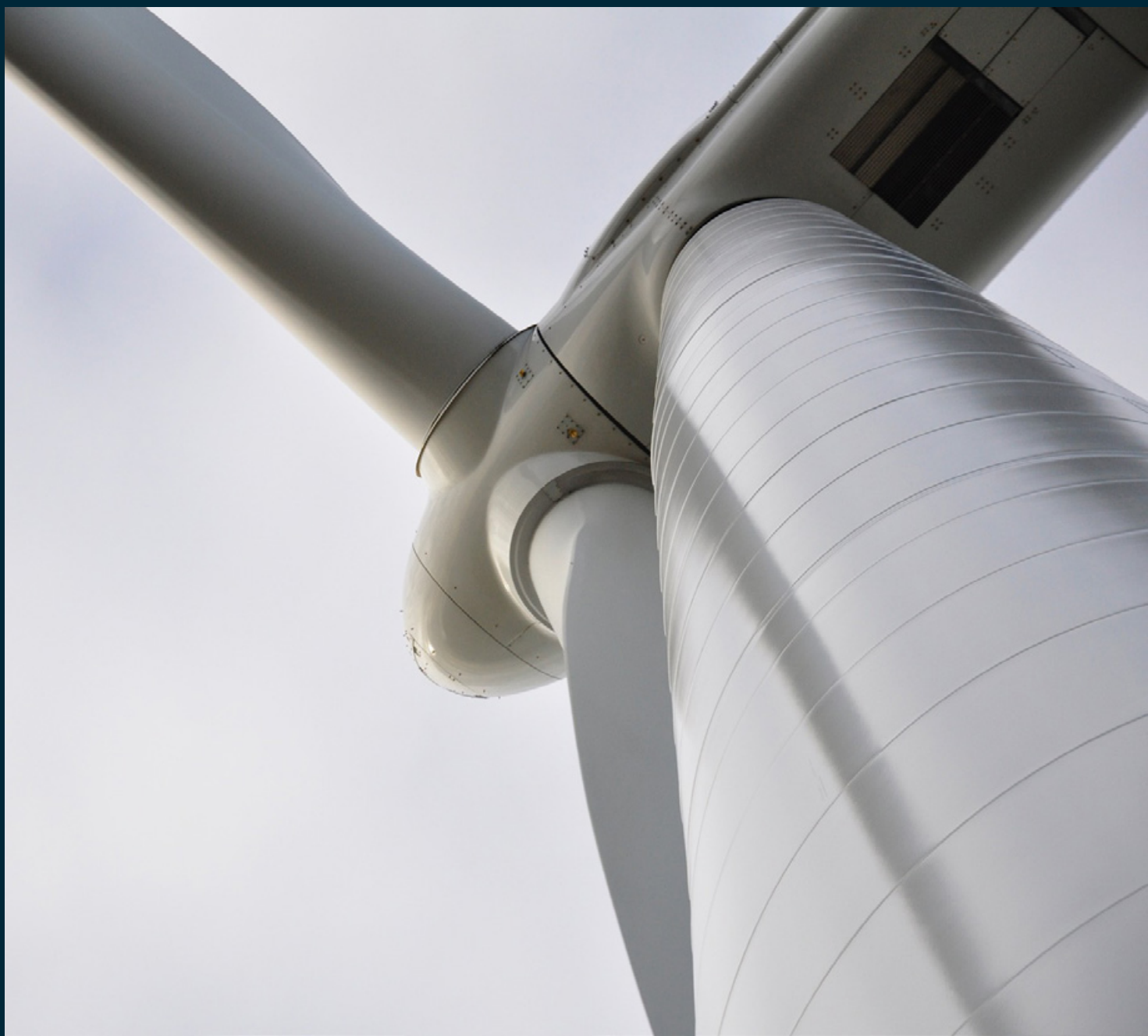
Tamarindo | WindESCo

SPECIAL REPORT

Repowering wind in the US for a climate-neutral future



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- **Vann Gupta**, Vice President, Asset Development, Brookfield Renewable US
- **John Clapp**, Chief Financial Officer, Scout Clean Energy
- **Borja Munoz**, Business Development Director, OX2
- **Eli Davis**, Director, National Australia Bank
- **Ben Stafford**, Sales and Commercial Executive, GE Renewable Energy
- **Juan Carlos Puente**, Chief Financial Officer, Atlantic Shores Offshore Wind

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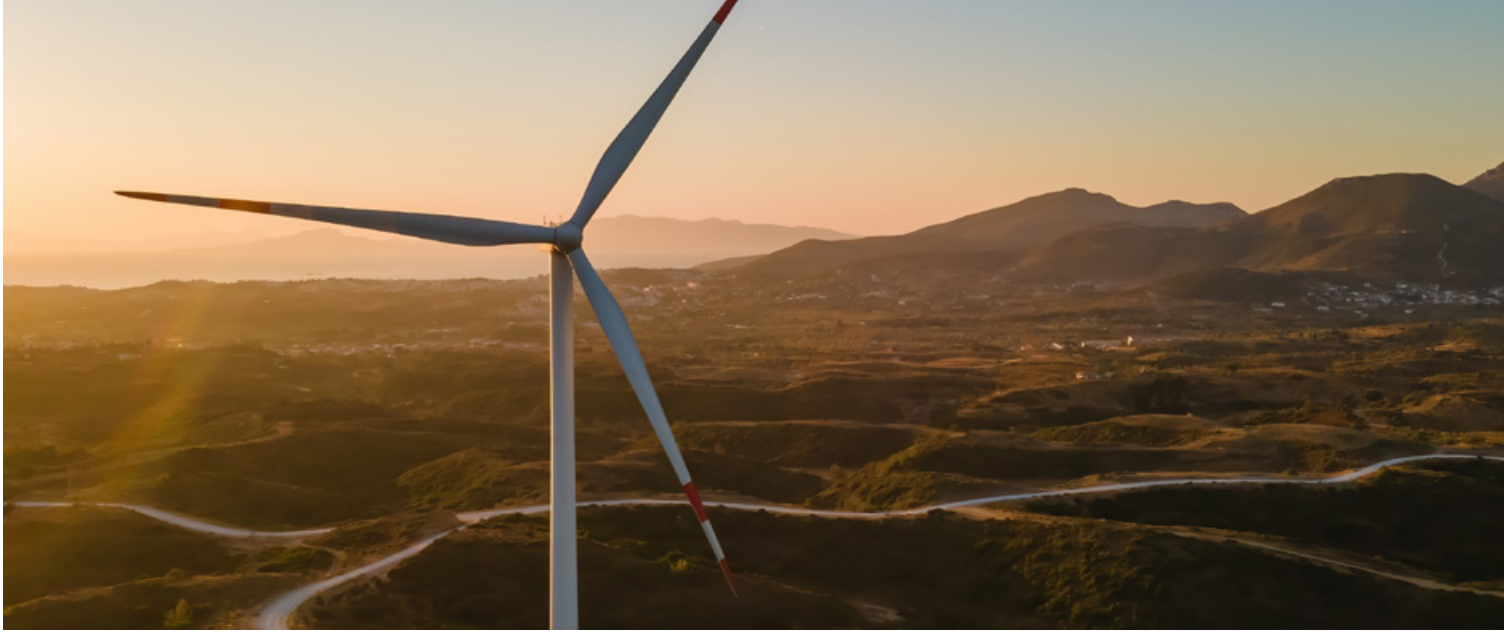


Executive summary

Repowering — upgrading wind plant components or systems to extend asset life — is going global.

In parts of Europe, repowering wind is a matter of course. Germany has a long history of incentivising repowering. Denmark has been doing so since 2001, and recently shifted its focus away from onshore wind growth and towards repowering its ageing fleet.

North American repowering is just getting off the ground. This potentially tens-of-GW market could be vital to meeting the US's 2030 climate goals by ensuring wind projects are not shut down prematurely and existing land and transmission is used efficiently.

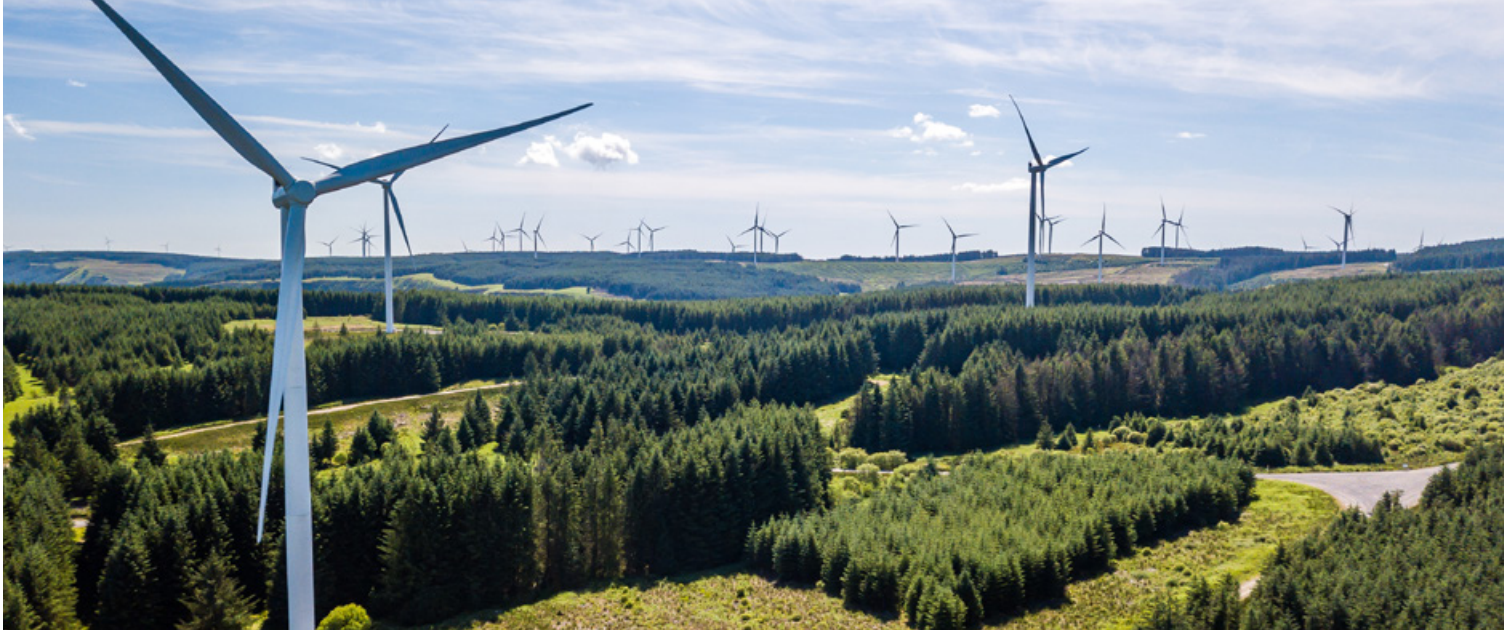
The US seems to have embraced repowering as a zero-carbon solution, including it in an extended and expanded tax credit subsidy regime for clean technologies under the newly passed Inflation Reduction Act.

While the previous US tax credit scheme supported repowering, the expanded tax credit scheme, alongside flagship repowering projects and aging wind fleets, has owners and operators looking closely at the financial opportunities presented by repowering.

Repowering is not without its teething problems. Local opposition to the bigger and more productive turbines is rising. What's more, taller turbines risk coming into conflict with the US federal government's review process for structures able to cause radar interference.

In addition, the narrative that repowering wind has no added climate benefits, e.g. "additionality", is one wind stakeholders must correct so that the emissions benefits of repowers are recognised in federal, state as well as corporate ESG guidance.

This report takes a look at what the future holds for repowering in the US, drawing from Tamarindo Group's recent Wind Investment Boardroom discussion on repowering.



Market for wind project repowering

In the US, around 1.6-3GW of turbines are partially repowered each year. This is just a shadow of the market's potential.

GE Renewable Energy Sales and Commercial Executive Ben Stafford estimates that up to 50GW of US onshore wind capacity will be assessed for repowering in the next several years given recent passing of the Inflation Reduction Act and the size of the US fleet that entered service from 2010 to 2017.

By the end of the 2020s, about 32 per cent of the US wind fleet will be slated for decommissioning, and more than a quarter of that is in Texas according to research from Texas A&M University.

While there is wider acceptance of repowering in the US today than in 2018, Stafford notes the sector has still not yet fully embraced repowering. While there is heavy demand for renewable finance, discussions on wind repowering finance can still be seen as a novelty.

"I think repowering for wind and solar is going to become the standard," says Scout Clean Energy Chief Financial Officer John Clapp. "Anyone who has older assets is looking into repowering internally."

The concept has yet to enter the conversation on returns from construction and ongoing financing in the US. One reason for the hesitancy is that wind investors find it hard to decide to finance the significant cost of repowering before the right data is available.

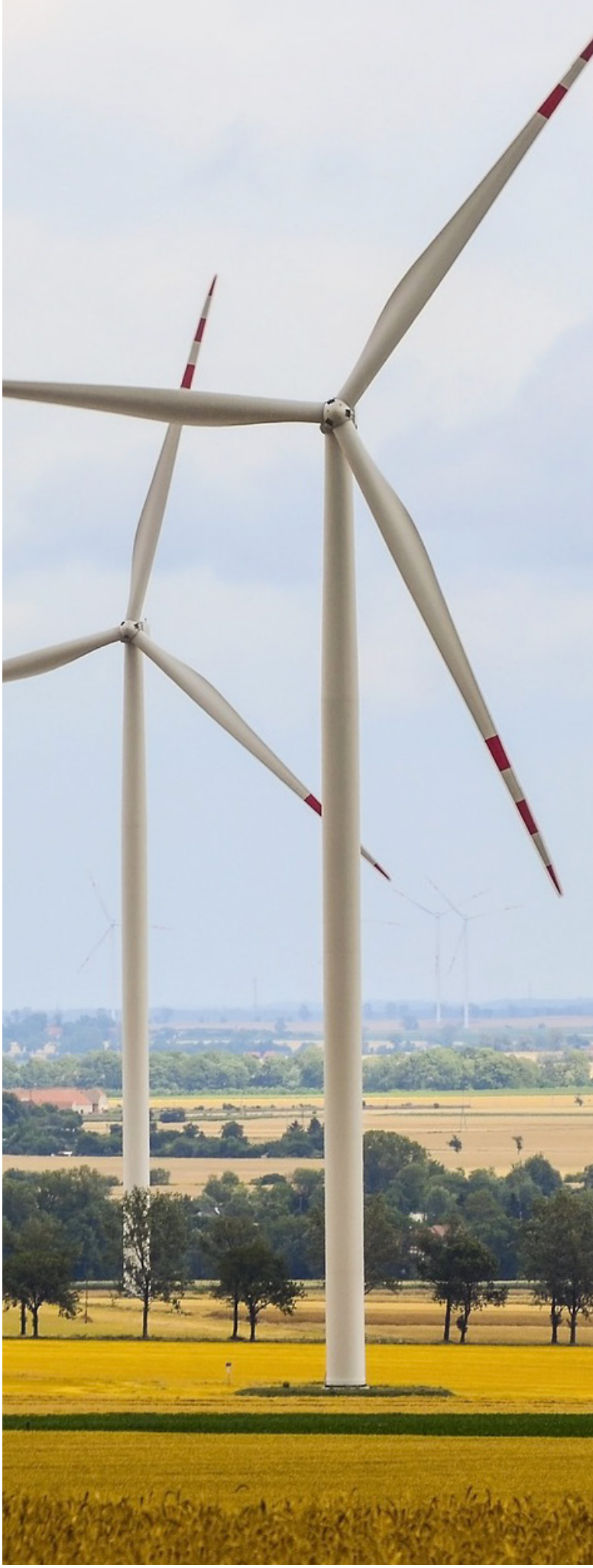
Only at the end of the project's life — when figures are available for contemporary technology costs, returns and transmission pricing — do discussions typically start, leaving years-old repowering plans in a lurch.

But the tide is turning on repowering. The IRA has strengthened incentives for repowering projects by extending and expanding existing tax credits available.

“The tax incentives allow you to pull that economic analysis forward closer from the end of useful life to just ten to 15 years after commercial operation date, and enabling repowering much sooner,” says Vandana Gupta, Senior Vice President, Asset Development at Brookfield Renewable US, which agreed to acquire Scout Clean Energy in September.

Brookfield Renewable recently completed the repowering of the Shepherds Flat project in Oregon, a three-wind-farm project built in 2012. Upgrading the 845MW project’s capacity factor by 25 per cent ranks it as the largest repowering projects in the world, Gupta believes.

The repowering gained notice to proceed in 2021, unusually far in advance of the end of its useful life, thanks to tax equity incentives available at the time. The financing combined a $263 million back-levered term loan, a $35 million subordinated letter of credit, a $164 million tax equity bridge and was structured around a two-year repowering period and an existing PPA. The turbine blade supplier on the project, GE, provided tax equity. Intelligence provider Proximo called the deal “an inspiration to other owners of mature wind assets.”



The importance of OEM collaboration

Wind project owners depend on OEMs and other technology providers to kickstart repowering projects. “In the case of Shepherds Flat, GE proposed a technology solution to the owners that made repowering economic,” says Gupta. The idea became reality as the owner and OEM worked together.

“Shepherds wasn’t even ten years old and GE was knocking, saying ‘let’s look at a repower,’” Gupta says. “It is to the extent that the OEMs offer technology, whether it’s blade extensions, or some type of enhancement that might make a project economic to repower, that can be a big driver in getting an owner to move towards a repower.”

“The wind industry has gone the route of lowering cost through economies of scale, and so every turbine generation is larger than the last,” Clapp says, adding, “That poses a physical problem in terms of repowering because there are great ridgetop locations that could be repowered, but the roads up to the ridgetop would need improvement to transport bigger rotors and blades.”

Asset owners are on the hunt for new technologies that reduce the costs of repowering and related technical issues, for example large, unwieldy turbine parts that are hard-to-impossible to move to existing sites and onsite crowding by large turbines that leads to “wake effect,” or turbines stealing wind from other turbines.

“Some of the older sites that we manage on a third-party basis are also old vintage,” Clapp explains, “We have looked into repowering those, but we find wake effects with some because they are not standalone.”

“Some older projects are sandwiched around other owners’ wind facilities. If someone puts in a giant turbine, it would be an issue for everyone around it,” Clapp says.

Many wind farms built in the 1980s and 1990s use smaller wind turbines crowded together on so-called “zombie sites” where there would be no benefit in repowering the old foundations with larger turbines. A complete teardown is the only existing alternative.

Some tech players are offering ways to improve generation at smaller sites due for repowering. WindESCo has developed a solution to adjust turbines for wake effect, Swarm, now being put through its first data gathering paces at the 306MW Milford Wind repower project in Utah, which is set to be completed by the end of 2022. Initial data shows “swarming” improves turbine Annual Energy Production by 3 per cent compared to repowered control turbines.

Tech players are also catching on to the demand to offer new solutions. Last year Enel Green Power, an Italian utility and IPP with six US wind power assets, was seeking a tech firm to develop a repowering breakthrough: Wind turbine blade tip extensions.

Asset owner's perspective on financing

Asset owners have a short time window in which to decide if a project is a zombie or a good repower prospect when the project is acquired.

"It starts with whether there is a technology out there that you can use, and then it's the economics of the site, the wind resource, what the net capacity factor is, what you think you can increase it to with a repowering," says Gupta.

Increasing per-turbine output in terms of AEP is a critical factor but not the only one to consider, says Gupta. "While AEP gain can be a big driver of economics, other factors, such as extended useful life, financeability and of course the price of power are key parts of the economic analysis.

"In addition, repowered wind farms typically have a narrower band of uncertainty around P50 production due to the availability of wind resource data. We reduced the band of uncertainty, which is attractive to lenders and tax equity," comments Gupta.

Executive Director at National Australia Bank Eli Davis agreed. "I think that what banks are always looking for is certainty. And I think we know enough to know what we don't know, and that we have to rely upon third-party consultants."

Once site economics are assessed, a potential repowering project should get a Power Purchase Agreement at or above market value, putting it in a "Goldilocks zone" of profitability. "It really is the projects that are in that Goldilocks zone where there is a strong market for offtake that have a faster, lower-cost way to get financed. Those would be the ideal kinds of projects we're talking about," says Clapp.

While PPAs are the priority for gaining finance, AEP added through repowering can add value, says Clapp. "If we were to get a technology solution that could be proven to get us additional AEP and additional revenue on the contract, that could significantly help banks make the decision on go or no-go," he says. "As long as there is an independent engineer telling

the banks that this is legitimate, and that it is going to be sustained, it could be a real enhancement to what we are trying to do."

Certain developers have considered repowering prospects at the land leasing stage, as leases determine repowering potential, for example long-term leases with extension provisions. For utility owners-operators, the land on which their renewable project is built is not likely to be sold for any more profitable purpose. Selling land developed for wind represents a loss within portfolios, especially as prime areas of wind resource have already been developed.

Bank's perspective on M&A deals

For banks evaluating an acquired project for repowering finance, assessing the players is a key part of assessing the project.

Sponsors matter when determining project viability, according to Davis. "From a bank standpoint, what we're looking for is who is the sponsor and have they done this kind of thing before," he says. Who will be taking care of O&M is also important.

Banks work with independent engineers to understand what kinds of potential stresses the new equipment would put on the old equipment, and to understand the interconnection regime.

"It could be a little bit more complicated, as you have to evaluate the stress on existing equipment, but I don't think it's necessarily any harder to do a repower than a new project. There are just different factors to consider. By the time the package comes to us, it should work either way," says Davis.

More importantly for the bank, however, is what the revenue looks like for the project, and PPAs are part of that equation. "Is the project entering into a new PPA, or extending the existing PPA? Is there a merchant story that we think is bankable? I think all those factors will have an impact as to how we would structure the financing," adds Davis.

As wind projects are increasingly financed with more uncontracted revenues, a repowering finance equation could see a project that is 75 per cent contracted and 25 per cent uncontracted. Alternatively, it could have a 15-year PPA in place and also provide a notional profile of over nineteen years, with a four-year merchant tail.

"It depends on which market it is in, what the forward curve looks like and what the other relevant market dynamics are. Those are some of the factors we look at," says Davis.

One advantage of assessing a project for repowering for banks is the wealth of existing operational and nodal pricing data at hand for older projects. "It's good solid data. We can say over time, the nodal price and basis has been at a certain level. So you have a more solid case, I think," Clapp notes.

Financing using the 80/20 rule

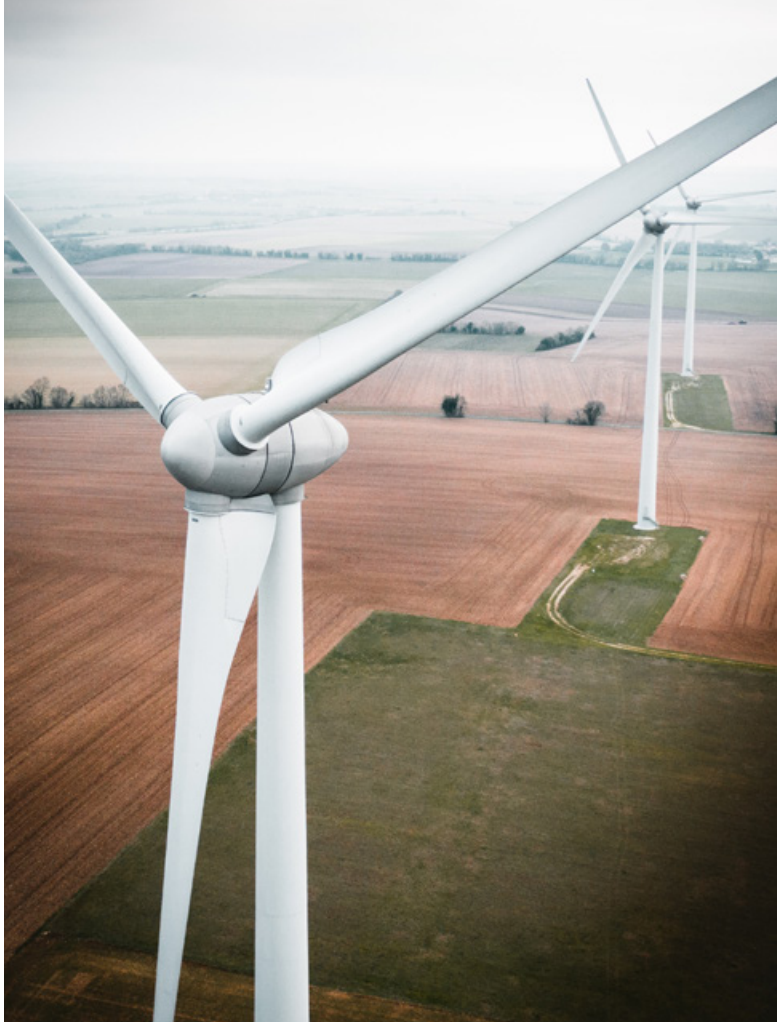
Partial repowering of wind projects has become more common in the US, mainly thanks to subsidies for partially repowered wind projects following the "80/20 rule."

The rule has been used by the US tax collection agency, the Internal Revenue Service, since the 1960s to offer continuing tax incentives to asset owners in certain sectors who have already built tax-advantaged projects.

Under the 2015 extension to the Renewable Energy Production Tax Credit (PTC), wind repowering projects were subsidised by tax credits as long as 80 per cent of the project (on a cost basis) is replaced.

One way to comply with the 80/20 rule was to preserve all towers, foundations and electrical balance of plant in a repowering project. While some project managers opted to keep old yaw systems nacelles and generators, others replaced every component above the tower. Still others built up towers onto the existing tower, US-based wind project owner's engineer Sargent & Lundy said in 2020.

The extended tax credit was phased down for projects starting later than 2017. Those that started construction before 2017 were eligible to receive the full inflation-adjusted per-kilowatt-hour credit for 10 years from the date they entered service.



Those that did so in 2017-2019 were awarded partial tax credits in successively lower amounts.

This led to "surging" repowering projects using newer and more advanced wind turbines by 2017, according to S&P Global.

Repowering also increased under the additional extension of the 60 per cent PTC offered starting in 2021, found Sargent & Lundy.

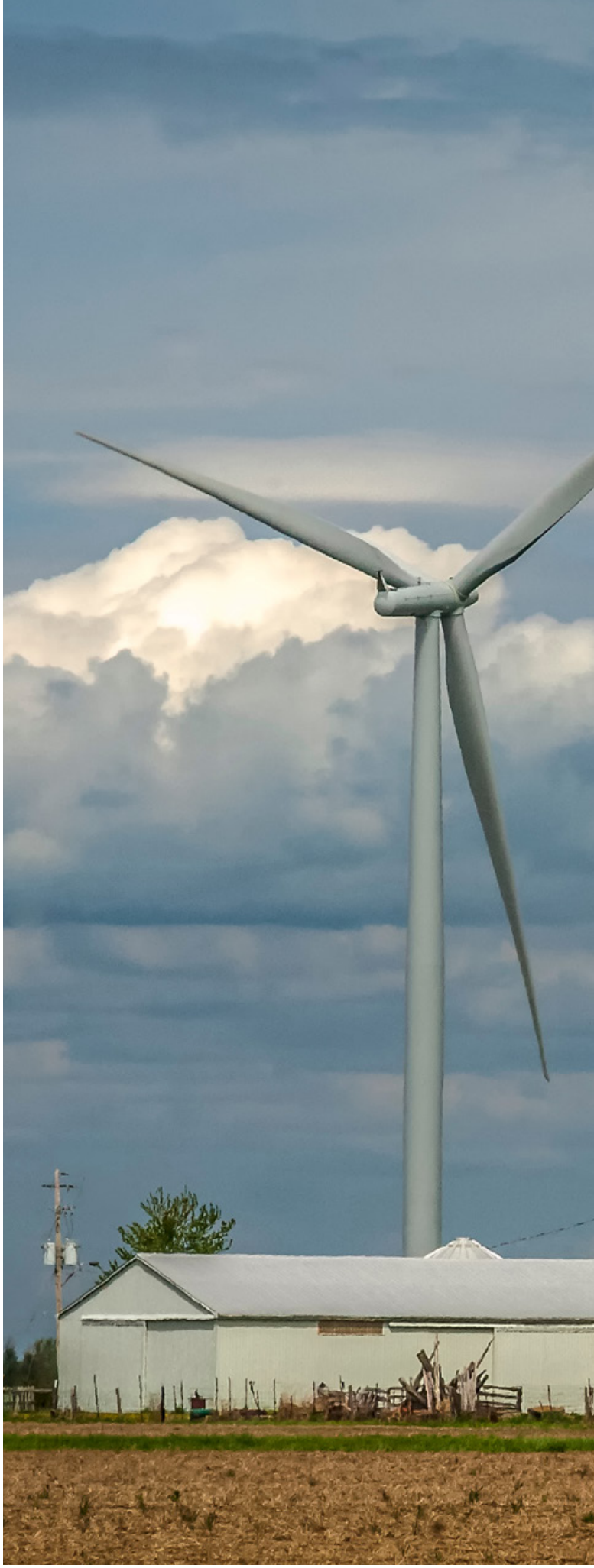
Holding on to land and networks for wind

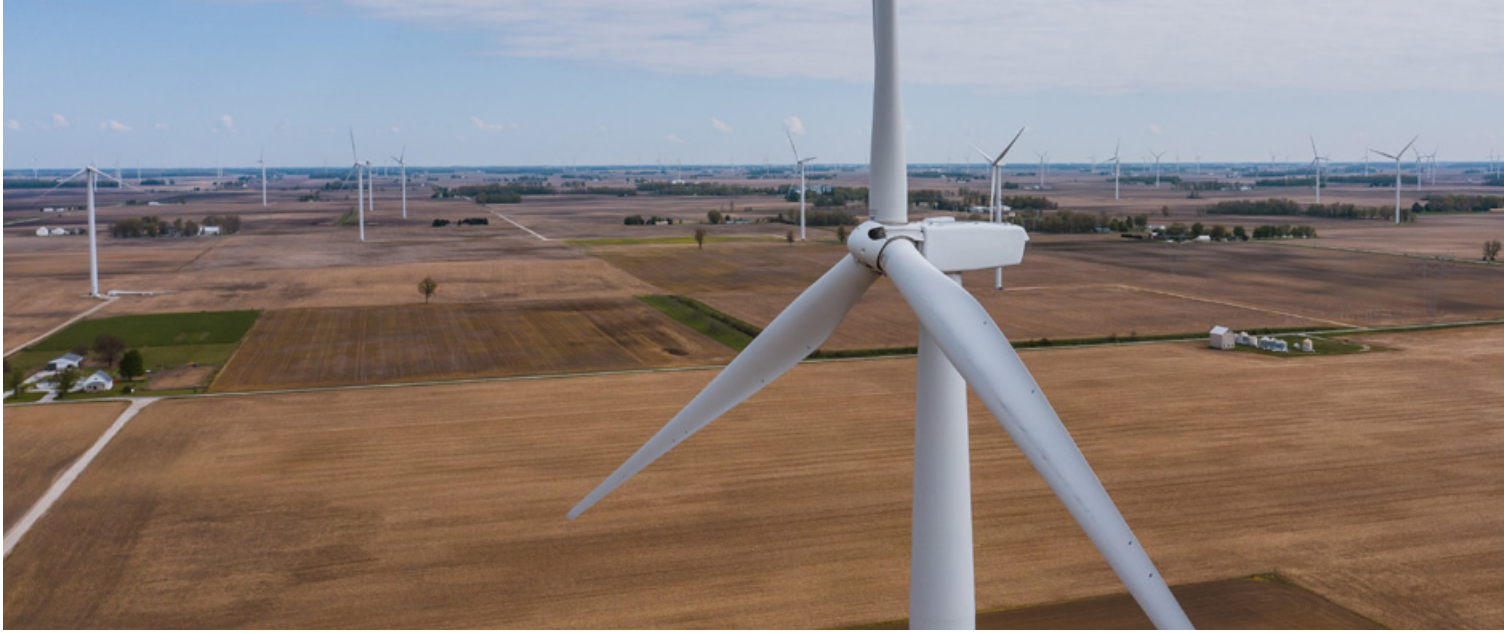
Maintaining the value of land that has already been selected and prepared for wind is a key benefit of repowering for owners. “We need to do everything we can to grandfather existing wind farms, because the beauty of repowering is reusing the land and reusing the interconnect,” says Gupta.

Dismantling a wind farm that wasn’t able to repower and building another elsewhere comes at an environmental cost, points out Atlantic Shores Offshore Wind Chief Financial Officer Juan Carlos Puente.

Local ordinances can be put in place to restrict wind turbine height and extend a turbine’s required distance from roads, transmission lines and properties, or setback. These may prevent a repowering project that could otherwise have made a cheap and rapid impact on emissions targets.

Such ordinances, for example on structure height, are increasingly preventing projects from repowering in the US. Reblading, for example, could be prevented as it increases a turbine’s height and rotor diameter.





Ordinance levels vary from county to county, making it difficult for developers to find out which ones will become restrictive. Sometimes the constituents favouring ordinances that prevent repowering are not the landowners adjacent to wind projects, who are receiving royalties, but constituents in the wider community.

Lobbyist-funded misinformation campaigns are actively turning US public opinion against wind projects, noted Global Wind Energy Council's Policy Officer Reshmi Ladwa in a presentation at the WindEnergy Hamburg conference last year.

Repowering doesn't yet have the same lobbying machine. "It's important that repower is not viewed as just an economic opportunity, but rather that it's also recognised as a way to breathe life into a wind farm and further the overall decarbonisation effort," urges GE's Stafford.

Scout Clean Energy ensures its projects are well-understood by communities. "Because we are also a long-term owner, we don't just go to the landowners where our site is. We go a little more broadly into the community, because we know we're going to be back, either to repower, add an energy storage facility, and in a number of cases, we are actually adding solar next to our wind farms to have a combined facility," says Clapp.

"We've had good experience building up community support, so when we go back for that next facility, we receive significant permitting support because we have walked the walk on our first project. I think a big part of it also is being a good owner and operator of the asset, and being a good member of the community," he concludes.

European and US markets diverge

Views of repowering in the more mature European wind power market differ significantly from those in the US market, says Swedish developer OX2 Business Development Director Borja Munoz.

In discussions with European financial backers, some financing of repowering for 20-year-old wind turbines is framed as an operational necessity to reach projected 30-year lifespans rather than a chance to increase profitability. Turbine components had to be replaced, for example, because the OEMs that could maintain them had gone out of business.

As of December, 170 wind farms had been repowered in Europe, mostly in Germany. The Netherlands was also a strong repowering market, according to European association WindEurope.

It said this was not the case for Spain, Italy and Denmark, which need more "coherent" strategies. "Most wind farms reaching end-of-life currently opt for some form of lifetime extension, often because legislative frameworks for repowering are not in place. But experience illustrates that wind turbines should be repowered wherever possible," the association said.

Denmark has supported repowering in the past. A Feed-in-Premium subsidy supported repowering until 2011, and in a 2016 political push to reduce wind subsidy costs, repowering was favoured over new-build projects. Most of the ageing Danish wind fleet had already been repowered by then. In 2019, 86 per cent of Danish gross added onshore wind capacity was due to repowering.

Also in Europe, Germany supported repowering through Feed-in-Premium bonuses between 2004 and 2014. The country recently added support for permitting approvals for repowering projects through the Federal Climate Protection Act. "Germany is one of the biggest countries in the world for repowering," says Munoz.

In Spain, Europe's rising onshore wind powerhouse, developers want to repower rather than decommission to retain the interconnection and the good relationship with landowners rather than starting afresh elsewhere, he says. At the same time, Spain has no permitting regulation promoting repowering like Germany and there are very few repowers despite a very large and old fleet.

There, old wind turbines go without repowering even though newer wind turbines help to optimise grid utilisation, bringing knock-on benefits for network operators, adds Munoz.

In both Europe and the US, utility aggregators play a growing role by buying old projects and repowering them. European utility wind farm owners drive repowering forward amid a trend for rate-basing projects or buying them to increase the value on which regulators base utility returns.

Likewise, in the US the same rate-basing occurs in utility-acquired wind projects. "We are seeing strong utility interest in owning assets we develop," says Clapp.

Expectations for the coming years

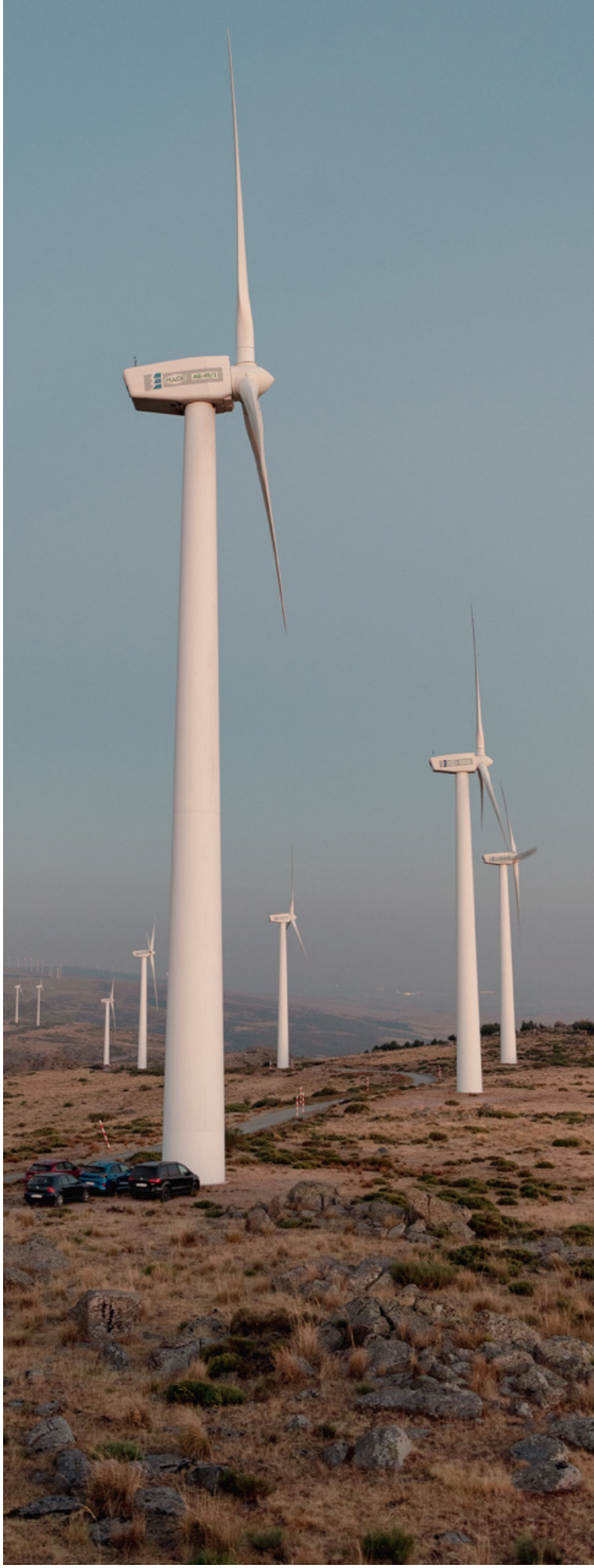
The IRA's passage brings with it the potential to accelerate repowering, and could encourage doing so earlier. In the past, the tax credit extensions have been a major driver for US wind project development.

The revamped regime looks like the old one on steroids. First of all, it extends the existing 10-year tax credit scheme set to expire in 2022 to the end of 2024.

Then it launches an upgraded version of the tax credit scheme, notable for promoting carbon-and-technology-neutrality, that will be phased out after 2033 and when US emissions from power generation decline 75%.

Among several bonuses for wind developers, the scheme due to expire in 2024 awards full-value credits and offers the chance to eliminate the pre-existing phasing-down of credits. But gaining full-value credits for projects requires complying with wage and apprenticeship must-haves. Other benefits are available for projects that meet local content rules or are sited in former coal, oil, or natural gas industrial areas.

Both stages of the upgraded tax credit regime will offer transferability of tax credits, which McGuireWoods said could revolutionise finance by allowing owners to directly monetise credits rather than seeking out tax equity partners.



Voices from the wind turbine manufacturing sector sound confident that the IRA will spur US repowering.

Jeff Fuchs, Senior Vice President of Sales for Vestas North America, says, "The IRA puts the US on the path to help revive repowering solutions for wind projects across the US in the coming years. A runway of 10-plus years for the PTC improves the business case for repowers by providing access to a renewed tax credit for annual generation and long-term certainty for investors and regulators."

But as the IRA puts technology neutrality into play, it is an open question whether it will necessarily improve repowering markets. Repowering could be overlooked by investors dazzled by the chance to use tax credits for energy storage and hydrogen.

A potential repowering trend on the horizon with the IRA is hybrid projects that add solar, battery energy storage, or green hydrogen production to existing wind sites. Clapp says adding solar to a wind project repower uses existing transmission more efficiently because of complimentary peaking times and avoids the expense of wires for solar. He says Scout Clean Energy is looking into hybrid wind opportunities.

In another possible trend, partial repowering will retain its advantage as a relatively low-capex and therefore low-risk PTC opportunity, particularly when the partial repowering improves the capacity factor, one market observer speculated.

Developers should take note as supply chain risk is a growing concern. "Repowering offers a fast development timeline, limited exposure to raw material cost increases, reduced permitting complexity, and O&M savings," noted Fuchs.

The transferability aspect of the IRA will see more investors crowding into US renewable energy by 2030, when the weighted average age of North American wind projects is due to reach nearly 15 years.

While there is still much to learn about this emerging process and who will be the actors within it, repowering could be a vital part of greening not just investor portfolios but the US economy overall.