RETHINKING ENERGY IN SOUTHEAST ASIA

SHAPING OUR FUTURE WITH A CLEAR ROADMAP TO NET ZERO

As the global shift to net zero accelerates, countries across Southeast Asia have an enormous opportunity to transition to clean power. By front-loading the deployment of renewables, Southeast Asian countries can accelerate decarbonisation and unlock myriad benefits. To illustrate the measures needed for cost-optimal paths to net zero, Wärtsilä has modelled the future power systems in Vietnam, the Philippines and Indonesia.

Each country has different geographies, socioeconomic dynamics, and power systems, yet the modelling shows that net zero is technically and commercially feasible for each of them. Net zero is not a distant possibility. The models provide a clear roadmap for the rapid expansion of renewable energy in the next decade, to create carbon-neutral power systems by mid-century. A recipe which can be translated throughout Southeast Asia.

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FOREWORD

How Southeast Asia can futureproof its energy sector and realise a renewable transition

Sushil Purohit,
President, Wärtsilä Energy and Executive Vice President at Wärtsilä Corporation

Southeast Asia is rapidly emerging as a colossus of the global economy, with nearly all of its economies more than doubling in size since 2000. This growth has largely been powered by fossil fuels. However, a storm is brewing. Across the region, the annual average fossil fuel import bill has been $43 billion USD or 1.7% of GDP over the past decade. However, based on current commodity prices, these costs are set to significantly increase[1]. The International Energy Agency (IEA) forecasts that fuel imports and energy security vulnerabilities will rise sharply in Southeast Asia unless clear planning and bold action is taken to accelerate the energy transition towards renewables.

At the same time, net zero commitments are proliferating worldwide, encompassing 91% of global GDP[2]. Science-aligned net zero pathways are now the baseline expectation for countries, companies, cities and regions. Having a clear, actionable pathway to net zero is fast becoming a prerequisite for international trade. Massive opportunities are on the table for countries that can get ahead of the net zero wave; the World Bank estimates that the Asia-Pacific region can create $47 trillion USD of growth by 2070 through transitions to net zero. The planned ASEAN Power Grid is one example, where the development of a power trading network for renewables will help the region to meet rising regional and global demand for green power.

Southeast Asia is on the front line of the intensifying impacts of climate change, with increased threats from heatwaves, typhoons and floods. In my view, it is now vital that national-level net zero pledges and decarbonisation goals are operationalised across the region's economies. This report provides a blueprint for that ambition.

Pioneering change in the power sector

In 2020, 40% of Southeast Asia's emissions came from power generation, followed by industry (29%) and road transport (18%)[3]. Power sector leaders hold the keys to pioneering decarbonisation of the region's economies. All of the technologies needed to decarbonise power exist at a commercial scale today, and Southeast Asia benefits from a diverse range of renewable resources, including hydropower, wind, solar PV, bioenergy and geothermal.

Progress is already being made. Renewables account for nearly a quarter of total generation in Southeast Asia, with the majority coming from hydropower, and the region aspires to achieve a 35% share of renewable electricity capacity by 2025. However, in our experience of modelling power systems around the world, a far higher share of renewables can reliably meet rising demand for power this decade, while dramatically cutting emissions.

[1] International Energy Agency, 2022
[2] Net Zero Tracker, 2022
[3] International Energy Agency, 2022

To demonstrate the potential in Southeast Asia, we modelled power systems in Vietnam, the Philippines and Indonesia. The results are striking. Building flexible renewable power systems in these countries does not cost more than running the existing power systems. As our modelling has shown in other regions around the world, shifting from fossil fuels to renewable energy significantly reduces a power system's operational expenditure. This is because a flexible renewable grid requires minimal levels of balancing fuel and low maintenance. In fact, by reaching net zero, when factoring in the carbon taxes forecasted by the IEA, the levelised cost of electricity (LCOE) of a net zero power system can be up to 23% lower than a system that continues to rely on inflexible fossil fuel for baseload power.

Flexibility, the best friend of renewables

To achieve a level of 85% renewables in 2050, which would align with the Paris Agreement, the IEA forecasts that Southeast Asia must collectively deploy 1,100 GW of renewable capacity in the next 30 years – this is equivalent to the combined total renewable capacity of China and India today.

However, the coal power plants and large combined cycle gas turbines (CCGTs) that currently dominate power systems in Southeast Asia cannot adapt to the intermittent nature of renewables, forcing some countries to curtail massive amounts of renewable energy. For renewable energy to become the main source of energy, grids need to be equipped to balance, store and optimise renewable energy.

Flexible capacity, provided by balancing engines and energy storage, creates the conditions where renewables are the most cost-efficient way to power our grids: by balancing intermittency and ensuring backup power is available when there is insufficient wind or solar. In my view, the systemic wastage of power caused by the inflexibility of legacy infrastructure needs to be urgently addressed by Southeast Asia's governments and regulators for the lowest cost energy source, renewable power, to fulfil its potential.

Understanding the interplay between short and long term

Shifting away from Southeast Asia's current fossil-dependent system demands an unprecedented transformation in power sector strategies, power plant portfolios, and operations. Policymakers need to play their role by shaping new markets and by recognising the systemic cost of inflexibility, which is often hidden or spread out across fossil fuel portfolios.

This report aims to help Southeast Asian countries determine the optimal power systems of the future. Through power system modelling and our on-the-ground experience, we can outline the key steps that Vietnam, the Philippines and Indonesia, plus other nations in Southeast Asia, can take to fully utilise renewable resources and unlock net zero power systems at the lowest cost and risk, and maximum reliability and affordability.

"Policymakers need to play their role by shaping new markets and by recognising the systemic cost of inflexibility.

EXECUTIVE SUMMARY

Southeast Asia is experiencing a perfect storm of unprecedented fuel price increases and volatility, increasing year-on-year demand for power, plus exposure to the intensifying impacts of climate change.

Amidst this uncertainty, leaders have the opportunity of a generation – to transform their power systems so that they do not just weather the storm, but create sustainable, scalable power systems for the future. Transitioning to net zero is a complex, multi-decade operation which requires deep power system planning and a rapid level of implementation this decade. By front-loading the deployment of renewables, Southeast Asian countries can accelerate decarbonisation and unlock myriad benefits. If they take a ‘business as usual’ approach, they run the risk of being left behind by the market and passed over by investors.

To help Southeast Asia accelerate decarbonisation, Wärtsilä has modelled three distinct power systems – Vietnam, the Philippines and Indonesia – to provide a roadmap to future clean power systems and help countries across the region find their optimal paths to net zero. We have used PLEXOS, a leading power market simulation software, for the power system modelling presented in this report.

These systems were chosen as they reflect different geographies, societies, and power systems. By modelling them, we can highlight the commonalities that all Southeast Asian countries can utilise to find optimal paths to net zero emissions by the middle of this century. The three countries in focus have different net zero ambitions. Vietnam has set a net zero target of 2050, while Indonesia is targeting a 2060 arrival at net zero. The Philippines has not yet explicitly communicated a net zero target but aims to power its grid with a 35% share of renewables by 2030 and 50% by 2040. We have modelled net zero power systems for the three countries within these timelines.

Each country is at a different starting point and has access to different resources, which affect their optimal pathway for phasing out coal, adding flexible energy solutions, and transitioning to renewable energy. Nuclear was one of the new-build options for the PLEXOS optimisation software to choose from, however, the modelling results of all three countries show no nuclear in the system. The least cost path to net zero consists of renewables and flexible technologies – adding nuclear will lead to higher total system costs for the countries. The three country models provide a clear roadmap for the rapid expansion of renewable energy in the next decade, as well as long-term action plans to create carbon-neutral power systems by mid-century.

Key findings:

1. Net zero is technically and commercially feasible for Southeast Asian power systems.

Net zero is not a distant possibility. The modelling shows that it is now technically and commercially feasible to increase renewable energy to meet almost all of the energy demand of the countries modelled, supported by a mix of technologies and sustainable fuels. Net zero power systems include:

- Renewable energy, including wind and solar photovoltaic (PV) as the main sources of primary energy, as well as hydro and bioenergy.
- Short-duration energy storage.
- Fast-starting grid balancing power plants, such as flexible engine-based power plants, to provide firm and dispatchable capacity.
- Sustainable fuels, such as hydrogen-based fuels produced from renewable sources, to be used in power plants to provide seasonal balancing.

The least cost path to net zero consists of renewables and flexible technologies.

2. Renewable energy can meet rising demand at a lower cost of production than legacy fossil fuel baseload.

The modelling shows that renewable power systems backed by grid balancing engines and energy storage can meet native load while avoiding blackouts and creating the right conditions for future demand growth. In addition, balancing engines are primed to utilise hydrogen once it becomes commercially available, creating net zero power systems.

A variable renewable power system does not cost more than the current system. In fact, when factoring in the IEA's upper forecasted carbon prices, the LCOE in net zero power systems can be 20% less in Vietnam by 2050; 23% less in the Philippines (Luzon) by 2040; and 23% less in Indonesia (Sulawesi) by 2060. Small amounts of fossil fuels are still used in optimal energy mixes by 2050 as balancing fuels. However, these can be replaced by sustainable fuels, such as green hydrogen, as they become more widely available.

3. Phasing out coal should be a priority for Southeast Asia.

Coal continues to play an important role in Southeast Asian power systems. However, with decreasing costs for renewable energy and a growing global imperative to phase out coal following COP26, the time is now right to consign coal to the history books. The modelling shows that most coal plants, along with other inflexible assets such as CCGTs, can be phased out before 2050, with any remaining units deploying carbon capture and storage (CCS) to eliminate emissions.

4. Flexible technologies are needed to support the integration of renewable energy and an optimal power mix.

Flexibility is the crucial technological fix that enables renewable energy to become the dominant source of power for Southeast Asian grids. In Vietnam, for example, significant balancing capacity is needed this decade for the system to run optimally and meet the peak demand, even without scaling up renewables for a net zero power system. Energy storage and grid balancing engines are needed in high renewable systems to balance the variability of renewable power.

Flexibility is the crucial technological fix that enables renewable energy to become the dominant source of power for Southeast Asian grids.

By adopting flexibility at scale, Southeast Asian countries can maximise renewable energy investments by balancing the intermittency of wind and solar power, as well as enabling new technologies – such as green hydrogen produced through the electrolysis of clean energy – to be scaled up and redeployed as balancing solutions, to ensure the power supply always matches demand.

5. Policy interventions are needed to shape flexible markets.

Policy interventions are needed to incentivise flexibility and the integration of renewable energy in Southeast Asia. By helping to establish well-functioning ancillary services markets and balancing markets, governments can encourage the integration of renewable energy and enhance competitiveness and affordability for energy users.

Countries can also contract flexibility and balancing capacity through specific power purchase agreements (PPAs). Such service offtake contracts for ancillary or flexibility services provide a means to procure balancing from independent power producers (IPPs), with private sector ownership of power assets.

Finally, transitioning to liberalised and diverse energy markets can help improve competitiveness in the modelled countries, and make the shift to renewable-powered systems faster.

Key steps to net zero

Despite the complexity of the transition of power systems from fossil fuel baseload to renewable technology, the modelling shows that it is possible for Vietnam, the Philippines and Indonesia to achieve net zero systems. While the steps to net zero differ across the markets, the modelling reveals several key steps which are needed, in sequence, to scale-up renewable energy into the dominant energy source by mid-century:

- Countries should rapidly increase renewable energy capacity now.
- To manage the intermittency of renewables, balancing engines and energy storage should be added to provide flexibility to the grid.
- Inflexible fossil fuel power plants, such as coal and CCGTs, should then be phased out or the small amount remaining should be retrofitted with CCS. New investments into inflexible assets should not be made.
- Finally, sustainable fuels produced from renewable energy, such as hydrogen, should be added to the mix to decarbonise balancing engines and support other sectors to decarbonise.

By doing so, countries will see a progressive reduction in the running hours of inflexible fossil fuel power plants, plus reduced curtailment of renewable energy assets. As this happens, the role of fuels can change from baseload to balancing, while renewables become the primary sources of output.

These steps are a starting point for planning power sector transitions across Southeast Asia. This report is designed to enable energy leaders throughout the region to implement the future-proof, sustainable power systems that all countries need to power their economic growth without impacting the climate as the major economies of the near future.

VIETNAM

THE CRITICAL STEPS FOR VIETNAM'S PATH TO NET ZERO

At the COP26 global climate conference, Prime Minister Pham Minh Chinh unexpectedly announced a target for Vietnam to reach net zero by 2050.

To reinforce its intentions, Vietnam also signed the Global Coal to Clean Power Transition commitment, to rapidly scale up renewables and build no more new coal power plants[4]. This was a major pivot for a country that currently relies on fossil fuels for around half of its power.

Vietnam has invested heavily in coal power over the past decade – operating the second highest installed coal capacity among the Lower Mekong countries (Myanmar, Laos, Cambodia, Thailand and Vietnam). Under its coal pledge, Vietnam effectively committed to retiring 30 coal plants. However, more than 80% of its coal plants were commissioned in the past 10 years, and most are nowhere near retirement age[5].

Nevertheless, Vietnam's incoming Power Development Plan 8 (PDP8) has shown positive intent – increasing the renewable targets compared to prior plans. However, the latest plan would still mean the country would fall short of its net zero goal by 2050.

It's clear that to realise net zero, Vietnam has to transform its use of energy, beginning with the power sector[6]. The key question for power sector leaders

[4] Council of the Parties, 2021

[5] China Dialogue, 2022

[6] S&P Global, 2022

is whether they will take the opportunity to proactively shape the new market dynamics of the energy transition, or be shaped by it.

A perfect storm: rising demand, plus soaring fossil fuel costs

Vietnam has experienced the fastest power demand growth in Southeast Asia following its recovery from COVID, with average demand increasing by 5.8% in Q1 2022 compared to Q1 2021 and exceeding the pre-pandemic level (Q1 2019) by 15.8%[7].

Just as demand is rising, soaring fossil fuel power prices are increasing the risk of electricity shortages within coming years, as power plants are forced to reduce output. For instance, the price of coal has risen dramatically in the past two years, from around $50 USD/MT in July 2020 to over $400 USD/MT today[8].

In addition, since 2015, Vietnam has shifted from a net exporter of energy to a net importer. In 2019, about 50% of the coal used in Vietnam originated from abroad and the net import of oil accounted for 30% of oil consumption (GSO, 2020)[9]. According to the Institute of Energy under the Ministry of Trade and Industry (MOIT), at current rates, Vietnam's domestic coal, natural gas, and crude oil resources are expected to last 70, 45 and 18 years, respectively. Under these conditions, the existing fossil fuel-powered system is economically untenable.

To protect future investment, Vietnam needs to build a clean power system that attracts foreign investors.

Another key factor driving the worsening economics of fossil fuel power is financing. Investment has drained out of the coal power sector globally, with over 100 globally significant banks, insurers, asset managers and owners having announced plans to divest from coal mining and coal-fired power plants[10]. As a result, many new coal projects in Vietnam are experiencing delays. To protect future investment, Vietnam needs to build a clean power system that attracts foreign investors.

A window into Vietnam's energy future

To understand the cost and environmental impacts of a range of decarbonisation paths, we modelled four scenarios for the energy transition in Vietnam by 2050. Each of the four scenarios deploys the lowest cost existing energy technologies to meet demand, based on different levels of emissions reduction by 2050, from business as usual to net zero emissions.

Power system modelling scenarios:

1. **Business As Usual (BAU)** – no restrictions on emissions from the power sector. Under this scenario, Vietnam would release 320 million tonnes of CO_2 emissions by 2050, a three-fold increase on 2020, putting net zero well out of reach.
2. **50% Emission Reduction** – a scenario demanding emissions are reduced by 50% by 2050, compared to the BAU 2050 scenario.
3. **80% Emission Reduction** – a scenario demanding an 80% reduction in emissions by 2050, compared to the BAU 2050 scenario.
4. **Net Zero** – a power system operating with net zero emissions by 2050.

[7] S&P Global, 2022

[8] Trading Economics, 2022

[9] Electricity and Renewable Energy Authority in Viet Nam & Danish Energy Agency, 2022

[10] Institute for Energy Economics and Financial Analysis, 2022

The scenarios refer to different levels of renewable energy ambition, with each requiring a different level of renewable capacity to meet power demand by 2050. The scenarios are focused purely on the power sector, rather than the total power system. For example, Vietnam could decide to pursue an 80% reduction in emissions for the power sector but still reach its whole-system net zero pledge by pursuing carbon-negative farming emissions.

Alongside the BAU and Net Zero scenarios, two intermediate scenarios are also modelled to showcase the sensitivity of different technology choices in reducing emissions, resulting in a more granular picture of the choices and trade-offs that the path to net zero entails.

The scenarios all agree that to meet rising demand, deliver a net zero system, and achieve energy independence, renewable energy should replace fossil fuels as the main source of generation. To achieve net zero by 2050, Vietnam's power sector emissions should peak by 2030.

Actions taken now will determine the long-term path to decarbonisation

Shifting from an established fossil fuel-powered grid, while managing renewable variability, is a complex, multi-year operation. Crucially, it requires a clear understanding of the interplay between the short and long-term; unless key steps are taken in the coming 5–8 years, the benefits of a high renewable power system will not be fully realised. To show this, the power system modelling results are presented as five key steps which are needed, in sequence, to scale-up renewable energy into the main source of energy.

Steps 1—2: The short term (from now to 2030):

Unless key steps are taken in the coming 5—8 years, the benefits of a high renewable power system will not be fully realised.

1. Add significant new renewable capacity to the system.

The four scenarios agree: running a cost-optimal system requires Vietnam to build the conditions now to enable renewables (including hydro, solar, wind and bioenergy) to provide almost 50% of Vietnam's generation by the end of 2030. For wind and solar generation, this represents a dramatic increase from around 10% of the total generation today to 30% by 2030.

PDP8 aims to encourage the expansion of renewable capacity, plus the production of new forms of energy such as hydrogen and green ammonia. However, action is required now to enable Vietnam's emissions to peak by 2030, as well as paving the way for a green hydrogen supply chain.

Having led ASEAN countries' uptake of renewables since 2019, Vietnam's momentum on renewables has stalled recently due to the lack of an incentive mechanism to replace the legacy Feed-in Tariff scheme. The Vietnamese government now needs to bring in a next-generation policy framework to support the required investment in renewables.

2. Add balancing engines and energy storage:

In each scenario, significant balancing capacity is needed by 2030 to smooth out the variable supply of renewable power and ensure grid stability. To achieve this, investment should shift to flexible balancing plants to integrate renewables into the system. By 2030, 7 GW of balancing capacity should be added to the system, provided by modular grid balancing engines which can ramp up to full load in less than two minutes, providing both long and short-duration balancing and backup power.

In addition to long-term and seasonal balancing provided by engine capacity, shorter-term balancing can be provided by energy storage, which can respond in milliseconds to balance output, store excess energy and re-dispatch power. The modelling shows that up to 1 GW of short-duration battery energy storage (1–2 hours), should be installed by 2035.

To unlock the opportunity of a flexible grid, regulators should act now to create market mechanisms which reward the value of flexible assets in wholesale power markets, for example, through capacity payments for flexible capacity, and ancillary services markets.

Steps 3—5: The medium to long term (2030—2050):

3. Phase-out inflexible plants:

Once there is sufficient renewable output, coupled with balancing power plant capacity in the system, legacy inflexible plants, such as coal and oil can be retired. The Net Zero scenario and 80% Emission Reduction scenario show that coal use can peak at 30 GW by 2025 (52% of total generation), before reaching 31% / 34% by 2030 and 12% / 16% of generation by 2035 respectively. In both scenarios, no new coal is added to the grid after 2025, besides plants already under construction.

To reduce 80% of Vietnam's emissions, renewables should provide 76% of the generation by 2050, and to achieve a net zero power system, 85% of generation should be renewables. 23 / 26 GW of balancing power plants and 29 / 64 GW of energy storage is required in each scenario by 2050, respectively.

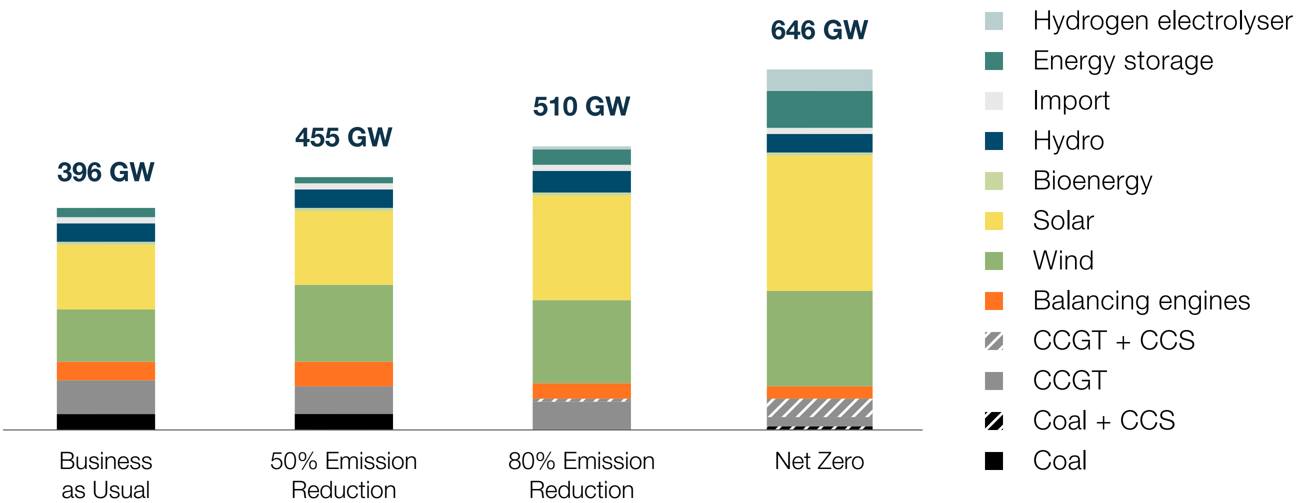


Figure 1. Installed capacity in GW in Vietnam by 2050 based on differing scenarios.

4. Convert to sustainable fuels:

The final push to reach a net zero power system requires the production of sustainable fuels such as green hydrogen, which will become the primary fuel for running balancing engines.

In the Net Zero scenario, a 646 GW system is built by 2050, providing a 63% increase in power system capacity, from 396 GW today. Solar PV capacity would double, from 118 GW in the BAU scenario to 239 GW in the Net Zero scenario, plus wind power would rise by 90%, from 90 GW in the BAU scenario by 2050, to 171 GW by 2050. Aside from creating more than enough power for Vietnam's growth, the Net Zero system would have excess electricity to produce 52 TWh of green hydrogen.

The availability of sustainable fuels such as green hydrogen will, in turn, displace natural gas, and allow balancing engines to run using carbon-neutral fuels. Locally produced green hydrogen will ensure long-term energy security, plus reduce reliance on high and volatile imported fuel prices – as well as decarbonising other energy-intensive sectors, such as mobility and heavy industry.

5. Fully phase-out fossil fuels:

The Net Zero scenario and 80% Emission Reduction scenario show that investments in renewables and flexible generation would make it possible for Vietnam to phase out most coal capacity by 2040, before the end of the technical lifetime of existing plants. For the small amount of remaining coal capacity left in the system by 2045, Vietnam needs to plan to deploy CCS.

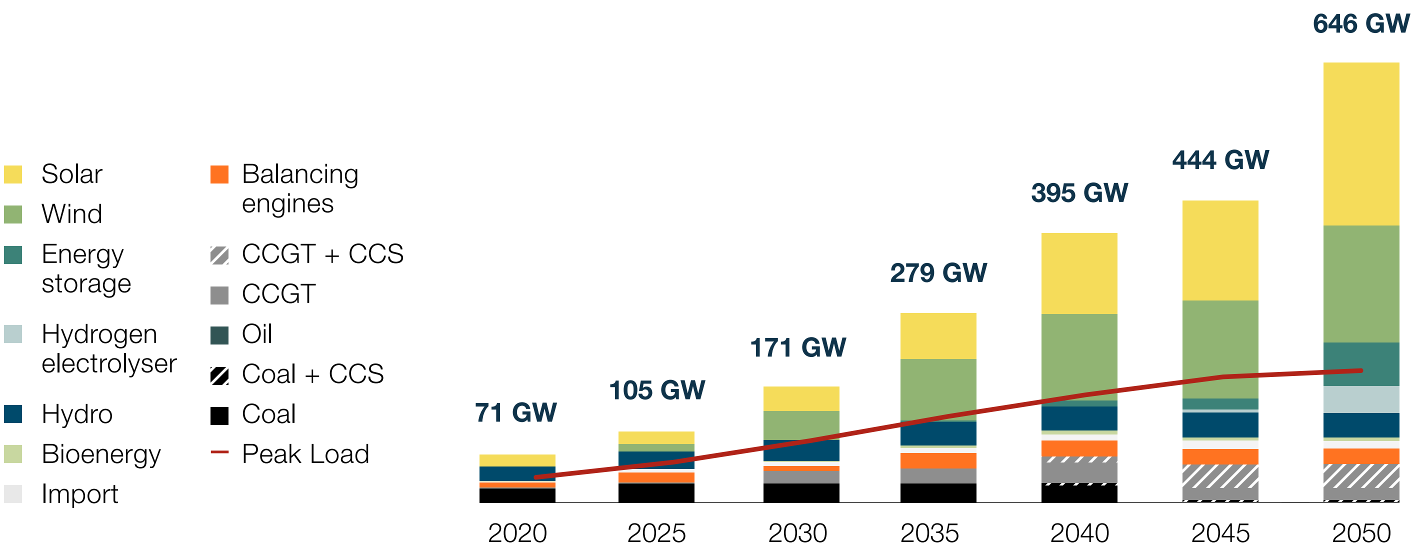


Figure 2. The roadmap to Net Zero emissions for the power sector in Vietnam.

Balancing present and future benefits

Our modelling shows that, compared to the BAU scenario, net zero can be achieved by 2050 through investing in the right technology with an optimised mix across the power system. Even though Vietnam's power capacity will need to be 63% higher than today by 2050 to meet rising demand, the levelised cost of electricity production by that date under the Net Zero scenario is similar to the current level. Many of the cost savings in a net zero system are driven by the fact that renewables are cheaper to run than fossil fuel power plants, with far lower operational costs (opex). This means that Vietnam can achieve a net zero power system without significant added overall system costs.

Moreover, in the coming decades, taxes on carbon emissions are forecasted to increase, meaning that renewable-generated electricity will be far cheaper by 2050. The IEA predicts that for emerging and developing economies, such as Vietnam, the carbon price per tonne of CO_2 will reach between $15–$40 USD by 2030, $35–$110 USD by 2040 and $55–160 USD by 2050. In the case of the upper carbon price forecast, of $160 USD per tonne, the net zero system would save nearly $28 billion USD annually by 2050, or 20% of the levelised cost of electricity (LCOE), compared to BAU[11]. As investors are attracted to well-designed energy frameworks, the cost of capital can be reduced if Vietnam is able to demonstrate its commitment to bankable renewables projects, underpinned by flexibility assets. Furthermore, the holistic value of an independent low-carbon or net zero power system, that insulates the economy from rising fuel import costs and protects Vietnamese people from the widely known health impacts of burning coal, should be part of the calculus of the country's long-term plans.

By building a flourishing green hydrogen market, Vietnam would also create the opportunity to decarbonise other sectors such as transport, as well as creating a supply chain of carbon neutral fuel for Asia and global markets. The production costs of sustainable fuels will fall as renewables scale up, so that by the 2045, balancing engines will run on sustainable fuels.

There are no shortcuts. Decarbonisation is a multi-year process, demanding stringent planning, but Vietnam's aim to become a net zero economy is viable if the power sector takes the necessary actions today and in the coming decade to deliver a net zero future by 2050.

[11] International Energy Agency, 2021

> **" Renewables must be the foundation of future power systems in Southeast Asia. Wärtsilä's modelling demonstrates that this is not only possible but economically beneficial for countries across Asia. But time is of the essence – we must act now to unlock the greatest benefits from a clean energy transition."**
>
> **Dr. Ha Duong Minh,** Chairman of Vietnam Initiative for Energy Transition (VIETSE)

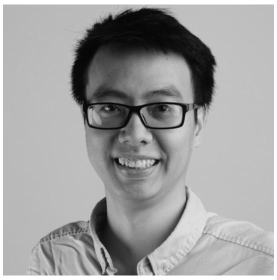
Critical regulatory frameworks need to be developed and put in place to incentivise renewables and flexible assets.

Vietnam in focus: policy as the driver of decarbonisation

In order to reach the net zero target in Vietnam, critical regulatory frameworks need to be developed and put in place to incentivise renewables and flexible assets, while creating a more competitive energy market:

- There should be additional mechanisms to continue the support for renewables development in Vietnam, providing investment support for new projects and a clear pricing scheme.
- Flexible assets are critical for a future power system running on an increasing share of renewables, and so it is crucial to develop mechanisms to ensure the financial viability of those assets. These mechanisms should include separate capacity payments for flexibility, and ancillary services markets with attractive revenue streams for participants.
- In addition, the next generation of PPAs should be designed so that incentives for flexibility are built-in to the agreements to encourage and effectively value operational flexibility.
- In the long term, competitive wholesale markets with real time and short interval pricing should be developed, which better reflect the reality of the changing power market. As a result, instead of having fixed price contracts, power plants will have to compete by bidding into the power markets. This would provide incentives to invest in more renewable and balancing capacity to meet demand when supply is low.

Meet the team



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PHILIPPINES

THE PHILIPPINES CAN UNLOCK INVESTMENT INTO A FUTUREPROOF POWER SECTOR BY SETTING A PATHWAY TO DECARBONISATION

The tide is turning for renewable energy in the Philippines.

In March 2021, the government published the National Renewable Energy Program (NREP) 2020–2040, providing the strategic building blocks to decarbonise electricity by increasing renewable energy production and investment. The NREP has set a target of 35% renewable energy by 2030 and 50% by 2040.

Although the NREP represents an important step in the right direction, the Philippines can benefit economically and improve energy security by going further to fully unlock its renewable potential. To do so, energy leaders need to overcome two key challenges.

First, if the NREP provides the architectural design to capitalise on low-cost renewables, the challenge now is to build a system to support this. The recently released Power Development Plan (PDP) 2020–2040 demonstrates that Luzon, the largest island in the Philippines, would only reach 26% renewable energy by 2030 and 34% by 2040[12], far behind the renewable targets set out by the NREP. More renewable capacity, plus the addition of flexible capacity to manage intermittency, is needed.

[12] The Philippines Department of Energy, 2021

The second challenge facing the Philippines is that, although the architecture is in place for the next two decades, there is no long-term plan to reach net zero. Without a clear net zero commitment, the country may not attract the inward investment it needs for the shift to renewable energy. With 91% of global GDP now represented by a net zero target[13] – including other ASEAN countries such as Vietnam and Thailand – the Philippines has the opportunity to join the global effort to avert climate breakdown by setting its own target.

Time is of the essence, not least because of the Philippines' own vulnerability to climate change. The country's low-lying and typhoon-prone geography means it is especially susceptible to climate change[14]. By averting these crises and reaching net zero, the Philippines can avoid a 6% loss to its annual GDP by 2100, as well as irrecoverable environmental damage, water scarcity and rising sea levels[15]. Moreover, a net zero commitment in the Philippines' will send a signal to investors and prevent continued investment in inflexible fossil fuel assets that will be stranded in a carbon-constrained economy.

Energy companies are already setting a course for net zero

The shifting political dynamic in the Philippines has meant the decarbonisation pathway remains unclear. Nevertheless, there has been movement towards net zero by the nation's largest utilities, including AC Energy and Energy Development Corporation (EDC).

For multinationals operating in the Philippines, international pressure has grown from investors to accelerate decarbonisation, spurring new low-carbon commitments by a number of the Philippines' major utilities. For example, the Ayala group (which owns AC Energy) has committed to net zero by 2050[16]. Similarly, San Miguel Corporation (SMC) has dropped its "clean coal" plans in pursuit of more renewable energy and energy storage, announcing plans to build energy storage with a capacity of over 1,000 MW[17]. Driven by reputational and economic concerns, the Philippines' utilities – which have had a large stake in the privatised system since 2001 – have begun to move the dial towards clean energy.

The national government has the opportunity to support this shift by setting a clear net zero target, placing itself on a pathway to transition towards renewable energy. Doing so will put it in line with its largest utilities and unlock the economic and environmental benefits of net zero.

Restricted by legacy inflexible technology

Until recently, decarbonisation has been hamstrung by the continued reliance on coal, which is projected to increase by 50% from current generation levels. A moratorium on new coal power has been introduced, but the list of plants that have already been approved is long.

Consequently, the Philippines risks curtailing renewable generation due to its inflexible fossil fuel baseload, which is made up of coal power plants and CCGTs. These power plants are designed to run at full load throughout the day. However, as more variable renewable energy is added, greater flexible

Without a clear net zero commitment, the country may not attract the inward investment it needs for the shift to renewable energy.

[13] Net Zero Tracker, 2022

[14] Amnesty International UK, 2021

[15] National Integrated Climate Change Database Information and Exchange System, 2022

[16] Ayala, 2021

[17] San Miguel Corporation, 2021

balancing generation is required. Consequently, grid operators need to choose between running baseload fossil fuel units at full load and curtailing renewable energy or using renewable energy to provide as much of the supply as possible, complemented by energy storage and balancing engines.

Many stakeholders continue to view baseload fossil fuel power as the key to reliable power systems, a mindset inherited from the boom years of the coal era. It's now clear that reliance on inflexible gas and coal power plants for baseload power limits the integration of low-cost renewable generation. What's more, renewables can become the main source of energy with the support of balancing engines and energy storage, providing reliable energy throughout the day. However, the Philippines currently lacks the flexibility for renewables to perform this role, leading to curtailment and excessive cost.

The first and most important step that Luzon need to take is to rapidly expand its renewable capacity.

Luzon – a window into decarbonisation in the Philippines

To test the potential for renewables to provide reliable grid power, we conducted a power system modelling study of the largest island in the country – Luzon.

As the economic centre of the country, Luzon makes up around half the population of the Philippines[18]. It represents around 72% of the total energy generation and contributes to 72.4% of the Philippines' peak demand (11.1 GW of 15.3 GW in 2020), compared to 14% in Visayas and 13% in Mindanao[19].

We have modelled two different scenarios: the 'Business As Usual' (BAU) scenario – without an emissions limit – and a scenario to achieve net zero by 2050.

Luzon, Philippines power system modelling scenarios:

1. **Business As Usual (BAU)** - no restrictions on emissions from the power sector. Under this scenario, the power system in Luzon, Philippines would release 95 million tonnes of CO_2 emissions in 2040, putting net zero well out of reach.
2. **Net Zero** – a power system operating with a 50% emission reduction by 2040 and with net zero emissions by 2050.

Luzon's power system can reliably run using renewable energy as the main power source, setting it on a clear a path to net zero, according to our modelling.

Short-term priority: laying the foundations for net zero

1. Rapidly scale-up renewable energy:

The modelling shows that the first and most important step that Luzon must take is to rapidly expand its renewable capacity. Luzon can achieve a 35% renewable target by 2030 – the year our modelling shows emissions will peak – by installing a total of 18 GW solar capacity, up from the current 11 GW of solar planned by the PDP until 2030.

[18] Boquet, 2017

[19] The Philippines Department of Energy, 2019

2. Stop investment in new inflexible power plants:

The second step Luzon should take is to move away from inflexible fossil fuel power plants, such as coal or CCGT units. Under the Net Zero scenario, gas has a continued role in an optimal system, but as a transition fuel only. Modern balancing engines have superior operational flexibility to CCGTs, with start-up times of less than two minutes, making them ideally suited to load following and balancing renewables. Conversely, CCGTs perform best when operating at a high load, flat operating profile, for long uninterrupted periods of time. As more low-cost renewable energy is added to the system – which will be given priority dispatch status – CCGTs will be seriously disrupted and capacity factors will decline, with operational profiles changing to multiple daily starts and stops, frequent ramping and plants running constantly on partial load. As CCGTs are pushed down the merit order, the total cost of ownership increases until profitability is eroded.

3. Add flexibility to balance intermittency:

As renewable capacity is scaled up, the modelling indicates that Luzon should rapidly accelerate the adoption of flexible gas-based balancing plants, with 1.3 GW needed by 2030. By doing so, Luzon can level up renewable energy, such as solar and wind, to become the main source of energy, enabling the Philippines to reach the goals set by the NREP. To underpin renewables, energy storage can be used to shift excess power to other times of the day. The modelling demonstrates that it will be optimal to add 6 GW of battery energy storage (4 hours) by 2030. This reduces the need for CCGTs and coal, down by 5 GW to 12.7 GW compared to the 17.2 GW under the BAU scenario.

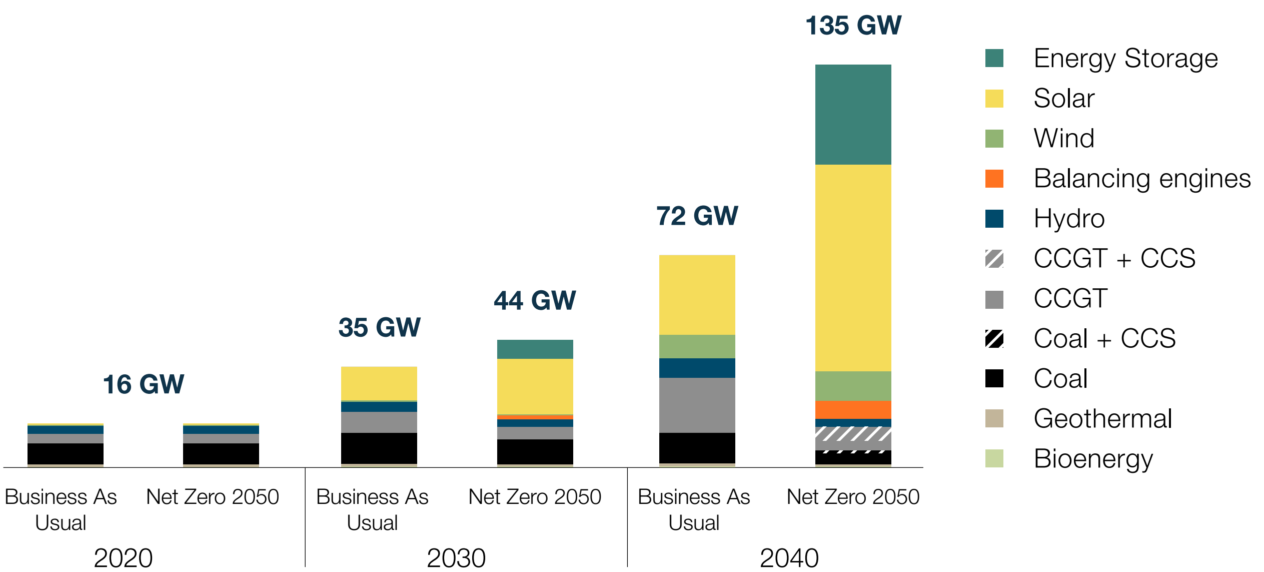

Figure 3. Installed capacity in GW. Fossil fuel capacity from coal and CCGTs is 5 GW lower by 2030 under the Net Zero scenario.

Medium-term priority: developing a renewable-led grid

Having laid the foundations for net zero in the short term, Luzon's next focus in the Net Zero scenario should be on developing a grid where the majority of the energy comes from renewable sources. Our modelling shows that with the right mix of balancing technology and renewable generation, Luzon can double the renewable generation in comparison to the BAU scenario, from 34% to 67% by 2040. This would also exceed the 50% target set for the whole of the Philippines power sector by the NREP – enabling Luzon to pioneer the country's decarbonisation. This compares to the BAU scenario, in which Luzon would only reach 34% renewable generation by 2040, putting net zero by 2050 well out of reach.

As renewable energy is scaled up, investment in new inflexible plants such as CCGTs should decrease. From the 2030s, dependency on imported fuels, mostly coal, should also reduce significantly under the Net Zero scenario. For the last remaining fossil fuel power plants, carbon capture and storage (CCS) would be introduced in the 2040s to cut the final emissions from the power system.

Long-term priority – the final push to net zero

By 2050, renewables dominate the energy transition in Luzon under the Net Zero scenario. In total, renewables provide 87% of the total generation by 2050, up from 18% in 2020, to reach 141 GW from solar and 33 GW from wind.

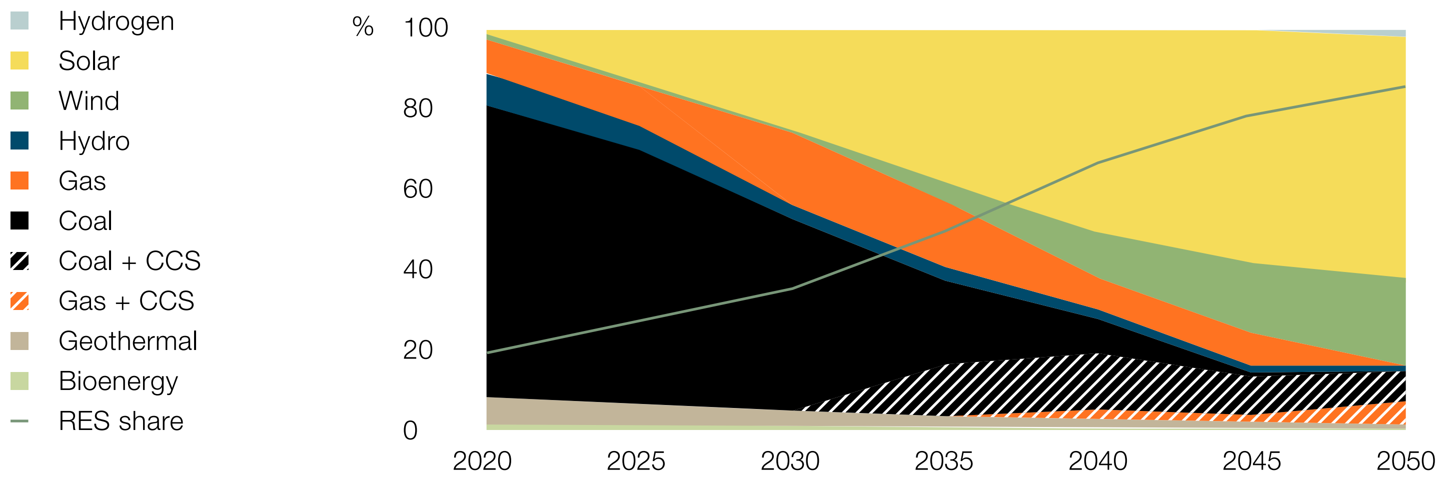

Figure 4. Generation mix until 2050 in the Net Zero scenario. Renewables will dominate a net zero power system, making up 87% of generation.

In the final stages of Luzon's decarbonisation, any remaining investment in thermal generation should shift from baseload to flexible assets as integrators of renewables in the system. By 2050, 14 GW of balancing power plants and 69 GW of energy storage would be required in Luzon's power sector to achieve net zero emissions.

Renewables and flexibility unlock cheap, clean energy and slash emissions

By increasing renewable energy and adding flexible technologies, as well as introducing CCS for newly installed coal and CCGT plants, the Philippines can unlock a 50% emission reduction in 2040 compared to the 2030 levels. Under the Net Zero scenario, emissions in Luzon peak at 66 million tonnes of CO_2 in 2030 before falling rapidly to 26 million tonnes of CO_2 in 2040. Under the BAU scenario, emissions would continue to increase, reaching 95 million tonnes of CO_2 in 2040, 72% higher than the Net Zero scenario.

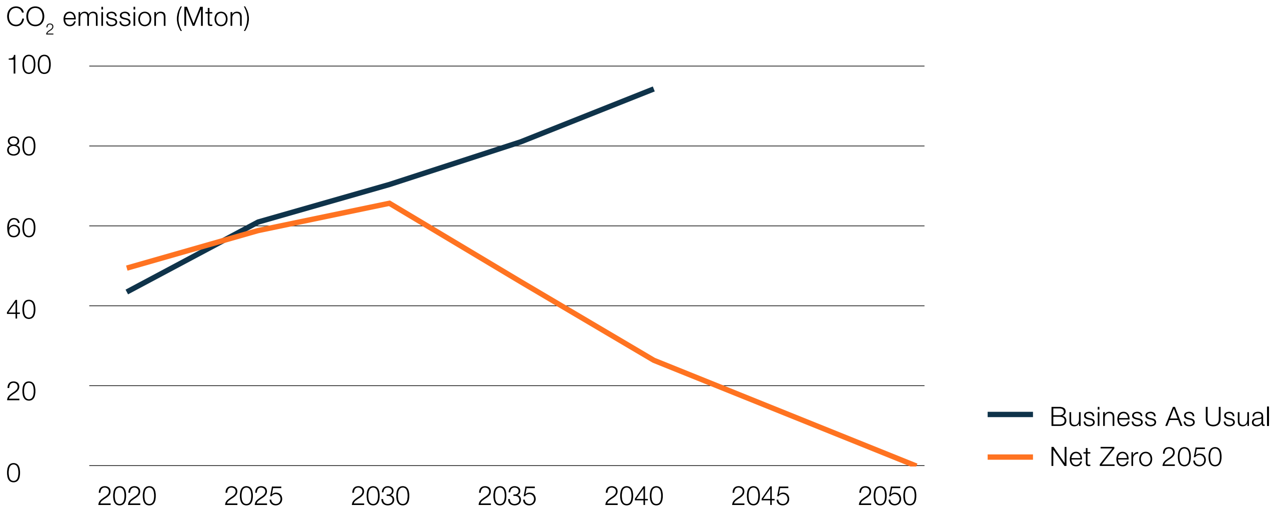

Figure 5. Emissions will peak by 2030 in the Net Zero scenario, before plummeting by 50% to 2040.

Crucially, carbon taxes are also expected to intensify around the world in the coming decades, meaning that renewable-based systems are likely to be far cheaper by 2050. As outlined in relation to Vietnam, the IEA predicts that for emerging and developing economies, such as the Philippines, the carbon price will reach between $15–$40 USD by 2030, $35–$110 USD by 2040 and $55–160 USD by 2050[20].

Although the LCOE under the Net Zero scenario is marginally higher than the BAU scenario without a carbon tax, the modelling shows that the cost of the BAU scenario spikes when a carbon tax is introduced. Importantly, when the IEA's upper forecast for a carbon tax is accounted for by 2040, i.e. $110 USD per tonne, the net zero system would save $6.5 billion USD annually, cutting the LCOE by 23% compared to the BAU scenario[21].

Realising the benefits of decarbonisation

The modelling of Luzon highlights that the island and the Philippines as a whole has an economically viable path to a net zero power system which would pioneer decarbonisation and electrify the economy, also benefitting associated sectors such as mobility and industry.

With a clear net zero target, the Philippines can begin to attract the needed outside investment to achieve this transition. However, without a long-term net zero goal, the Philippines risks detaching itself from an increasingly climate-conscious global community and worsening its own exposure to the climate change.

Time is of the essence, the decisions made now will affect the Philippines' power system for years to come.

[20] International Energy Agency, 2021

[21] International Energy Agency, 2021

The Philippines in focus: the value of flexibility

The value of flexibility in the Philippines can be seen in two examples: the Wholesale Electricity Spot Market (WESM) 5-minute pricing and a hybrid portfolio.

1. **The WESM 5-minute pricing:** As flexible gas engines can start and reach full load within 2–5 minutes and have no minimum up and down times, they can be dispatched for a single 5-minute price, meaning they can capture optimal spot prices. This results in a frequent start-stop dispatch pattern, perfect for balancing renewables on the grid.

   In contrast, coal and CCGT plants need good prices over 6–24+ hours before deciding to commit. Not only does this make trading more complex and reliant on good forecasts, but it adds to the number of risks in such projects. Ultimately, 5-minute pricing affects bottom-lines of inflexible assets as they are unable to capture all prices above their marginal cost.

2. **The hybrid hedge portfolio (solar + flexible power plant + WESM):** A portfolio of solar plus flexible gas engines can meet much of the load during the day for a mid-merit power supply agreement (PSA). During hours without solar generation, electricity can be purchased from the WESM to meet the remaining load. The price risk can be hedged with flexible assets, which are dispatched if the WESM price is higher than the marginal cost of the flexible power plant. This is possible due to the flexibility that engines provide with their quick response capabilities.

   Many such combinations of assets are possible in a system to make the portfolio even more economical. These include, but are not limited to, oversizing solar capacity to sell to the WESM, using the ancillary services market or participating as a merchant plant outside the PSA hours to generate additional revenue.

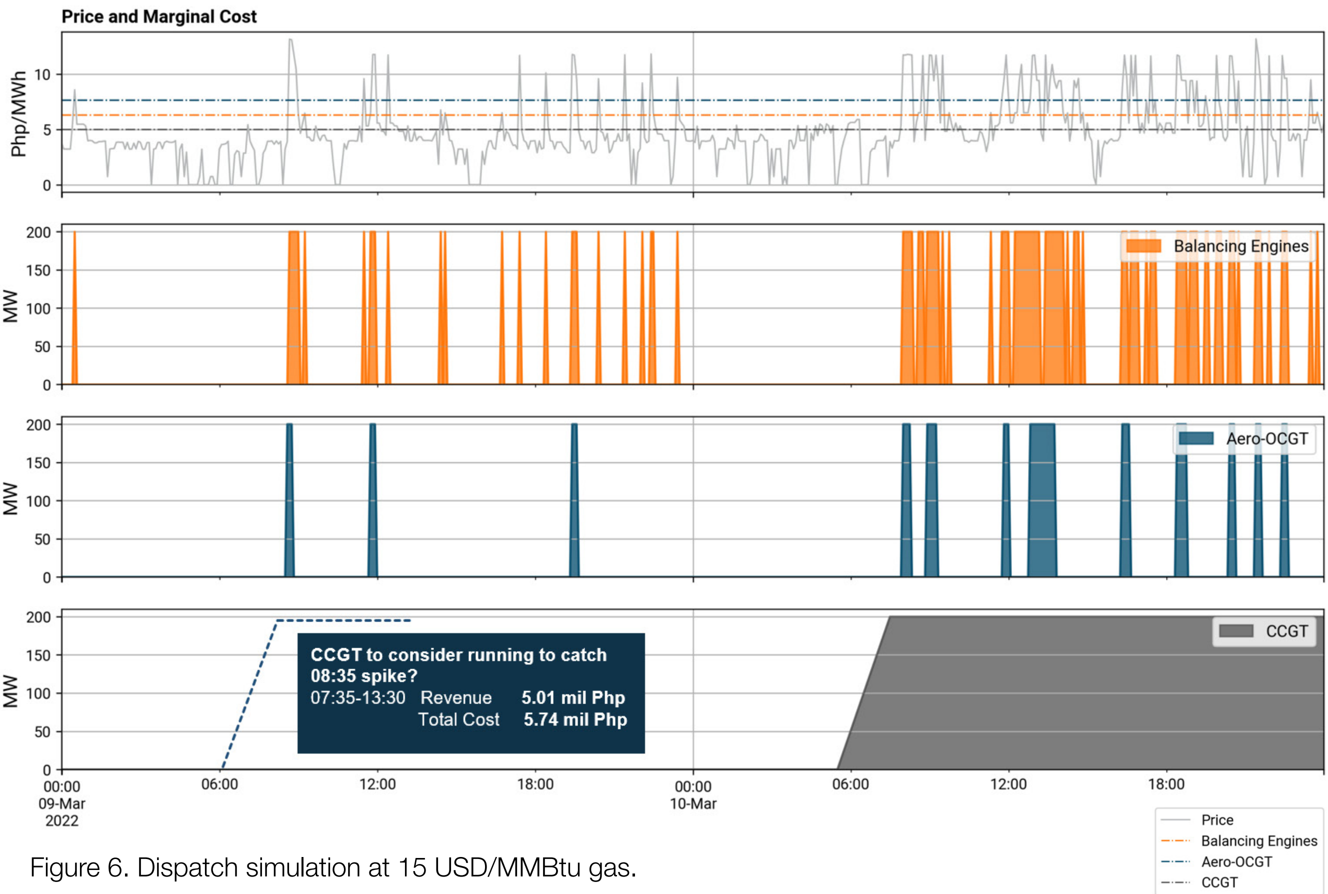

Figure 6. Dispatch simulation at 15 USD/MMBtu gas.

> “ **Baseload renewables must be the foundation of future power systems in Southeast Asia. Flexible power generation is necessarily part of this future, otherwise the renewable foundation will not be realised. Wärtsilä’s continued focus on balancing power plants, using an evolving fuel mix, will continue to be a critical enabler of the clean energy transition.”**
>
> **Anthony Shibley,** Chairman and CEO, Gigawatt Power, Inc.

> “ **The Philippines is at the start of a big energy transition and will require a combination of plans and technology to meet its future energy requirements. During the transition, it would need to properly plan on how it can harness indigenous energy such as solar, wind, geothermal and hydro while at the same time looking for complimentary sources of energy such as indigenous gas and fast-acting lower carbon power plants. This is a big task that requires the partnership of government, academe, private sector, and technology providers.”**
>
> **Rolando J. Paulino, Jr.,** President, Philippine Energy Independence Council (PEIC)

Meet the team

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INDONESIA

MATCHING INDONESIA'S NET ZERO VISION WITH CLEAR STEPS TO EXECUTION

Ahead of COP26, Indonesia unveiled plans to cut its emissions by 29% by 2030 independently, (or by 41% with international assistance), prior to reaching net zero emissions by 2060.

The next decade is crucial to delivering this net zero goal, beginning with putting Indonesia's power sector on the right path towards decarbonisation.

The National Grand Energy Strategy is a clear signal of where the Indonesian government believes the wind is blowing. The strategy proposes that renewable energy should provide 100% of power by 2060, with new added capacity from 2030 coming only from renewables, to bring the total installed renewable capacity to 587 GW by 2060[22]. This is a significant ambition, considering 83% of electricity in Indonesia currently comes from fossil fuels.

In addition, only Indonesia's major cities have sufficient power distribution at present, whereas in rural Indonesia around 50 million people in 40,000 villages on 4,000 islands remain without permanent access to reliable power[23]. Whilst decarbonising, the government aims to address this longstanding barrier to prosperity by providing universal electricity access by 2024[24].

[22] S&P Global, 2022

[23] Clean Power Indonesia & Center for International Forestry Research, 2019

[24] International Energy Agency, 2022

This presents an epoch-changing opportunity. While developed energy economies such as Europe and North America struggle to transition from deeply embedded legacy power systems that are incompatible with net zero, the decisions Indonesia makes now to provide reliable power nationwide can enable the country to leapfrog to a future-proof power system based primarily on the lowest cost power source – renewable energy. Through this, the country could transition to net zero power by 2060[25].

Matching vision with execution

Indonesia's vision stacks up economically, as the value of procuring and shipping expensive fossil fuels for thermal generators has been eroded by low-cost renewable resources. However, coal currently dominates the national energy supply, with renewables making up just 11% of Indonesia's energy mix. Around 15 GW of new coal plants, which could run for up to 40 years, are currently under construction.

Inflexible fossil fuel baseload assets are designed for full-load operation. However, as more variable renewable energy is added, increased balancing is required to manage intermittency. Baseload fossil fuel units running at full load heightens the chance of renewable energy curtailment. The better alternative is using renewable energy to provide as much of the demand possible, complemented by energy storage and balancing engines.

The decisions Indonesia makes now to provide reliable power nationwide can enable the country to leapfrog to a future-proof power system.

The transition is already underway with the government announcing a series of policies to curb power sector emissions: replacing diesel with LNG; halting the approval of new coal-fired power plants; plans to make biomass co-firing mandatory; and introducing a carbon price. However, inflationary pressures have recently led to policy changes and delays. For example, a carbon tax of Rp 30,000 ($2.02 USD) per kg of CO_2-equivalent was due to be introduced on coal plants in July, but has been postponed for a second time[26]. For Indonesia to avoid investments becoming stranded assets, it's vital that policy plans are kept to.

Sulawesi: A microcosm of Indonesia's energy transition

To help Indonesia's energy leaders take the necessary action to shape the transition, we conducted a power system modelling study, simulating the power system of the island of Sulawesi. Lying at Indonesia's centre, at 180,000 square kilometres (or 10% of Indonesia's landmass), Sulawesi is home to 20 million people. Its power demand is 13.5 TWh, equivalent to around 7% of Indonesia as a whole.

Like Indonesia as a whole, coal plays a significant role in Sulawesi's power system, making up 41% of the total installed capacity, and there is around 500 MW of new coal capacity in the pipeline for the island. Given these similarities, the modelled pathway in Sulawesi can be applied throughout Indonesia, plus other fossil fuel-dependent regions in Southeast Asia and beyond.

To understand the cost and environmental impacts of a range of decarbonisation paths, we modelled four scenarios for the energy transition

[25] International Energy Agency, 2021

[26] Argus, 2022

in Indonesia by 2060, based on different levels of emissions reduction, from business as usual to net zero. Each of the four scenarios selects the lowest cost energy technologies to meet demand.

Power system modelling scenarios for Sulawesi, Indonesia:

1. **Business As Usual (BAU)** – no restrictions on emissions. Under this scenario, Sulawesi would release 12.5 million tonnes of CO_2 emissions by 2060, putting net zero well out of reach.
2. **50% Emission Reduction** – a scenario demanding emissions are reduced by 50% by 2060, compared to the BAU scenario.
3. **80% Emission Reduction** – a scenario demanding emissions are reduced by 80% by 2060, compared to the BAU scenario.
4. **Net Zero** – a power system operating with zero emissions by 2060.

The government has set a mandate for Indonesia to produce 23% of total electricity generation from renewables by 2025, and 51.6% by 2030, requiring 20.9 GW of new renewable capacity[27]. However, the Sulawesi modelling indicates that, with the cost of energy production optimised, this figure can be three to four times greater in the short term and provide the basis for a high renewable power system by 2060.

Key short-term steps can unlock major opportunities for low-cost, low-emissions power systems by 2060.

Indonesia's unique geography, which stretches across 17,500 islands, provides ideal conditions for decentralised 'islanded' micro grids, powered by renewables. This approach also aligns with the government's aims to shift Indonesia from a regulated electricity market, towards greater de-regulation. Unbundling generation from the transmission and distribution system would create greater competitiveness, helping utilities to optimise their portfolios.

The interplay between short-term action and long-term opportunity

Decarbonising the power system of Sulawesi – and Indonesia as a whole – demands an acute understanding of the interplay between short and long-term actions: key short-term steps can unlock major opportunities for low-cost, low-emissions power systems by 2060. Overall, the power system modelling reveals five key steps which are needed, in sequence, to scale-up renewable energy to become the main source of energy by 2060.

[27] S&P Global, 2022

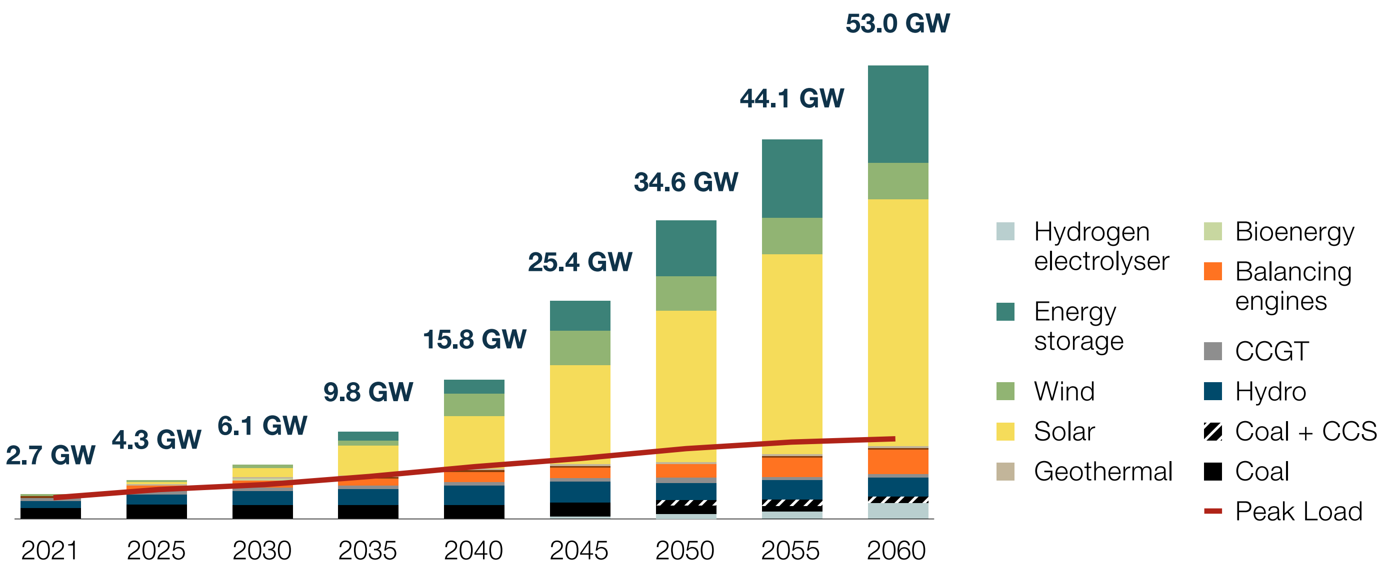

Figure 7. Installed capacity in GW between 2021 and 2060.

Steps 1—2: the short term (from now to 2030):

1. Add significant renewable capacity to the system.

The decarbonisation scenarios agree that to meet Indonesia's pledge to phase out coal by 2055, Sulawesi and other islands need to urgently accelerate renewables to replace coal generation between 2050–2055.

In the Sulawesi grid, the total planned capacity of wind and solar is 280 MW and 300 MW by 2030 respectively. However, for Sulawesi to align with Indonesia's net zero target while lowering system costs, the solar target should be increased to four times this level: 1,200 MW by 2030.

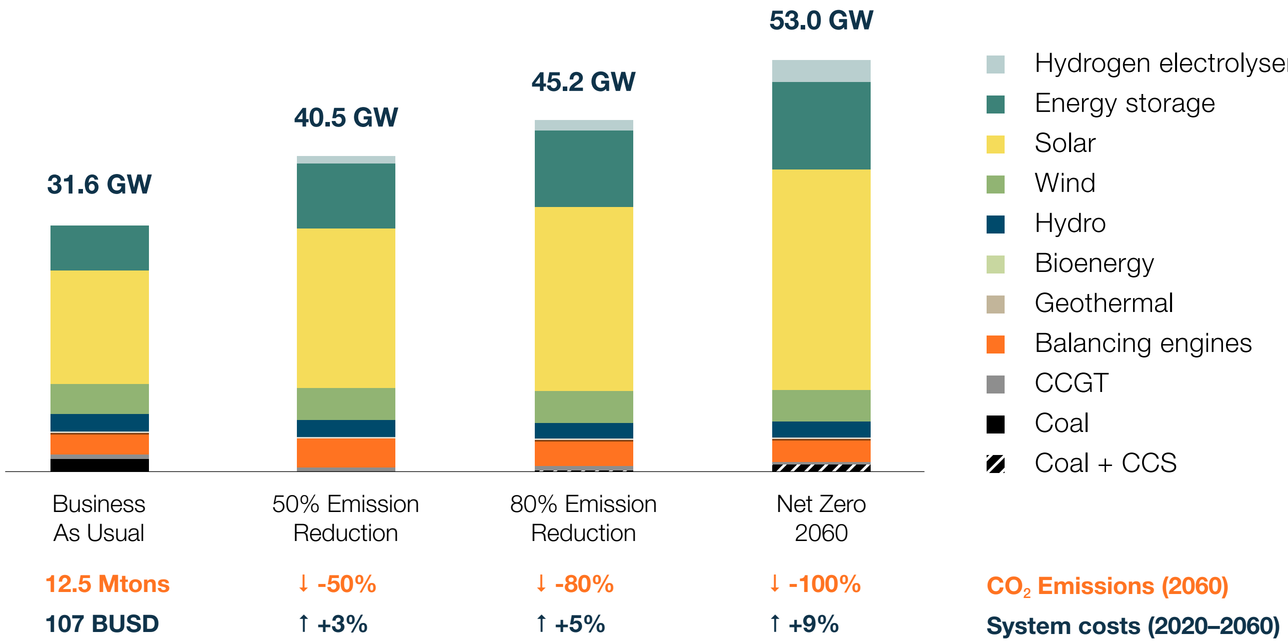

Figure 8. Installed capacity in GW by 2060 and the difference in CO_2 emissions and system costs.

2. Add balancing and flexible capacity:

Flexible generation is key to integrating new renewable energy into the system. To put it on course for net zero by 2060, Sulawesi's grid should be balanced by 800 MW of flexible engines by 2030 and 800 MW of energy storage by 2035. This is 63% higher than the 490 MW of new engine capacity planned for Sulawesi in the national electricity supply business plan (RUPTL) by 2030[28].

Indonesia is already moving to build much-needed grid balancing engine capacity; 2 GW of new engine capacity is currently in the pipeline to be built nationwide by 2030. While this is a step in the right direction, the modelling demonstrates the increased need for balancing engine capacity in major islands to maintain reliability through the transition. Sulawesi alone should add around 3 GW of balancing engine capacity by 2060.

Flexible generation is key to integrating new renewable energy into the system.

However, investment is also needed to develop the country's LNG infrastructure to support the switch from LFO/HFO to gas. Cost efficiencies can be made by converting existing liquid fuel power plants into flexible gas power plants, instead of retiring LFO/HFO power plants before their actual lifetime or building new power plants.

Steps 3—5 – the medium to long term (2035—2050):

3. Phase-out inflexible plants:

To achieve its net zero target by 2060, Indonesia's emissions should peak between 2030–2035, before steadily declining over the decades following. The Sulawesi model shows how a combination of renewables, energy storage, balancing power plants running on hydrogen, and lastly, carbon capture and storage (CCS) for existing coal plants, can achieve this.

Restructuring Indonesia's power system from an inflexible to a flexible model would also unlock new opportunities, particularly in terms of ancillary service markets. With mechanisms in place to put a clear 'value' on flexibility, IPPs would be incentivised to invest in adding flexible assets, such as balancing engines and energy storage, onto the grid.

4. Convert to sustainable fuels.

The modelling shows the potential for green hydrogen as the final piece of the puzzle to achieve net zero in Indonesia, with excess power from a high renewables system used to produce hydrogen-based sustainable fuels. The modelling projects a proportion of hydrogen-based fuels will be both economically feasible and applicable to assist the latter stages of the power sector's decarbonisation (from 2045 onwards).

Indonesia plans to start producing green hydrogen in 2031, with a target for 52 GW of electrolyser capacity in 2060[29]. In the Net Zero scenario for Sulawesi, 2.7 GW of hydrogen could be generated and used as grid balancing engine fuel by 2060, supported through the building of 28.53 GW of solar. This level of solar only needs 0.5% of Sulawesi's total land area and falls within the theoretical potential for solar capacity calculated by IRENA[30].

[28] PT Perusahaan Listrik Negara (Persero) (PLN), 2021

[29] Ministry of Energy and Mineral Resources, 2022

[30] International Renewable Energy Agency, 2017

These locally produced sustainable fuels would optimally power flexible balancing power plants from 2045 onwards; allowing the island to become fully carbon neutral. Hydrogen could also play a transformative role in decarbonising Indonesia's other energy intensive sectors, such as transport.

5. Phase out fossil fuels where feasible and minimise and abate remaining coal-fired emissions.

The Sulawesi model shows that it is feasible for more than half of Indonesia's coal capacity to be replaced by 2050. However, given the young age of many coal plants, there is a techno-economic argument to retain some of this coal capacity. Despite this pressure on the power sector to keep them running, it is likely that some new coal plants will be retired before the end of their lifetime due to rising climate change and health concerns.

In the scenarios modelled, there is a continued partial reliance on coal power instead of a complete coal phase-out. The remaining coal plants will need to be co-fired with biomass and equipped with CCS in order to neutralise their emissions and stay compliant with a net zero pathway.

The right technology choices now will shape Indonesia's transition path to 2060

The modelling reveals that Sulawesi can reach net zero power sector emissions by transitioning to a 94% share of renewable energy by 2060. Crucially, the IEA predicts that for emerging and developing economies, such as Indonesia, the carbon price per tonne CO_2 will be ratcheted up over the next 30 years, from $15–$40 USD by 2030, $35–$110 USD by 2040 and $55–160 USD by 2050[31]. When the upper IEA forecast of $160 USD per tonne is applied to the Net Zero scenario, Sulawesi would save $1.3 billion USD annually compared to the BAU scenario by 2060. This equates to a 23% reduction in the LCOE[32].

Indonesia's state-owned utility Perusahaan Listrik Negara (PLN) should take confidence that renewables can be levelled up using flexible capacity to serve the current load, while comfortably meeting rising power demand, and decarbonising at the lowest cost. While this demands up-front investment, the risks of slowing the transition – creating greater exposure to fossil fuel volatility, carbon taxes, and the intensifying climate emergency itself – far outweighs the cost of accelerating it.

By pivoting to a flexible renewable system by 2060, Indonesia can do more than cut emissions. It can transform the energy sector, creating a deregulated, competitive market which is better able to serve thousands of islands, ensuring that everyone has access to clean, reliable electricity. However, leaders need to plan to effect transformational change in the next 5–8 years, or the door will close on these opportunities.

By pivoting to a flexible renewable system by 2060, Indonesia can do more than cut emissions.

[31] International Energy Agency, 2021

[32] International Energy Agency, 2021

Having the right policies, regulations, and tender requirements in place to support the development of these installations is crucial.

Indonesia in focus: hybrid power plants for a renewable-led system

As Indonesia looks to meet its population's growing energy needs, the country can consider a combination of renewables and balancing engine power plants to enable increased green energy while still providing energy capacity that offers security of supply. Combining renewables and balancing engines can provide multiple benefits, such as dispatchable and reliable power, less exposure to fuel price changes, and a lower LCOE compared to a traditional baseload plant.

The economic advantage comes from the displacement of expensive fuel with generation from renewables that have declining installation costs. There are currently 1 GW of renewable energy projects planned in the RUPTL from 2026 to 2030 in Indonesia. Implementing such hybrid power plants requires developers, suppliers and contractors to integrate different technologies, and correctly model and optimise hybrid plant operations.

Having the right policies, regulations, and tender requirements in place to support the development of these installations is crucial. Hybrid power plants can be procured through either private IPP's or public ownership structures (engineering, procurement and construction). In the case of an IPP, a well-structured PPA is needed to account for the integration of assets, balancing of renewables, fuel consumption, and tariff mechanism.

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CONCLUSION

Wärtsilä modelling demonstrates that the economics of renewable power makes the transition to net zero power systems affordable, accessible and attractive across Southeast Asia.

Transitioning to net zero emissions can also lead to significant health benefits and support the global effort to avert climate change. The key question for energy leaders is how effectively they can steer the transition to maximise the opportunities, such as job creation, economic development, and country-wide electrification. McKinsey, for example, estimates that for every $10 million USD of government spending on renewable technologies, 75 jobs are created, compared to 27 jobs in the fossil fuels sector[33]. This report provides a blueprint to unlock this potential.

Renewable energy can unlock cheaper electricity

Progressing from a fossil fuel baseload to a renewable-based system does not entail a significant increase in overall system cost and can lead to a significant cost saving when factoring in future carbon prices. A renewable energy-based system requires additional capital expenditure (capex) investments but has a lower per megawatt-hour cost of production. Besides reducing emissions, this transition from an opex model, where fuel is constantly required, to a capex model, where 'unlimited' green energy is purchased upfront, also comes with the benefit of reduced dependence on imported fuels. Crucially, when carbon taxes, as forecasted by the IEA, are taken into account, the levelised cost of electricity of a net zero power system can be up to 23% lower than a system that continues to rely on inflexible fossil fuel for baseload power.

Graduating from a game of checkers to chess

Leaders face a new and unprecedented level of complexity in transitioning their power systems to a renewables-driven future. In a world with more renewables, variability and uncertainty increase. This shift from fossil fuel baseload to real-time renewable grids is akin to graduate from a simple game of checkers to the multidimensional dynamics of chess. Flexibility is needed to manage uncertainty, balancing intermittent renewable output to ensure overall grid stability. Deep multi-year, data-led planning is needed to maximise new and complex opportunities, from accelerated renewables growth to hydrogen, and to prevent investment in new fossil fuel baseload assets, which will become stranded sooner than expected. Crucially, the technologies required are available today and the pathway is technically and commercially viable.

Frederic Carron
Vice President, Middle East & Asia
Wärtsilä Energy

[33] McKinsey & Company, 2020

No time like the present for Vietnam, the Philippines and Indonesia

Vietnam, the Philippines, and Indonesia have different starting points and optimal decarbonisation paths. Nevertheless, there are commonalities in the steps that should be taken to reach net zero: adding renewables as the main energy source, stopping further investments in inflexible plants, investing in balancing engines and energy storage, and using sustainable fuels produced from renewable energy as a final step to decarbonise. Another clear commonality is the need to act now.

Vietnam's current PDP will not deliver enough renewable energy by 2050, putting their net zero ambition at risk. Vietnam needs rapid deployment of renewables alongside a switch from coal to flexible power plants to kick-start the transition towards a net zero economy. There should be mechanisms in place to support renewables development and incentivise flexibility.

The Philippines still has a long way to decarbonisation. The power sector needs to take necessary actions today to join the race to net zero. Flexible power plants can balance renewables, enable increasing renewable capacity, and capture value from the five-minute pricing power market.

If we act now, we can avoid locking ourselves into inflexible legacy technologies and instead build the optimal foundations for future Net Zero systems.

Indonesia need to align its net zero ambition with its rising demand for energy. This means ensuring that no new coal projects enter the power system and introducing ambitious plans to rapidly accelerate the adoption of wind and solar. Hybrid power plants combining renewables and balancing engines can provide green baseload generation with lower LCOE.

The modelling holds lessons for other countries in Southeast Asia and worldwide. If we act now, we can avoid locking ourselves into inflexible legacy technologies and instead build the optimal foundations for future Net Zero systems – achieving a cost-effective and rapid energy transition that delivers ever lower emissions, affordable power, and secure supply.

Attracting external investment for the transition

A net zero transformation in Southeast Asia demands the support of the global community to ensure the deployment of key technologies and infrastructure. This was explicitly articulated by the Prime Minister of Vietnam at the COP26 climate summit, who highlighted that emission reductions rely on "…the cooperation and support of the international community, especially from the developed countries, in terms of finance and technology"[34].

Capacity building and access to finance are critical for transforming Southeast Asia's net zero pledges into concrete commitments and plans, and vice versa - countries with clear net zero plans are more attractive to outside investment to realise those commitments. With many major banks no longer investing in coal projects, there has never been a better time to invest in renewables and flexible generation like balancing engines and energy storage, which will ensure stability of supply.

[34] Nhân Dân, 2021

A unified response to climate change

In November 2022, heads of state will gather in Bali, Indonesia, for the G20 Summit to discuss the global mission to "Recover Together, Recover Stronger" from the recent impacts of COVID-19, while also addressing the existential threat of climate change. The sustainable energy transition is a key pillar of the G20 agenda because clean, reliable and affordable power systems are an essential vehicle for security, growth and prosperity.

Outside of the economic imperative to decarbonise power systems, a key lesson from the pandemic is that the primary role of governments is to protect their citizens from major threats – and there is no greater threat to human civilisation than the climate challenge. The Intergovernmental Panel on Climate Change has laid out the consequences of not addressing climate change more starkly than ever before, highlighting Southeast Asia as one of the planet's most vulnerable regions to climate change[35].

Reenergising momentum for COP27

In November 2021, the governments attending the UN climate summit in Glasgow agreed that their existing pledges were not enough and needed strengthening in 2022[36]. As we approach COP27 in November, this is a critical period for governments and businesses to collaborate to strengthen their targets, and test implementation strategies to turn targets into action.

We hope this report helps countries to fully appreciate the potential for their power sectors to pioneer decarbonisation. By strengthening and delivering on their net zero commitments, Vietnam, the Philippines, Indonesia – and other Southeast Asian countries – can slash carbon emissions and reduce dependence on imported energy, while accelerating growth and investment towards a cleaner, brighter future.

[35] Hijioka, et al., 2014

[36] United Nations Framework Convent on Climate Change, 2022

METHODOLOGY

The modelling in this report is based on techno-economic optimisation of the power systems of Indonesia, the Philippines and Vietnam.

The optimisation finds the least-cost capacity mix to meet electricity demand in the future while respecting a range of emission scenarios. We have used PLEXOS, a leading power market simulation software, for the power system modelling results presented in this report.

The scenarios compare differing emissions reductions. The 'Business As Usual - BAU' scenario omits any new reductions – modelling the current plans in the three markets. The target date / deadline by which emission limits are met within the scenarios is based on the country-level net zero commitments, plus political pressure to decarbonise between 2050–2060.

For example, in the Vietnam modelling, the deadline to reduce emissions is 2050, in line with the national net zero target. In Indonesia, the modelled emissions reduction deadline is 2060, in line with the national net zero target. In the Philippines, where there is not currently a net zero target, the modelled emissions reduction deadline is 50% by 2040 and net zero by 2050, in line with several other ASEAN counties such as Thailand and Malaysia.

The parameters of the various modelled scenarios are outlined below. In Vietnam and Indonesia, all four scenarios are modelled. In the Philippines, only the BAU, based on the Power Development Plan 2020–2040, and Net Zero scenarios are modelled.

Conventional power plants are included with their technical properties and fuels to model their emissions. The flexible parameters of power plants are also included in the model. Wind and solar PV are modelled with their hourly generation profiles based on the weather conditions in the studied area.

The detailed optimisation modelling uses a chronological approach, i.e., the variability and seasonality of renewable generation and load need to be balanced hour-by-hour in the model. Thus, the modelling accurately dimensions the required flexibility and storage capacity in the studied power system. To meet the future demand and political targets, the optimisation adds different technologies to the system and selects the most cost optimal combination. The available options include thermal baseload generation, such as coal, combined cycle gas turbine, and nuclear; carbon capture and storage; different renewable sources, such as wind, solar PV and geothermal; grid balancing engines; storage technologies, such as energy storage and pump storage, and technologies to produce sustainable fuels, such as hydrogen produced through electrolysis.

Wärtsilä has modelled over 190 power systems across the world and regularly advises customers and policymakers on optimal future-proof power systems.

Business As Usual (BAU) - no restrictions on emissions.

50% Emissions Reduction – a scenario running with 50% less emissions by 2050 / 2060, than the BAU scenario.

80% Emissions Reduction – a scenario running with 80% less emissions by 2050 / 2060, than the BAU scenario.

Net Zero – a power system operating with net zero emissions by 2050 / 2060.

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Carbon tax ($/ton)	Philippines (2040) = 110		
	BAU	Net zero	Difference
Annual costs (billion $)	28.05	21.55	6.50
LCOE ($/MWh)	122	94	-23%

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Carbon tax ($/ton)	Vietnam (2050) = 160		
	BAU	Net zero	Difference
Annual costs (billion $)	138.80	110.82	27.98
LCOE ($/MWh)	112	90	-20%

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Carbon tax ($/ton)	Indonesia (2060) = 160		
	BAU	Net zero	Difference
Annual costs (billion $)	5.51	4.23	1.29
LCOE ($/MWh)	95	73	-23%

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RETHINKING ENERGY IN SOUTHEAST ASIA

SHAPING OUR FUTURE WITH A CLEAR ROADMAP TO NET ZERO

In this report, we offer an inspiring yet practical roadmap for reaching net zero in Southeast Asia. Now is the moment to recognise that affordable, reliable net zero power systems are within reach. It's time for us to #**ShapeOurFuture**.

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