

Pacific Hydrogen Roadmap

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Presented by Iain MacGill, based on the work of the UNSW team, and particularly Dr Rahman Daiyan and Dr M. Haider Ali Khan

UNSW SYDNEY
Australian Government Department of Climate Change, Energy, the Environment and Water
GlobH2E ARC Industrial Transformation Training Centre for the Global Hydrogen Economy
IRENA International Renewable Energy Agency
USP The University of the South Pacific
Pacific Community Communauté du Pacifique

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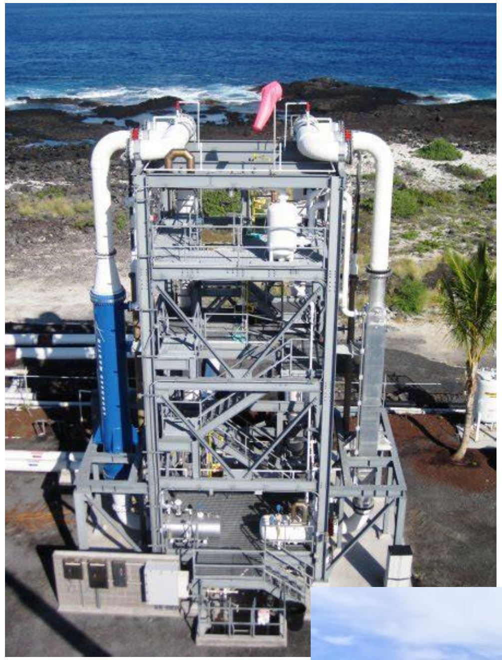
A key planning, deployment and operational challenge

assessing promising but still emerging energy technologies for the Pacific

- Established technologies with expanded roles
  - High level PV integration into island grids
  - Battery Energy Storage Systems (BESS)
  - Off-shore wind
- New variations on existing technologies
  - Floating PV
  - Enhanced geothermal technologies
  - New biomass technologies
- Emerging technologies
  - Ocean Energy options
  - **Hydrogen and its derivatives**



Deployment of emerging technologies in the Pacific

- Possible strategies to manage technology risks
  - Regionally relevant R&D and demonstration
  - Readiness assessments
  - Pilot projects
  - Ongoing Independent expert review and assistance for the region
  - **Tools that help us assess potential role of these technologies while minimizing risks and regret**
  - **Technology roadmapping**

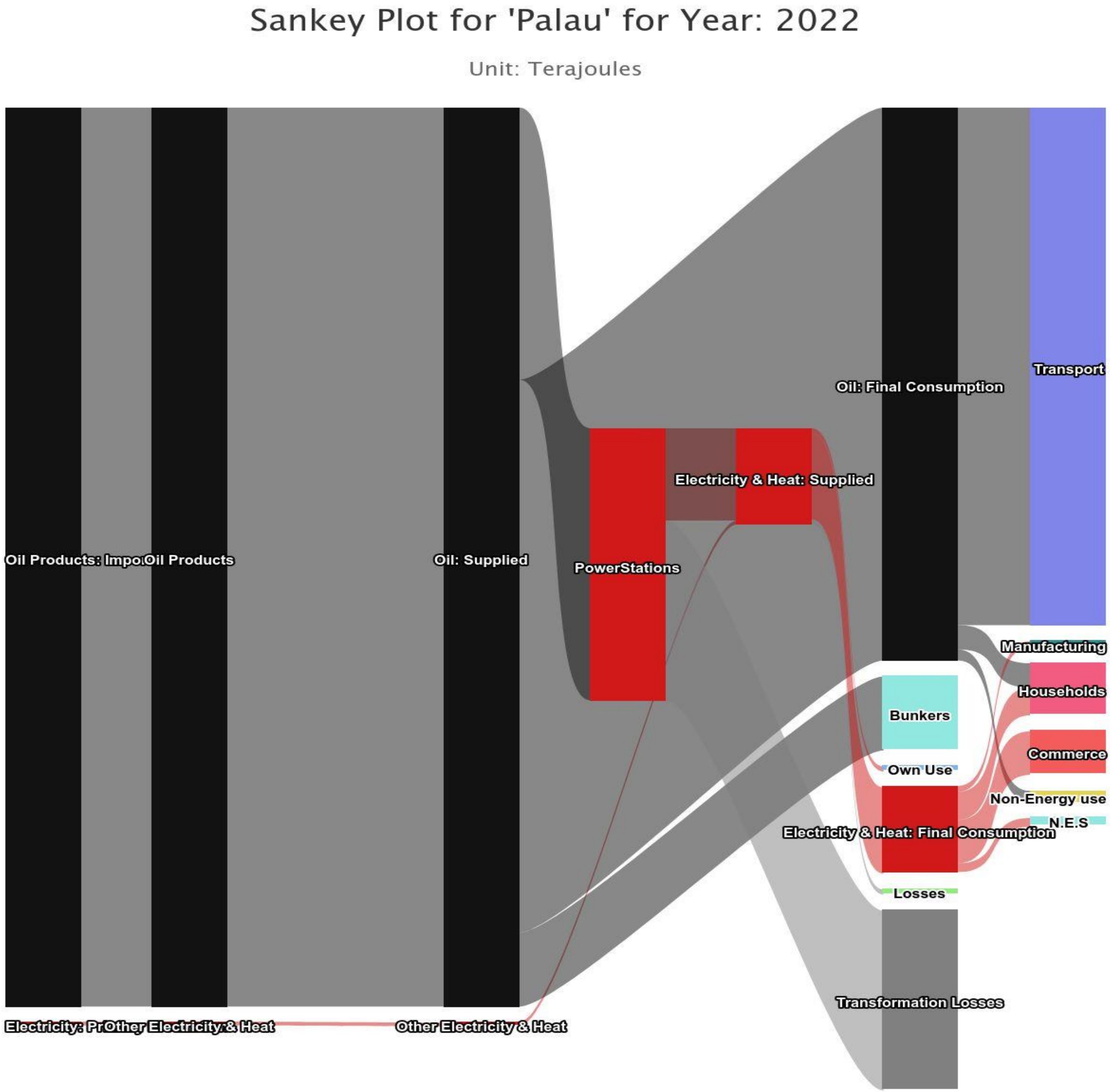
Leading Edge vs. Bleeding Edge

- Bleeding Edge: When failure occurs because an organization tries to be too far out on the technological leading edge

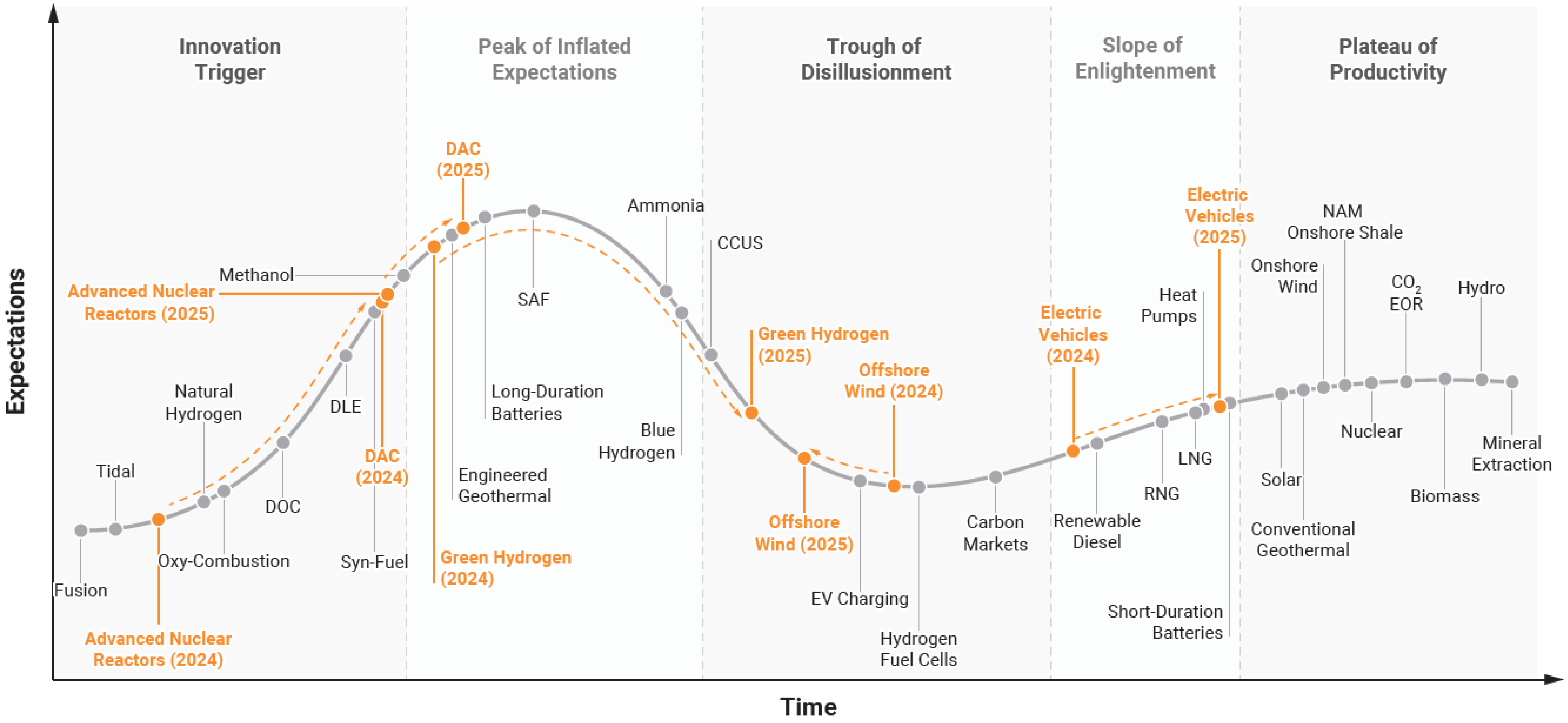
Clean energy transition –
isn't just cleaning up electricity

- Palua oil use dominated by transport – 30% road, 70% domestic naviation
- Bunkers consumption is for international aviation.

- **Electrification might cover all/most road transport, some short haul domestic navigation, *but what of other shipping, aviation***

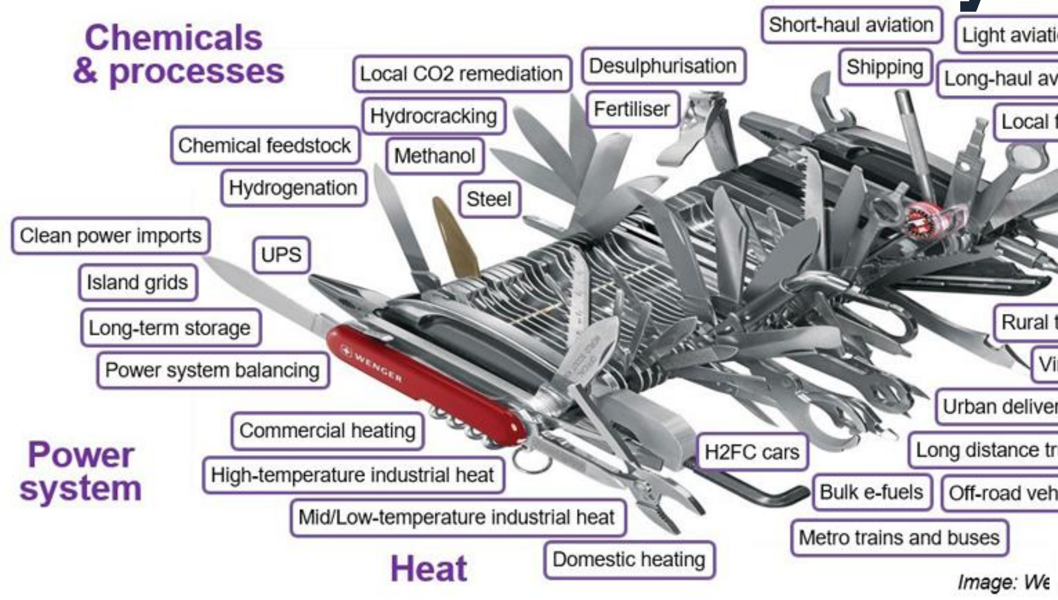


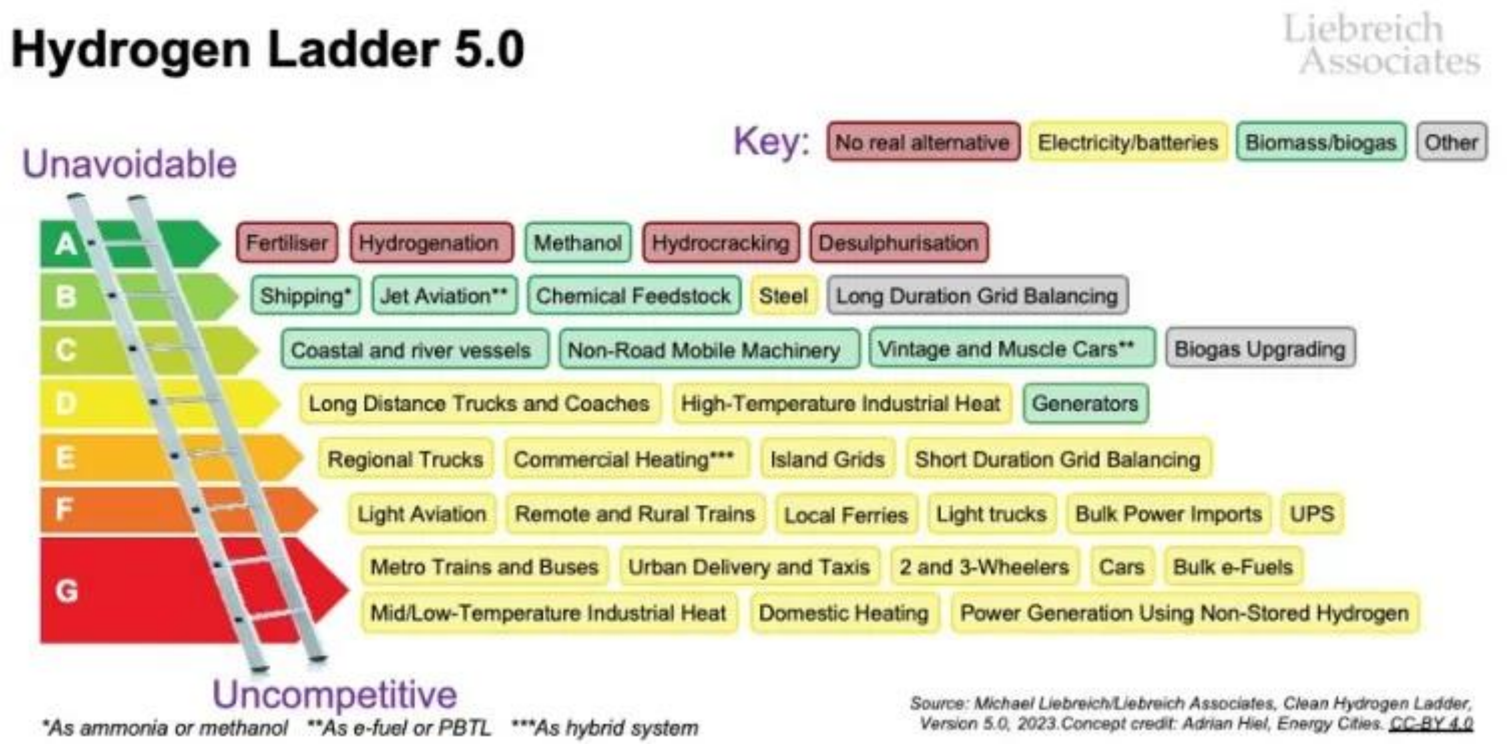
The h2 hype bubble has burst – time to get to work



Source | Enverus Intelligence® Research

H2 – the swiss army knife of energy, or a ladder?



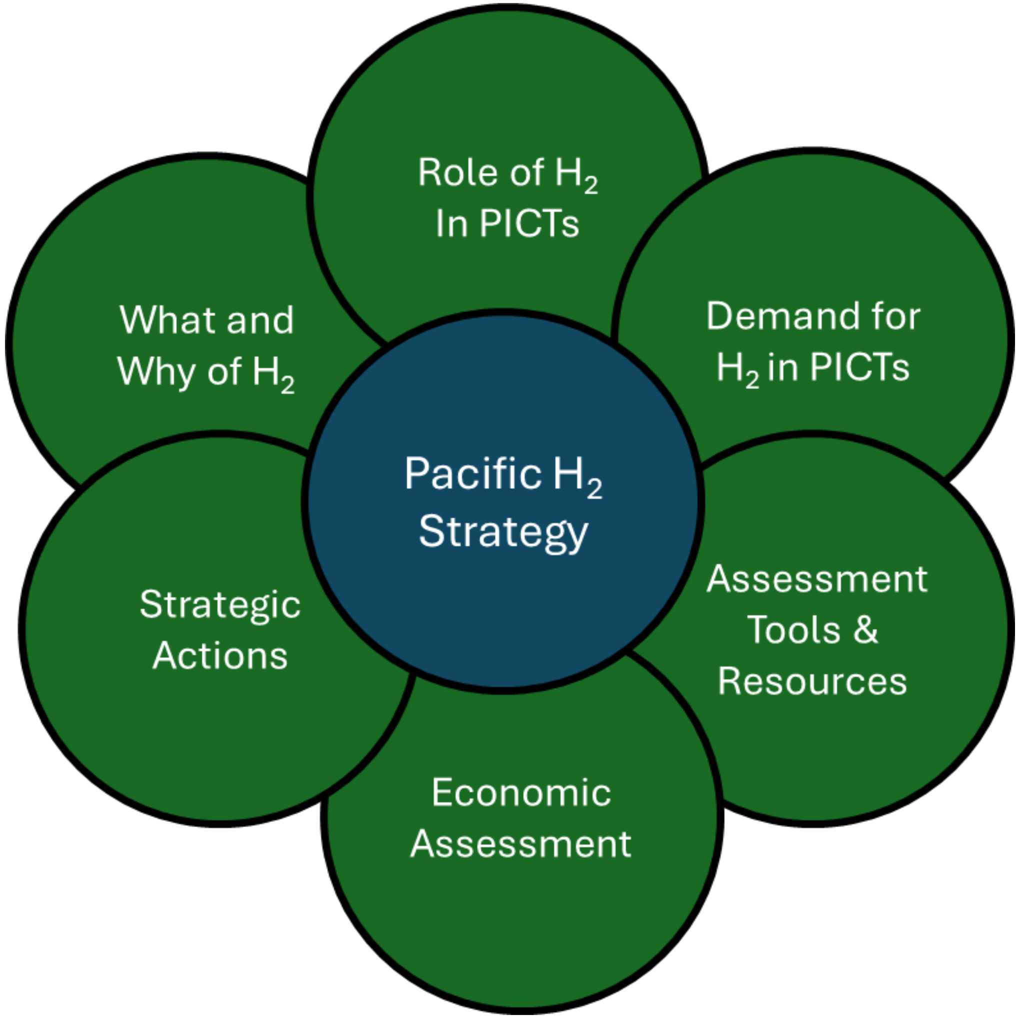


- H2 can do just about anything – the Swiss army knife of energy, wonderfully flexible, but you often have a better tool
- **The hydrogen ladder highlights that there is competition to h2 on many possible tasks**
- **A key issue for the pacific – likely restraints on local renewable generation means clean fuel imports likely required**

Project Overview

- The 2023 PRETMM Efate outcome statement recognises the need to consider the potential of green hydrogen and its derivatives in decarbonising the region. This included **endorsing the development of a timebound Pacific regional green hydrogen strategy.**

- Responding to this request, DCCEEW has funded UNSW Sydney consortia, supported by the International Renewable Energy Agency (IRENA) the Pacific Community (SPC), and the University of South Pacific (USP), to lead the development of a Pacific Hydrogen Strategy.

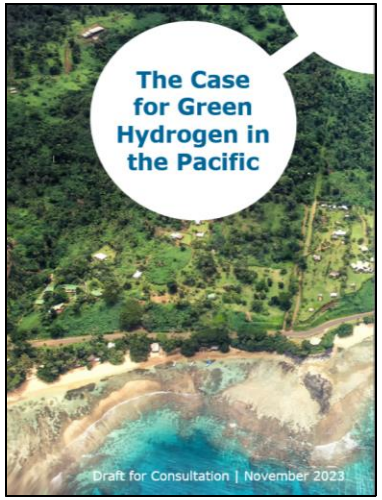


Project Overview

Reports

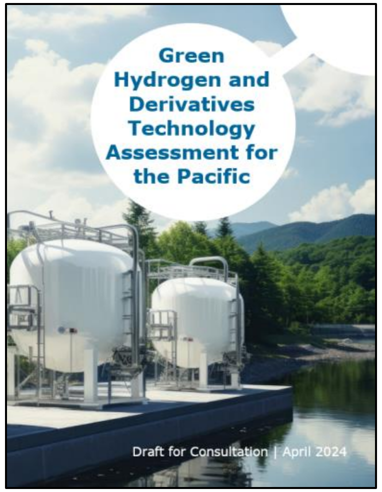
Assessing the H_2 Potential of the PICTs

Report A



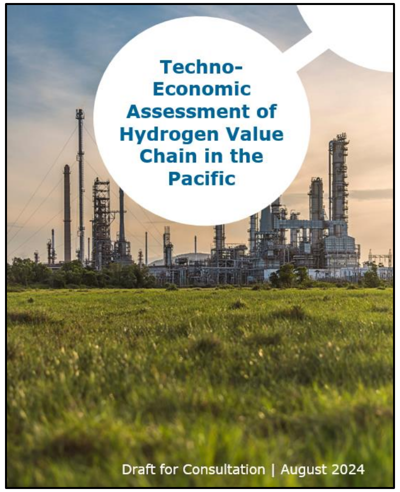
H_2 Technology Assessment

Report B

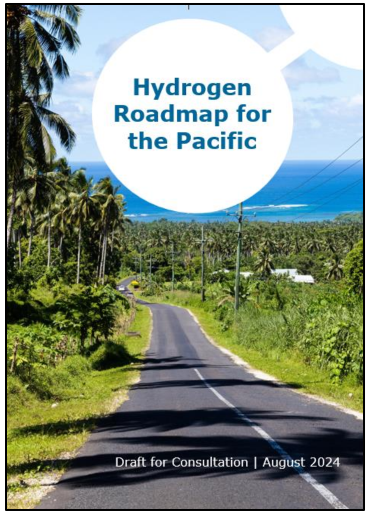


Technoeconomic Mapping of Pacific H_2 Value Chain

Report C



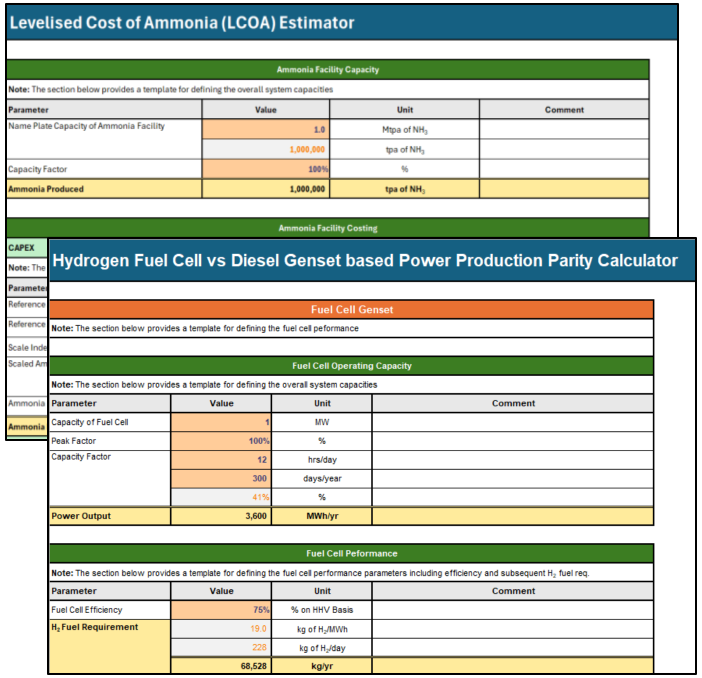
Strategic Actions for Advancing PICT's H_2 Opportunity



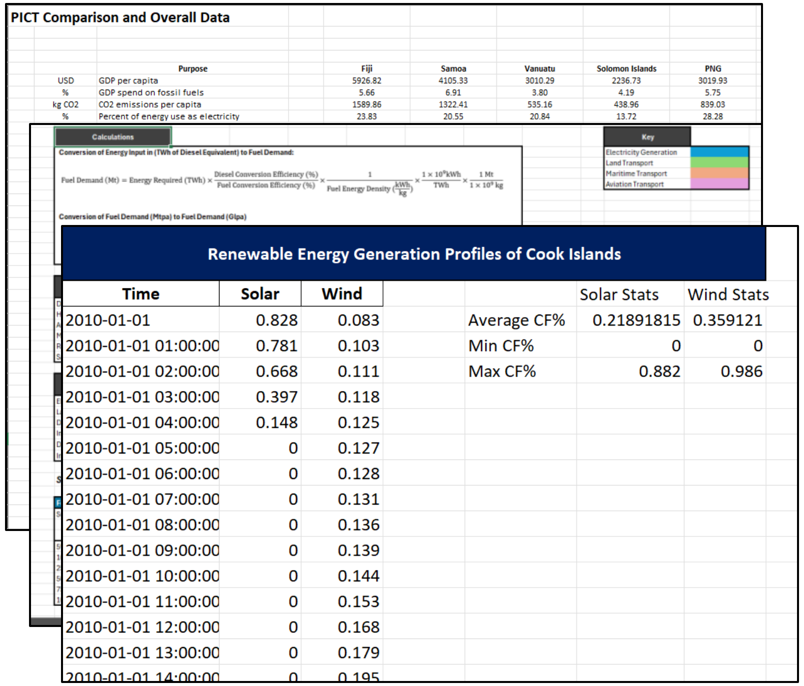
Report D

Project Overview

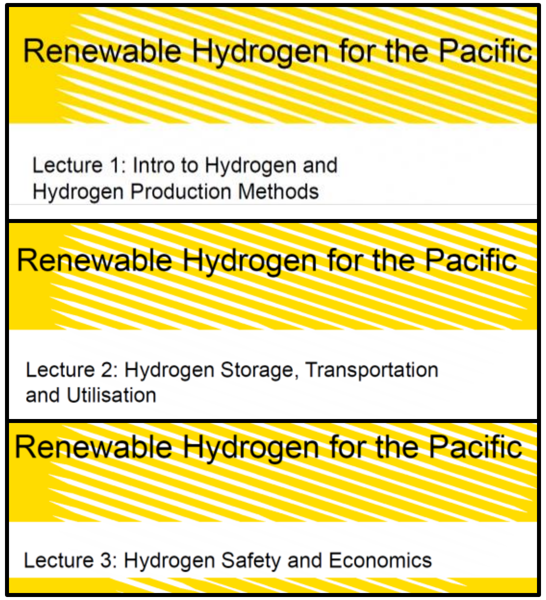
Resources



Tools



Database



Masterclasses

Report A: Overview

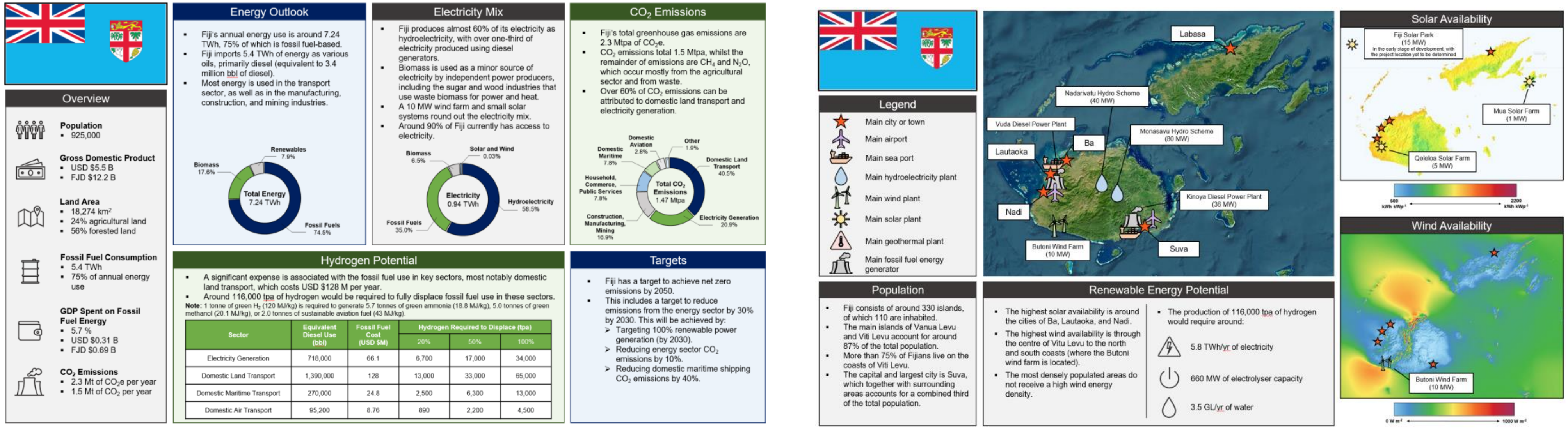
Purpose	Key Findings
▪ PICT-specific analysis of energy outlook, fossil fuel consumption, electricity mix, CO_2 emissions. ▪ PICT-specific assessment of sectors that face decarbonisation challenges using electrification. ▪ Indicative potential for hydrogen and derivatives in key sectors.	▪ **Over 6% of the combined GDP** of the PICTs is spent on imported fossil fuels, making up **~70%** of regional energy supply and resulting in **10 million tonnes** of CO_2 emissions. ▪ **1.1 Mtpa of H_2** and derivatives could play a complementary role to direct electrification in key sectors, including for electricity generation and mobility applications including the maritime and aviation industries. ▪ A **regional collaborated trade market** could entail the generation of bulk amounts of green fuels, that can be transported to the more remote and resource deficient regions across the Pacific to yield mutual benefits.

Status:

- Report A - Draft for Consultation is available on the Project Website (**https://pacifich2strategy.com/publications**).

Report A: Country Specific Assessment

- Country-specific assessments were undertaken to develop a state of play of the region (energy demand/supply, infrastructural resources and emission outlook).
- These assessments were carried out for Fiji, Samoa, Vanuatu, Solomon Islands, Papua New Guinea, New Caledonia, Kiribati, Federated States of Micronesia, Tonga, Cook Islands, Republic of the Marshall Islands, Tuvalu, and Nauru.
- The state of play was then used to develop a **case for H_2 and derivatives in the region (and identify potential end uses)**



Sector	Equivalent Diesel Use (bbl)	Fossil Fuel Cost (USD $M)	Hydrogen Required to Displace (tpa)		
			20%	50%	100%
Electricity Generation	718,000	66.1	6,700	17,000	34,000
Domestic Land Transport	1,390,000	128	13,000	33,000	65,000
Domestic Maritime Transport	270,000	24.8	2,500	6,300	13,000
Domestic Air Transport	95,200	8.76	890	2,200	4,500

FIGURE: EXAMPLE OF COUNTRY SPECIFIC ASSESSEMENT

Report B: Technology Assessment Across Value Chain

An in-depth assessment identifying H_2 and derivatives technology for generation, storage & distributing and eventual end use were identified and assessed for maturity.

The assessment considered and elaborates on:

- Background and description of each technology.
- Status of the technology and global market size.
- Technology suppliers.
- Current projects and decentralised facilities.
- Economics.
- Issues, challenges, opportunities for implementation within a Pacific context.

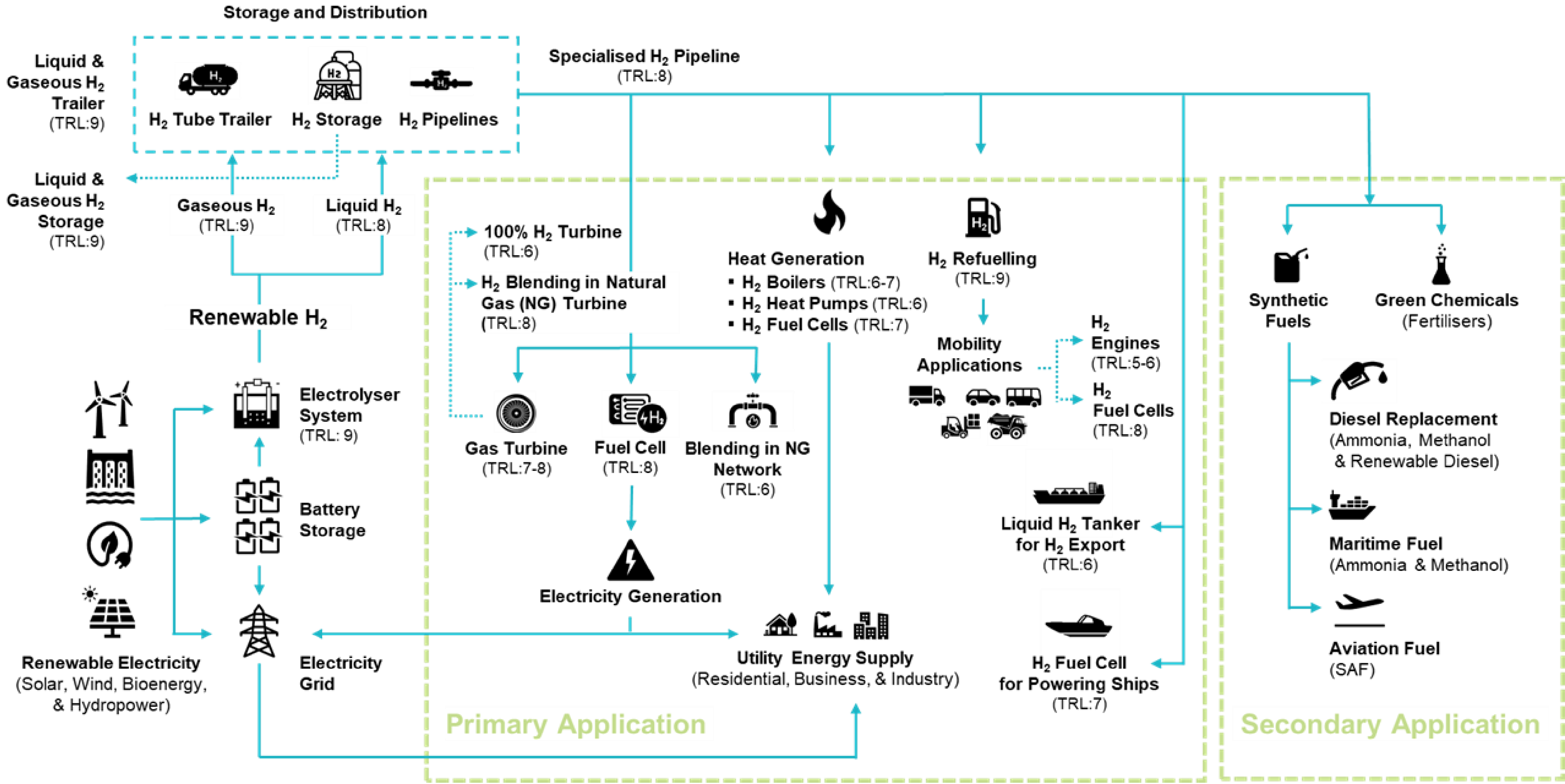


FIGURE: THE HYDROGEN VALUE CHAIN AND TRL OF RELEVANT TECHNOLOGIES.

Report B: Conclusion

- Based on the MCA result the end-use opportunities in the PICTs were reviewed. ***More targeted application for each fuel considering the economics, challenges, opportunities in a PICTs context.***

Application	Hydrogen	Methanol	Ammonia	Renewable Diesel	SAF
Seasonal power storage	✓			✓	
Power Generation	✓			✓	
Land mobility fuel	✓	✓		✓	
Maritime fuel		✓	✓	✓	
Aviation fuel					✓

FIGURE: REVISED EARLY MARKET OPPORTUNITIES FOR HYDROGEN TECHNOLOGIES IN THE PACIFIC REGION.

- A **near-term opportunity in the PICTs is the generation of biogenic fuels** like methanol, SAF, and renewable diesel using regional biomass resources, which can be produced at competitive costs and used as **drop-in replacements for fossil fuels through existing infrastructures.**

- **While e-fuels might initially be more suited for niche applications** like on demand power generation in remote areas using fuel cells powered with hydrogen. However, **widespread P2X technology distribution is hindered** by a lack of infrastructure and economics. Yet, **over the long-term**, the PICTs have the potential to become a green shipping corridor, supplying **maritime fuels like methanol and ammonia are key demands** due to lack of alternative solutions.

Report C: Assessment Framework

An assessment framework was developed to conduct the value chain modelling and costing

The framework has the following functionalities:

- **Demand Modelling:** Revise H_2/derivative demand based on energy scenario
- **Technical Viability:** Evaluate the technical viability based on feedstock and infrastructure requirement
- **Economic Viability**: Cost the value chain and provide a cost parity vs incumbent fossil fuel use.

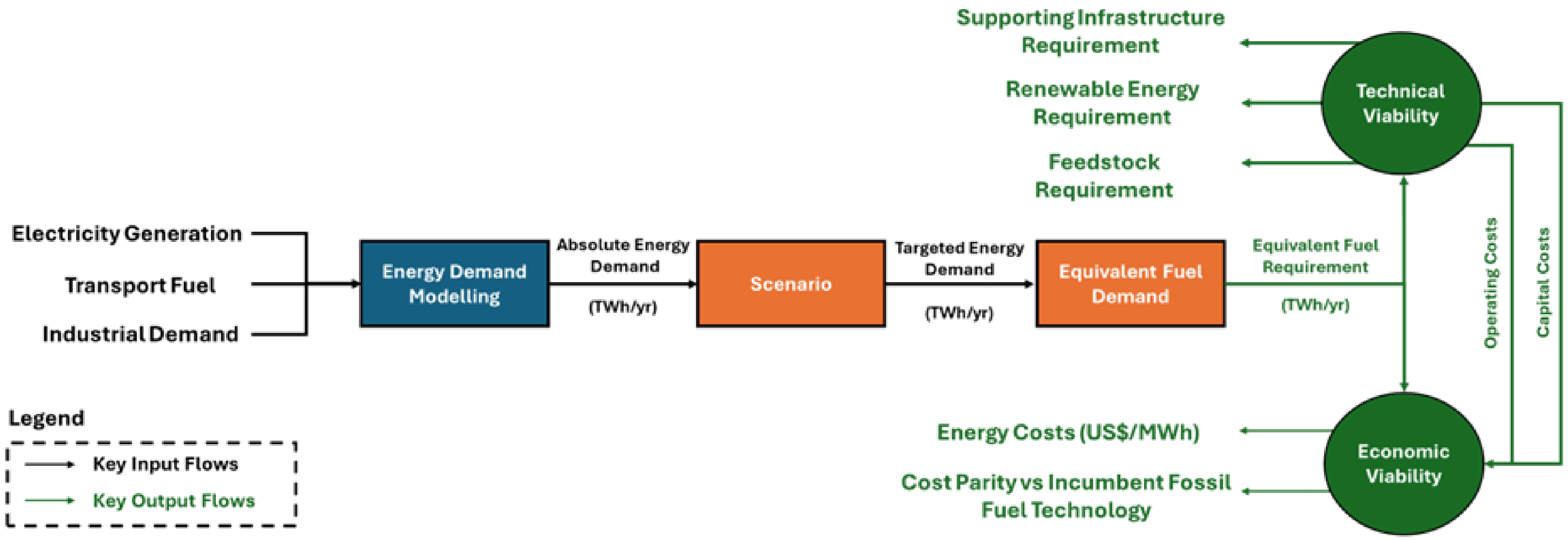


FIGURE: ASSESSMENT FRAMEWORK

Report C: Overview

Purpose	Key Findings
▪ Model the demand for hydrogen and derivatives towards target end-use applications. ▪ Map the energy resources, land availability, infrastructure, and other feedstocks that would be required to establish a hydrogen economy in the PICTs. ▪ Investigate the economics of developing a hydrogen economy in the PICTs.	▪ In progress. ▪ Initial findings suggest: a) The demand for H_2 could significantly exceed over the 1 Mtpa initially estimated. For context accounting for the energy content of H_2 and the efficiency of conversion technology, over **2 Mtpa of H_2** for electricity generation, **3.5 Mtpa of renewable diesel** for land transport, **2 Mtpa of ammonia** for maritime and **1 Mtpa of SAF** would be needed to displace 100% of the fossil fuel demand by 2050. **b) Production cost of electrolytic fuels would exceed global estimates** mainly due to lack of infrastructure and cost of project development in the region; therefore, would require funding support to become viable. **c) Biogenic pathways in comparison would be more cost competitive.** **d) Replacing fossil fuels for on demand power generation using H_2 could potentially be viable against diesel generators, renewable diesel can potentially be competitive for land transport and power generation. Shifting to 100% SAF, methanol and ammonia would entail significant premiums.**

Status: Report C - Draft for Consultation is currently in the works, with a draft expected this month.

Report D: Roadmap and Stakeholder Engagement Framework

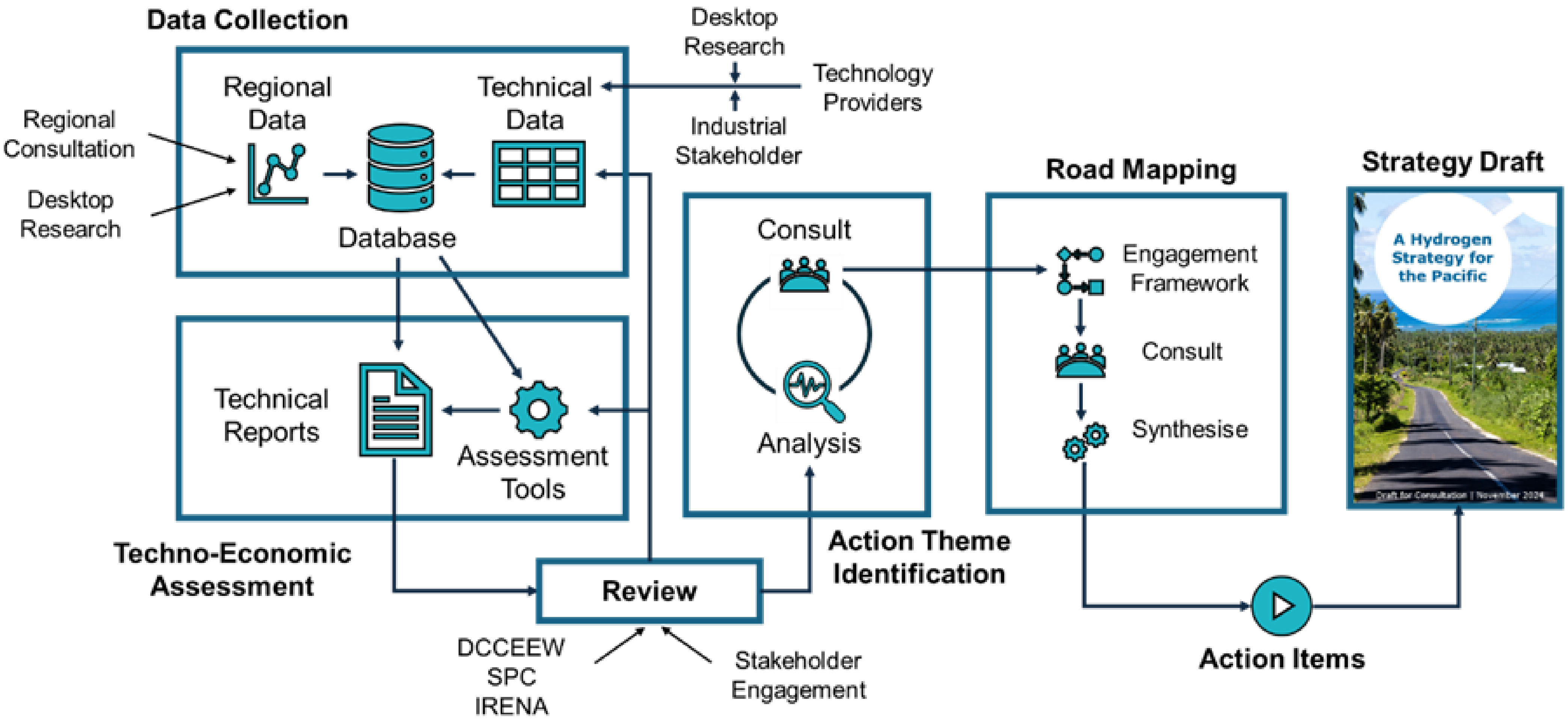


FIGURE: FRAMEWORK FOR ROADMAP DEVELOPEMT

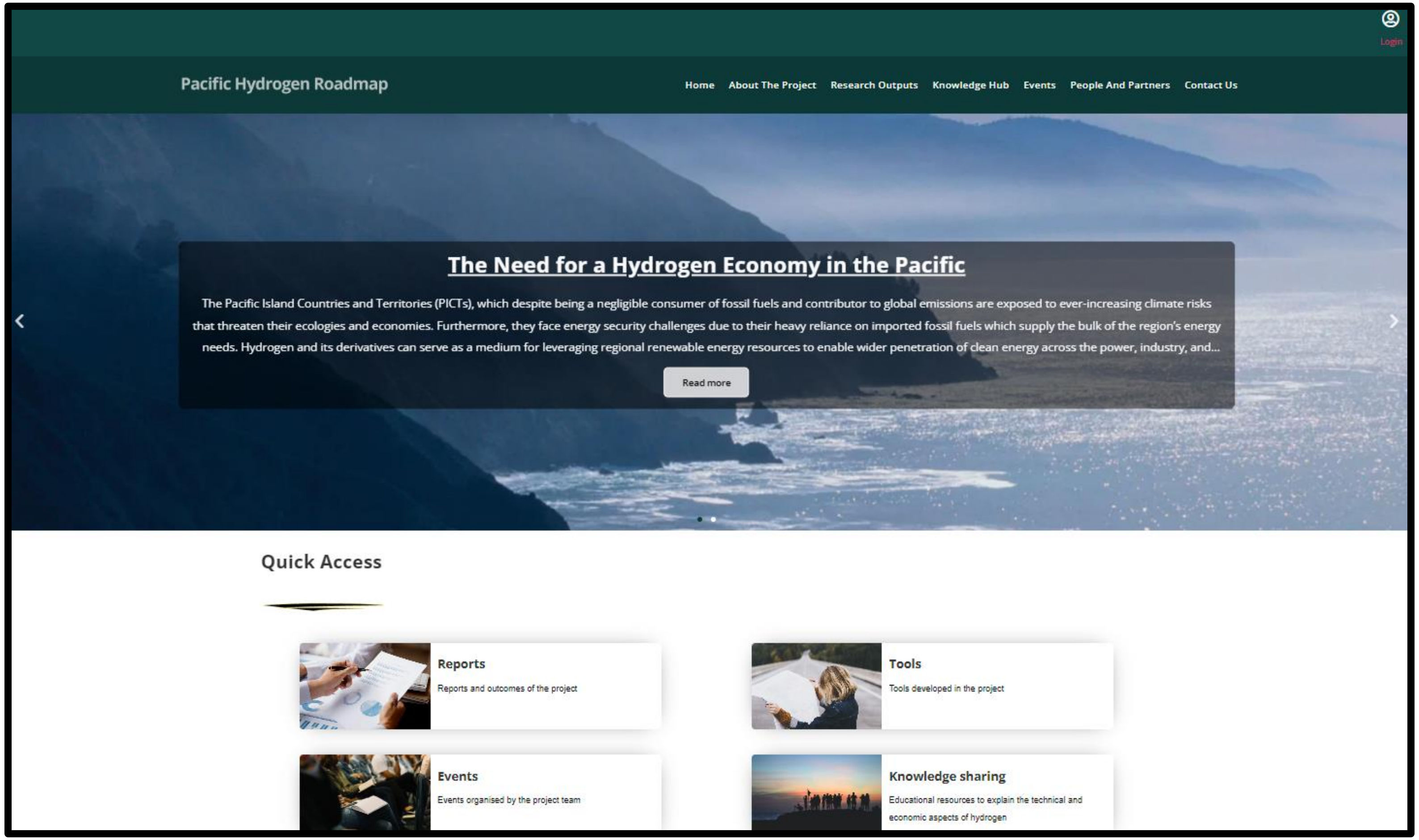
Stakeholder Engagement: Challenges Identified

- **General Understanding of H_2 and Derivatives:** Lack of greater understanding on role of H_2 and derivatives. There is a lot of hype but little practical movement to date.
- **Realistic Target setting, Feedstock Availability, and Allocation**: A need to understand and promote that H_2 and derivatives are not the only solution and will compete with other options for both feedstock (water, renewables and biomass), economics (capital investment) and land
- **Economics:** All these processes are capital intensive – e.g., a 1 MW electrolyser (500 kg a day of H_2) would cost between USD 500k to 1.8 million. In addition, the turnaround times of these facilities (ammonia, methanol and biofuels) at scale are 3 to 4 years so that's capital locked in for a significant time (that can be used in other places).
- **Infrastructure Readiness:** Biofuels have a significant opportunity to be used in as drop in replacement fuels – but why has there been little progress across the Pacific to implement these. Is it a production and distribution problem or an end use problem (social acceptance ?).
- **Risks:** Technical risks in terms of safety and compliance. SAF and RD are synthetic replacements and can leverage existing understanding and capabilities. Hydrogen, ammonia and methanol on the other hand will require infrastructural changes and new skills in the region.

Key Takeaway Messages

- Clean H_2 and derivatives will have a faciliatory role to play in decarbonising the PICTs. Especially complementing and not taking away focus from renewable based electrification.
- Aviation, maritime and drop-in fuel replacement opportunities are likely key markets for clean H_2 and derivatives for the region.
- Clean H_2 and derivatives may provide the region the opportunity to achieve a regionally self-sufficient and integrated energy future. It also provides the region an opportunity to take active ownership and leadership role in driving their regional H_2 strategy.
- Some jurisdictions in the Pacific have limited renewable energy opportunities and clean H_2 derivatives imports provides an opportunity to pursue ambitious climate goals.
- Altogether these reports and resources provides insights, knowledge and tools to enable the region to develop its own H_2 strategy, based on energy ambitions as well as social and economic priorities.

Project Website



Hub for information hosting and sharing for this project

Link: https://pacifich2strategy.com/

Project Partners

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