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**2023 renewable energy  
industry outlook**

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# Renewable energy growth set for takeoff amid supply and interconnection turbulence

In 2022, US renewable energy growth slackened its pace due to rising costs and project delays driven by supply chain disruption, trade policy uncertainty, inflation, increasing interest rates, and interconnection delays.<sup>1</sup> Many of these challenges will likely carry over into 2023, creating strong headwinds. But growth will likely accelerate powered by robust demand and the record-breaking raft of clean energy incentives in the Inflation Reduction Act (IRA).

The United States added 5.7 gigawatts (GW) of utility-scale solar generation capacity and 7.5 GW of wind capacity in the first eight months of 2022, down 26% and 8%, respectively, from January to August 2021.<sup>2</sup> Nevertheless, wind and solar accounted for nearly 70% of capacity added, and renewable energy's share of US electricity generation rose to 23% from 21% during the same period.<sup>3</sup>

Moving into 2023, drivers for renewable growth are some of the strongest the industry has seen, including competitive costs, supportive policies, and burgeoning demand:

- **Cost competitiveness.** While renewable energy costs may continue to rise temporarily in 2023 due to ongoing supply chain challenges, wind and solar will likely remain the cheapest energy sources in most areas, as fuel costs for conventional generation have been rising faster than renewable costs.<sup>4</sup>
- **Federal clean energy policies.** Among other supportive provisions, the IRA extends wind and solar tax credits for projects that begin construction before 2025 and technology-neutral credits through at least 2032.<sup>5</sup> Projections suggest the law will spur 525 to 550 GW of new US utility-scale clean power by 2030.<sup>6</sup>

- **State clean energy policies.** Twenty-two states and the District of Columbia are targeting 100% renewable energy or 100% carbon-free electricity, often through clean and renewable energy mandates and incentives, with target dates between 2040 and 2050.<sup>7</sup>
- **Utility decarbonization.** As of October 2022, 43 of the 45 largest US investor-owned utilities have committed to reducing their carbon emissions, and boosting renewables is one of their key strategies for meeting those commitments.<sup>8</sup>
- **Corporate renewable procurement** spurred a record 11 GW of US clean energy installations in 2021 and is set to exceed that in 2022.<sup>9</sup> More than 380 global businesses have committed to 100% clean electricity by joining the RE100 renewable electricity initiative, up from about 200 in 2019.<sup>10</sup>
- **Residential solar demand** is growing faster than ever, up 35% in H1 2022 year over year, as households react to rising retail electricity prices and weather-driven power outages.<sup>11</sup>
- **Private investment** in renewables hit a record high of \$10 billion in the past year.<sup>12</sup> That could continue, as investors are attracted by transparent returns on mature technologies backed by 10-year tax credits with direct pay options.

Growing demand in 2023 could exacerbate supply chain constraints and interconnection bottlenecks, further boosting prices and extending project timelines. And transmission limitations could continue to hamper growth until capacity is significantly expanded. But the evolving trends and opportunities that follow could help the industry navigate headwinds as it grows in 2023 and set the stage for faster growth in 2024.

# 1

## Domestic manufacturing

### Rising clean energy component manufacturing could ease supply chain snags over time

US manufacturing does not currently meet the renewable energy sector's needs for clean energy components supported by secure and sustainable domestic supply chains.<sup>13</sup> But IRA incentives have already spurred new plant announcements and significant investment, and that's likely to gain steam in 2023.<sup>14</sup>

US-based manufacturers produced nearly 5 gigawatts (GW) of solar photovoltaic (PV) modules in 2021,<sup>15</sup> falling well short of supporting the more than 20 GW of US solar power capacity installed the same year.<sup>16</sup> And to meet the administration's goal of 30 GW of offshore wind by 2030, the fledgling offshore wind supply chain for towers, blades, nacelles, and substructures will need to develop further.<sup>17</sup> In addition, the electric grid will need far more battery storage capacity to handle growing volumes of variable renewables and electric vehicles (EVs).<sup>18</sup> The United States lags several countries in the manufacture and supply of materials, components, and end products for grid storage,<sup>19</sup> and it mines and processes little to none of the raw materials required for lithium-ion batteries, such as cobalt, nickel, and lithium.<sup>20</sup>

One goal of the IRA is to help develop and secure supply chains for these clean energy components by stimulating domestic manufacturing and to eventually achieve cost competitiveness through economies of scale.<sup>21</sup> Key provisions include:

- **Advanced manufacturing production.** Tax credits for domestic production and sale of qualifying solar and wind components such as inverters; battery cells; PV wafers, cells and modules; wind turbine blades, nacelles, and towers; and a 10% credit for critical minerals production.<sup>22</sup>
- **Qualified advanced energy project.** Investment tax credits of 6% or 30% for a new category of projects: those that re-equip, expand, or build qualified domestic manufacturing or industrial facilities to assist in the production or recycling of renewable energy property.<sup>23</sup>
- **Domestic content.** Additional tax credits above the base investment tax credit for qualified advanced energy projects if the project uses certain components produced in the United States.<sup>24</sup>

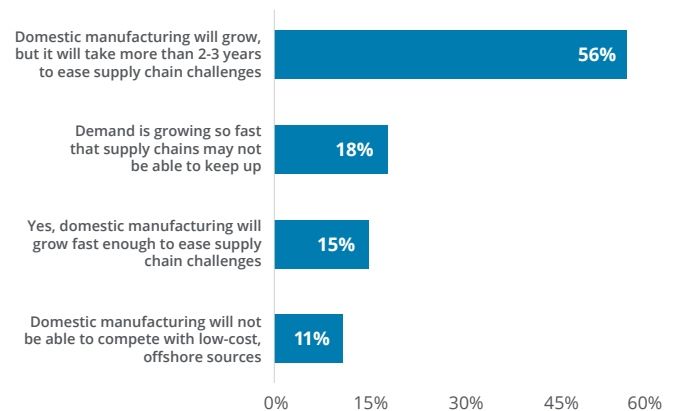
Within weeks of the IRA's passage it became clear that the incentives will likely bring significant new manufacturing of clean energy components to the United States.<sup>25</sup> Although the industry awaits federal guidance to clarify many details, investments are flowing.

Two months after the bill's enactment, one tally calculated about \$28 billion in new manufacturing investment in the solar, battery, and EV manufacturing sectors had already been announced.<sup>26</sup> Two of the largest solar manufacturers are planning new plants, expanding existing plants, and developing the supply chain from raw materials through modules.<sup>27</sup> And multiple battery manufacturers have announced plans for new US plants, with most currently focused on EV batteries.<sup>28</sup>

While this may spell good news for renewable energy supply chains in the longer term, many see at least a couple more years of challenges. In a recent Deloitte survey of US power sector executives, 56% of respondents said that while the new incentives for domestic manufacturing of clean energy components will spur new production, it could take more than two to three years to ease supply chain constraints (figure 1).<sup>29</sup> In addition, the Biden administration is working with the European Commission to address concerns related to the IRA's domestic manufacturing provisions.<sup>30</sup>

**Figure 1. Given new incentives for domestic manufacturing of clean energy components, do you think supply chain challenges will ease over the next two to three years?**

N=72



Source: Deloitte survey of power and utilities sector executives in September/October 2022.

# 2

## Decarbonized fuel

### New clean hydrogen economics could open avenues for renewable providers

Long-sizzling interest in green hydrogen ignited with the IRA's enactment in August 2022. The law's \$3 per kilogram tax credit for qualified "clean" hydrogen could make it price-competitive with higher carbon "gray" hydrogen in much of the country (figure 2).<sup>31</sup> While challenges such as lack of infrastructure still make hydrogen uneconomic for some uses, new IRA-driven economics could open avenues for renewable energy developers and producers to benefit in 2023.

Current US demand for hydrogen is about 10 million metric tons annually, and it's mainly used for oil and petrochemical refining and processing, ammonia production, food and drug production, and other industrial processes.<sup>32</sup> About 99% is gray hydrogen, usually produced through natural gas steam methane reforming, while only about 1% is "green" hydrogen, produced from electrolyzed renewable (or other low-carbon) electricity and water.<sup>33</sup>

There's growing interest in using green hydrogen in the transportation, electric power, natural gas distribution, and other industrial sectors, but often new or retrofitted infrastructure would be needed.<sup>34</sup> Further market and ecosystem development is also needed, and the \$8 billion investment in regional clean hydrogen hubs from the Infrastructure Investment and Jobs Act (IIJA) can help address that. Interest is already growing in participating in hydrogen and other low-carbon hubs, as cost savings from co-location can improve project economics. Some suggest the industry also needs a regulatory framework to assess the long-term risks and implications of transporting and distributing large volumes of hydrogen.<sup>35</sup>

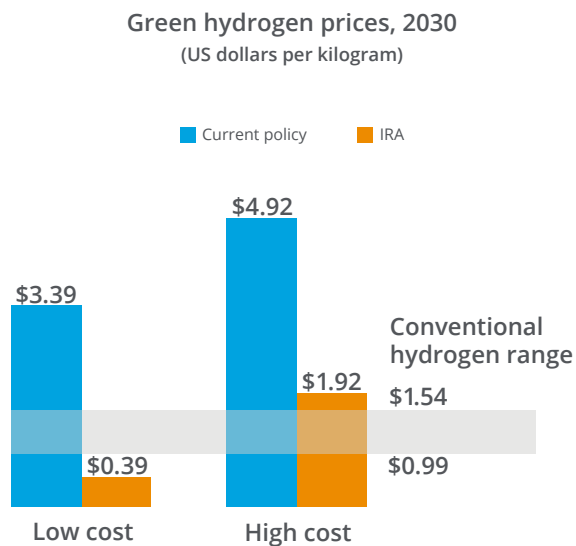
Despite challenges that may require longer-term solutions, the new tax credit creates economics that can potentially drive benefits for the renewable energy industry in the near term. Below are some options the industry can consider in 2023 and beyond.

- Site electrolyzers near current gray hydrogen users, where hydrogen infrastructure and markets already exist and industrial users could welcome the opportunity to decarbonize fuel.
- Use electrolyzers to draw power from renewable resources; use proceeds from clean hydrogen sales to deploy more renewable assets.<sup>36</sup>
- Connect electrolyzers to the grid and use them as flexible load

to help balance the grid, drawing renewable electricity when output is high and prices are low, and ramping down when renewable output is lower so the power can be used to meet grid needs. In some markets, compensation for providing flexible load could help offset hydrogen production costs.<sup>37</sup>

- Consider siting electrolyzers near ports to target a potentially growing clean ammonia export market.

**Figure 2. Green hydrogen is typically more cost competitive under the IRA**



Note: Green hydrogen assumed to be produced with utility-scale solar. Other zero-emitting electricity sources will lead to different costs.

Source: John Larsen et al., "A turning point for US climate progress: Assessing the climate and clean energy provisions in the Inflation Reduction Act," Rhodium Group, August 12, 2022.

# 3

## Energy equity

### IRA helps spur renewable providers to pursue opportunities in low-income communities

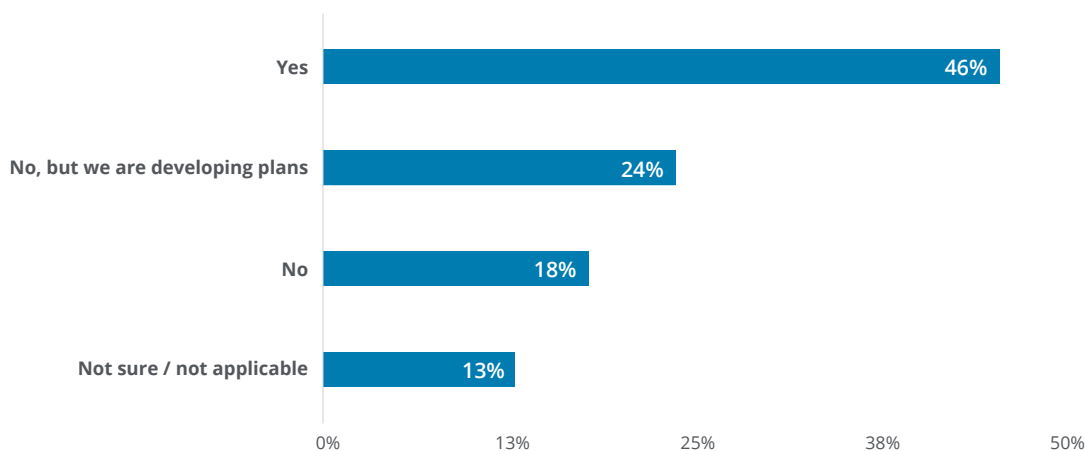
Until now, the clean energy transition has focused mainly on more affluent Americans, who have benefitted from incentives such as tax credits for rooftop solar or EVs, while many low-income communities were left behind.<sup>38</sup> But outreach to low-income communities could accelerate in the coming year as federal policy with environmental justice<sup>39</sup> provisions may further incentivize renewable developers to expand into these communities.

About 44% of US households are defined as low-income,<sup>40</sup> and this group could potentially benefit the most from clean energy savings because their “energy burden,” or share of household income spent on energy, at 8.6%, is about 3.5 times the national average and can be as high as 30%.<sup>41</sup> Business models such as community solar are expected to grow fast in low-income communities, as they can potentially offer customers more predictable, affordable rates and strengthen economic security while also improving air quality and providing local jobs.<sup>42</sup> Twenty-three states currently have community solar programs with low- and moderate-income customer-specific provisions.<sup>43</sup>

Some states and utilities have offered clean energy programs to low-income communities for several years. But rising electricity prices, a doubling of utility arrearages since 2019, and an increasing focus on environmental justice have added urgency to the issue.<sup>44</sup> In January 2021, the Biden administration created the Justice40 Initiative, which aims to deliver 40% of the overall benefits of federal climate and clean energy investments to “disadvantaged communities that are marginalized, underserved, and overburdened by pollution.”<sup>45</sup> For example, clean energy projects eligible for the IRA’s 30% investment tax credit can add a 10% or 20% bonus credit if located in an “environmental justice” area.<sup>46</sup>

Many types of programs serve low-income communities. A California program provides low-income households with solar photovoltaic (PV) systems and energy efficiency upgrades at little to no cost to residents.<sup>47</sup> As previously noted, many states offer community solar for low-income customers. Utilities and solar developers are developing business models that can leverage state and federal incentives to deliver free or low-cost solar to eligible households. And 46% of power and utility executives Deloitte recently surveyed said their companies had plans to build renewable energy projects in low-income communities or to help low-income customers procure renewable energy (figure 3).<sup>48</sup>

**Figure 3. Does the company you work for have plans to build renewable energy projects in low-income communities or to help low-income clients procure renewable energy?**



Source: Deloitte survey of power and utilities executives in September/October 2022.

# 4

## Cybersecurity

### Renewable energy industry focuses on managing increasing cyber risk

One sign that the renewable energy industry is maturing is that it's increasingly the target of cyberattacks.<sup>49</sup> Cyberthreats are expected to rise in 2023 and beyond as the clean energy transition progresses, focusing on both utility-scale and distributed renewable energy resources.<sup>50</sup> And the industry is preparing for the growing wave of distributed, often digitally controlled, third-party owned, and aggregated energy resources on the grid, about half of which are solar energy systems.<sup>51</sup> Utilities and renewable energy developers are also expected to continue staffing up cybersecurity departments amid a growing gap in qualified cybersecurity talent.<sup>52</sup>

The energy industry is deemed one of 16 critical infrastructure sectors by the US government—and oil, gas, and electric power infrastructure have been targeted for many years.<sup>53</sup> The utilities sector reportedly saw a 46% year-over-year increase in cyberattacks in 2021, averaging 736 attacks per week.<sup>54</sup> And as renewable deployment grows, these new resources are increasingly being targeted. In 2019, a US utility reported that its solar and wind plants had experienced a denial-of-service attack.<sup>55</sup> A cyberattack on a global wind turbine manufacturer in 2021 compromised data<sup>56</sup> and was followed by attacks on three European wind energy companies in 2022. The latter attacks disabled remote-control systems for approximately 7,800 wind turbines for about a day.<sup>57</sup>

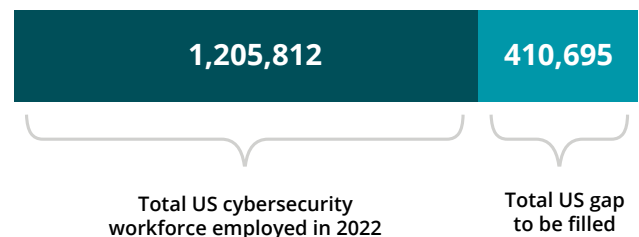
These attacks are expected to increase in 2023.<sup>58</sup> They could come from groups using ransomware for financial payment, nation state-affiliated cybercriminals aiming to disrupt critical infrastructure or society as a whole, or individual malicious hackers.<sup>59</sup> In recent years, attacks have increasingly targeted industrial control systems, often seeking entry through the least protected links in the supply chain.<sup>60</sup> This often comes in the form of phishing attacks launched via emails with malware-laden attachments or links.<sup>61</sup>

The US Department of Energy recently released a study assessing the risks to the electric grid posed by evolving growth of distributed energy resources (DER).<sup>62</sup> There are about 90 GW of DER installed in the United States today, including more than 3 million solar systems. DER deployment is expected to more than quadruple by 2025, to approximately 380 GW.<sup>63</sup> This could present significant challenges since DER are often internet-connected and subject to few, if any, cybersecurity requirements. Individual DER aggregators could control fleets of hundreds of thousands of devices, representing significant amounts of power.<sup>64</sup> And these entities are not currently subject to the cybersecurity standards to which other resources on the bulk electric system must adhere—including the North American Electric Reliability Corporation's Critical Infrastructure

Protection (NERC-CIP) standards. NERC is working with stakeholders to consider the risks associated with aggregated DER participation on the bulk power system and develop a plan to instate adequate security controls to manage them.<sup>65</sup>

Finally, as cyber risk rises, many companies have stepped up their hiring of leaders and professionals with information technology and security skill sets.<sup>66</sup> This could become more challenging in the new year due to an acute and growing shortage of skilled workers in the field (figure 4).<sup>67</sup> Some renewable energy providers plan to seek cybersecurity talent from the utilities and manufacturing sectors. But nearly all sectors are feeling the pinch, and in the longer term, some are focusing on developing and training more of these workers.<sup>68</sup>

**Figure 4. The US cybersecurity workforce gap increased 9% in 2022**



Source: (ISC)<sup>2</sup>, (ISC)<sup>2</sup> Cybersecurity workforce study 2022, pp. 6 and 8.

# 5

## Offshore wind

### Offshore wind industry addresses challenges to unlock rapid growth

By mid-2022, the US offshore wind project development pipeline had grown to more than 40 GW of potential generating capacity across 12 states.<sup>69</sup> Currently, just 42 megawatts (MW) of capacity is operational, about 1 GW is under construction, and almost 19 GW is in the permitting phase. A further 20 GW is in the siting and planning phases and will likely take many more years to develop. But the next few years could be critical for addressing challenges to unlock that growth.

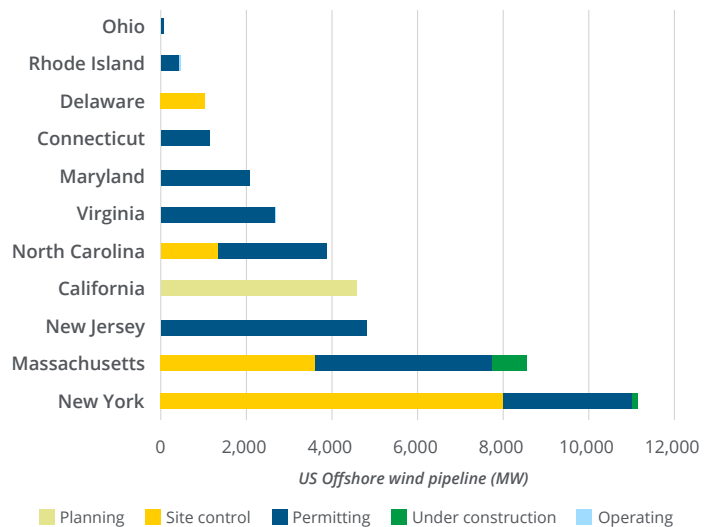
US offshore wind development is largely driven by state procurement policies. Nine states collectively aim to deploy about 45 GW of capacity by 2040,<sup>70</sup> and others are considering joining them. Together, they could help realize the administration's goal to deploy 30 GW of offshore wind capacity by 2030 and 15 GW of floating offshore wind capacity by 2035.<sup>71</sup> Funding and tax incentives in the IIJA and IRA could further support these goals. In 2023, as some of the first projects move forward, the industry is expected to be working to address some fundamental challenges, including:

- Financing and construction risk.** Offshore wind projects are typically large and complex, with multiyear development timelines, multiple uncertainties, and opportunities for delay.<sup>72</sup> The first US projects may be prone to time and cost overruns due to lack of experience, permitting delays, lack of coordination among numerous specialized contractors, technical and logistical complexity, supply chain constraints, or other factors. Partnering with experienced European developers and accessing IRA tax credits could help mitigate some of the financing risk, but developers could still face credit issues, according to Moody's.<sup>73</sup>
- Transmission and grid upgrades.** The first projects are being built with their own cables to shore, but as capacity increases, a common transmission "backbone" and grid upgrades will likely be needed.<sup>74</sup> This could require extensive, coordinated transmission planning at the state, regional, and federal levels and potentially new federal tax and funding policies.
- Vessels and port infrastructure.** The industry requires specialized vessels and port infrastructure that doesn't yet exist in the United States to accommodate extremely large and heavy equipment.<sup>75</sup> While loaner vessels can come from Europe, the Jones Act prevents them from entering US ports.<sup>76</sup> The IRA provides tax credits for eligible investments, but regional coordination and additional federal support may be needed.

- Local manufacturing and workforce.** Supply chain shortages and logistics constraints have boosted costs, so the industry is working to build domestic supply chains and train a local workforce. In the past two years, 10 major domestic manufacturing facilities were announced at ports along the East Coast, and IRA tax credits could spur additional investment.<sup>77</sup>

The industry will continue to address these challenges in 2023 and beyond and is expected to benefit from increasing scale, well-capitalized investors, expertise from abroad, regional coordination, and federal incentives and funding.

**Figure 5. US offshore wind project pipeline by state (as of May 2022)**



Source: US Department of Energy, *Offshore wind market report: 2022 edition*, Office of Energy Efficiency and Renewable Energy, Figure 2, p. 11.



# Growth unleashed within limits

The renewable energy industry enters the new year with supportive federal and state clean energy policies in place and growing demand across sectors. While this may position it for a strong takeoff in 2023, that growth could be tempered by some of the same headwinds it encountered in 2022—supply chain constraints, lack of transmission capacity, and interconnection delays. IRA tax incentives and IIJA investment encourage not only renewable energy and storage growth, but also the development of domestic critical materials and manufactured components to supply the industry. But these provisions are not expected to begin to ease supply chain snarls until 2024.<sup>78</sup> And transmission and interconnection constraints could temporarily tighten with burgeoning renewable energy demand as solutions are being considered.

Due to these headwinds, renewable energy costs could continue to rise in the short term before they return to the more than decade-long decline driven by increasing scale and technological advances. But wind and solar are still the cheapest energy sources for power generation in most areas, and that gap is widening.<sup>79</sup>

In 2023, the industry is expected to continue growing and expanding into new areas, such as offshore wind, and harnessing new opportunities opened by IRA incentives, such as clean hydrogen production and low-income area solar programs. And as it gains market share, it's expected to focus increasingly on managing the risks that come with that, such as cybersecurity. Overall, as the industry heads into 2023, soaring demand and attractive, long-term incentives are creating strong tailwinds, but there's still a patch of turbulence to get through.

# Let's talk



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