

## 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>Irish Domiciled</b>	Guinness Sustainable Energy Fund
<b>UK Domiciled</b>	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

### REVIEW OF THE FIRST HALF OF 2023

The first half of 2023 saw continued positive momentum for the energy transition. Further details emerged of the significant energy transition policy commitments by the EU and US last year. Against this, disruption in the banking sector, coupled with volatile sentiment around interest rates, brought fears of a slowdown in funding that could affect the level of future sustainable energy investments. This report covers macro developments, contribution to fund returns in the quarter, and portfolio valuation.

### EQUITIES

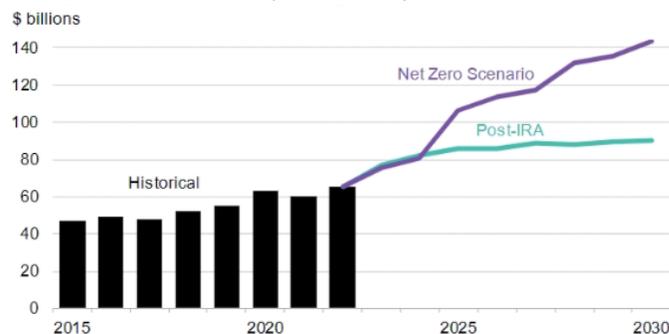
Sustainable energy equities underperformed global stock markets in June. The Guinness Sustainable Energy Fund (Class Y) returned +3.9% (in USD), behind the MSCI World at +6.0%. Year-to-date, the Fund has delivered +9.5% in USD versus the MSCI World at +15.1%. The Fund's performance in June was led by the efficiency (+16.5%) and electric vehicle (+10.4%) sub-sectors, while battery and IPP-oriented names were underperformers.

### CHART OF THE MONTH

As discussed in March, the grid is an often-overlooked part of the energy transition. As electrification continues apace and renewables become a greater portion of the energy mix, the grid needs to increase in scale and change in nature (bi-directional smart grids are needed vs analogue grids designed for centralized generation). July's chart of the month shows the latest BloombergNEF estimates for historic grid spend vs both forecasted post-IRA spend and what is required to hit net zero. The fund is well exposed to this theme through companies that own and operate electricity networks (Iberdrola, NextEra Energy), produce low and medium-voltage equipment (Legrand, Eaton, Schneider and produce smart meters (Hubbell, Itron).

### Comparison of US annual grid investment scenarios

(Source: BNEF)



**JUNE 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>Battery energy storage installations are set to grow tenfold by the end of the decade, according to new estimates from Rystad Energy. Total installations, which were 43GWh in 2022, are set to rise by more than 70% this year and to exceed 420GWh by 2030. The growth is set to occur at all levels (utility, microgrid and residential) and can be largely attributed to falling battery storage costs as well as increased incentives in North America, Europe and China.</p>	<p>Battery Electric Storage</p>	
<p>China's non-fossil fuel energy sources now exceed 50% of its total installed electricity generation capacity according to state media outlet, Xinhua. At 50.9% of generation capacity, the current installed base of non-fossil fuel power sources has surpassed targets initially set for 2025, which bodes well for meeting the country's target for peak carbon emissions in 2030.</p>	<p>China energy transition</p>	
<p>Siemens Energy, the world's largest provider of offshore wind turbines, issued a shock profit warning during the month. The company cited quality problems linked to select components from a few suppliers, which impacted 15-30% of the company's installed base and is expected to cost in excess of EUR 1bn to fix. As things stand, these issues appear company-specific and manageable (Siemens Energy has over EUR5bn in cash on its balance sheet), but the warning does highlight some of the pitfalls associated with ramping up new technologies at pace.</p>	<p>Wind supply chain</p>	
<p>The Biden administration has proposed a new regulation to lower project fees for renewable developments on federal lands by as much as 80% to further improve the economics of development. The proposal would relate to the Bureau of Land Management (BLM), which manages one in every 10 acres of land in the US and are congressionally mandated to permit 25GW of renewable energy by 2025.</p>	<p>US energy transition</p>	
<p>The Japanese government announced its intention to invest \$107bn in hydrogen supply over the next 15 years to help decarbonise some of the more difficult-to-abate domestic industries. The move represents a material step change in ambition, with a target to generate 12mtpa in hydrogen by 2040 vs prior plans of 3mtpa by 2030.</p>	<p>Hydrogen economy</p>	

## MANAGERS' COMMENTS

## Review of 1H23

## Summary

- The energy transition continues to accelerate, driven by economics and political needs. In the shorter term, **energy security** has become the most important catalyst for the transition (Europe displacing Russian hydrocarbons; North America and Europe reducing reliance on China).
- The policy backdrop remains highly supportive. The Inflation Reduction Act in the US is driving significant new investments in upstream solar, wind, grid energy storage, hydrogen, EVs and home efficiency upgrades. Europe is refining the Net Zero Industry Act and China is likely to upgrade its current five-year plan.
- Renewable power installations will reach **record levels in 2023**. The forecast for renewable power additions in 2023-2027 has been upgraded by around 30% to just over 2,400 GW; around double what was installed over the previous five years and equivalent to total Chinese power capacity.
- Solar installations in 2023 to reach a **new record level** in excess of 340 GW (growth of at least 30% vs 2022).
- Wind installations in 2023 likely to reach a **new record level** of more than 110 GW (growth of at least 15% vs 2022).
- **EV sales in 2023 around 14 million**, representing around 18% of total passenger vehicle sales (growth of c. 35% vs 2022).
- **Battery demand growing around 40% in 2023** driven by lower raw material costs and increased demand from both EVs and stationary storage.
- Despite the acceleration of the energy transition, **growth and installation rates are not consistent with a 1.5 degree/net zero scenario**. Further material acceleration is needed.
- The **Guinness Sustainable Energy portfolio** trades at a 18% and 5% P/E ratio premium to the MSCI World for 2023/24 respectively but is expected to deliver compound annual earnings growth of 22% out to 2025 (c.3x the earnings growth for MSCI World, which is expected at 6% per annum), with comparable cash flow returns. The fund's P/E ratio relative to MSCI World is the lowest that it has been since mid-2020 and, given the duration of higher earnings growth expected, could see a positive re-rating over the next few years.

## Review

**The first half of 2023 saw continued positive momentum for the energy transition. Further details emerged of the significant energy transition policy commitments that were announced by the EU and US last year. Against this, disruption in the banking sector, coupled with volatile sentiment around interest rates, brought fears of a slowdown in funding that could affect the level of future sustainable energy investments. In this report, we review macro developments, contribution to fund returns in the quarter, outlook and portfolio valuation.**

In the first half of 2023 the Guinness Sustainable Energy Fund delivered a total return (USD) of +9.5%, underperforming the MSCI World Index (net return) of +15.1%. The key events, both positive and negative for sector sentiment, that have affected the energy transition, company profitability and share price performance so far this year have included:

- The EU announced its new **EU Industrial Strategy** in a number of stages over the half, although full details still remain thin on the ground. Currently, we understand that the strategy aims to quadruple the EU renewable fleet by 2030 (requiring around €1tn of capex); to shorten the renewable project permitting process from 4-5 years to 9-18 months; and to establish an EU renewable supply chain with incentives for activities that achieve a 'made in Europe' minimum threshold. In March, the EU unveiled its 'Critical Raw Materials Act' which sets targets for the production, refining and recycling of key raw materials needed for the green and digital transitions.

- The **collapse of Silicon Valley Bank** and the **takeover of Credit Suisse by UBS** in mid-March brought growing concerns of a developed world credit crisis that, together with higher interest rates, raised concerns around funding for sustainable energy projects. The full implications are not yet clear, but further restricted funding from US regional banks could slow the growth rates of US residential solar installations.
- Further details around the **US Inflation Reduction Act** continue to tempt sustainable energy equipment manufacturers and producers to locate and grow their activities in the United States. Incremental detailed guidance on new tax rules (for example the proportion of domestic content that will be required for US manufacturing plants to qualify for the incentives) continued to be drip fed out by the treasury during the half, providing firms with the incremental certainty they need to make expansionary investments.
- The **removal of subsidies for new EV** sales in China and in certain parts of Europe slowed EV sales growth at the start of the year, but this has eased materially as OEMs cut prices by as much as 20% to stimulate demand. The latest EV sales data suggests the industry is growing 40% YTD across all segments of road transport (passenger vehicles, light commercial vehicles, buses and 2/3-wheelers). Looking longer-term, the quarter saw significant new investment announced in battery 'gigafactories' across the US.
- **Battery economics** improved meaningfully throughout the half with Chinese lithium supply growth prompting a material moderation in battery metal prices, helping to spur both EV and stationary storage demand. Battery demand now looks likely to grow by 40% for 2023.
- Following a rare bout of cost inflation in 2022, the **solar** complex resumed its deflationary trend during the half as a decline in input prices allowed the cost of solar modules to decline by 20%, making the economics of installation all the more compelling. In the US, some developers struck a more cautious note on growth as a function of higher interest rates and the phasing of regulation in California, but offsetting this, the US Department of the Treasury provided further clarity on incremental tax credits for companies using more than 40% domestic content in their projects. Overall, global solar installations have accelerated again and now appear likely to be up 30% year-on-year vs initial expectations of 20%.
- **Wind** OEMs have slowed the rate of new product launches this year as sluggish demand and higher input costs hamper profitability. Europe has set meaningful wind power targets, but recent policy announcements have not led to the investments hoped for into the local supply chain, risking shortages in the latter half of the decade. In the US, with improved IRA clarity there are signs of improvement, meaning that US wind additions are likely to trough in 2023 before recovering in 2024.

**Wind outlook scenarios**

(Source: BNEF)



**The Guinness Sustainable Energy Fund**

With a backdrop of volatile interest rate sentiment and a market characterised by a strong growth factor rotation, the Guinness Sustainable Energy Fund delivered solid returns during the first half of the year, finishing June +9.5% YTD. The fund underperformed the MSCI World Index, which finished the half +15.1%, despite enjoying better earnings revisions (2023 earnings +1.6% for the fund versus -0.3% for the MSCI World) over the period. Within the portfolio our best-performing segments were our semiconductor and grid-exposed names. Underperforming segments included our solar inverter holdings and wind-exposed names.

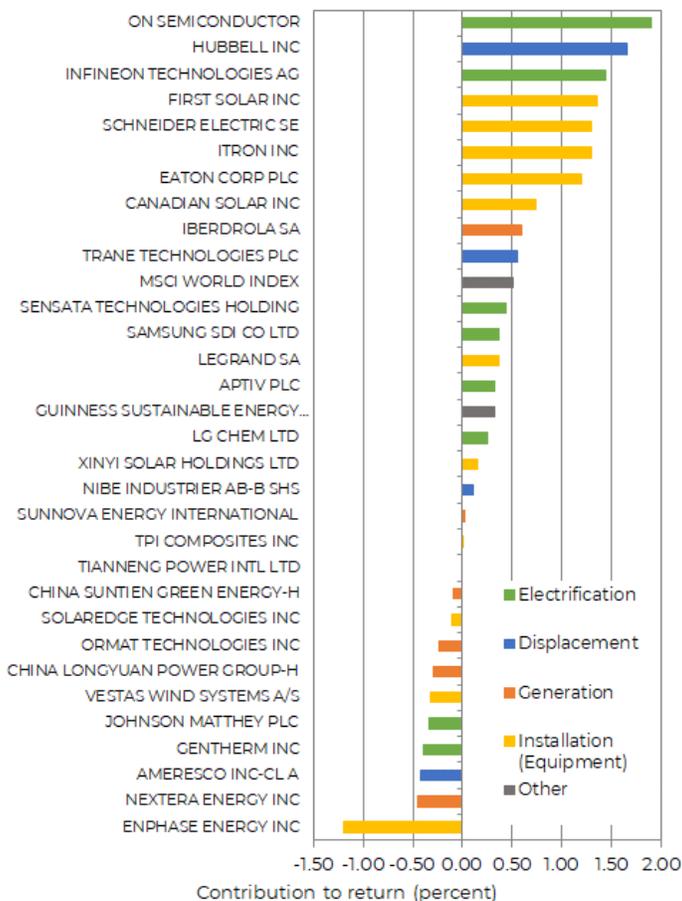
Within semiconductors, our holdings in Onsemi and Infineon both benefitted from the general strength in the semiconductor space, but also from improved company-specific outlooks. Onsemi hosted a capital markets day which highlighted the strong progress it is making in silicon carbide power semiconductors. It stressed its intention to grow faster than the broader semi market out to 2027 and upgraded its long-term margin targets from 28% to 40%. Infineon increased its revenue guidance and upgraded full-year margin expectations from 25% to “high 20s”, driven by robust activity in its core auto and industrial end markets.

Our electrical equipment names Eaton, Hubbell, Schneider, Itron and Legrand all performed strongly, driven by an acceleration in global electrification activity and an easing of supply chain bottlenecks. Hubbell noted particular strength in their utility division driven by a sustainable step up in grid modernisation activity. Schneider, Eaton and Legrand all cited strength in their core low-voltage markets, and Itron saw an easing in its supply chain, enabling it to procure components which had been difficult to source.

Within our solar holdings we saw a bifurcation between module manufacturers Canadian Solar and First Solar, which benefitted from declining polysilicon prices as well as favourable tax announcements, and inverter stocks Enphase and SolarEdge, which noted a slight slowdown in activity driven by higher interest rates and changing regulation in California. It was notable that both inverter players view this slowdown as temporary, as the market gets used to changes in regulation, and still expect annual earnings growth over 20%.

The final notable area of weakness was with our wind IPP holdings China Longyuan and China Suntien, where price evolution has been driven by concerns around Chinese subsidy reforms as well as underperformance in the broader Chinese equity market.

## H1 2023 contribution for Guinness Sustainable Energy Fund



Source: Bloomberg, Guinness Global Investors estimates; 30 June 2023

### Outlook

Looking at the remainder of 2023 and beyond, we expect further acceleration of the energy transition:

- On the supply side of the energy transition, the IEA is forecasting that **renewable power additions** over the coming five years will be just over 2,400 GW; a 30+% increase on its previous five-year forecast and their largest upward revision. The world is set to add as much renewable capacity in the next five years as it did in the past 20 years, equivalent to the entire current power capacity of China.
- The IEA has described **solar** power as "the cheapest electricity in history" and large-scale solar remains at the bottom end of the cost curve. At the start of the year we expected solar installations to grow around 20% year-on-year to 310GW, but with increased clarity from the IRA and improving polysilicon prices, various commentators are now suggesting that this could be higher, with Bloomberg New Energy Finance suggesting a figure of 340GW is more appropriate, a 30% increase.
- Despite cost issues amongst the **wind** OEMs and absence of detail from the European Net Zero Industrial Act we continue to expect annual wind installations of 110GW for 2023, with lower installations outside of China driven by developers struggling with financing and supply chain costs. Thereafter, with improved IRA clarity and easing supply chains, we would expect to see an improvement into 2024, with global wind capacity quadrupling by 2040.
- Within EVs, we would expect current growth momentum, post EV subsidy cuts, to continue into year end, driving **EV sales to around 14 million units**, representing an 18% penetration rate. Chinese penetration will likely end up even higher than this in the 35-40% range.

## Guinness Sustainable Energy

- **Battery** economics are likely to benefit from current low metal prices, which coupled with ongoing EV demand is likely to grow global battery demand by 40% in 2023 to nearly 1000GWh. Within that we expect stationary storage demand to double from 16GW in 2022 to 32GW in 2023. As a reminder, we think that this moderation of commodity prices, coupled with improvements to cell chemistry and efficiency improvements in battery pack design, will help deflate battery costs to \$100/kWh by 2027, which is the point at which EVs become cheaper than internal combustion engine vehicles.
- While much progress has been made regarding the deployment of renewables into electricity generation, grid investment has struggled to keep up. With growing interconnection queues increasingly becoming a bottleneck to further renewable deployment, we foresee a step up in **grid investment** from \$300bn in 2022 to closer to \$600bn by 2030, driven by digitalisation, improving resilience and extending the grid to new generation facilities.

The outlook we summarise here is broadly consistent with current government activity and observable investment plans. To be clear, however, the growth described falls well short of the energy transition activity needed to achieve a **net zero / 1.5 degree scenario** in 2050, as targeted by the IPCC and reiterated at COP27. In a net zero scenario, the deployment of renewable generation capacity, penetration of EVs and battery storage, use of alternative fuels and implementation of energy efficiency measures will need to accelerate markedly.

At 30 June 2023, the **Guinness Sustainable Energy Fund** traded on 2023/24 P/E ratios of 20.6x/17.1x. On a 12-month forward view, the fund trades at about a 13% P/E premium to the MSCI World Index, which is as low as it has been in the last three years:



Source: Bloomberg; Guinness Global Investors

We consider the current P/E ratio premium of the fund as low given the superior earnings growth expected. To the end of 2025, our portfolio is expected to deliver compound annual earnings growth of 22.1% (consensus), which is more than three times the earnings growth rate of the MSCI World.

As at 30 June 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	24.6x	20.6x	17.1x	15.5x	12.7x	10.7x	1.2%	1.4%	6.8%	22.1%	5.4%	7.5%
MSCI World Index	15.9x	17.5x	16.3x	10.4x	11.7x	10.7x	2.1%	2.3%	5.4%	6.1%	8.2%	8.1%
Fund Premium/(Discount)	55%	18%	5%	49%	9%	0%						

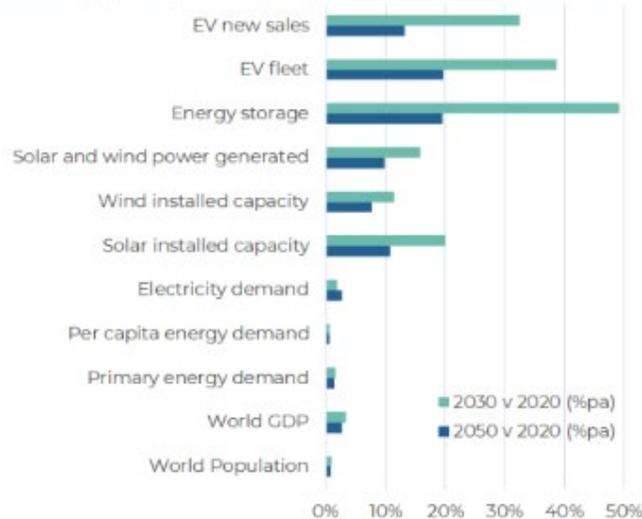
\*Portfolio = median CFROI; Index data = Credit Suisse MSCI World ETF median CFROI

Source: Guinness Global Investors, Bloomberg

## Guinness Sustainable Energy

Longer-term, many of the subsectors in which we are invested offer superior growth rates to the broader equity market. We expect the annual earnings growth of the fund to moderate to around 13-14%, but still comfortably ahead of earnings growth in the MSCI World.

### Ten- and twenty-year growth projections for sustainable energy sectors



Source: Guinness Global Investors estimates, Bloomberg, BP, IEA

The fund is broadly positioned across both the supply and demand side of the investment universe with positions in electrification, EV and battery manufacturing, wind, solar and energy efficiency.

### Key themes in the Guinness Sustainable Energy Fund

Theme	Example holdings	Weighting (%)
1 Electrification of the energy mix		24.4%
2 Rise of the electric vehicle and auto efficiency		20.8%
3 Battery manufacturing		7.9%
4 Expansion of the wind industry		8.7%
5 Expansion of the solar industry		15.1%
6 Heating, lighting and power efficiency		14.2%
7 Geothermal		3.1%
8 Other (inc cash)		5.9%

Source: Guinness Global Investors (30 June 2023)

PERFORMANCE

Past performance does not predict future returns.

The Guinness Sustainable Energy Fund (Class Y, 0.68% OCF) delivered a return of +3.9% in June, while the MSCI World Index (net return) delivered +6.0% (all in USD terms).

	Ytd	1 Yr	3 Yrs	5 Yrs*	10 Yrs*
Fund (Class Y)	9.5%	23.4%	85.4%	126.9%	119.8%
MSCI World NR Index	15.1%	18.5%	41.2%	54.4%	147.9%
Out/Underperformance	-5.6%	4.9%	44.2%	72.5%	-28.1%

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%

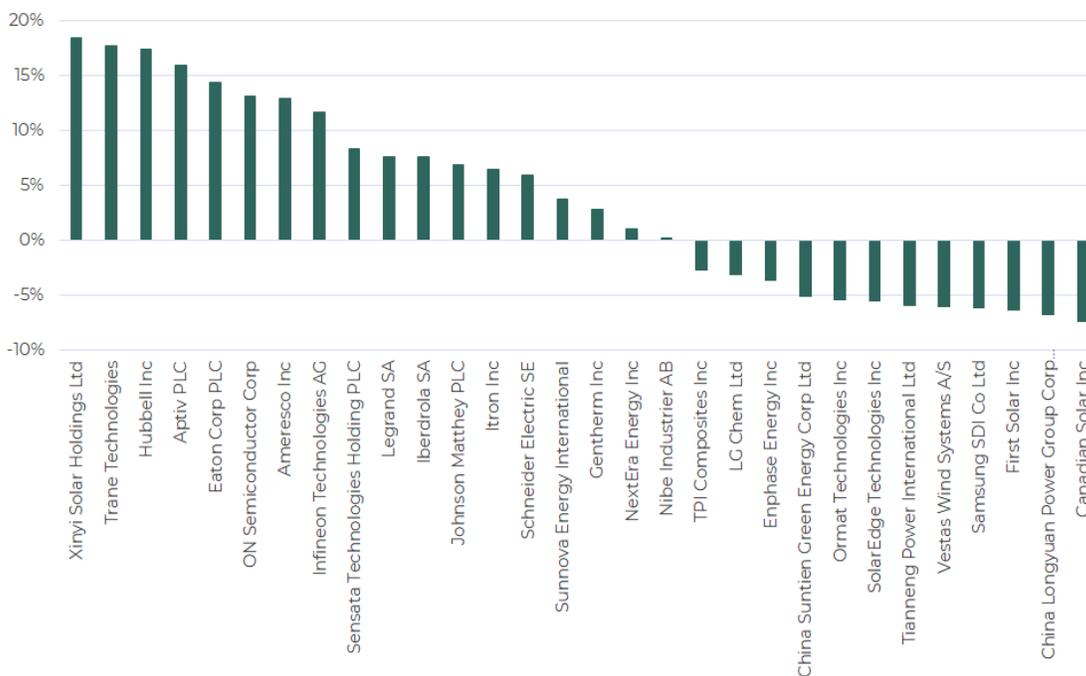
Annual performance	2017*	2016*	2015*	2014*	2013*
Fund (Class Y)	20.2%	-15.4%	-12.0%	-12.1%	70.8%
MSCI World NR Index	22.4%	7.5%	-0.9%	4.9%	26.7%
Out/Underperformance	-2.2%	-23.0%	-11.2%	-17.0%	44.1%

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 0.67% 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 Xinyi Solar, Trane Technologies and Hubbell. The weakest performers were First Solar, Samsung SDI, Vestas and Tianneng Power.

**Stock by Stock performance over the month, in USD**

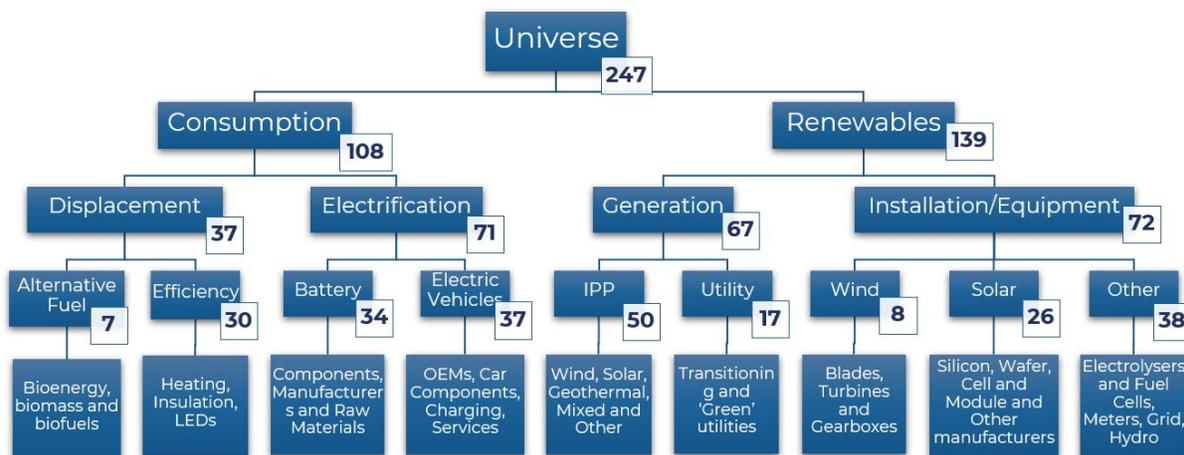


Source: Bloomberg. As of 30 June 2022

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:**

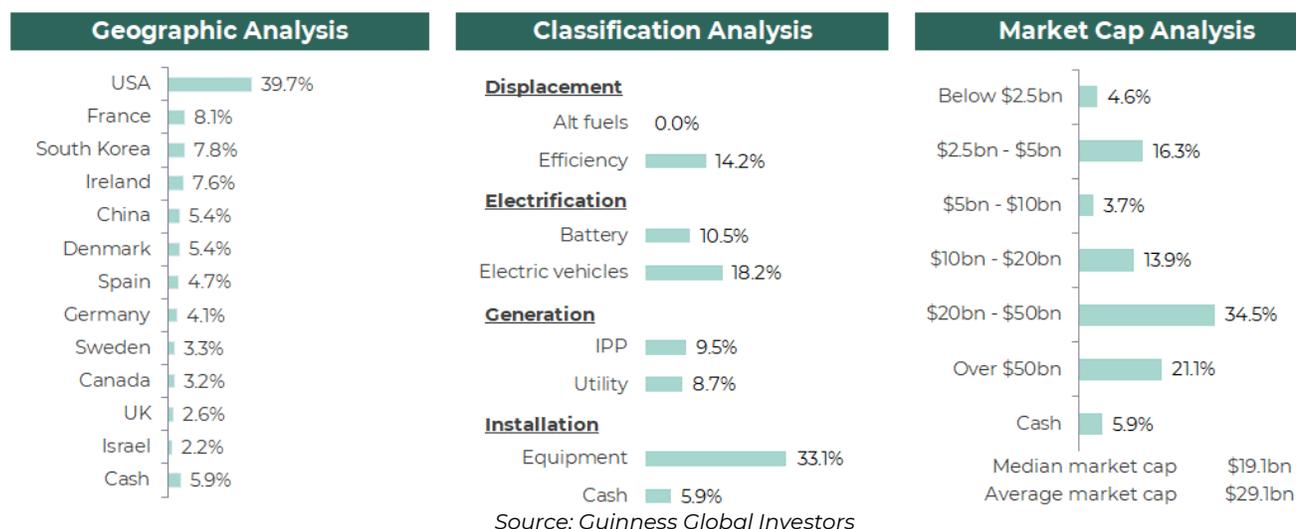


## Guinness Sustainable Energy

### Buys/Sells

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

### Portfolio structure analysis



### 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		
	Jun-23		Dec-22	Dec-21	Dec-20	Dec-19	Dec-18
<b>Consumption</b>	<b>42.9%</b>	<b>-2.0%</b>	<b>44.9%</b>	<b>43.4%</b>	<b>36.7%</b>	<b>41.7%</b>	<b>26.5%</b>
Displacement	14.2%	-0.8%	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	14.2%	-0.8%	15.0%	11.8%	9.9%	13.4%	12.5%
Electrification	28.7%	-1.2%	29.9%	31.6%	26.8%	28.2%	10.1%
Batteries	10.5%	-1.2%	11.6%	8.9%	10.8%	12.6%	3.9%
Electric vehicles	18.2%	0.0%	18.2%	22.8%	16.0%	15.7%	6.2%
<b>Renewables</b>	<b>51.2%</b>	<b>2.0%</b>	<b>49.3%</b>	<b>51.3%</b>	<b>60.4%</b>	<b>54.1%</b>	<b>69.7%</b>
Generation	18.2%	0.5%	17.7%	23.1%	24.6%	22.2%	27.3%
IPP	9.5%	0.8%	8.7%	14.5%	17.0%	18.9%	26.7%
Utility	8.7%	-0.3%	9.0%	8.6%	7.6%	3.2%	0.6%
Installation	33.1%	1.4%	31.6%	28.2%	35.8%	32.0%	42.5%
Equipment	33.1%	1.4%	31.6%	28.2%	35.8%	32.0%	42.5%
Cash	5.9%	0.1%	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 June 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	24.6x	20.6x	17.1x	15.5x	12.7x	10.7x	1.2%	1.4%	6.8%	22.1%	5.4%	7.5%
MSCI World Index	15.9x	17.5x	16.3x	10.4x	11.7x	10.7x	2.1%	2.3%	5.4%	6.1%	8.2%	8.1%
Fund Premium/(Discount)	55%	18%	5%	49%	9%	0%						

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

Source: Guinness Global Investors, Bloomberg

### Portfolio holdings as at end June 2023

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

We hold c.43% 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 (18% weight) while we have 14% 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 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 an 18% 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 biomass (Albioma), geothermal (Ormat) and then broad-based wind/solar renewable energy generation through TransAlta Renewables. 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 and Siemens Gamesa are both well placed providers 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 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 June 2023

Theme	Example holdings	Weighting (%)
1 Electrification of the energy mix		24.4%
2 Rise of the electric vehicle and auto efficiency		20.8%
3 Battery manufacturing		7.9%
4 Expansion of the wind industry		8.7%
5 Expansion of the solar industry		15.1%
6 Heating, lighting and power efficiency		14.2%
7 Geothermal		3.1%
8 Other (inc cash)		5.9%

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

Guinness Sustainable Energy Fund (31 May 2023)		P/E				EV/EBITDA			Price/Book			Dividend Yield		
Stock	% of NAV	2022	2023E	2024E	2025E	2022	2023E	2024E	2022	2023E	2024E	2022	2023E	2024E
<b>Displacement/Efficiency</b>														
Hubbell Inc	4.6%	27.1x	20.8x	19.9x	18.6x	18.6x	14.4x	14.0x	6.4x	5.5x	5.0x	1.5%	1.6%	1.8%
Nibe Industrier AB	3.6%	48.6x	35.9x	31.2x	27.1x	29.0x	22.0x	19.5x	7.7x	6.2x	5.4x	0.6%	0.8%	0.9%
Trane Technologies PLC	3.5%	22.7x	19.3x	17.7x	16.1x	15.2x	13.5x	12.8x	6.5x	5.9x	5.4x	1.6%	1.8%	1.9%
Ameresco Inc	2.2%	23.0x	24.1x	17.7x	12.6x	14.7x	14.4x	11.1x	2.8x	2.4x	2.1x	n/a	n/a	n/a
	<b>13.9%</b>													
<b>Electrification/Battery</b>														
LG Chem Ltd	4.3%	20.2x	21.3x	12.2x	8.0x	9.3x	8.3x	5.8x	1.6x	1.5x	1.4x	1.6%	1.5%	1.7%
Samsung SDI Co Ltd	4.4%	24.5x	23.9x	19.6x	15.8x	14.7x	13.9x	11.2x	2.8x	2.6x	2.3x	0.2%	0.1%	0.2%
Johnson Matthey PLC	2.6%	8.2x	9.5x	9.2x	8.4x	5.4x	6.3x	6.1x	1.2x	1.3x	1.2x	4.5%	4.5%	4.5%
Tianneng Power International Ltd	0.1%	4.8x	4.0x	3.3x	3.5x	3.4x	2.2x	1.8x	0.6x	0.5x	0.5x	5.5%	4.8%	4.8%
	<b>11.4%</b>													
<b>Electrification/Electric Vehicles</b>														
Aptiv PLC	3.2%	26.3x	20.9x	14.8x	11.5x	12.7x	10.4x	8.5x	2.9x	2.5x	2.2x	0.1%	0.2%	0.4%
ON Semiconductor Corp	4.7%	15.8x	17.3x	15.5x	13.5x	10.9x	11.7x	10.5x	5.8x	4.6x	3.7x	n/a	n/a	n/a
Infineon Technologies AG	4.5%	18.9x	13.4x	13.1x	11.9x	10.8x	7.9x	7.5x	3.5x	2.6x	2.3x	0.9%	1.0%	1.3%
Sensata Technologies Holding PLC	3.5%	12.5x	10.8x	9.6x	8.7x	10.1x	9.8x	8.8x	2.0x	1.9x	1.6x	0.8%	0.9%	1.0%
Gentherm Inc	2.5%	27.7x	22.3x	15.6x	10.3x	14.5x	10.4x	8.1x	n/a	n/a	n/a	n/a	n/a	n/a
	<b>18.4%</b>													
<b>Generation/IPP</b>														
China Longyuan Power Group Corp Ltd	2.0%	10.8x	8.5x	7.1x	6.0x	11.6x	9.8x	8.5x	1.0x	0.9x	0.8x	1.8%	2.3%	2.8%
Ormat Technologies Inc	3.4%	63.1x	42.9x	32.6x	26.2x	14.6x	12.9x	11.4x	2.5x	2.0x	1.9x	0.6%	0.5%	0.6%
NextEra Energy Inc	3.8%	25.5x	23.6x	21.6x	19.9x	19.8x	16.1x	14.6x	3.3x	3.3x	3.2x	2.3%	2.6%	2.8%
Sunnova Energy International I	1.3%	n/a	n/a	n/a	n/a	74.2x	40.5x	26.8x	1.3x	1.0x	0.9x	n/a	n/a	n/a
China Suntien Green Energy Corp Ltd	1.2%	4.8x	4.6x	3.9x	3.3x	8.5x	9.5x	7.9x	0.5x	0.5x	0.5x	7.1%	7.7%	9.0%
	<b>11.6%</b>													
<b>Generation/Utility</b>														
Iberdrola SA	4.5%	17.4x	15.7x	14.9x	13.9x	11.0x	9.9x	9.4x	1.7x	1.6x	1.5x	4.1%	4.5%	4.7%
	<b>4.5%</b>													
<b>Installation/Equipment</b>														
Schneider Electric SE	4.2%	22.3x	20.1x	18.8x	17.3x	15.1x	13.7x	12.9x	3.4x	3.3x	3.0x	1.9%	2.2%	2.3%
Legrand SA	3.6%	21.0x	19.7x	18.9x	17.7x	13.5x	12.7x	12.3x	3.6x	3.3x	3.0x	2.1%	2.3%	2.4%
Eaton Corp PLC	4.1%	23.3x	20.8x	18.9x	17.5x	18.5x	16.2x	15.0x	4.2x	3.8x	3.6x	1.8%	1.9%	2.0%
Itron Inc	3.8%	134.4x	46.9x	28.5x	17.4x	42.3x	25.6x	17.1x	2.7x	2.5x	2.3x	n/a	n/a	n/a
Xinyi Solar Holdings Ltd	2.0%	15.2x	13.7x	10.3x	8.6x	11.4x	9.7x	7.5x	2.1x	2.1x	1.8x	3.0%	3.4%	4.6%
SolarEdge Technologies Inc	2.2%	60.1x	26.7x	22.3x	19.1x	34.8x	18.1x	14.6x	7.7x	6.0x	4.7x	n/a	n/a	n/a
Enphase Energy Inc	2.0%	39.7x	31.4x	23.5x	18.5x	31.6x	23.3x	17.8x	43.3x	15.8x	9.5x	n/a	n/a	n/a
First Solar Inc	4.8%	n/a	27.7x	15.9x	10.2x	110.7x	18.9x	11.1x	3.7x	3.3x	2.7x	n/a	n/a	n/a
Canadian Solar Inc	3.6%	13.6x	7.4x	6.8x	7.4x	8.6x	4.8x	4.1x	1.1x	1.0x	0.8x	n/a	n/a	n/a
Vestas Wind Systems A/S	3.8%	n/a	337.3x	33.8x	20.8x	n/a	24.9x	12.9x	7.7x	8.3x	6.8x	0.1%	0.1%	0.8%
TPI Composites Inc	0.5%	n/a	n/a	n/a	22.6x	20.7x	20.9x	9.5x	5.0x	2.6x	2.8x	n/a	n/a	n/a
	<b>34.6%</b>													

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:

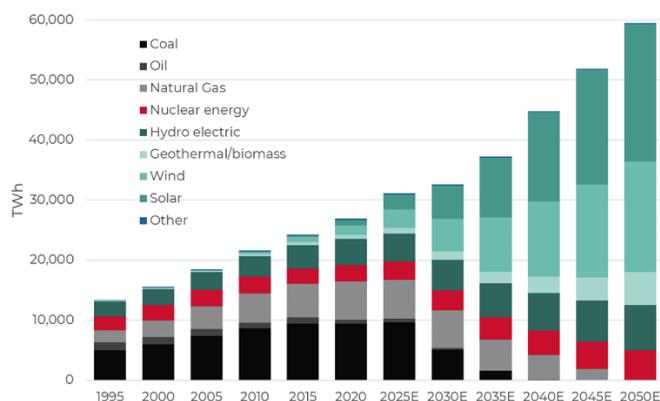
- **Population and GDP growth** putting a significant strain on today's energy supply
- **Economics** as sustainable sources of energy will be cheaper than the incumbents
- **Climate change** leading the world to reduce carbon emissions via cleaner energy
- **Pollution** forcing governments to drive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

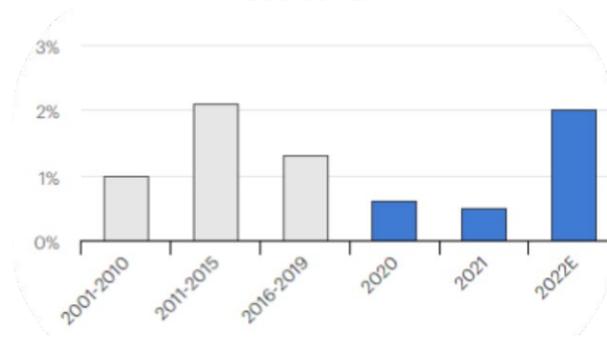
(insulation), cooling (efficient HVAC), and lighting (LEDs) offers some of the quickest ways to decarbonise whilst lowering energy bills and improving energy security.

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



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.

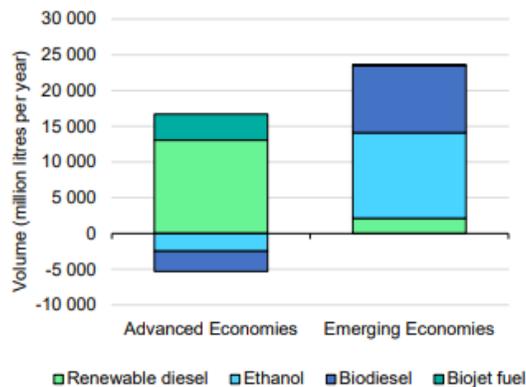
Liquid biofuel demand is expected to have reached 168bn litres in 2022, representing around 4.3% of transportation fuel consumption. The US and Brazil continue to dominate the market, making up around 40% and 25% of global demand respectively, supported by strong domestic industries for corn and sugar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

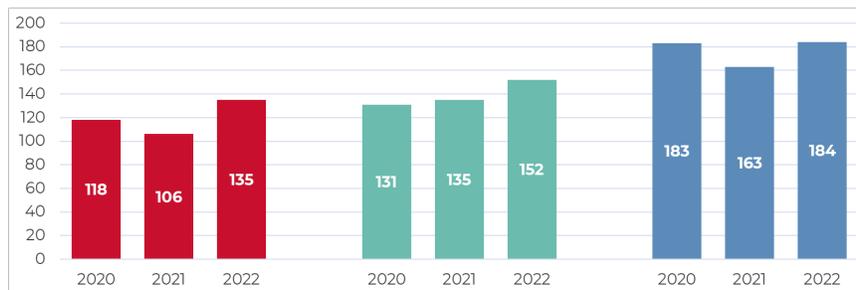
## Guinness Sustainable Energy

(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**

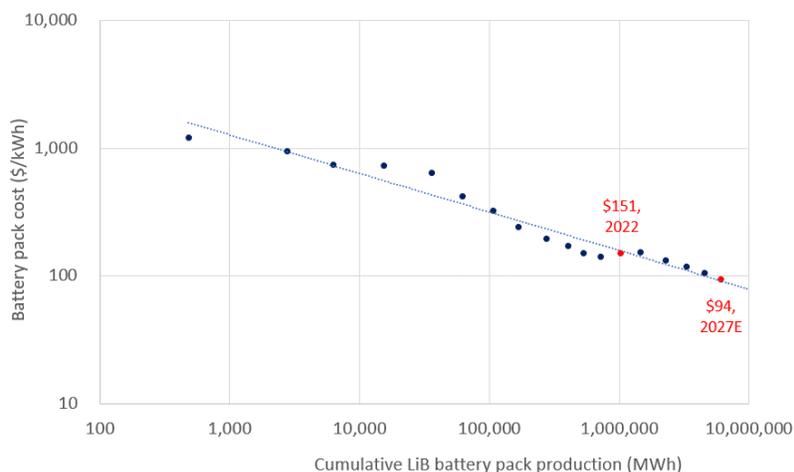
source: BNEF



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.

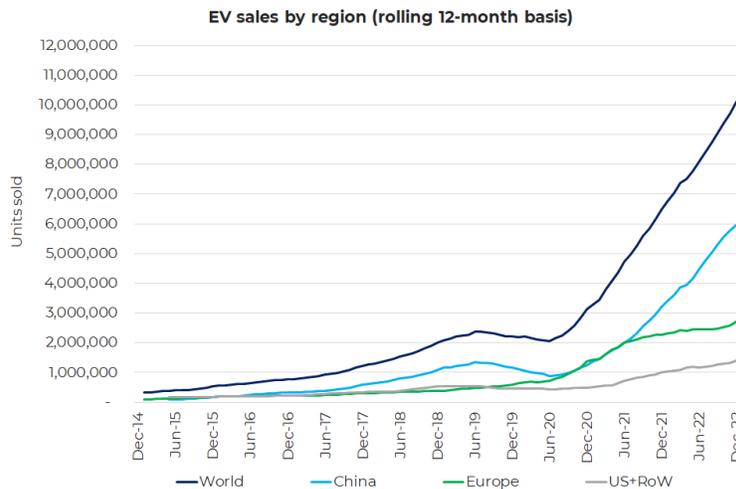
## Electric Vehicles

Electric vehicle (EV) adoption continued apace in 2022 with 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%.

### Global EV sales (rolling 12-month basis up to December 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 market continues to develop 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.

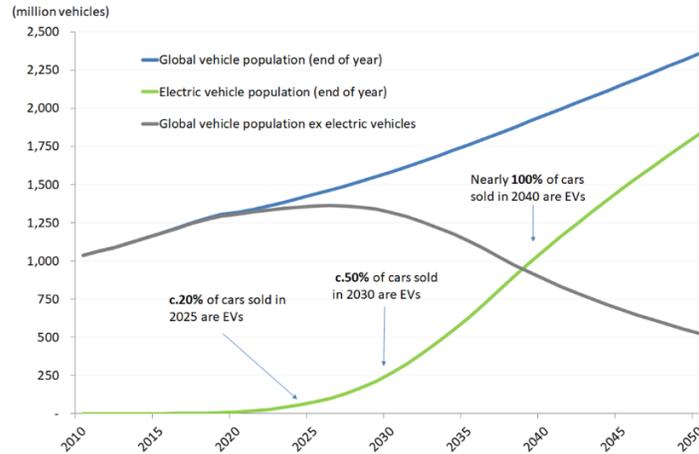
- **Economics:** Electric vehicles cost more to buy but have lower overall running costs. Excluding China, the IEA suggest that BEVs are typically \$15,000 more expensive to purchase. Assuming normalised fuel and electricity prices, we estimate that lifecycle running costs for an electric vehicle in 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



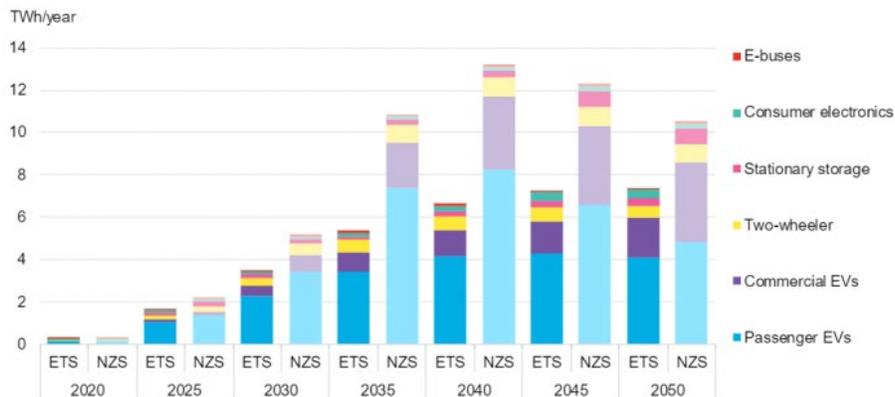
Our base case for electrification implies that there will be over one billion electric vehicles on the road by 2040, that electricity is 57% of total energy demand and that variable renewables such as wind and solar will represent 61% of global power grids. Achieving this would require annual EV sales 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 base case and net zero scenarios**

source: BNEF



**Generation & installation (equipment)**

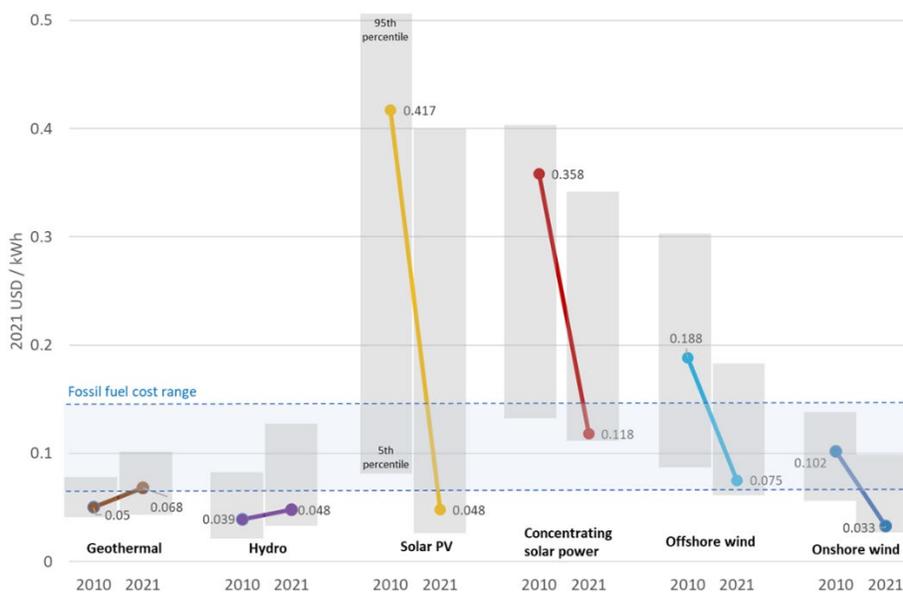
Before considering the detailed dynamics of key renewable power generation markets of wind and solar, it is worth considering the significant changes that have occurred to the economics of various renewable power generation

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 14<sup>th</sup> 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
<b>OECD solar installations (annual)</b>														
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
<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>51</b>	<b>70</b>	<b>88</b>	<b>115</b>
Change	10	7	0	0	2	4	0	-3	5	9	11	19	18	27
<b>Non-OECD solar installations (annual)</b>														
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
<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>93</b>	<b>114</b>	<b>172</b>	<b>195</b>
Change	1	3	2	11	2	6	19	26	5	1	15	21	58	23
<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>144</b>	<b>184</b>	<b>260</b>	<b>310</b>
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.

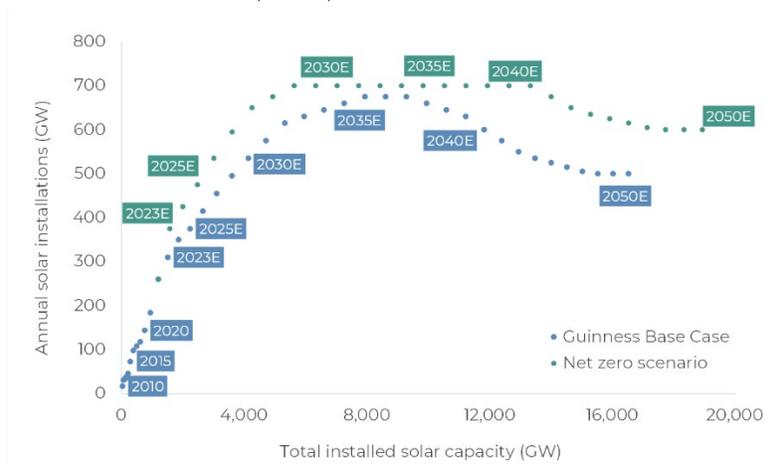
• **Solar module** prices moderated in the second half of 2022 with prices likely to average the same level as 2021. With elevated polysilicon and power prices, it is the module manufacturers that suffered the greatest margin compression in 2022. Module manufacturing nameplate capacity in 2022 is estimated 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*



### **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
<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>
<i>Change</i>		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>
<i>Change</i>		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>
<i>Change</i>		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 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 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.

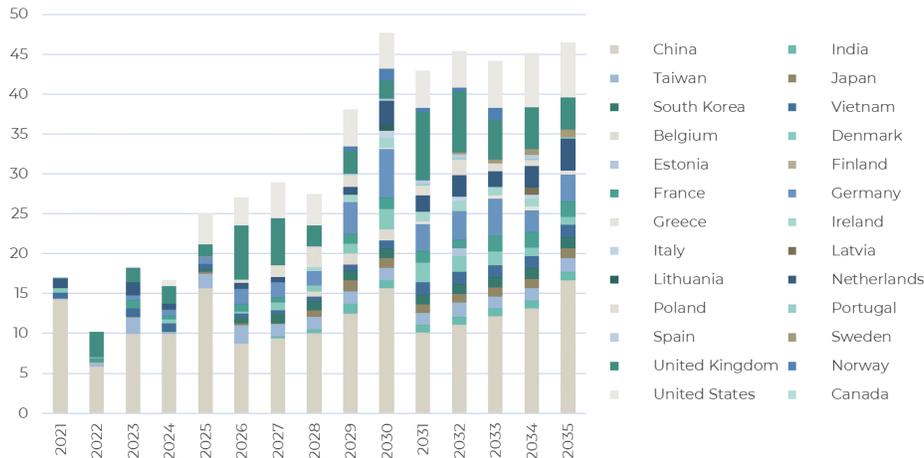
In 2022 the LCOE for the median offshore wind project continued to improve relative to the bottom end of competing fossil fuel generation, with key attractions being better operational and visual characteristics as well as being close to key demand areas which are often coastal. 2022 also marked the 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)

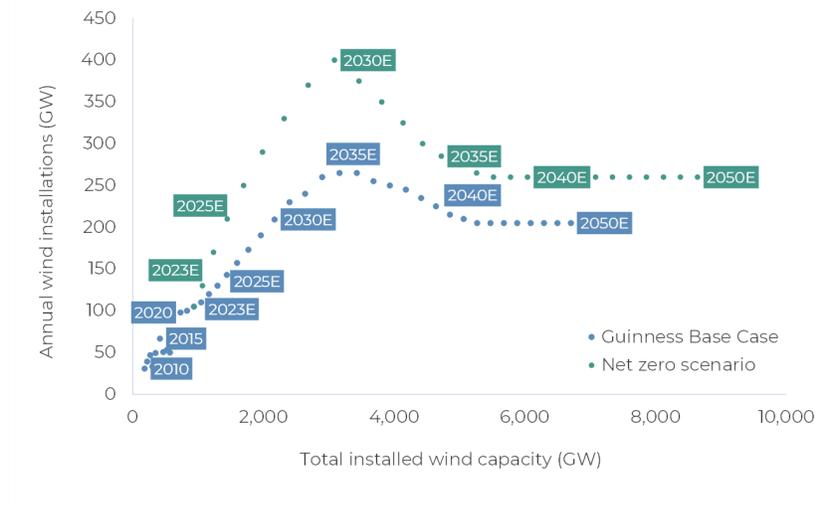
source: BNEF



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



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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: Link Fund Manager Solutions (Ireland) Ltd (LFMSI), 2 Grand Canal Square, Grand Canal Harbour, Dublin 2, Ireland; or the Promoter and Investment Manager: Guinness Asset Management Ltd, 18 Smith Square, London SW1P 3HZ.

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General enquiries: 0115 988 8200.

Dealing Line: 0115 988 8285.

E-Mail: [clientservices@tbailey.co.uk](mailto:clientservices@tbailey.co.uk)

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