THERMAL RECYCLING 101

THE ENERGY, UTILITY, AND CARBON BENEFITS OF THE GAS-DRIVEN HEAT PUMP
ENERGY?

THERMAL RECYCLING 101  THE ENERGY, UTILITY, AND CARBON BENEFITS OF THE GAS-DRIVEN HEAT PUMP
OVERVIEW OF HEATING AND COOLING

HEATING AND COOLING “AS USUAL”

12 tons
141,385 BTU
@ 1.00 kW/ton =
11.8 kW

Chiller

@ $0.10/kWh = $1.18/hr
8.1 kg CDE

Boiler

11 BHP
366,088 BTU
@ 80% effic =
457,610 BTU

@ $1.00/therm = $4.58/hr
24.3 kg CDE

THERMAL RECYCLING 101  THE ENERGY, UTILITY, AND CARBON BENEFITS OF THE GAS-DRIVEN HEAT PUMP
HEATING AND COOLING “AS USUAL”

Extended over 1000 operating hours

11,782 kW
$1178
8.1 t CDE

4576 therms
$4576
24.3 t CDE

THERMAL RECYCLING 101 THE ENERGY, UTILITY, AND CARBON BENEFITS OF THE GAS-DRIVEN HEAT PUMP
HEATING AND COOLING “AS USUAL”

Expressed as MBTUs

40,212 MBTU
$1178
8.1 t CDE

Chiller

457,610 MBTU
$4576
24.3 t CDE

Boiler

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HEATING AND COOLING “AS USUAL”

Taken together, as is often the case...

- **40,212 MBTU**
  - $1178
  - 8.1 t CDE

- **457,610 MBTU**
  - $4576
  - 24.3 t CDE

**497,822 MBTU / $5754 / 32.4 t CDE**
Carbon Footprint is the amount of carbon dioxide and other carbon compounds emitted due to the consumption of fossil fuels.

Fossil fuels are consumed via traditional, convenient utilities directly (natural gas) or indirectly (non-renewable electricity).

Utilities are consumed to conveniently add or remove energy for comfort (HVAC, DHW, pools, etc.). This is the largest fraction of overall emissions in typical buildings.

*When efficiencies are improved and/or shifts to more sustainable utilities occur, Carbon Footprint is reduced.*
CARBON FOOTPRINT (REALLY QUICK)

Energy conversion factors
The factors given below are taken from Defra/DECC’s GHG conversion factors for company reporting, published in August 2011.

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<th>Fuel</th>
<th>Units</th>
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<td>Grid electricity¹</td>
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<td>Renewable electricity²</td>
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<td>Natural gas</td>
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<tr>
<td>Diesel</td>
<td></td>
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</tbody>
</table>

Different utilities carry greater carbon penalties...

Grid electricity is 3x “worse” than natural gas per kWh consumed

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THERMAL RECYCLING

Thermal Recycling returns rather than rejects the energy from cooling, reducing the need to add additional heat.
Heating

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11 BHP
366,088 BTU

Cooling

278,000 BTU
@ $1.00/therm = $2.78/hr
14.7 kg CDE

12 tons
141,385 BTU

Extended over 1000 operating hours...

278,000 MBTU / $2780 / 14.7 t CDE
Every 1000 operating hours, 12 tons cool and 11 BHP heat:

Heating and cooling “as usual”
497,822 MBTU / $5754 / 32.4 t CDE

Thermal Recycling
278,000 MBTU / $2780 / 14.7 t CDE

Total benefit = (219,822 MBTU / $2974 / 17.7 t CDE)
SUMMARY

Comfort cooling and heating efforts, often occurring simultaneously, consume significant utility and contribute greatly to the current Carbon Footprint.

The Ilios gas-driven heat pump is uniquely suited to recycle energy from cooling to heating, reducing the overall energy consumed (−44%), utility purchased (−52%), and accelerates carbon reduction (−55%) as some cooling is shifted to more sustainable natural gas.

Working between the base cooling and heating loads, the Ilios heat pump intends to deprive existing chillers and boilers of very part load operation… the least efficient and most punishing operating condition.

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LANDSTOWN HIGH SCHOOL, VIRGINIA BEACH

$200,000 installed cost

$0.87/therm natural gas
$0.08/kWH electricity
Year round operation

8ish year expected payback

First Ilios water source unit in beneficial operation
(02 April 2015)

ENERGY STAR score now 41 (was 34)