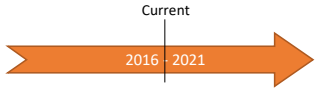
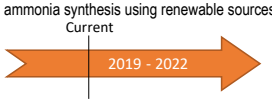
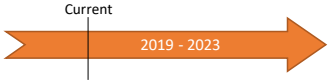
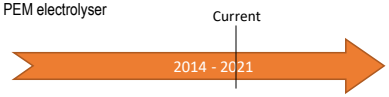
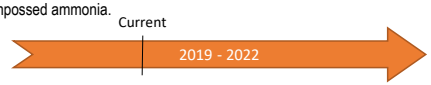
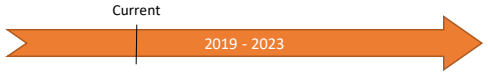
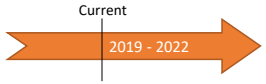
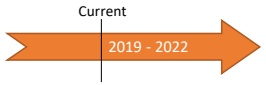
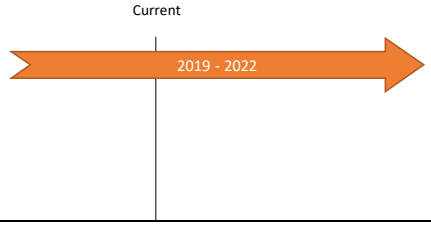
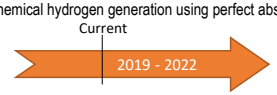
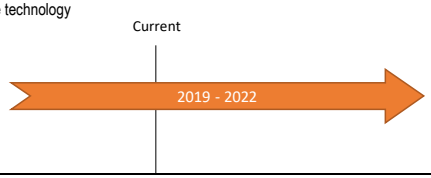
Country	Institute	Category	Related programs (with short summary)	Target / Goal Outcome	Lead person / Organization	Partnership (if any)	Related information
Australia	CSIRO	Production	Development of PEM electrolysis technology and kW class systems for distributed and off-grid applications 	Development of low cost electrolysis cells, stacks, BOP and control & safety system for building 1-2 kW PEM electrolysers.	Dr Sarb Giddey / CSIRO	ATCO Gas, WA	This technology is currently being discussed with ATCO Gas and MSV for further development, field trials and commercialisation.
			Developemnt of solid oxide electrolysis for steam / CO2 electrolysis for production of hydrogen, syngas and liquid fuels 	Development of catalysts, materials, cell designs for steam / CO2 electrolysis to build a prototype reactor that consumes less than 40 kWh/kg hydrogen for integration with liquid fuels synthesis reactor	Dr Ani Kulkarni / CSIRO	ARENA, Johnson Matthey, Ben Gurion Uni,, Northwestern Uni, RayGen, ADME Fuels	An external consultant has been hired (with funding from Innovation Acceleration Fund) to work with the team on commercialisation roadmap for the best use cases of the hydrogen production from this technology.
			Basic R&D for electrochemical ammonia synthesis using renewable sources of electricity. 	Develop catalysts (graphine/CNT, biological), materials and cell design for ammonia synthesis.	Dr Gurpreet Kaur / CSIRO	CSIRO Hydrogen FSP / strategic areas of research, RMIT University	
			Enzymatic pathways for hydrogen and ammonia production 	Using nitrogenase enzymes as athe basis of a new production technology that converts sunlight, water, and air to hydrogen and ammonia under ambient conditions.	Dr Craig Wood / CSIRO	ANU	
			Microbial hydrogen production from waste streams 	Integrating waste management with hydrogen production using microorganisms	Dr Anna Kaksonen/CSIRO	UWA	
		Transportation / Storage	Development of metal membrane based reactor for ammonia production at low pressures by sourcing hydrogen directly from a PEM electrolyser 	Development of catalysts, membrane materials, interfacial designs, and a prototype system to produce ammonia at a kg scale from renewable electricity.	Dr Sarb Giddey / CSIRO	ARENA, Orica, GRDC	
			Development of solid state hydrogen compressor for domestic use (small scale re-fuelling of fuell cell electric vehicles) / Fundamental research into metal hydride materials capable of compressing H2 using low grade heat sources (2018 - 2021) 	Development of a prototype solid state H2 compressor designed to deliver 350 bar H2	Dr Ashleigh Cousins / CSIRO	(Domestic) Griffith University	
			Commercialisation of CSIRO's metal membrane technology. This project aims to scale up the production of CSIRO's hydrogen separation membranes and construct two pilot plants each capable of producing 200kg/day of fuel cell quality hydrogen from decompossed ammonia. 	Demonstrate the viability of exporting hydrogen in the form of ammonia and extracting ultra high purity hydrogen at the point of use with a production rate of 200kg/day.	Dr. David Viano / CSIRO	(Domestic) Fortescue Metals Group Limited	https://www.csiro.au/en/News/News-releases/2018/CSIRO-tech-accelerates-hydrogen-vehicle-future
			Basic R&D into new carriers and pathways for hydrogen storage and distribution 	Direct production technologies for methanol and ammonia, as well as increasing our understanding of ortho-para conversion of hydrogen during liquefaction and new conversion processes for LOHCs.	Various - contact Dr Daniel Roberts / CSIRO	Various	

		Utilisation	Basic R&D for direct ammonia utilisation in a solid oxide fuel cell for power generation 	Develop catalysts, materials and cell design for ammonia cracking and hydrogen oxidation in the fuel cell.	Dr Ani Kulkarni / CSIRO	CSIRO Hydrogen FSP / strategic areas of research, RMIT University	
			Ammonia combustion in modified diesel engines 	Slow-speed ammonia engines allow distributed power generation without the need for cracking to H2, and also support decarbonisation of global shipping	Dr Louis Wibberley / CSIRO	FMG	
		Production	Development and demonstration of direct thermochemical reactors for production of hydrogen, syngas and liquid fuels using beam-down field configuration 	Development of catalysts, materials, cell designs for direct steam / H2 reaction, to build a prototype reactor for 250kWth solar field with liquid fuels synthesis reactor	Rob McNaughton / CSIRO	ARENA, Niigata University, Japan Institute of Applied Energy (IAE)	Field re-configuration underway. Optics commissioned by early 2021. Beam-down reactor can then be further configured for reserach into direct and indirect minerals processing. Will be infrastructure central to Newcastle Renewable Energy Demonstration Hub and input to the CSIRO Hydrogen Mission. https://arena.gov.au/projects/solar-thermochemical-hydrogen-research-and-development/
			Basic R&D for photoelectrochemical hydrogen generation using perfect absorber materials 	Develop catalysts and semiconductor materials + cell design for hydrogen generation	Dr Noel Duffy / CSIRO	CSIRO Hydrogen FSP / RMIT University	Next stage of projects will look at larger scale systems for increased generation.
			Development and demonstration of indirect production of hydrogen, syngas and liquid fuels using falling particle reciever and heat exchange technology 	Development of falling particle receiver (light capture andheat storage) systems for electricity and indirect steam / H2 reaction. A ~1MWth solar field with integrated heat capture and storage for industrial heat applications including hydrogen, ammonia and alternative liquid fuels.	Dr Jin-Soo Kim / CSIRO	ARENA, Sandia National Laboratories, ASTRI, US DoE	Field re-configuration underway. Receiver/storage commissioned by early 2021. System can then be further configured for reserach into indirect industrial heat processes. Will be infrastructure central to Newcastle Renewable Energy Demonstration Hub and input to the CSIRO Hydrogen Mission.

Country	Institute	Category	Related programs (with short summary)	Target / Goal Outcome	Lead person / Organization	Partnership (if any)	Related information
Australia	CSIRO	Electrochemical CO2 utilisation	Developemnt of solid oxide electrolysis for steam / CO2 electrolysis for production of hydrogen, syngas and liquid fuels Current 2016 - 2021	Development of catalysts, materials, cell designs for steam / CO2 electrolysis to build a prototype reactor that consumes less than 40 kWh/kg hydrogen for integration with liquid fuels synthesis reactor	Dr Ani Kulkarni / CSIRO	ARENA, Johnson Matthey, Ben Gurion Uni,, Northwestern Uni, RayGen, ADME Fuels	
		CO2 storage| In Situ Laboratory	2018 - 2021	Using an existing well (Harvey-2), CSIRO researchers will strategically place monitoring instruments in order to conduct a shallow CO2 release test in the subsurface area.	DR Karsten Michael / CSIRO		https://www.csiro.au/en/Research/EF/Areas/Low-emissions-technologies/CCS/In-situ-lab
		Post-combustion CO2 capture	PICA Project: 5000 hour evaluation of an advanced Post-Combustion CO2-capure process (PCC) with two advanced liquid absorbents for application in Victorian brown coal fired power 2015 - 2019	Evaluation of robustness and energy performance of two advanced amine-based processes for CO2 capture in preparation of larger scale demonstration in the Latrobe Valley	Dr Paul Feron, Mr Aaron Cottrell (CSIRO, Mr Takumi Endo (IHI)	CSIRO, IHI, AGL Loy Yang, ACI	https://www.csiro.au
		Methane production from atmospheric CO2	The technology development in this project aims to convert hydrogen produced from renewable electricity together with CO_2 from the atmosphere into a methane product that seamlessly fits in with existing energy export chains and available infrastructure 2018 - 2021	Development of efficient liquid absorbent technologies for CO2-capture from air Aim for methane production costs of $10/GJ excl. hydrogen production costs	Dr Paul Feron, Dr Ali Kiani	CSIRO, ARENA	https://www.csiro.au

Country	Institute	Category	Related programs (with short summary)	Target / Goal Outcome	Lead person / Organization	Partnership (if any)	Related information
Australia	CSIRO	Solar Electric vehicle charging	2014 - ongoing (R&D span) CSIRO began investigating barriers for EV adoption in Australia. Charging infrastrucutre was identified as being a key area where there could be improvments. Areas identified as problematic are charging in homes with multiple cars, large groups of vehicles and remote fast charges.	CSIRO has worked with industry to develop new charging stations to allow for greater adoption of EV's in Australia. Initial work has developed a home charging statioin that intergrates home charging, PV and battery storage. Future work is looking to develop battery buffered fast chargers.	Dr Christopher Munnings / CSIRO	Nissan (Australia), Delta electronics (Australia), SME connect (Funding), Victorian Government (Funding)	https://www.csiro.au/en/News/News-releases/2019/PV-for-your-EV-solar-tech-powers-electric-cars-through-summer and https://blog.csiro.au/solar-powered-electric-vehicles-cars-charged/
		Demonstration projects and the centre for hybrid energy systems	2014 - ongoing (R&D span) CSIRO works with a wide range of industry partners to help them to understand how new technologies can be used within their current business model and to also allow them to hybridise technologies that they manufacture to creat new products. We also work internally with groups in CSIRO to build prototypes using experimental CSIRO technology	CSIRO works with many industrial partners advising them on how emerging technologies can be used within their business with the goal being to accelerate adoption of new energy technologies.	Dr Christopher Munnings / CSIRO	EnergyAustralia, Melbourne Cricket Club, Sydney Opera House, Telstra, ATCO gas, Fortescue Metal Group, Woodside,	www.csiro.au/CHES
Australia	CSIRO	High-efficiency photovoltaics	2014 - ongoing (R&D span) CSIRO is developing a scaleable process for increasing the efficiency of silicon solar cells to >30% PCE using a tandem cell configuraiton of perovksite semiconductor on silicon wafer. With increased demand on photovoltaics as a preferred renewable energy source, this creates demand for new technologies that greatly exceed current commercial products that will reduce impact on demand for resources and energy intensity for manufacture.	Wafer-scale demonstration of perovskite-silicon tandem cells >30% light-to-electrical power conversion efficiency (PCE)	Dr Gregory Wilson / CSIRO	CSIRO, UNSW, Tindo Solar	
Australia	CSIRO	Solar Thermal Energy	CSIRO began researching high temperature solar thermal power in 1996, and has established itself as a world leader in this field. The R&D activity has since been enhanced by the establishment of the Australian Solar Thermal Research Institute, led by CSIRO and with six collaborating universities.	The key goal is the development of high temperature processes, materials and components with the aim of <7c/kWh dispacthable solar power, ie including storage. It also includes the development of non-electricity applications including solar fuels and heat for industrial processes.	Wes Stein	QUT, UQ, ANU, Flinders Uni, UniSA, Adelaide Uni.	www.astri.org.au