



Optimization of a Low Temperature Solar District Heating System by Integrating Space and Domestic Hot Water Loads

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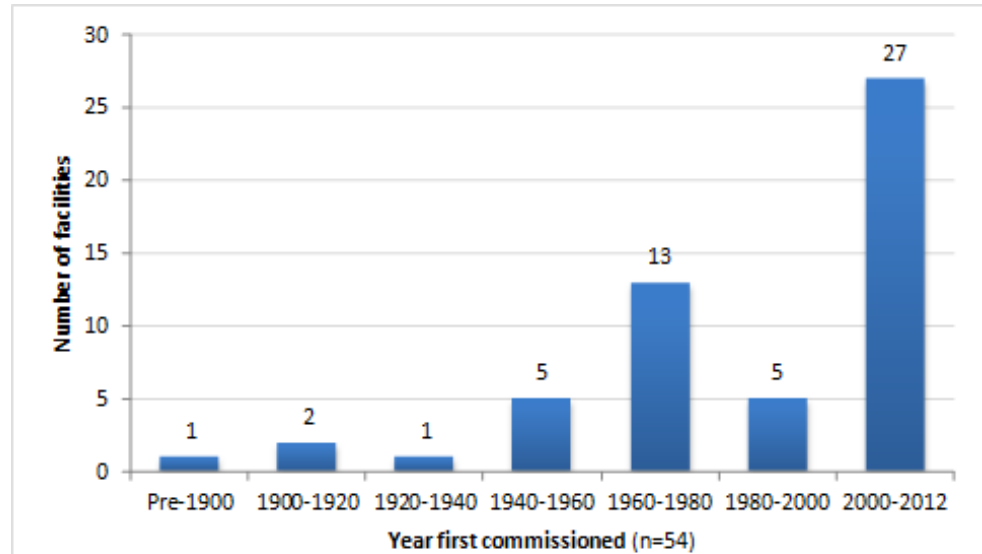
**2nd International Solar District Heating Conference,
Hamburg, Germany, June 3-4, 2014**

Outline

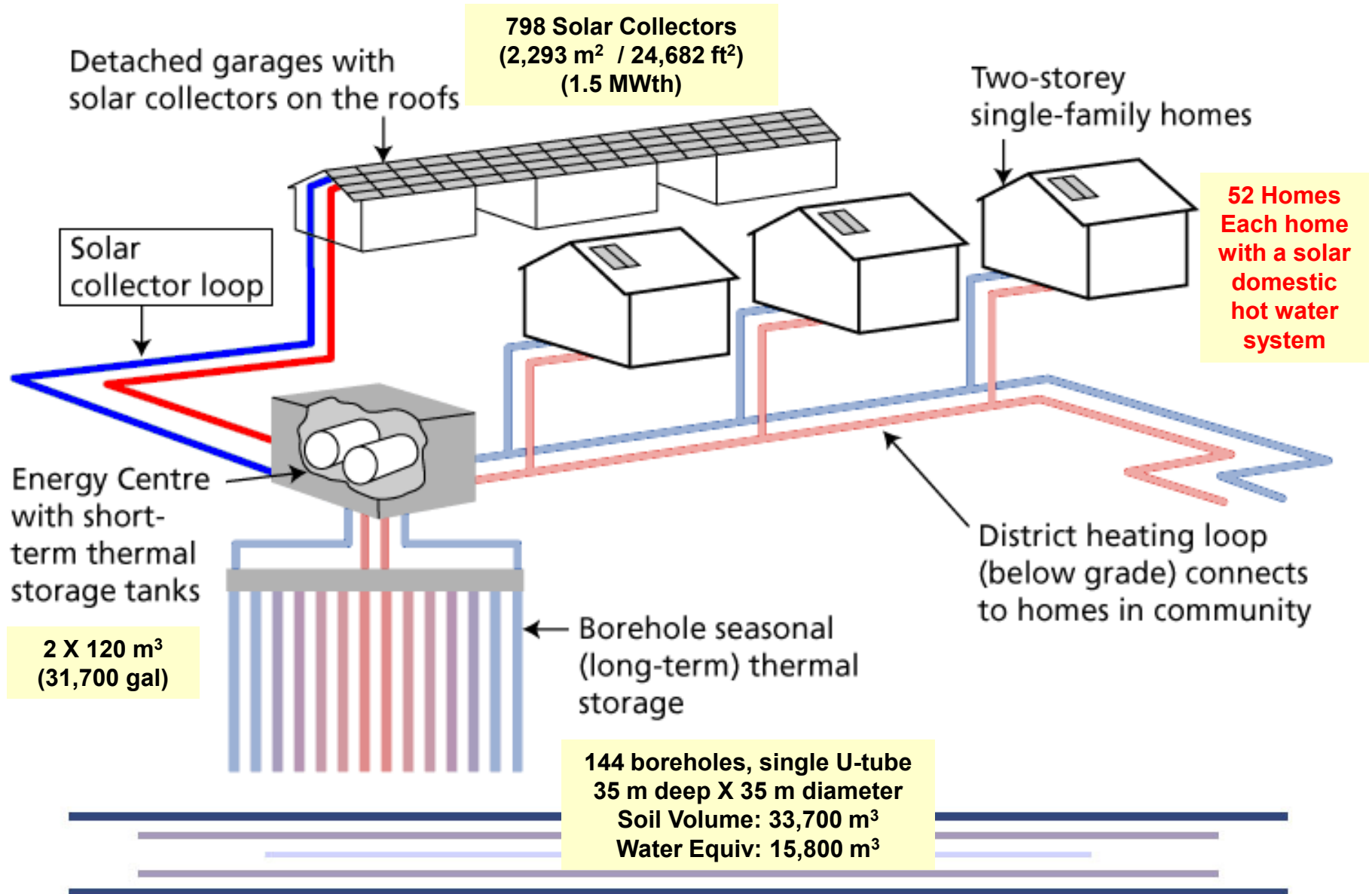
- Solar District Heating in Canada
- Objectives of the study
- Results
- Conclusions – Next Steps

District Energy Heating in Canada

- National total number of systems of only 120 to 130 systems
- Some growth in the number of installations in recent years
- Drake Landing is the only solar district heating system in Canada

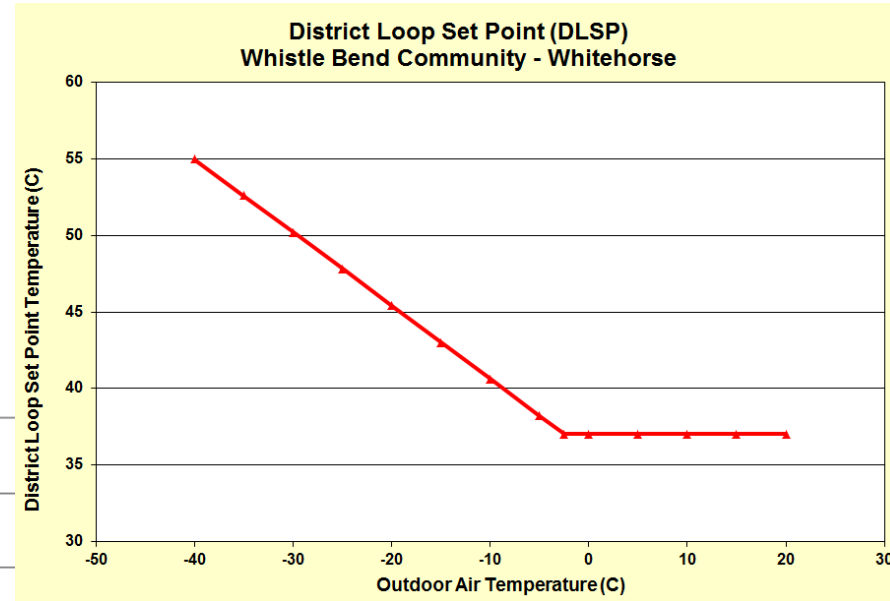
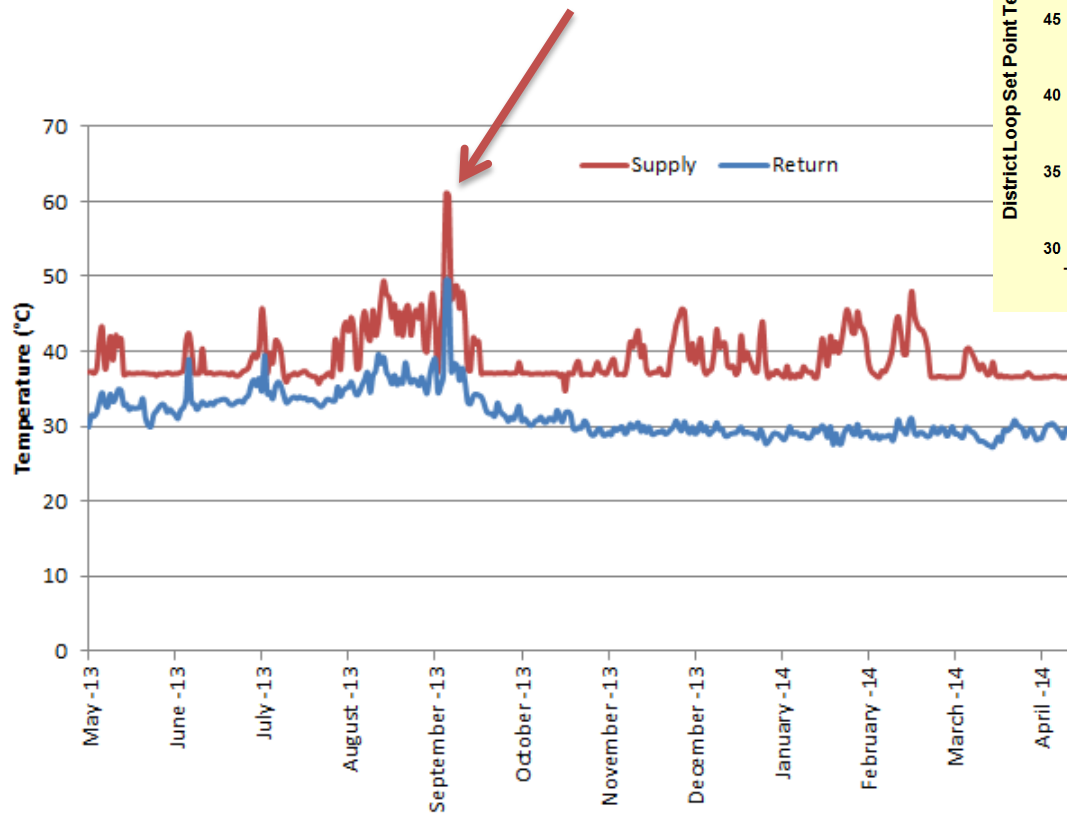


Reference Canadian SDH – Drake Landing

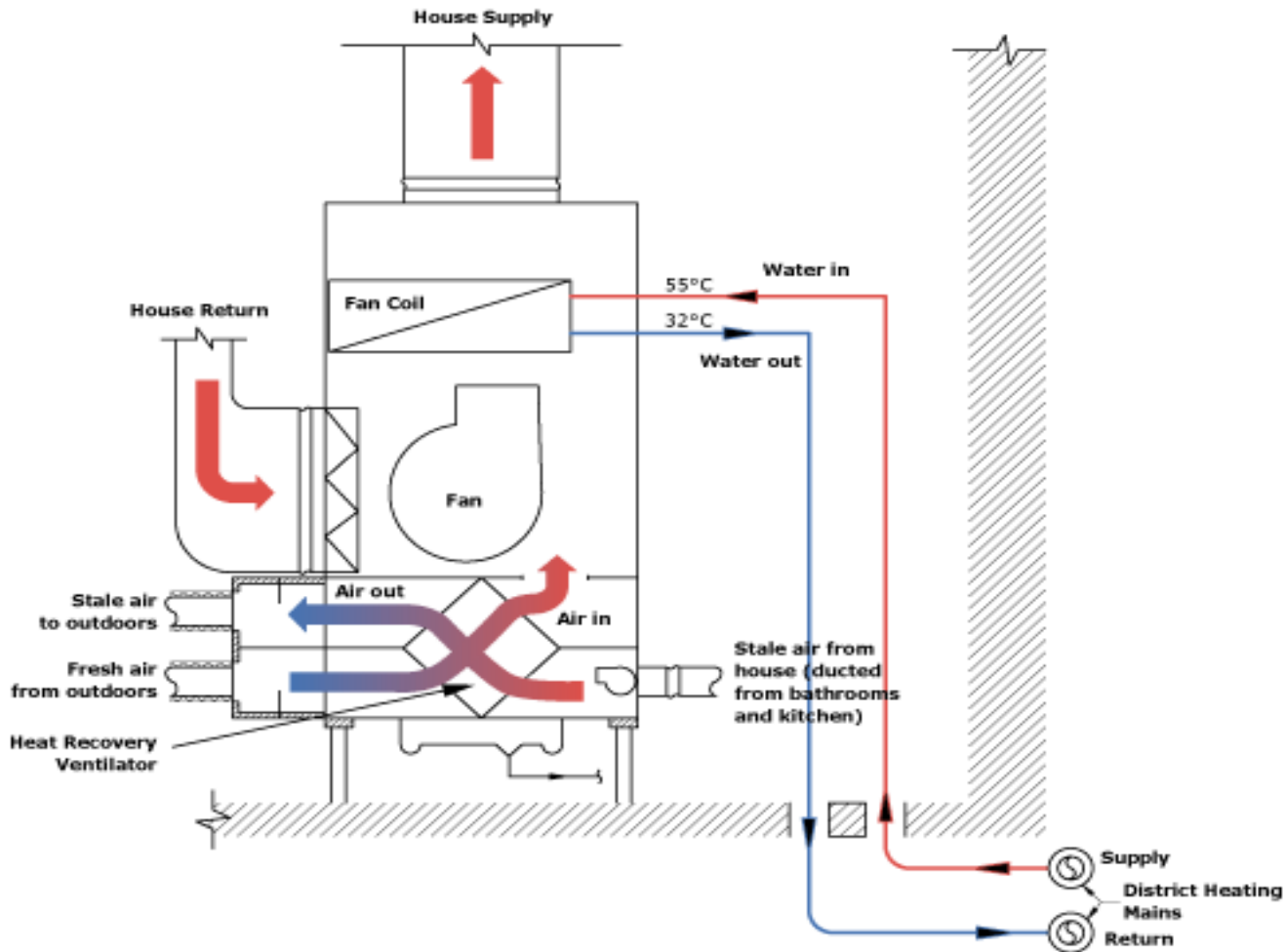


DLSC Daily Average District Loop Temperature

Solar "sterilization" of the DL.



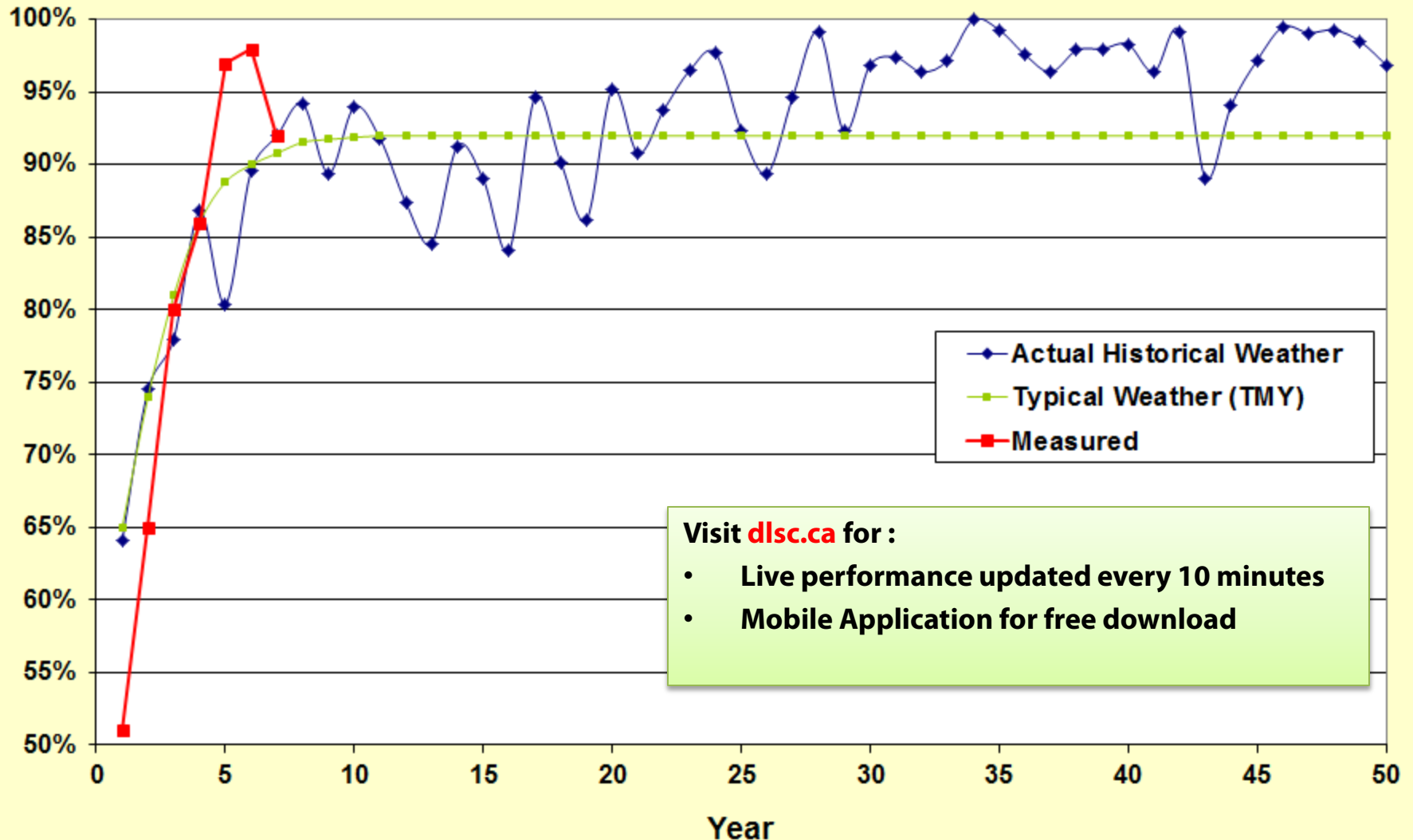
Drake Landing Air Handler Unit



Drake Landing – Year 7 performance

(Year 7 was the coldest year since system start)

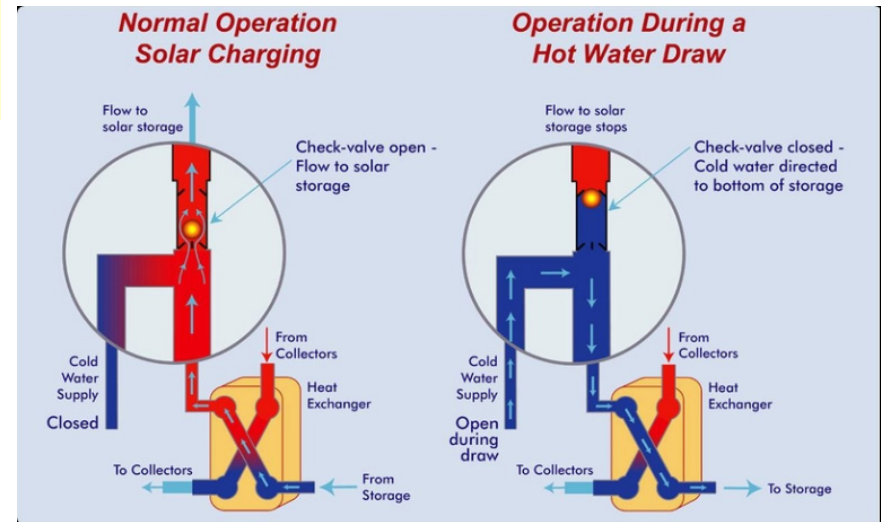
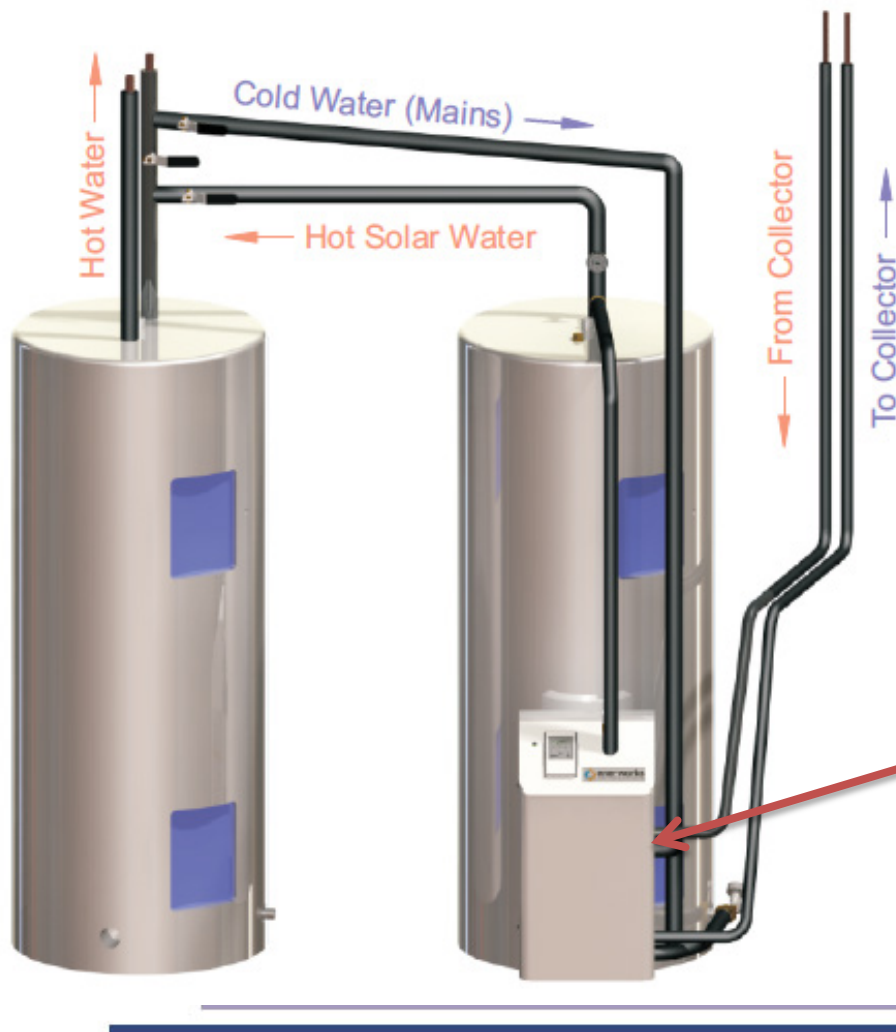
Solar Fraction - Actual vs. TMY Weather



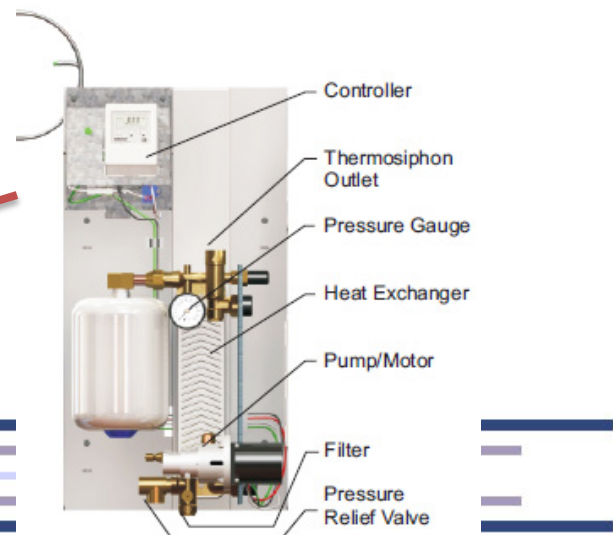
Canadian Low-Flow SDHW System

Passive anti-fouling back flush design

Side-arm **external** Heat Exchanger Thermosyphon flow on the tank side



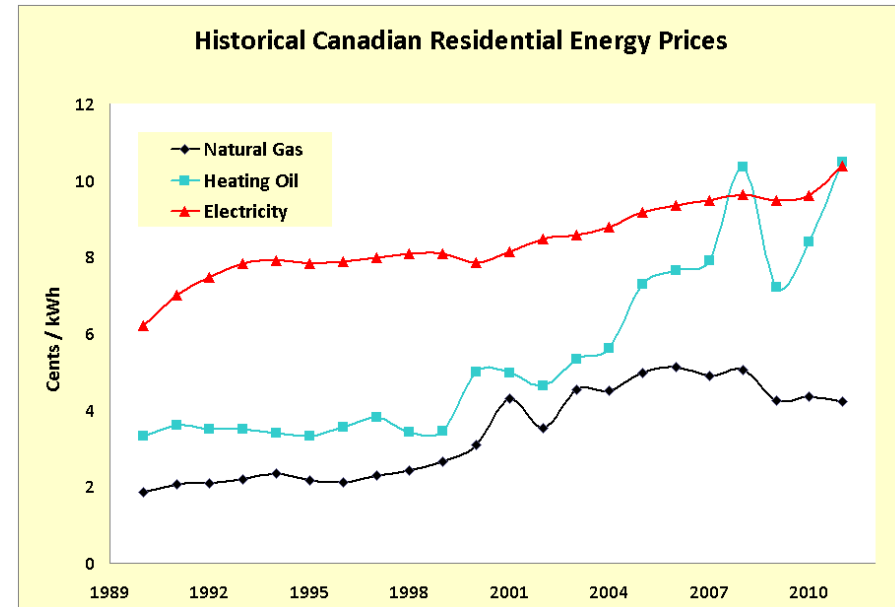
Front view



Ongoing R&D Activities

❑ Further system optimisation of DLSC design by:

- Reducing the cost of seasonal storage
 - Aquifer solar seasonal storage
 - Improved BTES design
- Economies of scale
 - Large scale solar collectors
 - Large scale BTES / ATES
- Integration of DHW into the solar district heating system
 - Various integration strategies
 - **Integrating solar preheat tanks to the district loop**
- Reducing parasitic load (more efficient pumps...)
- Reducing O&M costs, (wireless heat metering...)

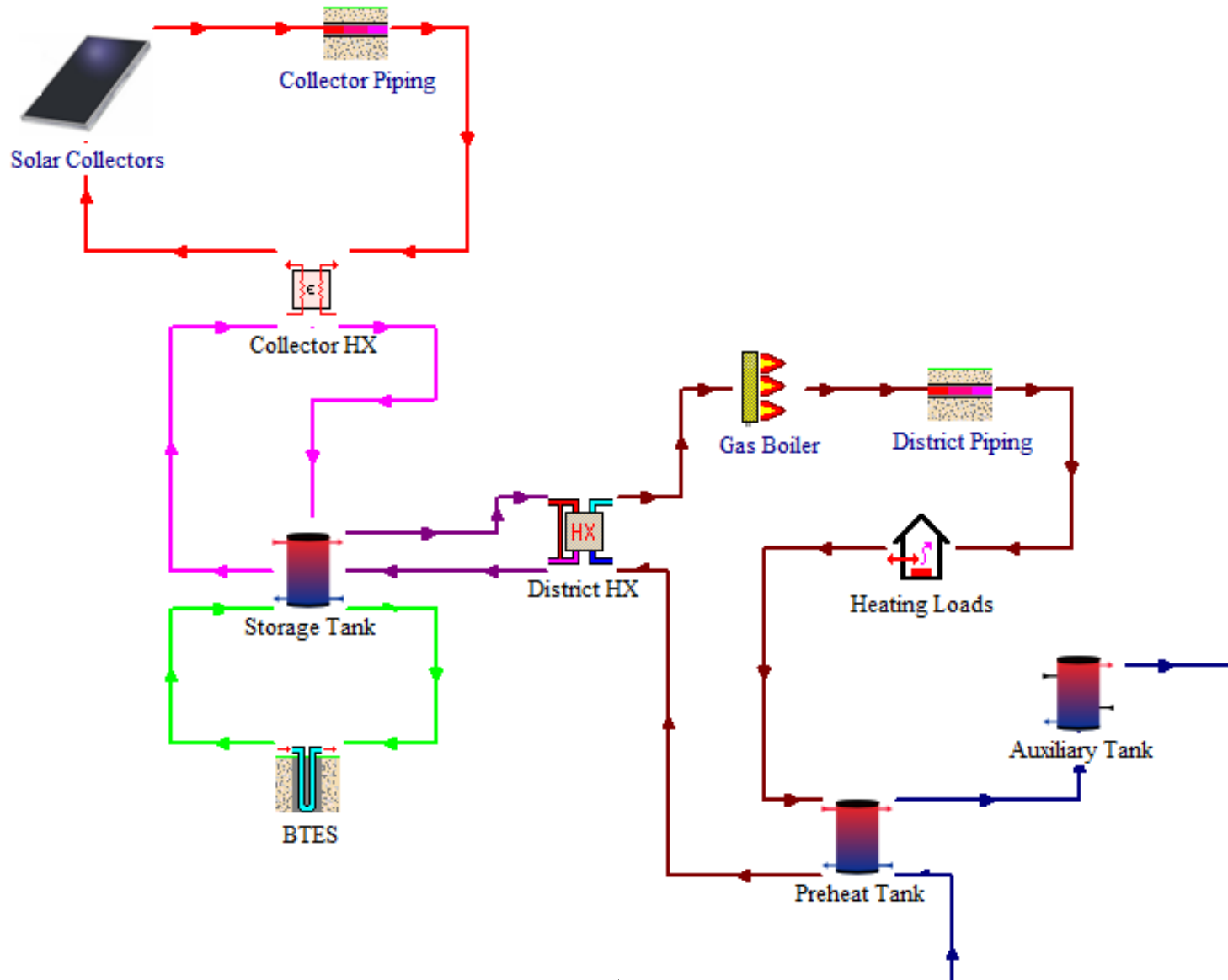


Objective

- Question addressed for this presentation is:
 - Comparison of the case where DHW is provided by standalone SDHW as in Drake Landing versus when provided by solar district heating system



TRNSYS Parametric Analysis Of Integrated Space and DHW



System design scenarios considered

	System 1 Reference Case	System 2	System 3	System 4
Simple Description	Drake Landing As-Built	Simplest add-on. Preheat tanks connected in series with AHU's. No control pump, or piping changes	Like system 2 but control changes to allow for increased use of solar for DHW.	Like system 3, but 90 additional collectors on the garages in order to match combined solar fraction of System 1.
# Collectors	798 on the garage roofs for space heating & 104 on the homes for SDHW	798 on the garage roofs for both space heating and SDHW	Like system 2	888 on the garage roofs for both space heating and SDHW
Heating and SDHW Integration	None	SDHW pre-heat tanks in series with the air handlers in each home.	Like system 2	Like system 2
District Loop Controls	As-Designed: Setpoint for the district loop = f(Ambient) only. Pump only runs on a call for heat and is controlled to meet the heating load. STTS supplies setpoint temperature water if available.	Like system 1	Pump runs 24/7 all year and is controlled to meet the larger of the heating load or the DHW load. STTS provides as much as heat as possible to the district loop up to 55 C maximum.	Like system 3

System design scenarios considered continued

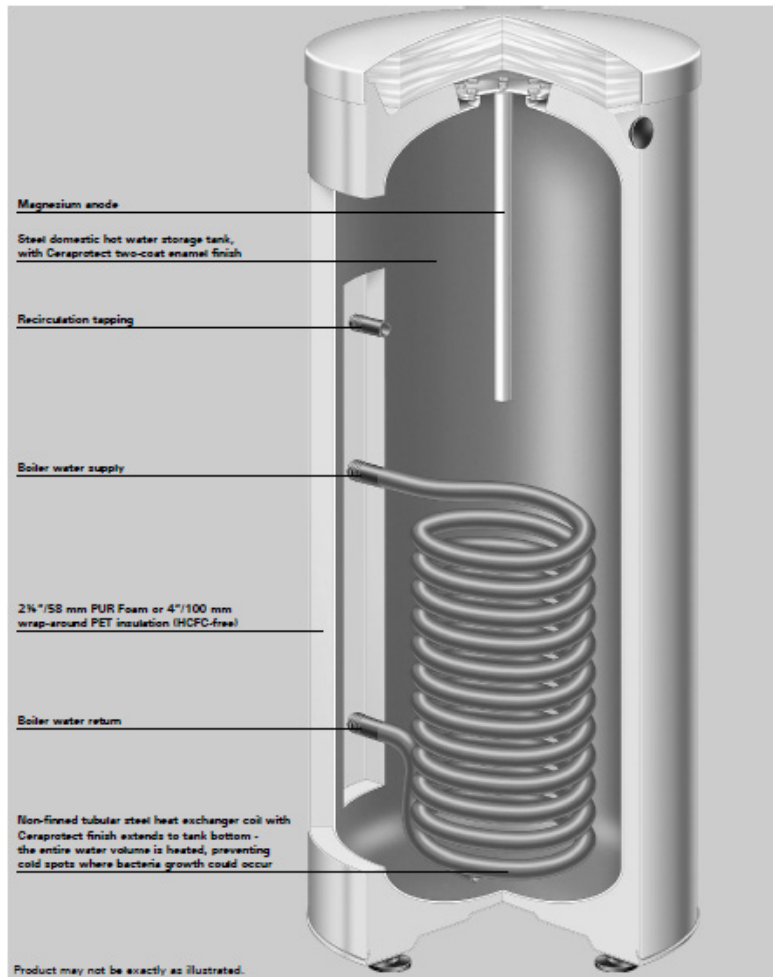
	System 1 Reference Case	System 2	System 3	System 4
Boiler Controls	Boiler controlled to only provide minimum required heating temperature.	Like system 1	Like system 1	Like system 1
BTES Control	Detailed algorithm for charging and discharging of the BTES based on setpoints and time of day (% charged algorithm)	Like system 1	BTES charging starts when STTS reaches 65 C and stops when STTS falls to 55 C no matter the time of day or time of year. BTES discharges whenever hotter than STTS (5/2 deadbands).	Like system 3
Advantage Over Reference Case System		With DHW in series with AHU, more energy is scrubbed from the district loop, allowing greater collection and less energy stored in "lossy" BTES.	Same advantages as System 2 + better controls allow more of the summer solar energy to be used directly for DHW without long-term storage.	Same advantages as System 2 + better controls allow more of the summer solar energy to be used directly for DHW without long-term storage.

System design scenarios considered continued

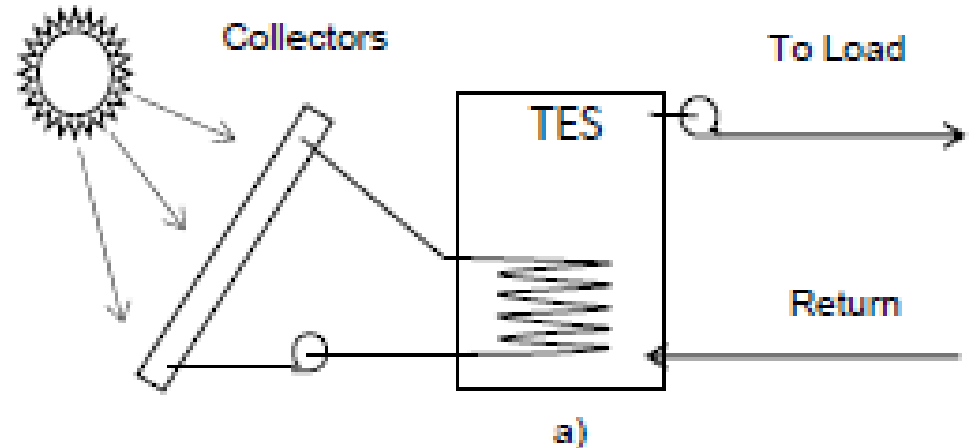
	System 1 Reference Case	System 2	System 3	System 4
Simple Description	Drake Landing As-Built	Simplest add-on. Preheat tanks connected in series with AHU's. No control pump, or piping changes	Like system 2 but control changes to allow for increased use of solar for DHW.	Like system 3, but 90 additional collectors on the garages in order to match combined solar fraction of System 1.
Total collector area (m²)	2293	Like system 1	Like system 1	2551
Space heating load (GJ/Year)	2675	Like system 1	Like system 1	Like system 1
DHW heating load (GJ/Year)	769	Like system 1	Like system 1	Like system 1
Total space and DHW load (GJ/Year)	3444	Like system 1	Like system 1	Like system 1



Other Solar storage pre-heat tank considered



Different sizes of Immersed single-coil **internal** Heat Exchanger



Technico Economical Results

	System 1 Reference Case	System 2	System 3	System 4
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Space heating solar fraction	93%	89%	85%	89%
DHW solar fraction	49%	34%	60%	62%
Combined space heat and DHW solar fraction	81%	73%	76%	81%
Space heating delivered by Solar (GJ/Year)	2490	2372	2262	2394
DHW delivered by solar (GJ/Year)	374	260	461	473
Total Solar Energy Delivered (GJ/Year)	2863	2632	2723	2867

Technico Economical Results Continued

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Capital cost of the solar district heating system (2014 \$)	\$4,863,943	\$ 4,937,935	\$4,937,935	\$ 5,137,107
Total cost of the 52 SDHW (2014 \$)	\$ 282,971	\$ -	\$ -	\$ -
Total solar cost (2014 \$)	\$5,146,915	\$ 4,937,935	\$4,937,935	\$5,137,107
Diff. With Ref. Case	-	-4%	-4%	0%
Specific Total solar cost (2014 \$/GJ)	\$1,798	\$1,876	\$1,814	\$1,792
Diff. With Ref. Case	-	1%	0%	0%

Conclusions & Next Steps

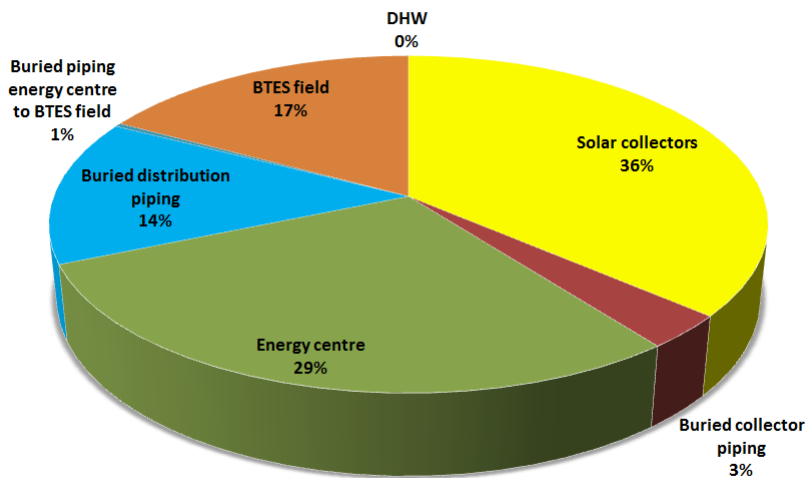
- Parametric analysis completed considering different solar pre-heat tanks and DHW integration scenarios into Drake Landing SDH system
- Both approaches, standalone SDHW and DHW provided by the Drake Landing SDH, offer similar cost/performance.
 - No clear winner for the particular case of the Drake Landing system reference case

Next Steps

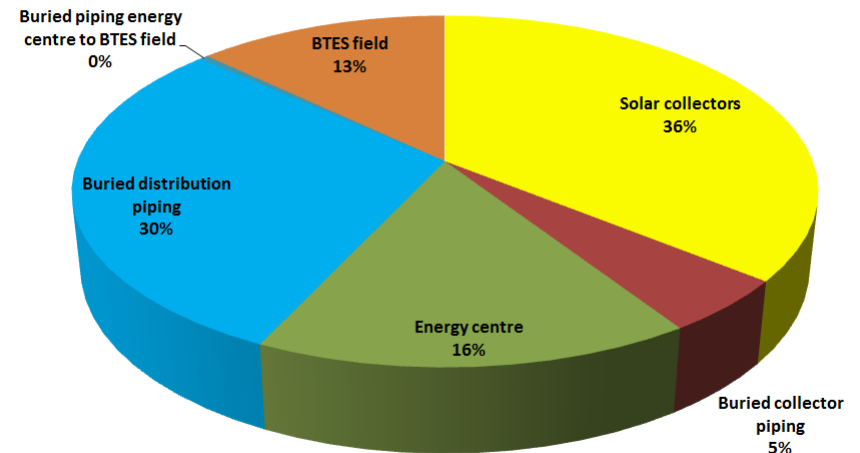
Investigate the benefits of:

- Larger scale SDH systems at different Canadian weather and market locations
- Other seasonal storage BTES and ATES designs
- Large area solar collectors

Capital cost various parts of solar district energy system
Drake Landing Solar Community



Capital cost various parts of solar district heating system
1000+ home Community in the Calgary Area



Thank You ! Questions?

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