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Core IV-B, Fourth Floor, India Habitat Centre
Lodhi Road, New Delhi – 110 003 (India)
Tel: +91-11-2468 2177/2180; Fax: +91-11-2468 2173/74
Email: dgoffice@ris.org.in

Sittwe in Myanmar: Partnering for Clean and Green Energy

Sujeet Samaddar*

Abstract: The paper explores the strategic potential of *Sittwe* in Myanmar as a green energy hub to drive economic growth in India's North Eastern Region (NER). It highlights the region's abundant renewable energy resources, such as solar, wind, and hydro, and the opportunity to establish clean and sustainable energy infrastructure. The brief also emphasizes the integration of green hydrogen production with renewable energy projects to support regional refineries to meet India's future energy demands. With *Sittwe*'s proximity to NER, the proposal outlines enhanced connectivity and energy security while aligning with India's strategic goals and economic objectives at least environmental burden.

Keywords**:** *Sittwe*, green hydrogen, renewable energy, desalination, refinery, energy, connectivity, north east region, development

The North Eastern Region of India (NER) comprises the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The NER shares a 5,182 km long and sensitive border with China, Myanmar, Bhutan, Nepal and Bangladesh. The NER is home to 3.75 percent of India's population and covers 7.9 percent of India's total geographical area, but it contributes only 2.75 percent to the national GDP centred around agro-horticulture, natural resources, and tourism.[1] Also, the NER's strategic importance lies in its potential to act as a gateway to Southeast Asia (Map 1).

* Visiting Fellow, RIS, New Delhi.

This paper follows up on the Policy Brief No 2 of May 2023, authored by Dr Prabir De, Professor, Centre for Maritime Economy and Connectivity (CMEC) at RIS New Delhi. Author is grateful to Professor Sachin Chaturvedi, Director General, RIS and to Dr Prabir De, for providing much valued guidance in preparing this Paper. Views are personal. Usual disclaimers apply. E-mail: sujeet.samaddar@ris.org.in

Map 1: Location of Sittwe in Myanmar with Respect to NER

Source: Author's own based on Google Earth.

The region is endowed with immense natural resources, such as water, forest resources, oil and gas reserves, and renewable energy (RE). The NER has an estimated RE potential of 57.4 GW solar, 0.76 GW wind, and 2.99 GW small hydropower plants, amounting to a share of 7.6 percent, 0.06 percent and 14.99 percent of the total national RE potential, respectively[2]. However, the total RE installed capacity at 2.6 GW amounts to only 1.36 percent of the total national installed capacity of 191 GW[3]. The per capita availability of power is 570 KWh compared to the All India consumption of 1255 KWh[4].

The high-speed diesel (HSD) consumption of the NER at about 2.5 million metric tons (MMT) amounts to only 2.82 percent of the total national HSD consumption[5]. The NER's four refineries, at Digboi,

Guwahati, Numaligarh and Bongaigaon, have a total installed capacity of 7.7 MMT, which may increase to 13.7 MMT once the expansion of the Numaligarh Refinery is stabilised at 9 MMT[6]. The key challenge for these refineries is access to crude, which in the case of Numaligarh is sourced from Paradip across 1614 Km of pipelines, whilst the others are mainly dependent upon captive and perhaps, depleting oil wells. The offtake of refined petroproducts is another challenge since the product pipeline network is currently limited between Guwahati and Siliguri. All petroleum and gas requirements of the southern NER are met by rail and road networks. Being landlocked, the NER rail and road lifeline to the rest of India is only through the 22 km wide Siliguri corridor.

The development of the NER is hinged upon improving connectivity, better resource availability, higher agricultural productivity, eco-friendly industry and tourism, which all require clean and green energy – electricity and fuel – so that the pristine natural beauty of the NER merges seamlessly and harmlessly with infrastructure and socio-economic development. Alternate access routes to unlock its economic potential and enhance social development are, therefore, necessary.

Myanmar's Energy Resource Credentials

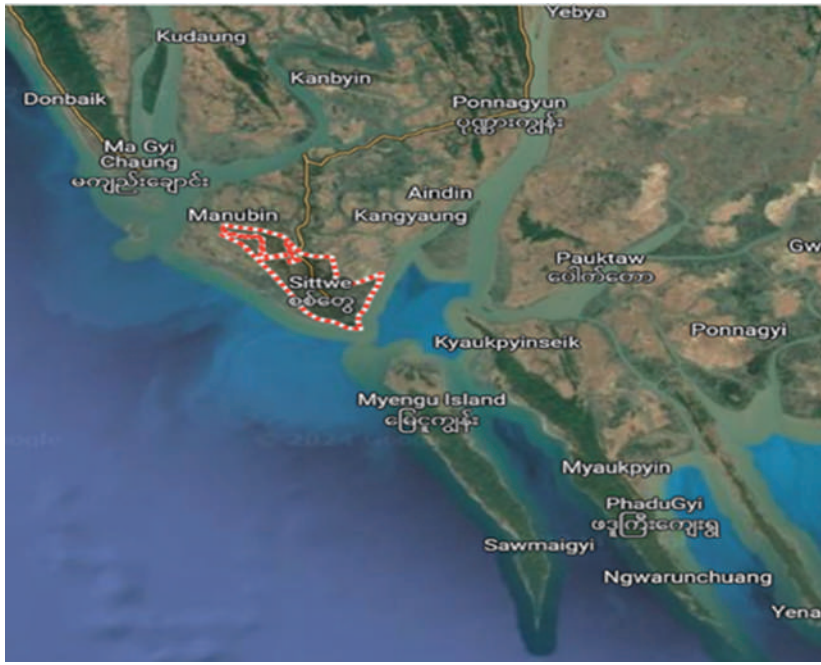
Myanmar, located to the South and South East of the NER, shares a border with Bangladesh, China, Lao PDR and Thailand, apart from Arunachal Pradesh (520 Km), Nagaland (215 Km), Manipur (398 Km), and Mizoram (510 Km) totalling about 1,643 Km with India. Myanmar and India also share a maritime boundary of 585 nautical miles (Nm) or (1083 km). Administratively, Myanmar is divided into seven states, namely *Chin*, *Kachin*, *Kayah*, *Kayin*, *Mon*, *Rakhine*, and *Shan*, which mainly cover the upland areas. Its seven regions namely, *Ayeyarwady*, *Bago*, *Magway*, *Mandalay*, *Sagaing*, *Tanintharyi*, and *Yangon* - are situated mainly on the plains. *Nay Pyi Taw* is the capital and is the only union territory. Myanmar has a population of about 58 million, and its largest city is *Yangon,* which has a population of 5.8 million. Myanmar is rich in natural resources, especially natural gas, hydropower and minerals – notably Rare Earths – Jade, Ruby, Sapphire, Limestone, Copper, Lead, Zinc, Tin, Tungsten, Gold, and Barite, amongst others.

Politically, Myanmar is unstable until the State Administration Council (SAC), which is the governing body of the junta, and the united front of ethnic armed groups and civilian opposition forces reach an agreement to administer the country anew.

The total length of the Myanmar coast is 2228 Km (1,260 Nm), of which the *Rakhine* coast is 713 Km, the *Irrawaddy* delta area is 437 Km, and the coast of *Tanintharyi* is 1078 Km long. Of its nine ports, Yangon Port is the major international port, handling more than 90 percent of the country's merchandise trade[7].

Sittwe is the capital of the *Rakhine* State and has a population of about 160,000 inhabitants. *Sittwe* is the nearest port (Map 2) in Myanmar for the southern states of the NER, particularly the states of Mizoram, Manipur, and Nagaland to gain access to the Bay of Bengal. The *Sittwe* port, located at the mouth of the Kaladan river, is an important component of the Kaladan Multi-modal Transit Transport Project (KMTTP) . The revamped port was operationalised with the arrival of a cargo of 10,000 bags of cement from Kolkata in May 2023[8]. Presently, under the management of India Ports Global Ltd (IPGL) and operated by Bharat Freight Group, the Port handled 70 vessels carrying relief cargo of about 83,000 tonnes and 30 other vessels carrying commercial cargo of about 26,000 tonnes in a little more than a year of operation (July 2024)[9]. Mostly, these ships carried general cargo, motorcycles, consumer goods, building materials, food grains and relief materials. As per recent reports obtained from the operator (November 2024),[10] small coastal vessels - between 500 DWT to 3000 DWT – are chartered for carrying cargo from Yangon. It was reported that "*Rakhine* Chief Minister U Htein Linn, along with government members and departmental officials, inspected the arrival of consumer goods and construction materials delivered by the cargo ship MV Royal Venus at *Sittwe* jetty. MV Royal Venus carried a total of 2,083.44 tonnes of rice, fuel oil, foodstuffs, construction materials, and related items ordered by the *Rakhine* State government in June 2024"[11]. Therefore, the port is operational and in use - albeit for coastal cargo. A recent chart of the port is placed in the Appendix.

Map 2: Sittwe Harbour Area



Source: Author's own based on Google Maps.

But, it is the Kyaukphyu (*Ma'de* island) deep seaport (DSP) and the petroterminal (Map 3) that is worth mentioning for its geopolitical and economic significance. Myanmar's potential reserves of crude oil, natural gas, and coal are 15,220 million barrels, 93.698 trillion cubic feet (tcf), and 711 MMT, respectively. Proven oil reserves are estimated at 50 million barrels, and gas reserves at around 10 trillion cubic feet[12]. China was able to identify this potential and invested in this Port and associated pipeline to carry 22 million tons of crude and about 10 million tonnes of natural gas per annum over about 2500 km to Kunming in Yunnan province at an estimated investment of US$ 2.5 billion[13]. This pipeline provides direct access for petroleum cargoes thereby circumventing the Malacca Straits[14].

Map 3: Kyaukphyu (*Ma'de* Island) deep seaport (DSP)

Source: China National Petroleum Corporation[15] and Author's own based on Google Maps.

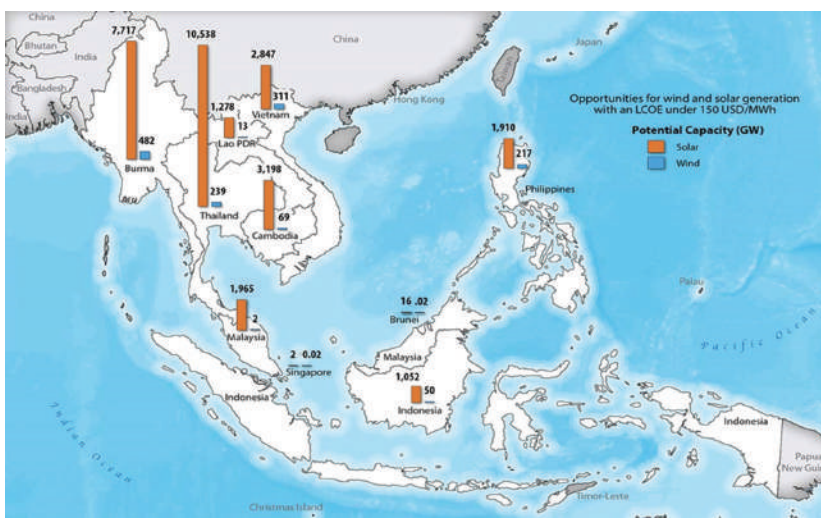
In 2023, Myanmar against its total import of 7,050,505 tons of Petroleum oils and oils obtained from bituminous minerals (HSN 2709), Yangon imported only 6,787 Metric Tons from India[16], which is a very small fraction of the 7.05 MMT imported from other countries.

As per a World Bank Group report, "Myanmar is endowed with abundant primary energy resources. Its hydropower potential is estimated at more than 100,000 Megawatts (MW), but has an installed capacity of only 3,262 MW (2023)"[17]. The Myanmar National Electrification Plan (2015) was intended to achieve universal electricity access by 2030, which would require an installed capacity of 16.6 GW – a substantial rise over its then capacity of 4.4 GW[18]. The national electric grid is damaged amid ongoing internal disturbances, and consequently, electricity consumption in Myanmar has declined to 308 kWh per capita[19] in 2022/23, which is only about 25 percent of India's per capita consumption.

Myanmar is in the "sunbelt" with the highest solar potential[20] in the state, reaching 6.6 kilowatt-hours per square meter (kWh/m^2). Its potential power generation capacity from PV Solar energy is 7,717 GW over an area of 214,347 km^{2,} and Wind power generation is 482 GW over a usable area

of 160,564 km^{2,} which makes it the second highest RE power source, after Thailand, amongst the ASEAN countries[21] (Map 4). Myanmar has ample water resources, and 91 percent of its present electricity requirements are generated by hydropower plants[22]. Given these resources, Myanmar has an estimated total potential to export 310 MMTPA of Green Hydrogen (GH)[23]. After the relevant technical corrections on account of geography, human settlements, etc., GH production could still be of the order of 3 – 5 MMTPA, which is worth about US$ 18 – 24 billion annually at present prices[24]. It is worth noting that "Hydrogen based on renewables, or Green Hydrogen, has emerged as a vital clean energy carrier. This is the only hydrogen 'type' fully compatible with net-zero emission targets and sustainable, climate-safe energy use"[25]. GH and its derivatives such as Ammonia and e-methanol, are future fuels and hence, this potential is of immense strategic importance apart from its economic value.

Map 4: Cumulative solar PV and wind opportunities (capacity in GW) potentially available at an LCOE of less than $150 USD/MWh in the ASEAN member states



Source: Exploring Renewable Energy Opportunities in Select Southeast Asian Countries[26]

Hence, on several counts, Myanmar provides an excellent opportunity for a comprehensive clean and green energy driven development of India's NER states.

Sittwe's potential to become a Hitech Energy Hub

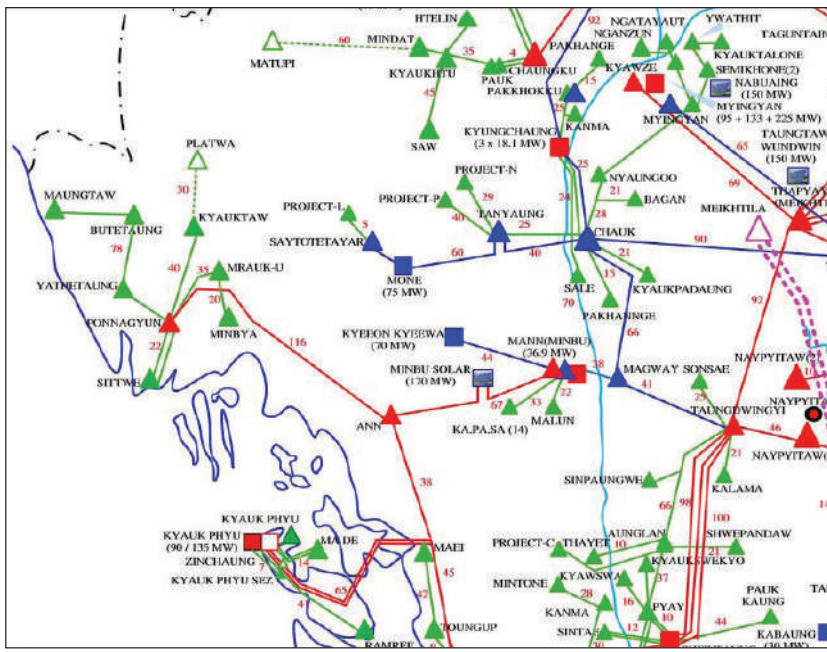
Specifically, *Sittwe* offers distinct advantages in this regard. Firstly, the Port of *Sittwe*, which was developed as part of the KMTTP, has now been approved to be administered by the Indian Ports Global Limited (IGPL). Materials required for construction, such as iron and steel, cement, piping, cabling, machinery etc, can be shipped directly to *Sittwe* from Kolkata and other ports such as Paradip and Visakhapatnam. Secondly, 1000 acres of land at *Ponnagyun* - located about 40 km from downtown *Sittwe* - has been leased by India, and additional land requirements could be met with little difficulty given the sparsely populated and rugged terrain in the area. Thirdly, the existing airfield, which earlier had direct flights to Kolkata, can be upgraded to a CAT 1 ICAO standard airfield at an estimated investment of about Rs 100 -150 crores (Map 5). This airfield could be utilised for Passenger and Cargo operations to support projects at *Sittwe*.

Map 5: Sittwe Airfield

Source: Author's own based on Google Earth

Sittwe has an estimated solar and wind energy potential of 26.96 GW and 33.83 GW respectively[27]. *Sittwe* is connected by a 66kV (green) power line, and the nearest 230kV (red) electricity line is at *Ponnagyun* (Map 6), which may only need to be suitably modernised to ensure stable power availability to *Sittwe* for port and airport operations. There is ample riverine and seawater supply due to the perennial nature of the Kaladan River.

Map 6: Local Electricity Supply Grid



Source: Extract from Myanmar National Grid[28]

Offshore, there are depths up to 30 meters available at a mere 5-7 Nm from the coast, which would permit VLCC ships to moor to Single Point Moorings (SPM) to discharge crude cargoes to a proximate tank farm and thereon to a designated greenfield / brownfield refinery for processing. Smaller ships, such as Handymax or LR1 product tankers, could moor to another SPM to offtake the processed petro-products from the refinery at an even closer distance from the shore (Map 7).

Map 7: Possible Location for SPMs

Source: Extract from Chart 3511 (INT 7431) Approaches to *Sittwe* Harbour, National Hydrographic Office, India.

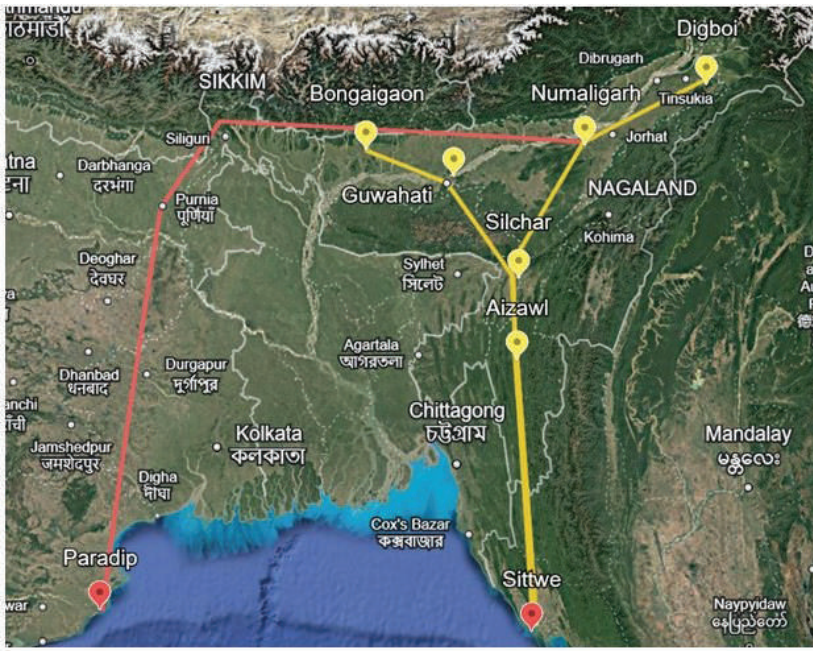
Sittwe also provides seaward access to NER Refineries, which are between about 470-730 km from Aizawl (Map 8). The additional distance from the *Sittwe* Port to Aizawl, along the Kaladan River, is about 300 Km.

However, a word of caution is essential. The turbulent political climate in the *Rakhine* State must be taken note of in any discussion on *Sittwe* matters. Specifically, "since the Arakan Army (AA) launched an offensive in *Rakhine* State in November last year, it has seized 10 *Rakhine* townships and Paletwa Township in southern Chin State. The AA is fighting in *Maungdaw, Ann, Gwa and Taungup* townships"[29].

Shri Sarbonanda Sonowal, Hon'ble Minister of Ports, Shipping and Waterways, made clear that Myanmar remains a country of interest for further engagement when he stated, " India remains committed to maintaining and enhancing trade and connectivity with both countries [Bangladesh and Myanmar]. In Myanmar, we are working closely with the authorities to ensure continued operation of the *Sittwe* Port"[30]. India, in an unprecedented move, had invited members of both the State

Administration Council and the Arakan Army to a funded conference[31] to specifically discuss the restoration of port operations between Kolkata and *Sittwe*. Therefore, engagement with Myanmar has political support but is not without challenges, and hence some diplomatic dexterity and economic incentives may be required to overcome these challenges to develop projects in the region.

Map 8: Access to the NER Refineries from Aizawl



- **Pipeline Routing Options**
- **Existing**
  - Paradip-Purnia-Siliguri- Numaligarh ***1630 kms***
- **Potential Alternatives**
  - Sittwe–Silchar -Numaligarh ***750 kms***
  - Sittwe–Silchar– Numaligarh–Digboi ***963 kms***
  - Sittwe–Silchar– Guwahati ***693 kms***
  - Sittwe–Silchar– Guwahati-Bongaigaon ***824 kms***

Source: Author's own based on Google Maps

South Korea also has a presence in *Sittwe* in the form of a development project and joint venture between the *Rakhine* State government and BXT International Company Ltd, South Korea. This "new city" was an ambitious plan for a comprehensive complex development area to make it an eco-friendly, future-oriented high-tech district. However, the project status has been uncertain since 2017[32]. Japan, in the past, has also engaged with Myanmar for the East-West Economic Corridor Highway Project (New *Bago-Kyaikhto* Highway Section) by providing JPY 27,779 million for developing the Myanmar – Thailand leg of the corridor[33]. Earlier, Japan had proposed the development of the Dawei deep sea port[34]. However, both projects have not materialised. The notable success has been the Myanmar–China Oil and Gas Pipelines - the largest energy infrastructure in Myanmar - but which as per present indications is delivering below capacity and requires security for it's protection and operations[35]. An Indian Company, M/s Punj Lloyd, were awarded a part contract for laying about 205 km of the oil pipeline and 183 km of the gas pipeline[36] which was successfully executed in 2013.

These examples indicate that the core problem impeding investment and development of the *Sittwe* Port is clearly political in nature. If political stability is restored, then there is no reason why *Sittwe* should not become an economic hub, given its location and resources. Hence, the clear benefits of geography and RE potential against the risks of political uncertainty hang in the balance. *Sittwe* is well suited as a mid-term potential location for integrated green energy projects, subject to the resolution of intra-state political conflicts.

Proposed Partnering Plan

India was already the world's second-largest crude oil net importer in 2023, which, as per projections by the International Energy Authority, would boost crude oil imports from 4.6 million barrels per day (mb/d) to 5.8 mb/d by 2030, which translates to an additional requirement of refining capacity of 60 MMTPA. This growth would be more than one-third of the total projected global growth of 3.2 mb/d[37]. India's domestic crude oil production is likely to fall from 700 kb/day in 2023 to 580 kb/day by 2030[38]. Hence, additional sources of crude oil and petroproducts

are required to preserve India's energy security. As reported in the media, 'the govt is holding talks with Saudi authorities for two refineries in Gujarat and Andhra Pradesh, each with an annual capacity of 10-15 million tonnes, along with petrochemical facilities"[39]. Given the emphasis on reducing emissions in the interest of climate change and global warming, these new refineries should be clean and green.

With the aforementioned advantageous features and complementariness between the NER and the *Rakhine*/*Chin* region it is possible to conceptualise a mega 'clean and green' energy project by locating an 18 MMTPA refinery at *Ponnagyun* for meeting India's requirements and aiding the economic development of the NER and the *Rakhine* State. The project could be preferably anchored around a modern 'green' refinery at *Ponnagyun,* which is only about 40 km North West of *Sittwe*, with crude feedstock accessed from the deep water SPM and product offtake dispatched from another SPM for export and also by pipeline to the NER. Therefore, with 5-6 VLCC cargoes of 250,000 MT per month (minimum to ensure the viability of port operations), the required refining capacity would be about 18 MMTPA. Clean petroproducts (gasoline, diesel, jet fuel, naphtha and kerosene) offtake could be dispatched for exports by 14 -15 LR1 (60-80000 DWT) product tankers per month, aggregating 11 - 12 MMTPA. The balance of 6 - 7 MMTPA would be available for utilisation in Myanmar and the NER by pipeline.

The energy requirements for the refinery could be met by using the ample RE resources supported by a Battery Energy Storage System (BESS) and Myanmar's Hydropower to ensure Round the Clock (RTC) green electricity. As per preliminary technical studies, the possible location for the Solar Farm could be on the plateau of the hills of *Myengu* Island. Between 700 - 800 MW of solar PV power can be installed at that location. For wind energy, Class 4 – 6 sites[40] with power density between 600 - 2000 Kw/m^2 are available in the *Ngape* area on the Chin Hills. An alternative site northwest of *Sittwe* can also provide good wind energy. Windmills, with a capacity of 3.5 MW or more, can be set up in 60-80 locations of 1 acre each, with a total installed capacity of 250 MW of wind energy.

Though the existing 230 kV grid line can be utilised for transmission to the proposed location at *Ponnagyun*, it may require repairs and modernisation. Detailed site surveys would be required to validate and further maximise the RE locations.

Hydrogen is required to reduce the sulphur content of crude oil to produce diesel, petrol, and other petrochemicals. As a thumb rule, the hydrogen requirement for desulphanation is 1 percent of the refining capacity. Refineries use the Steam Methane Reformation(SMR) process for production of Hydrogen and this typically emits 8 - 12 kilograms of carbon dioxide (CO_2) per kilogram of Hydrogen produced[41]. On the other hand, Hydrogen produced from the Alkaline Water Electrolysis (AWE) process using RE has zero CO_2 emissions. Hence, given *Sittwe*'s substantial RE resources and riverine water strengths, a GH hydrogen plant of 200,000 MTPA makes a logical choice to meet the hydrogen requirements of the refinery and also allow some surplus for exports. In the future, given the colocation of the production elements, *Sittwe* could be developed for the production and exports of green Ammonia and other GH derivatives for global markets.

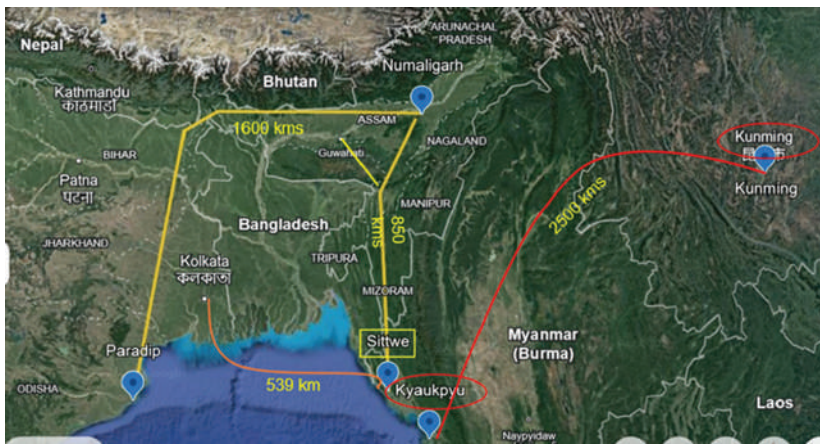
To meet the water requirements of the AWE, a desalination plant with a bioreactor can be conceived. Any of the commercially available processes, such as Multi-Stage Flash (MSF) desalination, multiple effect distillation (MED), MED with Vapour Compression (VC), and reverse osmosis (RO) or membrane-based desalination can be utilised. The input energy for the MSF, MED and MED-VC is 'thermal energy', which could be steam or hot water obtained from the flue gases of the refinery. For RO or membrane-based desalination the input energy is 'electrical energy', which again could be from the RE sources thus making the 'refinery' project further emission controlled. Carbon capture (CO_2) from refinery flue gases can also be combined with GH to generate Green Methanol.

The total land requirement for the refinery and GH production, including tank farms for storage of crude and petroproducts, is about 3000 acres[42]. Of this requirement, India has already secured 1000 acres at *Ponnagyun*. Given the low population density and large tracts of

unutilised land an additional 1500 – 2000 acres could be identified for this project, as mentioned earlier.

A second option could be to upgrade existing refineries in the NER. Against the investment of Rs 28,026 Crores for the upgradation of the *Numaligarh* project, including the 1614 Kms crude supply pipeline[43] from Paradip, the *Sittwe* option reduces the crude access pipeline routing to about 750 - 850 Kms (Map 9) which, as per industry sources, would require an investment of about Rs 4000 Crores. A similar length of a product pipeline would despatch Numaligarh petroproducts, notably HSD, to *Sittwe* and to other destinations in NER by pipeline for exports from the envisaged SPM at *Sittwe* Port at a rough order of magnitude cost of about Rs 3000 crores. The project has obvious geo-economic and strategic advantages apart from its environmental benefits, for example reducing the rail and road transportation of HSD to consumers in the NER.

Map 9: Distances between Ports and the Refinery



Source: Authors own own based on Google Earth

A third option is to establish a new 'greenfield' refinery at Aizawl. This would require laying crude oil and product pipelines from the proposed SPM at *Sittwe* port to the tank farm at *Ponnagyun* and then to a location in Aizawl over a distance of about 350 Km. Renewable energy transmitted from the Solar and Wind farms in the *Rakhine* region

supplemented by the NER hydropower plants – principally from the five hydropower plants being built by Satluj Jal Vidyut Nigam (SJVN) aggregating to a combined capacity of 5,097 MW[44]in the NER - would still make the refinery 'green'. GH produced at *Ponnagyun* could also be shipped to this greenfield refinery by pipeline, which though technically feasible has certain practical complexities. The petroproducts from this refinery could meet the requirements of the NER and surpluses piped to *Sittwe* for exports. The critical challenge would be the complex land acquisition process, environmental clearances, emissions and flaring, impact on local livelihoods and cultural issues etc. that may not be acceptable to the local population.

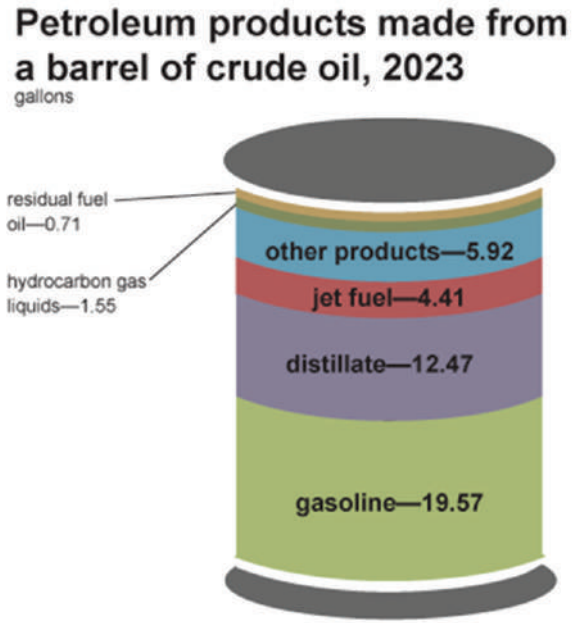
A cost-benefit analysis of these options and variations thereof that develop in the course of the study could be undertaken to identify the most suitable option.

From an investment perspective the investment towards the two SPMs (Rs 2300 Crores), tank farms for 15 days capacity of crude and petroproducts (Rs 1200 Crores), a 18MMTPA refinery (Rs 54,000 Crores), desalination plant[45](Rs 1000 Crores) and associated pipeline at *Sittwe* could total to about Rs 60,000 to Rs 65,000 Crores[46]. Augmentation of Port facilities by way of Offshore Support Vessels, Patrol Crafts, Tugs and Pilot Boats could require another Rs 500 crores. The energy requirements could be met by installed capacities of 700 MW of Solar (Rs 2800 Crores) and 250 MW (Rs 1750 Crores) Wind farm supported by a 200 MWh BESS (Rs 500 Crores). The proposed 200,000 TPA GH plant would require 280 x 5 MW AWE modules at an investment of about Rs 5000 Crores[47]. This investment could be supported through the Development Financial Institutions, Oil corporations, Renewable Energy Players and Port Management entities, including SMART financing such as blockchain-driven smart contracts for real-world asset monetisation through fractional ownership by way of tokens.

On the revenue side, assuming a conservative capacity utilisation rate of about 20% for the RE segment (wind and solar) the plants would annually generate about 1.8 billion kWh yielding about US$ 450 million annually[48]. GH, typically priced at US $ 6-7 /kg, would generate about

US$ 1.2-1.4 billion annually with the usual O&M cost pegged at 1.5% of the capital cost. The procurement cost of 18 MMTPA (131 Mn barrels per annum) of crude at US $ 75.12[49] is about US$10 billion annually and post-processing a benefit of about 15% profit margins is possible on petroproducts (Figure 1)[50].

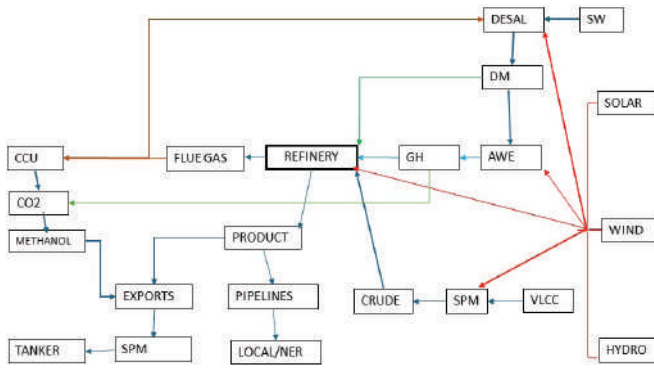
Figure 1: Composition of Petroproducts from Crude oil



Source: https://www.eia.gov/energyexplained/oil-and-petroleum-products/

In addition, port operations for servicing the crude and product tankers at the SPM would yield additional revenues. Hence, prima facie the economics make the project bankable. The schematic of the project is shown in Figure 2.

Figure 2. Top Level Schematic of the Green Energy Project at Sittwe



Source: Author's own

Legend: CCU = Carbon Capture and Utilisation. CO2 = Carbon dioxide. SW = Sea Water. DESAL = Desalination. DM = Demineralised Water. PL = Pipeline. SPM = Single Point Mooring. GH = Green Hydrogen. VLCC = Very Large Crude Carrier. AWE = Alkaline Water Electrolyser.

Conclusion and Way Forward

The strategic potential of *Sittwe* as a green energy hub to drive economic growth in the NER emerges from the foregoing analysis. *Sittwe*'s RE resources, location and topography provide an excellent opportunity to galvanise energy connectivity and commerce between the landlocked NER and the littoral states of the Bay of Bengal. *Rakhine* region's abundant renewable energy resources, such as solar, wind, and hydro, and the opportunity to establish clean and sustainable energy infrastructure by the integration of GH production and renewable energy projects to support regional refineries and meet India's energy demands is prima facie economically viable. The geopolitical realities would need to be factored in to investigate the long-term security of the project.

The project has the potential to realise India's vision to "develop new sources of oil and gas in bordering areas close to Myanmar that would enhance the production of refined products in Assam," as remarked by Dr S Jaishankar, Minister of External Affairs (MEA) during a speech on 15 February 2021. It would also comply with the observation of the Standing Committee on Petroleum and Natural Gas (2023-24), in it's Twenty-Third Report to "take concrete steps for the diversification of imports of crude oil and gas of the country by exploring new partners[51]."

For India, development of the Port town of *Sittwe* as an integrated 'green' energy hub is a strategic opportunity on various counts. First, it would help meet about 30 percent of India's projected *additional* crude demand with the added advantage of petroproduct offtakes by sea and pipeline to other locations in India and for export. Coupling the project with RE and GH would provide low-cost energy and generate additional revenues to make the project more bankable and sustainable for funding by the Development Funding Institution (DFI). Thirdly, the economic development of the region would bring stability to the state and hopefully promote reverse migration of the refugees. Potentially, several thousand direct jobs could be created and possibly fivefold indirect jobs. If a conditional Line of Credit is made available, it could add to India's industrial output, including design and consultancy services for the Port and SPM moorings, Refinery, RE Plants and GH production unit. This would also help develop Mizoram and Tripura with new industries using clean fuel and energy. It could add further impetus to the KMTTP initiative to connect the NER with the Bay of Bengal. Finally, the environmental load of such a project would be dramatically reduced for the same deliverables.

Co-developing the *Sittwe* airfield to an ICAO CAT 1 airport would improve connectivity to support the project and provide both commercial and strategic benefits. Air connectivity would help build confidence through better people-to-people contact.

Finally, it could support bunkering at the International Container Transhipment Terminal planned at Galathea Bay, with HSD and GH

and in the future with Methanol and Ammonia produced at *Sittwe*. Strategically, this would balance Chinese influence in the Myanmar economy and also bridge the communications between the SAC and the opposing elements. Finally, this could be a typical, and possibly unique, Blue Economy Project (Figure 3) that optimises the ocean-land interface with maximum economic benefits and at least environmental burden.

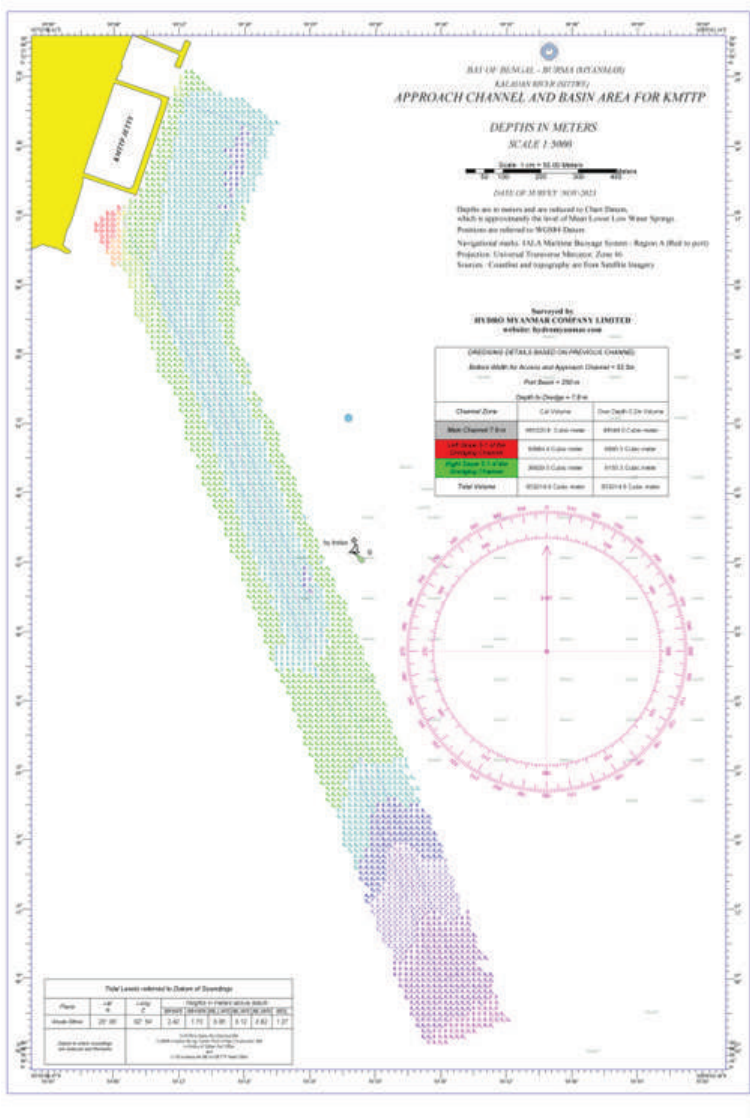
Figure 3: Graphic Depiction of the Sittwe Project

In view of the myriad benefits espoused in the foregoing analysis the following are recommended:-

- Expansion of the *Sittwe* port by locating two Single Point Moorings - one each for crude intake and product offtake - at depths of about 25- 30 m obtainable between 5 - 7 Nm from the coast - together with tank farms at a Rough Order of Magnitude (RoM) Cost of about Rs 3,500 Crores be considered.
- Augmentation of Port facilities by way of Offshore Support Vessels, Patrol Crafts, Tugs and Pilot Boats at a RoM cost of Rs 500 Crores would be consequentially required.

- A 18 MMTPA greenfield refinery may be considered at *Ponnagyun* – about 50 Km North East of *Sittwe* - to process the received crude at a RoM cost of about Rs 54,000 Crores.
- A product pipeline between the Refinery at *Ponnagyun* and Aizawl for meeting HSD requirements of the NER could be laid at a RoM cost of about Rs 1,000 Crores.
- The refinery could be entirely powered by renewable energy (RE) for which purpose a 700 MW Solar farm at a RoM cost of Rs 2,800 Crores at *Myengu* island off the *Sittwe* harbour and a 250 MW wind farm either NW of *Sittwe* or in proximity of *Ann* at a RoM cost of Rs 1,750 Crores supported by a 200 MWh Battery Energy Storage System (BESS) at a RoM Cost of Rs 500 Crores.
- The hydrogen requirements for sulphanation could be met through a 200,000 TPA Green Hydrogen (GH) plant at a RoM cost of about Rs 5,000 Crores.
- The water requirements of the refinery and the GH plant could be met by a desalination plant, which would also meet the potable water requirements of the *Sittwe* population at a RoM cost of about Rs 1,000 Crores.
- To improve connectivity and support the project, the existing airfield may be upgraded to an ICAO Cat 1 airfield at a RoM cost of about Rs 150 Crores.
- Development Funding Institutions, conditional Lines of Credit and Public-Private partnerships should finance the project, given its bankability.
- A study group be constituted with representatives of the concerned ministries to further crystallise the proposal.
- An irrevocable agreement may be negotiated with the Government of Myanmar for the joint development of the project.

Appendix


BAY OF BENGAL - BURMA (MYANMAR)
KALADAN RIVER (SITTWE)
APPROACH CHANNEL AND BASIN AREA FOR KMTTP
DEPTHS IN METERS
SCALE 1:5000
DATE OF SURVEY: NOV-2021
Depths are in meters and are reduced to Chart Datum,
which is approximately the level of Mean Lowest Low Water Springs.
Positions are referred to WGS84 Datum
Navigational marks: IALA Maritime Buoyage System - Region A (Red to port)
Projection: Universal Transverse Mercator, Zone 46
Sources: Coastline and topography are from Satellite Imagery
Surveyed by
HYDRO MYANMAR COMPANY LIMITED
website: hydromyanmar.com
DREDGING DETAILS BASED ON PREVIOUS CHANNEL
Bottom Width for Access and Approach Channel = 32.5m
Port Basin = 250 m
Depth to Dredge = 7.0 m
Channel Zone
Cut Volume
Over Depth 0.5m Volume
Main Channel 7.0 m
Left Slope 1:7 of Main Channel
Right Slope 1:7 of Main Channel
Total Volume
KMTTP JETTY
To Sittwe
Tidal Levels referred to Datum of Soundings

Endnotes

[1] The region shares an international border of 5,182 kilometres (3,220 mi) (about 99 percent of its total geographical boundary) with several neighbouring countries – 1,395 kilometres (867 mi) with China in the north, 1,640 kilometres (1,020 mi) with Myanmar in the east, 1,596 kilometres (992 mi) with Bangladesh in the south-west, 97 kilometres (60 mi) with Nepal in the west, and 455 kilometres (283 mi) with Bhutan in the north-west. It comprises an area of 262,184 square kilometres (101,230 sq mi), almost 8 percent of that of India. The Siliguri Corridor connects the region to the rest of mainland India. Source: https://databank.nedfi.com/index.php?q=content/general-information (accessed 04 October 2024) also other details available at https://necouncil.gov.in/

[2] Renewable Energy Statistics 2023-24, Ministry of New and Renewable Energy, www.mnre.gov.in (Accessed 31 October 2024).

[3] Ibid.

[4] Source: https://cea.nic.in/dashboard/?lang=en (Accessed 30 October 2024).

[5] Policy Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India.

[6] Ibid.

[7] Source: https://www.mpa.gov.mm/ports/kalagauk-deep-sea-port-project/#ports

[8] "First Indian cargo ship reaches Sittwe Port in Myanmar", The Economic Times, May 09, 2023. (Accessed 06 December 2024).

[9] Amid raging fighting in Myanmar, 100th shipment from India reaches Sittwe port". Source: https://www.thehindu.com/news/national/amid-raging-fighting-in-myanmar-100th-shipment-from-india-reaches-sittwe-port/article68426953.ece The port remains operational as was confirmed with a call with the Port operator.

[10] Authors interview with Port Operator.

[11] Source: https://www.moi.gov.mm/moi:eng/news/14462 (Accessed 02 November 2024).

[12] "Energy Poverty among Plenty", World Bank, Myanmar Energy Sector Update, June 2024. https://documents1.worldbank.org/curated/en/099062324221019838/pdf/P500473148b24a01b19ce31dee0cba378ed.pdf (Accessed 02 November 2024).

[13] Source: The people's map of China, https://thepeoplesmap.net/project/myanmar-china-oil-and-gas-pipelines/ (Accessed 07 December 2024).

[14] Cooperation Agreement between the Government of the People's Republic of China and the Government of the Union of Myanmar on the Myanmar-China Oil and Gas Pipelines, dated 24 .03. 2009. See also, https://hydrocarbons-technology.

com/projects/Myanmar-china pipelines/. A press release, dated 14 August 2024, by the Ministry of Foreign Affairs, People's Republic of China following a meeting between Foreign Minister Wang Yi and Myanmar's Deputy Prime Minister and Foreign Minister U Than Swe, *in Nay Pyi Taw*, the communiqué stated, "The two sides should maintain high-level exchanges and enhance political mutual trust, steadily promote the development of the China-Myanmar Economic Corridor, and ensure the safe and smooth operation of the China-Myanmar oil and gas pipeline project". Source: https://www.mfa.gov.cn/eng/wjbzhd/202408/t20240815_11474220.html (Accessed 02 November 2024).

[15] The Myanmar-China Oil and Gas Pipelines project, including a crude oil pipeline and a natural gas pipeline, is an international cooperation project. The Myanmar-China Crude Oil Pipeline is jointly invested and constructed by CNPC and MOGE, which established a joint venture of South-East Asia Crude Oil Pipeline Company Limited (SEAOP) to operate and manage the pipeline. The Myanmar-China Gas Pipeline is jointly invested and constructed by CNPC, MOGE, POSCO International Corporation, ONGC Nile Ganga B.V., GAIL (India) Limited, and KG-SEAGP Co., Ltd., which established a joint venture of South-East Asia Gas Pipeline Company Limited (SEAGP) to operate and manage the pipeline. The Myanmar-China Crude Oil Pipeline extends from Madè Island on the western coast of Myanmar to Ruili in China's Yunnan Province, running through Rakhine, Magwe, Mandalay, and Shan in Myanmar. In May 2017, the Myanmar-China Crude Oil Pipeline project was officially put into operation. The Myanmar-China Gas Pipeline starts at Ramree Island on the western coast of Myanmar and ends at Ruili in China's Yunnan Province, running in parallel with the Myanmar-China Crude Oil Pipeline. In July 2013, the Myanmar-China Gas Pipeline became operational and started to deliver natural gas to Myanmar's market through its off-take stations. Source: https://www.cnpc.com.cn/en/aboutcnpc/aboutcnpc_index.shtml (Accessed 07 December 2024).

[16] International Trade Center, Trade statistics for international business development, Source: https://www.trademap.org/Bilateral.aspx?nvpm=1%7c104%7c%7c699%7c%7c2710%7c%7c%7c4%7c1%7c1%7c1%7c1%7c%7c1%7c1%7c%7c1 (Accessed 02 November 2024) and UN Comtrade database, Source: https://comtradeplus.un.org/TradeFlow

[17] Myanmar Energy Sector Update, June 2024, "Energy Poverty amid Plenty" , Source: https://documents1.worldbank.org/curated/en/099062324221019838/pdf/P500473148b24a01b19ce31dee0cba378ed.pdf (Accessed 02 November 2024).

[18] "In Myanmar, there are 27 constructed hydropower plants that have an installed capacity of 3221 MW and 8 under construction hydropower plants which would generate 1737.60 MW. The installed capacity of (19) no of gas turbines is 2142 MW and the installed capacity of gas turbine that are being constructing is 449.9

MW and the installed capacity of a coal-fired power plant is 120MW. The installed capacity of 3 no of solar plants that are being constructing is 470 MW. Totally 47 constructed power plants have installed capacity of 2657.50 MW". Source: https://moep.gov.mm/en/ignite/contentView/1061 (Accessed 29 October 2024).

[19] "Myanmar Energy Sector Update: Energy Poverty Amid Plenty", June 2024, The World Bank.(Accessed 29 October 2024).

[20] "A country's solar energy resource potential is largely dependent on the intensity of solar irradiation, the estimated land area suitable for photovoltaics (PV) development, and the efficiency of the solar energy systems. The potential for solar energy can be assessed in theoretical, technical, and economic terms. Myanmar has good solar resource potential, with 60% of the land area suitable for PV development, having Global Horizontal Irradiation (GHI) levels of between 1,600 and 2,000 KWh/m^2 /yr, and average Direct Normal Irradiation (DNI) levels of about 1,400 KWh/m^2 /yr." Source: Renewable Energy Developments and Potential in The Greater Mekong Subregion, Asian Development Bank (2015), Source: https://www.adb.org/sites/default/files/publication/161898/renewable-energy-developments-gms.pdf (Accessed 02 November 2024).

[21] Refer, Table 9. Opportunities and Barriers for Renewable Energy Development across ASEAN Member States, "Exploring Renewable Energy Opportunities in Select Southeast Asian Countries: A Geospatial Analysis of the Levelized Cost of Energy of Utility-Scale Wind and Solar Photovoltaics", Nathan Lee, Francisco Flores-Espino, Ricardo Oliveira, Billy Roberts, Thomas Bowen, and Jessica Katz National Renewable Energy Laboratory (Revised June 2020). Source: https://www.nrel.gov/docs/fy19osti/71814.pdf (Accessed 29 October 2024).

[22] Lee, N., Cardoso de Oliveira, R., Roberts, B., Katz, J., Brown, T., & Flores-Espino, F. (2020). Exploring Renewable Energy Opportunities in Select Southeast Asian Countries: A Geospatial Analysis of the Levelized Cost of Energy of Utility-Scale Wind and Solar Photovoltaics. https://doi.org/10.2172/1527336 (Accessed 30 October 2024).

[23] Refer, Table 11, Green hydrogen export potential of the Association of Southeast Asian Nations(ASEAN) based on renewable energy potential and levelized cost of hydrogen. Hyeonjun KIM, Gayoung SONG, Yoonhee HA, Graduate School of Energy and Environment (KU-KIST Green School), Korea, University (#519, R&D Center Bldg., 145 Anam-ro, Seongbuk-gu, Seoul 02841,South Korea) (Accessed 02 November 2024).

[24] "Making The Breakthrough: Green Hydrogen Policies and Technology Costs" Source: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Nov/IRENA_Green_Hydrogen_breakthrough_2021.pdf (Accessed 02 November 2024).

[25] *ibid* Note 23.

[26] Source: https://www.re-explorer.org/lcoe-southeast-asia/index

[27] Calculated from the Global Wind Atlas and the Global Solar Atlas in consultation with subject matter experts.

[28] Source: https://data.opendevelopmentmekong.net/en/dataset/national-energy-grid-of-myanmar/resource/9c4b89aa-818e-4744-bfb0-b5803df2d738 (Accessed 02 November 2024).

[29] "Myanmar Junta Rakhine Grip Weakening: Analyst by Aye Chan Hsu, November 28, 2024. Source:"https://www.irrawaddy.com/opinion/analysis/myanmar-junta-rakhine-grip-weakening-analyst.html (Accessed 29 November 2024).

[30] "India Strengthens Maritime Ties with Myanmar and Bangladesh", https://www.thehindubusinessline.com/economy/logistics/india-strengthens-maritime-ties-with-myanmar-and-bangladesh-sarbananda-sonowal/article68705415.ece (Accessed 06 December 2024).

[31] Source: https://indiaseatradenews.com/india-trying-to-ensure-continued-operation-of-sittwe-india-port/ (Accessed 06 December 2024).

[32] Source: https://myanmar-now.org/en/news/blast-goes-off-near-korean-port-in-rakhine-state-capital/ (Accessed 06 December 2024).

[33] Exchange of Notes on two Yen Loan Projects "The East-West Economic Corridor Highway Project (New Bago-Kyaikhto Highway Section)" and "The Project for the Development of Finance for Small and Medium-Sized Enterprises (Phase 3)" Source:https://www.mm.emb-japan.go.jp/profile/english/press/20201104.html (Accessed 06 December 2024).

[34] Japan had commenced surveys for the Dawei Deep Sea Port in 2020. Source: https://www.myanmarwaterportal.com/news/2360-japan-to-conduct-survey-on-dawei-deep-sea-port-project.html (Accessed 06 December 2024).

[35] "Myanmar Junta Planning Joint Security Firm with China", China's government has reportedly proposed the establishment of a "joint security company" with Myanmar's military junta in order to ensure the safety of Chinese projects and personnel in the country. Source: The Diplomat, Source: https://thediplomat.com/2024/11/china-myanmar-to-establish-joint-security-company-reports-say/ (Accessed 07 December 2024).

[36] Source: http://www.punjlloydgroup.com/landmark-projects-gallery/myanmar-china-oil-gas-pipeline-project (Accessed 06 December 2024).

[37] Source: https://www.iea.org/reports/indian-oil-market/executive-summary (Accessed 07 December 2024).

[38] Ibid.

[39] "Maharashtra set to lose out on Mega refinery, talks on with Gujarat and Andhra", Source: https://timesofindia.indiatimes.com/india/maharashtra-set-to-lose-out-

on-mega-refinery-talks-on-with-gujarat-andhra/articleshow/115712179.cms (Accessed 06 December, 2024).

[40] As per scale adopted by Source: https://www.nrc.gov/docs/ML0720/ML072040340.pdf

[41] "Analysis of hydrogen production costs in Steam-Methane Reforming considering integration with electrolysis and CO_2 capture", Mary Katebah, Ma'moun Al-Rawashdeh, Patrick Linke, Science Direct, Source: https://www.sciencedirect.com/science/article/pii/S2666790822001574 (Accessed 01Nov2024).

[42] As per discussions with industry experts by author, the space requirements are about 350 acres for the Tank farms, 2600 acres for the refinery and about 50 acres for the GH plant and other supporting infrastructure.

[43] "NRL is executing a major expansion project of capacity augmentation from present 3.0 MMTPA to 9.0 MMTPA at a cost of Rs.18,968 crores. The Paradip – Numaligarh pipeline of around 1630 km for transporting 8 MMTPA of imported crude would cost Rs. 9,058 crores". Source: https://www.nrl.co.in/NRL-Current_Initiatives (Accessed 16 October 2024).

[44] "The largest of the sites, dubbed Etalin HEP, is targeting a capacity of 3,097 MW and is the biggest hydro project under development in India. The plan also includes the construction of the 680-MW Attunli, 500-MW Emini, 420-MW Amulin and 400-MW Mihumdon facilities". Source: https://renewablesnow.com/news/sjvn-plans-to-build-5-gw-of-hydropower-plants-in-northeast-india-831318/ (Accessed 16 October 2024).

[45] Processing 1 gallon (3.79 L) of crude oil in U.S. refineries requires 1.0–1.9 gallons (3.79–7.19 L) of water, with a median of 1.5 gallons (5.68 L) of water. "Estimation of U.S. refinery water consumption and allocation to refinery products". Pingping Sun, Amgad Elgowainy, Michael Wang, Jeongwoo Han, Robert J. Henderson. Hence, the indicated water requirement could be about 3400 million liters per day.

[46] These estimates have been obtained by the author after several rounds of interaction with industry experts, between September and November 2024, are a reasonable Rough Order of Magnitude cost.

[47] Derived after consultation with industry experts.

[48] The electricity rate is 500 kyat/unit. 1000 kyat is $0.48. Hence unit cost is $0.24. Source: https://www.nationthailand.com/news/asean/40041054 (Accessed 03 December, 2024).

[49] Snapshot of India's Oil and Gas data – October 2024. Source: file:///C:/Users/RISC-241/Downloads/1731643205_Snapshot-of-India-Oil-and-Gas-data-October-2024.pdf (Accessed on 03 December, 2024).

[50] Indian Oil's gross profit margin for fiscal years ending March 2020 to 2024 averaged 16.1%. Source: https://in.investing.com/pro/NSEI:IOC/explorer/gp_margin (Accessed 06 December 2024).

[51] Standing Committee on Petroleum & Natural Gas, (2023-24) Seventeenth Lok Sabha, Ministry of Petroleum & Natural Gas, "Review of Policy on Import of Crude Oil," Twenty-Third Report, Source: https://sansad.in/getFile/lsscommittee/Petroleum%20&%20Natural%20Gas/17_Petroleum_And_Natural_Gas_23.pdf?source=loksabhadocs (Accessed 28 October 2024).

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Core IV-B, Fourth Floor, India Habitat Centre
Lodhi Road, New Delhi-110 003 India., Tel. 91-11-24682177-80
Fax: 91-11-24682173-74, Email: dgoffice@ris.org.in
Website: http://www.ris.org.in