Sun and wind for net zero

Benchmarking renewables growth in South, Southeast and East Asia

Key findings

1 **While recent global additions of wind and solar are encouraging, progress of renewable energy development in South, Southeast and East Asia has been insufficient.** The share of solar and wind power in most countries in this region is below six percent today, despite the falling cost of clean energy technologies. Accelerating the deployment of wind and solar power within the next five years is crucial to meeting the region's climate mitigation goals.

2 **To be aligned with a 1.5°C-compatible pathway, renewables in the region will need to supply 50% of total electricity by 2030, with 30% coming from wind and solar.** This corresponds to annual capacity additions of at least 55 GW for solar and 20 GW for wind, compared to just 11.9 GW solar and 1.5 GW wind installed in 2021.

3 **Accelerating the integration of wind and solar power in the region requires a paradigm shift towards increased system flexibility and removal of policy, regulatory, and market barriers.** Some solutions include de-risking mechanisms and accelerated permitting processes which can kick-start wind and solar deployment while supportive grid codes can aid in their system integration.

Introduction

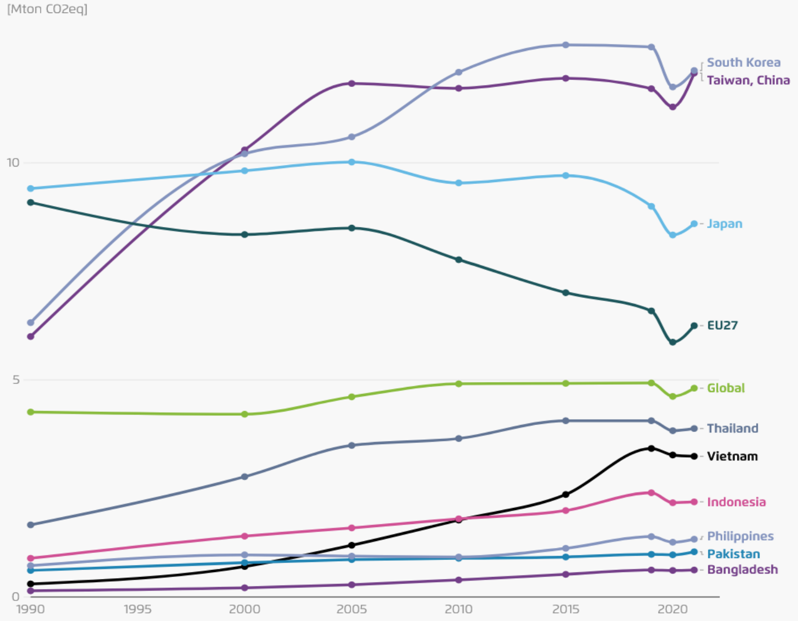
The message arising from global net-zero scenarios is clear: getting to climate neutrality requires adding 1000 GW of wind and solar power every year until mid-century, while also gradually electrifying most end-use sectors (IEA, 2022; IRENA, 2022). While useful, such global top-down assessments are often unable to capture local specifics, and thus provide little help to those seeking to develop energy transition roadmaps consistent with their domestic climate targets. What do these global numbers concretely mean for policy makers in South, Southeast and East Asia?

To answer this question, Agora Energiewende reviewed more than 35 long-term energy scenarios from Japan, South Korea, Vietnam, Indonesia, the Philippines, Thailand, Pakistan, Bangladesh, and Taiwan, China*. These scenarios are bottom-up analyses carried out by local institutions in close consultation with various stakeholders. They consider specific local constraints and political economy developments, including technology costs, resource potentials and social development targets. As such, they complement global analyses such as those by the IEA and IRENA.

This publication offers an overview of the transition to a flexible power system based around renewables, benchmarks wind and solar growth rates against such climate pledges – and provides recommendations to accelerate the transition.

Curbing emissions means turning pledges into action

GHG emissions per capita in several Asian geographies, the EU and the world



The economies of South, Southeast, and East Asia are diverse, with huge variations in natural resources, levels of development, and energy market structures. Yet, they share some key challenges: climate change impacts jeopardising development goals, and a prevalent reliance on fossil fuels combined with relatively low rates of renewable energy deployment.

South and Southeast Asia are home to some of the fastest growing economies in the world – with increasing energy demand to match, potentially growing by as much as 80% by 2050.

On the other hand, the more mature economies of East Asia are already home to some of the highest per capita greenhouse gas emissions globally.

Source: World Bank (2022)

Curbing emissions means turning pledges into action

Despite encouraging recent progress with many Asian governments setting net-zero targets and some adopting coal phase-down targets, the region overall lacks credible policy implementation plans.

Persistent investments into fossil fuels and relatively low rates of renewable energy deployment are common traits across the region.

Summary of climate pledges, coal phase-out targets, and power system information

	GDP in USD billion (2022)	Income group (2022)	Population in millions (2022)	Net zero target	Coal phase out	Electricity mix (2022)	Electricity demand (2000-2022)
Japan	4230	high	125.1	2050	N/A		
South Korea	1670	high	51.6	2050	N/A		
Taiwan	790	high	23.2	2050	N/A		
Thailand	495	upper middle	71.7	2050	N/A		
Vietnam	408	lower middle	98.2	2050	2040		
Indonesia	1320	upper middle	275.5	2060	2050		
The Philippines	404	lower middle	115.6	N/A	(coal moratorium)		
Pakistan	376	lower middle	235.8	N/A	N/A		
Bangladesh	460	lower middle	171.2	N/A	N/A		

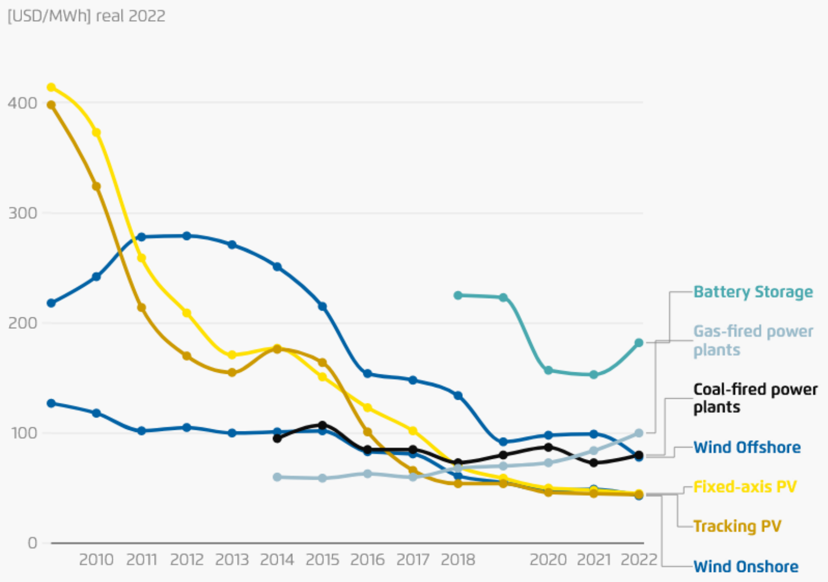
Source: World Bank (2023), EMBER (2023)

The next five years are crucial to achieve climate targets

Limiting global warming to 1.5°C requires immediate action to avoid overshooting temperature limits that could lead to irreversible changes to our natural environment and an increased burden on the region to adapt to climate impacts. The International Panel on Climate Change (IPCC) highlights that halving emissions by 2030 is imperative, and that the policy and technology options to do so are already available. For the energy sector, this will mean using energy and materials more efficiently, reducing fossil fuel use, and widespread electrification.

At the vanguard of this transition are wind and solar power. Their declining costs mean that they are already competitive and represent sustainable alternatives to fossil fuels. For example, utility-scale solar is already the cheapest source of electricity generation in several economies in the region, such as Vietnam.

Levelised cost of electricity – global average



Source: BNEF (2023)

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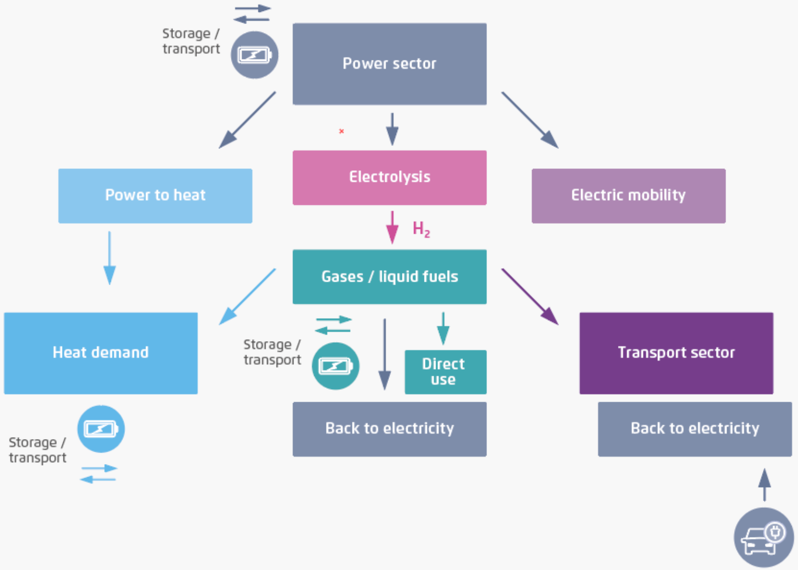
The next five years are crucial to achieve climate targets

Sector coupling interactions between power and end-use sectors



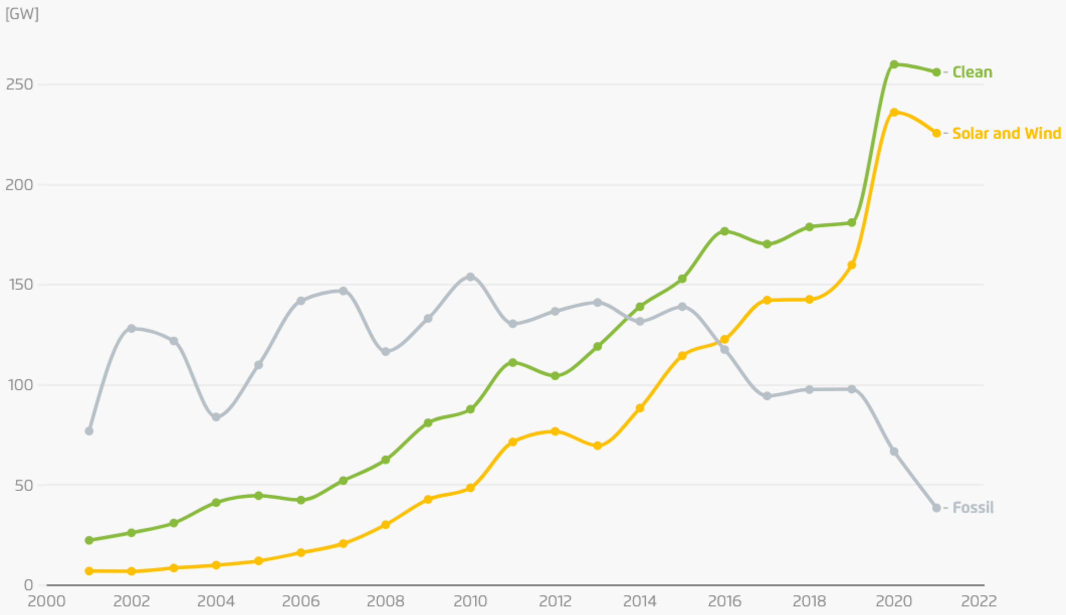
A swift decarbonisation of the electricity system unlocks opportunities for the decarbonisation of the transport, buildings, and industry sectors. Indeed, electricity is poised to displace fossil fuels in all sectors, either directly, e.g. in electric vehicles and power-to-heat applications, or indirectly using fuels derived from renewable electricity, e.g., green hydrogen.

These sectors, once electrified, can provide flexibility to help facilitate the integration of variable renewables into the power system. For example, smart electric vehicles can help absorb mid-day peaks.

Source: Adapted from IEA

Wind and solar additions in large parts of Asia have been insufficient

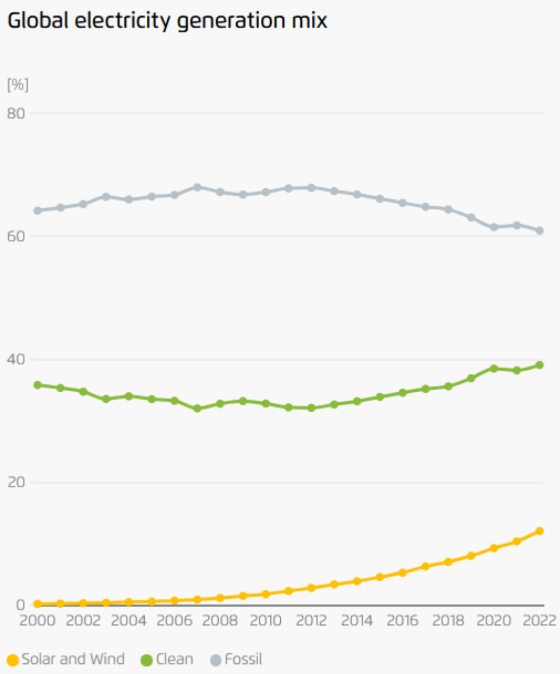
Annual global installed capacity additions (2001–2022)

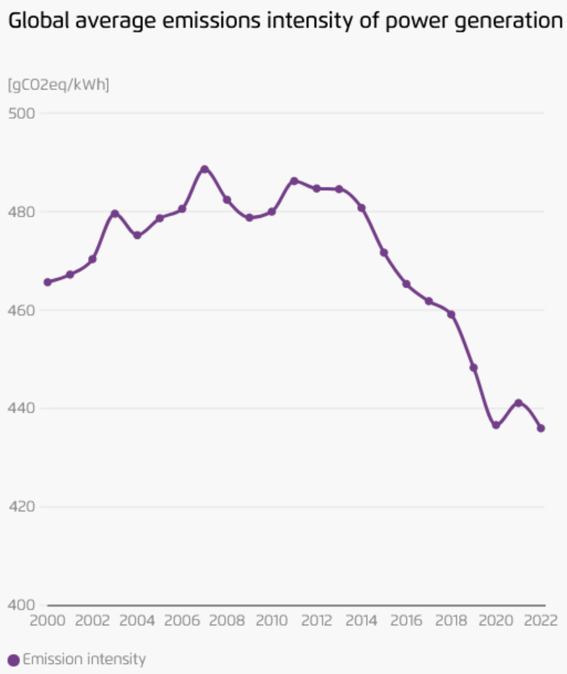


Since 2016, wind and solar additions have outstripped fossil fuels, but most additions were in China, the USA and India.

Source: IRENA (2023). Note: Clean includes renewables and nuclear.

Wind and solar additions in large parts of Asia have been insufficient





As a result, the global emission intensity of power generation has improved, and the world has reached the cleanest electricity mix since the industrial revolution. In 2022, global solar and wind power generation amounted to 12% of global electricity generation, nearly 3500 TWh (terawatt hours), which is equivalent to the electricity demand of the Asian geographies presented here.

Source: IEA (2022). Note: Clean includes renewables and nuclear.

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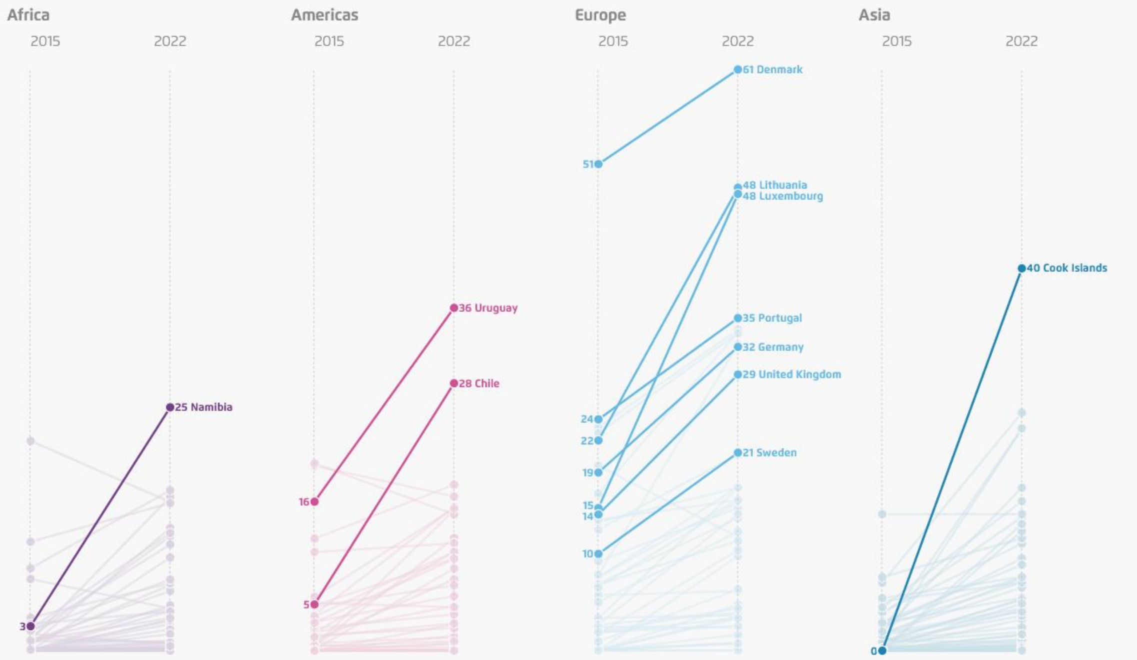
Wind and solar additions in large parts of Asia have been insufficient

Share of solar and wind in total electricity generation, 2015–2022 [%]



However, only a few countries around the world have achieved shares of wind and solar generation greater than 20%.

Source: EMBER Annual Electricity Data (2023)

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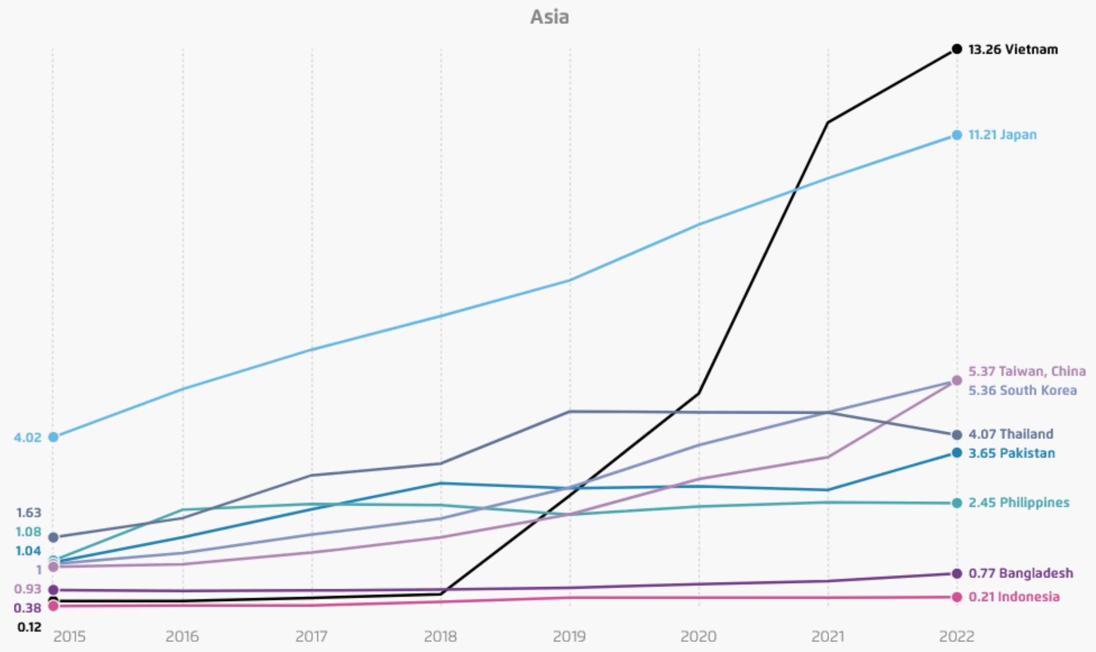
Share of solar and wind in total electricity generation, 2015–2022 [%]



In Asia, renewables still generate less than 6% of total electricity in most geographies, even though governments have in recent years adopted policies and laws to promote their uptake.

Only Japan and Vietnam have so far achieved solar and wind shares greater than 10%. Vietnam's feed-in tariff (FiT) programme led to a boom of solar and wind installations in 2019–2021. However, the scheme has since been abandoned and it is unclear if and how the trend will continue.

Source: EMBER Annual Electricity Data (2023)

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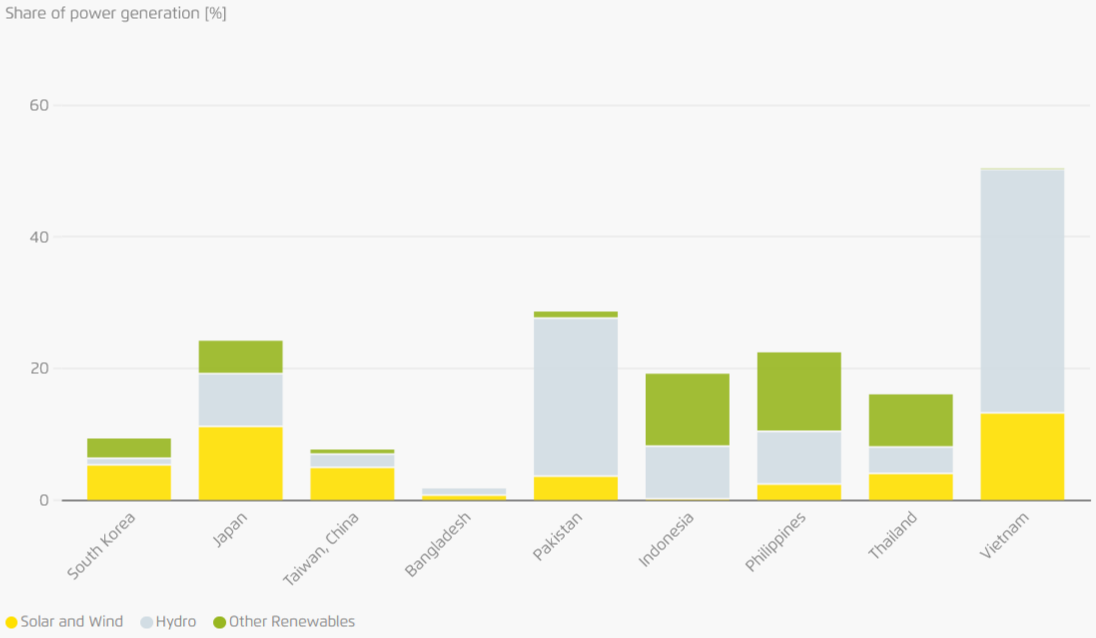
Wind and solar will need to supply 30% of total electricity by 2030

Share of renewables in power generation, 2022



Throughout the region, renewable electricity generation is still largely dominated by hydropower, geothermal and, to a lesser extent, biomass.

While these technologies are cost-competitive and poised to play vital roles by providing dispatchable power, their expansion potential is limited due to environmental and social impacts or resource availability.

Source: Agora Energiewende (2023)

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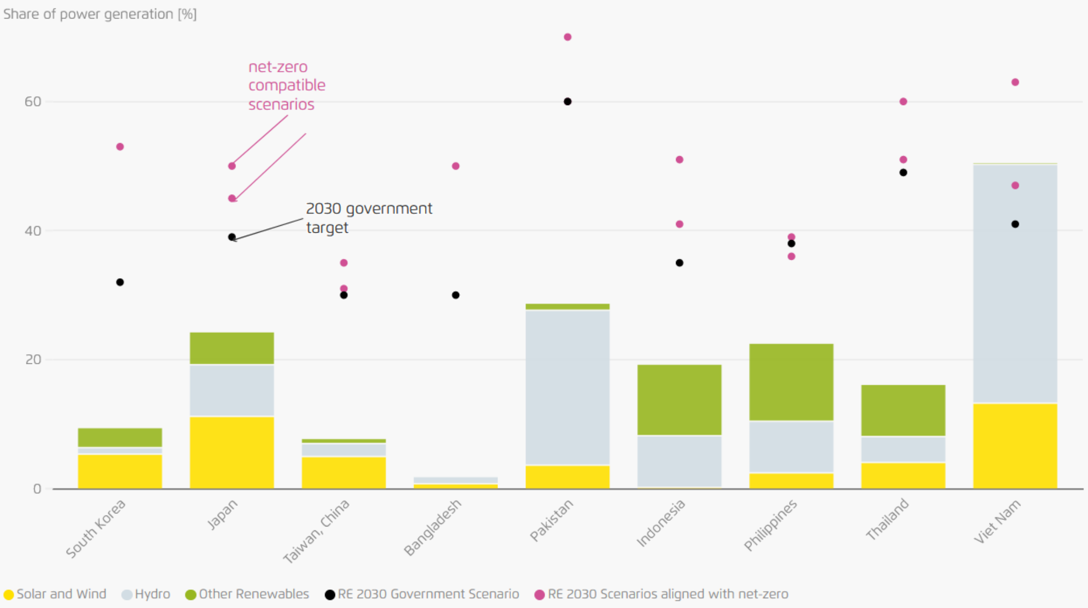
Wind and solar will need to supply 30% of total electricity by 2030

Share of renewables in power generation

Status quo (2022), governmental target (2030), upper and lower ranges (2030) to be aligned with net-zero

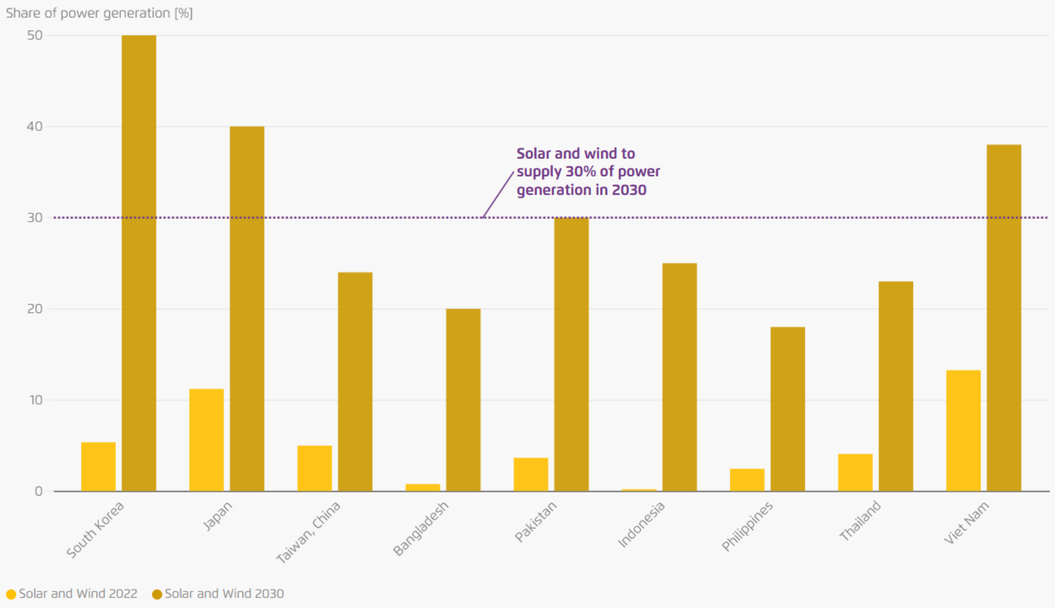


For most economies, current government scenarios and targets lack the necessary ambition to align with their climate pledges. Clear and consistent policy signals are one of the keys to quickly accelerating renewable energy deployment.

Source: Agora Energiewende (2023)

Wind and solar will need to supply 30% of total electricity by 2030

Total share of wind and solar power in 2022 and 2030 benchmark to be aligned with net-zero

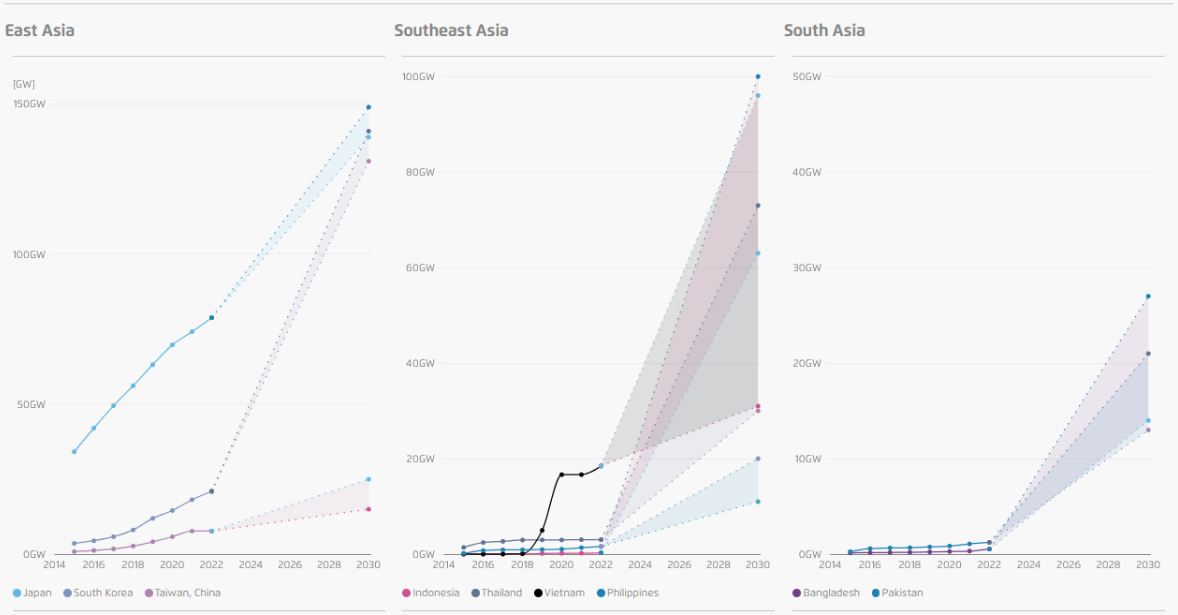


Still, when taking into account growing energy demand, increasing the shares of wind and solar will require significant investments.

Source: Agora Energiewende (2023)

The region should add 75 GW of wind and solar every year

Total installed solar capacity needed to be in line with net-zero pathways



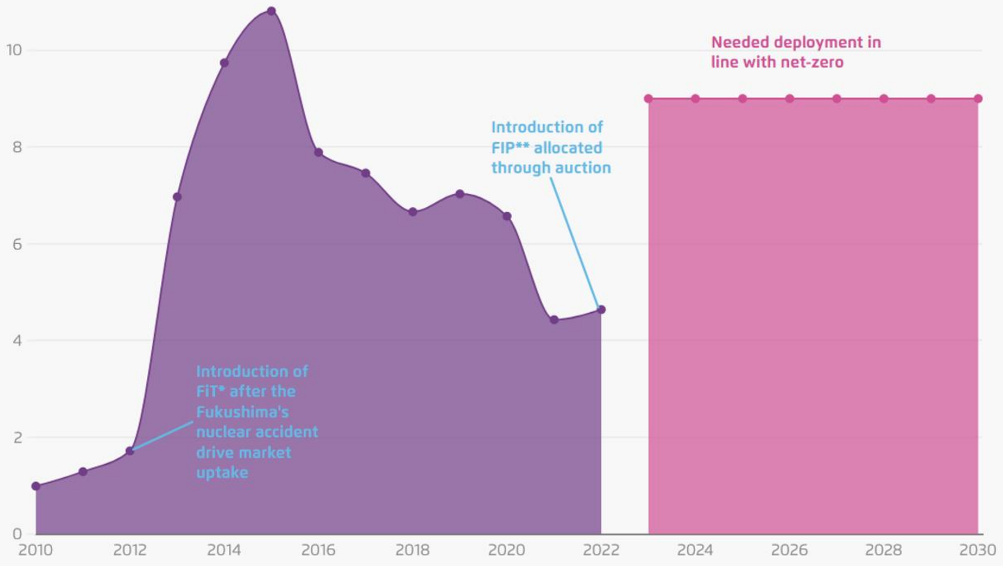
Translating renewable power shares into installed wind and solar capacities (GW) depends on several country-specific factors: resource availability, other competing low-carbon technologies (in particular hydropower), power demand growth, current state of the market, and other factors.

Overall, net-zero scenarios indicate that solar capacities in the region will need to grow from 125 GW in 2021 to about 600 GW in 2030, a fivefold increase.

Source: Agora Energiewende (2023) based on IRENA (2023) (historic)

The region should add 75 GW of wind and solar every year

Solar PV development per year in Japan (historic and net-zero)



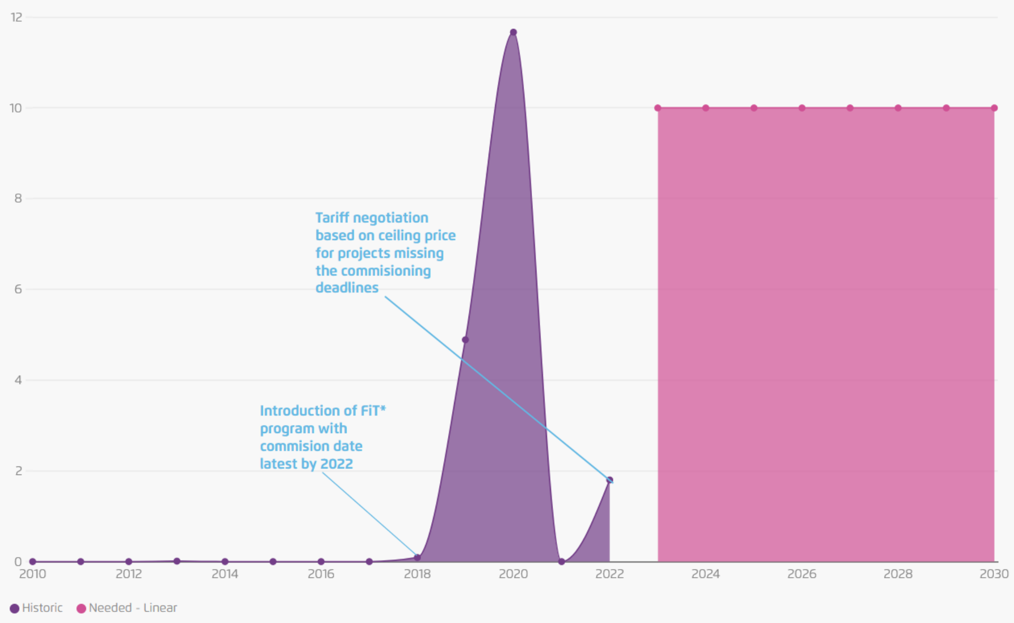
This corresponds to additions of 45 to 55 GW solar capacity per year across the region. Broken down by individual country:

→ Japan should install on average around 9 GW of solar power per year. Although this target is ambitious, it remains within the range of what Japan has achieved in a single year (11 GW installed in 2015).

Source: Agora Energiewende (2023) based on IRENA (2023) (historic) Note: *FIT = Feed in Tariff, **FIP = Feed in Premium

The region should add 75 GW of wind and solar every year

Solar PV development per year in Vietnam (historic and net-zero)

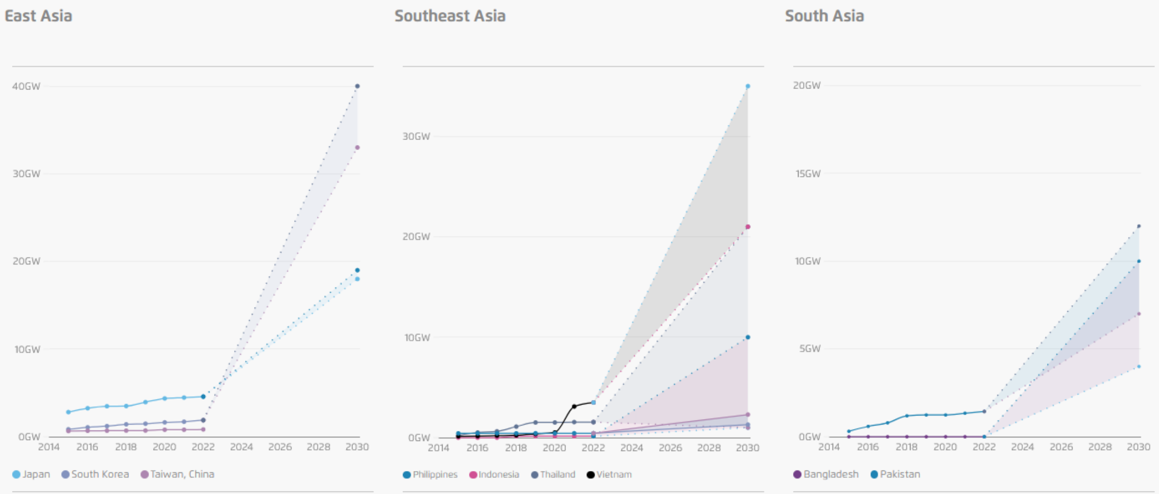


- → South Korea, Thailand, and Indonesia need to install between 8–14 GW per year each. This is particularly ambitious given early growth states of the South Korean and Thai renewables markets and Indonesia's nascent market.
- → Vietnam needs to add 10 GW of solar PV per year, which is achievable, given historic installation rates of 12 GW in 2020.
- → Pakistan, Bangladesh, and the Philippines need to add between 1–3 GW each per year.

Source: Agora Energiewende (2023) based on IRENA (2023) (historic) Note: *FIT = Feed in Tariff

The region should add 75 GW of wind and solar every year

Total installed onshore wind capacity needed to be in line with net-zero pathways



For wind, the analysed net-zero scenarios suggest that regional in stalled capacity will need to reach about 180 GW by 2030, a tenfold increase compared to the 18 GW installed in 2021. This means yearly additions of about 20 GW per year for the whole region.

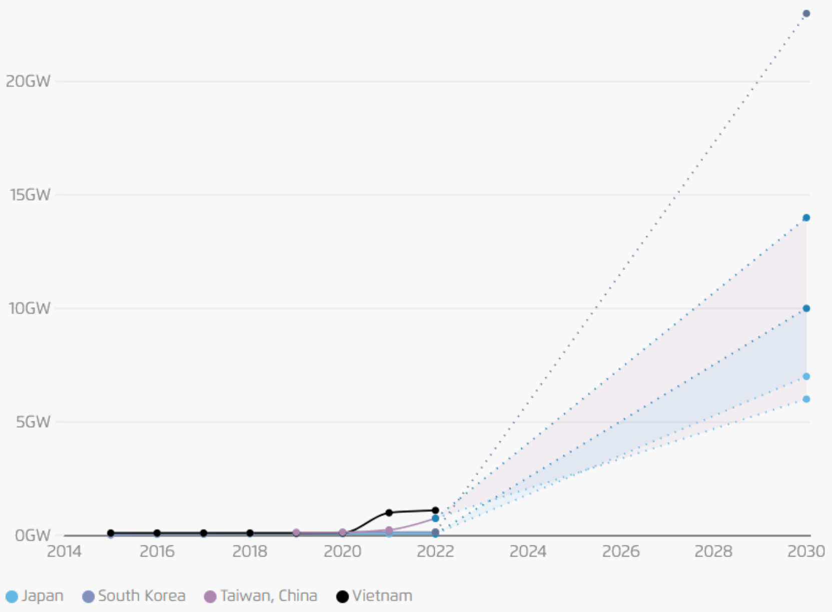
South Korea requires the greatest wind growth – 8 GW per year. Japan should deploy around 3 GW wind per year. Vietnam will need to add 4 GW per year.

With relatively low wind potentials, and the modelled growth for wind is only between 1 to 2 GW per year for other markets.

Source: Agora Energiewende (2023) based on IRENA (2023) (historic)

The region should add 75 GW of wind and solar every year

Offshore wind capacity consistent with net-zero



For those countries where it is available, offshore wind plays an important role.

South Korea relies on installing 3 GW offshore wind per year, while Japan needs to deploy 1 GW per year. Meanwhile, in Taiwan, China the majority of added wind occurs offshore, around 1 GW per year. Finally, in Vietnam, offshore wind developments are expected by 2035.

Source: Agora Energiewende (2023) based on IRENA (2023) (historic)

Policy, regulatory and market reforms can accelerate wind and solar growth

The growth of wind and solar power will depend on whether future regulatory and political economy choices are successful in creating an attractive investment environment to significantly scale-up deployment. Discussions around wind and solar integration into power systems are often still marred by misconceptions. Prioritising policies that succeed in accelerating the deployment and integration of variable renewable power must therefore be tackled gradually, depending on its share in the system.

Policy, regulatory and market reforms can accelerate wind and solar growth

Phase/vRES*	
Phase 6 >60%	vRES electricity is main energy supply, large scale production of green fuels
Phase 5 <60%	vRES systematically exceeds *classical* power demand for long periods
Phase 4 <50%	Period where vRES makes almost all generation
Phase 3 <25%	vRES shape system operation
Phase 2 <15%	Minor to moderate impact on system operation
Phase 1 <3%	**No impact on system level (but could be a local challenge)**

Challenge	Flexibility options/policy priorities
Substitute other fuels where direct electrification is not feasible	Large-scale use of green H_2
Absorb large volumes of *surplus* vRES generation	Electrification of transport and heat (reform tariffs and taxation), large-scale interconnections
Ensure stable power supply during period of high vRES	Flexibility as new paradigm, technology roll-out (battery, DSR, digitalization), stability technology
Accommodate greater variability of net load and change of power flow on the grid	Abating inflexibility, plant retrofit, improved grid, move operation close to real-time (*market*)
Minor changes to operating patterns of existing power system	**Improve forecast, economic dispatch and vRES investment certainty**

In countries where the share of renewables is low (*Phase 1* countries with a share of variable renewables below 5%), attracting investments into wind and solar through supportive de-risking mechanisms, and designing supportive grid codes for the integration of renewables should be priorities. Permitting processes that delay projects need to be streamlined. That could include consolidating approvals under a single authority, improving investor and stakeholder confidence and minimise investor risks. Allowing priority dispatch for renewables would offer a clear signal that market preference is given to clean sources of electricity, and can be very effective if combined with a structured retirement plan for fossil assets.

Source: IEA (2018) *share of variable renewable generation. Numbers are indicative and depend on the specifics of the system.

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In countries where renewables uptake has already progressed (*Phase 2* countries with a share of variable renewables below 15 percent), system operation starts to be impacted. The focus should be on managing integration challenges through a combination of regulatory and market refinements that minimise system inflexibilities. The question of land availability also starts to be especially prevalent in densely populated countries (such as in Bangladesh (1,330 people per square meter), Japan (340 per square meter) and Korea (515 per square meter)). Exploring alternative areas, e.g. solar PV on agricultural land, or floating PV on freshwater reservoirs can help widen the options for renewables developers.

Source: IEA (2018) *share of variable renewable generation. Numbers are indicative and depend on the specifics of the system.

Policy, regulatory and market reforms can accelerate wind and solar growth

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Minor changes to operating patterns of existing power system	Improve forecast, economic dispatch and vRES investment certainty

Typically, significant integration challenges begin to occur at wind and solar shares greater than 15% (*Phase 3*). Power system operations and planning will need to be fundamentally transformed to adapt to the variability of renewables and move towards a *flexibility paradigm*. The concept of *baseload* generators begins to become obsolete.

Source: IEA (2018) *share of variable renewable generation. Numbers are indicative and depend on the specifics of the system.

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Policy, regulatory and market reforms can accelerate wind and solar growth

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In the longer run, a more systematic approach to renewable integration will be required that fosters flexibility investments (e.g. grid development, storage) and renewables-based electrification of end-use sectors (sector planning). This approach requires much more integrated planning processes (multi-sectorial and long-term). However, in most scenarios, the large roll-out of battery storage technologies and electrification of end-use sectors become relevant only after 2030.

The measures needed to accelerate the renewable energy transition vary between countries, and depend on the state of the transition.

Source: IEA (2018) *share of variable renewable generation. Numbers are indicative and depend on the specifics of the system.

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Policy, regulatory and market reforms can accelerate wind and solar growth

Near-term policy priorities to increase wind and solar deployment and system integration

Bangladesh

Percent wind and solar generation: 0.8%

- Given scarce land, explore potential land use options for renewables and grid expansion plans
- Improve regulatory clarity to supporting development of utility scale renewables, including access to grid and land acquisition
- Foster international partnerships to leverage expertise, technologies, and financial resources

Pakistan

Percent wind and solar generation: 3.7%

- Establish a reliable tender plan for wind and solar PV, especially in Balochistan and Sindh provinces
- Unlock technical and contractual flexibility of thermal powerplants, and study flexible dispatch of existing hydropower
- Increase number of regional control centres for better forecasting for inter- and intraday renewables output

Indonesia

Percent wind and solar generation: 0.2%

- Increase renewables ambitions development plans and adapt regulations to increase the solar PV competitiveness, e.g. revising local content requirements
- Consider revising existing PPAs to encourage flexibility operation of thermal power plants
- Faced with structural overcapacity, expand the moratorium on coal projects to include projects in the pipline, and accelerate coal phase out to create space for renewables

The Philippines

Percent wind and solar generation: 2.5%

- Upgrade grid infrastructure, including interconnections between Luzon, Visayas and Mindanao
- Streamline permitting and planning requirements
- Strengthen policy signals by increasing ambition in clean energy scenario

Thailand

Percent wind and solar generation: 4.1%

- Establish more ambitious renewable targets in the Power Development Plan
- Establish utility-scale renewable procurement through competitive auctions
- Modernise power grid to integrate renewables and incentivise system flexibility technologies such as batteries and electric vehicles

South Korea

Percent wind and solar generation: 5.4%

- Establish more ambitious renewable deployment targets with more concrete policy measures so that the LCOEs of solar and wind can become competitive with other conventional electricity sources.
- Expand the electricity grid in a distributed manner for minimizing the RES curtailments.
- Introduce intraday and real-time markets which can reflect the change in time-specific demand and supply.

Japan

Percent wind and solar generation: 11.2%

- Unleash on- and offshore wind deployment by refining permitting processes to halve development time
- Incentivise short-term value of power on the intra-day market to better value flexibility providers and limit renewables curtailment
- Grid reinforcement, especially within (and between) Hokkaido and Honshu

Vietnam

Percent wind and solar generation: 13.3%

- Commit to long-term renewable energy policies & avoid boom-and-bust cycles
- Finalize preparations for the introduction of a competitive bidding mechanism
- Invest in grids, establish renewable zones, and identify price signals to reduce transmission bottlenecks and curtailment

Phase Phase 1 Phase 2

Source: Agora Energiewende (2023)

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