IHS Markit®

10 Cleantech Trends in 2021

Technologies to reduce emissions and confront climate change

IHS Markit's 10 Cleantech Trends in 2021			
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2	Rapid solar technology innovation continues despite shrinking PV system costs	7	Sustainability and security of supply concerns will continue to drive the localization of battery manufacturing
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1 Renewable installations will rebound by double-digits after covid-19 impasse

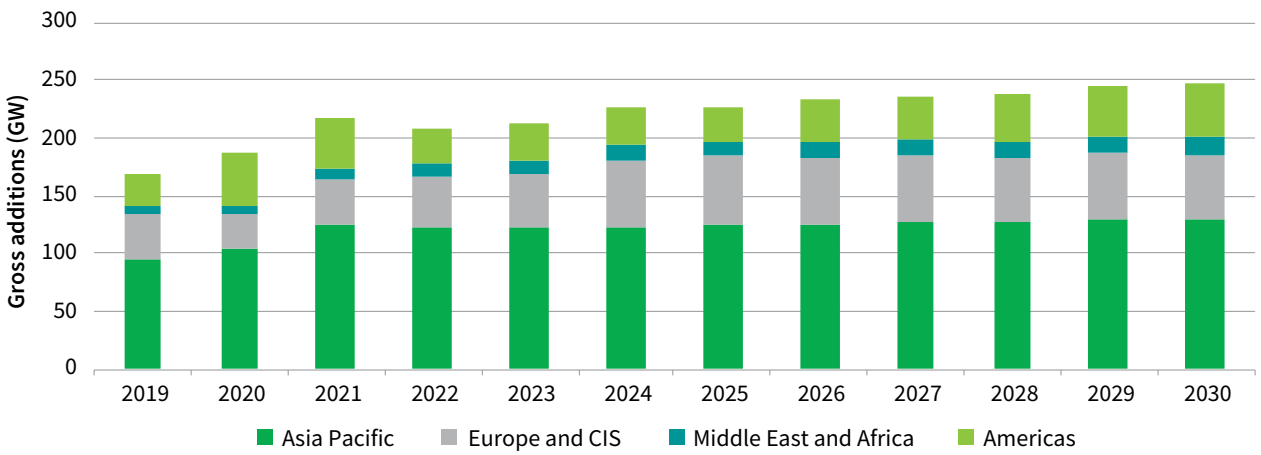
Annual solar installations are predicted to grow by over 30% in 2021 after volatile demand in 2020, triggered by the covid-19 pandemic. Although global installation numbers increasingly de-link from reliance on the Chinese market, China will still account for 35% of global annual installations in 2021. There are now 18 markets globally that have +1GW cumulative solar installations, compared to just six a decade earlier.

This strong market demand comes despite an increase in production costs (up 10–15%) driving a historic surge in module prices, especially in the first quarter. However, production costs are set to drop in the second half of the year, lowering module prices and laying the ground for record solar installations at the end of 2021.

2020 was a record year for wind with IHS Markit tracking activity of nearly 120 GW. Of this, nearly 60% was from mainland China including projects that have secured subsidy entitlement. Annual onshore wind installations in 2021 will continue to be derived from installation rushes in markets facing imminent subsidy cuts including the US and mainland China.

Non-mainstream renewables such as geothermal will continue generating increasing attention from conventional energy companies and investors - nearly 0.5GW of new capacity is expected to be commissioned throughout 2021, with Indonesia and Kenya leading the global market.

Annual renewable additions, by region, 2019–30



Note: All additios in AC capacity. Solar additions do not include unallocated demand.
Source: IHS Markit

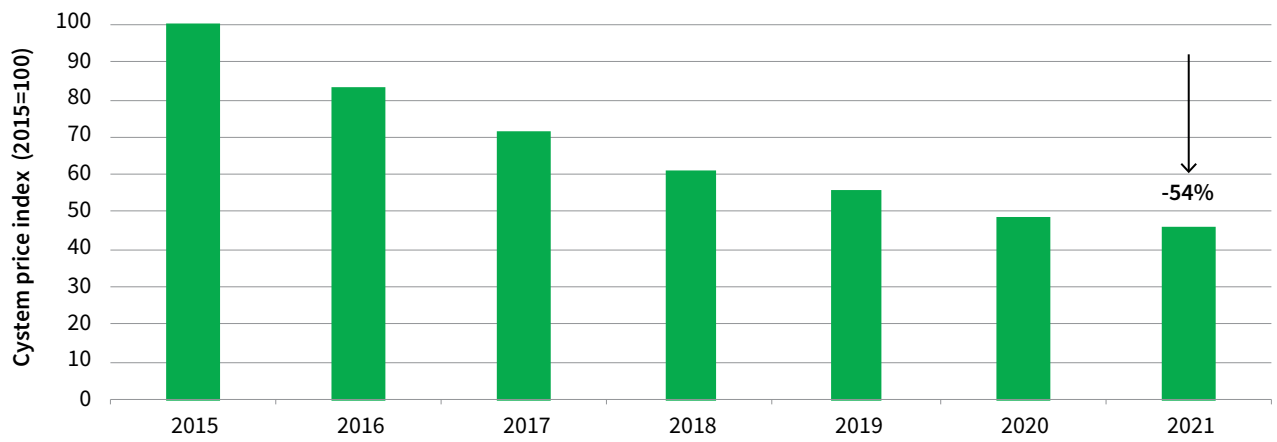
2 Rapid solar technology innovation continues despite shrinking PV system costs

Spain, India, and the Middle East region will continue to be the markets with the lowest solar levelized cost of electricity (LCOE). IHS Markit projects photovoltaic (PV) systems capex to continue declining in 2021 by 5% year on year, largely driven by decreasing component prices. Meanwhile, average module efficiency records continue to increase, surpassing 22.5% in PERC monocrystalline cell commercial production and are forecast to reach 24% by 2022. Perovskites technologies, a promising solar cell technology development with significant potential to increase cell efficiencies and reduce costs, is set to continue breaking efficiency records, but the technology will only be mature for commercial production in the next five years.

Single-axis trackers to account for over one third of ground-mount PV installations over the course of the year with installations forecast to exceed 33 GW. The plethora of solar tracker IPO's in 2020 will continue to fuel tracker technology adoption in new markets along with continued investment in next generation products, in particular the compatibility of trackers with larger and higher-powered modules above 500W.

PV inverter power ratings continue to increase for utility-scale with three-phase string inverters exceeding 250 kW and three-phase central inverters exceeding 3MW, as higher-powered inverters offer lower costs per watt. Solar inverters suppliers are increasingly focused on grid stability and grid forming functions to enable higher penetration levels of solar especially in geographies where solar installations are reaching high levels of penetration.

Evolution of PV system cost (global average)



Source: IHS Markit

3 Offshore wind annual installations to surpass the 10 GW threshold

In 2021 the offshore wind industry will deploy more than 10 GW of capacity, nearly twice as much as last year, driven by the boom in installations in mainland China. Capacity tenders will also burgeon this year with over 20 GW worth of capacity to be auctioned in the UK, France, Denmark, Netherlands, Germany, the US, Japan and Taiwan.

Oil and gas majors will further accelerate growth in the offshore wind market as they aim to leverage technical and project management skills to increase their footprint in the renewables space.

Technology will continue to deliver on cost reductions as larger turbines reach the market including the expected launch of the Vestas' new 10+ MW turbine platform. Therefore, as the industry gets ready to scale up, consolidation across the entire value chain will continue

4 Floating installations remain niche and lack scale but continue its acceleration path for both off-shore wind and solar PV technologies.

Floating foundations, the future of offshore wind in deep waters, is finally moving into the commercial phase. The industry has proven the reliability of technology in a dozen pilot projects, and in 2021 for the first time commercial floating capacity will be allocated through auctions in the UK and France. However, the industry Is yet to narrow down field of designs to accelerate growth.

In the case of PV, floating solar represents a growing opportunity for developers to install solar in countries that are land constrained, or in specific locations that have favourable conditions such as water bodies with proximity to existing grids, such as hydropower dams or water treatment plants where they can use of existing infrastructure to make floating PV more cost competitive. In 2021, China mainland will maintain its lead as the largest Floating PV market followed by India, South Korea, and Vietnam. IHS Markit expects Asia to account for over 70 percent of total floating PV installations until 2024.

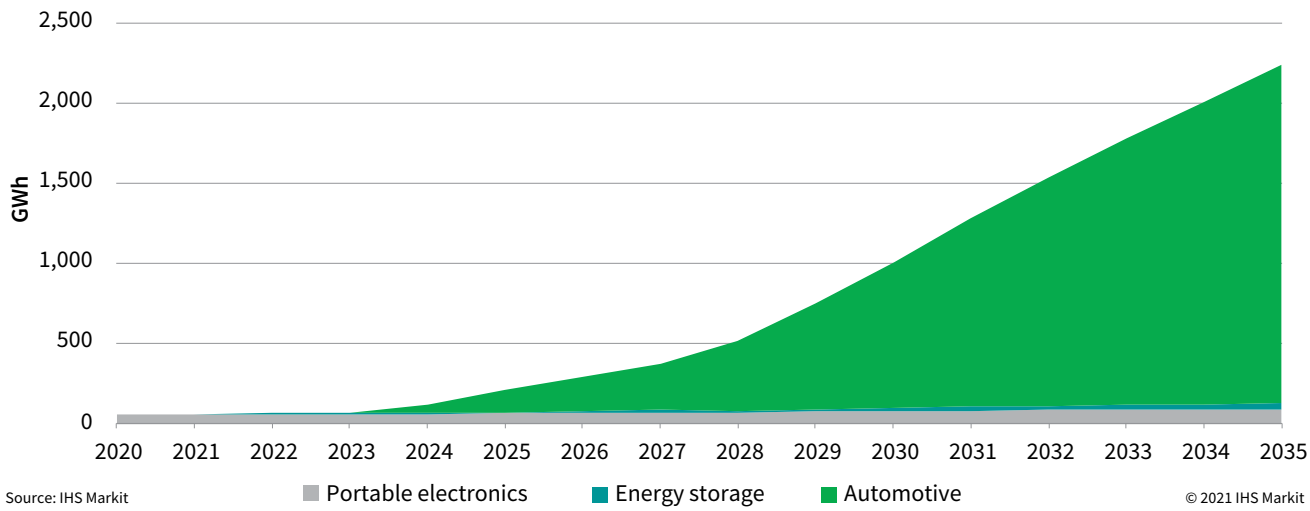
5 Recycling becomes a priority for companies and governments globally

New policies for battery recycling will be led by the automotive industry, spurred on with a sense of urgency due to the shorter life cycle of batteries compared to solar panels and wind turbines and the scale of the EV sector.

Meanwhile, recycling of renewable components is becoming a growing concern. With over 20 GW of the installed onshore wind fleet globally exceeding their 20-year design life in 2021, decisions about repowering, decommissioning, or extending life of existing capacity will play a growing role in mature markets. In the case of Germany, for example, over 6 GW of capacity will end subsidies this year. As a result, growing the share of recycling, especially of turbine blades, will be important to meet announced carbon neutrality goals and pave the way towards a circular economy. Policy facilitating a steady flow of retirements will be necessary to drive supply chain investments in recycling. This was evidenced by GE partnering with Veolia in their newly announced turbine recycling program late last year, boosted by the wave of PTC-driven partial repowering in the US.

Repowering practices will reduce product life cycles and accelerate the need for widespread recycling programs that will be complicated since not all technologies allow direct recycling of raw materials or components as highlighted in IHS Markit's recent report on the New Supply Chains for the 'Net-Zero Carbon' Future.

End-of-life batteries available for recycling by sector



Source: IHS Markit

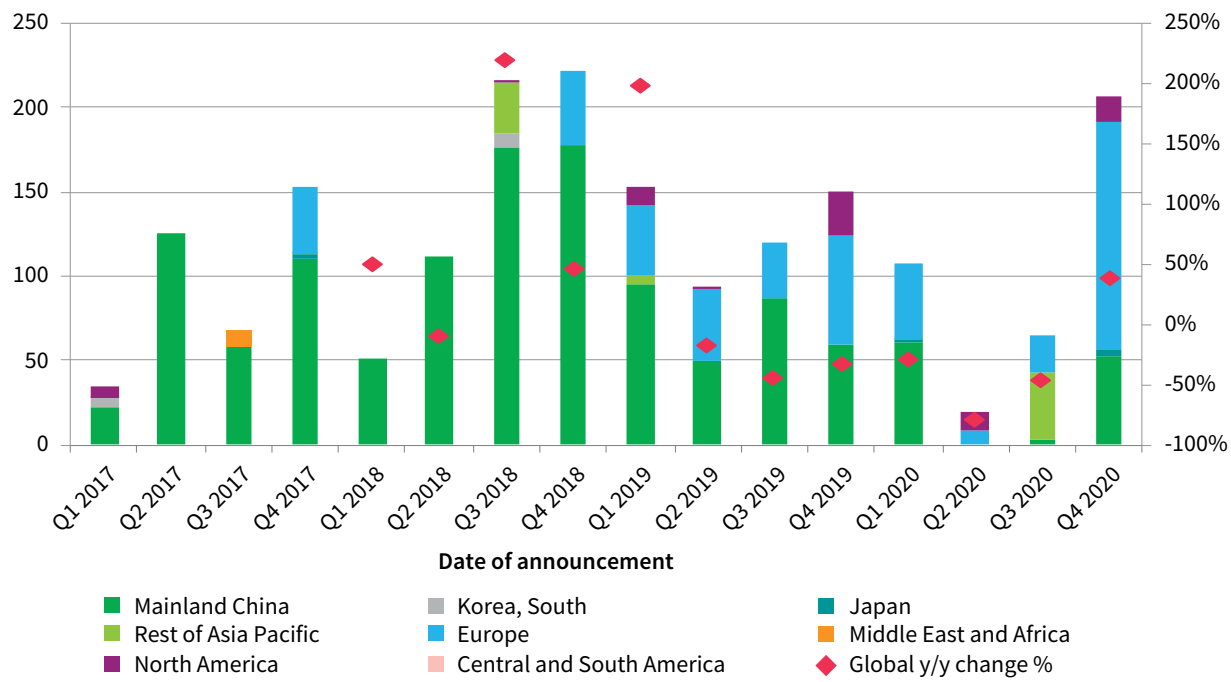
6 Li-ion price and technology trends in the energy storage sector will hinge on the automotive industry more than ever.

- Despite the rapid growth of the grid-connected battery energy storage market, it will account for only a minor share of global demand for Li-ion batteries. In 2021, the automotive & transport sector will account for 80% of Li-ion battery demand – a figure that is set to rise to 90% by the middle of the decade.
- As a result, the availability of batteries for the energy storage sector will be heavily impacted by the dynamics of the automotive sector and the pace of the uptake of EVs. Large tier 1 battery manufacturers will prioritize long-term supply agreements with large automotive OEMs over smaller agreements with energy storage system integrators, which could lead to potential shortages or delivery delays. This may also open up opportunities for smaller, less established, or more specialised battery manufacturers to forge relationships with leading energy storage system integrators.
- One specific example to watch in 2021 would be the availability of LFP batteries for energy storage systems. The energy storage industry has increasingly adopted LFP (lithium iron phosphate) batteries in recent years due to their lower cost and better safety track record, as well as an abundant supply – in comparison to the main alternative, NMC (lithium nickel manganese cobalt), which has been favoured for EVs. However, in late 2020 Tesla announced that it would buck this trend to use LFP batteries for its Chinese produced vehicles. Should this signal a wider trend amongst EV manufacturers, then the availability of this technology for new energy storage projects that are yet to be contracted and further price declines could be restricted.
- Potential supply challenges for Li-ion batteries do represent a glimmer of opportunity for alternative (non lithium) battery technologies, such as flow batteries. However, today's cohort of alternative technology providers remains challenged to quickly scale up to provide a contender with proven reliability and performance at a competitive cost.

7 Sustainability and security of supply concerns will continue to drive the localization of battery manufacturing

- With national plans to reduce carbon emissions hinging on the electrification of transport, Governments are increasingly promoting the development of local battery manufacturing. This is particularly the case in North America and Europe, as over 80% of global battery cell manufacturing was located in China at the end of 2020.
- In 2020, plans for over 500 GWh of new battery cell manufacturing facilities were announced. Of this amount, 42% is planned in Europe, 26% is planned in North America. 23% of the announcements made in 2020 are planned in China, a significant decrease 2019 when it accounted for 57% in 2019.
- Local supply of the critical raw materials that are required to manufacture batteries (e.g. Lithium, Nickel, Cobalt etc.) is limited in major end markets for EVs. This is one of the factors driving Governments and corporations to increasingly look to develop a recycling industry, as materials recovered from used batteries may quickly begin to provide a local supply.
- Although recycling activities will remain very limited in 2021, early progress towards establishing this crucial industry will continue. The amount of batteries reaching the end of their life is predicted to quickly ramp up throughout the decade and globally, 350 GWh of batteries are predicted to reach the end of their life in 2030, which could provide an estimated 20% of the lithium, and almost half of the cobalt, required to make new batteries that same year.
- Increasing regulation (e.g. EU Batteries Directive) will also help to drive this ramp up of battery recycling capacity.

Li-ion battery cell manufacturing capacity announcements by region (GWh)



Note: Based on announced factories included in the IHS Markit Battery Cell Manufacturer Database; cathode types included are LMO, NMC, NCA, LFP, NMCA, and LNMO; capacity announcement denotes the final capacity for an announced factory
Source: IHS Markit

8 2021 will see more cleantech and electric mobility companies choose to enter the public markets using SPAC (Special Purpose Acquisition Company)

- In 2020, the 16 cleantech and electric mobility startups choosing to go public via SPAC received an average valuation of $2 billion, with the resulting net proceeds from the merger averaging $470 million among the companies that disclosed this metric. It is remarkable that 50% of this cohort do not yet offer any commercial products.
- Many of the companies pursuing SPAC mergers are pursuing capital-intensive business models; these companies plan to use their new funding to develop a commercial product, scale manufacturing, and expand their offerings, in an accelerated timeframe in order to penetrate into an end market that is rapidly expanding before them.
- IHS Markit expects that in the near term, more companies in the cleantech and electric mobility sector will choose to enter the public markets using SPAC, as this pathway offers high cash benefits and media attention, which are invaluable to companies looking to quickly capture market share. However, companies that have been through the process will need to demonstrate long-term success in order for SPAC mergers to become mainstream

9 Low Carbon hydrogen projects enjoy exponential growth

The exponential growth in the electrolysis project pipeline in 2020 and the unprecedented interest around hydrogen as a decarbonization tool has been driven by a combination of falling costs and policy support. The declining cost of low-carbon hydrogen is anticipated to continue to fall by a further 40% through 2025 due to the falling cost of renewables electricity and the price decline expected in electrolysis technology as it is scaled-up.

This exponential growth in the electrolysis pipeline in 2020 and in general the unprecedented interest around hydrogen has been driven by a combination of falling costs and policy support:

- **Favorable policies are being put in place with sizeable funding.** An unprecedented wave of hydrogen strategies was released in 2020 despite the COVID-19 crisis. In 2020, six Major European countries and the European Commission released hydrogen strategies amid the COVID 19 pandemic (in most cases as part of a green recovery plan). Russia, Norway, Chile and Canada also released hydrogen energy frameworks in 2020 following suit to Japan, South Korea and Australia in previous years. Sizeable funding was also provided; around US$ 44 Billion of funding through various support mechanisms was made available for hydrogen projects in Germany, France, Italy, Spain, and Portugal alone, up to 2030. This is five times more than the global investments in research, development, and demonstrations from 2005 to 2018.
- **The costs of low-carbon hydrogen are declining and the trend is expected to continue:** The cost of hydrogen from electricity decreased in average by ~40% in the past five years (2015 – 2020). The levelized cost of green H2 in locations with good availability of renewables is today around 4-5 USD/kg. This cost reduction is anticipated to continue due to the lowering cost of renewables electricity and the cost decline expected in electrolysis technology as it is scaled-up. By 2025, an additional 40% cost decline in levelized cost of green hydrogen when triple digit MW electrolysis plant come online.

10 Hydrogen company stocks will build on their 2020 run up

- 2021 will test the lofty valuations enjoyed by hydrogen companies. 2020 saw a boom in stock prices as nations increasingly incorporated the low-carbon gas into their decarbonization strategies. A select portfolio of companies rose over 500% in 2020 (see chart)
- IHS Markit anticipates hydrogen-related investment will continue to boom. 2021 has started strong, with SK Global's investment in Plug Power increasing the NASDAQ:PLUG ticker by 35% (not pictured). Government support continues to de-risk investment and additional policy measures, like Canada's Clean Fuel Standards, add incentives to development. Despite these measures, business models and technologies are nascent, and while the overall market might boom, there will be some spectacular busts.
- To defray those risks, IHS Markit expects expanded use of joint ventures and strategic partnerships. Multiple production pathways and end uses predispose the hydrogen investment ecosystem to sharing technology and infrastructure. Alliances between large and small companies, like GM's proposal take a 10% stake in Nikola, can make these stocks pop. They can also be a sign of some froth in the market too.

Global Clean Energy Technology Service

The IHS Markit Global Clean Energy Technology service provides in-depth coverage of the supply chain economics and outlooks for batteries and energy storage, hydrogen and renewable gas, solar and wind. New areas of research under development include carbon capture and storage, geothermal and heating and cooling.

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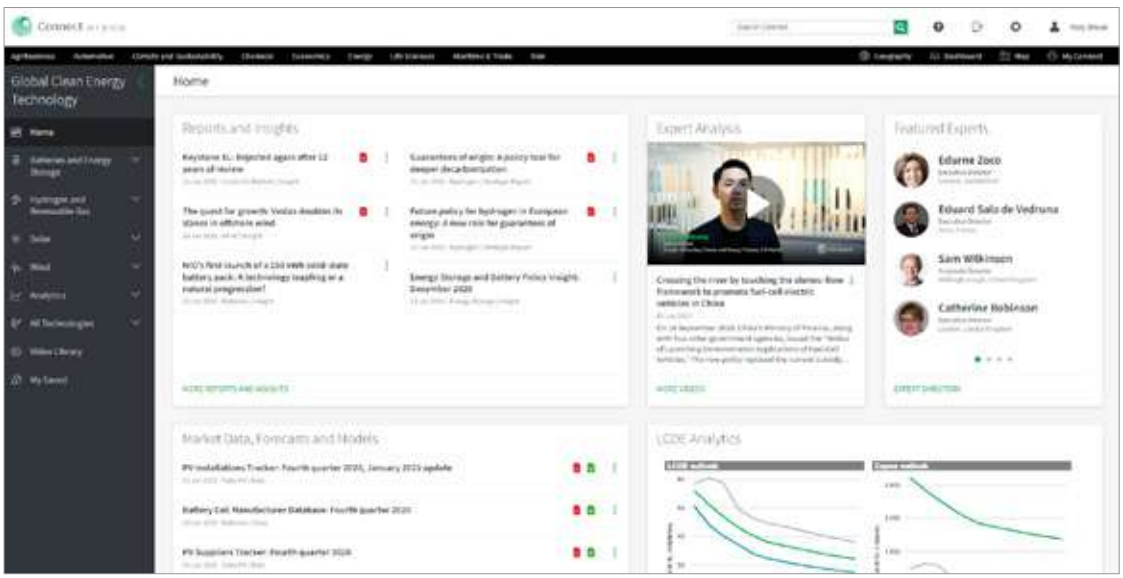
- Levelized cost of hydrogen and renewables gas production
- Capacity outlooks for power generation, storage and hydrogen production
- Emerging trends: drivers and inhibitors on the outlooks
- Corporate strategies and business models
- Global databases of projects



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