

Efficient Heat Pumps for Cold Climates

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Heat Pumps are electrically driven refrigeration apparatus that move “free” heat energy from a source to a higher temperature sink

“Free” energy extracted from the source
(outdoor air, ground or a water body)
PLUS
electric energy used by the heat pump
are used for space and/or water heating

It takes energy to move the “free” energy

The amount of energy needed
to move the free energy
depends on the temperature gradient

i.e., temperature difference between
the source and the sink

a common measure of performance is

COP (coefficient of performance)

“free” energy + electricity used by heat pump
electricity used by heat pump

or

how much you got
how much you bought

with COPs, higher is better

GROUND SOURCE HEAT PUMPS ON URBAN LOTS

**PERFORMANCE
COST EFFECTIVENESS
and
ENVIRONMENTAL IMPACT**

Two Duplexes

R-2000 certified

90 m² (1000 sq.ft.) over two floors

Design heat loss - 6 kW

2 ton heat pumps (7 kW heating)
plus
7 kW auxiliary electric heat

Two stage thermostats
first stage - heat pump
second stage - auxiliary heat

DHW desuperheater

Data acquisition systems continuously monitored/measured

power consumption

loop temperatures & flows

run times

	Cold Weather COP		
	All Heat Pump Energy Included		
	Initial (Winter 01/02)	During Occupancy (Winter 02/03)	
Range		Average	
1	2.8	1.3 – 1.9	1.43
2	2.5	1.4 – 2.9	1.48
3	2.4	2.3 – 2.6	2.53
4	2.2	2.3 – 2.7	2.58

heat pump in house 4 experienced a failure in 01 /02
 lack of maintenance in houses 1 and 2 caused low COPs

Air Conditioning Performance

GSHP SEER - 13.5

Desuperheater

Only 20% of available desuperheater energy
was delivered to the DHW tank

Shorter pipe runs and/or preheat tank
could significantly improve
desuperheater performance

2001 installed cost

\$12,500 per system

2001 incremental cost

\$8000 more than all electric

\$7000 more than high-efficiency gas
air conditioning included

Space Heat Energy Cost Comparison Winter 2002/2003

	House 1	House 2	House 3	House 4
Electric furnace	\$479	\$607	\$910	\$806
Heat pump	\$335	\$410	\$360	\$313
Energy Cost Savings	\$144	\$197	\$550	\$493

electricity at \$0.08/kWh

Other Savings

\$10 to \$20 per year
over conventional air conditioning

\$10 to \$100 per year from
desuperheater

Economic Summary

Best simple payback - over 12 yrs
ignoring maintenance costs

Worst simple payback - 40 to 100 yrs

Payback will be longer with
poor or professional maintenance

GHG Production - kg/yr Manitoba Electric Mix

	GSHP	Mid-Gas	High-Gas
1	44.9	1385	1231
2	54.8	1751	1557
3	48.0	2630	2337
4	41.8	2330	2071

GHG Production - kg/yr Manitoba Electric Mix

	GSHP	Electric Resistance	Mid-Gas	High-Gas
1	44.9	64.2	1385	1231
2	54.8	81.1	1751	1557
3	48.0	121.4	2630	2337
4	41.8	107.8	2330	2071

GHG Production - kg/yr

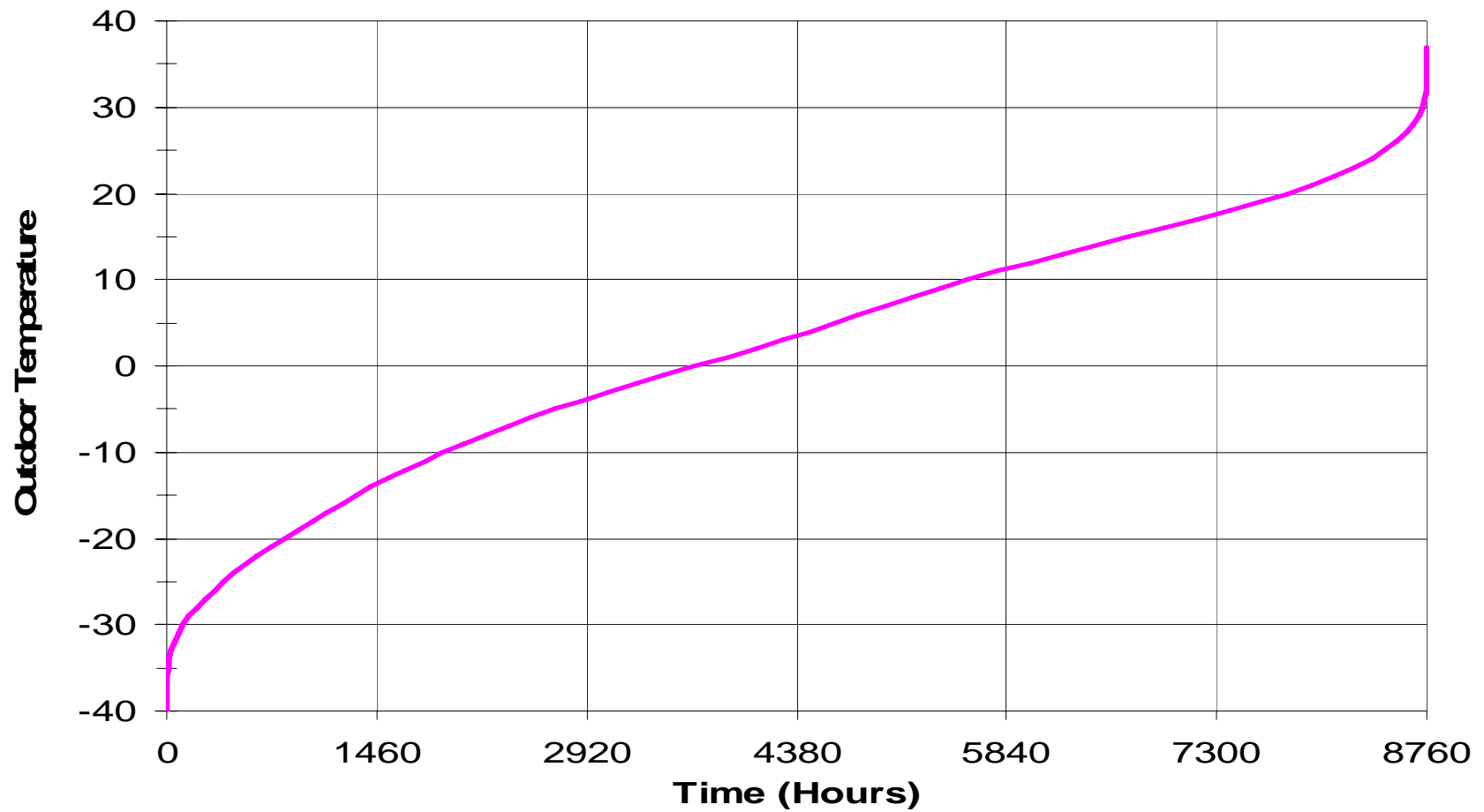
Prairie Electric Mix

	GSHP	Electric Resistance	Mid-Gas	High-Gas
1	2568	3667	1385	1231
2	3131	4633	1751	1557
3	2743	6935	2630	2337
4	2389	6158	2330	2071

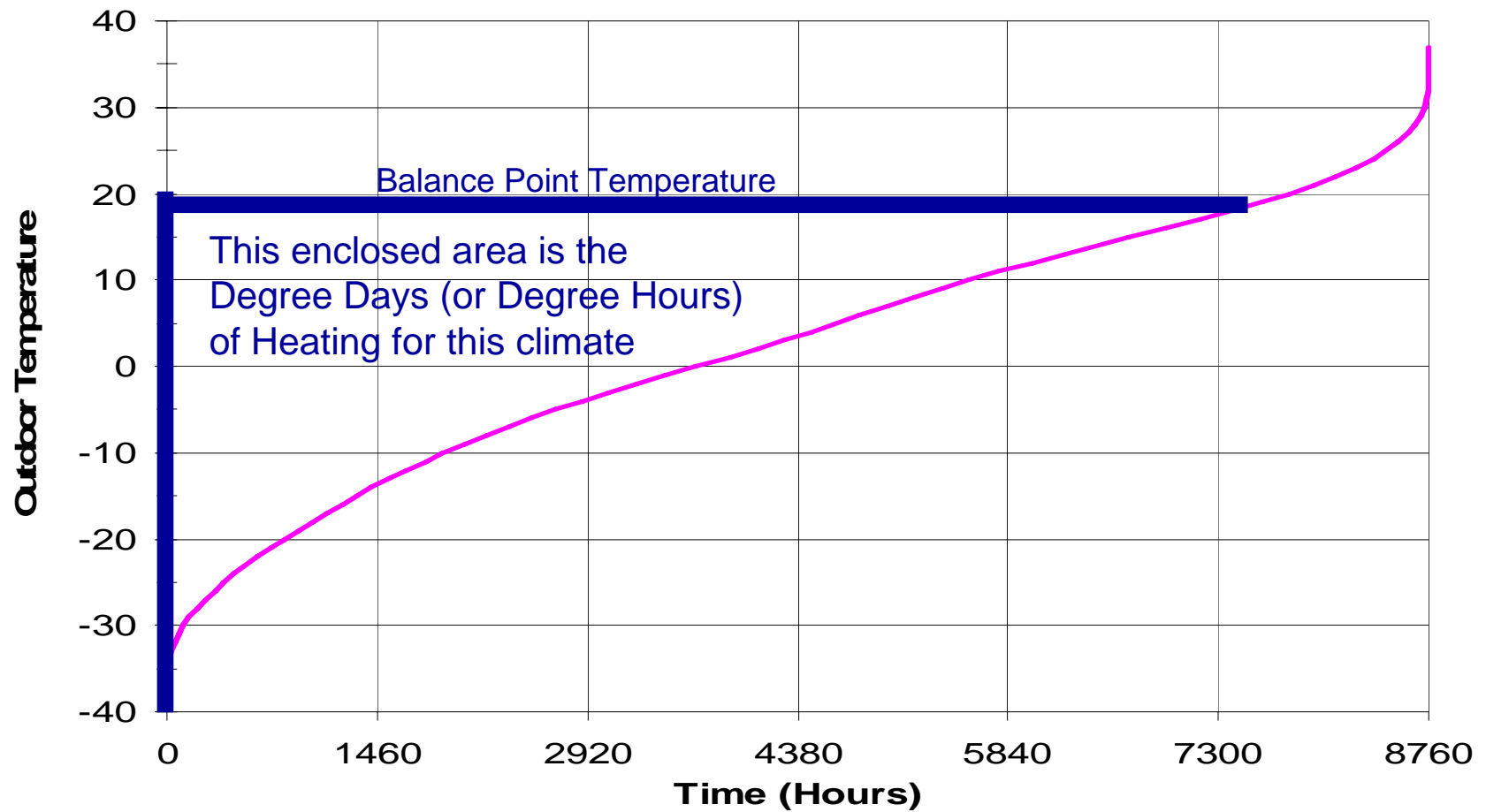
Ideas to improve heat pump performance and economics

Design heat pump for
less than
design condition heat loss

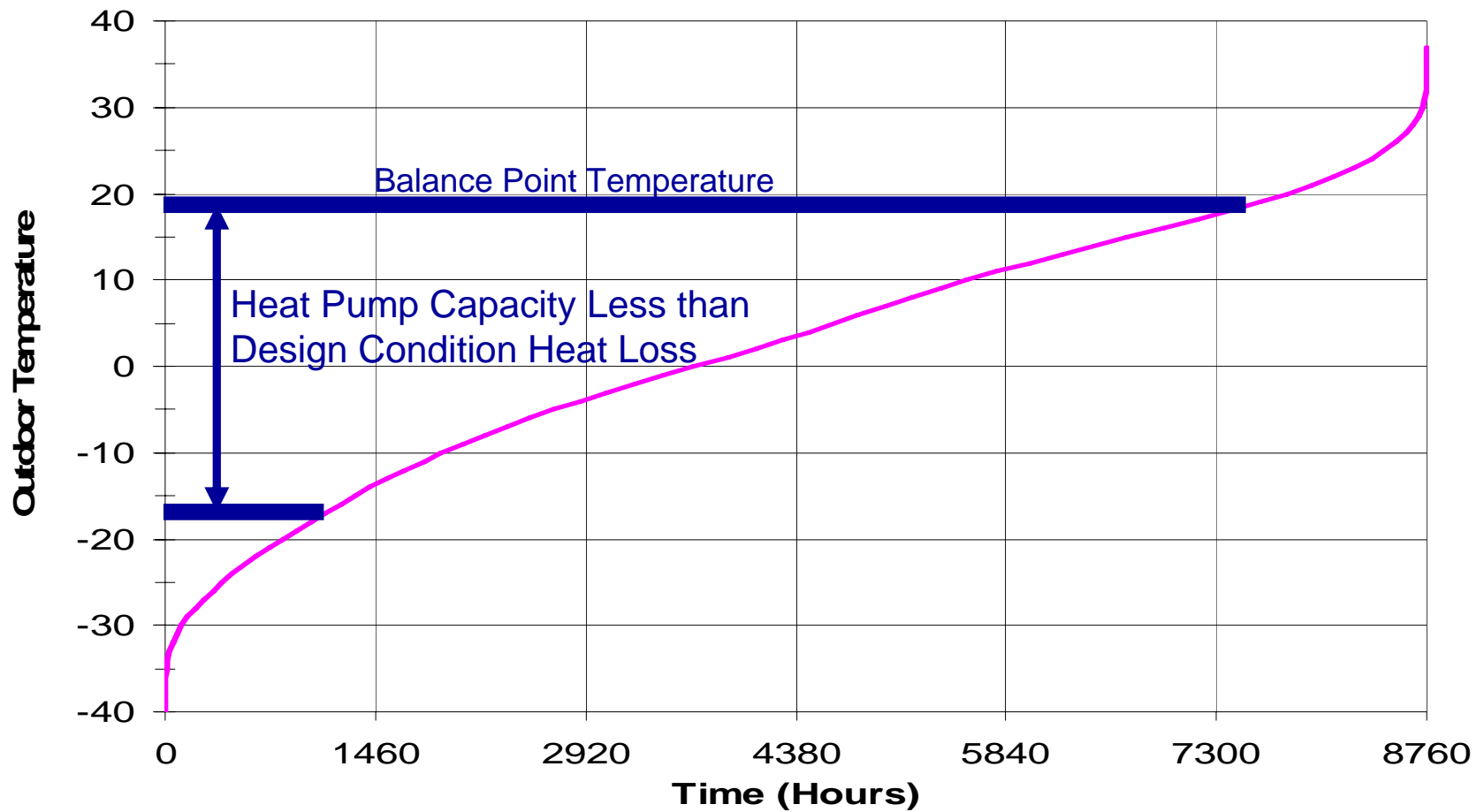
Cumulative Average Annual Temperature Profile for Winnipeg



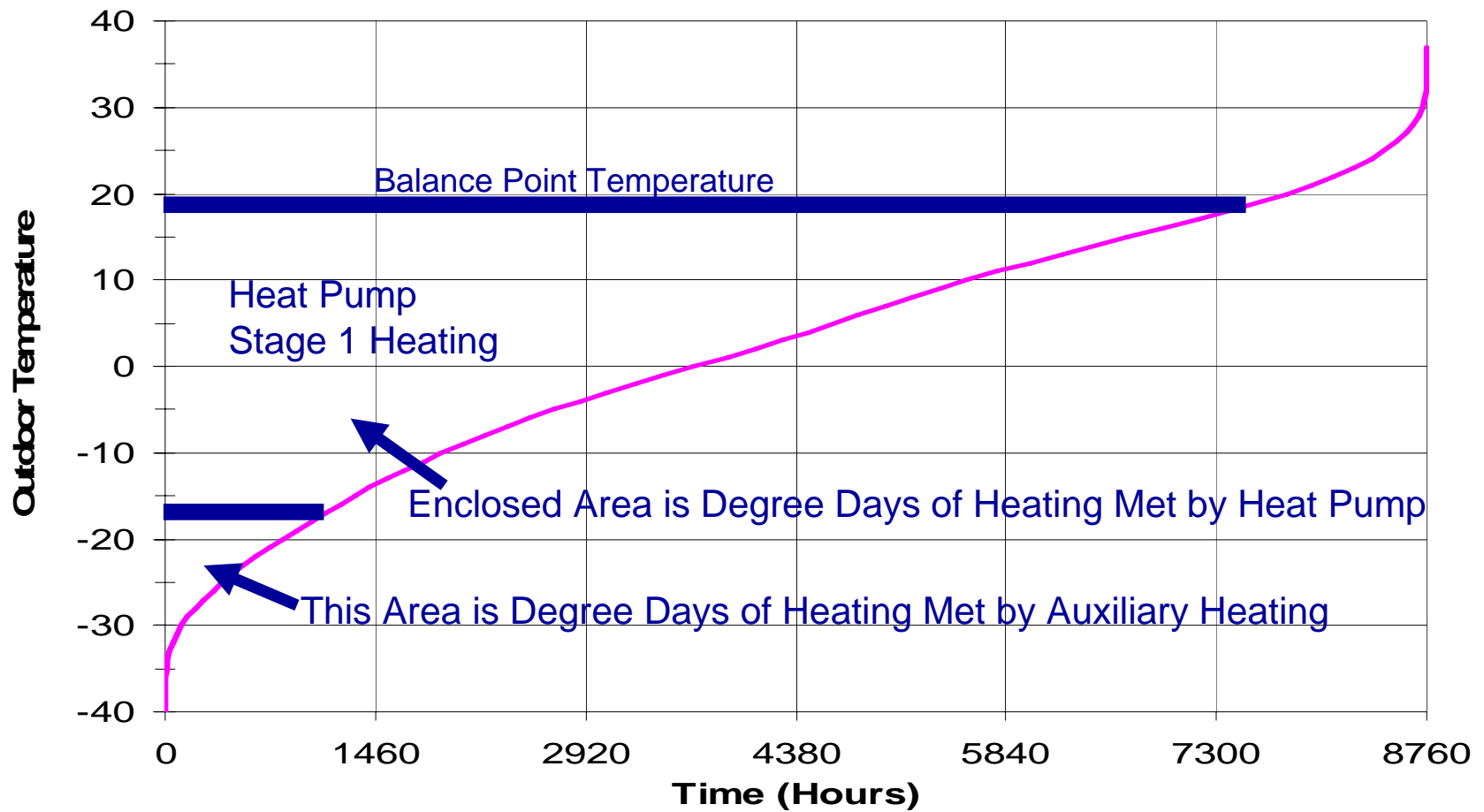
Cumulative Average Annual Temperature Profile for Winnipeg



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Cumulative Average Annual Temperature Profile for Winnipeg



Add ground loop to improve source
temperature

Minimize heat pump condenser
temperature

Before committing to
any energy conservation measure
or green measure
ask

“What other options are there for this money?”