Mitigating the parasitic effect of heat pump water heaters on home heating systems in cold climates

Steven Groves P.Eng.
Conservation and Energy Management

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  - Natural Resources Canada Office of Energy Efficiency
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  - BC Hydro
- Project Implementer
  - Energy 350

Sanden CO_2 Heat Pump Water Heater

- Outdoor unit with compressor, condenser, evaporator, heat exchanger, pump
  - the unit uses outdoor air as a heat source and CO2 as the refrigerant
- Indoor water tank with water loop and thermistor connection to outdoor unit
  - 160-liter (43-gallon) and 315-liter (83-gallon) used
- Manufacturer rated performance:
  - 3.09 EF, 2.9 UEFNC (160-liter system)
  - 3.84 EF, 3.3 UEFNC (315-liter system)
  - -29 to 60°C (-20 to 140°F) air temperature range
  - Tier 3 Advanced Water Heater Specification
- 65°C (149°F) hot water temperature set-point

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Rheem Heat Pump Water Heater

- Integrated unit with hot water tank, compressor, condenser, evaporator, backup heating element and controls combined
  - 246-liter (65-gallon) and 303-liter (80-gallon) used
- Manufacturer rated performance
  - 3.5 EF, 3.4 UEF_{NC} (246 and 303-liter systems)
  - 2.8 to 63°C (37 to 145°F) ambient air temperature operating range
  - Tier 3 Advanced Water Heater Specification
- Factory-default Energy Saver mode which optimizes heat pump and electric resistance heat for low power consumption and high recovery

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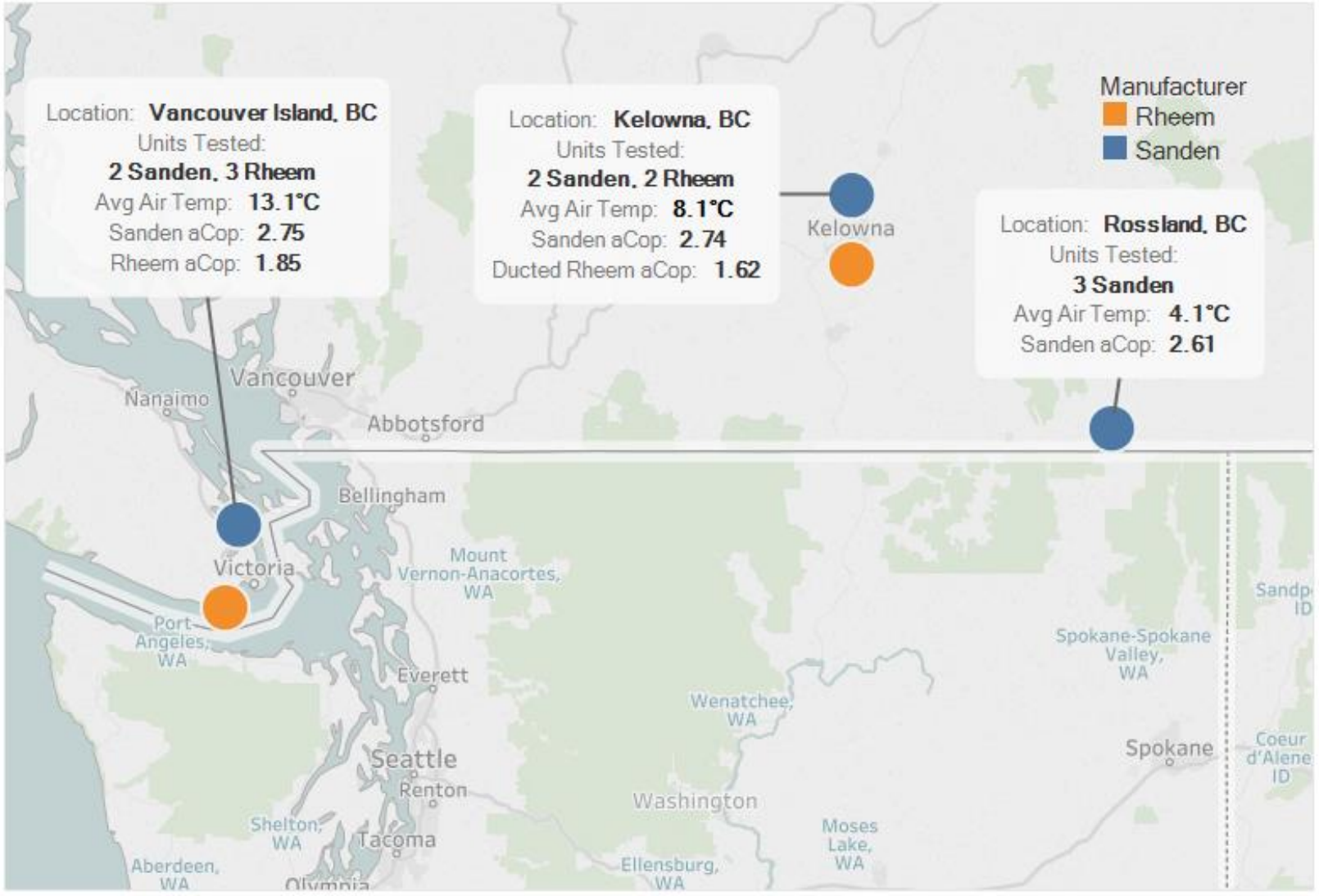
Study locations



Sanden Performance (SI units)

Site	aCOP	Tank Size (Liters)	Average Ambient Temp (°C)	Average Water Flow (Liters/Day)	Average Hot Water Temp (°C)	Average Inlet Water Temp (°C)	Months of Data
Rossland Site 1	2.62	314	2.6	102	52.9	11.0	15
Rossland Site 2	3.15	314	3.2	120	59.4	10.5	15
Rossland Site 3	2.06	314	6.6	100	52.5	10.7	15
Kelowna Site 1	1.86	163	6.6	74	52.4	16.5	15
Kelowna Site 2	3.62	163	8.0	288	51.6	10.2	15
V. Island Site 2	1.98	163	12.2	122	61.9	17.5	12
V. Island Site 3	3.52	163	10.8	148	61.3	15.8	12
Average	**2.69**	**228**	**7.2**	**136**	**56.0**	**13.2**	**14**

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Rheem Performance (SI units)

Site	aCOP	Tank Size (Liters)	Average Ambient Temp (°C)	Average Water Flow (Liters/Day)	Average Hot Water Temp (°C)	Average Inlet Water Temp (°C)	Months of Data
Kelowna Site 4	1.62	303	9.8	324	50.8	14.4	8
V. Island Site 1	1.76	246	9.5	195	49.4	10.3	4
V. Island Site 4	1.73	246	16.2	65	48.3	16.0	11
V. Island Site 5	2.06	246	16.7	279	49.7	13.5	12
Average	**1.79**	**260**	**13.0**	**216**	**49.6**	**13.6**	**9**
Kelowna Site 3	2.08	303	20.6	175	51.4	10.5	15

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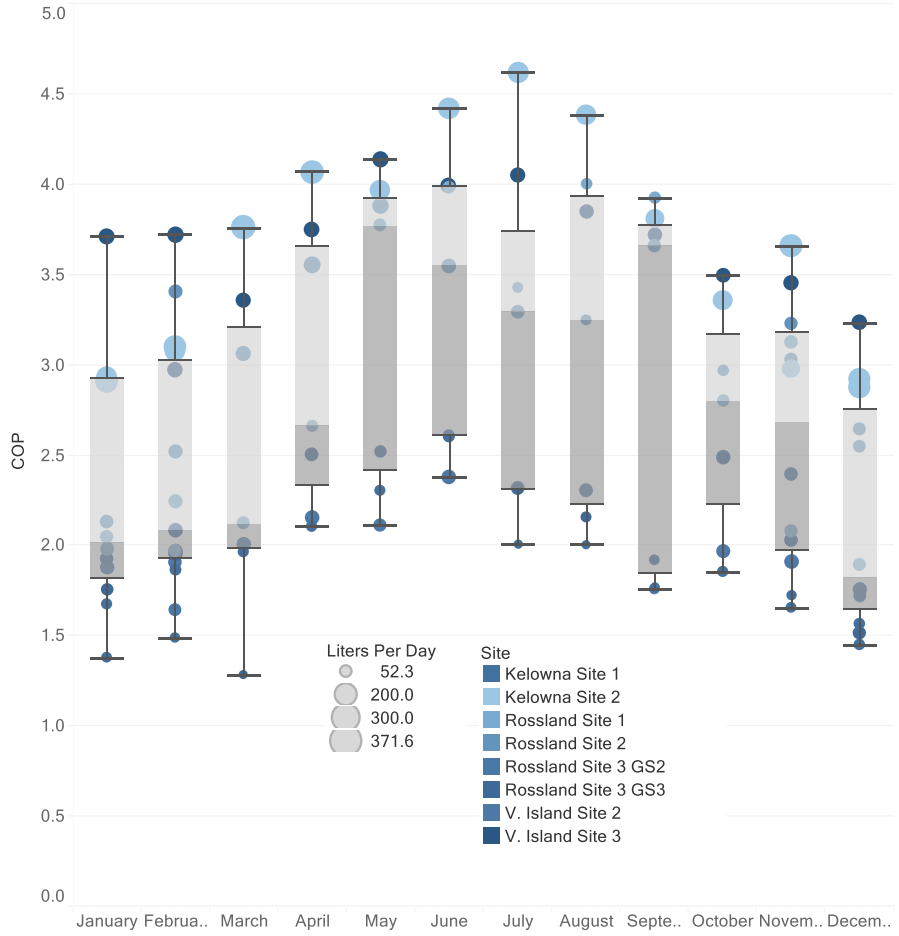
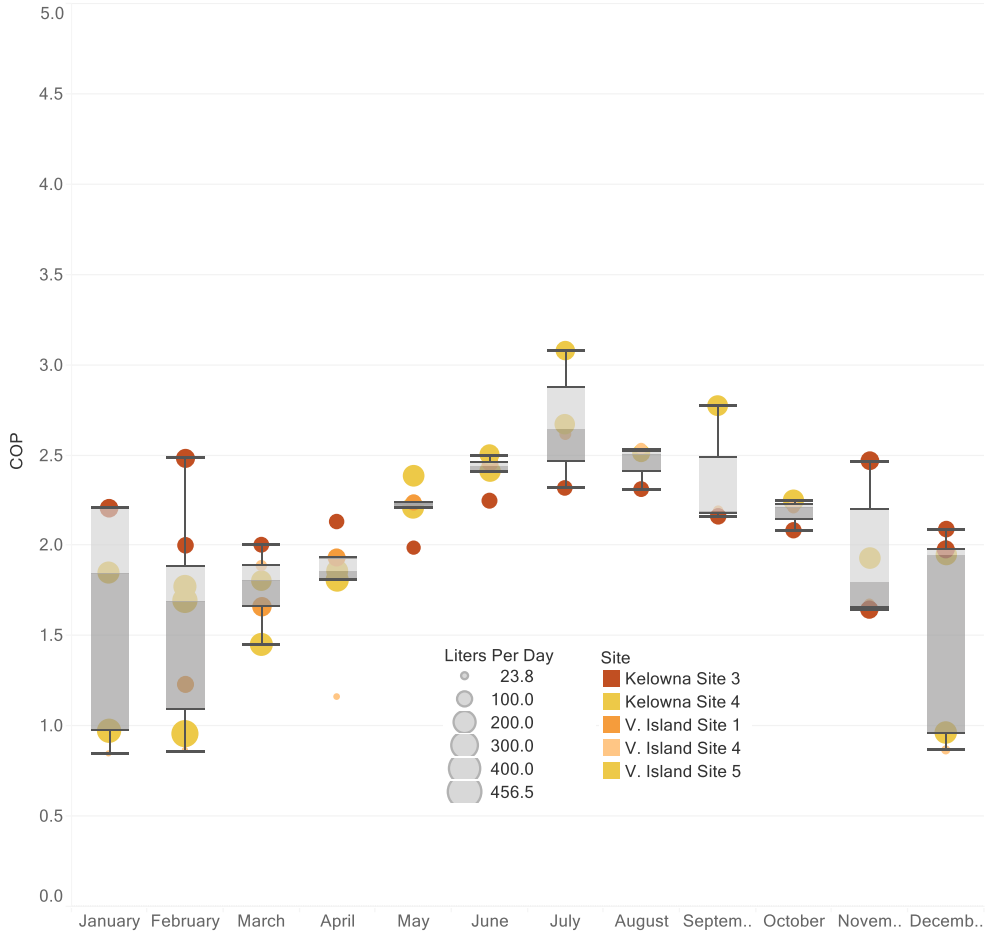
Monthly COP by Site

Sanden



Rheem



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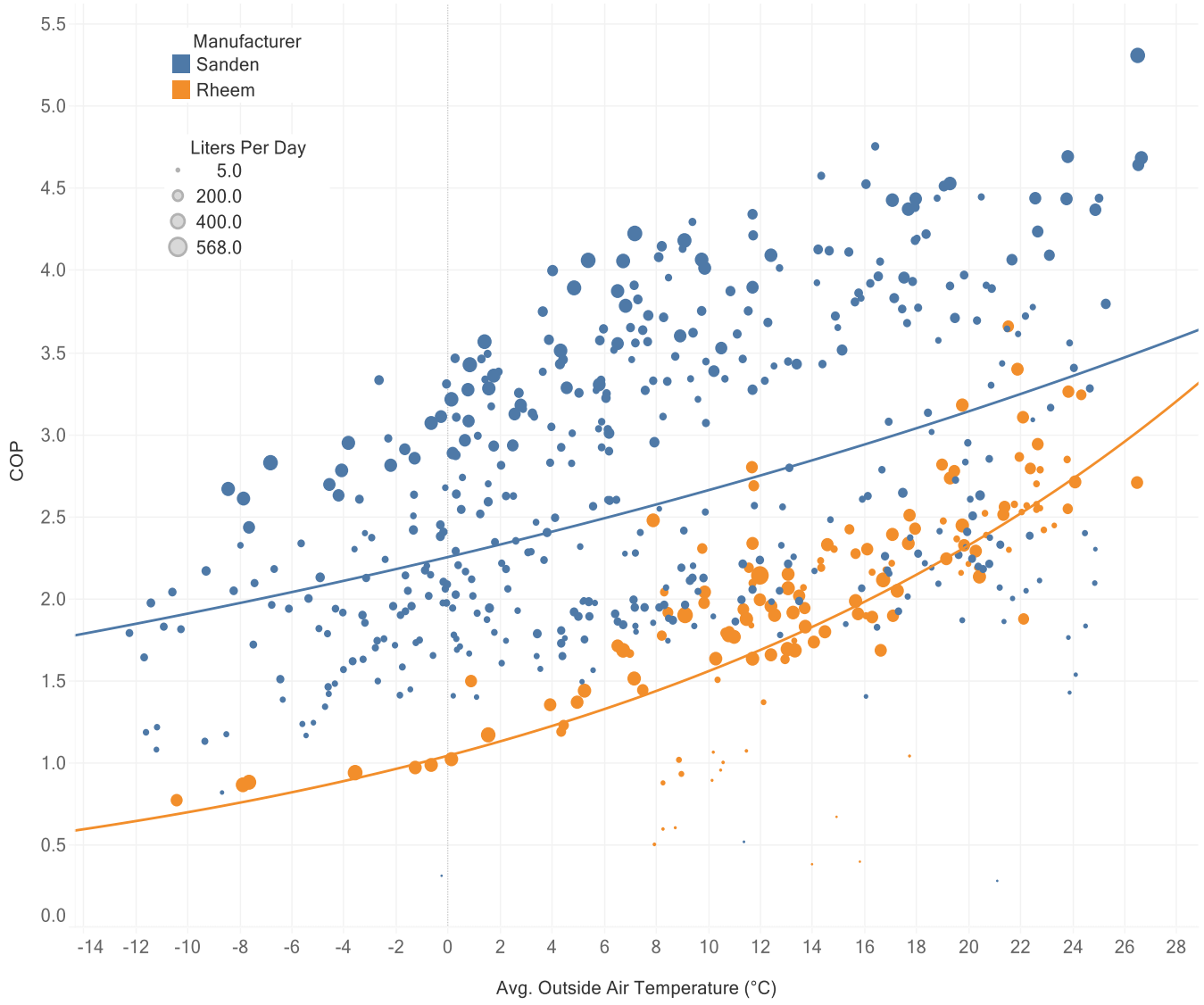
Weekly COP vs. Outside Air Temperature



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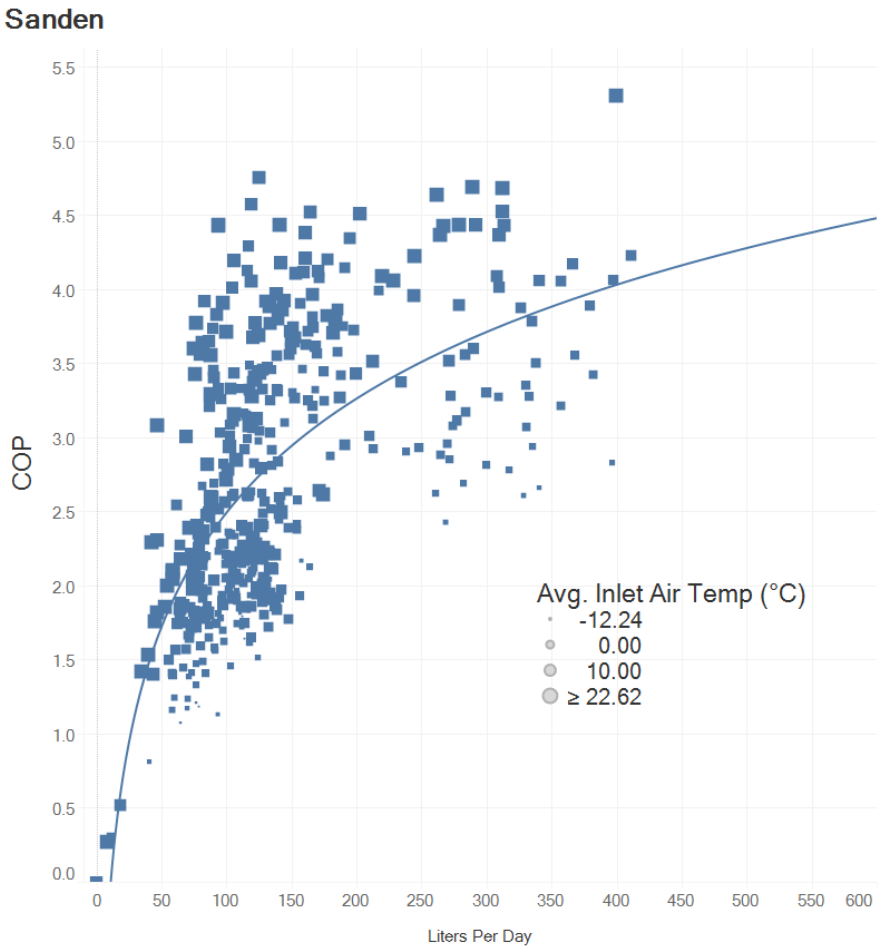
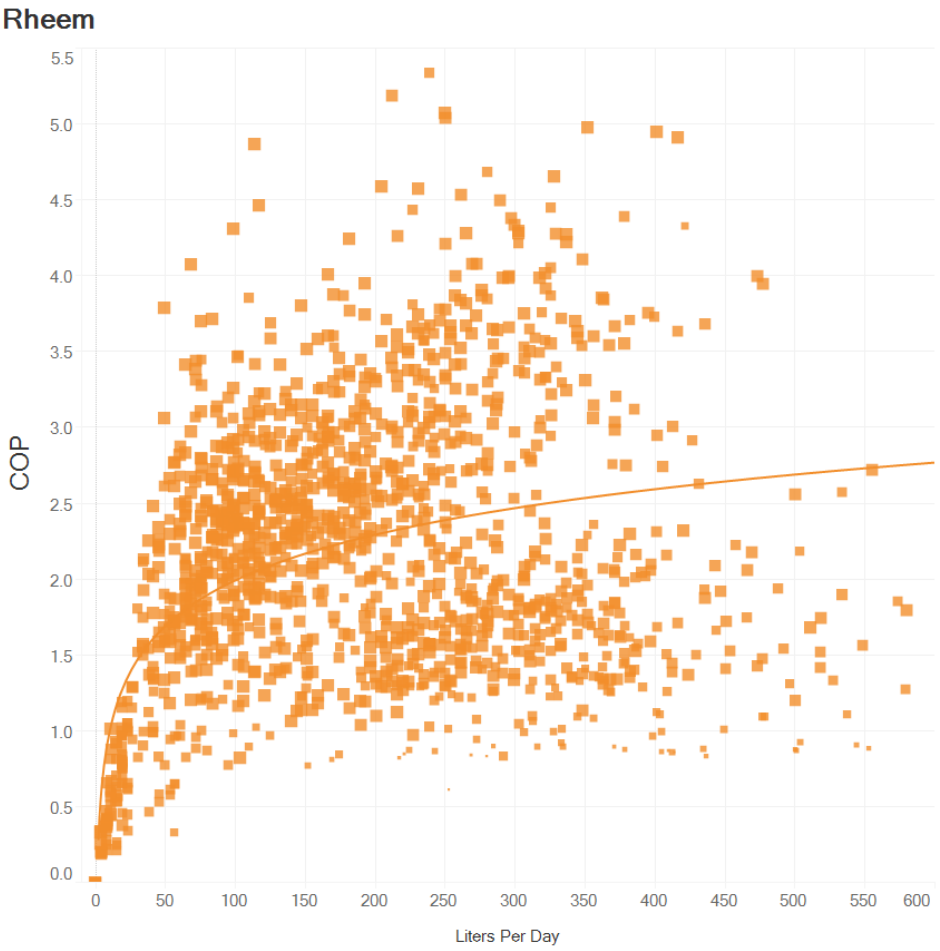
Weekly COP vs. Daily Water Draw





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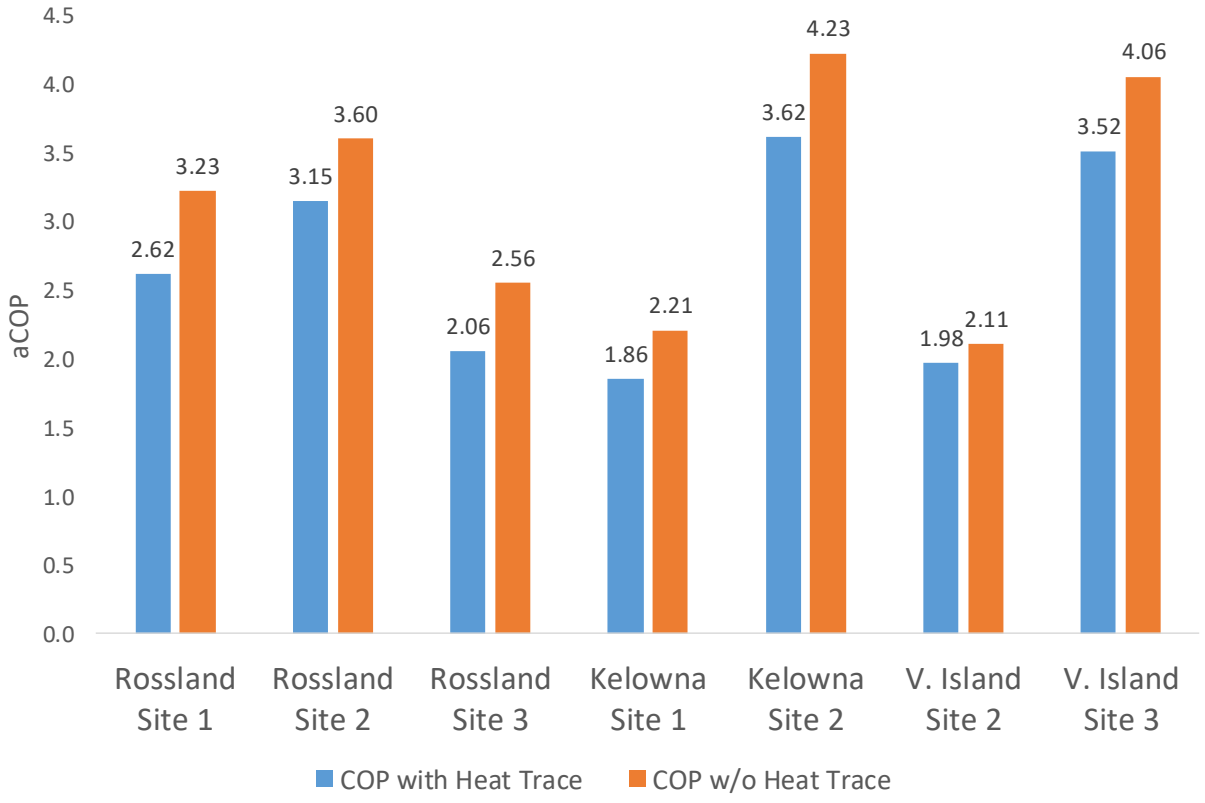
Heat Trace Effect on Sanden aCOP



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Troubleshooting

- Lost data
  - House sold
  - Pulse adaptor failure
- Performance issues
  - Undersized Rheem unit

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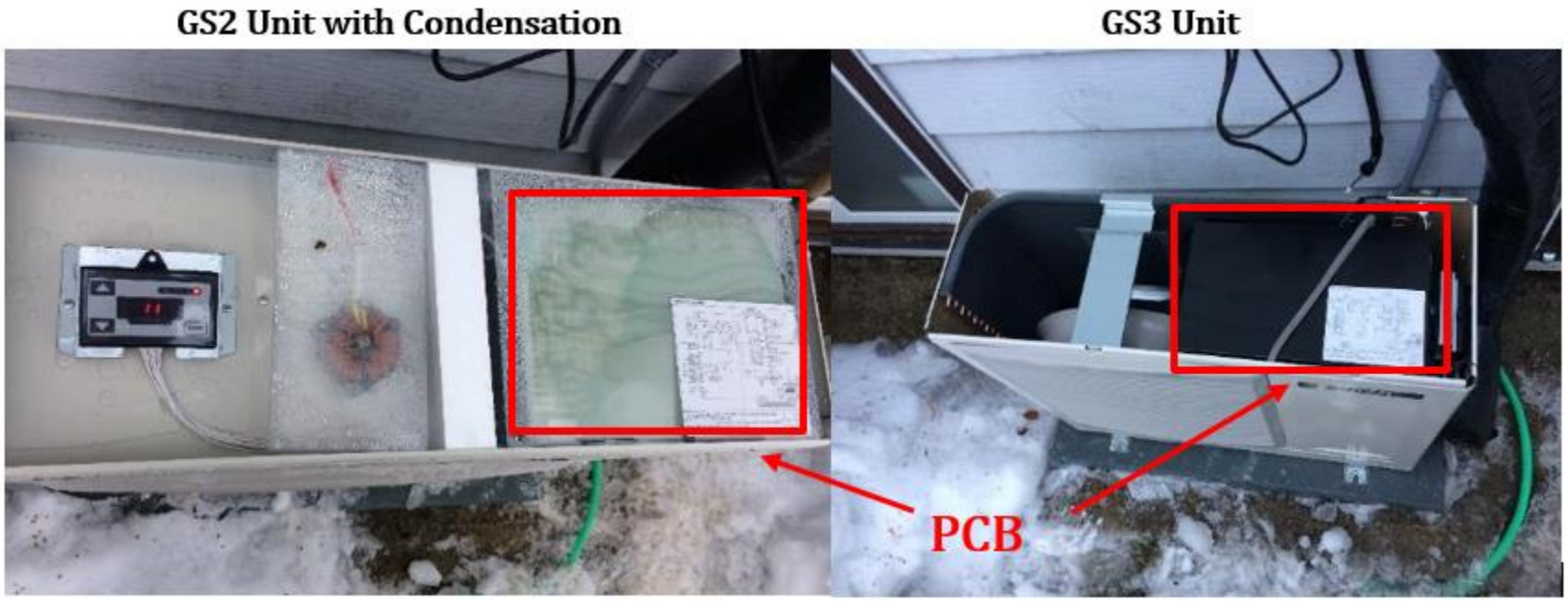
Troubleshooting

- Sanden GS2 vs GS3



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Findings summary

# of Units Tested	Manufacturer	Heat Pump Water Heater Technology	Storage Tank Sizes Tested (L)	Rated Northern Climate UEF	Field Tested aCOP	Incremental Installed Cost (CAD)	Energy Savings (kWh)	% Energy Savings
7	Sanden	CO2 "Split" System	160 and 315	2.9/3.3	2.69	$6,776	1,923	67%
5	Rheem	Integrated Unit	246 and 303	3.4	1.79	$2,346	1,896	52%

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Thank you

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For further information, please contact:

Steven Groves

steven.groves@fortisbc.com

(250) 469-8004

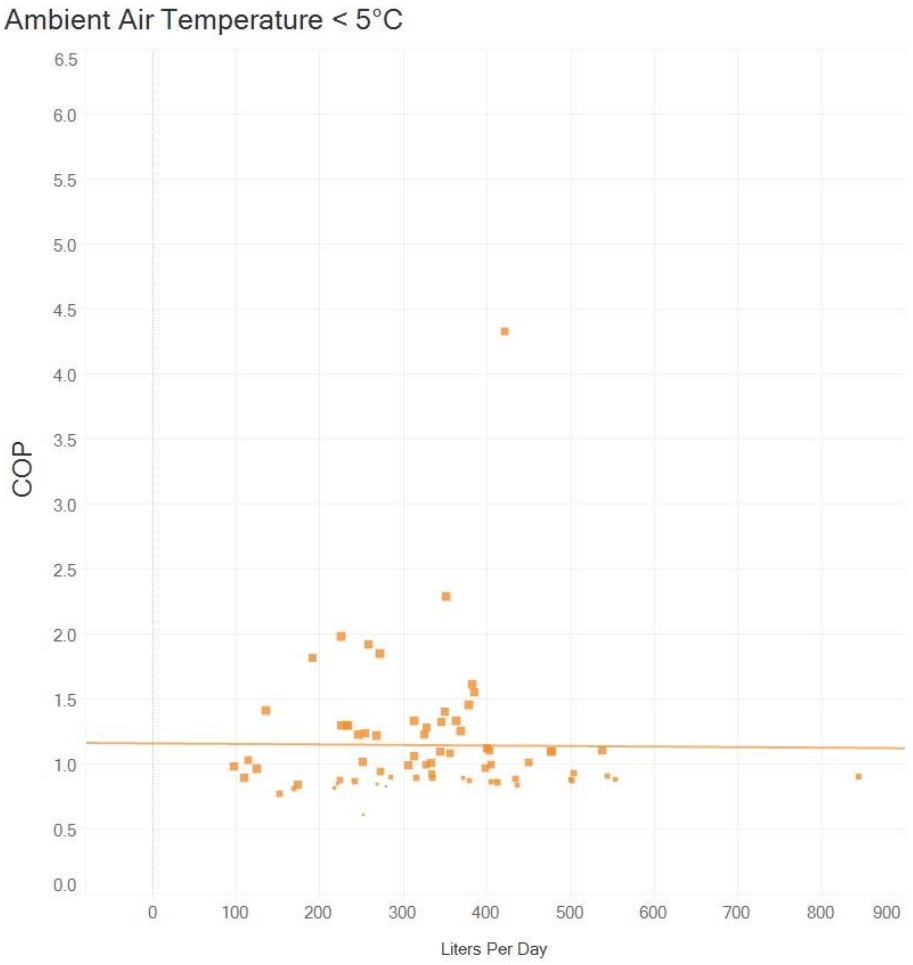
Find FortisBC at:

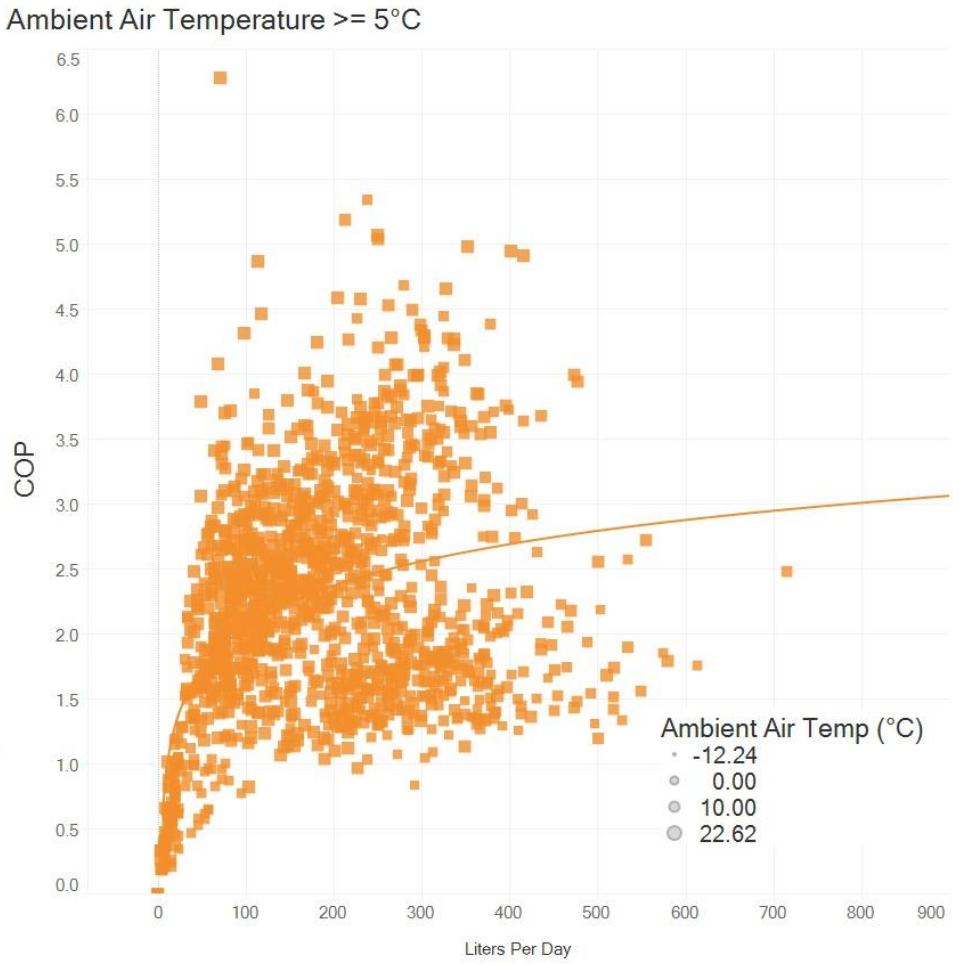
Fortisbc.com

talkingenergy.ca

604-576-7000

Rheem COP vs. Daily Water Draw





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