The Guinness Sustainable Energy Report

Developments and trends for investors in the global energy sector

This is a marketing communication. Please refer to the prospectus and 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.

December 2022

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 analysts Jamie Melrose and Dan Hobster. 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. Details on the risk factors are included in the Fund's documentation, available on our website. The Fund is actively managed with the MSCI World Index used as a comparator benchmark only.

◀ Lower risk		Risk & reward				Higher risk ▶
1	2	3	4	5	**6**	7
Typically lower rewards						Typically higher rewards

The risk and reward indicator shows where the Fund ranks in terms of its potential risk and return. The Fund has been classed as 6 because its volatility has been measured as above average to high. This is based on how investments have performed in the past and you should note that the Fund may perform differently in the future and its rank may change. Historic data may not be a reliable indicator for the future.

COP27 AND IMPLICATIONS FOR THE ENERGY TRANSITION

This month, we review some of the key outcomes of COP27, which took place in November, and assess the implications for the energy transition. While the Final Declaration at the conference reiterated the highest ambition of the Paris Agreement (a 1.5° temperature increase target), post-COP26 pledges/policies still imply warming well in excess of 1.5°.

EQUITIES

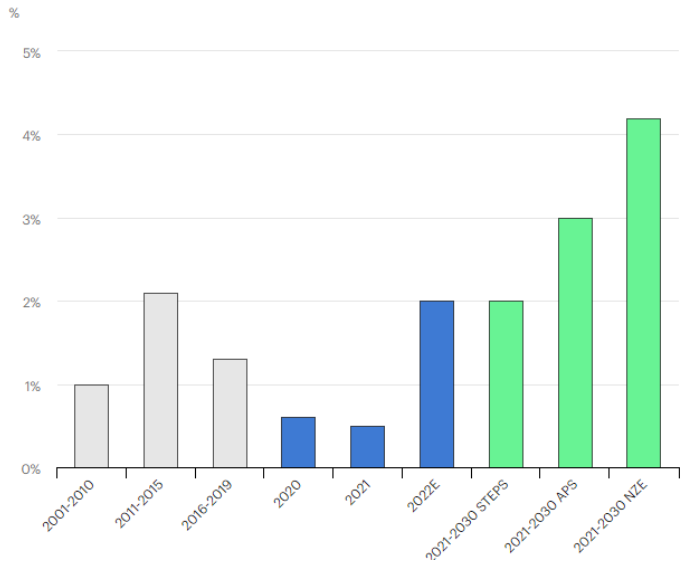
Sustainable energy equities outperformed in stronger global stock markets in November. The Guinness Sustainable Energy Fund (Class Y) delivered a return of +12.5% (in USD), ahead of the MSCI World at +7.0%. Year-to-date, the Guinness Sustainable Energy Fund (Class Y) has delivered -6.5% (in USD), versus the MSCI World at -14.5%. Full performance details are available in Section 3.

CHART OF THE MONTH

Energy efficiency action has accelerated in 2022 as a result of the global energy crisis sparked by Russia's invasion of Ukraine, according to the IEA. Efforts to conserve and better manage energy consumption are expected to result in a 2% improvement in annual energy intensity this year. This compares to an improvement of 0.5-0.6% during the 2020-21 pandemic years and an average of 1.3% per annum from 2016-19. In order to meet the IEA's 2050 net zero scenario, the rate of improvement in global energy intensity must accelerate further to average 4% per year out to 2030.

Annual global primary energy intensity improvement

(Source: IEA)



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PRI Principles for Responsible Investment

Contents

1. NOVEMBER NEWS AND EVENTS IN REVIEW

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

News	Sub Sector	Impact
The Chinese car manufacturer BYD saw its cumulative sales of new energy (hybrid & electric) vehicles top three million this month. It took the company 13 years to go from zero to one million, another year to hit two million, and has hit its most recent milestone just six months after the last. BYD has sold the largest number of plug-in vehicles of any car manufacturer year to date (January-September) at 1.2 million with Tesla a close second at 900,000.	EV sales	
Bloomberg New Energy Finance raised its forecast for global solar PV installations in 2022 by 7% (17GW) in its fourth quarter 2022 PV outlook to 268GW. This positive revision is primarily driven by additional demand from China which is expected to be responsible for 47% of total installations this year. They see solar module prices falling in 2023 thanks to an expected 60% decline in polysilicon prices as the market returns to oversupply.	Solar installations	
The UK government announced an investment of nearly £700m to support the Sizewell C nuclear power plant in Suffolk, taking the government's stake to 50% in the project. Sizewell C is expected to create 10,000 highly skilled jobs, provide "reliable low-carbon power" to 6 million homes for more than 50 years, and help to boost UK energy security.	Low-carbon generation	
WindPower Europe claims that repowering wind farms can nearly triple their capacity, while reducing the number of turbines by a quarter. As many of Europe's onshore wind farms reach the end of their operational lives, this is a triple win for energy security, public acceptance, and biodiversity. Currently, 14GW of Europe's wind farms have been operating for over 20 years and are prime repowering targets. This is set to grow to 78GW by 2030.	Wind generation	
In the US, Californian regulators provided an update on the state's approach to Net Metering (NEM 3.0). This policy determines the rate at which consumers can sell energy back to the grid from residential solar systems. The original proposal seen in December 2021 was seen as a strong negative for residential solar economics as it would have imposed a monthly fixed charge for consumers coupled with a lower rate for any electricity they exported. The most recent update has received a positive reaction after the monthly fee was withdrawn and a glidepath towards lower export rates was introduced.	Residential solar	

2. MANAGER'S COMMENTS

Review of COP27 and implications for Sustainable Energy

This month, we review some of the key outcomes of COP27 and the implications for the energy transition. While the Final Declaration at the conference reiterated the highest ambition of the Paris Agreement (a 1.5° temperature increase target), post-COP26 pledges/policies still imply warming well in excess of 1.5°. We assess the investment implications of COP27 and the implications for the energy transition as a whole.

COP27 was hosted by Egypt in November. The conference was always promoted as a less important event than COP26 12 months ago, but there was nevertheless hope of countries improving their pledges around decarbonisation (Nationally Determined Contributions or NDCs) and the wider energy transition. The Final Declaration of COP27, agreed on unanimously, kept the higher end of the ambition of the Paris Agreement (a 1.5° temperature increase target) intact, and explicitly mentions the need to reduce global GHG emissions by 43% in 2030 vs 2019 levels, but only after a challenging set of negotiations. While some countries proposed to weaken the 1.5° temperature increase target, others pushed back strongly, with the EU delegation threatening to leave the negotiations.

The wording in the Final Declaration from COP27 did not change the ambitions around fossil fuels that were set out at in Glasgow at COP26. It keeps the objective of a "phasedown of unabated coal power and phase-out of inefficient fossil fuels subsidies". This was in spite of India's proposal to extend the wording to a "phase down of all fossil fuels" versus coal only. This proposal had been supported by the EU but faced opposition from countries producing fossil fuels.

Interestingly, the Final Declaration from COP27 also quotes the IEA 2022 energy outlook on financing needs and highlights that "about USD 4 trillion per year needs to be invested in renewable energy up until 2030 to be able to reach net zero emissions by 2050, and that, furthermore, a global transformation to a low-carbon economy is expected to require investment of at least USD 4–6 trillion per year". It also highlights that such financing needs will require "a transformation of the financial system and its structures and processes, engaging governments, central banks, commercial banks, institutional investors and other financial actors".

Beyond the Final Declaration, and whilst COP26 saw numerous countries introduce or increase NDCs, last month's discussions in Egypt resulted in only a few announcements of improved climate ambitions. The most notable activity included:

- **Mexico** (1.4% of global GHG emissions) were the only G20 nation during COP27 to raise its emissions target. In the run-up to the summit, Mexico declared that it had raised its target to cut GHG emissions to 30% below 'BAU' levels, versus a previous target of 22%. Mexico's announcement brings the country's emissions target more in line with G20 partners, but still below average.

- **Brazil** (2.9% of global GHG emissions). It was too early for President-elect Lula da Silva to revise his country's NDCs, which under President Bolsonaro were heading backwards versus commitments made by Brazil under the 2016 Paris Agreement. It was encouraging, however, to see da Silva at COP27 vowing to make climate action a priority under his presidency and turn environmental policies "180 degrees" from those of Bolsonaro.

- During COP27, **India** (6.7% of global GHG emissions) submitted its Long-Term Emission Development Strategy to the UN. India's plans include the rapid expansion of green hydrogen production, a three-fold increase in nuclear capacity by 2032, an acceleration in the take-up of electric vehicles and ethanol blending in petrol, plus more energy efficient building codes.

Specific energy transition sector announcements were fairly thin on the ground at COP27, though we did note a strengthening of the "Global Offshore Wind Alliance" (GOWA). GOWA was launched in September by the International Renewable Energy Agency, Denmark and the Global Wind Energy

Council, and was joined during COP27 by nine new members, including Germany, Ireland, Japan, Netherlands, Norway, UK and the USA. The alliance brings together governments, the private sector and international organisations, and brings pledges for a rapid ramp up of offshore wind to tackle the climate and energy security crises.

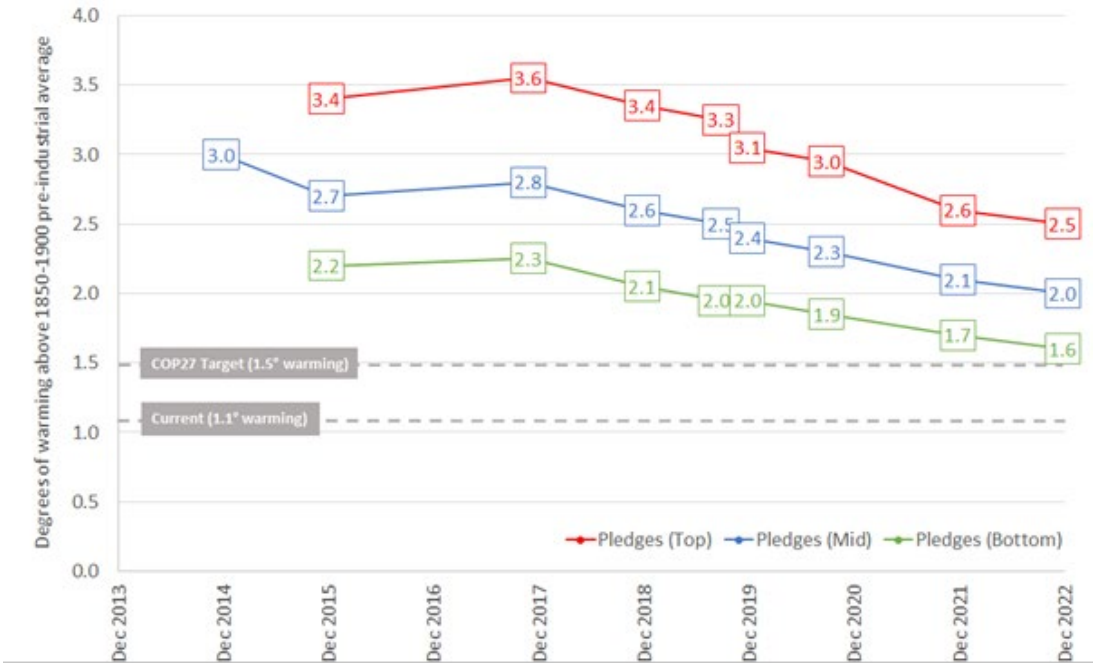
Beyond COP27, it was encouraging to see the US and China resume climate negotiations at the latest G20 summit, hosted by Indonesia. Negotiations between the two had previously stalled in August, knocked off course by tensions over trade and security. Deals between China and the US in the past helped to pave the way for the 2015 Paris Agreement, and last year culminated in the announcement of cooperation made at COP26. The G20 summit concluded with a commitment from all participants to the goals of the Paris Agreement, and the need to keep the 1.5C limit within reach. The G20 Bali Leader's Declaration reiterated the COP push to phase down coal-fired power, though it stopped short of a wider move away from other fossil fuels.

To put the achievements of COP27 and the wider UN climate process into perspective, we have analysed the work of Climate Action Tracker (CAT). CAT is an independent scientific analysis produced by two research organisations (Climate Analytics and the New Climate Institute) which has been provided to global policy makers since 2009. At the end of COP27, CAT forecasted the following:

- **Current policies.** If current country policies are sustained, a mid-point 2.7° increase in global temperature by 2100 (relative to the pre-industrial average temperature), with the range of outcomes being +2.2° to +3.4°. The lower end of this range has risen over the last twelve months by 0.2°, driven by a slowdown in coal retirements in the wake of the Russia/Ukraine crisis.
- **Current pledges.** If all countries fully implement their submitted and binding long-term targets and 2030 NDCs made at COP26, a mid-point 2.0° increase in global temperature by 2100 (relative to the pre-industrial average temperature), with the range of outcomes being +1.6° to +2.5°.

To put these assessments into some context, we have tracked historical CAT reports and, after making adjustments for the exit and return of the United States to the Paris Agreement, we find a trend of steady progress, culminating in the outcomes mentioned above.

Warming implied by current national pledges

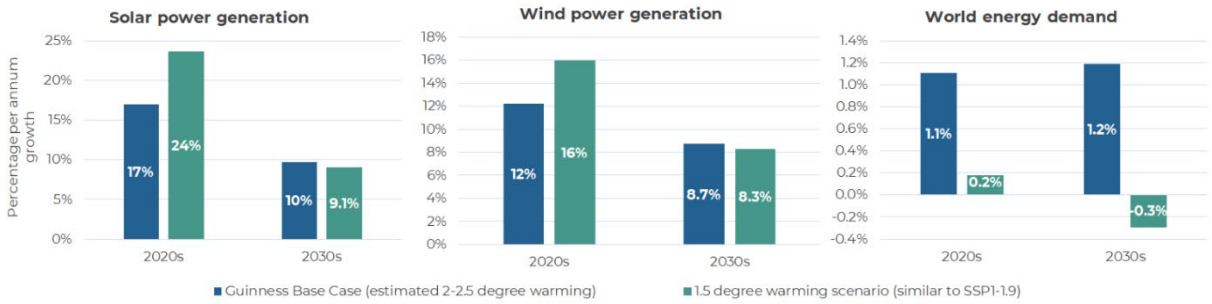


Sources: Climate Action Tracker; Guinness estimates

We can see from the chart that the decisions made in association with COP27 are part of a trend in reducing expected temperature increases. According to CAT analysis, expected temperature increases have fallen from 2.7° (after COP15 in Paris in late 2015) to 2.0° after COP27. Critically, though, this assumes that national energy policies continue to be brought into line with the pledges. Recent pledges are a step on the journey to 1.5°, but the additional steps required to get there are still very significant and becoming increasingly urgent, according to IPCC analysis.

- In terms of **current pledges**, ratcheting NDCs to reduce expected warming from 2.0° to 1.5° would require a further reduction of in excess of 850GT of CO2 (equivalent to the total emissions from the combustion of fossil fuels over the last thirty years) from being emitted. This would require governments to wean their economies off fossil fuels rapidly, especially coal.
- There remains a mismatch between current government pledges and current government policies, with policies lagging. In terms of **current policies**, reducing warming from 2.7° to 1.5° implies a significant uplift in investment and real activity. Based on data from the IEA, actual investment in clean energy generation would need to average $2.6trn per annum by 2030 – more than treble the recent investment of around $0.8trn. By our estimates, solar power generation would need to grow at a rate of around 24%pa in the 2020s and wind would need to grow at around 16%pa (both these rates being substantially higher than our base case estimates of 17%pa and 12%pa respectively). In addition, world energy demand would need to be flat over the next twenty years (a substantially more efficient outlook than our base case demand growth of around 1%pa and the 30yr historical average rate of around 1.9%pa).

Solar generation / wind generation / world energy demand: Guinness base case vs IEA net zero



Sources: IPCC; IEA; Guinness estimates

As the dust settles on COP27, we viewed the conference (and associated activity) as a modest step forward in the energy transition. To be realistic, policy announcements earlier in the year (in particular RePower EU and the Inflation Reduction Act) were more important catalysts, driven as much by energy security concerns as the need for decarbonisation.

Tying back to our sustainable energy portfolio, current policies and pledges offer significant investment opportunities in the energy transition, but still align with a level of climate warming that does not come close to 1.5°. COP27 has retained 1.5° warming as the central target, but there is still a long way to go. The Guinness Sustainable Energy Fund is positioned in companies that we expect to benefit from the transition that will accelerate further in 2023.

3. PERFORMANCE

Past performance does not predict future returns.

The Guinness Sustainable Energy Fund (Class Y, 0.66% OCF) delivered a return of +12.5% in the month, while the MSCI World Index (net return) delivered +7.0% (all in USD terms).

	Ytd	1 Yr	3 Yrs	5 Yrs*	10 Yrs*
Fund (Class Y)	-6.5%	-6.4%	106.1%	119.3%	213.3%
MSCI World NR Index	-14.5%	-10.9%	24.3%	42.6%	148.5%
Out/Underperformance	*8.1%*	*4.5%*	*81.8%*	*76.7%*	*64.8%*

Annual performance	2021	2020	2019	2018*	2017*
Fund (Class Y)	10.4%	84.1%	31.4%	-15.2%	20.2%
MSCI World NR Index	21.8%	15.9%	27.7%	-8.7%	22.4%
Out/Underperformance	*-11.4%*	*68.2%*	*3.7%*	*-6.5%*	*-2.2%*

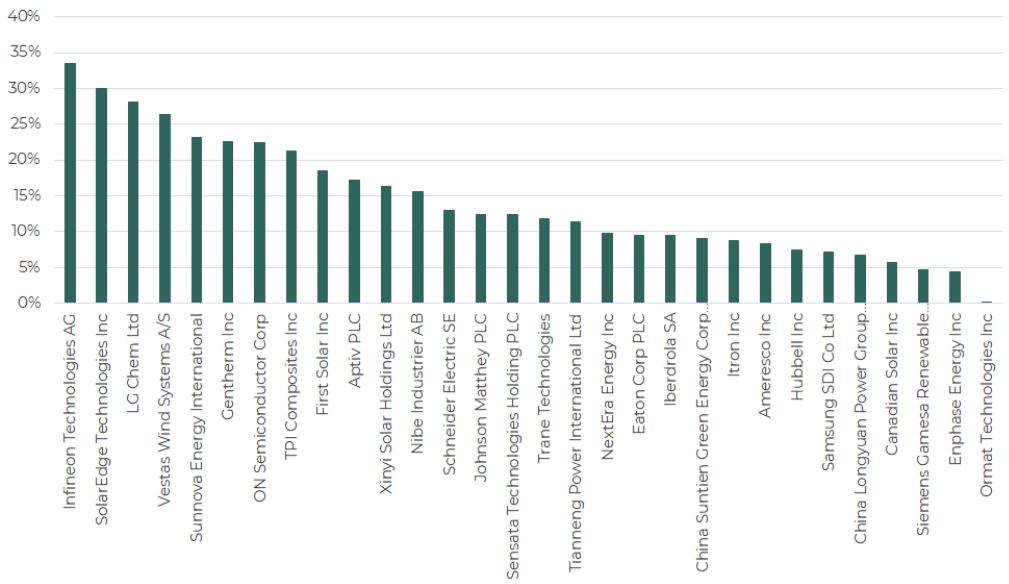
Annual performance	2016*	2015*	2014*	2013*	2012*
Fund (Class Y)	-15.4%	-12.0%	-12.1%	70.8%	-13.2%
MSCI World NR Index	7.5%	-0.9%	4.9%	26.7%	15.8%
Out/Underperformance	*-23.0%*	*-11.2%*	*-17.0%*	*44.1%*	*-29.1%*

*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.*

Investors should note that fees and expenses are charged to the capital of the Fund. This reduces the return on your investment by an amount equivalent to the Ongoing Charges Figure (OCF). The Fund performance shown has been reduced by the current OCF of 0.66% per annum. Returns for share classes with different OCFs will vary accordingly. Performance returns do not reflect any initial charge; any such charge will also reduce the return.

Within the Fund, the strongest performers were Infineon, Solaredge, LG Chem, Vestas, and Sunnova. The weakest performers were Ormat, Enphase, Siemens Gamesa, Canadian Solar, and Longyuan.

Stock by stock performance over the month, in USD

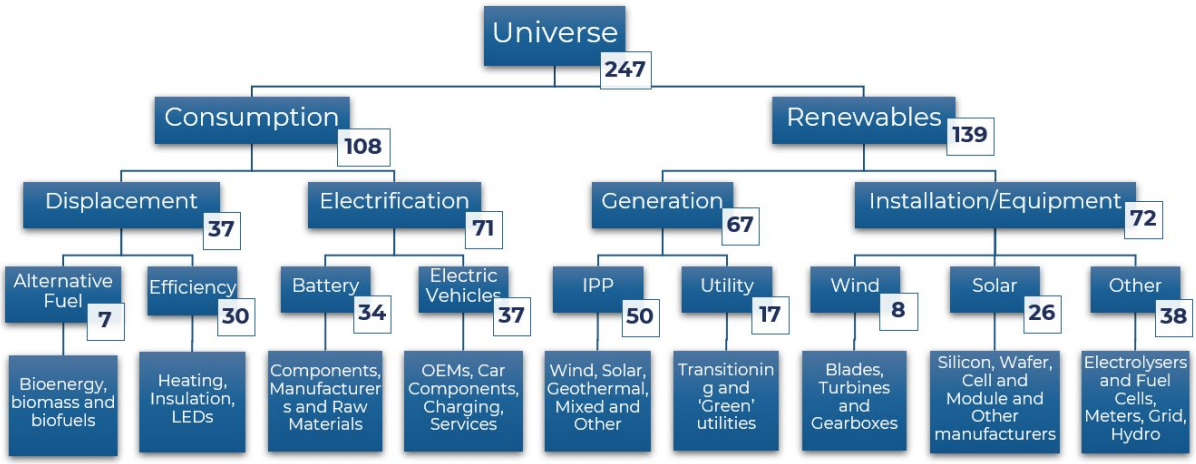


Source: Bloomberg. As of 30 November 2022

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:

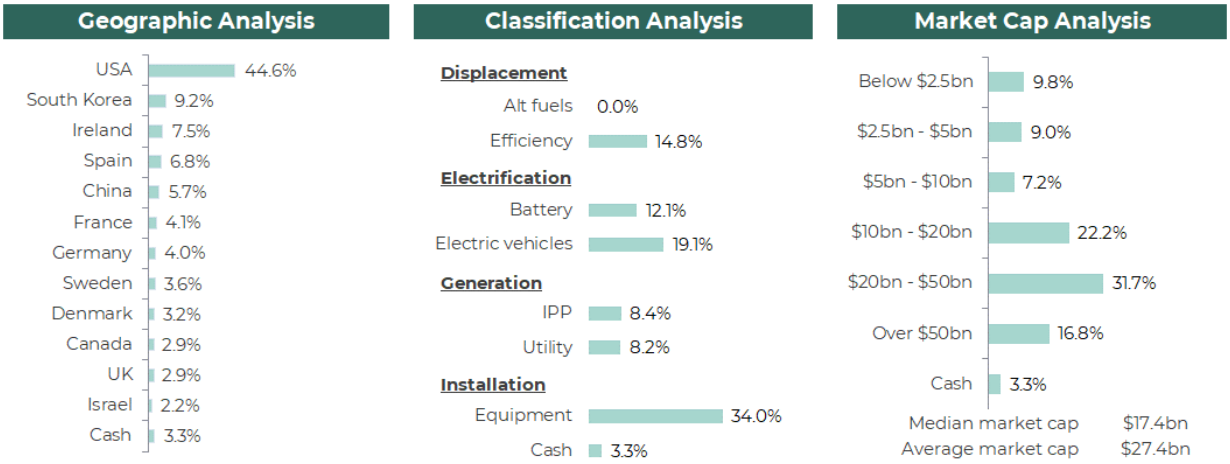
Signatory of:

PRI Principles for Responsible Investment

Buys/Sells

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

Portfolio structure analysis



Source: Guinness Global Investors

Portfolio sector breakdown

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

Asset allocation as %NAV	Current	*Change*	Year end	Year end	Previous year ends	
	Nov-22		Dec-21	Dec-20	Dec-19	Dec-18
Consumption	**46.0%**	**2.6%**	**43.4%**	**36.7%**	**41.7%**	**26.5%**
Displacement	14.8%	*3.0%*	11.8%	9.9%	13.4%	16.4%
Alternative Fuel	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*3.9%*
Efficiency	*14.8%*	*3.0%*	*11.8%*	*9.9%*	*13.4%*	*12.5%*
Electrification	31.2%	*-0.4%*	31.6%	26.8%	28.2%	10.1%
Batteries	*12.1%*	*3.3%*	*8.9%*	*10.8%*	*12.6%*	*3.9%*
Electric vehicles	*19.1%*	*-3.7%*	*22.8%*	*16.0%*	*15.7%*	*6.2%*
Renewables	**50.7%**	**-0.7%**	**51.3%**	**60.4%**	**54.1%**	**69.7%**
Generation	16.6%	*-6.5%*	23.1%	24.6%	22.2%	27.3%
IPP	*8.4%*	*-6.1%*	*14.5%*	*17.0%*	*18.9%*	*26.7%*
Utility	*8.2%*	*-0.4%*	*8.6%*	*7.6%*	*3.2%*	*0.6%*
Installation	34.0%	*5.8%*	28.2%	35.8%	32.0%	42.5%
Equipment	*34.0%*	*5.8%*	*28.2%*	*35.8%*	*32.0%*	*42.5%*
Cash	3.3%	*-1.9%*	5.3%	3.0%	4.2%	3.8%

Source: Guinness Global Investors

Valuation

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

As at 30 November 2022	P/E			EV/EBITDA			Dividend Yield		EPS Growth (%pa)		CFROI*	
	2022	2023E	2024E	2022	2023E	2024E	2023E	2024E	2014-21	2021-24	2022E	2023E
Guinness Sustainable Energy Fund	25.2x	20.6x	16.8x	15.2x	12.4x	10.3x	1.2%	1.3%	5.0%	20.3%	5.3%	6.5%
MSCI World Index	16.4x	15.6x	14.4x	10.9x	10.6x	10.1x	2.3%	2.4%	6.7%	5.4%	7.9%	8.3%
Fund Premium/(Discount)	*54%*	*32%*	*17%*	*39%*	*17%*	*2%*						

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

Source: Guinness Global Investors, Bloomberg

Portfolio holdings as at end November 2022

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 (19% weight) while we have 15% weight to those companies involved in either displacing existing energy sources or improving overall energy efficiency.

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

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

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

In terms of the supply of sustainable energy, we hold a 17% weight to companies involved in the generation of sustainable energy and 34% 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 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 November 2022

	Theme	Example holdings	Weighting (%)
1	Electrification of the energy mix	sunnova, NextEra Energy	19.7%
2	Rise of the electric vehicle and auto efficiency	Sensata Technologies, APTIV	22.0%
3	Battery manufacturing	Samsung SDI	9.2%
4	Expansion of the wind industry	Siemens Gamesa Renewable Energy, Vestas	9.9%
5	Expansion of the solar industry	CanadianSolar	17.6%
6	Heating, lighting and power efficiency	NIBE Industrier, Trane Technologies	14.8%
7	Geothermal	Ormat	3.5%
8	Other (inc cash)		3.3%

Portfolio at end October 2022 (one month in arrears for compliance reasons)

Guinness Sustainable Energy Fund (31 October 2022)				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	4.7%	12,754	22.8x	21.4x	19.4x	16.1x	14.7x	13.5x	5.4x	5.0x	4.3x	1.8%	2.0%	2.1%
Nibe Industrier AB	SE0015988019	3.5%	16,086	44.8x	39.1x	35.5x	26.7x	23.5x	21.3x	7.1x	6.3x	5.5x	0.7%	0.7%	0.8%
Trane Technologies PLC	IE00BK9ZQ967	3.9%	36,989	22.5x	20.6x	18.6x	15.3x	14.5x	13.6x	6.7x	6.5x	5.2x	1.6%	1.7%	1.8%
Ameresco Inc	US02361E1082	3.2%	3,135	32.1x	29.8x	24.2x	18.0x	16.6x	13.5x	3.9x	3.4x	3.0x	n/a	n/a	n/a
		15.3%													
Electrification/Battery															
LG Chem Ltd	KR7051910008	4.0%	30,933	18.7x	15.2x	11.5x	7.1x	5.9x	4.9x	1.6x	1.4x	1.3x	1.7%	1.9%	2.1%
Samsung SDI Co Ltd	KR7006400006	5.0%	35,475	27.2x	22.5x	18.8x	15.7x	12.6x	10.6x	3.0x	2.7x	2.3x	0.2%	0.2%	0.2%
Johnson Matthey PLC	GB00BZ4BQC70	2.9%	4,070	8.5x	10.0x	9.4x	5.3x	6.4x	6.0x	1.3x	1.4x	1.3x	4.3%	4.0%	4.1%
Tianneng Power International Ltd	KYG8655K1094	0.1%	1,083	4.0x	3.3x	3.0x	2.0x	1.7x	1.7x	0.5x	0.5x	0.4x	6.5%	8.3%	8.8%
		12.0%													
Electrification/Electric Vehicles															
Aptiv PLC	JE00B783TY65	3.5%	24,674	28.9x	18.1x	13.3x	11.6x	8.7x	7.3x	2.9x	2.6x	2.2x	0.1%	0.3%	0.6%
ON Semiconductor Corp	US6821891057	4.4%	26,564	11.7x	13.5x	12.2x	8.0x	8.7x	8.0x	4.3x	3.4x	2.8x	n/a	n/a	n/a
Infineon Technologies AG	DE0006231004	3.5%	31,814	13.0x	13.0x	12.0x	7.8x	7.6x	6.8x	2.4x	2.1x	1.9x	1.3%	1.5%	1.6%
Sensata Technologies Holding PLC	GB00BFMBMT84	3.7%	6,243	12.1x	10.8x	9.3x	10.2x	9.7x	8.6x	2.0x	1.7x	1.6x	0.8%	1.1%	1.1%
Gentherm Inc	US37253A1034	3.0%	1,937	32.7x	16.7x	12.4x	15.9x	9.8x	7.7x	n/a	n/a	n/a	n/a	n/a	n/a
		18.0%													
Generation/IPP															
China Longyuan Power Group Corp Ltd	CNE100000HD4	2.3%	16,061	9.9x	8.0x	6.9x	9.8x	8.3x	7.2x	1.0x	0.9x	0.8x	1.9%	2.5%	2.8%
Ormat Technologies Inc	US6866881021	4.1%	5,059	70.6x	46.1x	37.5x	16.2x	13.9x	12.5x	2.7x	2.4x	2.3x	0.5%	0.6%	0.5%
NextEra Energy Inc	US65339F1012	4.5%	152,270	26.9x	24.9x	22.9x	19.3x	16.0x	14.9x	3.5x	3.3x	3.1x	2.2%	2.4%	2.6%
Sunnova Energy International I	US86745K1043	1.3%	2,130	n/a	n/a	n/a	59.8x	32.2x	24.3x	1.3x	0.9x	0.8x	n/a	27.0%	27.0%
China Suntien Green Energy Corp Ltd	CNE100000TW9	1.5%	3,877	5.1x	4.4x	3.9x	10.7x	9.5x	8.2x	0.5x	0.5x	0.5x	6.6%	7.6%	8.2%
		13.6%													
Generation/Utility															
Iberdrola SA	ES0144580Y14	4.2%	64,632	15.6x	14.3x	13.5x	10.1x	9.3x	8.7x	1.5x	1.4x	1.3x	4.5%	4.9%	5.2%
		4.2%													
Installation/Equipment															
Schneider Electric SE	FR0000121972	4.4%	72,421	18.0x	17.0x	15.5x	12.7x	12.1x	11.3x	2.7x	2.5x	2.3x	2.4%	2.6%	2.8%
Eaton Corp PLC	IE00B8KQN827	4.7%	59,773	19.9x	18.2x	16.7x	15.9x	14.6x	13.8x	3.6x	3.4x	3.2x	2.1%	2.3%	2.4%
Itron Inc	US4657411066	3.0%	2,207	60.3x	22.0x	14.7x	27.0x	13.6x	9.6x	1.9x	1.9x	1.7x	n/a	n/a	n/a
Xinyi Solar Holdings Ltd	KYG9829N1025	2.2%	8,829	15.0x	11.0x	8.9x	10.8x	8.2x	6.5x	2.1x	1.9x	1.7x	3.1%	4.1%	5.2%
SolarEdge Technologies Inc	US83417M1045	1.9%	12,798	42.6x	25.7x	20.1x	35.8x	21.4x	17.1x	6.1x	4.9x	4.0x	n/a	n/a	n/a
Enphase Energy Inc	US29355A1079	3.9%	41,729	70.2x	59.3x	47.4x	57.5x	43.6x	34.1x	80.8x	56.8x	17.6x	n/a	n/a	n/a
First Solar Inc	US3364331070	4.5%	15,519	n/a	32.9x	14.2x	80.2x	23.7x	12.5x	2.6x	2.4x	2.0x	n/a	n/a	n/a
Canadian Solar Inc	CA1366351098	3.0%	2,175	12.8x	8.3x	6.7x	7.3x	4.9x	4.4x	0.9x	0.8x	0.7x	n/a	n/a	n/a
Vestas Wind Systems A/S	DK0061539921	2.8%	19,901	n/a	58.5x	24.3x	64.7x	14.7x	9.8x	5.3x	4.9x	4.3x	0.2%	0.5%	1.1%
Siemens Gamesa Renewable Energy SA	ES0143416115	3.1%	12,095	n/a	n/a	55.1x	n/a	29.5x	13.2x	3.4x	3.7x	3.4x	n/a	n/a	0.4%
TPI Composites Inc	US8726J1043	0.5%	371	n/a	n/a	11.0x	16.6x	8.8x	5.3x	1.9x	1.8x	1.7x	n/a	n/a	n/a
		34.0%													

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:

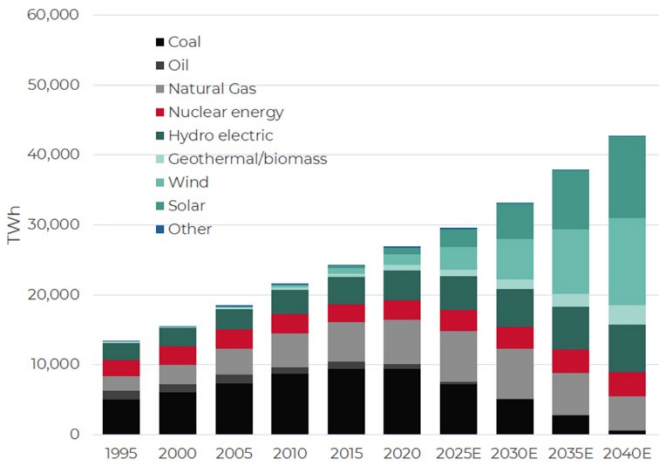
- **Population and GDP growth** putting a significant strain on today's energy supply
- **Economics** as sustainable sources of energy will be cheaper than the incumbents
- **Climate change** leading the world to reduce carbon emissions via cleaner energy
- **Pollution** forcing governments to drive 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 around 60% by 2050.

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



Sources: BP Statistical Review; IEA: Guinness Global Investors estimates; as of 31.12.2021

Policy support for decarbonisation

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

- **President Biden returning the US to the Paris Agreement** and announcing significantly increased 2030 GHG reduction targets. The new target - a 52% reduction in emissions by 2030 (vs 2005 levels) - was substantially ahead of the old target of a 28%

reduction by 2025.

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

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

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

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. The influential US "Build Back Better" (BBB) infrastructure package is the clearest example of the delay between policy announcement and actual investment. After it passed the House of Representatives in November, Democrat Senator Joe Manchin announced on December 19th that he would not be supporting the $1.75trn BBB bill (as currently written) thus delaying the passage of the bill through the House of Congress. A compromise bill, the Inflation Reduction Act (IRA) which includes $369bn of support for clean energy investment was passed in summer 2022 but was significantly smaller than Biden's initial proposed support package. In addition, the REPowerEU deal that was announced in March 2022 has a similar quantum of investment support but is unlikely to yield new investments until 2023/2024 and well into the second half of this decade. Both the IRA and the RePowerEU deal were direct responses to the Russian invasion of Ukraine and will both help to accelerate the energy transition.

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

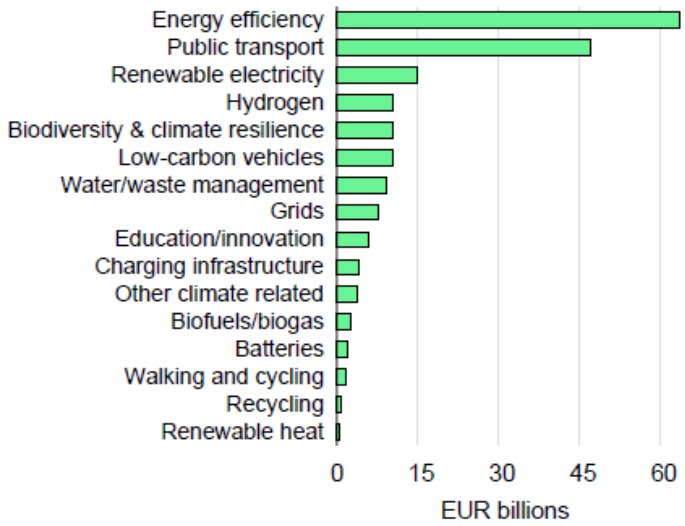
Energy efficiency measures were negatively impacted by Covid in 2020, as projects and investments were disrupted, but it appears that governments are turning their attention to efficiency measures as part of post-Covid stimulus measures. There is urgency to do this as current government policies imply that annual energy efficiency improvements need to increase by around 50% from a long-term historic 1.5%pa to a forecast level of 2.3%pa.

Energy efficiency measures are typically employment-intensive and offer a cheap form of carbon abatement. These factors help explain why the efficiency sector has received around US$144bn of stimulus spending since the start of Covid, the largest allocation within clean

energy spending globally. The renovation of public and private buildings and energy efficiency investment in the industrial sector are the largest beneficiaries of the allocated spending.

Despite the acceleration of energy efficiency spending for buildings, current spending plans will only be enough to keep total building heat consumption flat over the next few years, as per square foot efficiency gains are offset by an expanding stock of buildings.

EU Recovery and Resilience Facility (RFF) fund allocation



source: IEA World Energy Outlook 2022

Based on current government policies, the IEA estimates that energy efficiency spending needs to increase this decade from around $250bn pa to around $375bn pa, rising to $550bn in the 2030s. Within REPowerEU, the European Commission recognises that energy efficiency is the cheapest, cleanest, and quickest way to reduce the bloc's reliance on fossil fuel imports and reduce energy bills and the EU has increased energy efficiency targets from 9% to 13% accordingly.

However, current activity, plus recent subsidy announcements, are not sufficient to deliver even the IEA's base case, which is far from net zero.

Alternative fuels

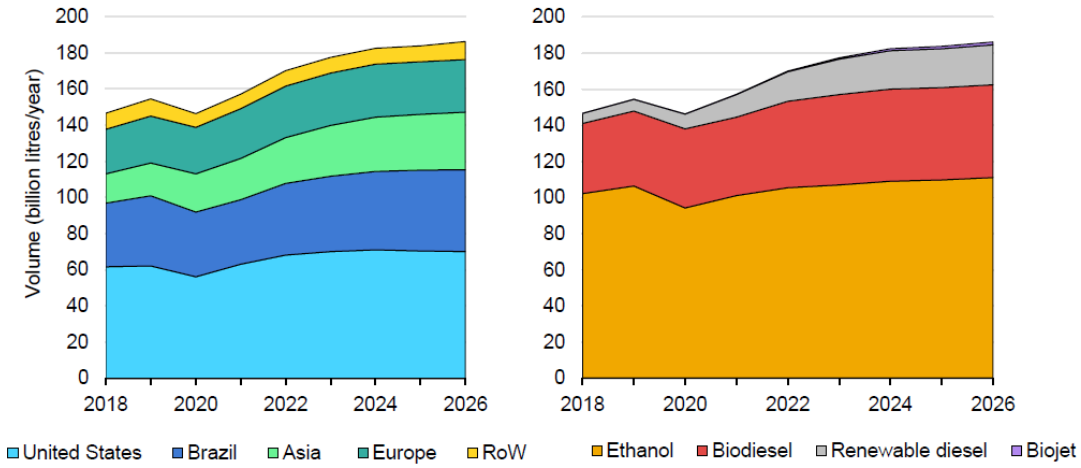
Alternative fuels such as ethanol (which displaces gasoline), biodiesel and renewable diesel (which displace conventional diesel) and Sustainable Aviation Fuels (SAF, which displace conventional jet fuel) serve a role in displacing existing fossil fuel demand, predominantly in transportation. In 2021, the global alternative fuel demand was nearly 160bn litres (over 2.5m b/day), representing nearly 3% of world oil transportation demand. The US has the largest alternative fuel market, at around 60bn litres (40% of the global market) where around 10% of all road fuel consumed is classified as alternative.

Alternative fuels consumption in 2021 grew by 10% versus 2020 and 3% versus 2019. Demand growth was significantly stronger than the underlying 6% increase in global oil demand, underlining the policy support for increased blending of alternative fuels in the transportation mix. Renewable diesel demand in the US and biodiesel demand in Asia were the biggest growth drivers. Over the next five years, alternative fuel demand is likely to grow at around 4%pa, reaching 186bn litres and continuing to outgrow global oil demand growth.

With regard to product mix, we see ethanol having the largest absolute demand growth, but its market share recedes to around 60% as demand for renewable diesel (using feedstocks such as used cooking oil, corn oil or rendered animal fats) accelerates and overtakes the current leading biodiesel technology. Combined, ethanol and renewable diesel satisfy 80% of the demand growth over the next five years.

We expect Asia to be the fastest growing market, driven for example by India's 20% ethanol blending target for 2025. However, North America will remain the largest market (40% market share) followed by Latin America (27% market share, driven by ethanol in markets like Brazil) and Asia (17% market share) and overtaking Europe (<15%).

Alternative fuel demand by region (left) and fuel (right) (2018-2026)



source: IEA World Energy Outlook 2022

On an unsubsidised basis, alternative fuels typically look expensive. Reliance on government subsidies increases the risk around the medium-term growth outlook. For example, in the US, there was significant uncertainty in 2021 around the Renewable Volume Obligation (RVO), a volume-driven subsidy. Various price-related subsidies in the US have also been volatile. In October 2021, the aggregate value of the subsidies, including Renewable Identification Numbers (RINs), Low Carbon Fuel Standards credits (LCFS) and the biodiesel Blenders Tax Credit (BTC), was around $4/gallon. With wholesale conventional diesel prices at around $2.50/gallon, it is clear how important subsidy is in delivering the growth of the biodiesel and renewable diesel industry in the US.

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.

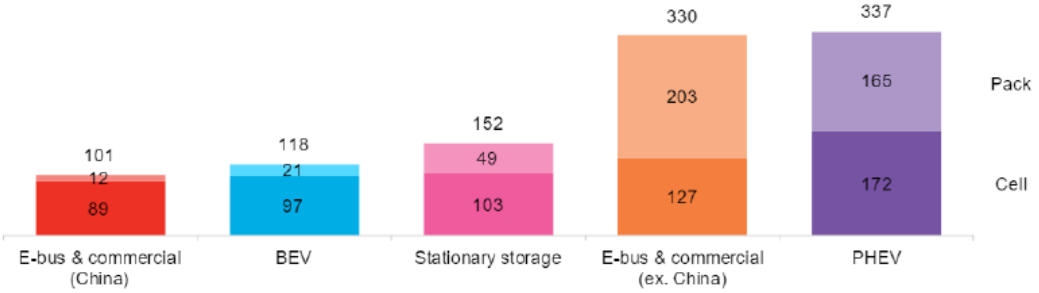
Batteries

The catalyst for greater **lithium-ion battery** use has been sharp falls in the cost of manufacturing. According to BNEF, battery pack costs are down 89% over the period 2010 to 2021 (an implied 'learning rate' of around 18%) with the average cost being $132/kWh in 2021 (split $101/kWh for the cell itself and an additional $31/kWh for the pack).

The $132/kWh survey outcome for 2021 is an average calculated across a wide range of uses and regions. China was typically the lowest-cost manufacturer with some individual passenger EV battery packs at below $100/kWh (and e-bus and commercial vehicle packs at $101/kWh on average) while BNEF calculated that Tesla's estimated average pack price in 2021 was around $112/kWh. The survey also includes stationary storage solutions which saw a fall in cost of around 16% in 2021, to $152/kWh, as manufacturers turned to simple and cheaper battery chemistries, such as lithium-ion phosphate, to offset raw material inflation.

BNEF lithium-ion battery survey 2021 ($/kWh)

source: BNEF



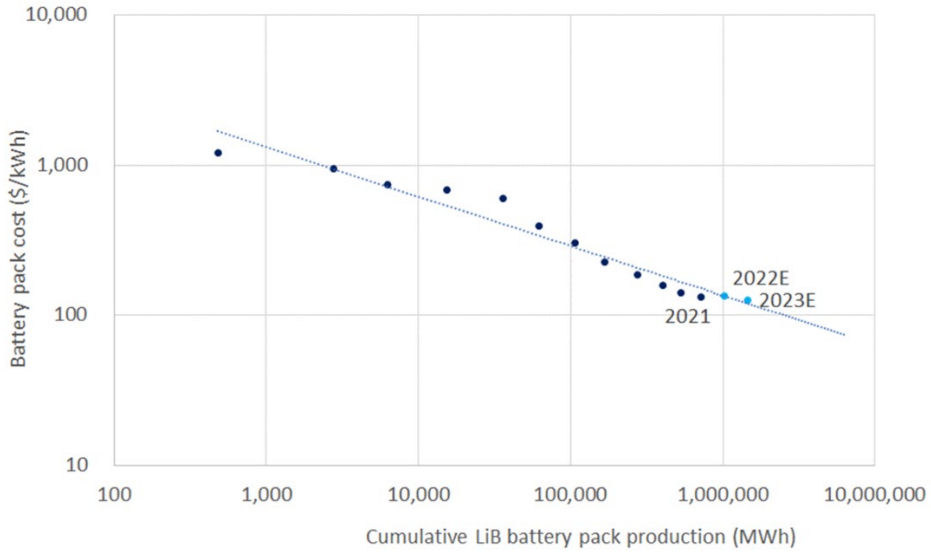
Raw materials make up around 50% of the cost of a lithium-ion battery pack, with cathode materials alone representing around 30% of the total cost. The key catalyst material is lithium carbonate, whose price in China rose by 270% in 2021. While battery manufacturers have long-term contracts and approaches in place to mitigate such inflation, they ultimately have little choice but to pass on the costs to consumers. In Q4 2021, BYD increased its battery prices by 20%.

Raw material cost inflation will continue to have an impact in 2022 and we see the likelihood that the cost of manufacturing may exceed levels seen in 2020. Rapidly increasing manufacturing capacity, (bringing further efficiencies of scale) together with reduced supply chain disruptions should help to alleviate the cost pressures in subsequent years and allow the average cost of producing a lithium-ion battery for an EV is likely to fall towards $100/kWh in the mid-2020s, somewhat later than we previously expected.

While the $100/kWh cost level is a key target, we note that in 2021 the battery and EV industry started focusing on manufacturing costs well below $100/kWh. EV manufacturers started to vertically integrate with battery manufacturers and form battery manufacturing JVs such as BlueOvalSK (Ford/SK) and Ultium Cells (GM/LG Energy Solutions) in efforts to improve manufacturing efficiencies with $60/kWh targets discussed for the end of the decade. The US Department of Energy also set $60/kWh as its 'stretch' goal, a level would be achieved by 2030 if the current 18% learning rate is maintained.

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

source: Bloomberg, Guinness Global Investors



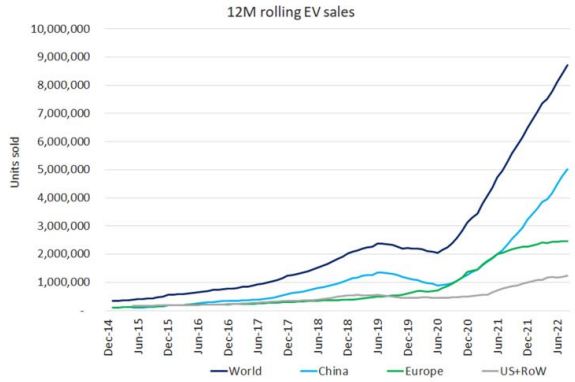
Electric Vehicles

Electric vehicle (EV) adoption continues apace in 2022. Based on data from Cleantechnica, around 5.8 million plug-in vehicles were sold from January to August this year, more than was sold in all of 2019 and 2020 combined. At the current rate, we could see EV sales for the full year exceeding 10 million units. August was a particularly strong month for EVs, with the battery electric (BEV)

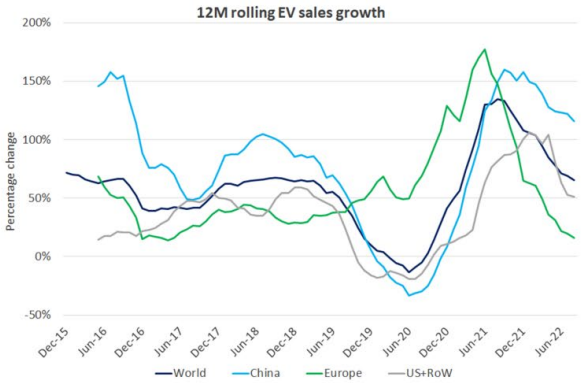
global market share reaching 11% and the share of all plug-in vehicles reaching 15%. This strong performance takes year-to-date plug-in penetration to approximately 13%, split around 9% for BEVs and 4% for plug-in hybrids (PHEVs).

Global sales growth is around 60% year over year (down from 130% last year) with China increasing its market share to around 60%, up from 40% in 2021. Just in the last 12 months, China has significantly extended its lead over the European market which is now in a distant second place with around one quarter of overall EV sales. The US continues to lag behind, making up just under 10% of global EV sales.

Global EV sales (rolling 12-months)



Global EV sales growth (rolling 12-months)



Source: Guinness, Cleantechnica. Data to 31.08.2022

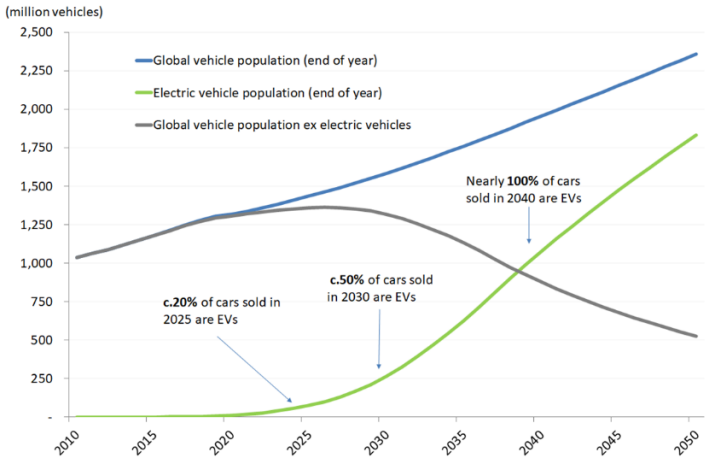
Policy support, both in terms of incentives to purchase new EVs and legislation to ban the sale of ICE vehicles, continues to underpin the uptake of EVs. The IEA estimates that governments around the world provided nearly $30bn of incentives in 2021 to support $250bn of consumer spending on electrified transport. Despite this headline number being nearly double 2020's figure, government support is slowly being reduced with incentives now making up around 10% of spending on electric cars, down from around 20% only five years ago. To support the transition, over 40 countries now have some form of legislation that either bans internal combustion engine sales or restricts tailpipe emissions.

Looking ahead, 2022 looks like it may be the first year where EVs claim over 10% of annual passenger vehicle sales driven by improving economics, driving range, and charging times.

On a global basis, we expect EVs will represent around 20% of new vehicle sales in 2025 (concurrent with the cost of EV lithium-ion batteries falling to around $100/kWh), 50% of new vehicle sales in 2030 and nearly all new vehicle sales by 2040. At that point, it implies an overall EV population of around 1bn vehicles, over sixty-five times greater than the global population of around 15m EVs at the end of 2021. With EVs using roughly one third of the energy of a typical internal combustion engine vehicle, this transition alone will have substantial impact on global energy efficiency and global decarbonisation.

Global EV population (to 2050)

Source: IEA; Guinness Global Investors estimates



Despite these rapid 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.

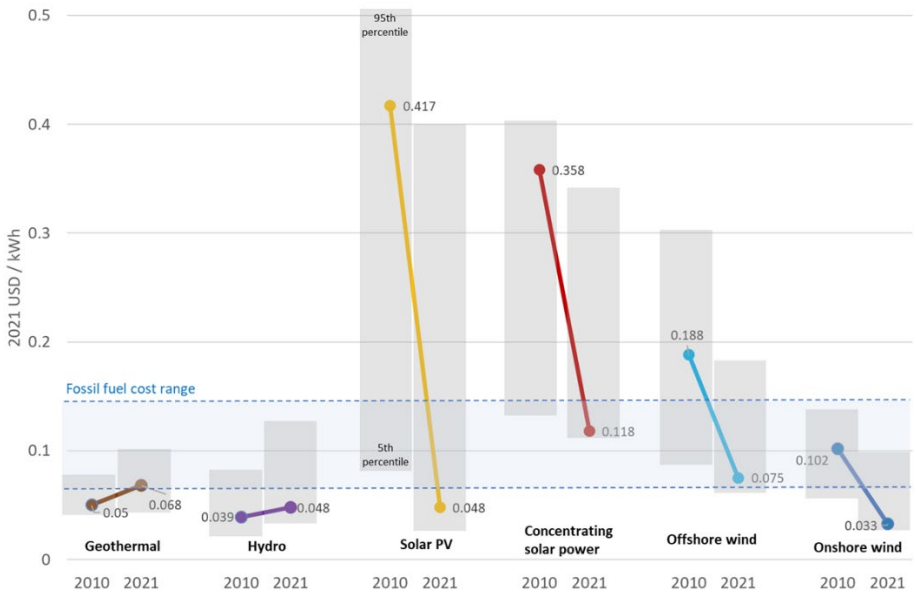
Generation & installation (equipment)

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 of utility-scale renewable power generation technologies (2010–2021)

source: IRENA, Guinness Global Investors estimates



The solar sector

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 Inflation Reduction Act (IRA) and the 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 NEM3.0 appears to be less of a threat (although it is still unresolved) and the WRO has not been as negative as initially feared. While the passing of the IRA in 2022 is a clear positive for solar, we do not expect the effect of the bill to be felt until 2023 and for it to be spread over a number of years, with installations reaching the 2021 peak of 30 GW again in 2023 and growing thereafter.

- Demand in **Europe** is expected to be around 45 GW in 2022, up from 24 GW in 2021, as the region reacted to higher fossil fuel generated electricity prices (as a result of lower Russian natural gas imports) 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. According to BNEF, Europe imported $2.5bn of Chinese PV products in July 2022, up $1.5bn on the level from July 2021. 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. Accordingly, we expect China will see more growth in 2023, reaching around 115 GW, double the levels seen in 2020/2021, and representing around 37% global market share.

- The rest of the **non-OECD** has also seen greater than expected growth in demand, estimated to reach 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. Indian installations look particularly impressive but activity was front-end loaded in response to a new import tax policy that placed a 40% surcharge on imported panels from April 2022.

Considering all these factors, we believe that installations could exceed 300 GW in 2023, and are potentially biased higher, with the non-OECD (at 195 GW) still dominating with a 63% market share.

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 in OECD annual installations	*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 in non-OECD annual installations	*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 in world annual installations	*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, expect 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 and the poly market continued to be the tightest part of the solar market in 2022, evidenced by polysilicon 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 poly silicon 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 a number of 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 and associated margins for poly producers 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 to 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 is in the hands of the five largest producers. This may be a factor to help support prices in 2023. A consideration slightly longer term will be the rate at which demand moves from p-type wafers to n-type wafers (with greater efficiency and lower degradation) and how this might cause some existing wafer and cell manufacturing capacity to become obsolete, effectively leaving this part of the market tighter than initially apparent.

- **Solar module** prices have moderated so far in 2022, down to around US$0.25/W currently, and are likely to average in 2022 the levels seen in 2021. With elevated polysilicon and power prices, it is the module manufacturers that have suffered the greatest margin compression so far in 2022. Module manufacturing nameplate capacity in 2022 is estimated to be 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.

Polysilicon and solar module pricing

source: Bloomberg

The wind sector

The long-term outlook for the wind industry remains very positive as wind power will play a critical role in global decarbonisation and the energy transition. Global wind generation capacity today is around 700GW with annual installations in 2022 expected to be around 105GW.

However, the wind industry is suffering short-term pressures as recent sharp peaks in installation demand (a 50% increase to 98 GW in 2020, driven by tax incentives and policy changes) have moderated and have been compounded by Covid-related project delays, raw material cost inflation, logistics issues and permitting constraints.

Wind turbine manufacturing is raw material intensive. According to Vestas in December 2021, steel plate prices were up 2x and resin up 2.5x versus the start of 2020. In terms of logistics, the cost of shipping containers was up 4x and the cost of delivery vessels was up 2x in 3Q 2021 vs 2020. While these cost increases are significant, they were compounded by supply chain issues, such as a 4x increase in the average time that equipment spent waiting in Chinese ports and a 50% reduction in the reliability of scheduling.

Below, we consider the key factors for the onshore and offshore wind markets in 2021 and beyond, concluding 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
Onshore wind installations (annual)															
North America	9	11	6	8	15	2	7	10	9	8	8	10	17	16	10
Latin America	0	0	0	0	0	0	5	3	3	3	4	4	2	5	3
Europe	6	9	9	10	12	11	11	11	12	13	8	9	12	15	19
China	6	14	17	18	14	15	21	29	22	17	19	26	54	41	48
India	2	1	1	1	2	2	2	3	4	4	2	2	1	3	4
RoW	3	3	3	4	4	3	4	5	5	5	4	4	5	3	8
Total onshore	**27**	**38**	**35**	**40**	**46**	**33**	**49**	**61**	**55**	**49**	**46**	**55**	**91**	**83**	**92**
Change in onshore annual installations		*12*	*-3*	*5*	*6*	*-14*	*17*	*11*	*-6*	*-6*	*-3*	*9*	*36*	*-8*	*9*
World ex China	*21*	*24*	*18*	*22*	*32*	*18*	*29*	*32*	*33*	*32*	*27*	*29*	*37*	*42*	*44*
Offshore wind installations (annual)															
China	0	0	0	0	0	0	0	1	1	1	2	3	4	14	6
UK	0	0	1	0	1	1	0	1	0	1	2	2	1	1	2
Germany	0	0	0	0	0	0	0	2	0	2	0	2	0	1	2
RoW	0	0	0	0	0	1	0	0	0	1	0	1	2	1	3
Total offshore	**0**	**0**	**1**	**0**	**2**	**2**	**1**	**4**	**1**	**4**	**4**	**8**	**7**	**17**	**13**
Change in onshore annual installations		*0*	*1*	*-1*	*1*	*1*	*-1*	*4*	*-4*	*3*	*0*	*3*	*-1*	*11*	*-4*
World ex China	0	0	1	0	1	2	1	3	0	4	3	5	3	3	7
Total wind installations (annual)	**27**	**38**	**36**	**40**	**48**	**35**	**50**	**65**	**56**	**53**	**50**	**63**	**98**	**100**	**105**
Change in world annual installations		*12*	*-2*	*4*	*8*	*-13*	*16*	*15*	*-9*	*-3*	*-2*	*12*	*35*	*3*	*5*

Onshore wind

Global onshore wind installations in 2021 were around 83 GW, down 8 GW from the record level seen in 2020 but still up 28 GW on the pre-pandemic installation level of 55 GW in 2019.

Onshore wind installations had been growing very steadily since 2008, averaging an increase of around 3 GW pa, with China representing around 70% of the annual growth. Chinese demand peaked sharply in 2000 and we expect installations to moderate to the longer-term trend resulting in around 41 GW of installations in 2022.

Outside China, onshore installations reached a new high in 2021, averaging 42 GW, up 5 GW on 2020 levels. Onshore installations outside China are expected to be slightly higher again in 2022, achieving a new record level of around 44 GW.

Combined with underlying new project increases, we note that by 2030 around one third of the world's total installed capacity will be more than 13 years old and will be strong candidates for refurbishing.

Offshore wind

Offshore wind remains a nascent industry, at only 17% of the size of onshore (by annual installations in 2021), but one where the growth trajectory is becoming increasingly visible.

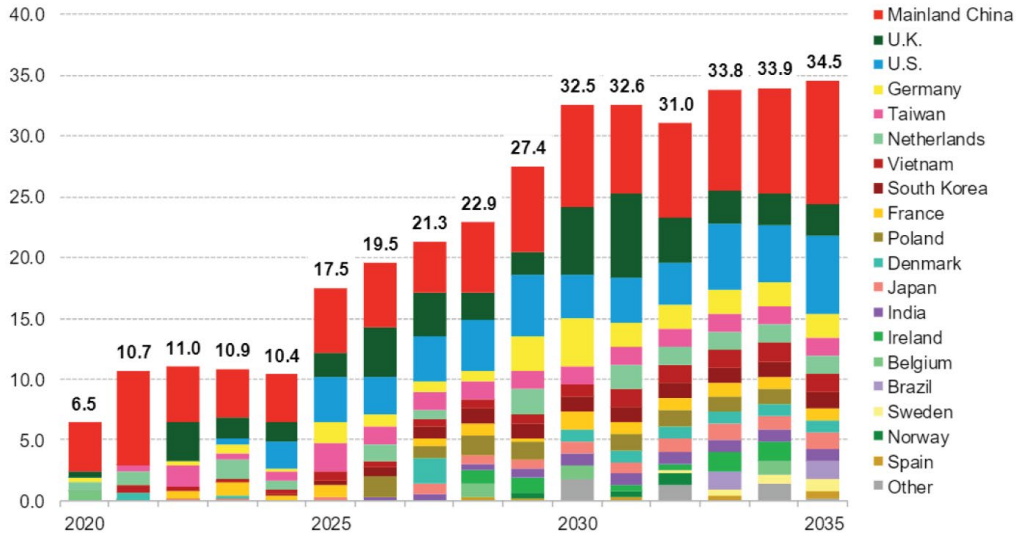
Annual installations of offshore wind capacity have increased from 0.9GW in 2010 to a new high of 17 GW in 2021. Chinese offshore installations reached 14 GW in 2021 while ex-China installations are likely to grow from 3 GW in 2021 to a new high of 7 GW in 2022.

The economics of offshore wind continue to improve and there was further constructive cost data in 2021 suggesting that the LCOE for the median offshore wind project halved between 2010 and 2020, and now sits at the bottom end of the competing fossil fuel generation cost range. The growing interest underlines the significant potential of the offshore industry which benefits from better operational (higher and more reliable wind speed) and visual characteristics as well as being close to key demand areas which are often coastal.

In the later part of this decade, we expect annual offshore wind installations to represent around 20% of the total wind market with cumulative installations in offshore between 2020 and 2030 likely to be around 140 GW. A broader spread of countries including the United States, Chinese Taipei, Korea, Vietnam and Japan means that cumulative installations will be split around 30 GW in the Americas, 90 GW in Europe, Middle East and North Africa and around 20 GW in Asia Pacific. The current European market will continue to grow, as excess offshore wind generation will be utilised for the generation of green hydrogen via electrolysers, and while the Chinese market will also grow it will not be as dominant globally as it is in the onshore market.

The outlook for offshore wind installations

source: BNEF projections August 2022



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