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Swissnex Regional Report 2021: Towards Carbon Neutrality in APAC

Chapter 1 – The Transition from Renewable Energies to Negative Emission Technologies

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Following the long-term temperature goal set by the Paris Agreement, more than 50 countries have already pledged and had it in written documents that they aim at reducing emissions to net zero by mid-century. To achieve above targets, a rapid and massive deployment of clean and energy efficient technologies is required. APAC region accounts for 60% of the world's total population and more than half of global energy consumption. Compared to other regions, APAC faces more challenges while going towards the decarbonization process. APAC makes up 77.5% of the world's total coal production and consumes nearly 80%. Especially countries like China and India, the economic development is still heavily fossil fuel dependent. Therefore, the actions taken by APAC countries will have critical impacts on achieving net zero emission.

Policy Direction

On the national level, countries have set different emission goals with specific timelines. 2050 is the year in which most countries aim at achieving carbon neutral. As the world's largest greenhouse gas emitters, **China** produces 28% of the world's emissions – more than the United States and European Union combined. In 2020, Chinese President Xi Jinping unexpectedly made a groundbreaking pledge that China would become carbon-neutral by 2060. The goal set by China is the single biggest climate commitment to date worldwide. The 14th Five Year Plan, China's newest fundamental economic and social development guideline, proposes to increase the share of non-fossil energy in total energy consumption to around 20% by 2025, up from 15.8% in 2020. In October 2020, **Japan's** Prime Minister Suga announced the country's target of carbon neutrality by 2050. On top of that, Japan will strive by 2030 to cut its emissions by 46% from 2013 levels, up from its earlier goal of 26%. In the same month, **South Korea** announced the plan to seek carbon neutral by 2050 in an effort to transform the country's fossil-fuel reliant economy into an eco-friendly one. Furthermore, under the flagship of the "Korean New Deal"[1], President Jae-in Moon announced earlier a new investment plan running till 2025. Part of it, the Green New Deal reveals the government's plans to move towards a net-zero society by supporting ongoing policies such as the 2030 target for GHG emissions reduction (minus 37% compared to the business-as-usual scenario), and the plan to have renewables account for 20% of the country's electricity generation capacity by 2030

There are also some countries that do not set a definite deadline. In 2015 **Singapore** pledged to reduce the amount of green-house gases (GHGs) emitted per dollar GDP by 36% from 2005 levels by 2030, and to stabilize emissions with the aim of peaking around 2030. By 2050, Singapore currently aims to cut emissions by 50% from their peak with no definite deadline for reaching net zero emissions[2]. India is now the world's 3rd largest energy producer and consumer and has the world's fourth largest emissions from fossil fuels. The government is still currently on the fence and debating whether to move towards setting a target for net-zero emissions from greenhouse gases by 2050. But the Indian government has set an ambitious target of 450 GW of power to be generated from renewables by 2030. However, Coal India Limited (CIL), the world's largest coal mining company, plays an important role in the economic and political spectrum of India and is responsible for 85 percent of the country's coal production. India will have to give due consideration for a structural overhaul of the energy production to even propose legislation towards achieving net-zero emissions. Australia now has the highest per capita carbon dioxide emissions of the OECD countries and 3.37 times more CO2 per capita than the global average. However, the Prime Minister Scott Morrison has resisted pressure to set more ambitious carbon emission targets than its pledge of cutting emissions by 26%-28% below 2005 levels by 2030 in line with the Paris climate agreement. Instead, he has signaled repeatedly that "Australia wants to achieve carbon neutrality as soon as possible and preferably by 2050" with a focus on technology rather than policy mechanisms such as a carbon tax. In 2020, Australia unveiled its "Technology Investment Roadmap", a strategy to accelerate R&D and the commercialization of new and emerging low emissions technologies with yearly low emissions statements.

[1] The Korean New Deal

[2] Climate Change, Ministry of Foreing Affairs Singapore

Huge Investment and Various Incentives

According to Wood Mackenzie, Asia Pacific investments in renewable energies could reach USD 1.3 trillion by 2030, doubling compared to the previous decade. China, Japan and South Korea are among the top contributors. Since 2012, the Chinese central government has allocated more than 450 billion RMB (CHF 63.5 billion) of subsidies to support the development of renewable energy. For 2021, the Chinese Ministry of Finance has announced the total subsidy is set to be at 5.95 billion RMB (CHF 840 million), up almost 5% compared to 2020. In **Japan**, government investment related to the zero emission plan totaled approximately 373 billion yen (CHF 3.1 billion) in 2021, which was an increase of more than 25% from the previous year. The "Green Growth Strategy Through Achieving Carbon Neutrality in 2050"[3] led by the Cabinet Office covers various budget measures, tax incentives and regulatory reforms in order to motivate private sector activities. Furthermore, Japan will also set up a 2 trillion yen (CHF 16.6 billion) Green Innovation Fund over ten years which will support R&D of green innovation all the way through commercialization. **The South Korean** government increases its R&D budget on green innovation yearly. It allocates the greatest total investment for the Green New Deal pillar with KRW 73.4 trillion (CHF 57.5 billion), almost 60% of which are from direct government investment. The money is spent on green transformation of urban, spatial and living infrastructures, diffusion of low carbon and distributed energy, building an innovative ecosystem for green industries.

By leveraging additional co-investment from the private sector and other levels of government, **Australian government** hopes to generate between AUD 50 and 100 billion (CHF 35 to 70 billion) in total investment in low emissions technologies over the decade to 2030. The government's investment framework spans from R&D to pre-commercial deployment. Financing instruments vary from grants to loans and equity investments in Australia, specialized institutions are formed to carry out these missions. The Australian Renewable Energy Agency (ARENA) provides grant funding towards R&D and the early-stage commercialization of renewable energy technologies. Since its launch in 2012, ARENA supported 602 projects with AUD 1.77 billion (CHF 1.24 billion) in grant funding. The government announced a further AUD 1.62 (CHF 1.13 billion) package for ARENA to invest in future technologies. The Clean Energy Finance Corporation (CEFC) supports energy efficiency, renewable and low emissions energy projects through loans and equity investments. Since its launch in 2013, the CEFC has made investment commitments of more than AUD 8.8 billion (CHF 6.16) billion through more than 170 projects. As part of its investment activity, the CEFC administers a number of targeted investment programs in grid reliability, hydrogen and recycling[4].

Various incentives and measures have been placed as well by the governments in APAC region to boost the development of renewable energy. Renewable energy subsidies exist in multiple formats in **China,** including tax-related incentive, pricing incentives, custom duties incentives, etc. The ministries also provides plenty funding opportunities for innovation and research on renewable energy. The renewable energy installation peak started in 2012 in China when a national feed-in-tariff (FIT) scheme published. The FIT scheme allows power generated from renewable energy sources to be purchased at a fixed price higher than coal-fired power. In India, the government is doing its best with relevant policy interventions such as Renewable Purchase Obligations (RPOs) for

[3] Green Growth Strategy through Achieving Carbon Neutrality in 2050
[4] Clean energy and the electricity market

solar as well as non-solar, uniformly for all States/ Union Territories, reaching 21% of RPO by 2022 with 10.5% for solar based electricity. This paves the path for India's commitment towards achieving ambitious goal of being a Net Zero Emission Nation in the long term. Mission Innovation, a government initiative is a concerted effort to enhance the pace of innovation and scale of transformation in support of a clean energy revolution to meet India's energy security goals. Chinese authorities take similar practices. The "Measures for the Guaranteed Full Purchase of Renewable Electricity"[5] sets a minimum purchasing requirement for wind and photovoltaics (PV) power. Provinces are formally required to purchase a minimum number of hours of utility-scale wind and PV power project output annually. The minimum purchase agreement along with other incentives have successfully brought the curtailment rate of wind power to approximately 3% in 2020.

Achievements so far

APAC has great potential for renewable energies. Actually, the growth of renewable energy projects in some countries has already outpaced that of Europe. In Singapore, solar energy is the most promising renewable energy option. Although Singapore's small land area and high urban density constrain its use of renewable energy, the growth of solar PV installations in the country has been significant.[6] Singapore plans to ramp up its solar capacity by more than 7 times from current levels and increase the current 260 megawatt-peak (MWp) to 2 gigawatt-peak (GWp) of installed solar capacity. A key initiative aimed at developing the solar industry in Singapore is the SolarNova program[7]. The SolarNova program led by the Economic Development Board (EDB) and Housing and Development Board (HDB) promotes and aggregates solar demand across government agencies. It aims to build up and support the solar ecosystem in Singapore, in fields such as manufacturing, project development, system integration, and financing so as to encourage greater adoption of solar energy. Due to Singapore's limited land space, most of the solar panels in the country are installed on rooftops. Floating PV is an innovation that would allow solar panels to be installed on water bodies, such as reservoirs, to further increase the solar capacity. Floating solar PV system are currently being test-bedded on Tengeh Reservoir which can generate up to 3.3GWh of electricity per annum, equivalent to the average annual energy consumption of 750 affordable public apartment buildings. At a cost of CHF 7.5 million, the project will also assess the impact of solar PV deployment on reservoir evaporation, biodiversity and water quality.

A recent report by the International Energy Agency's Photovoltaic Power Systems Program stated the South Korea solar module industry had an annual production capacity of around 8.69 GW at the end of 2017. South Korea is seeing stronger than ever solar project deployment (PV capacity of 1.64 GW in 2019 and 30.8 GW by 2030). The ambitious target is expected to be achieved with giant solar parks. For renewable energy formats other than solar, South Korea is also quickly catching up. In July 2020 ROK government announced its commitment to construct by 2018 more wind farms off the southwestern coast

[5] Measures for the Guaranteed Full Purchase of Renewable Electricity
[6] Renewable Energy, NCCS
[7] SolarNova

of the country with a combined capacity of 2.4 GW.

Australia's renewable energy industry passed a significant milestone in 2020, with 27.7% of the country's total electricity generation (227 GW) coming from renewable sources for the first time. Much of this was due to small-scale solar sector installations, which added more than 3 GW of new capacity, bringing the total production to 63 GW. In Western Australia, the Asian Renewable Energy Hub will be built across 6'500 square kilometers by a consortium of energy companies (investment est. AUD 50.6 billion / CHF 35 billion). The hub is planned to add 26 GW of wind and solar energy and up to 100 TWh of total annual generation for the large scale production of clean hydrogen and ammonia, for local and export markets.

China, on the other hand, is already leading the world in installed capacity and consumption of renewable energy. The country consumed 7'511 TWh of power in 2020, of which, slightly less than 30% is derived from wind, solar, hydropower or biomass. China is accounting for 28.7% of global wind production and 31.9% of global solar production[8]. According to the International Renewable Energy Agency (IRNEA), China is also the "largest producer, exporter and installer of solar panels, wind turbines, batteries and electric vehicles". It produces more than 60% of the world's solar panels and manufactures one-third of the world's wind turbines.

R&D efforts have also been emphasized in order to ensure a sustainable energy transition. Japan founded a Global Zero Emission Research Center (GZR) in 2020[9]. The center, led by Dr. Akira Yoshino who had just won the Nobel Prize in Chemistry in 2019, aims to be the hub for more than 120,000 researchers from around the world, mainly in the G20 countries but also including Switzerland.

> "APAC has great potential for renewable energies. Actually, the growth of renewable energy projects in some countries has already outpaced that of Europe.

In Singapore, under the National Research Foundation's (NRF) Research, Innovation, and Enterprise (RIE) 2020 Plan, $0.9 billion were invested in the Urban Solutions and Sustainability domain from 2016 to 2020 to tackle Singapore's energy, water, land, and livability challenges[10]. India Energy Storage Alliance (IESA) has partnered with the United Nations Industrial Development Organization (UNIDO) the "Innovation Challenge" for Facility of Low Carbon Deployment Innovation Challenge in technology innovation for deployment of electrical energy storage[11]. This initiative will help identify high-impact opportunities that have the potential for energy saving along with large-scale carbon emission reductions and to provide financial support for field validation and testing of their technology. Initiatives like the "Innovation Challenge" and the aforementioned "Mission Innovation" are paving the way for India to become a Net Zero Emission economy and this will hopefully chart a way towards a legally binding global commitment

[8] China dominates global wind and solar output
[9] AIST to Establish International Joint Research Center for Zero-Emission Technologies
[10] Research Innovation Enterprise 2020 Plan
[11] IESA & UNIDO Partner to Promote Innovations in Energy Storage in India

Problems and Challenges

APAC is rapidly becoming the global hub for renewable energy, but several challenges still remain. One major restraint is the coal-intensive economic model in many countries. Take India for an example, its major roadblock towards achieving carbon neutrality is its heavy dependence on thermal energy. Coal India Limited (CIL), the world's largest coal mining company, plays an important role in the economic and political spectrum of India and is responsible for 85% of the country's coal production[12]. India will have to give due consideration for a structural overhaul of the energy production to even propose legislation towards achieving net-zero emissions. The difficulties in grid integration exist in China. Due to the unbalanced development geographically, many renewable energy projects have not been utilized in an efficient way. Regions in north or northwest of China have abundant solar and wind energy resources while they are less-developed and remote from coastal cities with huge electricity demand. The transmission capacity investment is always outweighed by the generation capacity investment. It leads to a waste of large amount of renewable energy. In 2016, the curtailment rate of wind power in China reached to the highest record - 17%[13].

The high upfront cost of new technologies and the fierce domestic market competition are also very common. Financing support channels are limited at both central and local government level further impede the growth. South Korea's domestic industry is faced with cost-cutting competition from China, regulatory challenges and resistance from local residents. The overall environment for wind energy development in Korea has significantly improved. However, the market is dominated by foreign companies. From 2022, hydrogen will be separated from ROK's renewable portfolio standard (RPS) and will require state utilities to meet a certain quota in the fuel purchase separately from other renewable sources as a part of the state initiative to the promote hydrogen economy. The difficulty of hydrogen fuel expansion lies in the high cost of gas in the domestic market, which makes direct competition against other energy sources difficult. As a response, the government has announced price reductions for natural gas as the source for production of hydrogen fuel. India is also an extremely "cost-sensitive market" and finding economically viable renewable energy solutions will be essential.

The lack of a comprehensive legal framework is another challenge. Most countries have renewable energy targets and broad plans but have not enacted any specific laws for new technologies like renewable energy storage. An established regulatory framework is required to ensure a smooth coordination among government agencies and industry players. It will also help clearly identify the oversight and evaluate responsibilities of different involving parties. The society's confidence in government's actions is also a question mark. In Japan, although the renewable energy support plans have been positively received, there are concerns that the move is slow and too small. The Japanese government has also been reluctant to adopt carbon pricing for example, which in their eyes, could harm the country's competitiveness in the long term. In Australia, the so-called "climate wars" have been systematically derailing debates on climate policy for over a decades now. A combination of global warming skepticism among a minority number of politicians and the complicated regional political interests have thus far hindered substantial progress towards carbon neutrality[14].

[12] Coal is king in India—and will likely remain so

[13] Wind power curtailment rate in China from 2013 to 2020

[14] Australia's climate wars were always stupid. Now they've got even dumber

Development of Negative Emission Technology

Although the renewable energy capacity is rolling out fast in APAC, above 60% of energy generation mix still comes from fossil fuels[15]. Other than the renewable energy approach, negative emission technology (NET) has become a trending topic. NET refers to the technologies that can remove the greenhouse gas carbon dioxide from the atmosphere. There are a variety of NETs and the most popular ones nowadays are carbon capture and storage (CCS). Experts have suggested that CCS is essential to achieve long-term and cost-effective CO_2 mitigation objectives.

Securing transformative technologies to reduce emissions and improve environmental performance of existing industries is a priority for Korea. In recent years, South Korea has been one of the leading countries supporting the development of NET, in particular Carbon Capture Utilization and Storage (CCUS). Two 10 MW demonstration projects have been running since 2013, and the government has set out a three-step plan towards the creation of 500 MW CO_2 capture plant and transport/storage facilities for 4 Mt CO_2/year by 2030. The government is also actively supporting R&D investment in CO_2 utilization technology, and basic research on chemical and biological CO_2 conversion has been conducted. Since 2017, the 'Next Generation Carbon Upcycling Project' has been underway for developing several technologies that utilize various carbon resources such as CO_2, by-product gases and organic waste to produce clean fuels and chemical products such as methanol, olefins, aromatics, organic acids and polymers.

In neighboring Japan as well, Kawasaki Heavy Industries Ltd. is building a CCUS pilot plant to capture 40 tons of CO_2 per day. However, the cost effectiveness is being carefully studied. Furthermore in Japan, a large-scale CCS demonstration project was conducted between 2012 and 2019 in Hokkaido. The project achieved its target of 300,000 tons of injection over four years, one year before the initial plan. On another note, additionally in Japan, various technologies are being evaluated. For example, Nippon Steel Corp. in collaboration with universities has been conducting feasibility studies of blue carbon technologies utilizing steel slags for the restoration of seaweed beds and other marine ecosystems for CO_2 absorption. Research on bio char is supported by the Ministry of Agriculture, Forestry and Fisheries MAFF for CO_2 storage in agriculture land.

Researchers at the National University of Singapore (NUS) Department of Chemical and Biomolecular Engineering have developed a CO_2 capture technology based on gas hydrates[16]. Gas hydrates are crystalline ice-like compounds mainly composed of water that can capture and store small gas molecules like CO_2 and can selectively remove CO_2 from industrial waste gases, making it a promising possibility for energy-efficient carbon-capture technologies. In collaboration with ExxonMobil, NUS experts are also developing and testing a laboratory-scale prototype that can mimic the deep ocean environment, to investigate the stability of COCO hydrates for potential long-term storage of CO_2 in deep oceanic sediments. Separately, Singapore's lead public sector R&D agency - A*STAR, Nanyang Technological University and National University of Singapore collaborated to build a pilot plant which successfully demonstrated the capture and concentration of CO_2 from industrial emissions.[17]

[15] Energy Transition In Asia-Pacific: A Marathon, Not a Sprint

[16] How Singapore can tap carbon capture technology to fight climate change post-Covid-19

China started to integrate CCS into its national medium to long-term science and technology development plan as a key technology to achieve near zero fossil emission since 2006. At this early stage, CCS was not mentioned at all on the provincial level but some pilot projects were launched. In 2013, a specific CCUS plan was released by ministry which investigates CCS feasibility at national scale and sets aims, principles and tasks of CCS[18]. The development of CCS has been promoted to a new stage after the release of the 13th five year plan in 2016. CCS is listed as one of the nine major engineering projects of the 'Science and Technology 2030' scheme published by MOST. CCS projects are going towards the direction of low-cost and large-scale deployment in China. Active industry players includes Petro China, Shenhua, Sinopec and Huaneng. They are pioneers in CCS research in China and are also engaged in international projects. Shenhua Group Ordos CCS Demonstration Project was completed in 2014 and was the first deep saline aquifer storage in China. Guohua Jinjie CCS Full Chain Demonstration was just completed in 2021 and becomes China's largest CCS plant in operation so far. It can prevent 150'000 tons of CO_2 emission a year at a 90% capture rate.

In **Australia**, the Government identifies CCS as an important greenhouse gas mitigation option. CCS is one of the priority low emissions technology under its Technology Investment Roadmap[19] with CO_2 compression, transport and storage under AUD 20 per tonne as a stretch goal by 2030. Australia also recognises that international effort will be required to achieve widespread industrial uptake of CCS technology. In order to accelerate the development and deployment of CCS, Australia is a member of the Carbon Sequestration Leadership Forum[20] and develops opportunities for collaborative work on CCS with other countries directly and via international organisations such as the International Energy Agency's Greenhouse Gas R&D Programme[21] and the Global Carbon Capture and Storage Institute[22]. CSIRO[23], the national science agency, conducts research programs with the aim to reduce the cost and improve the efficiency of CCS. It has deployed large-scale demonstration projects in Australia and China and identified improved efficiencies from testing more than 100 novel solvents, ionic liquids, solid absorbents and enzyme technologies[24]. Australia has the largest facility in the world at Chevron's Gorgon LNG project[25] off the West Australian coast. With five million tons of CO_2 injected underground since operations began in August 2019, this project is still far from its objectives of capturing and storing 4 million tons per year[26]. Despite the momentum around CCS in Australia, the Climate Council points to the remaining technical challenges and costs of implementing large-scale projects and stresses that no CCS project has yet been delivered on time, on budget, or to agreed performance[27]. Recent reports have shown that almost AUD 4 billion of public funds has been committed since 2003 to develop CCS technologies with, so far, underwhelming projects that are still not operating at industry scale[28].

India's Carbon Capture Utilisation and Storage (CCUS) potential varies from 5 to 400 billion tonnes[29]. The Department of Science and Technology (DST) has set up National Program on CO_2 storage research which is inclusive of carbon capture research and will support relevant pilot projects. This is part of the accelerating CCS technologies (ACT) initiative, for which India has committed one million

[17] Carbon Capture and Storage/Utilisation Technology Primer : A Sumary
[18] China's carbon capture, utilization and storage (CCUS) policy: A critical review
[19] Technology Investment Roadmap
[20] Carbon Sequestration Leadership Forum
[21] International Energy Agency's Greenhouse Gas R&D Programme
[22] Global Carbon Capture and Storage Institute
[23] CSIRO
[24] Making carbon capture viable in Australia
[25] Chevron's Gorgon LNG project
[26] Australia's giant carbon capture project fails to meet key targets
[27] What is carbon capture and storage
[28] As carbon capture, storage commitments near $4b, what are the options for heavy industry?

euros to support Indian participants. Dialogue between the United States Department of Energy (US-DoE) and the DST has led to India's participation in Accelerating CCUS Technologies (ACT), which has resulted in a US–India collaboration[30] for CCUS development in the country. A 2030 roadmap for India-UK future relations[31] has clearly highlighted CCUS under clean energy and transport focus areas (MEA 2021). Though CCUS is far from becoming mainstream, the Government of India and the Indian industry are trying to understand the technology's techno-economic feasibility and scalability better. The absence of regulatory frameworks to deploy CCUS makes extremely prohibitive for industries to adopt technologies for its uptake. The Public Sector Undertakings (PSU's) are leading the way when it comes to the uptake of CCUS technologies and enhancing its competitiveness and sustainability. Heavy industry PSU's[32] such as National Aluminium Company (NALCO), Oil and Natural Gas Corporation (ONGC), and Bharat Heavy Electricals Limited (BHEL) are initiating the process of setting up the CCUS facilities.

However, despite these initiatives and projects in APAC, as today CCS does not seem to be a priority field for investments and most projects are in test and trial phase. Most APAC countries still tend to orient financial and technological efforts to renewable energies. Besides, public awareness and a thorough legal framework to clarify the adaptation, costs and financing of CCS technologies are crucial for wide-scale deployment of CCS.

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[29] Carbon capture and sequestration potential in India: A comprehensive review

[30] Ministerial meeting of Indo-US Strategic Energy Partnership highlight major accomplishments, prioritizes new cooperation areas

[31] 2030 Roadmap for India-UK future relations

[32] Carbon Capture, Utilisation, and Storage (CCUS) in India

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