AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Decarbonising process heat in the beverage industry

Tuesday 23 November 2021

Welcome

Jarrod Leak

Chief Executive Officer

jarrod.leak@a2ep.org.au

A2EP member & partner organisations

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

2XE
agl
ALFA LAVAL
ALLIANCE TO SAVE ENERGY
AMPC
AZELIO
GREATREX SINCE 1919
BLUESCOPE
Bright ENGINEERING CONSULTANTS
CLIMATE KIC AUSTRALIA
Coopers
CONTRACT RESOURCES
Dairy Australia
DENEFF
DETA CONSULTING
energetics
energylink
EECA
energy efficiency COUNCIL
Flexigen
flow power
GLACIEM
Griffith UNIVERSITY Queensland, Australia
Infrastructure Capital
UTS:ISF
Johnson Controls
LION
MARS
MAYEKAWA MYCOM
MINUS40
MONASH ENERGY INSTITUTE
MOVEMENT
ndevr environmental
Northmore Gordon
OPTIMAL
pitt&sherry
RACE for 2030
REGENERATE ENGINEERING
RMIT UNIVERSITY
Schneider Electric
SIEMENS
Simble
Simplot AUSTRALIA
smart consult
Sydney WATER
VEOLIA
VISY FOR A BETTER WORLD
Windsor Engineering
Howden
gTET

Welcome

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Tunnel Pasteurisers - optimisation and heat pump integration for RTD beverages

Kris Langley
Project Engineer

Flexigen
Experience. Innovation. Sustainability

Heat pump optimisation with thermal batteries and advanced controls

Andrew Weller
Business Development Manager

GLACIEM
COOLING TECHNOLOGIES

Welcome

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Heat pumps and craft breweries: The renewable heat brewery system

Jon Fettes
Founder, Principal Consultant

Michael Bellstedt
Managing Director

Welcome

Heat pumps and dairies

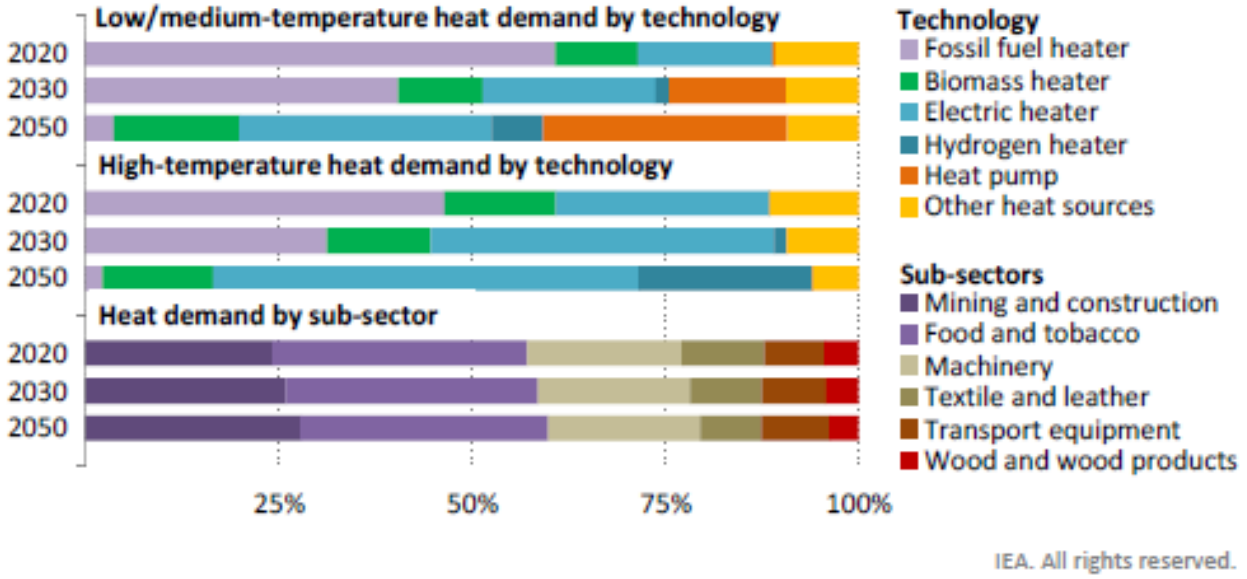
Jeff Smit
Director

DETA CONSULTING

Heat pumps – IEA's growth technology

- IEA's Net Zero by 2050 - Roadmap for the Global Energy Sector forecasts a large increase in heat pumps for low temperature (<400^{0}C) heating
- Food and especially beverage mainly have low temperature heating demands

Figure 3.20 ▷ Share of heating technology by temperature level in light industries in the NZE

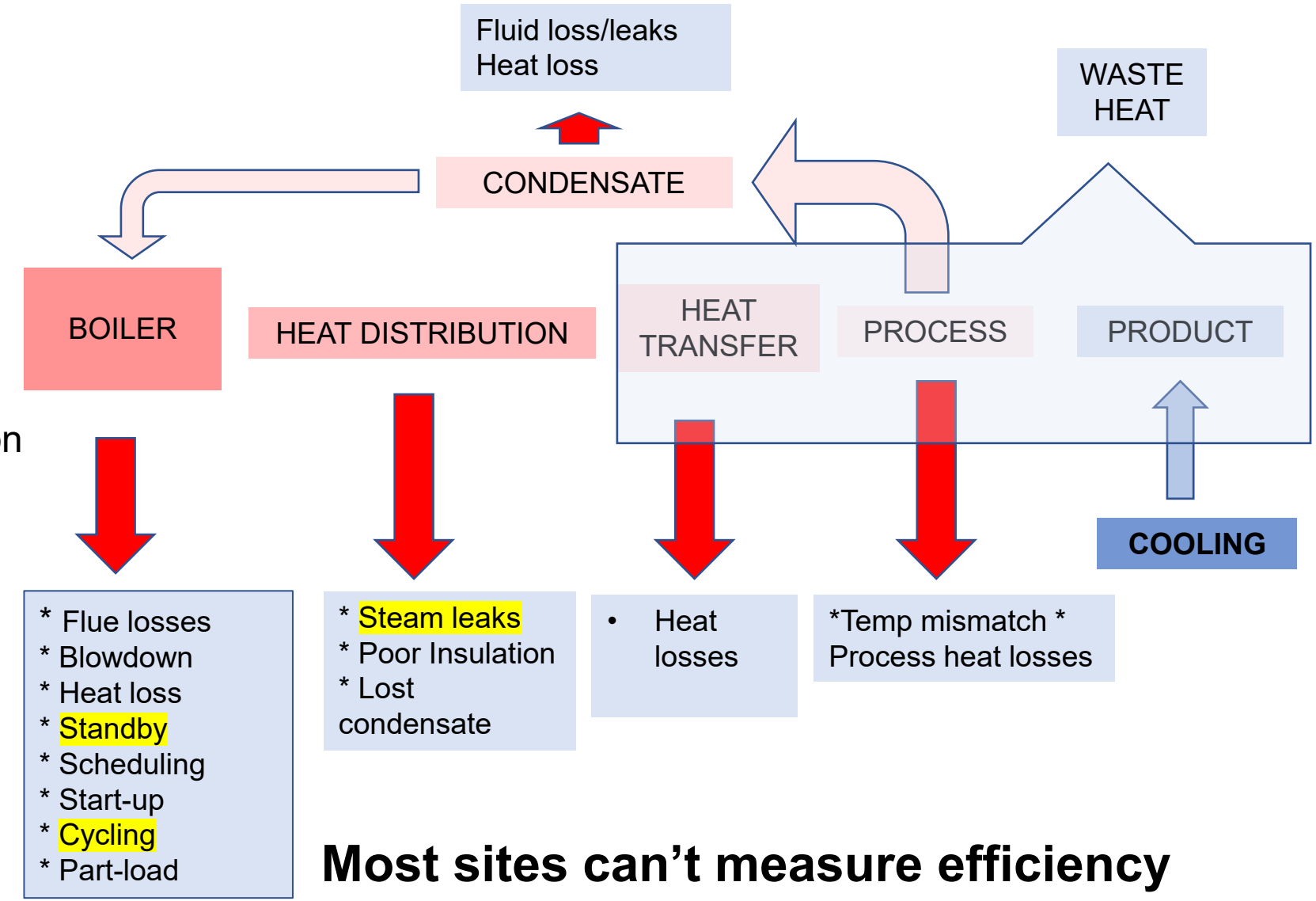


The share of electricty in satisfying heat demand for light industries rises from less than 20% today to around 40% in 2030 and about 65% in 2050

Your steam system is probably very inefficient

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Your boiler may be >80% efficient during normal operation but the steam system is likely less than 65% efficient when allowing for hidden losses



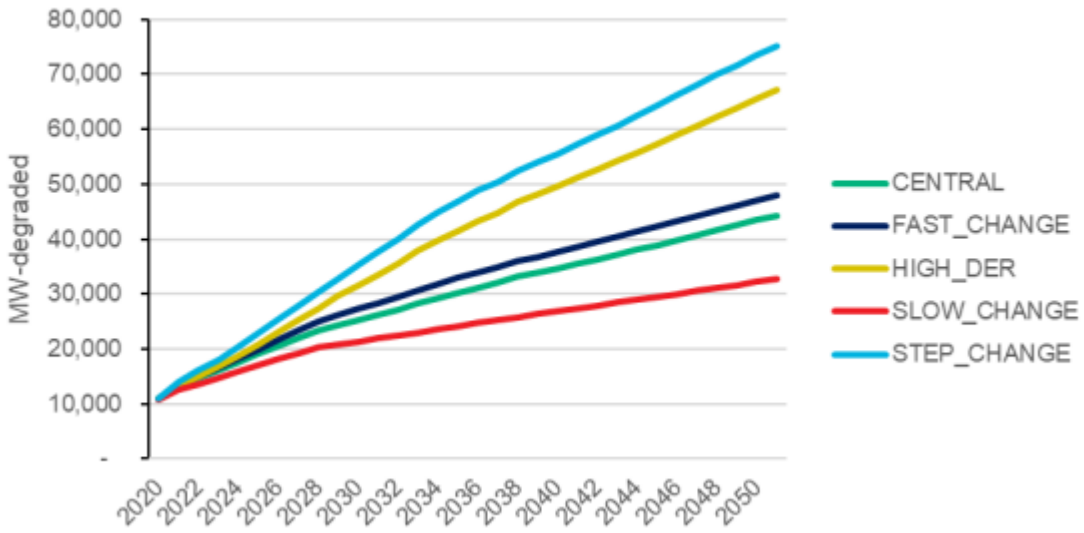
Most sites can't measure efficiency

60-90%	X	70-85%	X	80-95%	X	??%	=	<30-75%

Why consider heat pumps?

- As the electricity grid decarbonises, electrification of process heating becomes the best way to decarbonise process heating at low temperatures (<150C)
- Heat pumps have a negative carbon abatement cost, ie it saves you $
- Carbon free process heating alternatives include:
  - Biogas / biomass
  - Solar thermal
  - Geothermal
  - Hydrogen
  - Other electrical (microwave, steam boilers, etc)

Figure 1-1 National cumulative degraded megawatts of solar PV by scenario

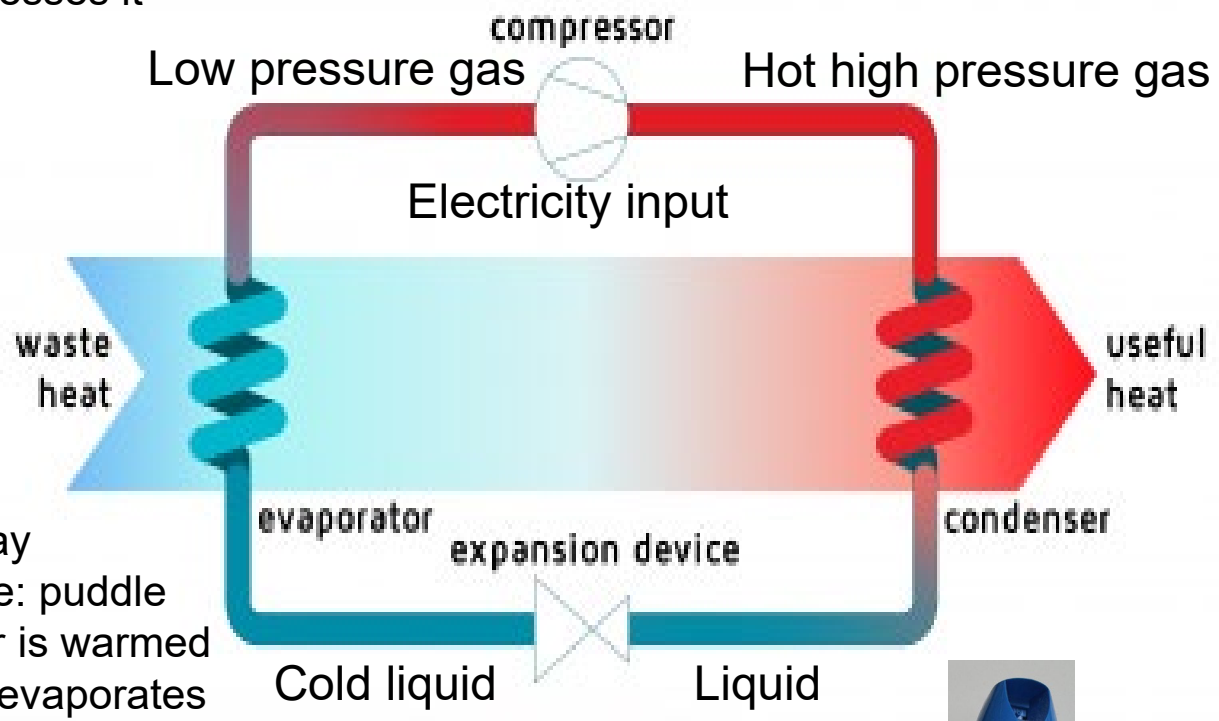


See recording of webinar on the 4th of November for other renewable heating alternatives

How does a Heat Pump Work ?
Principles and everyday examples of processes

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Everyday example: bike pump heats up air as it compresses it



Unlike resistive electric heating and fuel combustion, heat pump efficiency can be far higher than 100%!
HP can heat and cool at the same time – at even higher efficiency!

Everyday example: steam condenses to water as it cools, releasing heat

Everyday example: puddle of water is warmed up and evaporates as it absorbs heat from surroundings, sun and wind

Everyday example: liquid under pressure in spray can is released – becomes colder

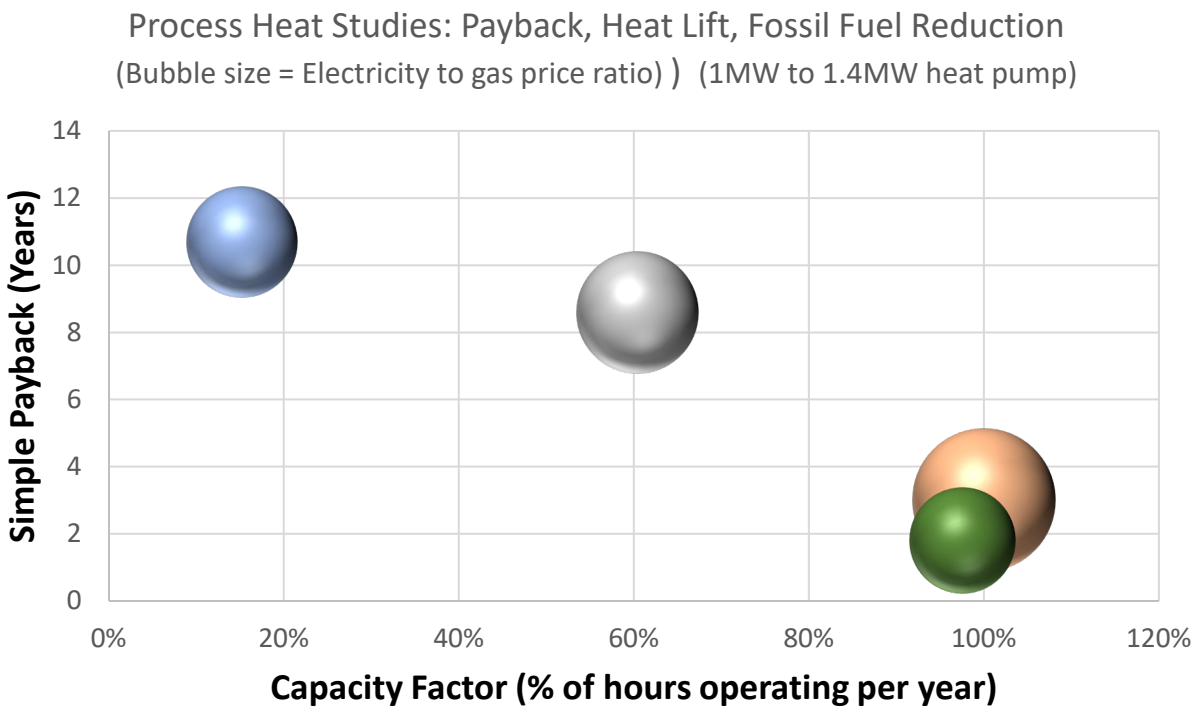
Source of graphic: De Kleijn 2017, www.industrialheatpumps.nl

A2EP Heat pump studies

- Process heat applications below 95°C
- 20 x pre-feasibility and 7 detailed feasibility studies completed between 2019 and 2021
- ARENA funding grant $900k
- Total project value $1.8M

Main findings:

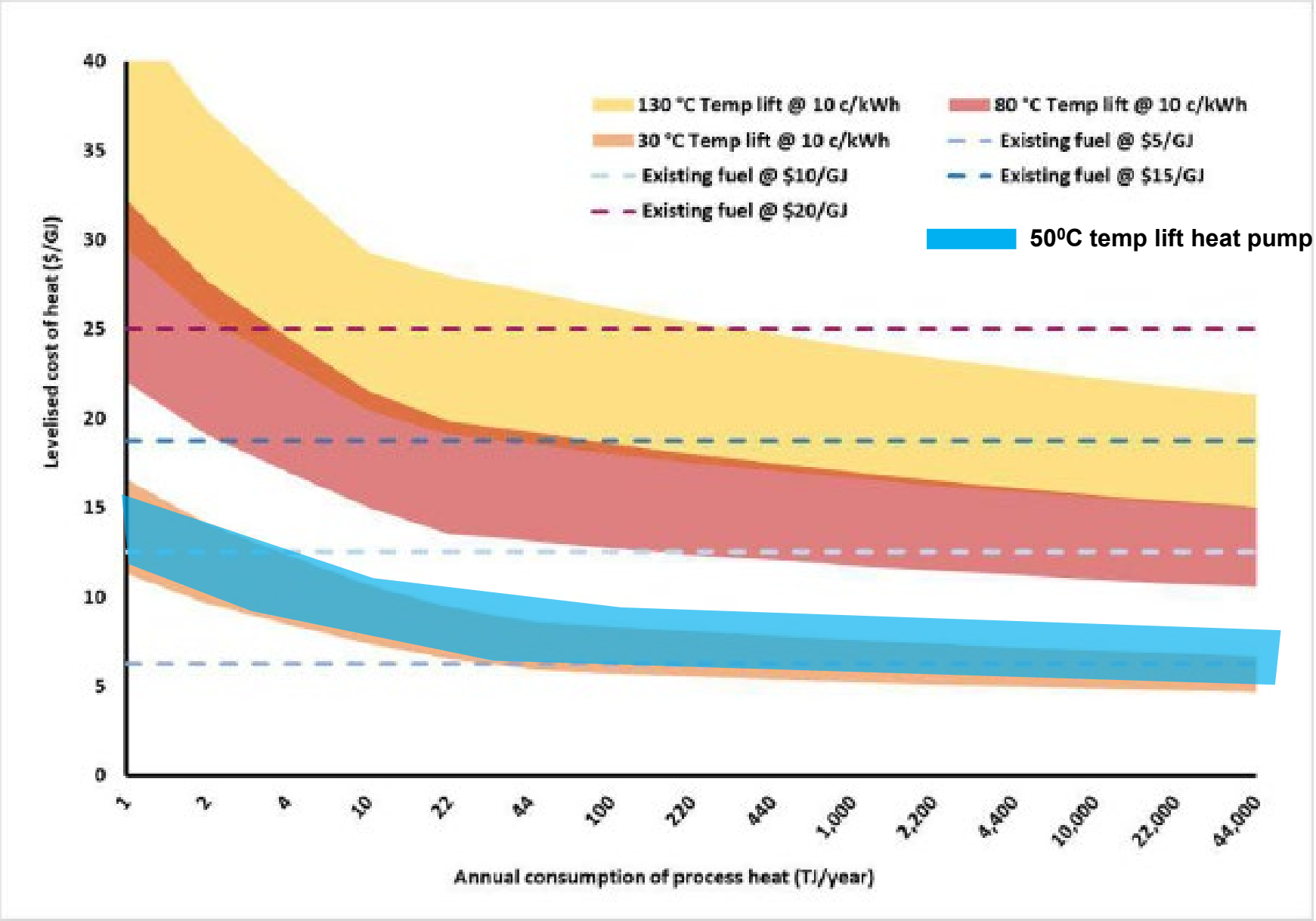
1. Heat pumps are viable and available today for heat supply up to 95C and >2MW
2. Replacing a steam boiler with a heat pump is not 'like for like'
3. It's all about minimising the peak heating demand and maximising the capacity factor (hours of operation per year), ie using a thermal battery
4. Expect your heat pump to be 40% of the nominal capacity of your steam boiler due to reduced heat losses and reduced peak capacity
5. Integrating the heat pump to utilise available waste heat is crucial – eg chiller plant
6. Electricity to gas price ratio is increasingly important as your temperature lift increases (& COP decreases)

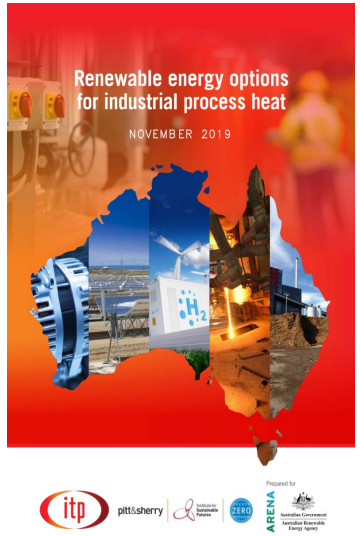


From A2EP Process Heat Phase 2 Study

Process heating costs (incl. CAPEX)

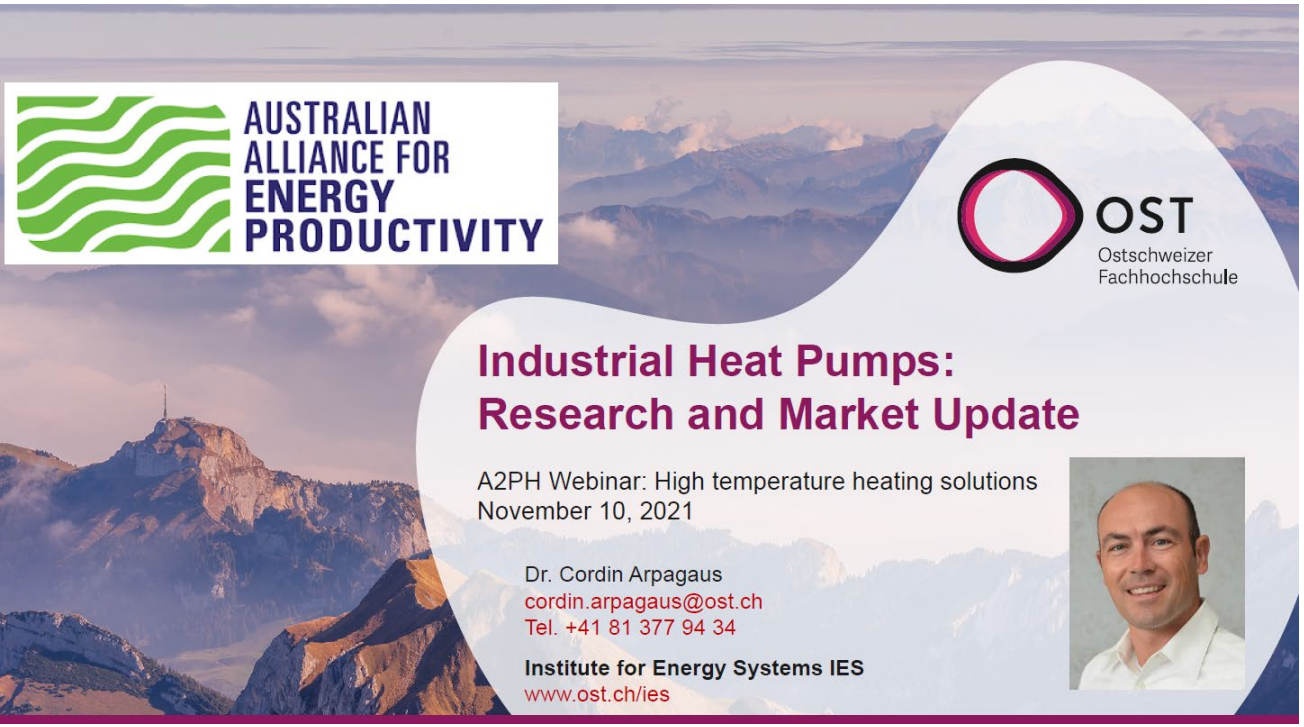
AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

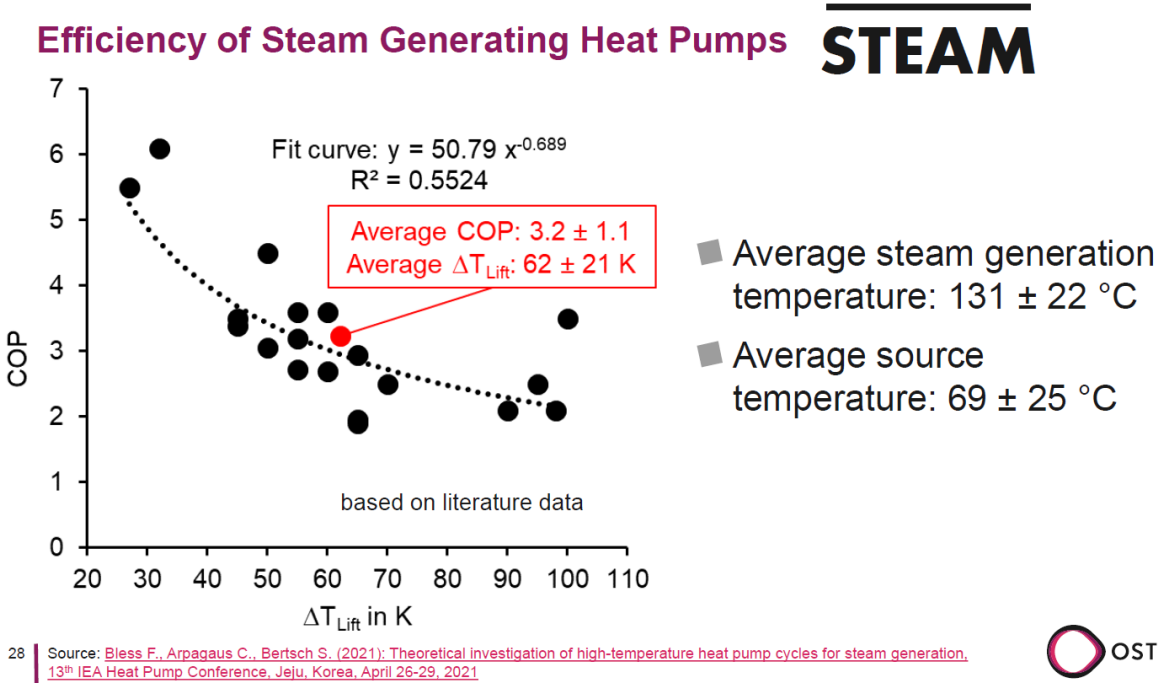




Electricity now at $0.06/kWh from renewables and forecast to go to $0.015/kWh (LETS, 2021)

Steam heat pumps are coming!





- Refer to A2EP webinar on 10th of November for more details

Heat pumps for drying @160C are coming!

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

DryF

DryFiciency: Insights in operation of high temperature heat pumps for drying

V. Wilk
AIT Austrian Institute of Technology GmbH

DryF

DryFiciency: Industrial demonstration

High temperature heat pumps up to 160ºC

Closed loop heat pump		**Open loop heat pump**
Brick drying	Starch drying	Bio sludge drying

Wienerberger AG Uttendorf (AT)	AGRANA Stärke GmbH Pischelsdorf (AT)	Scanship A/S Drammen (NO)

- Refer to A2EP webinar on 10th of November for more details

Welcome

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Tunnel Pasteurisers - optimisation and heat pump integration for RTD beverages

Kris Langley
Project Engineer

Flexigen
Experience. Innovation. Sustainability

Heat pump optimisation with thermal batteries and advanced controls

Andrew Weller
Business Development Manager

GLACIEM
COOLING TECHNOLOGIES

Tools to get started – HP performance

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Manual Inputs (Basic)

Current heating fuel cost ($/GJ)	15
Annual Process Heating Cost ($ p.a.)	50000
Process Hours of Use p.a.	
Current electricity cost ($/kWh)	0.1
Heat source	Water
Location	Melbourne
Is Load Flex/Demand Response Required (min 1MWe l	Yes
Duration of Load Flex Desired (minutes)	30

Manual Inputs (Advanced)

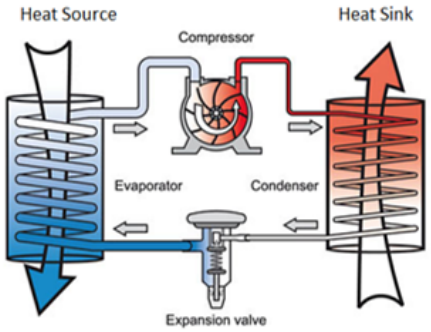
Current heating system efficiency (%)	
Other operating costs of current system ($ p.a.)	
Capital cost of current heating system ($)	
Current system rated life (yr)	
Discount rate for NPV calculation (%)	
Portion of energy use of heat pumps from solar (%)	

Image source: http://www.veoliawater2energy.com/en/references/heat-pumps/

Average heat required (kW)	500
Peak heating requirement (kW) - if known	600
Maximum hours of continuous peak heating use (hrs)	1

Heat source in temperature (C) 30

75 Heat sink out temperature (C)



Average heat sink return flow rate (L/s,

Heat source out temperature (C) 25

Is cooling usable? YES

35 Average heat sink return/in temperature (C, water only)

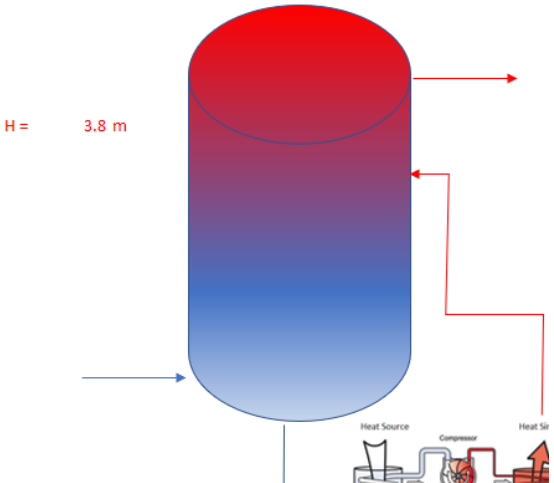
	Ammonia (R717)	CO2 (R744)
Annual heating energy use (MJ)	2,333,000	2,333,000
Max heat pump electrical demand (kVA)	132	122
Heat pump size required (kW thermal)	500	500
COP (heating)	4.0	4.3
COP (cooling)	2.8	1.0
Maximum cooling power (kW)	351	116
Capex	$576,000	$570,000
Opex (Maintenance and Energy)	$13,900	$17,900
Storage size (kWh)	525	525
Capex of Thermal Storage	$64,852	$64,852
Net Savings	$36,000	$32,000
Additional Revenue from Load Flex/Demand Response	$0	$0
Simple Payback (years)	17.8	19.8
Current LCOE of heating energy delivered ($/kWh)	#DIV/0!	#DIV/0!
Heat pump LCOE of heating energy delivered ($/kWh))	$0.03	$0.05
Required storage recharge time (hr/day)	1.1	1.1
NPV over 10 years	-$280,852	-$314,852

Thermal Battery Dimensions (Approximate)

Above ground tank - preferred if stratified heat is desired

D = 2 m

H = 3.8 m



This selection tool is available for testing. Please email a2ep@a2ep.org.au for a copy

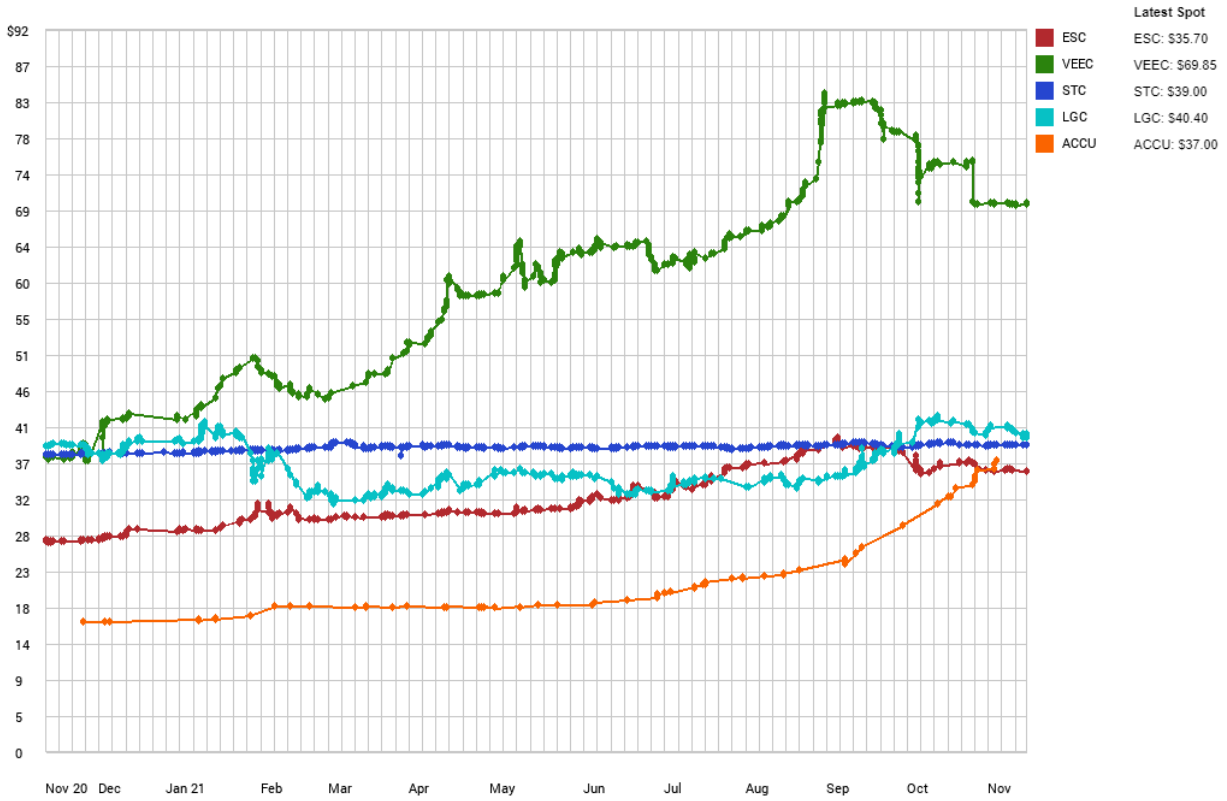
Tools to get started – screening

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

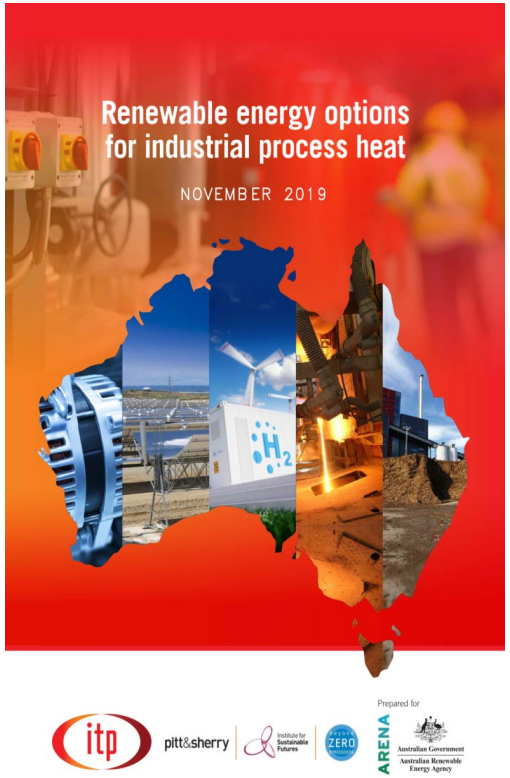
What are the current main business drivers /goals of the end-user organisation?
Does the organisation have sustainability or decarbonisation commitments?
If YES, what are they? Please answer in the text box below.
If NO, is there the intention to develop net zero or decarbonisation plans in the near future? Please answer in the text box below.
Has the site previously completed renewable energy or energy efficiency projects?
If YES, please provide a summary of the projects.
What are the site operating hours per week?
What are the site operating hours per year?
Are these operating hours expected to change within the next 3 years?
If YES, by how much?
Does the site have sufficient metering in place to determine energy flows i.e. electricity, gas, thermal?
If YES, please provide a summary of the metering in the text box below.
If NO, are you willing to invest in smart or sub-meters, potentially with 50% government funding? Please answer in the text box below.
What are the thresholds for CAPEX approval for decarbonisation projects in your organisation? (E.g. <$10k line manager sign-off, >$100k CEO approval, >$200k board approval)
What is the minimum accepted return on investment for decarbonisation projects? e.g. 4 - 6 year simple payback, internal rate of return
Is the site locked in to take or pay contracts for electricity or gas?
If using electricity for heating, what is the total electrical demand for heating?
What percentage of heating demand for the site is less than 90°C?
If significant percentage of heating demand is less than 90°C provide an overview of heating end uses and temperature ranges.
Does the site have excess solar PV production during the day?
If YES, what is the average and peak excess solar PV production during the day?
Does the site have spare electrical capacity?
If YES, what is the spare electrical capacity?
Is the site planning any production changes?
Does the site have spare space equivalent to 150% of the current boiler?
Is the spare space already covered/ enclosed?
Does the site already have a hot water storage tank?

Government support

- A typical 500kW$_{th}$ heat pump project will reduce emissions by >650 tonnes of CO_{2e} per year if using 100% renewables
- Potential to generate $250k to $400k in ‘white certificates’, but
- VEECs, ESCs, ACCU’s – all currently needing an expensive ‘measurement and verification’ process to confirm the energy reduction / carbon reduction
- A2EP is working with government to find simpler methods to allow awarding of certificates
- NSW DPIE is piloting support programs to help with heat pump assessment



Resources & support

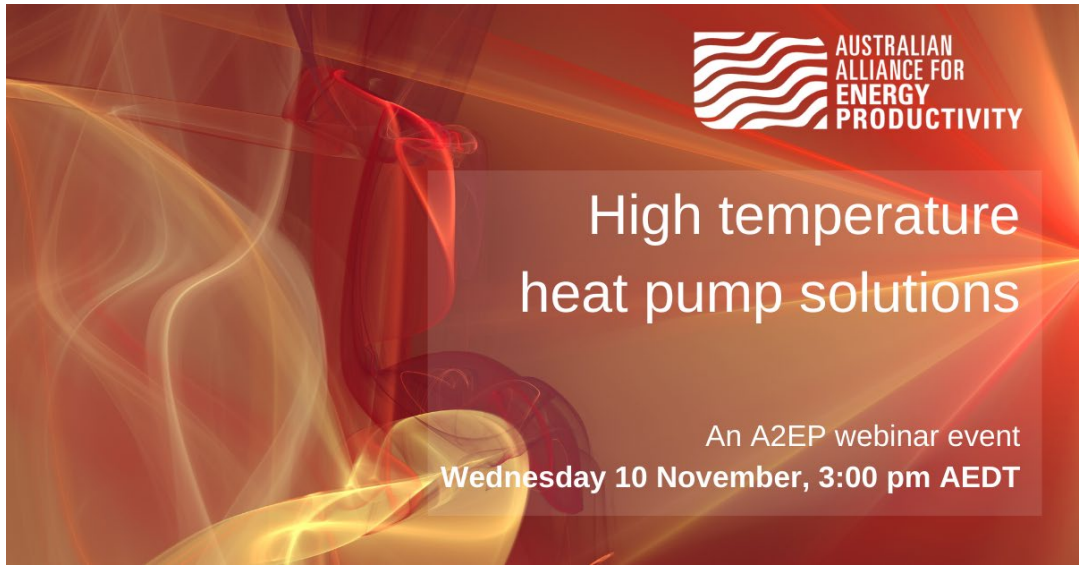


Who can help assess the options for you?

- Specialist consultants with relevant process knowledge
- A2EP
- In-house engineering departments

Recent webinars – recordings available

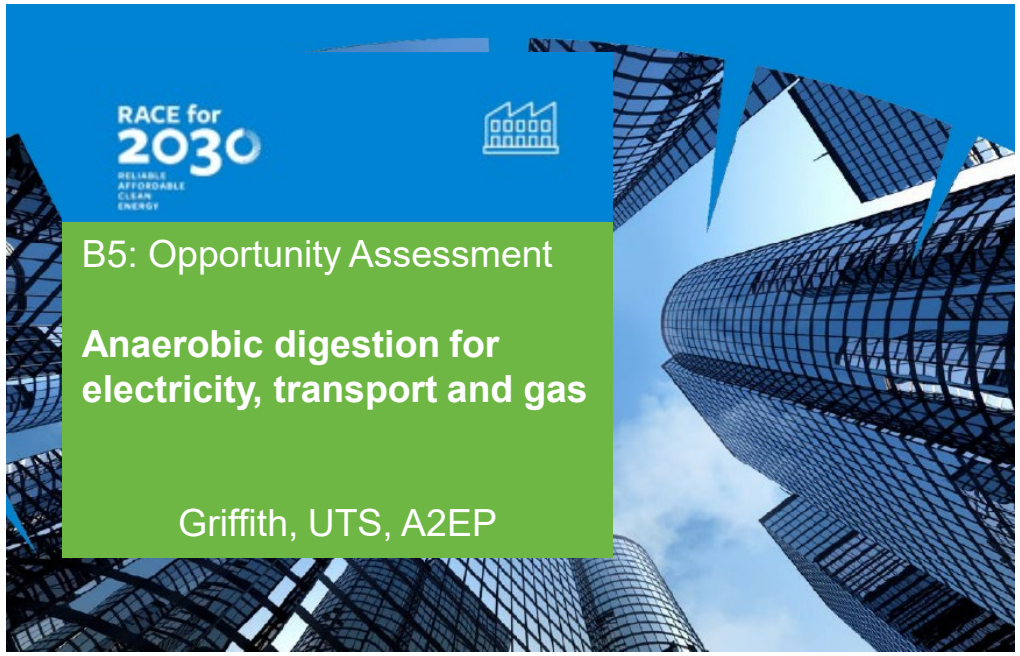
Biogas / biomass / hydrogen
Solar thermal
Gasification



Steam heat pumps
High temperature drying (up to 160C)
Mechanical vapour recompression

Upcoming webinars

Webinar
6th of December from 3:30 to 5:00 AEDT
Registration:
https://www.a2ep.org.au/events



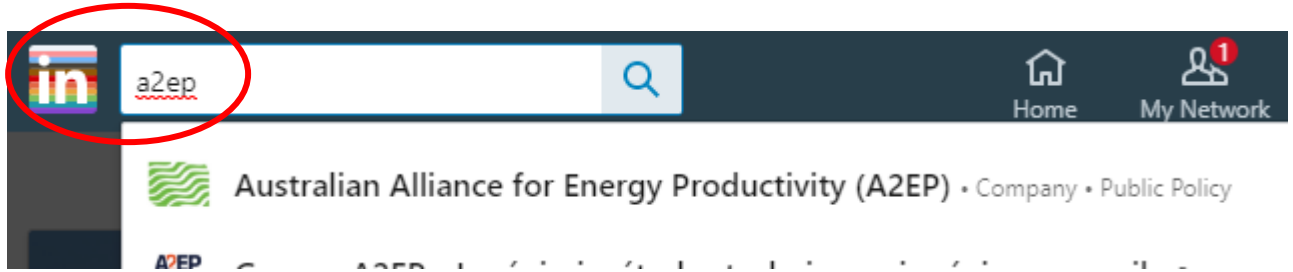
Webinar
7th of December from 3:30 to 5:00 AEDT
Registration:
https://www.a2ep.org.au/events

Want more? 3 steps to more A2EP

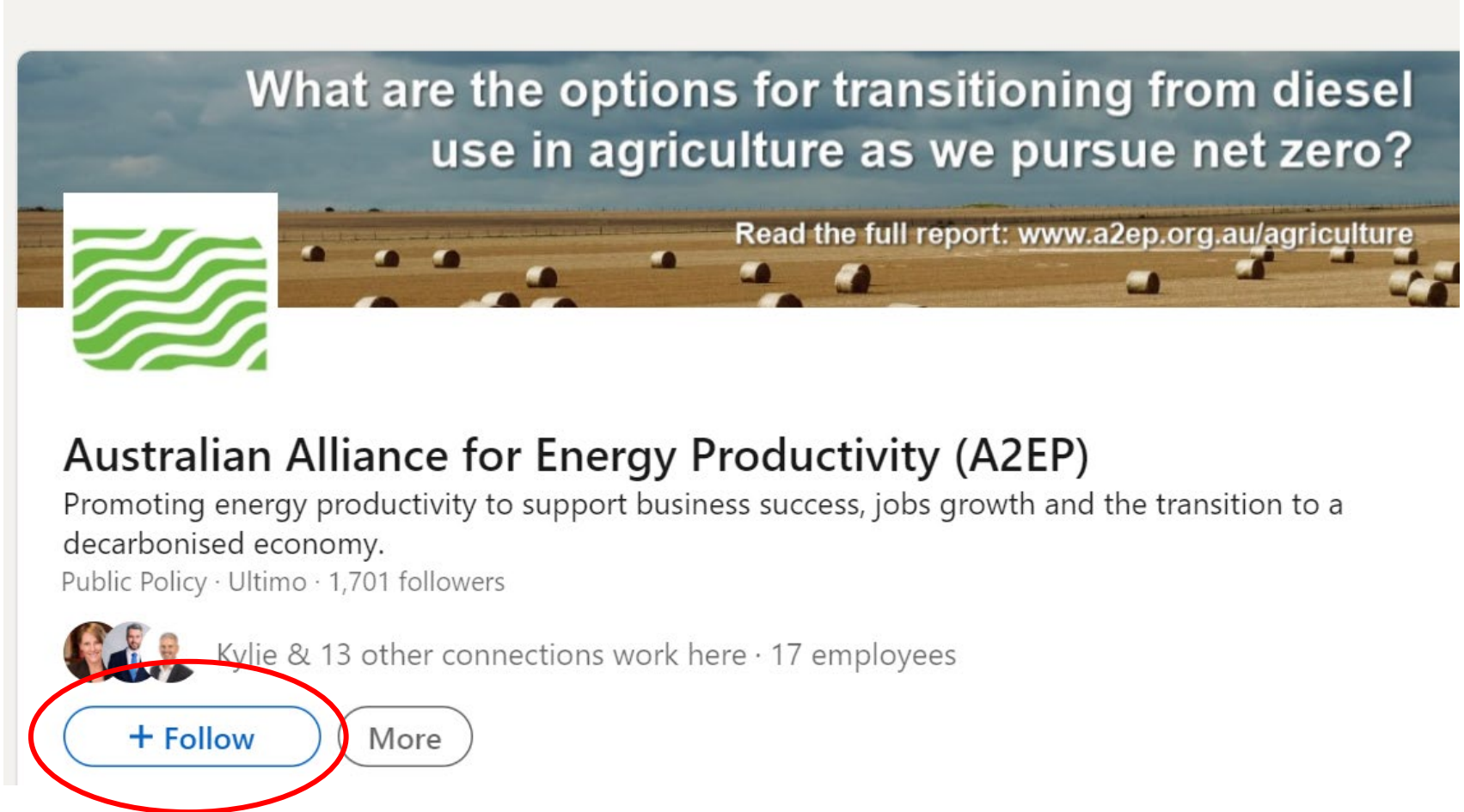
AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

1 LinkedIn

2



3



Chat from the Industry Briefing

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

A2EP: Hi Everybody, Katy from A2EP. Welcome to the A2EP Industry Briefing: Decarbonising process heating in the beverage industry. We would like to acknowledge the Traditional Custodians of country throughout Australia and their connections to land, sea and community. We pay our respect to their Elders past and present. If you would like to acknowledge the people or nation from where you are, please do so in the Chat. If you have a question about the presentation, please use the Q&A to direct these questions to the speakers.

Andrew Weller: I am on Kuarna Land in South Australia and pay my respects to the Kuarna elders, past and present and acknowledge their association with the lands on which I am working.

Andrew Weller: Glaciem's founder Julian Hudson was Engineering Manager at Bitzer for 6 years. He has green blood.

Jon Fettes: I'd like to respectfully acknowledge the Wurundjeri People of the Kulin Nation in Victoria who are the Traditional Owners of the land on which Regenerate Engineering is based and pay my respects to their Elders past, present and emerging.

Andrew Weller: Good to see you qualified the "in Melbourne" bit.

Andrew Weller: Large CO2 heat pumps tend to have parallel compressors that work at lower individual duty cycles. They last longer than large single screw compressor ammonia heat pumps.

Andrew Weller: CO2 heat pumps can provide 120 degrees hot air for some drying demands too.

Andrew Weller: Great points Jeff. The ring main concept is a great concept when executed well. It needs good controls and management so you don't spend too much energy on keeping the ringmain operating.

A2EP: Stay tuned for our upcoming events in December with Race for 2030! More details will be sent in our upcoming newsletter, sign up here: https://mailchi.mp/a2ep/a2ep-e-news-sign-up-page

Q&A from the Industry Briefing

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Q. To what extent does the heating of water to be used in the product complicate the heat pump set up? My concern would be contamination from the heat source side.

A. In the example I showed, the heat pump runs on a closed loop heating water circuit which doesn't mix with the pasteuriser water, instead using heat exchangers. You are correct- it is not recommended to pump pasteuriser water directly though heat pumps due to product and corrosion issues. Since there are two heat exchangers between the product and the refrigerant itself, the risk of contamination is reduced to existing low levels of something like a glycol plant.

Q. Are you able to give an indicative payback period for this system at a small brewery/brewpub?
Do they brew 24/7?

A. Just one shift but will go to 2 brews per day. For very small size <500kL per year, payback is quite long ~10 years but this an be better if you can use the mid temp heat.

Q. If sourcing waste heat from a refrig plant for a heat pump and then utilizing the cooling to offset some of the chilled load wouldn't that then result in less waste heat being available from the refrig plant to use and cause issues for the heat pump?

A. We are suggesting using the heat pump to provide "cooling" water e.g. 45C to the refrigeration plant for condensing loads. The refrigeration plant still fulfils the cooling demand for all low temperature processes. The heat pump uses heat that would have been otherwise wasted and sent to atmosphere to provide hot water at existing facility temperature. If future cooling loads do reduce, then there will be less heat available for the heat pump to use. The heat pump is essentially acting as a cascade compressor