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.

October 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 Jamie Melrose (analyst). 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.

◀ 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.

STRONG START TO 2022 FOR EV SALES

Electric vehicle (EV) adoption continues apace in 2022. Around 5.8mn plug-in vehicles have been sold globally to the end of August, representing a 13% new sales penetration for EVs so far in 2022 (with August reaching a new monthly peak of 15% EV penetration). At the current rate, we are likely to see EV sales for the full year exceeding 10 million units. Sales growth is around 60% year-over-year with China growing its market share (now around 60%) and leaving Europe in a distant second place (25% share) and the US lagging at 10% market share. In this month's manager's comments, we discuss developments in EV economics, driving range and charging times - the three key hurdles for EV adoption.

EQUITIES

Sustainable energy equities underperformed in weaker global stock markets in September. The Guinness Sustainable Energy Fund (Class Y) delivered a return of -9.8% (in USD), behind the MSCI World at -9.3%. Year to date, the Guinness Sustainable Energy Fund (Class Y) has delivered -21.6% (in USD), versus the MSCI World at -25.4%. Full performance details are available in Section 3.

CHART OF THE MONTH

In its recent "Tracking Clean Energy Progress" update, the IEA highlighted the tremendous growth required over the rest of this decade in grid scale battery storage, in order to reach a net zero 2050 target. Under their scenario, storage capacity needs to increase from the current 16 GW to around 680 GW in 2030 – an increase of 44x - with installations in 2030 being nearly 140 GW (versus 6 GW in 2021).

Grid scale battery storage capacity (GW)

(Source: IEA)

Signatory of:

PRI Principles for Responsible Investment

Contents

1. SEPTEMBER 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
Chinese coal imports from Russia reached a five year high in August as China suffered from high electricity demand due to hot weather, lower levels of hydropower generation and higher competing natural gas prices. Russian coal prices have increased recently due to higher Asian demand but, according to Reuters, are still cheaper than domestic coal of same quality.	Energy transition	
According to research from Ember, European solar power generation between May and August 2022 reached 99.4 TWh, 28% higher than the same period in 2021. It represented 12% of total power generation (up from 9% in 2021) although this was partly due to other power generation sources being lower.	Solar generation	
A new study from the University of Oxford, utilising probabilistic renewable energy cost forecasting methods, has concluded that transitioning away from fossil fuels over the next 30 years will save the world "at least $12 trillion". The research team analysed thousands of transition cost scenarios produced by major energy models and examined data on 45 years of solar energy costs, 37 years of wind energy costs and 25 years for battery storage.	Energy transition	
Sales of electric vehicle batteries expanded to 39.7 GWh in July, up 80% from July 2021. Contemporary Amperex Technology Co (CATL) leads the market with 13.3 GWh of sales, followed by Chinese car and battery manufacturer BYD (6.4GWh, up from third place in July 2021) and then LG Energy Solutions (4.4 GWh, down from second in July 2021).	Lithium ion battery demand	
Japan, the world's fifth largest carbon emitter, commenced a trial carbon credit trading scheme at the Tokyo Stock Exchange (TSE). The nationwide exchange based mechanism is designed to allow participants to trade or monetise carbon credits. The scheme currently includes 145 participants and initial carbon pricing was around $23/tonne.	Carbon pricing	
A subsidiary of Power Construction Corp of China has started construction at a 9 GW hydroelectric plant in the Indonesian portion of Broneo Island. The heavily delayed project which includes a total of five dams is expected to cost $17bn and is scheduled to fully operational in 2035.	Hydropower	

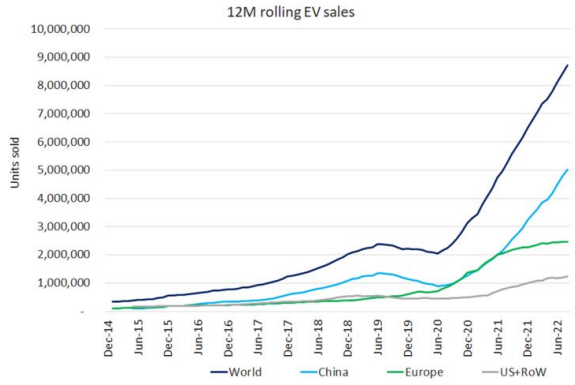
2. MANAGER'S COMMENTS

Electric vehicle sales in 2022 and the long-term outlook

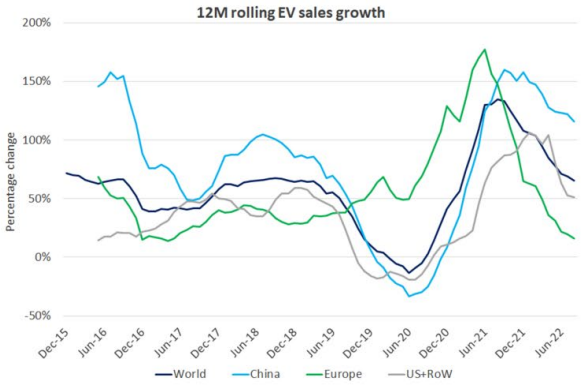
Electric vehicle (EV) adoption continues apace in 2022. Based on data from Cleantechnica, around 5.8 million plug-in vehicles were sold from January to August this year, more than ware sold in all of 2019 and 2020 combined. At the current rate, we could see EV sales for the full year exceeding 10 million 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, now in a distant second place with around one quarter of overall EV sales. The US continues to lag, 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

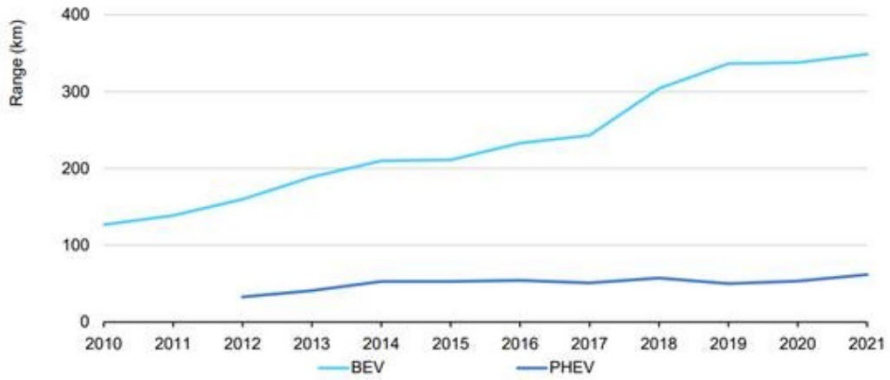
Policy support, both in terms of incentives to purchase new EVs and legislation to ban the sale of ICE vehicles, continues to underpin the uptake of EVs. The IEA estimates that governments around the world provided nearly $30bn of incentives in 2021 to support $250bn of consumer spending on electrified transport. Despite this headline number being nearly double 2020's figure, government support is slowly being reduced. Incentives now make up around 10% of spending on electric cars, down from around 20% only five years ago. To support the transition, over 40 countries 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. These three issues remain the key hurdles to wider EV adoption, and we consider each in turn here.

- The full life cycle **economics** of an EV over an ICE vehicle is affected by the upfront cost premium of an EV as well as its lower life cycle running costs. Upfront EV costs are dramatically different across regions, with the average European EV costing $48,000 in 2021, the market leading Tesla Model 3 and Model Y in the US costing $50-60,000 and the best-selling Wuling Hongguang EV in China costing only $5,000. Excluding China, the IEA suggests that BEVs typically still cost 45-50% more than the average conventional vehicle, a price premium of around $15,000. Allowing for the higher gasoline and electricity prices seen in 2022, we estimate that the fuel costs for an EV in Europe and the US are $23,000 and $13,000 lower respectively than the ICE equivalent, thus justifying the upfront price premium. The relative economics for purchasing an EV have improved in the US over the last two years and remain broadly unchanged in Europe, reflecting differences in relative electricity and gasoline prices in the two regions.

- The IEA estimates that the average **driving range** of a battery electric vehicle sold in 2021 was around 350km (215 miles), just under half that of the competing ICE vehicle. The EV clearly has an inferior range, but we note a Joint Research Centre of the European Commission report that highlights an average daily driving distance of only 40-90km. This makes current EV models and most older EV models capable of handling everyday distances. Despite this, range anxiety persists, especially on longer journeys, which can be hampered by access to fast charging infrastructure, which we explore in more detail below.

Evolution of average range of electric vehicles by powertrain



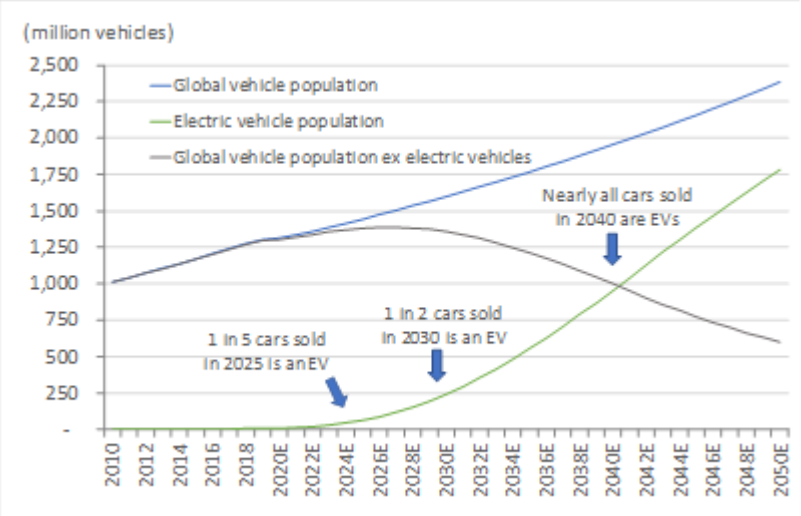
Source: IEA

- The time to **charge** an EV depends on the type of EV charger. Level 1 and level 2 AC chargers (typically available in residential and commercial environments and used for overnight or daytime charging) can replenish 5-30 miles of range per hour. They are relatively affordable (Level 1 chargers are often free with an EV purchase) and, in its Net Zero Scenario, Bloomberg New Energy Finance (BNEF) sees Level 1 and 2 chargers making up over 95% of all chargers in operation by 2040. However, we believe that access to level 3 DC fast chargers will prove to be the key crunch point as, despite BNEF's estimate that they will represent only 2% of all charging ports in 2040, they are likely to deliver around 25% of the total electricity. A typical level 3 charger, which might cost $1mn to install, is designed to offer fast charging in the middle of longer trips, delivering 200-600 miles of range per hour of charging. China is the furthest ahead in its nationwide charging infrastructure roll out with around 7 EVs per charger with the EU and US lagging behind at 15-20 EVs per charger.

Long-term growth expectations

We believe that these three obstacles to EV penetration will be overcome and EVs will achieve a broader mass market appeal. The recent rapid growth in EV 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% the year before. It is encouraging to see consensus moving closer to our long-held forecasts for EVs to make up 20% of new global vehicle sales by 2025, 50% by 2030 and predominantly all new vehicle sales by 2040. At that point, it implies an overall EV population of around one billion vehicles, over 60 times greater than the global stock in 2021 of around 16.5m electric vehicles.

Global EV population (to 2050)



Source: IEA; Guinness Global Investors

The journey towards an EV-dominated car population will continue to be supported by government incentives such as the tax breaks in the Inflation Reduction Act in the US, and disincentives such as the EU's restrictive tailpipe emissions standards. These, alongside further improvements in battery technology, will drive an acceleration to a smarter transportation system.

3. PERFORMANCE

Past performance does not predict future returns.

The Guinness Sustainable Energy Fund (Class Y, 0.68% OCF) delivered a return of -9.8% in the month, while the MSCI World Index (net return) delivered -9.3% (all in USD terms).

	Ytd	1 Yr	3 Yrs	5 Yrs*	10 Yrs*
Fund (Class Y)	-21.6%	-19.6%	79.9%	80.9%	147.4%
MSCI World NR Index	-25.4%	-19.6%	14.3%	29.5%	118.1%
Out/Underperformance	3.8%	0.1%	65.6%	51.5%	29.3%

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%*

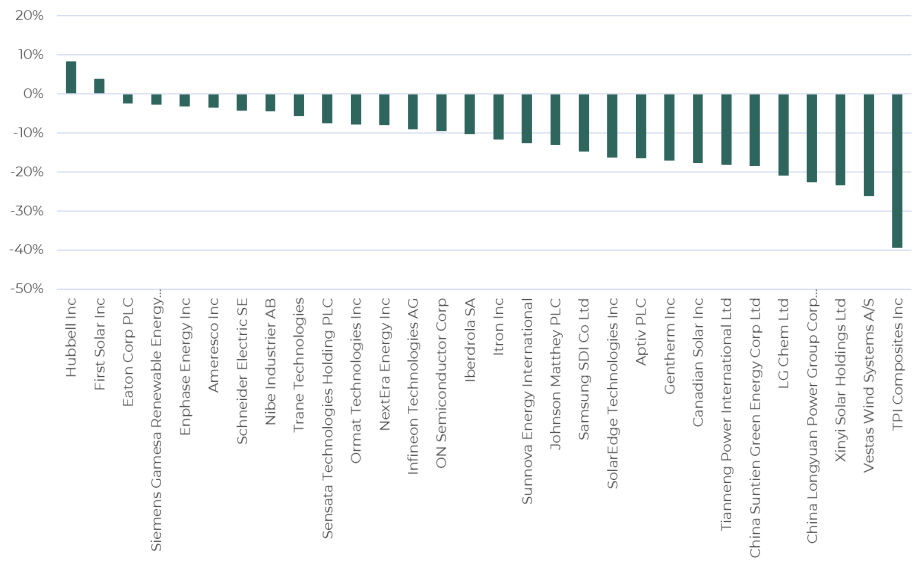
Annual performance	2016*	2015*	2014*	2013*	2012*
Fund (Class Y)	-15.4%	-12.0%	-12.1%	70.8%	-13.2%
MSCI World NR Index	7.5%	-0.9%	4.9%	26.7%	15.8%
Out/Underperformance	*-23.0%*	*-11.2%*	*-17.0%*	*44.1%*	*-29.1%*

*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 0.68% 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 Hubbell, First Solar, Eaton, Siemens Gamesa and Enphase. The weakest performers were LG Chem, China Longyuan, Xinyi Solar, Vestas and TPI Composites.

Stock by stock performance over the month, in USD

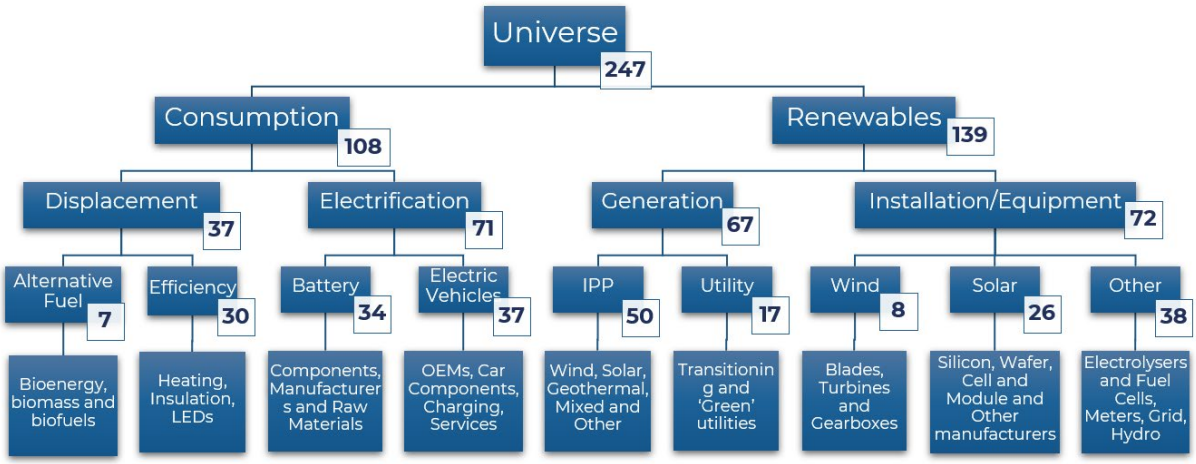


Source: Bloomberg. As of 30 September 2022

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 two new buys and two sells during the quarter and the portfolio was actively rebalanced. New additions were Trane Technologies and Sunnova International.

Trane Technologies is a US-domiciled leader in climate control products & services including commercial & residential Heating Ventilation Air Conditioning and Cooling (HVAC) systems and transportation refrigeration. The company was originally the climate business division of Ingersoll Rand and it became a separate listed entity (named Trane Technologies) in February 2022 when Ingersoll Rand spun off its industrial business and merged it with Gardner Denver (maintaining the Ingersoll Rand brand name). Thirty percent of global energy consumption comes from buildings and around 50% of this relates to HVAC activities alone. Trane offers highly efficient HVAC technologies that we believe will help to reduce the energy and carbon intensity of HVAC within buildings.

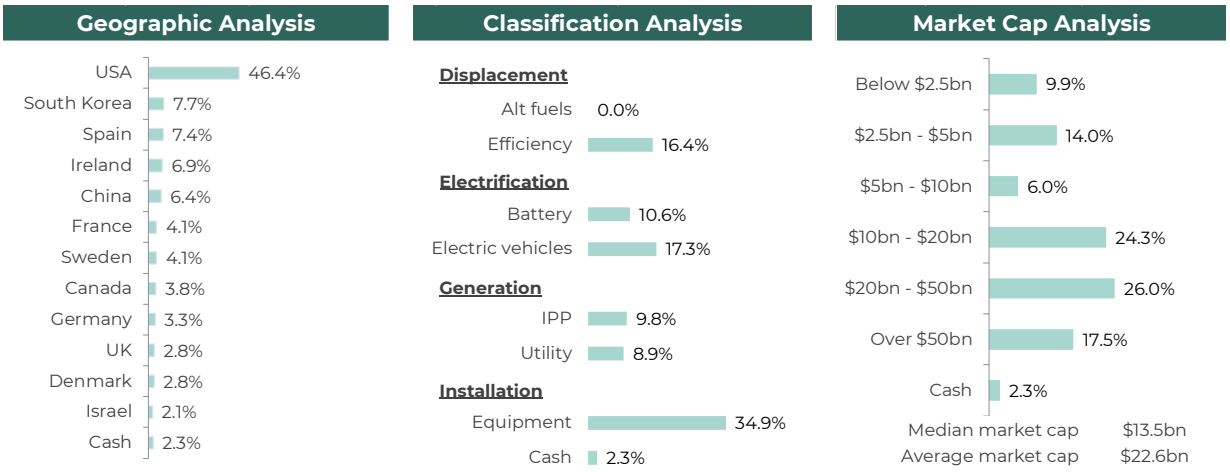
Sunnova Energy International is a US-domiciled residential solar power generator. The company sells rooftop solar power generated electricity to residential consumers typically on 25-year power purchase agreements that are at a discount to competing utility residential power prices. Increasingly, Sunnova intends to sell additional home services including home battery storage systems and EV chargers. We believe that the US residential solar market is under-penetrated and that the attractive pricing of residential solar power means that Sunnova could benefit from significant long-term growth with the potential to deliver a wider range of electrification products for the residential consumer.

Albioma and TransAlta Renewables were sold from the portfolio.

Albioma was acquired by KKR for EUR50/sh in August 2022, at about a 40% premium to the prior unaffected share price. The deal was announced in late April 2022 and completed in the summer of 2022. Albioma's main business is the generation of electricity in French overseas territories via the combustion of bagasse, an organic residue left over from the processing of sugar cane. The company is also in the process of developing a number of wind and solar power generating facilities as well.

TransAlta Renewables is a Canadian listed generation company with a range of wind, hydropower and natural gas power generation facilities across North America and Australia. We sold TransAlta due to stretched valuation metrics.

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	
	Sep-22		Dec-21	Dec-20	Dec-19	Dec-18
Consumption	**44.2%**	***0.8%***	**43.4%**	**36.7%**	**41.7%**	**26.5%**
Displacement	16.4%	*4.6%*	11.8%	9.9%	13.4%	16.4%
Alternative Fuel	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*3.9%*
Efficiency	*16.4%*	*4.6%*	*11.8%*	*9.9%*	*13.4%*	*12.5%*
Electrification	27.8%	*-3.8%*	31.6%	26.8%	28.2%	10.1%
Batteries	*10.6%*	*1.7%*	*8.9%*	*10.8%*	*12.6%*	*3.9%*
Electric vehicles	*17.3%*	*-5.5%*	*22.8%*	*16.0%*	*15.7%*	*6.2%*
Renewables	**53.5%**	***2.2%***	**51.3%**	**60.4%**	**54.1%**	**69.7%**
Generation	18.6%	*-4.5%*	23.1%	24.6%	22.2%	27.3%
IPP	*9.8%*	*-4.8%*	*14.5%*	*17.0%*	*18.9%*	*26.7%*
Utility	*8.9%*	*0.3%*	*8.6%*	*7.6%*	*3.2%*	*0.6%*
Installation	34.9%	*6.7%*	28.2%	35.8%	32.0%	42.5%
Equipment	*34.9%*	*6.7%*	*28.2%*	*35.8%*	*32.0%*	*42.5%*
Cash	2.3%	*-3.0%*	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 September 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	21.3x	17.4x	14.2x	13.2x	10.9x	9.2x	1.8%	1.9%	4.9%	19.0%	5.4%	6.6%
MSCI World Index	14.3x	13.4x	12.5x	9.8x	9.5x	9.0x	2.5%	2.7%	6.6%	8.3%	7.9%	8.4%
Fund Premium/(Discount)	*49%*	*30%*	*14%*	*35%*	*15%*	*2%*						

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

Source: Guinness Global Investors, Bloomberg

Portfolio holdings as at end September 2022

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

We hold c.44% weight to companies associated with the consumption (or demand) of sustainable energy. Our largest exposure here is to companies involved in the electrification of demand, either via the creation of new batteries (11%) or the electrification of transportation (17% weight) while we have 16% 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 19% weight to companies involved in the generation of sustainable energy and 35% 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 September 2022

	Theme	Example holdings	Weighting (%)
1	Electrification of the energy mix		20.2%
2	Rise of the electric vehicle and auto efficiency		20.1%
3	Battery manufacturing		7.7%
4	Expansion of the wind industry		10.6%
5	Expansion of the solar industry		18.6%
6	Heating, lighting and power efficiency		16.4%
7	Geothermal		4.2%
8	Other (inc cash)		2.3%

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

Guinness Sustianable Energy Fund (31 August 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	3.9%	11,074	21.0x	19.6x	17.9x	15.0x	14.1x	12.8x	4.7x	4.4x	4.2x	2.1%	2.2%	2.4%
Nibe Industrier AB	SE0015988019	3.8%	18,972	50.6x	44.2x	39.4x	30.5x	26.9x	24.1x	8.1x	7.1x	6.2x	0.6%	0.6%	0.7%
Trane Technologies PLC	IE00BK9ZQ967	3.5%	35,701	21.7x	19.7x	17.7x	14.9x	14.1x	13.2x	6.5x	6.7x	5.1x	1.7%	1.8%	1.9%
Ameresco Inc	US02361E1082	3.5%	3,569	36.5x	33.1x	26.7x	20.4x	18.8x	15.3x	4.4x	3.9x	3.4x	n/a	n/a	n/a
		14.6%													
Electrification/Battery															
LG Chem Ltd	KR7051910008	4.1%	33,234	18.4x	14.8x	11.8x	6.8x	5.7x	4.8x	1.5x	1.4x	1.3x	1.6%	1.8%	2.0%
Samsung SDI Co Ltd	KR7006400006	4.4%	30,631	24.7x	20.6x	16.8x	13.9x	11.3x	9.5x	2.5x	2.2x	2.0x	0.2%	0.2%	0.2%
Johnson Matthey PLC	GB00BZ4BQC70	2.9%	4,290	9.0x	10.1x	9.5x	5.5x	6.4x	6.1x	1.3x	1.4x	1.4x	4.1%	3.9%	4.0%
Tianneng Power International Ltd	KYG8655K1094	0.1%	1,201	4.2x	3.2x	2.4x	1.8x	1.6x	1.5x	0.5x	0.5x	0.4x	7.1%	9.3%	n/a
		11.4%													
Electrification/Electric Vehicles															
Aptiv PLC	JE00B783TY65	3.4%	25,313	29.2x	18.0x	13.5x	12.6x	9.5x	8.0x	2.9x	2.6x	2.3x	0.1%	0.3%	0.5%
ON Semiconductor Corp	US6821891057	4.3%	29,794	13.4x	13.7x	13.1x	8.9x	9.4x	8.9x	4.7x	3.7x	3.0x	n/a	n/a	n/a
Infineon Technologies AG	DE0006231004	3.2%	31,905	12.7x	12.7x	11.7x	7.7x	7.5x	6.8x	2.3x	2.0x	1.8x	1.3%	1.5%	1.7%
Sensata Technologies Holding PLC	GB00BFMBMT84	3.4%	6,254	12.0x	10.8x	10.1x	10.0x	9.1x	8.1x	2.0x	1.8x	n/a	0.7%	1.1%	1.1%
Gentherm Inc	US37253A1034	2.9%	1,987	32.3x	16.7x	12.4x	15.9x	10.4x	7.8x	n/a	n/a	n/a	n/a	n/a	n/a
		17.2%													
Generation/IPP															
China Longyuan Power Group Corp Ltd	CNE100000HD4	2.7%	20,896	13.5x	10.9x	9.4x	11.4x	9.6x	8.3x	1.3x	1.2x	1.1x	1.5%	1.9%	2.2%
Ormat Technologies Inc	US6866881021	4.4%	5,229	71.7x	48.6x	39.6x	15.3x	12.8x	11.5x	2.8x	2.5x	2.4x	0.5%	0.6%	0.5%
TransAlta Renewables Inc	CA8934631091	0.3%	3,542	28.5x	20.3x	17.9x	10.5x	10.2x	10.1x	2.6x	2.6x	2.5x	5.5%	5.5%	5.5%
NextEra Energy Inc	US65339F1012	5.0%	167,124	29.6x	27.4x	25.2x	19.8x	17.0x	15.5x	3.9x	3.7x	3.6x	2.0%	2.2%	2.4%
Sunnova Energy International I	US86745K1043	1.7%	2,892	n/a	n/a	n/a	62.1x	39.6x	26.3x	1.6x	1.3x	1.1x	n/a	19.8%	19.8%
China Suntien Green Energy Corp Ltd	CNE100000TW9	1.6%	4,712	5.7x	4.9x	4.2x	10.9x	9.7x	8.3x	0.6x	0.6x	0.5x	5.8%	6.7%	7.8%
		15.8%													
Generation/Utility															
Iberdrola SA	ES0144580Y14	4.0%	66,427	15.9x	14.5x	13.5x	11.0x	10.2x	9.4x	1.5x	1.5x	1.4x	4.4%	4.7%	5.0%
		4.0%													
Installation/Equipment															
Schneider Electric SE	FR0000121972	3.8%	66,759	16.5x	15.3x	14.0x	11.9x	11.2x	10.4x	2.6x	2.4x	2.2x	2.6%	2.8%	3.0%
Eaton Corp PLC	IE00B8KQN827	4.1%	54,424	18.3x	16.6x	15.1x	15.0x	13.7x	13.0x	3.2x	3.0x	2.8x	2.4%	2.5%	2.6%
Itron Inc	US4657411066	2.7%	2,148	63.4x	20.6x	13.1x	26.2x	12.8x	8.7x	1.9x	1.8x	1.6x	n/a	n/a	n/a
Xinyi Solar Holdings Ltd	KYG9829N1025	2.8%	12,285	20.6x	15.2x	11.7x	14.3x	10.7x	8.5x	2.9x	2.6x	2.3x	2.2%	3.1%	3.9%
SolarEdge Technologies Inc	US83417M1045	2.2%	15,354	49.8x	30.3x	23.9x	39.1x	23.8x	19.4x	7.3x	5.9x	4.7x	n/a	n/a	n/a
Enphase Energy Inc	US29355A1079	3.4%	38,800	70.8x	57.7x	47.0x	57.9x	44.3x	35.8x	52.7x	27.5x	15.3x	n/a	n/a	n/a
First Solar Inc	US3364331070	5.3%	13,596	n/a	57.2x	22.2x	65.0x	26.2x	14.5x	2.3x	2.2x	1.9x	n/a	n/a	n/a
Canadian Solar Inc	CA1366351098	4.0%	2,898	18.7x	10.6x	8.9x	8.1x	5.7x	4.8x	1.2x	1.1x	1.0x	n/a	n/a	n/a
Vestas Wind Systems A/S	DK0061539921	3.3%	25,447	n/a	57.9x	30.5x	54.8x	16.6x	12.1x	6.5x	5.4x	4.8x	0.2%	0.4%	0.9%
Siemens Gamesa Renewable Energy SA	ES0143416115	3.0%	12,275	n/a	n/a	46.4x	n/a	23.1x	11.8x	3.4x	3.7x	3.3x	0.1%	n/a	0.5%
TPI Composites Inc	US87266J1043	0.8%	693	n/a	n/a	21.4x	24.2x	12.2x	7.7x	3.2x	3.2x	3.3x	n/a	n/a	n/a
		35.3%													

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

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:

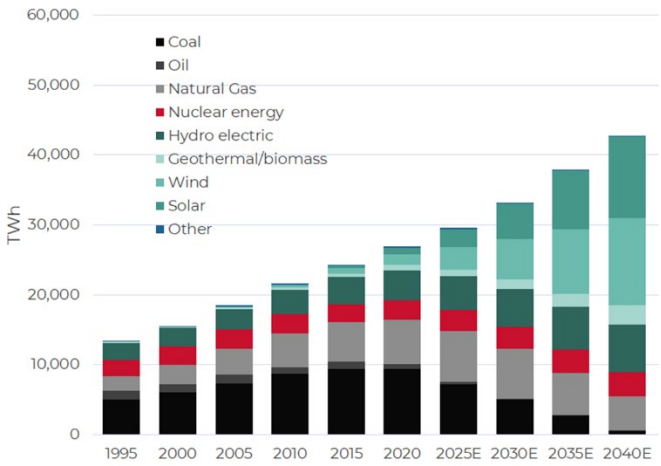
- **Population and GDP growth** putting a significant strain on today's energy supply
- **Economics** as sustainable sources of energy will be cheaper than the incumbents
- **Climate change** leading the world to reduce carbon emissions via cleaner energy
- **Pollution** forcing governments to drive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

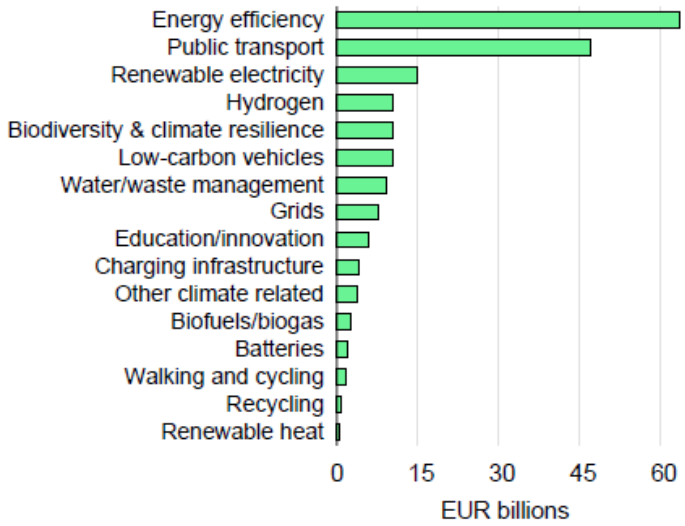
Energy efficiency measures were negatively impacted by Covid in 2020, as projects and investments were disrupted, but it appears that governments are turning their attention to efficiency measures as part of post-Covid stimulus measures. There is urgency to do this as current government policies imply 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

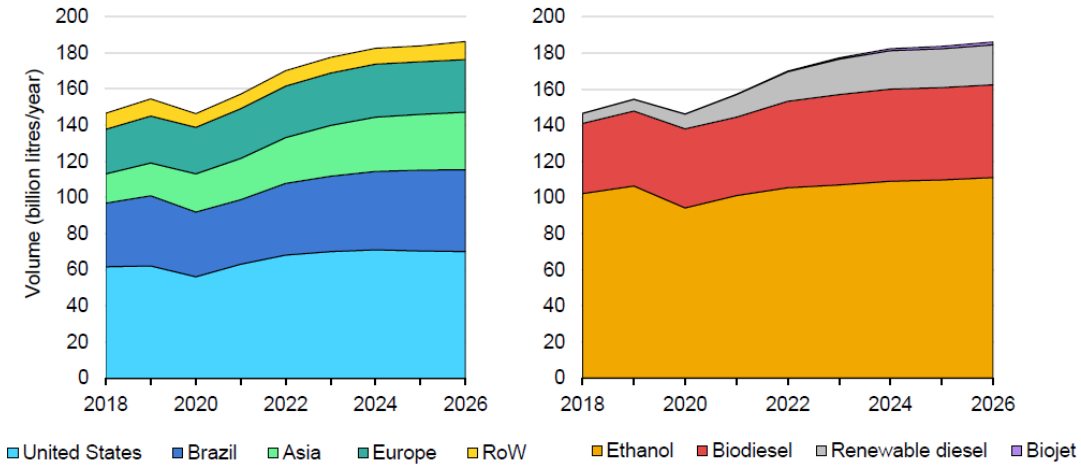
Alternative fuels such as ethanol (which displaces gasoline), biodiesel and renewable diesel (which displace conventional diesel) and Sustainable Aviation Fuels (SAF, which displace conventional jet fuel) serve a role in displacing existing fossil fuel demand, predominantly in transportation. In 2021, 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.

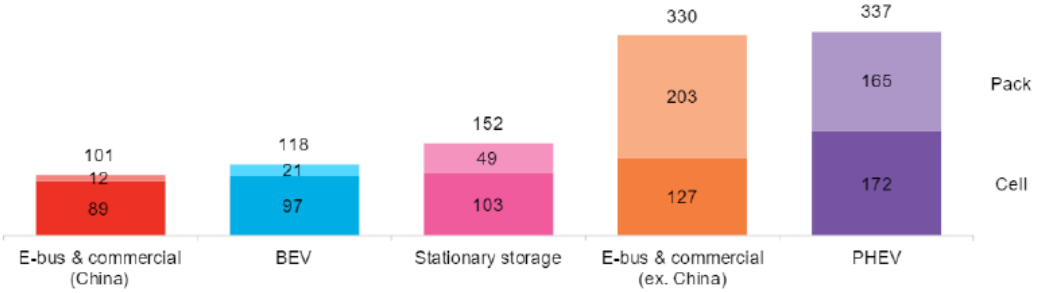
Batteries

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



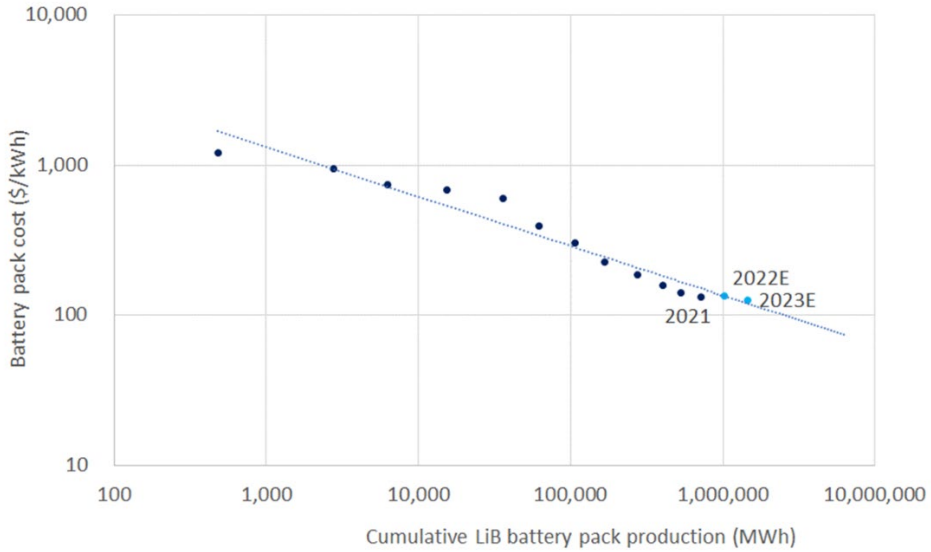
Raw materials make up around 50% of the cost of a lithium-ion battery pack, with cathode materials alone representing around 30% of the total cost. The key catalyst material is lithium carbonate, whose price in China rose by 270% in 2021. While battery manufacturers have long-term contracts and approaches 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



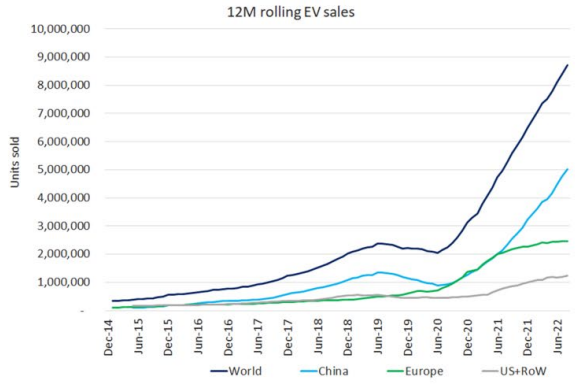
Electric Vehicles

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)

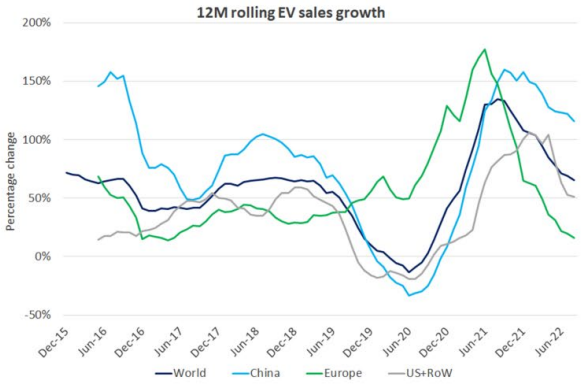
global market share reaching 11% and the share of all plug-in vehicles reaching 15%. This strong performance takes year-to-date plug-in penetration to approximately 13%, split around 9% for BEVs and 4% for plug-in hybrids (PHEVs).

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

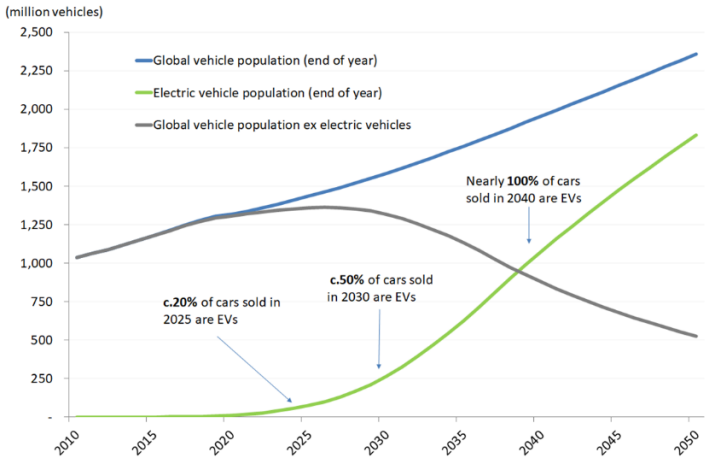
Policy support, both in terms of incentives to purchase new EVs and legislation to ban the sale of ICE vehicles, continues to underpin the uptake of EVs. The IEA estimates that governments around the world provided nearly $30bn of incentives in 2021 to support $250bn of consumer spending on electrified 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



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.

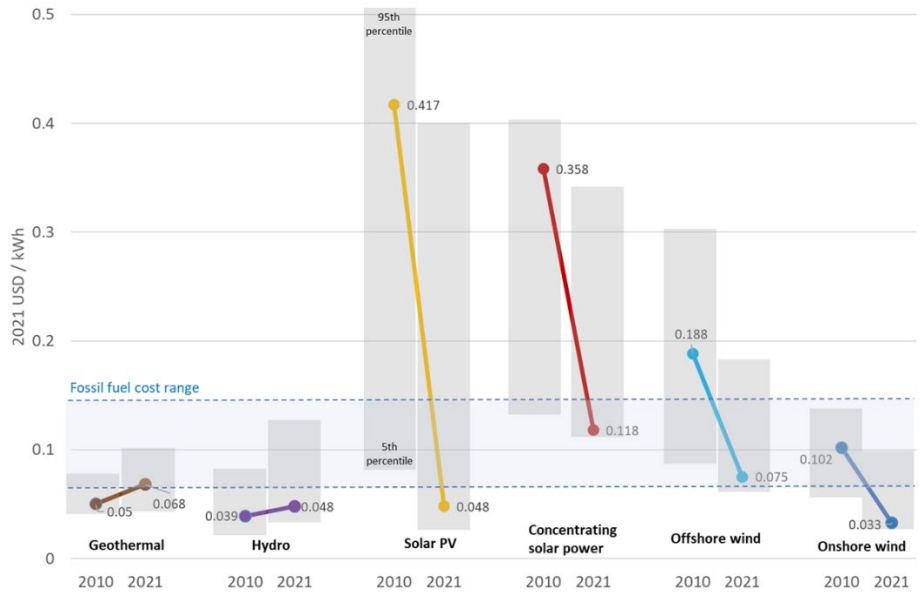
Generation & installation (equipment)

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

2021 was a year of record installations, but one that also witnessed a tick-up in the cost of solar module manufacturing as a result of raw material, power and logistics inflation. These issues slowed installation growth in the fourth quarter and lead to installations of 184 GW for the year. In 2020, the IEA described solar power as "now the cheapest electricity in history" and, despite near-term headwinds and cyclical cost inflationary factors, large-scale solar remains at the bottom of the cost curve.

Market estimates for global solar installations were for around 215 GW in 2022 but a strong start end to 2021 and start to 2022 leads us to expect installations will now be more like 250 GW (up 66 GW vs 2021). The growth has come from Asia and Europe and is likely to be achieved despite regulatory issues (for example the withhold release order (WRO) as well as anti-dumping/ countervailing duty (AD/CVD) investigations) that almost made US utility solar installations grind to a halt in the first half of the year).

Global solar module installations, 2010-2022E (GW)

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

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022E
OECD solar installations (annual)													
North America	1	2	4	6	7	8	14	11	10	11	19	30	20
Germany	7	7	8	3	2	1	2	2	4	4	5	5	8
Spain	0	0	0	0	0	0	0	0	0	5	3	4	6
Rest of Europe	3	4	5	5	5	6	4	3	4	6	8	15	26
Australia	0	1	1	1	1	1	1	2	4	4	4	5	6
South Korea	0	0	0	1	1	1	1	1	2	3	4	4	5
Japan	1	1	2	7	10	11	8	8	7	7	9	7	9
Total OECD	**17**	**23**	**24**	**24**	**25**	**29**	**29**	**26**	**31**	**40**	**51**	**70**	**80**
Change in OECD annual installations	*10*	*7*	*0*	*0*	*2*	*4*	*0*	*-3*	*5*	*9*	*11*	*19*	*10*
Non-OECD solar installations (annual)													
China	0	3	3	14	13	19	30	53	44	33	52	65	95
India	0	0	1	1	1	2	5	10	11	12	4	12	19
Rest of non-OECD	1	3	3	4	6	6	11	9	22	34	37	37	56
Total Non-OECD	**2**	**5**	**8**	**18**	**21**	**27**	**46**	**72**	**77**	**78**	**93**	**114**	**170**
Change in non-OECD annual installations	*1*	*3*	*2*	*11*	*2*	*6*	*19*	*26*	*5*	*1*	*15*	*21*	*56*
Total solar installations (annual)	**19**	**29**	**31**	**42**	**46**	**56**	**75**	**98**	**108**	**118**	**144**	**184**	**250**
Change in world annual installations	*11*	*10*	*2*	*11*	*4*	*10*	*19*	*23*	*10*	*10*	*26*	*40*	*66*

Supply solar supply chain

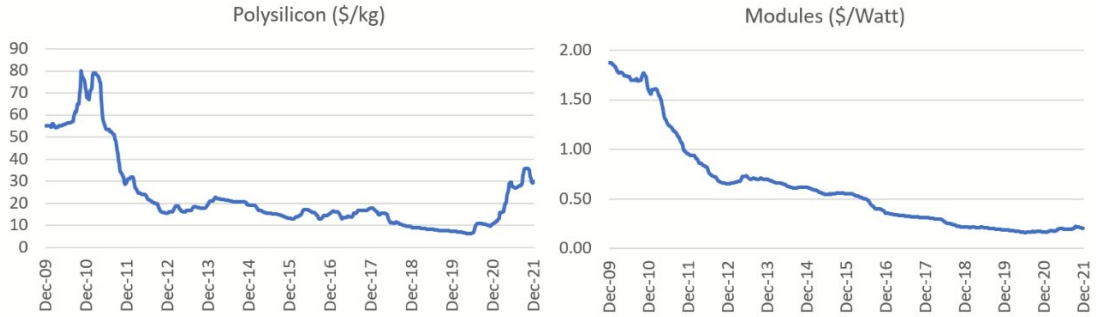
Most parts of the solar module manufacturing chain were oversupplied in 2021 and will likely remain so in 2022 as new capacity is added across the breadth of the chain, including polysilicon, wafers, cells and modules.

- **Polysilicon** is a key raw material for a solar wafer. This was the tightest part of the solar market in 2021, evidenced by polysilicon prices nearly trebling over the year to end the year at around US$30/kg. The price strength allowed polysilicon manufacturers to realise super normal profits and is incentivising a supply response. Capacity averaged around 460 MT in 2021 and while it has grown further in the first half of 2022, a further 150% increase in capacity is planned for 2023 vs 2Q 2022.

- **Wafer and solar cell** manufacturing capacity increased by over 60% in 2021 while mono wafer prices have increased by around 75%. The increase in capacity leaves this part of the value chain as oversupplied in 2022 as it was in 2021 although 78% of 2022 wafer capacity is in the hands of the five largest producers.

- **Solar module** prices increased around 25% during 2021 (to around US$0.28/Watt according to BNEF) – back to where they were in mid-2018 – and have maintained these levels so far in 2022. Module manufacturing continues to be significantly oversupplied with around 470 GW of available capacity in 2022, of which around 310 GW is newer 'Tier 1' capacity with lower costs resulting from the scale of manufacturing and new technologies.

Polysilicon and solar module pricing
source: Bloomberg



Rapid growth in solar installations is likely in the years ahead. European growth will accelerate sharply and sustain through to 2030 (partly as a result of RePowerEU) while the US solar industry is likely to return to growth in the second half of the year. We note a new optimism in the US following President Biden's Executive Order to overrule import tariffs for 24 months. Legal challenges to the EO, implementation of the new Uyghur human rights rules and the result of net metering discussions (at the end of 2022) could provide bumps in the road but demand for solar in the United States appears to be robust and supported by policy.

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.

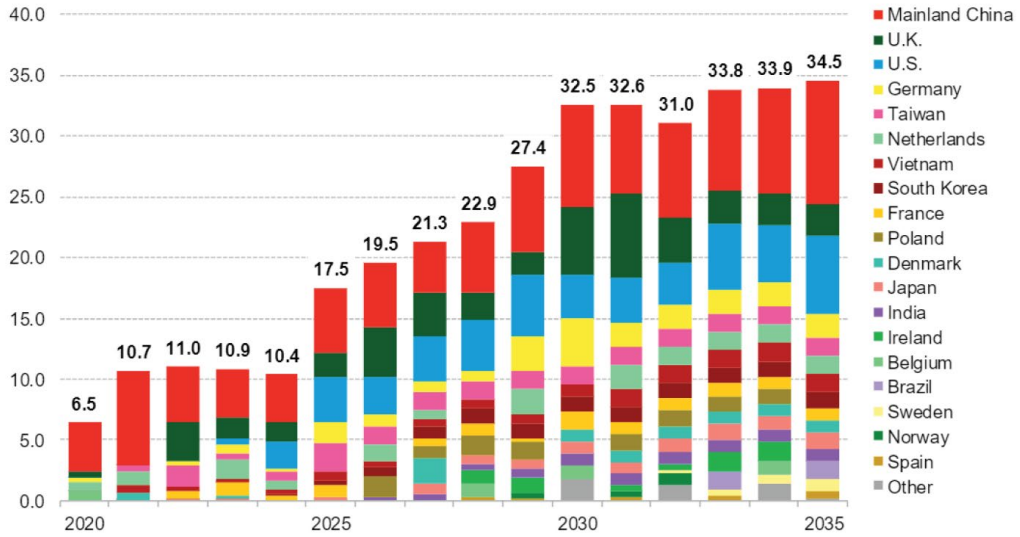
Annual installations of offshore wind capacity have increased from 0.9GW in 2010 to a new high of 17 GW in 2021. Chinese offshore installations reached 14 GW in 2021 while ex-China installations are likely to grow from 3 GW in 2021 to a new high of 7 GW in 2022.

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



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