




Heavy Industry Low-carbon Transition CRC **STAGE 2 PROSPECTUS**

HILTCRC



**“TECHNOLOGY OFFERS THE BEST PROSPECT OF
MAINTAINING AND EVEN STRENGTHENING OUR
POSITION AS AN ENERGY EXPORT LEADER, WHILE
SUPPORTING REDUCTIONS IN GLOBAL EMISSIONS.”**

HON ANGUS TAYLOR,
MINISTER FOR ENERGY AND EMISSIONS REDUCTION, MARCH 2020

Transforming the heavy industrial sector to a low-carbon future

Foreword

The heavy industrial sector is critical to our well-being, directly generating around \$180b per annum (roughly 9% of the Australian economy).

The sector processes minerals to produce materials such as iron, aluminium, cement and zinc and is inextricably linked to both upstream and downstream activities. Its impact reaches all areas of Australian life providing jobs, export income, investment in our regions, a wide range of industrial, commercial and consumer goods and making a major contribution to our industrial sovereignty. Its indirect benefit to Australia is much greater.

Our heavy industry sector has begun to reduce its greenhouse gas emissions, but these emissions are hard to abate with existing technologies and processes. Up to 75% of its greenhouse emissions cannot be avoided simply by purchasing renewable electricity; alternative carbon-neutral production technologies to produce the high temperature heat that the sector needs must be developed at scale. Further, most plants are large, bespoke, massively capital-intensive and long-lived. They produce large volumes for sale in a global market and they can't afford any interruptions or untested innovations that could jeopardise equipment, production or worker safety.

Hence, the focus of the proposed Heavy Industry Low-emissions Transition (HILT) CRC is to develop the technologies and methods that overcome these barriers.

Extraordinary possibilities for Australia

If the sector can transform its processes to produce certified 'green' or low-carbon products, it will markedly increase its value and provide an increasingly important market differentiator for its products against conventional import competitors. This will open new export opportunities and enable the extension of the life of existing domestic plants. The potential benefits of unlocking new mineral deposits, adding value with new processing technologies, reducing national emissions, boosting export income and generating jobs should easily exceed \$200 billion in infrastructure investment and increase annual income by \$20b pa.

The transition pathway to net-zero carbon emissions would be longer and riskier for individual companies to undertake alone, and this has created an unscalable investment barrier. The capital needed to develop and demonstrate new technologies and methods at scale and the risks to first movers are prohibitive. However, these costs and risks can be dramatically reduced if the sector works collaboratively with experts from across the industry and with Australia's best subject researchers to overcome the barriers and accelerate the transition, enabling the Australian industry sector to lead the world in the global transition.

Opportunity for partners

The HILT CRC bid team is preparing our Stage 2 proposal to the Australian Government's CRC Program. HILT CRC will be a dynamic, membership-based organisation where industry-chaired steering committees will direct research priorities, develop the agenda, and keep the CRC focused on developing viable solutions that the sector needs. The focus will be on advancing

members' opportunities to take advantage of Australia's natural endowments in mineral and clean energy resources. Direct benefits will flow through to technology and equipment suppliers, manufacturing industries, regional Australia and the economy as a whole.

Our partners will benefit from preferential access to technologies that will enable the transition to be undertaken at lowest cost and least risk and to secure their place as an industrial leader in a low-carbon world. To see our partnership opportunities, please have a look at page 16 of this Prospectus.

Bid progress to date

Stage 1 of the HILT CRC proposal was submitted to the Australian Government in July 2020. The proposal included major support from industry and government, with pledged contributions from partners totalling ~\$40 million cash and ~\$105 million in in-kind support. We are requesting a further ~\$40 million in grant funding from the CRC Program.

Now that we have been invited to Stage 2, we are preparing to submit our full proposal to the Australian Government in January 2021.

The time is right

As a signatory to the Paris Agreement, Australia has committed to reducing emissions to zero during the second half of this century. Our heavy industry directly accounts for 20 per cent of Australia's emissions.

The global demand for low-carbon products is increasing, driven by investors choosing to support products that are environmentally responsible, and by the expansion of policies that preference low emissions products in the European Union, China, Japan and parts of the USA. Companies responding to this demand and seeking to remain globally competitive are beginning to make the vital transition toward net-zero CO₂ emissions.

Australia has a strong industrial base and research capability. We can become world leaders in producing and exporting low-carbon products whilst simultaneously boosting our regional prosperity, increasing jobs and advancing self-sufficiency in the post-COVID-19 world.

I invite you to join the 40+ organisations that have already signed up to the HILT CRC's mission.



Yours sincerely,

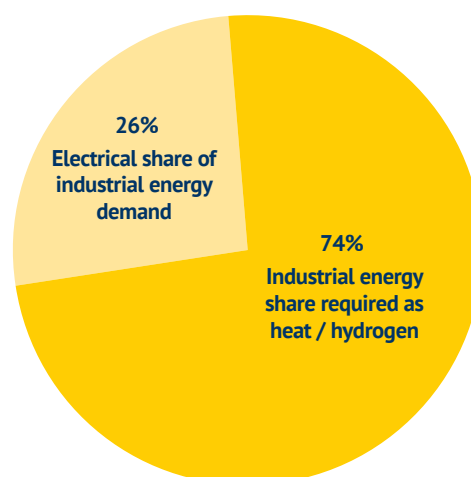
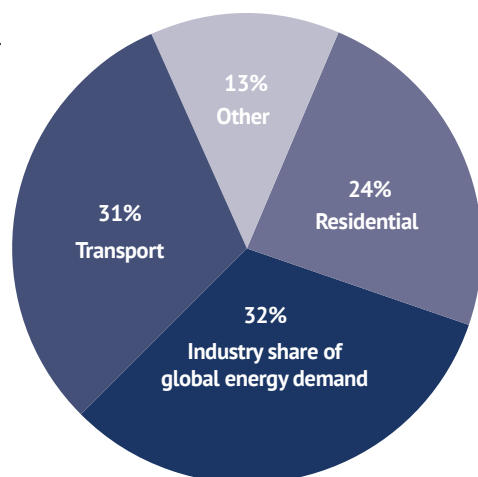
Ms Susan Jeanes
Interim Chair, HILT CRC

HILT CRC outcomes will unlock the following value for Australia

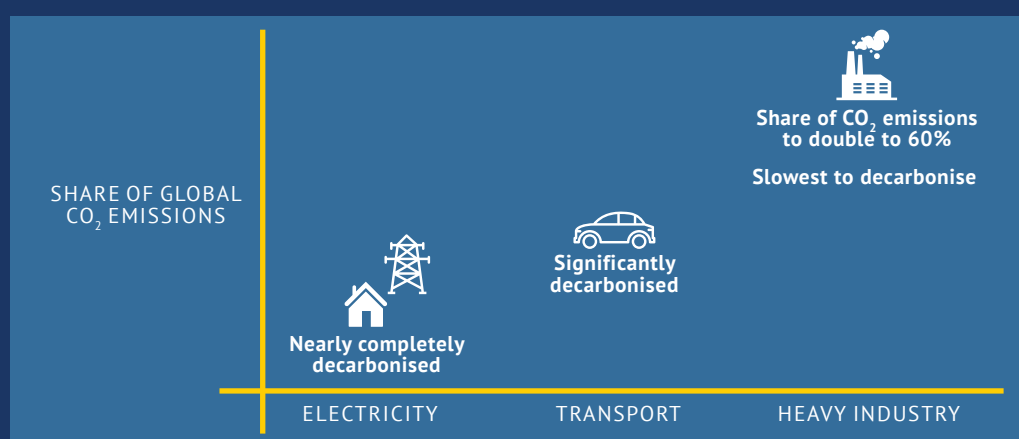
	Annual revenue (AUD)	Investment unlocked (AUD)
Upgrading 10% of Australia's iron ore exports (80 mtpa) to 'green' iron products, e.g. pellets or pig iron ^a	\$35B	\$70B
Extending the life of Australia's current alumina refineries to enable operation in future low-carbon markets ^b	\$8.2B	-
Investing in new Renewable Electricity Infrastructure to produce the green hydrogen for iron making ^c	-	\$22B
Extending the life of Australia's current cement plants to enable operation in future low-carbon markets ^d	\$2.4B	-
Extending the life of Australia's current primary iron and steel production processes to enable operation in future low-carbon markets ^e	\$3.1B	-

a. Value of unlocked investment based on SA Government's Magnetite Strategy **b.** Value of current exports based on Australia's Resources and Energy Quarterly **c.** Based on Whyalla consumption and costs from SA Government's Hydrogen Action Plan **d.** Based on current production from Australia's Cement Industry Federation **e.** Based on Federal Parliament Report and Australian Bureau of Statistics data

In 2017,...



IEA projected share of 2060 emissions based on present trends¹.



Research program structure

The bid team, which includes significant industry membership, has consulted widely with stakeholders to tease out the most pressing challenges for the sector. This includes drawing on the outcomes of The University of Adelaide's HiTeMP Forum, input from the Bid Development Industry Steering Committee, and ongoing engagement workshops. This process will continue as we refine the scope and further develop plans for projects of common interest and value to partners.

Overview

Industry-led and managed, HILT CRC will:

- capitalise on previous developments of cutting-edge technologies from Australia and overseas
- develop novel technologies through R&D with translation partners.

The following programs and streams are proposed:



Program 1 Process Technologies

Streams

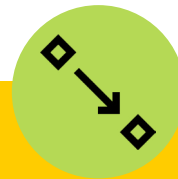
- a. Producing green iron products from magnetite
- b. Producing green iron products from Pilbara ores
- c. Green alumina calcination



Program 2 Cross-cutting Technologies

Streams

- a. Integrating variable energy sources into industrial processes
- b. New energy sources: electrification, hydrogen, solar thermal and biomass/waste
- c. Hybrid technology for multiple energy sources
- d. Integrated capture and re-use of CO₂ in industrial processes



Program 3 Facilitating Transformation

Streams

- a. Heavy industry roadmaps and scenario analyses
- b. Supply chain development and commercialisation pathways
- c. Community engagement and sustainability leadership
- d. Technology commercialisation

Each **program** will be co-led by an industry chair and a research leader, under the direction of an industry-chaired steering committee. The committees will manage the selection and progress of projects, focusing entirely on achieving the CRC's broader objectives and outcomes.

To encourage strong leverage of resources and knowledge sharing, **projects** will typically be managed within a primary program and co-managed by a secondary program. Projects will also be encouraged to leverage from and partner with major initiatives outside of the CRC. Each project will have its own KPIs, milestones and deliverables.

Technology development and demonstrations

HILT CRC will engage internationally to co-develop, upscale, demonstrate and de-risk technologies with strong potential value to the partners. These will be prioritised using expert techno-economic evaluations from an agreed common baseline.

New components and configurations will also be developed to facilitate step change. For larger demonstration projects, which may require resources beyond the HILT CRC budget, we will lead or support proposals for additional funding. Partnerships will also support full-scale demonstrations, independent evaluation and reporting.

Research will target solutions that can be retrofitted to existing plants and be transferable to greenfield projects that can deliver carbon-neutral operation.

Vision

Australia's heavy industry sector not only survives, but *thrives* over the coming decades with improved technological capabilities and cost competitiveness.

Objectives



Ensure long-term jobs, prosperity, competitiveness, intellectual property, ownership retention and self-sufficiency of Australian industry in the global low-carbon economy, while increasing domestic security through strengthened industrial capacity.



Provide professional and technical development for a new generation of highly skilled people, particularly in regional areas, with expertise in growing a sustainable heavy industry sector; this will include re-skilling workers following job-losses from COVID-19.



Create emissions reductions from heavy industry in the global supply chain of energy-intensive processes and products, through integration with renewable energy industries.



Enable integration with the 'new economy' by embedding the industry in circular economy and deep-sustainability principles.



Enhance national and international collaboration through a wide network of researchers, government and industry.

HILT outcomes will unlock:

92,000

new jobs over the next decade

312,000

jobs retained

\$250 billion

investment potential to 2050 for new projects

\$10 billion

in new developments invested to 2036

Up to \$4 billion

p.a. contributed by 2036 in increased export income

3-fold

increase in the value of our ore and processed mineral exports progressively to 2050

58 MT

p.a. of CO₂ emissions (10% of national total) reduced by 2040

Key deliverables

HILT CRC has worked with partners to develop a shortlist of project proposals to be further developed after the CRC is approved. This will be presented to the Steering Committee when the CRC starts, for recommendation to the Board. Representative projects on the shortlist are shown below.

Near-commercial, low-carbon technologies demonstrated in **industrial settings**

These example projects will de-risk the transition to low-carbon emissions in existing industrial plants:

- Converting iron pellet kilns to low-carbon operation using hydrogen and electrification
- Production and utilisation of 'green' steam for the Bayer alumina process
- Production of low-carbon lime for use in industry with CO₂ capture and re-use
- Establishment of a digital twin to enhance flexible production/consumption of green electricity and hydrogen
- Demonstration of low-carbon iron products for Pilbara ores.

Longer-term technologies developed to higher technology readiness

These example projects will be selected based on strong potential to be at commercial scale by 2040:

- Development and demonstration of a low-carbon calcination process for alumina production
- Development and demonstration of a hydrogen/electric hybrid heating system, with natural gas back-up, for industrial processes
- CO₂-to-X: Lowering the cost of converting CO₂ to higher value products
- Cement plants of the future with integrated CO₂ capture and re-use, blending of calcium carbonates with alternative feedstock and the use of alternative fuels
- Direct reduction of iron ore using fluidised-bed technology

High-value, mid-term technologies developed and demonstrated to **pilot-scale**

These example projects will be selected based on strong potential to be at commercial scale within 10 years:

- Technology to provide new value-added export products to present importers of iron ore, such as low-carbon iron pellets, DRI or pig-iron, together with the local steel makers
- Technology to capture CO₂ from a lime kiln and convert it to a higher value products, including fuel and chemical feedstock
- Technology for green calcination to produce alumina, lime, and cement
- Technology with potential to achieve significantly reduced cost of hydrogen, oxygen and other chemicals by integration into the process
- Integrated CO₂ capture and reuse to support the transition for other current plant.

At least **4** roadmaps developed for **specific industries** in conjunction with companies working with regional economies and state governments

Projects will identify new business opportunities, transition pathways and opportunities to remove regulatory impediments to implementation.

- Identification of local, regional and national benefits to attract co-investment in new infrastructure
- Analysis of value chains, investments and potentially beneficial reforms
- Development and engagement in the review of standards and regulatory processes
- Identification of new opportunities arising from synergistic investment, both between different parts of the heavy industrial sector and through circular economy principles.

HILT CRC Timeline

ESTABLISHMENT	STAGE 1	STAGE 2	STAGE 3
	0 – 3 years	3 – 6 years	6 – 10 years
Establishment phase <ul style="list-style-type: none"> • Finalise contracts • Establish management team • Establish steering committees • Election of Executive Board • Prioritise and finalise plans for quick-start projects 	Pre-selected projects <ul style="list-style-type: none"> • Planning • Implementation • Testing • Analysis • Quick-start projects completed and adopted New projects <ul style="list-style-type: none"> • Scoping studies • Techno-economic analysis • System and supply chain mapping • Roadmaps • Project proposals and approvals • Quick-start projects commenced 	Demonstration <ul style="list-style-type: none"> • Construction and implementation • Testing and analysis • Reporting and evaluation Technology development <ul style="list-style-type: none"> • Project implementation • Technology development and demonstration • Future industry analysis • Analysis and reporting • Planning for Stage 3 • Resourcing additional funds for larger projects 	Upscaling and commercialisation <ul style="list-style-type: none"> • Technology upscaling • Pilot-scale demonstrations (pending additional resources) • Industrial-scale demonstration (pending additional resources) • Commercialisation • Knowledge sharing

Australian Government's CRC Program


Cooperative Research Centres (CRC) Grants provide up to ten years of funding for industry-led, collaborative research.

The goal of the program is to solve industry identified problems to improve the competitiveness, productivity and sustainability of Australian industries.

The collaborations must include an industry-focused education and training program, increase R&D capacity in small-to-medium enterprises, and encourage industry uptake of research.

Applicants must at least match the amount of grant funding sought through cash and/or in-kind contributions.

www.business.gov.au/Grants-and-Programs/Cooperative-Research-Centres-CRC-Grants



**“THE SMART WAY IN DEALING WITH THIS TO
GET EMISSIONS DOWN ... IS TO FOCUS ON THE
TECHNOLOGY AND MAKING SURE THAT [THE]
TECHNOLOGY IS AFFORDABLE AND IT IS SCALABLE.”**

**HON SCOTT MORRISON,
PRIME MINISTER, AUSTRALIA, FEBRUARY 2020**

Industries at a glance

Global demand for **steel** is expected to rise by another 30% to an estimated 2.2b tonnes per annum by 2050².

The global market for **lead** is expected to double from US\$46.6 billion in 2015 to US\$84.46 billion in 2025³.

Alumina production is Australia's most significant high temperature industrial process, with more than four times the tonnage produced than steel.

Demand for **cement** and **lime** is continuing to grow, not only to support the building sector but also (via lime) as a feedstock in many industrial processes, so that they account for 5.5 Mt and 2.8 Mt, respectively, of CO₂ emissions annually⁴.

Nickel is a critical component in many emerging renewable energy technologies, particularly batteries.

Copper is in growing demand to support the increasing penetration of renewable energy into electrical networks.

Australia is the world's second largest producer of **gold**.

Program 1

Processing Technologies

Integration and Development



This program will accelerate carbon footprint reduction in industrial processes with preferred emerging technologies, including, for example:

- Iron pellets/DRI/pig-iron: Developing processes with trading partners to produce low-carbon, high value iron products for export, considering hydrogen, electrification and solar thermal.
- Alumina/aluminium: Addressing both the production of steam for digestion and high temperature calcination, considering electrification, hydrogen and solar thermal; together with integrating variable energy into aluminium smelting.
- Cement and lime: Tackling CO₂ capture and re-use in an industrial context, while leveraging from alternative fuels work in other programs, and the blending of by-products from other industrial processes.
- Copper, nickel, gold and other critical metals: Addressing the production of chemicals, such as sulphuric acid and regenerated activated carbon, while also leveraging from activities in hydrogen and oxygen production.
- Integration within broader electrical and hydrogen networks: Using digital twins to guide infrastructure planning and develop value propositions, with consideration at both plant level and broader system level.

Why this program is needed

Heavy industrial processes are large and complex. The HILT CRC will provide new understanding of ways to de-risk the large investments needed to transform energy intensive processes, while directly supporting the development and demonstration of emerging technologies. The CRC will also assess potential impacts on existing industrial processes.

The HILT CRC will address CO₂ emissions reduction from both the emissions arising from the combustion of fossil fuels and those derived from the process. It will identify pathways to utilise low-carbon alternative sources of heat, fuel and/or electricity, in addition to CO₂ capture and re-use.

Industry progress to date

HILT will leverage from the significant progress toward lowering CO₂ emissions that has begun internationally, for example:

- Large-scale trials have been held in parts of Europe to begin to displace coal with hydrogen; bio-derived coke is also being used. Germany has decided to phase out coal by 2038. Nevertheless, the most cost-effective way to fully decarbonising the sector by 2050 will be achieved through global supply chains.
- Progress has been made to evaluate the options for delivering steam at ~180 °C for the Bayer alumina process with low net CO₂ emissions; the two leading options are electrification and solar thermal. CST for steam production is already a commercial reality in other sectors. The HILT CRC will address the significant remaining challenge of decarbonising calcination.
- The cement and lime sector has made big progress in displacing fossil fuels with “waste” fuels, many of which are classified as low-carbons, and by blending cement with substitutes such as slag and dolomite. However, the management of the process-derived CO₂ emissions remains a significant challenge, which The HILT CRC will address.

Streams

Program 1 will be based on industrial processes, including, but not limited to:

- a) Producing green iron products from magnetite
- b) Producing green iron products from Pilbara ores
- c) Green alumina calcination.

“THE WAY YOU MAKE ALUMINIUM IN A ZERO-EMISSIONS WORLD ECONOMY IS TO USE RENEWABLE ENERGY TO TURN BAUXITE AND ALUMINIUM OXIDE INTO ALUMINIUM METAL.”

**PROFESSOR ROSS GARNAUT,
ABC NEWS, 2020**



Promising technologies

Hydrogen: H₂ can be used both as a fuel and a reductant to replace fossil sources such as metallurgical coal. However, each industrial process is unique due to the combination of ore properties and local resources. HILT CRC will evaluate the preferred technology options to lower the cost, address supply-chains, investigate integration and hybridisation, and upscale and advance new technologies.

CO₂ management: High value ways need to be identified to capture CO₂ and convert it with renewable energy to higher value products for sale or re-use within the process (e.g. as a fuel), termed carbon capture and utilisation, CCU. We anticipate prioritising the capture of CO₂ from lime production as a common industrial process building on the innovations of participating technology providers.

Concentrated solar thermal (CST): High value opportunities need to be developed to directly use solar heat in industrial processes,

capitalising on recent advances to reduce cost and increase temperature. To be evaluated: waste heat upgrading and thermal comminution, along with hybrid technologies where investment is justified.

Biomass and waste-derived fuels: Supply chains need to be examined so that we can explore new methods to unlock low-cost feedstocks, which may emerge opportunistically (for example, to mitigate bushfire risk) by addressing policy and regulatory barriers and identifying new market measures. Feedstock-specific trials will occur if needed to de-risk implementation.

Electrification: High value opportunities must be identified and developed to electrify heat. Hybrid technologies will also be considered, so energy sources can be switched in response to fluctuating prices.



The goal of this program is to develop and demonstrate novel technologies that have economic potential to lower carbon intensity through low-carbon heat, fuels, oxidants and reductants. Key fuels of interest across multiple processes include hydrogen and its derivatives, syngas, biomass and waste-derived fuels, together with fuels derived by regenerating captured CO₂. The conversion of captured CO₂ to provide high-value products including chemical feedstock and animal feed, via micro-algae, will also be evaluated. Interest in hydrogen is growing due to major national and international investments. Interest in biomass and waste is growing with that in the circular economy. The electrical grid, which is progressively being decarbonised, is expected to be a way to electrify heat and leverage hydrogen production, but must be addressed in a way that avoids excessive costs during periods of high price. On-site co-production of alternative fuels is also possible, to leverage co-products like oxygen or sulphuric acid into the production process, together with Ammonia, as either a fuel or energy carrier. Other opportunities may arise from the upgrading of low-grade heat and the direct use of CST as heat.

The program will investigate flexible ways to integrate intermittent resources into continuous industrial processes.

Common drivers include:

- the local production of hydrogen in regional hubs offers potential to lower costs through greatly reduced need for transport and storage, and providing a means to harness co-products (e.g. oxygen)
- the local re-use of captured CO₂ within a regional hub offers potential to lower costs through avoiding transport and storage

costs, while also providing access to local renewable energy or process heat into the conversion processes

- regional planning and cooperation can provide cost-share to lower the costs of hydrogen production, electrical services, biomass/waste use and co-products
- emerging thermal technologies for hydrogen production offer further potential to lower cost by access to low-value streams to from primary industrial processes and access to low-cost thermal storage.

Why this program is needed

This program will provide opportunities for partners in multiple sectors to share costs and determine how to best mitigate CO₂ derived from the processes themselves. HILT CRC will consider technology integration at local and regional levels, together with ore and process-specific challenges, to generate new intellectual property.

Industry has also expressed interest in harnessing by-products from one process as an input to another. Digital twins will help to optimise electrical use and co-production from within a plant, and also help in the consideration of bigger, regional hydrogen and electrical networks.

Streams

- Integrating variable energy sources into industrial processes
- New energy sources: electrification, hydrogen, solar thermal and biomass/waste
- Integrated capture and re-use of CO₂ in industrial processes.

Supporting Australia's National Hydrogen Strategy:

- Accelerate the application of hydrogen at scale
- Build the local hydrogen industry
- Grow the local supply chain
- Market diversification for exporters
- Build local capacity and skills

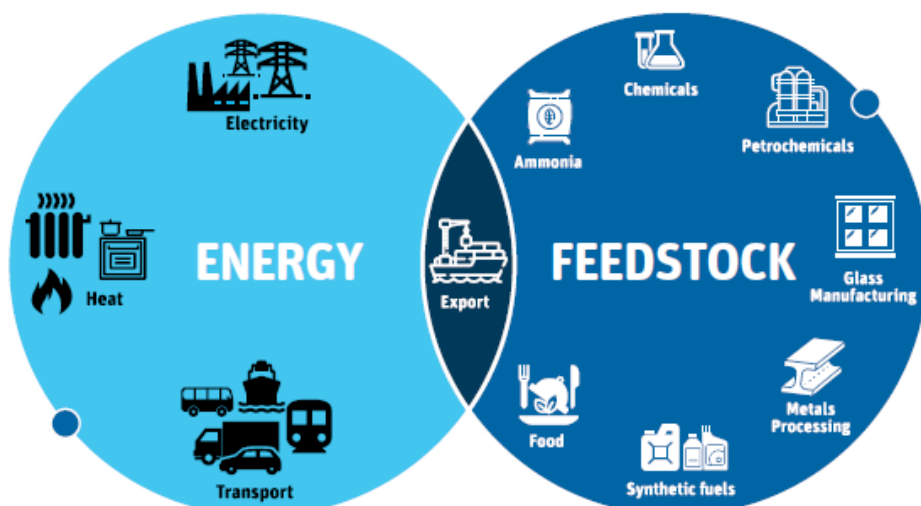

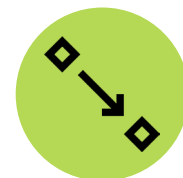


Figure from CSIRO's National Hydrogen Roadmap



**“THE MISSION POSSIBLE PLATFORM AIMS
TO ACHIEVE NET-ZERO CARBON EMISSIONS
BY MID-CENTURY FROM A GROUP OF
TRADITIONALLY ‘HARD-TO-ABATE’ INDUSTRY
SECTORS.”**

**ANTHONY HOBLEY,
EXECUTIVE DIRECTOR MISSION POSSIBLE PLATFORM,
WORLD ECONOMIC FORUM, 2020**



This program will identify:

- pathways for industry transformation
- pathways for commercialisation
- emissions along supply chains
- regional opportunities
- opportunities and unintended consequences of new/proposed policies and regulations.

Models will guide the development of carbon accounting and certification systems, tailored for heavy industry.

Questions such as where to establish new processes, which technology options make the most sense and how best to transition are multi-dimensional and complex. HILT CRC will create and evaluate alternative pathways, drawing on process-specific techno-economic evaluations of the process and the larger systems in which they operate.

Roadmapping

What are the merits and risks of policy drivers being considered around the world, such as carbon targets, market schemes and economic incentives? HILT CRC will identify ways to minimise and share the investment required, provide a 'shared voice' to engage government, and be a platform for intra-industry consensus.

Drawing on existing roadmaps for individual industrial processes and for cross-cutting technologies such as hydrogen, together with regional plans and new opportunities in the circular economy, HILT CRC will create a roadmap for the heavy industrial sector as a whole. It will:

- identify local, regional and national opportunities that will arise from investing in long-term sustainable and better-integrated industries
- identify ways to leverage from other investments in hydrogen and waste management
- identify methods for international cost-share
- analyse supply chains and value chains, investment options and reform opportunities
- develop and promote standards and regulatory processes.

Flexible energy integration

With the right technology, some challenges, such as the growing coupling between electrical and fuel networks, variability of power prices and the growing penetration of intermittent renewables, could be turned into economic advantages. Heavy industries could become a more effective producer/consumer ("prosumer") of fuels and electricity, and could develop novel approaches to switch between, or hybridise, alternative energy sources.

HILT CRC will investigate, through modelling and forecasting, the relative merits of new technologies and how they can be integrated or hybridised to achieve minimum cost, lowest carbon intensity and stable operation.

Future scenario analysis

Scenario analyses will build on the outcomes from the roadmaps and the modelling assessments, to evaluate a range of alternative scenarios. Developed under the guidance of HILT CRC Steering Committee, they will:

- Identify value propositions for regional investment in infrastructure, such as ports or network extensions, which could unlock new export opportunities
- Evaluate the extent of potential cost reductions in supplies of low-carbon feedstock through development projects under consideration
- Compare the relative merits of alternative sites for future greenfield investments in carbon-neutral processing plants of relevance to the partners.

Streams

- a) Heavy industry roadmaps and scenario analyses
- b) Supply chain development and commercialisation pathways
- c) Community engagement and sustainability leadership
- d) Technology commercialisation.

Anticipated outcomes

- Pathways both for individual sectors to drive effective decarbonisation and for synergistic transformation at regional, national and international scales
- Cost-benefit assessments of pathways to reduce supply-chain CO₂ emissions
- Carbon accounting and policy think-tank, which will monitor, support and engage in emerging policy initiatives to understand the impacts on heavy industry
- Techno-economic assessments of alternative options to manage variability in resource availability and/or prices
- Scenario analyses of the investment scenarios in greenfield carbon-neutral plants
- New intellectual property, including patents and know-how, supported by commercialisation plans and paths to market.

Industry participation opportunities

The HILT CRC is aiming for a total cash budget of \$80 million over the 10-year life of the CRC.

IP rights will be managed at a project or program level within The HILT CRC (see 'Research program structure', page 6), to protect partner investments. Funds and IP rights within the programs will be allocated in proportion to industry funds committed. Small-to-Medium Enterprises (SMEs) are encouraged to join to translate the innovations and roll them out to industry.

PARTNER TIER	INVESTMENT LEVEL (Average)	BENEFITS
Core	\$250k p.a. and above plus in-kind contributions	<ul style="list-style-type: none"> • Membership of CRC Entity and associated voting rights. • Partners who contribute significantly above the minimum threshold for core membership will have the option to discuss rights to one extra vote for every \$100k p.a. above the threshold. • First rights to Project IP at no cost in project agreements, with 6 months to take up. • Primary rights to IP arising from projects of core interest (pro-rata to contributions), within a framework in which all partners benefit. • All rights associated with the lower partner tiers in this table.
Key	\$100k p.a. and above plus in-kind contributions	<ul style="list-style-type: none"> • Nominate research priorities for consideration by the Steering Committee • Be a representative on program, project and partner committees • Access to Project IP rights at a discounted rate in project agreements aligned with core interests, with 6 months to take up. • Access to pilot program and CRC facilities. • Access to the CRC's industry embedded PhD program. • All rights associated with the lower partner tiers in this table.
Affiliate	Any cash contribution plus in-kind contributions	<ul style="list-style-type: none"> • Be a representative on project and partner committees. • Access to Project IP rights on a commercial basis in project agreements, with 6 months to take up. • If applicable, royalty returns from the commercialisation of IP in proportion to the partner's cash contributions to the CRC. • All rights associated with the lower partner tiers in this table.
Associate	In-kind contributions only	<ul style="list-style-type: none"> • Be a representative on partner committees. • May be eligible for tax offsets under the R&D tax incentive.

Staggered cash-flow

The cash flow from members will ramp up over the first three years to achieve the average values shown above. This will allow the scale of the research to ramp up progressively and to accommodate the current, COVID-19-affected global financial situation. Details of the cash flow requirements must be finalised by the members before the submission of the Stage 2 proposal to the Australian Government.

Partners have the right to exit their partnership with The HILT CRC after providing 12 months' notice. This provides time for the CRC to engage with alternative partners to cover the gap in contributions and to meet matched funding obligations under the Commonwealth Agreement.

Bid development costs

Core and key partners are asked to contribute funding towards the Stage 2 bid development.

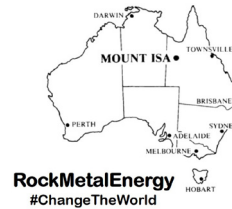
R&D Tax Incentive

Where sponsorship of The HILT CRC is from an Australian entity it may qualify for a tax offset under the Australian Government's R&D tax incentive. The incentive provides up to 43.5% refundable tax offsets for eligible entities to encourage and support industry to conduct R&D.

Industry partners

HILT CRC has already secured strong support, with the following organisations signed up as Core, Key, Affiliate or Associate partners.

End users



Equipment, technology and service providers



Government and industry associations



Department of
Jobs, Tourism, Science
and Innovation



Relationship with other CRCs and initiatives

The HILT CRC will continue to build relationships with major national and international programs to ensure strong leverage and complementary of effort. Together, we will identify and prioritise technologies and expertise of strong relevance to The HILT CRC partners, and will likely focus on those that have already received substantial investment.

Partnerships will particularly be sought where there is strong co-investment. This will take place formally and informally as the programs are rolled out and synergies with other initiatives emerge.

National programs with which we will seek to establish mutually beneficial partnerships include:

- Future Fuels CRC – particularly where mutual benefit exists from augmenting the establishment of low-carbon hydrogen
- Australian Solar Thermal Research Institute (ASTRI) – to leverage opportunities to demonstrate novel solar thermal process heat and fuels technology
- Steel Research Hub – to leverage synergy into green steel production
- Future Battery Industries CRC – particularly in work to transition heavy industry to battery-supported vehicles and machinery
- Future Energy Exports CRC – to leverage synergy into maximising opportunities in export value chains.

Research organisation partnerships

HILT CRC engages with Research Organisations to explore the options of either direct participation as partners or of collaboration via other funded programs. CRCs must foster high-quality research directed to solve industry-identified problems. They are a proven model for linking researchers with industry to focus and drive industrial innovation.

Our research partners have been selected because they have the best researchers and research programs in the world related to decarbonising heavy industry energy processes.

HILT CRC:

- is seeking to support 60 higher degree by research students across the university partners
- will count in-kind contributions of staff when evaluating the shares in project IP
- will link research organisations to a network of heavy industry processing companies, technology and service providers, research organisations and SMEs
- will host forums to help to drive the heavy industry transition, addressing relevant technology, market and policy issues.

Research partners

The following organisations have signed up as Research partners.





**“IN THIS TRANSFORMATION PROCESS, NEW,
HIGH-VALUE OPPORTUNITIES ARE GOING TO
EMERGE FOR AUSTRALIA.”**

PROFESSOR GRAHAM (GUS) NATHAN,
DIRECTOR, CENTRE FOR ENERGY TECHNOLOGY,
THE UNIVERSITY OF ADELAIDE

Education and training program

The HILT CRC will lead the upskilling of the heavy industry's workforce, enabling skilled personnel to transition the sector to a low-carbon sector. Retraining will also be offered to skilled people whose jobs have been lost in the COVID-19 crisis, and to others looking to reskill.

A dedicated education and training program will be established to take advantage of the highly innovative environment. A proposed ~7.5% of The HILT CRC's budget be allocated to the program which will build on established education and technology transfer infrastructure in the sector, both within industry and universities.

The goal is to build capacity for innovation and leadership.

Industry Program

Short courses will be created and delivered to provide life-long learning for industry employees. These will be designed to support a structured 'ladder of learning' for industry partners, and will include findings from The HILT CRC research programs.

Courses will draw upon vocational education and training (VET) principles. Undergraduate and coursework master modules may be created to provide formal qualifications, if required/ desired. With workforce shortages and skills gaps in regional areas, alternative delivery methods such as web-based learning and weekend block courses could be made available if regional industry partners require these.

Postgraduate Program

The will include postdoctoral fellowships for promising young researchers in the industry, doctoral scholarships (both full and 'top-up') to support research in the field with industry placements, and a mid-career professional development master by coursework program for industry employees. Industry-embedded training positions will be made available.

Tertiary Undergraduate Program

This program will start with research into labour market needs, such as workforce shortages and skills gaps, the appropriateness of traineeship and apprenticeship learning packages, and ways of overcoming low retention rates among trainees and apprentices. Next, course material will be developed for tertiary and VET courses in fields such as hydrogen safety, concentrated solar energy and mineral processing technologies. The CRC will provide **Honours Research Awards, Summer Scholarships and Work Experiences** for near-final year undergraduate students.

Secondary schools education

This program will create an informative and interactive website that will provide support material and information for the study of new technologies. Information on careers in heavy industry and renewable energy sectors will encourage school-leavers to seek further study and employment in these industries.

International experience and collaboration

The HILT CRC will encourage international experience and collaboration as part of the education and training program through activities such as exchanges. It will offer guest lectures and seminars and student research placements and exchanges with overseas universities. Students and researchers will be encouraged to attend and present at international conferences.

Governance and management

Governance

The HILT CRC will be an incorporated not-for-profit entity limited by guarantee with:

- an independent, skills-based Board of Directors appointed by industry partners, with a view to ensuring alignment with HILT priorities and equity principles it will be led by a CEO with an industrial rather than academic background
- partners represented on an Industry Steering Committee, which makes recommendations about projects to the Board
- a board member assigned to liaise with each partner to ensure direct linkages between the management and its board.

All income will be expended on research, education and related activities so that The HILT CRC will not be liable to pay tax. Profits, if any, will be reinvested.

IP and commercialisation principles

IP arrangements will be structured to maximise the financial benefits to The HILT CRC partners pro-rata to their contribution, while also fostering market penetration. IP will be managed at a project or program level, to allow each partner to be engaged in different projects. The management of IP at the project or program level is attractive for most companies, allowing them to participate in activities best-suited to their capability and to achieve a commercial advantage.

The exact terms will be negotiated at the start of each project to provide complementary benefits to different partners, including royalties, preferential access and/or segmented market rights.

We anticipate that any new IP will be owned either directly by The HILT CRC, or that the ownership can be transferred to other companies that the Board may approve to take new technologies forward on a case-by-case basis.

The HILT CRC will seek to maximise benefits to its partners rather than to the revenue from licensing income. It will seek to diffuse IP into the supplier or end-user sector as rapidly as possible to facilitate rapid translation to commercial outcomes. The HILT CRC will be judged not on licencing income but on the extent to which it provides benefits to industry. In reviewing commercialisation plans for IP, it will seek the optimum business plan for commercialisation and to ensure an economic benefit relative to the contributions of the partners.

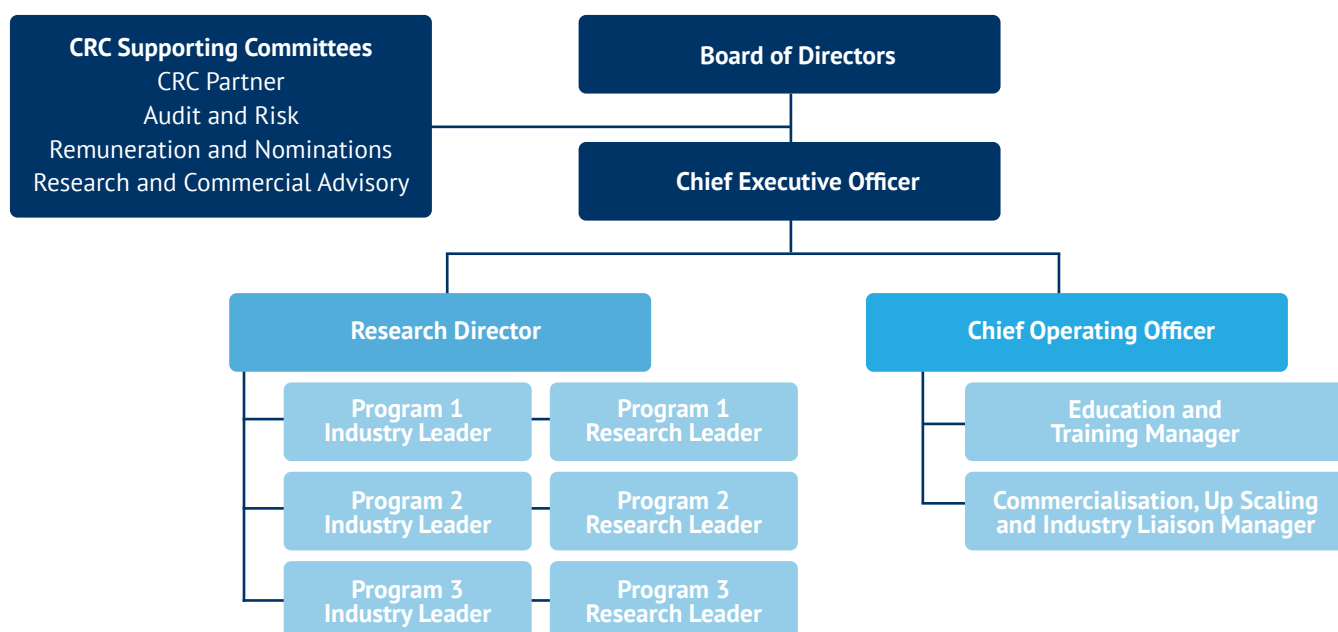
Regular workshops have been held with partners to develop the project plan and establish a suitable IP framework. This will form the basis of the IP agreement to be negotiated after the award of the grant.

CRCs are of maximum ten years' duration with no extensions or renewals. For example, a six- or eight-year CRC cannot be extended to ten years.

A ten-year CRC with three phases of three-year contracts and a major review between each phase is proposed (allowing three months' commencement time, three months between each phase, and three months' wind up time). Projects may run for three, six or nine years. The Participation Agreement would be for ten years with one-year's notice of withdrawal as is standard in CRCs, but with the understanding that withdrawals should be between the three-year contract phases in order that contractual commitments can be honoured.

Project approval process

Project proposals will be developed by researchers in consultation with industry. Projects will be selected by the Industry-chaired Steering Committee for recommendation to the Board.



Terms

- Ten years maximum duration.
- Three phases, with three-year contracts and major review between each phase.
- Projects may run for three, six or nine years, in addition to scoping studies.
- Participation Agreements will be for ten years, with one year's notice of withdrawal.
- Shorter Participation durations will be considered but are not preferable given the likely lengthy timeframes required from solution development to demonstration.

Contributions and structure

Our total funding goal is \$80 million in cash (\$8 million per year), comprising:

- ~\$40 million from the CRC Grants Program
- ~\$40 million from industry and research partners via the HILT CRC partner program.

To date (November 2020), partners have signed up to collectively contribute:

- ~\$25 million (industry partners)
- ~\$12 million (research partners)
- \$2 million (government partners).

A further \$105 million has been collectively committed as in-kind contributions from the partners.

Financial model

Of the total cash funding for the CRC, we anticipate the following approximate breakdown of expenditure:

- R&D projects 50%
- Administration and hosting of The HILT CRC headquarters and head office, etc. 12.5%
- Education and training programs 7.5%
- Large-scale demonstration projects 20%
- IP and commercialisation support 5%
- Contingency and funding for special acceleration projects 5%.

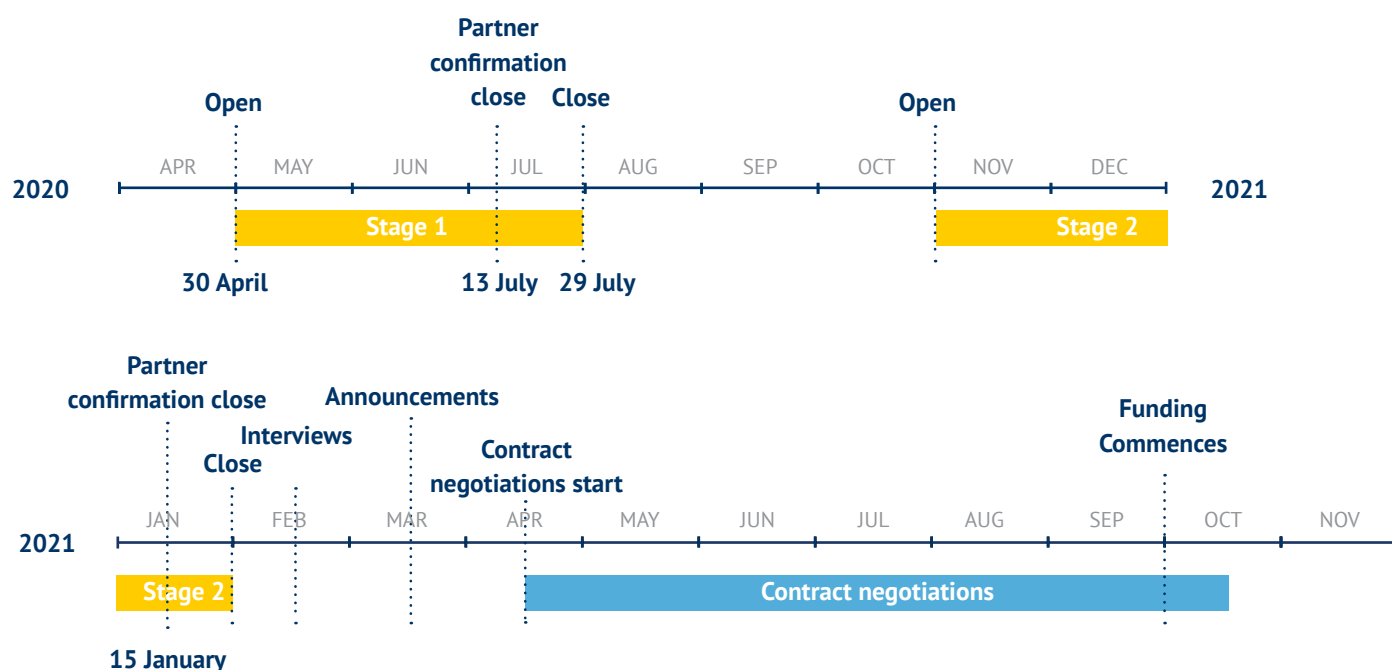
Additional resources for large-scale demonstrations

The HILT CRC will lead and support additional funding submissions to attract further co-investment from government and other partners to enable large-scale (including full-scale) demonstrations that are beyond the scope of the HILT CRC's currently requested budget.

Bid process timeline

CRC Grants Round 22 (subject to change):

- Stage 1 Open: **30 April 2020**
- Stage 1 Partner confirmation close: **13 July 2020**
- Stage 1 Close: **29 July 2020**
- Stage 2 Open: **November 2020**
- Stage 2 Partner confirmation close: **15 January 2021**
- Stage 2 Close: **January 2021**
- Interviews: **February 2021**
- Announcements: **March 2021**
- Funding commences: **1 October 2021**
- Contract negotiations start: **mid April 2021**



Disclaimer

The information herein is provided as a potential working model for a future HILT CRC. The nature of HILT CRC is likely to change from the working model herein as consultations continue with government, companies, research organisations and SMEs.

The working model is that over its ten-year life HILT CRC receives cash contributions of ~\$40 million from industry and research organisations, and ~\$40 million from the CRC Program. Additional in-kind contributions are required from research organisations and anticipated from government and industry partners. The partnership levels for individual projects will evolve as project budgets, numbers of partner companies for each project and the amount of funding from the CRC Program become clear.

References

¹ Philibert, 2017

² Suenaga, 2018

³ Grand View Research

⁴ DeGaris, 2018

⁵ Parham, 2018

⁶ Nathan, 2018

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