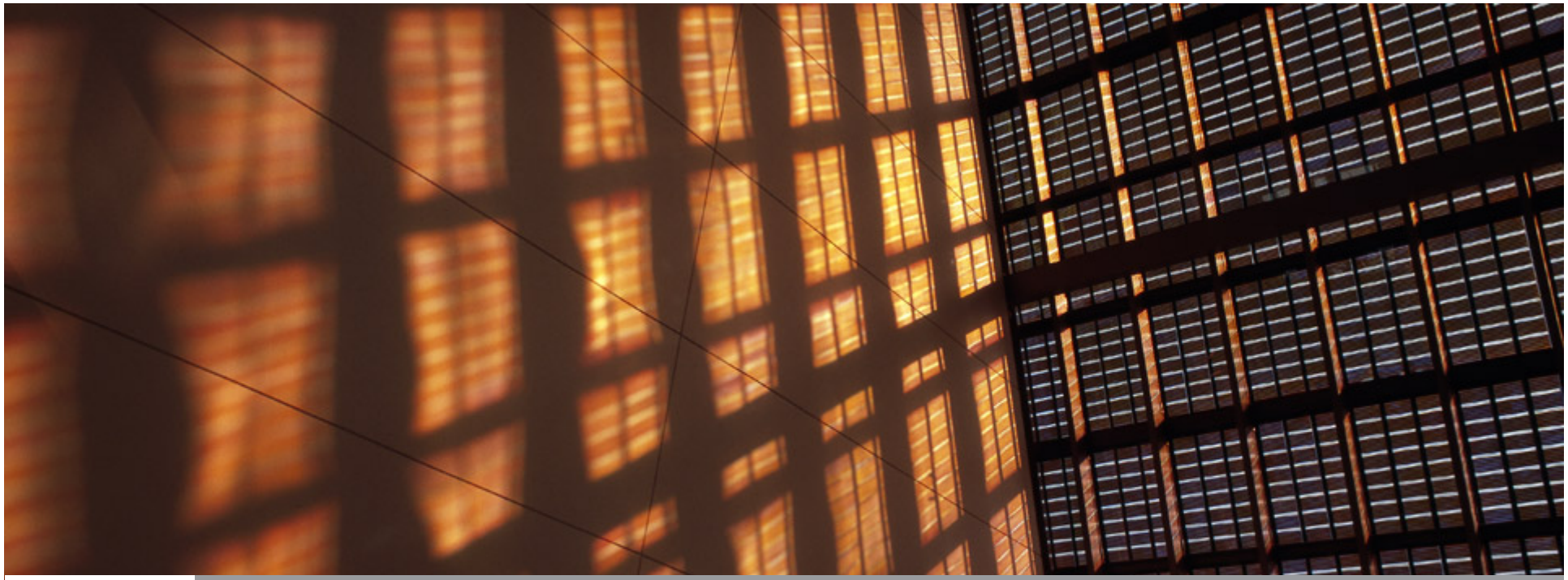


Waste Heat & Distributed Energy

Stephen White

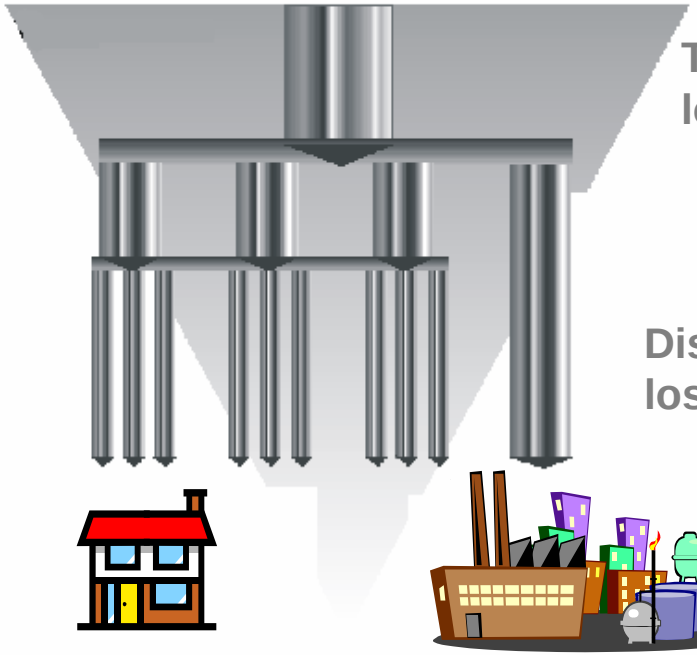
Waste Heat Stream Leader

7th February, 2007

www.csiro.au

Today's “centralised” electricity system

Large distant power plants supply almost all customers. In Australia the average efficiency is 33.1%

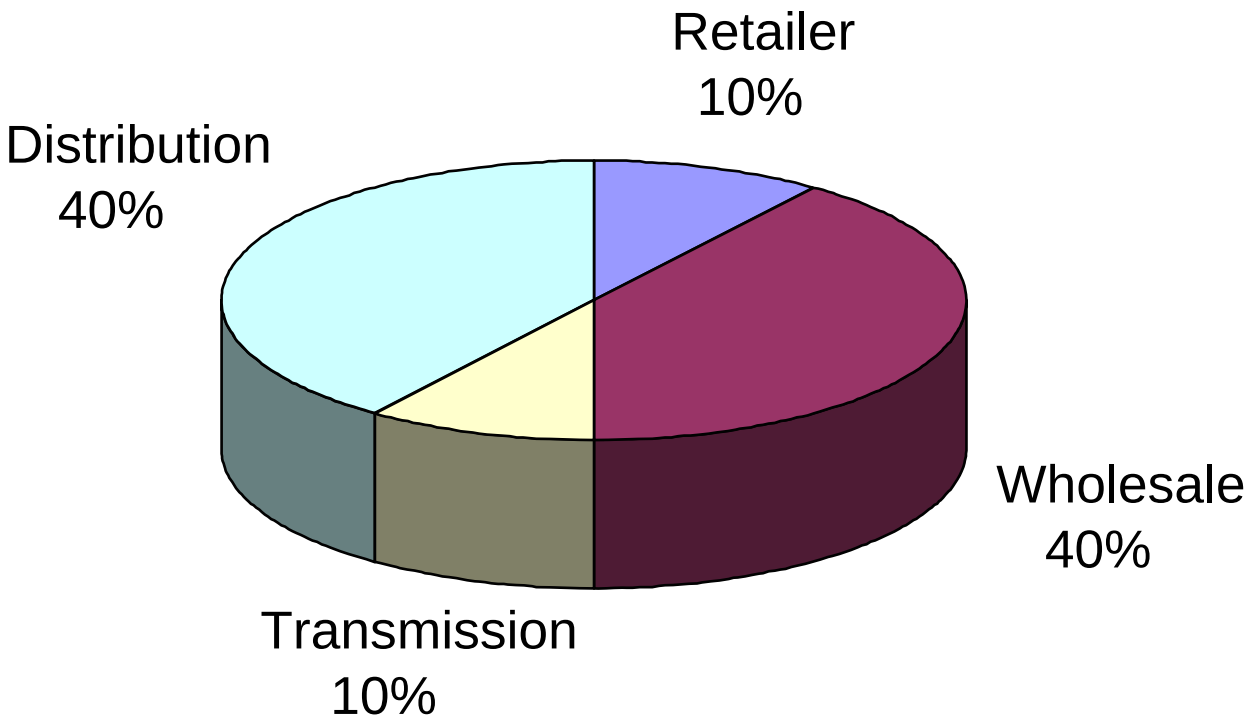


Transmission losses

Distribution losses

Effective energy utilisation ~ 28.5%

“Distributed” generation avoids 50% of your bill

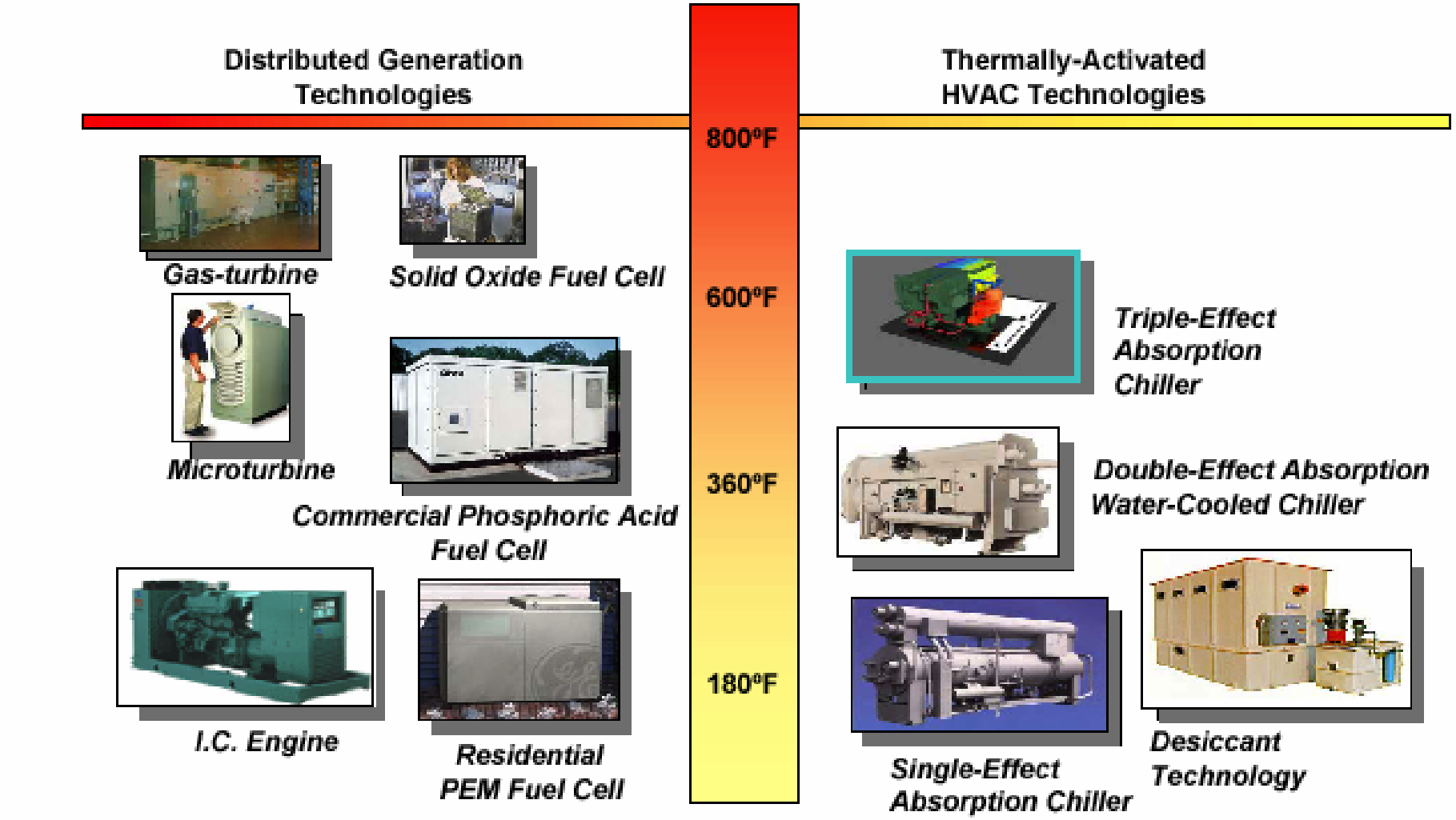


(IPART, 1999)

New distributed power generators

Type	Typical Size	Efficiency
Solar photovoltaic/ thermal	up to 3 kW	Renewable
Wind turbine	30kW – 2MW	Renewable
Reciprocating engines	5kW – 5MW	25-40%
Microturbine	30 – 500 kW	20-35%
Fuel cells	5 – 50 kW	35-55%
Stirling/ Rankine engines	0.5 – 3 kW	10-25%

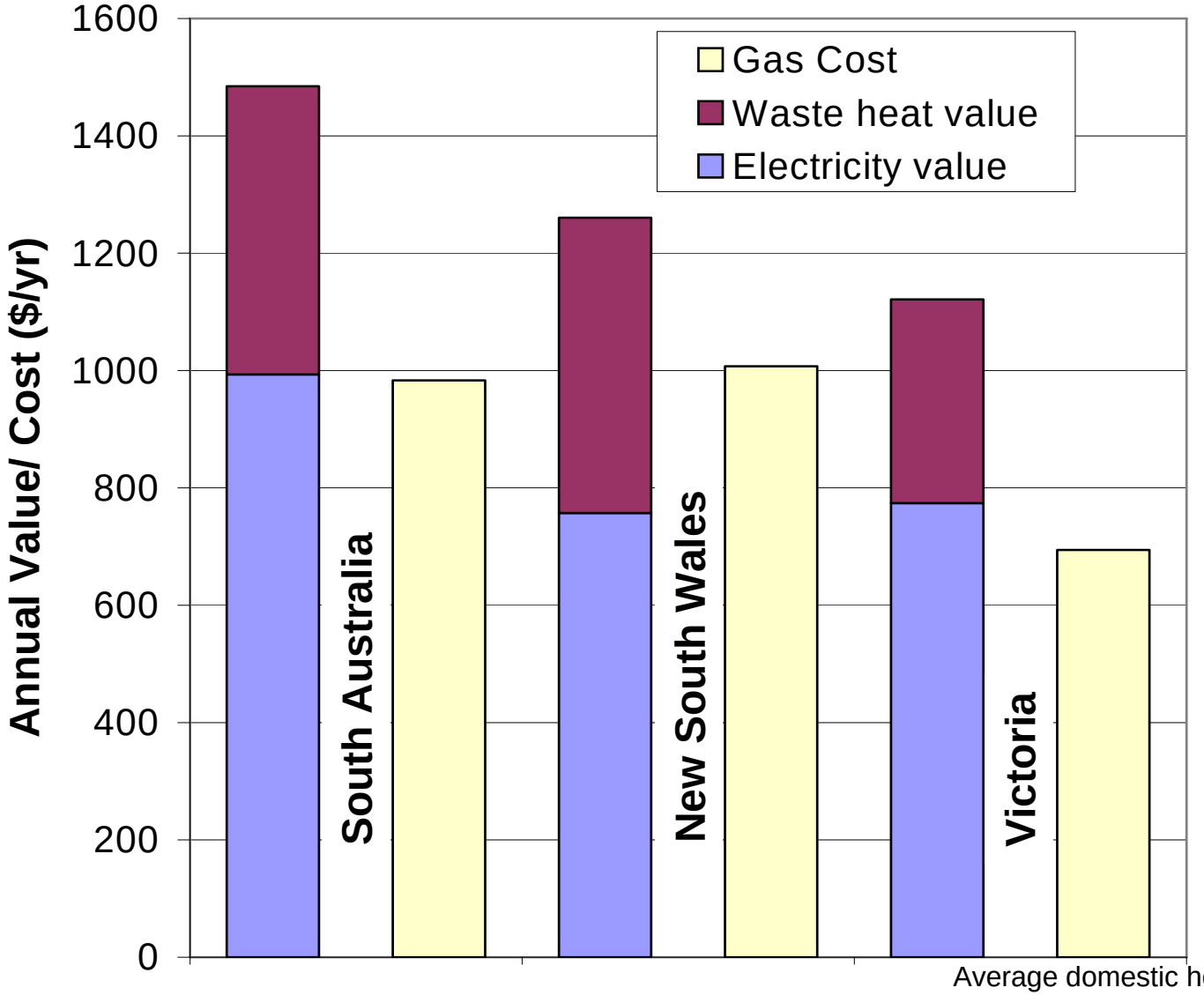
Heat from distributed generation is useful



Recoverable Energy Quality (Temperature) and HVAC Technology Match

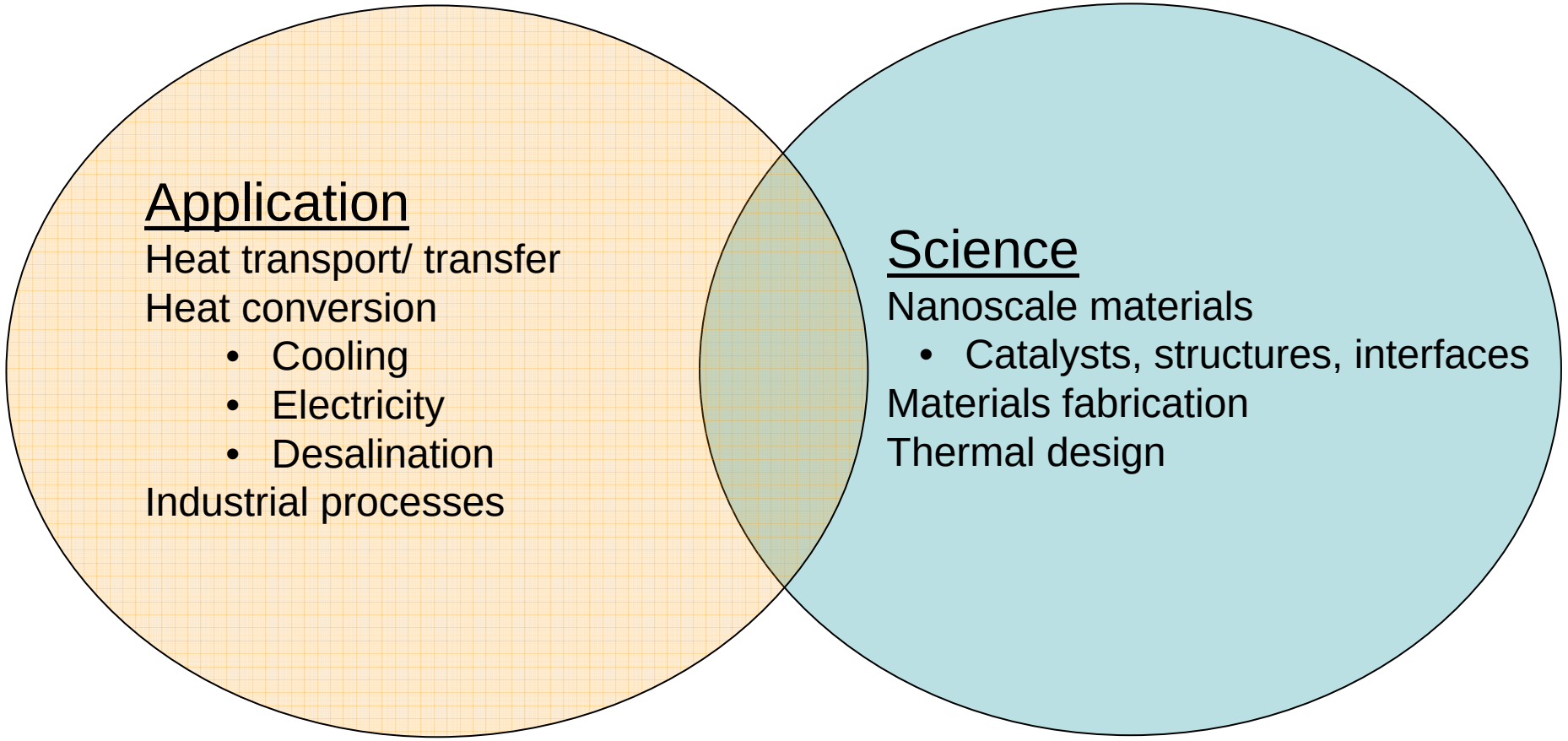
But gas is expensive too

- Waste heat is a necessary extra revenue stream



Average domestic house (4500kWh)
Generator electrical efficiency = 30%
Assumed 100% waste heat utilisation

Waste heat research



Hornsby trigeneration

Project Goals

Large reduction in CO_2 emissions at a single site

Showcase energy efficiency

Location

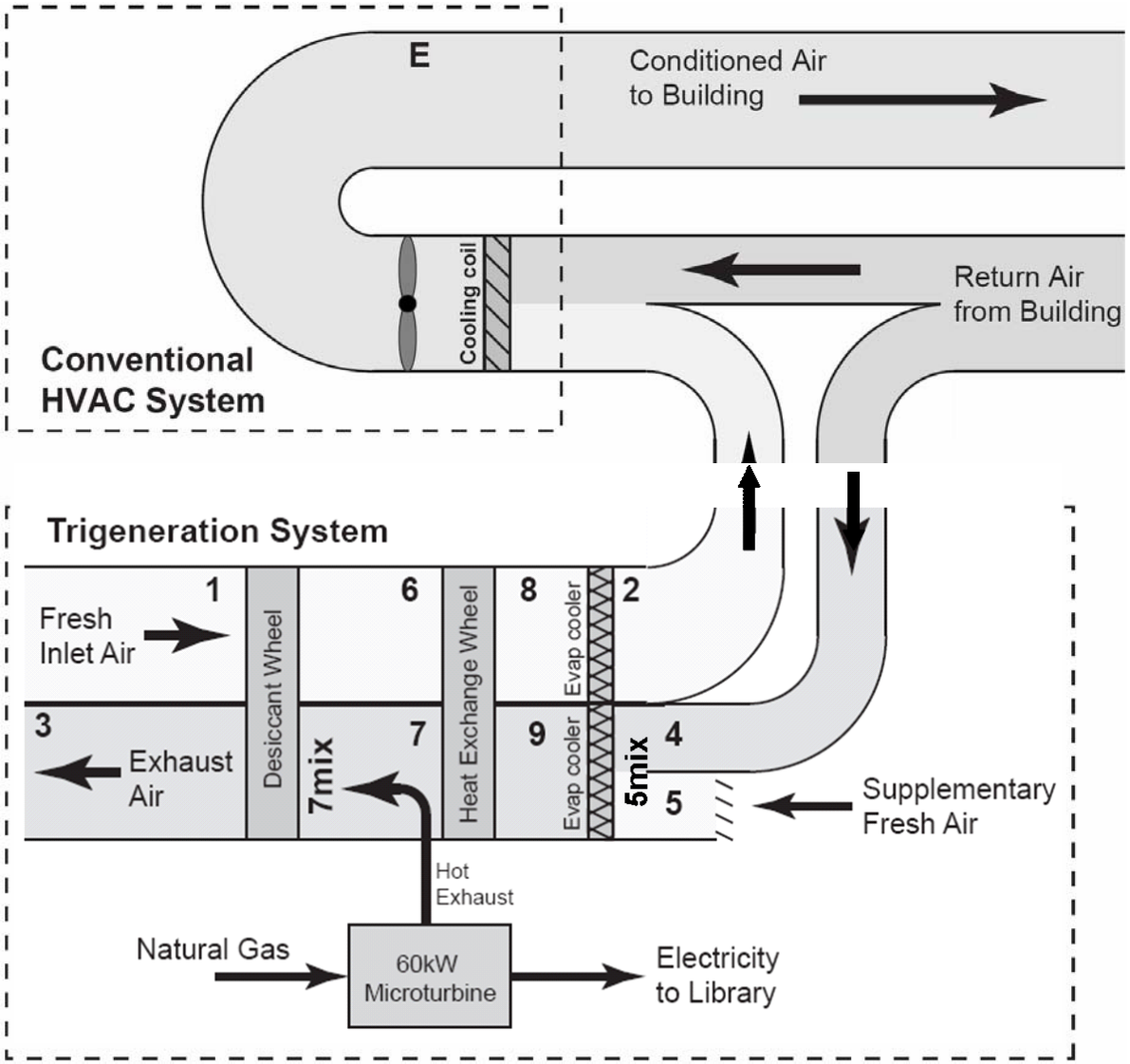
Hornsby City Library, Sydney

Method

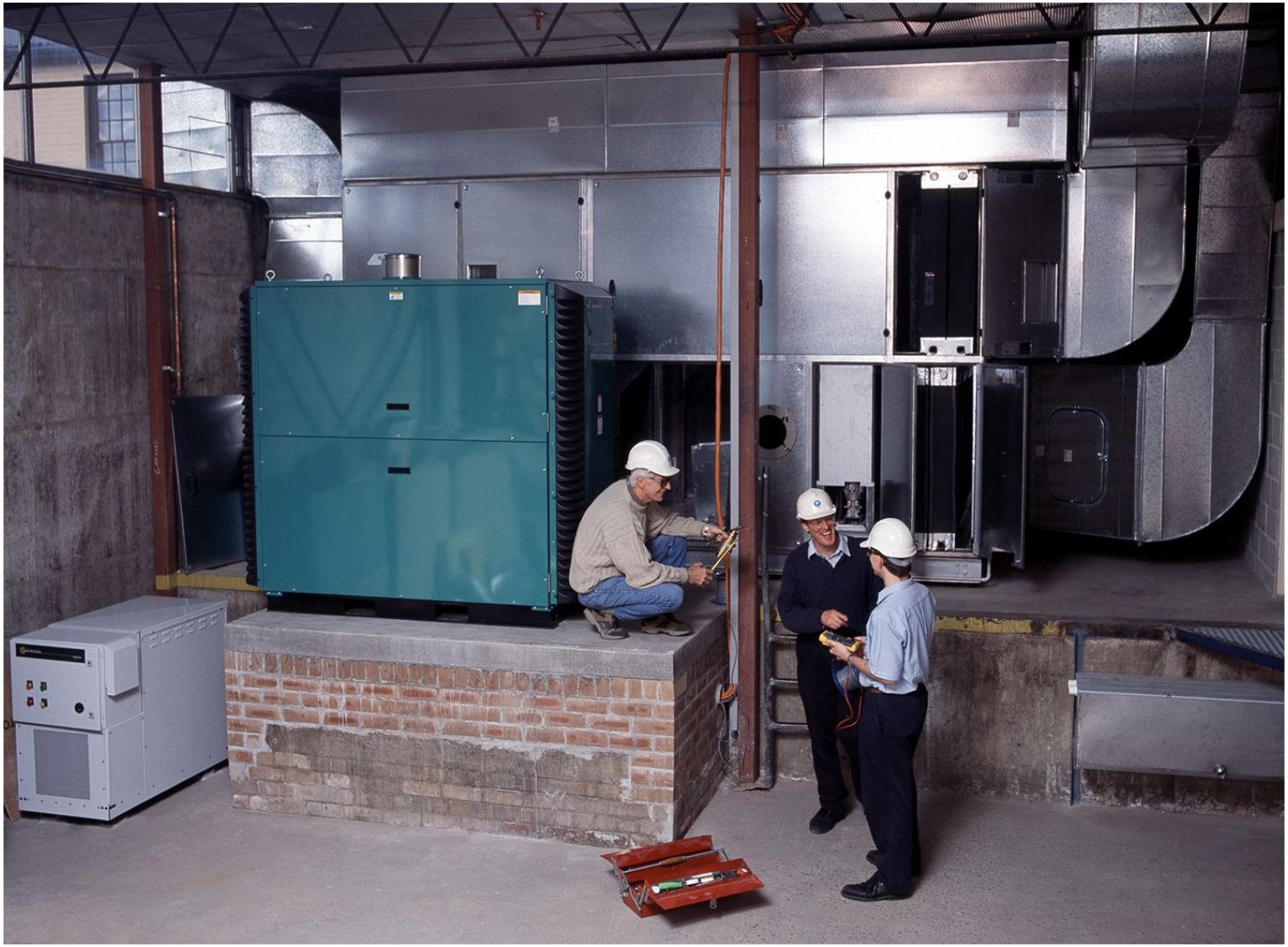
Trigeneration (power and cooling)

- Microturbine
- Desiccant cooling

Tri-generation schematic

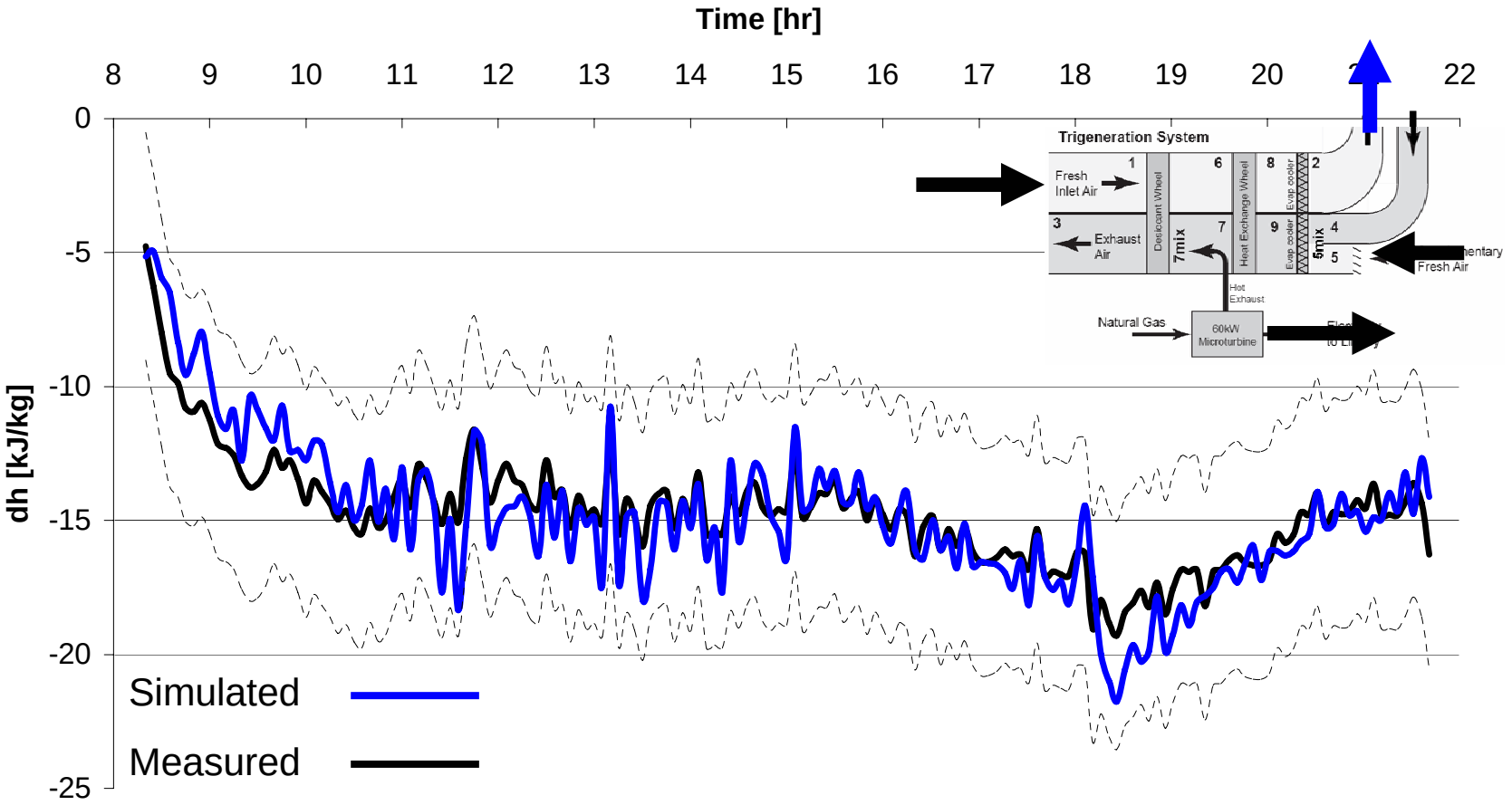


Trigeneration system during construction

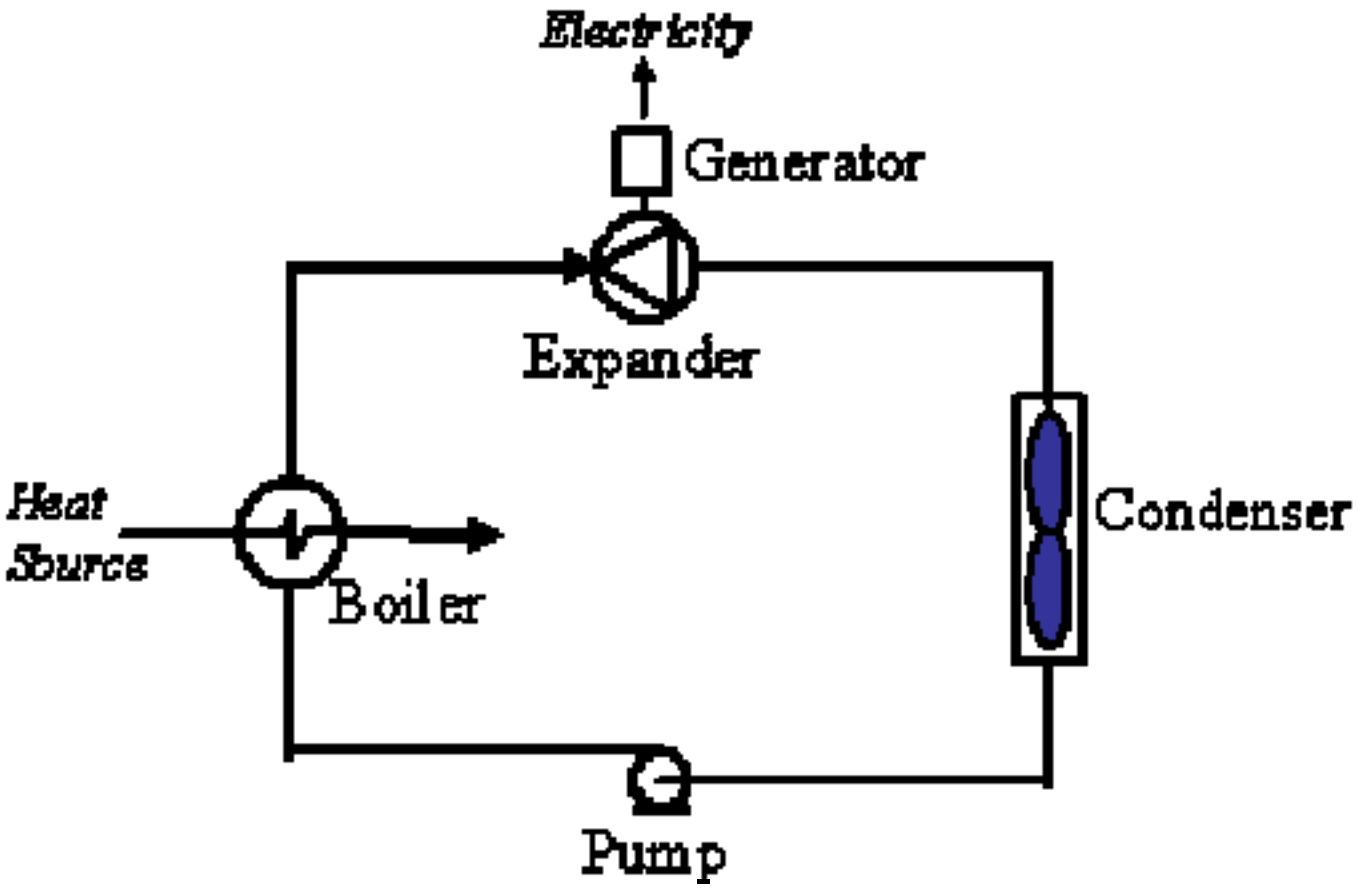


Desiccant system model validation

Enthalpy removed from the fresh supply air stream



Organic Rankine cycle



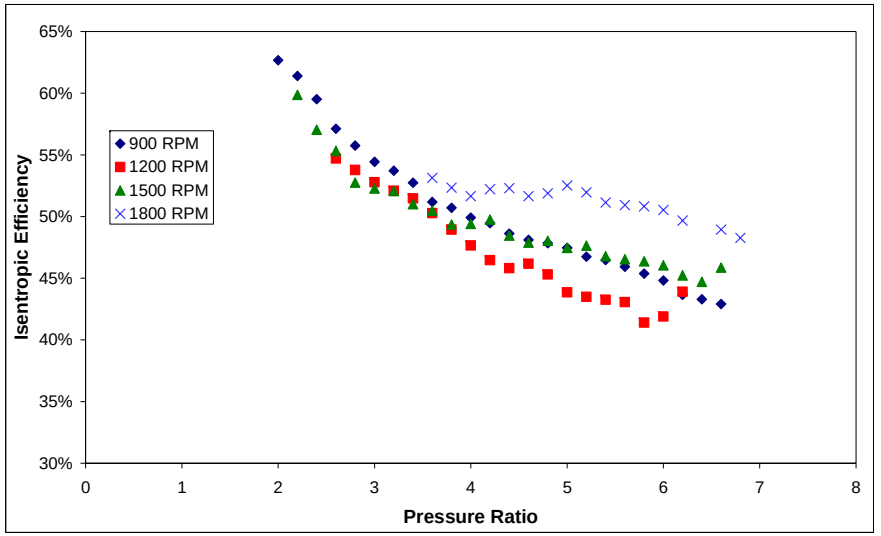
ORC fluid motor options

New Rotary Expander

Patented technology development

Benefits

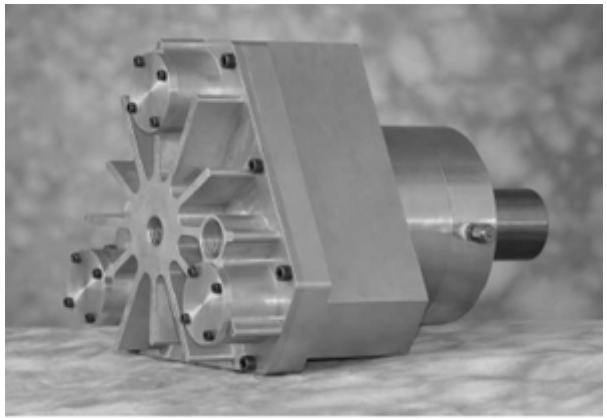
- Simplicity/ robustness/ cost
- Efficiency
- Flexibility
- High capacity



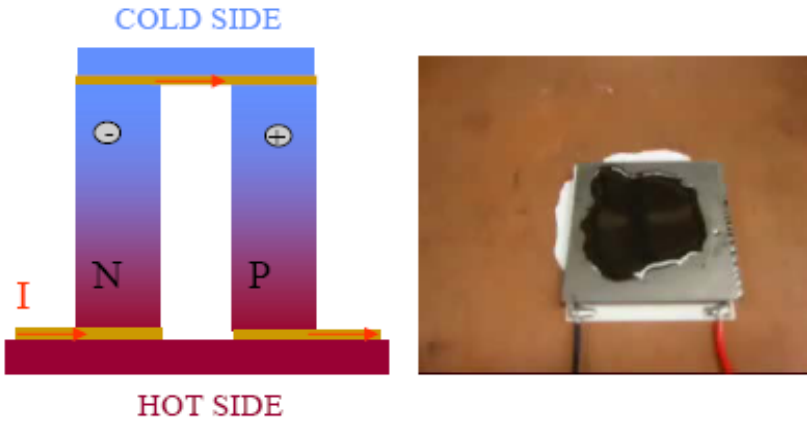
Rotary Scroll

Immediate availability

- Semi hermetic
- Low noise
- Oil free ?



Thermoelectric power generation
- The ZT challenge

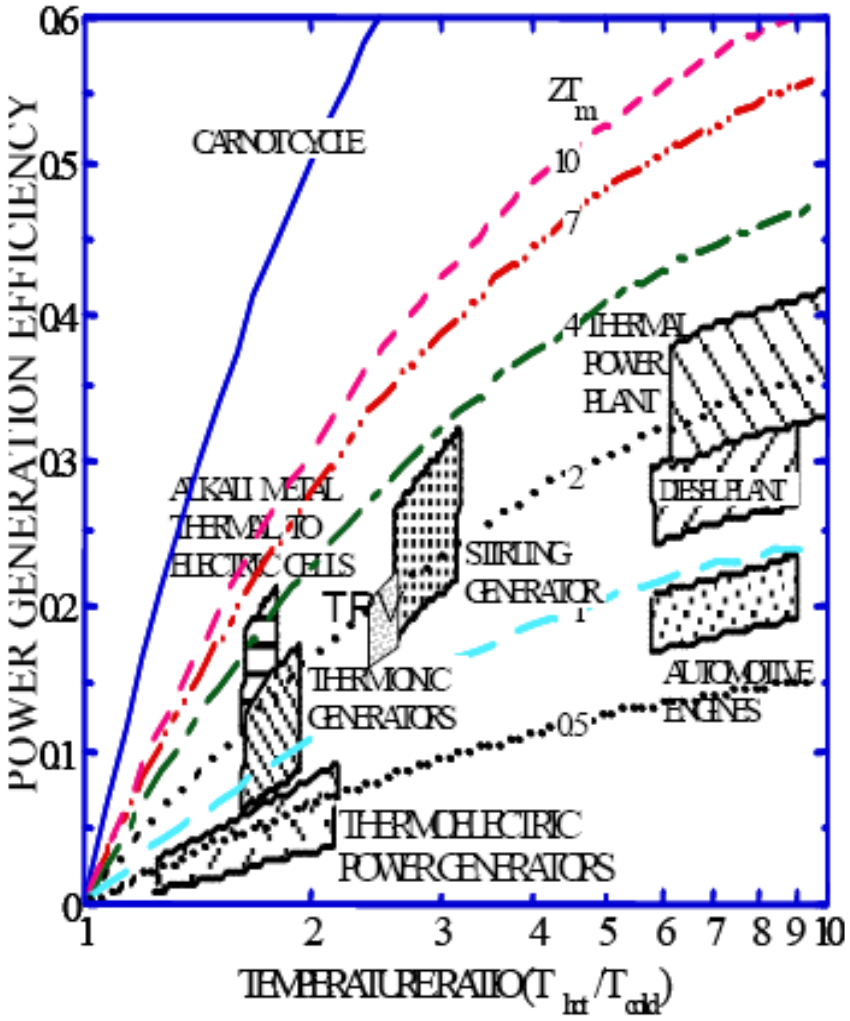


Nondimensional Figure of Merit

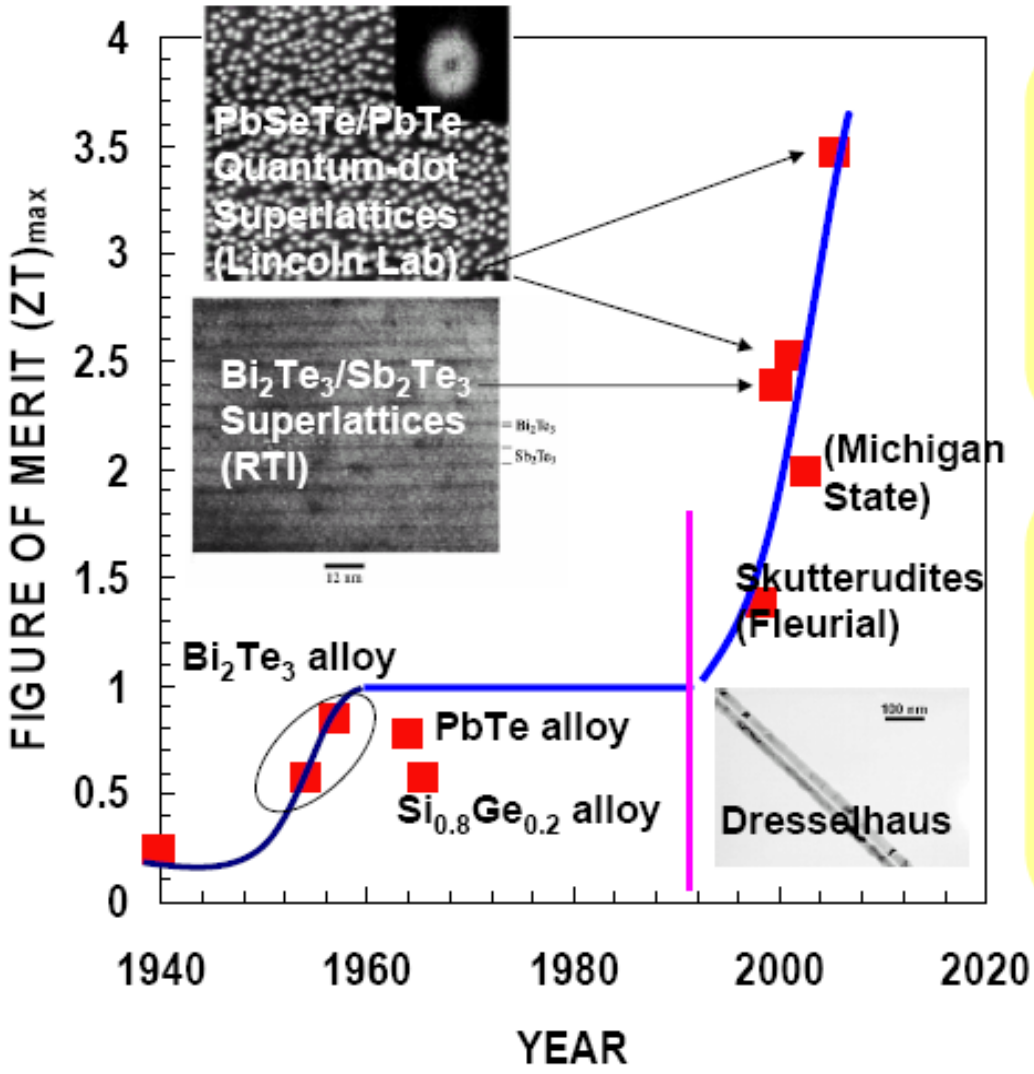
Joule Heating — **Seebeck Coeff. Electron Cooling**

$$ZT = \frac{\sigma S^2 T}{k}$$

Reverse Heat Leakage Through Heat Conduction



Progress in the challenge



PbTe/PbSeTe	Nano	Bulk
$S^2\sigma$ (μW/cmK^2)	32	28
k (W/mK)	0.6	2.5
ZT (T=300K)	1.6	0.3

Harman et al., Science, 2003

Bi_2Te_3/Sb_2Te_3	Nano	Bulk
$S^2\sigma$ (μW/cmK^2)	40	50.9
k (W/mK)	0.6	1.45
ZT (T=300K)	2.4	1.0

Venkatasubramanian et al., Nature, 2002.

What could the future look like ?

Figure 4.5: Reductions in CO_2 emissions from 2005 level by 2025 – by energy source
How the different decentralised energy technologies contribute to the CO_2 savings

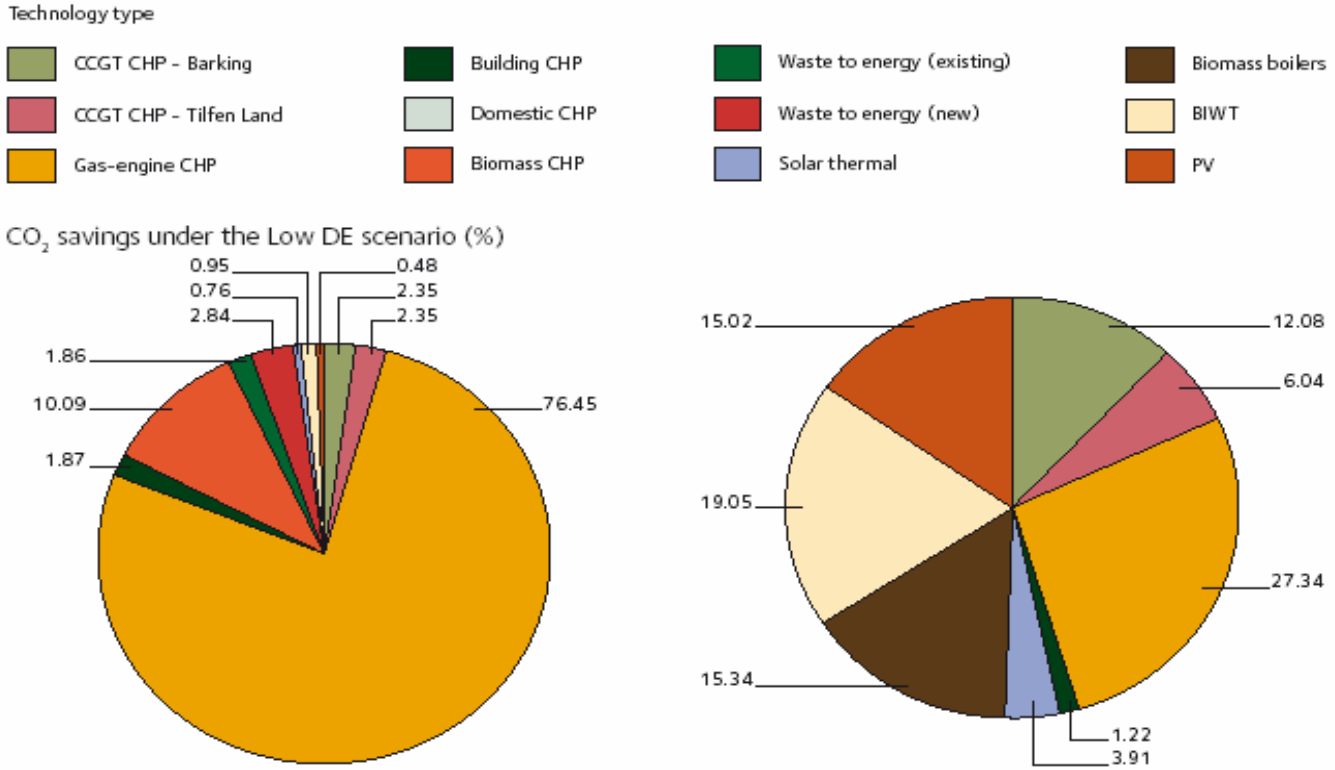


Figure A. For the existing building stock
Efficient use of gas through widespread use of gas-engine CHP (and associated Community Heat networks) dominates the CO_2 savings from existing properties. Biomass as a fuel becomes significant with building integrated low and zero carbon technologies making a marginal contribution.

Figure B. For the new build properties
Renewable technologies account for over half of the CO_2 savings when they incorporated in to new buildings.

Energy Technology
Distributed Energy

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Thank You

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