Guinness Sustainable Energy

Investment Commentary – May 2023

RISK

This is a marketing communication. Please refer to the prospectuses, KIDs and KIIDs for the Funds, which contain detailed information on their characteristics and objectives, before making any final investment decisions.

The Funds are equity funds. Investors should be willing and able to assume the risks of equity investing. The value of an investment and the income from it can fall as well as rise as a result of market and currency movement, and you may not get back the amount originally invested. Further details on the risk factors are included in the Funds' documentation, available on our website.

Past performance does not predict future returns.

ABOUT THE STRATEGY

Launch	19.12.2007
Index	MSCI World
Sector	IA Commodity/Natural Resources
Managers	Will Riley Jonathan Waghorn
Irish Domiciled	Guinness Sustainable Energy Fund
UK Domiciled	TB Guinness Sustainable Energy Fund

INVESTMENT POLICY

The Guinness Sustainable Energy Funds are managed for capital growth and invests in companies involved in the generation, storage, efficiency and consumption of sustainable energy sources (such as solar, wind, hydro, geothermal, biofuels and biomass). We believe that over the next twenty years the sustainable energy sector will benefit from the combined effects of strong demand growth, improving economics and both public and private support and that this will provide attractive equity investment opportunities. The Funds are actively managed and use the MSCI World Index as a comparator benchmark only.

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COMMENTARY

UPDATE ON THE POWER GRID

The power grid is the backbone of global decarbonisation, being key to facilitating both the electrification of energy demand and the transition to renewable power supply. But with interconnection queues growing, grid capacity is fast becoming a bottleneck and investment is needed in power infrastructure to modernize, digitize, and expand this scarce resource. In this month's manager's comments, we discuss power grids: where they fit in the electricity value chain, the present state of the grid, and current and future investment needs.

EQUITIES

Global stock markets were strong in April, with the MSCI World Net Return Index delivering +1.8% in USD. Over the month, the Guinness Sustainable Energy Fund (Class Y) delivered a return of -4.2% (in USD), underperforming the MSCI World by 6.0%. Year to date, the fund is up 5.4%, underperforming the MSCI World which is up 9.6%. Full performance details are available in Section 3.

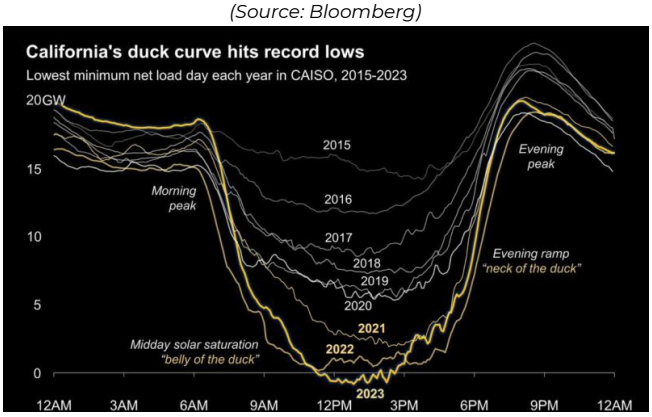
In the portfolio, the strongest performers included our electrification-biased installation companies, Hubbell and Schneider, following good Q1 results. Hubbell beat earnings estimates by 40% driven by better revenues and margins in its utility division. The weakest performer was Enphase Energy, which also beat Q1 earnings estimates, but announced that it expected to see a pause in Q2 solar orders before an inflection from Q3 onwards.

CHART OF THE MONTH

As renewables become a larger part of the grid, the amount of traditional energy demanded when the sun is shining grows ever smaller, placing strain on baseload capacity and highlighting the need for further investment in smart grid and storage solutions.

California's duck curve

(Source: Bloomberg)



APRIL NEWS AND EVENTS IN REVIEW

In this section, we review the key news items and their impact on our various portfolio sub-sectors over the last month.

News	Sub-Sector	Impact
The European Union agreed a deal to set binding targets for airlines in Europe to increase their use of sustainable aviation fuels in an attempt to start curbing the aviation sector's carbon footprint. Sustainable aviation fuels (SAF) have net-zero CO2 emissions but are produced in small quantities and are more expensive than conventional fuels. By mandating that 2% of fuel used in EU airports is SAF by 2025 (rising to 20% in 2035 and 70% in 2050) the EU is hoping to kickstart a market for green fuels and to begin curbing emissions in one of the hardest sectors to decarbonise.	Alternative fuel economics	
The US Environmental Production Agency (EPA) proposed an aggressive transport emissions reduction plan, requiring 13% annual pollution cuts and a 56% reduction in average fleet emissions vs current 2026 requirements. If adopted, automakers would need to produce 60% EVs by 2030 and 67% by 2032 in order to meet requirements. This compares with just 6% in 2022. The proposals also include targets for medium and heavy trucks, as well as for vocational vehicles such as buses and garbage trucks.	US EV penetration	
The Chilean government moved to take state control of key lithium projects in an attempt to accelerate development of the national resource. Various market commentators have concluded that the move is likely to have the opposite effect by deterring international investors and moving the country's geopolitical risk premium more in line with places such as Bolivia and Mexico. The combined market cap of the country's two lithium incumbents declined $8.5bn following the announcement.	Battery economics	
The German government approved a bill banning new oil and gas heating systems from 2024 onwards. Heating accounts for a third of German energy consumption, 80% of which comes from fossil fuels. The new policy aims to move towards new installations being at least 65% based on renewable energy, with substantial subsidies attached to help people make the transition.	Heat pump demand	
The US Department of Energy (DOE) announced a $3bn loan guarantee to speed the installation of residential solar panels in disadvantaged communities. Historically the solar loan/leasing market has focussed on higher FICO score customers to limit default risk, however, this new move provides explicit government backing for the extension of such loans to customers with FICO scores of 680 or less, increasing the addressable market for residential solar players.	US residential solar penetration	

MANAGER'S COMMENTS

An update on global power grids

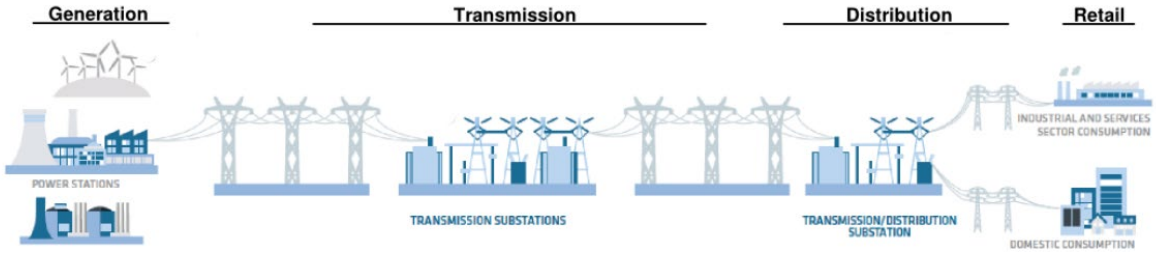
The power grid is the backbone of global decarbonisation, being key to facilitating both the electrification of energy demand and the transition to renewable power supply. But with interconnection queues growing, grid capacity is fast becoming a bottleneck and more investment is needed in power infrastructure to modernize, digitize, and expand this scarce resource. In this month's manager's comments, we discuss power grids: where they fit in the electricity value chain, the present state of the grid, and current and future investment needs.

Power grids in the electricity value chain

The power industry is normally divided into generation, transmission, distribution, and retail / end customer supply. Generation companies convert fuel (coal, gas, uranium) or renewable resources (wind, solar, hydro) into electricity. High-voltage transmission lines are used to send electricity efficiently over long distances, delivering energy from power plants to local distribution hubs. Substations are used to convert high-voltage power into medium and low voltages, before electricity distribution infrastructure transports these electrons to commercial and retail end customers.

The electricity value chain

Source: Morgan Stanley



The operators of electricity transmission and distribution (T&D) networks charge generators for access to their power infrastructure, a fee which may be reflected in customer bills as a fixed daily connection charge (as happens in the UK) or built into the unit electricity tariff (as happens in the US). Typically, these companies operate monopolies so are highly regulated. Grid operators are responsible for forecasting future power demand, submitting costed expansion plans to regulators to ensure sufficient future supply and executing project investments over the course of 3-5 year regulatory windows. This investment typically falls into one of three buckets: "in-front of meter" (e.g. T&D cables, transformers, switchgear), "behind the meter" (e.g. onsite generation, storage, microgrids), and "grid edge" (e.g. advanced metering infrastructure, data analytics).

Present state of the global power grid

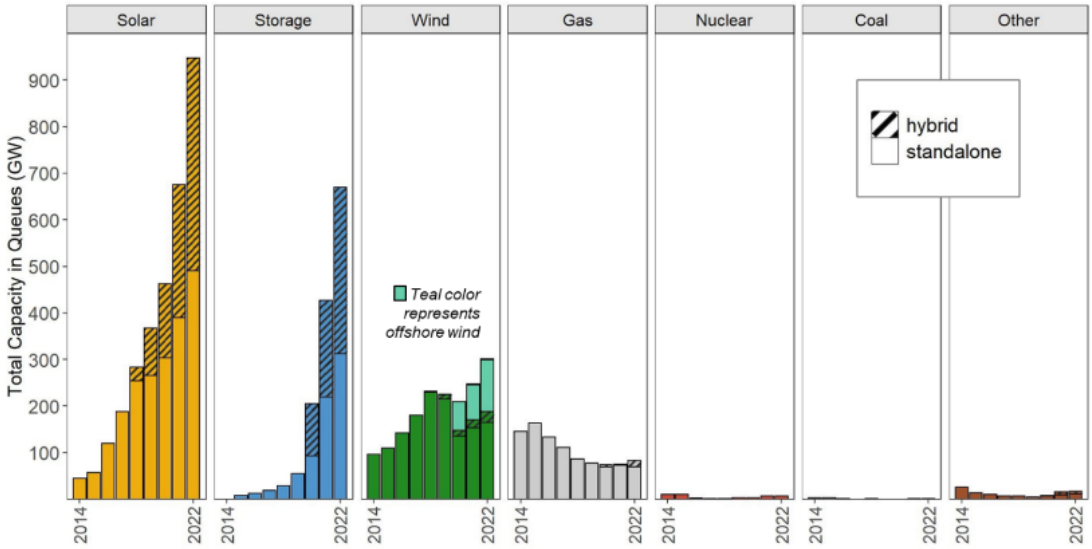
The global power grid consists of over 2.6 million miles of transmission lines, over 43 million miles of distribution lines and over 700,000 substations. A significant proportion of this infrastructure in the US and Europe is ageing, analogue (rather than digital) and increasingly capacity constrained.

- **Ageing** Much of Europe and the US's power infrastructure is reaching the end of its 40-50 year useful life and needs to be replaced and modernized. In the UK, more than 50% of the T&D networks are more than 50 years old. In 2015, a US Department of Energy report found that the average age of large power transformers, which handle 90% of US electricity flow, was more than 40 years. According to global insurer Swiss Re, this is the age at which transformer malfunctions tend to escalate.
- **Analogue** In the past, electricity grids facilitated the one-way flow of electricity from large, centralized generation plants to end consumers. Historically, the focus was purely on physical connections. In recent years, with mass adoption of the internet, focus has shifted to both physical and digital connections as the grid moves towards a bi-directional smart grid. Despite this, IEA data suggests spending on digital grids captured just 19% of grid investment in 2022.

- **Capacity constrained** Before connecting a new energy project, grid operators require a series of impact assessments to establish what electrical infrastructure upgrades may be needed. The list of projects in this process are known as "interconnection queues". In the US, renewables currently represent 95% of projects in these queues and have grown over 40% in the last year. Overcoming these queues is a structural challenge since it takes around four years for the full development of a renewable energy project yet it takes 8–10 years to develop new transmission lines.

US capacity in interconnection queues at the end of 2022

Source: Lawrence Berkley National Lab

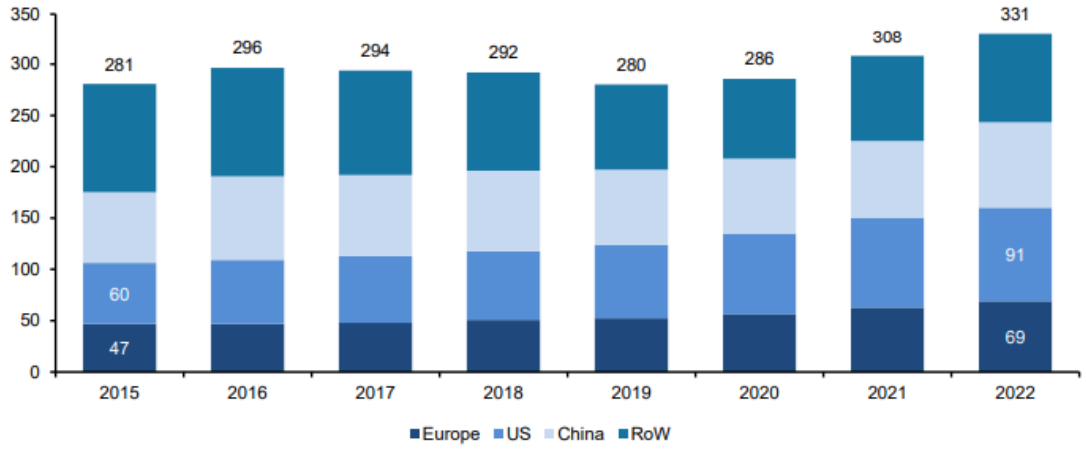


Current and future investment requirements

According to the IEA, global grid investment averaged c.$300bn from 2018-22 and has been growing slowly (2%pa) over the past eight years. Growth has predominantly been driven by Europe and the US (c.6%pa) due to decarbonisation and replacement spending. Distribution (low and medium-voltage) accounted for roughly two-thirds of the spend with transmission (high-voltage) making up the rest.

Annual transmission and distribution investments ($bn)

Source: Bernstein, IEA



Our base case assumes that annual grid investment grows by around 4%pa, rising from $300bn in 2022 to over $800bn pa in the 2040s. Although not our base case, the IEA net zero scenario requires investment to nearly double from the current

$300bn to around $580bn pa for the remainder of this decade and to more than double again to around $1.4tn per annum in the 2040s. In our base case scenario, two-thirds of investment will be spent on distribution and one-third on transmission, with a rising share of this being digital. Around 40% will be spent on replacing ageing assets, 40% reinforcing the network to improve reliability and efficiency and 20% extending the existing grid to new generation facilities.

- Greater residential adoption of heat pumps and electric vehicles leads us to expect that **distribution** will attract a higher proportion of the investment than transmission. Heat pumps and EVs increase residential electricity demand by c.90% and c.50% respectively. Moreover, the addition of EVs requires modernisation/digitisation of the distribution grid in order to facilitate bidirectional charging and allow EV batteries to help balance the grid. Bernstein estimate that, to ensure grid reliability, US utilities will need to spend nearly $1,600 on transmission & distribution infrastructure for each electric vehicle on the road.
- The continued adoption of renewables, characterised by smaller and more distributed power plants, will drive demand for more **transmission** lines. We see transmission investment enjoying a further tailwind from the building of more interconnectors to facilitate the international trade of electricity. We think these will be vital for ensuring energy security but will also allow regional renewable energy surpluses and deficits to be equalised.
- We see investments in **digitalisation** of the grid increasing from c.19% in 2020 to 42% in 2050. Integrating the physical grid into computer-based systems through the use of smart meters and sensors, communication networks and data analytics can help identify outages faster, automate grid performance, and improve uptime and efficiency. For network operators, data insights allow them to reduce maintenance costs through predictive maintenance. For consumers, smart meters can help reduce energy bills by enabling smart charging of electric vehicles at off-peak tariffs.

To conclude, the Guinness Sustainable Energy Fund is well positioned to benefit from these trends associated with upgrading global power grids in the coming decades. The fund has exposure to companies that own and operate electricity networks (Iberdrola, NextEra Energy), produce low and medium voltage equipment (Legrand, Eaton, Schneider) and manufacture smart meters (Hubbell, Itron).

PERFORMANCE (to 28.04.2023)

Past performance does not predict future returns.

The Guinness Sustainable Energy Fund (Class Y, 0.67% OCF) delivered a return of -4.2% in the month, while the MSCI World Index (net return) delivered +1.8% (all in USD terms).

	Ytd	1 Yr	3 Yrs	5 Yrs*	10 Yrs*
Fund (Class Y)	5.4%	11.5%	112.9%	96.9%	132.6%
MSCI World NR Index	9.6%	3.2%	44.7%	47.9%	130.4%
Out/Underperformance	*-4.2%*	*8.4%*	*68.2%*	*49.1%*	*2.2%*

Annual performance	2022	2021	2020	2019	2018*
Fund (Class Y)	-12.5%	10.4%	84.1%	31.4%	-15.2%
MSCI World NR Index	-18.1%	21.8%	15.9%	27.7%	-8.7%
Out/Underperformance	*5.6%*	*-11.4%*	*68.2%*	*3.7%*	*-6.5%*

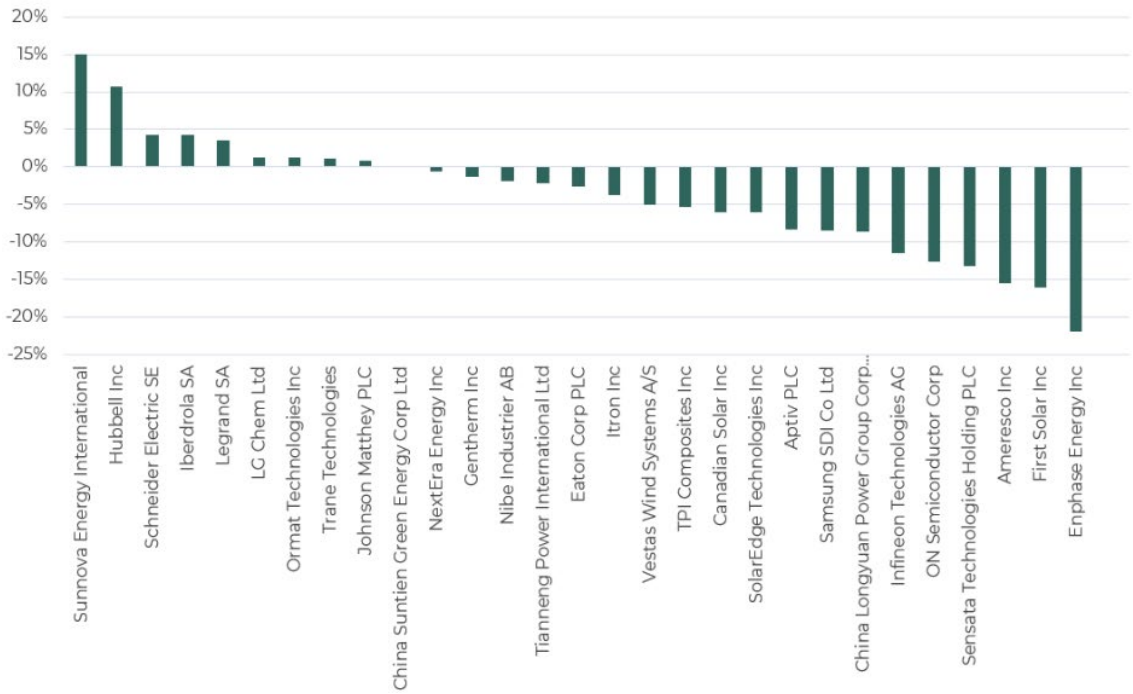
Annual performance	2017*	2016*	2015*	2014*	2013*
Fund (Class Y)	20.2%	-15.4%	-12.0%	-12.1%	70.8%
MSCI World NR Index	22.4%	7.5%	-0.9%	4.9%	26.7%
Out/Underperformance	*-2.2%*	*-23.0%*	*-11.2%*	*-17.0%*	*44.1%*

*The Guinness Sustainable Energy Fund was launched on 19/12/2007. *Simulated Past Performance prior to the launch of the Y class on 16/02/2018. The Performance shown is a composite simulation for Y class performance being based on the actual performance of the Fund's E class, which has an OCF of 1.24%. Source: Financial Express, bid to bid, total return. On 31 Dec 2018, the index for the Guinness Sustainable Energy fund became the MSCI World NR. Prior to this, the benchmark was the Wilderhill Clean Energy Index (ECO Index)*

Investors should note that fees and expenses are charged to the capital of the fund. This reduces the return on your investment by an amount equivalent to the Ongoing Charges Figure (OCF). The fund performance shown has been reduced by the current OCF of 0.67% per annum. Returns for share classes with different OCFs will vary accordingly. Transaction costs also apply and are incurred when a fund buys or sells holdings. Performance returns do not reflect any initial charge; any such charge will also reduce the return.

Within the Fund, the strongest performers were Hubbell, Schneider, Iberdrola, Legrand and LG Chem. The weakest performers were Enphase, First Solar, Amereco, Sensata and ON Semi.

Stock by stock performance over the month, in USD

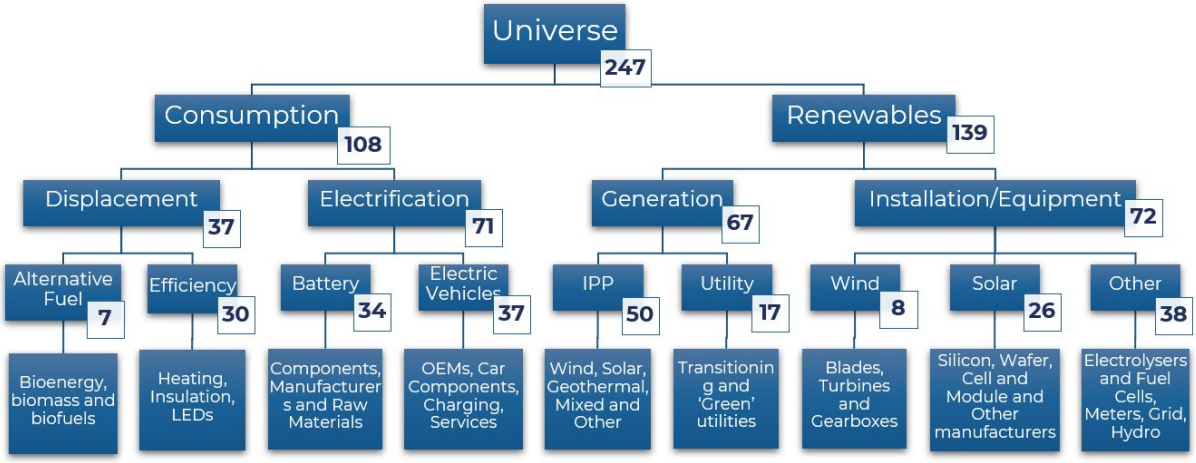


Source: Bloomberg. As of 28 April 2023

PORTFOLIO

The Guinness Sustainable Energy Fund is positioned to benefit from many of the long-term themes associated with the transition towards a lower-carbon economy and of sustainable energy generation via investment in companies with activities that are economic with limited or zero government subsidy and which are profitable. Our investment universe comprises around 250 companies which are classified into four key areas:

- **Generation** includes companies involved in the generation of sustainable energy, either pureplay companies or those transitioning from hydrocarbon-based fuels
- **Installation** includes companies involved in the manufacturing of equipment for the generation and consumption of sustainable energy
- **Displacement** includes companies involved in the displacement or improved efficient usage of existing hydrocarbon-based energy
- **Electrification** includes companies involved specifically in the switching of hydrocarbon-based fuel demand towards electricity, especially for electric vehicles



We monitor each of the industry areas very closely and hope that detailed top-down (macro) analysis of each (complemented with disciplined equity screening and stock valuation work) will allow us to deliver attractive fund performance via an equally weighted portfolio of 30 stocks. The portfolio is designed to create a balance between maintaining fund concentration and managing stock-specific risk.

Guinness Global Investors is a signatory of the United Nations Principles for Responsible Investment. The Guinness Sustainable Energy Fund prioritises returns whilst delivering concentrated exposure to companies playing a key role in global decarbonisation. The Fund's holdings align most closely with four of the UN's sustainable development goals:

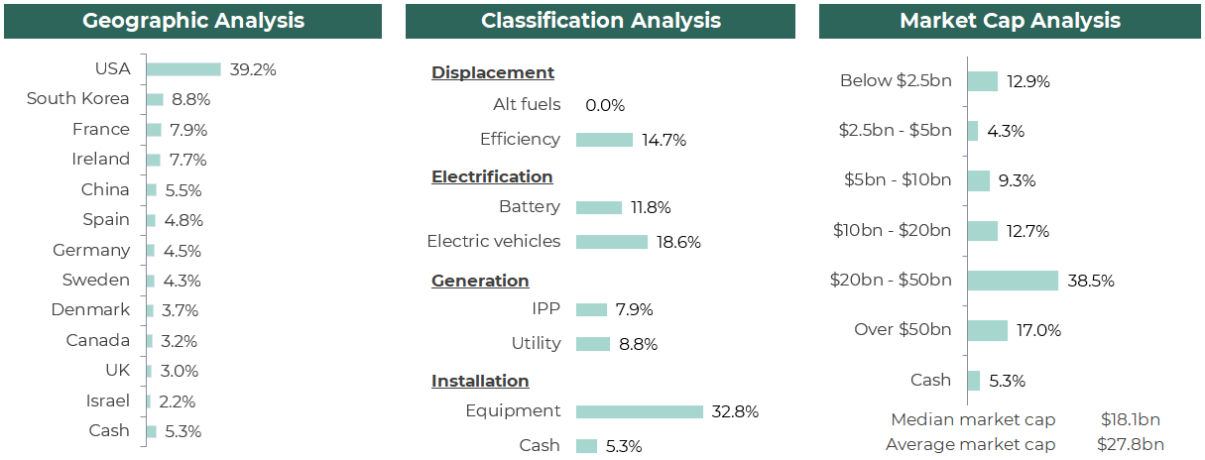
Signatory of:

PRI Principles for Responsible Investment

Buys/Sells

There were no stock switches during the month, but the portfolio was actively rebalanced.

Portfolio structure analysis



Source: Guinness Global Investors

Portfolio sector breakdown

The following table shows the asset allocation of the Fund at month end and at previous year ends.

Asset allocation as %NAV	Current	*Change*	Year end	Previous year ends			
	Apr-23		Dec-22	Dec-21	Dec-20	Dec-19	Dec-18
Consumption	**45.1%**	***0.3%***	**44.9%**	**43.4%**	**36.7%**	**41.7%**	**26.5%**
Displacement	14.7%	*-0.3%*	15.0%	11.8%	9.9%	13.4%	16.4%
Alternative Fuel	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*3.9%*
Efficiency	*14.7%*	*-0.3%*	*15.0%*	*11.8%*	*9.9%*	*13.4%*	*12.5%*
Electrification	30.4%	*0.5%*	29.9%	31.6%	26.8%	28.2%	10.1%
Batteries	*11.8%*	*0.2%*	*11.6%*	*8.9%*	*10.8%*	*12.6%*	*3.9%*
Electric vehicles	*18.6%*	*0.3%*	*18.2%*	*22.8%*	*16.0%*	*15.7%*	*6.2%*
Renewables	**49.5%**	***0.2%***	**49.3%**	**51.3%**	**60.4%**	**54.1%**	**69.7%**
Generation	16.7%	*-1.0%*	17.7%	23.1%	24.6%	22.2%	27.3%
IPP	*7.9%*	*-0.7%*	*8.7%*	*14.5%*	*17.0%*	*18.9%*	*26.7%*
Utility	*8.8%*	*-0.3%*	*9.0%*	*8.6%*	*7.6%*	*3.2%*	*0.6%*
Installation	32.8%	*1.2%*	31.6%	28.2%	35.8%	32.0%	42.5%
Equipment	*32.8%*	*1.2%*	*31.6%*	*28.2%*	*35.8%*	*32.0%*	*42.5%*
Cash	5.3%	*-0.5%*	5.8%	5.3%	3.0%	4.2%	3.8%

Source: Guinness Global Investors

Valuation

At the month end, the Guinness Sustainable Energy portfolio traded on the following multiples:

As at 30 April 2023	P/E			EV/EBITDA			Dividend Yield		EPS Growth (%pa)		CFROI*	
	2022	2023E	2024E	2022	2023E	2024E	2023E	2024E	2014-21	2022-25	2022	2023E
Guinness Sustainable Energy Fund	23.9x	20.0x	16.4x	14.7x	12.2x	10.1x	1.2%	1.4%	6.7%	21.5%	5.7%	7.6%
MSCI World Index	15.9x	16.9x	15.6x	10.4x	11.3x	10.3x	2.2%	2.4%	5.4%	6.0%	8.3%	8.1%
Fund Premium/(Discount)	*50%*	*18%*	*5%*	*41%*	*8%*	*-2%*						

*Portfolio = median CFROI; Index data = Credit Suisse MSCI World ETF median CFROI

Source: Guinness Global Investors, Bloomberg

Portfolio holdings as at end April 2023

Our portfolio is typically allocated across 30 equally weighted equities providing exposure across the value chain of sustainable energy.

We hold c.45% weight to companies associated with the consumption (or demand) of sustainable energy. Our largest exposure here is to companies involved in the electrification of demand, either via the creation of new batteries (12%) or the electrification of transportation (19% weight) while we have 15% weight to those companies involved in either displacing existing energy sources or improving overall energy efficiency.

We hold two lithium-ion battery manufacturers. LG Chem is a large Korean chemicals company that is a top 3 lithium-ion battery manufacturer in the world, while Samsung SDI is a pure play lithium-ion battery manufacturer, currently in the top 10 in the world.

The portfolio holds five names in the electric vehicle sub-category, giving it exposure to companies that provide semiconductors, electronics, components and software/services to the growing EV and autonomous vehicle industry. Onsemi and Infineon are providers of power semiconductors that are a necessity for higher-voltage electric vehicles to become competitive with ICE (internal combustion engine) vehicles, while Gentherm, Aptiv and Sensata are component manufacturers and service providers that should benefit from the ever-increasing amount of electronics present in electric vehicles.

Our displacement holdings provide pure-play quality exposure to heating industries (Nibe Industrier, Trane Technologies), energy efficient electrical equipment and services (Hubbell) and energy efficiency projects (Ameresco), and the group as whole will benefit from the increasing industry focus on energy efficiency that is expected to be a very long-term trend.

In terms of the supply of sustainable energy, we hold a 17% weight to companies involved in the generation of sustainable energy and 33% weight to those exposed to the installation of or equipment used in the process of sustainable energy generation.

China Suntien and China Longyuan are our two pure play Chinese wind power producers and they represent around a third of our generation exposure. The remaining exposure comes in the form of geothermal (Ormat), US residential solar (Sunnova) and then broad-based wind/solar renewable energy generation through NextEra Energy (the largest producer of renewable energy in the world). Iberdrola is our one utility.

We hold exposure to the solar and wind equipment and manufacturing value chains. Xinyi Solar is the world's largest supplier of the glass used in solar cell modules and both EnPhase and SolarEdge manufacture the inverters required to convert DC solar power into consumable AC electricity. Canadian Solar and First Solar give integrated exposure to the solar cell and module manufacturing process. Vestas is a well placed provider of wind turbines in the world providing broad exposure to the strong growth that we expect in the onshore and offshore wind markets, while TPI Composites offers niche exposure to the high-skilled business of manufacturing wind turbine blades.

Our remaining exposure to Installation (Itron, Eaton, Legrand and Schneider Electric) gives exposure to companies that provide equipment and services to improve the efficiency and metering of electricity transmission and consumption.

Portfolio themes as at end April 2023

	Theme	Example holdings	Weighting (%)
1	Electrification of the energy mix	sunnova, NextEra Energy	23.6%
2	Rise of the electric vehicle and auto efficiency	Sensata Technologies, APTIV	21.5%
3	Battery manufacturing	Samsung SDI	8.9%
4	Expansion of the wind industry	Vestas	7.4%
5	Expansion of the solar industry	CanadianSolar	15.2%
6	Heating, lighting and power efficiency	NIBE Industrier, Trane Technologies	14.7%
7	Geothermal	Ormat	3.4%
8	Other (inc cash)		5.3%

Portfolio at end March 2023 (one month in arrears for compliance reasons)

Guinness Sustianable Energy Fund (31 March 2023)			P/E				EV/EBITDA			Price/Book			Dividend Yield		
Stock	**ISIN**	**% of NAV**	**2022**	**2023E**	**2024E**	**2025E**	**2022**	**2023E**	**2024E**	**2022**	**2023E**	**2024E**	**2022**	**2023E**	**2024E**
Displacement/Efficiency															
Hubbell Inc	US4435106079	3.8%	23.4x	21.4x	20.0x	18.5x	16.3x	14.8x	13.8x	5.5x	5.0x	4.6x	1.8%	1.9%	2.1%
Nibe Industrier AB	SE0015988019	4.2%	58.4x	45.7x	40.4x	35.2x	34.6x	27.7x	24.8x	9.2x	7.5x	6.6x	0.5%	0.6%	0.7%
Trane Technologies PLC	IE00BK9ZQ967	3.8%	25.6x	21.9x	20.2x	18.5x	17.0x	15.2x	14.5x	7.4x	6.5x	5.9x	1.4%	1.5%	1.6%
Ameresco Inc	US02361E1082	2.4%	26.3x	27.2x	20.5x	14.6x	16.7x	16.3x	12.9x	3.1x	2.7x	2.4x	n/a	n/a	n/a
		14.1%													
Electrification/Battery															
LG Chem Ltd	KR7051910008	4.3%	21.2x	23.3x	15.0x	11.1x	9.4x	8.6x	6.5x	1.6x	1.6x	1.5x	1.5%	1.5%	1.7%
Samsung SDI Co Ltd	KR7006400006	4.4%	25.5x	24.4x	20.0x	16.1x	15.2x	13.8x	11.3x	2.9x	2.7x	2.4x	0.2%	0.1%	0.2%
Johnson Matthey PLC	GB00BZ4BQC70	2.8%	9.4x	10.6x	10.0x	9.3x	5.9x	6.7x	6.4x	1.4x	1.4x	1.4x	3.9%	4.0%	4.1%
Tianneng Power International Ltd	KYG8655K1094	0.1%	5.0x	4.2x	3.4x	n/a	3.5x	2.7x	2.2x	0.7x	0.6x	0.5x	5.3%	5.6%	6.4%
		11.7%													
Electrification/Electric Vehicles															
Aptiv PLC	JE00B783TY65	3.9%	33.5x	25.7x	18.1x	14.3x	15.6x	12.8x	10.4x	3.7x	3.2x	2.8x	0.0%	0.2%	0.3%
ON Semiconductor Corp	US6821891057	4.4%	15.6x	18.6x	16.0x	13.8x	10.7x	12.0x	10.4x	5.8x	4.6x	3.8x	n/a	n/a	n/a
Infineon Technologies AG	DE0006231004	4.8%	21.0x	16.0x	15.4x	13.7x	12.0x	9.0x	8.5x	3.8x	2.9x	2.6x	0.8%	1.1%	1.1%
Sensata Technologies Holding PLC	GB00BFMBMT84	4.1%	15.1x	13.3x	11.9x	10.5x	11.5x	10.9x	9.7x	2.5x	2.2x	2.0x	0.7%	0.9%	0.9%
Gentherm Inc	US37253A1034	2.6%	30.4x	23.5x	16.6x	11.0x	15.8x	11.2x	8.7x	n/a	n/a	n/a	n/a	n/a	n/a
		19.8%													
Generation/IPP															
China Longyuan Power Group Corp Ltd	CNE100000HD4	1.9%	11.0x	8.0x	6.8x	5.9x	10.7x	8.7x	7.5x	1.0x	0.9x	0.8x	1.8%	2.4%	2.8%
Ormat Technologies Inc	US6866881021	3.2%	62.8x	45.5x	33.2x	29.6x	15.6x	13.9x	12.2x	2.5x	2.3x	2.2x	0.6%	0.6%	0.6%
NextEra Energy Inc	US65339F1012	3.8%	26.7x	24.8x	22.7x	21.0x	20.5x	16.7x	15.1x	3.4x	3.2x	3.1x	2.2%	2.4%	2.7%
Sunnova Energy International I	US86745K1043	1.1%	n/a	n/a	n/a	n/a	72.0x	40.3x	27.0x	1.1x	0.9x	0.8x	n/a	n/a	n/a
China Suntien Green Energy Corp Ltd	CNE100000TW9	1.3%	5.6x	5.3x	4.6x	4.0x	8.5x	8.3x	6.9x	0.6x	0.6x	0.5x	6.2%	6.6%	7.6%
		11.4%													
Generation/Utility															
Iberdrola SA	ES0144580Y14	4.4%	17.9x	16.0x	14.9x	13.7x	11.4x	10.1x	9.3x	1.8x	1.6x	1.5x	4.0%	4.4%	4.7%
		4.4%													
Installation/Equipment															
Schneider Electric SE	FR0000121972	3.9%	21.7x	19.7x	18.0x	16.8x	14.5x	13.1x	12.2x	3.4x	3.2x	2.9x	1.9%	2.3%	2.4%
Legrand SA	FR0010307819	3.3%	20.4x	19.4x	18.3x	17.1x	13.1x	12.3x	11.7x	3.5x	3.2x	2.9x	2.1%	2.3%	2.5%
Eaton Corp PLC	IE00B8KQN827	3.9%	22.7x	20.7x	18.8x	17.2x	18.1x	16.2x	14.9x	4.1x	3.8x	3.6x	1.9%	2.0%	2.1%
Itron Inc	US4657411066	3.0%	110.0x	60.5x	25.2x	11.8x	35.4x	27.6x	14.7x	2.2x	2.1x	2.0x	n/a	n/a	n/a
Xinyi Solar Holdings Ltd	KYG9829N1025	2.4%	18.4x	16.6x	12.5x	10.3x	13.4x	11.3x	8.5x	2.5x	2.5x	2.2x	2.5%	2.8%	3.8%
SolarEdge Technologies Inc	US83417M1045	2.2%	64.1x	34.2x	25.9x	20.5x	37.9x	21.9x	17.2x	8.2x	6.6x	5.3x	n/a	n/a	n/a
Enphase Energy Inc	US29355A1079	2.3%	48.0x	38.4x	28.7x	22.4x	39.2x	29.2x	21.5x	52.4x	18.9x	11.4x	n/a	n/a	n/a
First Solar Inc	US3364331070	4.9%	n/a	31.3x	18.1x	10.9x	123.4x	21.5x	12.8x	4.0x	3.5x	3.0x	n/a	n/a	n/a
Canadian Solar Inc	CA1366351098	3.3%	12.9x	8.2x	6.5x	7.3x	7.9x	5.1x	4.0x	1.1x	0.9x	0.7x	n/a	n/a	n/a
Vestas Wind Systems A/S	DK0061539921	3.7%	n/a	453.7x	35.6x	21.5x	n/a	26.0x	13.0x	7.9x	8.5x	7.0x	0.1%	0.1%	0.8%
TPI Composites Inc	US87266J1043	0.5%	n/a	n/a	94.6x	15.6x	13.0x	12.3x	5.7x	6.2x	3.1x	3.5x	n/a	n/a	n/a
		33.5%													
Cash	Cash	**5.2%**													
Portfolio		**100.0%**	**25.0x**	**21.3x**	**17.2x**	**14.4x**	**15.3x**	**12.7x**	**10.5x**	**2.9x**	**2.6x**	**2.4x**	**1.1%**	**1.2%**	**1.3%**

The Fund's portfolio may change significantly over a short period of time; no recommendation is made for the purchase or sale of any particular stock.

OUTLOOK - sustainable energy & the energy transition

Sustainable energy: the long-term outlook

Over the next thirty years, the world will continue its transition to a sustainable energy system. The key factors driving the transition are:

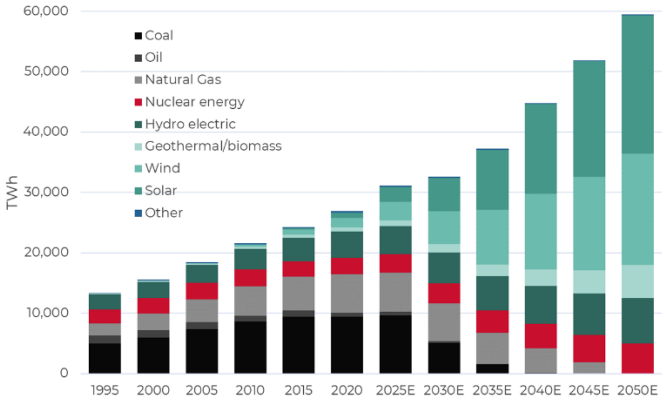
- **Population and GDP growth** putting a significant strain on today's energy supply
- **Economics** as sustainable sources of energy will be cheaper than the incumbents
- **Climate change** leading the world to reduce carbon emissions via cleaner energy
- **Pollution** forcing governments to drive air pollution out of cities via cleaner energy
- **Energy security** as sustainable energy sources, which are more evenly spread across all countries, facilitate lower reliance on energy imports.

The outcomes of the energy transition will of course be wide-ranging. On the **supply** side, we see a sustained shift towards renewable power generation, fulfilling global power generation needs which are set to double by 2050. On the **demand** side, we believe that improved energy efficiency will be key to limiting energy consumption growth to a manageable level so that it can be increasingly satisfied by renewable sources.

The long-term direction is clear and is driven by economics, in our opinion, while near term geopolitical issues (such as the invasion of Ukraine in February 2022) could potentially have an effect on the speed of the transition and the relative importance of the factors stated above.

Within the power generation industry, we expect a radical change in energy mix. Today, the global power mix is predominantly driven by coal and natural gas (35% and 24% respectively), whilst variable renewable generation (wind and solar) have less than a 10% share. By 2035, we expect wind and solar to have grown to around 40% of the generation mix, increasing to over 60% by 2050.

Global power generation by type (TWh, 1995-2040E)



Sources: BP Statistical Review; IEA: Guinness Global Investors estimates; as of 31.12.2022

Policy support for decarbonisation

Policy commitment in recent years has been particularly supportive. However, the path has not always been smooth and it is unlikely to be a smooth ride from here. The most significant policy milestones in the recent period include:

- **President Biden returning the US to the Paris Agreement** and announcing significantly increased 2030 GHG reduction targets. The new target - a 52% reduction in emissions by 2030 (vs 2005 levels) - was substantially

ahead of the old target of a 28% reduction by 2025.

- **The 2021 IPCC climate report.** The Intergovernmental Panel on Climate Change (IPCC) published its sixth assessment report on the physical science of climate change and the physical impacts of various carbon emission and warming scenarios

- **COP26 climate conference.** In November 2021, the COP26 climate conference was held in Glasgow. The conference produced results which we considered to be better than feared, but not as good as hoped. Key headlines included new net zero targets, additional country pledges and some 'alliances of the willing' to reduce coal usage and methane emissions.

- **Carbon pricing.** Developments in carbon pricing remain hopeful with momentum towards the introduction of emissions trading schemes (ETS) as a tool for decarbonisation. At the start of 2021, China commenced a new national ETS scheme which immediately became the world's largest carbon market (covering around 2,225 entities in the power generation industry with annual emissions of around 4,000 MtCO2e) while Canada introduced a federal carbon tax that will increase by 2030 to around US$130/tonne.

- **The RePowerEU deal**. In response to the invasion of Ukraine, the REPowerEU deal was passed. It is designed to increase the resilience of the EU energy system in the short term to deal with the loss of Russian gas imports and it provides a greater emphasis on energy efficiency and increasing domestic renewable energy capacity. It builds on the EU's 'Fit for 55' proposals .which are designed to deliver a 55% reduction in GHG emissions by 2030 (vs 1990)

- **The US Inflation Reduction Act**. In response to the invasion of the Ukraine and increased need for energy security, the Inflation Reduction Act was passed. It brings a potential $369bn in support for energy security and climate change, specifically targeting financial support for clean sources of electricity and energy storage as well as tax credits for clean fuels and clean commercial vehicles.

While policy towards stimulus plans continues to be positive, the passage of actual investment into the energy transition has been slower than expected and still remains a positive catalyst from here. Both the REPowerEU deal and the Inflation Reduction Act are unlikely to yield new investments until 2023/2024 and well into the second half of this decade.

Energy displacement

It is a common misconception that achieving rapid growth in renewable power generation will be enough to deliver government targets for pollution, energy security and de-carbonisation. Renewable power generation is a key part of the solution, but we see the displacement and more efficient use of existing energy sources as just as critical, and arguably more urgent, in achieving these goals. The IEA refers to the theme of energy efficiency as being the 'first fuel' that should be considered in delivering the energy transition. It is the one energy source that every country can access in abundance today.

In our base case, we assume global energy demand growth over the next thirty years of around 1%pa. This assumes significant efficiency improvements relative to an historical energy demand growth rate of around 2%pa. For our base case scenario to be achieved, per capita energy demand over the next thirty years needs to stay broadly flat, whilst the energy intensity of global GDP needs to fall by around 40%.

Within the energy displacement sector, key areas of focus are **efficiency** and **alternative fuels**.

Energy efficiency

Energy efficiency is a key pillar of new policy. For example, the EU had previously set itself a challenging target to consume 9% less energy in 2030 than in 2020 and the new RePowerEU deal saw this ratcheted up to 13%, supported by €100bn of funding for residential and industrial efficiency. A few months later the US Inflation Reduction Act included $53bn in support for building efficiency.

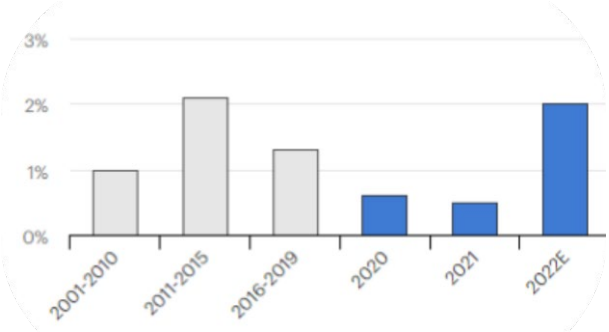
The focus on building efficiency is important, since buildings are responsible for 30% of primary energy consumption and nearly 40% of global carbon emissions. Electrifying heating (heat pumps) and improving the efficiency of heating (insulation), cooling (efficient HVAC), and lighting (LEDs) offers some of the quickest ways to decarbonise whilst lowering energy bills and improving energy security.

Despite the importance of energy efficiency, investment in energy efficiency from 2015-2020 remained flat at around $400bn per annum. More recently, rising energy costs have increased the incentive to invest, driving a 27% increase in 2021. This rose a further 16% in 2022, bringing total efficiency spending to $560bn. Building efficiency comprising heating, cooling, lighting, and appliances, made up over half of this spend at $300bn.

This higher level of efficiency spending alongside behavioural change is expected to have resulted in a 2.0% improvement in global energy intensity in 2022. This represents a meaningful increase from the 0.5-0.6% levels seen in the pandemic years but still not enough to hit net zero by 2050, according to the IEA.

Annual global primary energy intensity improvement

Source: IEA



While a number of energy efficiency investments are already economic today (typical payback periods would be 1-3 years for LEDs and 3-5 years for loft / cavity wall insulation) others are still too expensive for most consumers. We expect global governments to continue to incentivise the roll out of these technologies through subsidies and minimum efficiency standards to improve energy security and deliver the transition to a low-carbon future.

To achieve a net zero scenario, annual energy efficiency improvements would need to jump from 2%pa currently to 4%pa by 2030 globally. This translates to building efficiency spending increasing to over $750bn per annum between 2026-2030 (from just over $400bn in a base case scenario and $300bn in 2022). Worldwide heat pump capacity would need to triple by 2030 and then double again by 2050, implying that heat pumps meet 24% of heating demand in 2030 and 52% in 2050, up from just 8% today. Lighting sales would need to be 100% LED globally by 2030 (vs 50% in 2022).

Alternative fuels

Alternative fuels are materials or substances which can be used as fuel to displace coal, oil, and natural gas. They encompass solid biofuels (also known as biomass e.g. wood, bagasse, animal waste), biogas (e.g. renewable natural gas, biomethane), and liquid biofuels. Below we will predominantly focus on the outlook for liquid biofuels, including bioethanol (derived from corn/sugar) which displaces gasoline, bio-based diesels (derived from plant and animal fats) which displace conventional diesel, and Sustainable Aviation Fuel (SAF, derived from multiple organic/inorganic feedstocks) which displaces jet fuel or kerosene.

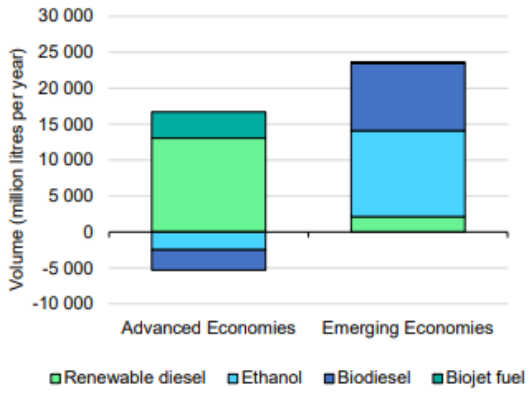
Liquid biofuel demand is expected to have reached 168bn litres in 2022, representing around 4.3% of transportation fuel consumption. The US and Brazil continue to dominate the market, making up around 40% and 25% of global demand respectively, supported by strong domestic industries for corn and sugar cane.

Biofuel consumption grew 6% in 2022 versus 2021, outpacing the underlying 2% increase in world oil demand. Growth continued to benefit from government support, especially from India and Indonesia. However, high prices for retail diesel and gasoline led to a watering down of blending and environmental targets in Brazil, Finland and Sweden, lowering this year's growth by around 2ppts.

Currently, demand for biofuels is met by a roughly even split of bioethanol and bio-based diesel (biodiesel & renewable diesel) with SAF/biojet kerosene making up less than 1% of the market. By 2027, we expect global consumption of alternative fuels to increase by 20%, making up 5.4% of transport fuel. Just five countries (USA, Canada, Brazil, Indonesia, India) will be responsible for 80% of this growth.

Biofuel growth for advanced and emerging economies out to 2027

Source: IEA



In developed economies, demand will be driven by renewable diesel (which can directly replace conventional diesel) and biojet fuel. New policies introduced in the last year, namely the Inflation Reduction Act in the USA and Clean Fuel Regulations in Canada, will see the biofuel share in transport energy demand climb from 6% and 4% in 2022 to 8% and 7% respectively in 2027.

In contrast, emerging economies will see biodiesel (which is blended with conventional diesel) and ethanol make up over 90% of their increase, thanks to rising blending requirements over this period. At 30%, Indonesia currently has one of the highest blending requirements in the world and the government has ambitions to raise this over time to 40%.

However, the alternative fuel industry will continue to rely on government regulation, subsidies and tax credits for its existence. We estimate for one of the most profitable US alternative fuel manufacturers, the average level of support in 2022 amounted to around $4.50 per gallon. When compared to the relatively high average retail gasoline prices observed year to date of $4 per gallon, it is clear just how reliant government support is in decarbonising liquid fuels.

To achieve a net zero scenario, demand growth for alternative fuels would need to increase from 4%pa to over 15%pa, taking industry production capacity from 168bn litres in 2022 to around 600bn litres by 2030. This would mean that the contribution of biofuels to transport energy demand would need to more than triple to 15% by 2030, up from 4.3% today.

Electrification

The energy transition is seeing energy demand being 'electrified' as it moves away from predominantly hydrocarbon fuels and gases towards the consumption of electricity. Our 'electrification' sector includes some key enablers of this transition: the lithium-ion battery and the electric vehicle industries. The battery industry is critical

here in that it will serve electric vehicles and also provide a stationary energy storage solution in electricity grids, allowing variable renewable energy (i.e. solar & wind) to play an expanding role in the global power stack.

Batteries

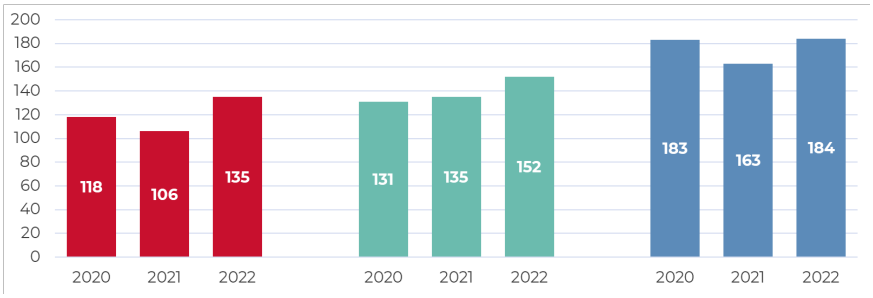
The speedy adoption of lithium-ion batteries in recent years has been spurred on by a vast improvement in economics. According to BNEF, the volume weighted average price of a lithium-ion battery fell 88% from 2010 to 2020. Prices fell a further 6% in 2021 but this was offset by a 7% increase in 2022 due to higher prices for the key battery metals, lithium and nickel. This represented the first observed increase since 2010, taking the average price to $151/kWh.
At the end of 2022, lithium and nickel prices were trading 800% and 60% higher than levels seen in December 2020 as supply has struggled to keep pace with strong demand for electric vehicles. Lithium carbonate prices in China reached new peaks in 2022, exceeding $78,000 per tonne, as the market suffered from COVID-19 disruptions and long lead times (5-8 years) for new projects. Nickel prices peaked at $100,000 per tonne in April following Russia's invasion of Ukraine and a short squeeze on the London Metal exchange. This has since moderated to $29,000 per tonne, but future concerns over Russia's ability to supply its 17% share of the world's class 1 nickel could keep prices elevated.

These metals are used in the cathode, which typically represents around 60% of the cost of a cell and just under half of the cost of a battery pack. Electric vehicle batteries are dominated by three main cathode chemistries: Nickel Manganese Cobalt (NMC), Nickel Cobalt Aluminium (NCA), and Lithium Iron Phosphate (LFP) and each has specific performance and cost attributes.

Making up over half of the global cathode mix, NMC and NCA enjoy high energy densities, but require more complex and expensive thermal management to keep them stable. In contrast, LFP is much more stable and costs 10-35% less than NMC and NCA, but suffers 30% lower energy density.

Historical LFP (red), NCA (green), NMC (blue) pack prices, US$/kWh

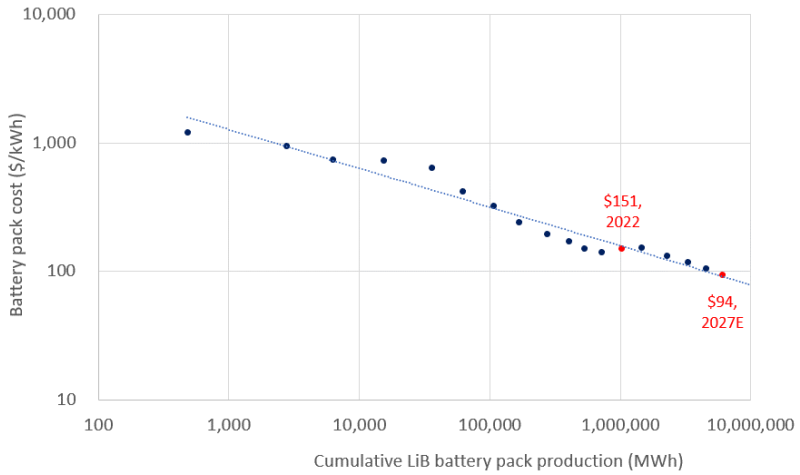
source: BNEF



Despite seeing the biggest increase in prices in 2022 (+27% for LFP vs +13% for NMC and NCA), LFP battery pack prices remain the cheapest option. Its enhanced safety and simpler supply chain (no cobalt or nickel required in the manufacturing) have made it increasingly popular among electric vehicle manufacturers, reaching a 40% share of the global cathode mix in 2022, up from just 15% in 2018. This shift towards cheaper LFP cathodes was key to limiting the increase in battery prices in 2022 to only 7%.

Cumulative demand for LiB packs (MWh) vs Battery pack price ($/kWh)

source: Bloomberg, Guinness Global Investors



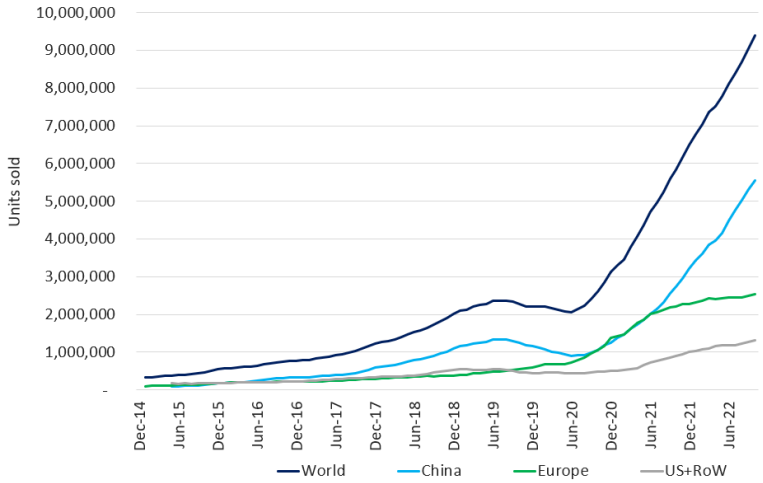
In 2020, the expectation was that the industry battery pack cost target of $100/kWh (the price at which EVs reach price parity with ICE vehicles) would be hit by 2024. On our estimates, higher lithium and nickel prices are now likely to delay this until 2027. The $50/kWh cost reduction over the next five years is likely to come equally from i) moderation of commodity prices, ii) improvements to cell chemistry (moving to higher nickel cathodes and increasing silicon content in anodes) and iii) improvements in pack design and manufacturing (moving towards cell-to-vehicle architectures, with lower scrap rates). If the current learning rate of 17% is maintained, battery pack prices could fall as low as $77/kWh by 2030 and $62/kWh by 2035.

Electric Vehicles

Electric vehicle (EV) adoption continued apace in 2022 with just under 8 million plug-in vehicles sold between January and October, more than in 2019 and 2020 combined. Battery electric vehicles (BEVs) made up just under 10% of new car sales with total plug-in penetration (BEV + Plug-in Hybrids) reaching 13%. Global sales are currently growing 60% year-over-year driven largely by China, which now accounts for 60% of sales. Europe is a distant second, with around one quarter of overall EV sales, while the US trails at under 10%.

Global EV sales (rolling 12-month basis up to October 2022)

Source: Guinness, EV-Sales, Cleantechnica



Much of this growth has been driven by policy, with governments now subsidising 10-30% of the price of an electric vehicle, while bringing forward the timeline on banning internal combustion (ICE) sales. Governments cannot

maintain subsidies long-term and it will be interesting to see how the Chinese markets develops in 2023 now that the long-existing NEV subsidy program has completely ended, meaning that no NEVs purchased after 1 January 2023 will be subsidised. Nonetheless, looking ahead, we believe that we are now at a tipping point where improving economics, driving range, and charging times begin to drive mass adoption.

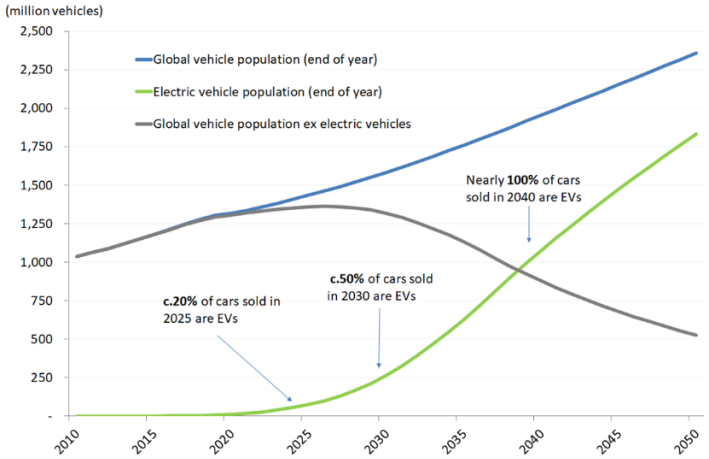
- **Economics:** Electric vehicles cost more to buy but have lower overall running costs. Excluding China, the IEA suggest that BEVs are typically $15,000 more expensive to purchase. Assuming normalised fuel and electricity prices, we estimate that lifecycle running costs for an electric vehicle in Europe and the US are $23,000 and $13,000 lower respectively than the ICE equivalent, broadly justifying the upfront price premium.
- **Range:** The average range of a battery electric vehicle sold in 2021 was around 215 miles, just under half of an ICE equivalent. This is clearly inferior, yet average daily driving distances are only 25-55 miles, meaning that most EVs are easily capable of handling everyday distances, and the market is rapidly waking up to this reality.
- **Charge time:** Level one and two chargers (available in residential and commercial environments) are cheap and can replenish 5-30 miles of range per hour. Level three fast chargers, however, offer fast charging on longer trips, delivering at a significantly higher rate of 200-600 miles of range per hour. Once again, China is leading the regional charging infrastructure roll out with seven electric vehicles per charger whereas the EU and US lag behind at 15-20 EVs per charger.

The recent rapid growth in electric vehicle sales has caught many forecasters by surprise, leading to swift revisions to long-term adoption rates. For example, BNEF revised its 2025 forecast for EV sales penetration up to 23% in its 2022 outlook report, up from 16% in 2021. Our long-held forecast is that electric vehicles will make up 20% of new global vehicle sales by 2025, 50% by 2030 and predominantly all new vehicle sales by 2040. At that point, it implies an overall population of one billion EVs, over 60 times greater than the global stock in 2021 of 16.5 million.

Despite our rapid base case EV growth assumptions, we calculate that oil demand from passenger vehicles will not peak until around 2024/25 and that, even by 2030, passenger vehicle oil demand will be similar to 2021 levels. With transportation generating just over 7bn tonnes of carbon emissions in 2020, accelerating the transition and reducing associated oil demand is critical to achieving a net zero 2050 scenario.

Global EV population (to 2050)

Source: IEA; Guinness Global Investors estimates



Our base case for electrification implies that there will be over one billion electric vehicles on the road by 2040, that electricity is 57% of total energy demand and that variable renewables such as wind and solar will represent 61% of global power grids. Achieving this would require annual EV sales of around 135m vehicles and annual lithium-ion battery demand of around 6,400 GWh per year in 2040.

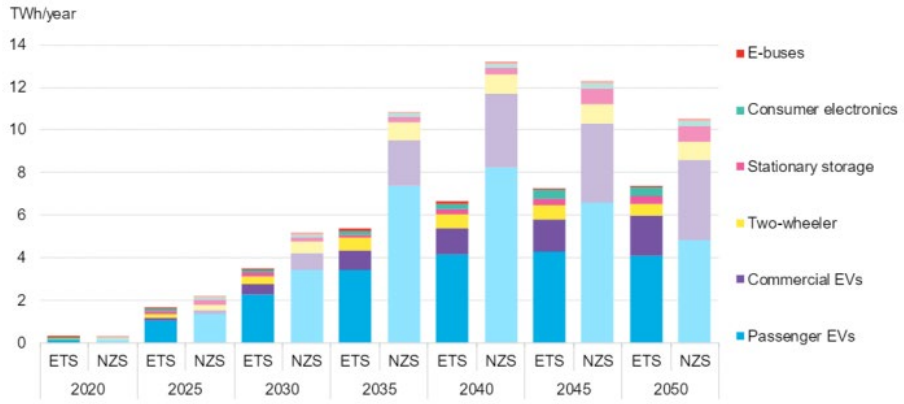
A net zero scenario will require an even faster uptake of passenger electric vehicles (reaching 100% penetration by 2035 than 2040) and would require other transportation, such as ICE heavy trucks, to be 100% electric by 2045. To

support the rollout of EVs, investment in public charging infrastructure would need to increase from $6bn in 2022 to around $40bn pa in 2030 and around $120bn pa in 2040, significantly ahead of our base case estimates.

The implication would be that electricity demand would likely grow around 3.3%pa to 2040 (faster than our base case of 2.5%pa) with variable renewables reaching 60% grid penetration in 2030 (rather than our base case of 2040) and thus rapidly displacing fossil fuels from the grid. To support the rapid electrification, according to BNEF annual battery demand would grow from 340 GWh in 2021 to 5,600 GWh by 2030 and potentially as much as 13,000 GWh by 2040 (more than double the base case estimate).

Lithium-ion battery demand under economic transition scenario (ETS - base case) and net zero scenario (NZS)

source: BNEF estimates



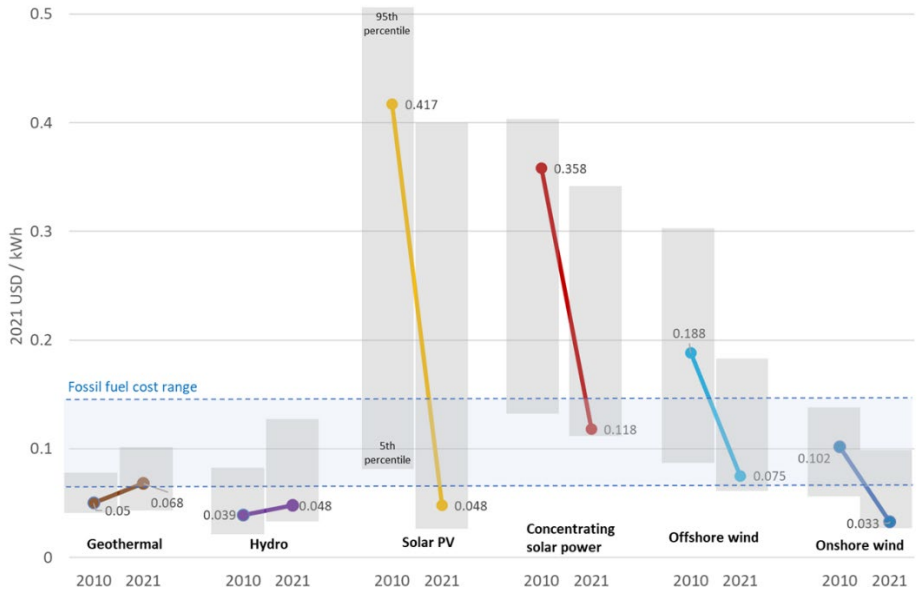
Generation & installation (equipment)

Before considering the detailed dynamics of key renewable power generation markets of wind and solar, it is worth considering the significant changes that have occurred to the economics of various renewable power generation technologies since 2010. Onshore wind and solar PV have joined hydro and geothermal power to sit at the lower end of, or below, the cost range for new fossil fuel power generation.

The structural story of cost reduction that we have witnessed for a number of years has recently been complicated by cyclical raw material, energy and logistics cost inflation. However, while the cost of renewable power generation is likely biased upwards short-term, the **relative economics of renewables versus hydrocarbons** continue to improve thanks to fossil fuel generation inflation.

Global LCOE (Levelised Cost of Electricity) of utility-scale renewable power generation technologies (2010–2021)

source: IRENA, Guinness Global Investors estimates



The solar sector

The relative economic attractiveness of solar power generation continued to improve in 2022. On one hand, the structural story of cost deflation that we have witnessed for a number of years has stalled as a result of cyclical raw material, energy and logistics cost inflation. But, on the other hand, industry growth has brought improved economies of scale, plus the relative economics of solar versus hydrocarbons continues to improve thanks to inflation in competing fossil fuel generation. According to the IEA, the cost of solar in 2022 (as implied by auction prices in the chart below) sits comfortably below competing fossil fuel-based options and current wholesale electricity prices, meaning that solar (or sometimes wind) is typically the most economic option for new supply that can also help to alleviate energy security concerns.

Solar's improved relative economics and the increased need for security of supply mean that installations in 2022 are likely to be around 260 GW, substantially higher than the 200 GW estimate that we made at the start of the year. With momentum strong, especially following the US IRA and RePowerEU deals, we introduce an estimate for 2023 module demand of 310 GW, another record year for global installations, with growth of 50 GW versus 2022.

Regionally, the key moving parts in 2022 and 2023 are as follows:

- In the **United States** we initially expected installations in 2022 (20 GW) to be lower than 2021 (30 GW) as a result of i) the Withhold Release Order (WRO) placed on various solar product imports from China, ii) concerns around the level of residential solar support coming from a clean energy infrastructure bill and iii) the impact of new net metering rules (NEM3.0) in California which reduce the attractiveness of solar economics for residential consumers. Actual installations in 2022 are now likely to be around 25 GW as demand is less likely to be impacted by NEM3.0 and the WRO.
- Demand in **Europe** is expected to be around 45 GW in 2022, up sharply from 24 GW in 2021, as the region reacted to higher electricity prices and the need for energy security. It is here that the relative economics of solar have improved the most, and the RePowerEU deal has already started to incentivise new demand for solar installations. Looking to 2023, we see further installation increases, with Europe reaching a new record of

62 GW spread well across an increasing number of countries, leading to substantially more growth in future years.

- In **China** module demand is also likely to beat our initial estimates, reaching 95 GW in 2022 (up 30 GW on 2021) as first half 2022 installations of 40 GW were more than double the levels seen in 1H 2021. Growth has come across utility, residential and commercial and we note plans for the development of significant offshore utility scale plants in 2023. As with Europe, higher power prices have been a key factor in driving stronger demand. In mid-2022, China published its 14th five year plan for renewables which suggested that solar (and wind) installations in 2021-2025 should be double the levels seen in 2015-2020.

- The rest of the **non-OECD** has also seen greater than expected growth in demand, reaching around 60 GW in 2022 (up 23 GW on 2021 levels) with demand increases well spread across Latin America (especially Brazil), African and Middle Eastern countries.

Global solar module installations, 2010-2023E (GW)

Source: BP, BNEF, PV InfoLink, IEA and Guinness Global Investors estimates

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022E	2023E
OECD solar installations (annual)														
North America	1	2	4	6	7	8	14	11	10	11	19	30	23	30
Germany	7	7	8	3	2	1	2	2	4	4	5	5	8	11
Spain	0	0	0	0	0	0	0	0	0	5	3	4	7	9
Rest of Europe	3	4	5	5	5	6	4	3	4	6	8	15	30	42
Australia	0	1	1	1	1	1	1	2	4	4	4	5	6	8
South Korea	0	0	0	1	1	1	1	1	2	3	4	4	5	6
Japan	1	1	2	7	10	11	8	8	7	7	9	7	9	9
Total OECD	**17**	**23**	**24**	**24**	**25**	**29**	**29**	**26**	**31**	**40**	**51**	**70**	**88**	**115**
Change	*10*	*7*	*0*	*0*	*2*	*4*	*0*	*-3*	*5*	*9*	*11*	*19*	*18*	*27*
Non-OECD solar installations (annual)														
China	0	3	3	14	13	19	30	53	44	33	52	65	95	115
India	0	0	1	1	1	2	5	10	11	12	4	12	17	18
Rest of non-OECD	1	3	3	4	6	6	11	9	22	34	37	37	60	62
Total Non-OECD	**2**	**5**	**8**	**18**	**21**	**27**	**46**	**72**	**77**	**78**	**93**	**114**	**172**	**195**
Change	*1*	*3*	*2*	*11*	*2*	*6*	*19*	*26*	*5*	*1*	*15*	*21*	*58*	*23*
Total solar installations (annual)	**19**	**29**	**31**	**42**	**46**	**56**	**75**	**98**	**108**	**118**	**144**	**184**	**260**	**310**
Change	*11*	*10*	*2*	*11*	*4*	*10*	*19*	*23*	*10*	*10*	*26*	*40*	*76*	*50*

Solar supply chain in 2022 and 2023

All parts of the solar module manufacturing chain, except polysilicon, appear to have been in oversupply again in 2022 and are likely remain so in 2023. We treat nameplate capacity estimates here with some caution because technological advances and cost improvements can bring rapid capacity obsolescence, meaning that actual supply may well be lower than nameplate capacity. Nonetheless, significant new manufacturing capacity is planned across the entire value chain which will likely bring lower module prices and will likely help to support global solar module demand.

- **Polysilicon** is a key raw material for a solar wafer. The poly market continued to be the tightest part of the solar market in 2022, evidenced by prices rising through the year to reach nearly $40/kg in August. Poly prices have been high enough over the past two years to incentivise new supply and we can now see signs that the new supply is on the cusp of arrival. BNEF estimates that the capacity of the polysilicon industry rose to 900 mtpa in 2022 (sufficient to support over 300 GW of solar module manufacturing) but that new capacity additions of nearly 2,500 mtpa are being planned by either existing players or new entrants. While many plants will not be built and many will take longer than expected to reach full production capacity, the scale of capacity growth leads us to believe that poly prices will fall in 2023 and beyond, allowing margin expansion elsewhere in the value chain as well as lower solar module prices.

- **Wafer and solar cell** manufacturing capacity, according to PV InfoLink, will reach 583 GW in Q4 2022 and will grow a further 15% in 2023. In 2022, wafer and cell companies have generally been able to pass through cost inflation and to defend reasonable margins but, similar to polysilicon, this may come under pressure in 2023 as new capacity is added. Unlike polysilicon however, the wafer business is highly concentrated, with nearly 80% of 2022 wafer capacity in the hands of the five largest producers. This may be a factor to help support prices in

2023. Technological changes in wafer manufacturing could lead to existing capacity becoming obsolete, leaving this part of the market tighter than it appears.

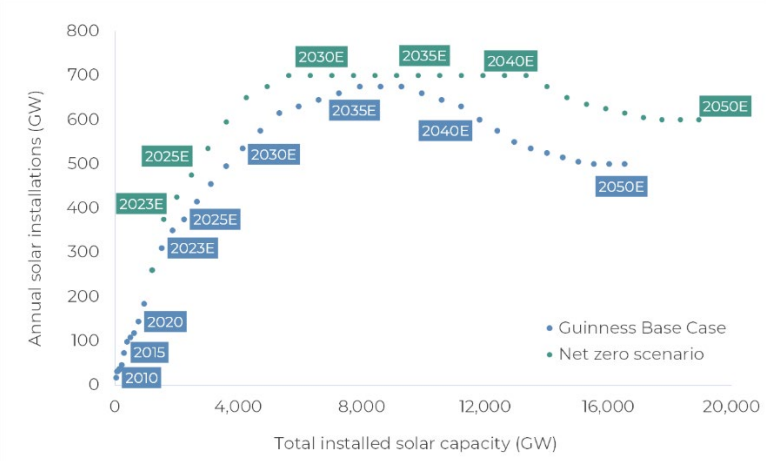
- **Solar module** prices moderated in the second half of 2022 with prices likely to average the same level as 2021. With elevated polysilicon and power prices, it is the module manufacturers that suffered the greatest margin compression in 2022. Module manufacturing nameplate capacity in 2022 is estimated to have been around 470 GW, of which around 310 GW is newer 'Tier 1' capacity with lower costs resulting from the scale of manufacturing and new technologies. In 2023, this likely expands to 660 GW and potentially to as high as 820 GW by the end of the year.

The long-term outlook for solar has improved through 2022. In August, BNEF updated its long-term projections, increasing its 2030 module installation forecast to 460 GW from the prior year's forecast of 334 GW, an increase of 37%. The impact of the increase is that a total of 3.4 TW of solar is forecast to be installed globally this decade (up 0.8 TW, or 30%, on the previous forecast) with total capacity in 2030 being 4.2 TW (versus prior estimate of 3.4 TW). This, however, is not consistent with a net zero scenario.

In BNEF's net zero scenario, total installed solar capacity would need to be around 5.3 TW by 2030 (25% higher than their base case). For comparison, the Guinness net zero scenario indicates that total installed capacity would need to be 5.6 TW in 2030 (a compound growth rate of 22%pa from 2021) and that reaching this level of installed capacity would require annual installations to reach as much as 700 GW pa. While solar is a key and well-placed component of any net zero energy transition scenario, the industry still has to deliver more growth in order to be fully aligned.

Global solar annual installations, base case and NZE scenario

source: IEA, IPCC, Guinness Global Investors estimates



The wind sector

Despite recent headwinds, the long-term outlook for the wind industry remains very positive as the sector plays a critical role in global decarbonisation and the energy transition. Global wind generation capacity today is around 918 GW, but installations have temporarily paused as the industry has wrestled with COVID-related disruptions and various "regulatory airpockets". Looking forward, we expect these issues to inflect positively over the next few years, leading to a sustained ramp in global wind installations out to 2030.

Below, we discuss some of this new legislation and consider the key factors for the onshore and offshore wind markets in 2023 and beyond. We conclude that the near-term issues are likely a bump in the road on the journey to delivering wind as the second most significant renewable power generation source.

Annual onshore and offshore wind installations (GW)

source: BP, IEA, BNEF, Guinness Global Investors estimates

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022E	2023E
Onshore wind installations (annual)																
North America	9	11	6	8	15	2	7	10	9	8	8	10	17	16	12	12
Latin America	0	0	0	0	0	0	5	3	3	3	4	4	2	5	4	6
Europe	6	9	9	10	12	11	11	11	12	13	8	9	12	15	18	19
China	6	14	17	18	14	15	21	29	22	17	19	26	54	41	49	51
India	2	1	1	1	2	2	2	3	4	4	2	2	1	3	2	3
RoW	3	3	3	4	4	3	4	5	5	5	4	4	5	3	3	4
Total onshore	**27**	**38**	**35**	**40**	**46**	**33**	**49**	**61**	**55**	**49**	**46**	**55**	**91**	**83**	**88**	**95**
Change		*12*	*-3*	*5*	*6*	*-14*	*17*	*11*	*-6*	*-6*	*-3*	*9*	*36*	*-8*	*5*	*7*
World ex China	*21*	*24*	*18*	*22*	*32*	*18*	*29*	*32*	*33*	*32*	*27*	*29*	*37*	*42*	*39*	*44*
Offshore wind installations (annual)																
China	0	0	0	0	0	0	0	1	1	1	2	3	4	14	6	10
UK	0	0	1	0	1	1	0	1	0	1	2	2	1	1	3	2
Germany	0	0	0	0	0	0	0	2	0	2	0	2	0	1	0	1
RoW	0	0	0	0	0	1	0	0	0	1	0	1	2	1	1	6
Total offshore	**0**	**0**	**1**	**0**	**2**	**2**	**1**	**4**	**1**	**4**	**4**	**8**	**7**	**17**	**10**	**18**
Change		*0*	*1*	*-1*	*1*	*1*	*-1*	*4*	*-4*	*3*	*0*	*3*	*-1*	*11*	*-7*	*8*
World ex China	0	0	1	0	1	2	1	3	0	4	3	5	3	3	4	8
Total wind installations	**27**	**38**	**36**	**40**	**48**	**35**	**50**	**65**	**56**	**53**	**50**	**63**	**98**	**100**	**98**	**113**
Change		*12*	*-2*	*4*	*8*	*-13*	*16*	*15*	*-9*	*-3*	*-2*	*12*	*35*	*3*	*-2*	*15*

Onshore wind

The global onshore wind market currently sits at an installed capacity of 853 GW, with China and the US accounting for around 60% of capacity and Europe making up most of the remainder. Installations have been volatile but were reasonably consistently between 40-60GW from 2011 until 2020. Since 2020 there has been an uptick in installation activity driven, in large part, by both Chinese and US developers rushing to complete projects before subsidies expired. Following this period, it was widely thought that we would subsequently revert to a lower absolute level of installations, with a subdued 5-6% growth rate thereafter. Instead, we have witnessed unprecedented global policy support, which serves not only to keep installations at the current high levels, but also to triple the subsequent growth rate out to 2030, should current government policies be followed through. The three key policy announcements were as follows:

- **Europe's REPowerEU plan** committed a further EUR 86bn in incremental renewables investment out to 2030 and also sought to remove Europe's permitting bottlenecks by setting set out plans to streamline the arduous permitting process from 6 years on average to 2 years. Streamlining this process is critical, in our opinion, since the backlog of projects awaiting permitting is around five times the level of annual installations. Overall, the plan represents a dramatic shift, with a target to increase European capacity from 190 GW at present to 510 GW by 2030.
- The **Chinese 14th 5 year renewable energy plan** aims to double the installed capacity of both wind and solar by 2030. This has led to China's major state-owned power companies setting goals to increase total wind and solar capacity by 600 GW by 2025 (5 years ahead of schedule).
- The **US Inflation Reduction Act** outlined a $369bn package that targets climate and energy security focusing on reducing emissions from (amongst other things) electricity generation and transport. This not only provides very material tax credits, it also guarantees them out to 2033 (providing much needed policy visibility). According to Princeton University, the combined incentives may help increase US wind installations by 2x over the next 3 years compared to 2020 levels.

The result of these policy initiatives is that we no longer expect a dip in installations in the next few years, but instead think that installations stay higher and grow faster, with global capacity nearly tripling by 2030.

Offshore wind

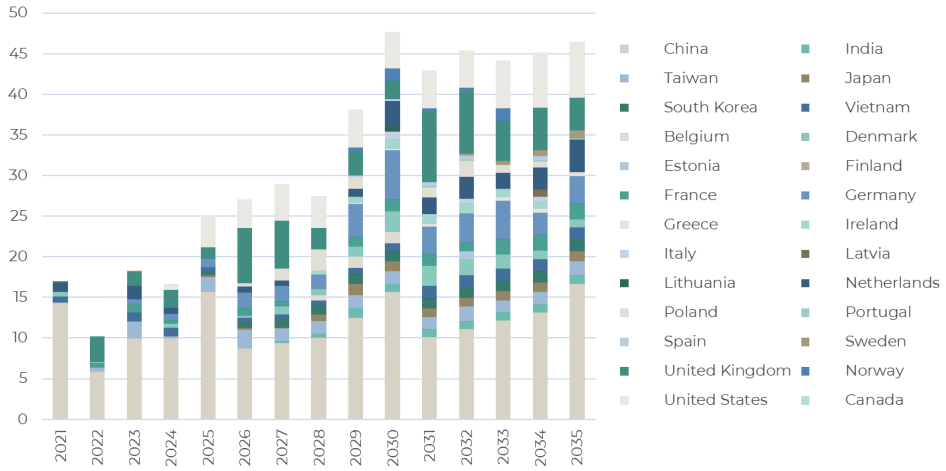
Offshore wind remains a nascent industry, at only 7% of global wind capacity, but it has doubled over the last 2 years and should grow nearly five times by the end of the decade driven by improving economics, further geographical adoption and the support of many of the packages outlined above.

In 2022 the LCOE for the median offshore wind project continued to improve relative to the bottom end of competing fossil fuel generation, with key attractions being better operational and visual characteristics as well as being close to key demand areas which are often coastal. 2022 also marked the completion of the first *floating* offshore wind project by Equinor, which while uneconomic today, when industrialised, offers the hope of multiplying the number of potential installation sites.

Positive dynamics for offshore wind in 2022 lead us to increase our 2030 capacity outlook to close to 300 GW, implying 20%pa growth versus 2021. By then, we expect the industry to be primarily made up of Europe and China, with the US still accounting for less than 10% (if President Biden's target 30GW plan is enacted).

Outlook for offshore wind installations (GW per annum, to 2035)

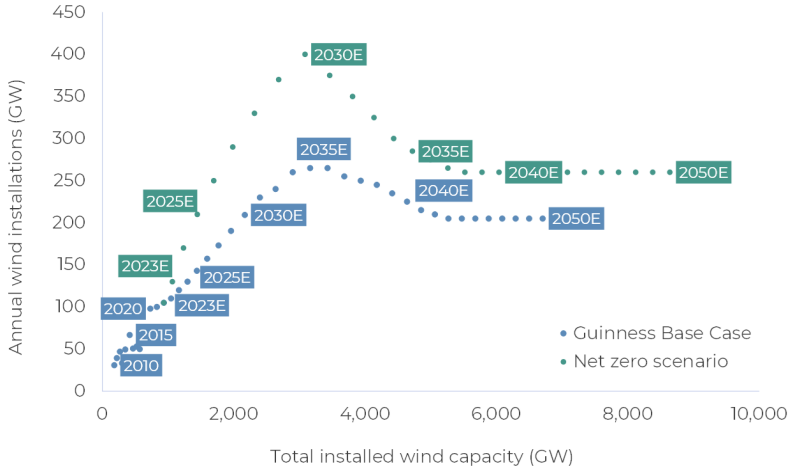
source: BNEF estimates



Our base case assumes that total wind installed capacity will be around 2.2 TW in 2030. The Guinness net zero scenario indicates that total installed capacity would need to be 3.1 TW in 2030 (a compound growth rate of 16%pa from 2021) and that reaching this level of installed capacity would require annual installations to reach as much as 400 GW pa. While there appears to be significant policy support to grow the wind industry, we note that it has a very significant way to go in order to be fully aligned.

Global wind annual installations, base case and NZE scenario

source: IEA, IPCC, Guinness Global Investors estimates



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GUINNESS SUSTAINABLE ENERGY FUND

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