

This is a marketing communication. Please refer to the prospectus and KID/KIID for the Fund, which contain detailed information on the Fund's characteristics and objectives, before making any final investment decisions. Past performance does not predict future returns.

April 2023

GUINNESS SUSTAINABLE ENERGY FUND

The Guinness Sustainable Energy Fund is 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 Fund is run by co-managers Will Riley and Jonathan Waghorn, supported by Jamie Melrose and Dan Hobster (analysts). The investment philosophy, methodology and style which characterise the Guinness approach have been applied to the management of various energy equity portfolios at Guinness since 1998.

RISK

The Guinness Sustainable Energy Fund is an equity fund. 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. The Fund invests only in companies involved in the energy sector; it is therefore susceptible to the performance of that one sector and can be volatile. Further details on the risk factors are included in the Fund's documentation, available on our website.

Signatory of:



REVIEW OF THE FIRST QUARTER OF 2023

The first quarter of 2023 saw continued positive momentum for the energy transition. Further details emerged on 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 increasing 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, and portfolio valuation.

EQUITIES

Global stock markets were stronger in March, with the MSCI World Net Return Index delivering +3.1% in USD. Over the month, the Guinness Sustainable Energy Fund (Class Y) delivered a return of +3.3% (in USD), outperforming the MSCI World by 0.2%. Over the quarter, the fund is up 10.0%, outperforming the MSCI World which is up 7.7%. Full performance details are available in Section 3.

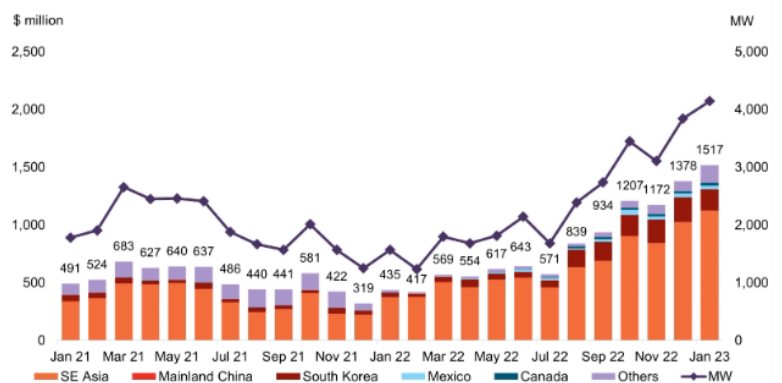
The strongest performers in the quarter were First Solar and Infineon, which both delivered solid results and provided confident outlooks for 2023. The weakest performer in the fund was Enphase due to growing concerns over the outlook for US residential solar.

CHART OF THE MONTH

January 2023 saw the highest level of US spending on solar module imports since BNEF started tracking this customs data in 2017. Modules were imported at an average price of \$0.37 per watt suggesting an imported volume of over 4GW. The increase in volume and value is likely due to clearer rules on how to comply with Uyghur Forced Labor Prevention Act along with the release of previously detained modules.

US imports of PV modules, by month and origin

(Source: Bloomberg New Energy Finance)



The Guinness Sustainable Energy Report

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1. MARCH 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>March saw EU lawmakers approve a law which will effectively ban the sale of new petrol and diesel cars in the bloc from 2035. Germany raised a last-minute objection, threatening to scupper the legislation. However, the EU managed to negotiate a compromise, allowing an exemption for vehicles exclusively powered by carbon neutral e-fuels produced from green hydrogen and carbon captured from the atmosphere.</p>	European decarbonisation policy	
<p>Last month, Chinese lithium carbonate prices fell to ~CNY200,000 per tonne, representing a decline of over 60% from peak levels seen in November 2022. The price weakness reflected the prospect of an increase in global supply later this year, along with signs of slowing growth in Chinese EV sales. The drop provides relief for EV OEMs after high metal prices pushed up average battery prices (which make up ~40% of the cost of an EV) in 2022.</p>	Battery economics	
<p>January saw Tesla slashing prices by up to 20% across its EV range to offset slowing EV demand growth in China. The weakening in demand was due to Beijing ending its clean mobility incentive programme. Since then, a flurry of domestic and international EV-makers have followed suit, with BYD, XPeng, Nio and Volkswagen racing to offer Chinese customers generous discounts. In March, the price war escalated, drawing in additional Chinese OEMs and spreading to petrol and diesel vehicles. There is no consensus on how long the price war will last, but commentators expect a profound industry revamp, driving some automakers out of business and accelerating the pace of new energy vehicle adoption.</p>	Electric vehicle affordability	
<p>The world's top climate scientists have stated that global warming is "more likely than not in the near-term to reach a 1.5C rise since pre-industrial times". The UN Intergovernmental Panel on Climate Change found that the risks of warming were greater than thought at the time of the last assessment in 2014, stressing that the solutions already exist: renewable energy, electric vehicles, carbon taxes, removal of fossil fuel subsidies. The report highlighted the need for more action as current targets put the world on track for 2.8C of warming by 2100.</p>	Global climate action	
<p>The pace of US solar capacity additions fell by 16% in 2022 according to Wood Mackenzie and the Solar Energy Industries Association. Customs delays, tariff uncertainty and soaring global demand have hiked solar costs and delayed US projects. Installations are expected to rebound in 2023 thanks to the Inflation Reduction Act, a landmark subsidy package with a goal to halve emissions by 2030.</p>	US solar demand	

2. MANAGERS' COMMENTS

Review of 1Q 2023

The first quarter of 2023 saw continued positive momentum for the energy transition. Further details emerged on 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 increasing 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, and portfolio valuation.

The first quarter of 2023 saw the Guinness Sustainable Energy Fund delivering a total return (USD) of +10.0%, outperforming the MSCI World Index (net return) of +7.7%. 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 quarter, 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 4-5yrs to 9-18mths; and to establish an EU renewable supply chain with incentives for activities that achieve a "made in Europe" minimum threshold. Towards the end of the quarter, 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, could negatively affect funding for sustainable energy projects. The full implications are not yet clear, but 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. The surge of interest caused a war of words with the EU over the size of subsidies and ultimately catalysed the evolution of the EU Industrial Strategy and Critical Raw Materials Act mentioned above.
- The **removal of subsidies for new EV** sales in China and in certain parts of Europe slowed EV sales growth. Data for China in January indicated that total EV market share fell from 30% on average in 2022 to 26% in January, while pure BEV sales were down 24%yoy. Looking longer term, the quarter saw significant new investment announced in battery 'gigafactories' across the US.
- Also on the broader pace of the **energy transition**, we noted strength in EU carbon prices (exceeding Eur100/tonne for the first time in February) and the increase in coal-fired power development by China (in response to higher LNG prices) as the economy re-opens post COVID. BP also pivoted back towards fossil fuel development, although it also increased its renewables investment plans and IRENA outlined the need for \$35 trillion of cumulative investments in clean energy by 2030, if any hope of 1.5 degrees is to be maintained.

Drivers of fund performance

The strongest sectors in the quarter were installation (equipment) and electrification, with nine of ten strongest performers being in these sectors. The strongest individual contributor was **First Solar**, just as it was in 2022, reflecting the 210% total return that the shares have delivered since end June 2022. The strength reflects the fact that First Solar's predominantly US solar module manufacturing process will allow the company to receive significant tax credits from the Inflation Reduction Act. Consensus estimates for First Solar's 2025 EPS have increased from around \$5/sh (at the end of June 2022) to around \$20/sh currently, leaving the shares trading on around 10x P/E for that year.

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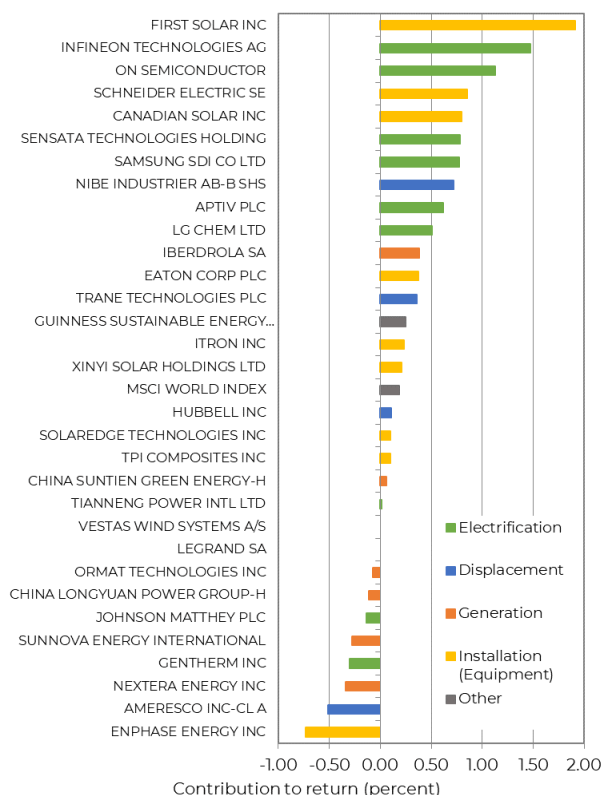
Also within installation, **Canadian Solar** shares reacted well to solid full year 2022 earnings, increased margin guidance for 2023 and strong performance in the new battery business. In addition, the approval of the long awaited China A share listing was announced, hopefully providing the company with access to growth capital at a lower cost.

Within the electrification sector, we saw strong contribution from both of our power semiconductor companies and both of our battery manufacturers as well as some of our auto suppliers. The strong performance contrasted with the fact that cash returns expectations for the sector as a whole continued to weaken as a result of supply chain issues as well as raw material and energy cost inflation. In general, valuation multiples here have started to expand so far this year.

- **Onsemi** continued to execute well, announcing an expanded pipeline of new design contract wins and an increased outlook for silicon carbide (SiC) revenues resulting from new SiC relationships with Tesla, Jaguar and a major Tier-1 European platform. **Infineon** also delivered well and provided an improved outlook for its SiC business plus also announcing the acquisition of privately-owned GaN Systems. At the end of the quarter, Infineon positively pre-announced 2Q revenues and increased 2023 guidance for revenues and margins that we believe imply consensus earnings increases of around 10%.
- Our two battery manufacturers, **LG Chem** and **Samsung SDI**, were among the top contributors partly as a result of stronger domestic stock markets but also because of greater growth expectations. In particular, thanks to the Inflation Reduction Act, operations are growing in the US.
- **Sensata** and **Aptiv** performed well as there were signs that the negative earnings cycle for our auto suppliers is maybe coming to an end, after declining through all of 2022, as raw material cost inflation and supply chain issues are starting to resolve. We note that our auto chain exposed companies as a whole are well placed to benefit from the growing share of EV sales in the vehicle mix and, as a group, trade at around 15x P/E for 2024.

1Q 2023 indicative stock contribution, in USD

source: Bloomberg, Guinness Asset Management estimates



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There were fewer sector specific drivers at the weaker end of the portfolio. The weakest individual contributor was **Enphase**, which delivered earnings ahead of expectations in Q4 2022 and provided solid guidance for 1Q 2023, allowing cash return expectations to increase over the quarter (also the same for its peer Solaredge). We ascribe the weakness to growing concerns over the outlook for US residential solar resulting from a negative ruling over utility net metering pricing in California (NEM 3.0) and the impact of higher interest rates. Enphase is a dominant provider of inverters for solar modules on US residential solar systems and the US represents 80% of all Enphase's activities. Later in the quarter, the collapse of Silicon Valley Bank raised concerns about the access to funding for US residential solar installations and put further pressure on Enphase shares. The growing risk of a credit crisis also impacted on US residential solar power producer **Sunnova**. While the company does not have any direct exposure to SVB, it is likely that less access to funding will slow the growth of their lease and loan-oriented solar business.

Ameresco shares suffered from missed 4Q 2022 earnings and delays at the key Southern California Edison battery storage development CE project as well as supply chain issues at some of its biogas projects potentially causing delays. Rising interest rates were a negative factor for our generation companies, with four of our six holdings delivering negative contribution over the quarter.

From our analysis, we can see that underlying earnings and profitability metrics for the fund's holdings improved slightly over the quarter, reflecting generally good results announcements and earnings guidance broadly in line with expectations. Within the fund, the displacement and installation (equipment) sectors saw small net positive cash return improvements while generation and electrification were small net negative. Overall, the solar sector saw the greatest cash return improvements.

The portfolio was actively rebalanced over the period and, combined with the addition of Legrand, the weighting to Displacement (demand) increased from 45% at the end of 2022 to 46% at the end of March 2023 while the weighting to Renewables (supply) stayed flat at 49%. Within these subsectors, our exposure to installation increased from 32% to 34% as a result of performance and the purchase of Legrand while our weighting to electrification increased from 30% to 31%. Further detail on portfolio positioning is included later in this report.

Valuation

As the table below shows, at 31 March 2023, the Guinness Sustainable Energy Fund traded on a 2023 P/E ratio of 21.2x and 2024 P/E ratio of 17.2x. The fund trades at a premium to the MSCI World, reflecting greater expectation for growth from sustainable energy companies relative to the index. Indeed, we can see that consensus EPS growth (2022-2025E) of the portfolio (at 21.6%pa) is well ahead of the MSCI World (at 6.5%pa).

The growth outlook for the sector continued to improve in the first quarter of 2023 and the excess earnings growth of the fund versus the MSCI World for 2022-25 (15.1%pa) is significantly higher than the 7.8%pa excess seen at the end of 2021, prior to the announcement of IRA and the EU Industrial Strategy. Looking beyond 2025, we believe that the portfolio is likely to deliver normalised earnings growth of around 14%pa, still well ahead of growth in the MSCI World Index. This would bring the fund P/E ratio down from 21.1x for 2023 to an estimated 13x for 2026.

Guinness sustainable energy fund key financial and valuation metrics

source: Bloomberg, CS HOLT, Guinness Asset Management estimates

As at 31 March 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	25.0x	21.2x	17.2x	15.3x	12.8x	10.7x	1.2%	1.3%	6.8%	21.6%	5.7%	7.6%
MSCI World Index	15.9x	16.7x	15.4x	10.4x	11.1x	10.2x	2.2%	2.4%	5.4%	6.5%	8.2%	8.1%
Fund Premium/(Discount)	57%	27%	12%	47%	15%	5%						

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

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3. PERFORMANCE (to 31.03.2023)

Past performance does not predict future returns.

The Guinness Sustainable Energy Fund (Class Y, 0.67% OCF) delivered a return of +3.3% in the month, while the MSCI World Index (net return) delivered +3.1% (all in USD terms).

	Ytd	1 Yr	3 Yrs	5 Yrs*	10 Yrs*
Fund (Class Y)	10.0%	5.5%	149.1%	118.4%	172.6%
MSCI World NR Index	7.7%	-7.0%	57.7%	47.0%	133.6%
Out/Underperformance	2.3%	12.5%	91.4%	71.4%	39.1%

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%

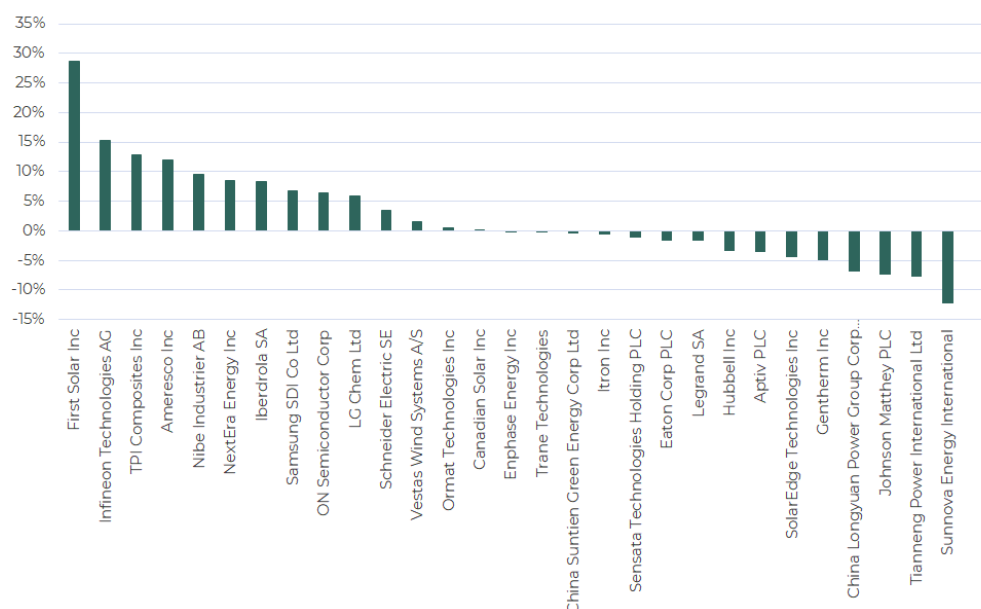
Annual performance	2017*	2016*	2015*	2014*	2013*
Fund (Class Y)	20.2%	-15.4%	-12.0%	-12.1%	70.8%
MSCI World NR Index	22.4%	7.5%	-0.9%	4.9%	26.7%
Out/Underperformance	-2.2%	-23.0%	-11.2%	-17.0%	44.1%

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

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

Within the Fund, the strongest performers were First Solar, Infineon, TPI Composites, Ameresco and Nibe. The weakest performers were Sunnova, Tianneng, Johnson Matthey, China Longyuan and Gentherm.

Stock by stock performance over the month, in USD

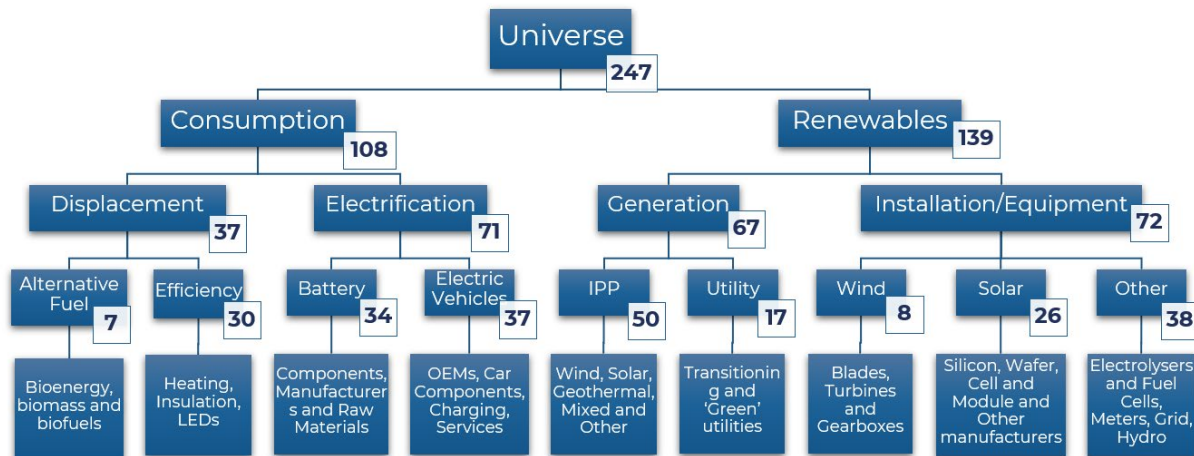


Source: Bloomberg. As of 31 March 2023

4. PORTFOLIO

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

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



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

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

Signatory of:

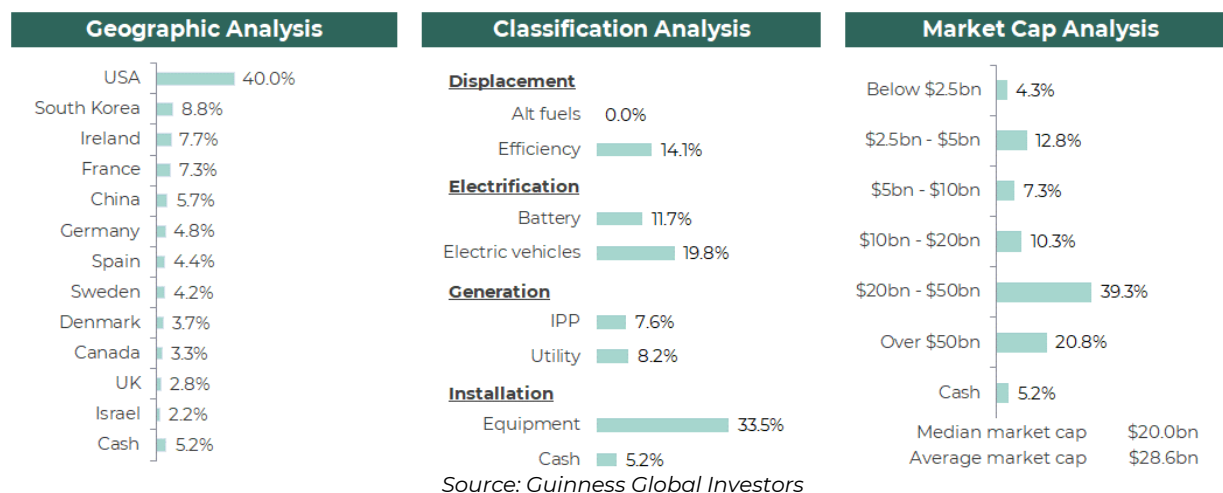


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Buys/Sells

During the month, we initiated a position in Legrand. Legrand is the world's only global specialist in electrical and digital building infrastructures. It sells more than 300,000 individual electrical products, biased to residential and commercial markets, to a broad global customer base. We believe that the company is well placed to benefit from secular trends such as electrification and efficiency.

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		
	Mar-23		Dec-22	Dec-21	Dec-20	Dec-19	Dec-18
Consumption	45.6%	0.7%	44.9%	43.4%	36.7%	41.7%	26.5%
Displacement	14.1%	-0.9%	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	14.1%	-0.9%	15.0%	11.8%	9.9%	13.4%	12.5%
Electrification	31.4%	1.6%	29.9%	31.6%	26.8%	28.2%	10.1%
Batteries	11.7%	0.0%	11.6%	8.9%	10.8%	12.6%	3.9%
Electric vehicles	19.8%	1.5%	18.2%	22.8%	16.0%	15.7%	6.2%
Renewables	49.2%	0.0%	49.3%	51.3%	60.4%	54.1%	69.7%
Generation	15.8%	-1.9%	17.7%	23.1%	24.6%	22.2%	27.3%
IPP	7.6%	-1.1%	8.7%	14.5%	17.0%	18.9%	26.7%
Utility	8.2%	-0.8%	9.0%	8.6%	7.6%	3.2%	0.6%
Installation	33.5%	1.8%	31.6%	28.2%	35.8%	32.0%	42.5%
Equipment	33.5%	1.8%	31.6%	28.2%	35.8%	32.0%	42.5%
Cash	5.2%	-0.6%	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 31 March 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	25.0x	21.2x	17.2x	15.3x	12.8x	10.7x	1.2%	1.3%	6.8%	21.6%	5.7%	7.6%
MSCI World Index	15.9x	16.7x	15.4x	10.4x	11.1x	10.2x	2.2%	2.4%	5.4%	6.5%	8.2%	8.1%
Fund Premium/(Discount)	57%	27%	12%	47%	15%	5%						

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

Source: Guinness Global Investors, Bloomberg, CS HOLT

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Portfolio holdings as at end March 2023

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

We hold c.46% weight to companies associated with the consumption (or demand) of sustainable energy. Our largest exposure here is to companies involved in the electrification of demand, either via the creation of new batteries (12%) or the electrification of transportation (20% 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 a top 3 lithium-ion battery manufacturer in the world, while Samsung SDI is a pure play lithium-ion battery manufacturer, currently in the top 10 in the world.

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

Our displacement holdings provide pure-play quality exposure to heating industries (Nibe Industrier, Trane Technologies), energy efficient electrical equipment and services (Hubbell) and energy efficiency projects (Ameresco), and the group as a 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 16% weight to companies involved in the generation of sustainable energy and 33% weight to those exposed to the installation of or equipment used in the process of sustainable energy generation.








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

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

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

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Portfolio themes as at end March 2023

Theme	Example holdings	Weighting (%)
1 Electrification of the energy mix		22.3%
2 Rise of the electric vehicle and auto efficiency		22.6%
3 Battery manufacturing		8.8%
4 Expansion of the wind industry		7.4%
5 Expansion of the solar industry		16.2%
6 Heating, lighting and power efficiency		14.1%
7 Geothermal		3.2%
8 Other (inc cash)		5.2%

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

Guinness Sustainable Energy Fund (28 February 2023)				P/E			EV/EBITDA			Price/Book			Dividend Yield		
Stock	ISIN	% of NAV	Market Cap USD	2022	2023E	2024E	2022	2023E	2024E	2022	2023E	2024E	2022	2023E	2024E
Displacement/Efficiency															
Hubbell Inc	US4435106079	4.3%	13,483	24.2x	22.1x	20.7x	16.8x	15.3x	14.3x	5.7x	5.3x	4.8x	1.7%	1.9%	2.0%
Nibe Industrier AB	SE0015988019	4.1%	20,964	53.3x	42.3x	37.7x	31.7x	25.7x	23.2x	8.4x	7.0x	6.1x	0.5%	0.7%	0.7%
Trane Technologies PLC	IE00BK9ZQ967	3.9%	42,372	25.7x	22.1x	20.3x	17.1x	15.3x	14.5x	7.4x	6.5x	5.9x	1.4%	1.5%	1.6%
Ameresco Inc	US02361E1082	2.2%	2,283	23.5x	25.0x	18.4x	13.3x	13.0x	10.3x	2.8x	2.4x	2.2x	n/a	n/a	n/a
		14.5%													
Electrification/Battery															
LG Chem Ltd	KR7051910008	4.1%	36,418	20.0x	19.3x	13.1x	8.2x	7.2x	5.6x	1.6x	1.5x	1.4x	1.6%	1.6%	1.8%
Samsung SDI Co Ltd	KR7006400006	4.4%	36,310	23.9x	22.5x	18.5x	14.3x	12.8x	10.4x	2.7x	2.5x	2.2x	0.2%	0.2%	0.2%
Johnson Matthey PLC	GB00BZ4BQC70	3.1%	4,844	10.1x	11.6x	10.9x	6.2x	7.3x	6.9x	1.5x	1.5x	1.5x	3.6%	3.6%	3.7%
Tianneng Power International Ltd	KYG8655K1094	0.1%	1,443	5.4x	4.4x	4.0x	3.2x	3.1x	2.5x	0.7x	0.6x	0.6x	4.9%	6.2%	6.6%
		11.8%													
Electrification/Electric Vehicles															
Aptiv PLC	JE00B783TY65	4.1%	31,506	34.8x	26.6x	18.9x	16.1x	13.2x	10.7x	3.8x	3.3x	2.9x	0.0%	0.2%	0.3%
ON Semiconductor Corp	US6821891057	4.3%	33,439	14.7x	17.5x	15.1x	10.0x	11.4x	10.0x	5.4x	4.2x	3.3x	n/a	n/a	n/a
Infineon Technologies AG	DE0006231004	4.3%	46,420	18.2x	15.0x	14.3x	10.5x	8.5x	8.0x	3.3x	2.7x	2.4x	1.0%	1.1%	1.2%
Sensata Technologies Holding PLC	GB00BFMBMT84	4.2%	7,713	15.2x	13.7x	11.9x	11.4x	10.8x	9.6x	2.5x	2.3x	2.1x	0.7%	0.9%	0.9%
Gentherm Inc	US37253A1034	3.0%	2,109	32.0x	24.7x	17.4x	16.5x	11.8x	9.1x	n/a	n/a	n/a	n/a	n/a	n/a
		20.0%													
Generation/IPP															
China Longyuan Power Group Corp Ltd	CNE100000HD4	2.1%	17,430	11.8x	8.6x	7.4x	10.2x	8.7x	7.5x	1.0x	0.9x	0.8x	1.6%	2.2%	2.6%
Ormat Technologies Inc	US6866881021	3.3%	4,741	62.7x	47.0x	35.3x	14.7x	12.9x	11.3x	2.5x	2.3x	2.2x	0.6%	0.6%	0.6%
NextEra Energy Inc	US65339F1012	3.6%	141,172	24.6x	22.9x	21.0x	19.2x	15.7x	14.2x	3.2x	3.0x	2.8x	2.4%	2.6%	2.9%
Sunnova Energy International I	US86745K1043	1.3%	2,044	n/a	n/a	n/a	74.0x	40.4x	27.6x	1.3x	0.9x	0.8x	n/a	n/a	n/a
China Suntien Green Energy Corp Ltd	CNE100000TW9	1.4%	4,195	5.6x	5.0x	4.4x	10.3x	9.4x	8.1x	0.6x	0.5x	0.5x	6.2%	6.8%	7.5%
		11.6%													
Generation/Utility															
Iberdrola SA	ES0144580Y14	4.2%	74,284	16.5x	15.4x	14.3x	10.8x	10.0x	9.3x	1.6x	1.5x	1.5x	4.3%	4.6%	4.9%
		4.2%													
Installation/Equipment															
Schneider Electric SE	FR0000121972	4.2%	92,139	21.0x	19.6x	18.1x	14.1x	13.1x	12.3x	3.2x	3.1x	2.9x	2.0%	2.2%	2.4%
Legrand SA	FR0010307819	0.9%	24,790	20.7x	20.4x	19.2x	13.3x	12.9x	12.2x	3.6x	3.3x	3.0x	2.1%	2.2%	2.3%
Eaton Corp PLC	IE00B8KQNB27	4.4%	69,622	23.2x	21.2x	19.3x	18.4x	16.5x	15.3x	4.2x	3.9x	3.7x	1.8%	1.9%	2.0%
Itron Inc	US4657411066	3.1%	2,526	110.7x	60.7x	25.2x	35.6x	27.7x	14.6x	2.2x	2.1x	2.0x	n/a	n/a	n/a
Xinyi Solar Holdings Ltd	KYG9829N1025	2.2%	9,499	16.4x	13.3x	10.4x	12.2x	10.1x	7.7x	2.2x	2.2x	1.9x	2.8%	3.4%	4.4%
SolarEdge Technologies Inc	US83417M1045	2.4%	17,850	67.1x	36.4x	27.3x	39.8x	23.2x	18.0x	8.6x	6.9x	5.6x	n/a	n/a	n/a
Enphase Energy Inc	US29355A1079	2.4%	28,737	48.1x	38.5x	29.2x	39.0x	29.0x	21.3x	52.5x	19.2x	11.6x	n/a	n/a	n/a
First Solar Inc	US3364331070	4.7%	18,032	n/a	27.3x	14.1x	93.4x	17.6x	10.2x	3.1x	2.8x	2.4x	n/a	n/a	n/a
Canadian Solar Inc	CA1366351098	3.3%	2,550	13.1x	7.8x	6.7x	7.4x	4.2x	3.5x	1.1x	1.0x	0.9x	n/a	n/a	n/a
Vestas Wind Systems A/S	DK0061539921	3.7%	28,865	n/a	386.3x	34.8x	n/a	25.6x	13.2x	7.8x	8.5x	6.9x	0.1%	0.2%	0.7%
TPI Composites Inc	US87266J1043	0.5%	488	n/a	n/a	48.4x	12.2x	11.7x	5.5x	5.5x	2.2x	2.8x	n/a	n/a	n/a
		31.7%													

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.

5. 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:

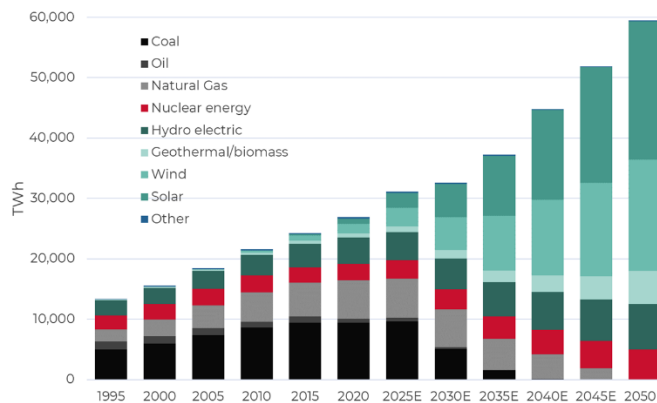
- **Population and GDP growth** putting a significant strain on today's energy supply
- **Economics** as sustainable sources of energy will be cheaper than the incumbents
- **Climate change** leading the world to reduce carbon emissions via cleaner energy
- **Pollution** forcing governments to drive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

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- **The 2021 IPCC climate report.** The Intergovernmental Panel on Climate Change (IPCC) published its sixth assessment report on the physical science of climate change and the physical impacts of various carbon emission and warming scenarios
- **COP26 climate conference.** In November 2021, the COP26 climate conference was held in Glasgow. The conference produced results which we considered to be better than feared, but not as good as hoped. Key headlines included new net zero targets, additional country pledges and some 'alliances of the willing' to reduce coal usage and methane emissions.
- **Carbon pricing.** Developments in carbon pricing remain hopeful with momentum towards the introduction of emissions trading schemes (ETS) as a tool for decarbonisation. At the start of 2021, China commenced a new national ETS scheme which immediately became the world's largest carbon market (covering around 2,225 entities in the power generation industry with annual emissions of around 4,000 MtCO₂e) while Canada introduced a federal carbon tax that will increase by 2030 to around US\$130/tonne.
- **The RePowerEU deal.** In response to the invasion of Ukraine, the REPowerEU deal was passed. It is designed to increase the resilience of the EU energy system in the short term to deal with the loss of Russian gas imports and it provides a greater emphasis on energy efficiency and increasing domestic renewable energy capacity. It builds on the EU's 'Fit for 55' proposals which are designed to deliver a 55% reduction in GHG emissions by 2030 (vs 1990)
- **The US Inflation Reduction Act.** In response to the invasion of the Ukraine and increased need for energy security, the Inflation Reduction Act was passed. It brings a potential \$369bn in support for energy security and climate change, specifically targeting financial support for clean sources of electricity and energy storage as well as tax credits for clean fuels and clean commercial vehicles.

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

Energy displacement

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

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

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

Energy efficiency

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

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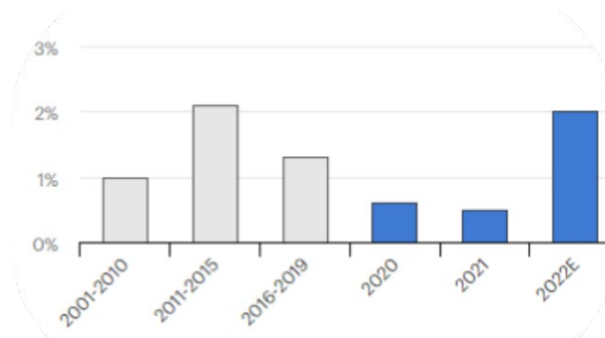
The focus on building efficiency is important, since buildings are responsible for 30% of primary energy consumption and nearly 40% of global carbon emissions. Electrifying heating (heat pumps) and improving the efficiency of heating (insulation), cooling (efficient HVAC), and lighting (LEDs) offers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

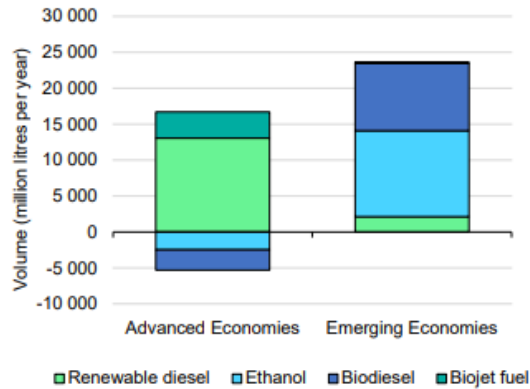
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blending and environmental targets in Brazil, Finland and Sweden, lowering this year's growth by around 2ppts.

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.

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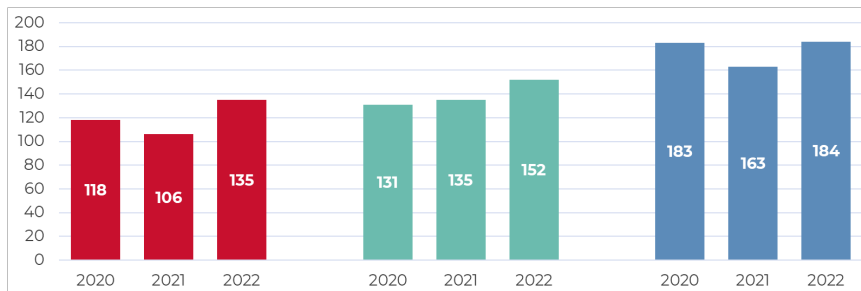
At the end of 2022, lithium and nickel prices were trading 800% and 60% higher than levels seen in December 2020 as supply has struggled to keep pace with strong demand for electric vehicles. Lithium carbonate prices in China reached new peaks in 2022, exceeding \$78,000 per tonne, as the market suffered from COVID-19 disruptions and long lead times (5-8 years) for new projects. Nickel prices peaked at \$100,000 per tonne in April following Russia's invasion of Ukraine and a short squeeze on the London Metal exchange. This has since moderated to \$29,000 per tonne, but future concerns over Russia's ability to supply its 17% share of the world's class 1 nickel could keep prices elevated.

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

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

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

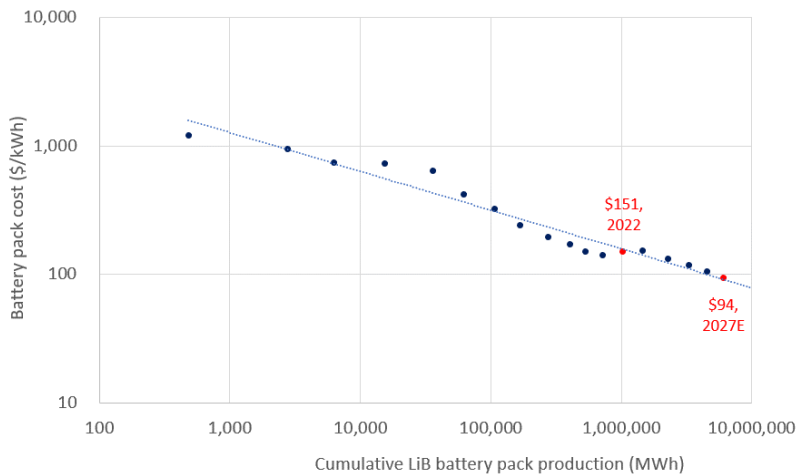
source: BNEF



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

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

source: Bloomberg, Guinness Global Investors



In 2020, the expectation was that the industry battery pack cost target of \$100/kWh (the price at which EVs reach price parity with ICE vehicles) would be hit by 2024. On our estimates, higher lithium and nickel prices are now likely to delay this until 2027. The \$50/kWh cost reduction over the next five years is likely to come equally from i) moderation of commodity prices, ii)

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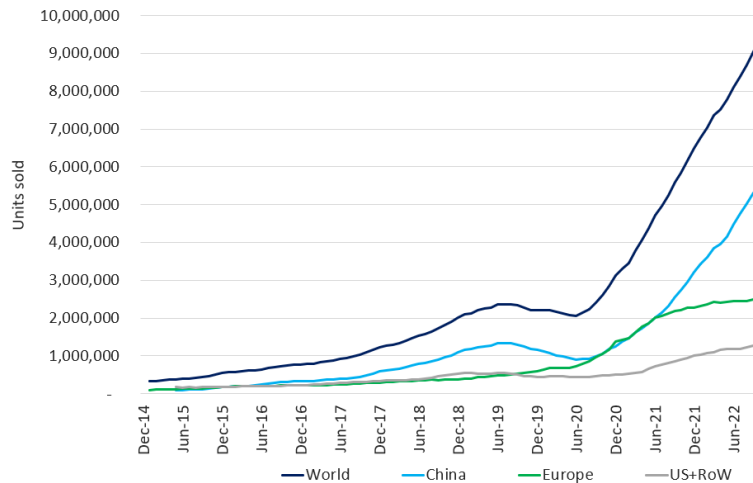
improvements to cell chemistry (moving to higher nickel cathodes and increasing silicon content in anodes) and iii) improvements in pack design and manufacturing (moving towards cell-to-vehicle architectures, with lower scrap rates). If the current learning rate of 17% is maintained, battery pack prices could fall as low as \$77/kWh by 2030 and \$62/kWh by 2035.

Electric Vehicles

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

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

Source: Guinness, EV-Sales, 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 markets develops in 2023 now that the long-existing NEV subsidy program has completely ended, meaning that no NEVs purchased after 1 January 2023 will be subsidised. Nonetheless, looking ahead, we believe that we are now at a tipping point where improving economics, driving range, and charging times begin to drive mass adoption.

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

The recent rapid growth in electric vehicle sales has caught many forecasters by surprise, leading to swift revisions to long-term adoption rates. For example, BNEF revised its 2025 forecast for EV sales penetration up to 23% in its 2022 outlook report, up from 16% in 2021. Our long-held forecast is that electric vehicles will make up 20% of new global vehicle sales by 2025,

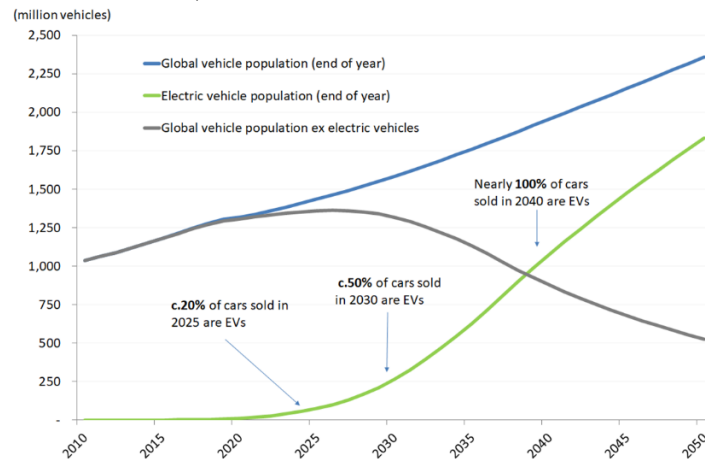
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50% by 2030 and predominantly all new vehicle sales by 2040. At that point, it implies an overall population of one billion EVs, over 60 times greater than the global stock in 2021 of 16.5 million.

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



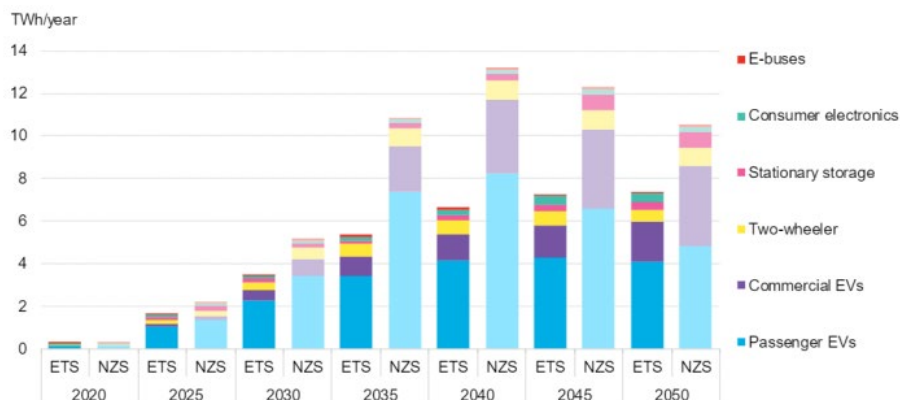
Our base case for electrification implies that there will be over one billion electric vehicles on the road by 2040, that electricity is 57% of total energy demand and that variable renewables such as wind and solar will represent 61% of global power grids. Achieving this would require annual EV sales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



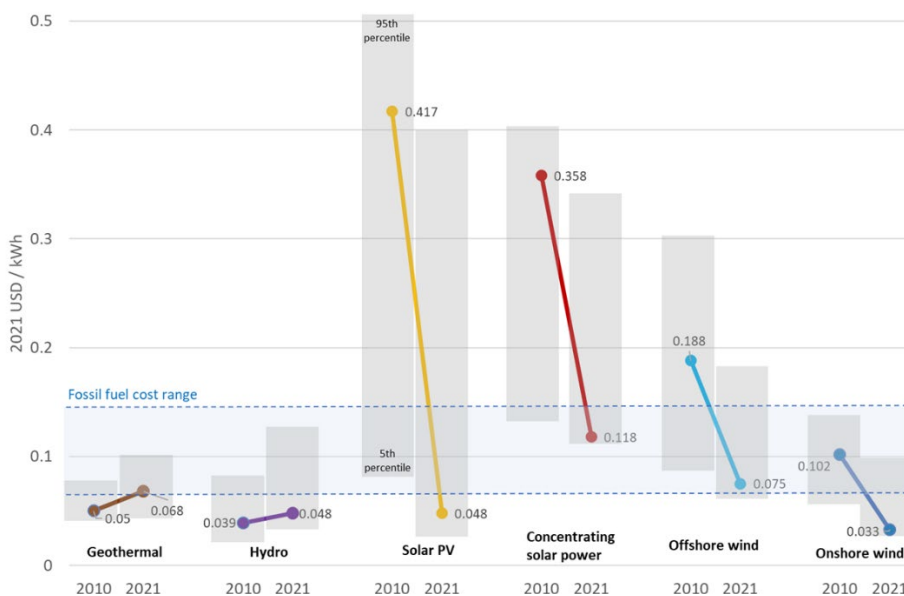
Generation & installation (equipment)

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

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coming from a clean energy infrastructure bill and iii) the impact of new net metering rules (NEM3.0) in California which reduce the attractiveness of solar economics for residential consumers. Actual installations in 2022 are now likely to be around 25 GW as demand is less likely to be impacted by NEM3.0 and the WRO.

- Demand in **Europe** is expected to be around 45 GW in 2022, up sharply from 24 GW in 2021, as the region reacted to higher electricity prices and the need for energy security. It is here that the relative economics of solar have improved the most, and the RePowerEU deal has already started to incentivise new demand for solar installations. Looking to 2023, we see further installation increases, with Europe reaching a new record of 62 GW spread well across an increasing number of countries, leading to substantially more growth in future years.
- In **China** module demand is also likely to beat our initial estimates, reaching 95 GW in 2022 (up 30 GW on 2021) as first half 2022 installations of 40 GW were more than double the levels seen in 1H 2021. Growth has come across utility, residential and commercial and we note plans for the development of significant offshore utility scale plants in 2023. As with Europe, higher power prices have been a key factor in driving stronger demand. In mid-2022, China published its 14th five year plan for renewables which suggested that solar (and wind) installations in 2021-2025 should be double the levels seen in 2015-2020.
- The rest of the **non-OECD** has also seen greater than expected growth in demand, reaching around 60 GW in 2022 (up 23 GW on 2021 levels) with demand increases well spread across Latin America (especially Brazil), African and Middle Eastern countries.

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

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

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

Solar supply chain in 2022 and 2023

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

- **Polysilicon** is a key raw material for a solar wafer. The poly market continued to be the tightest part of the solar market in 2022, evidenced by prices rising through the year to reach nearly \$40/kg in August. Poly prices have been high enough over the past two years to incentivise new supply and we can now see signs that the new supply is on the cusp of arrival. BNEF estimates that the capacity of the polysilicon industry rose to 900 mtpa in 2022 (sufficient to support over 300 GW of solar module manufacturing) but that new capacity additions of nearly 2,500 mtpa are being planned by either existing

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players or new entrants. While many plants will not be built and many will take longer than expected to reach full production capacity, the scale of capacity growth leads us to believe that poly prices will fall in 2023 and beyond, allowing margin expansion elsewhere in the value chain as well as lower solar module prices.

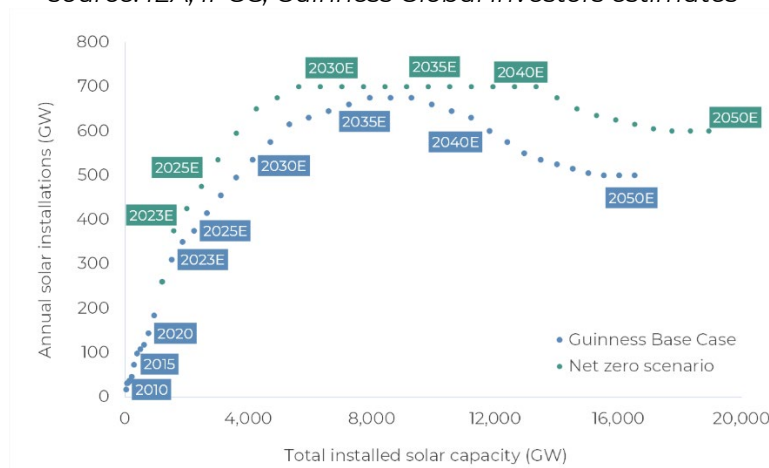
- Wafer and solar cell** manufacturing capacity, according to PV InfoLink, will reach 583 GW in Q4 2022 and will grow a further 15% in 2023. In 2022, wafer and cell companies have generally been able to pass through cost inflation and to defend reasonable margins but, similar to polysilicon, this may come under pressure in 2023 as new capacity is added. Unlike polysilicon however, the wafer business is highly concentrated, with nearly 80% of 2022 wafer capacity in the hands of the five largest producers. This may be a factor to help support prices in 2023. Technological changes in wafer manufacturing could lead to existing capacity becoming obsolete, leaving this part of the market tighter than it appears.
- Solar module** prices moderated in the second half of 2022 with prices likely to average the same level as 2021. With elevated polysilicon and power prices, it is the module manufacturers that suffered the greatest margin compression in 2022. Module manufacturing nameplate capacity in 2022 is estimated to have been around 470 GW, of which around 310 GW is newer 'Tier 1' capacity with lower costs resulting from the scale of manufacturing and new technologies. In 2023, this likely expands to 660 GW and potentially to as high as 820 GW by the end of the year.

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

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

Global solar annual installations, base case and NZE scenario

source: IEA, IPCC, Guinness Global Investors estimates



The wind sector

Despite recent headwinds, the long-term outlook for the wind industry remains very positive as the sector plays a critical role in global decarbonisation and the energy transition. Global wind generation capacity today is around 918 GW, but installations have temporarily paused as the industry has wrestled with COVID-related disruptions and various "regulatory airpockets".

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Looking forward, we expect these issues to inflect positively over the next few years, leading to a sustained ramp in global wind installations out to 2030.

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

Annual onshore and offshore wind installations (GW)

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

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

Onshore wind

The global onshore wind market currently sits at an installed capacity of 853 GW, with China and the US accounting for around 60% of capacity and Europe making up most of the remainder. Installations have been volatile but were reasonably consistently between 40-60GW from 2011 until 2020. Since 2020 there has been an uptick in installation activity driven, in large part, by both Chinese and US developers rushing to complete projects before subsidies expired.

Following this period, it was widely thought that we would subsequently revert to a lower absolute level of installations, with a subdued 5-6% growth rate thereafter. Instead, we have witnessed unprecedented global policy support, which serves not only to keep installations at the current high levels, but also to triple the subsequent growth rate out to 2030, should current government policies be followed through. The three key policy announcements were as follows:

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

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

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Offshore wind

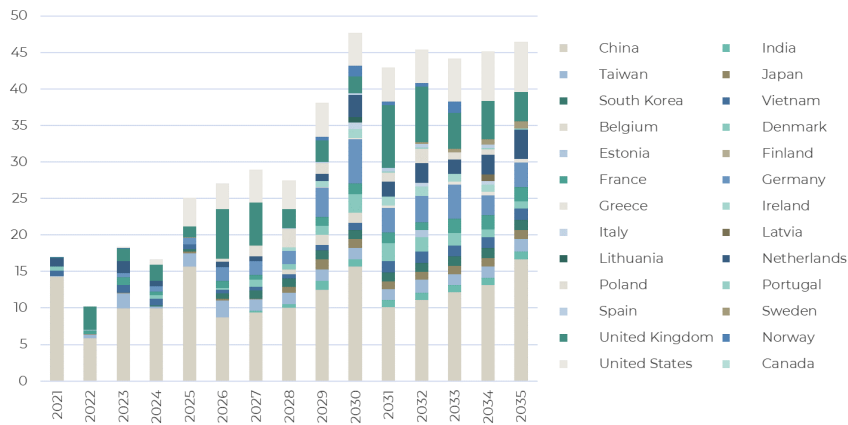
Offshore wind remains a nascent industry, at only 7% of global wind capacity, but it has doubled over the last 2 years and should grow nearly five times by the end of the decade driven by improving economics, further geographical adoption and the support of many of the packages outlined above.

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)

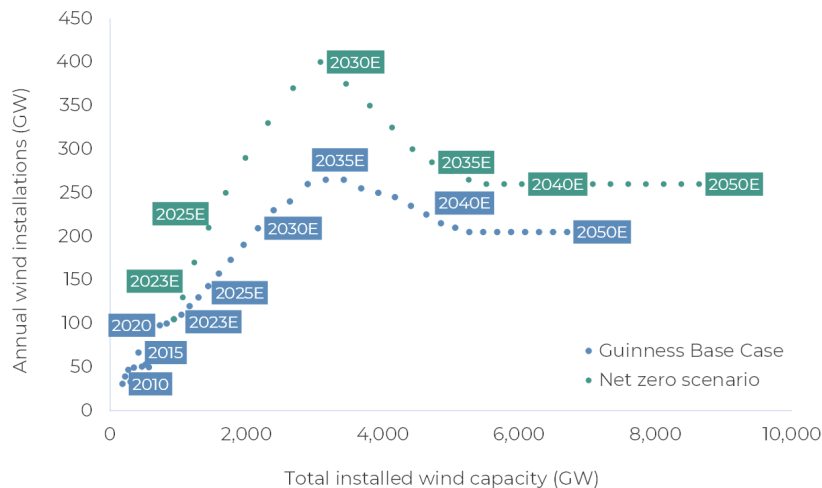
source: BNEF



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



IMPORTANT INFORMATION

TB Guinness Sustainable Energy Fund: The Guinness Sustainable Energy strategy is also available via a UK-domiciled vehicle - TB Guinness Sustainable Energy Fund. The documentation needed to make an investment, including the Prospectus, the Key Investor Information Document (KIID) and the Application Form, is available from the website www.guinnessgi.com.

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Documentation

The documentation needed to make an investment, including the Prospectus, the Key Information Document (KID) / Key Investor Information Document (KIID) and the Application Form, is available in English from 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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