THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Industrial Process Heat - Options for Efficiency Improvements and Emissions Reduction

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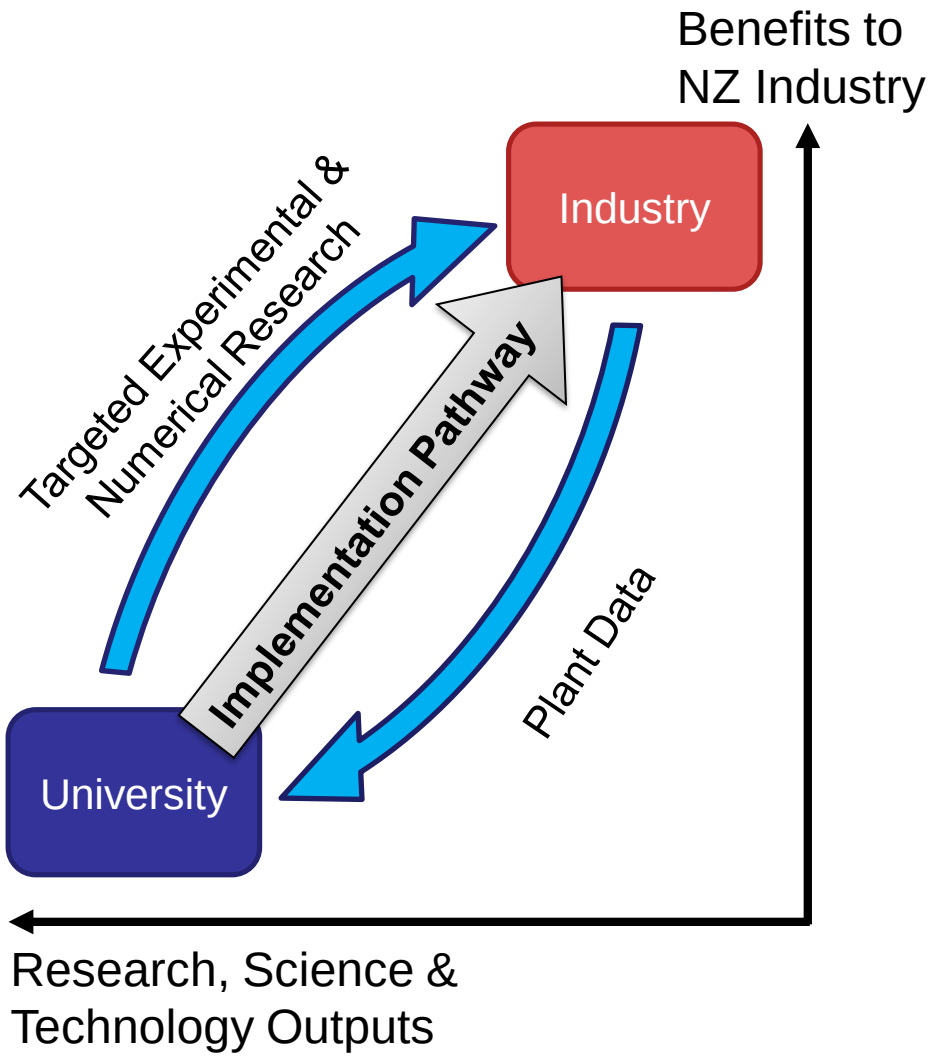
University of Waikato

EMANZ 2017

Waikato Energy Research Group

- Focus on meaningful research for industry
- Deliver engineering solutions
- Work with industrial producers & suppliers
- Influence industry best practice / standards

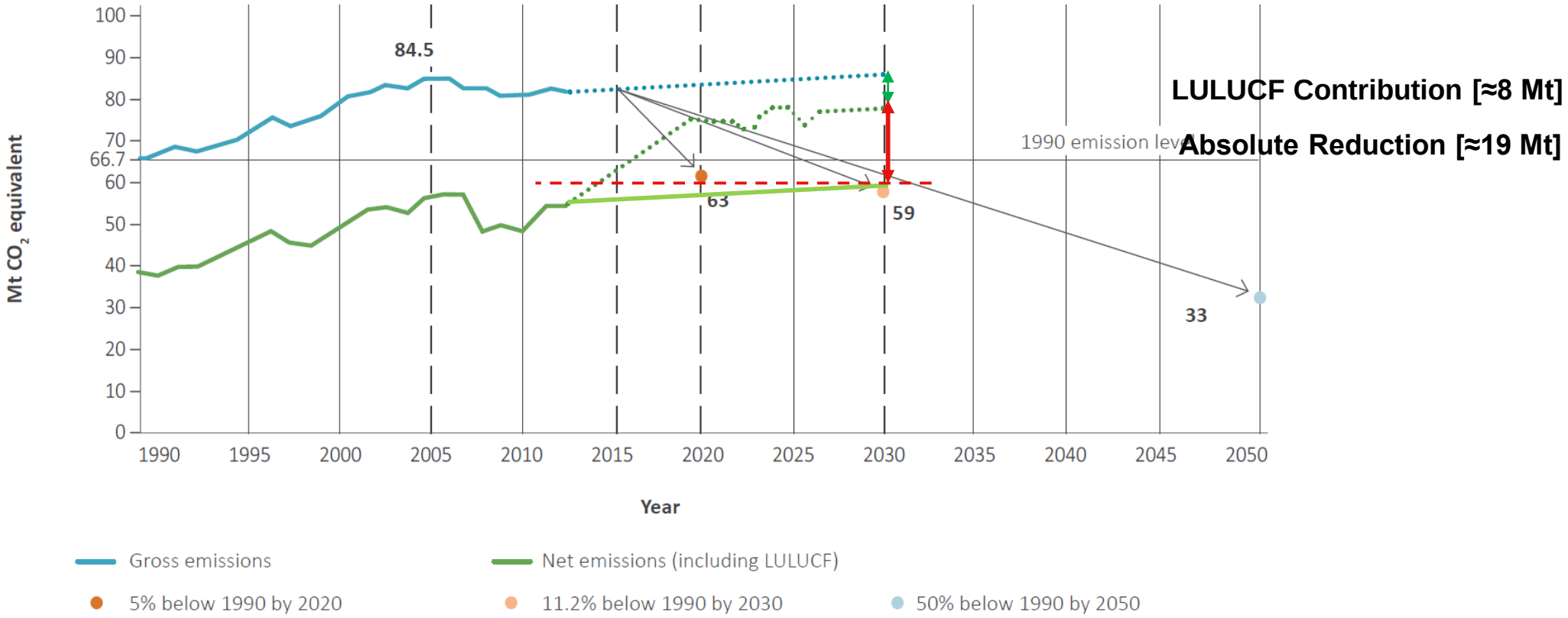


End User Focused

NZ GHG EMISSIONS & PROCESS HEAT

Emissions Targets & Situation

Figure 3.5 New Zealand's gross and net emissions from 1990 to 2013, future projections and national emission reduction targets for 2020, 2030 and 2050.



LULUCF Contribution [≈8 Mt]

Absolute Reduction [≈19 Mt]

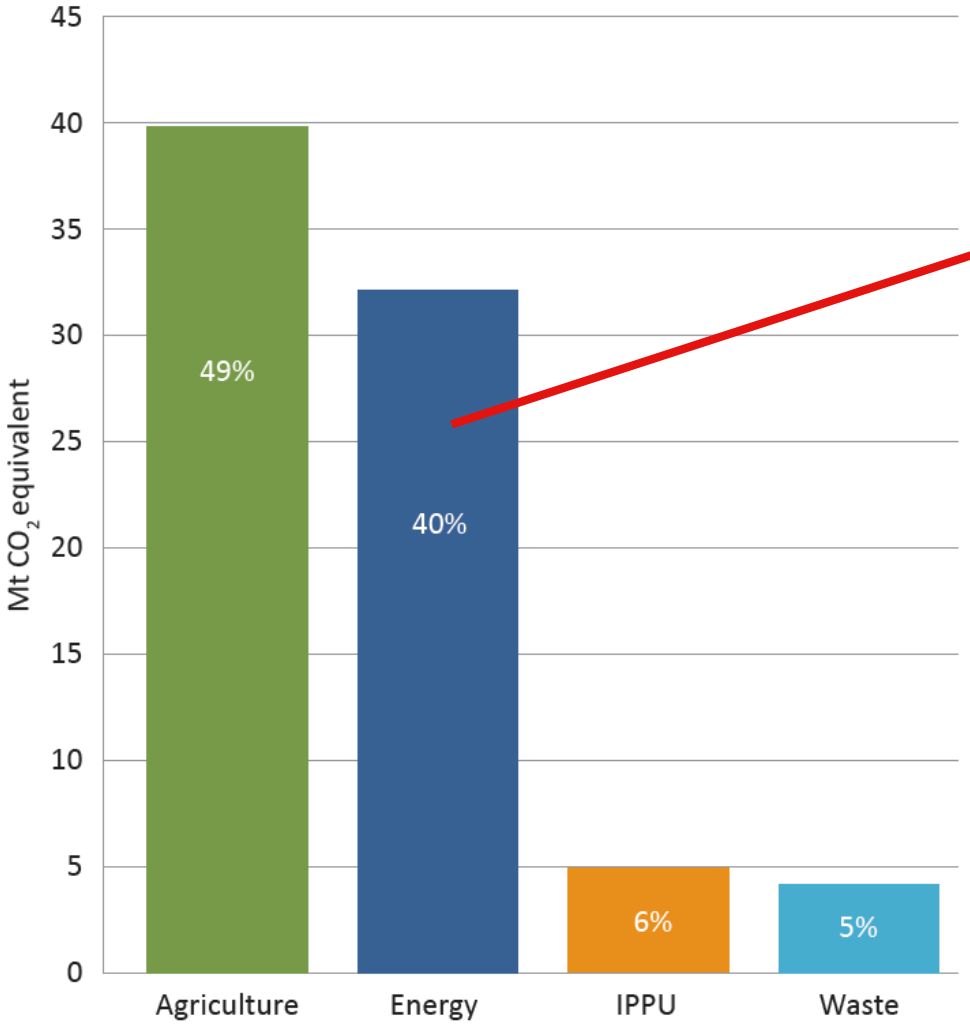
Note: The 2020 conditional target range of 10–20% below 1990 is not shown.

Source: Based on MfE (2015e).

Royal Society, 2016

NZ Emissions by Sector

Figure 1: New Zealand's gross greenhouse gas emissions by sector in 2014 MBIE, 2014

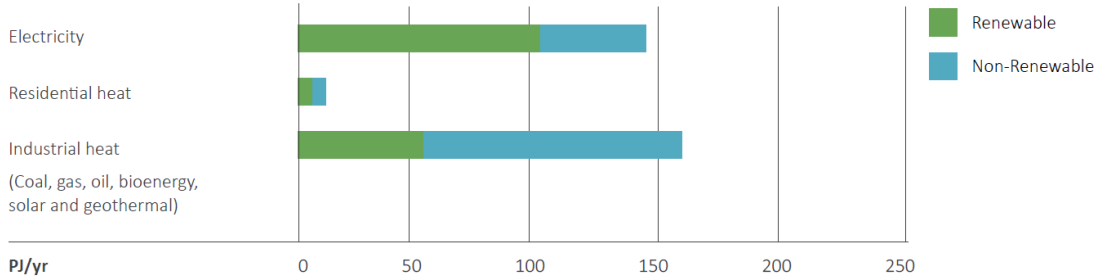


Transport ≈ 14.1 $Mt_{CO2\text{-}e}$

Electricity ≈ 5.5 $Mt_{CO2\text{-}e}$

Process Heat ≈ 7.3 $Mt_{CO2\text{-}e}$

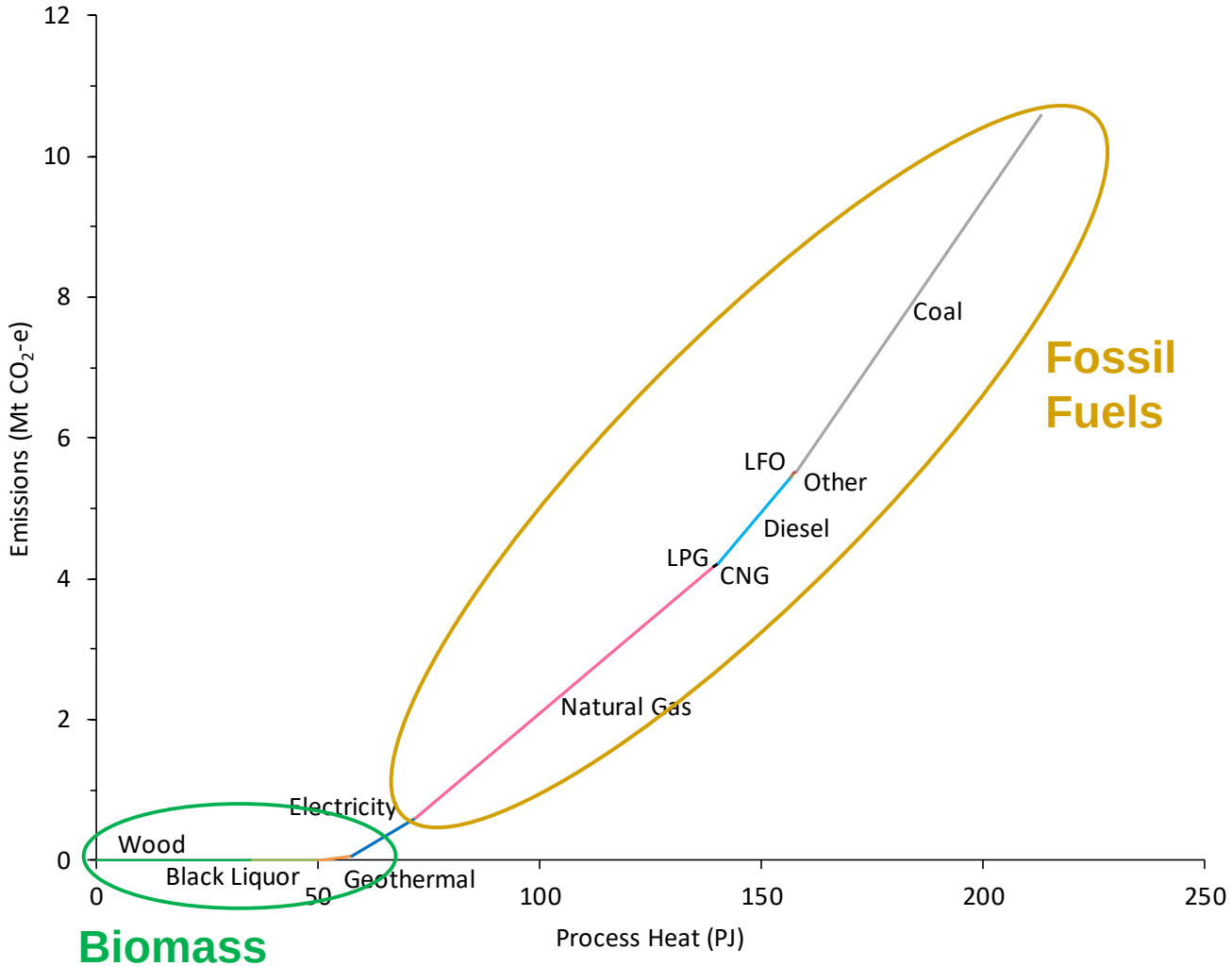
Figure 5.1 Renewables had around an 80% share of electricity in New Zealand in 2013 with consumer heat energy demand being met mainly by fossil fuel combustion together with some renewable bioenergy (including domestic firewood), solar and geothermal sources.



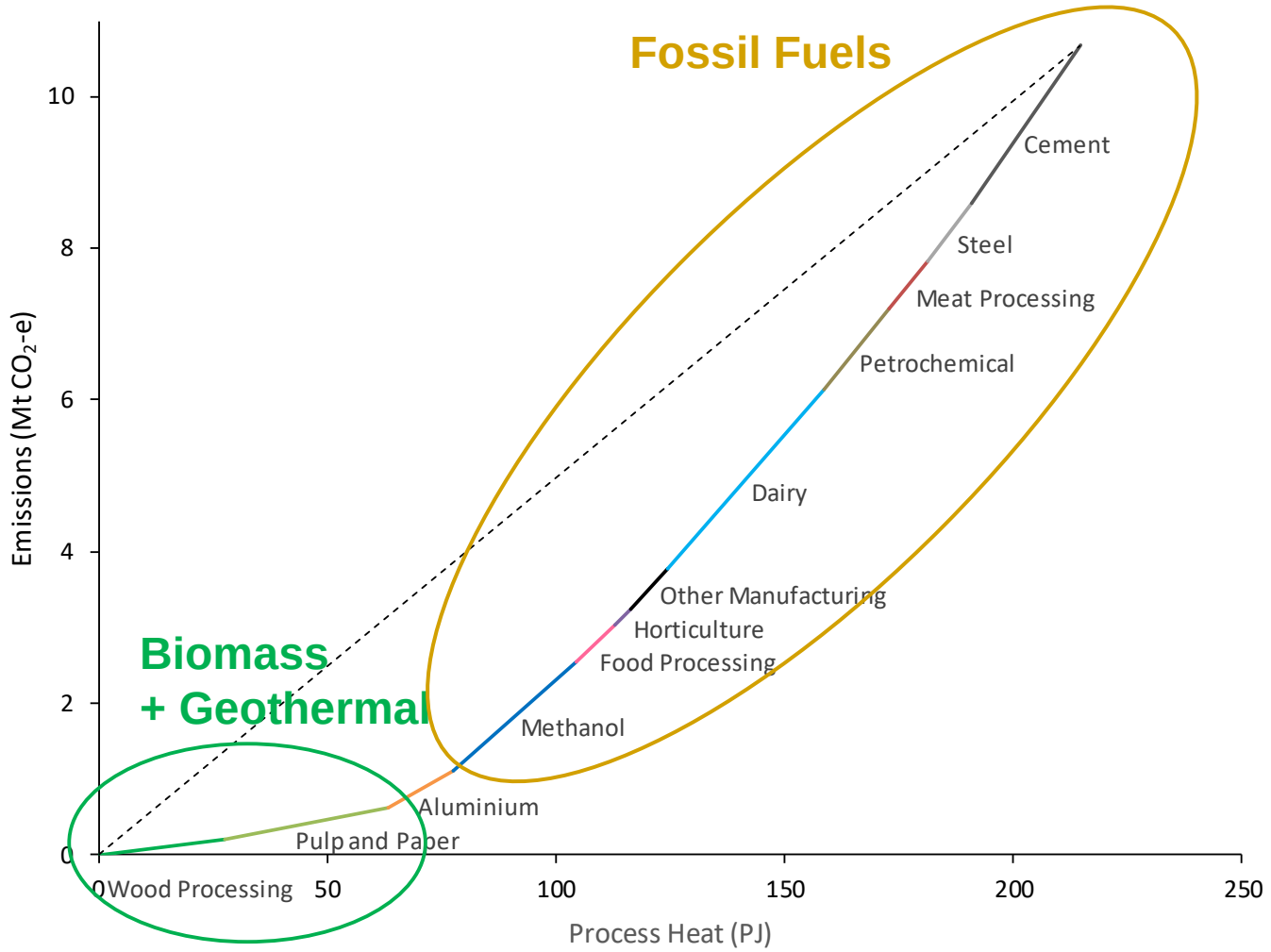
Source: MBIE (2014).

Royal Society, 2016

Process Heat & Emissions by Fuel in 2014

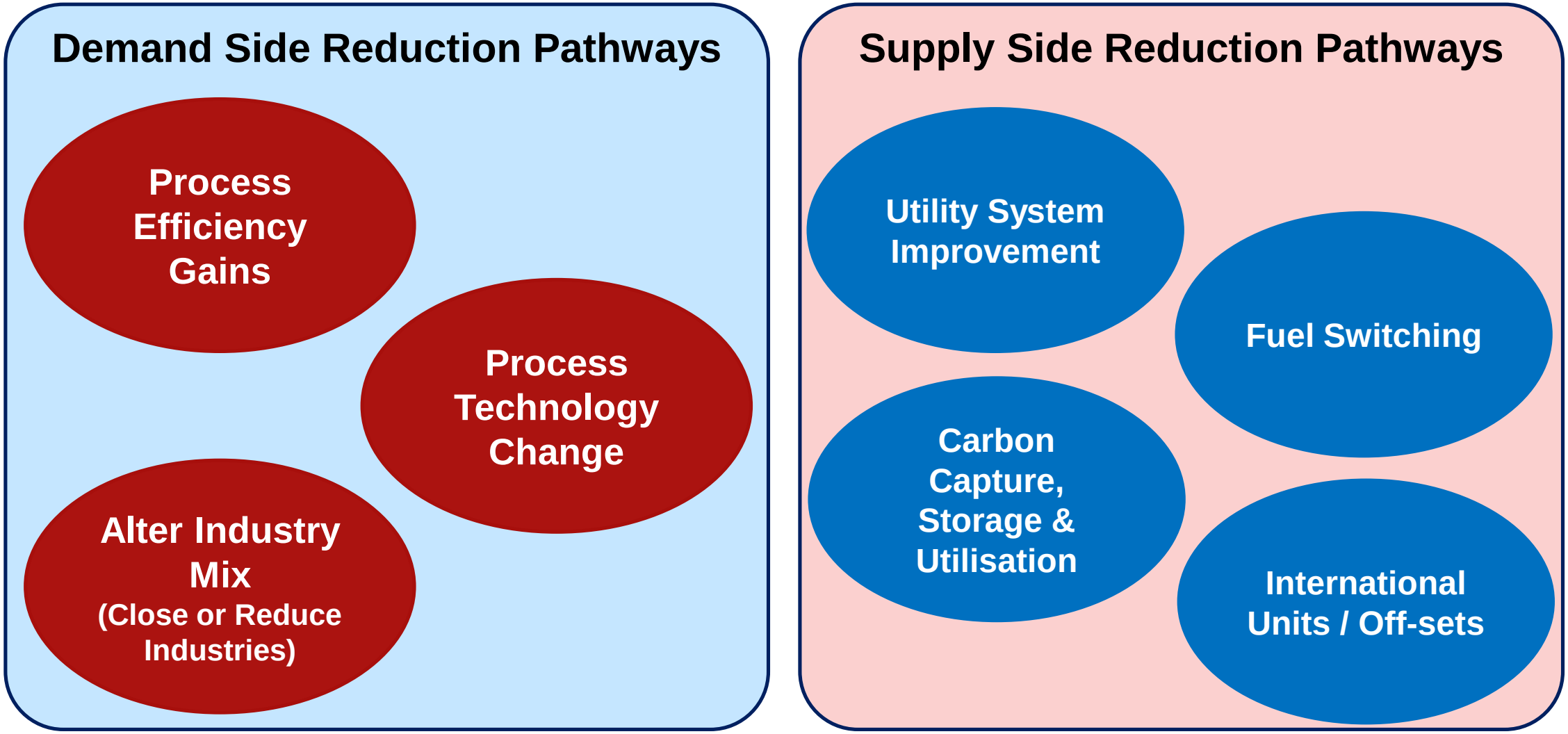


Process Heat & Emissions by Industry in 2014



EMISSIONS REDUCTION OPTIONS

Industrial Process Heat Emissions Reduction



Process Technology Change

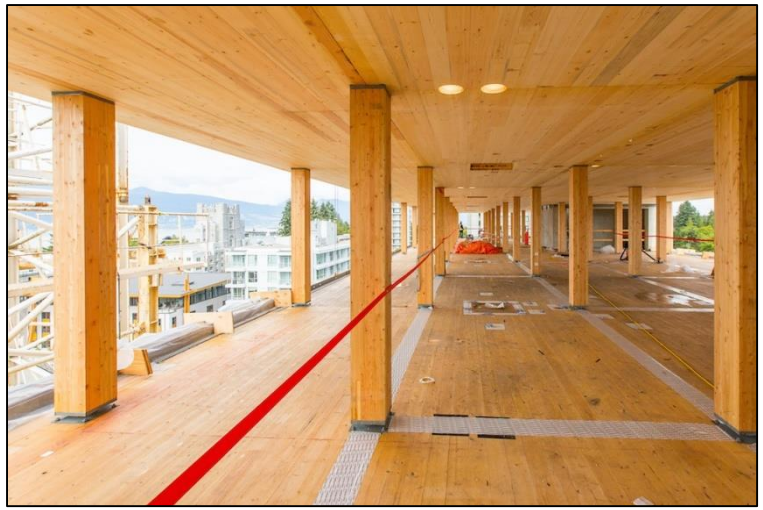
- Alternate Unit Operations, Processes
  - e.g. Milk evaporation Reverse Osmosis, MVR technology

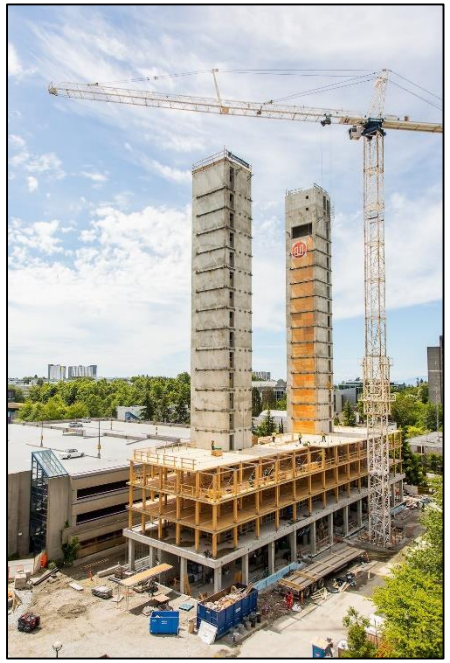
- New Processing Routes or Feedstocks
  - e.g. steel manufacture

- Substitute Products
  - e.g. Green platform chemicals (DME etc.)

Industry Mix

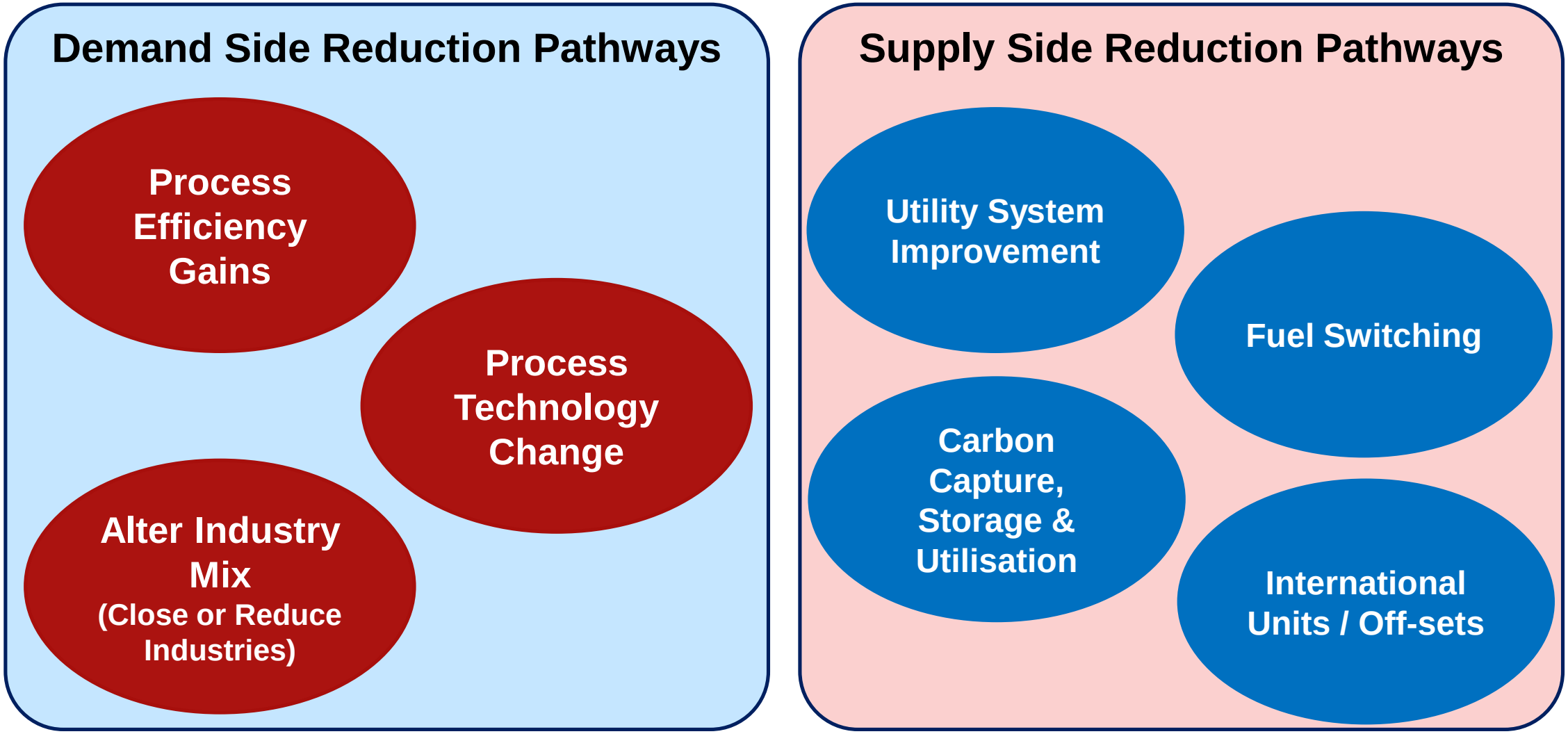
- Government Policy
  - e.g. Promote Engineered Wood Products to reduce cement demand





UBC 18-storey Student Residence

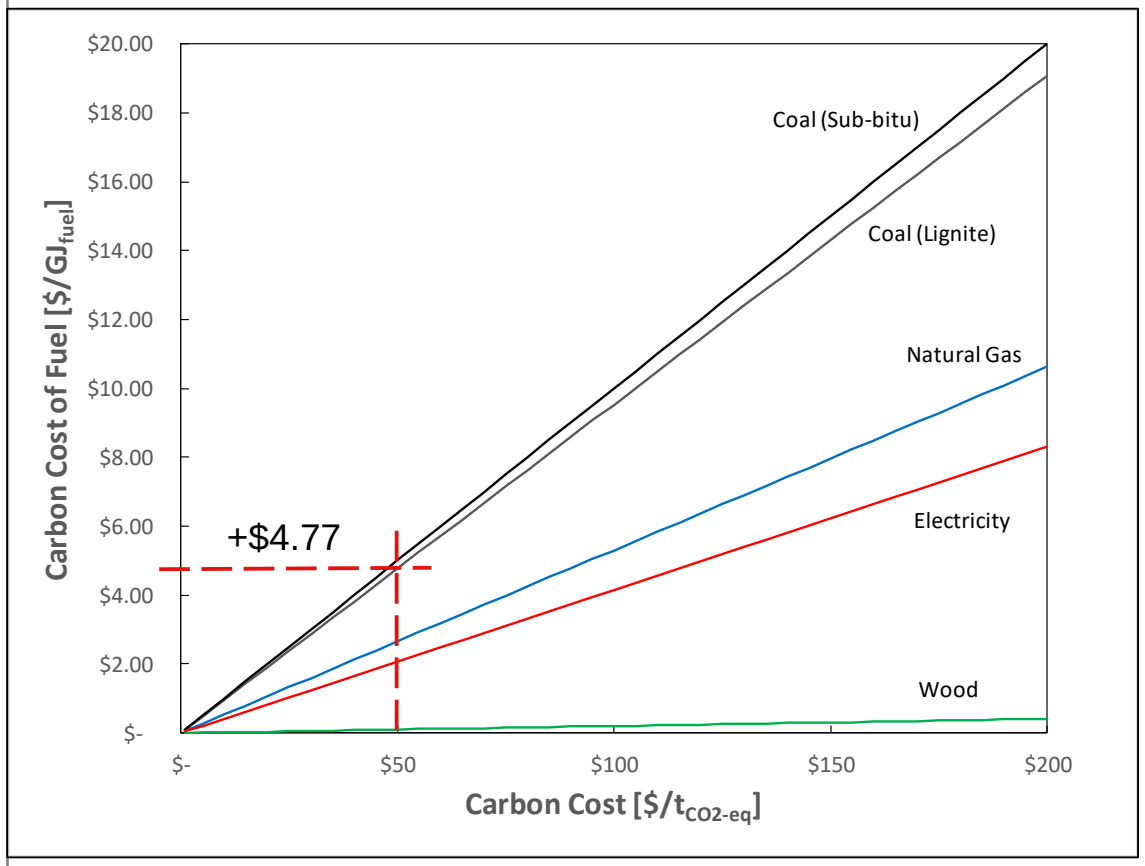
Industrial Process Heat Emissions Reduction



Fuel Switching
Renewable/Low Carbon Process Heat

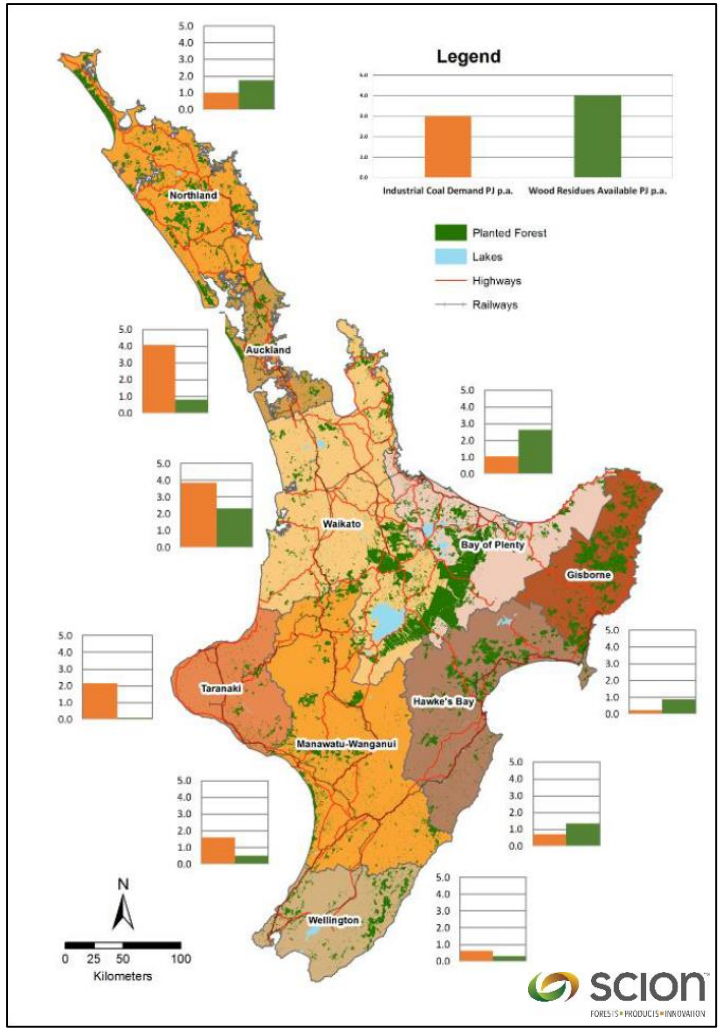
- Biomass
- Solar
- Renewable Electricity
  - Hydrogen
- Biogas
- Geothermal

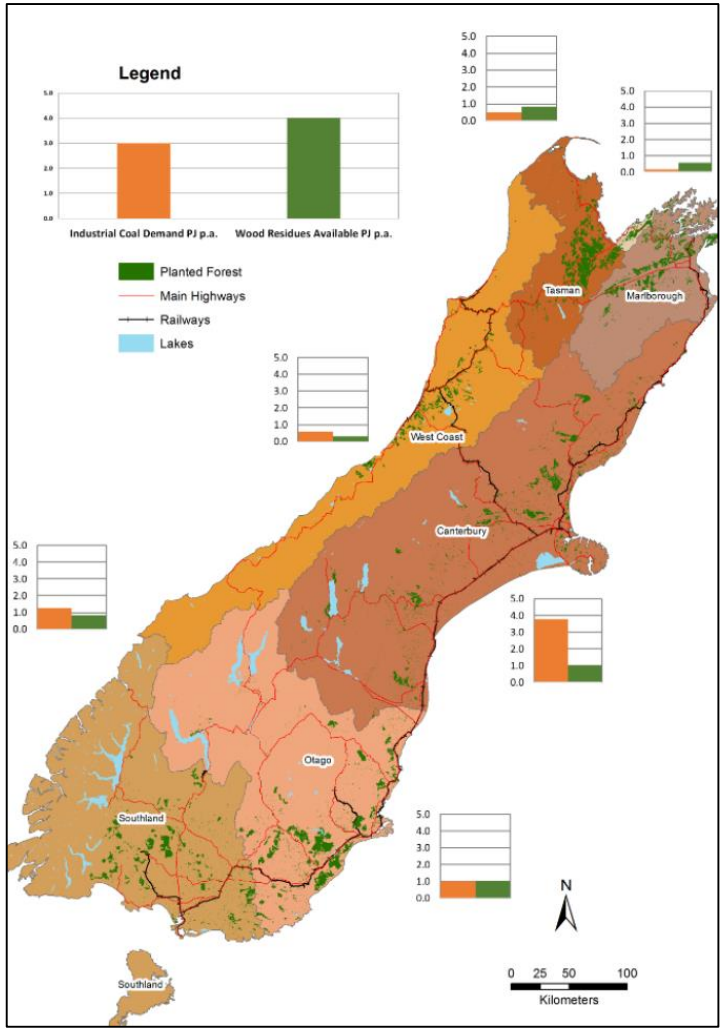
Fuel Switching – ETS Effect on Fuels



Fuel	Fuel Emissions Factor (ε_{fuel}) [t_{CO2}/GJ_{fuel}]
Natural Gas	0.053
Coal – Sub-Bituminous	0.100
Coal – Lignite	0.095
Wood – Forest Residues	0.002
Wood – Chip	0.002
Electricity (0.150 t_{CO2-eq}/MWh)	0.042
Electricity (0.05 t_{CO2-eq}/MWh)	0.014

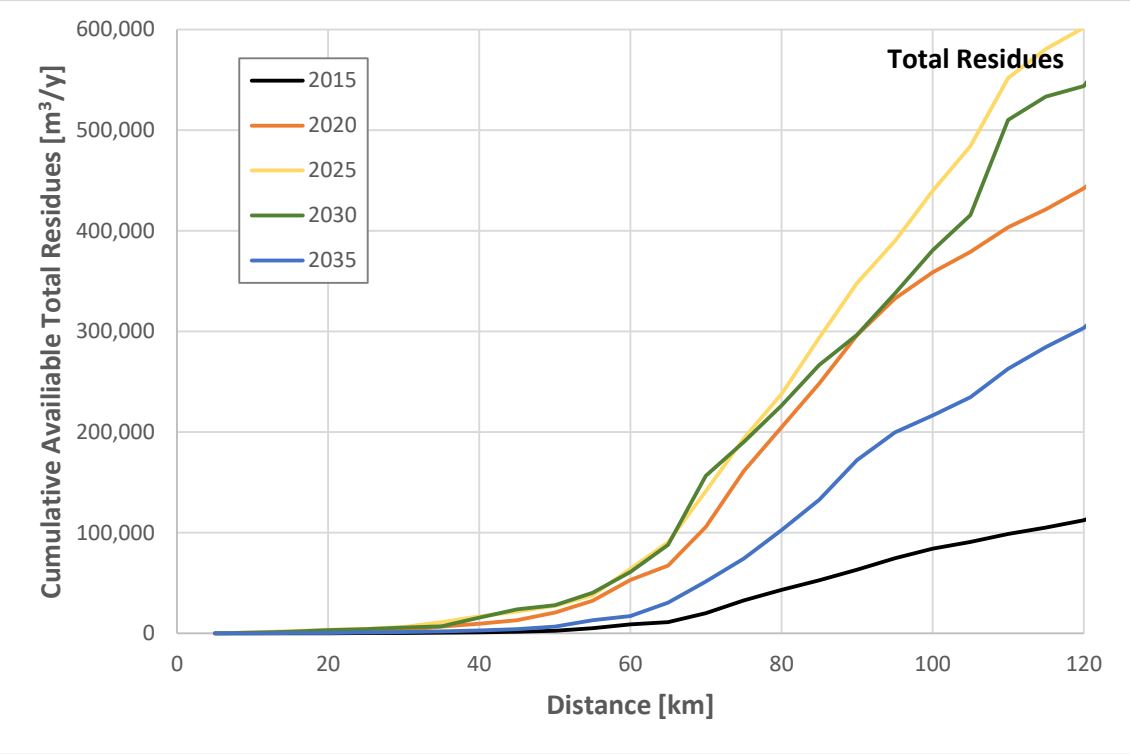
Fuel Switching - Biomass

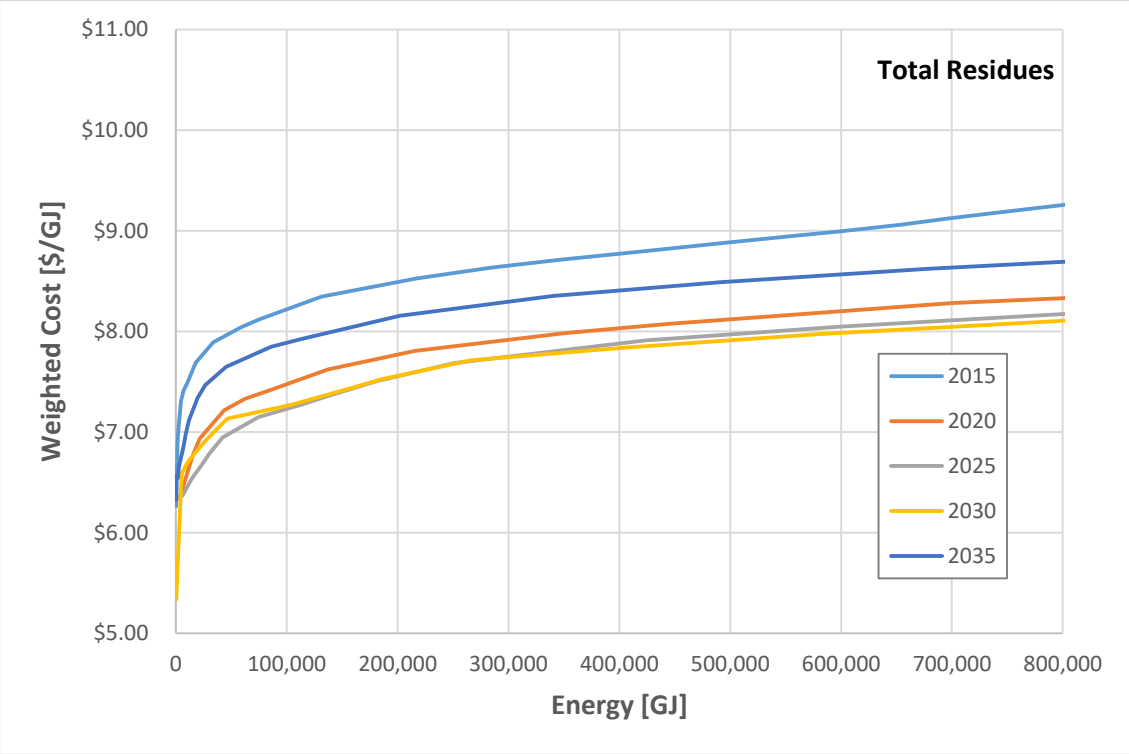




- Biomass
  - Limited Supply and Regional
  - Time Dependant
  - Seasonal Variations
  - Competition for Processing Residues

Fuel Switching – Biomass Supply Curves





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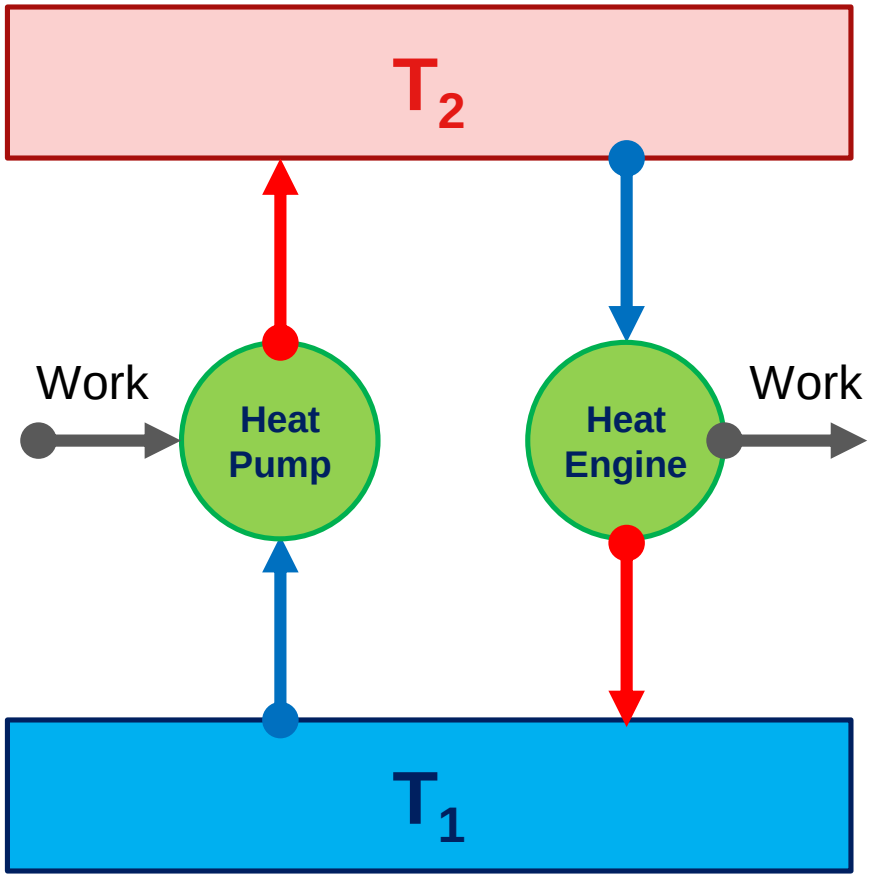
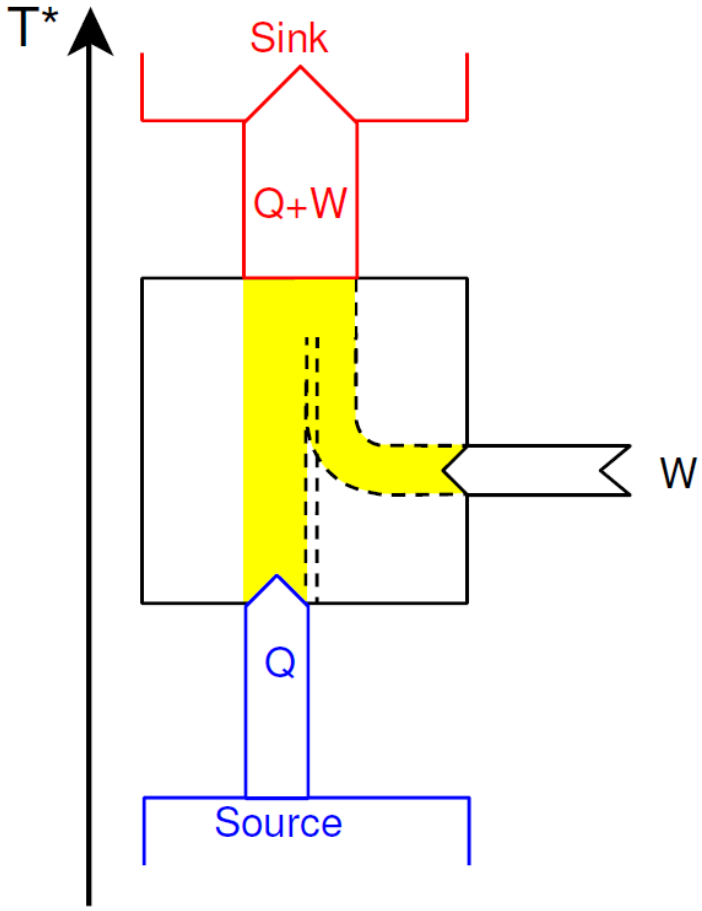
Fuel Switching – High Temperature Heat Pumps (Low Temperature Industrial Heat)





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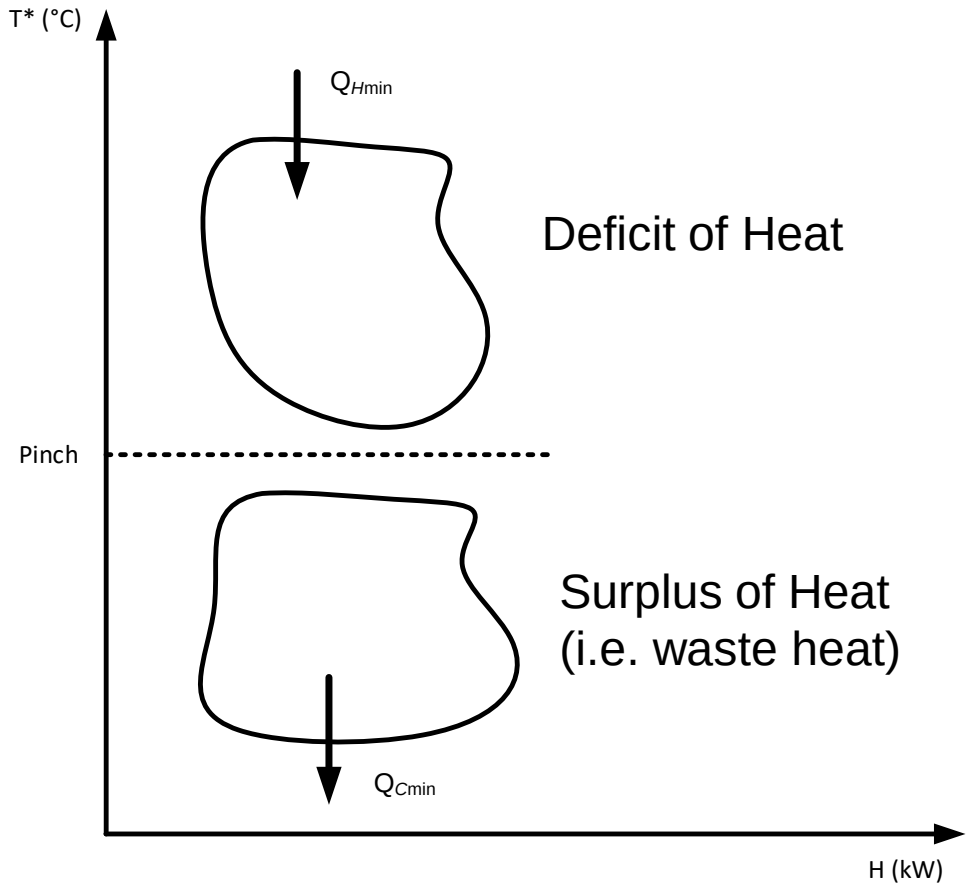
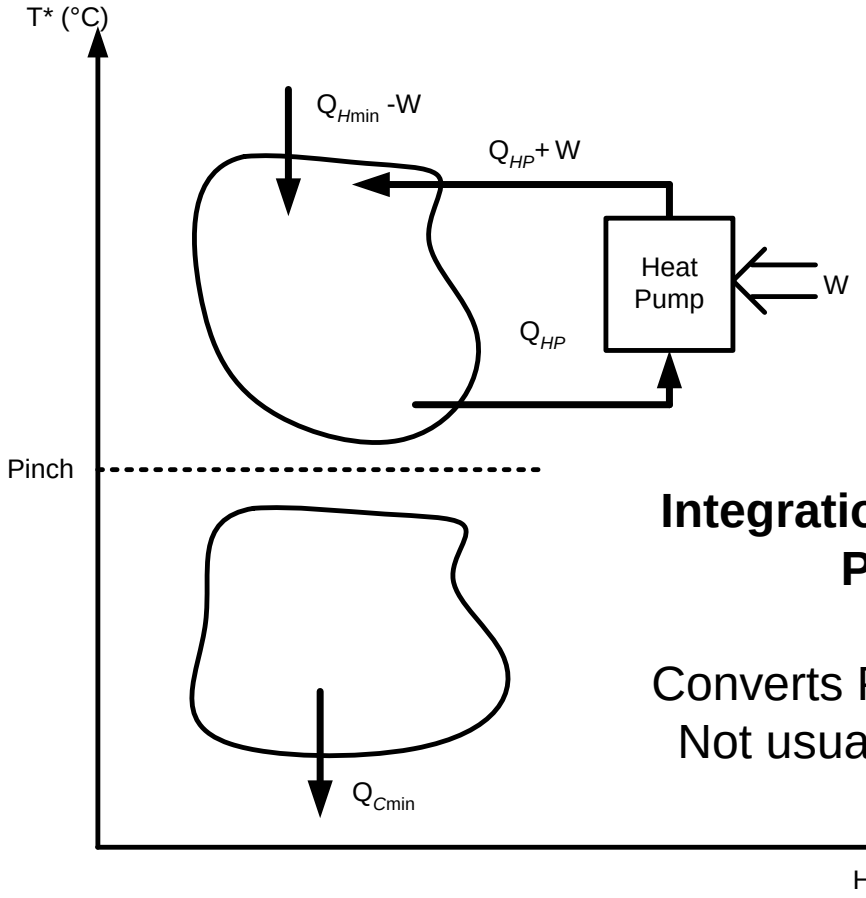
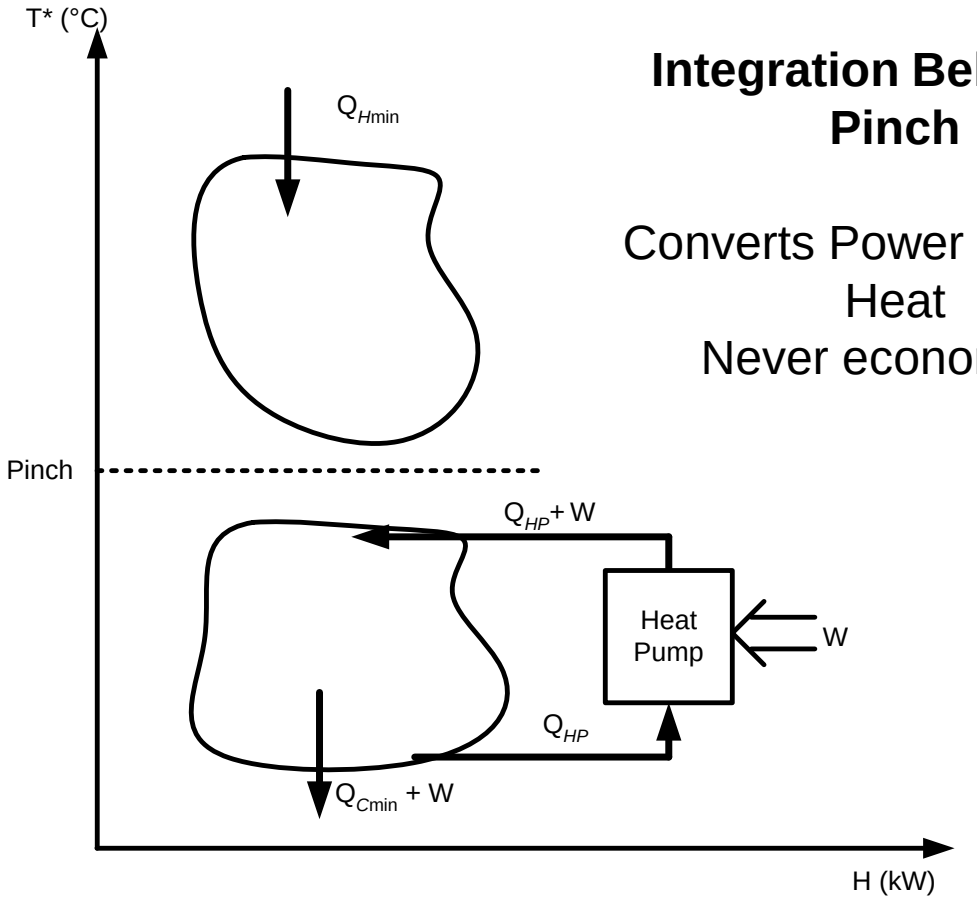




Integration Above the Pinch

Converts Power to Heat
Not usually economic

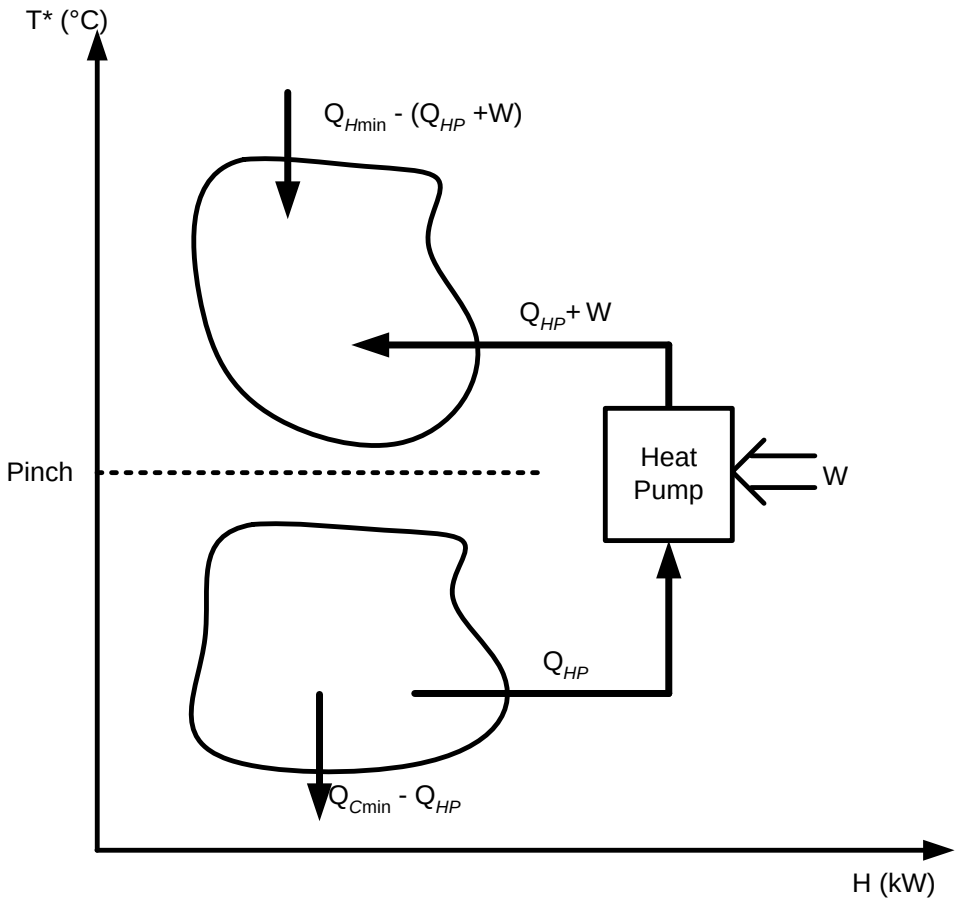
Fuel Switching – High Temperature Heat Pumps (Low Temperature Industrial Heat)



Integration Below the Pinch

Converts Power to Waste Heat
Never economic !!

Fuel Switching – High Temperature Heat Pumps (Low Temperature Industrial Heat)

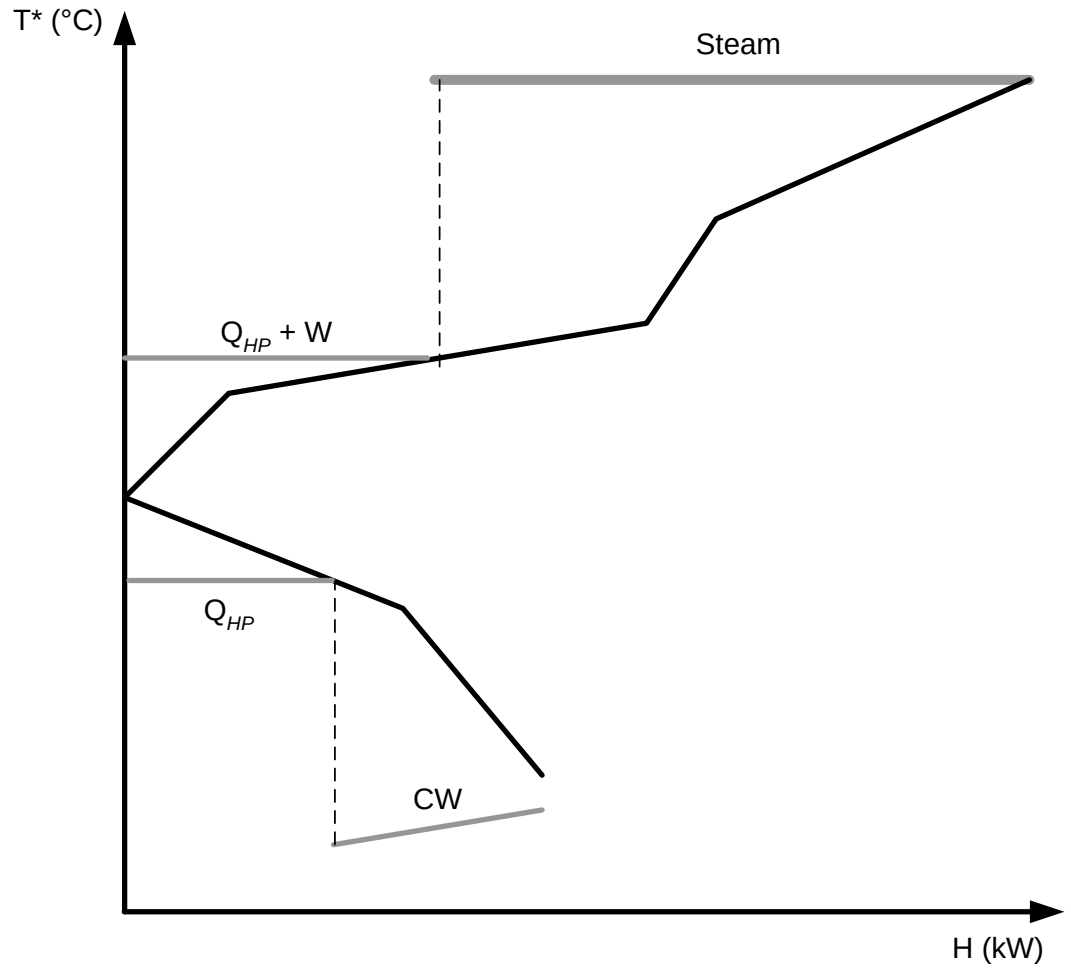


Integration Across the Pinch

Appropriate Placement of Heat Pump

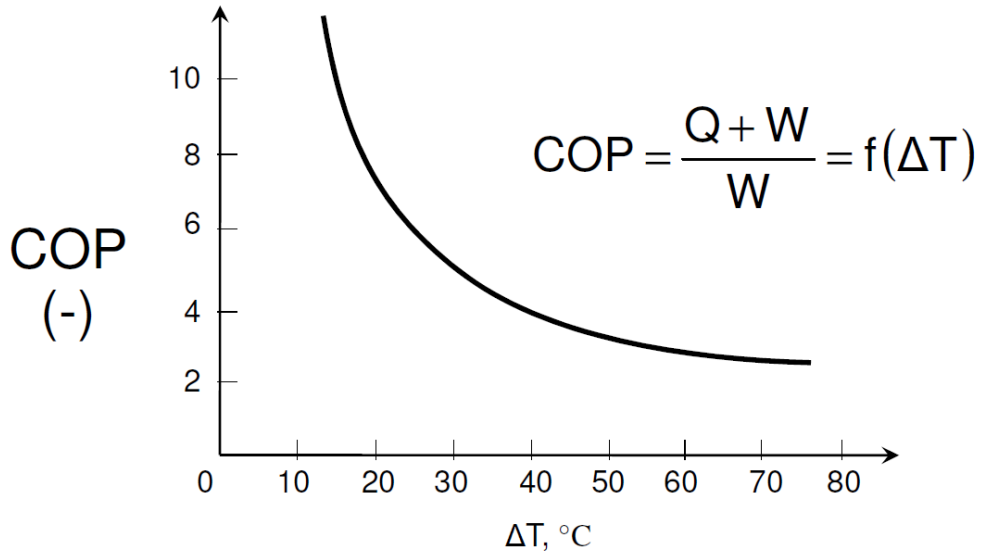
Upgrades Temperature of Waste Heat
To Useable Temperature
(i.e. above the pinch)

Fuel Switching – High Temperature Heat Pumps (Low Temperature Industrial Heat)



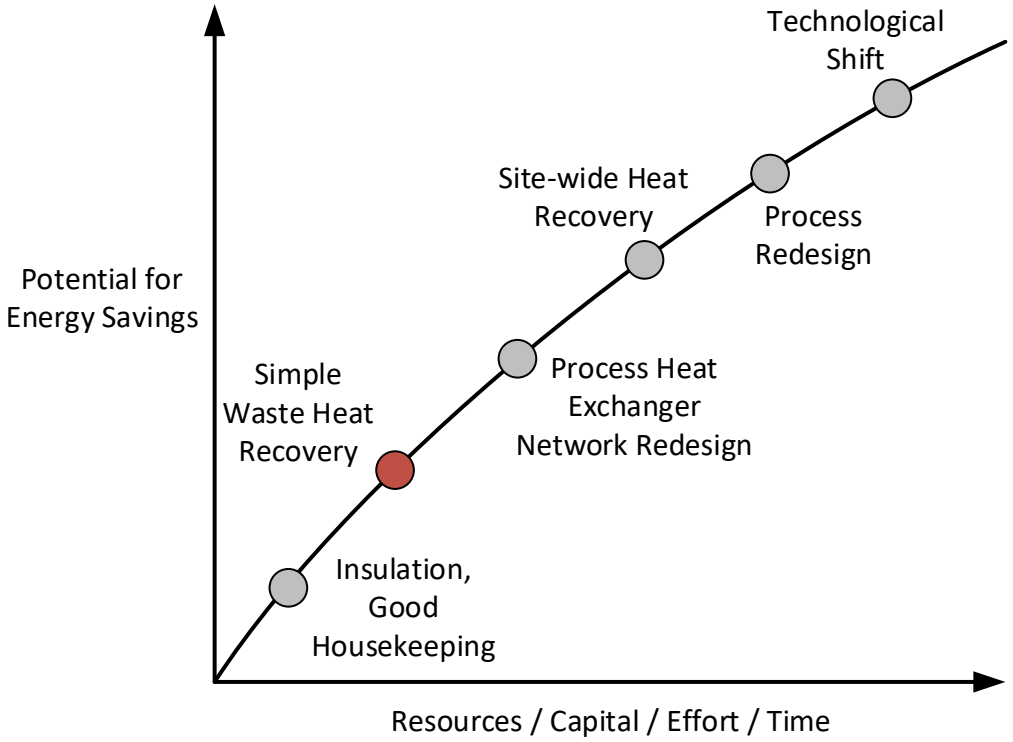
The smaller the temperature lift the better the COP

Temperature Lifts > 25°C are rarely economic

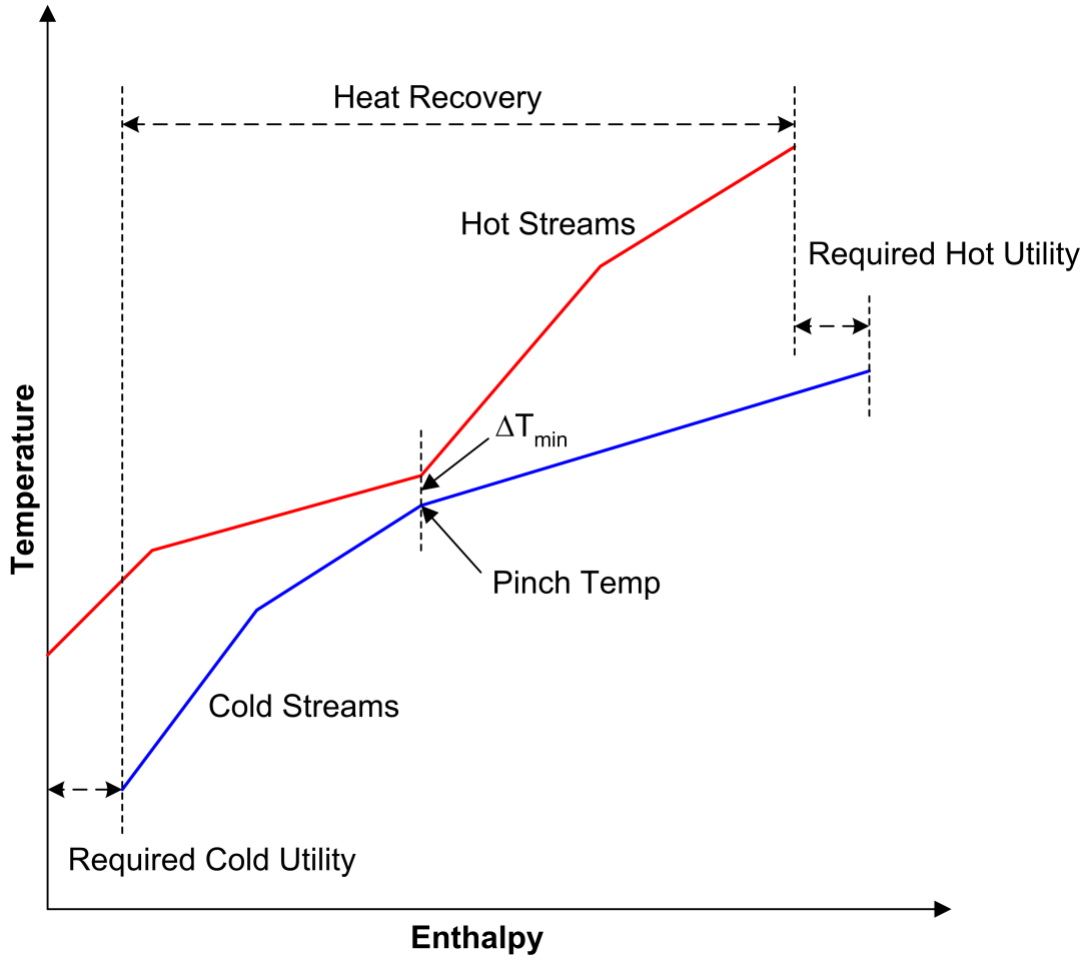


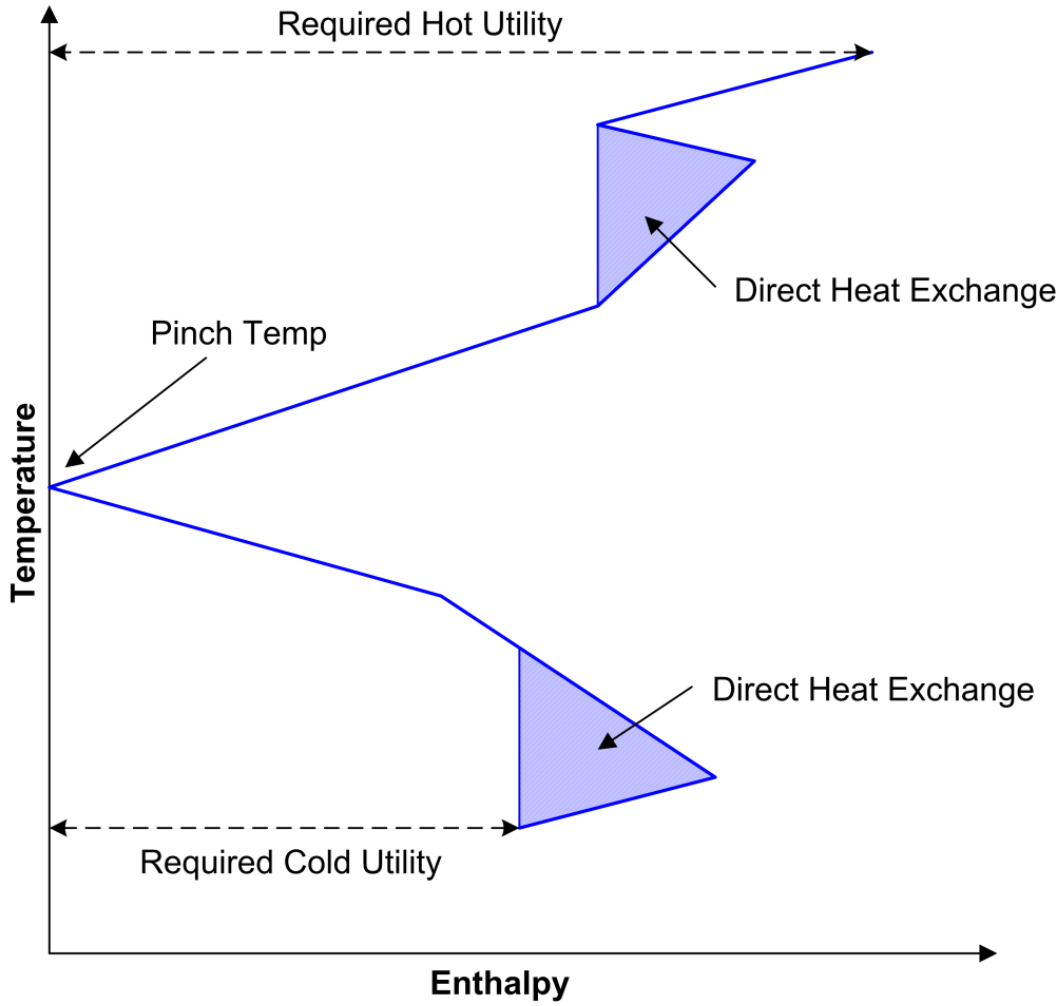
Process Efficiency Gains

- Best Available Technologies
- Better House Keeping
- Process Optimisation
- Process Integration
  - Increased Heat Recovery



Process Integration





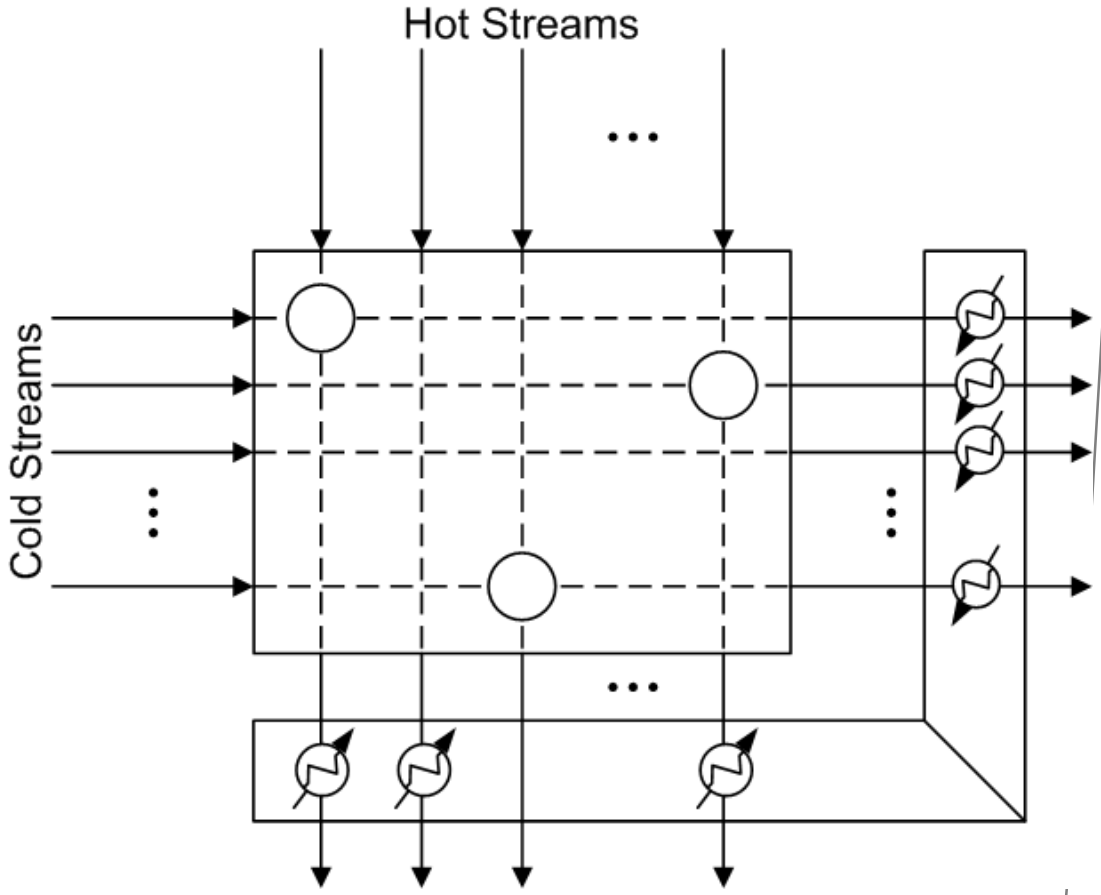
Process Integration / Heat Recovery

System/Network of Heat Exchangers

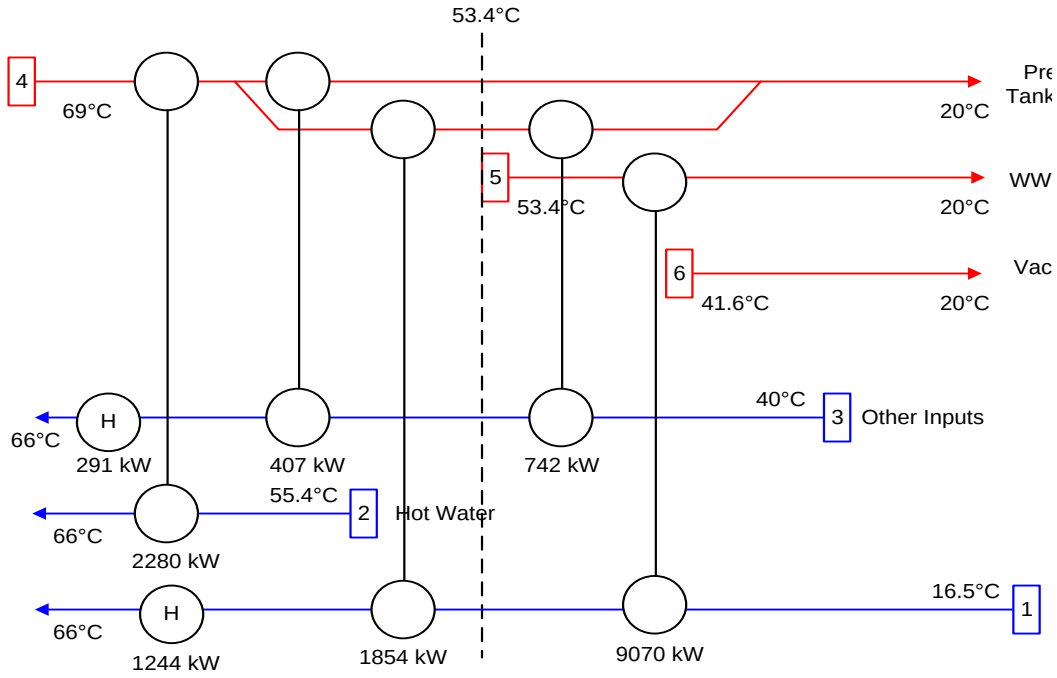
- Process to Process HX
- Heaters and Coolers (Utility HX)

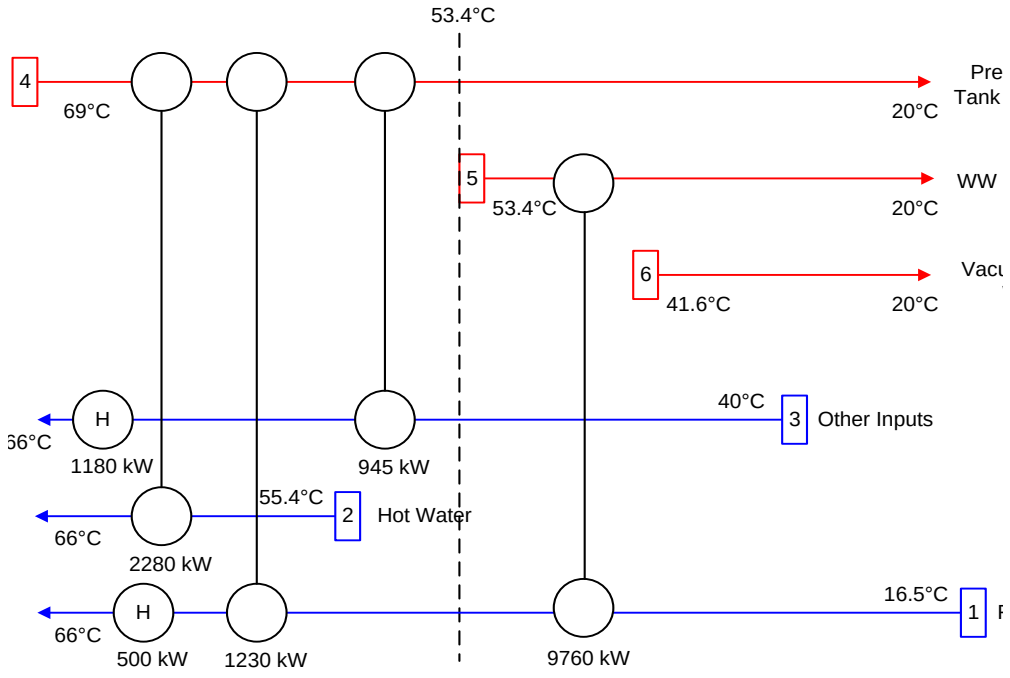
Recovers Heat from ***Process Streams***

Supplies ***Utility*** to Process Streams



Heat Exchanger Network Retrofits





Summary

- Process Heat – Important source for emissions reduction
- Different approach than other sectors
- Need to integrate solutions well to maximise benefits