



Australian Government  
Australian Renewable Energy Agency

ARENA

# Renewables for Industrial Processes

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EPRI and IEA workshop: renewables and  
clean energy for industries

30 November 2016

# Australian Renewable Energy Agency



**Accelerating  
Australia's shift  
towards a  
sustainable,  
affordable and  
reliable energy  
future**

**\$1.1 billion funding  
committed to  
support over 270  
projects**

**\$800m funding  
available to support  
innovative energy  
technology -  
certainty for ARENA  
and renewable  
energy sector**

**150 active  
and  
60 completed  
projects**

**\$200 million Clean  
Energy Innovation  
Fund co-managed by  
Clean Energy  
Finance Corporation  
and ARENA**

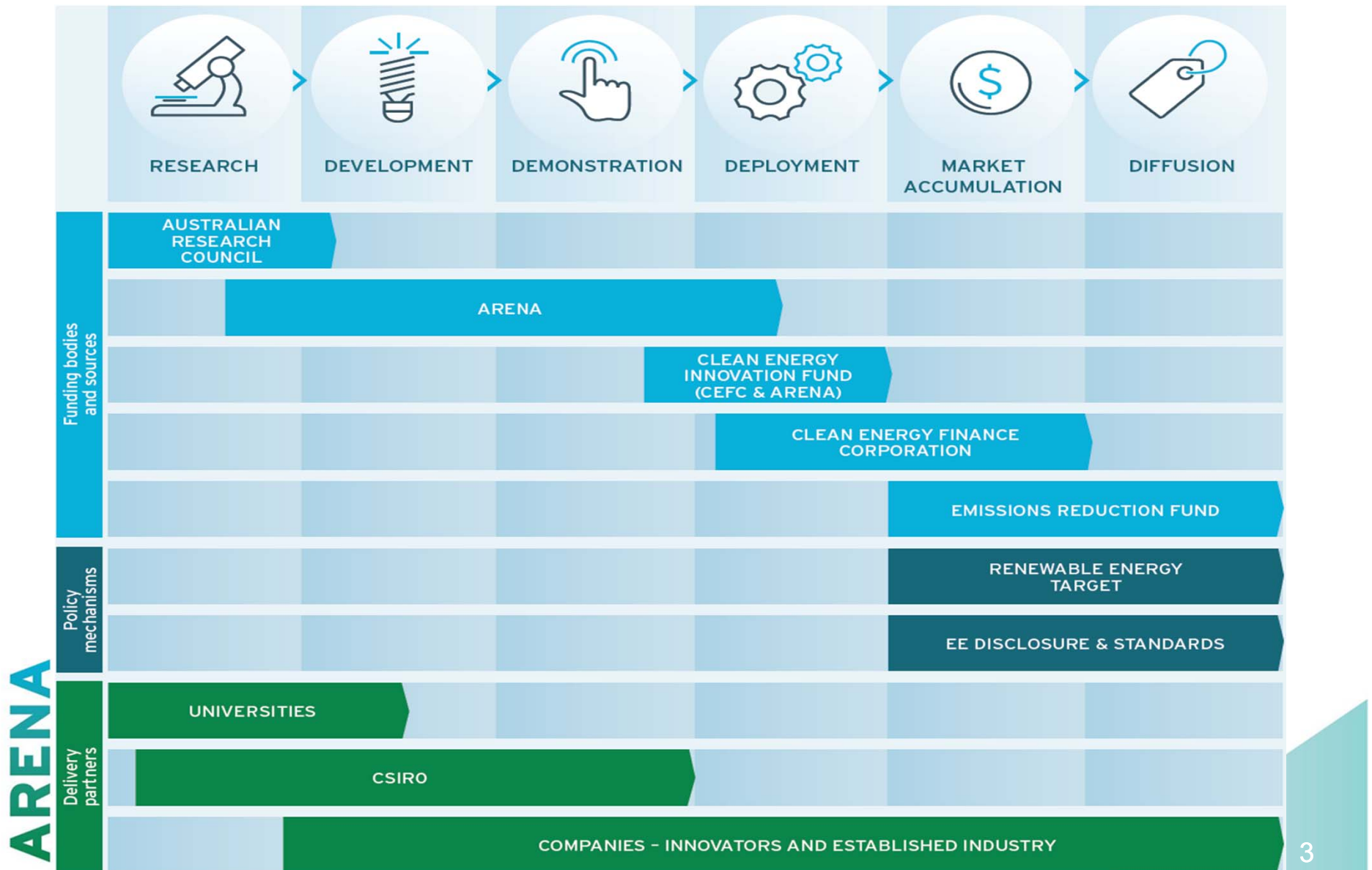
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## **Knowledge Sharing | Collect, analyse, interpret and disseminate**

- Address real and perceived barriers
- Build on lessons learnt
- Accelerate path to commercial adoption without subsidy

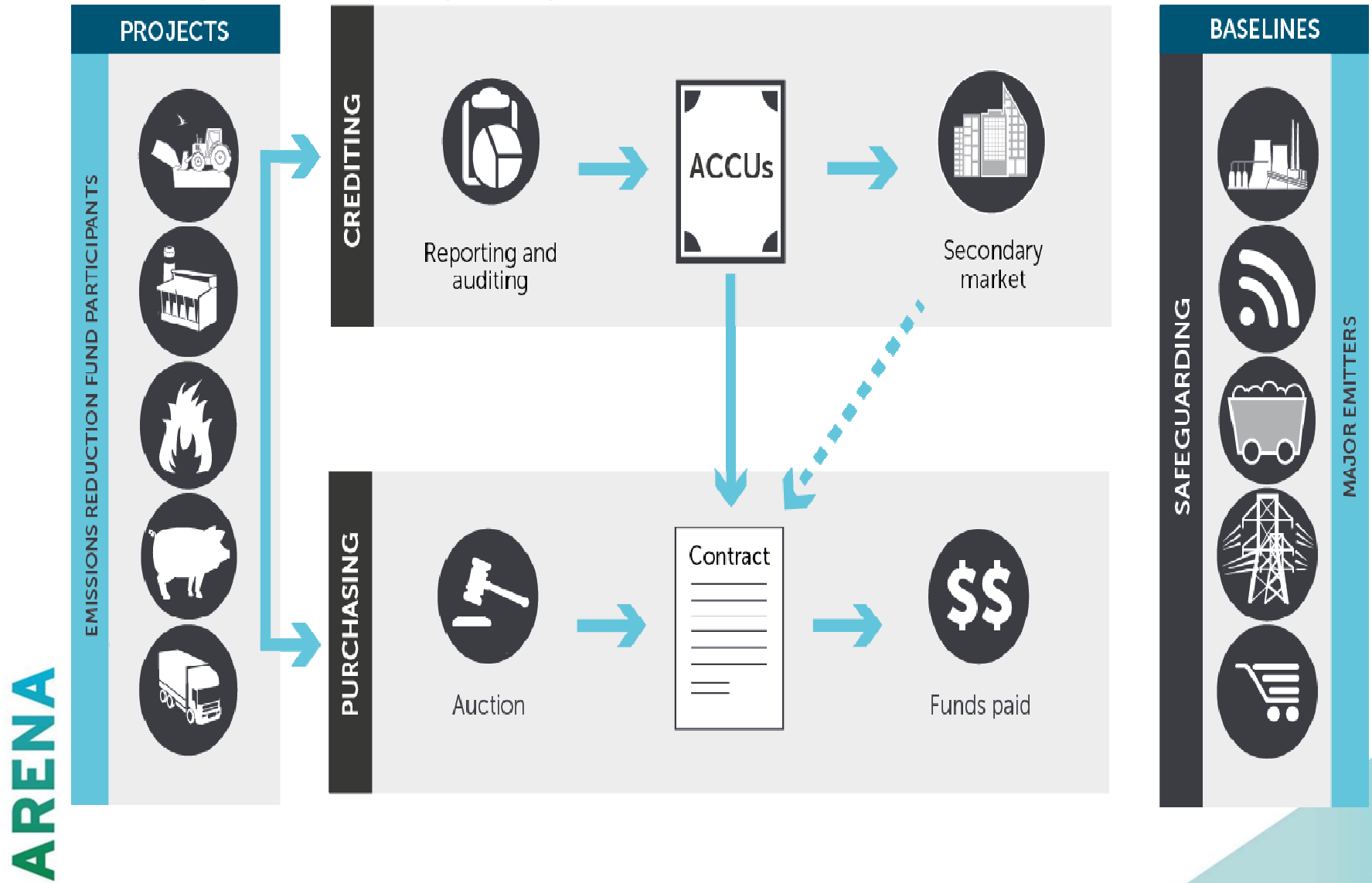


# Where we fit as an innovation catalyst

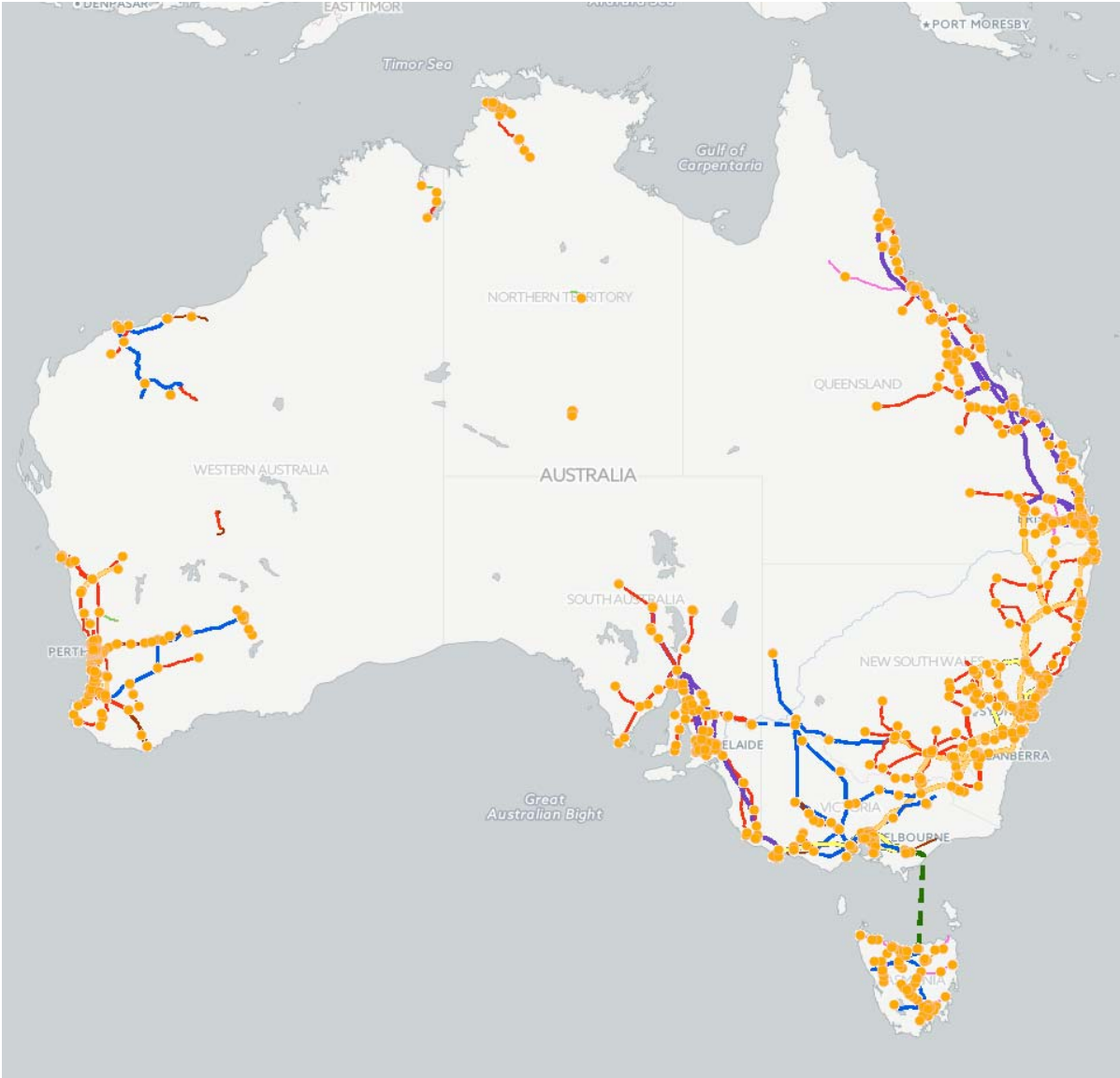


# Emissions Reduction Fund

## How it works



# Big Brown Land



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# Off Grid Mining - Degruassa solar project

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- Total project value \$40 m; \$20.9 m ARENA recoupable grant funding; CEFC \$15 m debt finance
- 10.6 MW solar PV installation with 6MW battery storage, integrated into existing 19 MW diesel generator
- Offsetting more than 20% of total diesel consumption annually
- Up to 93% peak penetration
- 26% annual contribution



# Rio Tinto's Weipa Project

**ARENA funding provided: \$11.3 million. Total project value: \$23.4 million.**

- 6.7 MW solar PV farm with battery storage - the system will connect to Rio Tinto's existing mini-grid at Weipa and deliver electricity
- No upfront cost for Rio Tinto
- Stage 1 operating 14 months
- 99.73% availability
- 20% peak penetration
- 600,000 litres of diesel saved per year offsetting up to 20% of diesel generated electricity



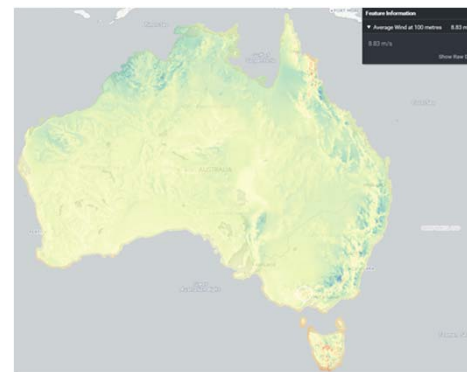
# Future opportunities along Australia's long, skinny grids

Using the tool Australian Renewable Energy Mapping Infrastructure (AREMI) opportunities to deliver optimal low carbon solutions to meet supply/demand needs of industry can be identified and explored

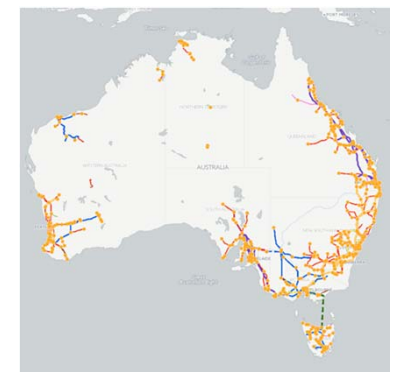
AREMI is online at [www.nationalmap.gov.au/renewables](http://www.nationalmap.gov.au/renewables)

ARENA funding: \$2.1 million

Developed by Australian ICT research group Data61

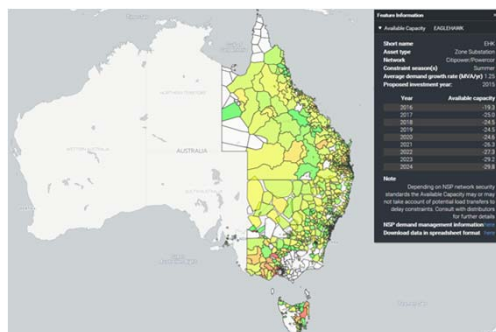


Wind speed

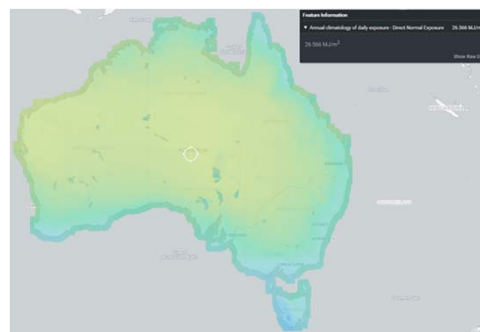


Transmission lines and substations

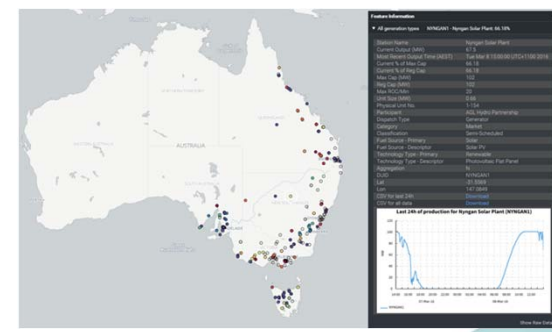
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Grid constraints



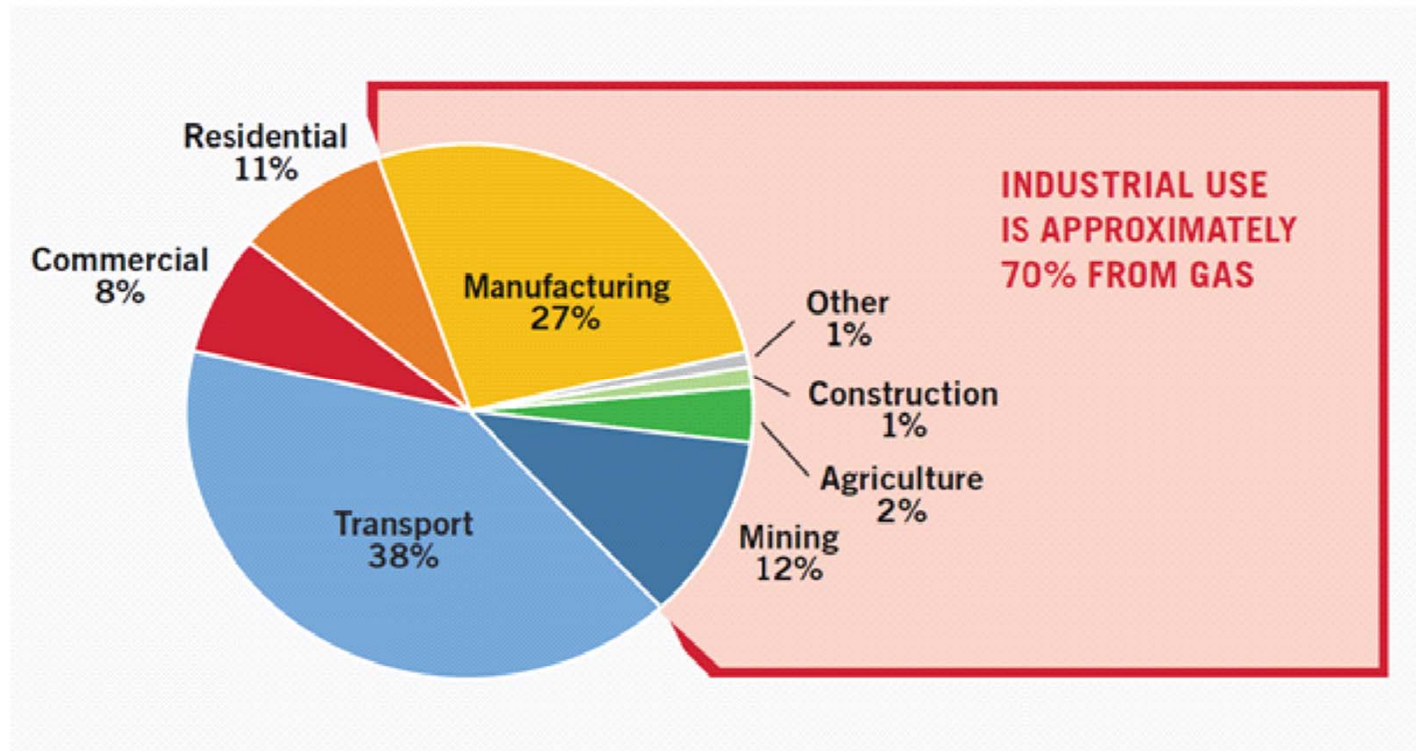
Solar radiation



Existing power generation



# Energy use in Australia



Industry sector consumes approximately 43% of total energy generated in Australia (482 TWh)

Approximately 70% is from gas (337 TWh), with a large proportion used for generating heat

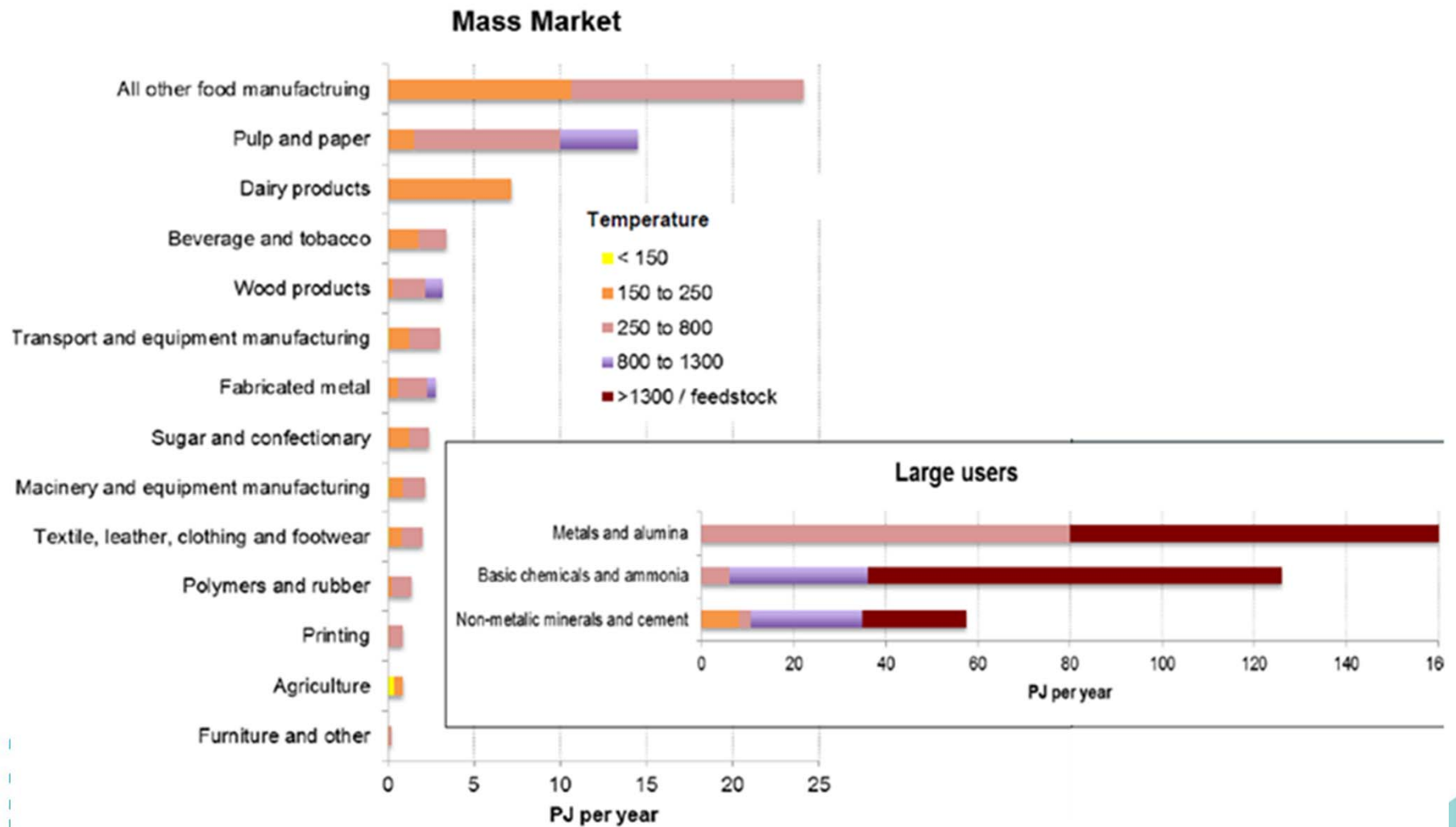
# Industrial Processes



## Process Summary

- **Identification of Opportunity:**
  - High level assessment of energy end users
  - Detailed study undertaken by independent consultant
- **Industry Engagement:**
  - Market Education
  - Engagement with the industries to identify potential opportunities and key challenges
- **Size of the Prize:**
  - Assessment of overall market size
  - ARENA targeted investment potential

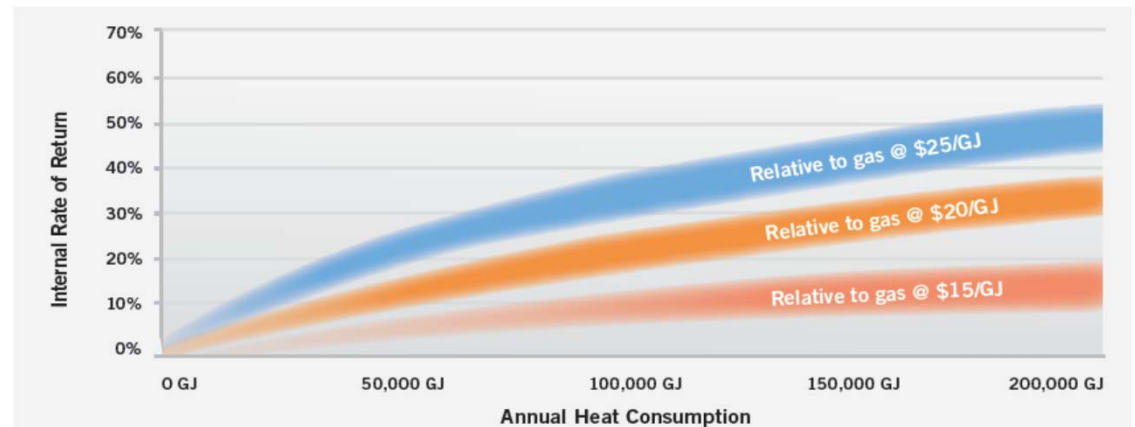
# Industrial energy use



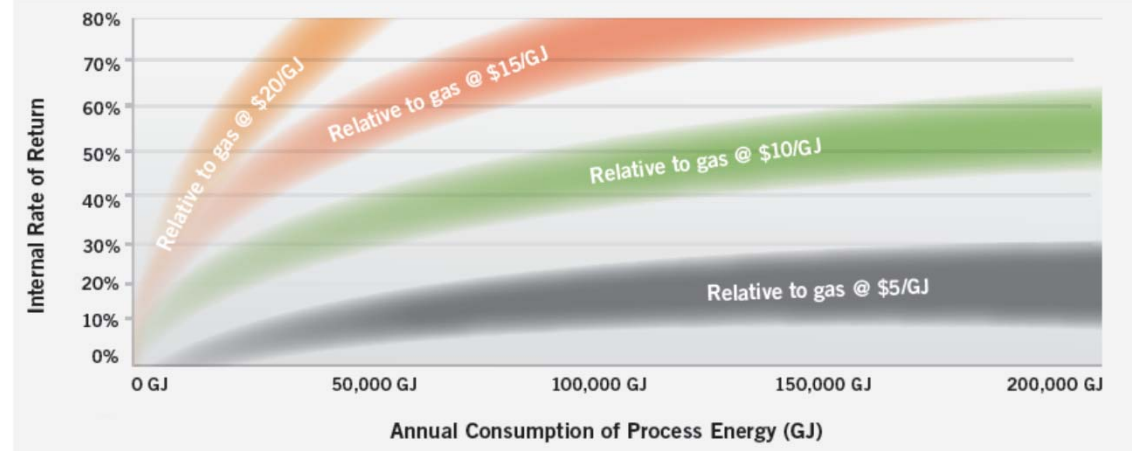
# Industrial Processes



- Included analysis of technology IRR compared to gas
  - Bioenergy at \$5 per GJ



- Solar thermal at 100 °C



# Heat, power & renewables can combine for industrial applications

## What we've found



### LOW COST WASTE OR BIOMASS

Biomass may be viable if a low-cost suitable resource is available and accessible at low cost. Bio-resources could come from bio-crops or from waste streams from food, crop, municipal, agricultural, water.



### STEAMING SOLAR

Solar heating may be viable for heating of water or steam at temperatures lower than 250°C if in a good location for solar.



### OTHER HOT OPTIONS

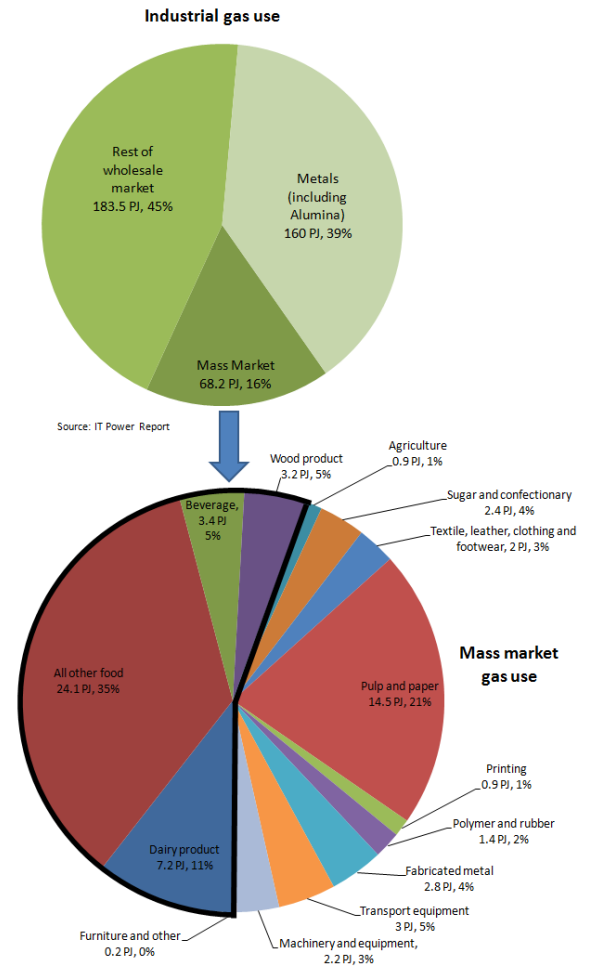
Geothermal heat can provide low temperature process heat in nearby locations. Heat pumps can be competitive in place of electricity or gas supply equivalents.

# Industrial Processes



- Food, dairy and beverage manufacturing have been identified as target sectors, with wood product manufacturing and resource processing, particularly alumina refining, also being of note. Reasoning for this includes:
  - - The majority of energy use is linked to process temperatures below 250°C, making renewable energy, particularly solar thermal, more prospective
  - - Companies within these sectors may have access to low cost agricultural or process waste streams, making bioenergy or waste-to-energy technologies possible.
  - - End-users from the target sectors have had positive engagement with ARENA to date through workshops and industry associations, which is a clear expression of interest in renewable energy.
  - - Companies in these sectors (aside from Alumina refining), are in the mass market of gas users, meaning that they typically will pay higher prices for gas, making renewable alternatives economically more attractive.

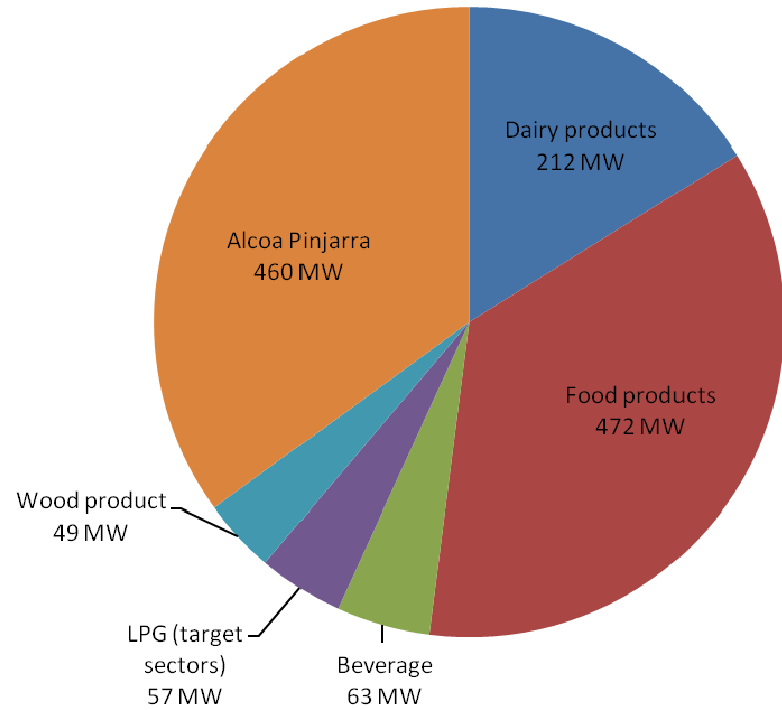
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# Industrial Processes



- Other sectors of interest
  - The wood product manufacturing sector is of interest, both as a potential user of renewable energy, and as a provider of biomass for other applications
  - Amount of gas used for processes with temperatures up to 250°C in Alumina refining is substantial.
  - ARENA supporting R&D Project with Alcoa, opportunity at one refinery (Pinjarra) estimated at 460 MW.
  - Total size of opportunity increased to 1.3 GW when wood product and alumina included
  - Caveats in Alumina refining. Due to the amount of gas used, corporations purchase gas from the wholesale market at low prices, reducing the economic arguments for renewable energy.



# Renewables as an option to address industrial processes

## Challenges

- Lack of precedent projects, creating uncertainty about technical viability
- Need for continuous (24/7) operation
- High return expectations, making renewable energy project investment difficult (<2 year paybacks)
- Lack of awareness about technology suppliers
- Lack of knowledge about the operation and maintenance of renewable energy systems
- Differing risk appetites

## Opportunities

- Whole of system analysis to understand, reduce and optimise energy use
- Alternate deployment and operation models that reduce risk
- Use of energy storage technologies, particularly thermal energy storage, to increase the amount of time systems can be operated.
- Grants to reduce capital costs and improve returns
- Structured knowledge sharing, with involvement from industry associations, to communicate success stories and benefits of renewable energy deployment.



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# ARENA Projects

# Integrating concentrating solar thermal energy into the Bayer alumina process

**Lead organisation:** University of Adelaide. **Program:** Research and development  
**ARENA funding:** \$4.5 million. **Total project value:** \$15.1 million

## Alumina processing using concentrating solar thermal: Alcoa-University of Adelaide collaboration

**Aim:** Determine economic viability of using low temperature solar concentrators to provide heat for alumina processing.

**Impact:** If research idea is taken through to commercial stage – could displace up to 2.5 GW of gas capacity (80PJ per annum) in alumina refining sector



# Parallel Technology Paths



## Low temp CST

- Develop process models
- Techno-economic evaluation
- Recommend preferred options



## CST reforming of natural gas

- Identify low-cost options for syngas storage
- Assess implications of fuel-change on process
- Identify preferred techno-economic options

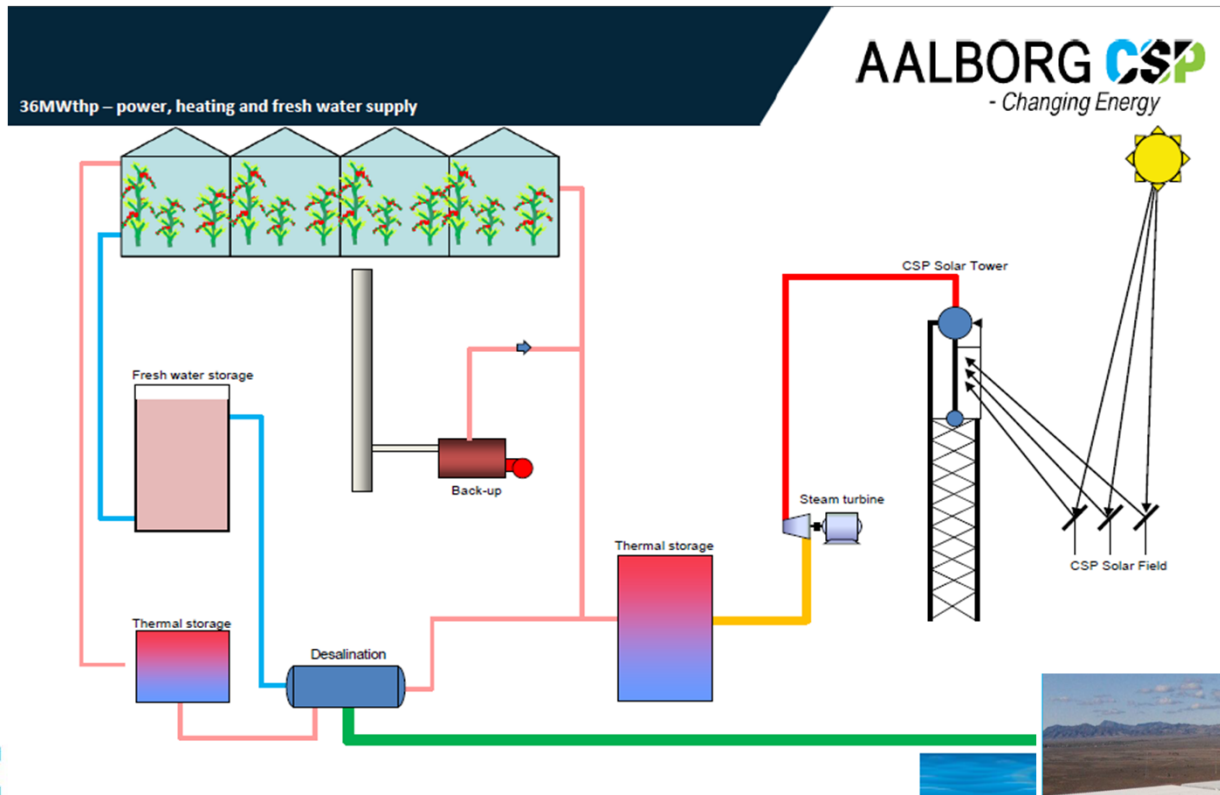


## CST Calcination

- Develop reliable models of reactor
- Develop reactor configuration
- Evaluate impact on process
- Techno-economics

Not ARENA supported

# Aalborg: Sundrop Farm South Australia

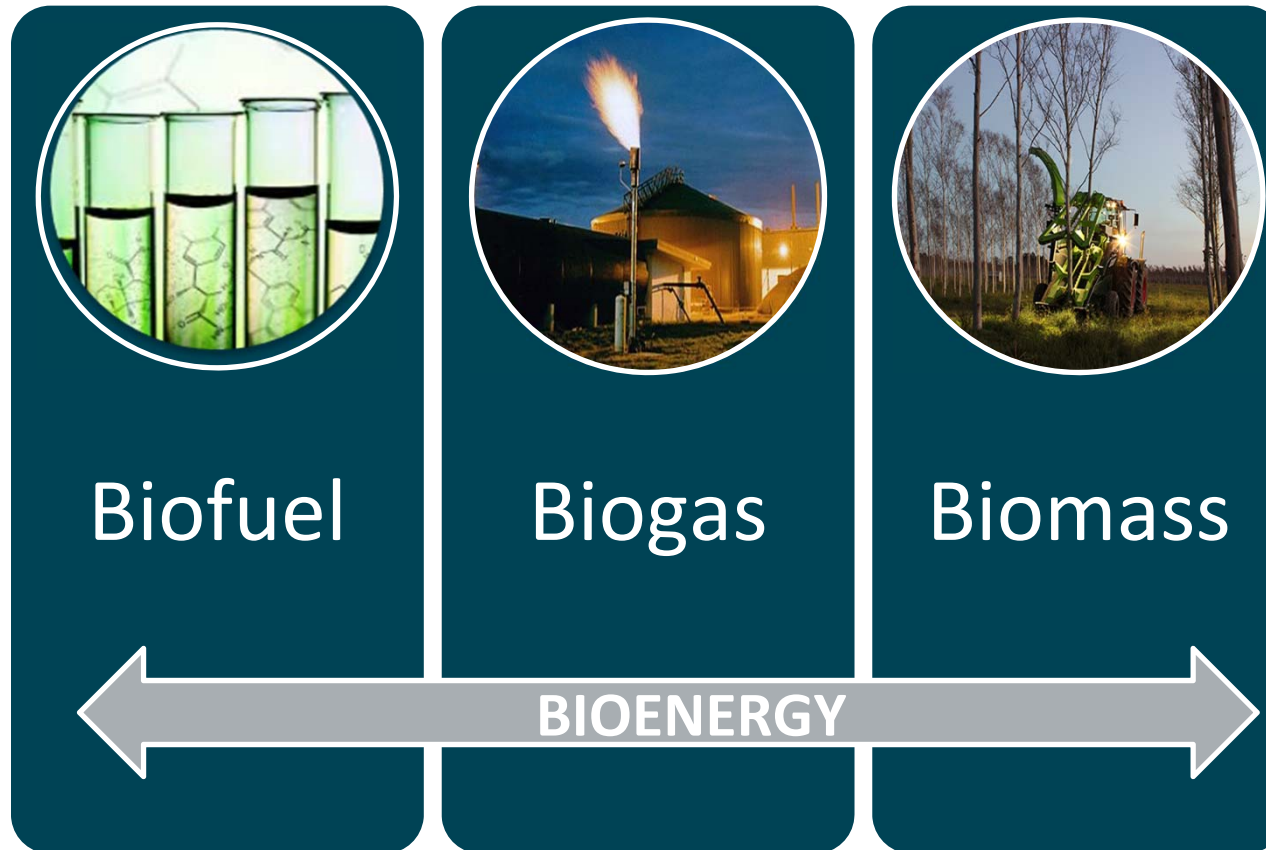


85-90% of energy used to power the farm is generated through renewables

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# ARENA's pipeline



Currently there are 11 active projects in ARENA's pipeline related to industrial processes

- With a combined total cost of over \$300 million
- Of which, funding requested from ARENA is over \$70 million

# Goulburn Bioenergy Project

**Lead organisation:** Geodynamics

**ARENA funding:** \$2.1 million **Total project value:** \$6.1 million

- Geodynamics is developing the Goulburn Bioenergy Project – located at Southern Meats sheep abattoir in Goulburn NSW
- Project will generate 1.6MWe, and supply 4,000 MWh of energy to the abattoir annually
- Dual fuel technology generator, blending biogas with natural gas to meet peak demand
- Portfolio development to reduce the cost of generation from future deployments



# Queensland University of Technology

## Utilising biogas in sugarcane transport and milling

**Lead organisation:** University of Queensland **Program:** Research and development

**ARENA funding:** \$2.1 million **Total project value:** \$5.7 million

The project aims to develop technologies to further integrate bioenergy into the sugarcane production, transport and milling processes to lower costs and emissions

Biogas using AD with sugarcane trash as feedstock

Biofuels using HTL with AD solids as feedstock



# Upcoming pipeline concepts

## Conversion of chicken litter to grid electricity

- >5MW Net Energy Output able to compliment intermittent wind and solar
- PPA with bankable retailer and PPA with behind the meter industrial customer
- Eligible for Large Scale Generation Certificates (LGCs)
- Provide process heat
- Water recycling integral part of project
  - 5+ to be sold as potable water

## Pork waste to biogas

- Commercial scale Anaerobic Digestion plant at fringe-of-grid
- >200kW gas turbine
- Redox Flow Battery
- Back-up diesel generation



# Reflections for an Industry Roadmap

Start with a deeper understanding of energy flows, where to reduce them and where RE / WR / CCU best able to reduce

Distributed biogasification using agricultural waste – being taken up (cost to dispose + increase gas price motivating)

Energy intensive industries

- conservative & follow low cost energy supply
- short term paybacks
- innovation driven by burning platform

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Opportunities – Senior energy champion, risk takers (Sandfire) and smart financial models (Sun Drop Farms) whole of energy service supply models. (Aarlboung)



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# The Emissions Reduction Fund

Three components:

## Crediting

- Methods
- Australian Carbon Credit Units (ACCUs)

## Purchasing

- Methods
- Australian Carbon Credit Units (ACCUs)

## Safeguard

- Emissions baselines
- High emitters

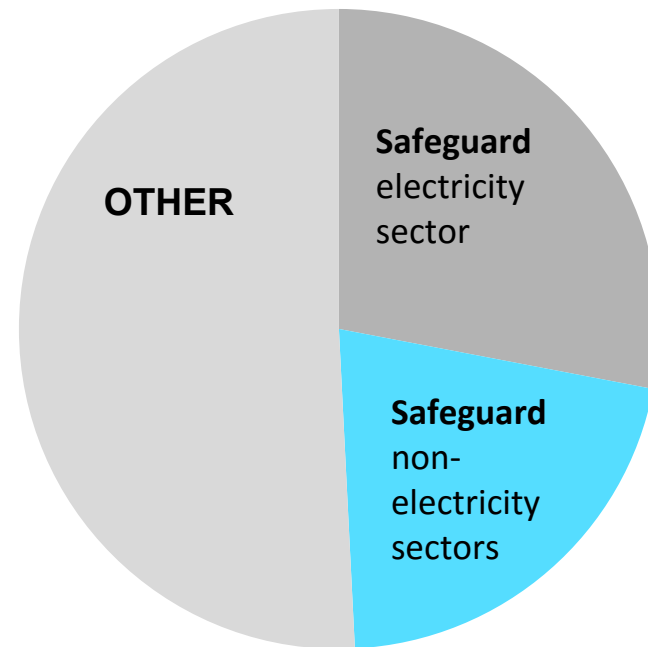
# Safeguard Mechanism

- Commenced 1 July 2016.
- Sets emissions limits on large emitters (>100,000 t CO<sub>2</sub>-e p.a.)
- Around 50% of economy covered.

## Emissions Reduction Fund components



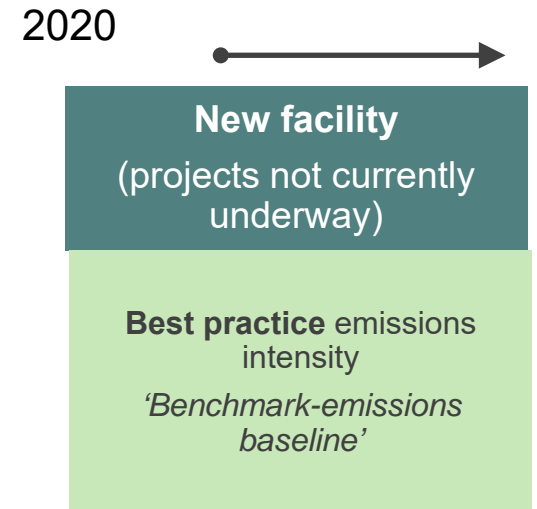
National economy coverage



Key legislation:  
*National Greenhouse and Energy Reporting  
(Safeguard Mechanism) Rule 2015*

# Safeguard Mechanism

- Best practice benchmarks apply from 1 July 2020 for new investments.
- Reduce emissions intensity of Australian industry.
- Emissions limits for new investments will reflect best practice emissions performance.
  - ❑ Best performing 10 per cent of Australian production.
- Legislation will specify best practice emissions intensities.
- Historical emissions and production data used to determine benchmarks.





CRICOS PROVIDER 00123M

## Introducing CST into the Bayer Refining process

Gus Nathan, Bassam Dally, Keith Lovegrove, Evatt Hawkes, Wes Stein, Aldo Steinfeld, Ross Haywood, John Abraham, Ian Harrison, Jim Hinkley, Peter Ashman, Woei Saw, Philip van Eyk, Ray Chatfield, Ian Stephenson, Rob Taylor, Zhao Tian, Guan Yeoh

[adelaide.edu.au](http://adelaide.edu.au)

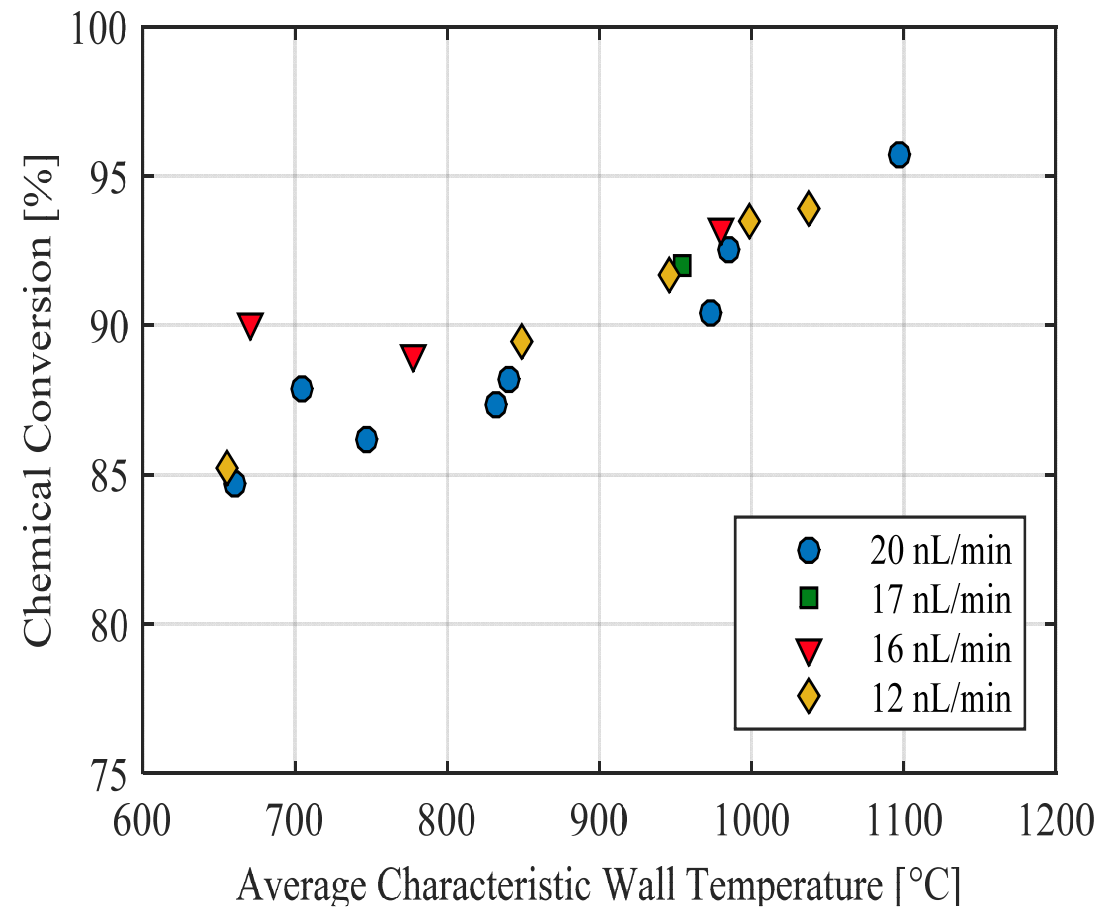
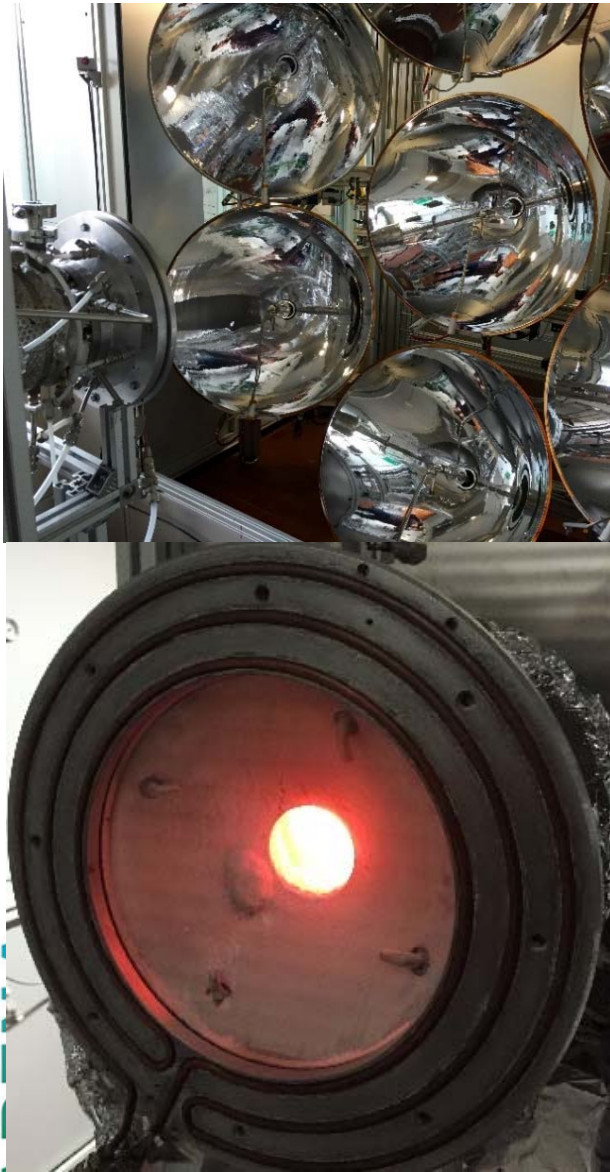
*seek* LIGHT

# Key approaches of joint ARENA project

Target 29-45% CST into a hybrid system:

- Staged implementation of:
  - Near-term low temperature process heat
  - Mid-term solar reforming of natural gas
  - Further-term high temperature process heat
- Develop hybrid technologies
  - Utilise solar when resource is strong
  - Can revert to present operation if needed
- Address both Retro-fit and Greenfield
  - Retrofit: low-cost barrier for demonstration & implementation
  - Greenfield: greater performance when technology is available

# First Demonstration of alumina calcination:



Davis, Miller, Saw, Steinfeld, Nathan (2016),  
High Temperature Processing Symposium



# Summary

	Industrial processes	Water and agriculture
<b>Energy use</b>	<ul style="list-style-type: none"> <li>• Industry 43% of Australian energy end-use (482 TWh)</li> <li>• 70% of industry energy use gas for process heating (337 TWh)</li> </ul>	<ul style="list-style-type: none"> <li>• Agriculture about 99.7 PJ</li> <li>• 90% oil for mobile equipment and off-grid electricity</li> </ul>
<b>Key technologies</b>	<ul style="list-style-type: none"> <li>• Bioenergy/waste-to-energy</li> <li>• Solar thermal</li> </ul>	<ul style="list-style-type: none"> <li>• Solar</li> <li>• Bioenergy/waste-to-energy</li> </ul>
<b>Target sectors/areas</b>	<ul style="list-style-type: none"> <li>• Food, dairy and beverage manufacturing.</li> <li>• Wood product and alumina refining also of note</li> </ul>	<ul style="list-style-type: none"> <li>• Water pumping, irrigation</li> <li>• Wastewater treatment</li> </ul>
<b>Size of opportunity</b>	<p>Food, dairy and beverage:</p> <ul style="list-style-type: none"> <li>• 804 MW</li> <li>• \$10 - \$30 million funding</li> <li>• 10 to 20 projects</li> </ul> <p>Opportunity increases to 1.3 GW including wood and Alumina</p>	
<b>Market approach</b>	<ul style="list-style-type: none"> <li>• Open-ended via Advancing Renewables Program</li> <li>• Targeted engagement with food, dairy and beverage:               <ul style="list-style-type: none"> <li>○ C-level engagement to create momentum in large companies</li> <li>○ Whole of systems analysis to improve efficiency and maximise benefit from renewables leading to feasibility studies</li> <li>○ Aggregation of projects from small companies to improve demonstration effect</li> <li>○ PPAs to reduce operational risk</li> </ul> </li> <li>• Monitor opportunities in wood product and alumina refining sectors, particularly results of Alcoa R&amp;D Project</li> </ul>	<ul style="list-style-type: none"> <li>• Better understand what current ARENA projects are of relevance</li> <li>• Pursue technical or commercial innovation</li> <li>• Maintain and leverage contacts through key organisations (QFF, QRAA, FIAL) to identify potentially innovative projects.</li> </ul>