

## 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

<b>Launch</b>	19.12.2007
<b>Index</b>	MSCI World
<b>Sector</b>	IA Commodity/Natural Resources
<b>Managers</b>	Will Riley Jonathan Waghorn
<b>EU Domiciled</b>	Guinness Sustainable Energy Fund
<b>UK Domiciled</b>	WS 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

### SUSTAINABLE ENERGY EQUITY PERFORMANCE

This month we provide a review of some of the factors that could act as catalysts for sustainable energy equities in the months ahead. We have grouped them into macro, policy and momentum factors. Ultimately, valuation metrics in the sector appear to misprice the earnings growth that is likely to occur.

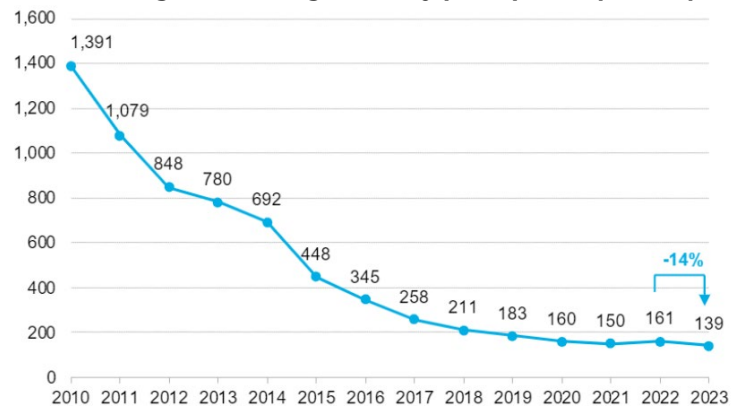
### EQUITIES

The Guinness Sustainable Energy Fund (Class Y) delivered a return of +11.3% (in USD), ahead of the MSCI World at +9.4%. Year-to-date, the Fund has delivered -9.5%, versus the MSCI World at +18.0%. Within the Fund, the strongest stocks were US insulation installer Installed Building Products (IBP), automotive semiconductor supplier Infineon, and wind turbine manufacturer Vestas. IBP delivered strong results and benefited from improving property market sentiment as bond yields fell during the month from October highs. Infineon and Vestas both delivered results ahead of consensus and benefited from broker upgrades. Weaker performers included Chinese renewables names such as Longyuan, Suntien, and Xinyi Solar.

### CHART OF THE MONTH

Bloomberg New Energy Finance (BNEF) released its annual battery price survey, noting a 14% drop in average pack prices year-over-year. The decline was driven by falling raw material prices, slowing EV demand growth, and the continued adoption of lower-cost chemistries such as lithium iron phosphate (LFP).






### Volume weighted average battery pack prices (\$/kWh)



Source: BNEF, November 2023

NOVEMBER 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
<p>Brazil signed onto an agreement to triple renewable energy capacity and double the rate of energy efficiency improvements globally by 2030, joining a prospective deal backed by the EU, US and UAE. Brazil is now one of around 100 countries to have signed up to the deal, with the aim for it to be officially adopted by leaders attending the United Nations' 28th Conference of the Parties (COP28). If adopted more broadly, this would see installed renewable capacity increase from around 3,400GW today to over 11,000 GW by 2030 and annual improvements in energy efficiency increase from 2% per annum to 4% per annum.</p>	<p>Global renewables &amp; efficiency</p>	
<p>As noted in our chart of the month, BNEF's annual battery price survey found that average pack prices had fallen 14% to \$139 per kilowatt hour in 2023. This was the largest decline in prices since 2018, with falling battery metal costs such as lithium being the key driver behind improving battery affordability. Despite battery demand increasing over 50% versus 2022, battery supply followed a similar trend, with overcapacity in China exerting further downward pressure on prices. Lithium iron phosphate, the cheapest battery chemistry, continued to see strong adoption, taking a c.50% share in passenger EVs and &gt;75% share in e-buses and stationary storage.</p>	<p>Battery affordability</p>	
<p>The German government and Siemens AG have agreed a deal in principle to cover billions of euros of project-related guarantees for wind turbine manufacturer Siemens Energy. If signed, this deal could provide crucial support for Europe's wind industry, helping to provide a reported €15bn in guarantees for project and warranty bonds, safeguarding the company's €109bn orderbook. The news came shortly after the EU published its Wind Power Package, aiming to strengthen and solve challenges faced by the industry including permitting, auction design and access to financing.</p>	<p>European wind</p>	
<p>Global plug-in EV registrations in October were 1.28m units, just below the previous monthly sales record of 1.29m units set a month earlier in September. This translated into battery electric (BEV) and plug-in hybrid electric vehicles (PHEV) taking a 17% share of new car sales in the month. Regionally, China remains the largest EV market worldwide with over 800,000 units sold, representing 39% market share. Europe comes in second at 260,000 plug-ins sold in October, making up a 25% share, and the US remains a laggard at around 130,000 units and 11% share.</p>	<p>EV penetration</p>	
<p>The EU announced its Action Plan for Grids to accelerate investment in power grids and remove a key bottleneck to the adoption of renewable energies. The plan highlights the need to accelerate cross-border interconnection projects, reduce waiting times for renewable projects to connect to the grid, improve the uptake of smart grid technologies, and strengthen supply chains. Permitting has been key to overall timescales, with grid reinforcement projects taking 4-10 years and high-voltage projects 8-10 years.</p>	<p>European grids</p>	

## MANAGERS' COMMENTS

**This month we provide a review of the some of the factors that could act as catalysts for sustainable energy equities in the months ahead. We have grouped them into macro, policy and momentum factors. Ultimately, valuation metrics in the sector appear to misprice the earnings growth that is likely to occur.**

### Macro

The sustainable energy sector has suffered this year from the impact of **rising interest rates**. Companies producing renewable power have been affected because of their long-duration cash flows (meaning that they are disproportionately sensitive to a rising cost of capital in their valuation), while equipment manufacturers have been affected as a higher cost of debt has pressured the economics of many new renewables projects. As we discuss below, the relative economics of renewables remain attractive despite higher rates, but it is evident that a stable or declining interest rate environment (as we saw in November) would benefit the sector.

Similar to interest rates, a continued trajectory towards **normalised inflation rates** would be positive generally for equities, but would also have specific positive impacts within the sustainable energy sector. The wind sector has suffered in this regard in 2023 as the rate of inflation for raw materials has been greater than the rate at which long-term revenue agreements (power purchase price agreements) have been increased. This painful short-term mismatch has caused projects to be delayed and cancelled but recently it has also catalysed governments to adjust long-term pricing and contracting/permitting processes to account for higher costs. As inflation bottlenecks work their way out and input costs normalise, we expect this to prove positive for sentiment on the equities. There are some signs of improvement; wind turbine manufacturer Vestas, for example, has recently posted its first quarterly profit since early 2022 and is forecast to move back into full-year profitability next year.

Inflation and interest rate increases weaken the main argument in favour of sustainable energy equities – that they have **improved relative economics** versus fossil fuel equivalents. However, after factoring in the inflation and interest rate rises that have occurred, our analysis points to renewable energy remaining the cheapest form of incremental electricity generation. This assessment is clearly relative to fossil fuels. And as we head into the European winter, we are concerned that natural gas prices could spike higher if heating demand is robust and Chinese demand for liquefied natural gas (LNG) continues. If we do see this or other examples of **higher fossil fuel prices** (especially natural gas and coal), then policy and investor sentiment will likely turn again, as it has done before, towards the attractive and economic energy security aspects of sustainable energy and energy efficiency.

### Policy

As we write these comments, **COP 28** is concluding in Abu Dhabi with an agreement to triple renewable power generation capacity and double energy efficiency. Additional agreements also appear to focus on substantially scaling up zero and low-emission technologies, providing climate finance to help emerging market countries and also “transitioning” away from fossil fuels in a just, orderly and equitable manner. To some degree, COP 28 will increase the momentum that has built around the energy transition since the Paris Agreement in 2015 as commitments drip through into country-level policy and investment plans. The commitments to increase renewable capacity and increase energy efficiency especially show that global support for the energy transition remains firm.

We see clarity on specific items within the **US Inflation Reduction Act (IRA)** and the **EU Industrial Strategy** as being more tangible drivers of sustainable energy equities in the near term. The scale of the IRA is impressive, with some commentators estimating that \$1.6trn of clean energy investment will be catalysed by its investment and production tax credits. However, some uncertainties still persist around its implementation, and these are keeping some renewables developers waiting on the sidelines. For example, we are aware of delays to some offshore wind projects (following uncertainty over whether they qualify for ‘energy community’ status, which allows for a 40%, rather than the base 30%, tax credit) and some hydrogen projects (following uncertainty over whether their hydrogen qualifies as being truly ‘green’ or not). The US Treasury Department has promised greater clarity, which should help to unlock further investment and job creation that is expected as result of the IRA.

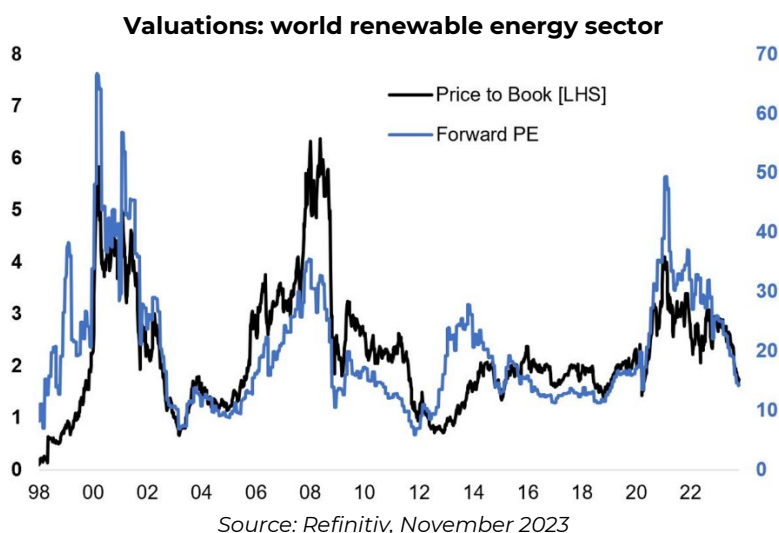
Unlike the US, the European Union has so far been long on aspirational targets and short on tangible funding. In part, this is because of the structure of the bloc, with top-down targets coming from the EU and funding being determined country by country. In August, the German Government passed the 'Climate and Transformation' package, which commits to providing EUR 212bn of funding towards building efficiency and renewables between 2024-27. We expect that more of these tangible state-level plans will be announced in the future so that countries can progress towards the broader EU targets.

Beyond the EU and US, we note that the **14th Chinese five-year renewable energy plan (2021-25)** targeted renewable energy capacity to exceed 50% of the grid by 2025. This was achieved in June of this year, and the expectation is that we get updated targets prompting further investment in the near future. China is pursuing the energy transition in a very significant manner.

### Momentum

Policy around the transition has been and is likely to remain supportive, but earnings and share price momentum in parts of the sustainable energy sector have been poor in the second half of 2023. This trend is clear in many passive clean energy investment products such as the largest one, the iShares Clean Energy Index ETF, which is suffering the **highest rate of redemptions** since its inception. This selling appears to be quite indiscriminate and has been compounded by what seems like a long season of **tax loss selling** in the United States. In our view, passive selling has amplified the recent sector pullback. Critical to turning around this negative momentum will be the step-by-step, quarter-by-quarter delivery of earnings growth providing confidence that the sector can grow its earnings substantially faster than the broader equity market.

This negative momentum leaves the sustainable energy sector on a **substantially lower valuation multiple** than one year ago. Based on data from Refinitiv, global renewable energy equities currently trade at Price/Earnings and Price/Book multiples that are back at 2014-2019 levels, before the significant acceleration in clean energy activity and government commitments made in 2020-2023. The decarbonisation intentions of the EU, US and China that were announced in 2020-2023 are no longer discounted in this basket of renewables stocks.



Updating for recent earnings and guidance announcements, we find that the consensus earnings per share growth outlook for the Fund remains strong at 18.6% per annum forecast between 2022-2025. It would be disingenuous to suggest that it will be plain sailing in all sustainable energy subsectors from here. Some will continue to suffer shorter-term earnings downgrades as high levels of renewable product inventory are worked through, for example. But many others will see earnings upgrades, as the policy momentum is translated into higher investment and higher demand. Overall, the Fund offers around three times the earnings growth of the MSCI World (currently around 6.6% pa), despite trading at a discounted 1-year forward P/E ratio. Current valuation multiples appear, therefore, to **discount an earnings outcome that is far worse** than that implied by current interest rates and inflationary conditions.

## Guinness Sustainable Energy

### Guinness Sustainable Energy Fund P/E premium/discount vs MSCI World (1yr fwd)



Source: Bloomberg, Guinness estimates, November 2023

PERFORMANCE

Past performance does not predict future returns.

The Guinness Sustainable Energy Fund (Class Y, 0.66% OCF) delivered a return of +11.3% in the month, while the MSCI World Index (net return) delivered +9.4% (all in USD terms).

Cumulative performance to 30.11.2023	Ytd	1 Yr	3 Yrs	5 Yrs	10 Yrs*
Fund (Class Y)	-9.5%	-15.4%	0.0%	98.2%	34.7%
MSCI World NR Index	18.0%	13.0%	22.7%	60.9%	122.2%
Out/Underperformance	-27.5%	-28.3%	-22.7%	37.3%	-87.5%

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%

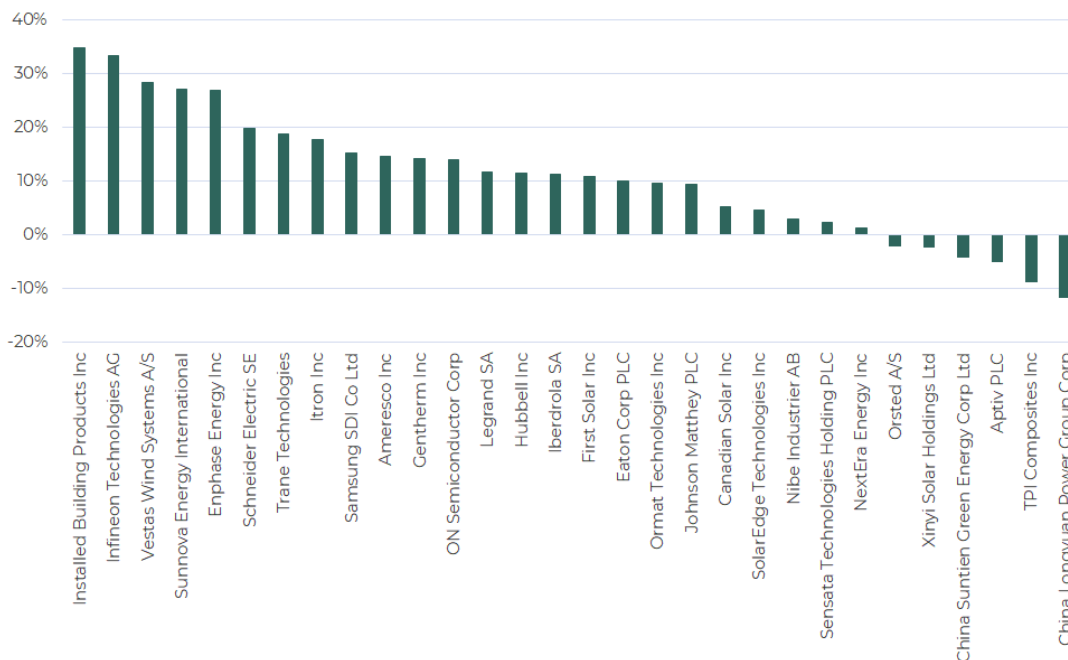
Annual performance	2017*	2016*	2015*	2014*	2013*
Fund (Class Y)	20.2%	-15.4%	-12.0%	-12.1%	70.8%
MSCI World NR Index	22.4%	7.5%	-0.9%	4.9%	26.7%
Out/Underperformance	-2.2%	-23.0%	-11.2%	-17.0%	44.1%

The 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 31/12/2018, the benchmark 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 0.66% 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 Installed Building Products, Infineon, Vestas, Sunnova, and Enphase. The weakest performers were China Longyuan, TPI Composites, Aptiv, China Suntien, and Xinyi Solar.

Stock by Stock performance over the month, in USD



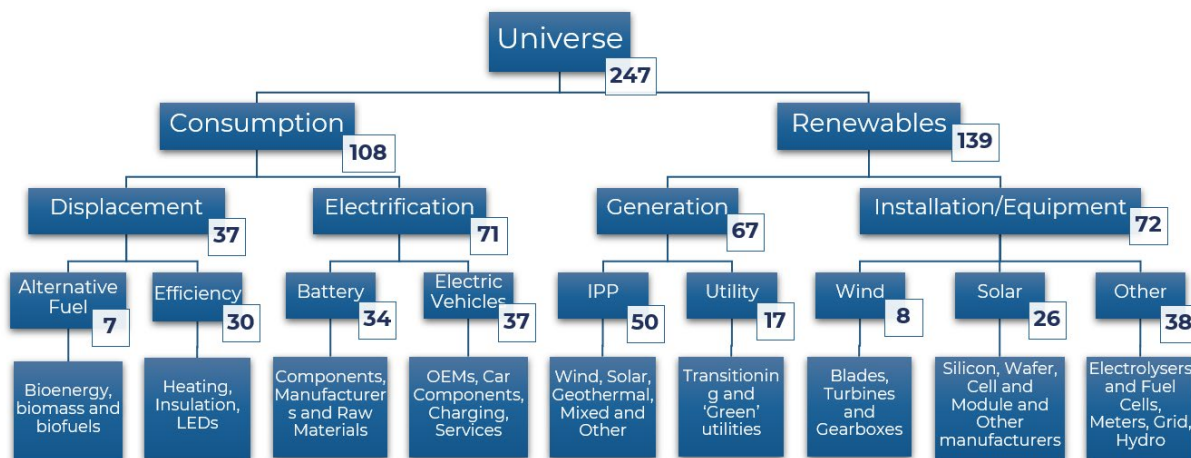
Source: Bloomberg. As of 30 November 2023



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 pure-play 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:**

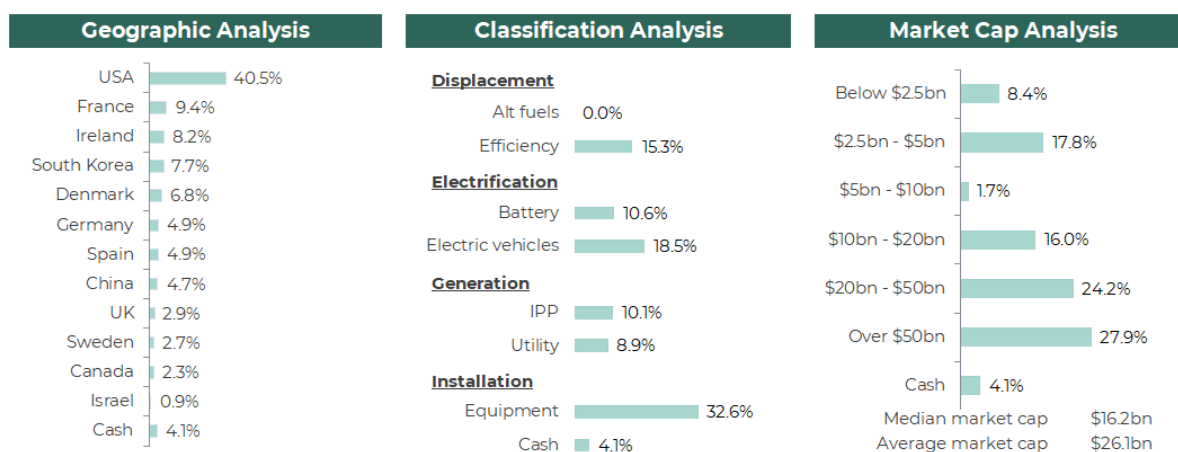


## Guinness Sustainable Energy

### Buys/Sells

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

### Portfolio structure analysis



Source: Guinness Global Investors. Portfolio holdings are subject to change.

### 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		
	Nov-23		Dec-22	Dec-21	Dec-20	Dec-19	Dec-18
<b>Consumption</b>	<b>44.4%</b>	<b>-0.5%</b>	<b>44.9%</b>	<b>43.4%</b>	<b>36.7%</b>	<b>41.7%</b>	<b>26.5%</b>
Displacement	15.3%	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	15.3%	0.3%	15.0%	11.8%	9.9%	13.4%	12.5%
Electrification	29.1%	-0.8%	29.9%	31.6%	26.8%	28.2%	10.1%
Batteries	10.6%	-1.1%	11.6%	8.9%	10.8%	12.6%	3.9%
Electric vehicles	18.5%	0.3%	18.2%	22.8%	16.0%	15.7%	6.2%
<b>Renewables</b>	<b>51.6%</b>	<b>2.3%</b>	<b>49.3%</b>	<b>51.3%</b>	<b>60.4%</b>	<b>54.1%</b>	<b>69.7%</b>
Generation	19.0%	1.3%	17.7%	23.1%	24.6%	22.2%	27.3%
IPP	10.1%	1.4%	8.7%	14.5%	17.0%	18.9%	26.7%
Utility	8.9%	-0.1%	9.0%	8.6%	7.6%	3.2%	0.6%
Installation	32.6%	0.9%	31.6%	28.2%	35.8%	32.0%	42.5%
Equipment	32.6%	0.9%	31.6%	28.2%	35.8%	32.0%	42.5%
Cash	4.1%	-1.8%	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 November 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	20.1x	17.3x	15.1x	13.5x	11.3x	9.6x	1.5%	1.7%	6.9%	18.6%	5.4%	6.3%
MSCI World Index	16.0x	18.0x	16.9x	10.4x	12.4x	11.2x	2.1%	2.2%	5.3%	6.6%	8.1%	7.9%
Fund Premium/(Discount)	26%	-4%	-11%	30%	-9%	-14%						

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

Source: Guinness Global Investors, Bloomberg



### Portfolio holdings as at end November 2023

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

We hold c.44% 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 (11%) 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 Korean chemicals company and the largest 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), 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 19% 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 two of our seven generation holdings. The remaining exposure comes in the form of geothermal (Ormat), US residential solar (Sunnova) and then offshore wind and broad-based wind/solar renewable energy generation through Orsted and 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 provides 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 and Schneider Electric) consists of companies that provide equipment and services to improve the efficiency and metering of electricity transmission and consumption.

Portfolio themes as at end November 2023

Theme	Example holdings	Weighting (%)
1 Electrification of the energy mix	 	26.8%
2 Rise of the electric vehicle and auto efficiency	 	21.5%
3 Battery manufacturing		7.7%
4 Expansion of the wind industry		9.8%
5 Expansion of the solar industry		11.6%
6 Heating, lighting and power efficiency	 	15.3%
7 Geothermal		3.3%
8 Other (inc cash)		4.1%

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

Guinness Sustainable Energy Fund (31 October 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
<b>Displacement/Efficiency</b>															
Hubbell Inc	US4435106079	4.6%	28.1x	17.8x	16.5x	15.5x	17.0x	12.7x	11.8x	5.3x	5.1x	4.5x	1.6%	1.7%	2.0%
Nibe Industrier AB	SE0015988019	2.7%	27.2x	24.0x	21.7x	18.9x	17.2x	15.5x	13.9x	4.1x	4.0x	3.5x	1.1%	1.2%	1.4%
Trane Technologies PLC	IE00BK9ZQ967	5.3%	25.9x	21.2x	19.1x	17.1x	16.1x	14.8x	13.8x	6.5x	6.7x	6.1x	1.4%	1.6%	1.7%
Installed Building Products Inc	US45780R1014	1.2%	15.1x	11.8x	11.1x	10.1x	8.0x	8.2x	7.8x	5.7x	4.8x	3.7x	1.9%	1.7%	1.2%
Ameresco Inc	US02361E1082	1.7%	14.4x	14.5x	10.5x	8.4x	12.1x	11.2x	8.5x	1.6x	1.5x	1.3x	n/a	n/a	n/a
		<b>15.5%</b>													
<b>Electrification/Battery</b>															
LG Chem Ltd	KR7051910008	3.4%	18.4x	17.2x	9.6x	6.3x	6.5x	6.1x	4.2x	0.9x	1.0x	0.9x	2.4%	2.3%	2.6%
Samsung SDI Co Ltd	KR7006400006	3.4%	13.3x	14.4x	12.5x	9.9x	9.5x	9.0x	7.3x	1.5x	1.6x	1.4x	0.3%	0.2%	0.3%
Johnson Matthey PLC	GB00BZ4BQC70	2.8%	8.8x	8.0x	9.6x	8.3x	6.4x	5.7x	6.3x	1.1x	1.1x	1.0x	5.1%	5.3%	5.0%
		<b>9.6%</b>													
<b>Electrification/Electric Vehicles</b>															
Aptiv PLC	JE00B783TY65	4.1%	35.1x	18.4x	14.2x	11.1x	13.6x	10.4x	8.7x	2.7x	2.5x	2.2x	n/a	0.1%	0.3%
ON Semiconductor Corp	US6821891057	3.8%	11.9x	12.3x	13.0x	11.1x	9.1x	8.4x	8.6x	3.6x	3.3x	2.7x	n/a	n/a	n/a
Infinion Technologies AG	DE0006231004	4.0%	16.2x	10.5x	11.0x	9.8x	8.4x	6.5x	6.5x	2.3x	2.1x	1.9x	1.2%	1.4%	1.5%
Sensata Technologies Holding PLC	GB00BFMBMT84	3.6%	9.5x	8.7x	7.9x	6.9x	7.8x	8.4x	7.8x	1.5x	1.5x	1.3x	1.4%	1.4%	1.5%
Gentherm Inc	US37253A1034	2.4%	26.0x	17.6x	13.3x	10.9x	13.9x	8.1x	6.7x	2.0x	n/a	n/a	n/a	n/a	n/a
		<b>17.9%</b>													
<b>Generation/IPP</b>															
China Longyuan Power Group Corp Ltd	CNE100000HD4	2.0%	6.7x	6.5x	5.5x	4.8x	10.1x	9.6x	8.4x	0.8x	0.7x	0.6x	2.1%	3.0%	3.5%
Ormat Technologies Inc	US6866881021	3.2%	37.7x	31.5x	23.5x	18.3x	15.7x	11.6x	10.3x	1.6x	1.5x	1.4x	0.8%	0.8%	0.8%
NextEra Energy Inc	US65339F1012	4.3%	23.7x	18.6x	17.2x	16.0x	22.3x	14.3x	13.6x	2.5x	2.4x	2.3x	2.9%	3.2%	3.5%
Sunnova Energy International I	US86745K1043	1.1%	n/a	n/a	n/a	n/a	154.1x	42.8x	26.6x	0.7x	0.6x	0.5x	n/a	n/a	n/a
Orsted A/S	DK0060094928	2.6%	41.0x	n/a	16.3x	14.4x	7.5x	9.7x	8.2x	2.5x	1.9x	1.8x	4.0%	4.2%	4.4%
China Suntien Green Energy Corp Ltd	CNE100000TW9	1.4%	4.2x	4.8x	3.9x	3.2x	4.6x	4.9x	4.0x	0.5x	0.5x	0.5x	8.3%	7.5%	8.9%
		<b>14.6%</b>													
<b>Generation/Utility</b>															
Iberdrola SA	ES0144580Y14	5.4%	15.2x	14.2x	13.7x	12.8x	10.1x	8.9x	8.5x	1.5x	1.5x	1.4x	4.6%	5.0%	5.2%
		<b>5.4%</b>													
<b>Installation/Equipment</b>															
Schneider Electric SE	FR0000121972	4.8%	20.7x	18.6x	17.4x	15.9x	14.6x	12.8x	12.1x	3.2x	3.0x	2.8x	2.2%	2.4%	2.6%
Legrand SA	FR0010307819	4.6%	20.6x	17.6x	17.3x	16.1x	12.9x	11.7x	11.5x	3.2x	3.1x	2.9x	2.0%	2.5%	2.6%
Eaton Corp PLC	IE00B8KQNB27	5.6%	31.8x	23.3x	21.1x	19.1x	25.8x	18.6x	16.7x	4.5x	4.5x	4.2x	1.6%	1.7%	1.8%
Itron Inc	US4657411066	3.7%	91.0x	25.9x	20.6x	15.0x	35.7x	16.0x	12.8x	2.2x	2.1x	1.9x	n/a	n/a	n/a
Xinyi Solar Holdings Ltd	KYC9829N1025	1.8%	10.7x	10.5x	7.3x	5.9x	8.1x	7.7x	5.6x	1.4x	1.3x	1.1x	6.5%	4.4%	6.5%
SolarEdge Technologies Inc	US83417M1045	0.8%	52.2x	12.6x	15.5x	8.1x	13.7x	7.4x	8.5x	1.7x	1.7x	1.6x	n/a	n/a	n/a
Enphase Energy Inc	US29355A1079	1.2%	28.5x	18.3x	20.6x	13.4x	19.6x	13.4x	15.2x	10.7x	10.1x	7.6x	n/a	n/a	n/a
First Solar Inc	US3364331070	3.6%	n/a	18.4x	11.0x	7.3x	57.2x	12.7x	7.6x	2.4x	2.3x	1.9x	n/a	n/a	n/a
Canadian Solar Inc	CA1366351098	2.3%	4.3x	3.6x	3.5x	3.4x	5.3x	3.3x	2.7x	0.5x	0.4x	0.4x	n/a	n/a	n/a
Vestas Wind Systems A/S	DK0061539921	3.9%	n/a	2696.5x	32.2x	17.6x	n/a	21.2x	11.7x	7.0x	6.6x	5.5x	n/a	0.1%	0.8%
TPI Composites Inc	US87266J1043	0.1%	n/a	n/a	n/a	6.4x	9.4x	n/a	7.4x	n/a	1.5x	2.1x	n/a	n/a	n/a

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:

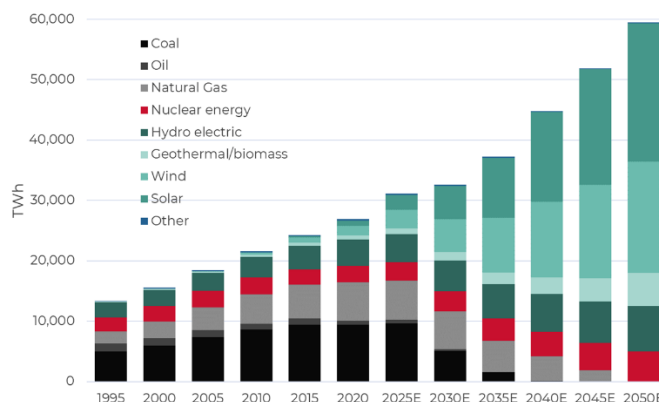
- **Population and GDP growth** putting a significant strain on today's energy supply
- **Economics** as sustainable sources of energy will be cheaper than the incumbents
- **Climate change** leading the world to reduce carbon emissions via cleaner energy
- **Pollution** forcing governments to drive 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 MtCO<sub>2</sub>e) 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

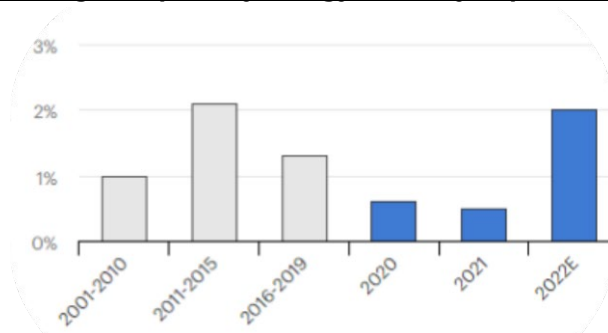
Energy efficiency is a key pillar of new policy. For example, the EU had previously set itself a challenging target to consume 9% less energy in 2030 than in 2020 and the new RePowerEU deal saw this ratcheted up to 13%, supported by €100bn of funding for residential and industrial efficiency. A few months 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, to 31 December 2022

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

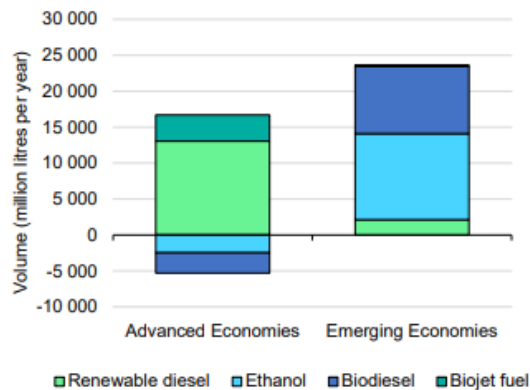
Alternative fuels are materials or substances which can be used as fuel to displace coal, oil, and natural gas. They encompass solid biofuels (also known as biomass e.g. wood, bagasse, animal waste), biogas (e.g. renewable natural gas, biomethane), and liquid biofuels. Below we will predominantly focus 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, November 2023

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 decarbonising liquid fuels is on government support.

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 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 mix.

**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.

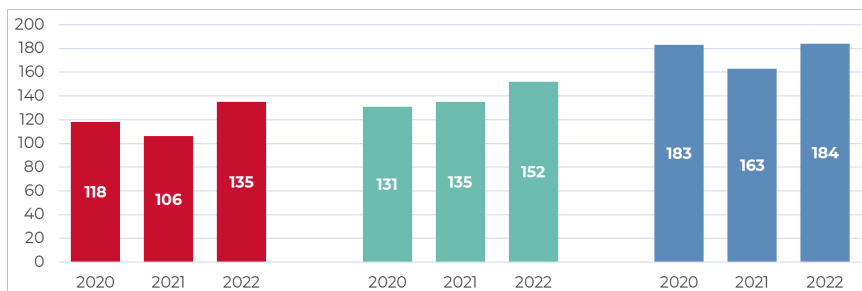
These metals are used in the cathode, which typically represents around 60% of the cost of a cell and just under half of the cost of a battery pack. Electric vehicle batteries are dominated by three main cathode chemistries: Nickel Manganese Cobalt



(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.

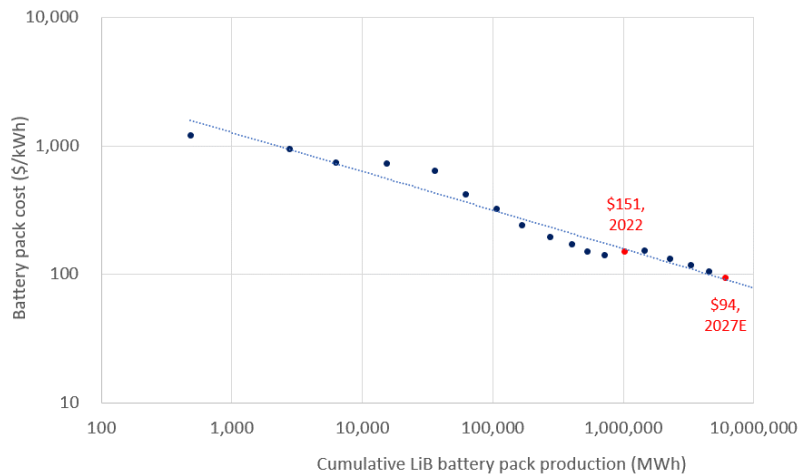
### **Historical LFP (red), NCA (green), NMC (blue) pack prices, US\$/kWh**



Source: BNEF, November 2023

Despite seeing the biggest increase in prices in 2022 (+27% for LFP vs +13% for NMC and NCA), LFP remains the cheapest. 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)**



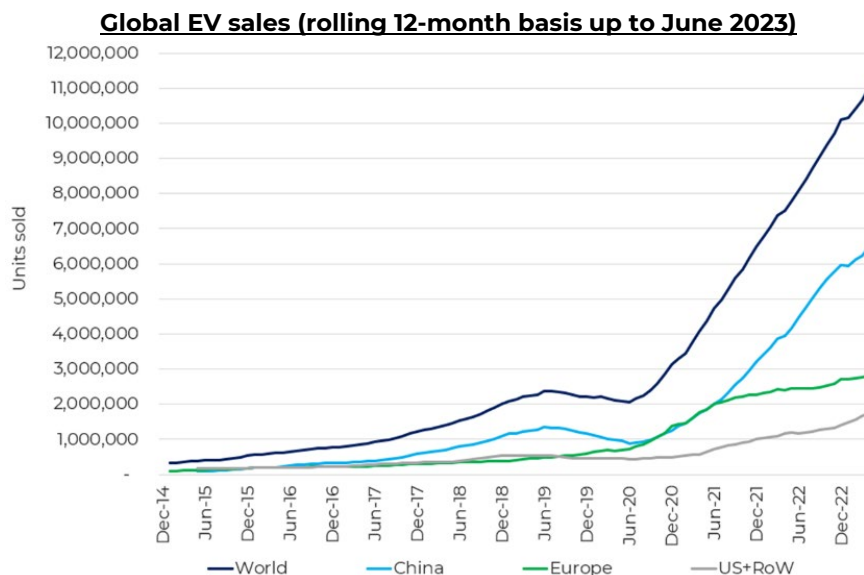
Source: Bloomberg, Guinness Global Investors, November 2023

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 over 10 million plug-in vehicles sold throughout the year, 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%.



Source: Guinness Global Investors, EV-Sales, Cleantechica

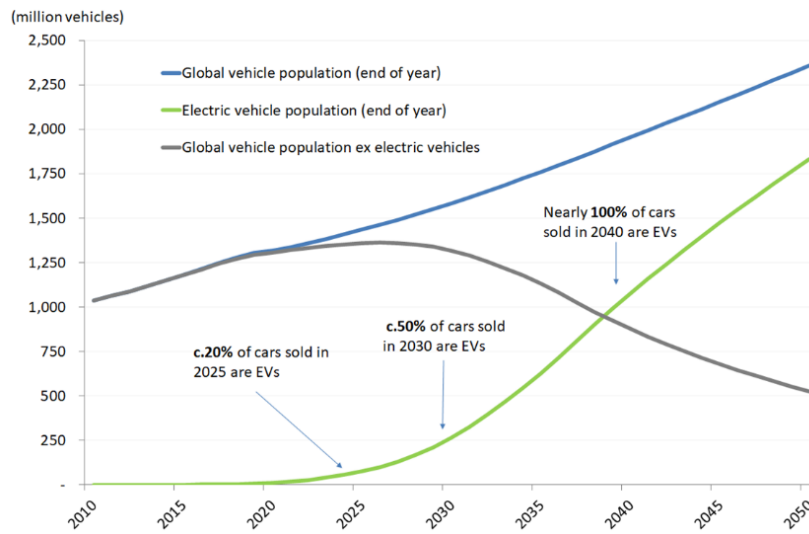
Much of this growth has been driven by policy, with governments now subsidising 10-30% of the price of an electric vehicle, while bringing forward the timeline on banning internal combustion (ICE) sales. Governments cannot maintain subsidies long-term and it will be interesting to see how the Chinese market continues to develop in 2023 now that the long-existing new energy vehicle (NEV) subsidy programme 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, 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)**



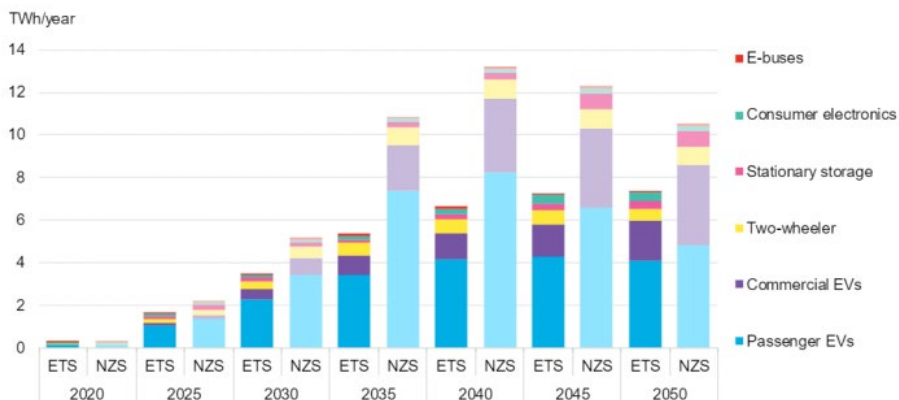
Source: IEA; Guinness Global Investors estimates, November 2023

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 base case and net zero scenarios**



Source: BNEF, November 2023

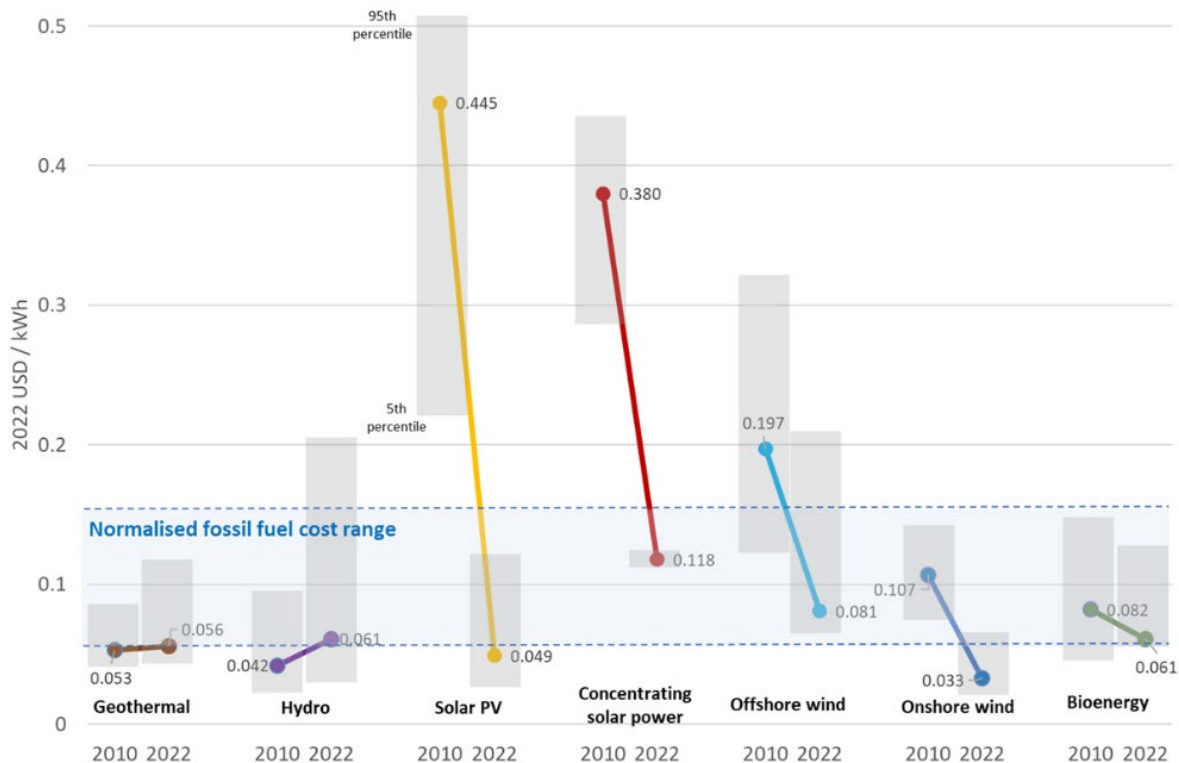
**Generation & installation (equipment)**

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 (2010–2022)**



*Source: IRENA, Guinness Global Investors estimates, to 31 December 2022*

### **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 above) 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, our initial estimate for 2023 module demand of 310 GW has now increased to 345 GW, another record year for global installations, with growth of nearly 100 GW versus 2022.

Regionally, the key moving parts 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 2023 are now likely to be around 33 GW as demand is less likely to be impacted by NEM3.0 and the WRO.

- Demand in **Europe** was 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 was around 107 GW in 2022 (up nearly 40 GW on 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)**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023E
<b>OECD solar installations (annual)</b>														
North America	1	2	4	6	7	8	14	11	10	11	19	25	24	33
Germany	7	7	8	3	2	1	2	2	4	4	5	6	7	10
Spain	0	0	0	0	0	0	0	0	0	5	3	5	7	8
Rest of Europe	3	4	5	5	5	6	4	3	4	6	12	19	21	29
Australia	0	1	1	1	1	1	1	2	4	4	4	5	4	5
South Korea	0	0	0	1	1	1	1	1	2	3	6	4	3	3
Japan	1	1	2	7	10	11	8	8	7	7	9	6	6	6
<b>Total OECD</b>	<b>17</b>	<b>23</b>	<b>24</b>	<b>24</b>	<b>25</b>	<b>29</b>	<b>29</b>	<b>26</b>	<b>31</b>	<b>40</b>	<b>58</b>	<b>71</b>	<b>76</b>	<b>98</b>
Change	10	7	0	0	2	4	0	-3	5	9	18	13	18	22
<b>Non-OECD solar installations (annual)</b>														
China	0	3	3	14	13	19	30	53	44	33	52	69	107	154
India	0	0	1	1	1	2	5	10	11	12	4	12	18	16
Rest of non-OECD	1	3	3	4	6	6	11	9	22	34	32	30	47	78
<b>Total Non-OECD</b>	<b>2</b>	<b>5</b>	<b>8</b>	<b>18</b>	<b>21</b>	<b>27</b>	<b>46</b>	<b>72</b>	<b>77</b>	<b>78</b>	<b>88</b>	<b>111</b>	<b>172</b>	<b>247</b>
Change	1	3	2	11	2	6	19	26	5	1	10	23	58	75
<b>Total solar installations (annual)</b>	<b>19</b>	<b>29</b>	<b>31</b>	<b>42</b>	<b>46</b>	<b>56</b>	<b>75</b>	<b>98</b>	<b>108</b>	<b>118</b>	<b>146</b>	<b>182</b>	<b>250</b>	<b>345</b>
Change	11	10	2	11	4	10	19	23	10	10	28	36	76	95

Source: BP, BNEF, PV InfoLink, IEA and Guinness Global Investors estimates, November 2023

**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 to 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

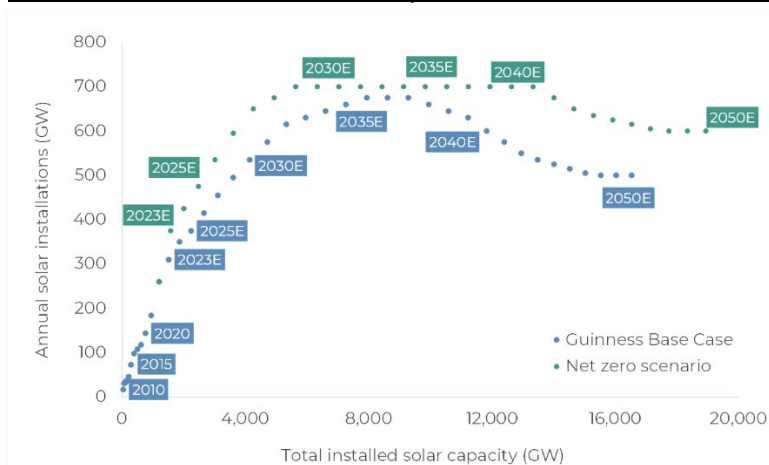
prices will fall in 2023 and beyond, allowing margin expansion elsewhere in the value chain as well as lower solar module prices.

- **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 improved through 2022. In August 2022, 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, November 2023

**The wind sector**

Despite recent challenges, 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 installation growth has 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)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022E	2023E
<b>Onshore wind installations (annual)</b>																
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
<b>Total onshore</b>	<b>27</b>	<b>38</b>	<b>35</b>	<b>40</b>	<b>46</b>	<b>33</b>	<b>49</b>	<b>61</b>	<b>55</b>	<b>49</b>	<b>46</b>	<b>55</b>	<b>91</b>	<b>83</b>	<b>88</b>	<b>95</b>
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
<b>Offshore wind installations (annual)</b>																
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
<b>Total offshore</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>4</b>	<b>4</b>	<b>8</b>	<b>7</b>	<b>17</b>	<b>10</b>	<b>18</b>
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
<b>Total wind installations</b>	<b>27</b>	<b>38</b>	<b>36</b>	<b>40</b>	<b>48</b>	<b>35</b>	<b>50</b>	<b>65</b>	<b>56</b>	<b>53</b>	<b>50</b>	<b>63</b>	<b>98</b>	<b>100</b>	<b>98</b>	<b>113</b>
Change		12	-2	4	8	-13	16	15	-9	-3	-2	12	35	3	-2	15

Source: BP, IEA, BNEF, Guinness Global Investors estimates, November 2023

### 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 14<sup>th</sup> 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 three 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.

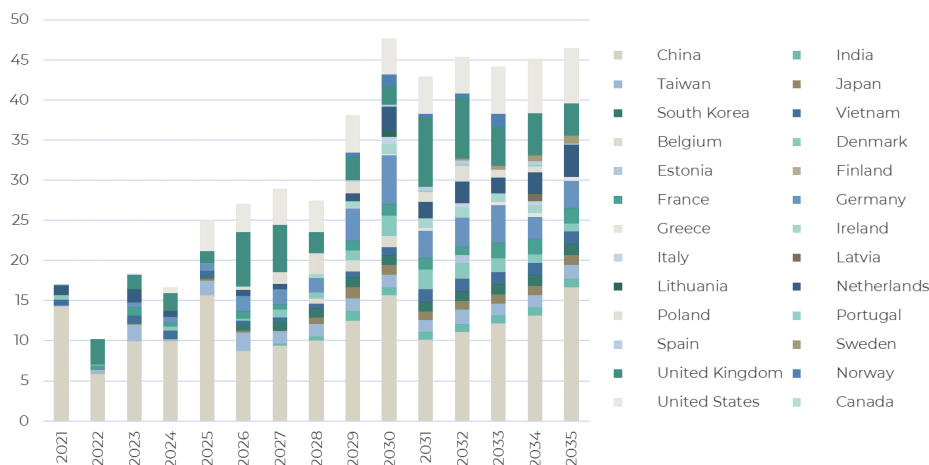
**Offshore wind**

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). The first half of 2023 brought a number of problems for offshore wind companies including significant impairments and profit warnings from turbine manufacturers (example Siemens Gamesa) as well as developers (example Orsted) reflecting a number of shorter-term supply chain-related issues as well as more structural longer term issues around the economic viability of the resource.

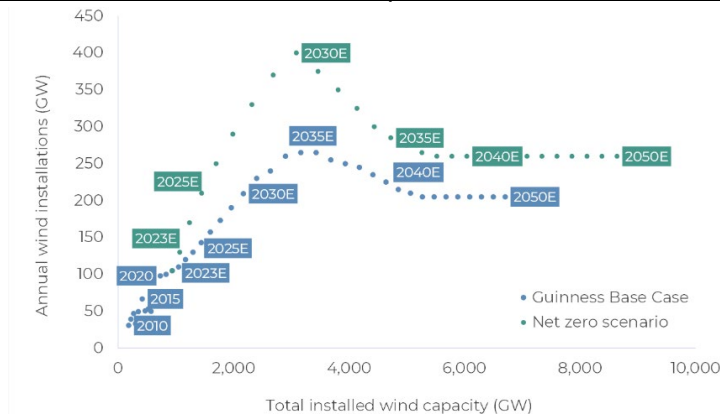
**Outlook for offshore wind installations (GW per annum, to 2035)**



Source: BNEF, November 2023

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 and recent announcements in 2023 are slowing the momentum.

**Global wind annual installations, base case and NZE scenario**



Source: IEA, IPCC, Guinness Global Investors, November 2023

## IMPORTANT INFORMATION

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The documentation needed to make an investment, including the Prospectus, the Key Investor Information Document (KIID), Key Information Document (KID) and the Application Form, is available in English from [www.guinnessgi.com](http://www.guinnessgi.com) or free of charge from the Manager: Waystone Management Company (IE) Limited 2nd Floor 35 Shelbourne Road, Ballsbridge, Dublin D04 A4E0, Ireland; or the Promoter and Investment Manager: Guinness Asset Management Ltd, 18 Smith Square, London SW1P 3HZ.

Waystone IE is a company incorporated under the laws of Ireland having its registered office at 35 Shelbourne Rd, Ballsbridge, Dublin, D04 A4E0 Ireland, which is authorised by the Central Bank of Ireland, has appointed Guinness Asset Management Ltd as Investment Manager to this fund, and as Manager has the right to terminate the arrangements made for the marketing of funds in accordance with the UCITS Directive.

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