IDEA2022
Building Connections

June 6-9 | Sheraton Centre Toronto Hotel | Toronto, ON

INTERNATIONAL
DISTRICT ENERGY
ASSOCIATION

Natural refrigerant heat pumps for district energy systems

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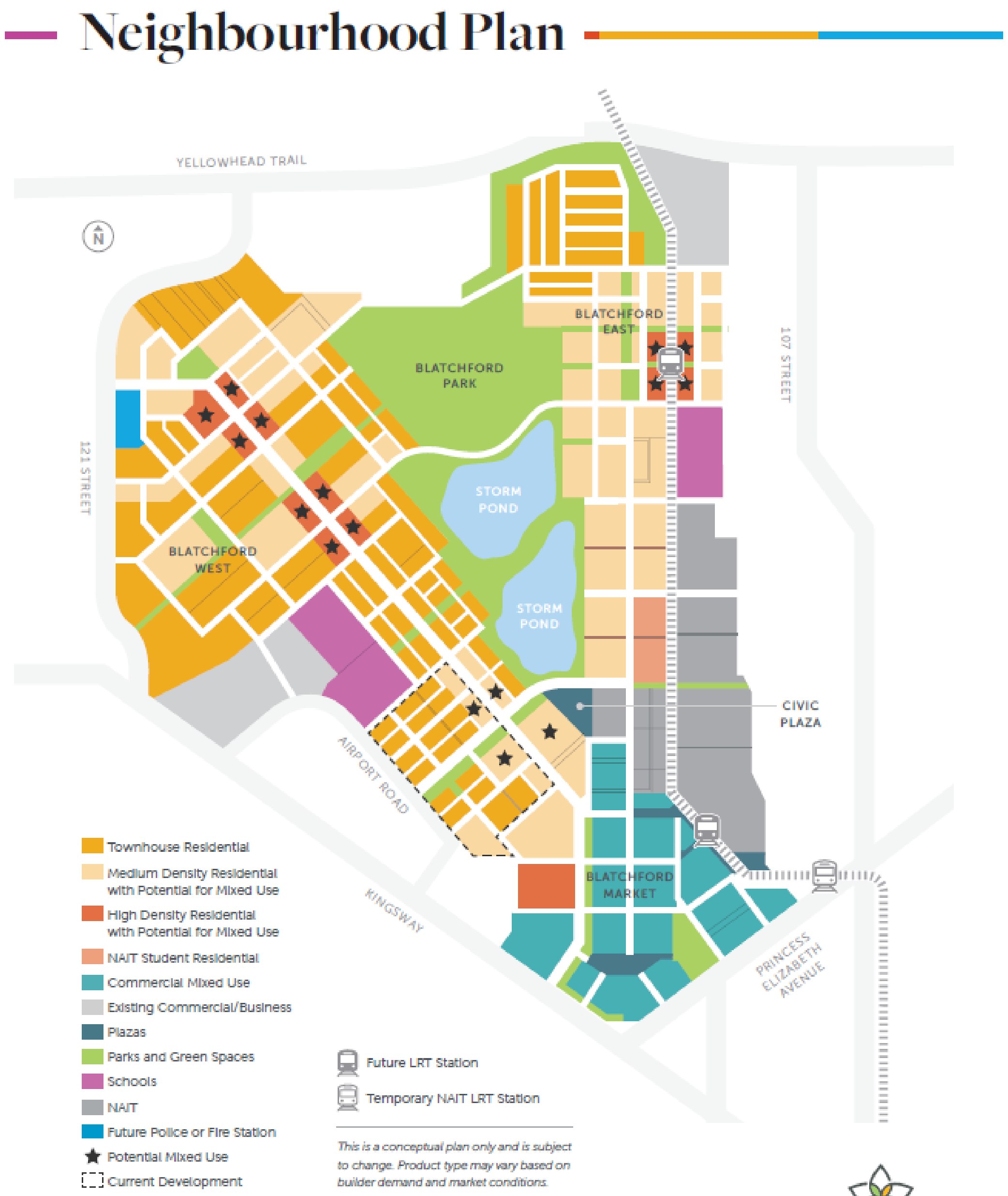
TOROMONT CIMCO

The Challenge

- Blatchford airport redevelopment
- 30,000 residents
- 1.5 million m^2
- Target to be a sustainable, net-zero carbon community powered by 100% renewable energy



Blatchford

From this…. To this

The Plan...District Energy sharing system

5th Generation Ambient DESS

- Heating
- Cooling
- Hot water heating

Planned Heating Cap:35MW (119MMbtu)

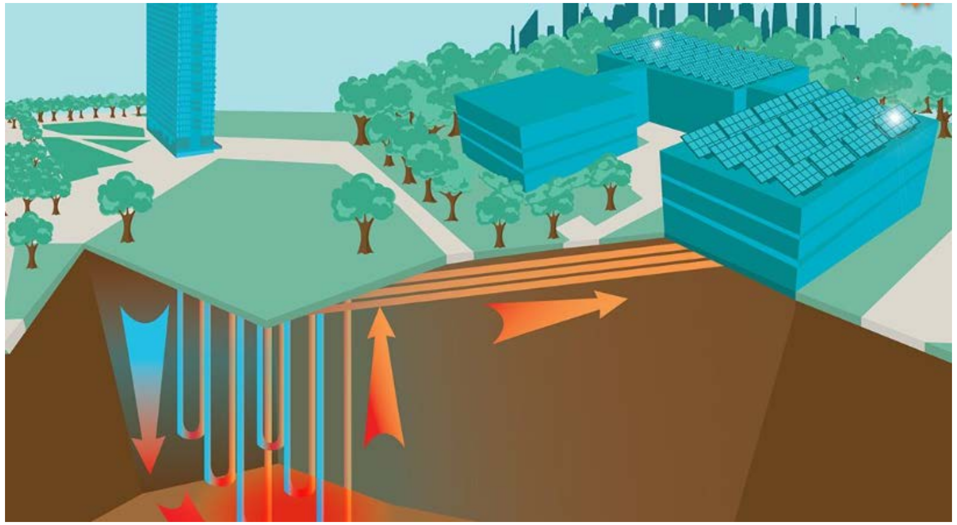
Planned Cooling Cap:46MW (157MMbtu)

Energy Source

- Geoexchange Borefield
- Peaking Boilers
- Sewer Heat Recovery

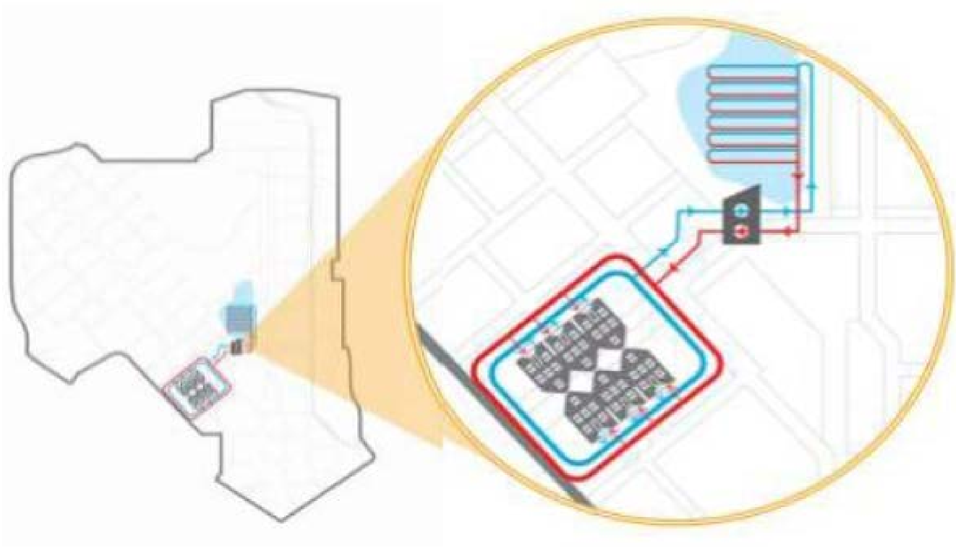
Energy Recovery

- Sharing of heating and cooling
- Investigating Recovery from ice Arenas, Adjacent District Heating Plants, Transit Electrical Rooms



Solutions (Case Study)

- 1 x Ammonia Heat Pump (1MW/300TR) +2 future
- Geoexchange glycol Borefield
- 2 pipe water distribution loop
- Point of use residential equipment
- Target 1.5 Te of CO2 reduction per household



Solutions (Case Study)

GEOEXCHAGNE BOREFIELD

- 570 boreholes
- 150m(500ft) deep
- Installed under storm water lake

SITE DISTRIBUTION

- Uninsulated HDPE
- 10-25C (55-77F) operating temp
- Water distribution system
- HDPE reduces cost and simplified installation vs 4 pipe steep system
- Burial depth 3m(10ft) for freeze protection

Solutions (Case Study)

Typical Hybrid Utility ownership Model

- Utility owns energy generation and distribution
- Utility owns service connection and energy meters

Small building customer owns HP

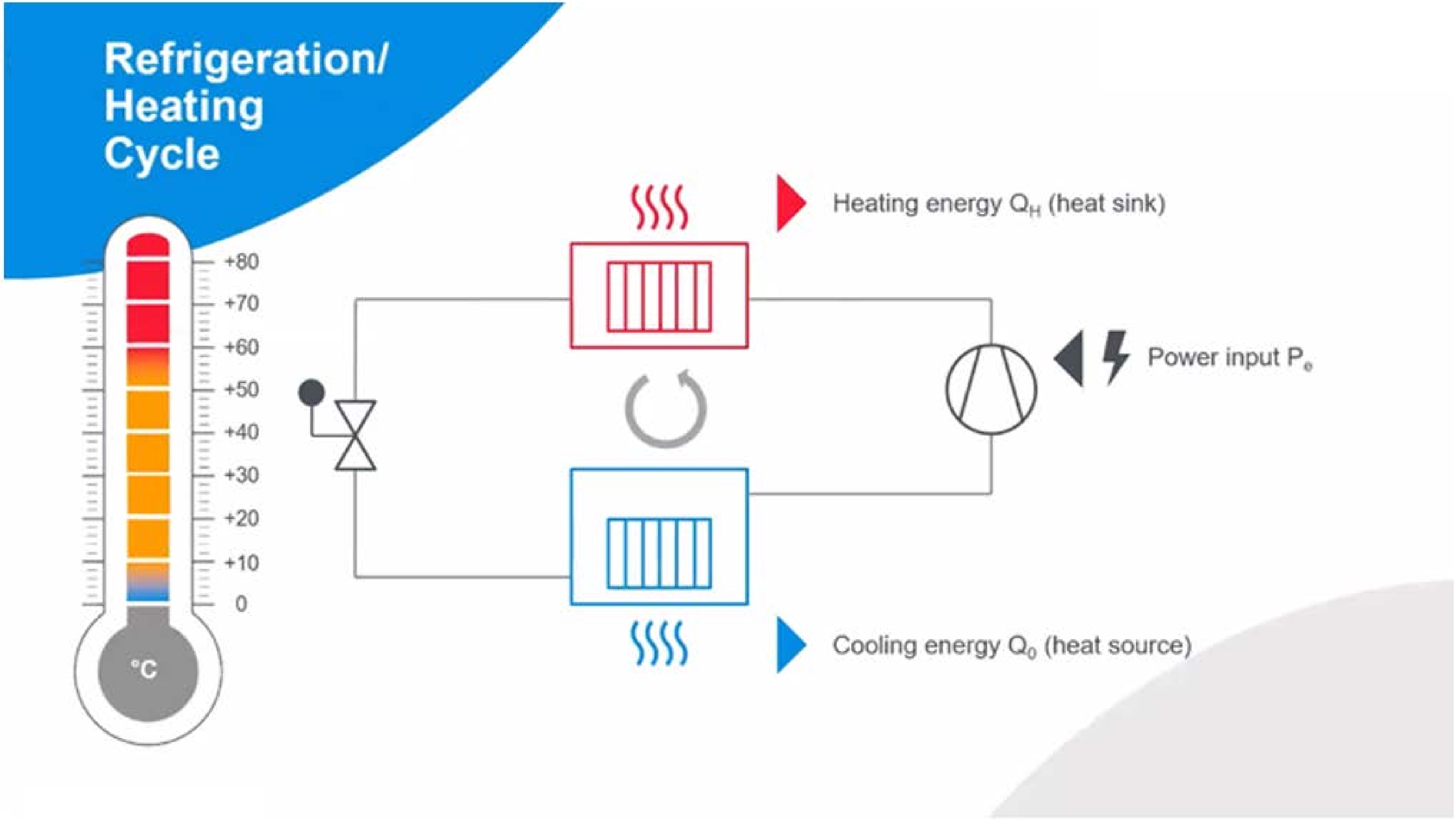
- Difficulty accessing equipment in customer space
- More flexibility for builder/homeowner
- Lower first cost

Large building utility owns ETS HP

- Ensure quality system design & performance
- Utility responsible for design, operation and maintenance
- Reduce customer responsibility
- Better access for utility staff

Energy Transfer Station & qualified operating staff

Solutions (Case Study)



The Ammonia Heat Pump

- Natural refrigerant GWP=0
- Fully welded steel construction
- Major components are serviceable
- Not subject to regulatory phase out
- 25+ year service life
- Easily rationalized total cost of ownership
- Very high COP

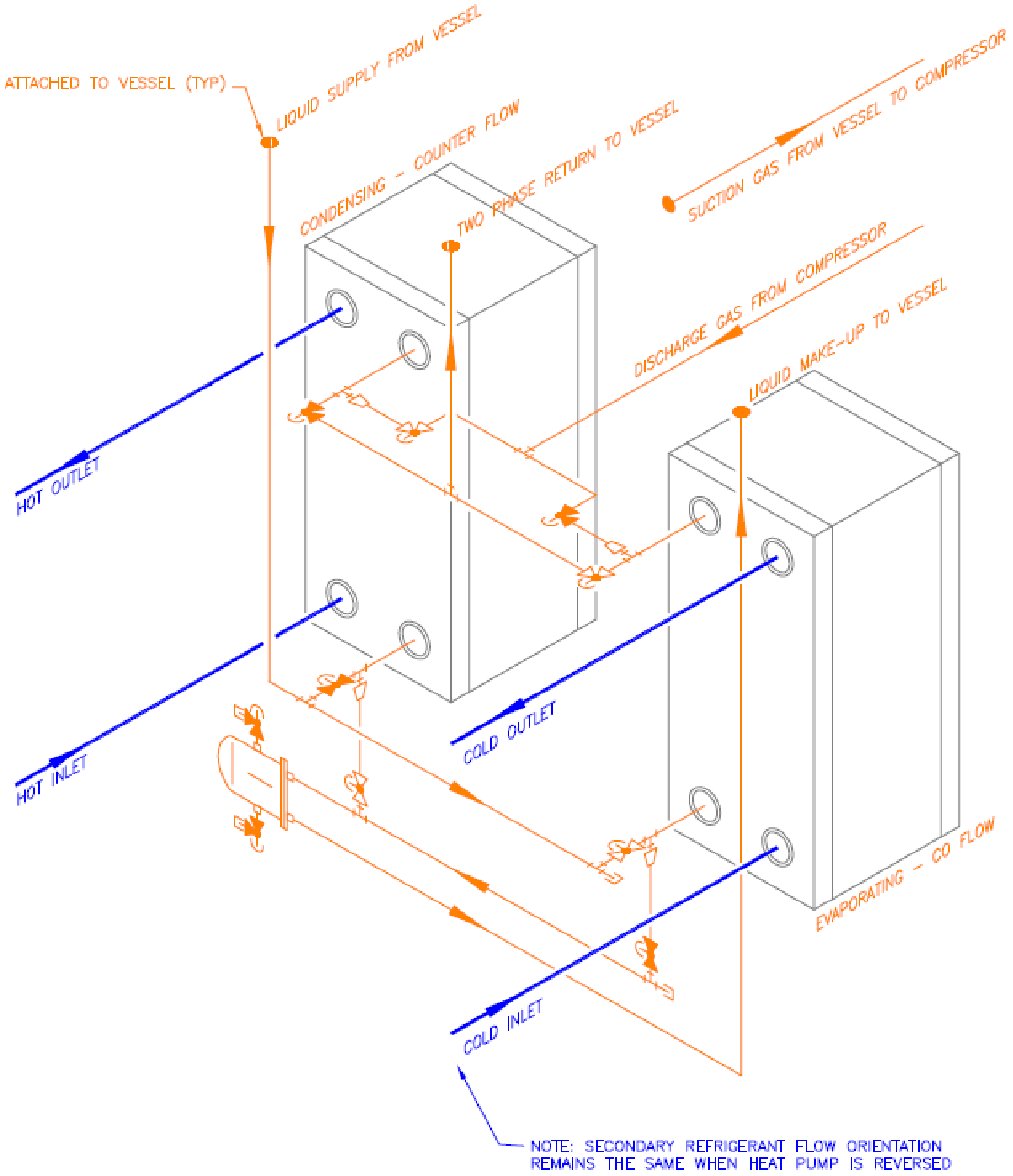
Seasonal operating conditions

1. The Heat Pump is reversible it provides Cooling in Summer and Heating in Winter.

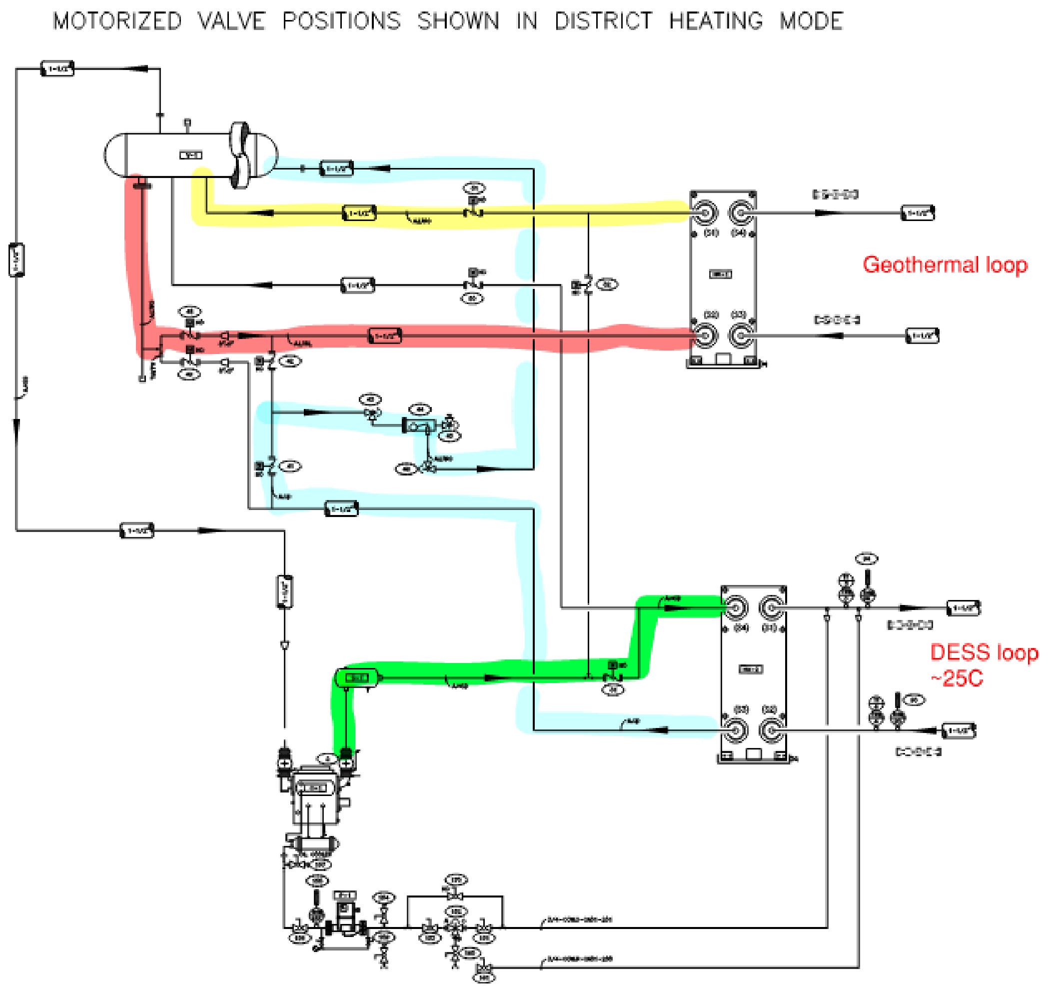
2. In Winter The System is designed for 250 TR using Geo Thermal Ground Loop for Chilling and supply 10 C Fluid Source to the Housing Development to operating individual small scale residential heat pumps.

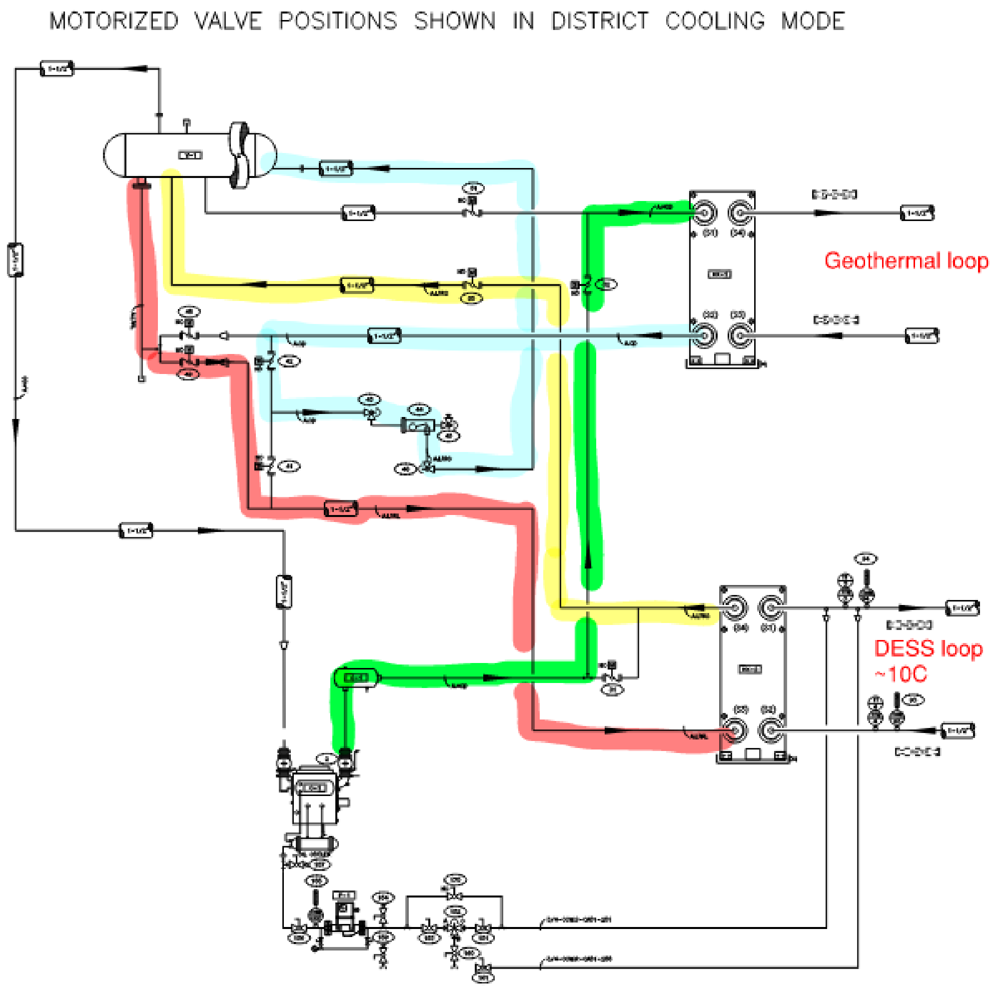
3. In Summer Ground Source Geo Thermal to providing 25C Circuit for Summer Air Conditioning up to 350 TR.

4. Ammonia flow is reversible from Plate to Plate changing from Chiller to Condenser. It eliminates any Brine/or Water Flow Changes in the Plate and any concern with Flow Rates.



Solutions (Case Study)





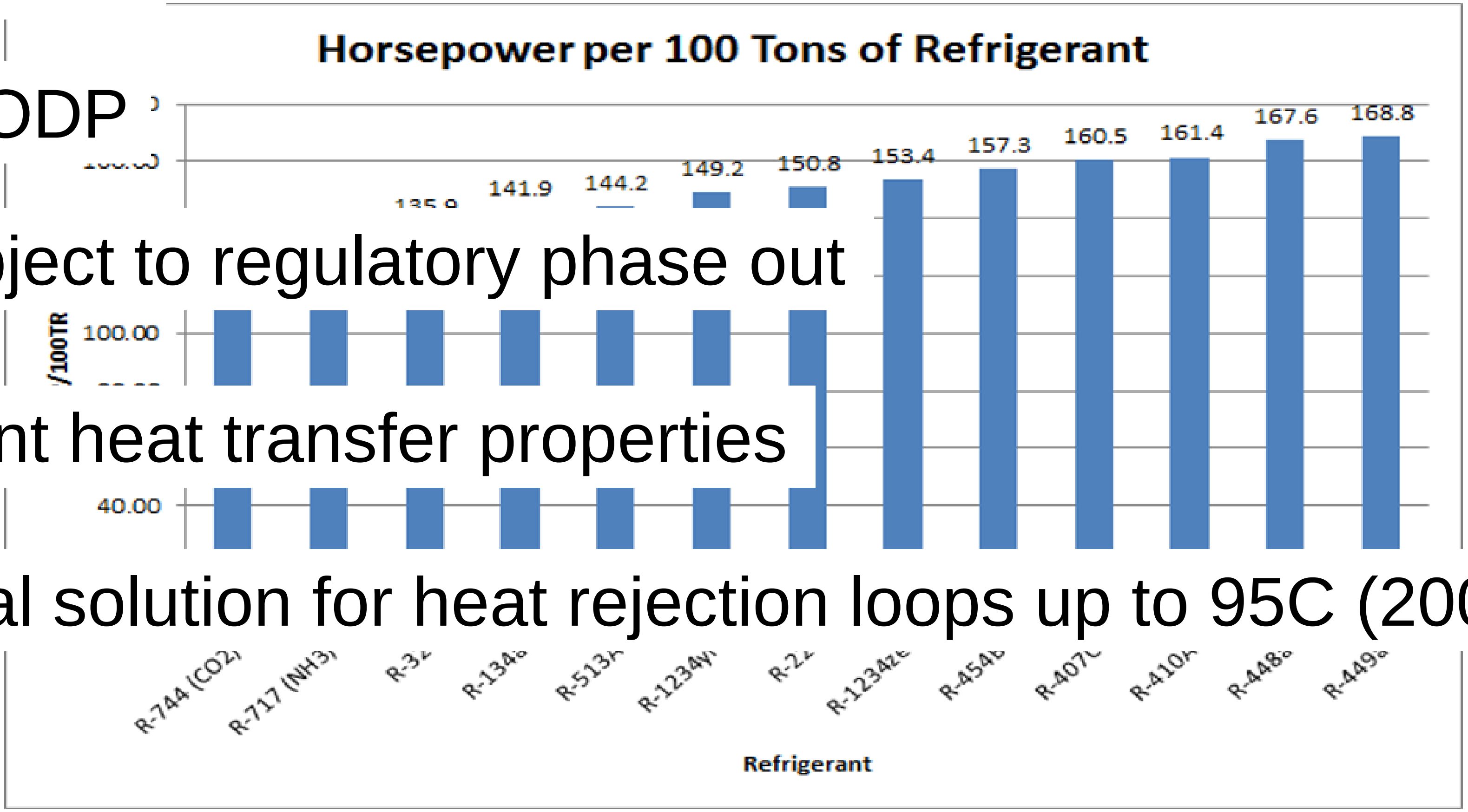
Performance & Energy

- For both winter and Summer conditions COP ranged from 8.62-10.8
- Just the heat pump compressor circuit
- COP's achieved due to very low compression lift
- Summer 45 to 98 PSIA (2.17:1)
- Winter 108 to 196 PSIA (1.84:1)

MODEL	N8MII	Water-cooled				
		Heating				Cooling
COOLING CAPACITY	[kBTU/H]	3300.7	2475.5	1650.3	825.2	463.1	3720.2
COOLING CAPACITY	[TR]	275.1	206.3	137.5	68.8	38.6	310
ABSORBED POWER	[HP]	144.9	110.0	75.2	40.4	20.0	134.8
HEAT REJECTION	[kBTU/H]	3669	2755	1842	928	514	4063
SPEED	[Rpm]	1451	1451	1451	1451	800	1475
LOAD	[%]	100	75	50	25	13.8	50
CONDENSING TEMP.	[F]	55	55	55	55	55	95
EVAPORATIVE TEMP.	[F]	17	17	17	17	17	60
SUCTION PRES.	[PSIA]	45.1	45.1	45.1	45.1	45.1	108
DISCHARGE PRES.	[PSIA]	98.1	98.1	98.1	98.1	98.1	196
DISCHARGE TEMP.	[F]	132	133	134	145	153	148
REFRIG. FLOW RATE (SUC.)	[CFM]	677	508	338	169	95	357
REFRIG. FLOW RATE (DIS.)	[CFM]	385	289	193	98.9	56.3	229
COP (COOLING)	[-]	8.95	8.84	8.62	8.03	9.08	10.8
COP (HEATING)	[-]	10.0	9.8	9.6	9.0	10.1	

Why Ammonia?

Performance of refrigerant on a perfect refrigeration cycle



ZERO GWP

ZERO ODP

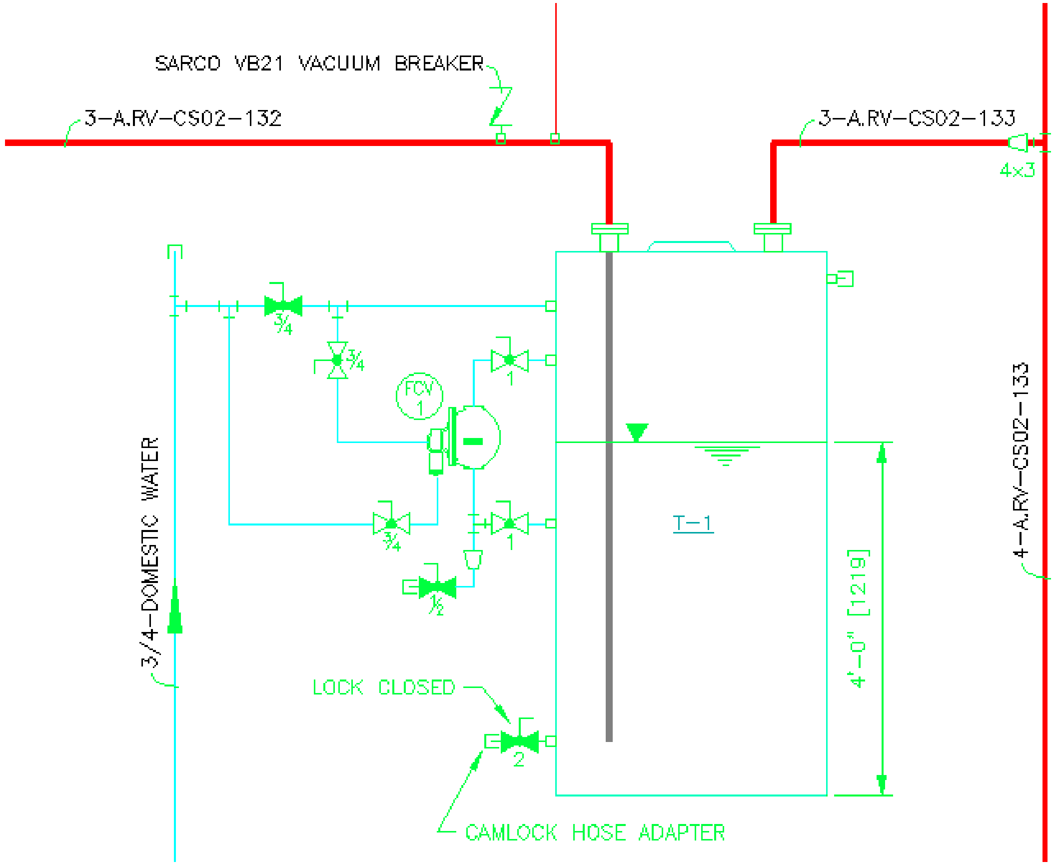
Not subject to regulatory phase out

Excellent heat transfer properties

Practical solution for heat rejection loops up to 95C (200F)

Safety

- Plate HX result in low ammonia charge, less than 350lbs
- Inclusion of water/ammonia dilution tank for emergency relief system



Solutions (Case Study)

Major components

Compressors

- Used in this application 30bar/435psi MAWP
- Products with 50bar/725psi MAWP available

Plate heat exchangers

- Used in this application 21bar/300psi MAWP
- Products with 62bar/900psi MAWP

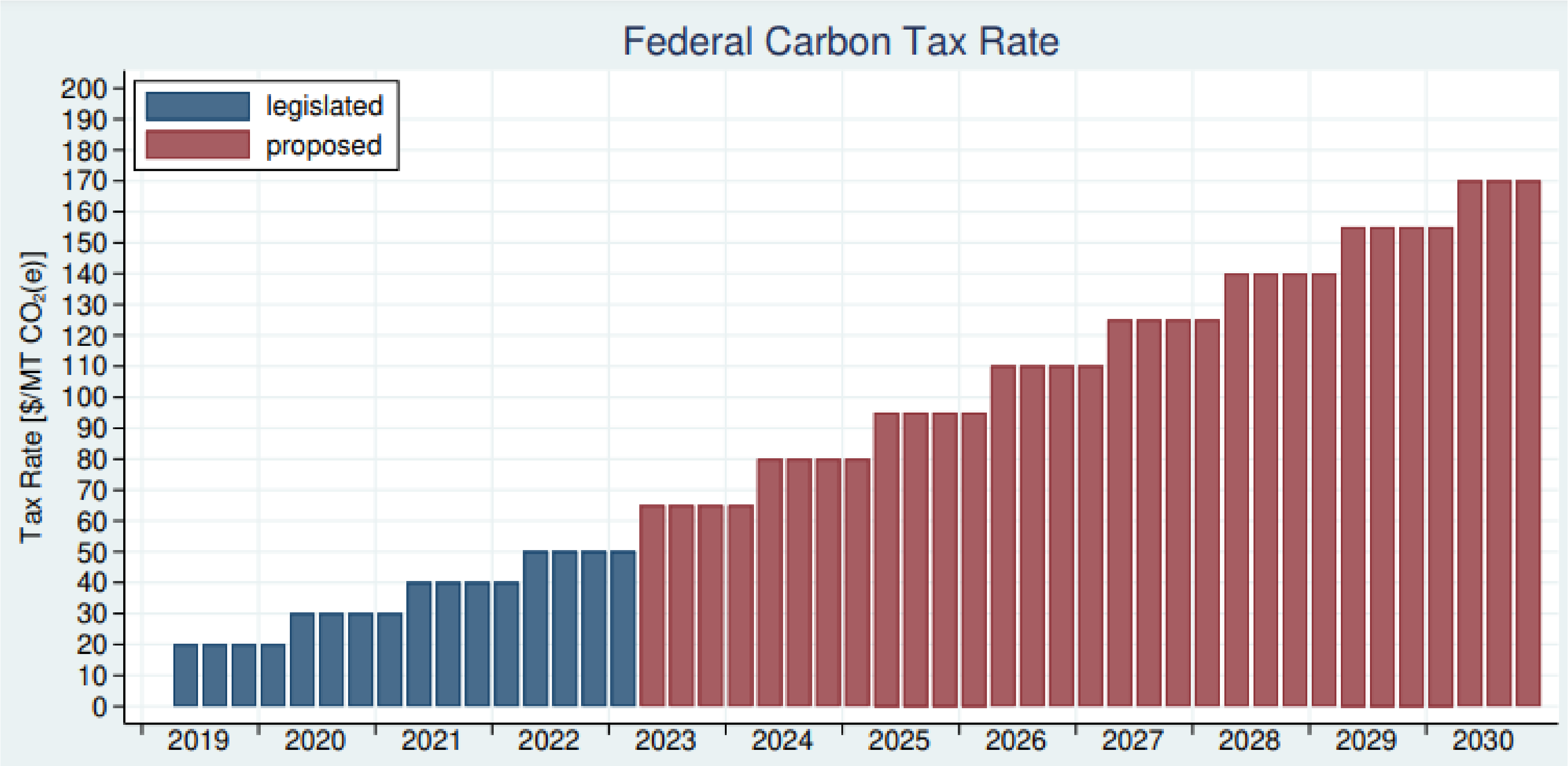
Achievable Ammonia saturated condensing temperature ~100C/212F

Solutions (Case Study)

Future residential options

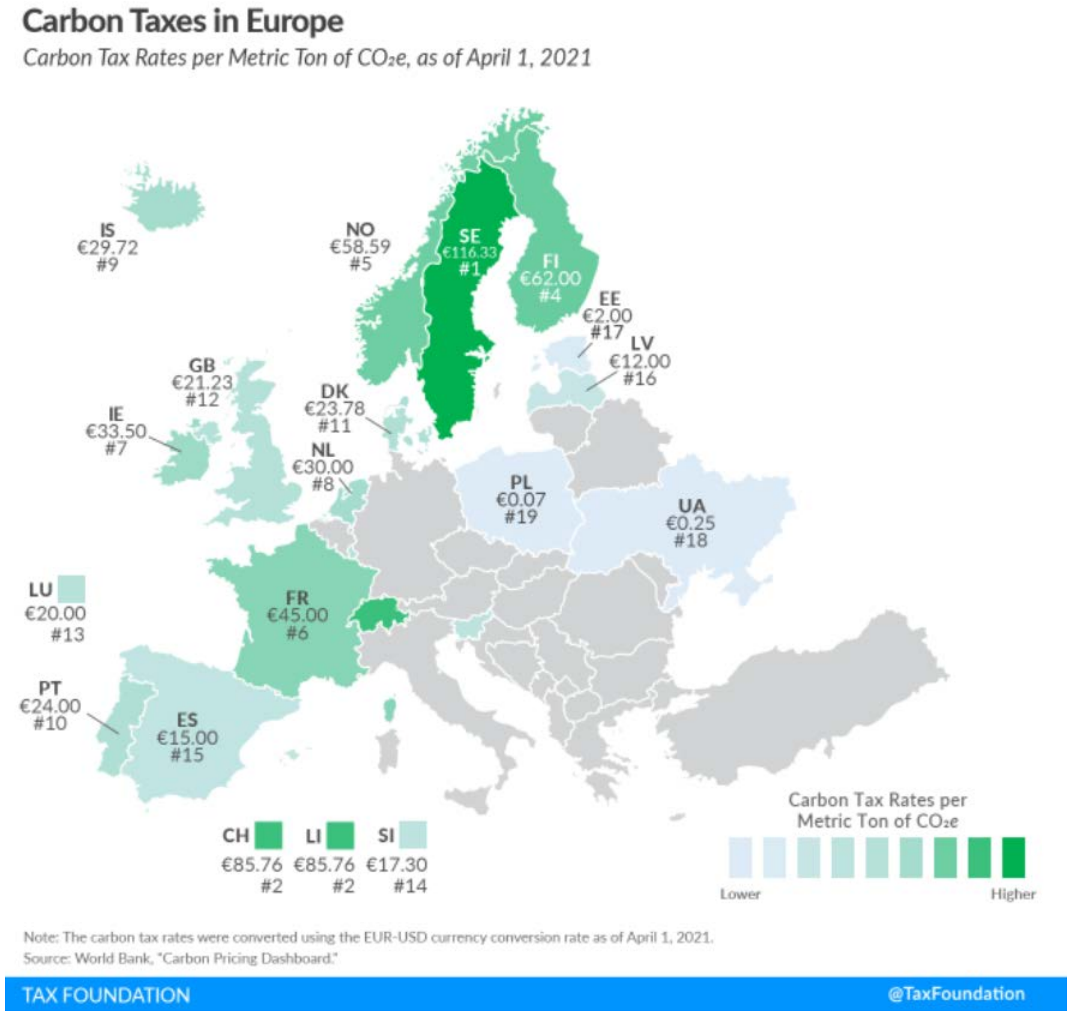
- HC and CO_2 technology
- Currently available in European and Asian markets
- Highly efficient if applied correctly
- GWP 0 to 1
- Not subject to regulatory phase out
- Mass production/adoption will improve price point

Solutions (Case Study)



Source https://wernerantweiler.ca/blog.php?item=2020-12-14

Solutions (Case Study)



European Countries (as of April 1, 2021)

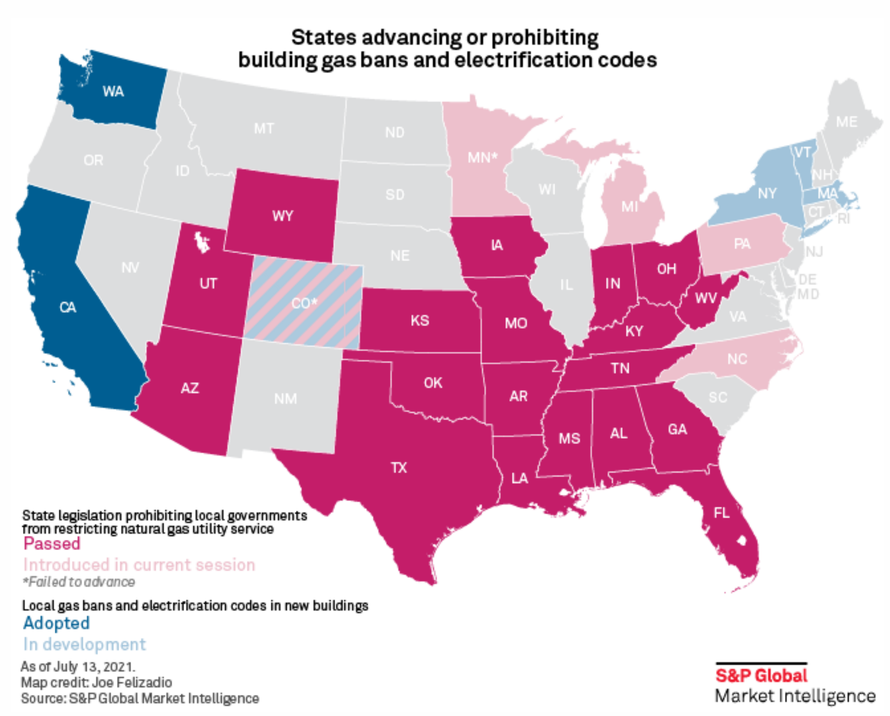
	Carbon Tax Rate (per ton of CO_2e)		Share of Jurisdiction's Greenhouse Gas Emissions Covered	Year of Implementation
	Euros	US Dollars		
Denmark (DK)	€23.78	$28.00	35%	1992
Estonia (EE)	€ 2.00	$2.36	6%	2000
Finland (FI)	€62.00	$73.02	36%	1990
France (FR)	€45.00	$53.00	35%	2014
Iceland (IS)	€29.72	$35.00	55%	2010
Ireland (IE)	€33.50	$39.45	49%	2010
Latvia (LV)	€12.00	$14.13	3%	2004
Liechtenstein (LI)	€85.76	$101.00	26%	2008
Luxembourg (LU)	€20.00	$23.55	65%	2021
Netherlands (NL)	€30.00	$35.33	12%	2021
Norway (NO)	€58.59	$69.00	66%	1991
Poland (PL)	€0.07	$0.08	4%	1990
Portugal (PT)*	€24.00	$28.26	29%	2015
Slovenia (SI)	€17.30	$20.37	50%	1996
Spain (ES)	€15.00	$17.67	3%	2014
Sweden (SE)	€116.33	$137.00	40%	1991
Switzerland	€85.76	$101.00	33%	2008

Source: https://taxfoundation.org/carbon-taxes-in-europe-2021/

Solutions (Case Study)

USA natural gas Bans

- More than 50 cities have banned natural gas infrastructure in new buildings
- At federal level government plans to transition 300,000 buildings to “carbon pollution free electricity” by 2032



Net-zero but at what cost $$$

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ENBRIDGE
Life Takes Energy™

Pard

SMELL GAS? 1-866-763-5427

For Inquiries: 1-877-362-7434 **enbridgegas.com**
Make Payments to: PO Box 644 Scarborough, ON M1K 5H1
Enbridge Gas Inc.

Bill Date
Apr 13, 2022

WHAT DO I OWE?

Billing Period Mar 12, 2022 - Apr 12, 2022

Total Amount
$143.30
(Taxes Included)
Due Date
May 03, 2022

- Charges for Natural Gas
- Other Enbridge Charges

• See page 2 for details •

HOW MUCH GAS DID I USE?

Meter Reading

Meter Number:	
Actual:	59825
Previous:	59552

You used	This cost you
275m³	**$131.76**
approx. 8.59m³ per day	approx. $4.12 per day

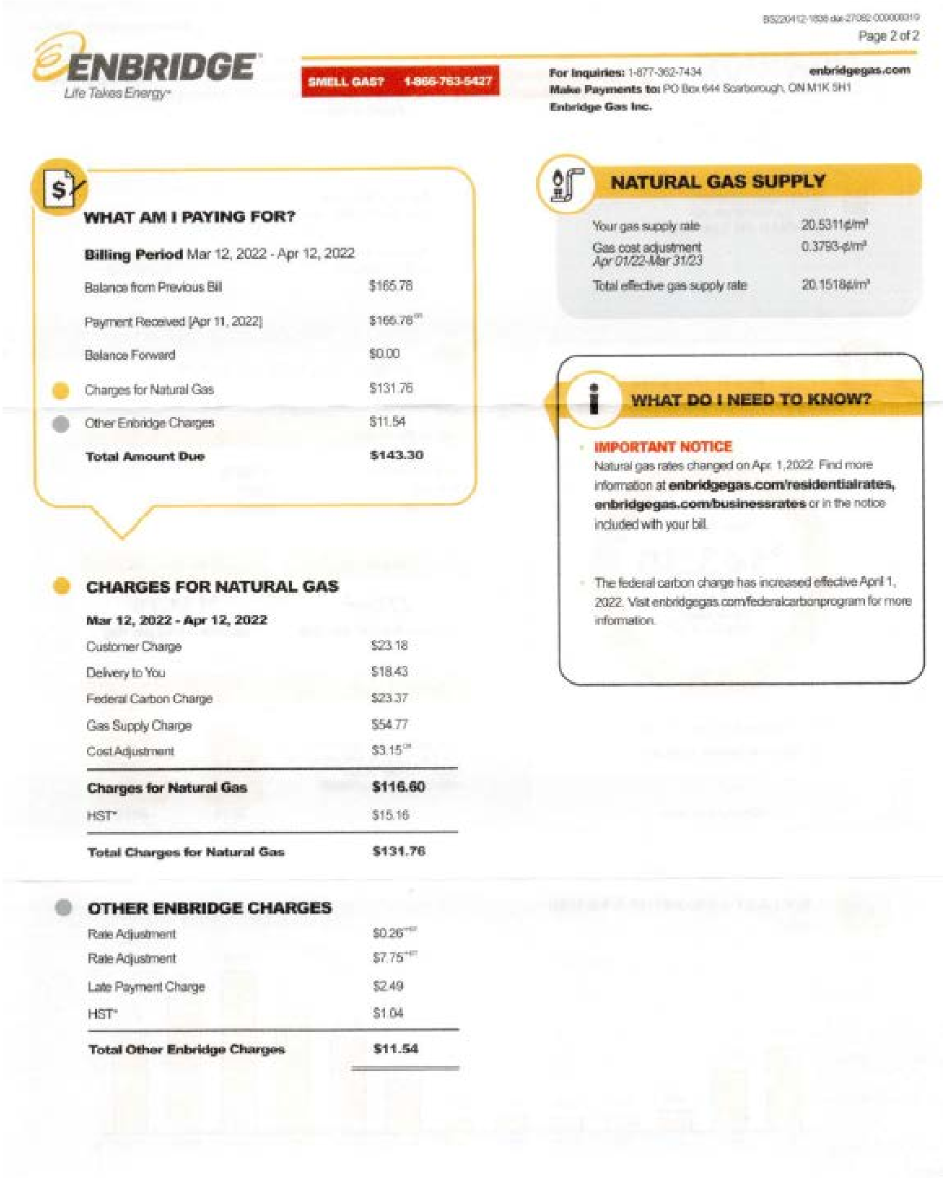
Did you know?

Your average daily use is more this year than last year. Choose eBill to access your last 24 bills: **enbridgegas.com/ebill**

2021	2022
228m³	275m³

MY LAST 13 MONTHS GAS USE
(in m³)

Apr 21	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21	Jan 22	Feb 22	Mar 22	Apr 22
228.0	165.0	68.0	45.0	40.0	44.0	39.0	146.0	261.0	345.0	434.0	374.0	275.0



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WHAT AM I PAYING FOR?

Billing Period Mar 12, 2022 - Apr 12, 2022

Balance from Previous Bill	$165.78
Payment Received [Apr 11, 2022]	$165.78 CR
Balance Forward	$0.00
Charges for Natural Gas	$131.76
Other Enbridge Charges	$11.54
Total Amount Due	**$143.30**

CHARGES FOR NATURAL GAS

Mar 12, 2022 - Apr 12, 2022

Customer Charge	$23.18
Delivery to You	$18.43
Federal Carbon Charge	$23.37
Gas Supply Charge	$54.77
Cost Adjustment	$3.15 CR
Charges for Natural Gas	**$116.60**
HST*	$15.16
Total Charges for Natural Gas	**$131.76**

OTHER ENBRIDGE CHARGES

Rate Adjustment	$0.26 HST
Rate Adjustment	$7.75 HST
Late Payment Charge	$2.49
HST*	$1.04
Total Other Enbridge Charges	**$11.54**

NATURAL GAS SUPPLY

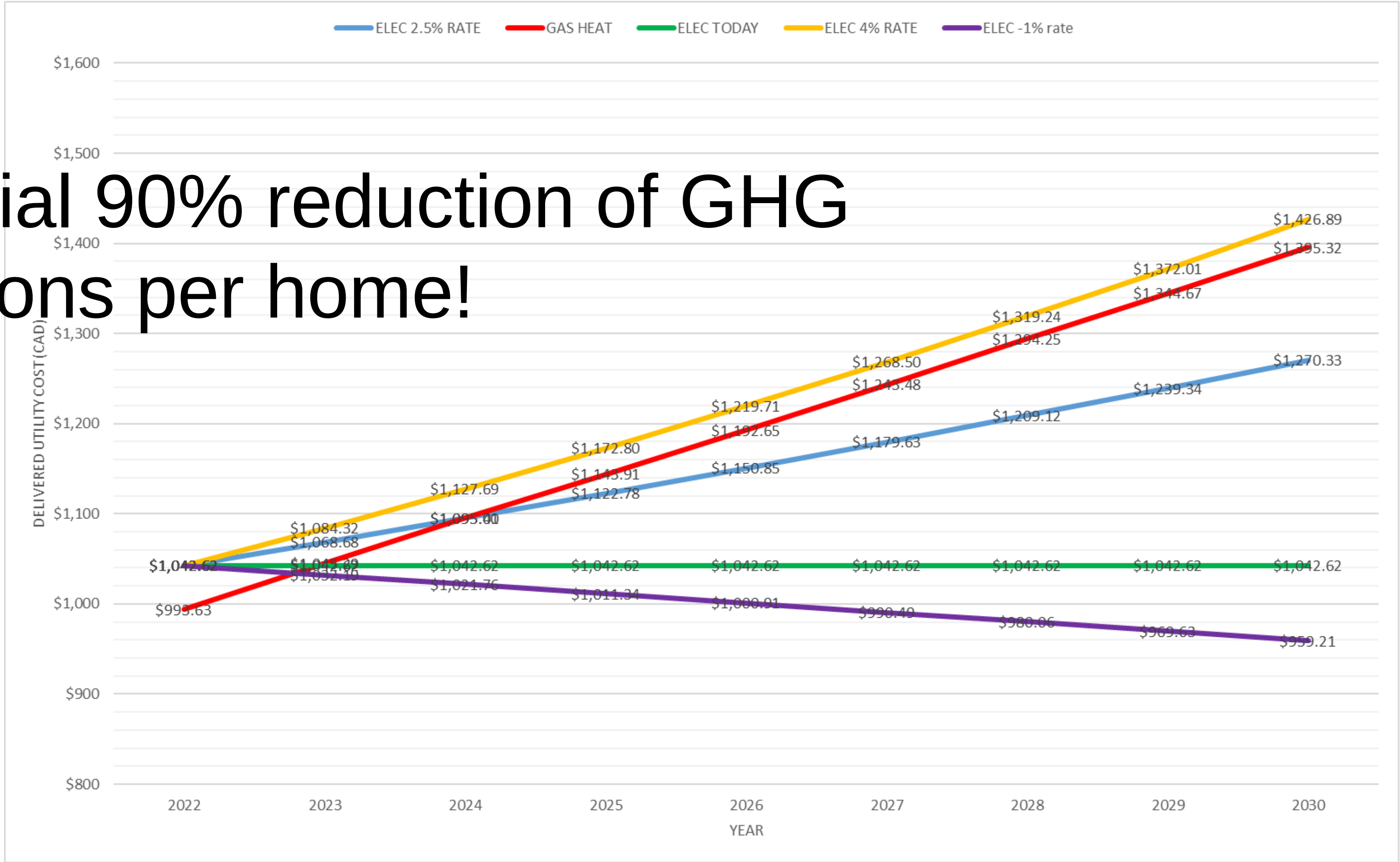
Your gas supply rate	20.5311¢/m³
Gas cost adjustment *Apr 01/22-Mar 31/23*	0.3793-¢/m³
Total effective gas supply rate	20.1518¢/m³

WHAT DO I NEED TO KNOW?

- **IMPORTANT NOTICE**
Natural gas rates changed on Apr. 1,2022. Find more information at **enbridgegas.com/residentialrates, enbridgegas.com/businessrates** or in the notice included with your bill.

- The federal carbon charge has increased effective April 1, 2022. Visit enbridgegas.com/federalcarbonprogram for more information.

Net-zero but at what cost $$$



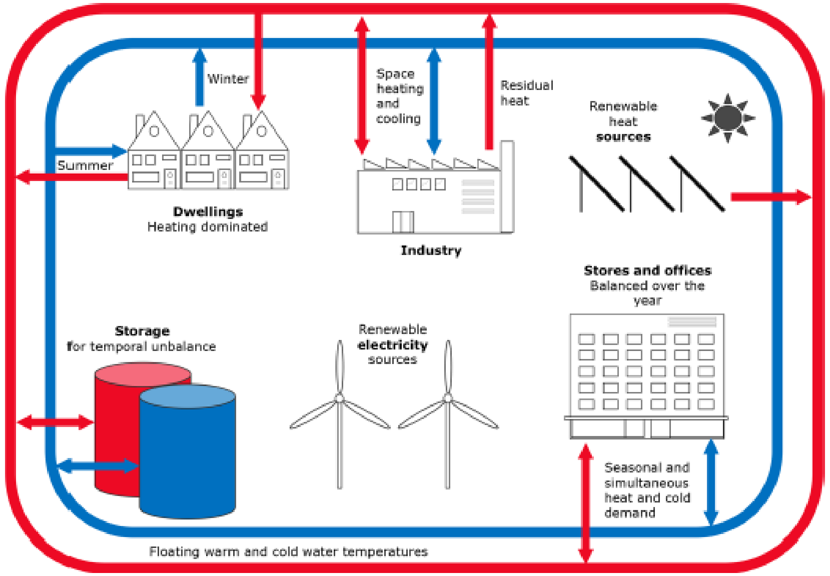
Potential 90% reduction of GHG emissions per home!

- Costs are delivered less HST (tax)
- DESS HVAC systems COP ~4.75, Natural gas furnace COP ~.92
- My utility cost rate gas vs electric
- Projection of carbon tax till 2030

- Assumed electrical rate inflation at 2.5% and 4% per year
- Initial equipment cost neglected
- Heating only
- Annual service fee for DESS connection not included

Practical Challenges

- This concept not easily retro-fitted to existing communities.
- Requires co-operation between many parties to design and implement.
- Common perception that this concept is not financially viable.
- Availability of Clean and cheap electrical power.
- Need for electrical grid upgrade/expansion to support the concept of electrification on a large scale.
- Feasibility of access to heat source/sink



Thank you!

- Community of Blatchford
- Andrew Byrnes P.Eng, Pinchin Ltd

Q&A

Thank You!

- Jonathan Berney P.Eng
- CIMCO Refrigeration
- jberney@toromont.com