PV-WIND MONTHLY MARKET UPDATE

Net PV Capacity Additions Are 3,792 MW in January

April 2024 Issue

(Data Updates for January 2024)

U.S. PV-WIND CAPACITY **January 2024 PV and Wind Capacity Additions**

- In January, PV capacity additions total 3,792 MW
- In January, wind capacity additions total 786 MW

U.S. ELECTRICITY GENERATION **January 2024 PV and Wind Electricity Generation**

- PV and wind electricity production is 13.0% of total U.S. electricity generation
- Of total U.S. electricity generation, PV is 3.8% and wind is 9.2%

TRADE – U.S. PV IMPORTS/EXPORTS **January 2024 U.S. PV Panel Imports**

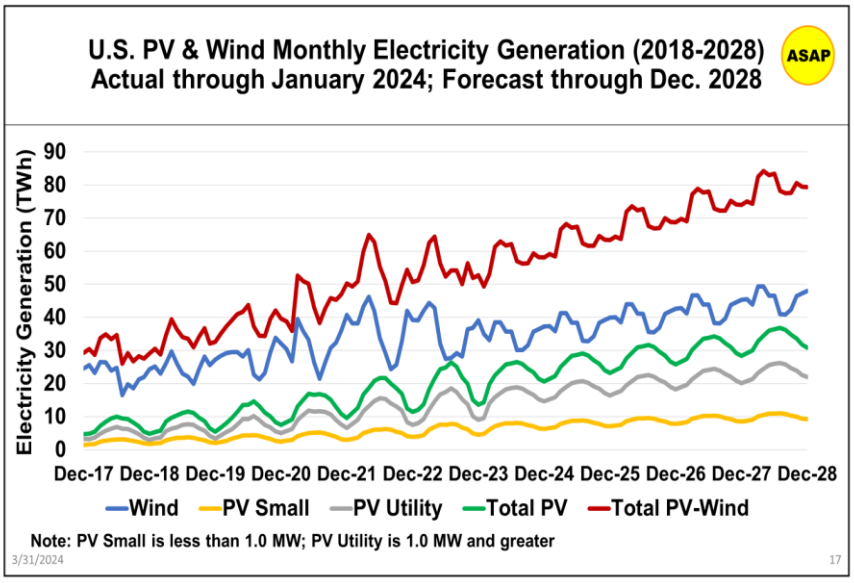
- In January, the value of U.S. PV panel imports decreased 2.0% to $1.4 billion
- Vietnam, Thailand, and Malaysia are the top suppliers of U.S. PV panel imports

PV-WIND COMPANY FINANCI2AL PERFORMANCE **March ETF Share Performance**

- For March 2024, TAN (solar) share price performance is a positive 5.1%
- For March 2024, FAN (wind) share price performance is a positive 1.8%

WORLD PV-WIND CAPACITY **2024 Forecast for World PV and Wind Additions**

- U.S. PV Forecast for full-year 2024 is 29 GW of capacity additions
- U.S. wind forecast for full-year 2024 is 10 GW of capacity additions
- The world PV forecast for 2024 is 400 GW of capacity additions
- The world wind forecast for 2024 is 50 GW of capacity additions



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PV-Wind Monthly Slideshow

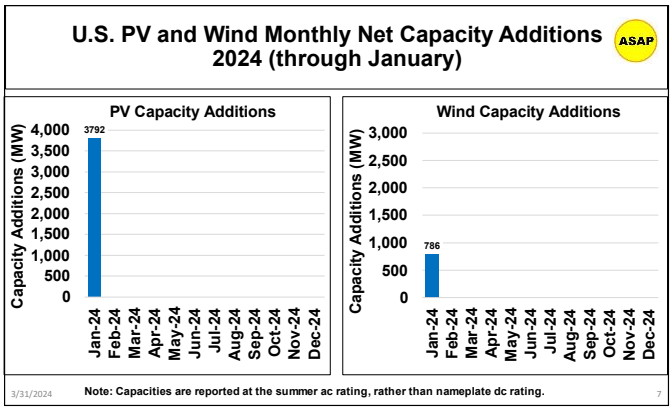
Battery Storage Analysis

Global Warming Update

U.S. PV and Wind Capacity

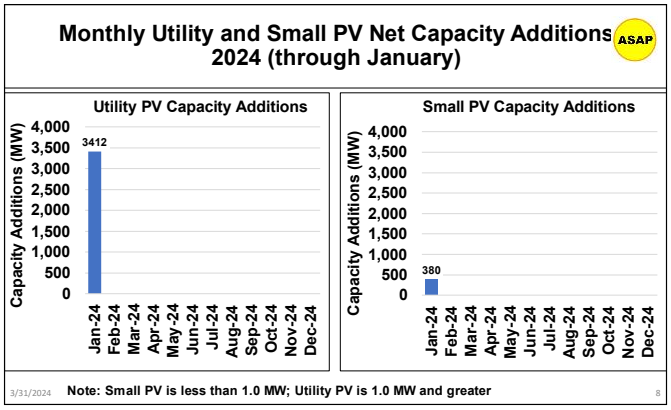
January U.S. PV capacity additions total 3,792 MW

In January, U.S. PV net capacity additions total 3,792 MW, which brings cumulative capacity to 141.3 GW. Utility scale PV capacity additions are 3,412 MW, which is 90% of new PV, and small PV capacity additions are 380 MW. PV capacity additions are above pace to meet the full year forecast of 29.0 GW. PV cumulative capacity is expected to surpass wind cumulative capacity in 2024.



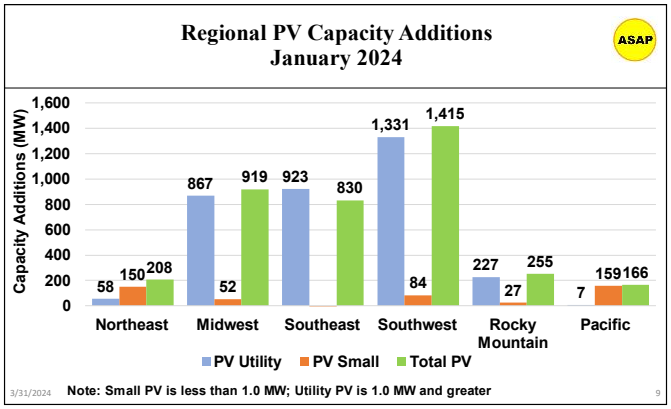
January wind capacity additions total 786 MW

On a regional basis, the Southwest region led in January PV capacity additions with 1,415 MW. The Midwest and Southeast regions followed with 919 MW and 830 MW respectively. The top three states for PV capacity additions are Texas, Ohio, and Florida with 958 MW, 870 MW, and 785 MW respectively.



The 2024 forecast for PV capacity additions is 29 GW, and the wind forecast is 10 GW

Wind installations in January total 786 MW, which brings cumulative wind capacity to 148.4 GW. U.S. wind capacity additions for the year are on pace to meet the 10.0 GW forecast. The Southwest and Rocky Mountain regions led with 451 MW and 251 MW respectively. Texas installed 451 MW, Montana installed 208 MW of new wind capacity, Indiana installed 81 MW. The wind industry is facing numerous headwinds, which include manufacturing and permitting issues, as well as general political opposition to wind installations in the Plains states.

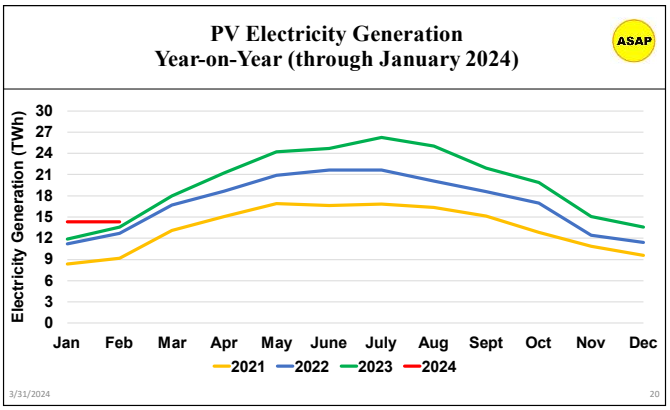


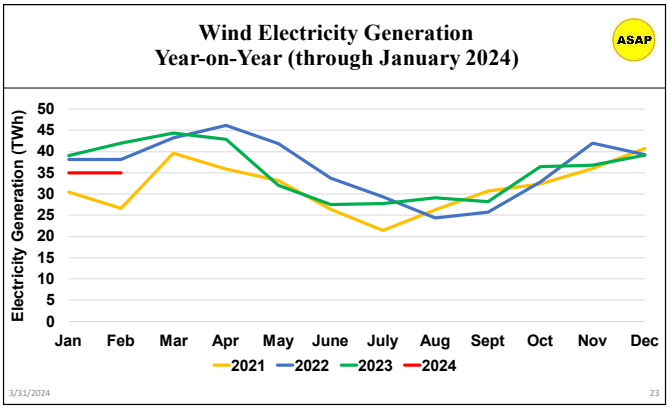
The PV forecast is supported by a two-year freeze on PV import tariffs for Malaysia, Vietnam, and Thailand. In addition, the forecast is supported by PV incentives that are included in the Inflation Reduction Act passed by the 2022 Congress and. The Southeast Asian PV import market becomes complicated when tariff relief expires in June 2024 and the imposition of high tariffs on PV content sourced from sanctioned Chinese companies.

U.S. PV-Wind Electricity Generation Update

In January, combined PV and wind electricity generation is 13.0% of total U.S. electricity generation

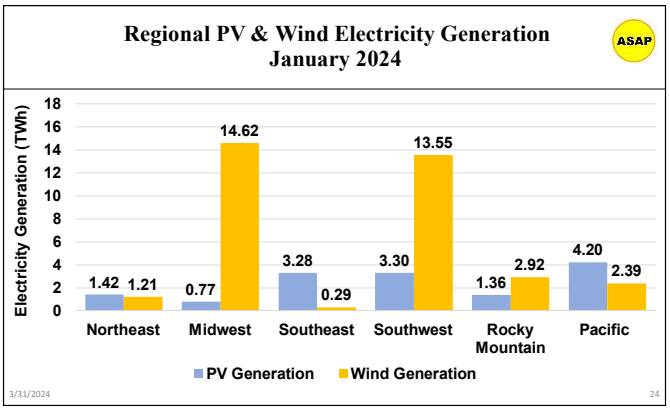
In January, PV generated 14.4 TWh of electricity, and wind turbines generated 35.0 TWh of electricity. For January, combined PV and wind electricity generation is 13.0% of total U.S. electricity generation. PV contributes 3.8%, and wind provides 9.2%. PV is expected to provide over 6.0% of total electricity generation in 2024. The gap between PV and wind electricity generation is narrowing, but wind electricity generation will continue to dominate.





Year-on-year (YoY), January-22 to January-23, PV electricity generation has increased 20.7%, and wind electricity generation has decreased 10.5%. YoY, combined PV and wind electricity generation has declined 3.2%. Note that climate variability influences annual and monthly comparisons.

In January, the Pacific region led in PV electricity generation, and the Midwest region led in wind electricity generation



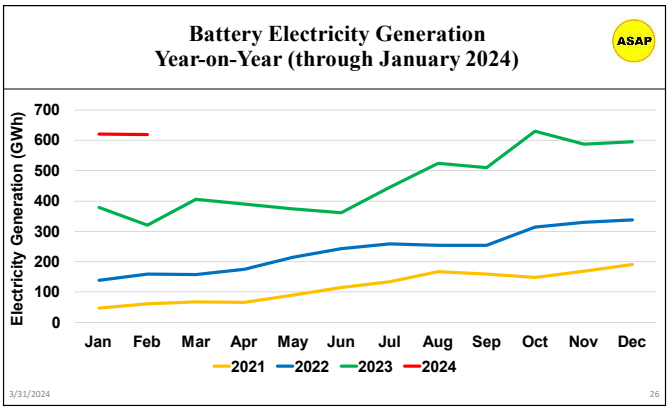
In January, the Pacific region led the nation in PV electricity generation with 4.2 TWh and is followed by the Southwest region with 3.3 TWh and the Southeast region with 3.3 TWh. California is the leading state with 3.9 TWh of PV electricity generation, which is 27% of total U.S. PV electricity generation in January. Texas follows with 2.3 TWh, Florida 1.2 TWh, Arizona 0.7 TWh, North Carolina 0.7 TWh, and Nevada 0.6 TWh.

In January, the leading regions for wind electricity generation are the Midwest with 14.6 TWh and the Southwest with 13.5 TWh. These two regions combined produced 81% of total U.S. wind electricity in January. The Rocky Mountain and Pacific regions are distant third and fourth with 2.9 TWh and 2.4 TWh of wind electricity generation respectively. Texas is the leading state with 9.4 TWh of wind electricity generation and is followed by Iowa 3.4 TWh, Oklahoma 2.8 TWh, Kansas 2.2 TWh, and North Dakota 1.2 TWh.

U.S. Utility Battery Storage

In January, battery storage capacity additions are 1.7 GW

U.S. battery storage capacity additions total 1.7 GW in January, which increases cumulative battery storage capacity to 15.7 GW. Full year 2024 battery capacity additions are 1.7 GW, which is above the pace needed to reach the 8.0 GW annual forecast.



U.S. cumulative battery storage capacity increases to 15.7 GW in January

The reported January average monthly battery utilization factor is 5.3%, which is a daily average of 1.3 hours. The implied battery electricity generation is 620 GWh. From company battery installation announcements, four hours of battery storage capacity is becoming the norm but is not being fully realized. At present, stored battery electricity is applied to shaving pe demand electricity generation rather than the replacement of fossil fuel power plants.

Obviously, variability in PV and wind electricity production requires electricity storage to convert PV and wind into a dependable supply of on-demand electricity. At present, the U.S. has approximately 800 GW of fossil fuel power plants, which implies the need for hundreds of GW of storage capacity if PV and wind electricity is to replace fossil fuel power plants. At present, the large-scale storage options are pumped hydro, batteries, hydrogen, molten salt for thermal solar, underground compressed air energy storage. Currently, pumped hydro is the largest storage technology with over 22 GW of installed capacity. Due to siting constraints, it is expected that pumped hydro storage capacity will remain at approximately 22 GW going forward.

In January, the average battery utilization factor is 5.3%

There are several green hydrogen projects on the drawing board with hydrogen produced from water using PV, wind, and hydro electricity. Green hydrogen is being discussed as a fuel for hydrogen fuel-cell heavy Class 8 transport trucks. Other PV and wind storage technologies are molten salt and compressed air energy storage systems. Molten salt storage at solar thermal concentrating power plants and compressed air energy storage are basically being ignored in the U.S. with only power plant of each technology in current operation. Looking ahead, one compressed air energy storage project in Texas using salt dome compressed air storage is permitted and is slated to begin construction in 2024.

PV Market Outlook 2024

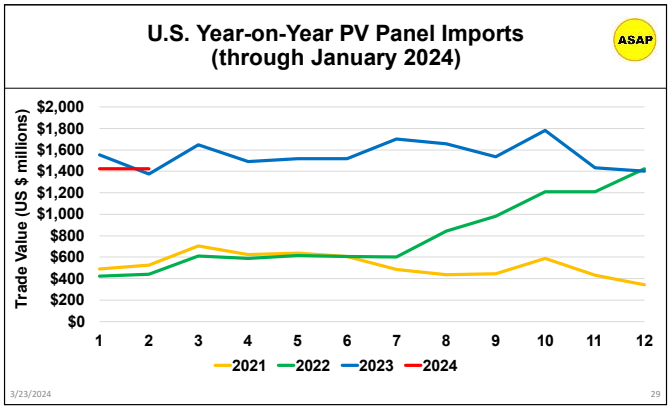
The Inflation Reduction Act is creating strong interest in expanding U.S. PV manufacturing

The U.S. PV industry installed a record 27.4 GW of new PV in 2023. This is an outstanding 52% increase over the previous high year. However, less than half of the PV panels installed were manufactured in the U.S. The majority of U.S. PV is sourced from the Asian countries of Vietnam, Thailand, Maylasia, Cambodia, and India with 37%, 21%, 13%, 12%, and 8% U.S. import market shares respectively. In the near term, the U.S. needs to ramp up domestic PV production through the incentives of the Congressional U.S. Inflation Reduction Act. Growth is essential, and the immediate question is “how soon can the U.S. top 30 GW of annual PV capacity additions? Keep in mind that China installed 219 GW (ac) of new PV in 2023.

U.S. PV Trade

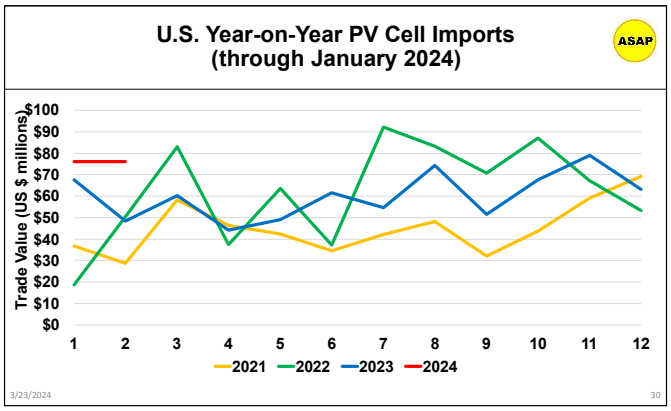
In January, the value of U.S. PV panel imports is $1.42 billion

In January, the value of U.S. PV panel imports increased 1.4% month-on-month to $1.42 billion. The full year value of U.S. PV panel imports is $1.42 billion, which is above pace for the $15.0 billion annual 2024 forecast. U.S. PV imports are expected to remain high in 2024 due to the freeze on U.S. import tariffs for PV modules and cells produced in the Southeast Asian countries of Malaysia, Vietnam, and Thailand that are lowing PV prices. The tariff freeze expires in June, which creates uncertainty for the second half of the year.

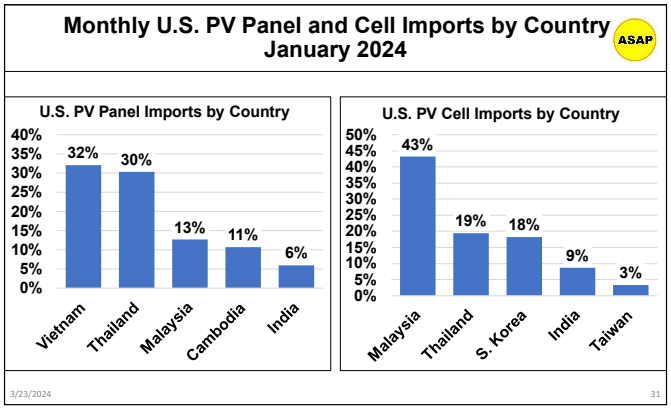


Vietnam, Thailand, and Malaysia are the top three sources of U.S. PV panel imports in January

Vietnam, Thailand, and Malaysia are the top three countries for U.S. PV panel imports in January. These three countries account for 75% of total U.S. PV imports. Vietnam leads the market for U.S. PV panel imports in January with a 32% market share. Thailand follows with a 30% share of the U.S. PV panel import market, and Malaysia rounds out the top three with an 13% share. India is a newcomer to the top tier countries for U.S. PV panel importers and is expected to be a growing source in future years.



S. Korea, Malaysia and Cambodia are the top three sources of U.S. PV cell imports in January



Turning attention to U.S. imports of PV cells, the total value of January U.S. PV cell imports increased 20.5% month-on-month to $76.0 million. Malaysia leads U.S. supply of imported PV cells in January with a 41% share. Thailand and South Korea round out the top three sources for U.S. PV cell imports with 19% and 18% market shares respectively. These three countries account for 81% of U.S. PV cell imports in January.

In terms of U.S. exports, the value of U.S. PV panel exports in January declined 69.4% month-on-month to $3.9 million. Year-to-date, the total value of U.S. PV panel exports for 2024 is $3.9 million. U.S. PV panel exports are behind the pace needed to reach the $20.0 million forecast for 2024.

The value of January U.S. PV cell exports increased 156% month-on-month to $14.6 million. For the full year, the value of U.S. PV cell exports is $14.6 million in 2024. The pace of U.S. PV cell exports in 2024 far exceeds the $50.0 million annual forecast. The export growth is driven by increases in Mexico and South American PV manufacturing.

The value of U.S. PV panel and cell exports have grown but essentially remain minimal

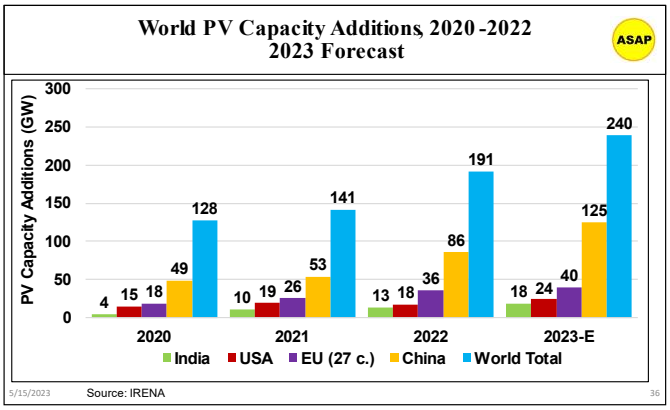
Global PV demand has been constrained by polysilicon shortages and high prices. Large additions to polysilicon production capacity are providing price relief in 2024. The Chinese spot silicon price has plummeted from $46/kg to ~ $10/kg in the first quarter of 2024. Low China silicon prices are supporting strong global market demand for silicon-based PV. Silicon PV holds a 95% share of the global PV market with only marginal growth in thin film PV technologies.

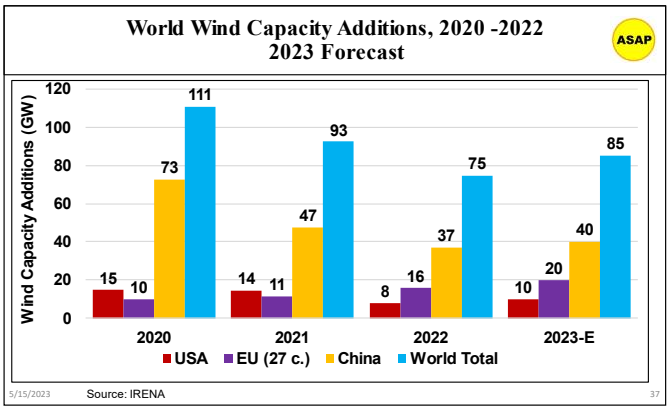
The U.S. is attempting to create a domestic PV manufacturing base to compete with China in the PV market. The U.S. Inflation Reduction Act aims to accelerate domestic solar manufacturing by offering tax credits at all stages of the solar supply chain. The tax credit incentives allow companies to front-load capital expenditures, which will enable companies to rapidly scale domestic production of PV system resources and components.

World PV and Wind

In 2023, world PV capacity additions topped 300 GW, which shatters the PV forecast of 240 GW. While the U.S. set a record of 27 GW of new PV, China steals the show with 219 GW (ac) of new PV. Wind capacity additions were a disappointing 75 GW. On the other hand, wind project developments are facing headwinds, and the 2023 forecast for wind capacity additions calls for a 13% increase to 85 GW.

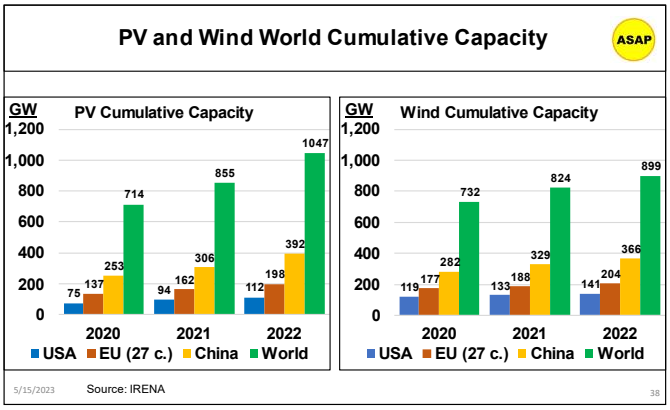
In 2023, world PV capacity additions were 300+ GW, and world wind capacity additions were 75 GW.





A few trends are evident as we move forward with the transition to renewable energy sources from fossil fuels. Photovoltaics (PV) and wind are proving to be the work horse in the clean energy transition. In 2022 PV passed the 1.0 trillion watts of cumulative installed capacity, and wind is not far behind at 925 GW of cumulative installed capacity. In 2023, two important global PV targets will be realized. Annual PV capacity additions will exceed 200 gigawatts (GW), and China will become the first country to install over 100 GW of new PV capacity. Also, wind is expected to pass the 1.0 trillion watts of cumulative installed capacity threshold in 2023.

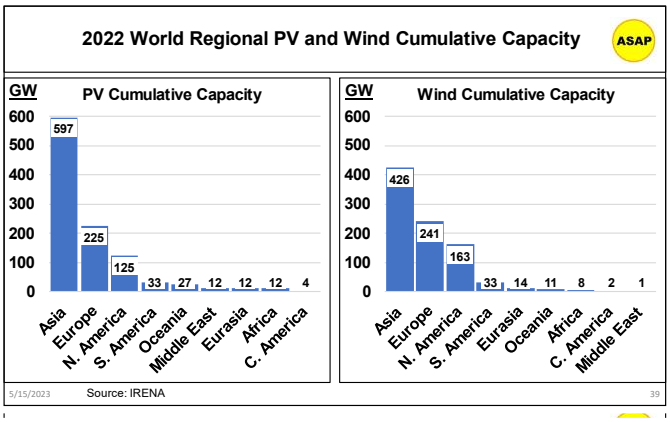
While topping 300 GW of PV capacity additions in 2023 is significant, the 200 GW is far short the 600 GW of annual global PV capacity additions needed to achieve climate change mitigation targets. China is the only country that is on pace to meet climate change goals. The U.S., Europe, and India are lagging far behind.

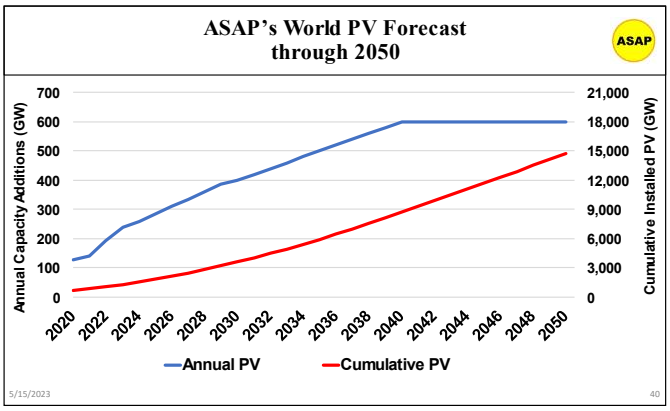


In contrast, global wind energy development is struggling to maintain growth. Wind companies state that they are facing headwinds that include slow permitting, electric grid constraints, and regulatory uncertainty. Such market conditions are, in turn, causing sizeable losses in the wind business, employment destruction and investment constraint. The companies conclude that the sizeable gap between recent installation expectations and targets is endangering the world energy transition.

Annual global PV capacity additions need to reach 500-600 GW by 2030 to meet net zero energy emissions targets

To meet the international goal of limiting the increase in average global temperature to below 2.0 degrees Celsius, ongoing research by the International Energy Agency (IEA) concludes that the world needs to install about 23 TW of PV and wind capacity by 2050 to reach net zero carbon emissions. In addition, the IEA plan calls for 3.0 TW of battery storage and 435 billion kilograms of hydrogen for transportation.





ASAP's PV and wind annual installation forecast achieves the IEA target by scaling annual PV installations to 600 GW and wind installations to 350 GW over the 2040-2050 timeframe. In addition, ASAP estimates the need for 3.3 TW of wind baseload storage capacity and 5.4 TW of PV storage peak storage capacity. ASAP also models PV for electrolytic hydrogen production of 415 billion kilograms per annum in 2050 for transportation use.

Storage is the primary obstacle to achieving complete zero carbon emissions electricity generation with intermittent PV and wind electricity generation. However, battery,

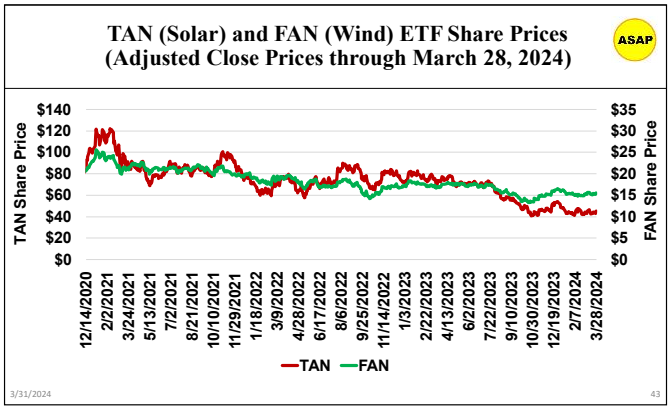
underground compressed air energy storage, and green hydrogen offer opportunities for large-scale PV and wind storage systems. ASAP estimates the total cost of a PV and wind with storage energy system, including storage, to be about $3.0 trillion per annum over a thirty-year transition period, 2021-2050, which will comprise about 2.5% of global GDP over the thirty-year transition period. This is a tall order, but it can be done with planning commitments in the international finance industry and governments.

PV and Wind Industry Financial Performance

Each month ASAP reports the share price performance of the TAN (solar) and FAN (wind) ETF index funds as proxy financial indicators of the PV and wind industries.

In March, the share values of TAN and FAN both increased

For the month of February 2024, the TAN ETF share value increased 5.1%, and FAN increased 1.8%. Year-to-date, TAN is down 15.0%, and FAN is down 6.3%.



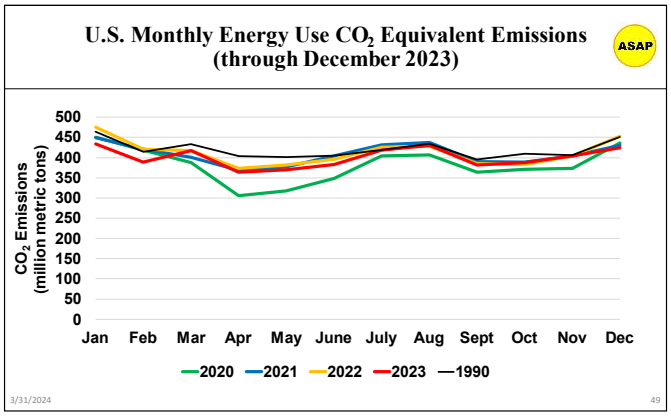
As shown in the graph, the share prices of the TAN and FAN ETFs have had disappointing performance over the past three years relative to 2021 highs. From the January 2021 highs through March 2024, the TAN share price is down 62.8%, and FAN share price is down 35.3%.

It is important to note that supply chain costs are improving with declining PV prices in 2024. Global demand for PV and wind installations is growing at a healthy rate, which should translate into share price increases for solar and wind companies going forward with continuing improvement in supply chain issues.

Carbon Dioxide Emissions

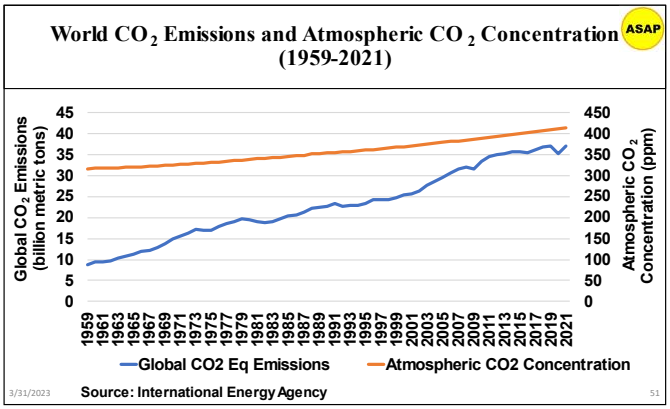
U.S. energy related carbon dioxide emissions have rebounded from the pandemic induced lows of 2020 as shown in the graph. On a positive note, total U.S. 2023 CO_2 emissions are 4.6% less than the 1990 level. For the past twenty-five years the goal has been to reduce energy use CO_2 emissions to below the 1990 level, which the U.S. appears to have finally accomplished. This is just the beginning, and it is sobering that it has taken 25 years to achieve this relatively modest reduction in CO_2 emissions.

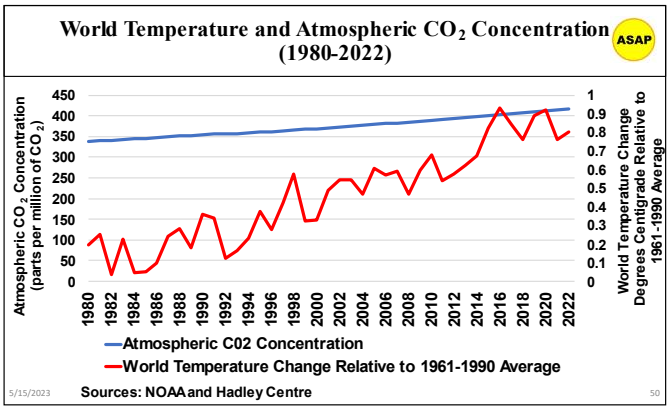
In 2023, U.S. CO_2 emissions fell 4.6% below the target 1990 level



In 2021, world carbon dioxide emissions set a new record high of 37.1 Gt

World carbon dioxide (CO_2) emissions related to energy consumption and industrial production rose to 37.1 giga-tonnes (Gt) in 2021, which is a new high mark. After a pandemic induced decline in 2020, energy consumption rebounded in 2021 causing the increase in CO_2 emissions. The atmospheric concentration of CO_2 in 2022 increased 0.6% over the 2021 levels to 417 parts per million.





The average global temperature has increased by at least 1.1° Celsius (1.9° Fahrenheit) since 1880 according to NASA's Goddard Institute for Space Studies (GISS). Most of the increase in global temperature has occurred over the past forty years. Further increases in the atmospheric concentration of greenhouse gases will result in higher temperatures. As the average global temperature continues to rise, extreme weather events will become ever more common and with ever greater intensity worldwide.

ASAP Data Sources

ASAP benchmarks U.S. PV and wind capacities and electricity generation to the estimates provided by the Energy Information Administration (EIA) of the U.S. Department of Energy. ASAP reports the EIA net summer capacity changes for PV and wind due to the high cost of supplying summer peak demand electricity. For example, summer PV net capacity is 10%-15% less than nameplate capacity due to heat losses.

ASAP benchmarks historical U.S. trade to U.S. Census Bureau trade data. Global data sources include the International Energy Agency (IEA), International Renewable Energy Association (IRENA), European Wind and Solar Industry Associations, China's NEA, Taiwan's Infolink, and company reports.