	8	60	_____*__9	-0.6	-0.6	2.3	100	103420		9
1970	1	1	9	60	_____*__9	-0.6	-0.6	2.3	100	103450		9
1970	1	1	10	60	_____*__9	1.7	1.7	4.6	100	103480		9
1970	1	1	11	60	_____*__9	3.9	3.3	6.2	96	103440		9
1970	1	1	12	60	_____*__9	4.4	3.3	6.2	93	103370		9
1970	1	1	13	60	*__9	4.4	3.3	6.2	93	103350		

CAN_BC_Vancouver.718920_CWEC.ep

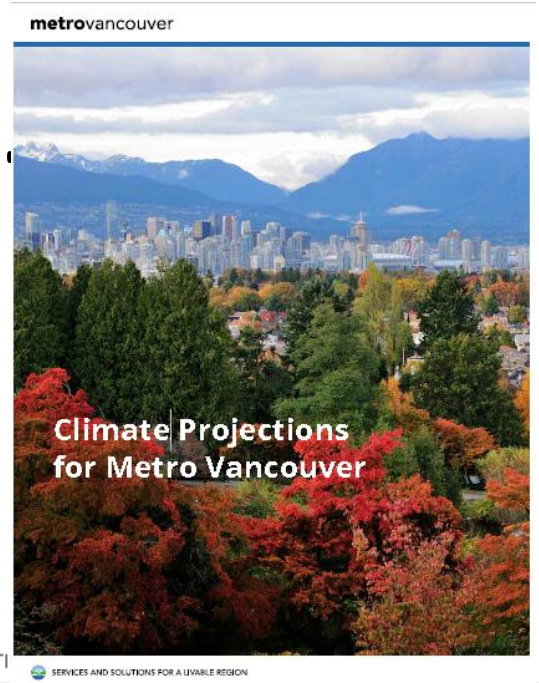


TABLE 1: AVERAGE DAYTI

	Past (°C)	2050s Change (°C)	
		Average	(Range)
Winter	5	2.4	(1.3 to 3.0)
Spring	12	2.9	(1.7 to 4.7)
Summer	21	3.7	(2.4 to 5.2)
Fall	13	2.8	(1.3 to 3.9)
Annual	13	2.9	(1.6 to 4.2)

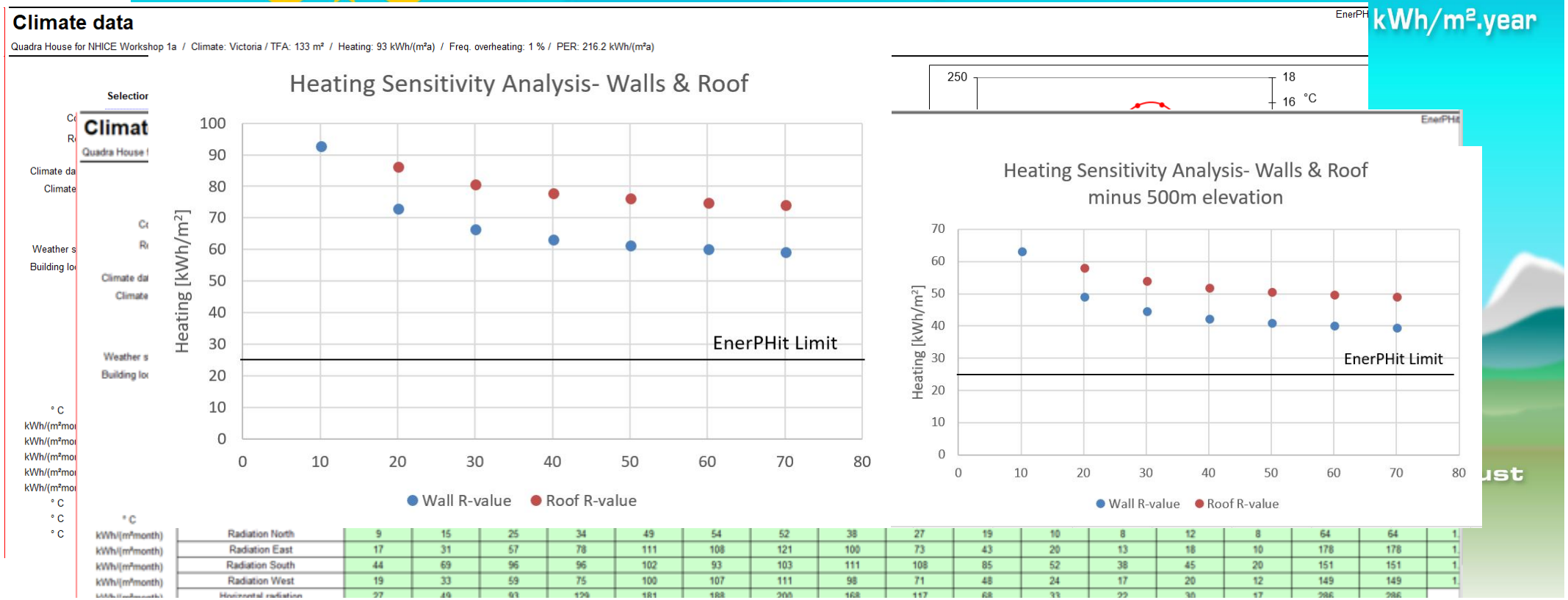
TABLE 2: AVERAGE NIGHTTIME LOW TEMPERATURE

	Past (°C)	2050s Change (°C)	
		Average	(Range)
Winter	-1	2.9	(1.8 to 3.5)
Spring	3	2.9	(2.0 to 3.8)
Summer	10	3.2	(1.9 to 4.7)
Fall	5	2.8	(1.7 to 4.0)
Annual	4	2.9	(1.9 to 4.0)

Passive house

The universal standard in very low energy buildings

1. - Annual heat requirement ≤ 15 kWh/m².year
2. - Annual active cooling needs * ≤ 15 kWh/m².year
3. - Airtightness n50 ≤ 0.6/hour (≤ 1/hour hot climates)



Overheating (hours above 25°C):

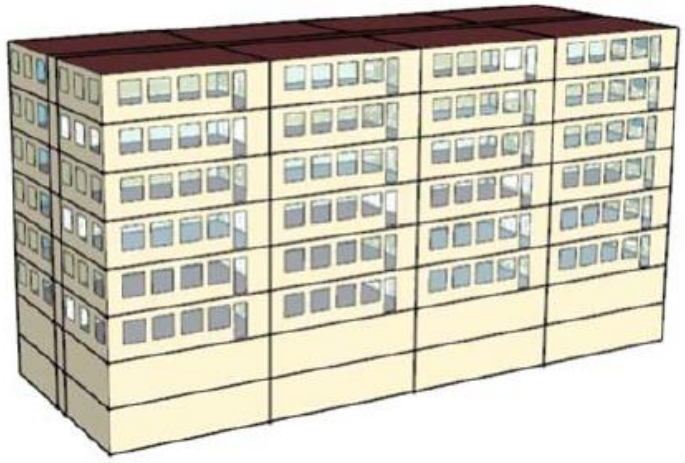
1% today → 7% retrofit optimized on recent data → 27% with ~2°C warming

“Morphing” weather files

- Used across the world: the UK, Hong Kong, Australia, The U.S, Canada (Montréal), Malaysia etc.
- Projections from GCMs are used to adjust observed weather data, usually “TMY files”
- TMY = typical meteorological year: hourly data for months that are median months from period of record

Belcher SE., Hacker JN., Powell DS. Constructing design weather data for future climates. Building Services Engineering Research and Technology 26. (2005)

Unmet Cooling Hours



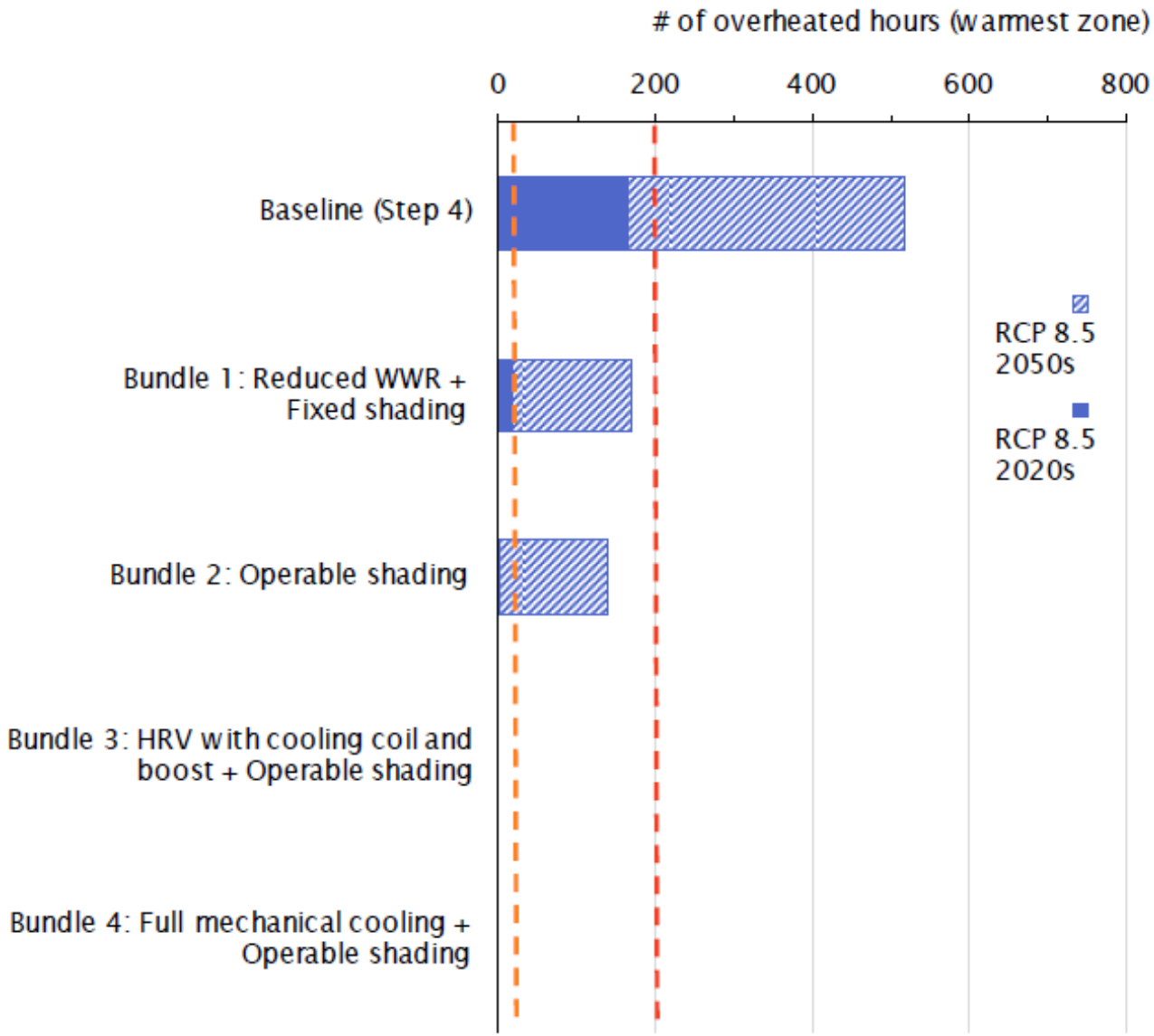
Building Archetype
Low Rise New
(No Mechanical Cooling)

NW	N1	N2	NE
CORRIDOR			
SW	S1	S2	SE

≤ 200 hrs	201-500 hrs	501-800 hrs	> 800 hrs	# of hrs pear year above the upper temperature limit
< 2%	2-6%	2-9%	>9%	% of hrs per year above the upper temperature limit

	CWEC 2016 *Hottest Suite: SW - Top Floor*	RCP-8.5 2020s *Hottest Suite: SW - Top Floor*	RCP-8.5 2050s *Hottest Suite: SW - Top Floor*	RCP-8.5 2080s *Hottest Suite: SW - Top Floor*
Top Floor	63 11 11 16 57 160 95 93 87	110 30 30 44 120 246 160 160 161	370 222 216 234 560 589 536 531 503	453 312 306 318 695 702 667 665 601
Mid Floor	24 2 2 6 23 101 69 68 62	45 5 5 13 48 149 99 100 97	236 117 114 148 402 463 425 428 375	301 164 154 194 532 549 536 525 476
First Floor	7 0 0 1 7 57 49 49 40	27 2 1 5 23 105 74 76 67	142 44 42 76 208 352 295 290 249	179 77 73 104 291 429 377 373 322

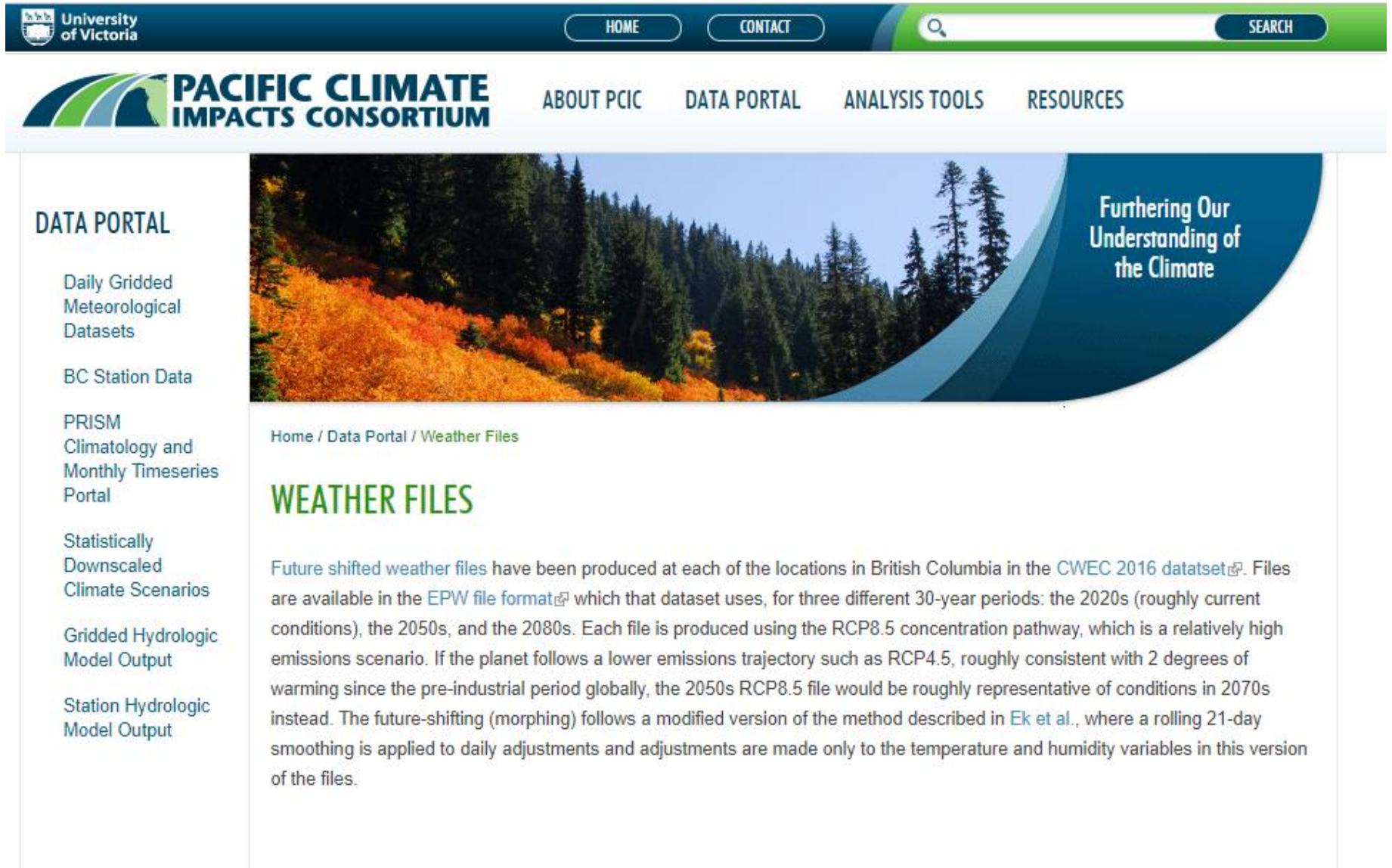
Unmet Cooling Hours



Summary: future shifting weather files

- Using historical information for building design → maladaptation even (or especially!) for energy efficient buildings
- Climate projections & guidance within building codes will take time but codes already call for future climate to be considered
- Energy models use hourly weather data → opportunity to consider future climate quantitatively
- Morphed weather files are being produced with energy modellers → opportunities to improve methods
- Training on using future shifted weather files is being planned now

www.pacificclimate.org/data/weather-files



Weather Files Training and Engagement

- Engage with energy modellers & their colleagues
- Training workshops
- Feedback to inform design of web portal; what info, where?
- Coming spring 2020

Summary files

Prince.George.Intl.AP.718960	Past (TMY)	2020s Future		2020s Change		2050s Future		2050s Change	
		Average	10th%-90th%	Average	10th%-90th%	Average	10th%-90th%	Average	10th%-90th%
HDD (Degree Days)	4906	4362	(4222 to 4487)	-544	(-684 to -419)	3870	(3523 to 4148)	-1036	(-1383 to -758)
TNN (°C)	-30.8	-28.4	(-29.2 to -27.2)	2.4	(1.6 to 3.6)	-26.8	(-29.2 to -24.8)	4	(1.6 to 6)
Heating 99.0% (°C)	-18.5	-16.7	(-16.9 to -16.2)	1.8	(1.6 to 2.3)	-15.1	(-16.6 to -14)	3.4	(1.9 to 4.5)
Heating (Wetbulb) 99.0% (°C)	-19.9	-18.1	(-18.3 to -17.6)	1.8	(1.6 to 2.3)	-16.6	(-18 to -15.4)	3.3	(1.9 to 4.5)
CDD (Degree Days)	31	62	(44 to 82)	31	(13 to 51)	142	(69 to 237)	111	(38 to 206)
TXX (°C)	32.4	33.6	(32.6 to 35)	1.2	(0.2 to 2.6)	35.2	(33.1 to 37.4)	2.8	(0.7 to 5)
Cooling 2.5% (°C)	22.1	23.7	(22.9 to 24.6)	1.6	(0.8 to 2.5)	25.8	(23.9 to 27.8)	3.7	(1.8 to 5.7)
Cooling (Wetbulb) 2.5% (°C)	19.9	21.5	(20.7 to 22.3)	1.6	(0.8 to 2.4)	23.4	(21.6 to 25.3)	3.5	(1.8 to 5.4)

Vancouver.Intl.AP.718920	Past (TMY)	2020s Future		2020s Change		2050s Future		2050s Change	
		Average	10th%-90th%	Average	10th%-90th%	Average	10th%-90th%	Average	10th%-90th%
HDD (Degree Days)	2797	2350	(2230 to 2512)	-447	(-567 to -285)	1986	(1704 to 2307)	-811	(-1093 to -490)
TNN (°C)	-5.6	-3.7	(-4.5 to -2.8)	1.9	(1.1 to 2.8)	-2.8	(-4.3 to -1.8)	2.8	(1.3 to 3.8)
Heating 99.0% (°C)	-1.7	-0.2	(-0.5 to 0.3)	1.5	(1.2 to 2)	1	(-0.1 to 1.6)	2.7	(1.6 to 3.3)
Heating (Wetbulb) 99.0% (°C)	-3.2	-1.7	(-2 to -1.3)	1.5	(1.2 to 1.9)	-0.5	(-1.7 to 0)	2.7	(1.5 to 3.2)
CDD (Degree Days)	42	128	(81 to 169)	86	(39 to 127)	291	(146 to 452)	249	(104 to 410)
TXX (°C)	27.7	29.6	(28.9 to 30.5)	1.9	(1.2 to 2.8)	31.9	(30.2 to 33.4)	4.2	(2.5 to 5.7)
Cooling 2.5% (°C)	21.6	23.3	(22.7 to 23.8)	1.7	(1.1 to 2.2)	25.3	(23.9 to 26.8)	3.7	(2.3 to 5.2)
Cooling (Wetbulb) 2.5% (°C)	19.5	21.1	(20.6 to 21.6)	1.6	(1.1 to 2.1)	23.1	(21.7 to 24.5)	3.6	(2.2 to 5)

What is an action you can take to enable the use of future shifted weather files?

Exercise

1. Find a computer
2. Download a summary file for your location
3. Discuss how design might be affected by the future projections in the summary file

PACIFIC CLIMATE IMPACTS CONSORTIUM

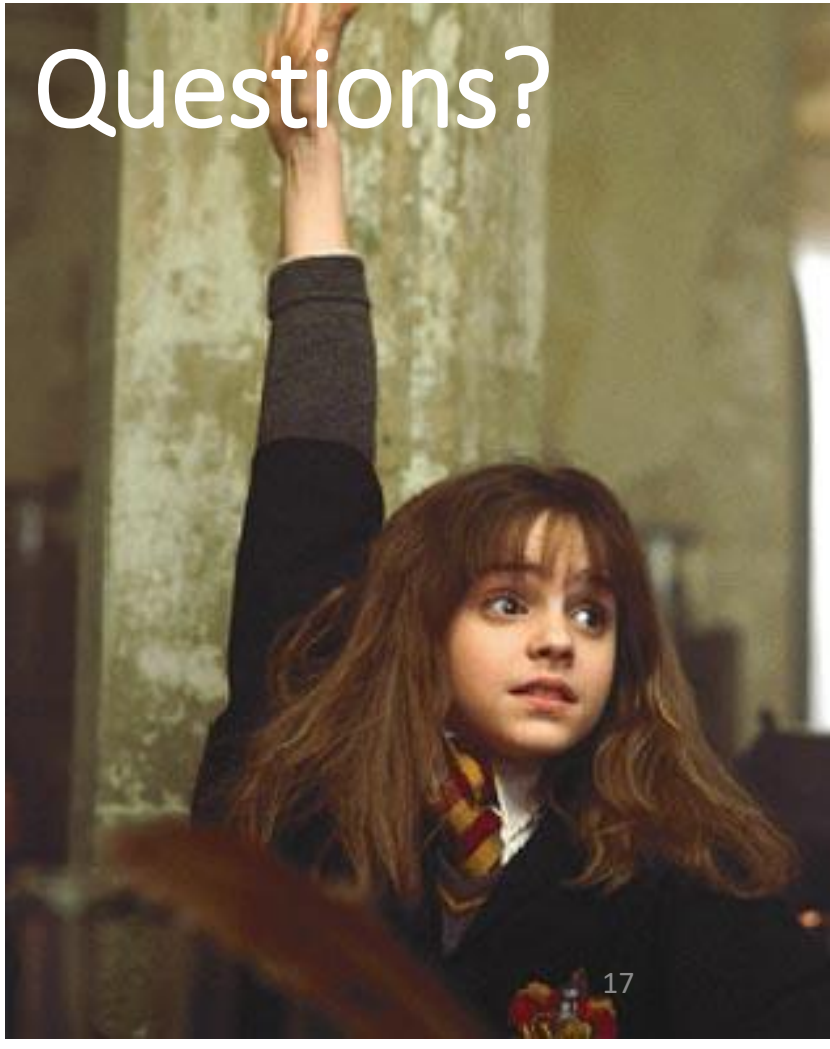
University of Victoria
British Columbia • Canada

Thank you

tmurdock@uvic.ca

ktyler@uvic.ca

www.PacificClimate.org



Weather File Development

1. Future shifted wx files @ existing stations using temp & evap only
2. Add a few dozen additional locations using PRISM climatology
3. Create an online data portal so that files can be produced on the fly for any location in BC
4. Replace evaporation from GCMs with diagnosed evaporation from BCCAQ temperature
5. Add precipitation, wind, snow load, and other variables
6. Replace downscaling method
7. Provide AMY files in addition to TMY files