

Green Economy Evolution - 2021

Increased acknowledgement that the earth is warming, and the resulting environmental stress, have become catalysts to drive global action to reduce carbon emissions.

Solutions will embrace a wide range of interconnected tactics including, for example, renewable energy, digital technologies, EVs, industrial efficiency, electrification, carbon offsets, energy storage, hydrogen, circular strategies, and more.

This discussion focuses on actions and opportunities going forward to help reduce global warming and its negative effects. Specific initiatives and companies mentioned are illustrative only.

Top Countries for CO2 Emissions

1. China (10.06 GT)	28%	Plans to be carbon neutral by 2060. Extensive R&D.
2. U.S. (5.41 GT)	15%	
3. India (2.65 GT)	7%	Largest expected rise in energy demand of any country, IEA
4. Russian Federation	5%	
5. Japan	3%	
6. Next 15 Countries	21%	
7. Rest of World	21%	

I. Key Drivers of a Greener Economy

- Increasing alignment of political, private sector, and consumer interests
 - Biden, Paris Agreement Reentry, John Kerry, Janet Yellen/Climate Czar
 - Larry Fink/BlackRock - climate risk is investment risk, ESG investing
 - Bill Gates - Breakthrough technology investments, e.g. nuclear, cement, carbon extraction
 - Public opinion, in particular among Millennials
 - COP26, Glasgow, Nov. 2021, UN Climate Change Conference, Mike Bloomberg, Special Envoy
- Shifting mindset from “environmental restrictions” to “commercial opportunities”.
- Competition among countries and companies for future industry leadership and jobs.

II. Trends & Directions (Generation, Transmission and Storage, End Use)

Generation

The world is transitioning to a lower carbon mix of energy sources. 70%-80% of today's investment in new power generation is for renewables. In 2020, sustainable power exceeded coal for the first time.

Royal Dutch Shell announced peak oil occurred in 2019. It will rely on oil production to help finance its conversion to renewable energy sources like wind, solar and hydrogen. Its current plan is to invest \$2 billion to \$3 billion a year in renewable energy assets — out of a \$22 billion capital investment budget.

BloombergNEF projects a tripling of overall worldwide power capacity between 2019 and 2050.

- Renewables surge from 35% to 68%, (Solar, Wind, Hydro)
- Fossil fuel power capacity drops from 56% to 24%, (Coal, Gas, Oil)
- Nuclear, Other, 8%

\$15.1 Trillion to be invested in new power capacity to 2050 (BloombergNEF)

- \$11 Trillion or 73% in renewables, 80% (including batteries)
- Asia Pacific sees 45% of all new capital, (China and India account for 72%)

IEA World Energy Outlook 2020

“Renewables grow rapidly in all our scenarios, with solar at the centre of this new constellation of electricity generation technologies. Supportive policies and maturing technologies are enabling very cheap access to capital in leading markets. With sharp cost reductions over the past decade, solar PV is consistently cheaper than new coal- or gas fired power plants in most countries, and solar projects now offer some of the lowest cost electricity ever seen.

Hydropower remains the largest renewable source of electricity, but solar is the main driver of growth as it sets new records for deployment each year after 2022, followed by onshore and offshore wind”.

Annual **solar** installations to pass 150GW in 2021; After a 2020 that defied coronavirus disruption and produced yet another record for solar installations, at a provisionally estimated 132GW, BloombergNEF

Enphase, Solar Edge, JKS, ETFs: TAN, QCLN, PBW, Copper

Wind additions to jump by 15%

Just as it did in 2020, we expect the wind sector to set new records this year. Across sea and land, we expect a total of 84GW of new wind capacity to be added in 2021. Most of this will be onshore (75GW). For the first time, we expect six European countries to exceed 1GW of annual

onshore installations. It means that across Europe we expect to see around 20GW of new capacity, 5GW more than its previous record. After an expected dip in installations in 2020 (unrelated to the pandemic), new offshore additions will jump 33% this year with 8.7GW added worldwide.

FAN (ETF), Vestas Wind Systems, (VWS)

Offshore Wind

In the UK, BP and Total **emerged as the two top victors** in a bidding war for an area set aside for offshore wind farm development.

Competition is heating up between European oil companies which see offshore wind as their best way to seize a lucrative slice of the growing market for zero-carbon electricity and leverage offshore operational skills from their drilling days. The UK bids follow at least two **other big offshore wind deals** this year: In January, Total announced plans to build one of the world's largest wind farms off the coast of Denmark, while BP **won one of the biggest renewable energy deals** in US history for an offshore wind farm in New York. Altogether, offshore wind projects in Europe **drew a record \$31.7 billion** in investments in 2020; the market in the US is just **beginning to open up**.

Green Hydrogen and Fuel Cells: Transportation: Trains, Ships, Trucks; Industry: Fork Lifts Plug Power: Amazon, Walmart, Home Depot; partnerships with Renault, SK Group. Ballard Power: Hydrogen fuel cell train planned for Scotland, China based projects Air Products and Saudi Arabia's ACWA Power to invest \$5 billion to build what will be the world's largest green hydrogen production facility.

Hydrogen electrolyzer additions to more-than-double in 2021. BloombergNEF has identified 240MW of projects announced for completion in 2021, compared to just 90MW finished in 2020. The growth is a testament to the enthusiasm around the world for hydrogen, which many countries and companies recognize as a means of decarbonizing some of the hardest-to-abate sectors. Oil and gas majors like it too, because hydrogen can be pumped through gas networks and, like oil, is hugely capital-intensive to produce, providing a barrier to new entrants.

China: pledge to achieve net zero carbon by 2060 to help address adverse effects of climate change, create 40 million jobs, and drive economic growth. (Today China accounts for 30% of global CO2 emissions, and 64% of the increase since 2000).

- \$16 trillion of clean tech infrastructure investments
- Key interconnected scalable technologies - electrification, tripling of renewable power to 90%, clean hydrogen, (industry and heating), potential border adjustment on carbon prices on e.g. steel, seek close to 100% new energy vehicles, and \$1 trillion in charging infrastructure.

India: “To meet growth in electricity demand over the next twenty years, India will need to add a power system the size of the European Union to what it has now. Solar power is set for explosive growth. The pace of change in the electricity sector puts a huge premium on robust grids and other sources of flexibility, with India becoming a global leader in battery storage”. IEA

Nuclear:

WSJ: Mini Nuclear Reactors Offer Promise of Cheaper, Clean Power.

New innovations e.g. Gates/TerraPower/GE, liquid sodium vs. water.

https://www.wsj.com/articles/mini-nuclear-reactors-offer-promise-of-cheaper-clean-power-11613055608?&mod=article_inline

Transmission and Storage

“The pace of change in the electricity sector puts an additional premium on robust grids and other sources of flexibility, as well as reliable supplies of the critical minerals and metals that are vital to its secure transformation. Storage plays an increasingly vital role in ensuring the flexible operation of power systems, with India becoming the largest market for utility-scale battery storage”. IEA

\$14 Trillion in grid investment between now and 2050 (BloombergNEF)

Key factors: Resilience, Distributed Energy, Changing requirements, e.g. EV, Heating... Demand management... two way flows, interconnection, MicroGrids for more isolation and access

WSJ: The Battery is Ready to Power the World . . . After a decade of rapidly falling costs, the rechargeable lithium-ion battery is poised to disrupt industries.

https://www.wsj.com/articles/the-battery-is-ready-to-power-the-world-11612551578?st=9p715h6ouctubxs&reflink=article_email_share

Companies: Schneider, Siemens, ABB, Tesla, Panasonic, LIT (ETF)

Energy Consumption / End Use

Corporate Clean Energy Buying Grew 18% in 2020, BloombergNEF

<https://about.bnef.com/blog/corporate-clean-energy-buying-grew-18-in-2020-despite-mountain-of-adversity/>

NEE, XLU, HASI, NEP, CWEN

Industrial Efficiency, Advanced Manufacturing, Robotics, 3D Printing, Simulation...

Companies: ANSS, FLEX, ARKQ, DDD, SSYS, DM, MTLN, PRLB, Fanuc Corp, (FANUY)

BloombergNEF: “We expect a record year for **heat pump installations**, with the potential for sales of more than 12 million units globally in 2021. This would mark the greatest year-on-year growth rate since 2017, and a million more unit sales than there were in 2019”.

Companies: Trane, Carrier

Energy Resilience: Tesla, (batteries); Generac, (generators, storage, demand management)

Construction and Materials . . . globally an amount equivalent to New York City will be built every month for the next 40 years. (Bill Gates) Innovations needed in for example, cement and steel production. (e.g. cement incorporating 30% carbon).

Agriculture: Precision Farming, Farm Equipment, Drought / Pest Resistant Seeds, Fertilizers, CAT, DE, CTVA; Plant based foods vs. meats . . . Beyond Meat, Impossible Burgers

Digital Technologies...Internet of Things, (IoT), Demand Management, Factories, Buildings, Smart Cities, Robotics; ITRI, Tesla pilot for discounts on charging during off-peak periods.

Transportation

GM announced their move to all electric vehicles by 2035.

EV's, BloombergNEFThere are now over 10 million electric vehicles on the road globally, and adoption will continue to accelerate in 2021. We expect around 4.4 million passenger EVs (including battery electrics and plug-in hybrids) to be sold globally in 2021, up about 60% from 2020.

- EV adoption will also rise quickly again in China this year, where we expect around 1.7 million passenger EV sales, up from 1.2 million in 2020.
- North American EV sales should come in a little over 500,000. This is far behind Europe and China, but 2021 marks a dramatic change on the policy front in the U.S. The incoming Biden administration's appointments and statements so far show strong ambitions on EVs and charging infrastructure.

Tesla, GM, F, NIO, BYDDF, APTV . . . Charging Infrastructure, e.g. Enel, Blink,

Tesla supercharger production facility announced to be built in Shanghai.

Substitute materials. BMW project to substitute aluminum, (produced with solar energy), for steel.

III. Additional Information

BloombergNEF: Energy, Transport, Sustainability – 10 Predictions For 2021

<https://about.bnef.com/blog/energy-transport-sustainability-10-predictions-for-2021/>

International Energy Agency, IEA, World Energy Outlook 2020

<https://www.iea.org/reports/world-energy-outlook-2020>

BloombergNEF New Energy Outlook 2020

<https://about.bnef.com/new-energy-outlook/>

Goldman Sachs: China Net Zero: The clean tech revolution

<https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-china-netzero/report.pdf>

IEA: India Energy Outlook 2021

https://www.iea.org/reports/india-energy-outlook-2021?utm_content=bufferf8810&utm_medium=social&utm_source=twitter-ieabirol&utm_campaign=buffer

UN Environment Program, (Twitter: @UNEP)

The International Renewable Energy Agency, (Twitter: @IRENA)