



Australian Government
Australian Renewable Energy Agency

ARENA

Commercial Readiness Index for Renewable Energy Sectors

ARENA has developed the Commercial Readiness Index as a tool that project proponents may want to use when considering their projects and ARENA will use to measure the “commercial readiness” of renewable energy solutions.

It is expected the Index will be updated from time to time.

1. Context

1.1 Why is a Commercial Readiness Index required?

The Technology Readiness Level (TRL) index is a globally accepted benchmarking tool for tracking progress and supporting development of a specific technology through the early stages of the technology development chain, from blue sky research (TRL1) to actual system demonstration over the full range of expected conditions (TRL9).

The TRL methodology was developed by Stan Sadin with NASA in 1974.¹ Since then, the process has evolved and is used across a wide range of sectors including renewable energy. An example of this is the ESB and Vattenfall classification system for evaluating the Technology Readiness for Wave Energy Projects.² ARENA also uses the TRL index in the Emerging Renewables Program, for example, to help applicants in the early stages of technology development identify the stage of development of their particular innovation.³

While the majority of technology risk is retired through the TRL 1–9 framework there is often significant commercial uncertainty and risk remaining in the demonstration and deployment phase. New technology and/or entrants entering a market place typically supplied by proven incumbents and financed by capital markets that are often risk adverse, face a multi-faceted range of barriers during the commercialisation process. This is particularly relevant in the context of renewable energy where capital cost and therefore access to capital is a key barrier to accelerating deployment.

There is a wide body of knowledge and literature on the general commercialisation process that has evolved to inform public policy and associated funding tools to enable renewable energy development and deployment.⁴ However, there does not appear to be an accepted process to benchmark the commercial readiness of renewable energy technology across the facets of a typical investment due diligence process following successful initial demonstration.

Historically, the majority of support for the development of new renewable energy technologies has been through the provision of upfront capital grants. Upfront grants can be useful in assisting companies with acquiring funding for their projects, especially where they are small scale and the Government funding covers most of the costs. Yet the experience of this traditional funding model is also that rapid change increases risks to projects. Projects that have attempted to go straight from bench or desktop to demonstration at a commercial scale face the greatest challenges, such as raising private sector co-investment commitments, costs exceeding early expectations and the external market context changing over time such that the original goals no longer deliver a sustainable commercial proposition. ARENA has been given a broad mandate for assisting renewable energy technologies and projects through to commercialisation; accordingly, ARENA will structure its funding support to best reduce risks and barriers at the various stages of the technology development chain.

1.2 How does Commercial Readiness relate to Technology Readiness and Development along the Technology Development Chain?

A pictorial representation of the TRLs and CRI is shown in Figure 1 and Figure 2. The figures demonstrate that the CRI begins once the technology is at the stage where there is research to prove that it is feasible in the field (TRL 2). The CRI extends to when the technology or application is being commercially deployed and has become a bankable asset class (eg. Status Summary Level 6).

Figure 1: TRL and CRI

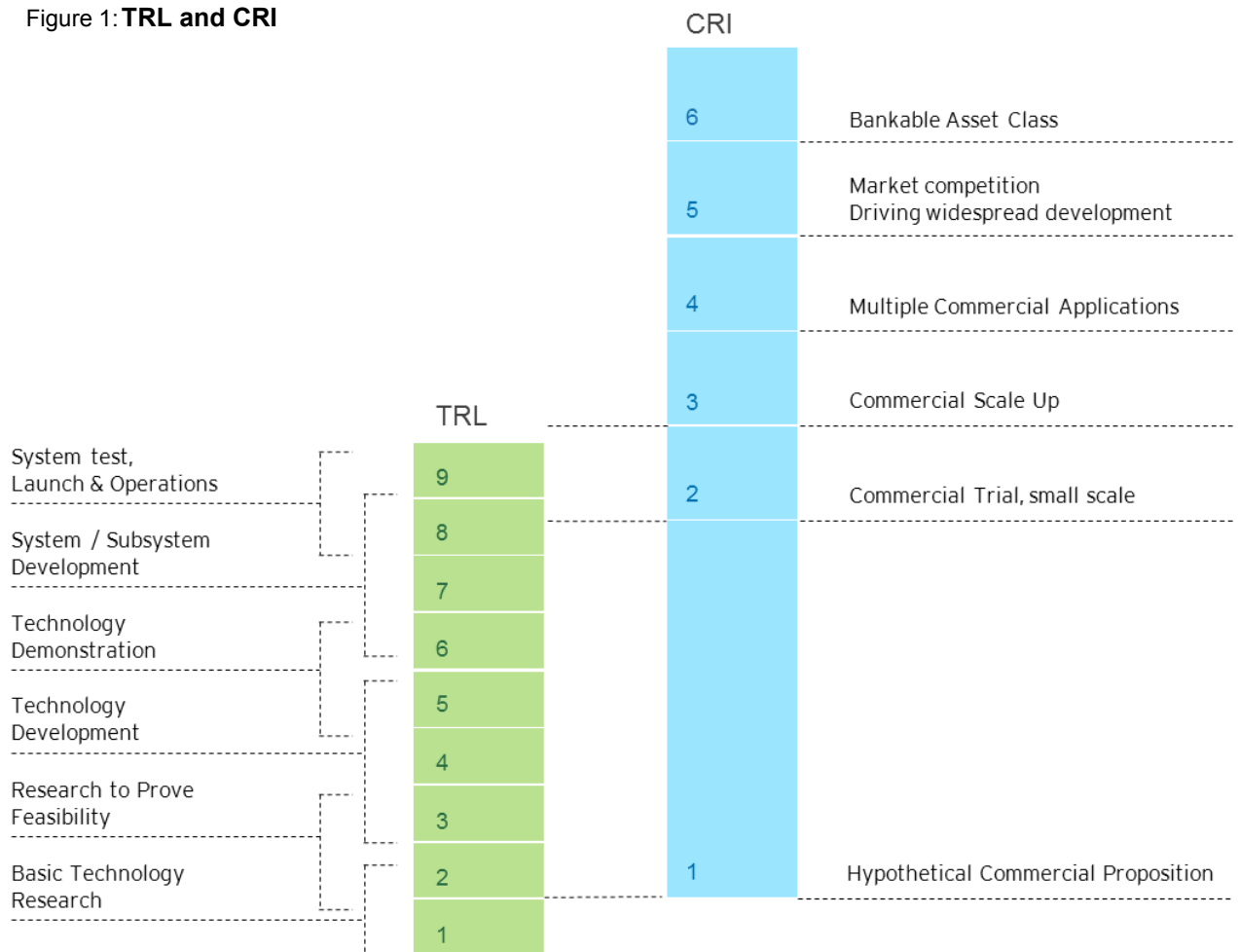
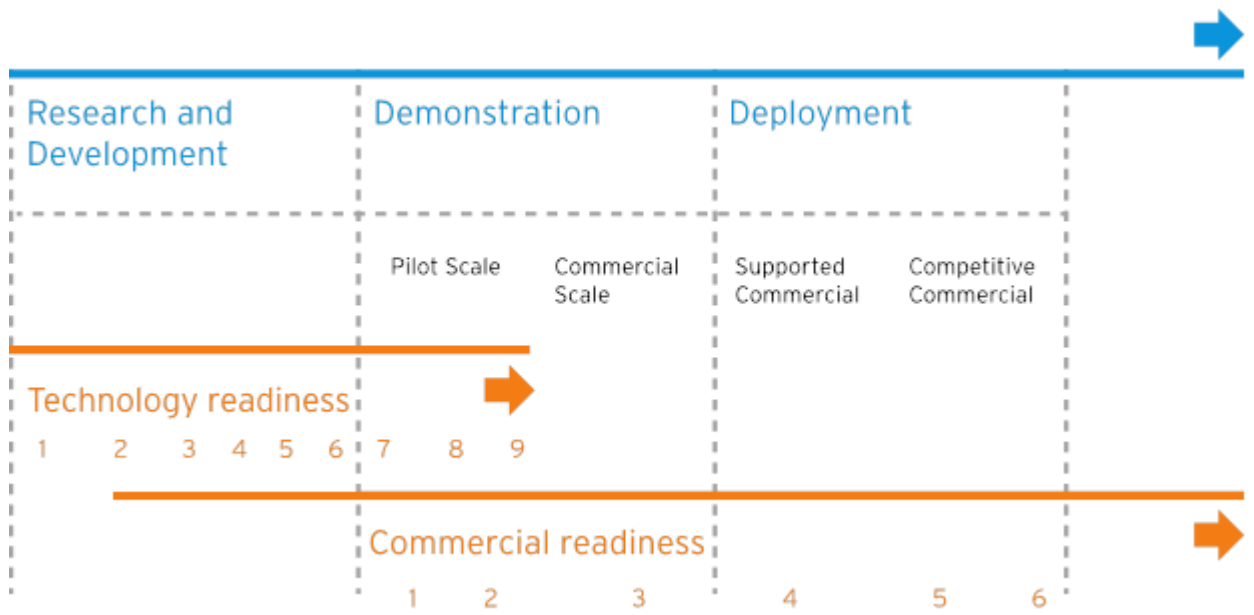


Figure 2: TRL and CRI mapped on the Technology Development Chain



1.3 Commercial Readiness – Status Summary and Indicators

There are two components to the CRI, the Status Summary (green component of the CRI) and the detailed Indicators (blue component of the CRI) as shown in Figure 3.

Figure 3: CRI – Status Summary and Indicators

		Indicators								
		Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - Costs	Financial Proposition - Revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity	
Status Summary Level	'Bankable' Grade Asset Class									6
	Market competition driving widespread deployment									5
	Multiple commercial applications									4
	Commercial scale up									3
	Commercial trial									2
	Hypothetical commercial proposition									1

Status Summary

This is the single, overall rating numbered 1 to 6, as shown in Table 1 on the next page. The Status Summary correlates to the current status in the market, such as commercial trial (i.e. Status Summary Level 2) or multiple commercial applications (i.e. Status Summary Level 4) etc.

The Status Summary is determined by evidence in the market (ie for Status Summary Level 2, whether a a commercial trial has been conducted) and does not require each of the individual Indicators to be at the same level as the Status Summary. In most cases, an individual project will not raise the overall Status Summary but rather will increase an Indicator/s.

Table 1: Description of Status Summary

Status Summary Level	Descriptions
6	"Bankable" grade asset class driven by same criteria as other mature energy technologies. Considered as a "Bankable" grade asset class with known standards and performance expectations. Market and technology risks not driving investment decisions. Proponent capability, pricing and other typical market forces driving uptake.
5	Market competition driving widespread deployment in context of long-term policy settings. Competition emerging across all areas of supply chain with commoditisation of key components and financial products occurring.
4	Multiple commercial applications becoming evident locally although still subsidised. Verifiable data on technical and financial performance in the public domain driving interest from variety of debt and equity sources however still requiring government support. Regulatory challenges being addressed in multiple jurisdictions.
3	Commercial scale up occurring driven by specific policy and emerging debt finance. Commercial proposition being driven by technology proponents and market segment participants – publically discoverable data driving emerging interest from finance and regulatory sectors.
2	Commercial trial: Small scale, first of a kind project funded by equity and government project support. Commercial proposition backed by evidence of verifiable data typically not in the public domain.
1	Hypothetical commercial proposition: Technically ready – commercially untested and unproven. Commercial proposition driven by technology advocates with little or no evidence of verifiable technical or financial data to substantiate claims.

Indicators

The Indicators are used to reflect the commercialisation process of renewable energy. The CRI addresses a range of interlinked barriers in making progress towards widespread deployment.

In drawing on past experience, consulting with stakeholders and reviewing available literature, ARENA has identified the following Indicators as being sufficiently quantifiable to warrant inclusion (as shown in Table 2 on the next page). To improve a technology solution or an application's overall commercial readiness, we consider that it needs to progress along each of these dimensions. We would also expect that projects that are transitioning from measuring themselves in the TRL index to the CRI will aim to increase one or more of these Indicators.

Descriptors for each of the Indicators are provided in **Appendix A** on page 10. The Indicators are measured from 1 to 6. An example of the Indicators and the progression through the levels is:

- Stakeholder Acceptance Indicator Level 1 –Stakeholder support/opposition is hypothetical.
- Stakeholder Acceptance Indicator Level 6 –Established process understood and expected by all parties, used to gain stakeholder acceptance.

Table 2: Description of Indicators

Indicators	Summary of Indicators
Regulatory Environment	The maturity of the planning, permitting and standards relating to the technology.
Stakeholder Acceptance	The maturity of the process for evidence based stakeholder consultation linked to renewable energy integration into the energy markets.
Technical Performance	The availability of discoverable technical performance information.
Financial Proposition – Costs	The availability of robust, competitive financial information linked to capital and operating costs and forecast revenues allowing investors to take increasing levels of future market and project risk.
Financial Proposition – Revenue	
Industry Supply Chain and Skills	The development of a competitive and efficient industry product and skills supply chain required to support a commercially viable sector.
Market Opportunities	The development from a hypothetical commercial plan to the demonstration of a viable market (local and/or overseas) via competitive channels to market and sustainable business models.
Company Maturity	The development of the sector to include established companies with strong credit ratings and established performance records.

2 Self-Assessment: Using the Commercial Readiness Index

Project proponents may find that the CRI is a helpful tool to evaluate their project. An example project evaluation is included in section 2.1 below. A blank template for project proponents is at **Appendix B** on page 14..

2.1 An Example Self-Assessment

An example of how the Index may be completed is shown in Figure 4.

Figure 4: **Example Project Evaluation for a Utility Scale Solar PV Project**



One can see that solar PV is seen within the market as a solution at Commercial Scale Up (Status Summary Level 3). This is demonstrated by the placement of the green circle within the green Status Summary area.

Also four of the Indicators are expected to progress if this particular Solar PV project was to proceed. This is demonstrated by the blue bars moving apart in the columns titled: Stakeholder Acceptance, Technical Performance, Financial Performance – Costs and Market Opportunities. The arrows in those four columns suggest that the progression is expected to be an improvement rather than a decrease in capability (which would be shown as a down arrow). Following this logic, the diagram also shows that four Indicators are not expected to advance if the project was to proceed.

End Notes:

1. Jim Banke (2010) Technology Readiness Levels Demystified
2. J. Fitzgerald (2011) Technology Readiness Level definitions through a private communication, Ireland.
3. ARENA Emerging Renewables Program use of TRL framework <http://www.arena.gov.au/documents/erp/ERP-Tech-Readiness-Level.pdf>
4. Simon Müller, Adam Brown, and Samantha Ölz (2011) [Renewable Energy: Policy Considerations for Deploying Renewables by IEA](#); International Renewable Energy Agency (2013) [Renewables Readiness Assessment Process](#); Baker & McKenzie (2010), [Global Benchmarking Report on Solar R&D Funding Sources and Models Report](#) for the Australian Solar Institute; Jochem Weber (2012) WEC Technology Readiness and Performance Matrix – finding the best research technology development trajectory, 4th International Conference on Ocean Energy.

Appendix A: Descriptions of Indicators

Commercial Readiness Indicator Descriptions

Regulatory Environment

Level	Summary of Indicator
6	Regulatory, planning and permitting process documented and defined with ongoing process of review and refinement. Investment markets see policy settings long term, robust and proven.
5	Regulatory, planning and permitting challenges understood and under review, yet some unresolved and becoming critical as penetration grows.
4	Key findings published on planning, permitting and regulatory challenges based on actual evidence. Multiple jurisdictions with experience leading to emergence of national standards. Policy settings moving to “Market pull”.
3	Draft recommendations emerging to address key barriers. Early developers investing in process development in order to gain certification. Policy settings focused on “project/technology push”.
2	Key regulatory barriers emerging that often require project specific consideration.
1	Regulatory processes including planning, permitting, OH&S, and specific Australian standards such as electrical connection are undefined. Timing and cost of network connection and/or fuel certification assumed in modelling but not known.

Stakeholder Acceptance

Level	Summary of Indicator
6	Established process understood and expected by all parties, used to gain stakeholder acceptance.
5	Transparent process using discoverable evidence used to engage stakeholders.
4	Evidence and experience is available to inform stakeholders increasing their acceptance.
3	Broader stakeholder support issues emerging. Stakeholder concerns & addressing these become key considerations in project development timelines and future commercial uptake scenarios.
2	Stakeholder support or opposition is on a case-by-case basis with project developer skills a critical success factor.
1	Stakeholder support or opposition is hypothetical.

Technical Performance

Level	Summary of Indicator
6	Secondary markets exist to access externally verified performance information for routine due diligence. Performance review and warranty credit rating transparent.
5	Multiple data sets discoverable on commercial projects operating in range of operating environments. Performance evaluation methodology and warranties defined and driven by project financing requirements. Renewable resource forecasts highly sophisticated based on experience from wide range of sources.
4	Performance yield, efficiency vs. forecasts published and key drivers understood. Performance evaluation methodology and warranties becoming standard with key risk allocation process driving equity and debt return expectations. High confidence in expected renewable resource.
3	Performance and yield forecasts based on extrapolation from reduced scale sites or similar applications or similar pathways. Credit rating of project performance warranties become a key factor in bankability of project. Renewable resource forecasts driven by site-specific data capture. International evidence key in investment.
2	Performance forecasts based on simulation models referenced to evidence from research & development or pilot scale demonstration. Renewable resource forecasts driven by site-specific data capture. International evidence often used to support investment case.
1	Performance forecasts based on proponent modelling.

Financial Proposition – Costs

Level	Summary of Indicator
6	System cost sufficiently reliable and competitive to drive uptake. Cost detail widely published and accepted for multiple similar applications. Global and/or local price indices established and reported.
5	Price and value proposition clear and attractive with open access to cost trends and projections based on actual project data from wide range of applications.
4	Key cost elements of projects in public domain. Commoditisation of major components occurring. Cost drivers are understood with roadmaps in place to bring costs to being market competitive
3	Costs data based on projections from single site or comparable site or comparable pathway. Key cost drivers are understood enabling broader market to judge long-term prospects of technology.
2	Key costs based on projections with little actual data available to verify.
1	Cost data (if available) based on projections and forecasts with little or no prior data to substantiate.

Financial Proposition – Revenue

Level	Summary of Indicator
6	Revenue forecasting proven and accepted by finance industry with transparent benchmarking evident. Examples of different forms of market participation strategies with debt finance willing to back merchant risk.
5	Revenue projections based on proven forecasts and accepted commercial data. Greater PPA or contract optionality for large scale developers, with investors comfortable with underlying value of proposed asset.
4	Revenue projections backed by commercial data. Price gaps understood and roadmaps in place to address. Long term PPAs or contracts or offtake agreements required to secure debt.
3	Revenue projections being tested in commercial context, highly discounted by investors with requirements for long term PPAs or contracts or offtake agreements for large scale applications.
2	Revenue projections highly discounted by investors.
1	Revenue data based on projections and forecasts with little or no prior data to substantiate.

Industry Supply Chain and Skills

Level	Summary of Indicator
6	Multiple alternatives with proven capability. Project and service differentiation key selection factor.
5	Specialisation occurring along supply chain with standards defined and supplier performance externally benchmarked.
4	Key skills demonstrated with replicable results. Limited supply options proven. Time to build a key driver of future efficiencies.
3	Project by project approach from engineering, procuring, construction and transportation providers with limited prior experience. Limited availability of key components and EPC and/or O&M skills. Major supply chain participants may not support development due to conflicts with their current business model.
2	Supply chain not available or not willing to participate for many key components. Project developer typically designing and procuring multiple elements to own specification. Engineering, procuring, construction and transportation costs often based on time and materials with high degree of risk loading.
1	Supply chain not fully considered with key elements typically from specialist source, often under technology proponent specification.

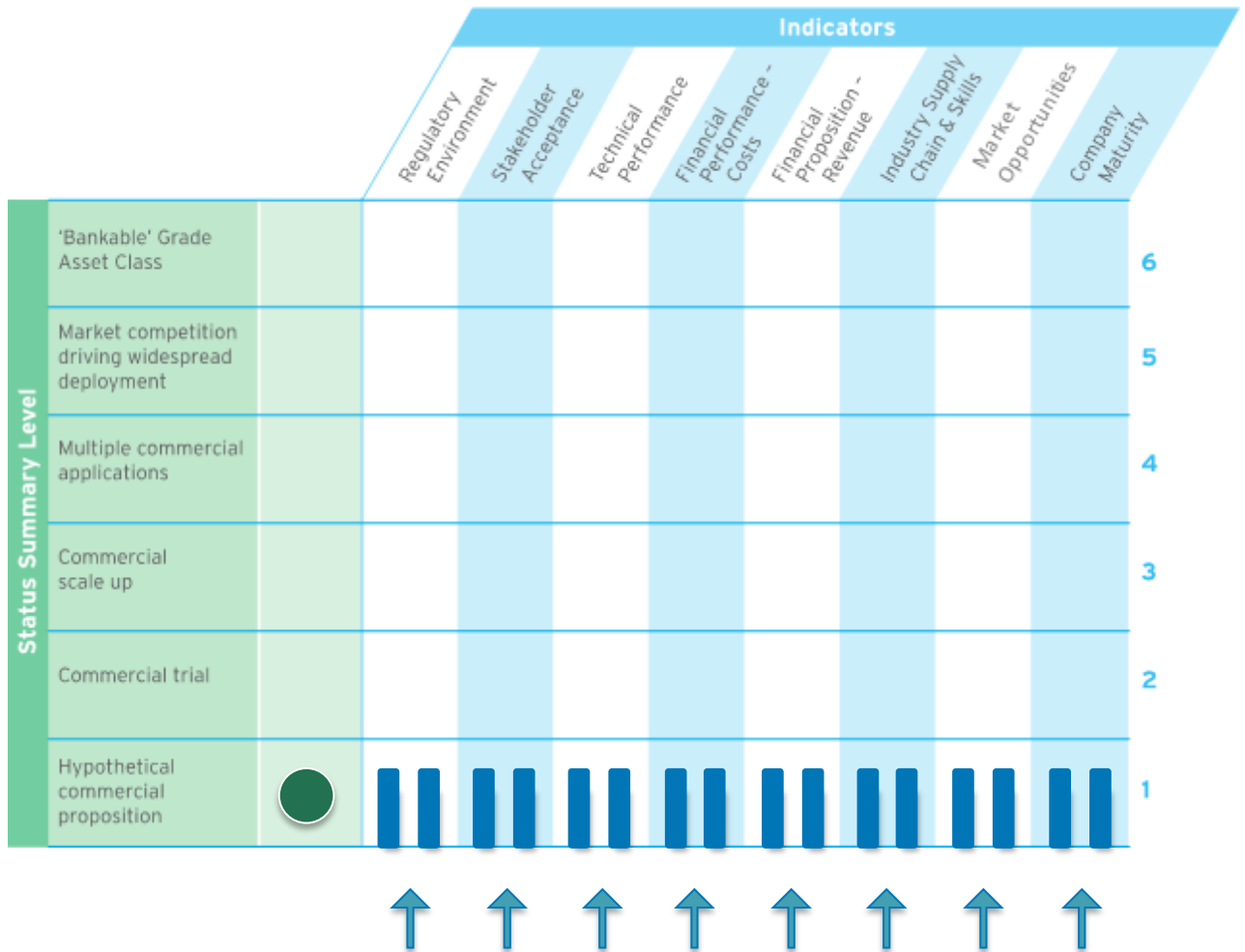
Market Opportunities

Level	Summary of Indicator
6	Market driving the investment process with little or no concessional policy support. External factors may slow down or accelerate ongoing deployment. Market opportunities clear and understood.
5	
4	Market demand primary driver of the investment case with clarity on market segments and industry supply chain and/or market channels to deliver. Market size widely available and verified by third parties. Funding gaps between net present value of revenue and cost understood, with target segment customers a key stakeholder in the investment decision process. Some concessional policy support required to drive uptake.
3	Focus moving from proving commercial performance to optimising project cost and revenue structures and lowering \$/unit of energy support required in the target market segment. Detailed market research to understand the size, interest and readiness of the market available. Post subsidy revenues generating sufficient cash flow to service debt and equity expectations.
2	Commercial trial has identified target market segment for a trial with goal of proving to future investors that the technology can operate reliably and generate predictable revenue from a cost base that is understood, even if still uneconomic. Market research has been done to enable proponents to estimate the market size locally and internationally. The commercial trial does not seek to optimise \$/unit of energy but seeks to balance the absolute cost of the trial with the scale required to demonstrate basic commercial performance.
1	Critical stage for a technology to move from a promising technical solution to a prospective commercial opportunity. Investment case for commercial trials supported by evidence of peer reviewed business plans with verifiable cost and revenue estimates, market size and early channel to market identified. Key risks identified both within and external to the proponents sphere of control.

Company Maturity

Level	Summary of Indicator
6	Leading proponents are major, public companies with large balance sheets. Management capability is no longer a consideration for most projects, as proponents have strong track records.
5	Leading players in sector have significant balance sheets and wide management experience in energy and delivery of technology and/or project class.
4	Established energy players now also considered part of the sector (although at the edge). Balance sheets and the influence of technology proponents increasing. Capability of management is still a significant factor in project selection.
3	Industry bodies in place and strongly representing sector to external stakeholders. Industry still driven by technology proponents.
2	Industry bodies have formed but are weaker than contract counterparts.
1	Established energy players not yet part of sector. Management capability is dependent on individual proponents.

Appendix B: Template for using Commercial Readiness Index



1. Position the circle symbol to indicate where your project is located on the Status Summary axis.
2. Position the coloured bars within the Indicators to identify where your project is currently positioned.
3. Use arrow symbol where appropriate to demonstrate progress of a project towards an Indicator.

A project status example is shown at Figure 4 on page 8.

Explanation of Index

EVIDENCE OF STATUS SUMMARY	
Status Summary:	[Insert overall Level 1 to 6]
Market Position Identified (1–6)	[Insert information on rationale for Status Summary] <ul style="list-style-type: none"> • [Up to 3 dot points are sufficient]
Rationale	[Insert domestic or international examples to substantiate the Status Summary] Project name <ul style="list-style-type: none"> • [Insert project specifics] • [Up to 1/2 page]

EVIDENCE OF INDICATORS	
Indicator:	[Insert indicator name, for example regulatory environment]
Indicator Level (1–6)	[Insert project indicator level, for example Level 3]
Movement	No Change <input type="checkbox"/> Improvement <input type="checkbox"/>
Rationale	[Insert specific project rationale for level and change] <ul style="list-style-type: none"> • [Insert specifics] • [Up to 1/2 page]

This box is repeated for all eight Indicators.

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