



Chinese Offshore Wind Goes Global

China's Leader in Offshore Wind Could Add Fresh Competition to Global Markets

Executive Summary

The offshore wind turbine industry has traditionally split between China and the rest of the world, with different players in each. However, China's Mingyang Smart Energy (Mingyang) appears poised to disrupt international, non-Chinese markets at a vulnerable time for established competitors. Mingyang's entry into non-Chinese markets is welcome. As a new competitor with world class designs and ample capital at its disposal, Mingyang would help drive turbine sizes higher and offshore wind power prices lower. Mingyang's entry into international markets would benefit a global offshore wind turbine industry dominated by three players.

Mingyang has established itself for its in-house research and development pushing the boundaries on larger capacity offshore wind turbines and blades. If Mingyang succeeds in its UK production facility investment, the global offshore wind industry could change significantly by the end of this decade.

Offshore wind is a small industry by comparison to onshore wind. The market profiles of the two are distinct, with onshore wind fragmented and offshore wind a near duopoly. Offshore wind enjoys substantial interest from countries, states, and municipalities as a clean power source, close to coastal population centers, able to keep the associated jobs and economics within their jurisdictions.

Offshore projects generally cost more than onshore farms due to construction and maintenance challenges that raise the cost of capital for a project. The solution has been to build larger turbine sizes which cut back the number of turbines. Floating wind would offer opportunities for even larger turbine sizes, but commercial deployment is unlikely until 2025. To build taller towers with longer blades, there have been advances in turbine technology designed to minimize the weight of the generator at the hub of the blades and the main shaft.

China became the world's largest offshore wind industry in 2021. While China's solar industry grew originally from European demand, the country's wind industry

As a new competitor with world class designs and ample capital at its disposal, Mingyang would help drive turbine sizes higher and offshore wind power prices lower.

grew out of domestic demand, raw materials advantages, and an import substitution effort by the government.

Chinese offshore wind industry is expected to grow to nearly 120GW by 2030. Shanghai Electric (SEWind) is the country's largest supplier of offshore turbines, but much of that is off of technology licenses from Siemens Gamesa.

Mingyang is China's most formidable offshore turbine supplier. Since 2020, one of out every five turbines installed offshore was a Mingyang model. The company has focused on developing technologies necessary to make larger offshore turbines, and was the largest supplier of turbines larger than 5MW in the world in 2021.

The company runs a conservative balance sheet and has raised capital wisely. It has consistently maintained ample cash to fund R&D and business development. It earns most from its larger turbine sales as well, with an estimated USD1m margin on every 6MW+ model. Mingyang is now preparing to venture out and has recently raised equity in London that can be used to fund a turbine assembly and blade manufacturing facility in the UK.

This couldn't come at a worse time for incumbents like Vestas, GE, and Siemens Gamesa. All three have seen a drastic fall of operating margins in the wake of higher commodity and transport prices. Siemens Gamesa and GE are also both on the cusp of potentially significantly disruptive reorganization efforts that would see Siemens Gamesa acquired while GE spins out its power unit as GE Vernova.

As Mingyang ventures abroad, it faces markets which are expected to add more capacity between 2025-30 than near term. Rather than defending its nearby East Asian neighbor markets, Mingyang has a chance to go big on offense in the UK and potentially other continental European markets. If Mingyang is successful in this UK expansion effort, it could be a game-changer for the company and the global offshore wind industry.

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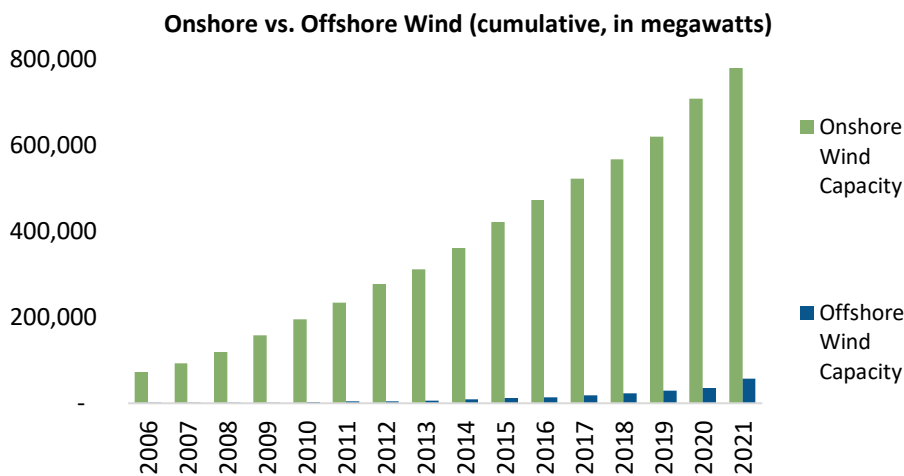
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Offshore Wind – Going Bigger

Offshore wind is a relatively new source of clean energy and remains a fraction of the onshore wind capacity. It wasn't until 2008 that the cumulative installed global offshore capacity passed 1 gigawatt (GW), while onshore wind added more than 25GW globally the same year. Only in 2020 did offshore capacity add up to more than 5% that of onshore capacity.

Figure 1: Onshore vs. Offshore Wind Capacity, 2006-21 (MW)



Source: BNEF, GWEC, IEEFA Research

In 2010, total global offshore wind capacity remained below 3GW, while onshore wind capacity was more than 195GW. By the end of 2021, total global offshore wind capacity was over 57GW, up 170% annually on average, while onshore capacity totaled 780GW.¹

Until recently, European offshore wind development has been responsible for much of this capacity growth. Between 2010 and 2020, Britain, Germany, and the Netherlands accounted for 57% of the world's offshore wind growth.

Asia has only recently begun to build out its offshore wind capacity, and this has been almost entirely in China. From 2010 to 2020, China's offshore wind capacity growth accounted for 32% of total global expansion.

Major Competitors

The leading global offshore and onshore wind turbine markets are distinct. The onshore market is highly fragmented, with Bloomberg New Energy Finance (BNEF) data showing more than 25 players serving over 120 markets around the world.²

¹ World Forum Offshore Wind 2021 Data.

² All data from Bloomberg New Energy Finance (BNEF) "Wind Turbine Market Shares" dataset based off its Renewable Project Database. Database is updated on daily basis.

Even though China became the largest market for onshore wind around 2011, its domestic onshore wind turbine market remains highly fragmented. Only China's Goldwind shows up as a significant supplier (i.e., greater than 10%) of global onshore turbines.

The majority of global onshore wind installations over the past 10 years have been supplied by non-Chinese turbine companies. The three largest are Vestas, GE, and Siemens Gamesa (SGRE). Together they have supplied about 36% of onshore turbines since 2011.

The offshore market is more concentrated. It has around the same number of global competitors, but they serve just over 20 offshore markets.³ SGRE dominates with direct supply of about 32% of global installations over the past decade. However, this understates SGRE's presence due to its licensing agreements with Shanghai Electric Wind (SEWind) for offshore turbines in China that are credited via that entity. By contrast to SEWind's licensing, China's Mingyang is the country's most dominant supplier of homegrown offshore turbine technology.

Figure 2: Turbine Suppliers, 2011-21 (Total MW)



Source: BNEF, GWEC, IEEFA Research

What's Driving Wind Offshore?

The drive to greater offshore wind capacity is driven by many factors. The most significant is perhaps proximity. Most of the world's largest urban centers are near water and can be well-served by offshore wind. Without offshore wind, many cities, states, and countries might need to import clean energy from far away sources.⁴

In the same way, offshore wind power investments keep associated revenues, jobs, and tax receipts within the country, state, or municipality in which they are consumed. Offshore wind opens up new leasing opportunities for clean energy

³ ibid

⁴ Singapore is a recent example of the need to import clean energy (hydro) from faraway sources like Laos, across Thailand and Malaysia. Devi, Uma. Singapore commences first renewable energy electricity import. The Business Times, June 23, 2022.

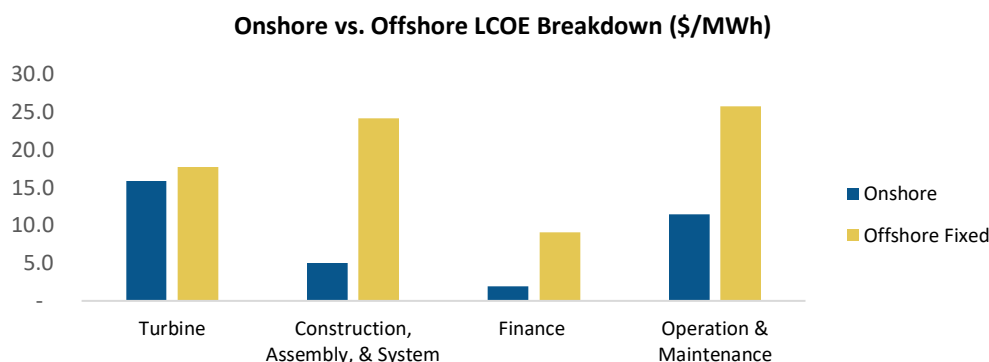
generation nearby demand centers. Whether talking about New York state or Shanghai municipality, there is a political incentive toward self-sufficiency and local job creation.

Offshore winds are also strong and consistent, leading to a generally higher offshore wind capacity factor than for onshore wind and solar. For instance, both Vestas and GE claim their latest offshore turbines achieve over 60% utilization rates.⁵ British Petroleum data indicates a mere 15% global average for solar and just 27% for global wind.⁶ BNEF calculates US onshore wind, among the highest capacity factors for onshore wind in the world, to be just over 40% since 2018.⁷

LCOE Differences

The problem with offshore wind is its cost. Bloomberg New Energy Finance's (BNEF) 2H22E global average estimate for the levelized cost of electricity (LCOE) of offshore wind is USD86 per megawatt hour (MWh). That is nearly double BNEF's 2H22E global average estimate for onshore wind at USD46/MWh.

Figure 3: LCOE Breakdown for Offshore vs. Onshore (\$/MWh)



Source: National Renewable Energy Labs, IEEFA Research

The largest absolute differences in costs between offshore and onshore wind are in construction and maintenance.⁸ Unfortunately, the complexity of each of those two factors feeds into the risk assessment of the project, which increases the financing and insurance costs for offshore projects relative to onshore wind as well.

⁵ Kainth, Rohma Ahsan. *From First To The Finest: The Evolution Of Wind Turbines*. Proxima Solutions, February 17, 2022.

⁶ Calculations based off *Statistical Review of World Energy 2022*.

⁷ Brandily, Tifenn & Vasdev, Amar. *1H 2022 LCOE Update*. [paywall] BNEF, June 30, 2022.

⁸ During a down year for fund-raising, its notable that SkySpecs and Aeronex, two wind turbine service models which employ drones and robots (resp) for turbine maintenance, have both successfully raised capital this year. For offshore wind, cutting operation and maintenance costs will require innovations.

Benefits of Scale

While larger offshore turbines may not be a significant source of LCOE difference on their own, larger units can still drive declines in offshore LCOE. Fewer, larger turbines mean fewer construction sites, a simplified system infrastructure, more discrete financial risks, and less onerous maintenance routines.

A Rystad Energy study found that while larger turbines may come with premium pricing, the construction and installation savings between a farm populated by 10MW turbines and 14MW turbines could be over USD100 million.⁹

Fewer, larger turbines mean fewer construction sites, a simplified system infrastructure, more discrete financial risks, and less onerous maintenance routines.

Table 1: Turbines Required by Farm & Capacity

Turbine Size (MW/Unit)	Wind Farm Size (MW)				
	500	1000	1500	2000	2500
6	83	167	250	333	417
10	50	100	150	200	250
14	36	71	107	143	179
18	28	56	83	111	139

Source: IEEFA Research

A study by the National Renewable Energy Laboratory found that moving from smaller offshore wind farms powered by smaller turbines to larger farms powered by larger turbines could cut the offshore LCOE by as much as 23%.¹⁰ A similar study by TNO and BLIX Consultancy in the Netherlands found potential savings of 33% from larger farms composed of larger turbines.¹¹

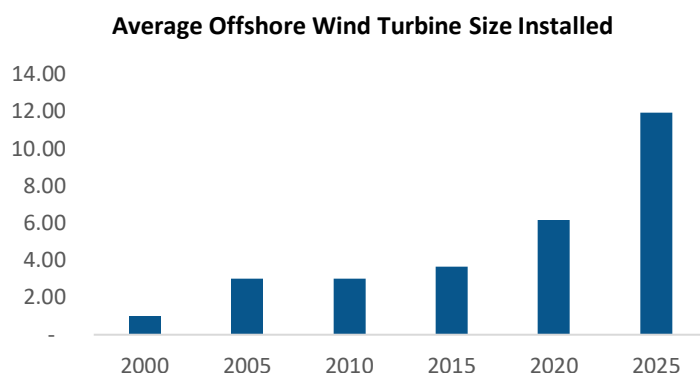
While the complete analyses from these studies is complex, the simple math of farm size vs. individual turbine MW capacity (see Table 1) implies simplified construction as well as fewer servicing components, vessels, and specialized technicians.

⁹ Flotre, Alexander & Karagiannopoulos, Lefteris. [Size Matters in Offshore Wind: Why Costlier 14 MW Turbines Actually Reduce the Large-Scale Farm Bill](#). Rystad Energy, September 17, 2020.

¹⁰ Shields et al. [Impacts of Turbine and Plant Upsizing on the Levelized Cost of Energy for Offshore Wind](#). Applied Energy Journal Volume 298, September 15, 2021.

¹¹ Bulder et al. [Pathways to Potential Cost Reductions for Offshore Wind Energy](#). TKI Wind op Zee, January 2021.

Figure 4: Average Wind Turbine Installed, MW



Source: BNEF, IEEFA Research

A higher tower with larger rotors also accesses higher wind speeds and captures greater energy. Wind speeds generally increase at higher altitudes, and larger rotor diameters increase exposure and torque provided to the generators. A 200m-high tower off certain coasts of Japan and Korea, for instance, will access wind power density 30-50% greater than a tower at 100m.

As a result, offshore wind farms are installing larger and larger turbines driven by wider and wider rotors. BNEF's (admittedly limited) data for 2025 installation plans shows average offshore turbine installation size could double from about 6MW/unit in 2020 to almost 12MW in three years. A survey of 140 wind experts in 2020 also found forecasts for average offshore turbines may reach 17MW by 2035.¹² The market migration toward larger capacity units is clear.

Floating Wind Frontier

In this report we focus mostly on fixed offshore wind, installed in coastal waters at maximum depths of 50-60m. However, the global potential for floating offshore wind is far higher than for fixed foundation, with estimates that 80% of offshore wind potential exists in waters deeper than 60m.¹³

Floating offshore wind is a promising and increasingly viable technology. Moving farther offshore provides access to greater and more consistent wind resources, while avoiding near shore complications around ocean transport and fishing resources. Floating offshore wind also opens opportunities for even larger turbines of 20MW or more, once commercially available.

¹² This survey also found consensus forecast for a drop in LCOE for offshore on the order of 35% by 2035 driven mostly by larger turbines that cut capex, lowered financing costs (WACC), and trimmed operating costs. Wisler et al. [Expert elicitation survey predicts 37% to 49% declines in wind energy costs by 2050](#). Nature Energy, May 2021.

¹³ Williams, Zhao, & Lee. [Global Offshore Wind Report 2022](#). Global Wind Energy Council, June 29, 2022.

While fixed offshore wind is young relative to onshore wind, floating offshore technology is not yet commercially available. Data from the Global Wind Energy Council (GWEC) show existing floating offshore capacity of just 134MW globally, with another 105MW under construction. There are currently a number of floating offshore wind structures in trial, and GWEC expects floating offshore wind to become commercially viable sometime after 2025.¹⁴

**Floating offshore wind
should be commercially
viable by 2025.**

By 2030, BNEF forecasts there could be over 5GW of floating wind in operation, while GWEC expects almost 19GW. As commercial farms develop, improved scale, turbine sizes, and system technologies should combine to drive the cost profile closer to that of fixed foundation offshore wind farms.¹⁵

Generation Technology

The drive toward larger rotors on top of higher towers has put pressure on the nacelle – the unit at the hub of the blades that houses the turbine drivetrain technology. At higher heights of installation, the weight of the nacelle needs to be balanced against installation logistics, the tower's structural integrity, as well as the ease of rotation and yaw to adapt to shifting wind conditions.

Given longer and heavier blades, the nacelle's generation technology also needs to optimize that weight against both wind response and power conversion efficiency. The nacelle and its contents must also employ technologies that minimize operational maintenance requirements and failure rates. Finally, of course, the drivetrain technology can't cost too much.

Manufacturers of offshore turbines have begun to gravitate toward two versions of a permanent magnet synchronous generator (PMSG): direct drive (DDPMSG) or medium speed hybrid gearbox (MSPMSG). There can be differences in the cost of the various magnets, copper, and steel required for the two technologies. Some research comparing the two has leaned toward the hybrid MSPMSG technology as the better option at larger sizes.¹⁶ However, while DDPMSG is theoretically supposed to weigh more than MSPMSG, there are real-world examples that contradict that

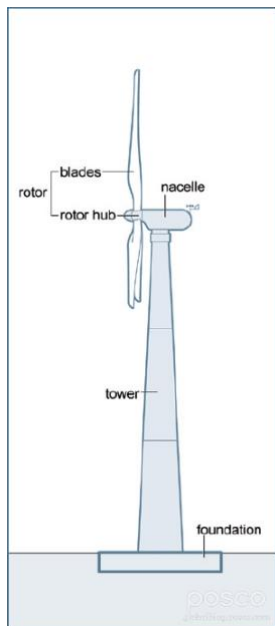
¹⁴ Ibid.

¹⁵ Sanghera, Sanjeet. Tomorrow's Cost of Floating Wind. (PAYWALL) Bloomberg New Energy Finance, December 9, 2021.

¹⁶ Moghadam, Farid K. and Nejad, Amir R. [Evaluation of PMSG-Based Drivetrain Technologies for 10-MW Floating Offshore Wind Turbines: Pros and Cons in a Life Cycle Perspective](#). Wind Energy, Volume23, Issue7, July 2020.

assumption.¹⁷ While the two drives are very different, there doesn't appear to be a material operation and maintenance cost advantage.

Figure 5: Turbine



Source: Benchmark Institute, IEEFA Research

DDPMSG requires more magnets made from rare earths (mainly neodymium and dysprosium) so can be more expensive.¹⁸ China dominates both the supply and processing of global rare earths, and the recent creation of China Rare Earth Group (CREG) will only make this worse for foreign buyers. The merger of three firms into CREG will concentrate more rare earths production into a single company than all of the US and Australia combined.¹⁹ Going forward, non-Chinese turbine manufacturers looking for the neodymium, dysprosium, and terbium necessary for permanent magnets are likely to face an even more concentrated and even more politically fraught supply structure.

MSPMSG is a relatively new technology. According to GWEC, MSPMSG wasn't a factor in offshore wind design until around 2016. Since then, MSPMSG has gained share to take over around half of the European market (led by Vestas) and take second place in the Chinese market (led by Mingyang – the world's largest MSPMSG turbine supplier). GWEC data indicate that MSPMSG technologies gained an

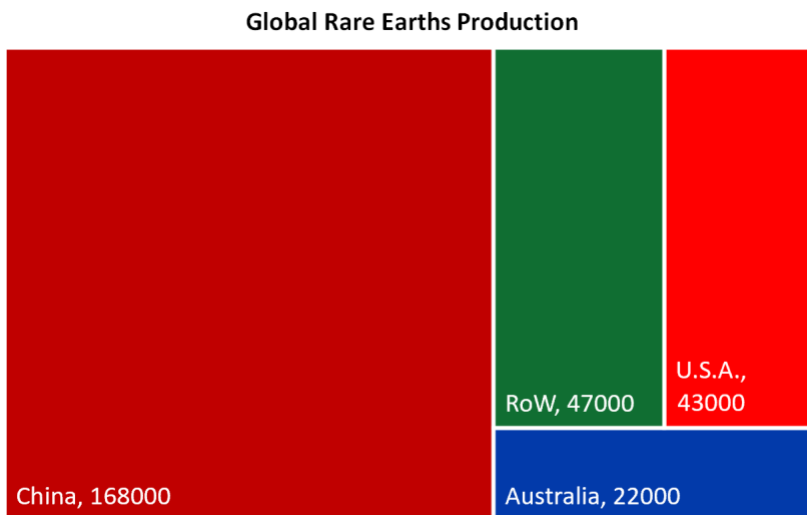
¹⁷ Siemens-Gamesa's SG-14-222 14MW nacelle unit housing a DDPMSG reportedly weighs 35.7 t/MW while Mingyang's MySE 16-242 16MW nacelle unit containing an MSPMSG weighs approx. 37t/MW.

¹⁸ The availability of rare earths has also been prone to geopolitical risk, as when China cut Japan rare earths exports in 2010 over a maritime resources dispute, or in Chinese threats to suspend exports to the US Military last year.

¹⁹ van Wyk, Barry. [More Consolidation for China's Rare Earths Industry as Beijing Seeks Geopolitical Leverage](#). SupChina, June 6, 2022.

additional 3.6% of total wind market share in 2021 alone. We don't pretend to be experts in these technologies, but it appears to be the case that MSPMSG is enjoying greater adoption momentum at concurrent with the trend toward larger turbine sizes.

Figure 6: Global Rare Earths Production, 2021



Source: USGS, IEEFA Research

Chinese Wind Power – Onshore Origins

In January 2022, China's National Energy Administration made global headlines when it announced China's 2021 offshore wind installations totaled 16.9GW.²⁰ According to Bloomberg New Energy Finance (BNEF) data, this buildout was greater than all of Europe's offshore wind capacity additions over the past five years combined. In a single year, China grew its offshore wind capacity by 78% to become the world's largest single offshore wind market.

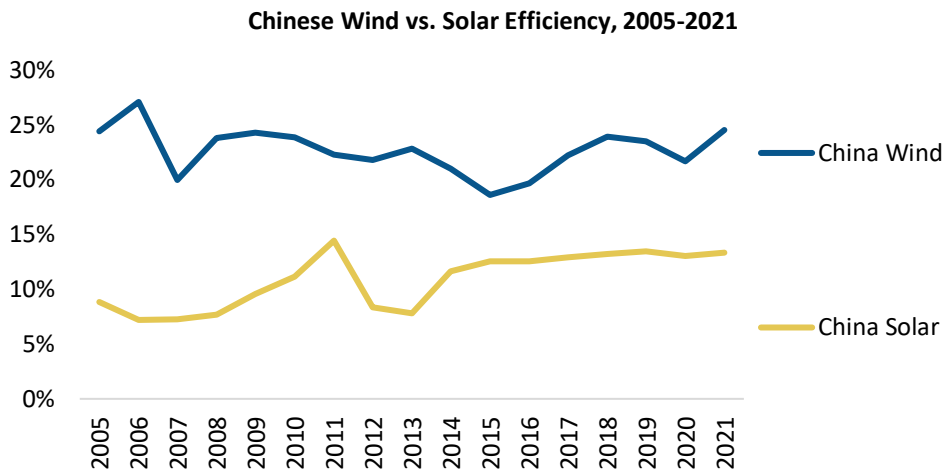
China is now the world's largest country for solar (as of 2015), onshore wind (2011), and offshore wind (2021) energy generation equipment demand. Chinese solar is most famous for its global dominance, but that industry originated from exports to rapidly expanding European (mainly German) markets 20 years ago. It was only after European tariffs were imposed around a decade ago that China's central government stepped up efforts to increase domestic solar demand through solar capacity targets.

Organic Demand

²⁰ This is total capacity installed rather than grid-connected. According to the World Forum Offshore Wind (WFO), China's newly grid-connected offshore wind in 2021 was 12.7GW. National Energy Administration Spokesperson. [国家能源局举行新闻发布会 发布2021年可再生能源并网运行情况等并答问](#) (National Energy Administration Press Conference and Q&A on 2021 Grid-Connected Renewable Energy) National Energy Administration, January 29, 2022.

China's demand for wind power was from more organic domestic demand. Wind was a relatively cheap source of power, with higher productivity than solar.²¹ Starting in 2007, China introduced national policies and regulations to support wind sector development, but the policies were toward greater coordination and resource optimization, rather than market creation as with solar.²²

Figure 7: China Wind vs. Solar Efficiency, 2005-2021



Source: BP, IEEFA Research

China's early demand for wind power was predominantly served by foreign suppliers who controlled 50-70% of China's wind turbine market in some years. The government preferred onshore capacity, however, and employed local content requirements to keep economics and job creation within China.

Even today, global suppliers still ship large blades and turbines large distances, at significant cost, creating significant shipping emissions, for installation in other countries. For small economies this can make sense, but for China this was counterproductive.

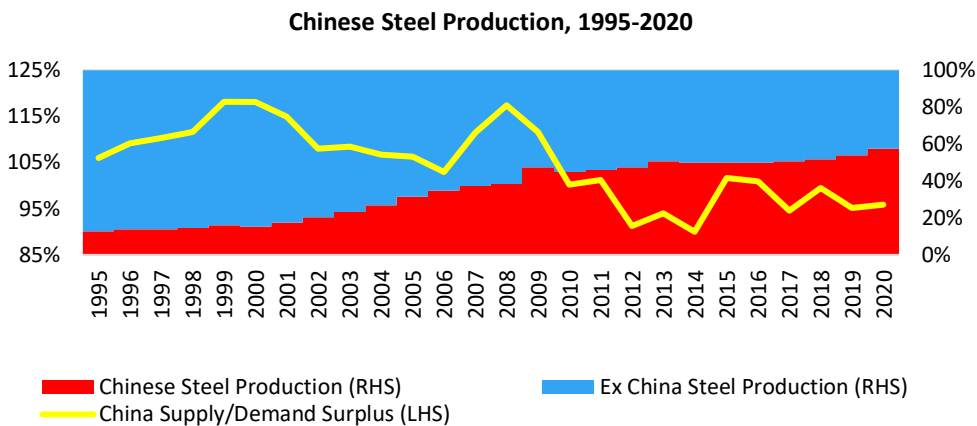
The majority of any wind turbine is steel, accounting for 75-85% of total weight.²³ China has been the world's largest steel producer since 2002, and the country's early turbines didn't require sophisticated engineering. It made no sense for China's wind farm developers to import a product made from a material the country was producing in surplus.

²¹ Based on BP's Statistical Review of World Energy 2022 data.

²² In 2007 China published its 11th Five Year Plan for Energy Development and a Mid- to Long-Term Development Plan for Renewable Energy which elevated the planning, logistics, and oversight of the wind power sector to national importance.

²³ Vestas indicates "steel & iron materials" make up to 84-90% of their smaller turbine weight.

Figure 8: Chinese Steel Production vs. World; Surplus



Source: World Steel Association, Bloomberg, IEEFA Research

Turbine prices in China quickly dropped and demand increased. While strict content requirements didn't last long, China maintained an informal preference for domestic suppliers on cost as well as other factors. This informal trade barrier sustained domestic turbine supply growth from just over 1GW in 2005 to nearly 30GW in 2010. As a result and as mentioned above, China became the world's largest single country for onshore wind power in 2011.

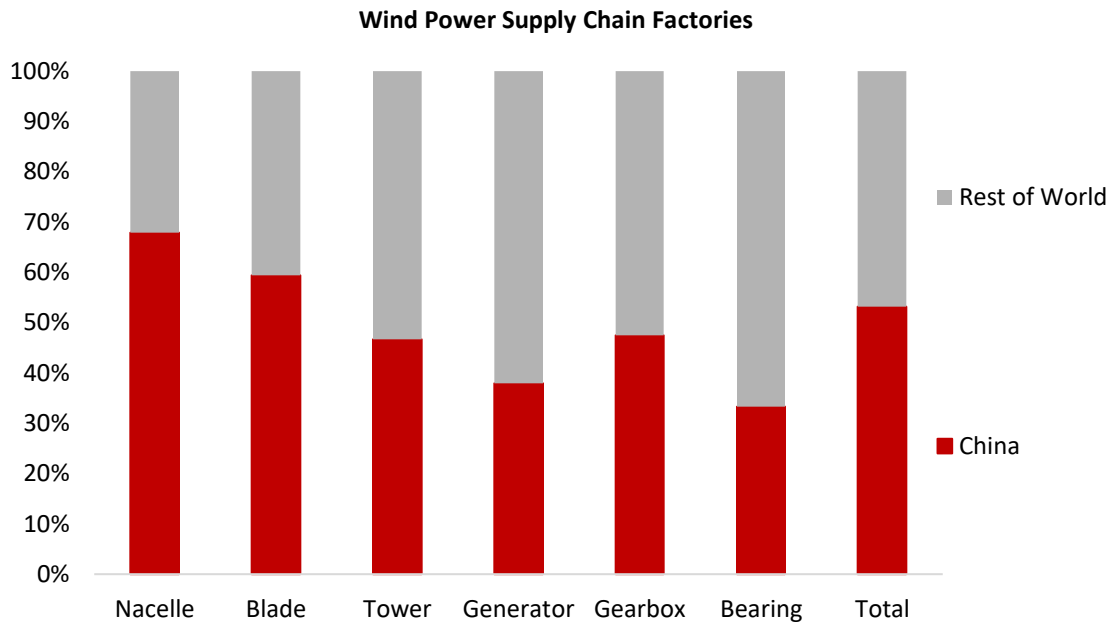
As competition intensified, China's emerging turbine players sought ways to improve their technology. Chinese turbine suppliers funded their own R&D, but often achieved quicker success via JVs, partnerships, licensing agreements, R&D cooperation, and other arrangements with global peers. China's young turbine manufacturers like Goldwind, Envision, Mingyang, Shanghai Electric, and Guodian United Power worked with and learned from established European wind players like Nordex, Repower, Vensys, Aerodyn, and Siemens.²⁴

Thriving Supply Chain

China's thriving wind turbine industry has created the world's largest turbine supply chain. China maintains over 50% of the world's nacelle, blade, tower, generator, gearbox, and bearings producers. According to BNEF research, China has the most factories of any single country in every category.

²⁴ Gandenberger, Unger, Strauch, & Bodenheimer. [The international transfer of wind power technology to Brazil and China](#). Working Paper Sustainability and Innovation, No. S7/2015, Fraunhofer-Institut für System- und Innovationsforschung ISI, June 2015.

Figure 9: Global Wind Supply Chain Factories



Source: BNEF, IEEFA Research

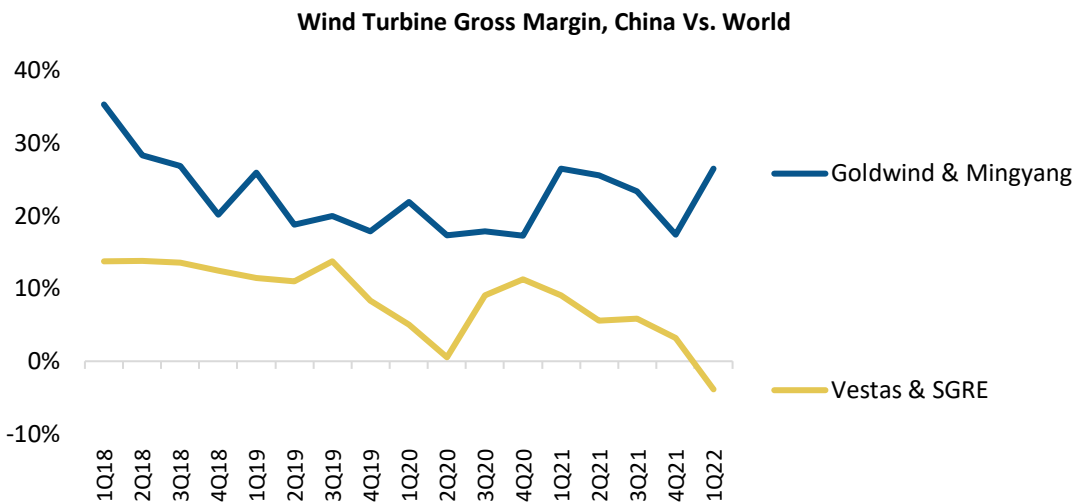
This supply chain serves both local and global turbine manufacturers. International players still ship parts around the world, especially for projects in Asia or Australasia. This supply chain has been created out of steady demand backed by clear policies, low input costs, and intense competition. This competition has produced high supply chain efficiency and low product prices. China's domestic turbine manufacturers enjoy supplier choice and therefore bargaining leverage that is unparalleled in other areas.

Margin Advantage

China's wind turbine makers are more profitable than western competitors. They achieve this despite competitive turbine prices, with onshore wind with storage now China's cheapest energy source at just USD66/MWh. (see Figure 14, below) The country's overcapacity in steel, its dominance in rare earths, and its competitive supply chain combine to keep gross profit margins 14 percentage points higher than international turbine players on average.

Recently the margin gap between western and Chinese turbine margins reached extremes. International commodity price volatility and supply chain bottlenecks continue to depress international turbine margins. At the same time, Chinese steel prices have remained low due to the slowdown in the country's property market. The result is more than a 30 percentage point difference between Chinese and western turbine company gross and EBIT margins as of 1Q22.

Figure 10: Gross Margins, China vs. International



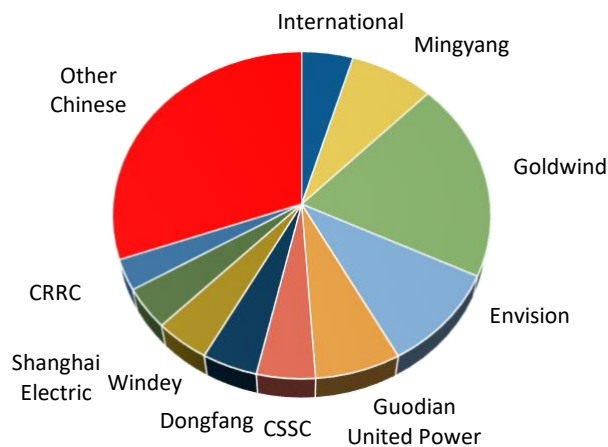
Source: Bloomberg, IEEFA Research

Onshore Turbine Landscape

Founded in 1998, Goldwind is China's oldest wind turbine company, and it controls the largest share of the country's onshore wind market. It also figures among the world's largest turbine suppliers. The company's growth took off after joint development of new turbine technology with Germany's Vensys, and Goldwind eventually purchased a majority interest in that company.

Figure 11: Chinese Onshore Wind Turbine Share, 2011-2021

China 2011-21 Onshore Wind Turbine Market Share



Source: Bloomberg New Energy Finance, IEEFA Research

Mingyang, Envision, and Guodian United Power are the next tier down in the onshore wind market. They each have market shares above 5% over the past

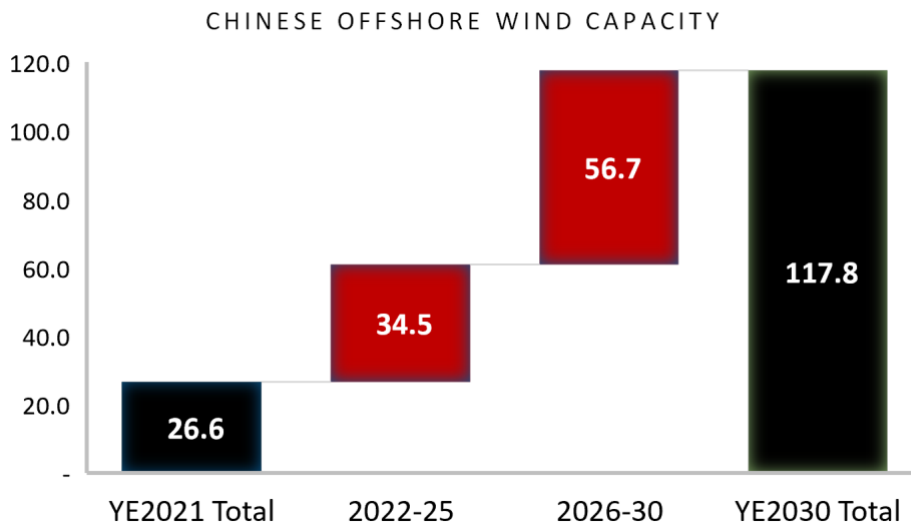
decade. There are many smaller competitors below them. Over the last decade, BNEF data indicate that international suppliers have combined to less than 5% of China's total onshore wind turbine market.

In China's offshore market international players rarely factor in at all.

Chinese Offshore Wind – Creating New Champions

Chinese offshore wind had an installed base of 1GW by 2015, but by 2017 it began to add more than 1GW every year. Between 2017 and 2020, China's offshore build made up around 8% of total wind power expansion. Last year, as feed-in-tariff premiums were set to expire, the nearly 17GW of new grid-connected offshore wind capacity made up 25% of the country's total for wind power additions. Since 2020, seven out of ten offshore turbines have been installed in China.²⁵

Figure 12: China Offshore Wind Outlook



Source: Average GWEC & BNEF Forecasts, IEEFA Research

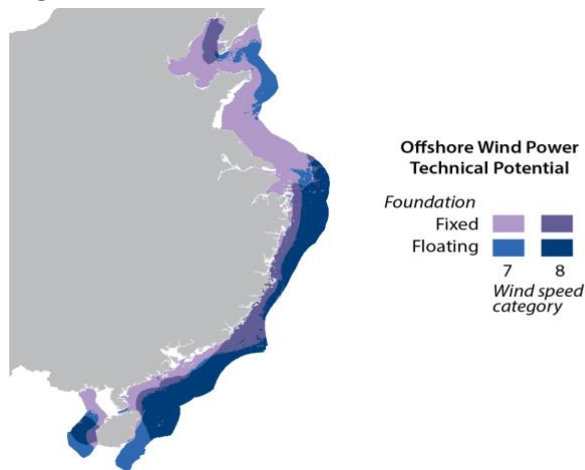
While China may slow its offshore buildout near term, GWEC and BNEF long-term projections forecast almost 120GW of offshore capacity by YE2030. This would be only a fraction of the country's onshore wind capacity today (300GW), but the higher capacity factor for offshore wind could yield an over 35% improvement in power plant productivity. 120GW would also be only a fraction of the potential 1,400GW fixed and 1,580GW of floating capacity the World Bank estimates can be tapped off Chinese shores. China has strong winds offshore, both nearby along its coast as well as farther out in deeper waters.

²⁵ According to both GWEC and WFO offshore wind farm data.

Locals Only

The only international player that has played a significant role is SGRE. SGRE had previously cooperated with China's energy equipment powerhouse Shanghai Electric on gas turbines, so when SEWind started a wind turbine business SGRE licensed some of its offshore wind technology to the company. As a result, SEWind's historic offshore installations can be at least partially, and potentially substantially attributed to SGRE.²⁶

Figure 13: Chinese Offshore Wind Potential



Source: World Bank Energy Data, IEEFA Research

SEWind has developed its own in-house turbines, and those homegrown technologies now make up over 50% of its top line.²⁷ Last October, SEWind introduced its own 11MW offshore DDPMSG unit, the largest the company will have in its suite of offshore turbine options. In response, SGRE announced it will license its 11MW design to Guodian United Power (GUP) instead of SEWind.²⁸

GUP is a subsidiary of China's largest electric utility China Energy Investments (CEIC). While it hasn't been a major player in offshore wind up until now, this license from SGRE could provide a quick entrance at higher and more attractive

²⁶ SGRE claims more than 6GW of China's total installed 25GW in offshore wind is based on its technology. GWEC data indicate that the entire installed capacity base that can be attributed to SEWind or SGRE up to 2021 totalled 8.7GW. Siemens Gamesa. [Forging Ahead in China: Siemens Gamesa Signs MoU to License 11 MW Direct Drive Offshore Technology to China Energy United Power](#). Siemens Gamesa Press Release, November 5, 2021.

²⁷ Mu, He. "海上风电一哥" 电气风电: 吸收消化西门子技术, 复制中国高铁模式 ("Offshore Wind's Big Brother" Shanghai Electric: Absorbing and Digesting Siemens Technology, Replicating China's High-Speed Rail Model) Market Capitalization via 163.com, April 13, 2022.

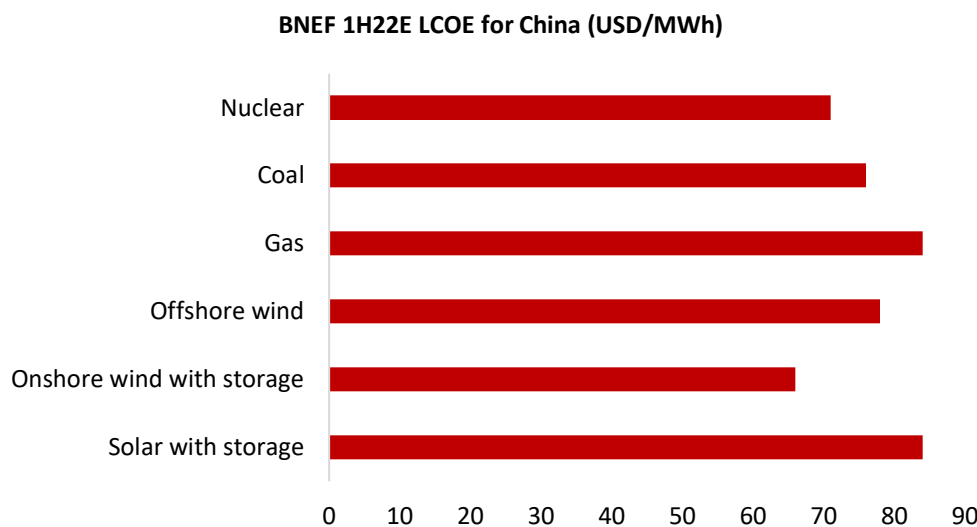
²⁸ Siemens Gamesa. [Siemens Gamesa Reinforces Offshore Strategy in China by Licensing the 8 MW Direct Drive Technology to Partner Shanghai Electric](#). March 2, 2018.
Siemens Gamesa. [Forging Ahead in China: Siemens Gamesa Signs MOU to License 11 MW Direct Drive Offshore Technology to China Energy United Power](#). November 5, 2021.

turbine sizes. It will also provide GUP its first exposure to SGRE's DDPMSG technology.

Success Factors

Chinese development of offshore wind shared the same kind of nationwide policy effort seen with onshore wind. As early as 2011 China outlined the planning and approval process from provincial to national level.²⁹ So long as consideration was given to military, shipping, and marine resources, provinces had latitude to optimize their offshore wind development.

Figure 14: 1H22E Chinese LCOE (USD/MWh)



Source: BNEF, IEEFA Research

This is important, as Chinese municipal and provincial leaders have been resistant to inter-provincial electricity trading. China's onshore wind resources are concentrated in the North and West of the country, far from much of the urban populations on the coast. Since China's air pollution crisis of 2012 and 2013, sub national cadres have been caught between importing energy (exporting GDP, jobs, tax receipts, etc) and the nationwide efforts to combat urban air pollution by minimizing thermal coal power generation near urban centers. Now that offshore wind has a levelized cost of electricity (LCOE) that is near coal (USD78MWh including transmission vs. USD76MWh) this decision is far easier.³⁰

²⁹ National Energy Administration and State Oceanic Administration. "海上风电开发建设管理暂行办法实施细则" (Rules for Management of Offshore Wind Power Construction and Development). Originally published on State Oceanic Administration website July 2011, accessed via Shanghaiinvest.com.

³⁰ We focus on utility offtake LCOE and thus exclude smaller distributed, community, and micro-grid solar. As a result, we include solar and onshore wind LCOEs that include storage. Some provinces require storage already and the central government has begun to guide onshore wind and solar to include storage as well. At the moment offshore wind has not seen similar guidance.

In 2019, China announced that the feed-in-tariff scheme for offshore wind would end in 2021 and move to an auction.³¹ Only projects approved before YE18 and constructed by YE21 would receive the existing tariff premium. This policy change led to China's 2021 addition of nearly 17GW, more than the world had ever added globally in any single year.

To accomplish this, China needed to marshal the supply chains and logistics operations necessary to erect more than 2,500 offshore wind turbines that year. China had anticipated this potential bottleneck in 2011, when it began to include offshore wind construction equipment within the plans for offshore engineering equipment.³² While international vessels had to play a role in this project, China's homegrown offshore engineering capacity was critical to its gargantuan effort last year.³³

China's offshore wind farms also often look quite different from their non-Chinese peers. IEEFA research finds 38 offshore Chinese wind farms that employ multiple turbine models from either a single supplier or, more frequently, different models from more than one supplier. This practice of mixed model farms appears rare outside China. Some of this may be a function of supplier constraints, but this also might be intentional by design.

The head-to-head competition of mixed model farms, controlling for operating conditions, provides opportunities for data collection on comparative performance that inform both turbine engineers and asset owners. China's mixed model farms can accelerate the learning process as wind turbine technologies and designs can be compared in real time under controlled conditions.

Big Choice

Offshore wind markets outside of China are dominated by Vestas and SGRE at the moment, each with over 10 models above 7MW on offer. GE will soon become a more significant competitor as its Haliade models at 12MW, 13MW, and 14MW enter the market. Aside from those three vendors there is little else. The total market of large-scale offshore wind turbines adds to less than 30 models.

By comparison, China's offshore wind turbine industry has produced more choice. China's ample steel production, policy clarity, and homegrown supply chain have created a diverse market of large-scale offshore wind turbine choices. At present, we estimate that China has 11 turbine manufacturers, offering four generation technologies, with a total market of 44 models above 7MW. China also boasts two

³¹ National Development and Reform Commission. "关于完善风电上网电价政策的通知 (Notice on Policy to Improve Wind Power Feed-in-Tariff)" NDRC Website, May 21, 2019.

³² National Development and Reform Commission, Ministry of Science and Technology, Ministry of Industry and Information Technology, and National Energy Administration. "海洋工程装备产业创新发展战略 (Offshore Engineering Equipment Industry Innovation and Development Strategy)" Originally published August 2011, accessed via China Government Network

³³ Xu, Yihe. *Chinese Yards Accelerating Construction of Offshore Wind Vessels*. Upstream, January 5, 2021.

suppliers of 16MW turbines, 1MW larger than the largest option available outside the country.

Figure 15: Offshore Wind Turbines Above 7MW, China vs. Ex-China (MW/unit)

Ex China	Technology	Minimum	Maximum	Models	China	Technology	Minimum	Maximum	Models
	Doosan DD PMSG	8.0	8.0	1		CRRC MS PMSG	7.5	7.5	1
	GE Renewable Energy DD PMSG	12.0	14.0	3		CSSC HS PMSG	7.0	8.0	3
	Siemens Gamesa DD PMSG	7.0	14.0	12		MS PMSG	10.0	16.0	2
	Unison DD PMSG	10.0	10.0	1		Dongfang DD PMSG	7.0	13.0	7
	Vestas MS PMSG	7.0	15.0	11		Envision HS DFIG	7.0	8.0	2
	TOTAL MARKET	7.0	15.0	28		Goldwind DD PMSG	8.0	8.0	3
						MS PMSG	12.0	12.0	1
						Harbin Electric DD PMSG	7.0	8.0	7
						Mingyang MS PMSG	7.0	16.0	7
						SEWind DD PMSG	7.0	11.0	3
						MS PMSG	8.0	8.0	1
						Taiyuan Heavy Industries MS PMSG	8.0	8.0	1
						United Power HS DFIG	8.0	10.0	2
						DD PMSG	11.0	11.0	1
						Windey MS PMSG	9.0	15.0	3
						TOTAL MARKET	7.0	16.0	44

Source: BNEF, wind-turbine-models.com, GWEC, IEEFA Research

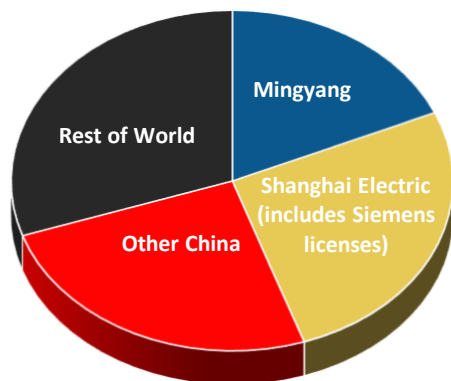
Some of China's turbine companies and turbine models are uncompetitive, rely on outdated technology, or haven't found much success in the market. Some of the turbine technologies, corporate wind divisions, or entire corporate enterprises may eventually be acquired by or merged with China's stronger offshore wind turbine competitors. Some of those stronger offshore wind turbine competitors are world-class and offer products ready to compete with SGRE, Vestas, and GE.

Mingyang – China's Strongest Offshore Competitor

Mingyang is China's most formidable offshore wind turbine supplier at the moment. The company produces onshore wind turbines too, but its large-scale offshore wind turbines represent the most significant threat to global competitors. Over the past three years, nearly 1 out of every 5 MWs of offshore wind turbines installed globally has been from Mingyang.

Figure 16: Global Offshore Wind Farm Installations, 2020-22

2020-2022 Global Offshore Wind Farm Turbines
Installed & Under Construction



Source: World Forum Offshore Wind, IEEFA Research

In contrast to other Chinese turbine players, Mingyang has moved much of its production in-house. The company keeps external suppliers for redundancy, but does much of its production of blades, drive gearboxes, and other systems on its own to protect its intellectual property. There is no sign that this has significantly impaired the company's profitability.

Mingyang is now the world's largest supplier of hybrid MSPMSG turbines. It supplied almost 90% of hybrid drives in China last year.³⁴ The company is preparing to introduce the world's largest offshore wind turbine at 16MW, commercially available by 2024. Mingyang will install two of those 16MW units in of its own wind farms in Guangzhou around that time. The company has been talking about a new 20MW offshore unit for some time, which would be a natural choice for new floating platforms, but so far there is no date set for introduction of such a model.

Mingyang is a private company. While Goldwind, SEWind, and GUP all have histories of state-ownership, Mingyang has always been a private enterprise. Only Envision is comparable, but they have not been a major player in offshore wind so far.

Focus On Offshore

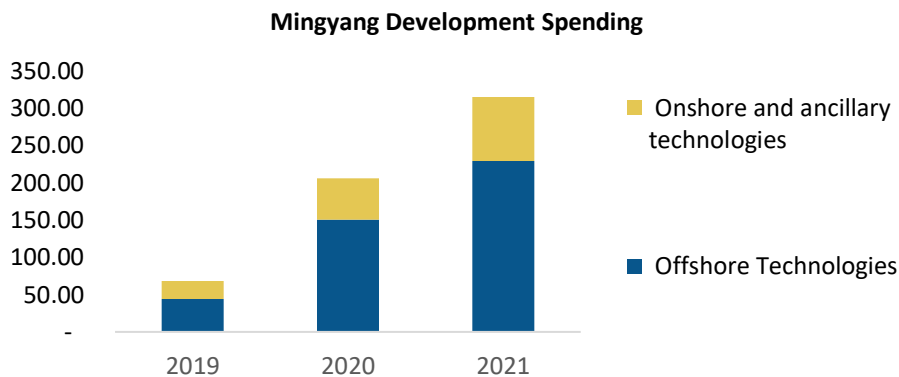
Like many Chinese wind turbine suppliers, Mingyang began making turbines through relationships with foreign companies. The German firm Aerodyn had partnered with many turbine suppliers in the mid 2000s. Mingyang had some early success from Aerodyn designs. However, in contrast to other players, Mingyang

³⁴ Attributed to Frost & Sullivan, taken from Mingyang's GDR filing of July 8, 2022.

went beyond licensing Aerodyn designs to jointly develop new technologies with the company.

Aerodyn was one of the pioneers of the hybrid MSPMSG drive, what it called a Super Compact Drive (SCD). Mingyang obtained the exclusive license to manufacture and distribute Aerodyn's SCD turbines in China. Mingyang used Aerodyn's SCD drive license up until their turbines reached 6MW capacity/unit. Mingyang then began to purchase some of Aerodyn's SCD patents.

Figure 17: Mingyang Development Spending (CNYm)



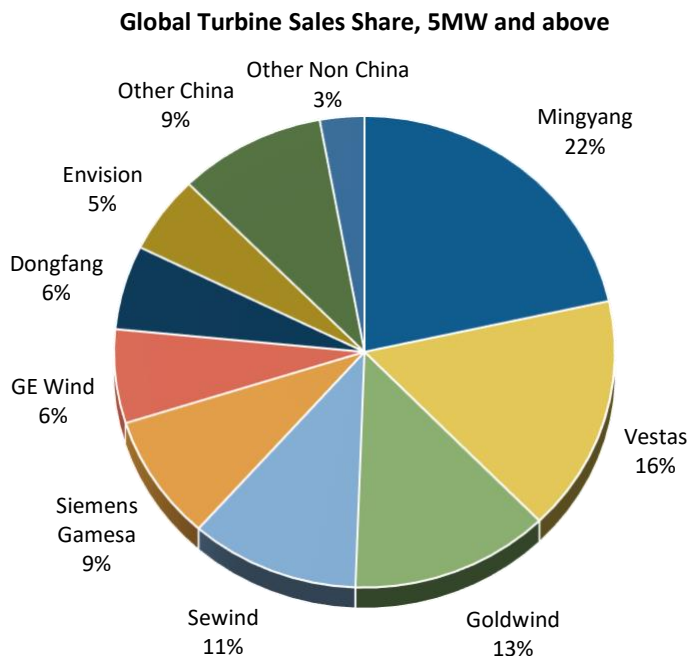
Source: Company Filings, IEEFA Research

Mingyang has now developed its own MSPMSG drives that it has deployed in larger turbine capacity models. 17 of Mingyang's 23 onshore models employ an MSPMSG drive. All of Mingyang's offshore models employ MSPMSG drives. MSPMSG drives are lighter and smaller ('super compact') and therefore conducive to the higher towers (150-200m) required for larger capacity turbines.

Mingyang has its own R&D operations in cities around China, as well as in Europe and the United States. According to its filings, Mingyang's turbine research and development has focused on technologies involving hybrid MSPMSG drives, large-capacity offshore turbines, anti-typhoon turbines, floating turbines, and large rotor turbines for low wind areas. IEEFA estimates that 50-55% of Mingyang's revenue is still sourced from onshore turbine models. That ratio should decline if the company's research and development, squarely aimed at offshore technologies, is any indication of the company's direction.

Mingyang has led the way in China toward larger offshore units. It was the first to introduce 6.5MW, 8MW, and 11MW offshore wind turbines to the China offshore wind market. According to GWEC data, it is currently the global leader in hybrid drives. That same data show Mingyang was also the world's largest supplier of large scale (5MW+) turbines in 2021, beating Vestas and SGRE, as well as Goldwind and SEWind.

Figure 18: Global Turbine Sales Above 5MW, 2021



Source: GWEC, IEEFA Research

Cash Rich

Mingyang's technology and design focus hasn't been cheap. To fund the company's substantial investments, it has been active in equity markets. The company is now listed on the Shanghai Exchange, but it used to be listed as an American depositary receipt (ADR) in New York. Its NY initial public offering (IPO) came in late September 2010 at USD14/share (around 25X earnings at the time). It raised around USD400m. In November of 2015, after the stock had lost over 80% of its value, Mingyang was taken private at USD2.51/share (around 10X earnings).

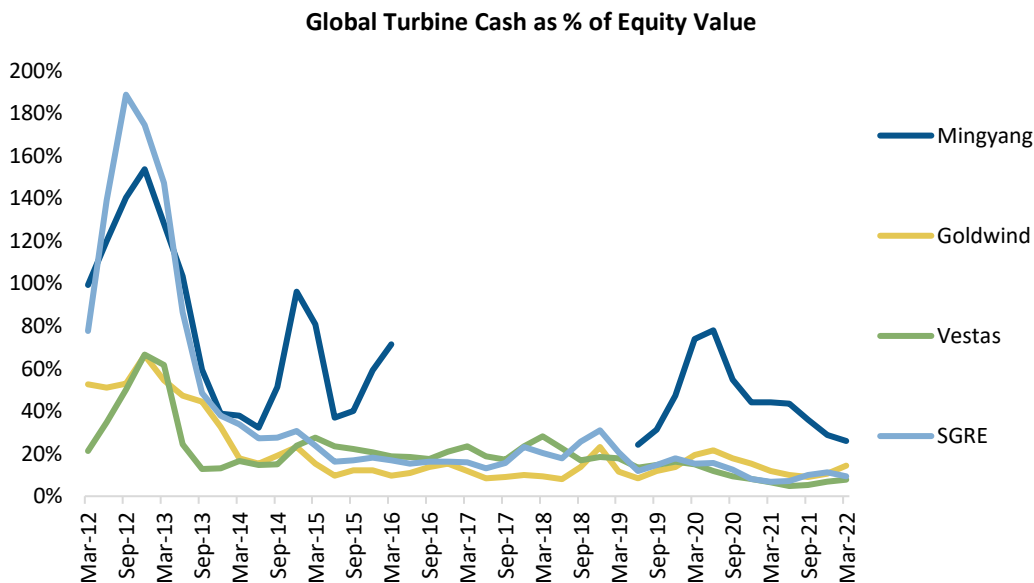
The US market never warmed to the stock, due to its low liquidity and some disappointing results. However, the drop in the stock and subsequent buyback turned into a subsidy to Mingyang as the company pocketed over USD300m in the process. For five years, Mingyang was paid by investors to spend on R&D, pursue M&A opportunities, and grow its footprint. This was free money, as Mingyang never even paid a dividend.

This is not to suggest that this was Mingyang's intention in any way. Mingyang's stock lacked liquidity, but Mingyang's performance was also unimpressive. The final straw appeared to be a 2015 purchase of REnergy, which resulted in a 25% dilution of the shares. It is noteworthy that many on the management team had been replaced by 2017.

In early 2019, Mingyang listed on China's Shanghai exchange. It IPO'd at around 10X earnings and raised a little over USD200m. In January 2020 Mingyang announced there would be a follow-on secondary offering without saying when.

In October of 2020, a month after Xi Jinping pledged to the UN that China would reach peak emissions by 2030, Mingyang launched its follow-on offering. The company raised another USD880m at a valuation of over 20X. Within two years it had raised over USD1B to be used on more R&D, more M&A, and more growth.

Figure 19: Global Turbines, Cash as % of Equity



Source: Bloomberg, Company Reports, IEEFA Research

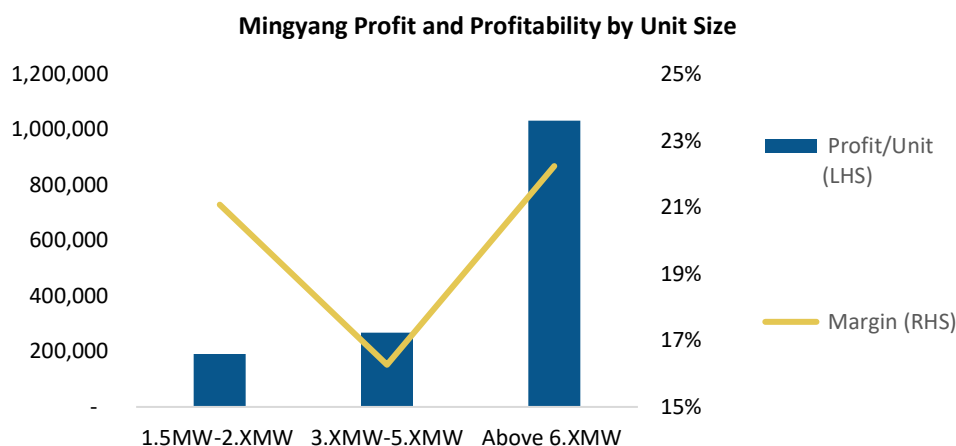
Mingyang's ample liquidity can be seen against its peers by looking at the percentage of the share price that can be attributed to cash and cash equivalents. While SGRE also had high cash values at one time, Mingyang cash/share value ratio has stayed above its major peers consistently since 2014. This is not a valuation discount, but rather a reflection of the dry powder Mingyang maintains to execute its research and development plans.

Higher Profits From Larger Sizes

In the drive toward larger and more efficient turbines, Mingyang is thus well-supplied, well-funded, and leading in technology and design. Mingyang financial reports show the company's highest margins are achieved at turbine sizes above 6MW – sizes which are almost entirely installed offshore. Higher margins on higher prices for larger sizes puts Mingyang's unit profitability from large units well above smaller sizes – USD1M+ for 6MW and above, vs. around USD200K for smaller sized models. Mingyang supplies many small-scale offshore wind turbines but simple economics maintains that it would always prefer to supply larger sizes if given the choice.

Mingyang isn't unique in achieving higher returns at larger turbine sizes. As turbine sizes get larger, the cost relationship isn't 1:1 and costs/MW capacity can come down. Mingyang's 11MW offshore turbine, for example, weighs 57.5 tons/MW while its 5.5MW offshore unit weighs 80.6 tons/MW. This is mainly the result of lower marginal steel inputs as turbine sizes grow larger, but it would also apply to the aluminum, copper, and rare earth magnets necessary for larger turbines as well.

Figure 20: Mingyang Unit Profits and Margin by Size



Source: Company Reports, IEEFA Research

While this structure might therefore not be unique to Mingyang, it is further incentive to the company's clear and consistent efforts to provide larger size turbines to offshore fixed and floating markets. For a company focused on developing larger offshore turbines, it is convenient that they are earning a premium for doing so.

Venturing Out

Now that it dominates China's offshore wind turbine business, Mingyang has begun to dip its toes into international markets. It has just completed a modest 30MW offshore wind project (10X3MW units) off the coast of Southern Italy and is contracted to supply an even smaller 9MW farm (3X3MW) in Japan in 2023. It has also won the contract to supply Vietnam's largest offshore (intertidal) wind project to date, the 375MW (75X5MW) Ca Mau project, which should be operational sometime next year. Finally, Mingyang has been awarded a contract to supply its 11MW units to a European floating project from the Spanish developer EnerOcean.³⁵

Since the Chinese Renminbi isn't easily convertible, funding this international expansion isn't easily financed from its balance sheet onshore in China. As a result, Mingyang returned to international equity markets in July 2022, this time to London

³⁵ Buljan, Adrijana. [MingYang Secures Second Offshore Wind Turbine Order in Europe.](#) OffshoreWind.biz, October 29, 2021.

as part of the stock connect program with China. The company originally planned to raise USD550m at around USD20/share, but subscriptions were so strong that the deal was enlarged. The company wound up raising over USD700m for its international expansion, implying a USD10B valuation for the company.

This is now a substantial offshore war chest for Mingyang. Mingyang has signed a memorandum of understanding to invest in turbine assembly and blade manufacturing facility in the UK. According to GWEC, the UK is likely to be the world's second largest source of offshore wind capacity expansion by 2030 behind China. The UK also has substantial plans for multiple GW of floating capacity as well. A well-funded operation within the UK would provide a significant beachhead for expansion into other European markets.

Mingyang will use some of its recent capital raise to finance its international expansion.

Non-China Wind Power

Mingyang's move into offshore markets appears well-timed. The global wind turbine industry has become a near oligopoly, with SGRE, Vestas, and GE as the main players. Those three have supplied the majority of non-Chinese onshore windfarms. The non-Chinese offshore wind industry is currently a duopoly between SGRE and Vestas, with hopes of becoming an oligopoly with GE's new offshore models.

All three non-Chinese incumbents have large-scale product offerings to match those from Mingyang. SGRE has a 14MW DDPMSG offshore turbine and GE's newly launched 12-14MW turbines also use direct drive. Vestas' offshore models use MSPMSG, just like Mingyang, and it will soon launch a 15MW hybrid offshore turbine that is the closest answer to Mingyang's 16MW model.

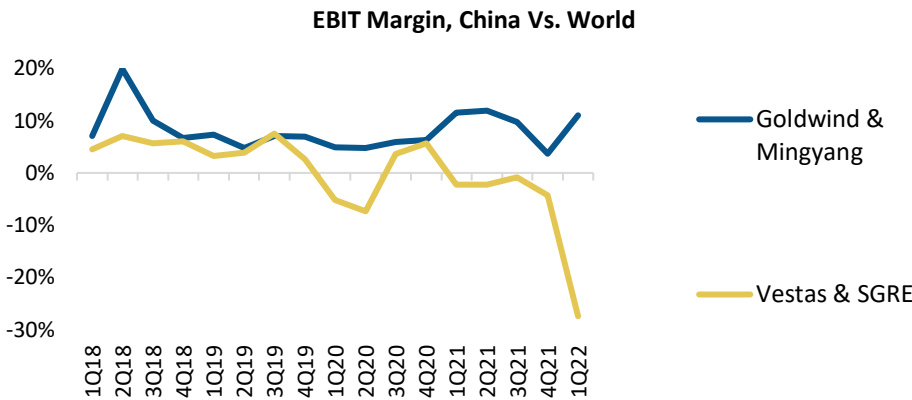
As Mingyang moves offshore, all three of these competitors face challenges. Vestas is probably best off, as its troubles are so far limited to cost pressures rather than organizational. By contrast, SGRE and GE not only both share Vestas' cost challenges but also face impending organizational restructurings which may prove disruptive.

Cost Crunch

The past 30 months have been difficult for non-Chinese turbine OEMs. Profitability has been declining for years, but the recent rally in commodity prices and shipping bottlenecks have made all three of largest non-Chinese competitors see heavy losses. Chinese turbine players have generally realized stronger EBIT margins than

international peers, but recently the divergence in profitability has reached extremes.

Figure 21: Global Turbine Company EBIT, China vs. World

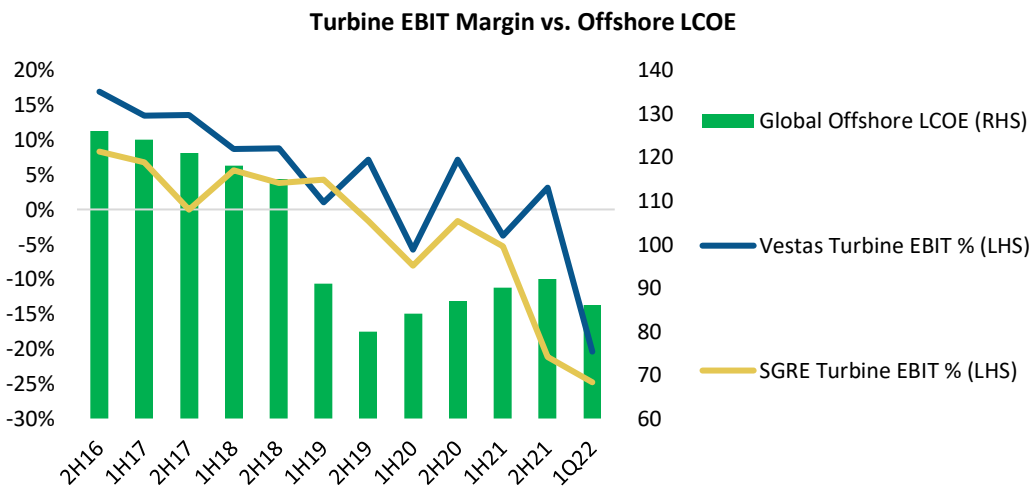


Source: Company Report, IEEFA Research

Corporate consolidated EBIT margins can include maintenance services and other sources of income beyond turbine sales. Luckily, BNEF has tracked the turbine-specific EBIT margins for Vestas and SGRE for some time. The decline of turbine profitability has been ongoing since 2019 as global offshore wind LCOE contracted. Turbine prices appear to have been declining faster than costs since at least 2016.

Turbine prices have fallen even faster in China. As the country's preferential feed in tariff schemes expired – onshore in 2020, offshore in 2021 – China's turbine prices plunged. Chinese turbines have dropped by around 30% on a USD/MW basis since YE19. Chinese wind turbines are now the cheapest in the world

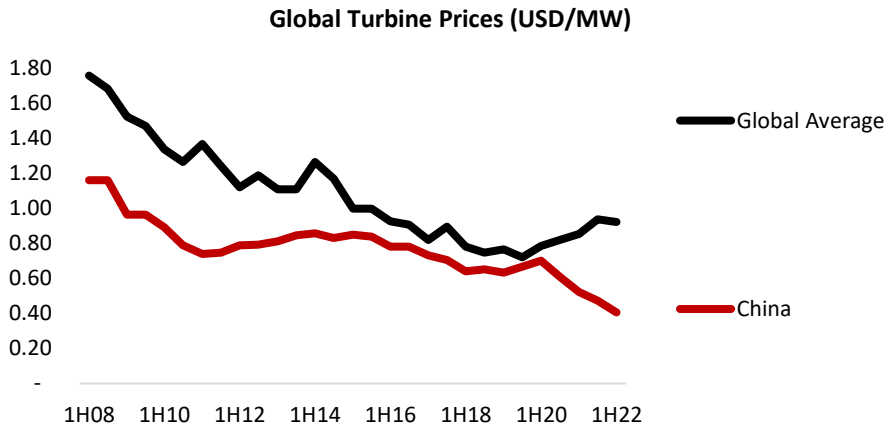
Figure 22: Turbine EBIT % vs. Offshore LCOE



Source: BNEF, Company Documents, IEEFA Research

BNEF's global average of turbine prices has gone up 30% from 2H19 lows – the opposite direction of Chinese turbines but the same %. The impact of higher commodity prices and shipping rates has put pressure on turbine suppliers to pass those costs along to consumers. Yet the global turbine players continue to lose money.

Figure 23: Turbine Prices (USD/MW)



Source: BNEF, IEEFA Research

If GE, SGRE, or Vestas need equipment from Chinese suppliers, they face shipping bottlenecks that are holding freight rates 3X higher than 2019. If they are able to source parts locally, both European and North American suppliers are experiencing elevated steel (tower and turbines) and resin prices (blades).

This is in addition to globally higher rare earths prices, seen in the Shanghai price for Neodymium, which is two and a half to three times higher than pre-COVID levels. While we're hopeful these prices normalize in the near future, the disruptive forces behind higher commodity prices and freight rates from China may not resolve quickly.

Figure 24: Global Shipping, Regional Steel, and Regional Resin Inflation



Source: BNEF, Bloomberg, IEEFA Research

Corporate Restructuring

On top of this profit crunch, both SGRE and GE have embarked on major organizational restructurings. Only Vestas appears likely to have the same profile by 2025. What's interesting is that SGRE and GE are heading in different directions, one consolidating with its parent, the other spinning out from its parent to become an independent entity. These restructurings may ultimately yield substantial benefits, but reorganization of entities of this size can be both disruptive and distracting in the near term.

SGRE was created in 2017 by the merger of Germany's Siemens Wind Power with Spanish Gamesa. Siemens Energy remains the controlling shareholder with 67% of SGRE. SGRE has seen deteriorating earnings on lax cost control, an erratic dividend policy, and a decline in balance sheet health. As a result, the company recently fired its CEO, Andreas Nauen, less than two years after taking over.

Siemens Energy announced its offer to buy the remaining 33% of SGRE it doesn't own on May 18, 2022 for USD4.3B. It plans to delist SGRE by YE22. Siemens Energy will attempt to stabilize SGRE's business by bringing German control of strategy, marketing, and governance that can cut costs and raise revenue opportunities.

All of this will take time. These are two very large organizations, and combination is unlikely to be straightforward. At the moment almost 80% of Siemens Energy's valuation can be attributed to its SGRE stake, which suggests that synergies could be limited.³⁶

GE is going in the opposite direction as it splits into three different units: aviation, healthcare, and power. The power unit will be called GE Vernova, and will include the company's conventional gas and nuclear, its wind turbine business, as well as its grid intelligence assets. It will list as an independent entity in early 2024.

However, GE is guiding that GE Vernova will be the least profitable of the three new entities. GE reported that GE Vernova will have the lowest organic growth, operating margin, and free cash conversion of all of the three new companies. The renewable energy business has been loss making since 2019 and GE is guiding it will remain in the red through 2022. GE may need to restructure or reorient the renewables business before the spin off.³⁷

GE Vernova therefore faces two main issues as it prepares to list. Most importantly is the company's renewables operation, which will at least require cost cuts and potentially a review of strategic direction prior to listing. Next will be GE Vernova's access to capital, as the company will come out from under GE's umbrella.³⁸ GE Vernova will likely begin to restructure lending facilities in the runup to its spin-off,

³⁶ As of Aug 5, 2022, Siemens Energy's stake in SGRE is worth approximately EUR8.18B, while Siemens Energy's enterprise value is EUR10.5B.

³⁷ This appears already to have begun: Root, Al. [GE Shelves Wind Turbine Blade Plant. Renewable Energy Has Been a Tough Go](#). Barrons, July 13, 2022.

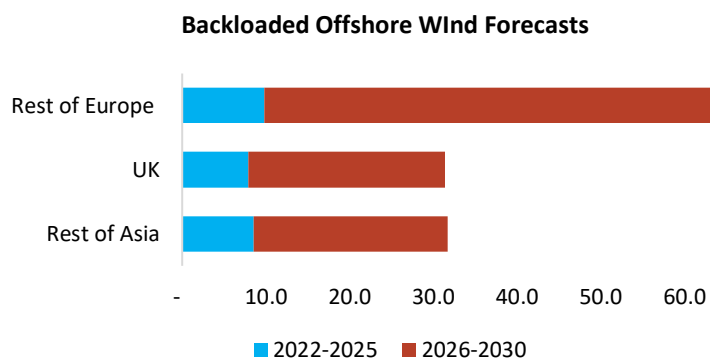
³⁸ Bloomberg data as of August 5, 2022 indicates GE's weighted average cost of capital is 7.8%, lower than Vestas at 9.1% and SGRE at 9.8%.

so we may see GE's wind operations hit by a step change higher in financing rates at the same time the company is taking out operational costs.

Battle at Sea

Mingyang faces three weakened incumbents as it ventures outside China to compete for offshore wind contracts in non-Chinese markets. All three of the global majors are racking up losses, and only Vestas is doing so without the further stress of an imminent restructuring. Mingyang arrives in new markets with a strong balance sheet off its recent capital raise, reliable cash generation and pipeline within its China operation, as well as large-scale and world-class turbines which it could price aggressively as a result.

Figure 25: Global Forecast for Offshore Wind Additions (GW)



Source: Average of GWEC & BNEF Forecasts, IEEFA Research

Offshore wind is not a sector that changes quickly, and this may suit Mingyang's interest. While turbine lead times may only be 9-18 months for production, offshore wind farm planning, permitting, and construction requirements can add another five years before commissioning. Forecasts for significant offshore wind capacity additions are generally backloaded toward the latter half of this decade, between 2026-2030, as a result. Mingyang has some time before supply contracts are locked in.³⁹

³⁹ Mingyang's contract to supply Italy's 30MW project actually came as a replacement for an original agreement with Senvion for those same turbines. The offshore wind sector shifts slowly, but decision points can also yield quick changes as well. Buljan, Adrijana. [MingYang Turbines for Taranto OWF Arrive in Italy](#). OffshoreWind.biz, October 4, 2021.

Mapping Opportunities

As Mingyang contemplates setting up production in the UK, the three global majors are currently active in emerging offshore markets in East Asia – Taiwan, Korea, Japan, and Vietnam. It would be reasonable to assume Mingyang has an advantage in nearby Asian markets, while GE Vernova, Vestas, and Siemens Energy will hold advantages in European markets.

However, given the current state of Mingyang versus these global players, that assumption may prove incorrect. Mingyang has just upsized an equity offering in the UK for fresh USD funding, for instance, while Siemens Energy has offered to buy SGRE shares it doesn't own on weakness. Mingyang has fresh cash and a strong share price for investment that places it an advantage against established incumbents.

Mingyang has fresh capital and share value that incumbents lack.

While these Asian markets are all promising, their state of offshore wind development varies. In East Asia, only Taiwan has shown progress in developing policy and pricing to achieve steady offshore wind development. Other markets in Asia are just beginning their offshore buildout and present significant uncertainty for those who would provide the long-term funding necessary to move forward.

European offshore wind markets are generally more established, with UK arguably its most mature market. Germany, Denmark, Belgium, and the Netherlands are all also substantial offshore markets already. Other European markets like Sweden, Ireland, and Portugal are developing as well.

We examine these competitive markets in the Appendix, below. We don't consider other markets at this time, because Mingyang has so far shown no indication it plans expansion beyond this UK facility. The other substantial markets would be the US, Brazil, and Australia, but any discussion about them would be purely speculative at this time.

Having said that, Brazil is interesting as it is China's largest destination for outward foreign direct investment into clean sources of power: solar, onshore wind, hydro, and biomass.⁴⁰ To the extent that Brazil develops its offshore market, Chinese Mingyang seems well-positioned to play a role.

⁴⁰ According to data collected by Boston University's Development Policy Center. Gallagher, Li, Chen, & Ma. [China's Global Power Database](#). Global Development Policy Center, 2020.

Conclusion

This report began with an analysis of the trend toward larger turbines in offshore wind around the world. Offshore farm developers are using larger offshore turbines to cut construction, infrastructure, and maintenance costs and lower the cost of offshore wind power. Outside of China, the world's offshore wind industry is effectively a duopoly between SGRE and Vestas at the moment, with GE Vernova set to play a larger role going forward.

We then examined how China's wind turbine players have grown within a protected market with clear and supportive policies, cost advantages, supply chain strength, and intense competition. Today China's largest wind turbine players enjoy gross margins 14 percentage points higher than their non-Chinese international peers on average. The country's offshore wind turbines have grown out of that same crucible as their onshore counterparts. Most of China's offshore wind turbine suppliers may not survive or will be merged with stronger competitors. A few of China's stronger turbine players are world class and may be able to compete in non-Chinese markets.

Mingyang is now China's strongest offshore wind competitor. The company has focused its research and development to lead China's drive toward larger offshore turbine sizes. In 2021 Mingyang was the largest supplier of 5MW+ turbine sizes in the world. In 2024 the company will introduce the world's largest offshore turbine size at 16MW.

Mingyang's most important offshore market will always be China, but the company's recent listing in London could fuel a push into non-Chinese markets. Mingyang has signed a memorandum of understanding to build blade and turbine assembly plant in the United Kingdom. The UK is the world's second largest offshore wind market behind China, and Mingyang's facility would be some of the country's only domestic turbine manufacturing capacity.

Mingyang's move into global markets is welcome. Asian and European markets could add up to 100GW of new offshore wind capacity between 2026-2030. Mingyang's international expansion would add new large offshore turbine choices and production capacity beyond that of Vestas, GE, and SGRE. New players and more capacity would help grow the global offshore wind industry efficiently and inexpensively. Mingyang's successful expansion into the UK could be a game-changer for the company, as well as the global offshore wind industry.

**Mingyang's UK
investment
opportunity could
be a game-changer
for the company
and the industry.**

Appendix

We present an analysis of global markets in which Mingyang might compete, below. Markets in East Asia like Taiwan, Japan, Korea, and Vietnam look interesting, but each holds challenges to Mingyang that make the value of its participation ambiguous.

In contrast to East Asian markets, the UK provides a single, coherent, and established policy environment. The UK is likely to remain the world's second largest offshore market behind China, and is forecast to add more offshore capacity by 2030 than all four East Asian countries combined. Success in the UK could also provide optionality in other European markets.

Taiwan

Taiwan is one of Asia's most advanced offshore wind markets. While installed capacity has been stalled for some time, the new Yunlin and Changhua farms will add 192 SGRE 8MW turbines this year. There are hopes that the Changfang farm will add a further 62 Vestas 9.5MW turbines in 2023. BNEF and GWEC projections for new offshore additions suggest Taiwan will remain Asia's second most active offshore market until the end of this decade, adding a projected 11GW between 2023-2030.⁴¹

Taiwan's offshore policy has been relatively clear and reliable. However, the policy has also evolved to soon include bidding price limits (to the equivalent marginal price for coal fired power), farm size restrictions (to 500MW), and higher local content requirements (to at least 60% for some costs). The country has legacy heavy industry, including steel and shipbuilding, which is being redirected toward serving offshore wind component, servicing, and assembly demand.

So far this hasn't led to any change in enthusiasm. Taiwan's offshore wind resources are substantial with GWEC estimating 67GW of potential fixed capacity and over six times that number for floating capacity. As a first mover in offshore wind, offshore projects in Taiwan now also enjoy financial support from large scale domestic insurers and pensions. Finally, Taiwan also has one of the most active corporate purchasing power agreement (PPA) markets in Asia. These corporate PPAs can carry long-term offtake commitments and substantially de-risk a project.⁴²

VERDICT: SHUT OUT?

Taiwan has a vibrant offshore market, so far dominated by SGRE and Vestas who have both invested in local production. GE Vernova should also be a factor, but it lags those two at the moment. However, we find no evidence that Mainland Chinese turbine suppliers, including Mingyang, have had any success in Taiwan's wind power market thus far. If this changes, Mingyang would have obvious advantages in proximity and culture for localization of training and production.

⁴¹ These estimates may have downside against the backdrop of current geopolitical hostilities. The risk that insurers and investors pull back from exposure to assets in areas within the Straits of Taiwan would appear material at the time of writing.

⁴² The most famous Taiwan offshore wind PPA signed so far has been with TSMC for the offtake of all of the Changhua farm's output, which had been the largest renewable PPA ever signed in 2020. Ørsted Press Release. [Ørsted and TSMC Sign the World's Largest Renewables Corporate Power Purchase Agreement](#). Orsted Taiwan, July 8, 2020.

Vietnam

Vietnam has shown an ability to incentivize large additions in solar and onshore wind capacity through the use of feed in tariff premia in the past. However, the country's offshore ambitions have so far been stymied by continued delays in the government's promised Power Development Plan VIII (PDP 8). There are indications that PDP8 will contain a targeted 7GW of offshore wind capacity by 2030, but so far there is no confirmation on the regulatory framework that will be in place to support that goal. Until things like permitting, grid connections, and pricing have been settled, Vietnam won't be low risk enough to attract the investors and insurers necessary to support long duration offshore wind assets.

The country has significant wind resources at depths below 60M for fixed offshore capacity.⁴³ However, the country's "offshore" wind installations so far have only been in intertidal areas just off the east coast of the country's southernmost province. The farm that Mingyang is supplying is also intertidal, but will be the largest of its kind once it comes online later in 2022.⁴⁴

VERDICT: DOMESTIC PARTNERSHIPS

Vestas and SGRE have already installed offshore capacity in Vietnam, and GE has won contracts as well. However, Mingyang is establishing a presence with domestic and Chinese developers with the country's largest intertidal farm to date. When policy improves and Vietnam becomes an active offshore market, Mingyang may be able to compete with global majors by continuing to work with these same developers and remaining cost competitive.

⁴³ World Bank estimates Vietnam has as much as 261GW of fixed offshore potential and a further 338GW for floating. See [Technical-Potential-for-Offshore-Wind-in-Vietnam-Map.pdf](#).

⁴⁴ Saur News Bureau. [China's Mingyang Bags 375 MW Wind Project in Vietnam](#). Saur Energy International, October 27, 2021. Also, Buljan, Adrijana. [Mingyang to Supply Wind Turbines for Vietnam's Largest Intertidal Wind Farm](#). Offshorewind.biz, October 25, 2021.

Japan

The Japanese offshore wind market could be substantial, with GWEC estimating 122GW of fixed offshore potential and a staggering 1,775GW for floating.⁴⁵ The country only has around 160MW installed to date. In December 2021, Vestas blades and nacelles for its 4.2MW turbines began to arrive from Denmark for a project that will nearly double the country's offshore capacity.

The government has been sensitive to local communities as well as the country's powerful commercial fishing interests. This has added another layer of approvals to complicate an already complicated process. The central government is working to develop a national bidding system that would work with local governments on site development and surveys, which could streamline the process considerably.⁴⁶

Nonetheless, Japan's offshore market is currently frozen as it reassesses its bidding system. In December 2021, a Mitsubishi-led consortium swept the auction for three fixed offshore projects with bids that were far below those of the next closest rival by 28-43%.⁴⁷ All 1.7GW of the three farms will be supplied with GE's new 13MW turbine that will partially source locally through a GE-Toshiba partnership.⁴⁸

The government is now reviewing and revising the bidding system to ensure greater competition. Japan's ample world class steel, machine works, and offshore engineering operations should provide opportunities to localize production going forward.

Both Vestas and SGRE had been looking for local opportunities for production in anticipation of future wins. However, in the wake of Mitsubishi's win Vestas has already announced it has shelved plans for a local manufacturing facility.⁴⁹

VERDICT: WAIT AND SEE

Japan is a promising wind market that is complicated by policy complexities, uncertainties, and mistakes. The government has stated it has a goal of 10GW by 2030, but BNEF and GWEC forecasts have been lowered to under 5GW. Mingyang has only so far only won a contract for 3X3MW for a very small 9MW offshore farm but has yet to be included in any consortia of bidders for larger projects. For now, Mingyang doesn't appear competitive, but there should be time to adjust strategy.

⁴⁵ Estimate from Japan's New Energy and Industrial Technology Development Organization, as seen on p7: Kato, Jin. [Initiatives to Make Offshore Wind Power the Primary Power Source](#). Japan Wind Power Association Presentation to Taiwan Global Offshore Wind Summit, October 13, 2020.

⁴⁶ Harrison, Kasai, & Yu. [Change is In the Air – Japan Introduces Changes for a More Efficient OSW Site Selection Process](#). White & Case, September 17, 2021

⁴⁷ Analysis from Robert Liew of Wood Mackenzie during Day 1 "Spotlight Presentation: Impact and Result of Japan's First Offshore Wind Auction" of July 26-28 APAC Power & Renewables conference.

⁴⁸ Durakovic, Adnan. [GE and Toshiba Bringing Haliade-X Offshore Wind Turbine to Japan](#). OffshoreWind.biz, May 11, 2021.

⁴⁹ Staff. [Lack of Offshore Wind Orders Forces Vestas to Put Japanese Plans on Hold](#). Renewables Now, July 21, 2022.

South Korea

As in Japan, South Korea holds ample domestic steel, forging, and offshore engineering capacities that would be helpful in localizing production. However, Korea thus far has a similarly complex and evolving policy framework that is prone to resistance from local and commercial fishing interests. The government attempted to streamline and centralize its cumbersome permitting process a few years ago but fishing interests helped derail the effort.⁵⁰

The recent election of Yoon Suk-yeol has added a new element of uncertainty, as he has voiced support for additional nuclear power where his predecessor had not. A switch to nuclear may hit gas before it impacts renewable energy, but at this point that remains a risk.

Korea is unique is not only in its floating potential, but also in its floating capacity probability. According to GWEC, Korea has only 78GW of potential fixed wind but nearly 550GW of floating offshore capacity – second only to China in Asia. Korean waters to the east of the country drop off quickly, leaving floating as an attractive renewables option within proximity to areas of demand.

Forecasts for Korean fixed offshore wind continue to come down, but Korea appears to be expediting approvals for floating offshore ventures. GWEC expects the country to contribute 3.6GW of capacity between 2023-30. That's the most commercial floating capacity additions of any country, and 60% of GWEC's forecast offshore wind for the country.

VERDICT: NOT YET IN THE MARKET

The Korean wind turbine market has had its own local supply in the past, with Doosan surviving to add its own 8MW offshore model. SGRE has allied itself with Doosan, and Vestas and GE have also pursued local partnerships as well. Mingyang hasn't broken into South Korea in any way so far. Vestas has focused on the floating market⁵¹ and is already positioned in a market where Mingyang's turbines would be competitive.

⁵⁰ Williams, Zhao, & Lee. [Global Offshore Wind Report 2022](#). Global Wind Energy Council, June 29, 2022.

⁵¹ Durakovic, Adnan. [Vestas Joins 9 GW Floating Offshore Wind Project in South Korea](#). Offshorewind.biz, March 9, 2022.

United Kingdom

The UK is one of the world's most mature offshore wind markets for good reason, with GWEC estimating a potential for 439 GW of fixed capacity and 1,361GW floating. The country had been the world leader in offshore capacity until China's buildout in 2021. They have set an ambitious target to add another 30-40GW of offshore wind by 2030. Both BNEF and GWEC appear confident that the UK will add at least 30GW, about 10% of which is expected to be floating.

The result could be a wholesale restructuring of the country's energy supply. According to BNEF New Energy Outlook (NEO) generation data, the UK sourced about 5% of power generation from offshore wind in 2015, but that rose to 15% in 2021. NEO forecasts that offshore wind could supply over 50% of the country's power generation by 2030, five times the power provided by either gas or nuclear.

There is currently a bidding process for offshore wind that uses a contract for difference (CFD) that has included a subsidy over the wholesale price. This structure insulates the government as the generator pays the government back anytime the wholesale price rises above the bid price. However, the subsidy has been declining, and it will increasingly be a heavy influence on that wholesale rate as offshore wind gains share.

VERDICT: WORTH THE RISK

All three of the global majors have played major roles in the UK offshore development but have been supplied by facilities in continental Europe. Mingyang's capital raise in the UK follows its signing of a memorandum of understanding (MOU) last December to create production facilities to supply wind turbines and blades domestically – one of the first companies to do so.⁵²

This is a risky endeavor, as Mingyang may find its culture, cost structure, and product quality difficult to translate. However, the UK promises to add more offshore capacity by 2030 than Korea, Japan, Taiwan, and Vietnam combined – in a single, mature, transparent market. The UK investment is well worth the risk.

⁵² Buljan, Adrijana. [MingYang Enters UK Offshore Wind Market with Major Investment Plans and MoU with Government](#). Offshorewind.biz, December 17, 2021.

Continental Markets

A full discussion of other continental European markets is beyond the scope of this report. However, as mentioned above, there are many markets that are forecast to add substantial new capacity. Some of these markets like Germany and the Netherlands are well established. Others like Poland and France are relatively new to offshore wind.

These other European markets are generally open. They would of course prefer the jobs associated with localization, but thus far don't appear to require it as a strict barrier to entry like many Asian countries.

The outlook for other European countries is very bright indeed. As seen above (Figure 25: Global Forecast for Offshore Wind Additions) BNEF and GWEC expect the rest of Europe to add twice as much offshore wind capacity as the UK or non-Chinese Asian markets.

VERDICT: OPTIONALITY

These other European markets have been dominated by SGRE, with Vestas and GE playing smaller roles. However, Mingyang has had an R&D presence in Copenhagen since 2009 and a business development operation in Hamburg since 2020. Bloomberg reported in 2021 that Mingyang had an interest in opening production facilities in Germany, but the story preceded the UK MOU by three months and appears to have been shelved in favor of that opportunity.⁵³

However, Mingyang's effective production operation in the UK and improved presence in that offshore market would provide material optionality to Mingyang for turbine wins and potential production facility expansion in other European markets as well.

⁵³ Liu, John and Ding, Luz. [Wind Turbine Maker Plans First Big Chinese-Built Plant in Europe](#). Bloomberg, September 24, 2021.

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