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Renewable energy in Southeast Asia:
Unlocking opportunities in a world on lockdown

April 16 2020

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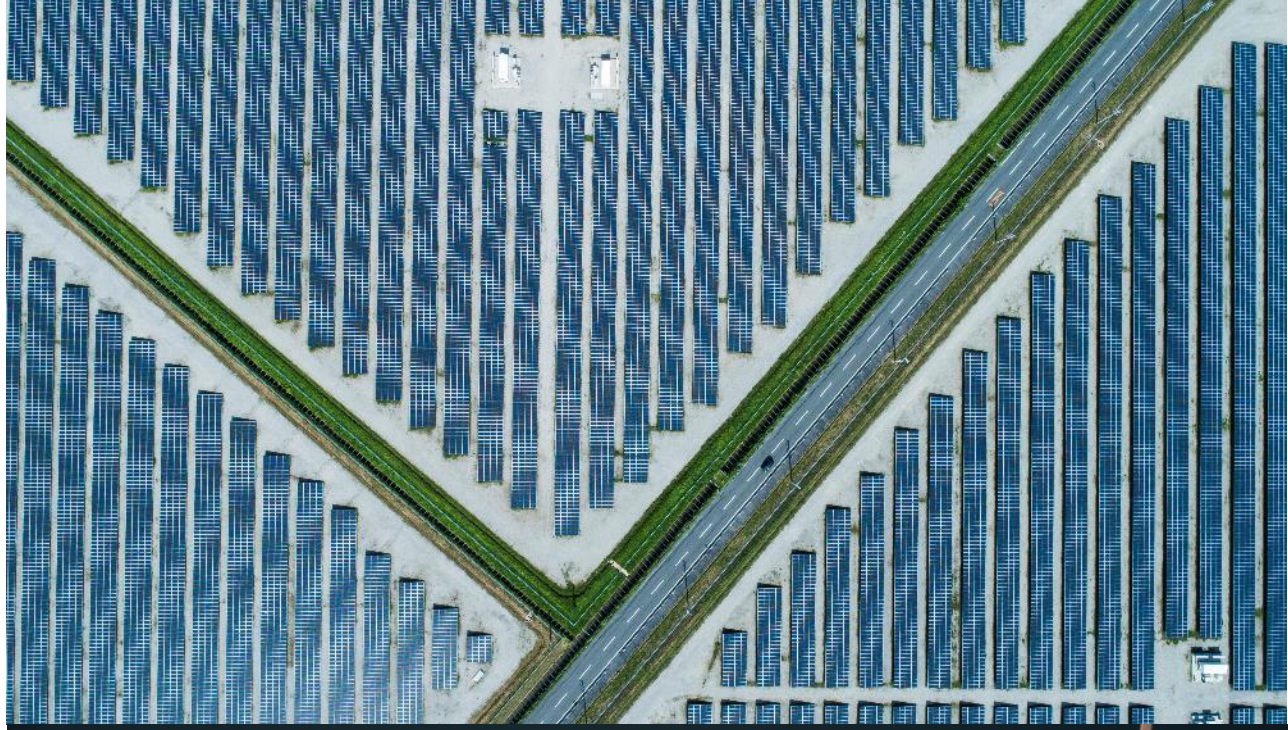
Before we start…

— **Questions:** please ask at end of presentation, if time allows

— **Slides file:** we will send this slide pack, following the webinar



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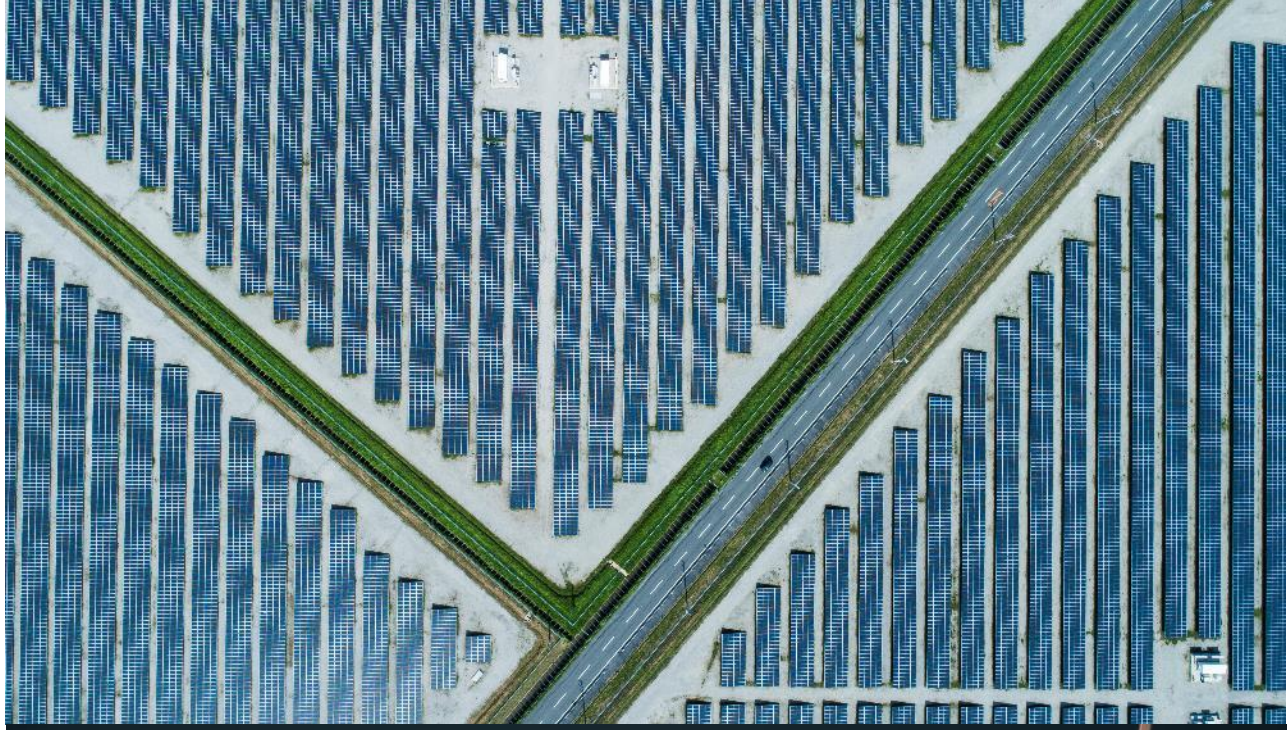
2. Capacity to-date and future pipeline
3. The role of support mechanisms
4. Drivers of successful renewable growth
5. Results & opportunity ranking
6. Concluding remarks



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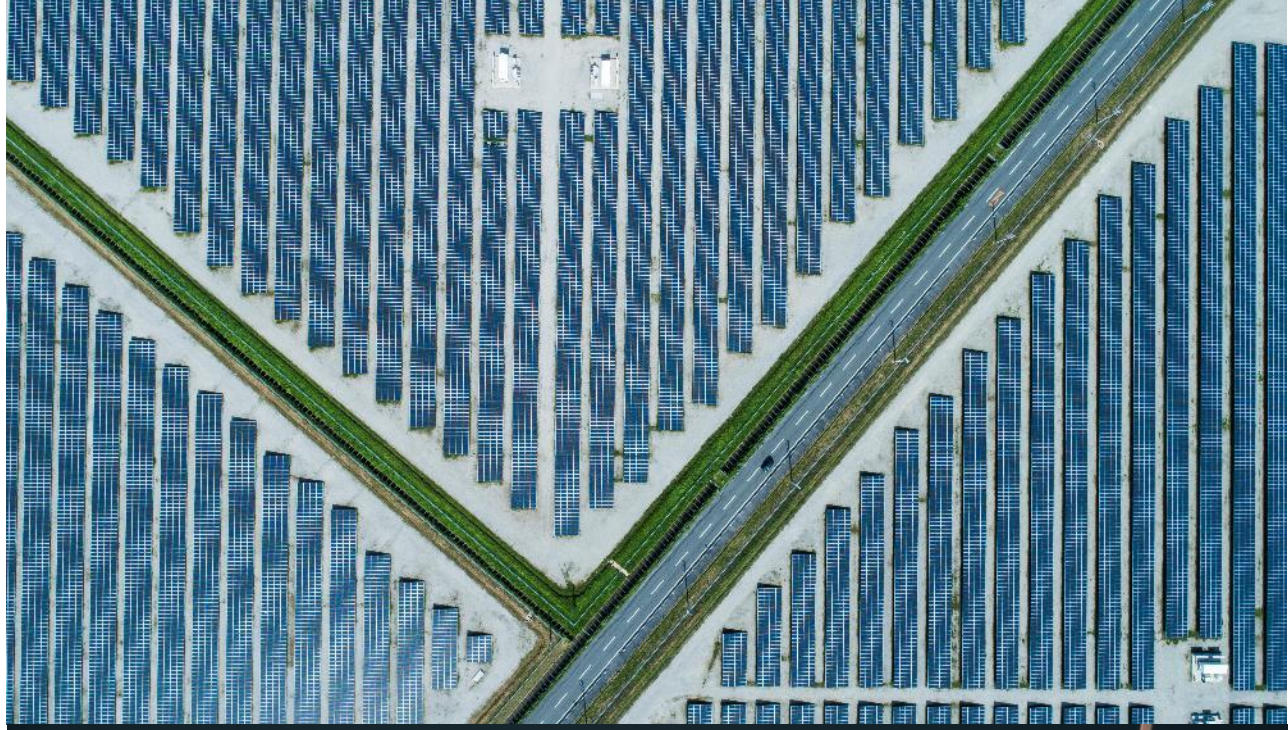


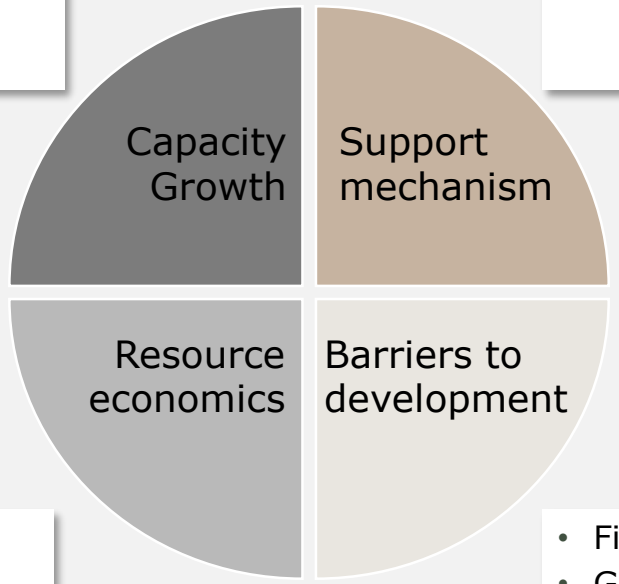
OPPORTUNITY IN THE SOUTH EAST ASIAN RENEWABLE ENERGY SPACE

When we look across 5 key Southeast Asian markets we see great renewable opportunities

Assessment of technologies across countries in 4 dimensions

- Demand growth
- Existing capacity
- Future capacity targets

- Existing support
- Future support
- Merchant potential

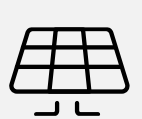


- Solar resource
- Wind resource
- LCOE

- Financing
- Grid constraints
- Country risk

2 technologies and 5 countries

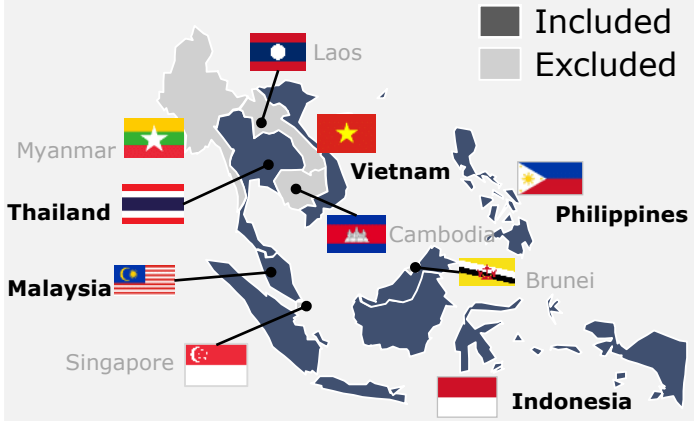
Technology coverage



Solar PV

Onshore wind

Geographic scope



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OPPORTUNITY IN THE SOUTH EAST ASIAN RENEWABLE ENERGY SPACE

PV Magazine Dec 2019

"The outlook for growth in Vietnam's renewables sector is positive… the solar segment is one of the key drivers of this impressive growth. Vietnam still has substantial untapped solar power potential. Coupled with an increasingly supportive regulatory environment, and an expected surge in electricity consumption over the next decade, the country's renewables sector is poised for a new dawn. And this will bring substantial opportunities for investors."

Reuters Oct 2019

"Among the encouraging signs for the solar industry was a recent auction for a 500 megawatt (MW) solar project in Malaysia of which 365 MW were bid at a price lower than the country's average gas-powered electricity."

IEEFA March 2020

"Indonesian government pushing ahead with reforms to jump-start renewable energy transition."

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OPPORTUNITY IN THE SOUTH EAST ASIAN RENEWABLE ENERGY SPACE

Growth everywhere, but big variance in other elements driving RE growth

Market comparison								
Market	Size (2019)		Size (projected by 2030)		RE targets (enforcability)	Strong RE support programs & policies	Strong offtaker/PPA	Overall opportunity
	Demand (TWh)*	Capacity (GW)**	Demand (TWh)*	Capacity (GW)**				
					✓ 2028	✗	✗/✓	
					✓ 2030	✓✓	✗/✗	
					✓✓ 2038	✗	✓/✓	
					✓✓ 2030	✓	✓/✓	
					✓ 2040	✗	✓/✓	

*: full Harvey ball = 600 TWh
**: full Harvey ball = 150 GW

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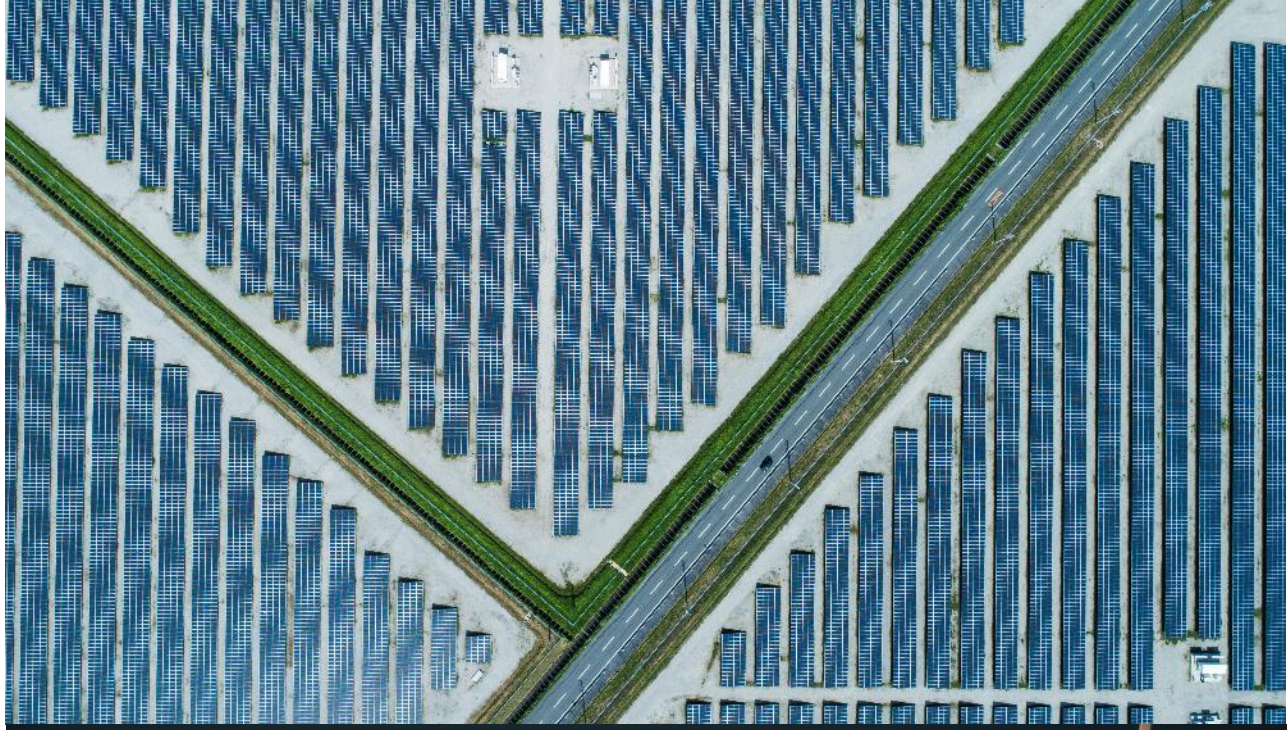
6. Concluding remarks and next steps



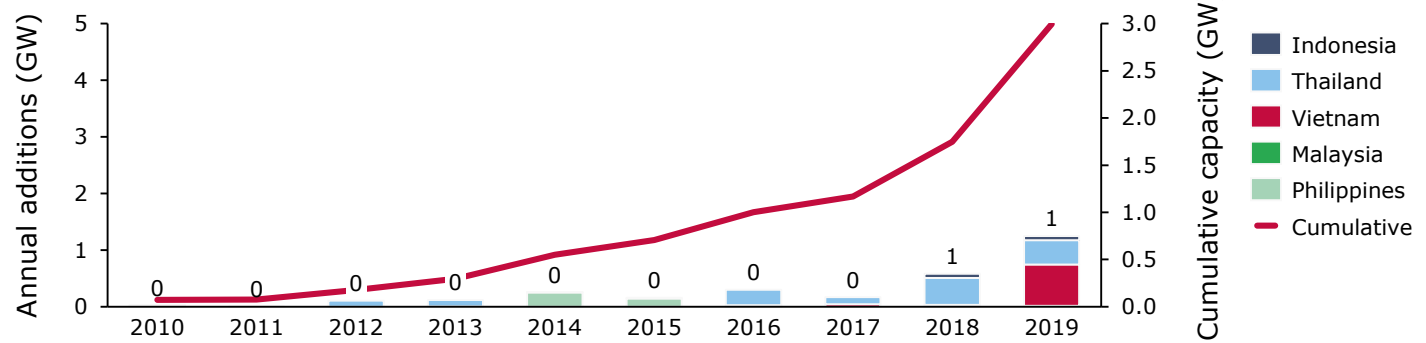
Onshore wind

CAPACITY TO-DATE AND FUTURE PIPELINE

In wind Thailand led previously; Vietnam growing rapidly

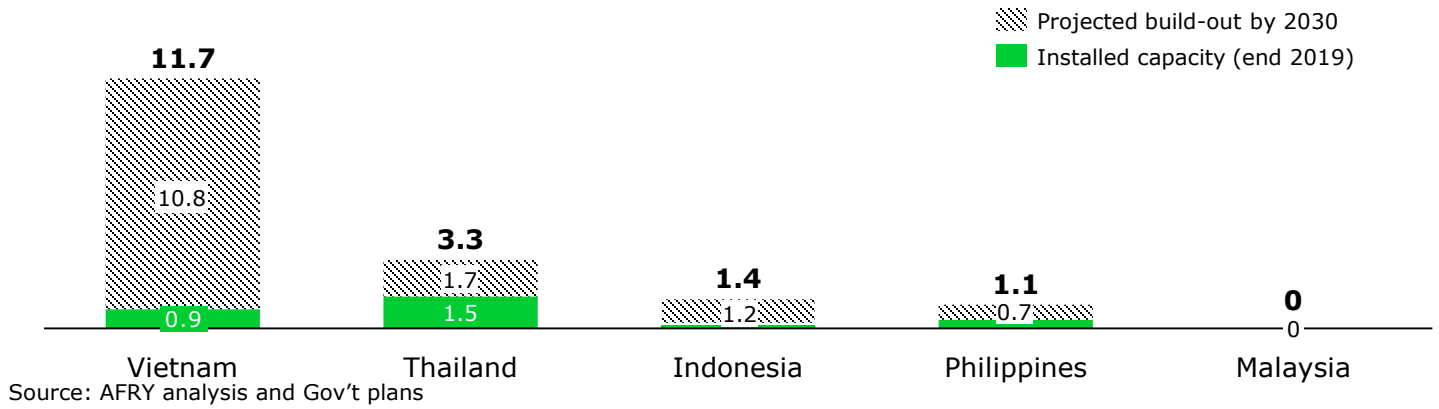
Installed onshore wind capacity & targets

Installed capacity and annual additions (GW)



Source: AFRY analysis

On. wind capacity 2019 and plans by 2030 (GW)



Source: AFRY analysis and Gov't plans

Main observations and trends

Thailand has historically led the region; but future growth expected to be only moderate, as many good sites have already been used

Vietnam a relative late-comer, but rapid recent growth – and expected to continue

Philippines and Indonesia both have some regions with excellent wind resource, but they tend to be located far from load centers, and regulations don't support wind growth

Malaysia has very few areas with strong wind resource

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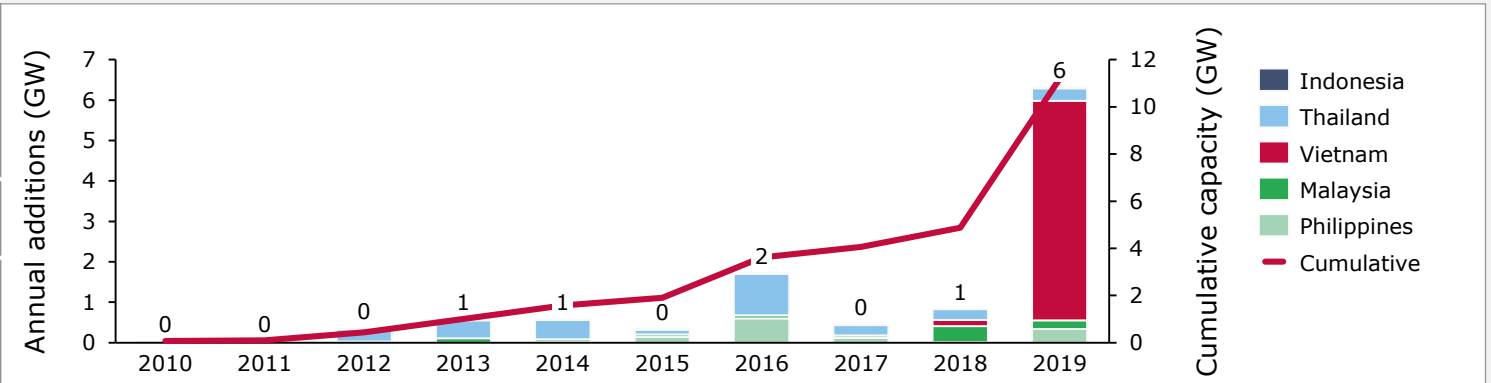
Solar PV

CAPACITY TO-DATE AND FUTURE PIPELINE

For PV, Vietnam growing explosively; strong growth expected in region

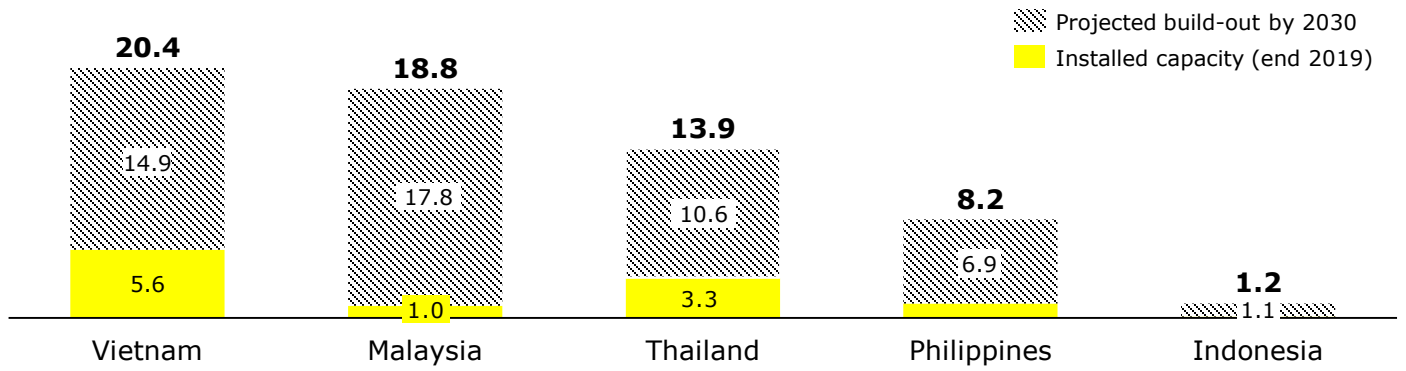
Installed solar PV capacity & targets

Installed capacity and annual additions (GW)



Source: AFRY analysis

Solar PV capacity 2019 and plans by 2030 (GW)



Source: AFRY analysis and Gov't plans

Main observations and trends

Solar capacity has seen good growth
Between 2010-19 the 5 countries have added ~11 GW of solar PV capacity

Solar explosion in Vietnam – over 5 GW in 2019 – and generally expected to continue

Indonesia curiously lags severely, despite big needs for new power, and good solar resource.

High future targets and/or aspirations for most of the 5 countries, with total 50 MW seemingly possible by 2030

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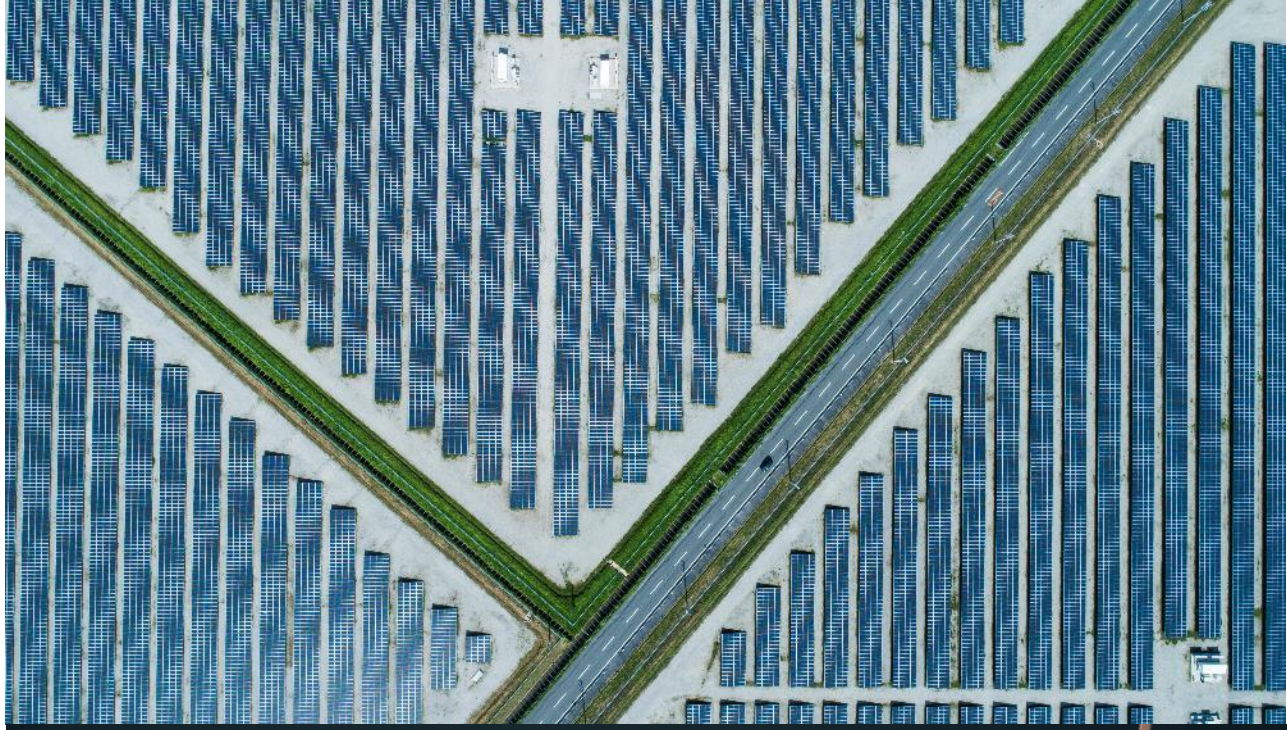

THE ROLE OF SUPPORT MECHANISMS

We expect a shift to auctions in time as seen elsewhere

Support Mechanisms						
Market	Solar PV			Onshore Wind		
	Historic (recent)	Future	Commentary	Historic (recent)	Future	Commentary
	✓ FiT	✗	— Current tariff linked to average (coal-driven) tariff	✓ FiT	✗	— Limited resource near demand centre
	✓ FiT	✓ Auction?	— PPA & curtailment issues	✓ FiT	✓ Auction?	— FiT less attractive than solar PV
	✓ FiT	✓ (?) Auction?	— New support scheme yet unclear	✓ FiT	✓ (?) Auction?	— New incentive scheme yet unclear
	✓ FiT/Auction	✓ Auction	— Solar auction very active	✗	✗	— No near term potential
	✓ FiT	✓/✗ RPS	— RPS design yet unclear	✓ FiT	✓/✗ RPS	— RPS design yet unclear

THE ROLE OF SUPPORT MECHANISMS

Key risks to consider in transactions

- Same standard ones as in RE projects in other countries; plus, in particular for Southeast Asia:

- **Off-taker risk.** Some off-takers in the region have very poor financials (however, minimal history of non-payments)
    - *Potential mitigation:* Government guarantee (more common for thermal projects)
- **Curtailment risk.** Notoriously, in Vietnam's RE PPAs, curtailment risk is put to the project
    - *Potential mitigation #1:* Add batteries (but adds cost)
    - *Potential mitigation #2:* Hope the utility sorts it out
- **Exchange rate / convertibility risk.** Can constrain ability to repatriate revenues
    - *Potential mitigation:* Negotiate these terms (but such terms are often non-negotiable)

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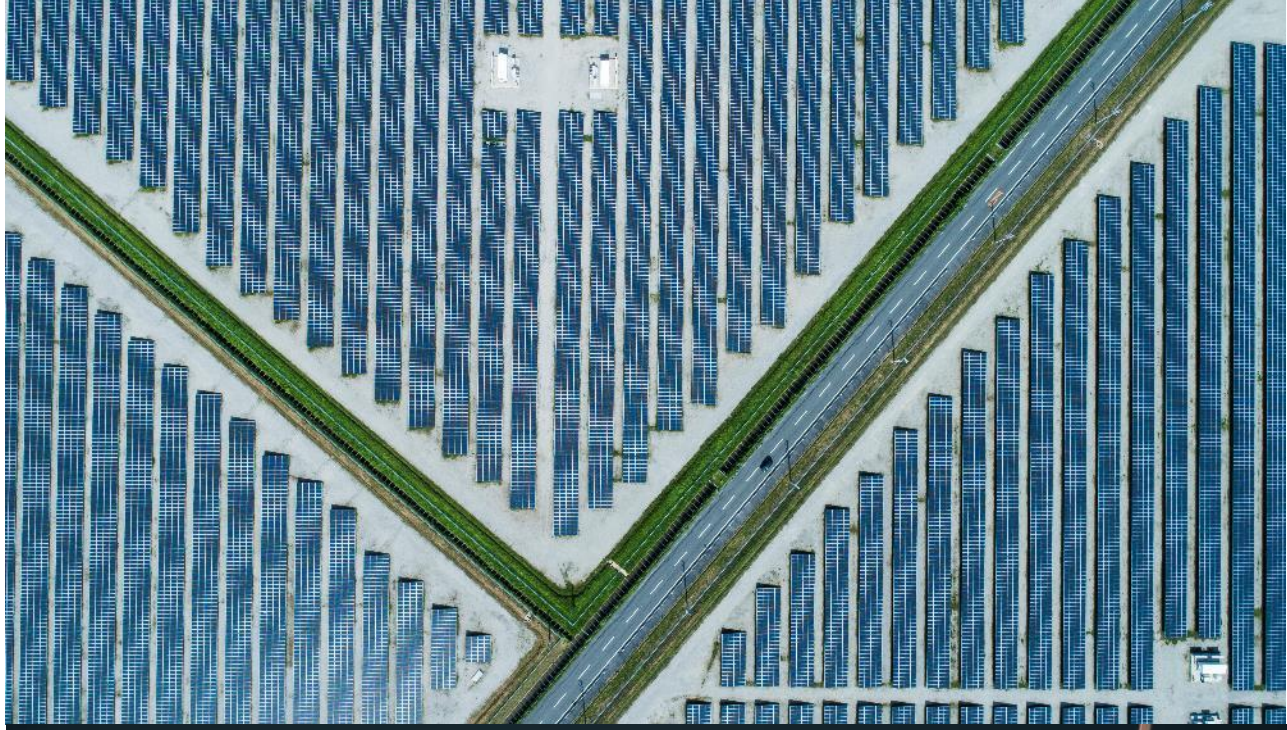
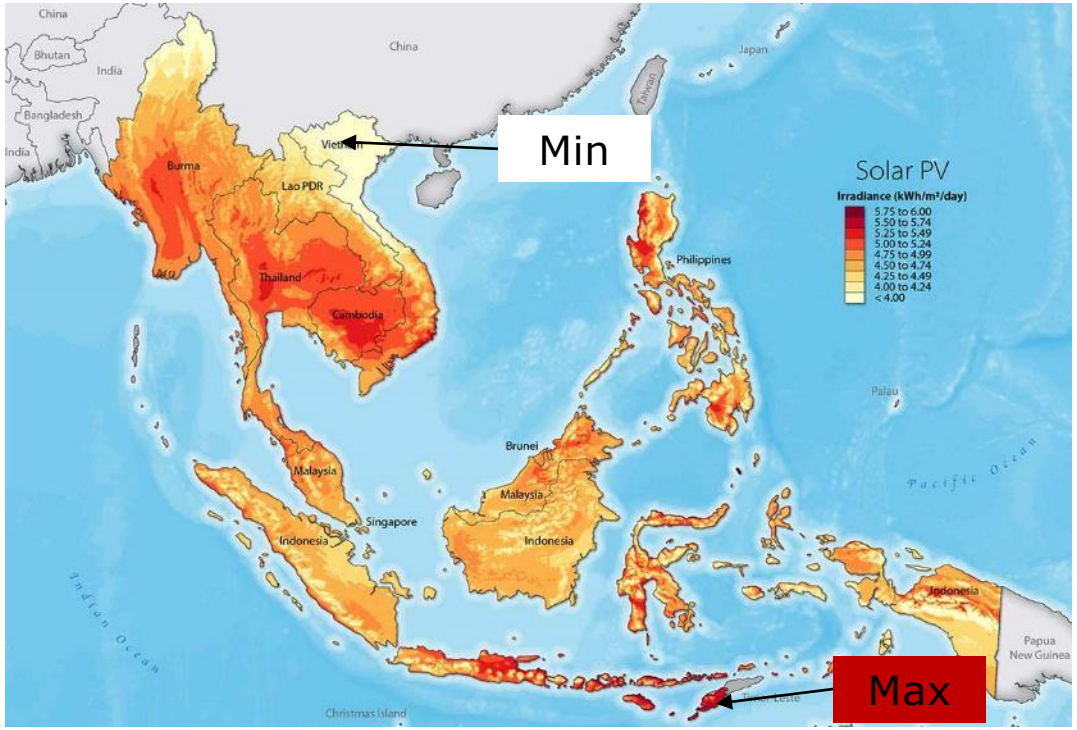


Solar PV

DRIVERS OF SUCCESSFUL RENEWABLE GROWTH

Solar resource generally strong throughout region, but with important variations within and among countries

Solar resource (Irradiance in kWh/m²/day)



Source: NREL with solar resource data from World Bank (2017)

Assessment

Country	Avg. Resource quality	Commentary
		— Indonesia has areas with some of the irradiation across the 5 countries (5.72 kWh/m2/day)
		— Strong resource in the south (and south-central) — Weak in northern half
		— Thailand has the highest average irradiation across the five countries
		— Malaysia is considered a moderate location for solar projects
		— 50% of area has moderate irradiation — 40% of area has high irradiation

^: full Harvey ball = 5.74 kWh/m²/day (= highest max. irradiation)
empty Harvey ball = 3.16 kWh/m²/day (= lowest min. irradiation)

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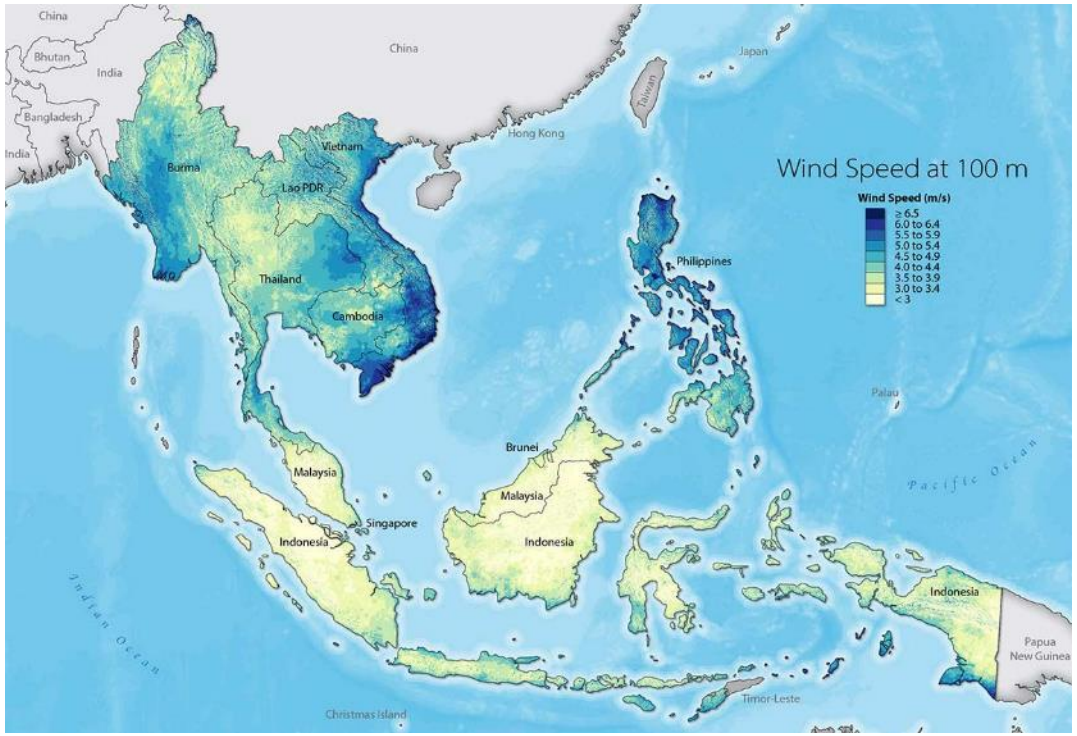
High wind resource variance within and among countries, though Vietnam and the Philippines have the best overall resources of the five SEA countries

Wind resource (wind speed in m/sec. at 100m)



Source: NREL with wind resource data from the Danish Technical University (2017)

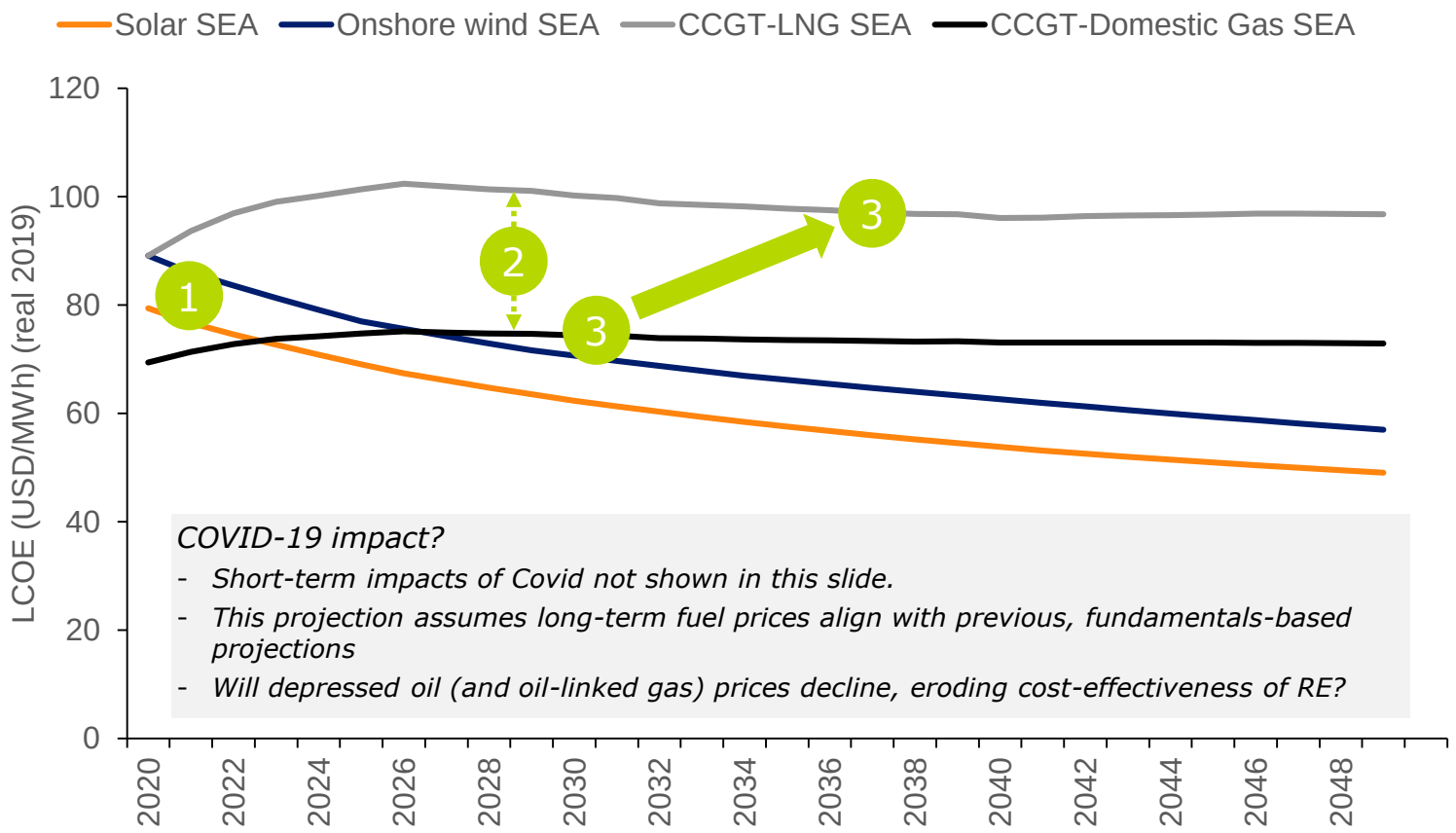
Assessment

Country	Avg. Resource quality	Commentary
		— Generally poor in western parts — Better in the eastern provinces; but far from load centers
		— Best in the central provinces — Generally poor in the north, better in the south
		— Good in the northern and eastern provinces — Otherwise moderate to poor
		— Limited hot-spots in peninsular Malaysia — Otherwise poor
		— North and Central have some of the best wind resource in SEA, but far from load centres

^: full Harvey ball = 6m/second
empty Harvey ball = 3m/second

DRIVERS OF SUCCESSFUL RENEWABLE GROWTH

Solar and wind LCOEs projected to continue declines; increasingly competitive with conventional (thermal) options



COMMENTARY

- **Values shown are *representative* for SE Asia – individual values can vary significantly across country**

1. Solar (and wind) already cost-competitive with imported LNG-fired CCGTs
2. Difference between (expensive) LNG and (inexpensive) domestic piped gas prices is significant
3. Domestic piped gas supplies are running out in many SE Asia countries. Therefore in the future, CCGT costs will tend to be driven by (expensive) LNG costs

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DRIVERS OF SUCCESSFUL RENEWABLE GROWTH

Transition from vertically-integrated to liberalized – but each country on its own path

MARKET ARRANGEMENTS ACROSS SOUTH EAST ASIAN MARKETS

	Private generators (IPPs)	Independent system operator	Wholesale market	Retail competition
	Yes	No	No	No
	Yes	No	No	No
	Yes	Planned	Partial/ In-progress	Planned
	Yes	Partial/ In-progress	Partial/ In-progress	Planned
	Yes	Yes	Yes	Partial/ In-progress

Source: AFRY analysis

COMMENTARY

- General trend toward liberalized markets (though some more, and some less)
- **Thailand** and **Indonesia** allow IPPs but are otherwise basically vertically integrated
  - No plans for liberalizing
- **Malaysia** and **Vietnam** are transitioning from essentially fully-integrated (though allowing IPPs), to generally liberalized markets (including retail)
- **Philippines** is largely fully liberalized; some additional steps in the retail sector are in-progress

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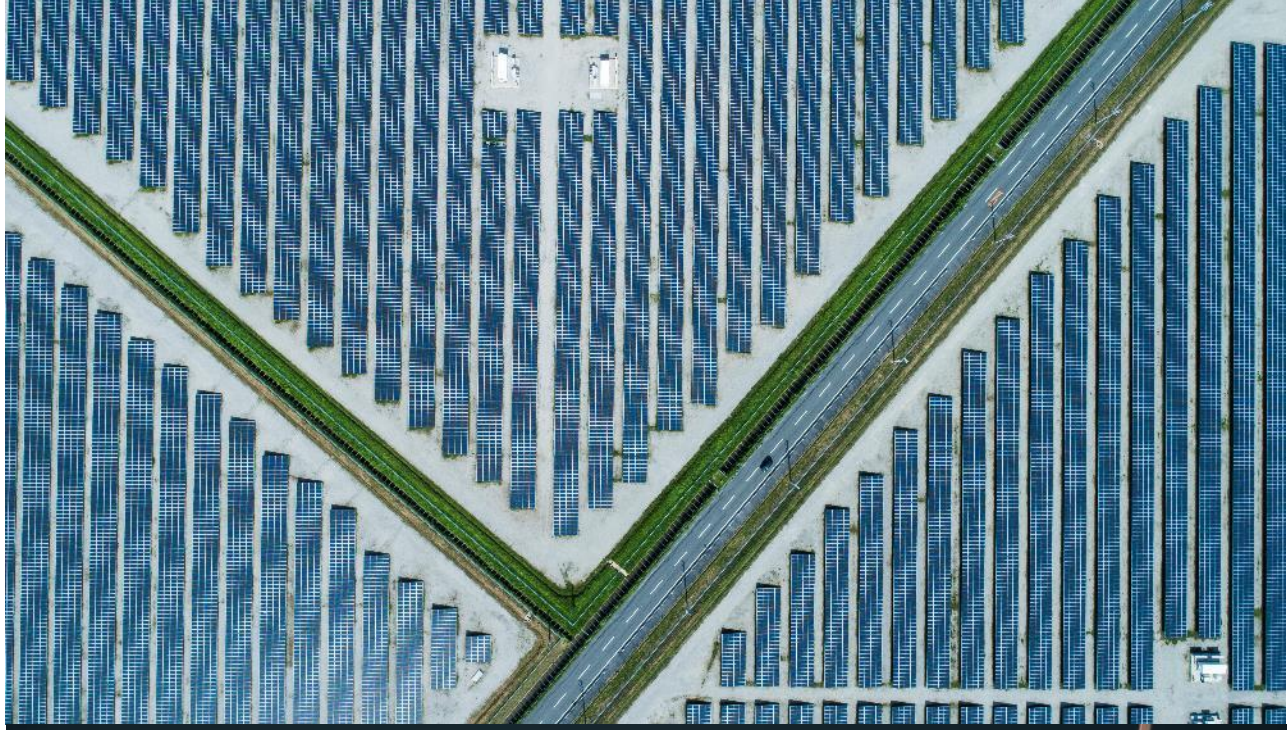
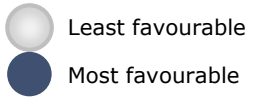


RESULTS & OPPORTUNITY RANKING

Vietnam and Malaysia are the most promising countries for renewables in the near-term

Rank	Country	Technology	Capacity growth	Support mechanism	Resource economics	Comments / Barriers
1		Solar PV				- Strong growth likely to continue - Curtailment & PPA concerns likely to be fixed
2		Onshore wind				- Strong growth likely to continue - Curtailment & PPA concerns likely to be fixed
3		Solar PV				- Solar program continuing; but very competitve - Government change poses some risk to growth
But keep an eye on...						
4A		Solar PV				- Currently unsupportive regulatory environment - *Wait & see:* Could change, with new government
4B		Solar PV				- Current programs very limited; and overcapacity - *Wait & see:* Historically supportive of RE
4C		Solar PV				- Currently unsupportive regulatory environment - *Wait & see:* Could change, with new government



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RESULTS & OPPORTUNITY RANKING

Limited offshore wind in SE Asia – Vietnam an exception

— Offshore wind resource considered not strong in most of Southeast Asia

— Often times, competing with current low-cost generation sources (e.g. coal)

— Offshore wind resource that does exist, tends to be located far from load centers

— **Vietnam as an exception:** multiple projects in various stages of development; additional future growth likely

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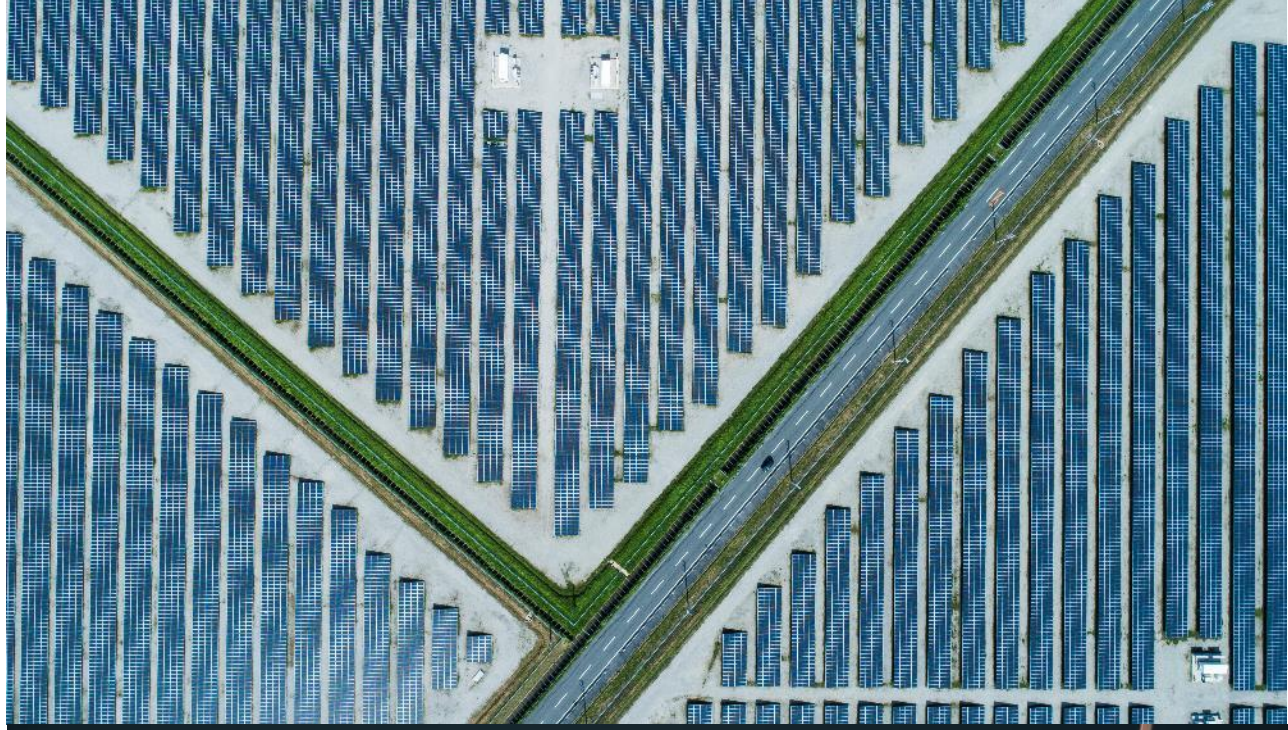
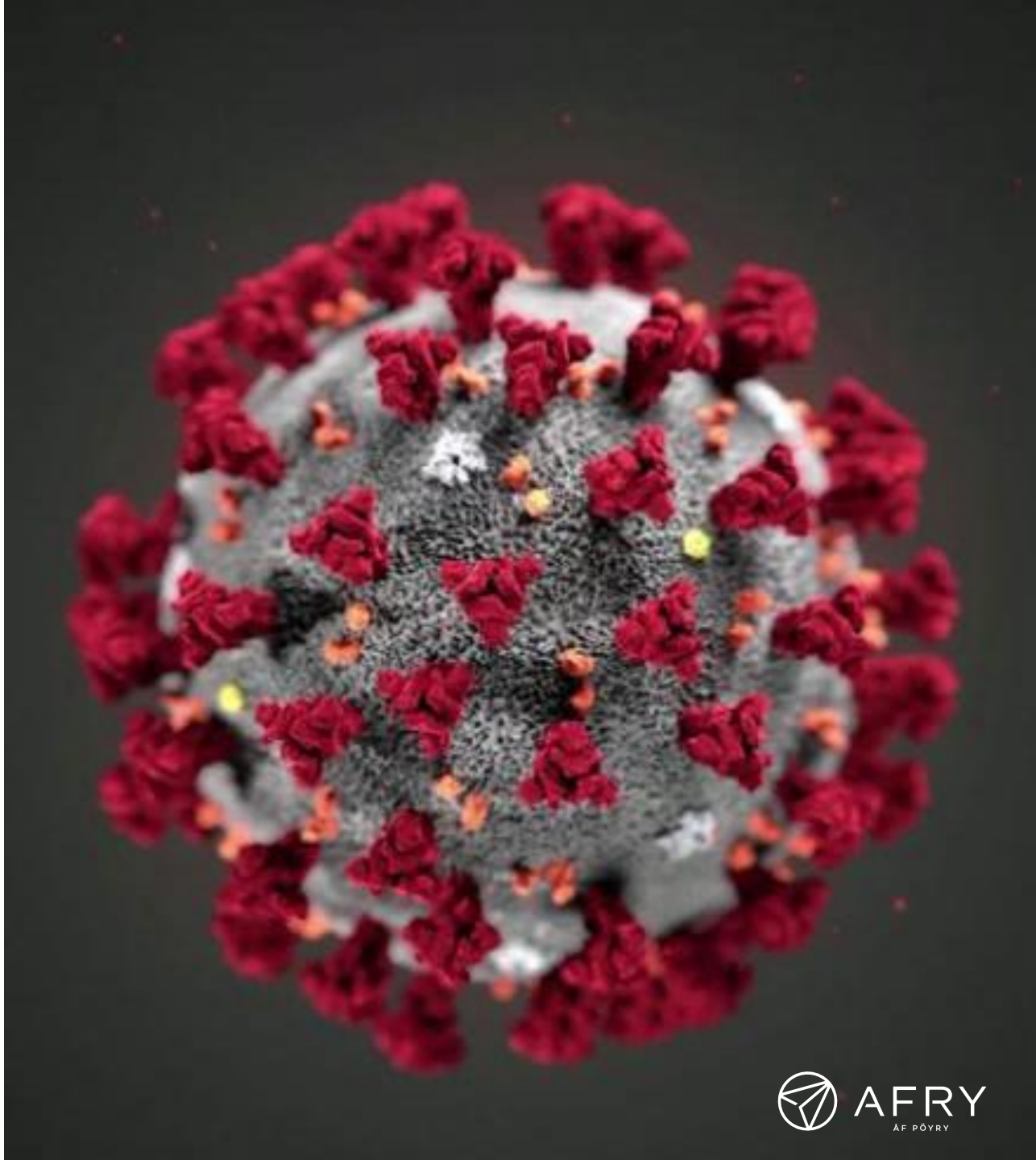


CONCLUDING REMARKS

COVID Impact

- Clearly impacting electricity demand
- Rebound will depend primarily on return of economic activity
- Associated challenges for RE sector:
  - *Near-term:* Supply chain disruption / ability to meet COD deadlines
  - *Near-term:* Financing availability and/or increased off-taker risk
  - *Longer-term:* Reduced demand for new capacity?
  - *Longer-term:* Reduced economic attractiveness if fuel prices do not also recover
- Associated opportunities for RE sector:
  - M&A transactions continue
  - Increased interest in sustainability (?)



CONCLUDING REMARKS

Batteries will be a key enabler…

— More wind and solar means more need for flexible resources to balance the intermittency

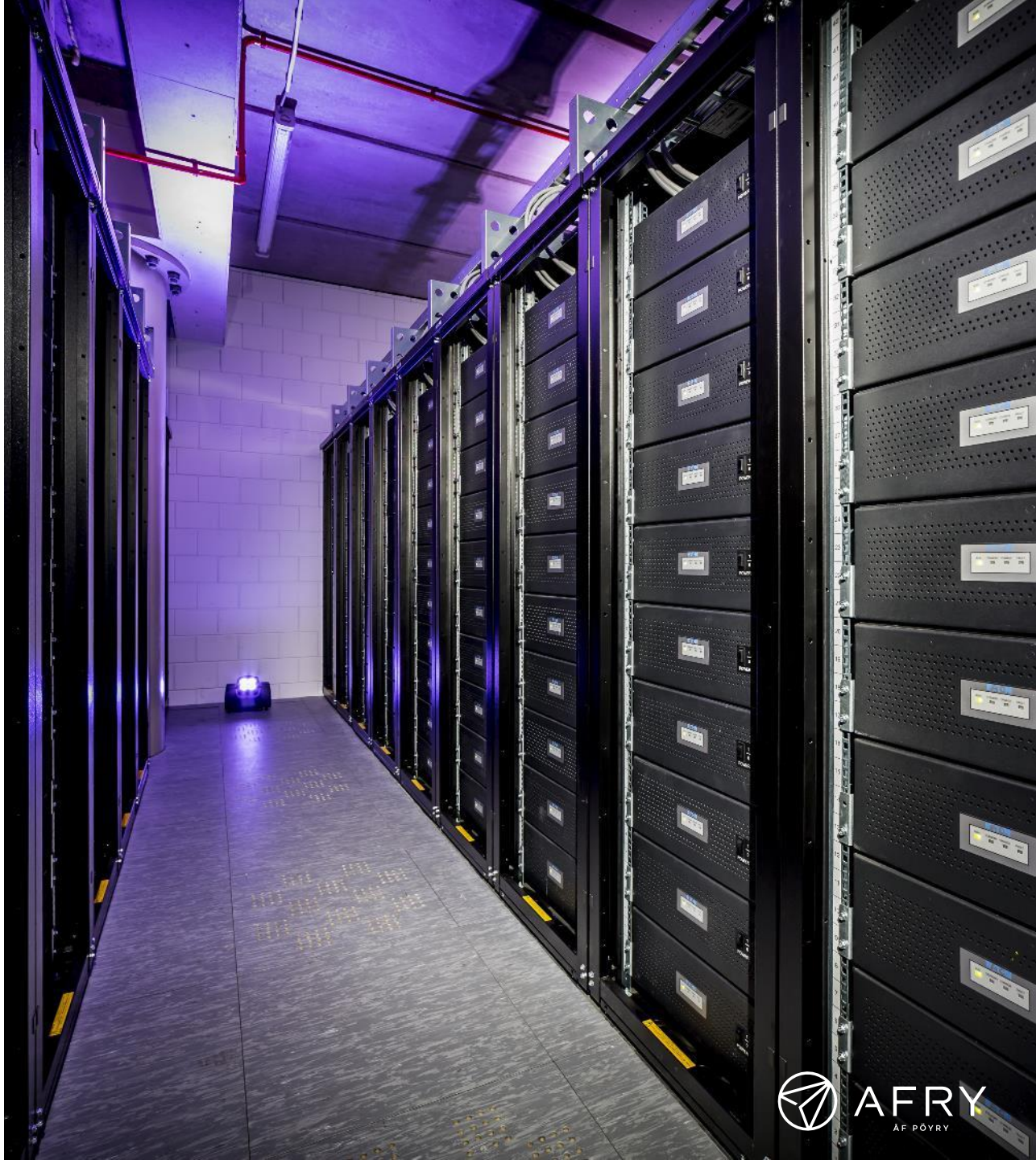
— Declining costs make batteries an increasingly attractive provider of flexibility

— Local system operators (slowly) gaining experience with batteries

… but growth will likely continue to lag other regions of the world

— In non-liberalized markets, battery deployment will depend on the utility internally deciding to pursue batteries

— The liberalized (and liberaliz*ing*) markets largely do not have products or markets (e.g., A/S markets) where batteries would effectively compete



CONCLUDING REMARKS

Many opportunities for those targeting South East Asian renewable investment opportunities – but the devil is in the details

Project developments	**There are renewable projects under development and in the planning phase in Southeast Asia – there are also a number of assets coming up for transaction**
Commercial, political and technical challenges	**Developers of renewable projects have a complex set of commercial decisions to make requiring in-depth understanding of the policy, regulatory, and financial environments in the South East Asian markets**
Cost reductions and locational factors	**RE resource levels are often strong, but good sites can be hard to find** **RE will be increasingly cost-competitive, but will COVID-19-related impacts on fuel prices affect relative economics?**
Key risks to consider	**Off-taker risk, PPA/curtailment risk, and exchange/convertibility risk (among others) can be significant in SE Asia** **How will COVID-19 affect the industry?**

CONCLUDING REMARKS

AFRY is supporting clients in South East Asia in identifying the attractive RES investment options and market entry strategies

Strategy to support entry and acquisitions

- Renewables strategy at multi levels from familiarisation through to execution and acquisition
- Examination of the renewables value chain to identify optimal market entry opportunities
- Investment opportunity assessment and business case analysis
- Industrial & commercial renewables (including PPA design)

Analysis and detailed modelling

- Detailed modelling of impact of intermittency
- Analysis of renewable technology and asset specific capture rates
- PPA assessment and design

Policy mechanisms and macro economics

- Developing renewables strategy at national and regional levels
- Examination of societal benefits of renewables
- Support to lobbying efforts and identify support mechanisms and policy to promote renewable capacity growth

CONCLUDING REMARKS

AFRY also provides a complete range of technical consulting services for power projects all across Asia

- Owner's Engineering
- EPC/EPCM/Contractor's Engineer
- Lender's Engineer/Advisor
- Feasibility studies

- ✓ Thermal Power
- ✓ Renewable Energy
- ✓ Hydropower
- ✓ Power Transmission & Distribution
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*Ranked #4 in power generation globally**

>70 GW
combined capacity of thermal power plant projects designed and built

250+
Involved in over 250 solar power projects globally

2,250
experts in power sector consulting and engineering globally

>10%
Contribution to totally hydropower capacity globally

* source: ENR 2019 international design firms
All ENR rankings in power sector (internationall design firms):
- All power generation #4
- Cogeneration #1
- Hydropower #4
- T&D#4
- Fossil Fuels #5
- Nuclear Power #5

CONCLUDING REMARKS

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— AFRY's renewables and market modelling teams for Southeast (and East) Asia are here to support project developers and investors looking to enter markets in Southeast (and East) Asia

— **Contact us** to find out more information

matthew.h@afry.com

— **More webinars** will follow with most relevant topics, and any update on the evolving situation

Next week's webinar:

The Middle East electricity sector: the impact of coronavirus and low oil prices

Thursday 23rd April

10 AM BST / 11 AM CEST

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