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Australia's north, Australia's future: A vision and strategies for sustainable economic, ecological and social prosperity in northern Australia

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Abstract

The release of the United Nations Sustainable Development Goals and the Paris Climate Change agreement highlighted the importance of global sustainability internationally. Here, we outline a vision and strategies for developing northern Australia that demonstrate how a focus on sustainable prosperity can both expand historical approaches and current government plans and integrate the biophysical realities with the social, political, and cultural characteristics of the region. We highlight examples of the significant horizontal and vertical integration opportunities that this expanded vision and related strategies provide for (a) *land* (carbon farming, targeted food production systems, and native title arrangements); (b) *water* (water resources management); (c) *energy* (renewable energy production, storage, and distribution); (d) *workforce* (culturally appropriate ecotourism, Indigenous ranger programs, and protected area management); (e) *knowledge services* (health care and innovative employment opportunities); and (f) *governance* (greater participatory

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governance). We found that realisation of even 10% of these emerging opportunities over the next 10 years alone could result in economic growth worth over AUD 15 billion and 15,000+ jobs for northern Australia as well as the further ecological and social benefits derived from a sustainable prosperity strategy.

KEYWORDS
ecological sustainability, northern Australia, sustainability, sustainable development, sustainable prosperity

1 | INTRODUCTION

Northern Australia is a land of unique ecosystems, ancient and ongoing cultures and cultural knowledge systems, significant resources, and a sparsely distributed but uniquely talented population (Commonwealth Scientific and Industrial Research Organisation, 2013a, 2013b). Innovations in technology have resulted in increased access to services and resources for some (Russell-Smith, 2016), while at the same time, many of the opportunities presented by global sustainability agendas within the domestic and national policy settings have diminished for others. This is particularly relevant for the region's Indigenous (Aboriginal and Torres Strait Islander) peoples and has resulted in significant inequities and lost opportunities for the region.

Historical and current perspectives on developing northern Australia have often relied on two key approaches: (a) transplanting models developed in southern Australia and other regions, which have regularly been demonstrated to be inappropriate to the unique ecological, social, and economic landscape of northern Australia (Dale, 2014), and (b) perspectives largely based on "business as usual" and "empty world" assumptions of unlimited resource availability (Costanza, 2014). These approaches are illustrated by the Australian Government's *White Paper on Developing the North* (referred to hereafter as the *White Paper*), the current blueprint for development (Commonwealth of Australia [CoA], 2015). However, these assumptions are no longer valid in a world of finite and diminishing resources that have resulted in the global Sustainable Development Goals (SDGs, 2017) agenda. In this paper, we review an alternative approach to development based on leveraging the unique characteristics of the north within the changing regional and global environment to achieve what Hatfield-Dodds et al. (2015) refer to as "sustainable prosperity." We recognise that northern development policy is an area that has historically attracted much attention, often with conflicting visions and strategies. To achieve our objective, we therefore review (a) a novel framework for development in northern Australia based on achieving sustainable prosperity; (b) a SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis of the region's key economic, ecological, and social characteristics; (c) a review of the key regional and global environment trends impacting northern Australia; (d) an alternative vision and strategies for sustainable prosperity in northern Australia; (e) policy implications to achieve this vision and resultant strategies including governance and financial constraints; and (f) potential economic, ecological, and social outputs of the application of this sustainable prosperity framework in northern Australia.

2 | A FRAMEWORK FOR ACHIEVING SUSTAINABLE PROSPERITY

As a starting point for establishing our development framework for sustainable prosperity, we reviewed the six key focus areas addressed in 2015 *White Paper* and categorised these into core resources (land, water, and energy) and key support structures (governance, infrastructure and investment, and workforce; CoA, 2015). An alternative development framework was then created based on these core resources and support structures to achieve sustainable prosperity. Strategies were then reviewed within this structure to test the Hatfield-Dodds et al. (2015) assumption that sustainable prosperity can be achieved through policies that leverage regional and global opportunities to achieve a stronger alignment and balance between economic, ecological, and socially sustainable outcomes (Figure 1). This was also based on the assumption that economic growth cannot be decoupled from ecological and social impacts (Ward et al., 2016), however, that a balanced approach with appropriate policy and implementation could achieve a goal of sustainable prosperity in the region. This approach then allows the opportunity to not only expand initial work developed in the *White Paper* but also compare strategies against the criteria of sustainable prosperity and highlight the importance of appropriate and well-implemented policies in achieving this outcome.

3 | UNDERSTANDING NORTHERN AUSTRALIA'S UNIQUE ECONOMIC, ECOLOGICAL, AND SOCIAL ENVIRONMENT

A significant criticism of historical approaches to the development of northern Australia has been a reliance on transporting models from other regions. The unique nature of the northern ecological, social, and economic landscape has often resulted in these approaches being either

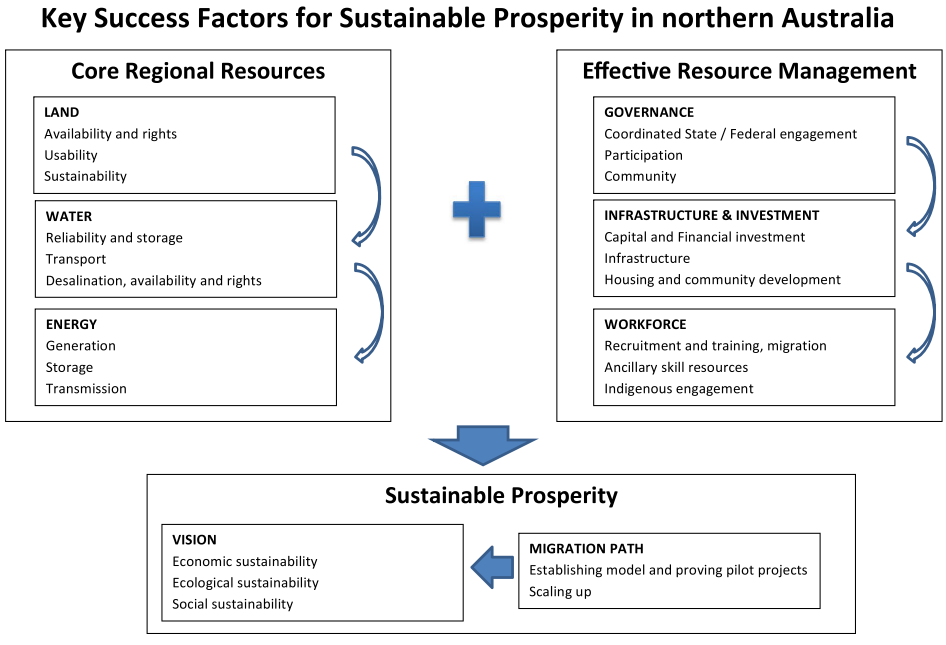

FIGURE 1 Development framework for sustainable prosperity in northern Australia

unsuitable or unsustainable (Dale, 2014). Successful and sustainable development therefore can only occur if strategies are leveraged within the context of the North's unique ecological, social, and economic environment (Northern Australia Land and Water Taskforce, 2009). We have therefore used a SWOT Analysis to capture the region's unique ecological, social, and economic characteristics (Picton & Wright, 1998). The full SWOT Analysis is available in Data S1 and highlights a number of key themes and strategic opportunities: (a) to address the need for climate resilience and adaptation; (b) to deploy key infrastructure capabilities (e.g., energy, water, and communications); (c) to leverage the development of human resources; and (d) to "value-add" to raw products such as iron and cattle. This analysis also highlights the requirements for a more highly coordinated and regionally based self-governance structure to achieve the required balance between economic, ecological, and social outcomes (Dale, 2014).

Though beyond the scope of this paper to address all areas identified in the SWOT Analysis, we have examined examples of strategies that are either already operating and could be expanded or could be developed based on the unique characteristics of the North and the regional and global context in which it operates.

4 | UNDERSTANDING THE REGIONAL AND GLOBAL CONTEXT

There are two key factors that drive the regional and global context within which northern Australia operates: (a) *geography*—the proximity to South East Asia presents significant opportunities for the North due to access opportunities to resource, food, tourism, education, and energy markets, and (b) *global trends*—the increasing trends towards the achievement of a greater balance between ecologically, socially, and economically sustainable outcomes in reviewing the international political, business, and social context. These trends are reflected in the emergence of societal progress measures such as the Genuine Progress Indicator and the development of the United Nations (UN) SDGs (2017). These trends also bring significant "waves of opportunity" as captured in Figure 2 (Chambers & Humble, 2012).

Taking advantage of these opportunities requires a significant policy shift from the historical business as usual approach as displayed in the *White Paper*, to a much broader investment vision, strategy, and policies (Hatfield-Dodds et al., 2015) based on the unique attributes of northern Australia.

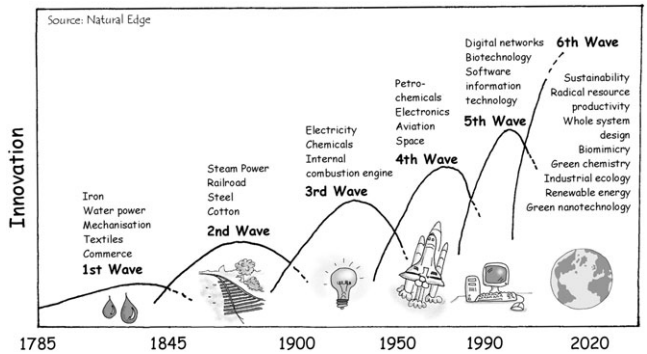

FIGURE 2 Leveraging emerging eco-economy opportunities. Copyright © 2005, The Natural Edge Project

5 | DEVELOPING A VISION FOR NORTHERN AUSTRALIA

Costanza highlights the critical importance of establishing a vision or overarching goal as a key component of any successful development strategy. Yet this is regularly overlooked even on agendas as broad as the UN SDGs (Costanza, 2014). This oversight is often due to the perceived complexity of determining this vision. However, Raskin et al. (2002) as well as Costanza (2014) have identified scenario planning (SP) as an approach that has been successfully applied to determine preferred futures in other regions and countries.

A notable example was the use of SP to develop a broader vision in South Africa to facilitate the transition from apartheid to the preferred future of "all in this together" (Kahane, 2004). Since then, SP has continued to be used successfully in a range of regional and national settings to identify preferred futures and support strategies to achieve these futures (Costanza et al., 2017). SP was therefore the approach adopted in this paper to determine a preferred vision for northern Australia.

In a national survey conducted in 2016 to determine the preferred future Australians aspired to, a demographically representative sample of over 2,000 participants was asked to indicate preferences across four potential future scenarios for Australia (Chambers et al., 2017). These scenarios were Strong Individualism, Free Enterprise, Coordinated Action, and Community Well-Being (Figure 3).

The results of the survey showed a clear preference by the majority of Australians (70%) for the Community Well-Being scenario when asked "What is your preferred future scenario?" The parameters of this scenario align closely with the objective of sustainable prosperity. However, when asked "Where is Australia now?" participants perceived Australian society currently

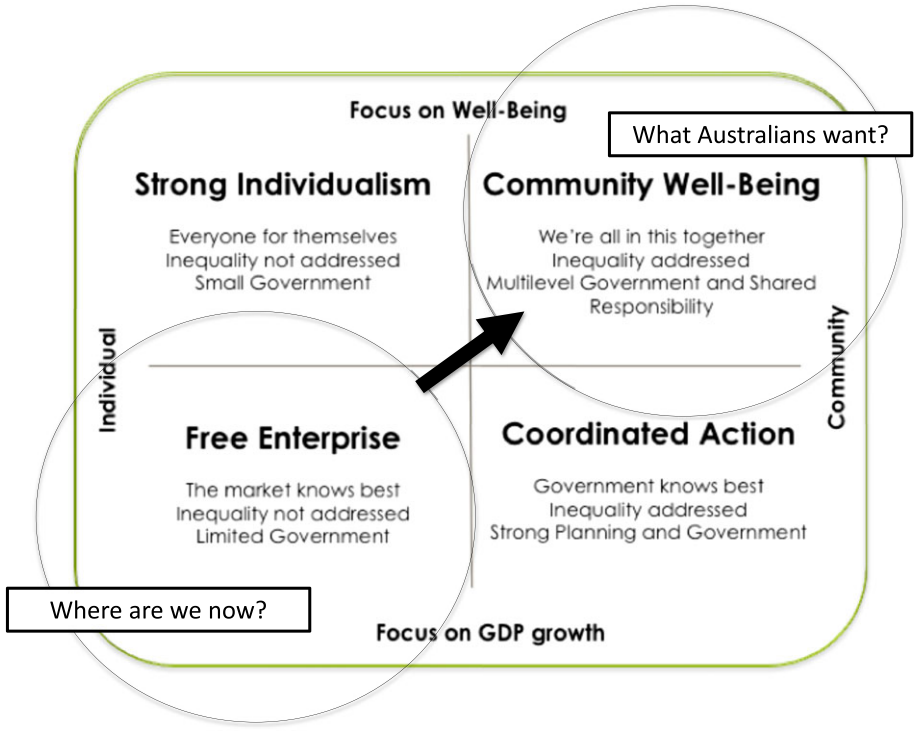

FIGURE 3 Australia: Our Future, Your Voice Survey (2016)

operating in the opposite quadrant that aligns more closely with the *White Paper* (CoA, 2015). This preferred vision for Australia's future therefore provides not only an alternative vision to the "business-as-usual" approach articulated in the current *White Paper* but also a vision that is endorsed by the majority of Australians.

To determine whether this approach could contribute to our identified goal of sustainable prosperity, we tested examples of strategies and their potential contribution to economically, ecologically, and socially sustainable outcomes in northern Australia.

6 | STRATEGIES FOR ACHIEVING SUSTAINABLE PROSPERITY IN NORTHERN AUSTRALIA

6.1 | Land sector

Land is a core asset underpinning successful sustainable development because it provides basic human survival requirements—food, shelter, water, and a supporting environment. Currently, the main land use in northern Australia is extensive, free-range beef cattle pastoralism. However, as industry assessments indicate, most regional pastoral enterprises are currently neither economically (profitability) or environmentally (ecologically) sustainable (McLean, Holmes, & Counsell, 2014) and therefore do not fit with the objective of sustainable prosperity. Sustainable prosperity in the land sector therefore requires alternative land use options that leverage economic, ecological, and social sustainable opportunities. Three strategies provide examples of alternative land use approaches that address regional and global trends within the unique economic, ecological, and social environment of northern Australia.

6.1.1 | Carbon farming

Carbon farming provides an example of a strategy that addresses the opportunity presented by the emerging carbon trading market. The opportunity not only leverages the unique landscape characteristics of the North but also provides economic "hedging" that can redress the historical "boom and bust" nature of the northern economic and ecological systems (Dale, 2014). This is best exemplified in the case study of savannah fire management (Russell-Smith, Yates, Edwards, Murphy, & Whitehead, 2015).

The annual monsoon rains bring to the north over 60% of the nation's annual rainfall (CoA, 2015). The result is rapid growth of both native and introduced grass species followed by long dry flammable periods. Fires lit throughout this flammable dry period have the potential, if left unmanaged, to significantly impact pastoral enterprises and natural ecosystems alike (Russell-Smith & Whitehead, 2015). However, Indigenous communities have been managing this boom and bust ecological cycle successfully for thousands of years by simply "cleaning up" flammable vegetation through the undertaking of prescribed fire management early in the dry season. This results in less likelihood of vegetation being ignited later in the season under more severe fire-weather conditions. A similar approach is taken in the southern regions of Australia by rural fire services to manage build-up of ground fuels.

An economic opportunity presents itself in the rapidly emerging carbon offsets market driven by global initiatives to address the threats of climate change, and profit by doing so. The differential between reduced greenhouse gas emissions under early season "cool fire" burning compared with later season "wildfires" is substantial and can be leveraged for economic as well as community well-being benefits.

The economic value of this "carbon farming" opportunity is substantial based on the current Australian Government-regulated value of a carbon offset price of ~$12 per tonne CO_2-e (Australian Government Clean Energy Regulator, 2016). "Voluntary" markets typically offer substantially higher prices. Existing carbon farming projects, of which there are currently over 80 registered and operating in the North (Emissions Reduction Fund, 2017), are already generating between $10 and $20 million annually based only on greenhouse gas emission offsets. These annual revenues could be significantly expanded by (a) extension to additional regions (currently estimated at a total land area 4 times that already developed) and (b) incorporating carbon sequestration that would increase offset by a further 5 to 10 times (Russell-Smith, 2016). Based on the carbon trading market, combining these approaches could potentially realise in excess of AUD 2 billion over the next 10 years.

Implementing this approach also provides further ecological, social, and economic benefits to northern Australia. These include feral animal and weed control; cultural site and habitat maintenance; mine site rehabilitation; and regional employment opportunities. It also builds on the substantial community investment already being made to support regional Indigenous ranger groups and management of Indigenous Protected Areas (Altman & Kerins, 2012). (Further discussion of this opportunity is available in Data S2.)

6.1.2 | Diversifying pastoral enterprises

Economic activity on pastoral land in the north is largely marginal, often with return on investment as low as 1% (McLean et al., 2014). These low returns are impacted by four key drivers: (a) limited potential of the majority of pastoral enterprises due to generally poor soils and pastures; (b) seasonal water availability; (c) limited infrastructure; and (d) distant and volatile markets (McLean et al., 2014; Russell-Smith et al., 2015). Based on these factors, it is estimated that only 20% of the northern savannahs are suitable for agricultural development (Northern Australia Land and Water Taskforce, 2009). Based on the objective of sustainable prosperity, the immediate opportunities therefore are to develop and implement strategies that (a) direct funding and resources to pastoral land with high productive potential and, in other regions, address the significant rehabilitation issues associated particularly with riparian zones and ecologically significant water bodies; (b) diversify and expand the range of opportunities on high potential land by increasing opportunity to develop "value add" products, ecosystem services, and nature-based tourism; (c) address issues of consistent water supplies (see Section 6.2); and (d) ensure secure and low-cost energy (see Section 6.3).

6.1.3 | Rehabilitation of mining land

The North is characterised by significant spent or noneconomic mining leases. Throughout Australia, it is estimated that there are up to 50,000 spent mining sites. Rehabilitation costs have been estimated at over AUD 17.8 billion (Barker, 2015). Lapsed mining sites also hold significant health threats and ecological challenges. Addressing these challenges however holds significant economic opportunities.

Mining companies hold fund reserves for site rehabilitation, whereas state and territory governments hold mining securities for mine rehabilitation. However, these funds are rarely fully deployed for site rehabilitation (Dale, 2014). Key barriers to this fund deployment are a combination of regulatory policy, human resources, expertise, and governance. Current legislation to ensure effective rehabilitation activities is weak. This is as a result of either insufficient funds

being allocated to address the rehabilitation of leases or corporate structures being utilised to enable companies to avoid the liabilities of rehabilitation when the time comes to rehabilitate (Dale, 2014). The Redbank and McArthur River mines in the south-west Gulf of Carpentaria region of the Northern Territory provide examples of the extent of the challenges. These examples however also demonstrate the financial, workforce, social, and ecological opportunities presented by a robust and coordinated rehabilitation strategy and policy (Kerins & Green, 2016). Realisation and implementation of as little as 15% of the estimated mining rehabilitation costs over the next 10 years and translation of these into business opportunities would establish a mining rehabilitation industry of over AUD 2 billion. It would also create significant employment opportunities as well as the ecological and social benefits to regional communities (Kerins & Green, 2016; Rouche & Judd, 2017).

The immediate opportunity is therefore to conduct a national inquiry and audit into all mining sites to establish Australian standards of mine closure, determine the gap between existing mine rehabilitation status and existing bonds, and forecast costs of rehabilitation. From this, site by site rehabilitation and performance management and reporting plans can be developed and be included in company balance sheets. From these management and reporting plans state and federally coordinated jurisdictional planning, management and implementation structures can be put in place (Rouche & Judd, 2017). This would provide the framework and structure under which these business opportunities could be developed.

6.2 | Water

The unique nature of the North's "boom and bust" water supplies results in the region having the highest rainfall in the country yet significant challenges in storing and harnessing these supplies over the extended dry season. These challenges remain one of the significant factors limiting the development in the North. However, reframing these challenges with the objective of sustainable prosperity highlights the opportunity to combine Indigenous knowledge, smart ecosystem water management techniques, and emerging technologies to address these issues. This in turn can facilitate expanded development opportunities for agriculture and related value add industries.

6.2.1 | Smart water storage

Historically, approaches to water storage such as large-scale dams that have largely been imported from outside the region and only met with only limited success (Cendón et al., 2010). The alternative is to leverage Indigenous knowledge and develop strategies that mimic and replicate natural systems and management approaches that already exist, only on a larger scale.

The *White Paper* approach to water storage and management focuses on establishing a feasibility study on the potential for three major dam systems in the North (CoA, 2015). The limitations of this approach are (a) the lack of suitable storage landforms in areas of high water demand; (b) the high levels of water loss through evaporation due to generally shallow storages (at times over 100%); and (c) the high cost of dam building. These factors make these facilities uneconomic as well as wasteful and ecologically damaging (Cendón et al., 2010; Larson, Gibbs, & Quiggin, 2014).

Water storage through the use of underground aquifers ("water banking" or aquifer recharge) provides an alternative strategy that overcomes these challenges (Schwartz, 2015).

Rather than investing in high cost and low efficiency dam facilities, largely unsuited to the region, the opportunity is to expand the use of underground water storage. It is cheaper to build and operate, more ubiquitous, avoids evaporative losses, and has the added benefit of cleansing contaminated water. Initial mapping studies of the northern landscape highlight that a "mosaic approach" combining recharge and reextraction of water from a large network of aquifers is both feasible and promising.

Further, leveraging this opportunity facilitates the extension of pastoral leases to include growing of stockfeed and horticultural crops through the use of recharged aquifer water storage to irrigate crops. This would enable the development of high-value products and services significantly increasing export returns, employment, and social benefits, while having minimal impact on the environment. Aquifer recharge also has the advantage of very low capital costs compared with dam construction and thus represents a significant saving of public expenditure (Larson et al., 2014).

6.2.2 | Marine ecosystems

Achieving sustainable prosperity in the North requires not only a review of strategies to address "life on land" but also "life under water" (SDGs, 2017). Though it is beyond the scope of this paper to examine the entire northern coastline, a case study of the Great Barrier Reef highlights the limitations in our current business as usual approach. However, it also highlights key strategies that can be potentially applied not only to the Great Barrier Reef region but also to other coastal regions in the North such as Ningaloo in north-west WA and other coral reef zones.

The Great Barrier Reef currently contributes AUD 6 billion to the Australian economy, over 60,000 jobs, and is a world heritage listed ecosystem (Great Barrier Reef Water Task Force—Final Report, 2016). However, these existing contributions to the ecological, social, and economic prosperity of the North are currently under threat. The key threats identified by the Great Barrier Reef Marine Park Authority in order of priority are (a) climate change; (b) continued declining water quality from catchment run-off; and (c) loss of coastal habitats from impacts of fishing of threatened species (Great Barrier Reef Marine Park Authority, 2014).

The first, climate change, is a global issue in which the region and Australia can only play a part. However, the other two major threats are within regional and national control. Within this context, Bohensky et al. (2011) identified a range of strategies that could be deployed based on assessment of four long-term potential scenarios for the Great Barrier Reef (to 2100). These are summarised in Figure 4.

Strategies identified covered both a global approach to climate change and regional management of the issues of declining water quality and coastal habitats. The importance of the interconnectedness of these strategies is captured in Figure 5 (Great Barrier Reef Water Task Force—Final Report, 2016).

The challenge is that although we know the issues, as well as many of the solutions, at a regional level, success in implementing these strategies has been extremely limited (Great Barrier Reef Water Task Force—Final Report, 2016). For example, management approaches addressing dissolved organic nitrogen have only resulted in a decrease of 17% relative to the 2009 baseline, compared with a 2018 target of 50% (Great Barrier Reef Water Task Force—Final Report, 2016).

Significantly, the key barriers to success in this and other key initiatives were identified as primarily management issues: (a) complexity (governance, reef science, bureaucracy, and program delivery); (b) poor communication and engagement (science communication, inconsistent narrative, and misunderstanding); (c) fragmentation (policy, delivery, governance, funding, extension, monitoring, and communication; Great Barrier Reef Water Task Force—Final

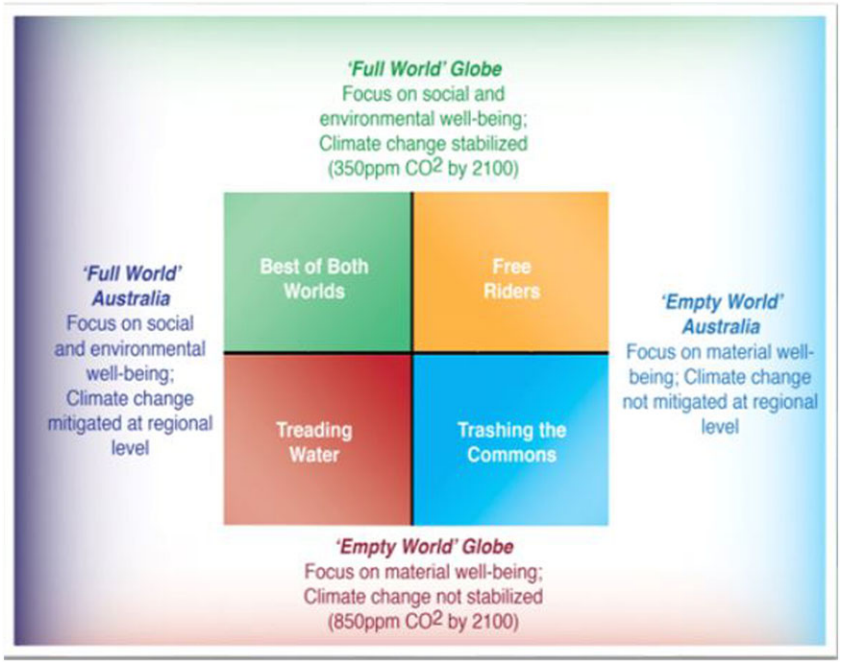

FIGURE 4 Four possible scenarios and alternative strategies for the Great Barrier Reef

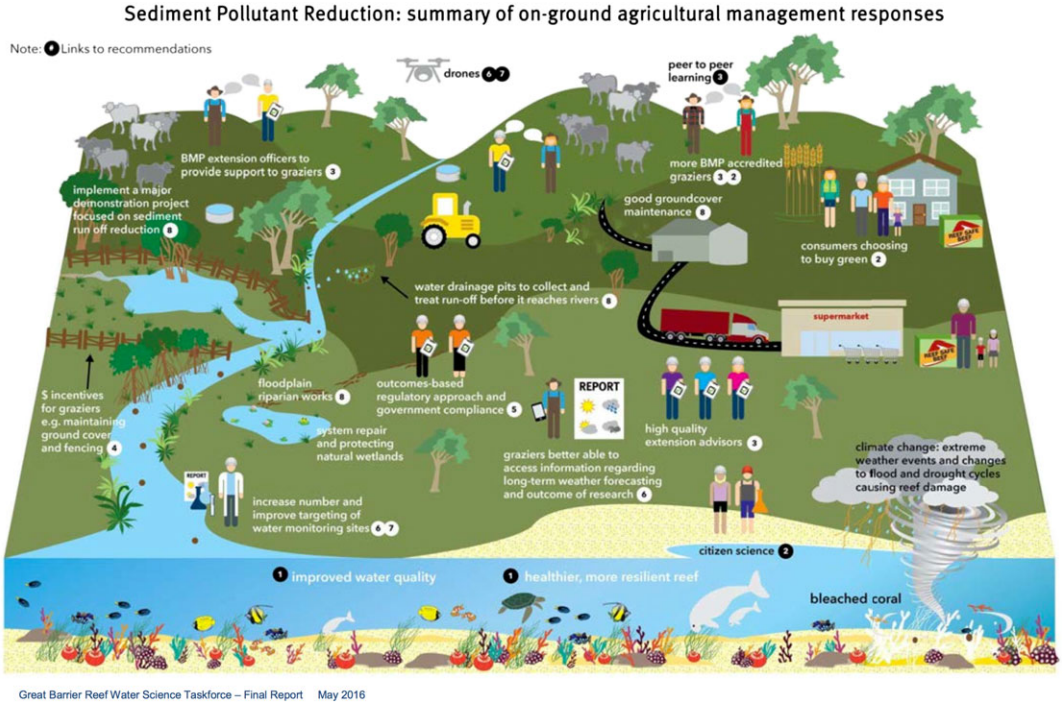

FIGURE 5 Great Barrier Reef Water Task Force—Final Report (2016)

Report, 2016) not ecological or technical. This highlights the opportunities provided by improved management and governance to achieve a preferred scenario of Best of Both Worlds. Improved governance strategies and the key policy initiatives required are summarised in Table 2. (Further discussion is available in Data S3.)

6.3 | Energy

The large distances, diverse population spread, and limited supplies of energy resources have resulted in the supply of low-cost energy being another significant factor limiting the development of the North. However, the emergence of new renewable, storage, and transmission technologies, combined with global trends toward sustainable development, has opened up fresh opportunities.

Historically, energy supplies have been available in southern and eastern Australia due to large coal deposits that have powered the growth of industry and cities throughout most of Australia's recent industrial history. In the North however, the historical gap in ready energy supplies has limited the ability to similarly vertically integrate, resulting in products of its extractive industries having to be transported and processed elsewhere. For example, bauxite from Weipa is shipped to New Zealand to be turned into aluminium using hydropower. The region is also completely dependent on imported oil for most of its industries, transport, and communities. This not only limits development opportunities but also exposes the entire region to supply, cost, and security risks. The provision of low-cost energy to the North could therefore significantly expand economic, workforce, and community development opportunities (Australian Renewable Energy Agency, 2016).

The worldwide trend to reduce fossil fuel consumption in favour of renewable energy is changing everything (Garvey, 2017). With the markets for Australian fossil fuel energy products potentially contracting, the converse is also true, with the demand for Australia's broad range of renewable energy resources having the potential to expand rapidly as these resources are also exportable. From a national perspective, this is strategically important. Development of these capabilities has the potential to offset any decline in international fossil fuel demand and prices. It can therefore play an important role in diversifying the national economy against any downturn in fossil fuel exports.

Northern Australia can play a key role in this potential transition and diversification due to its natural endowment of renewable energy resources, including one of the highest intensity solar regions in the world, and its close proximity to the Asian market. Solar alone, using existing solar panel technology leveraged with high-voltage direct current (HVDC) long-distance transmission technology, is sufficient to not only supply national energy requirements but also generate substantial exports into the Asia-Pacific region (Blakers, Luther, & Nadolny, 2012; Figure 6).

Australia is also ranked in the top three nations for wind resources (Drew, 2015). Combined with Australia's other renewable energy sources (tide, wave, and geothermal) and the increasing range of storage capabilities (hydro, battery, and thermal), the development of cost effective and efficient long-distance transmission has the potential to be substantial game changer. This is not only for the North but also for Australia and the rapidly expanding Asian energy market.

6.3.1 | Developing a "national energy superhighway"

Australia already has the longest geographically connected power system in the world. However, the 2017 Finkel Report on security of the Australian electricity market identified that

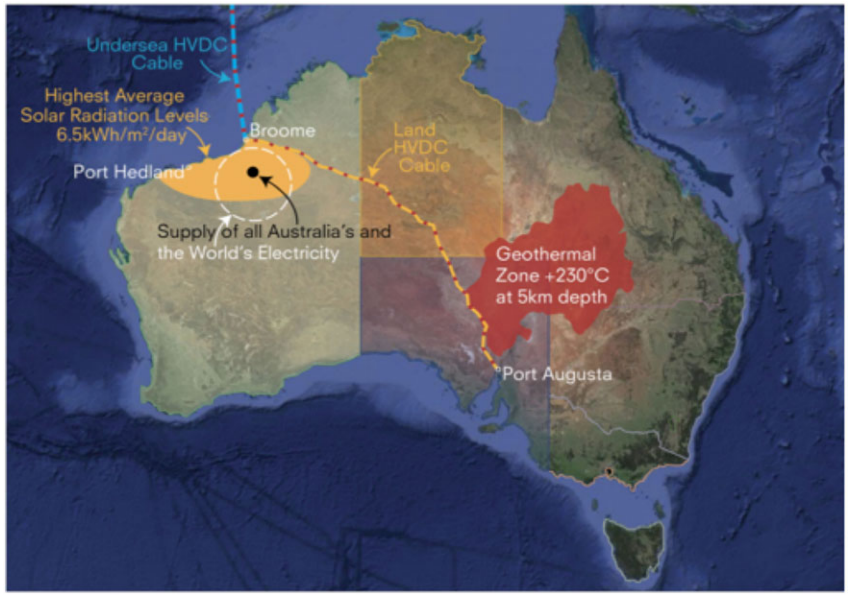

FIGURE 6 Australia's solar energy opportunities in the north alone could power the global market. HVDC: high-voltage direct current

the lack of full connectivity as significantly limiting Australia's ability to capitalise on its huge geographical and physical diversity in energy sources (Finkel, Moses, Munro, & Effency, 2016). A strategy that combines the existing range of energy sources with the unique weather patterns and landscapes therefore provides the cornerstone for consistent, secure, and sustainable energy supplies across Australia. It can also provide a potential competitive advantage internationally (Drew, 2015). The Finkel Report also highlighted that the successful development of energy opportunities lies not in governments trying to "pick winners" or favouring one type of energy sector over another but in developing the infrastructure that allows all types of energy to be integrated and to compete on a level playing field (Finkel et al., 2016).

The advent of HVDC long-distance cable transmission now allows the establishment of this full connectivity both cost-effectively and efficiently (World Nuclear Association [WNA], 2017). HVDC loses as little as 3.5% per 1,000 km, compared with 30–40% losses using the standard AC overhead cables that make up the Australian grid (WNA, 2017). HVDC cabling can be strung overhead or buried in a trench, alongside optic fibre and other services. It is also submersible and is currently used to link the Victorian and Tasmanian energy grids. Under development for more than 80 years, there are now almost 200 HVDC lines in use worldwide spanning distances up to 3,000 km or more. Many developing and newly industrialised countries, such as Brazil, China, India, Mongolia, and Russia, are well ahead of Australia in their adoption of this technology, placing Australia currently at a global competitive disadvantage in power supply (WNA, 2017).

By starting in the population-dense south-east, the "national energy superhighway" could collect energy traffic from coal, gas, wind, solar, hydro, and any other local energy sources (including private solar roof panels), with spur lines from the south (wind from the Bight) and north (Queensland coal and gas). Crossing central Australia would allow the leveraging

of the extensive solar thermal and photovoltaic sources in the cloudless centre and the emerging hot rock geothermal opportunities. These have the benefit of supplying the 24-hr "base load" that could be further complimented by hydro storage in the North (Blakers et al., 2012) and thermal storage in South Australia (Latimer, 2018). The "highway" would then extend across from the Pilbara region, to link up with Northwest Shelf gas, tidal, solar, wind, wave, and ocean current resources as they develop, before crossing to Timor and then into Asia (Figure 6). Horizontal integration of geographically diverse energy sources though this "energy superhighway" also brings the benefits of economies of scale to energy sources. Connecting sources that may currently not be economically viable as standalone operations, such as potential geothermal opportunities in central Australia, can potentially become viable when connected and integrated into the national system.

6.3.2 | Connecting to the ASEAN "super-grid"

An energy superhighway strategy utilising the North as a hub provides the opportunity to not only connect the south-east of Australia to the north-west but also access South East Asian energy markets through HVDC. Blakers et al. have highlighted the opportunity to establish HVDC connectivity to the Association of Southeast Asian Nations (ASEAN) super-grid. This would link Australia to Indonesia then through to Malaysia, Thailand, and Vietnam and could ultimately deliver power directly into industrial southern China (Figure 7). Costs of transmission from Australia to the super-grid are offset by the higher output of energy sources such as Australia's high intensity solar regions in the Pilbara region (Blakers et al., 2012).

FIGURE 7 Australian connection to the existing and planned Association of Southeast Asian Nations "super-grid." HVDC: high-voltage direct current

The ASEAN super-grid replicates the approach already being developed in Europe (WNA, 2017). Linking into this ASEAN super-grid would then provide Australia with a similar competitive advantage to energy rich European and ASEAN countries based on the significant renewable energy export opportunities this would provide (Drew, 2015). These benefits are substantial. Commitments already made on climate action by the rapidly growing ASEAN market counties are targeting 20% renewable energy supply by 2050. Supplying 50% of this would be worth AUD 35 billion to the Australian economy. This is equivalent to over 60% of the current GDP contribution of fossil fuels such as coal (Thirlwell, 2017). Over the next decade, this would equate to AUD 13.1 billion in the ASEAN market and AUD 4.4 billion for the Indonesian market alone.

Connecting to the ASIAN super-grid to an Australian energy superhighway via a hub in northern Australia therefore would enable Australia to (a) leverage the diverse range of national energy sources available; (b) transition to the new renewable energy economy; and (c) diversify the economy against the risk of reduced demand for existing fossil fuels such as coal (Drew, 2015).

6.3.3 | Opportunities for vertical integration

A national energy superhighway strategy also provides the North with the power needed to vertically integrate and kick-start major industrial value add developments in food (beef, fish, fresh fruit and vegetables, and processed food) and minerals (iron, steel, aluminium, copper, manganese, graphite, etc.) processing. This vertical integration can thus provide the foundation for the development and growth of northern cities and even remote communities (for whom new industries such as "cloud" server farms would then become economic). The advantage of the energy superhighway strategy also lies in creating a level playing field on which all energy resources can compete equally to be the most efficient supplier, thus providing Australia, as well as the Asia, power at the most competitive prices.

6.3.4 | The cost of connection

The cost of building an HVDC line can be estimated as approximately AUD 2 million per kilometre plus AUD 200 million for each converter station from recent European contracts. This is consistent with the estimate by Pilbara Solar to build the 2,400-km HVDC network connection to Indonesia at a cost of AUD 7.2 billion at current prices. An EPA proposal has already submitted (Vorrath, 2017). The cost of connecting the eastern grid from the Pilbara region to an eastern hub in Port Augusta is estimated at AUD 6 billion based on costs of similar existing and planned land-based HVDC cable in Europe (WNA, 2017). This is less than 20% of estimated cost of either the National Broadband Network (AUD 45 billion) or the Stealth Submarine Contract (AUD 50 billion). It is comparable with the AUD 5.6 billion annual subsidies currently being provided to the fossil fuel industry (Gordeljevic, 2017). Therefore, a refocus of less than 25% of the Australian annual fossil fuel subsidies over the next 10 years would fund both a national energy superhighway and connection of the full range of Australia's energy capabilities to the lucrative and expanding Asian energy markets.

An energy superhighway investment strategy therefore provides (a) key horizontal and vertical integration opportunities for the North; (b) energy security for Australia; and (c) significantly expanding and diversifying Australia's energy export opportunities.

6.3.5 | Benefits to Indigenous and remote communities

The benefits of the renewable energy trends and technologies can also provide social and economic further benefits to Indigenous and remote communities. Solar technology combined with battery storage is now a viable substitute for current diesel-powered energy supplies for remote Indigenous communities. This both reduces ongoing costs to these communities, thus increasing their viability, as well as reducing their carbon footprint (Indigenous Business Association, 2017). An example is the Daly River project, which will provide renewable energy to over 20 remote communities. The project will save over AUD 100 million in diesel fuel costs over the lifetime of the project. At a cost of AUD 55 million, this represents a 90% return on investment over the project's lifespan (Frydenburg & Scullion, 2017). This strategy also has the benefit of reducing capital outflow and dependency on outside energy supplies.

Equally significant are the economic opportunities opened up by a national energy superhighway and ASEAN super-grid for the current Indigenous Advancement Strategy. In the Pilbara region, an important potential renewable hub site, Pilbara Solar, one of the companies seeking to develop both solar and wind production capabilities, as well as the HVDC cable connection to the ASEAN super-grid is 25% owned by the Yamatji Maripa Aboriginal Corporation (Vorrath, 2017).

6.3.6 | Australia as an alternative transport fuel supplier

North Australia is also totally dependent on imported fuels for transport, making it extremely vulnerable to oil prices, fluctuations in supply, and energy security. The global trends towards reducing the use of fossil fuels will potentially increase the vulnerability of the North to these changes. In addition to the vertical integration opportunities, the building of an Australian energy superhighway offers the benefit of leveraging the resources of the North to horizontally integrate through the production of alternative clean transport fuels.

Production of alternative land transport and aviation fuels from algal biofuel is a rapidly emerging technology for which the North is ideally suited (Pilburra Development Commission, 2018). At current yields, it is estimated that Australia's entire transport fuel supply could come from 600,000 ha of pondage. This is the equivalent of a single northern cattle station. Consortiums such as the Asian Renewable Energy Hub are also looking at production of other transport fuels such as hydrogen using renewable energy (Milne, 2018).

Further economic, ecological, and social benefits can also be realised through the by-products of biofuels. Development of the biofuel industry allows the spin-off of subsidiary industries for which this region is also ideally suited. By-products are suitable for (a) fish, allowing for the further development of the aquaculture industry; (b) meat for livestock production; and (c) novel health foods made from the protein, carbohydrate, and micronutrient content of algae after the oil has been extracted. It has been estimated that the current aquaculture industries, including “high-value” barramundi, prawn, and mud crab, are annually worth AUD 1 billion alone. This will continue to grow significantly due to the increased efficiencies of aquaculture over other food production, increased global and national demand for sea foods, and limitations on supply of catch supply (Kierath, 2017). The long-term global supply of current aquafeeds has been identified as both uneconomic and unsustainable (Tacon & Merian, 2008). Therefore, the provision of the low-cost feeds that algae culture can supply has been identified as a viable important alternative (Towers, 2013) that northern Australia would be in an ideal position to supply. The further benefit is the opportunity to supply stock feed to the regional pastoral

industry, accelerating the move from low-value export cattle, to high-value meat, food products, and services.

Adopting an alternative fuel supplier strategy would therefore provide (a) national self-sufficiency and security in transport fuels; (b) a secure, renewable supply of fuel for defence, emergency services, and health care; (c) a net gain of AUD 44 billion to the Australian economy by replacing foreign oil purchase mainly from the Middle East (Department of the Environment and Energy, 2016); (d) significant spin-off industries in food, stockfeed, textile fibres, plastics, and fish aquaculture; and (e) an estimated 50,000 regional jobs (Murphy, 2013).

6.4 | Governance

To date, unsuccessful and largely uncoordinated development of the North can be attributed to inconsistent decision-making. This has been due to the vertically based governance system combined with a lack of understanding of the region's unique ecosystems (Dale, 2013). The challenge therefore for the successful implementation of any vision and strategy for northern Australia is the effective management of this "vertically divided" governance mix across the region (Dale, 2013). This is particularly relevant for achieving sustainable prosperity. This objective is dependent on cross regional coordination to leverage global opportunities such as the renewable energy market, coupled with the requirement to make tough choices on policies that both mobilise technology and reduce pressure on the environment (Hatfield-Dodds et al., 2015). These challenges are also exemplified in the coordinated approach required to addressing the crises facing the Great Barrier Reef.

Current governance however is based on historical circumstances spanning multiple state, territory, regional, and federal jurisdictions. From an ecosystem perspective, this involves the artificial conception of "State divisions" covering the jurisdictions of Western Australia, Northern Territory, and Queensland. These divisions are further exacerbated by the role of the Federal Government, which effectively creates a fourth player. The requirement therefore is for an integrated and coordinated model of governance in the North that addresses the diverse political landscape and addresses the historical limitations (Dale, 2013). This is therefore a key success factor for the successful deployment of economical, ecological, and social strategies to achieve sustainable prosperity.

6.4.1 | Achieving governance consistency across the North

The first step, as outlined by Dale, is the establishment of consistency in state and federal regulation across economically, ecologically, and socially sustainable principles and practice. The platform for this is already in place in the North's joint Federal/State leadership forums; however, current management approaches are often framed by three competing agendas: (a) desire for major new greenfield economic development; (b) efforts to preserve internationally and nationally significant conservation landscapes; and (c) Indigenous land and resource use rights and aspirations (Dale, 2013).

These three agendas can however complement each other at local, regional, and national levels through a cohesive governance approach based on systematic reform to achieve "genuine bipartisan, cross-jurisdictional cooperation on policy development and investment priorities" (Dale, 2013). The development of this governance approach would provide the framework to achieve "an exciting new economic, social and cultural dynamic in the north" (Dale, 2013), as exemplified by the strategies outlined in this paper.

This "top down" approach can be further complemented through the strengthening of Indigenous-led and regional and local governance systems (Kerins, 2013). For example, Indigenous communities can establish corporate bodies, which are capable of joint decision-making reflective of community clan and kinship structures. These structures then provide the opportunity to leverage finances and investment, and the development of economic, ecological, and social sustainability opportunities, as seen in the Pilbara Solar project (Vorrath, 2017), but equally in education and Indigenous cultural development (Kerins & Green, 2016).

6.5 | Infrastructure and investment

The range of investment and infrastructure initiatives to support the development of the North in the *White Paper* are comprehensive and include roads, aviation, and water storage and management totalling over AUD $1 billion over the next 10 years. Expanding the scope to include economically, ecologically, and socially sustainable development allows this type of expenditure to be both more focused and more strongly linked to economic, as well as ecological and social benefits. It also allows the investment to be leveraged across a broader range of economic opportunities, significantly increasing the return on these investments.

Examples of the economic growth opportunities relative to infrastructure costs across the three key core resource areas of land, water, and energy from a sustainable prosperity approach for the North are provided in Table 1.

Expanding the vision and strategies to achieve sustainable prosperity in the North addresses the limitations in the current *White Paper* approach by (a) focusing on energy as a core requirement for sustainable prosperity; (b) leveraging existing industries through value-added capabilities and leveraging emerging market and technology opportunities; and (c) expanding economic opportunities through vertical and horizontal integration.

It is also recognised that there are financial constraints in expanding the vision and strategies for the North to achieve sustainable prosperity. However, as highlighted in this paper, many of these can be largely addressed through (a) removal of infrastructure costs from nonproductive assets (pastoral industry); (b) reallocation of resources freed by this improved focus to additional opportunities created by a sustainable prosperity vision and strategies (energy transport infrastructure); and (c) leveraging the private funding opportunities created by this expanded vision (carbon farming). (Further discussion of these opportunities is available in Data S4.)

6.6 | Workforce

A key focus of this paper has been to outline the economic opportunities that are available through the rapidly developing sustainability economy. These include renewable energy, ecosystem services, carbon farming, value-added pastoral agriculture, and aquiculture. Each of these areas provides significant employment and workforce growth opportunities as noted in the strategy examples outlined in this paper.

6.6.1 | Carbon farming and ecosystem services

In examining the requirements of the sustainable development approach to the North, people power and expertise in many of these areas are already in place. Carbon farming and ecosystem services management is already in place through Indigenous land management expertise and cultural knowledge and has been so for thousands of years. The spread of Indigenous

TABLE 1 Growth/cost reduction opportunities by reframing development from "business as usual" growth model to "sustainable prosperity" model in northern Australia

	Core resource	White Paper infrastructure cost	Sustainable prosperity infrastructure cost	Employment growth opportunities	Revenue growth opportunities	Comments
1.0	Land					
1.1	Carbon farming/ ecosystem services		AUD 120 million	500 jobs	AUD 2 billion	Potential revenues over the next 10 years
1.2	Pastoral industry (roads)	AUD 100 million	AUD 20 million			AUD 80 million cost savings
1.3	Mining rehabilitation			500 jobs	AUD 3.5 billion	Based on realisation of 20% of rehabilitation costs over the next 10 years
1.4	Aquiculture industry			Further research required	Further research required	
2.0	Water					
2.1	Mosaic underground water management	N/A	Further research required	Further research required	Further research required	
2.2	Great Barrier Reef (integrated management approach)			6,000 (based on potential to lose 10% of 60,000 current jobs	AUD 0.6 billion (based on potential to lose 10% of current AUD 6 billion)	Based on loss of 10% of current contribution to economy and employment market
3.0	Energy					
3.1	Renewable energy (export)		Infrastructure costs currently covered by private investment	3,000 FT during construction, 400 operations	AUD 4.4 billion (Indonesia) AUD 13.1 billion (ASEAN)	Revenues based on 10% of 2025 Indonesian and ASEAN energy markets Employment based on the Pilbara Energy Hub estimates only will increase with Pilbara Solar

(Continues)

TABLE 1 (Continued)

	Core resource	White Paper infrastructure cost	Sustainable prosperity infrastructure cost	Employment growth opportunities	Revenue growth opportunities	Comments
3.2	Renewable energy (domestic)		AUD 6 billion	As above	As above	Costs of establishing national energy superhighway (Pilbara—Port Augusta). Could be privately funded.
3.3	Renewable energy (oil substitution products)			5,000 jobs	AUD 4.5 billion	Based on realisation of substitution 10% of Australia's oil imports and job growth estimates
	Total			15,000 jobs	AUD 15 billion	Totals have been based several conservative assumptions: 1. Realisation of 10% of market opportunities over the next 10 years 2. Renewable energy export market to Indonesia only 3. 10% losses included based on potential decline of the GBR

Note. GBR: Great Barrier Reef.

communities across large parts of the North results in these people power capabilities already being readily available in situ.

6.6.2 | Knowledge services

The *White Paper* outlines the strong position in which Australia already operates in knowledge and education services as an innovator and leader (CoA, 2015). An expanded vision and associated strategies for the North's development incorporating not only sustainable economic but also ecological development, and social well-being, further enhance the scope and application of these capabilities. This includes areas already mentioned in the *White Paper* such as international education, tropical health care and medical research, aged care, natural sciences, and carbon management. A broader vision and scope however expand the range of opportunities in knowledge services to areas such as renewable energy and energy transfer expertise, carbon trading and management, aquaculture, and remote services provision and management.

Commercialisation of this knowledge, an area where Australia has been historically weak (Drew, 2015), provides further opportunities, as do partnerships with other countries to develop these opportunities.

6.6.3 | Renewable energy services

The vast opportunities in the renewable energy sector not only offer the opportunity to develop secure and sustainable energy resources for Australia and the region but also provide the opportunity to develop skills and expertise in these areas that are transferable nationally and internationally.

6.6.4 | Value add pastoral services

Value-added pastoralism provides further employment opportunities by increasing the efficiencies in the pastoral industry as well as reducing its environmental footprint. This enables a more efficiently focused yet expanded workforce through diversification across a range of value-adding industries such as meat processing, storage, and transport.

6.6.5 | Aquaculture

Strategic opportunities have also been noted in this paper for the development of the aquaculture industry in the Pilbara and Gulf regions with the concurrent development of an Australian energy superhighway.

6.6.6 | Mining rehabilitation

Mining rehabilitation provides another important strategic opportunity for Australia to lead the world in this developing market (Rouche & Judd, 2017) and, at the same time, increasing employment and community well-being in the North. The immediate employment opportunity is to refocus the 12,000 lost mining jobs since 2012 to mining site rehabilitation (Rouche & Judd, 2017).

TABLE 2 Key strategy policy implications to achieve sustainable prosperity in northern Australia

Objective	Strategy	Policy implications
Land	Carbon farming and ecosystem services	Native title and Indigenous land • Expand Indigenous ranger programs to address and expand the carbon farming and ecosystem services management opportunities. • Expansion of native title to afford property rights over land and fisheries to leverage sustainable economic and community well-being opportunities. • Ensure consistency of tenure arrangements for carbon/biodiversity in the landscape.
	Pastoral land	• Identify and focus resources on "high potential" pastoral leaseholds. • Allow feed grain development on high potential pastoral leaseholds. • Develop and implement "mosaic water storage and irrigation systems" on high potential pastoral leaseholds. • Harmonise key tenure related practices across jurisdictions and establish "whole of government" point of contact for tenure resolution. • Adopt consistent principles to improve flexibility and diversify land use especially on pastoral and Indigenous lands.
	Mining site rehabilitation	• Conduct a national inquiry and audit all mining sites to establish Australian standards of mine closure, determine the gap between existing mine rehabilitation status and existing bonds, and forecast costs of rehabilitation. • Establish site by site rehabilitation and performance reporting plans to be included in company balance sheets. • Establish state and federally coordinated jurisdictional management coordination.
Water	Smart water storage	• Land-based water ecosystems: Expand the northern Water Feasibility Study to include the option of mosaic aquifer water storage options as an alternative strategy to the *White Paper on developing the North* large-scale dam construction and transport option. A cost/benefit analysis of these two options can then be established, and a preferred option determined.
	Sustainable marine ecosystems	• Ocean-based water ecosystems: Management of the threats and opportunities for the Great Barrier Reef through a national multiscale, cross agency, and cross community approach that integrates national, state and regional government, business, and community management responses for the GBR region that account for the interaction of land and water economic and ecological systems. • Proactive national and international support for global initiatives on addressing climate change. • Examine application of the above approaches to other coastal ecosystems in the North.

(Continues)

TABLE 2 (Continued)

Objective	Strategy	Policy implications
Energy	National energy superhighway	• Establishing a feasibility study of the Australian energy superhighway.
	Renewable energy export	• Establish feasibility study to support a national energy superhighway and ASEAN super-grid connectivity, including technology, capital and government, business partnership options, economic and community well-being costs, and benefits.
	Alternative transport fuel supplier	• Establish a feasibility study to support a development program for by-product industries in the Pilbara and Gulf Regions, that is, aquiculture and pastoral industries.
Governance	Governance consistency	• Implement systematic governance reform to achieve cohesive governance to achieve genuine bipartisan, cross-jurisdictional cooperation on policy development, and investment priorities. • Strengthening of Indigenous-led and local governance systems to enable Indigenous and local communities to achieve economic and community autonomy.
Infrastructure and investment	Rationalise White Paper 2015	• Review and update the *White Paper for the Development of the North* infrastructure and investment recommendations to leverage cost and revenue benefits presented to support sustainable prosperity strategies.
Workforce	Ecosystem services	• Expand the Ranger Network in the North to leverage the opportunities for carbon farming and other ecosystem services
	Knowledge services	• Expand scope of knowledge services to include partnership knowledge transfer opportunities and commercialisation
	Renewable energy services	• Develop renewable energy generation and transport industries through the north and into the South East Asian markets
	Value add pastoral development	• Develop "value-added" pastoral industries through focus on development of high potential pastoral leaseholds, freeing up limitations on growing stock feeds, and through development of mosaic water storage and irrigation systems
	Aquaculture	• Support development of the aquaculture and fisheries industries in the Gulf and other appropriate regions through the provision of low-cost energy and communications facilities
	Mine rehabilitation	• Leverage employment opportunities presented by the development of the mining rehabilitation industry.
	Workforce planning	• Establish coordinated state/federal workforce planning and implementation to support sustainable prosperity outcomes.

Note. GBR: Great Barrier Reef; ASEAN: Association of Southeast Asian Nations.

6.6.7 | Workforce planning

Key to managing expansion of these existing and new industries is effective workforce planning. This is made more critical due to the potential geographical spread of the economic opportunities as well as the technological and skills base required to support these opportunities. However, as seen in the cases of both the mining rehabilitation industry and carbon farming, many of the human resources are already in place and skilled in the areas. Harnessing these capabilities however becomes a critical component in the development strategies for the North, with skills, sourcing, and recruitment approaches identified with associated timelines. (Further discussion of this opportunity is available in Data S5.)

7 | POLICY IMPLICATIONS

Achieving successful sustainable prosperity in Australia is not predestined, but it is achievable (Hatfield-Dodds et al., 2015). As demonstrated in this paper, nowhere is this more applicable as in northern Australia. Success therefore needs to be based on well-developed and implemented policy that supports the realisation of the strategies and opportunities as identified in the case study examples in this paper. To facilitate this, a summary of each of these strategies and their relevant policy implications are identified in Table 2.

8 | CONCLUSION

It has often been an assumption that a model that pursues sustainability and community wellbeing objectives will compromise the economic objectives and opportunities of a region or country. However, as seen in this paper, the rapidly developing global sustainability economy, and trends driven by challenges posed by climate change and the UN SDGs, has resulted in this assumption no longer being appropriate in the North, or anywhere in the world. Further, proximity to rapidly growing South East Asian markets and abundance in sustainable energy sources, land, resources, and expertise indicate that North Australia is ideally positioned to leverage these opportunities.

The *White Paper* vision and strategies are limited in that they are based on an empty world model of development (Costanza, 2014), a model based on the assumption of unlimited availability of resources that has failed the North in past decades (Dale, 2014). The philosophy of "build it and they will come" no longer applies in a highly competitive and rapidly changing world. North Australia, however, has the opportunity to change this way of thinking and achieve sustainable prosperity. This paper demonstrates that this can be achieved by moving beyond the historical business as usual approach and pursuing a vision, strategies, and policies that leverage both emerging global trends and the North's unique location, cultures, resources, and ecosystems.

Leveraging the experience of the past with current and rapidly emerging technologies and global trends therefore provides significant opportunities to build sustainable economic, ecological, and social prosperity that will benefit the North as well as all Australians.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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