AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Industry Reference Group Meeting #4

Opportunity Assessment

Theme B3: Electrification and renewables to displace fossil fuel process heating

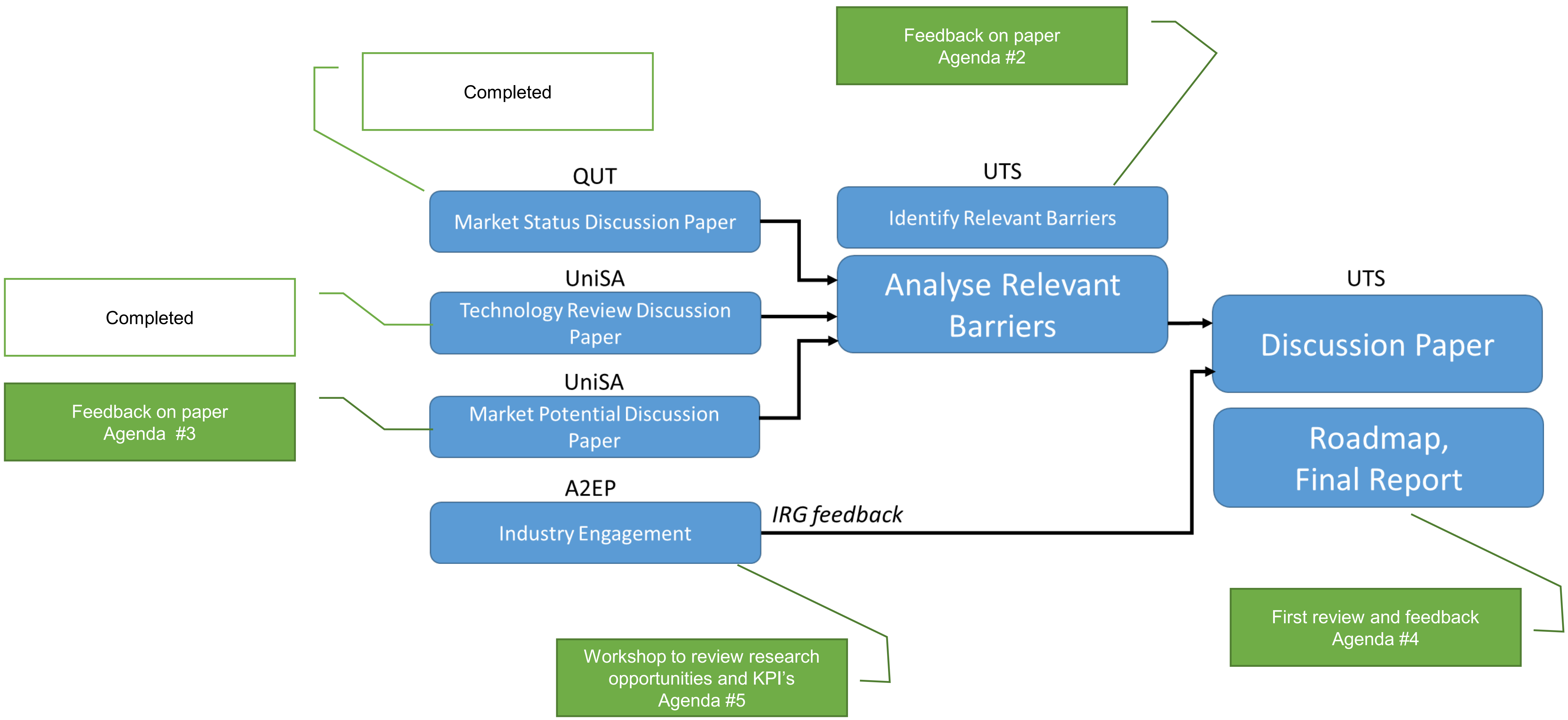
Tuesday 04 May 2021, 13:30 to 15:00 AEST

RACE for 2030 BUSINESS

Housekeeping

- This webinar is being recorded.
- The PowerPoint will be available afterward.
- We welcome participation and questions but please mute when not speaking to eliminate background noise.
- Feel free to use the comments box along the way

A brief orientation



Agenda

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

Item	Time	Lead
1. Open & Welcome	1.30pm – 1.40 pm	Jarrod Leak – A2EP
2. Presentation of the barriers work	1.40pm – 1.50 pm	Jahangir Hossain – UTS
3. Presentation of market potential work	1.50 – 2.00 pm	Dr Tim Lau - UniSA
4. Presentation of roadmap and proposed projects	2.00 – 2.15 pm	Gary Rosengarten – RMIT
5a. Feedback workshop – introduction & project overview	2.15 – 2.25 pm	Jarrod Leak and Gary Rosengarten
5b. Feedback workshop – discussion in breakout rooms	2.25 – 2.45 pm	
5c. Feedback workshop – wrap-up from each group leader	2.45 – 2.55 pm	
Wrap-up and close	2.55 – 3.00 pm	Jarrod Leak

2. Presentation of barriers

– Jahangir Hossain, UTS

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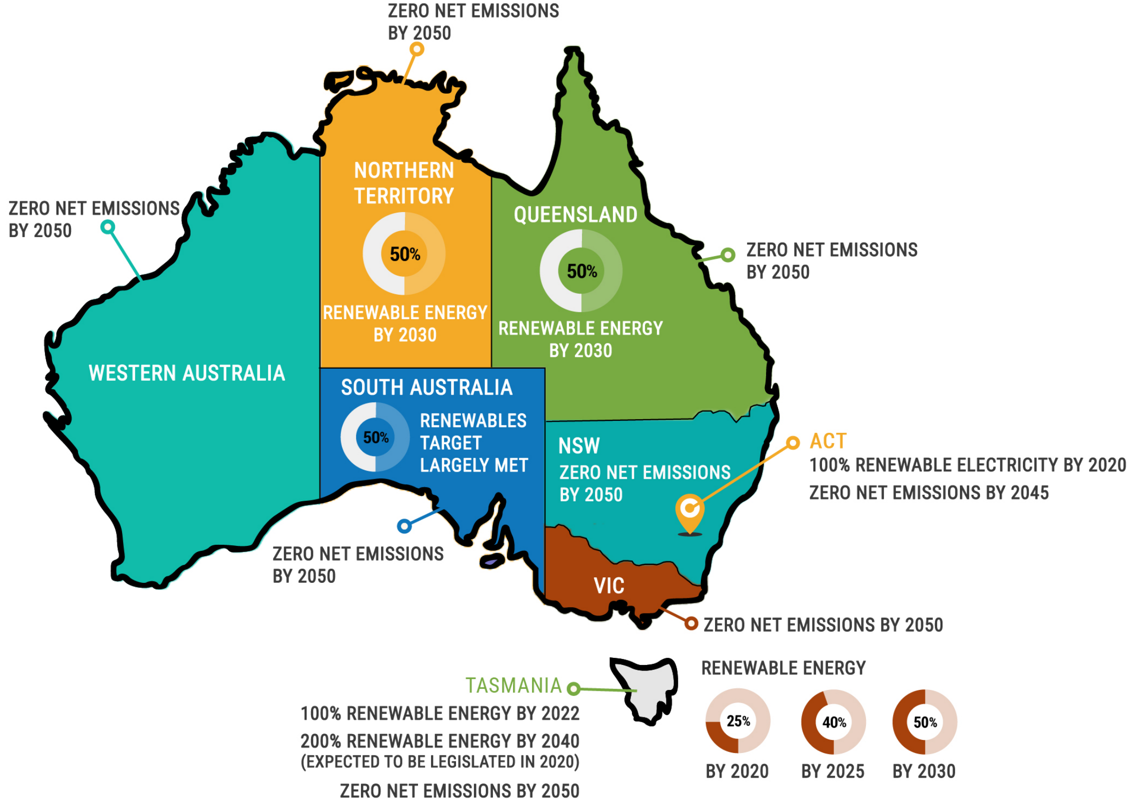
RELIABLE AFFORDABLE CLEAN ENERGY

Research Theme B3: Electrification & Renewables to Displace Fossil Fuel Process Heating

Task: Barriers

Aim and Methodology:

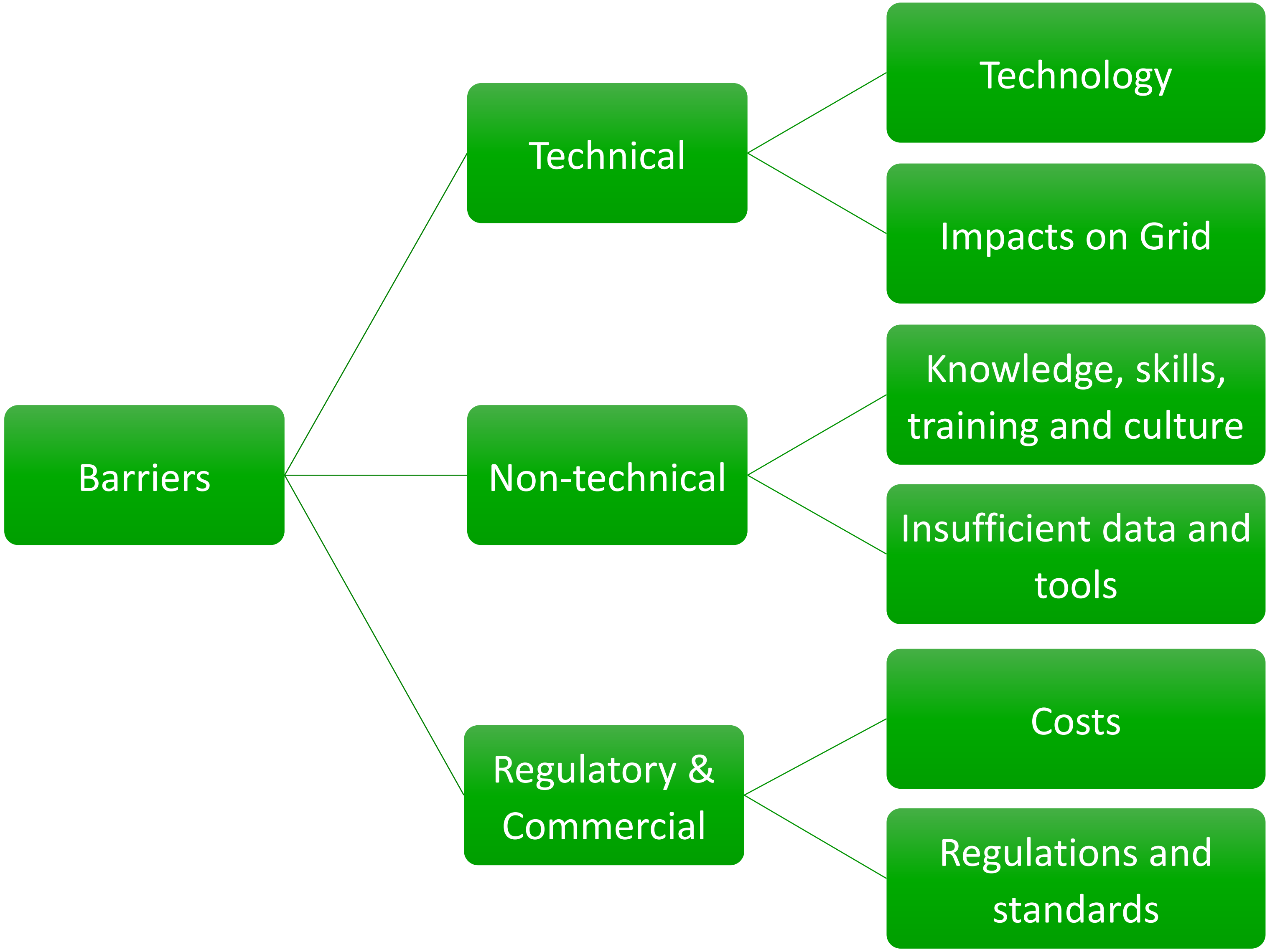
- Identify potential barriers for–
  - Renewables and electrification of process heat by 2030
  - Process heat temperature under the scope: <150 °C
  - Target sectors: Alumina and Non-ferrous Metals Industry, Food and Beverage Industry, Pulp and Paper Industry, Wood and Wood Processing Industry, Hospitals, Hotels, and Residential Aged-care Facilities.



CARBON REDUCTION AND RENEWABLE ENERGY COMMITMENTS OF STATES AND TERRITORIES

Barriers Categorisation → Barriers identification and mapping → Opportunities and Recommendations

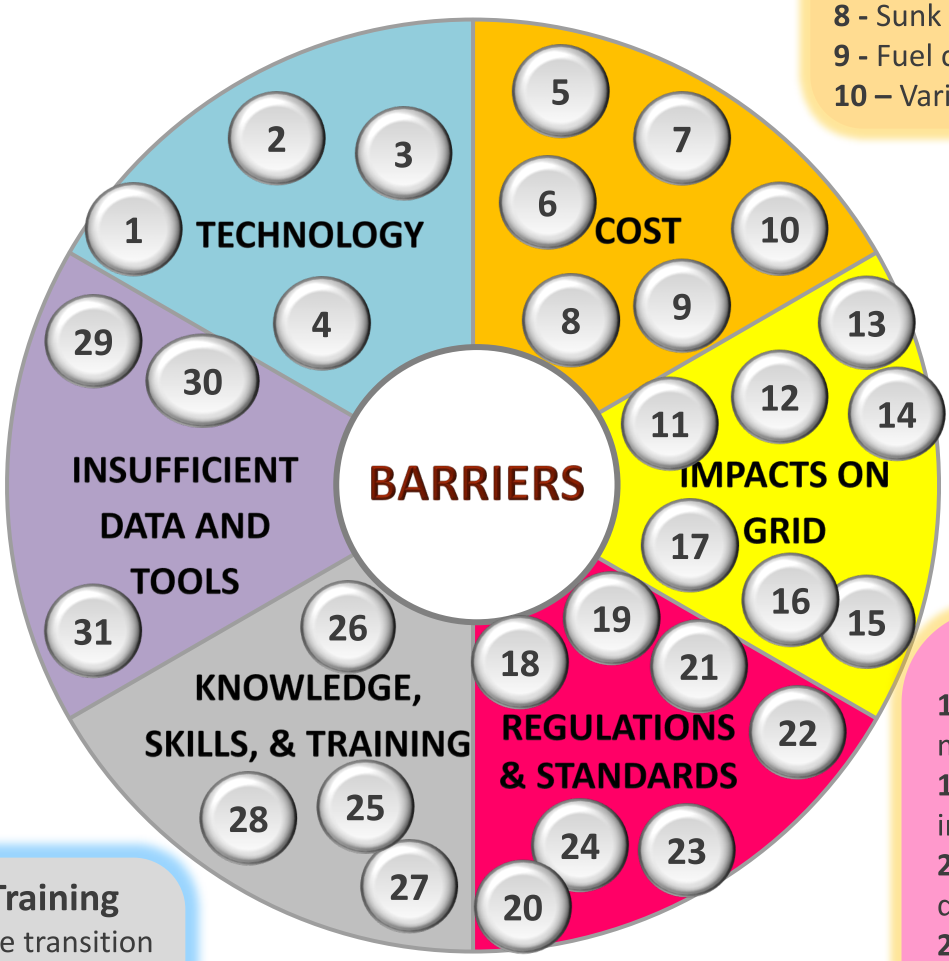
Categorisation



Barriers Map

Technology
1 - Practical process integration
2 - Availability of resources
3 - Solar thermal technology Integration
4 - Thermal storage integration

Insufficient Data and Tools
29 - Inadequate information on manufacturing & manufactured products
30 - Lack of precedents
31 - Lack of efficient and localized software and tool



Cost
5 - Upfront cost
6 - Process modification cost
7 - Return on investment
8 - Sunk cost
9 - Fuel cost
10 – Variable energy cost

Impacts on Grids
11 - Load growth
12 - Voltage instability
13 - Frequency instability
14 - Transmission congestion
15 - Reliability issues
16 – Variability and intermittency of RESs
17 - Costs and Upgrades

Regulations & Standards
18 – National electricity market & DR mechanism
19 - Connection to the grid by large industrial electricity consumers
20 - Bill structure: Higher maximum demand charges
21 - Abolished Carbon pricing mechanism
22 - MRET (no heat requirements)
23 - Standards and codes for new technologies
24 – Policy uncertainty

Knowledge, Skills & Training
25 – Knowledge needs for the transition
26 - Lack of skilled workforce
27 – Public awareness for non-fossil fuel process heat alternatives
28 – End-users with cultural risk aversion

Estimated renewables and electrification opportunities by sectors

Sector	Total fossil fuel heat (50 -150°C) use in PJ/year	Opportunity potential ST – 0 to 5 years MT – 0 to 10 years		Key renewable Technologies						Comments
				Bioenergy	Geothermal	Heat Pump	Other electric	Solar thermal	Hydrogen	
Alumina and non-ferrous metals	88	ST	5.3%			✓		✓		Low temperature potential portion is accessible in medium term if barriers overcome.
		MT	39.6%			✓		✓		
Pulp and paper industry	2.544	ST	14.3%	✓						Strong use of bioenergy already. Progress may be limited by bioenergy supply, leverage other RE technologies for lower temperature processes.
		MT	45%		✓	✓	✓	✓		
Food product processing and beverage sector	46.41	ST	18.9%	✓	✓	✓	✓	✓		Low temperatures first, all RE technologies have a role.
		MT	51.3%	✓	✓	✓	✓	✓		
Heating in Hospitals	6.466	ST	50%	✓	✓	✓	✓	✓		Low temperatures first, all RE technologies have a role.
		MT	50%	✓	✓	✓	✓	✓		
Heating in residential aged care facilities	0.51	ST	50%	✓	✓	✓	✓	✓		Low temperatures first, all RE technologies have a role.
		MT	50%	✓	✓	✓	✓	✓		
Heating in Hotels	1.12	ST	50%	✓	✓	✓	✓	✓		Low temperatures first, all RE technologies have a role.
		MT	50%	✓	✓	✓	✓	✓		

Sources: [1] ARENA, "Renewable energy options for industrial process heat", November 2019.
[2] "Market status" report.

Potential Sectors-Demand and Flexibility

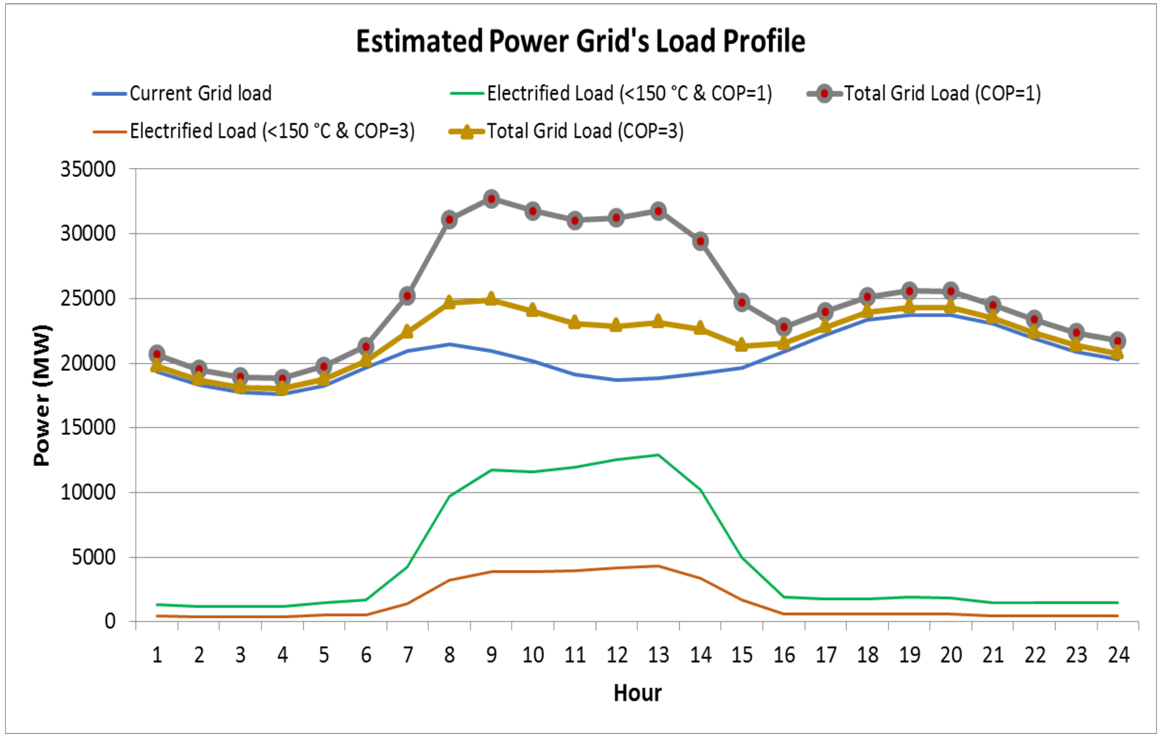


Figure 1. Estimated power grid load profile after electrification of processes <150°C.

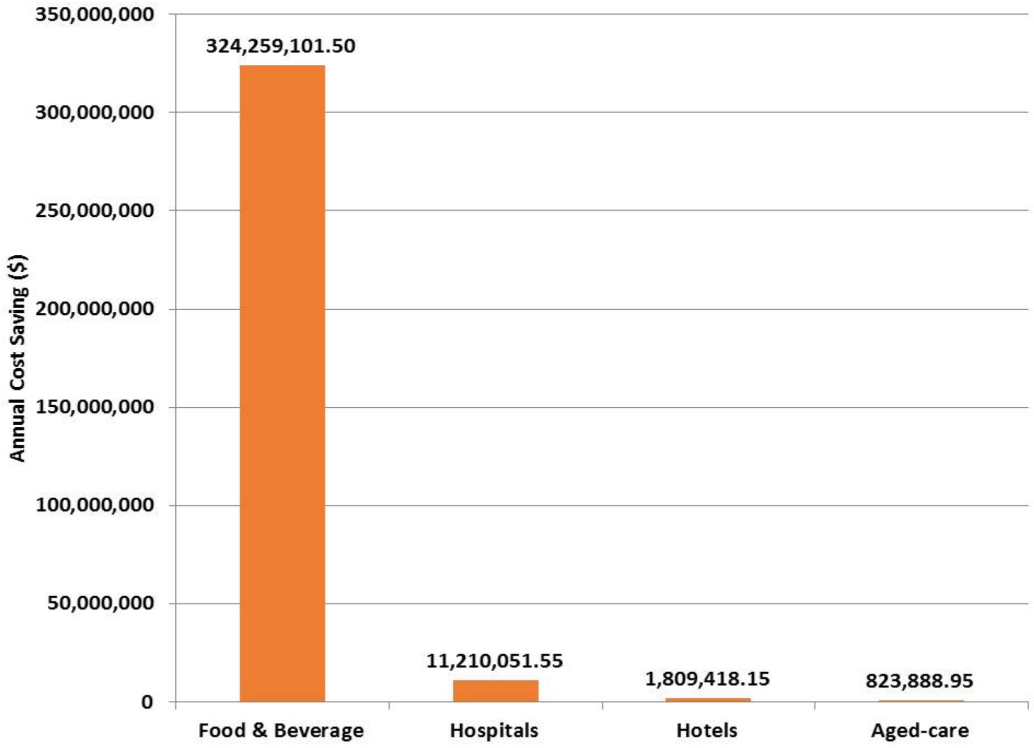
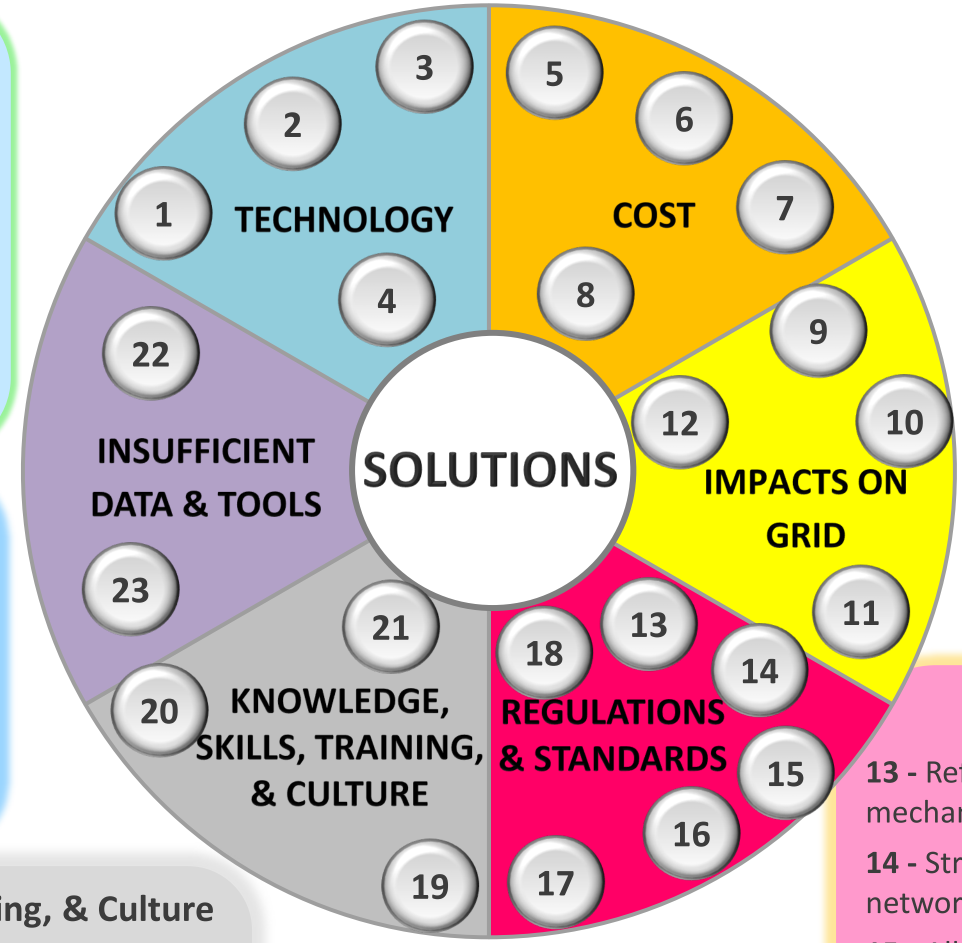


Figure 2. Annual cost saving for each sector after demand response.

Solutions/Opportunities



Technology

1 - Careful site identification for TES

2 - Absorbing the lost solar PV electricity by TES

3 - TES shortens compressors' run times and extends plant life

4 - TES can delay upgrading of transformers

Insufficient Data & Tools

22 - Regular share of data among stakeholders, advisory and manufacturers

23 - Designing customised system analysis tools for Australian industries

Knowledge, Skills, Training, & Culture

19 - Knowledge sharing in varied forms across sectors

20 - Encouraging end-users to map their energy flows

21- Dedicated industry associations for non-fossil fuel technologies

Cost

5 - Governmental Incentives & grants

6 - Governmental rebates

7 - low-interest loans

8 - Lowering electricity/gas price ratio using renewable power generation

Impacts on Grid

9 - Activating high flexibility potential of industrial loads

10 - Providing ancillary services (flexible industrial loads , heat pumps)

11 - Storing energy

12 - Postponing investments using DR & RESs

Regulations & Standards

13 - Reforming a two-sided market with DR mechanisms enabling industrial load to participate

14 - Streamlined process and enabled sub-loads network metering policies

15 - Allowing a separate metered connection (NMI) for a DER system

16 - Using market's reliability and emergency reserve trader mechanism

17 - Reintroducing a carbon pricing mechanism

18 - Updating energy efficiency standards in industries & development of standards for new technologies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3. Presentation of market potential

– Tim Lau, Uni SA

RACE for 2030 Opportunity Assessment Project

Theme B3: Electrification and Renewables to Displace Fossil Fuel Process Heating

Market Potential Summary

University of South Australia

https://www.racefor2030.com.au/

Methodology

- Identify feasible technology options for each sector
- Provide qualitative analysis on the potential for the above for each sector
  - I.e., discuss pros/cons and suitability of options to displace fossil fuels
- Simple estimation of GHG reductions for each sector
  - Business-as-usual (BaU), based on historical (~10-20 years) data for GHG emissions and industry growth where available
  - Accelerated scenario (ACL), targeting 50% reduction in GHG emissions due to process heat for 100°C-150°C by 2035
  - Show required increase in uptake rate to achieve accelerated scenario

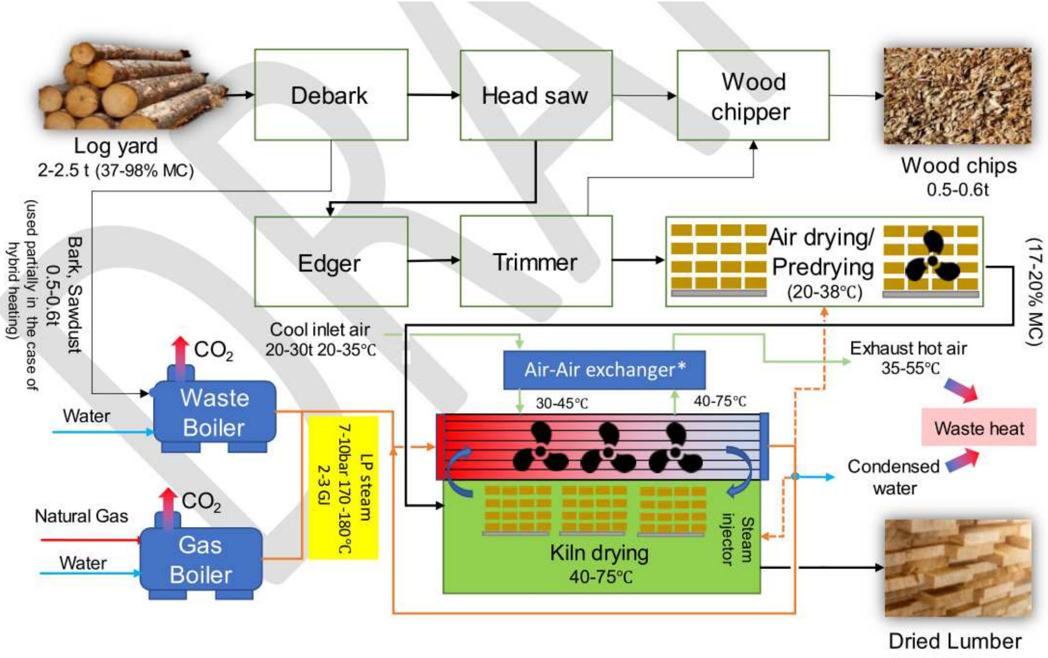
High temperature heat pump by Mayekawa

1414 Degrees' thermal energy storage system

Wood and Wood Products – Log Processing

- In log processing and drying, typically natural gas is used in a conventional boiler to produce steam
  - A waste (e.g. sawdust) boiler provides supplementary heating
  - Options include:

Technology	Benefits	Challenges
Biogas	No major changes to infrastructure	Availability & cost of biogas
Solar thermal	Low capital cost, negligible running costs. Potentially suitable for pre-drying	Intermittent source, site specific, difficult to control temperature
Solar thermal + thermal energy storage	Negligible running costs	Capital cost, site specific
Heat pump	Higher efficiency, lower energy usage, low capital cost	Electricity is not be carbon neutral. High electricity prices. Increased grid demand.

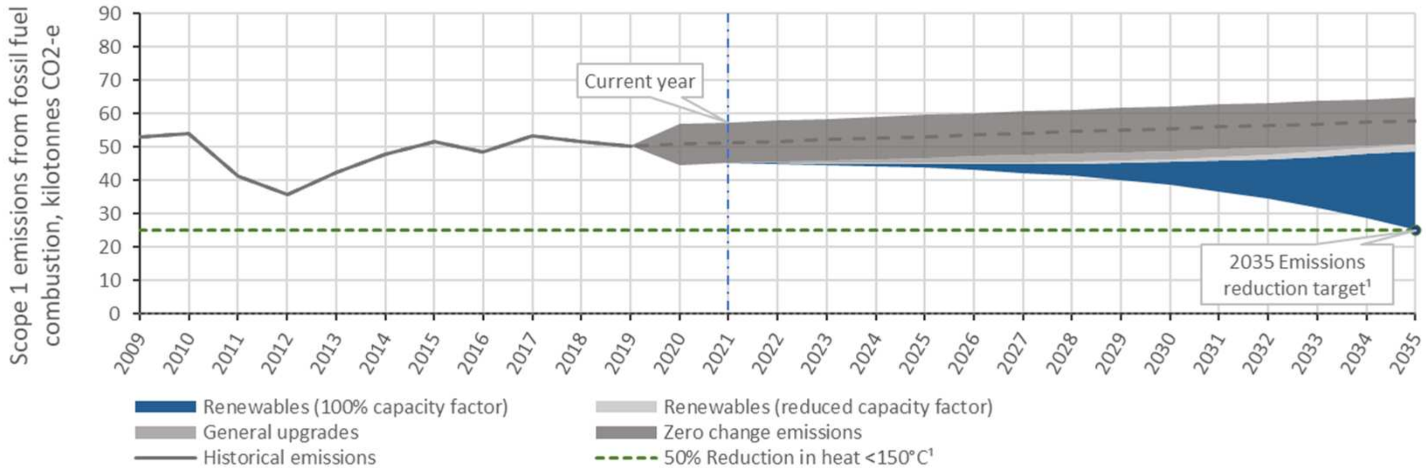


MC: Moisture content in wet basis
*: Still uncommon(temperatures are only an approximation) / the extra air is simply exhausted mostly in conventional kilns

University of South Australia

Wood and Wood Products – Log Processing

- As of 2020, the wood & wood products sector currently consumes 16.9 PJ of energy per year
  - 35% of this energy is required for wood processing and drying
  - Expected to increase at ≈ 0.93% per annum
  - Process heat from fossil fuels for wood drying <250°C, contributing 50 kilotonnes $CO_{2,eq}$ per annum
- It is estimated that in 2035:
  - Under BaU, emissions would be 44 kt $CO_{2,eq}$ per annum (reduction of 12 % relative to 2019 levels)
  - Under the ACL scenario, emissions would be 25 kt $CO_{2,eq}$ per annum (reduction of 43% relative to BaU)
- Tech uptake rate needs to be increased from ≈ 0.1% per year (BaU) to 1.2% per year over the next 5 years to meet emissions target



Feedback

- Is the current methodology appropriate/useful?
- Would we get more industry traction if reduction in energy costs were estimated?
  - If so, do you have any suggestions on the most appropriate way to predict these costs?

4. Presentation of roadmap & proposed projects

– Gary Rosengarten, RMIT

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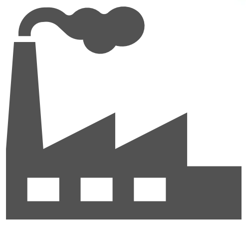
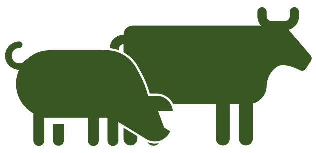
Industrial process heat decarbonisation



Manufacturing and processing

- 7,500 kt CO_{2e} – Alumina refining
- 780 kt CO_{2e} – Pulp & paper
- 58 kt CO_{2e} – Wood drying



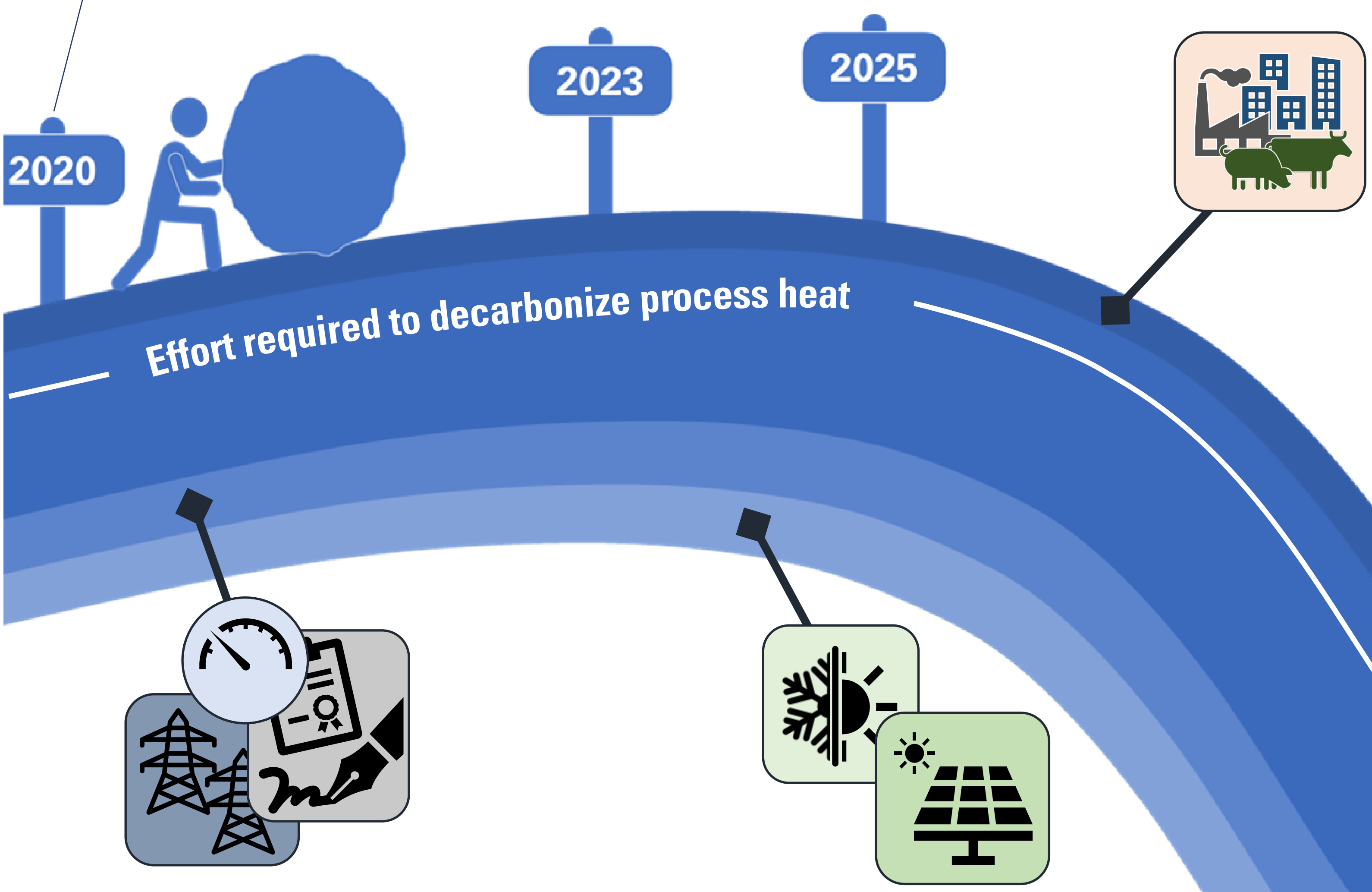
Agriculture food and beverage

- 1,405 kt CO_{2e} – Dairy
- 592 kt CO_{2e} – Meat processing
- 120 kt CO_{2e} – Beer production

Commercial and services

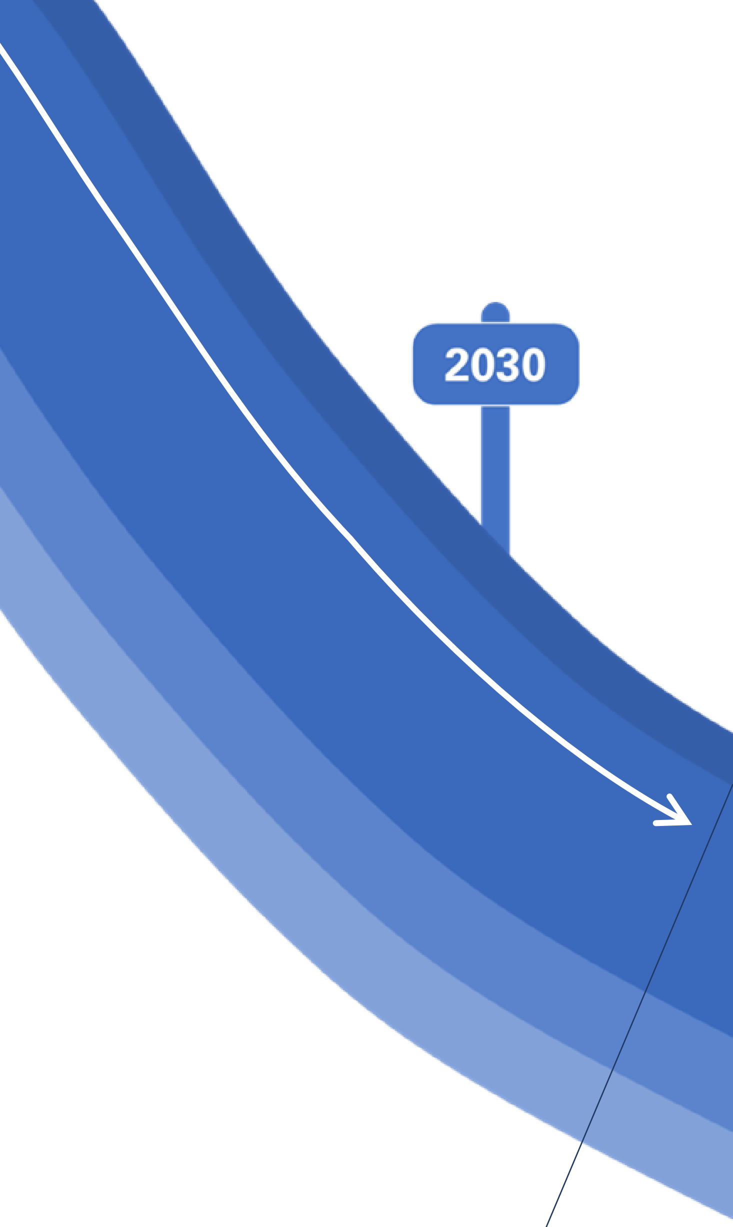
- 3,900 kt CO_{2e} – Healthcare
- 3,500 kt CO_{2e} – Hotels

2020 major consumers of process heat below 250°C. Combined emissions account for 59% of total.



Key long-term actions:

1. **Continuously collect, monitor and analyse** fossil fuel usage data to verify the impact of actions taken, and redirect future efforts as required [L1]
2. **Incentivise and support** Australia's largest industries to solve their own unique decarbonisation challenges [L2]
3. **Address the impact to the electrical grid** caused by increased electrification of process heat [L3]



Key short-term actions:

1. **Increase availability and utilisation of data** via smart gas metering and development of renewable heat source models for process design tools [S1-S2].
2. **Reform policy surrounding emissions targets** to cover process heat, remove uncertainty and provide incentive for industry to achieve these targets [S3]
3. **Increase confidence** in renewable heat technologies and **improve industry engagement** via several measures [S4-S8].
4. **Develop funding models** to support the adoption of low-zero carbon process heat technologies [S9].
5. **Address immediate technology integration challenges** through modelling and simulation, and **Improve operating performance of technologies** that are on the brink being able to meet the demands of industry [S10-S11]

Key medium-term actions:

1. **Reduce barriers to electrification** of process heat [M1].
2. **Build the knowledge and skills** required to support the transition to, and maintenance of, zero carbon process heat in industry [M2].
3. **Continue to build industry confidence** in renewable process heat technologies through targeted demonstrations and pilot plants [M3].
4. **Address supply chain issues** and **Reduce barriers** to access and utilisation of un-tapped renewable heat sources [M4-M5].

Targeting **50% reduction in emissions** from process heat below 250°C **by 2035**

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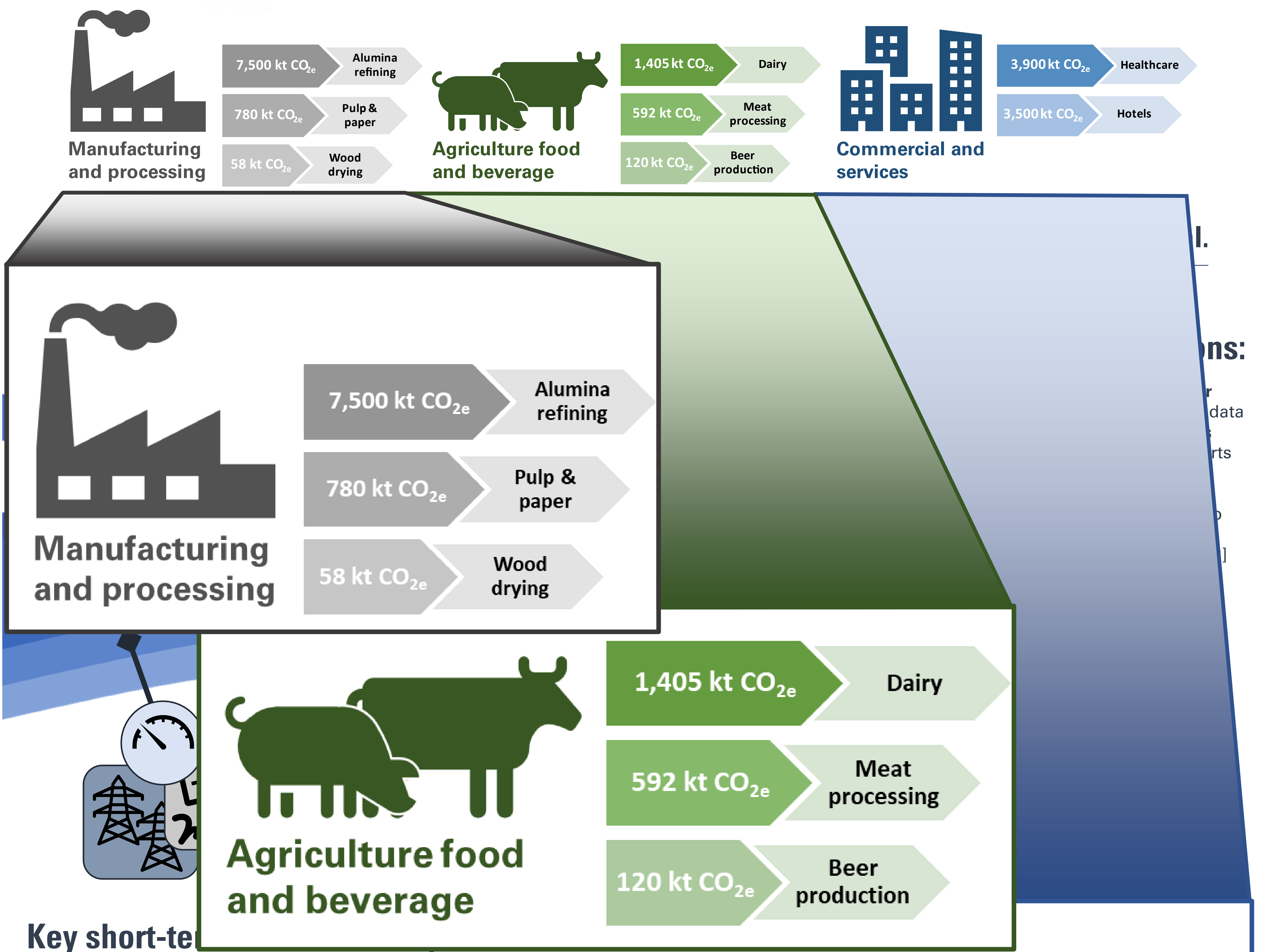
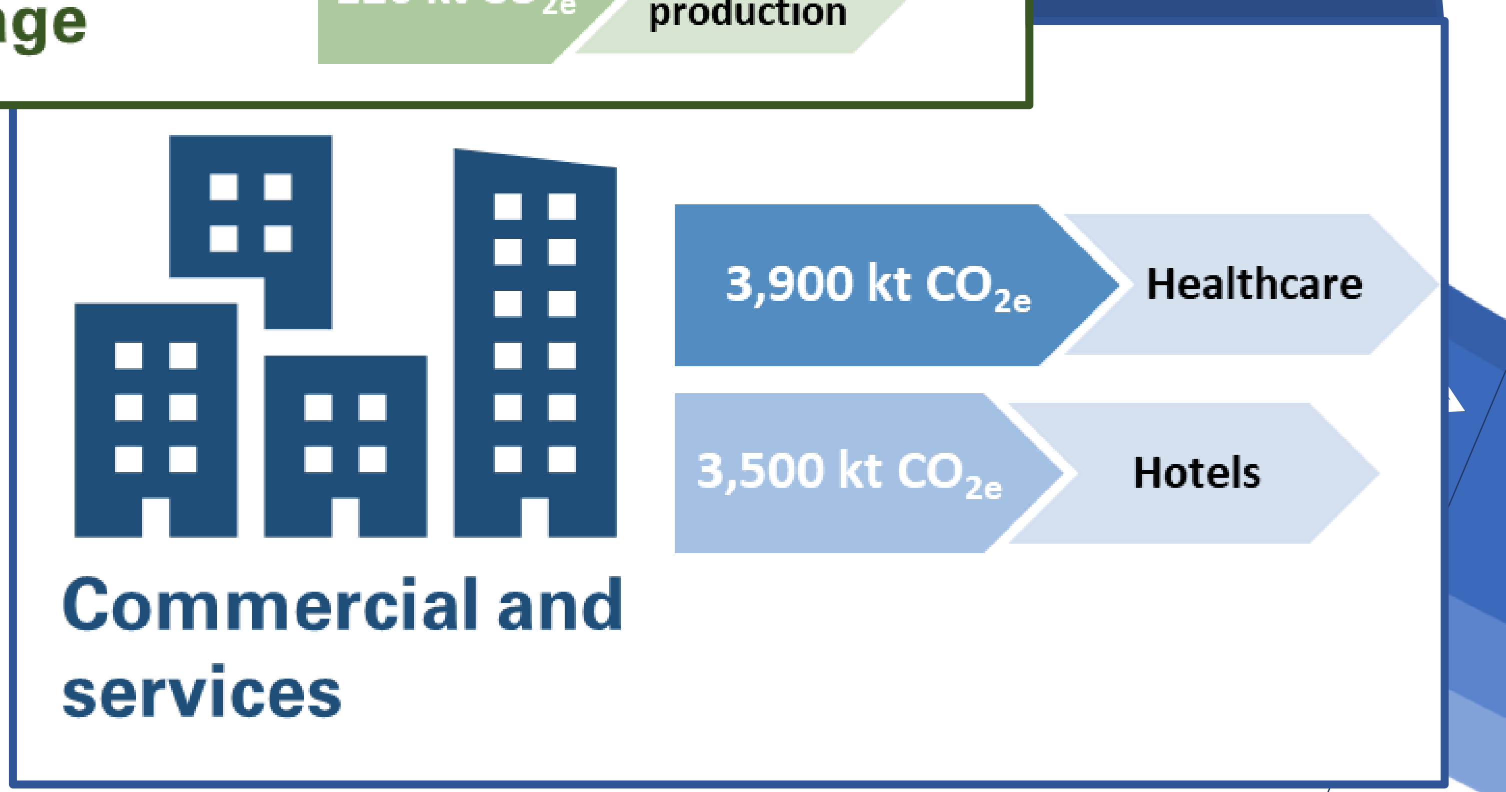
Industrial process heat decarbonisation





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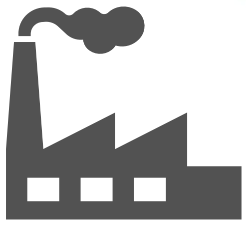
Industrial process heat decarbonisation



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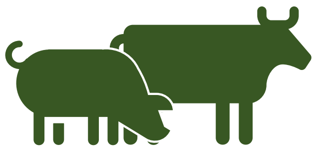

Agriculture food and beverage

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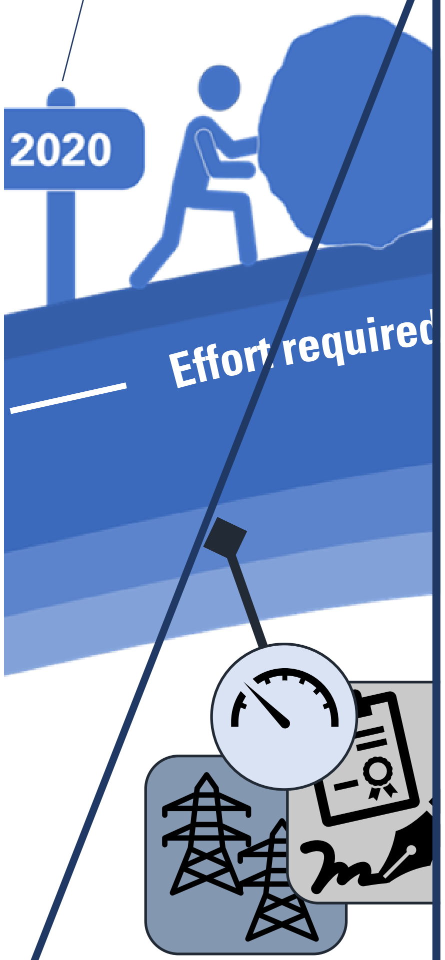

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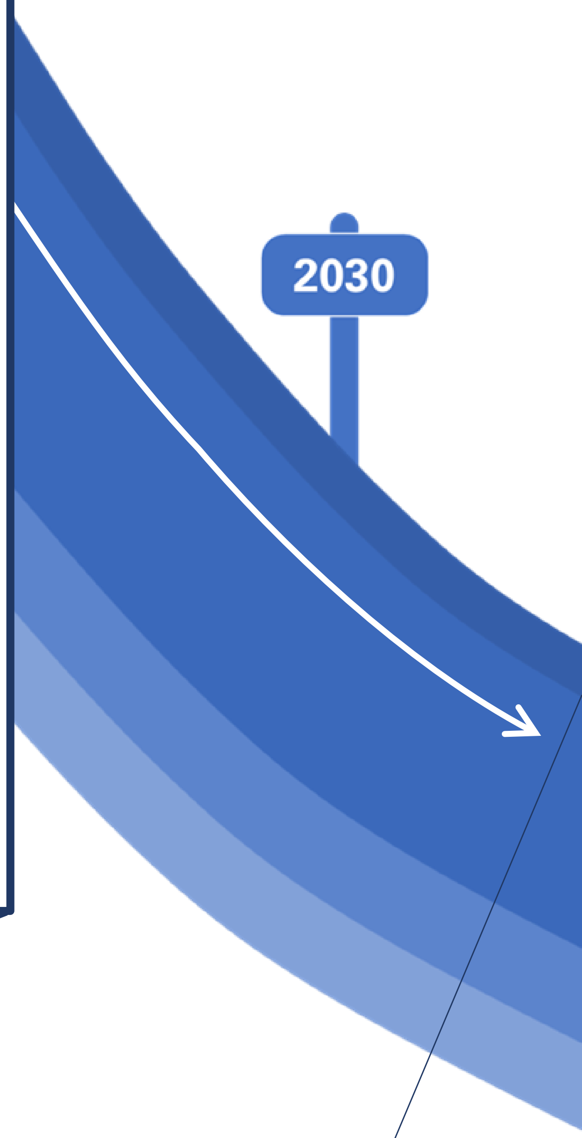

Targeting **50% reduction in emissions** from process heat below 250°C **by 2035**

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Industrial process heat decarbonisation

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2020 2023 2025 2030

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3. **Continue to build industry confidence** in renewable process heat technologies through targeted demonstrations and pilot plants [M3].
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Targeting **50% reduction in emissions** from process heat below 250°C **by 2035**

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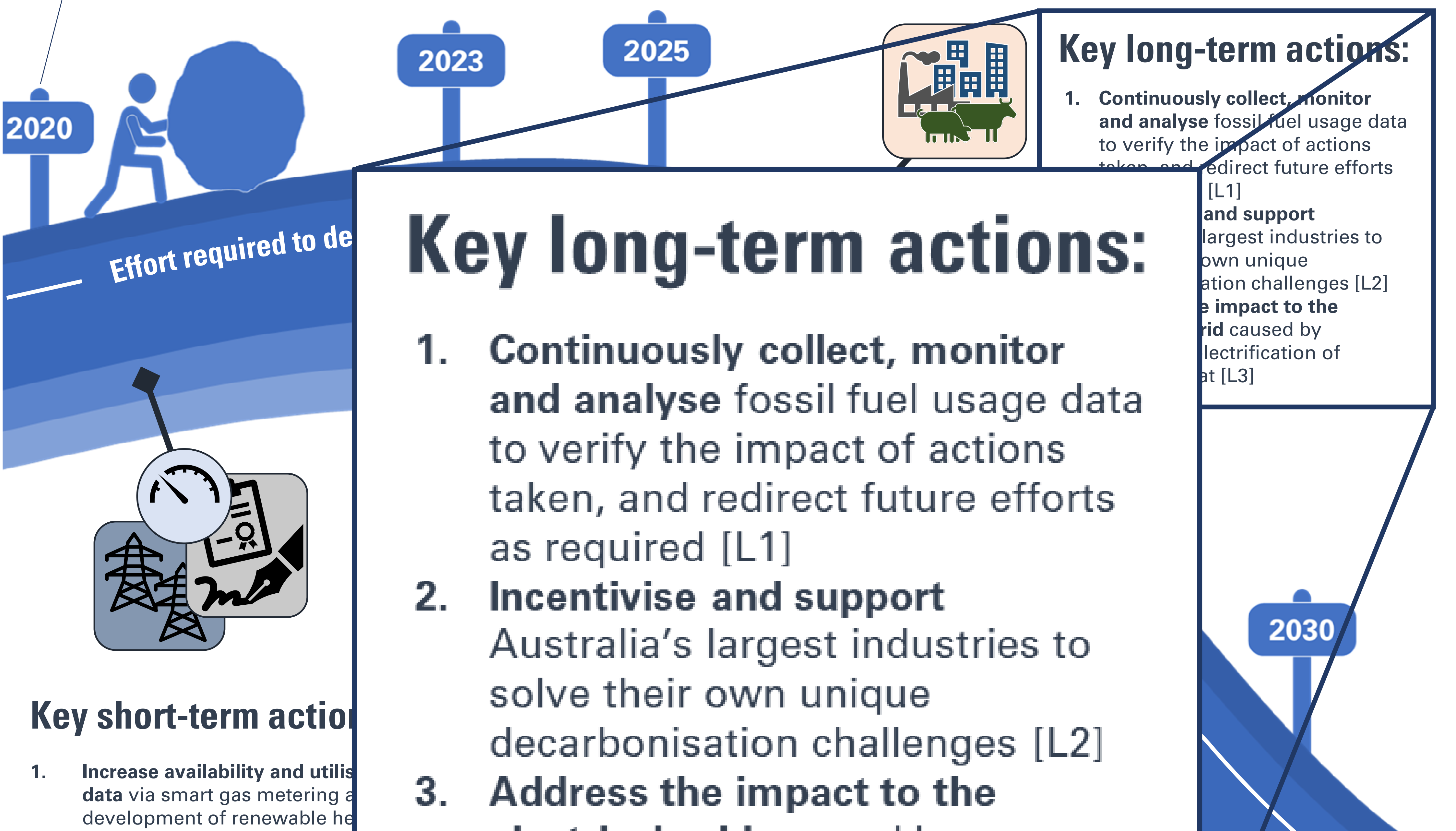

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Targeting **50% reduction in emissions** from process heat below 250°C **by 2035**

Barriers

- Technology
- Economic
- Impact on the electricity grid
- Regulations and standards
- Knowledge, skills, training and culture
- Data availability and utilisation

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Industrial process heat decarbonisation

Short, medium and long term actions needed to reach a 50% reduction in CO_{2e} emissions from industrial process heat by 2035. Research opportunities are listed based on their required year of completion and chronological dependence, while their start date will depend on the relative scale (budget, work hours needed etc.) of each opportunity. Taking these actions, especially those in the short and medium term, will build momentum, leading industry onto the path towards complete decarbonisation of process heat.

Short-term actions: Complete by 2023

Index	Barrier	Research opportunity	Research questions	Size	Impact
S1	Availability of detailed fossil fuel usage data	Potential for a combination of smart gas metering and targeted process heat energy flow analysis to provide more granular data on industry fossil fuel use for process heating and to make potential energy savings visible to end users.	1. How can smart gas meters be rolled out more extensively? 2. How could data from smart gas metering benefit; i. The end user e.g. highlight potential energy savings? ii. The electrical grid e.g. identifying potential processes for implementation of demand response mechanisms? 3. What are the specific areas of inefficiency in Australian industrial process heat?	□□■■	★★★☆
S2	Lack of renewable process heat technologies included in process simulation tools	Providing process modelling tools for accurate design and assessment of methods for economically reducing fossil fuel consumption in process heating.	1. What is the best approach for modelling and simulating the various industries for both energy efficiency improvement and renewable application analysis (e.g. commercial software, existing open source software or develop new software)? 2. Are new algorithms for renewable technologies better developed as plug-ins to existing software or integrated into existing software? i. What new/revised component-level (e.g. heat exchangers, heat pumps, thermal energy storage) information/models are required to enable accurate and reliable system-wide models? 3. What data is required for model validation, and how do we obtain this information?	□□■■	★★☆☆
S3	Policy uncertainty	Effect of clear and consistent policy regarding emissions targets on the adoption of decarbonising technologies.	1. How can state and federal policy around emissions reduction targets be improved to remove uncertainty in the future economics associated with CO_{2e} emissions, including those associated with process heat, as well as clarifying the obligations of business in meeting those targets? i. Should process heat be added to MRET?	□□■■	★★★★
S4	Lack of confidence in renewable process heat technologies	Overcoming past negative experiences with, or misconceptions about different renewable process heat technologies	1. How can the negative impact of prior failed renewable process heat programs be addressed/overcome? (e.g. heat pumps for process heat in the Victorian dairy industry) 2. How can misconceptions regarding the potential performance of renewable process heat supply technologies be addressed? 3. What guidelines and/or standards are needed for selection and implementation of these technologies?	□□□■	★★☆☆
S5	Low appetite for risk and lack of industry engagement	Quantifying the impact of investment in process heat decarbonisation for different industry sectors.	1. What is the relative cost of decarbonisation for each industry? i. Are there any industries with significantly higher leverage (i.e. low $/kg$CO_{2e}$ reduction) than the average? ii. Are there any industries that will require additional support (due to a high $/kgCO2e reduction ratio)?	□□□■	★★★☆
S6	Low appetite for risk and lack of industry engagement	Potential measures that can drive effective and tangible decarbonisation within Australian Industry by increasing industry engagement	1. How do you get industry to participate/invest? 2. How do we encourage a decarbonisation 'ecosystem'? 3. What mechanism/s can act as a 'stick'? i.e. how can a cost be attached to doing nothing? 4. What can act as a carrot? e.g. clean energy rebates, local government capex avoidance, third party thermal energy purchasing contracts etc. 5. How can learnings from other successful programs be leveraged? i. Could a rating scheme similar to NABERS be employed for process heat? 6. How can tangential environmental targets be leveraged to encourage adoption of renewable heat sources? e.g. refrigerant phase out targets	□□■■	★★★★
S7	Low appetite for risk and lack of industry engagement	Development of a database of desktop case studies (e.g. drawing on output of masters research programs) applicable to different technologies.	1. How can the benefits of different renewable process heat technologies with respect to specific sites and specific process be communicated to the people making investment decisions in those industries?	□□□■	★★☆☆
S8	Low appetite for risk and lack of industry engagement	Improving understanding around the additional commercial and environmental benefits of renewable heat technologies.	1. What are the secondary (non-energy) benefits associated with decarbonising process heating (e.g. improved process monitoring, productivity, data capture and analysis, maintenance scheduling etc.)	□□□■	★★☆☆
S9	Access to capital	Innovative funding models to support low-zero carbon process heat retrofitting	1. Who are the stakeholders that may help fund initial investment or pilot projects? 2. What are the domestic and international experiences? 3. Are there any low-risk innovative options to fund projects?	□□□■	★★☆☆
S10	Technology integration	Targeted modelling and analysis of the different renewable process heat technologies identified in this opportunity assessment applied to the respective industrial processes.	1. What are the best ways to reduce the energy consumption in the current processing technologies (finding the best techniques for energy efficiency improvement)? 2. What are the best renewable options to integrate into these industries?	□□■■	★★★☆
S11	Technology integration	Addressing the limitations of operating temperature for heat pumps technologies	1. What are the factors limiting the development of high temperature heat pumps? e.g. is oil the limiting factor? 2. What are the added benefits of utilising new-generation heat transfer fluids, e.g. supercritical CO2? 3. How can we best harness available waste heat (specific focus on recovering heat from humid air)?	□□■■	★★☆☆

Barriers

- Technology
- Economic
- Impact on the electricity grid
- Regulations and standards
- Knowledge, skills, training and culture
- Data availability and utilisation

RACE for 2030

Industrial process heat decarbonisation

Short, medium and long term actions needed to reach a 50% reduction in CO_{2e} emissions from industrial process heat by 2035. Research opportunities are listed based on their required year of completion and chronological dependence, while their start date will depend on the relative scale (budget, work hours needed etc.) of each opportunity. Taking these actions, especially those in the short and medium term, will build momentum, leading industry onto the path towards complete decarbonisation of process heat.

	Index	Barrier	Research opportunity	Research questions	Scale	Impact
Medium-term actions: Complete by 2025	M1	Grid connection challenges for large electricity consumers and distributed energy resources (DERs)	Potential of electrical grid connection policy and regulation reform to support decarbonisation of industrial process heat and improve the ability of the grid to adapt to the changing nature of both power generation and demand.	1. How can the current non-standard 'negotiated services' model required when connecting to the grid or upgrading to a relatively larger load be streamlined? 2. How can metering of sub-loads be practically implemented at minimal cost? i. Could this allow for better engagement with demand response mechanisms?		★★☆☆
	M2	Availability of required expertise within the broader workforce	Capacity for skills and knowledge sharing/symbiosis between industries to support the transition to zero carbon process heat	1. What existing industries have the skills/expertise required to support different renewable process heat technologies? E.g. refrigeration industry and heat pumps. 2. How can this expertise be extended to those industries that will become end users of these technologies?		☆☆☆☆
	M3	Lack of confidence in renewable process heat technologies	Targeted pilot demonstrations, building on the work in this opportunity assesment and subsequent in depth modelling and analysis, to kickstart market adoption of renewable process heat technologies.	1. Which industries will benefit most from targeted demonstrations? 2. How can the results of these demonstrations be communicated to give the greatest impact?		★★★☆
	M4	Availability of resources	Development of local supply chains for renewable process heat technologies e.g. industrial high temperature heat pumps	1. How can early adopters of decarbonising technologies be supported until supply chains are established? 2. How will the bespoke nature of renewable process heat solutions effect development of part and equipment supply chains and how can this be overcome? 3. How can supply chains/support from tangential industries (e.g. refrigeration) be leveraged?		★★☆☆
	M5	Availability of resources	Development of technologies to exploit waste streams from different industries for the generation of renewable fuel. e.g. production of biogas from anaerobic waste water treatment in the Australian paper industry	1. What is the feasibility of using out-gassing products (e.g. syngas) for direct combustion? 2. Would this require new burners/boilers or can existing plant be used? 3. How does this compare to natural gas combustion? 4. How does this compare to reformed methane?		★★☆☆
Long-term actions: Complete by 2030	L1	Availability of detailed fossil fuel usage data	Continuous monitoring of fossil fuel usage data and project performance	1. How do the projections in the market potential paper compare to emissions calculated from actual detailed fuel use data? 2. What is the impact of actions to date on fossil fuel consumption in key industries? [Annual or Biennial review] i. How is fossil fuel use tracking against required levels to reach the decarbonisation targets? 3. Are there additional actions/opportunities indicated by the collected data?		★★★☆
	L2	Cost of development	Funding structures/mechanisms to support industry lead development of decarbonising technology for Australia's largest consumers of process heat.	1. What funding mechanisms could be adopted in order to allow the expertise within Australia's largest consumers of industrial process heat to be effectively utilised in tackling the specific issues associated with decarbonising those same industries? i. How much funding could renewable energy certificates for process heat decarbonisation provide?		★★★★
	L3	Impact on the electricity grid	Demand response mechanisms and industry based energy storage as a means of addressing issues associated with wide spread electrification of industrial process heat	1. How can the adoption of renewable process heat technologies provide opportunities for demand side energy storage or demand response mechanisms to aid in mitigating the potential negative effects of wide spread electrification of process heat?		★★☆☆

5. Feedback workshop on projects

Please enter your feedback and four choices for priorities on this Google Slides doc by COB Friday 7 May

Discussions in breakout rooms:

– What are we missing?
– What are the priorities?
– What are the right KPIs?

End of meeting.

Next steps:

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