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A UK-Indonesia Low Carbon Energy Partnership

The anatomy of the 2021 energy price crisis

The reality and the lessons the learn for Indonesia

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Background consensus of situation – by others

Why has this all happened? – global, regional & national reasons

(Ref to: https://www.zerohedge.com/energy/what-earth-going-commodities-morgan-stanley-explains)

The story **starts in China**. The combination of a **post-COVID-19 recovery** and **unusually hot weather** has **increased consumption of electricity** sharply this year. Most of China's electricity is produced from coal, but **domestic coal production is increasingly struggling to keep up** – the result of **regulatory reforms, under-investment** and **more stringent HSE** inspections. Another important source of electricity generation in China is hydropower**,** but because of **droughts in key parts of the country, hydropower has failed to grow this year too.**

Over the summer, this led to power crunches that forced regional governments to curtail consumption – street-lights were even switched off at night in a number of regions. Another victim of these measures was aluminum smelting, which is a particularly electricity-intensive process. Normally, China supplies ~60% of the world's aluminum. **With its production curtailed and global demand continuing to grow, aluminum prices soared.**

China's domestic coal shortage compelled it to turn to the seaborne market. However, **coal production elsewhere has also had its issues** – e.g., **heavy rains and staff shortages** in Indonesia, **railway disruptions** in Russia and **unrest** in South Africa**. As the seaborne coal market tightened, global coal prices rallied.**

The same factors drove up China's demand for LNG, but here China was not alone. For example, **droughts in Brazil** also curtailed its production of hydropower, driving up LNG demand as well. With a number of **production outages at liquefaction terminals,** the global **LNG market has tightened severely** in the last few months.

Europe is usually the end market for a substantial share of the world's LNG. However, with other regions pulling harder, **European LNG imports declined sharply this summer**. At the same time, **power generation from offshore wind disappointed** – it has not been that windy in Europe recently – boosting demand for natural gas. Yet, with gas supply from Russia and other regions constrained, **Europe was unable to build natural gas inventories** as much as it normally does in the summer. **European gas inventories are now unusually low for this time of the year,** with winter yet to start. **As natural gas prices largely set electricity prices, they have surged in tandem.**

So, what does this all mean? We highlight three conclusions:

- **First, this sequence of events shows how inter-connected commodity markets are.** One region impacts another and multiple commodities are eventually linked. A drought in China can drive up the price of electricity prices in Spain but also the cost of soft drink cans in the US.
- **Second, this year has shown how difficult it can be to anticipate such moves**. Even a few months ago, the common view was that practically all these commodities were abundant and would become more so over time.
- **Finally, it shows how little margin of safety there is in the world's energy system**, and this has important implications for the future.

Over the next few decades, the world will need to fundamentally retool the way it produces and consumes energy. So far, the supply side of the energy system is adjusting faster than our consumption patterns. The world is still in the early stages of its decarbonisation journey, so this creates the potential for further instability and squeezes in the future. Their impact could be felt well beyond the energy and commodities markets, impacting everything from growth to inflation to politics.

Specific UK issues – full market exposure due to reduced storage capacity (ref: https://www.hellenicshippingnews.com/time-for-europe-and-the-iea-to-create-a-strategic-gas-reserve/)

Across Europe, levels of gas storage are down. Storage sites are 72% full, compared with inventory levels of 94% at the same time in 2020 across the 28-member group of nations. In the UK—which fully exited in the EU last year—closure of the Rough storage site in the North Sea in 2017 now looks premature, leaving the country with just seven relatively small commercial storage facilities.

Instead of infrastructure, the British government prefers to rely on a supply strategy dependent on the international market. The UK has domestic supply but is dependent on importing gas from diverse sources including Qatar, Nigeria, Norway, the US and interconnections with Europe, which in theory can import energy indirectly from Russia.

The result of the UK's strategy and the various forces pressuring international energy markets has been a near 500% increase in domestic wholesale gas prices in the last year, forcing six small suppliers into bankruptcy and the government to subsidize the production of vital industrial gases to protect the economy and food supply chain. However, Business Secretary Kwasi Kwarteng has described the issue of storage as "a bit of a red herring."

Still, the establishment of government-controlled strategic reserves of gas held in storage beyond existing commercially owned inventories could play an important role protecting countries like the UK from future price spikes. For example, the IEA requires its 30-member nations to hold the equivalent of 90-days oil imports in strategic reserve in case of unexpected supply shocks. No such policy exists for gas, which is dependent across Europe on commercial inventories and is at the mercy of foreign suppliers.

Examples of supporting evidence

Overview of topics addressed

- Critique of current situation
- UK compared with RoW
- Role of offshore wind in UK
- Offshore wind in Indonesia

UK – anatomy of the crisis, mainly about gas price

Global natural gas (https://tradingeconomics.com/)

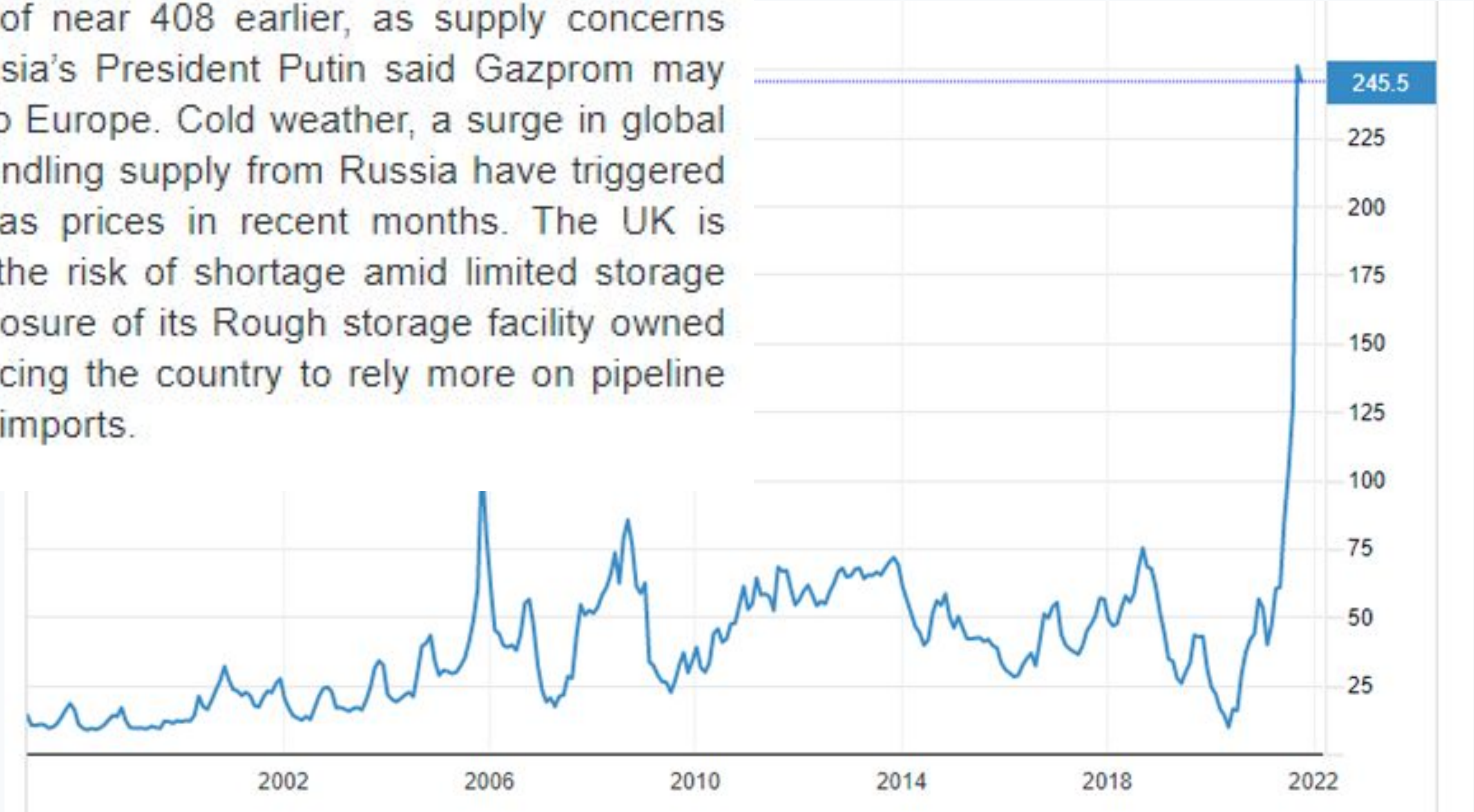
US natural gas futures hovered around $5.7 per million British thermal units, below the 7-year high of $6.5 early hit on October 6th, following Russia's announcement to export more gas to Europe via Ukraine. Demand rose sharply as utilities attempted to raise stockpiles ahead of the winter season in the northern hemisphere, which is forecasted to bring colder than usual temperatures in the coming weeks. At the same time, eolic electricity production is expected to drop, further tightening energy supplies. The US, which has become a major LNG exporter, has seen domestic storage remain below five-year average levels.

EU – natural gas

Dutch Natural Gas futures settled 9.3% lower at 87.61 euros a megawatt-hour on Friday, extending declines for the third session on easing concerns about tight supplies after Russia, Europe's biggest gas supplier, pledged to send more gas via Ukraine than it's contracted to this year. Yet, the natural gas market remains highly volatile after breaking records above 160 earlier in the week, amid a strong rebound in demand and reduced inventories. At the same time, heating demand is expected to increase next week due to forecasts of below-normal temperatures while wind generation is set to drop.

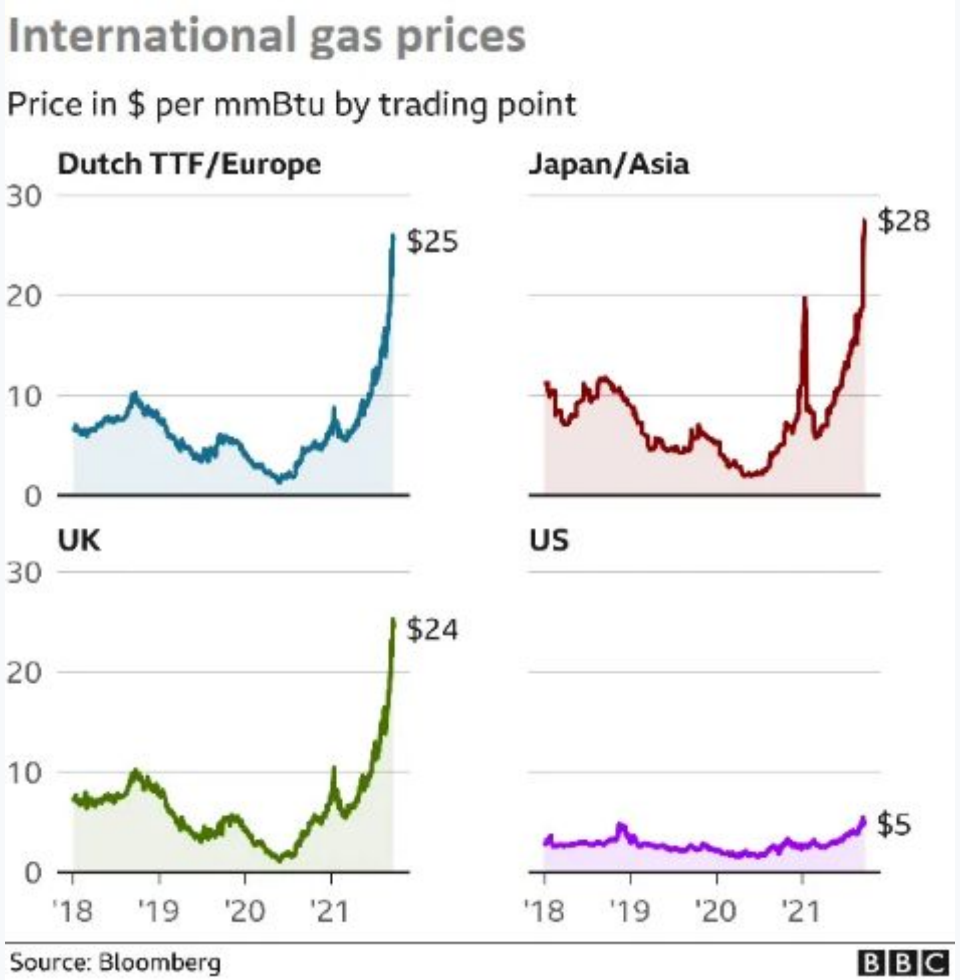
UK natural gas

UK Natural Gas futures traded around 266 pence a therm, having touched a record high of near 408 earlier, as supply concerns eased slightly after Russia's President Putin said Gazprom may increase supplies to help Europe. Cold weather, a surge in global energy demand and dwindling supply from Russia have triggered a spike in European gas prices in recent months. The UK is particularly exposed to the risk of shortage amid limited storage gas capacity after the closure of its Rough storage facility owned by Centrica in 2017, forcing the country to rely more on pipeline and liquified natural gas imports.



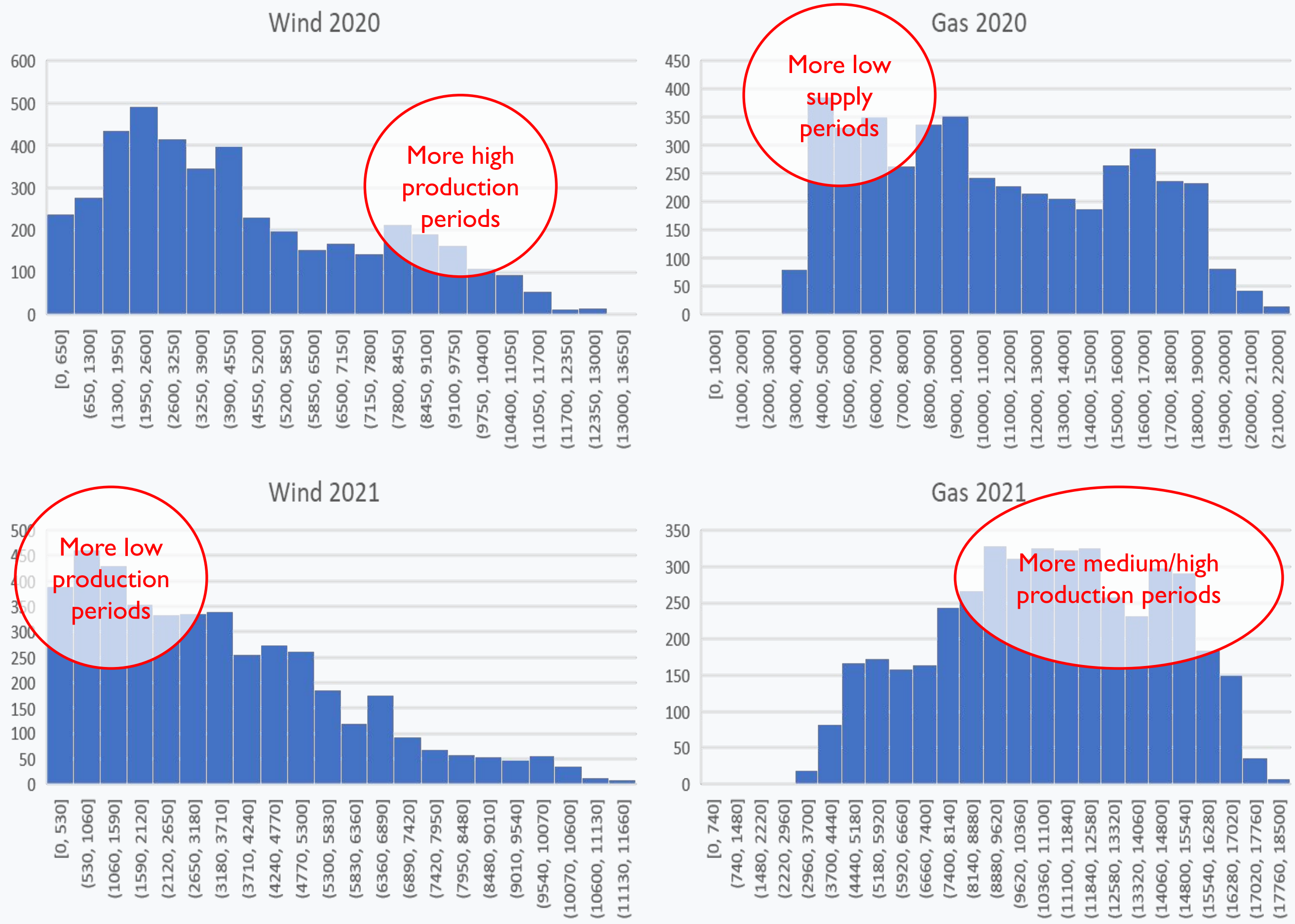
Conclusions

- Gas prices and linked electricity price increases are not a UK specific issue
- Whilst lower than usual wind production has happened real issue in UK is lack of strategic storage capacity and lack of geographical renewables balancing



UK 2020 and 2021 comparison – wind and gas supply (amount per hour)

- There has been a difference in wind power output in 2021 compared to 2020
- There has also been a difference in gas usage between 2020 and 2021
- These differences are however similar in scale to other years and periods
- The difference is the global supply and national storage context within which these variations sit!
- Slightly higher demand, less storage/reserves and higher global prices mean that UK retail prices have sored



UK – the recent wind energy story

UK wind output over the last year

Scale of variation in wind speed month by month (average across the UK)

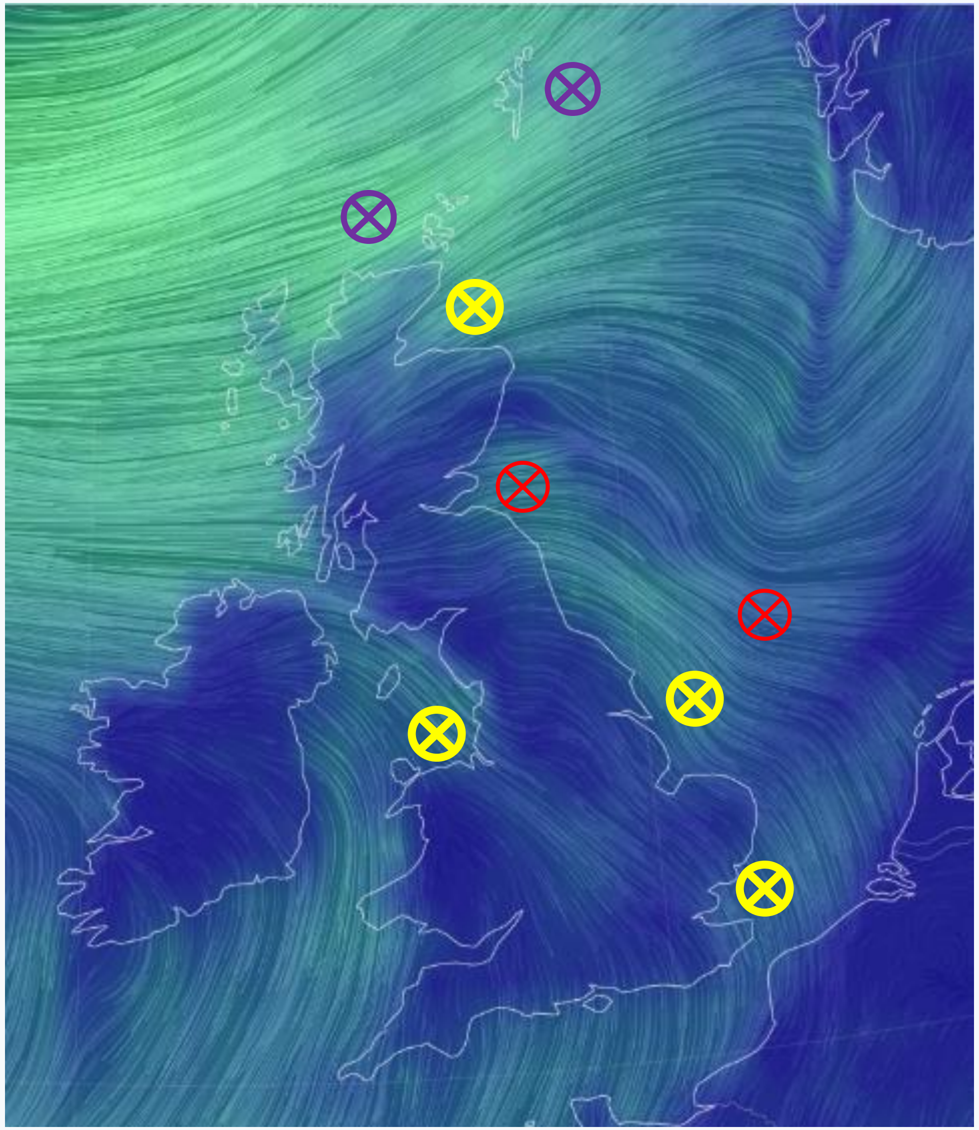
Deviation from 10-year mean

Calendar month	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021 p
January	-2.1	+0.6	+0.7	-0.3	+2.7	-2.2	+3.0	+1.5	-0.5	-2.7	-2.8	-0.1	-1.7	+0.1	+1.8	+0.3	-2.3	-0.1	-2.5	+0.1	-3.0
February	-0.6	+4.6	-0.4	+0.1	-0.4	-0.9	-0.6	+1.5	-1.6	-2.9	+0.5	-0.5	-1.3	+3.9	-0.0	+1.0	+0.9	-0.3	-0.1	+4.7	+2.2
March	-0.2	+0.5	-0.8	+0.2	-0.8	+0.1	+1.2	+2.1	+0.8	-0.9	-2.3	-2.0	-1.1	+0.3	+1.1	-1.1	-0.4	-0.0	+1.5	+0.7	-0.6
April	+0.3	+0.6	-0.0	+0.7	+1.1	+0.6	-1.2	+0.0	-0.4	-0.7	-0.8	-0.5	+1.3	-0.4	-0.8	-0.3	-0.2	-0.1	-0.6	-1.2	-1.9
May	-1.4	+1.1	+1.1	-2.0	+0.1	-0.1	+0.1	-1.6	+1.1	-2.1	+2.3	-1.5	+0.2	-1.4	+1.1	-0.9	-1.2	-1.7	-1.9	-0.9	-1.2
June	+0.6	+2.0	+0.7	+0.9	-0.5	-0.6	-0.5	+0.6	-1.1	-1.3	-0.2	+0.1	-0.3	-1.7	+0.5	-1.0	+1.1	-0.9	+0.1	+0.2	-0.8
July	-0.2	-0.8	+0.7	-0.2	-0.6	-0.6	+0.4	+0.4	+0.8	+1.1	-1.1	-0.8	-1.5	-1.0	+0.5	-0.1	-0.0	-1.4	-0.7	+0.2	-2.2
August	-0.8	-1.4	-0.6	-0.3	-0.2	+0.3	+0.4	+0.7	+1.9	-0.2	-0.5	-0.4	-0.0	+1.0	+0.2	+0.4	+0.1	-0.3	+0.4	-0.0	-1.0
September	+0.3	-2.3	-1.3	+2.0	+0.7	-0.1	+0.0	-1.2	+0.1	+0.1	+1.9	+0.6	-1.0	-3.0	-1.5	+0.5	-0.3	+0.9	-0.8	-0.4	
October	+2.2	-0.7	-0.5	+0.5	+0.4	-0.0	-2.0	+1.8	-0.6	-0.3	+1.4	-2.0	+0.3	+1.0	-2.4	-2.6	+1.1	-0.3	-1.3	-0.2	
November	-1.0	-0.3	+0.2	-1.5	-1.1	+2.3	-0.7	-0.2	+1.9	-0.8	+0.1	-1.5	-1.7	-2.2	+1.2	-2.2	-1.1	-0.1	-2.4	-0.6	
December	-0.9	-0.8	-0.2	+0.8	-1.2	+2.5	+1.1	-0.8	-1.6	-3.0	+3.2	+0.1	+3.3	+1.1	+4.1	-0.4	-0.0	-0.2	+0.6	-0.6	
Year	-0.3	+0.2	-0.0	+0.1	+0.0	+0.1	+0.1	+0.4	+0.1	-1.1	+0.1	-0.7	-0.3	-0.2	+0.5	-0.5	-0.2	-0.4	-0.7	+0.1	

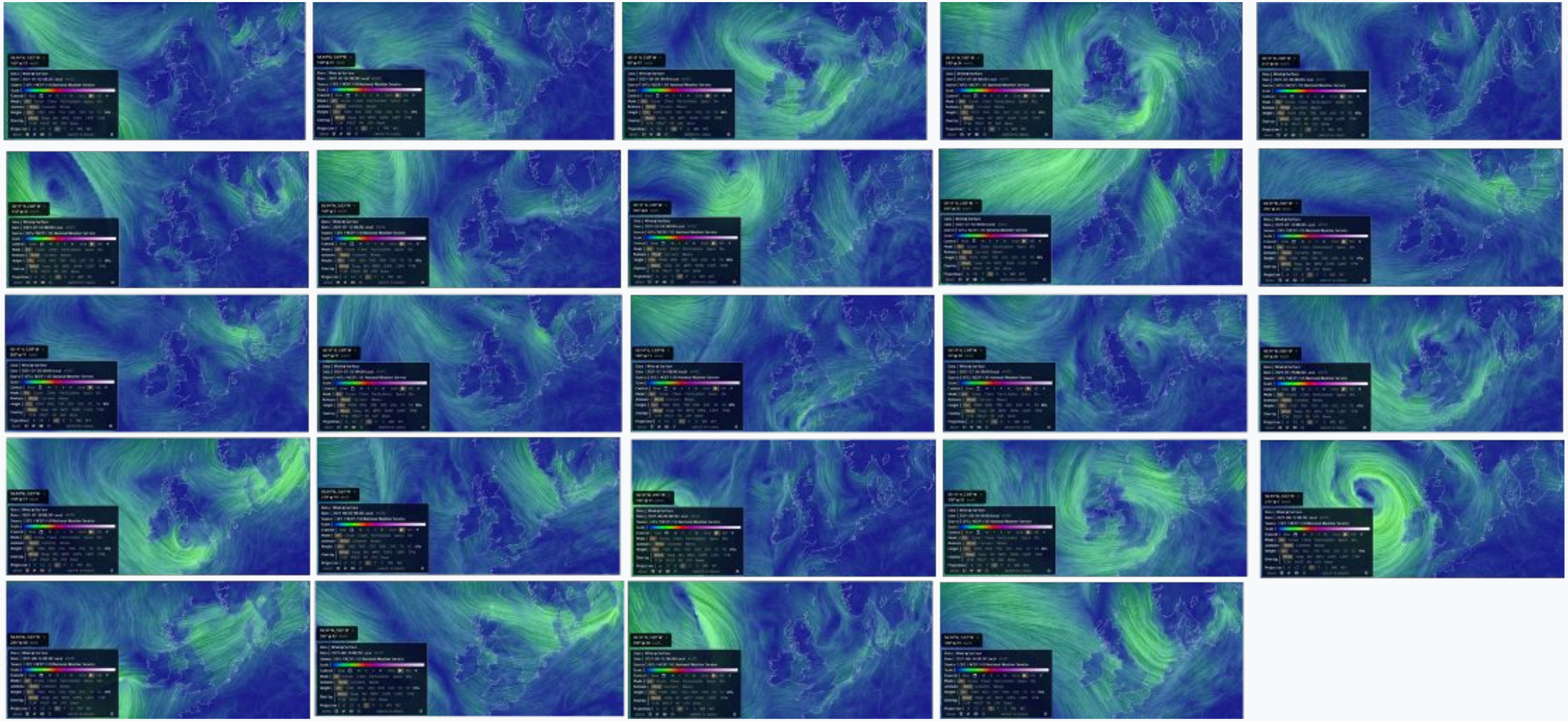
- This data shows that the variation in 2021 has been up to -2.2 (index units), however, such variation is not unprecedented and 2010 had even greater variation
- Variability in weather regimes has long been known about, can be modelled and is strongly predicted to increase
- Any energy systems need to be designed to meet such conditions, not to fail when they arise

Demonstrating the role of spatial planning in supply resiliance

- As outlined each place has a distinct pattern of wind speeds over time
- Managing the distribution of development areas can help determine the resilience and capacity of supply
- Data has been compared fo rthree sets of developments – base case , planned and new
- Data was compared from 0800 on every second day over three months



UK wind energy patterns – maritime and temperate climate



The difference of building across weather regimes

- This data shows simultaneous wind speeds across 8 different regions of the UKCS
- On most days there is quite a bit of variance
    - Biggest difference 44 km/hr (10 to 54)
    - Lowest difference 13 km/hr (5 to 18)
- Adding new areas does not make a difference every day but over time the aggregate effect in marked

		Shetland East	Orkney West	Moray Firth	Offshore Forth	Dogar Bank	Offshore Humber	Thames	Irish sea	With new	Plan	Delta with new over plan	Base	Delta with new over base
Aug	2	22	11	14	5	16	17	15	19	14.9	14.3	0.5	16.3	-1.4
	4	18	13	11	13	17	16	11	5	13.0	12.2	0.8	10.8	2.3
	6	33	36	35	44	27	27	41	43	35.8	36.2	-0.4	36.5	-0.8
	8	20	23	17	9	38	42	45	37	28.9	31.3	-2.5	35.3	-6.4
	10	13	15	18	20	12	21	24	17	17.5	18.7	-1.2	20.0	-2.5
	12	19	15	7	15	26	18	19	38	19.6	20.5	-0.9	20.5	-0.9
	14	3	19	30	39	20	30	24	10	21.9	25.5	-3.6	23.5	-1.6
	16	43	19	31	39	54	43	39	28	37.0	39.0	-2.0	35.3	1.8
	18	21	42	42	21	21	21	27	24	27.4	26.0	1.4	28.5	-1.1
	20	21	22	18	11	7	3	18	10	13.8	11.2	2.6	12.3	1.5
	22	21	10	13	15	25	16	26	18	18.0	18.8	-0.8	18.3	-0.3
	24	17	12	2	4	14	14	30	13	13.3	12.8	0.4	14.8	-1.5
	26	39	14	22	37	30	40	39	12	29.1	30.0	-0.9	28.3	0.9
	28	11	10	2	6	23	28	36	9	15.6	17.3	-1.7	18.8	-3.1
	30	25	16	16	22	29	29	32	17	23.3	24.2	-0.9	23.5	-0.3
	Average	21.7	18.5	18.5	20.0	23.9	24.3	28.4	20.0	21.9	22.5		22.8	
Sept	2	20	13	3	16	28	22	22	25	18.6	19.3	-0.7	18.0	0.6
	4	8	23	21	12	14	19	27	20	18.0	18.8	-0.8	21.8	-3.8
	6	20	25	9	16	12	11	9	5	13.4	10.3	3.0	8.5	4.9
	8	17	12	6	4	16	17	20	11	12.9	12.3	0.5	13.5	-0.6
	10	17	28	9	12	15	22	21	14	17.3	15.5	1.8	16.5	0.8
	12	33	16	25	30	25	19	13	9	21.3	20.2	1.1	16.5	4.8
	14	22	4	17	23	27	22	23	18	19.5	21.7	-2.2	20.0	-0.5
	16	3	32	15	15	13	12	11	14	14.4	13.3	1.0	13.0	1.4
	18	20	26	9	8	20	14	16	5	14.8	12.0	2.8	11.0	3.8
	20	20	39	19	16	15	8	17	15	18.6	15.0	3.6	14.8	3.9
	22	25	37	31	37	28	22	13	30	27.9	26.8	1.0	24.0	3.9
	24	50	51	39	33	29	30	21	28	35.1	30.0	5.1	29.5	5.6
	26	38	26	35	28	21	22	19	22	26.4	24.5	1.9	24.5	1.9
	28	44	37	33	34	40	31	28	16	32.9	30.3	2.5	27.0	5.9
	30	10	54	45	43	53	36	27	33	37.6	39.5	-1.9	35.3	2.4
	Average	23.1	28.2	21.1	21.8	23.7	20.5	19.1	17.7	21.9	20.6		19.6	
Oct	2	41	45	32	42	52	33	26	21	36.5	34.3	2.2	28.0	8.5
	4	45	34	26	30	36	38	42	23	34.3	32.5	1.8	32.3	2.0
	6	14	14	26	39	31	41	55	20	30.0	35.3	-5.3	35.5	-5.5
	8	8	19	9	22	17	19	13	5	14.0	14.2	-0.2	11.5	2.5
	10	36	50	35	27	27	24	19	24	30.3	26.0	4.3	25.5	4.8
	12													
	Average	28.8	32.4	25.6	32.0	32.6	31.0	31.0	18.6	29.0	28.5			
										Aggregate delta		12.4		33.6

Wind power variability and balancing mechanisms

- Wind power outputs vary by place at any time and also by minute, hour, day, month year etc
- Energy demand also varies over space and time, but this may or may not be in phase with generation
- It is important therefore to try and match generation and demand as far as possible
- Wind power variability can be balanced by:
    - spreading generation sites into different wind regime areas
    - Storage vectors such as batteries, hydrogen, ammonia, kinetic mechanisms can help modulate/control output
    - Alternative renewables a such as solar, hydro, geothermal, biomass and other blue energy resources can also be used as balancing supplies
    - Alternative back-up mechanisms can include gas and oil/diesel power station (Coal and nuclear power stations are less flexible as back-up)
- The key factor is to have an overall energy supply plan and control mechanism which links generation, connectivity, balancing, storage and demand into one integrated system for all types of energy which is predicated upon reaching the carbon transition imperative committed to

Individual wind farm data available

All numbers are to the end of 2020. Analysis by EnergyNumbers.info. Raw data from Ofgem and Elexon	Latest rolling 12-month capacity factor	Life capacity factor	Age (y)	Installed capacity (MW_p)	Total elec. gen. (GWh)	Power per unit area spanned (W/m^2)	Rolling annual capacity factors (click to enlarge)
Total	46.9%	39.7%		10,426	184,198	2.2	
Aberdeen EOWDC	38.2%	37.5%	2.5	93	768	1.7	
Barrow	32.3%	35.7%	14.3	90	4,028	3.2	
Beatrice	46.3%	47.4%	1.6	588	3,894	2.1	
Burbo Bank	37.0%	34.0%	13.2	90	3,544	3.1	
Burbo Bank 2	45.0%	41.1%	3.8	254	3,444	2.6	
Dudgeon	49.6%	48.1%	3.3	402	5,528	3.5	
East Anglia ONE	48.6%	52.3%	0.4	714	1,449	2.3	
Galloper	51.0%	47.0%	2.7	353	3,997	1.5	
Greater Gabbard	43.6%	41.0%	7.4	504	13,540	1.4	
Gunfleet Sands	41.7%	37.0%	10.5	173	5,948	4.0	
Gwynt-y-Mor	37.6%	35.0%	5.5	576	9,862	3.0	

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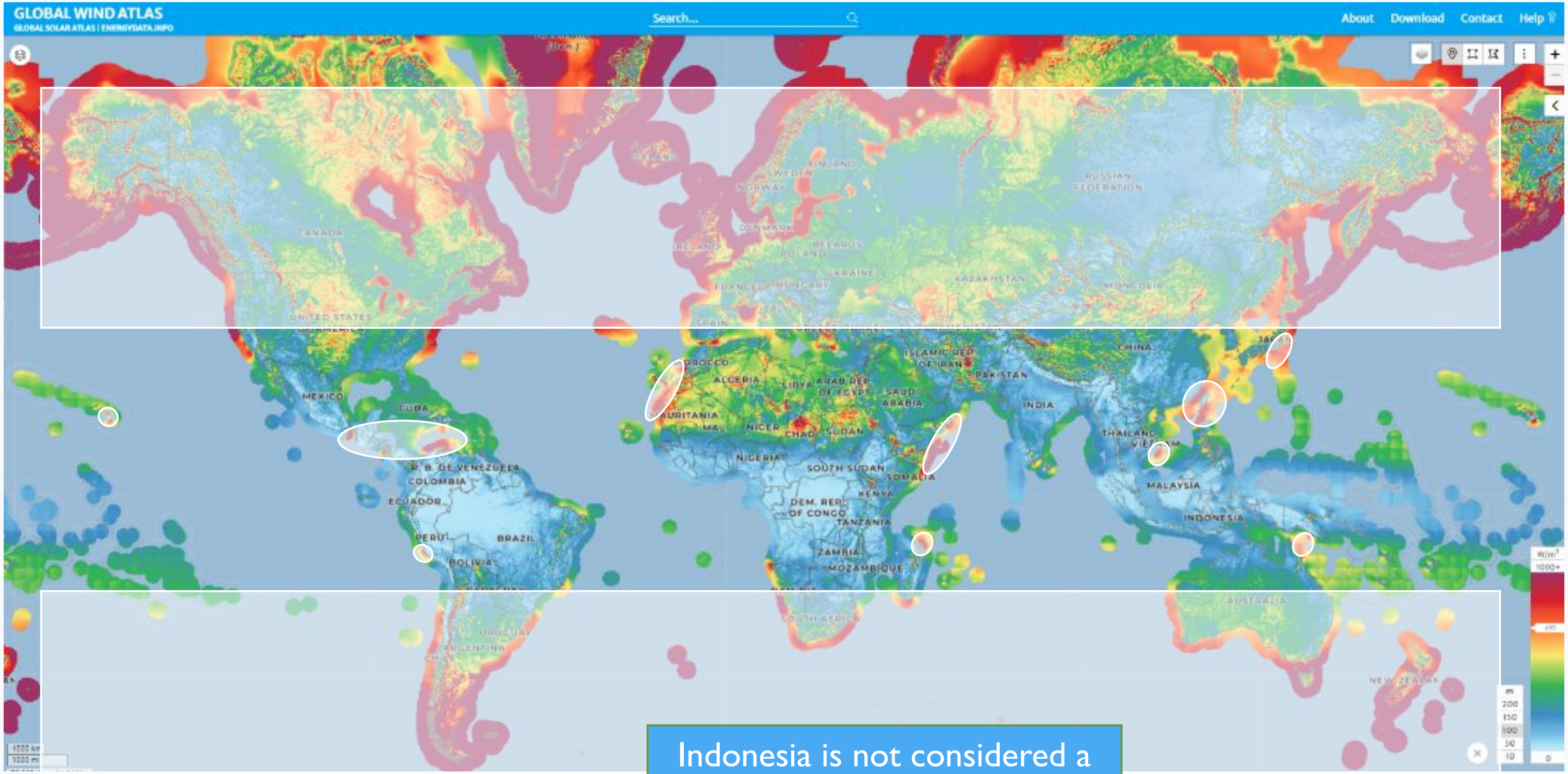
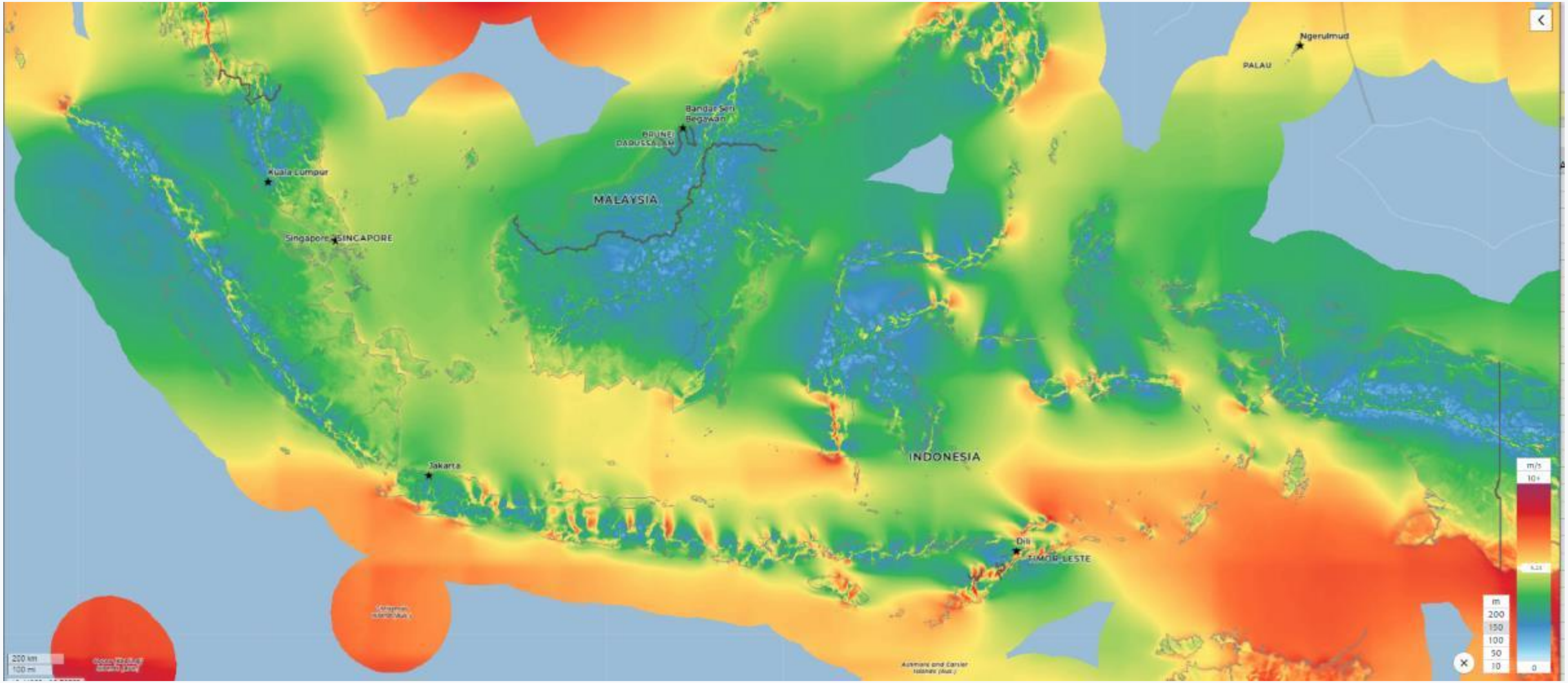
Offshore wind prospects in Indonesia

Global wind resource map



Indonesia is not considered a prime resource area

Indonesia – wind speed data



More than raw resources!

Potential for offshore wind development is linked to:

- Level of energy need
- Availability of alternative energy resources
- The acceptability of development
- Scale of development area in parallel with market demand
- The local cost of offshore wind development
- Any ancillary industrial, blue economy or strategic opportunities

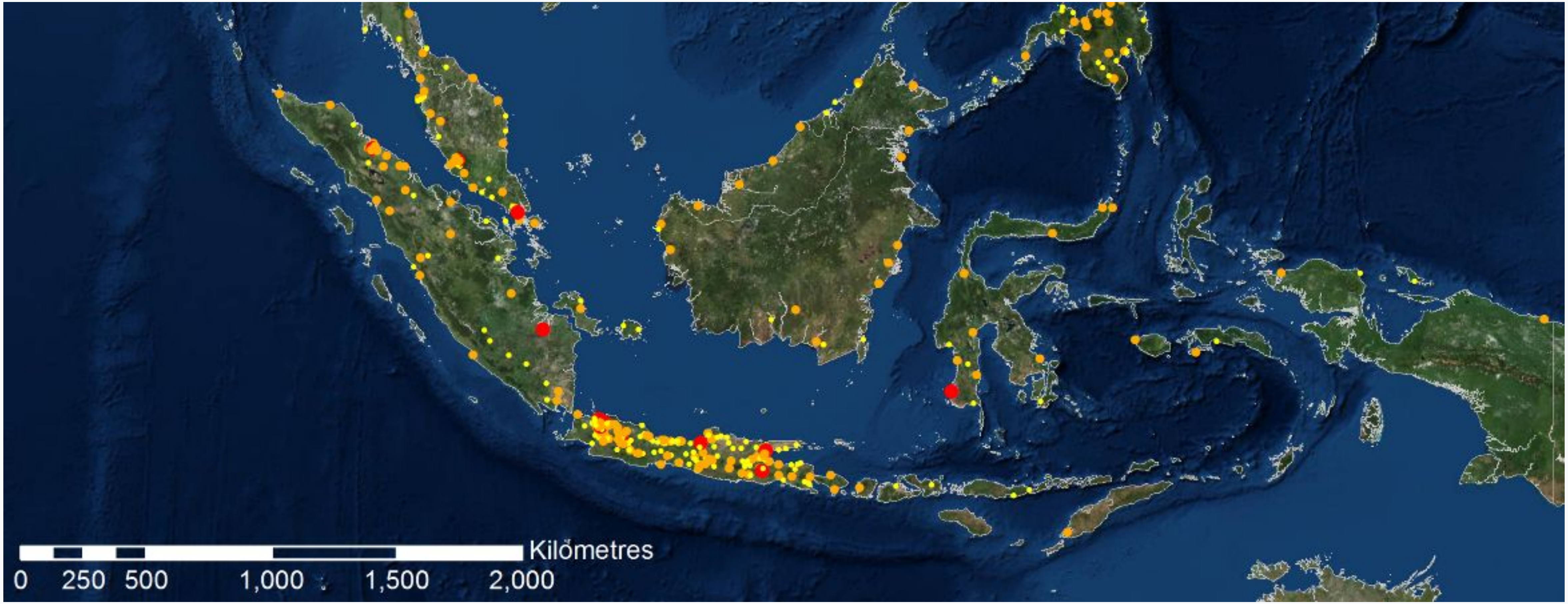
INDONESIA OVERALL

- High/growing energy demand
- High levels of floating solar potential
- Constrained onshore resources & space
- High demands for food, people, biodiversity
- Numerous distant/isolated market nodes
- Major resource area with no local market
- Low levels of extreme conditions
- Strong industrial & blue economy opportunities

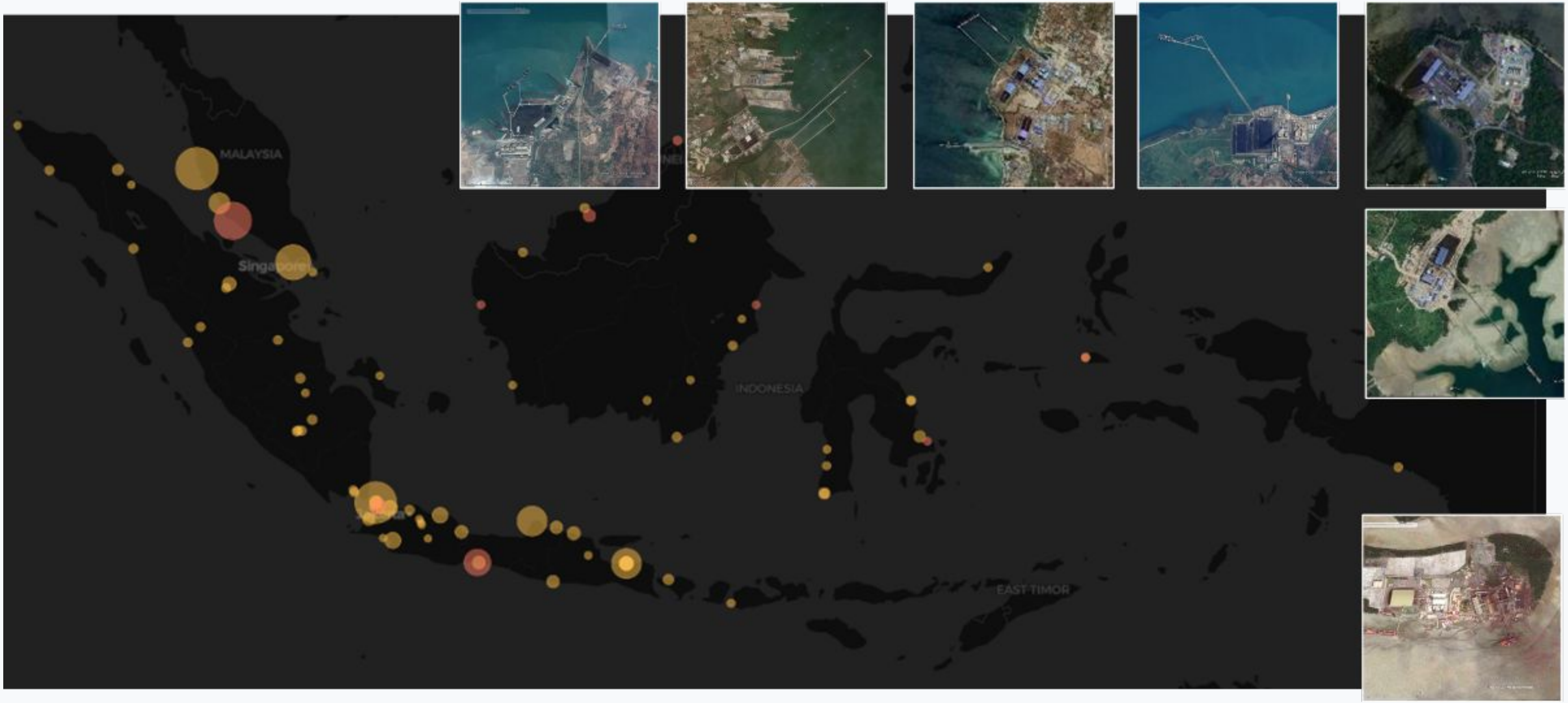
In addition very strong regional character

Indonesia bathymetry

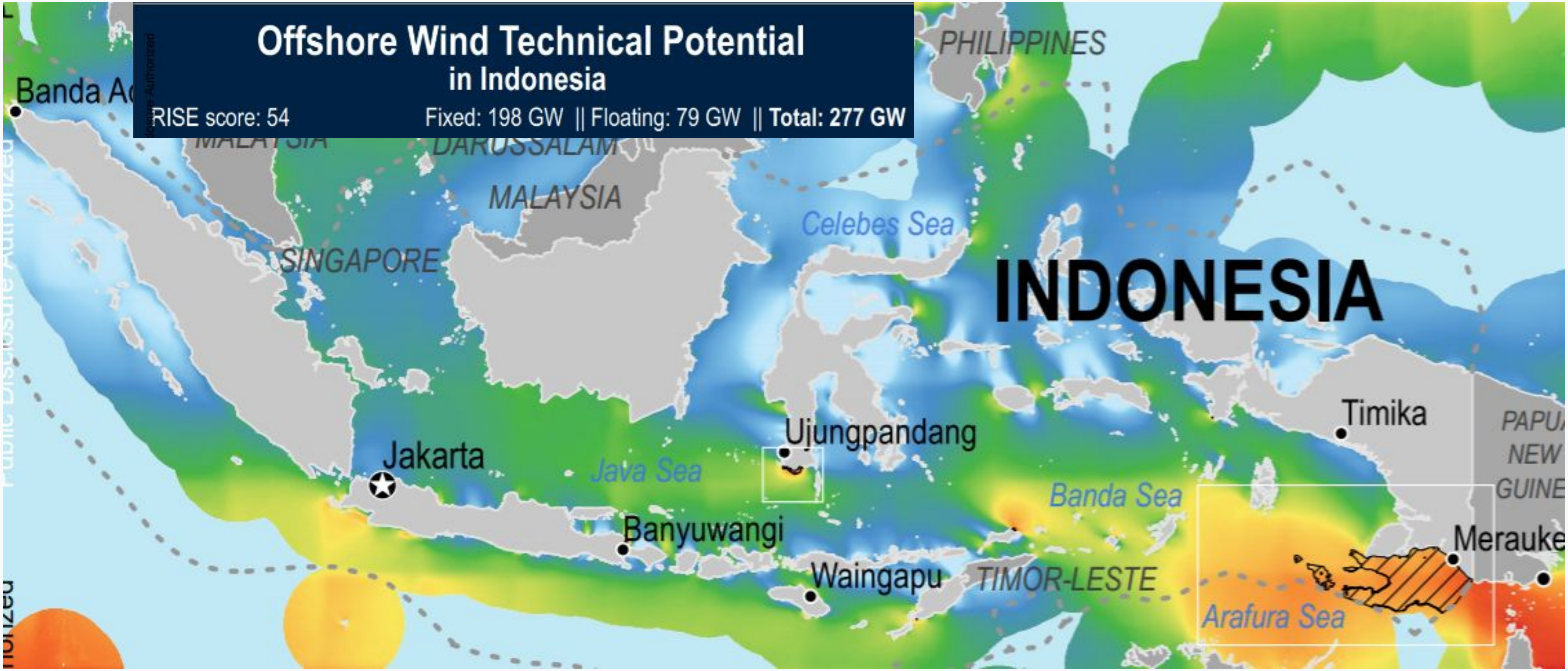
Indonesia - residential and urban markets



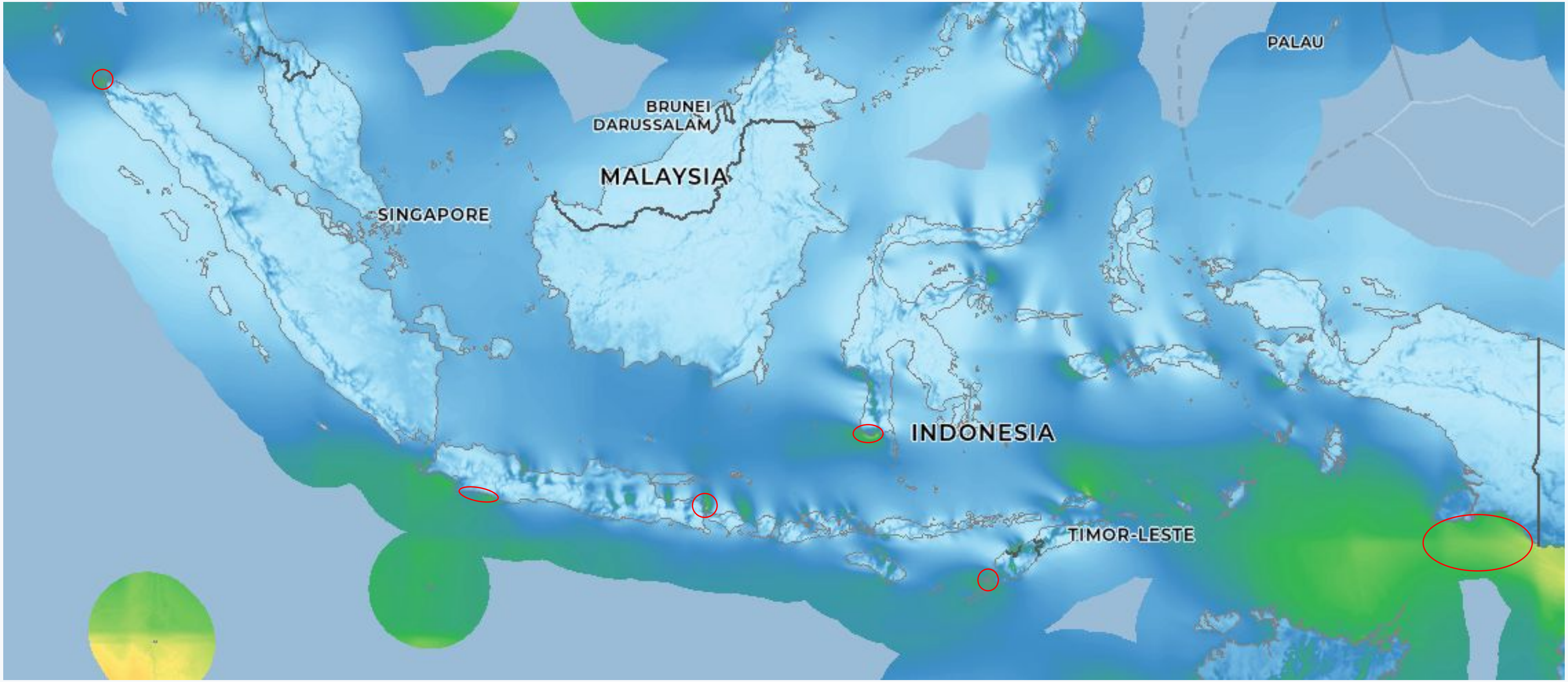
Coal power station support and replacement market



World Bank – depth and resource driven assessment



Other offshore wind development prospects (capacity factors)



Offshore wind overview

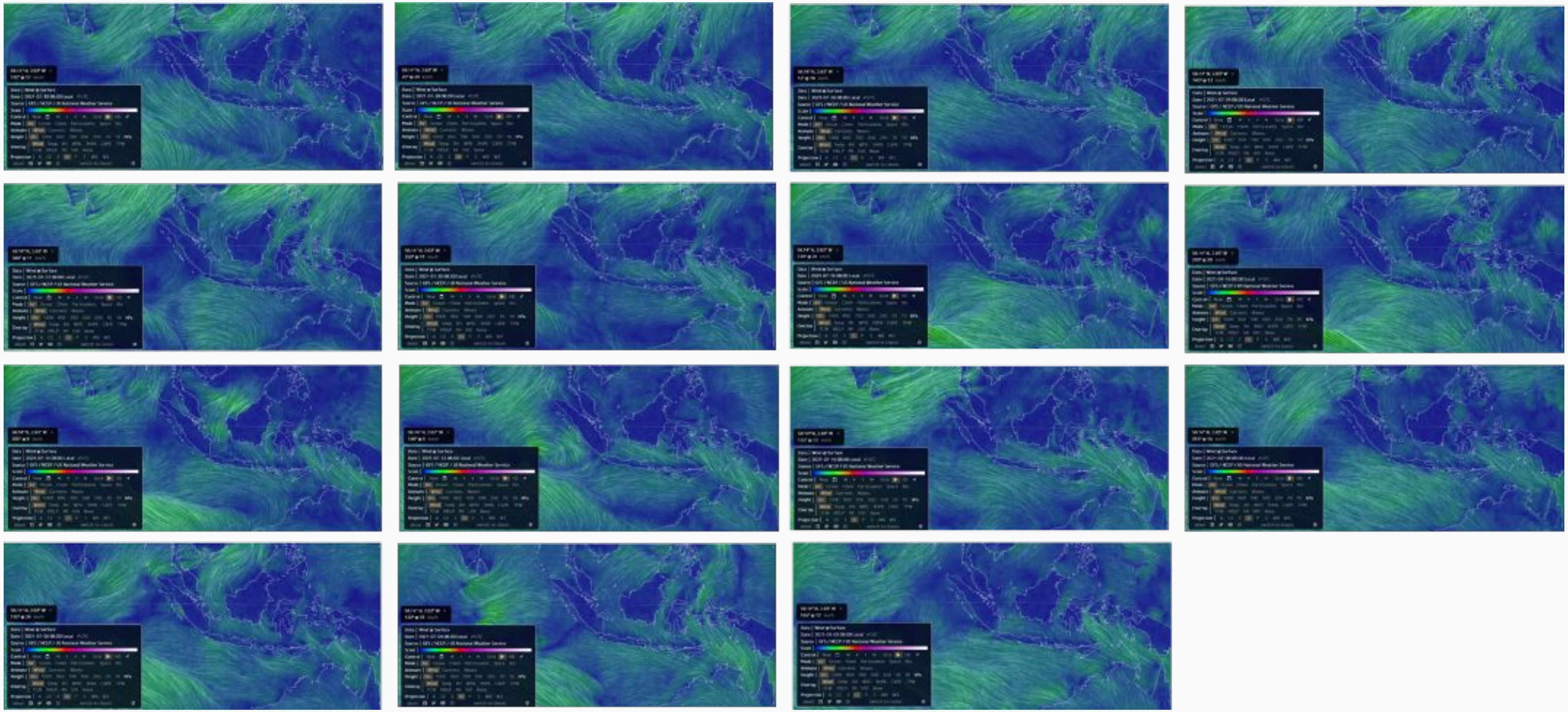
Location	Area	Depth	Number of turbines*	Installed capacity (MW)	Capacity factor	Output (GWh)	Seasonal variation	Daily variation
Aceh	40 km2	10-50 m	20	300	36%	940	Moderate	Night drop off
Garut (S Java)	100 km2	25-100 m	50	750	33%	2153	Very strong	Morning peak
Bali Strait	50 km2	20-100 m	25	375	43%	1403	Very strong	Night drop off
SW Sulawasi	400 km2	10-50 m	200	3000	40%	10440	Moderate	Night drop off
Kupang (Timor)	100 km2	5-50 m	50	750	32%	2088	Very strong	Variable drop off
South of Papua	24,000km2	5-50 m	12,000	180000	41%	642060	Strong	Night drop off
Overall				**185175**		**659084**	Lowest: Jan-Apr	Night suppression

* Number of turbines based upon 1 turbine every 2 km^2 due to unidirectional wind pattern

- These six areas are considered to hold most potential.
- Each will have a unique combination of markets, resources & development attributes
- South of Papua, the largest prospect would need an inter-connector to Java or to serve an export market via an energy carrier such as hydrogen or ammonia etc

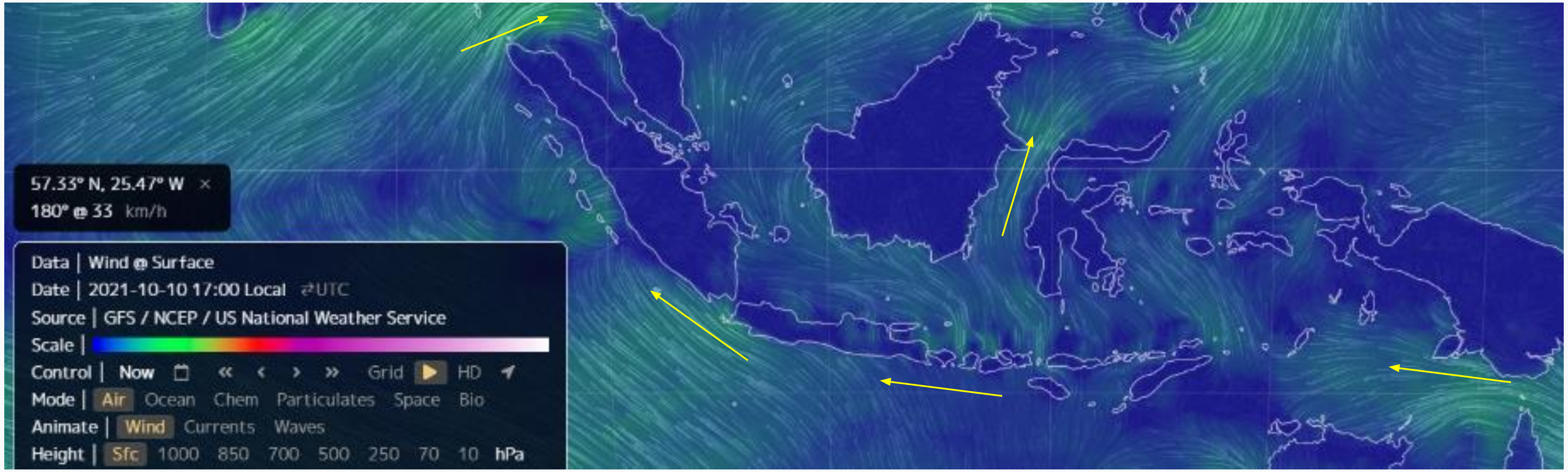
Indonesia – spatial and seasonal variation

Indonesian wind variability – maritime and tropical climate

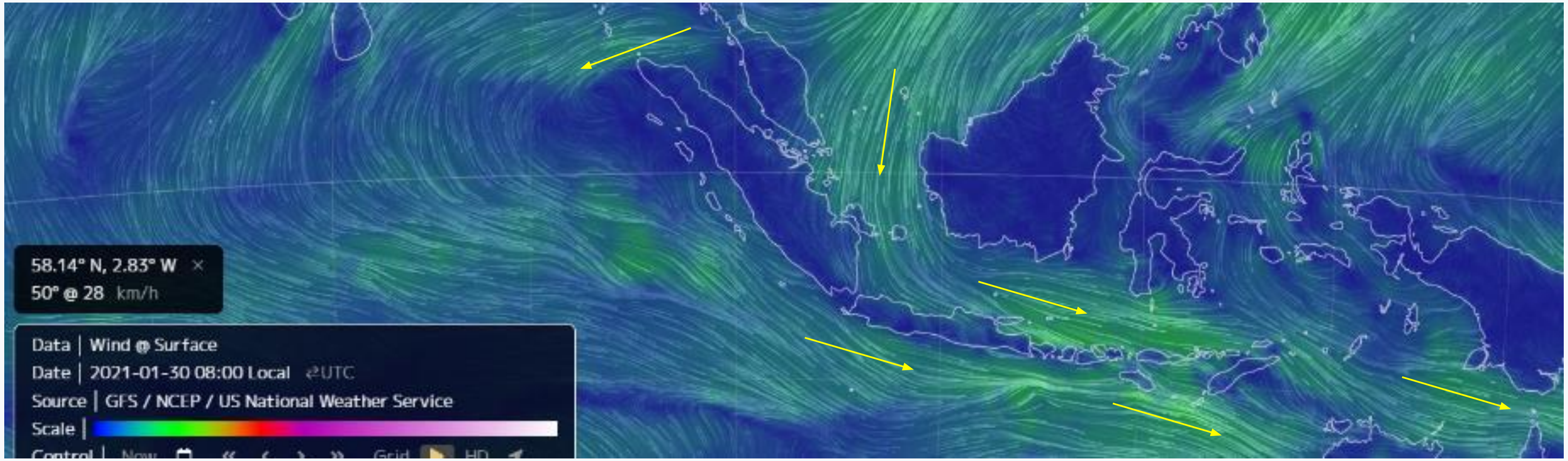


Indonesia – seasonal variation in wind regimes

Dry
April-Oct

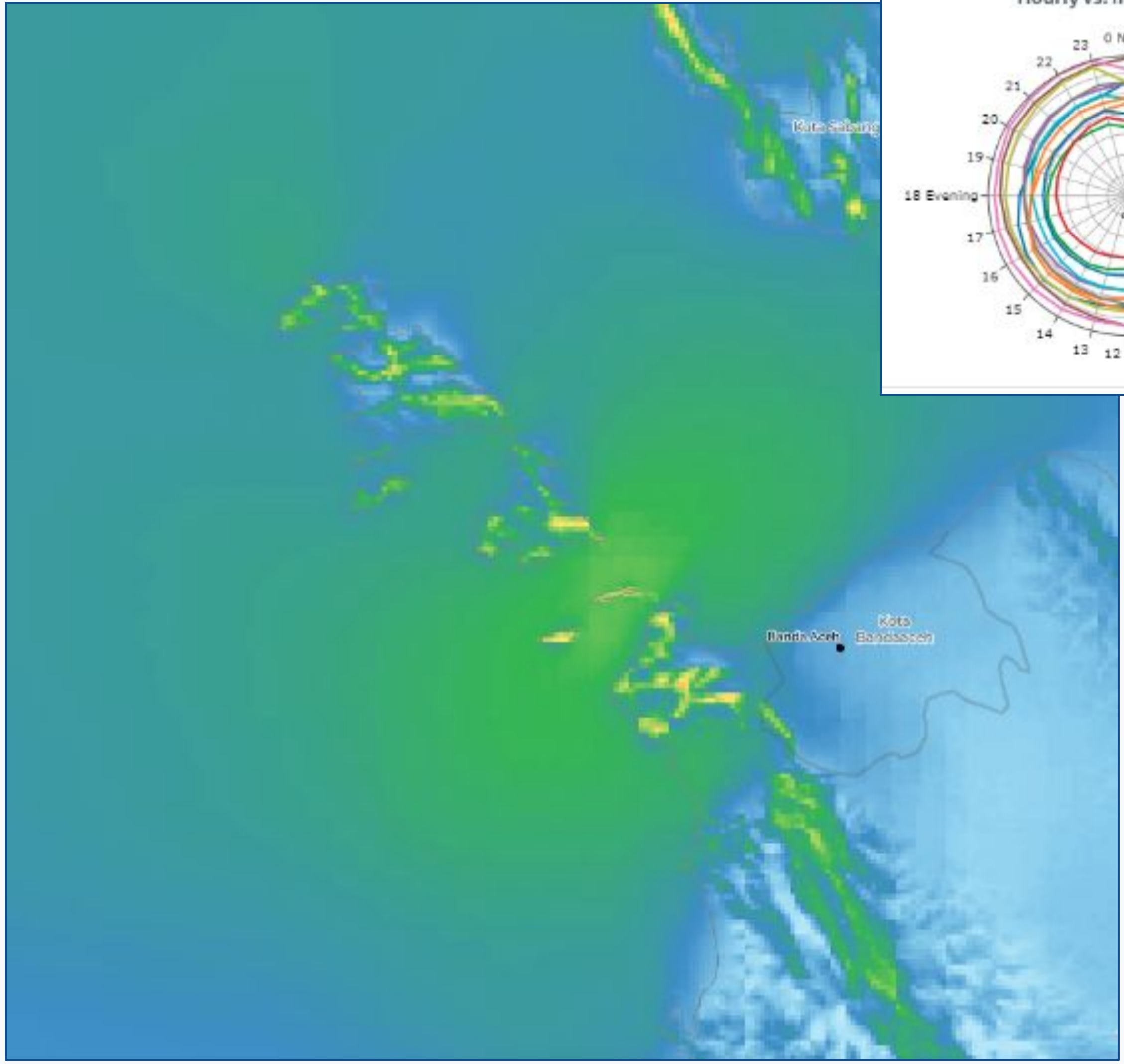


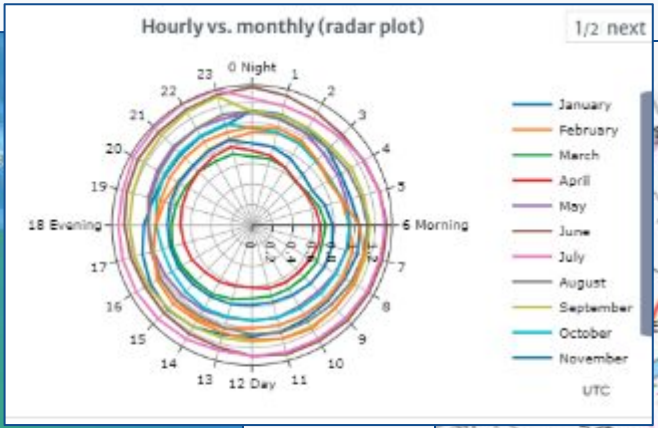
Monsoon
Nov-March

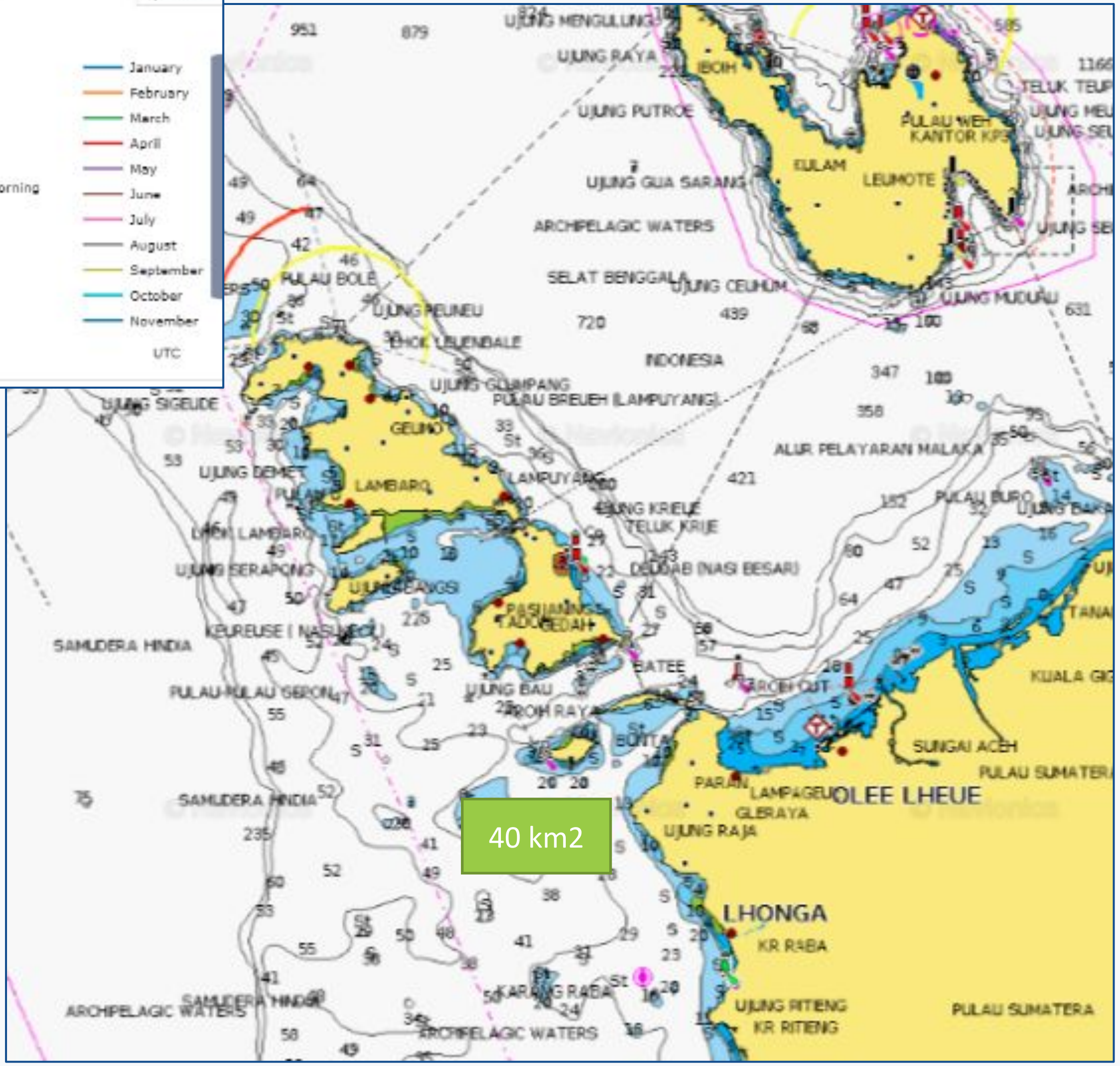


Indonesia - prospective site details

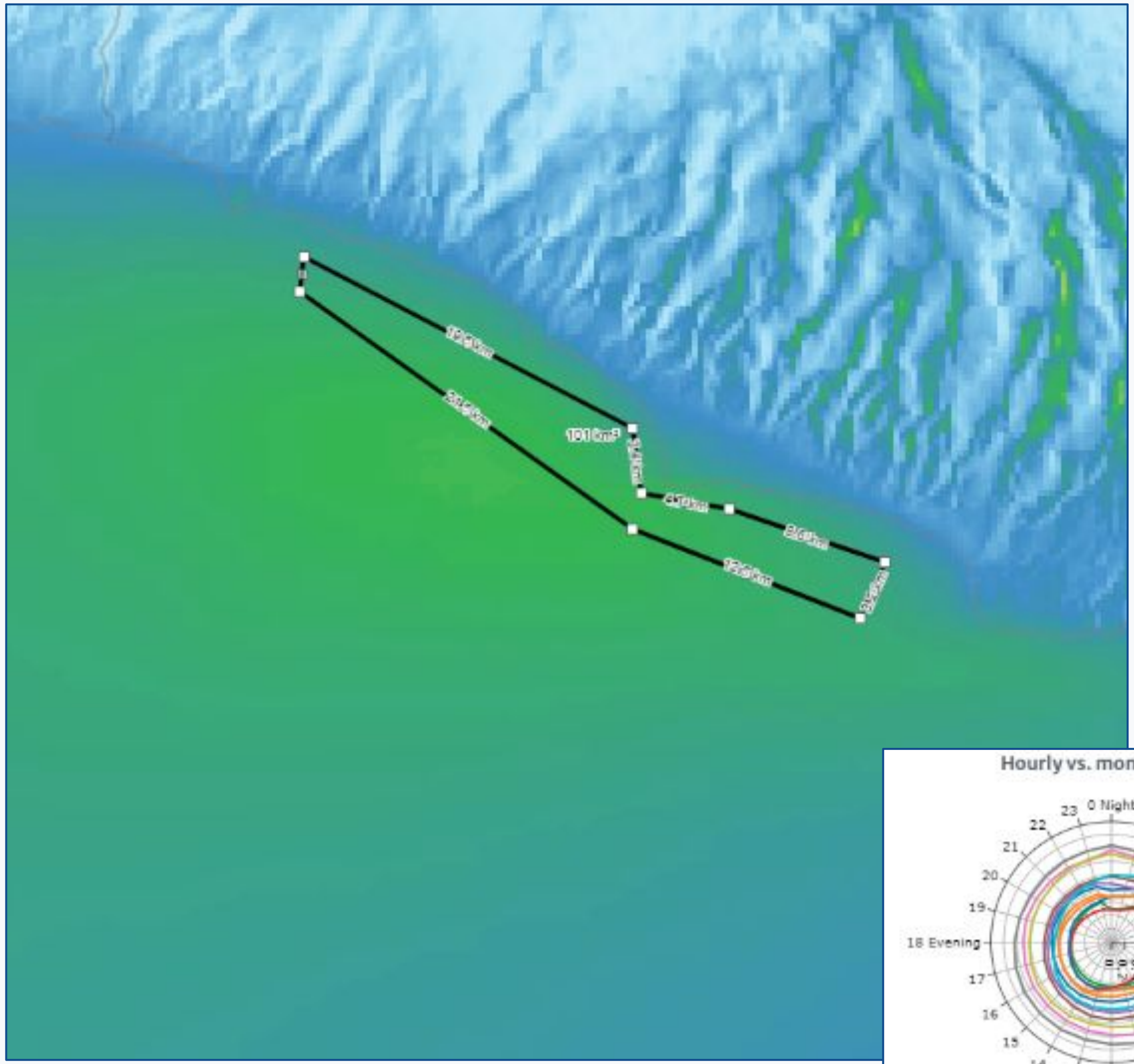
•Ache (Capacity = <1,600 MW; CP = 36%)

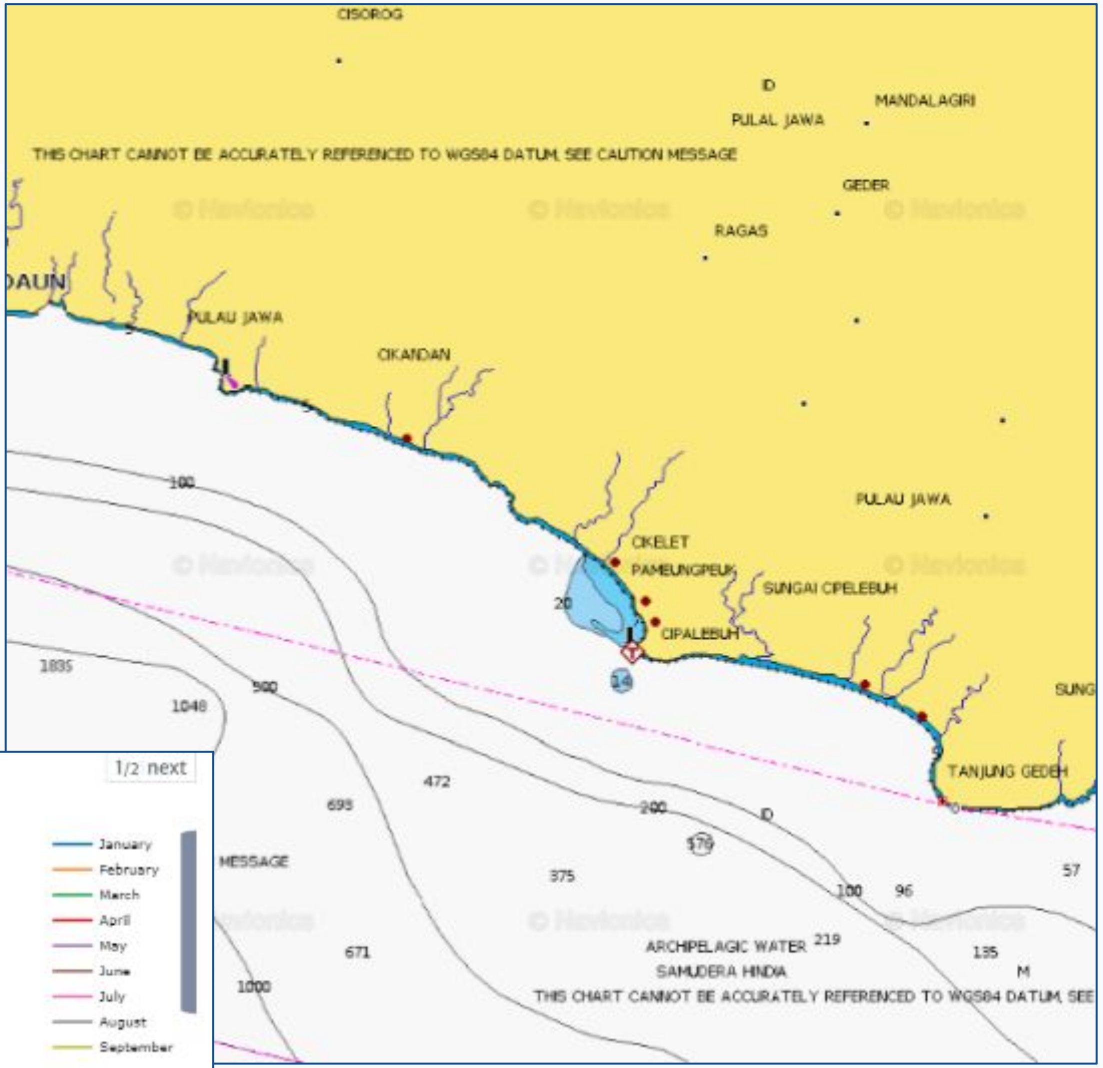


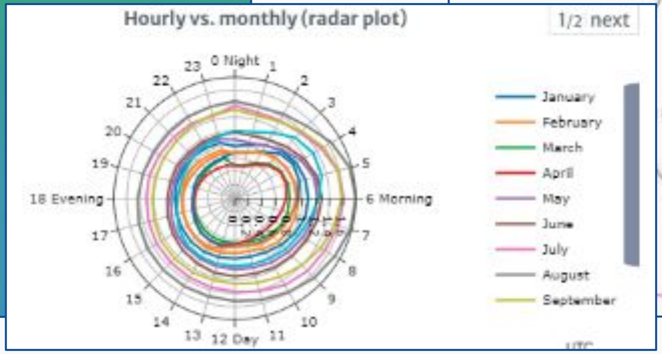




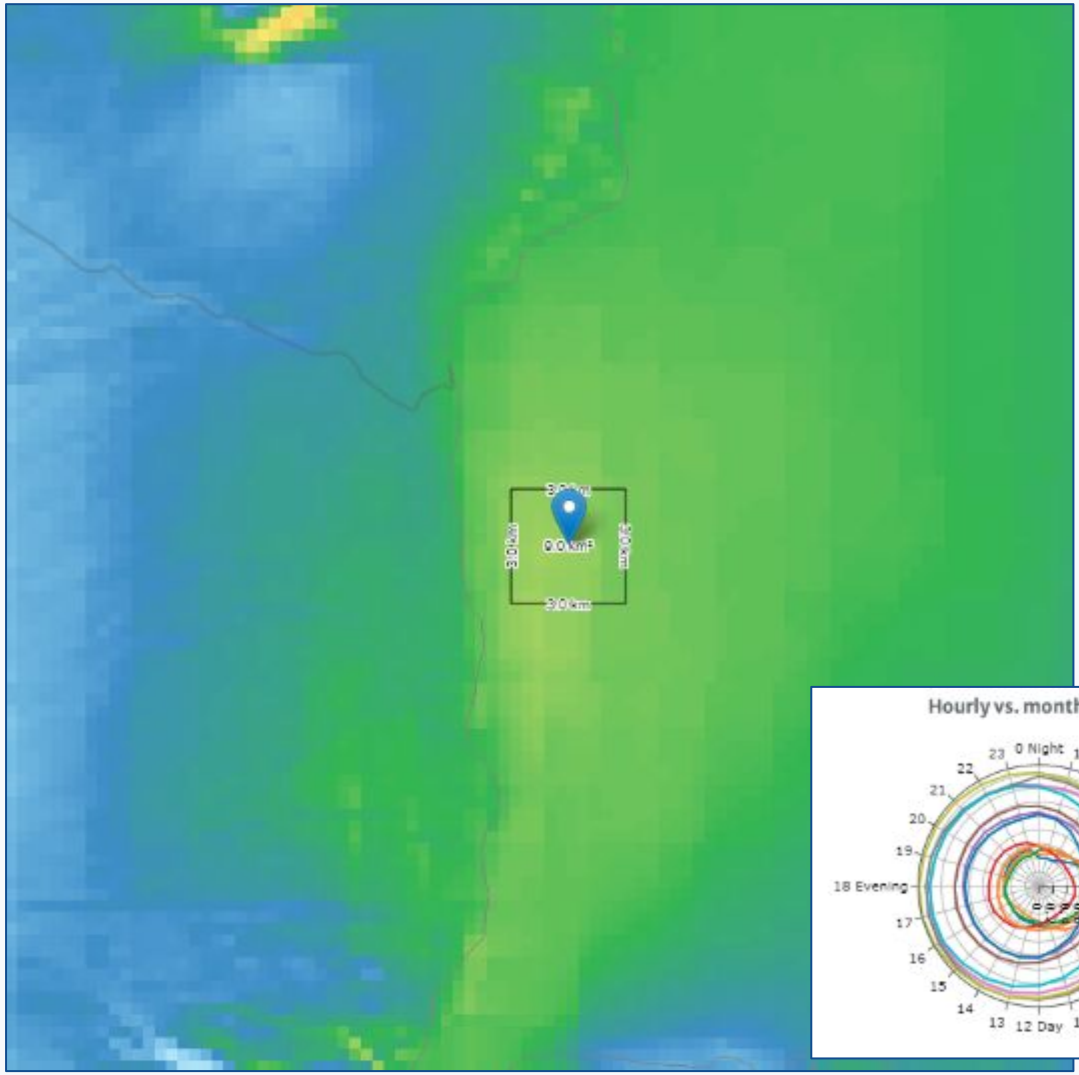
SW Java (Capacity 4,000 MW; CP 33%)

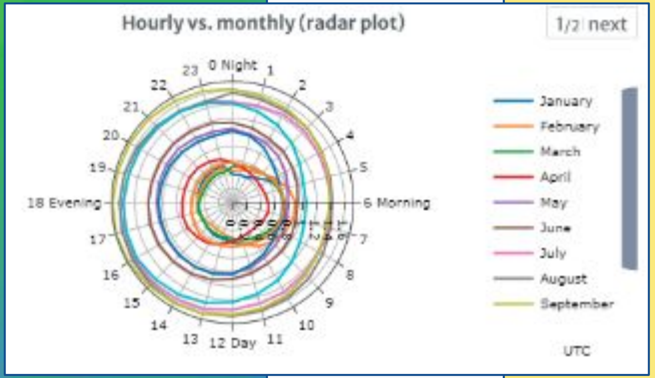


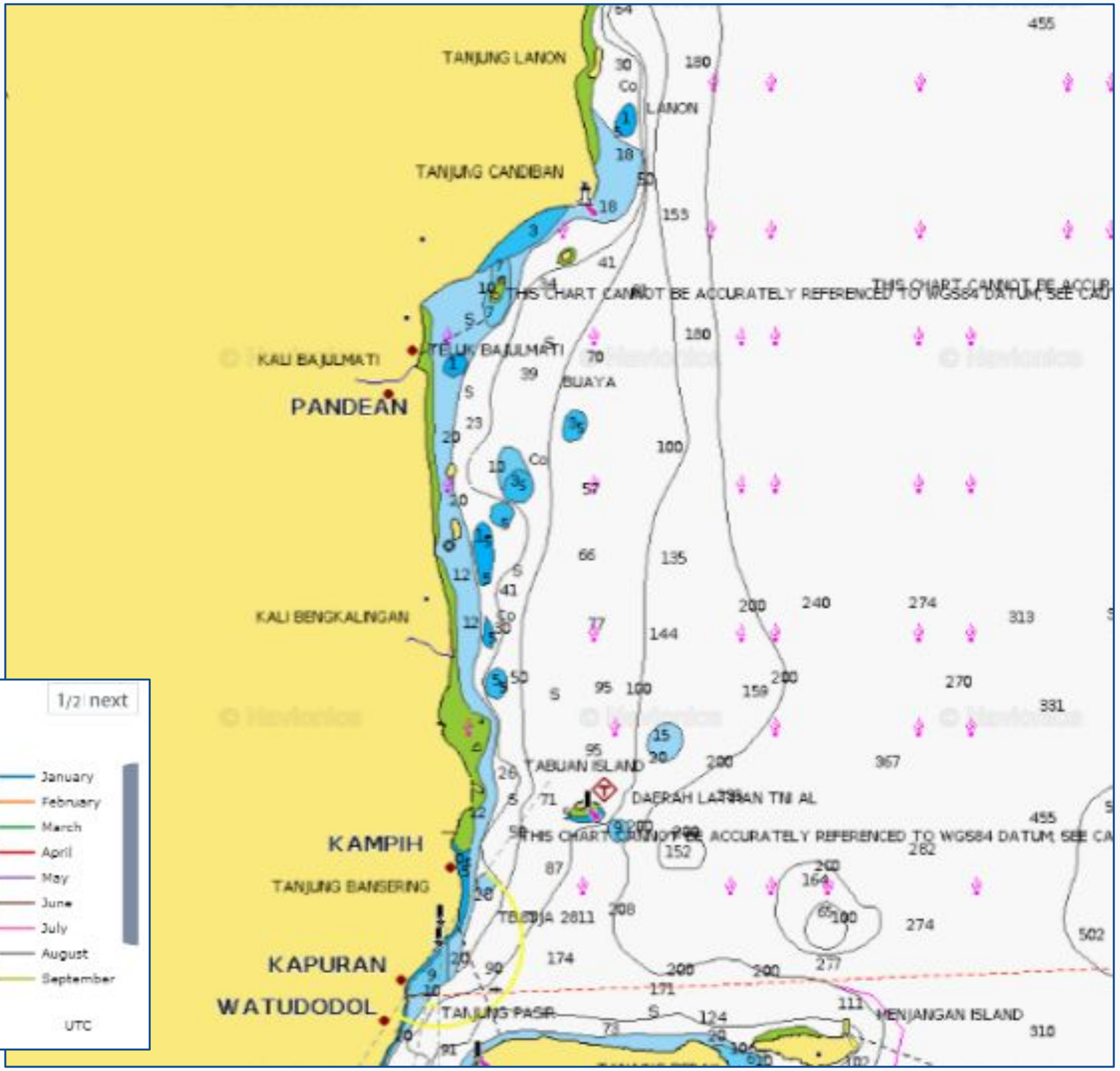




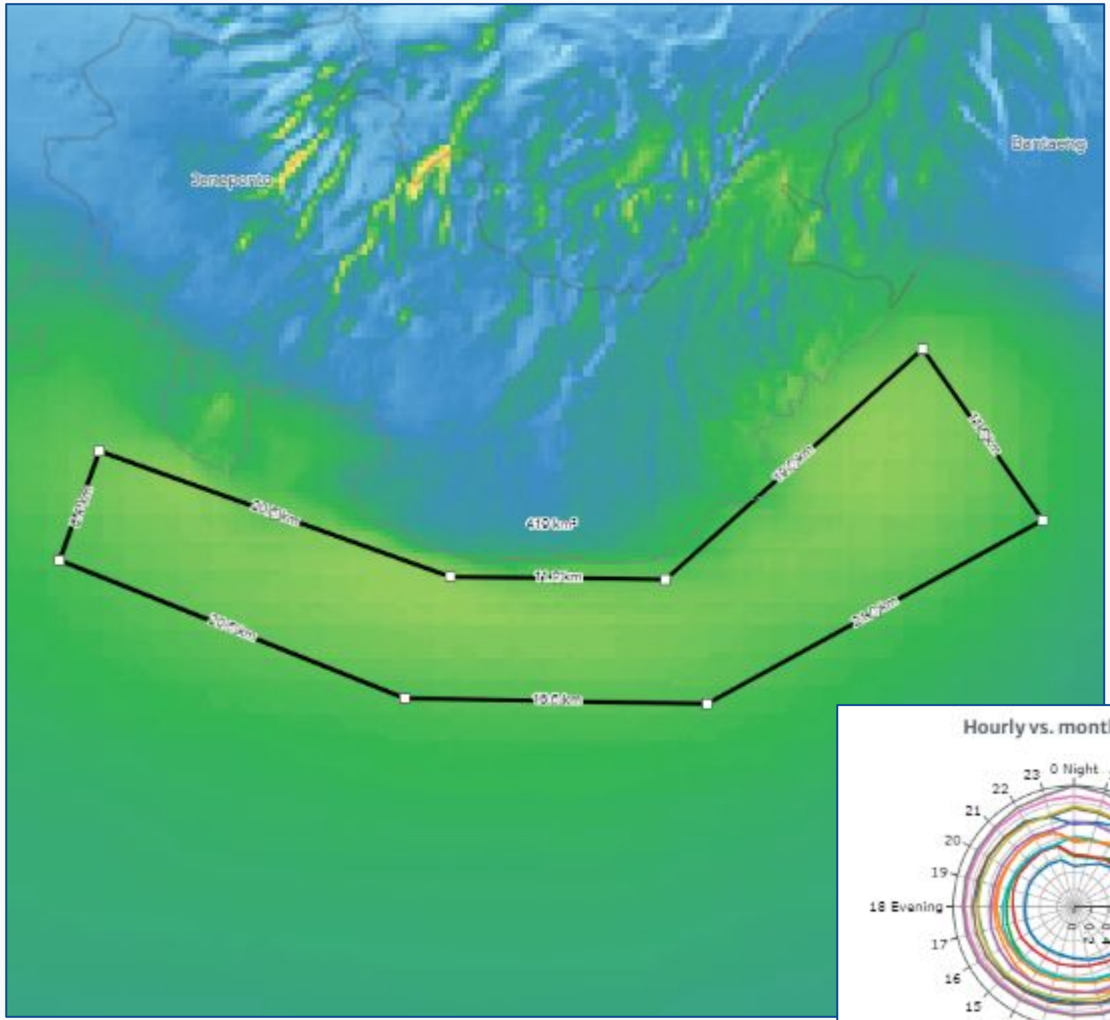
Bali Strait (Capacity 2000 MW; CP 43%)

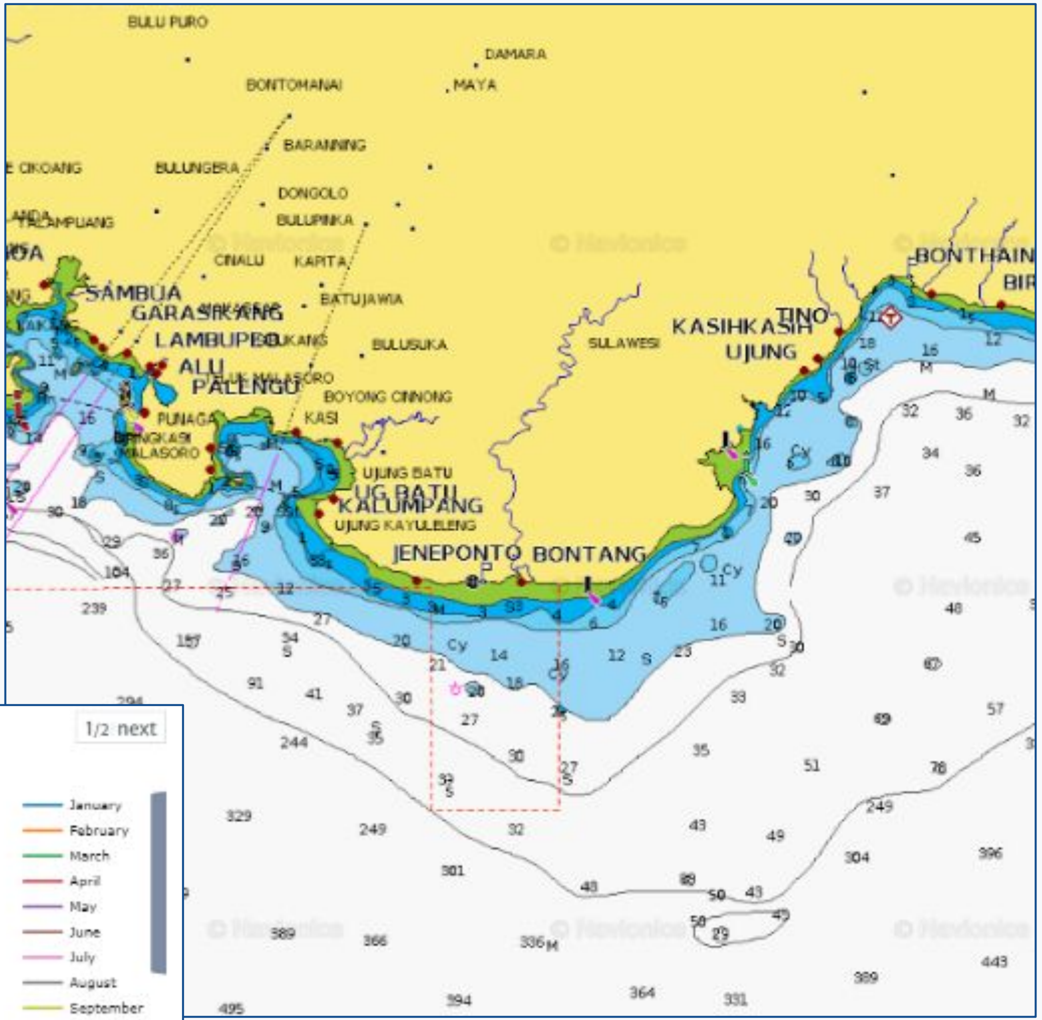


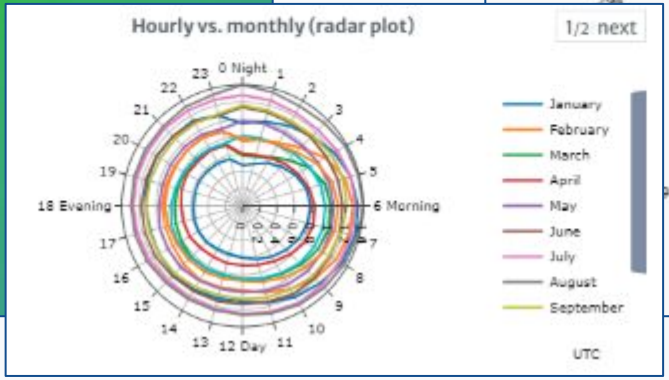




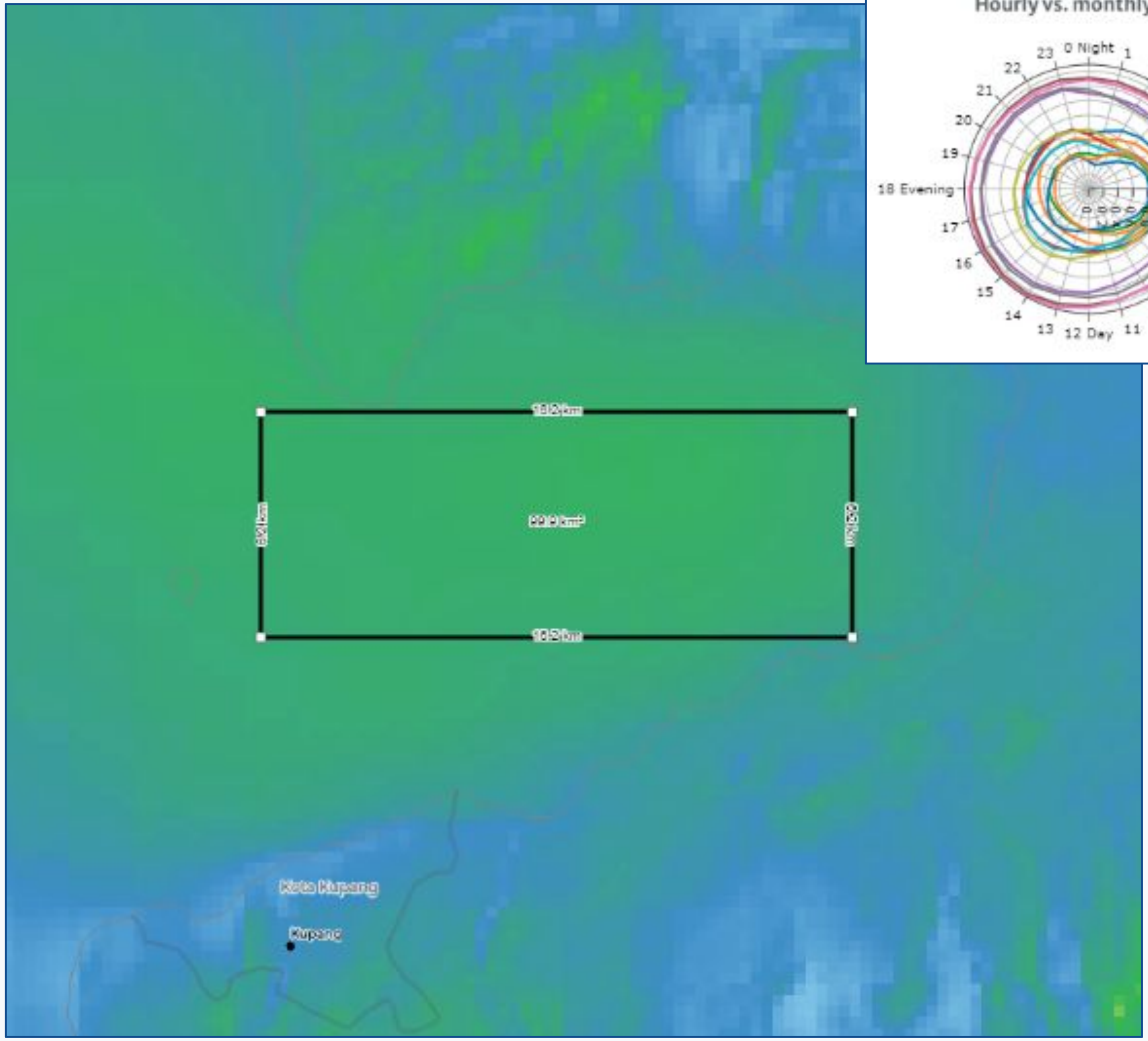
SW Sulawasi (Capacity 16,000 MW; CP 40%)

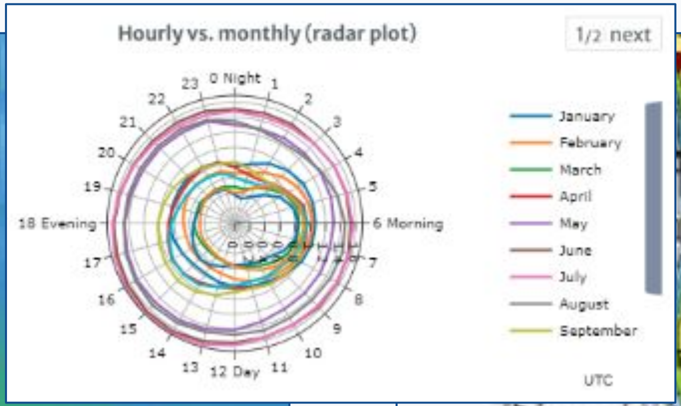




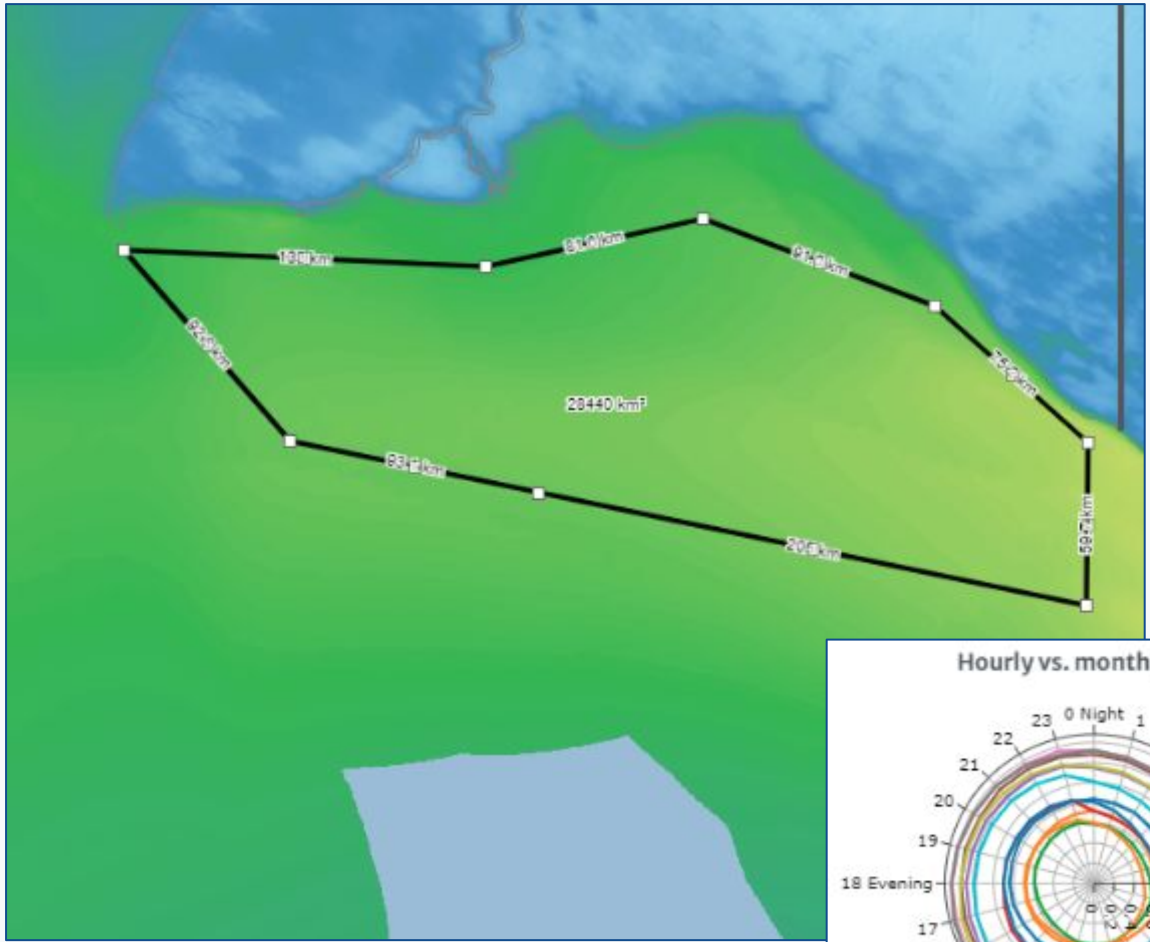


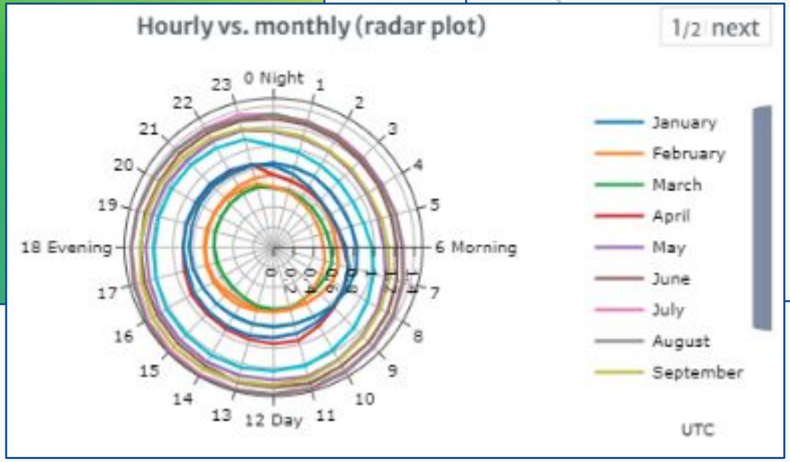
Kupang (4,000 MW; CP = 32%)





West Papua (1,000,000 MW, CP = 38% to 44%)





Offshore wind overview

Location	Area	Depth	Number of turbines*	Installed capacity (MW)	Capacity factor	Output (GWh)	Seasonal variation	Daily variation
Aceh	40 km2	10-50 m	20	300	36%	940	Moderate	Night drop off
Garut (S Java)	100 km2	25-100 m	50	750	33%	2153	Very strong	Morning peak
Bali Strait	50 km2	20-100 m	25	375	43%	1403	Very strong	Night drop off
SW Sulawasi	400 km2	10-50 m	200	3000	40%	10440	Moderate	Night drop off
Kupang (Timor)	100 km2	5-50 m	50	750	32%	2088	Very strong	Variable drop off
South of Papua	24,000km2	5-50 m	12,000	180000	41%	642060	Strong	Night drop off
Overall				**185175**		**659084**	Lowest: Jan-Apr	Night suppression

* Number of turbines based upon 1 turbine every 2 km^2 due to unidirectional wind pattern

- These six areas are considered to hold most potential.
- Each will have a unique combination of markets, resources & development attributes
- South of Papua, the largest prospect would need an inter-connector to Java or to serve an export market via an energy carrier such as hydrogen or ammonia etc

Conclusions

Comparison of UK and Indonesia

UK

- Renewables dominated by wind at present
- Installed wind capacity concentrated in certain areas
- Best resources not yet used
- Strong seasonal variability in demand driven by weather – hot weather cooling, cold and windy weather heating
- Reducing domestic gas reserves
- Reduced gas storage since 2017
- Current system has a strong reliance on diverse markets
- No strategic energy plan

Indonesia

- Mix of solar, wind, and geothermal possible
- Wind resources spread out but dominant area south of Papua
- Low seasonal variability
- Strong gas reserves
- No storage at present
- Net exporter of energy
- System yet to be established
- Energy plan under re-evaluation

Conclusions

- UK energy crisis is part of a wider global energy crisis
- There is no one factor, but many contributing factors
- The situation is symptomatic of the changing energy picture, global interdependency and reduced resilience
- UK vulnerability linked to reduced storage capacity and reduced domestic energy security
- Options for increased domestic supply of renewable energy have been shunned in favour of short term 'cheaper' European supplies
- Strategic planning can significantly increase resilience and reduce global market exposure
- Appropriate storage and balancing capacity is essential in future energy systems, as is the case now – the mechanisms will however be different