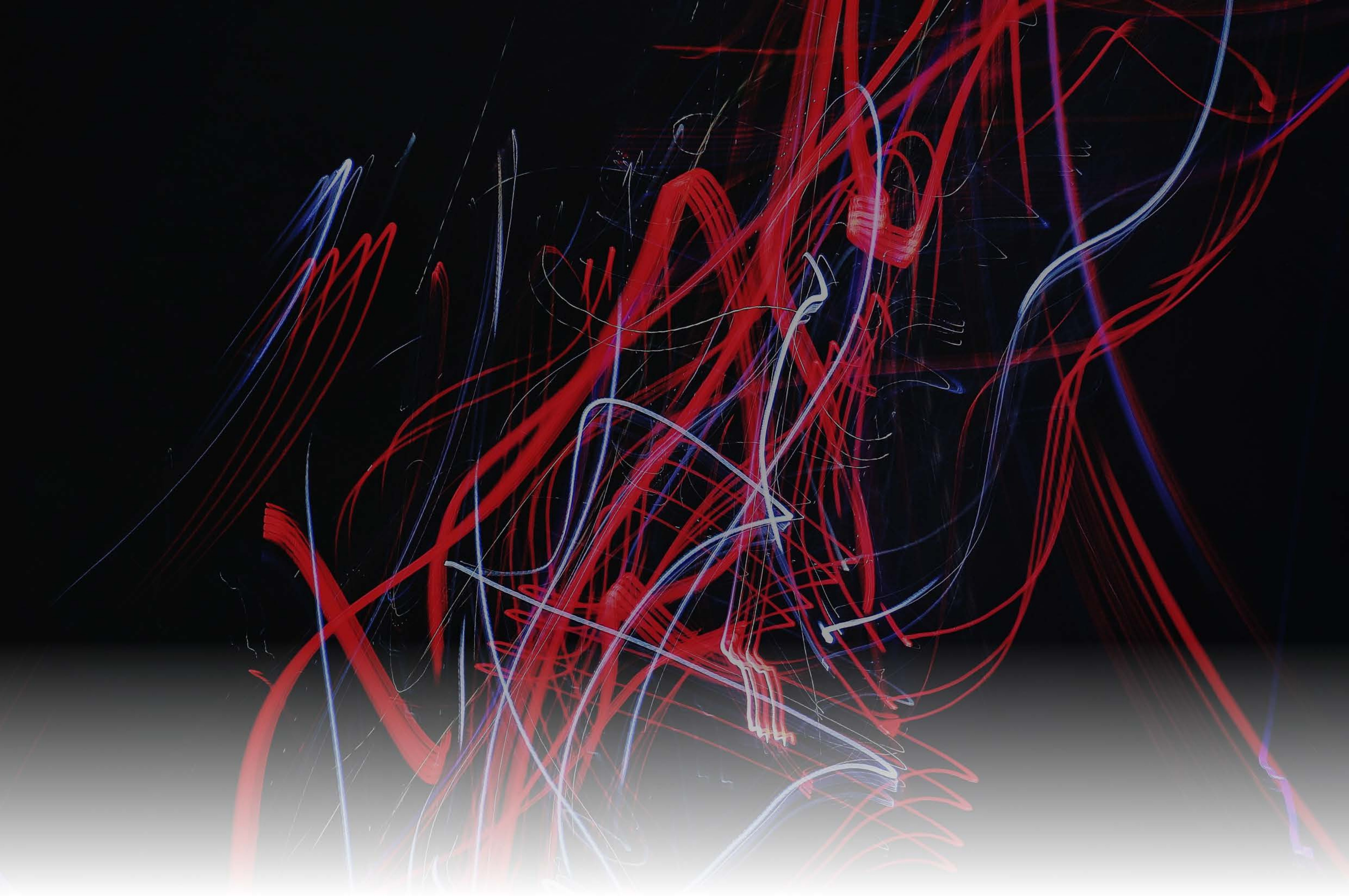


Sustainable Urbanisation: Southeast Asia's Transition to Clean Energy

Building a path towards widespread adoption
and distribution of renewable energy.



Rapidly rising energy demands

Energy demand in Southeast Asia is projected to increase by 70%¹ between 2015 and 2040. This is hardly surprising - Southeast Asia is one of the fastest growing regions in the world, home to 615 million people² and bustling economies. Two decades ago, such energy demands were met largely by a doubling in fossil fuel use, setting the scene for the region's heavy dependence on fossil fuel for energy generation.³ This has underpinned the region's transition from agriculture to industrialisation along with rapid urbanisation.

¹ International Climate Initiative

https://www.international-climate-initiative.com/en/news/article/accelerating_an_energy_transition_in_southeast_asia

² International Renewable Energy Agency

<https://www.irena.org/asiapacific/Southeast-Asia-regional-initiative>

³ International Energy Agency

<https://www.iea.org/reports/southeast-asia-energy-outlook-2019>

More than ever, urbanisation lies at the heart of the region's growth with 100 million more people expected to migrate to cities by 2030, and medium-sized cities (of between 0.2 million and 2 million residents) forecast to drive 40% of the region's growth.⁴

Urban centers are undoubtedly driving the region's transformation and economic growth. This, in turn, allows us to grasp why Southeast Asia's energy future is so inextricably tied to the sustainable development of its cities.

If the rising energy demands and pressures from city building are still to be met by "cheap" fossil fuel-based power generation, it can't bode well for our planet's climate or for the health and well-being of the people in the region. Seen through the lens of climate-change planning, sustainable urbanisation and energy transition are two pieces of the same puzzle.

Adding renewables to the mix

Recognising this, and under the growing climate change emergency, the Association of Southeast Asian Nations (ASEAN) has intensified their efforts to drive a sustainable transformation and development of new cities.

Firstly, they have set out to shift energy reliance towards renewables, and to support energy sustainability, security, and affordability. Whereas in 2019 only 15%⁵ of the region's energy demand was met by renewable energy, the region has now set a target of, by 2025, a 23% share of renewable energy in the region's total primary energy supply and 35% in ASEAN installed power capacity.⁶

To meet this target means a necessarily rapid increase in their share of renewable energy, with approximately 35GW-40GW of renewable energy capacity to be added by then.⁷

Secondly, they seek to harness the power of smart cities to drastically change how cities consume and generate energy. To do so, the ASEAN leaders established in 2018 the ASEAN Smart Cities Network (ASCN) to work towards the common goal of smart and sustainable urban development.⁸ From an energy perspective, smart cities and solutions could eliminate up to 270,000kt of greenhouse-gas (GHG) emissions annually.⁹ Evidently, facilitating cooperation on the development of smart cities at a regional level goes hand in hand with the collaboration required for the region's energy transition.

This exponential growth of cities and their rising energy demands can be viewed as a welcomed opportunity to accelerate the energy transition while pursuing economic growth that is sustainable. A "green recovery" is a win-win scenario for our COVID-battered economies and for our planet - job creation, and a catalyst for innovation and environmentally conscious practices.

Playing to each country's unique strengths

Governments, with the participation of public and private actors, have laid out ambitious programmes to meet these new energy demands, and have launched dedicated funding mechanisms and R&D initiatives to accelerate the transition. Collectively, these efforts form fertile ground for the identification and adoption of technologies that would power their energy transition.

4 ASEAN Smart Cities Network (ASCN) Concept Note
<https://asean.org/storage/2019/02/ASCN-Concept-Note.pdf>

5 <https://www.asean.org/reports/southeast-asia-energy-outlook-2019>

6, 7 <https://www.power-technology.com/comment/south-east-asia-renewable-energy/>

8 ASEAN Smart Cities Network (ASCN)
<https://asean.org/asean-smart-cities-network/>

9 <https://www.mckinsey.com/business-functions/operations/our-insights/smart-cities-in-southeast-asia>



Following interviews with various stakeholders, public and private, these are some of the non-negotiables that the region’s energy transition will have to be built around:

- increased reliability of power supply,
- enhanced energy security, and
- regionally collaborative infrastructure that supports a diversified energy mix.

- the leveraging of geological resources (their natural advantages), and
- regional collaboration for knowledge sharing and to accelerate the implementation of new technologies.

Each country’s energy transition journey will be unique to its own energy value chains and lean on its natural advantages in the availability of such resources. Their success requires stakeholders to build supply from renewable sources, while also addressing how energy is consumed (i.e. addressing energy efficiency, consumption, storage, etc.).

Meaningful progress will require:

- public buy-in and understanding of the need for and advantages of such energy transition,
- clear policy support and long-term funding mechanisms for the energy transition,

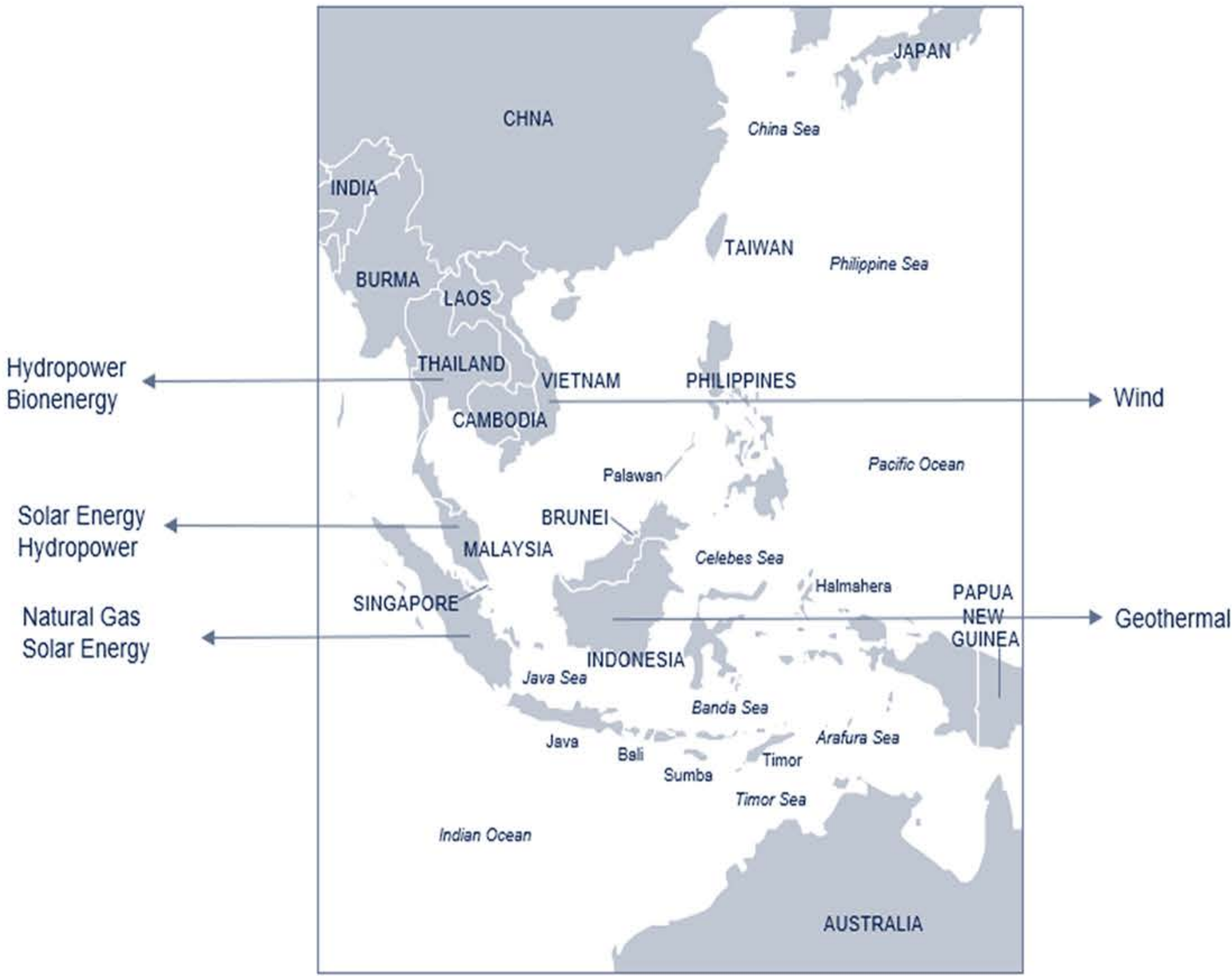


Figure 1: Southeast Asia’s energy supply & natural advantages

Let us look at the contemplated future pathways of four ASEAN countries more closely: Singapore, Vietnam, Indonesia, and Philippines, to better identify both local and broad-based challenges faced on the ground.

SINGAPORE

Singapore's energy transformation stands out within the region for being a holistic strategy seeking to address all at once the energy trilemma - energy security, environmental sustainability, and economic competitiveness - while tackling its natural challenges (such as the lack of natural and renewable energy sources).

Historically, the country transitioned from using fuel oil for power generation to natural gas after 2000. It has also since 2015 grown its solar deployment more than 7 times to about 444MWp as of 1Q2021.¹⁰

The Singapore Green Plan 2030 is built on four pathways to materialise their energy story:

- a steadfast development of solar energy as its most viable renewable energy option,
- maximising efficiencies from its existing natural gas-powered energy sector,
- harnessing the advantages of regional power grids, and
- the acceleration of emerging low-carbon initiatives.

VIETNAM

Vietnam has significant natural advantages in the renewables arena, and also has the largest amount of installed renewable energy capacity at about 24,519MW.¹¹

Hydroelectric power already forms 25% of its current energy supply but this resource is likely also already maximised. Solutions that help avail it to harder-to-reach sources of hydroelectric energy will be particularly useful.

By 2025, Vietnam is anticipated to lead Southeast Asia's installed renewables capacity with over 13GW of these installations currently being planned for. Solar and hydro are expected to support the majority of this transition with around 70% share of the new renewable capacity. Wind power will comprise 17%, and biopower approximately 11%, of renewable capacity.

INDONESIA

Indonesia has pivoted aggressively towards climate mitigation. It aims to increase renewable energy's share of its energy mix from 9% in 2020 to 23% by 2025, and 31% by 2050.¹² This renewable segment is expected to comprise largely of geothermal and hydroelectric power.

Thanks to its volcanic geology, it is estimated that at 29,000MW, Indonesia alone accounts for 40% of the world's potential geothermal resources. In 2017, installed geothermal power capacity was 1,800MW and its President Joko Widodo wants to change that. The country expects its geothermal production capacity to reach 5,000MW by 2025, and 8,000MW by 2030.¹³ This would position Indonesia as the country with the largest geothermal utilisation in the world.

Geothermal power, however, comes with its own set of challenges. Critics assert that geothermal projects combine the worst risks of mining and of power generation, because in seeking a deep underground resource, one must first find that resource. While mapping and predictive models build confidence in what may lie underground, until drilling is done much still remains unknown: where, how powerful, and how long it'll last.

¹⁰ Energy Market Authority/SGN/Hello Tomorrow Questions & Responses dated 12.07.2021

^{11, 12} <https://www.power-technology.com/comment/south-east-asia-renewable-energy/>

¹³ <https://www.adb.org/news/features/developing-indonesia-s-geothermal-power-potential>

PHILLIPPINES

Similar to Indonesia, geothermal power is also abundantly available in the Philippines and is its most economical renewable energy resource, followed by wind, hydro, and solar.¹⁴

Of the Southeast Asian countries, the Philippines has the most balanced mix of indigenous renewable energy sources, and has, correspondingly, readily embraced a future energy mix that comprises the highest proportion of renewables.

Its Department of Energy aims to increase the share of renewables in its energy mix to 35% by 2030, and to more than 50% by 2040.¹⁵

Enjoying such a diverse range of renewable energy mediums and sources also means its power plants must be capable of flexible adjustments, battery energy storage, pumped-storage hydropower, and thermal energy storage.



¹⁴ <https://jrenewables.springeropen.com/articles/10.1186/s40807-018-0047-2>

¹⁵ <https://www.pna.gov.ph/articles/1143797>



Doing more with less

The pathways explored within these Southeast Asian countries expose several challenges that need to be met in order for a successful energy transition to take place within the context of increasing urbanisation. Capitalising on natural resources alone will not be sufficient.

From the outset cities tend to concentrate on environmental and societal challenges. In the face of growing populations, natural resource constraints, rising energy demands, and underperforming infrastructure systems, cities must make better use of technology to do more with less.

Challenges

A. Normalising peak supply and demand

Renewables have not always been predictable, reliable, or secure - they sometimes fluctuate with the weather. Utilities operators are tasked with integrating distributed energy into the mix without compromising the steady flow of electricity the population needs.

B. Grid stability and updated infrastructure to support a diversified energy mix

In order to incorporate renewable energy sources into their existing infrastructures, operators must take care of issues around system stability, such as voltage management, frequency control and maintaining a smooth power curve.

Part of the issue stems from the traditional grid being a top-down, one-way centralised distribution system.

The rise of distributed energy resources (DERs) requires that traditional grids be updated to accommodate two-way flows of electricity. Once achieved, DERs can alleviate some of these capacity issues by providing grid services like capacity, voltage, and frequency regulation.

Modernising existing infrastructure is also needed in order to implement smart grid solutions which allow us to monitor and optimise in real time our energy consumption. This will in turn accelerate the development of regional smart grids.

C. Lack of space to accommodate large renewable energy infrastructure in densely populated areas, such as metropolitan cities

In order for DERs to be fully utilised, associated infrastructure must be able to exist close to the point of utilisation, such as in the vicinity of large industrial/ residential communities. Within densely populated areas, high land values make such arrangements commercially unfeasible.

These areas require substantial investment and technical progress for improved commercial viability. Supporting the development and adoption of technical solutions to these challenges is intrinsically linked to the region (and the rest of the world, really) being able to obtain their clean energy targets in the coming years.

Creative solutions that incorporate modularity and are economical on spacial needs can support DERs in these environments.

D. Easy-to-access renewable energy sources have reached saturation

As with all forms of resource extraction, many easily accessible sources of energy have already been cultivated for extraction, but energy needs in the region are still growing rapidly. This requires tapping on sources of renewable energy that tend to be costlier, compromising commercial viability vis-a-vis hydrocarbon-based sources.

E. Extraction processes can be inherently harmful to the environment

Environmental issues are likely to emerge as part of building capacity around geothermal and hydroelectric sources as sources of energy. Consequent spillover effects such as GHG emissions, earthquakes, floods, and biodiversity loss are not uncommon, and need to be appropriately managed.





Innovative solutions are aplenty

Having framed some of these primary challenges, we highlight some companies working on possibly promising solutions.

Odqa Renewable Energy Technologies

Odqa Renewable Energy Technologies is developing state-of-the-art concentrated solar power (CSP) systems with modularity, cheap storage, and industrial heat provision capabilities. By using CSP and long-lasting thermal energy storage as a mechanism for harvesting and storing solar energy, rather than solar PV electricity generation, Odqa is able to help utilities operators meet both base load and peak demand.

Current CSP systems are limited by the maximum operating temperature of the medium that captures heat in the receiver (appx. 600°C).

Odqa's aerospace-inspired solution allows hot air capture to the tune of 1500°C, allowing much higher energy efficiency conversion and consequently lower harvesting costs.

This allows for a solar-based solution that could be more cost efficient than PV generation, while meeting grid stability issues thanks to its compatibility with long-term thermal energy storage.

Helios Atlas

Helios Atlas produces the world's first suspended hydroelectric generator, the Helios PowerWheel. By rising and falling with changing water levels, it allows full aquatic passage without catching debris. It requires little to no civil infrastructure and is designed to be added to existing projects, capturing unused energy.

Being small, modular, and engineered to optimise efficiency, the Helios PowerWheel is able to generate 1kW from 10sqft of space, and can work with rates of flow as slow as just 1m/s. This allows harvesting not just from large, fast-flowing bodies of water, but from much smaller sources such as large canals, thereby opening up the options space and increasing access to hydroelectric resources in countries such as Vietnam that are reaching saturation.

Print Solar Technologies

Print Solar Technologies developed a method of printing perovskites on existing safety and architectural glass, allowing a completely customisable, easily scalable, and aesthetic solution to solar power integration in buildings. These printable PVs have efficiency levels that are competitive with existing solar PV panels.

Strategically, this allows for deployment of solar PV cells on vertical building surfaces as well, opening up opportunities in heavily built-up environments. In densely populated urban centers such as Singapore and Bangkok, Thailand, there is more vertical than horizontal surface area facing the sun. The technology has since been acquired by a glass manufacturer, which is exciting news for market adoption of the technology!

Eavor Technologies

Eavor Technologies represents the world's first truly scalable form of clean, baseload, and dispatchable power by way of a closed-loop geothermal solution. Its system allows for the deployment of geothermal infrastructure without fracking, GHG emissions, earthquake risks, or aquifer contamination.

The system instead circulates a fluid within a closed loop, completely isolated from the external environment, much like a massive

subsurface radiator. This “radiator” simply collects heat from the natural geothermal gradient of the Earth via conduction, at geologically common and drilling-accessible rock temperatures.

This is poised to be a game changer as geothermal energy is one of the few renewable sources that allows for constant, stable delivery of energy. Further, by tweaking the flow rate of the working fluid, the amount of energy delivered can be varied to meet demand, delivering predictable load-following.

Seaborg Technologies

Seaborg Technologies is developing an inherently safe 4th generation nuclear Compact Molten Salt Reactor (CMSR) with an essential proprietary moderator. With its uranium-based fluoride fuel salt, the CMSR has a number of prominent features: it cannot meltdown or explode, release radioactive gases to air or water, or be used for nuclear weapons.¹⁶

The CMSR will be installed on modular floating power barges, enabling full mobility. The power barge design is enabling configurations with two, four, six, or eight CMSRs delivering up to 800MW-electric or 2,000MW-thermal. The first power barges will have two reactors installed delivering 2 x 100MW-electric for the 24-year lifetime of the power barge.

This trifecta of stability, output, and consistency reframes the perspective around nuclear energy. In the words of Dr. Troels Schönfeldt, CEO of Seaborg Technologies:

“Our technology will be cheaper than gas and coal. That is crucial if we want to stop the heavy buildup of fossil fuel in many areas around the world where renewable energy faces challenges due to poor meteorological conditions, like in South East Asia. One of our smaller CMSR power plants will mitigate around 33.6M tonnes of CO2 in its 24-year life span.”

¹⁶ <https://www.seaborg.co/press-release-dec-2020>



Deep technologies are a crucial part of the solution

The success of Southeast Asia's energy transition is in no small way bound to the sustainable development of its cities. In the face of growing populations, natural resource constraints, rising energy demands, and underperforming infrastructure systems, it is vital that our cities leverage the power of deep-tech solutions to do more with less.

As we strive to support the emergence of new technologies to address the stability, productivity, and resilience of a diversified energy mix, each country must develop their energy transition by considering their geostrategic advantages and regional opportunities for knowledge transfer and collaboration.

End Notes

This is part of an ongoing series, *Sustainable Urbanisation*, produced by Hello Tomorrow Asia Pacific and supported by the Singapore Global Network (SGN). Here we expound on the opportunities (and necessity) for city-living to be gentler on our planet, and highlight emerging deep-tech innovations making it possible.

Our mission is to draw attention to the existing deep-tech innovations, and to identify those needed to help bridge the remaining gaps. These solutions are central to building the sustainable and energy-efficient cities of tomorrow. While solutions exist, they require considerable support from our ecosystems to thrive and become established solutions for our future cities.

Next on the horizon, we will take a closer look at what sustainability means when designing and building these future cities. Understanding sustainable urbanisation in Southeast Asia would not be complete without addressing the role to be played by the construction industry, and contemplating the building materials of the future.



Hello Tomorrow Asia Pacific (part of a global non-profit) is on a mission to accelerate deep technologies to solve our most pressing industrial, environmental and societal challenges. Its world-renowned **Global Challenge** unearths and embraces these start-up solutions at their earliest stages, projecting them forward for maximum impact.

For more information, please visit: hello-tomorrow-apac.org

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