

Net PV Capacity Additions Are 1,488 MW in February

May 2024 Issue

(Data Updates for February 2024)

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

- In February, PV capacity additions total 1,488 MW
- In February, wind capacity additions total 385 MW

U.S. ELECTRICITY GENERATION February 2024 PV and Wind Electricity Generation

- PV and wind electricity production is 18.5% of total U.S. electricity generation
- Of total U.S. electricity generation, PV is 5.5% and wind is 13.0%

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

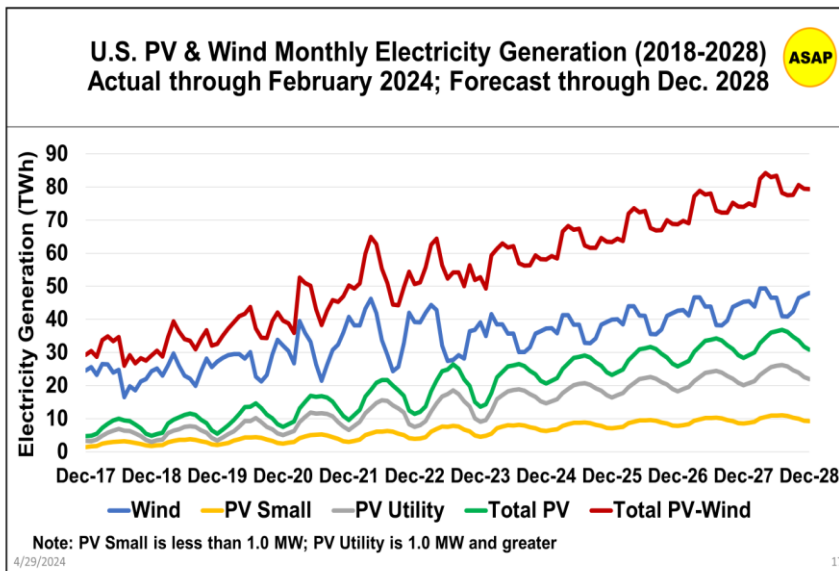
- In February, the value of U.S. PV panel imports decreased 2.0% to \$1.4 billion
- Vietnam, Thailand, and Malaysia are the top suppliers of U.S. PV panel imports

PV-WIND COMPANY FINANCIAL PERFORMANCE April ETF Share Performance

- For April 2024, TAN (solar) share price performance is a negative 11.1%
- For April 2024, FAN (wind) share price performance is a negative 0.8%

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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U.S. PV and Wind Capacity

In February, U.S. PV net capacity additions total 1,488 MW, which brings cumulative capacity to 142.8 GW. Utility scale PV capacity additions are 751 MW, which is 50.4% of new PV, and small PV capacity additions are 737 MW. PV capacity additions are on pace to meet the full year forecast of 29 GW. PV cumulative capacity is on pace to surpass wind cumulative capacity in 2024.

February U.S. PV capacity additions total 1,488 MW

February wind capacity additions total 385 MW

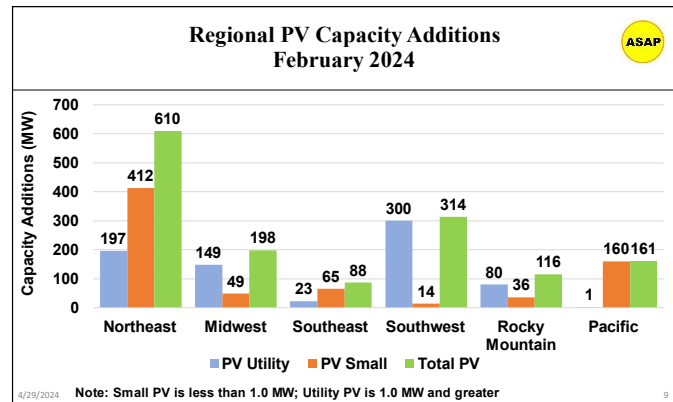
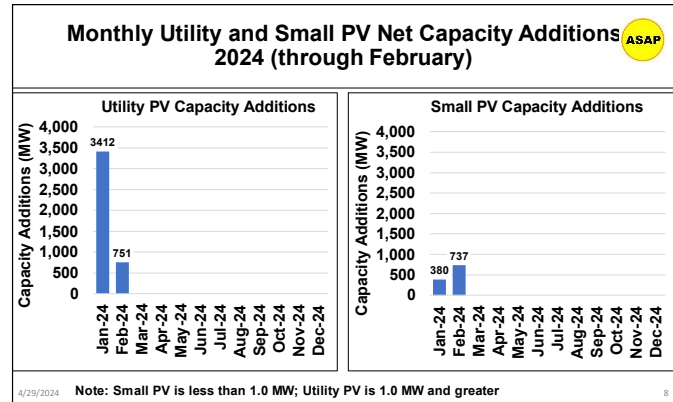
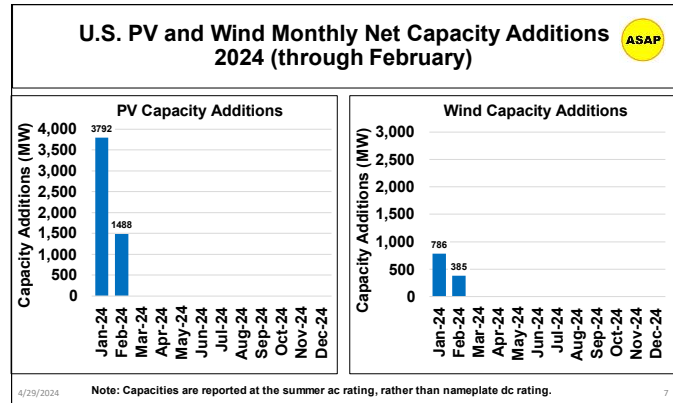
On a regional basis, the Northeast region led in February PV capacity additions with 610 MW. The Southwest and Midwest regions followed with 314 MW and 198 MW respectively. The top three states for PV capacity additions are Pennsylvania, Texas, and California with 266 MW, 185 MW, and 138 MW respectively.

Wind installations in February total 385 MW, which brings cumulative wind capacity to 148.8 GW. U.S. wind capacity additions for the year are

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

below pace to meet the 10.0 GW forecast. The Southwest region led with 403 MW with losses in some regions. Oklahoma was the only state with positive installations at 403 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 February, combined PV and wind electricity generation is 18.5% of total U.S. electricity generation

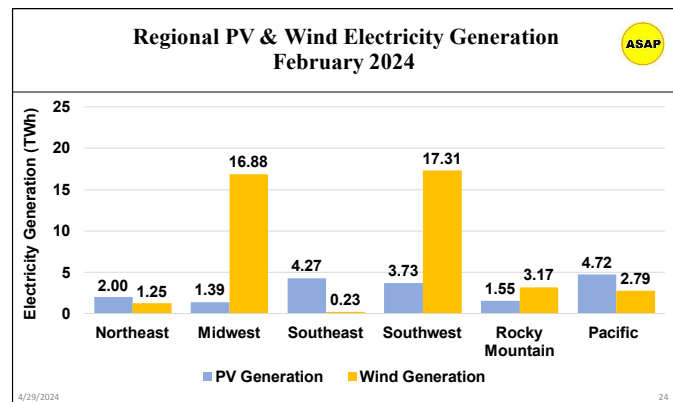
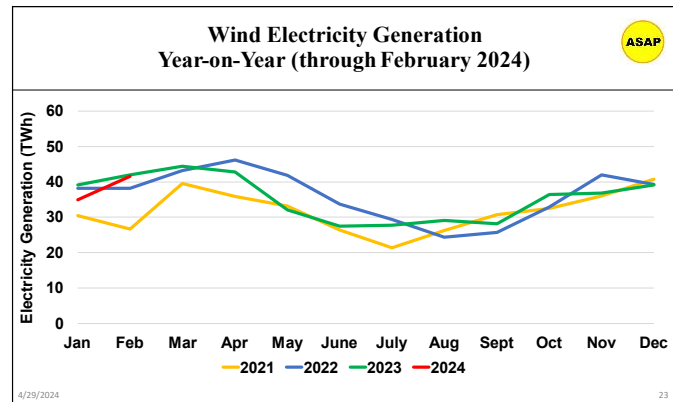
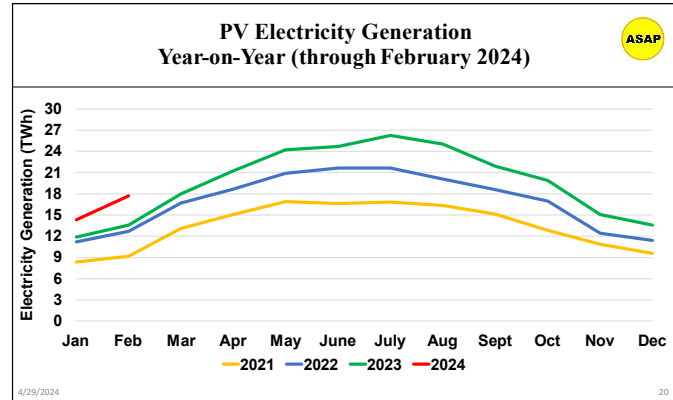
In February, PV generated 17.7 TWh of electricity, and wind turbines generated 41.6 TWh of electricity. For February, combined PV and wind electricity generation is 18.5% of total U.S. electricity generation. PV contributes 5.5%, and wind provides 13.0%. PV is expected to provide over 6.0% of total electricity generation in 2024. Wind electricity generation dominates total PV and wind electricity generation. Wind turbines generate ~20% more electricity than PV per unit of capacity.

Year-on-year (YoY), February-23 to February-24, PV electricity generation has increased 30.6%, and wind electricity generation has decreased 0.9%. YoY, combined PV and wind electricity generation has increased 6.8%. Note that climate variability influences annual and monthly totals.

In February, the Pacific region led in PV electricity generation, and the Southwest region led in wind electricity generation

In February, the Pacific region led the nation in PV electricity generation with 4.7 TWh and is followed by the Southeast region with 4.3 TWh and the Southwest region with 3.7 TWh. California is the leading state with 4.4 TWh of PV electricity generation, which is 25% of total U.S. PV electricity generation. Texas follows with 2.6 TWh, Florida 1.6 TWh, North Carolina 0.9 TWh, Arizona 0.8 TWh, and Nevada 0.7 TWh.

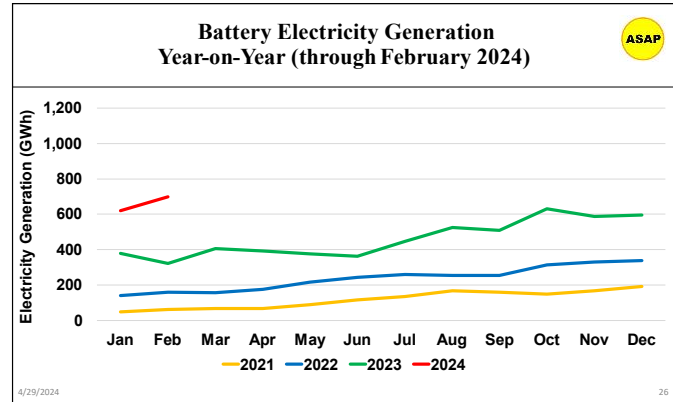
In February, the leading regions for wind electricity generation are the Southwest with 17.3 TWh and the Midwest with 16.9 TWh. These two regions combined produced 82% of total U.S. wind electricity in February. The Rocky Mountain and Pacific regions are distant third and fourth with 3.2 TWh and 2.9 TWh of wind electricity generation respectively. Texas is the leading state with 11.9 TWh of wind electricity generation and is followed by Iowa 4.1 TWh, Oklahoma 3.7 TWh, Kansas 2.7 TWh, and Minnesota 1.3 TWh.



U.S. Utility Battery Storage

In February, battery storage capacity additions are 176 MW

U.S. battery storage capacity additions total 0.2 GW in February, which increases cumulative battery storage capacity to 15.9 GW. Full year 2024 battery capacity additions are 1.9 GW, which is above the pace needed to reach the 8.0 GW annual forecast.



The reported February average monthly battery utilization factor is 6.3%, which is a daily average of 1.5 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.

U.S. cumulative battery storage capacity increases to 15.9 GW in February

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 February, the average battery utilization factor is 6.3%

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 an opportunity to expand 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, Malaysia, 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 217 GW of new PV in 2023.

U.S. PV Trade

In February, the value of U.S. PV panel imports is \$1.38 billion

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

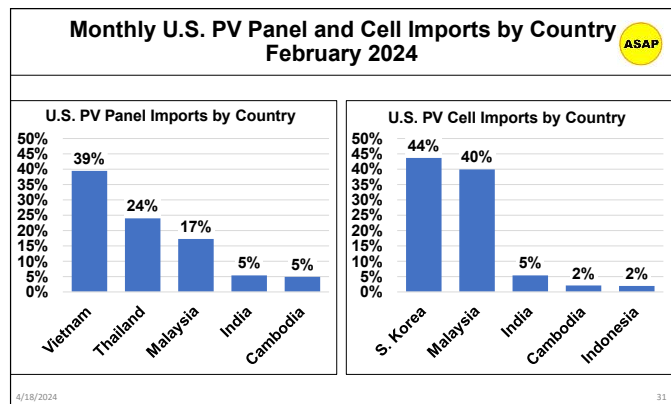
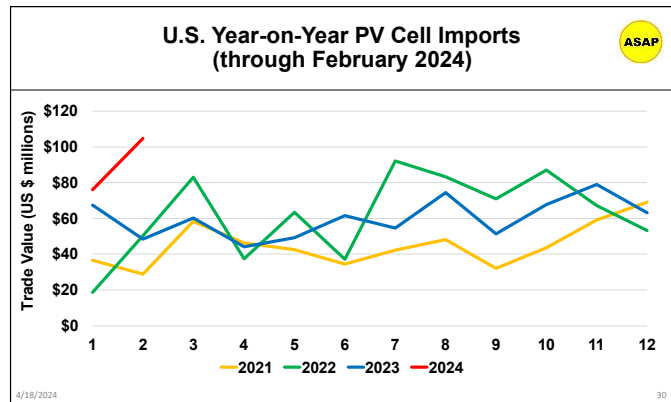
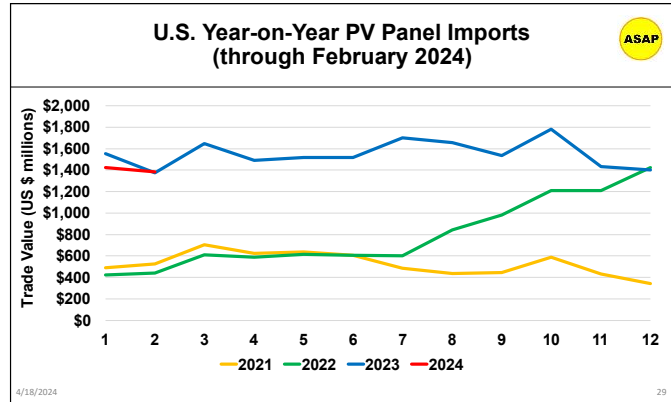
S. Korea, Malaysia and India are the top three sources of U.S. PV cell imports in February

In February, the value of U.S. PV panel imports declined 2.6% month-on-month to \$1.38 billion. The full year value of U.S. PV panel imports is \$2.81 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 lowering 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 countries for U.S. PV panel imports in February. These three countries account for 81% of total U.S. PV imports. Vietnam leads the market for U.S. PV panel imports in February with a 39% market share. Thailand follows with a 24% share of the U.S. PV panel import market, and Malaysia rounds out the top three with an 17% 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.

Turning attention to U.S. imports of PV cells, the total value of February U.S. PV cell imports increased 37.8% month-on-month to \$104.8 million. South Korea leads U.S. supply of imported PV cells in February with a 44% share. Malaysia and India round out the top three sources for U.S. PV cell imports with 40% and 5% market shares respectively. These three countries account for 89% of U.S. PV cell imports in February.

In terms of U.S. exports, the value of U.S. PV panel exports in February declined 73.6% month-on-month to \$1.0 million. Year-to-date, the total value of U.S. PV panel exports for 2024 is \$5.0 million. U.S. PV panel exports are on pace to reach the \$30.0 million forecast for 2024.



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

The value of February U.S. PV cell exports declined 61.9% month-on-month to \$5.6 million. Year-to-date year, the value of U.S. PV cell exports is \$20.2 million in 2024. The pace of U.S. PV cell exports in 2024 far exceeds the \$30.0 million annual forecast.

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.

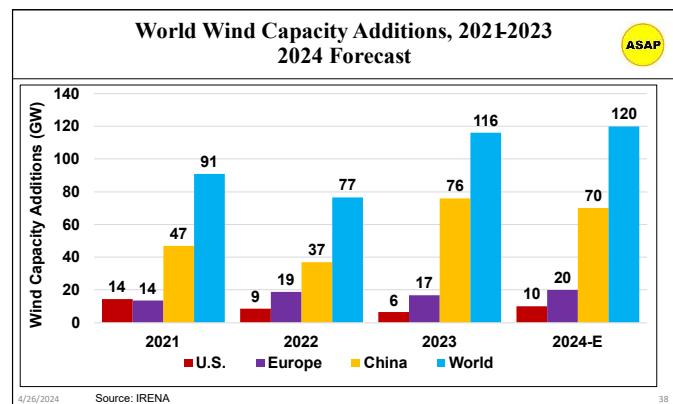
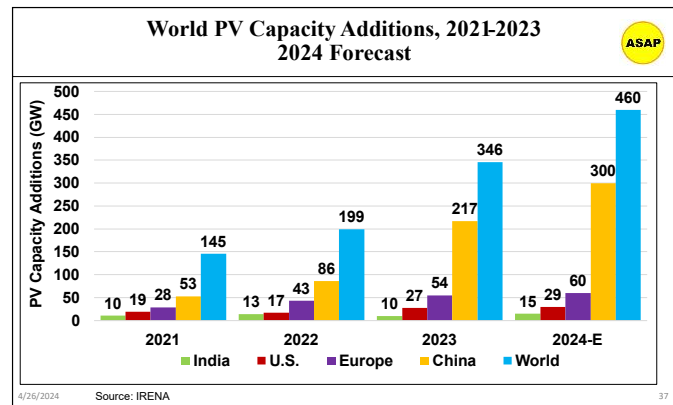
World PV and Wind

In 2023, world PV capacity additions were 346 GW, and world wind capacity additions were 116 GW.

In 2023, world PV capacity additions were 346 GW, which shattered the PV forecast of 240 GW. While the U.S. set a record of 27 GW of new PV, China steals the show with 217 GW of new PV. China delivered on their projected increase in PV manufacturing capacity to over 300 GW. Wind capacity additions were a record 116 GW. China accounted for 66% of new wind capacity with 76 GW of capacity additions. Cumulative world capacity of both PV and wind are above a terrawatt, 1.4 TW and 1.0 TW respectively.

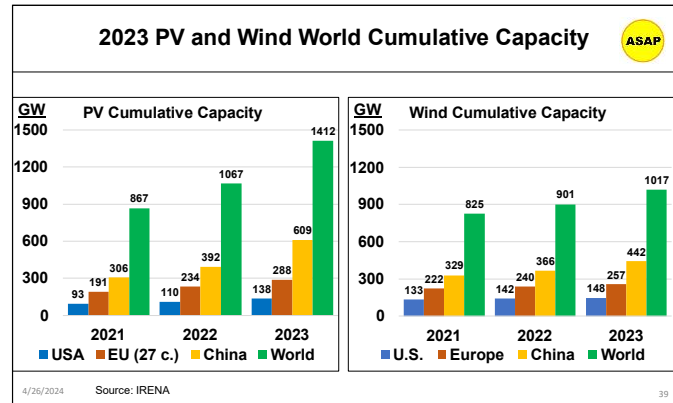
In 2023, China began applying PV and wind electricity for industrial scale electrolytic hydrogen production.

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 2023, PV cumulative installed capacity is 1.4 trillion watts (TW) of wind cumulative installed capacity is 1.0 TW. In 2023, two important global PV targets were realized. Annual PV capacity additions exceeded 300 gigawatts (GW), and China became the first country to install over 200 GW of new PV capacity. Importantly, China has begun the storage of PV and wind electricity in the form of electrolytic hydrogen production for refining, chemical and transportation end-uses.



While 346 GW of PV capacity additions in 2023 is significant, it is far short of 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.

PV capacity additions are: Europe installed 54 GW, the U.S. installed 27 GW, India installed 10 GW. Germany installed 14 GW, and Brazil installed 12 GW. China, U.S., Germany, Brazil and India are the only countries to install at least 10 GW of new PV capacity.



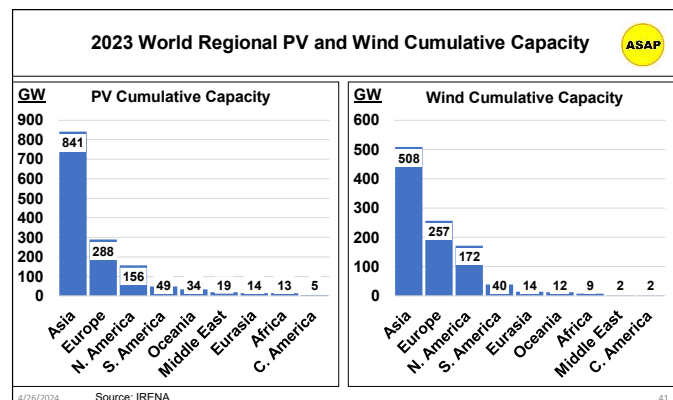
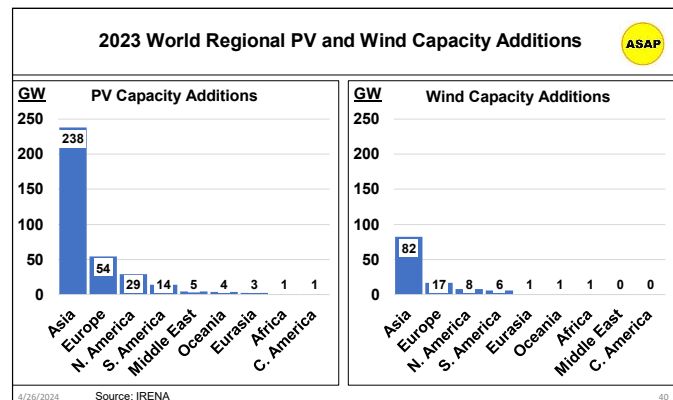
Wind capacity additions in 2023 were dominated by China with 76 GW, followed by Europe with 17 GW, and the U.S. with 6 GW. Brazil gained traction with 5 GW of wind capacity additions. Germany led the European nations with 3 GW of new wind capacity.

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 million tonnes of hydrogen for transportation and industrial end-uses.

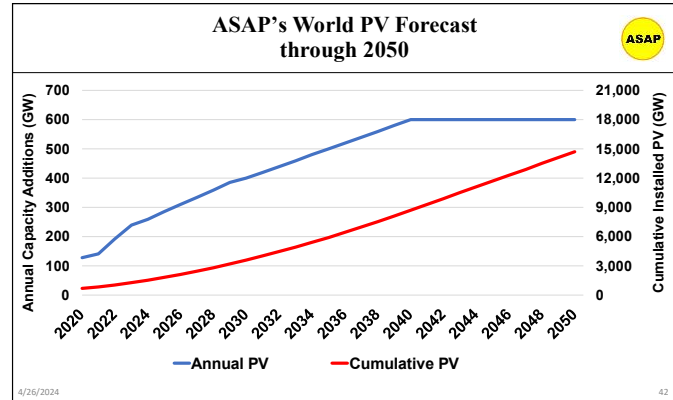
Annual global PV capacity additions need to reach 500-600 GW by 2030 to meet net zero energy emissions targets

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 and wind electricity for electrolytic hydrogen production from water for transportation and chemical applications at 415 million tonnes per annum in 2050.

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.

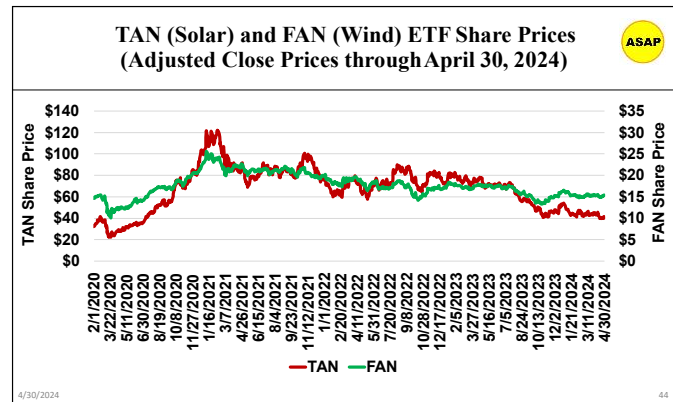


PV and Wind Industry Financial Performance

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 April, the share values of TAN and FAN both declined

For the month of April 2024, the TAN ETF share value declined 11.1%, and FAN declined 0.8%. Year-to-date, TAN is down 24.4%, and FAN is down 7.0%.



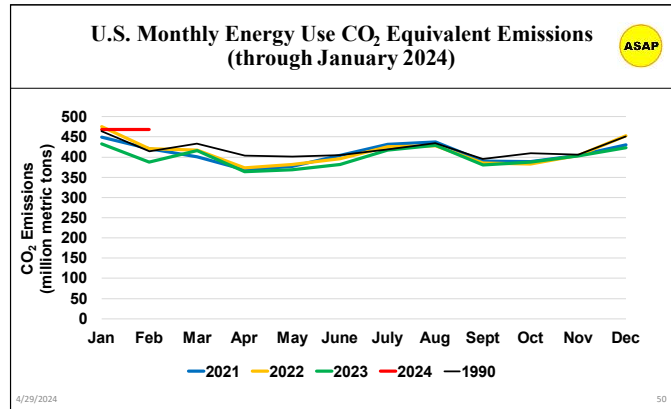
As shown in the graph, the share prices of the TAN and FAN ETFs have had disappointing performance over the past three years relative to 2021 highs. From the February 2021 highs through April 2024, the TAN share price is down 66.9%, and FAN share price is down 35.8%.

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

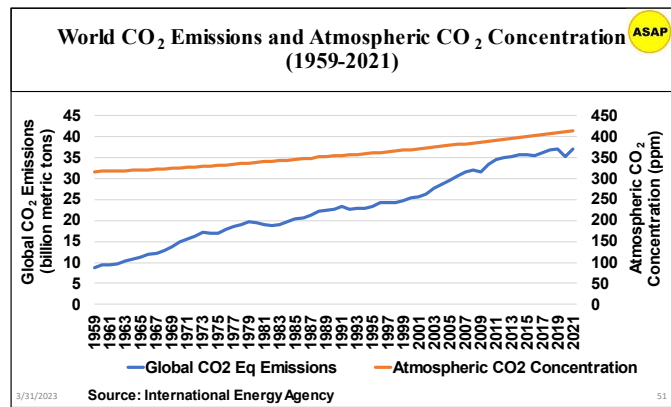
In 2023, U.S. CO₂ emissions fell 4.6% below the target 1990 level

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 CO₂ emissions are 4.6% less than the 1990 level. For the past twenty-five years the goal has been to reduce energy use CO₂ 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 CO₂ emissions.

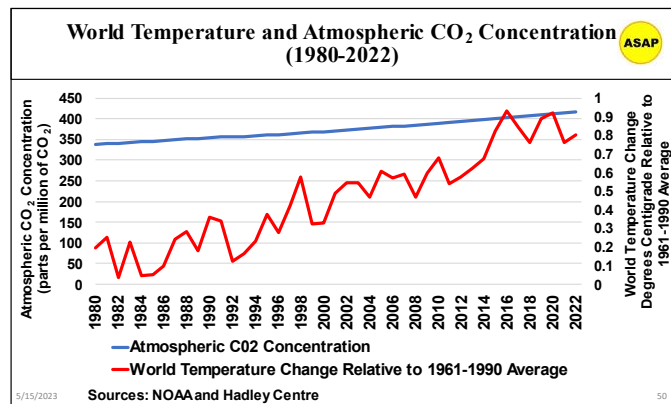


In 2021, world carbon dioxide emissions set a new record high of 37.1 Gt

World carbon dioxide (CO₂) 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 CO₂ emissions. The atmospheric concentration of CO₂ 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.