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What to expect from an energy transition for Australia's energy security and its Defence Force?

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Abstract

Now that most countries are taking energy transition more seriously, Defence forces must also adapt their energy use accordingly. In Australia, where the energy future is still undefined while moving constantly between clean energy initiatives and renewed interest in coal, the energy transition remains to be developed. Australia will gain in developing an energy plan which will pave the way to energy transition considering the forecasted decrease of demand for coal in favour of renewable energy sources. This will imply for Australia the necessity to regain control of strategic elements of its energy network and production. It also means to keep the upper hand in energy exports and to maintain full control on its energy transition process. In prevision, the Australian Defence Forces are already preparing themselves to reduce their energy use and to design new equipment powered with a greater share of renewable energy.

Introduction

In the 2021 Climate Change Performance Index[1] [13] [16], looking at national climate action across the categories of emissions, renewable energy, energy use and policy, Australia ranked 54th among 61 countries evaluated. The country received *extremely low* ratings in the Energy Use category and ranked at the bottom of *low* performers in both, the GHG Emissions and the Renewable Energy categories. Concerning climate policy, Australia is placed among the worst with unclear and environmentally unfriendly measures. Yet, Australia with its energy production system being the most polluting sector of the country, will have no choice but to walk the path of energy transition. The country is still powered principally by an aging coal industry and is making slow progress in clean energy efforts despite its high potential. Moreover, with no true will to begin an energy transition, Australia faces an uncertain energy future. This lack of planning is fragilizing the energy system which is already suffering from energy reliability issues causing blackout events in one of the richest countries with respect to energy resources. In this paper we will take a closer look to the Australian mineral and renewable industries, revealing Australia's ambiguous position on climate change, economy, and energy choices. We will then focus on energy security issues brought by the indecisive position of Australia on energy, as well as study the impacts on the Australian Defence Forces' (ADF) choices of energy use. Finally, we will question and discuss the state of Australia's energy transition.

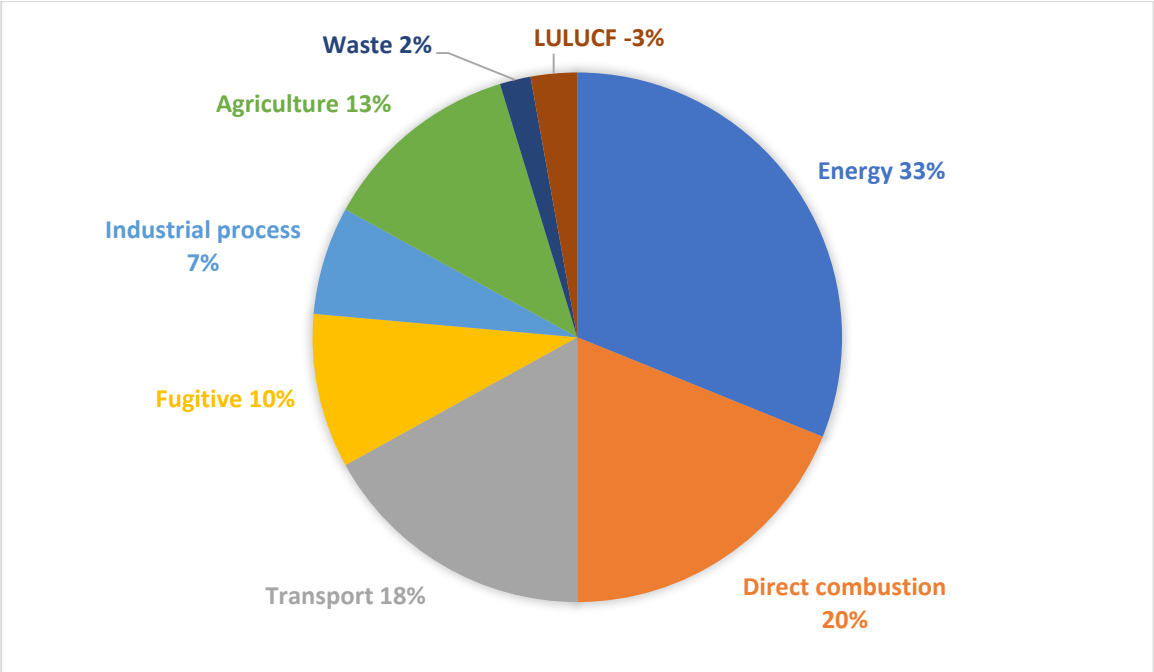
Australia's energy choices

Eight sectors are responsible for the majority of Australia's greenhouse gas emissions: energy, transportation, direct combustion[2], agriculture, fugitive emissions (gases leaked or vented from fossil fuel extraction and use), industrial processes, waste, land use, land use change and forestry (LULUCF) (see Figure 1). Among these sectors, energy (production) is the largest emitter of greenhouse gas. Australia's reduction scheme uses a pro-rata emissions reduction target of 26-28% by 2030 for each economic sector. According to the Climate Council [12], it will be more cost-effective for Australia to concentrate its efforts on sectors allowing a lower reduction cost. Such is the case of the energy sector where options to reduce electricity sector emissions are readily available and cost-effective, giving Australia's high potential in renewable energy and storage technologies. Moreover, Australia has an important renewable energy potential which is, per capita, superior to any other developed country [33]. Yet coal remains a massively used source of energy, representing 44.3% of Australia's energy mix.

Figure 1: Major sectors contributing to greenhouse gases emissions in Australia / Source: Data from government and Climate Council for the year 2020 [5] [7] [27]

[1] It is an independent monitoring tool of countries' climate protection performance. It aims to enhance transparency in international climate politics and enables the comparability of climate protection efforts and progress made by individual countries. The ranking results are defined by a country's aggregated performance in 14 indicators within the four categories "GHG Emissions", "Renewable Energy" and "Energy Use", as well as on "Climate Policy", in a globally unique policy section of the index. It is prepared by a group of think tanks comprising the NewClimate Institute, the Climate Action Network and Germanwatch.

[2] Produced from burning fuels for energy used directly either in the form of heat, steam, or pressure. This includes emissions from energy production, mining, manufacturing, commercial and residential buildings (mainly from heating), agriculture, forestry, fishing, and the military.



To date Australia's energy needs have been largely met by fossil fuels [14]. Australia's abundant and low-cost coal resources are used to generate three-quarters of domestic electricity and underpin some of the cheapest electricity in the world. In 2019, with 70% of its coal exported predominantly to Eastern Asia, Australia became the world's largest coal exporter with a dominance in the global market for high-quality coking coal used to make steel [18]. Even though coal production has been slowing down in the past few years due to the rising use of gas and renewable energies, production has soared back in 2017, going against international agreements to move toward a zero-carbon future [25].

Australia's renewable capacity has surged rapidly over the past decade, a growth helped by an extraordinary fall in the cost of equipment for solar and wind energy production as well as for technologies to store renewable energy in order to balance demand and supply. By 2017, production from renewable sources other than hydro had more than tripled from 2007 levels, providing 10% of the electricity demand. In 2019, the share of renewable sources in electricity generation came up to 24%, overachieving the government's Renewable Energy Target (RET) [14]. But recently, the government declared that it will not extend the target and investments in new renewable energy capacity were slowing down. After more than a decade of unstoppable growth, 2019 saw a 50% downturn in new large-scale renewable energy investment commitments [29].

In addition, to compensate times of low renewable energy productivity, gas turbines were chosen to adjust for energy needs. Natural gas provides notable advantages in electricity generation, heating, and transport as it yields relatively less greenhouse gas emissions per energy output than other non-renewable forms of energy (except for nuclear) and can make use of already existing equipment. LNG exports make up about 2.5% of the Australian GDP and are shipped to Japan, China, and South Korea. But the climate effects of LNG exports are mixed. Australia claims that gas export is helping to bring down global emissions, especially in developing countries that are moving away from coal. Even though natural gas emits only about half the quantity of greenhouse gases during combustion as coal,

gas leakage is important and offsets much of the difference[3]. Indeed, the projected increasing emissions in the energy subsector are mainly driven by the growth in LNG production [4].

In Australia, along with hydropower and storage, gas power generation will continue to play a part in managing the output variability of wind and solar power plants. Factors that could impact gas generation and gas supply could be unexpected shifts in the timing of building new transmission lines, renewable energy generation, or energy storage developments. Alan Simon Finkel, Australia's Chief Scientist[4] who helped prepare and release the National Hydrogen Strategy in late 2019, believes that Australia will need to rely on gas generation to support renewables for the next 10 to 20 years and potentially for up to 30 years, but tipped that hydrogen might be the way forward. He points out that hydrogen carries more energy than natural gas, is carbon-free and the burning of it does not contribute to climate change if produced through electrolysis using solar and wind energy. However, hydrogen may also be produced by using fossil fuels like coal and gas, thus leading to a high climate impact.

The importance of coal in Australia's energy mix and the still weak role of renewable energies poses two questions: First about the current state of energy transition in Australia and second about energy security. Coal power infrastructure has been ageing and it has been 10 years since a new coal power plant was commissioned. Also, about 75% of coal-fired power stations in Australia are currently operating beyond their life design. Using intensively an ageing coal fleet without having a real energy transition plan will mean more carbon leakage and unreduced GHG emissions. This may lead ultimately to climate warming and a greater energy demand for air conditioning in Australia with the risk of summer blackouts and heavy consequences when Australia will have no choice but to turn to new sources of energy.

Which obstacles: an energy security issue

Before heading for an energy transition, Australia will have to build a reliable and secure energy system as well as to design an energy transition plan. Despite being the 10th richest country in natural resources, Australia has suffered from blackouts in the South, the most densely populated region, following extreme weather events [21]. The blackouts revealed several issues in Australia's energy system. First, that energy capacities lacked risk and mitigation planning and second, that national energy thinking was affected by inconsistent political decisions and disconnected energy management which depends on private companies.

The Australian energy system is not efficiently designed to respond to an energy shortage. It has no energy storage, no back up plan and little consideration of the impact of climate change. Natural events are not seen as a direct threat to the energy grid. Yet, due to climate change, they have become more frequent and severe presenting a considerable risk to the energy infrastructure. These external factors combined with a non-existent global energy framework showed the precarity of Australia's energy security status on a national level.

Australia will have to focus on three axes: energy storage, transmission and policy [31]. With the increasing share of renewable energy that an energy transition will bring, supply flexibility is now as

[3] The biggest source of LNG fugitive emissions is from gas venting and gas flaring. Venting is in the intentional release of gas (including carbon dioxide and methane) usually from routine operations. Flaring is the burning of excess gasses that cannot be recovered or reused during plant operations and is important in managing the pressure, flow, and composition of the gas in production and processing.

[4] The Office of the Chief Scientist (OCS) is part of the Department of Industry, Innovation and Science. Its primary responsibilities are to enable growth and productivity for globally competitive industries.

important as stability. When Australia's energy grid was powered mostly by coal, vast amounts of excess electricity were produced because generators could not be easily turned on or off. Now Australia is moving toward a nonlinear energy mix due to the fluctuating characteristic of renewable sources [20].

The diversity of renewable energy sources and of their location can be exploited as an asset if coupled with a smart and integrated energy grid [6] which is able to source the renewable energy in relation to the demand, and provide storage of energy generated by renewable sources when not needed. The adaptation of the electricity and power distribution grid could also facilitate the achievement of a low-carbon economy. This will require sensors, smart meters, and digital relays to provide energy savings, and for identifying control faults. Aside from using renewable energy's full potential and managing the flow of electricity through storage and smart mechanism, the transmission system needs to be improved because renewable energy production is often located in remote areas. For example, solar energy is maximised in the interior and in the northern part of the continent which are the least populated regions of Australia. An enhanced energy transmission system will therefore increase connectivity between consumers and such renewable energy supplies.

The Australian Renewable Energy Agency[5] (ARENA) [11], is providing more and more funding for transmission networks to review the opportunities and challenges presented by connecting large-scale renewable generators to the National Electricity Market NEM [26]. Investment in transmission will help to build a more interconnected electric highway that allows diverse resources to be shared across the system. Interconnected transmission will be necessary not only to secure greater geographic diversity of weather dependent resources but also to manage the risk of anticipated but uncontrollable climate effects such as bushfires, droughts, and long heat periods. An interconnected grid can provide the flexibility, security, and economic efficiency associated with a power system designed to take maximum advantage of existing resources, integrate variable renewable energy, and support efficient competitive alternatives for consumers.

Australia's energy dependence on foreign decisions

Despite Australia's rich share of energy resources, other aspects of energy security are also at risk due to the increasing level of foreign ownership of Australia's energy infrastructure. The potential of foreign governments to influence Australia's critical energy supplies is non negligible and exposes Australia to manipulation, sabotage, espionage and coercion in addition to cyber manipulation.

There are four parts to Australia's electricity market: generation, transmission, distribution, and retail[6]. Of Australia's eight states and territories, only three governments retain full ownership of all elements of their electricity networks: Western Australia, Tasmania and the Northern Territory. For the rest of the country, the retail energy markets in southern and eastern Australia are dominated by three private players: AGL Energy, Origin Energy and EnergyAustralia. Of these three companies none is only Australian owned. AGL Energy and Origin Energy are both partly Australian owned, whereas

[5] ARENA is an independent agency of the Australian federal government, with the objective of increasing supply and competitiveness of Australian renewable energy sources.

[6] Power generators, which produce energy to sell to the wholesale electricity market / Distributors, who design, construct and maintain the network of "poles and wires" / Transmitters, which transport power from generators to the distribution system via the high-voltage transmission network / Retailers, who purchase power from the wholesale electricity market to sell to retail customers.

EnergyAustralia is a full subsidiary of the Hong Kong-based energy company China Light and Power (CLP) Group.

Looking more closely at energy company ownership in Australia, we find a dominance of Chinese ownership of critical energy infrastructure. The Chinese Government-owned State Grid Corporate[7] and Hong Kong-listed Cheung Kong Infrastructure Power Assets (CKI) already own significant shares of the privatised state power distributors. When it comes to gas, Chinese and Hong Kong companies have a stake in 99% of the transmission and distribution network in Victoria, 100% in NSW and the ACT, as well as 86% in South Australia, 78% in Queensland, 74% in the Northern Territory and 62% in Western Australia. China is duplicating in Australia the very same strategy like in Europe, where Chinese state-owned companies already acquired large parts of electricity and gas transmission and distribution networks in Greece, Italy, Luxemburg, Portugal and other European countries.

Foreign ownership is also a problem for mining industries specialized in metals like lithium, copper, and nickel. These companies play a critical role in the energy transition processes. A 2016 Treasury paper on Foreign Investment in Australia stated that less than 10% of mining projects are solely owned by Australian companies, while over 90% have some level of foreign ownership[8]. Chinese investment in minerals is specifically directed to lithium, a resource sought after in the electric batteries industry [23].

The foreign control over Australia's energy needs is amplified by Australia's great dependence on petroleum and crude oil imports [34]. Unlike electricity or gas where the source energy is produced in Australia, less than 10% of liquid fossil fuels are produced in the country. Moreover, Australia's fuel security is precarious and does not meet the internationally mandated 90-day stockpile requested by the IEA. This makes Australia the only IEA member that fails to meet its stockholding obligations [10]. Moreover, on an economy-based thinking, the number of refineries has also decrease from seven to four in 2015 as refined fuels became cheaper to import making Australia largely dependent on market forces. Before releasing a review of Australia's Liquid Fuel Security in April 2019, fuel supply was not addressed as an energy security problem by the Government and the Oil Industry. Yet, any serious disruption of such resource supplies will have negative consequences for food supplies, medication stocks, and military capabilities.

The importance of both, foreign export ownership and investment in the energy sector, makes Australia's highly dependent on external decisions. Without full control over crucial energy and strategic metal supplies for the energy transition, Australia's renewable energy plan and energy security projects might be slowed down. Energy security is fundamental to both civilian and military. Without energy security and without resilient supply chains, basic national needs cannot be fulfilled, and Defence Forces are unable to operate. It rather puts national defence capacities at the mercy of foreign nation's decisions to deal with harvested energy and may end in cutting supplies at their will [22]. This potential threat elevates Australia's energy security issues to the national security level.

[7] The State Grid Corporation of China (SGCC), commonly known as the State Grid, is the state-owned electric utility monopoly of China [10]. It is the largest utility company in the world, and as of 2019, the world's fifth largest company overall by revenue. The Area served include China, Philippines, Australia, Brazil, Italy, Portugal, and Greece.

[8] Foreign investment accounts for 86% share of ownership of major mining projects, including 26% from the US and 27% from the UK. Nowadays, there are 625 companies in the Metals Mining industry listed on the Australian Stock Exchange (ASX) from which can be found Australia's leading mining industries except Hancock Prospecting a privately owned Australian company leading in iron ore.

Toward a "green" Defence?

Energy is a critical and essential input to all Defence activities. Reliable supplies of energy are needed to fuel aircraft, ships, and other military vehicles, to transport and house personnel and to power offices, computer centres and laboratories. ADF's energy requirements are significant, its energy use represents close to 0.42% of Australia's total energy consumption and over 70% of the energy used by the Australian Government as a whole. Thus, energy transition is a matter taken seriously by the ADF. In its Defence Environmental Strategy [19], the Australian Department of Defence claims that it will become "a leader in sustainable environmental management to support the ADF capability to defend Australia and its national interests".

The ADF has the responsibility to manage its energy use, supply and security to continuously support operations and maintain its ability to defend Australia and its interests. Improving energy performance is compulsory for two reasons: First, to make economies to invest in other crucial military activities. Indeed, in 2011-12, from its total government funding of AUD 24.2 billion, Defence's annual spending on energy exceeded AUD 607 million (AUD 483m for fuel and AUD 124m for electricity) and this share has increased. The Defence's Strategic Reform Program (SRP) has implemented cost reduction targets in energy to improve efficiency and enable reinvestment of funds in other strategically important areas. Second, to minimize the impacts of operations on the environment[9] [9].

The ADF faces a number of challenges in implementing a consistent and reliable energy transition. To cite but a few there are the problems of the extent and diversity of the ADF Estate in terms of location and speciality, the ADF's ageing infrastructures, the activity and operation intensity and the ADF's budget.

Indeed, Defence Estates are located in different parts of Australia, near different types of resources and with diverse energy needs depending on the military activity held. A standardised approach to energy management is therefore difficult to implement. In response, the ADF is planning to take advantage of the diversity of viable energy resources available at Defence sites (e.g. land, wind, sun, waste and geothermal heat) and to switch to renewable energy generation. In the case of ageing infrastructure, plans for new equipment and facilities using renewable energy sources are developed. But for Defence's frequency of activity and funding, uncertainties remain as they depend on Government decision, as well as on natural and external political threats. For now energy security is the predominant concern and safeguard capabilities will depend on the budget and resources allocated by the Government.

One of the energy solutions commonly used by ADF bases is solar energy. In 2018, the Australian Air Force installed a solar and battery storage microgrid system at a facility in the Northern Territory. The Department of Defence subsequently installed a 1.2MW solar array at the Australian Defence Satellite Communications Station near Geraldton, Western Australia, as well as 12.5MW of solar arrays split between two facilities, the Robertson Barracks in the Northern Territory and the RAAF base in Darwin. In July 2020 a program to upgrade the Headquarters Joint Operations Command [10] (HQJOC),

[9] In this regard, Defence has released a *Defence Estate Energy Policy* under the *Defence Environmental Strategic Plan (DESP)* in charge of implementing Australia's Defence Environmental Policy. The policy describes Defence's commitments, objectives and targets related to energy on the Defence Estate that must be met over the period 2014- 2019. The Defence Estate Energy Strategy includes initiatives under four themes: Improving the efficiency of existing assets and equipment/ Providing efficient new infrastructure and equipment/ Using energy from renewable and alternative sources/ Driving energy saving behaviour.

[10] The HQJOC, houses Australia's most senior defence leadership, and is where Australia's international defence operations are coordinated.

announced a solar installation with a capacity of 1.9MW to power Australia's defence operations headquarters located outside Canberra, following the trend of other defence facilities already supplied by an on-site solar energy installation.

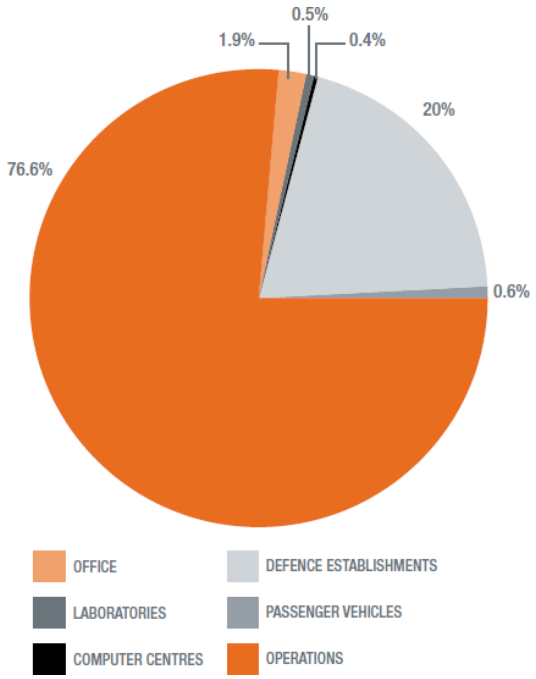
Ensure the mobility and the independence of the Australian Defence Force

Fuel consumption represents a large proportion of total ADF's energy use. The Department of Defence relies on petroleum for approximately 77% of its energy needs (see Figure 2). Thus, research and partnerships are developed to explore the possibility of using alternative fuels and sources of energy to reduce Australia's dependency on oil imports and coal power. The Strategic Logistics Branch works closely with the Defence Science and Technology Organisation (DSTO) to coordinate research into alternative fuels and energy. Ongoing projects study the feasibility, costs, energy security and interoperability benefits of using biofuels for operational requirements. Biofuels is also a matter of interest in other military forces such as the United-States. This common interest has led to a partnership between the two Defence agencies. In 2013, the Royal Australian Navy has signed an agreement with the US Navy which is now on the way to achieve the permission to use a 50/50 blended biofuel for its equipment. Through this partnership the Australian and US Navies are co-operating on research into alternative fuels for the naval fleet[11].

With the need to address the 2050 zero emissions target, looking for alternatives to fossil fuels is a primary concern of the ADF. In the civil sector electric vehicles are seen as the future for mobility considering the encouraging results of research and development in battery technology. But this does not address all mobility needs of the ADF which include long-range, long endurance air, surface, and undersea vehicles. The current step in shipping is to shift from the present low sulphur fuels to liquefied natural gas (LNG) by that halving emissions by 2050, a target set by the United Nations International Maritime Organisation. LNG causes lower carbon emissions for the same energy output compared with diesel oil fuel. However, that alone will not suffice to meet the zero-emissions goal. Instead, various forms of hybrid propulsion are being developed to make further reductions possible, mostly using some form of battery storage to supplement conventional internal combustion engines.

[11] Since 2013, the Royal Australian Navy (RAN) has maintained interoperability with the US Navy (USN) to benefit from alternative naval fuel to meet its Great Green Fleet energy initiative, which outlines the USN's commitment to source 50% of fuel from renewable sources by 2020.

Figure 2: Defence Energy use by End-use Category (2012-2013) / Source: *Defence Estate Energy Strategy*, Department of Defence



To decide in which fuel to invest in the future, the ADF must focus on the needs of their land, air, and sea (surface and underwater) operations. The Defence Science and Technology Group (DSTG) must evaluate alternatives to fossil fuels for all vehicles employed in ADF operations and prioritize investments in emerging new technologies for ADF early adoption. Air mobility may use electric energy but most likely with a limited performance and range. A more likely way ahead for military aircraft is the use of synthetic fuels[12]. Surface mobility for land vehicles using hydrogen is already under development and will most likely be adopted for ADF land vehicles and for naval vessels not designed for high performance or long-range independent operations. For high-performance naval vessels, and especially submarines, nuclear propulsion will be the preferred choice and is being investigated by the Submarine Institute of Australia through its Nuclear Seminar series[13] [28].

Yet, an important part of the ADF equipment is not really under Australia's control, because major industries providing military equipment are foreign owned. For Australia's Defence in order to obtain full control over their energy transition process, the Defence industry must solve three problems: The high level of imports, the low level of production and the existing control by foreign entities. The Australian defence industry's exports are greatly outweighed by the scale of imports of military goods and services to Australia[14]. Between 2001 and 2016, the total value of defence exports from Australia

[12] Synthetic fuels are usable in much the same way as current fossil oil-based diesel and aviation fuels. The difference is they are manufactured and consumed by chemical processes in which the carbon content is added to create the fuel and then recovered in combustion to return through the cycle again.

[13] Nuclear propulsion is in wide use for submarines and high-performance, long-endurance ships including aircraft carriers. Australia has the resources to produce nuclear energy but did not developed the industry for ethical reason. There are many issues to be resolved for nuclear propulsion for the ADF, including repeal of legislative prohibitions on nuclear power and on adding value to Australian mined uranium to create nuclear fuel or to reprocess spent fuel and consign residual radioactive waste to approved geologically stable repositories.

[14] The United States, Spain and France were the major exporters of weapons to Australia during the last five years. F-35 combat aircraft and P-8A Poseidon anti-submarine warfare (ASW) aircraft received from the US and warships from Spain accounted for more than 80% of Australia's imports between 2014 and 2018.

(using the Stockholm International Peace Research Institute SIPRI methodology, the world's leading authority on global military spending), represented only 6.8% of the total value of defence imports to Australia. In 2019, figures from the SIPRI showed that Australia has become the world's second largest weapons importer but has dropped to 25th in the export rankings [8]. In the July 2020 *Force Structure Plan* [36] and *Defence Strategic update* [35] a highlight was put on the Australian Defence industry, outlining the Government's commitment to a program of future investment and opportunity for its defence industry.

What will push transition in Australia

Australia's poor commitment to climate change mitigation has tarnished the country's international reputation. In September 2019 Australia was denied from speaking at the United Nations climate summit in New York. More recently, the country has been held responsible for the weak outcome of the COP25 and criticised for stopping its contribution to the Green Climate Fund [15]. Moreover, despite Australia's claim of being on track to meet its 2030 target, the country's own 2020 emission projections reveal the contrary [5]. While climate talks are not making significant moves, investors are directing investments toward a renewable energy transition as the value of clean energy companies is soaring[15]. Thus, Australia will have no choice but to take the path of energy transition.

In the political debate the transition costs have been considered too high to take action. Yet, there is nowadays a growing emphasis on the potential opportunities and gains from embracing the energy transition. A study[16] of the Australian-German Energy Transition Hub, published in September 2019, has examined the economic opportunities of decarbonisation over the coming decades [32], a view shared by several other papers and reports [17] [1]. According to the report, embracing low-carbon opportunities could lead to a clean electricity system and could meet 100% of Australia's electricity requirements by the 2030s, with high degrees of security and reliability. They also detailed how Australia could become a net exporter of clean energy through green hydrogen, green steel and aluminium produced from green electricity and become an energy "superpower" in a carbon-constrained world. Moreover, the major importers are moving slowly away from coal, which will mean that Australian coal export will depend on the rate at which the largest importers are able to transition away from using fossil fuels to generate energy to cheaper renewable sources.

In the future, for other countries to import large volumes of low-emission products from Australia, the country will have to comply and be seen as delivering on emissions reduction targets consistent with the Paris objectives. Else, Australia will lose important markets because many countries are getting more and more interested in low-emissions products. However taking the example of the European Union, some countries already apply restrictions on imports of high-carbon products. Consequently, the import of zero-emissions products would follow assessments that the exporter is making acceptable contributions to the global mitigation effort.

[15] In the end of 2019, Goldman Sachs announced it had ruled out direct finance for new or expanding thermal coal mines and coal-fired power plant projects worldwide, and has committed to phase out financing for significant thermal coal mining companies that do not have a diversification strategy.

[16] The researchers examined six scenarios for the Australian economy ranging from the status quo – which considered only Australia's existing climate and energy policies – to a "leadership and export" scenario, which assumed deep decarbonisation across sectors including electricity, transport and industry. Under the latter, renewable would produce 200% of Australia's domestic electricity demand and supply a large export market. There would also be widespread electrification of transport, buildings, heat, and industrial processes. But the researchers note that achieving this would require the world to move to a zero-carbon energy system.

There is also a certain urgency to the need for transition. With the projected decline of coal industries [3], an unplanned energy transition will place increasing pressure on major coal-using regions in Australia. If done right, the coal industry decline could be compensated for by an increasing demand in other mining branches. The development of renewable energy will require specific materials, and this presents inter alia, an opportunity for the extraction of e.g. nickel and copper, both strategic materials in energy transition technologies and batteries. Thus, with the prospect of an Australia with abundant low-cost electricity, the country could also grow into a major global producer of minerals needed in the post-carbon world, such as lithium, titanium, vanadium, nickel, cobalt and copper [30].

Conclusions

Australia is a country full of contradictions. Despite being greatly exposed to climate change, few state policies exist to mitigate its negative effects. Regardless of the country's large options for generating renewable energy, coal and gas are still favoured for electricity generation and exportation while reports describe how Australia could become a 100% renewable country and a leader in green exports. Australia's measures for the energy transition are still uncertain, weakening the already fragile energy system [15]. This raises energy security issues already at stake, considering Australia's strong dependency on fossil fuel imports and on decisions from foreign ownership in the mining and energy industry. At this level, energy security in Australia is not just about energy supply reliability for consumers but a question of national security. In this complicated equation between climate change, energy and policies, Australia's Defence Forces must find an equilibrium to align their national and international duties with the protection of Australia's national interests. In response to the climate challenge, the ADF is now working on both, mitigation plans for reducing greenhouse gas emissions and adaptation, and on designing equipment to operate under more variable environmental conditions while keeping in mind energy security and cost effectiveness.

The Australian Defence Forces' energy use and supply depends on the national energy system. Today, the ADF is on its way to acquire suitable defence capacities alimented by renewable energy resources. Yet, just like the national energy system, the energy distribution networks within the forces are fragmented and are in need of a central management. As the need for energy security will push Australia to implement its 5th generation[17] energy capability so it will be the case of the defence sector. The 5th Generation promises more integrated technologies, efficiency and amplified capabilities which will enhance the sustainability and capabilities of the ADF and provide safety to a more resilient Australian Nation [2].

The ADF has developed several plans in view of a renewable powered Australia, considering energy transition planning, energy storage, connectivity, transmission, and reliability. Energy independence is an important factor for any defence force and energy security holds a central part in the Defence road map including solutions to reduce the need for imported fuels. The impact of climate change on the ADF's performance capabilities is also an increasingly discussed matter and presented in front of the government as a key issue, mainly as a threat for defence cooperation, activities and infrastructure.

The impacts of climate change in Australia will be complex and to some degree uncertain, but all analyses agree on how much Australia will lose if the country does not act now. Well planned

[17] By following the construction of generations capability from the energy sector we can speak of biomass as Australia's 1st Generation, coal as its 2nd, oil and gas as its 3rd and nuclear and renewables as the 4th. Acquiring a 5th Generation in the energy platform will mean achieving a generation capability which will include energy security assessment and an integrated energy network.

mitigation and adaptation measures combined with global cooperation can reduce the ultimate extent of climate change and its impacts. Yet, the federal Australian government continues to reject a 2050 target of net zero emissions and has chosen a gas-led economy recovery in response to the COVID-19 pandemic, also supporting the coal industry [24]. In this context, the Australian Defence Forces as the safeguard of national security could play an important role in pushing the Australian government back onto the track for an energy transition towards renewable energy and tip the balance toward climate change mitigation.

Bibliography

[1] AEMO. (2020). 2020 Integrated System Plan For the National Electricity Market.

https://aemo.com.au/-/media/files/major-publications/isp/2020/final-2020-integrated-system-plan.pdf?la=en&hash=6BCC72F9535B8E5715216F8ECDB4451C .

[2] Air Vice Marshal (Retd) John Blackburn. Energy security: Is there a problem? - australian defence magazine. https://www.australiandefence.com.au/budget- policy/energy-security-is-there-a-problem, 10 September 2018.

[3] Australia coal consumption [1965 - 2020] [data & charts]. com/en/indicator/australia/coal-consumption.

[4] Australia's emissions-projections 2019. *Australian Government, department of Environment and Energy*, December 2019.

[5] Australia's emissions-projections 2020. *Australian Government, department of Environment and Energy*, December 2020.

[6] Australia's Renewable Energy Future. Technical report, Australian Academy of Science, December 2009.

[7] Australian energy update 2019, Australian energy statistics. page 43, 2019.

[8] Australian Defence Export Office. Australian Defence Sales Catalogue. Technical report, Australian Department of Defence.

[9] Australian Government, Department of Defense. Defence Estate Energy Strategy. Technical report, May 2014.

[10] Australia Government | Department of Foreign Affairs and Trade DFAT. https://www.dfat.gov.au/.

[11] Australian Renewable Energy Agency (ARENA). https://arena.gov.au/.

[12] Bourne, G., et al. Australia's rising greenhouse gas emissions. Technical report, Climate Council of Australia, 2018.

[13] Burck, J., et al., Germanwatch. *Climate Change Performance Index Results 2020*. 2019. OCLC: 1131952162.

[14] CLEAN ENERGY AUSTRALIA REPORT 2020. Technical report, Clean Energy Council.

[15] Climate Action Tracker. https://climateactiontracker.org/.

[16] Climate Change Performance Index. https://www.climate-change-performance- index.org/.

[17] Climate Council. (2020). The Clean Jobs Plan.

https://climate-council.shorthandstories.com/clean-jobs-plan/index.html

[18] Coal: building Australia's future|Minerals Council of Australia.

https://minerals.org.au/minerals/coal.

[19] Defence Environmental Strategy 2016-2036. Technical report, Australian Government: Department of Defence, 2016.

[20] Finkel A. Independent Review into the Future Security of the National Electricity Market. Blueprint for the Future. Technical report, 2017.

[21] Lucas, A. Confected conflict in the wake of the South Australian blackout: Diversionary strategies and policy failure in Australia's energy sector. 2017.

[22] Major Keyurkumar Patel. Australia's petroleum supply and its implications for the ADF. Technical report, Australian Defence Force Journal edition, 2018.

[23] Mazzucchi, N. Transition Énergétique et numérique: La course mondiale au lithium. Technical report, Fondation Pour La Recherche Stratégique (FRS), March 2018.

[24] Murphy, K. (2020, August 11). *Australia's Covid commission downplays "green recovery" and confirms gas push* . The Guardian. https://www.theguardian.com/australia-news/2020/aug/11/australias-covid-commission-downplays-green-recovery-and-confirms-gas-push?CMP=Share_iOSApp_Other

[25] Parra, P.Y., Roming, N., Hare, B., Fuentes Hutfilter, U., Evaluating the significance of Australia's global fossil fuel carbon footprint. Tech- nical report, Climate Analytics for the Australian Conservation Foundation (ACF), July 2019.

[26] Powerlink Queensland: 2018-2019 Annual Report and Financial Statements 2018-19. Technical report, Powerlink Queensland, August 2019.

[27] Quarterly Update of Australia's National Greenhouse Gas Inventory: September 2020*, Australian Government Department of Industry, Science, Energy and Resources*.

[28] Skinner, C. Op-ed: The future of ADF mobility and energy security beyond naturally occurring fossil fuels - defence connect. https:// www.defenceconnect.com.au/key-enablers/5930-op-ed-the-future-of- adf-mobility-and-energy-security-beyond-naturally-occurring-fossil- fuels.

[29] The carbon brief profile: Australia. https://www.carbonbrief.org/the-carbon- brief-profile-australia.

[30] The Growing Role of Minerals and Metals for a Low Carbon Future. Technical report, World Bank Group, June 2017.

[31] Tidemann, C. Barriers to Energy Security in Australia: The Electricity Sector Governance and the Need for Change. In *In: Mouraviev N., Koulouri A. (eds) Energy Security. Palgrave Macmillan, Cham*. 2019.

[32] Ueckerdt F., et al. Australia's power advantage Energy transition and hydrogen export scenarios (Insights from the Australian-German Energy Transition Hub). Technical report, Australian- German Energy Transition Hub, September 2019.

[33] Wood, T. Australia's energy transition: a blueprint for success. Technical report, Grattan Institute, September 2019.

[34] World's Top Exports — Trade metrics that inspire global thinking. http://www.worldstopexports.com/.

[35] 2020 Defence Strategic Update. Technical report, Australian Department of De- fence, July 2020.

[36] 2020 Force Structure Plan. Technical report, Australian Department of Defence, July 2020.