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 before making any final investment decisions. Past performance does not predict future returns.

MAY 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 is ranked as higher risk as its price has shown high fluctuations historically. 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. Investors should note that fees and expenses are charged to the capital of the fund. This reduces the return on your investment by an amount equivalent to the Ongoing Charges Figure (OCF). The fund performance shown has been reduced by the current OCF of 0.67% per annum. Returns for share classes with different OCFs will vary accordingly. Performance returns do not reflect any initial charge; any such charge will also reduce the return.

HIGHLIGHTS FOR APRIL

THE NEED FOR SMART ELECTRIFICATION

This month, we assess the risks and opportunities that exist around the trend of 'electrification' that will transform both the supply and demand for electricity, as part of the energy transition. Higher levels of variable renewable electricity supply increase the need for 'smart electrification' approaches including demand shifting, diverse energy storage and the supply of effective grid services. We have exposure to a number of these themes in the Guinness Sustainable Energy fund.

EQUITIES

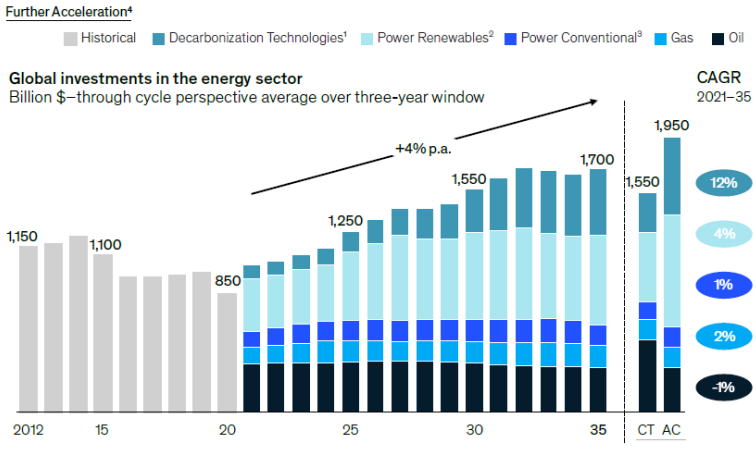
Sustainable energy equities underperformed global stock markets during April. The Guinness Sustainable Energy fund (Class Y) delivered a return of -9.3% (in USD) which was behind the MSCI World at -8.3%. Year to date, the Guinness Sustainable Energy fund (Class Y) has delivered -17.3% (in USD), behind the MSCI World at -13.0%.

In the portfolio, the strongest performers were Johnson Matthey and Albioma. Albioma received a take private offer from KKR while Johnson Matthey's shares reacted to news that a fund linked to US industrial conglomerate Standard Industries had taken a 5% stake in the company.

CHART OF THE MONTH

The current global 'energy crunch' is highlighting the need for new investment across all parts of the energy spectrum in the years ahead. McKinsey predict a 4%pa growth in energy investments with new energy investments capturing around 65% of the total by 2035.

Global energy sector investment *(source: McKinsey)*



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1. APRIL 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
China car manufacturer BYD stopped manufacturing conventional gasoline passenger cars at the end of February 2020. It is our understanding that every BYD car from here will be either a battery electric vehicle (BEV) or a plug-in hybrid electric vehicle (PHEV) and all of them will have an electric plug. In February, BYD sold 90,268 passenger cars, of which 87,473 (96.9%) were either BEVs or PHEVs.	Electric Vehicles	
The UK has announced plans to build 8 new nuclear power plants on existing sites, part of a new energy strategy to boost UK energy independence and security which will lead to up to 95% of the UK's electricity coming from low-carbon sources by 2030. One new nuclear plant is to be approved per annum to 2030, leading to nuclear power representing up to 24 GW – 25% of projected electricity demand - by 2050.	Nuclear	
According to a presentation by ExxonMobil mid-month, the market for carbon capture and storage (CCS) could be worth as much as $4trn by 2050. This assessment is in the same range as a prior $3-5trn estimate made by Occidental Petroleum. Exxon believes that the CCS market will be 60% of the $6.5trn market for oil and gas at that time.	CCS	
In its first annual energy outlook, JP Morgan found that the world needs to find $1.3trn of new investment by 2030 for all types of energy output and infrastructure from renewables to oil and gas to avoid an energy crunch. The report states "*Our main finding is that by 2030, energy demand growth will exceed supply growth by circa 20% based on current trends, primarily driven by emerging economies and their efforts to develop and lift their citizens out of poverty*"	Energy investment	
US environmental group Global Energy Monitor (GEM) has reported that global coal plant capacity grew by 18.2 GW to about 2,100 GW (0.87% growth) in 2021. Chinese coal capacity increased by 25.2 GW in the year. The report also said that the capacity of global coal plants being built in 2021 fell from 525 GW in 2020 to 457 GW, a decrease of 13%.	Decarbonising power	

2. MANAGER'S COMMENTS

The need for smart electrification in the energy transition

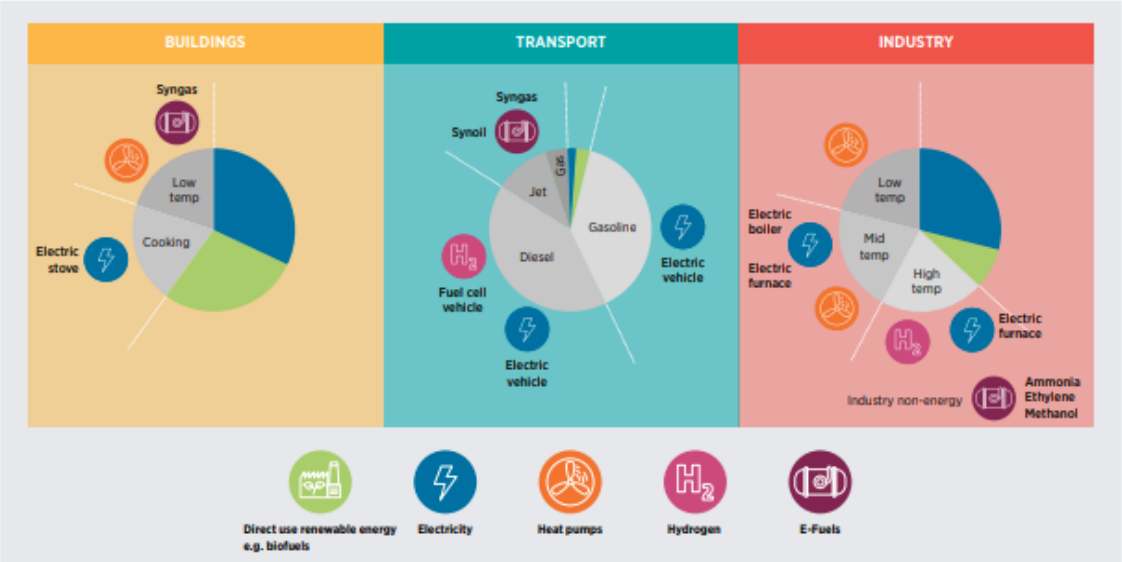
This month, we assess the risks and opportunities that exist around the trend of 'electrification' that will transform both the supply and demand for electricity, as part of the energy transition. Higher levels of variable renewable electricity supply increase the need for 'smart electrification' approaches including demand shifting, diverse energy storage and the supply of effective grid services. We have exposure to a number of these themes in the Guinness Sustainable Energy fund.

The energy transition, the process of moving away from fossil fuels towards sustainable energy sources, will be a long-term complex one and one which relies upon the broad trend of 'electrification'. In the 1.5°C scenario in its World Energy Transitions Outlook 2021, IRENA forecasts that electricity demand needs to double by 2050 (rising to over 50% of global final energy consumption) with at least 90% of that supply coming from renewable sources. We see this significant trend as having two distinct aspects:

1. A change on the **supply** side away from 'indirect' electricity generation from fossil fuels towards 'direct' electricity generation from renewable sources such as wind, solar and hydropower
2. A change of **demand** activities from the combustion of fossil fuels (to create heat 'indirectly' to allow the generation of electricity as an example) towards the 'direct' consumption of renewable electricity

A mismatch between the development of these two long term electrification themes could easily lead to power grids being overwhelmed causing energy security and economic growth to be compromised in the energy transition. We see the need for a carefully planned and managed transition of both supply and demand such that fossil fuel consumption can be reduced, sustainable generation can grow and electricity demand can adjust accordingly. This will require well planned and smart usage of storage and efficiency in order to achieve a balanced electricity system within and across countries, measured daily and seasonally.

Prominent applications for electrification



Source: IRENA

The scale of the opportunity here is significant and we expect electrification to reach industries and sectors that have seen limited electrification so far. For example, Avinor, the public operator of Norwegian airports, expects all flights under 1.5 hours to be capable of electrification while China's railways system is expected to go from just 40% electrified a few years ago to 90% electrified by 2050. Demand like this implies the need for 'smart' electrification, which includes steps that will allow electricity demand to be adjusted (shifted through time), storage to be readily available with suitable useful capacities and the grid to be strong and stable via a range of required grid services. We consider each of these factors in turn below.

Methods to shift demand and limit peak loads on electricity grids

There is potential for electricity demand to be shifted across a range of sectors and markets but here we focus our thoughts on examples in the transportation and buildings sectors.

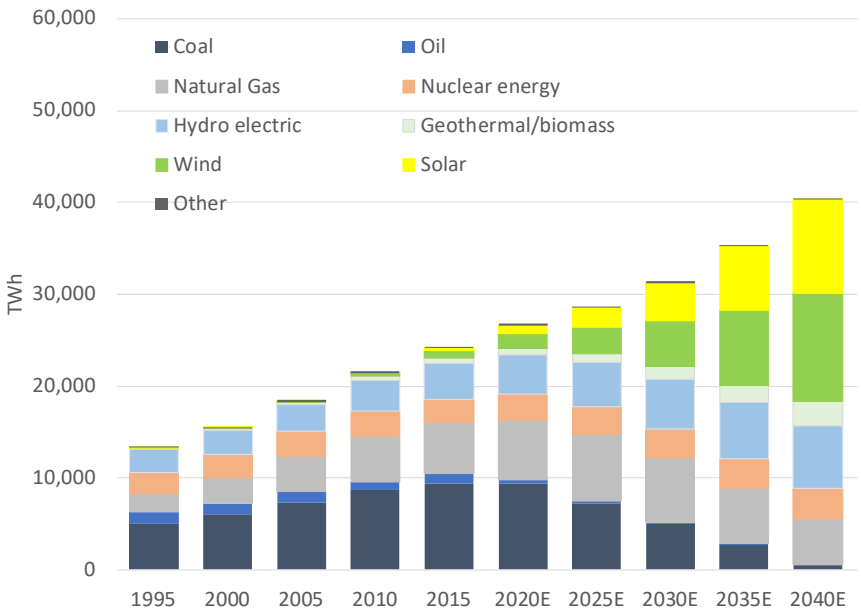
Electricity currently satisfies less than 1% of current global **transportation** energy demand and there is enormous potential for higher EV penetration and a growing need for the concept of smart charging for electric vehicles. Success here could see electricity representing nearly 50% of total transportation demand by 2050. However, EV charging could potentially stress power grids at peak times, so simple approaches like lowering the price of off-peak electricity to provide incentives for consumers to defer their charging from peak to off-peak periods can spread demand significantly.

More complex approaches within EV charging include automated real-time control over the rate and/or direction of charging, so that EVs are able to sell power back to the grid or owner's house to meet sudden demand peaks. This later technology, known as vehicle-to-grid (V2G), would have significant impact on moderating demand peaks and would effectively use individual EVs as grid storage. It is still in the early stages of development but is a clear and efficient solution to proving grid storage, based on strong consumer demand for EVs.

Buildings represent about 30% of total energy demand and efficiency improvements here could have a significant impact on overall energy demand. A move to electrification here however would still see electricity demand in the buildings sector double by 2050. Heat pumps are an obvious option for electrification and greater efficiency, but their uptake is still limited (for example, only 12mn US households, 10% of the total, rely on air source heat pumps). Like smart charging for EVs, smart heating and cooling systems could utilise simple time-of-use tariffs to provide incentives for consumers to defer their heating and cooling demands from peak to off-peak periods, for example, while automated real-time control using digital technologies over the timing of heating and cooling can quickly adjust demand to better match supply. Effectively, these approaches enhance the efficiency of the building's heating system and, combined with better insulation and building envelope efficiency, could have significant positive effects.

In addition, heat pumps connected to smart electricity meters, thermostats and building management systems can serve as distributed heating loads to participate in demand response programmes. In commercial cooling, there are opportunities to boost overall system efficiency by capturing currently wasted heat, such as the excess heat generated by refrigeration systems in supermarkets. That heat can be used for space and water heating or can be distributed to local thermal grids. As an example, the city of Qingdao in China is investing US$3.5bn to build a district heating network (based on air and ground source heat pumps and waste heat from industrial plants) to in order to eliminate the use of coal in heating.

Global electricity generation by type (TWh)



Source: BP Statistical Review; Guinness Global Investors

The need for a broad range of energy storage approaches

Improved economics are allowing lithium-ion batteries to become more significant in the electricity storage market but we note that, despite further improvements to come, they are likely to only ever be one part of the overall storage solution that is required to cope with higher levels of variable renewable power generation. In terms of grid storage, lithium-ion batteries are most efficient over a 4-6 hour time period and are typically coupled with solar power generation for intra-day storage in countries that have reliable daily sunshine, for example, California.

However in countries like Germany, winter energy demand is 30% higher than in summer yet renewable energy sources generate around 50% less electricity in winter than they do in summer. As mentioned, batteries would not be helpful over these time periods so a switch to hydrogen, potentially utilising existing gas infrastructure to store hydrogen over longer time periods, could avoid the need to expand the electricity grid and help decrease wastage of variable renewable electricity.

Energy storage technologies, on a seasonal scale, include underground thermal energy storage, such as aquifers, tank thermal energy storage as well as emerging approaches using chemicals, salts and liquid air. Thermal storage may not be sufficient, however, to address significant seasonal heating and cooling demand peaks under scenarios of total direct electrification and it reminds us of the need for greater energy efficiency overall.

Considering the associated grid services to enable smart electrification

Renewable energy generation is far more variable, distributed and independent than centralised power plants. This means there is a greater need for grid services such as load following, frequency regulation and provision of operational reserves in order to maximise the utilisation of variable renewable electricity. Many technologies now are available to

provide these services, helping to accelerate the adoption of renewable energy generation and to improve efficiency.

There are additional benefits to a hydrogen based system that would typically have been built to use excess renewable electricity to decarbonise the natural gas system or 'hard to decarbonise' industries. One example is that a hydrogen-producing electrolyser could also be cycled up and down rapidly as a flexible load, providing grid services such as frequency regulation. Proton exchange membrane (PEM) electrolysers are well suited for such an operation in the longer term but current system efficiencies are still too low for mass scale.

Within transportation, when EVs are parked and connected to grid, their batteries can also provide a broad range of important services to the system. For example, power from EV batteries can help regulate both voltage and frequency on the grid and can significantly reduce the need to ramp up expensive generating capacity or grid upgrades to meet demand peaks. For example, a recent pilot project in the UK using more than 200 Nissan Leaf EVs showed that a smart charging strategy, with associated grid services, could save up to $3bn of grid reinforcement costs by 2050.

Conclusion

Smart electrification and the smart grid are critical components of the energy transition but their role is not as well understood as wind and solar power, for example. We see a number of attractive opportunities within our investment universe around the thematic from micro-scale activities to macro-scale activities. Within the fund, we have exposure predominantly via our consumption (demand) oriented investments with various companies having exposure to activities such as electrical equipment, heat pumps, lithium-ion batteries, catalysts, EV charging and vehicle efficiency, inverters, smart metering and demand moderation.

3. PERFORMANCE

The Guinness Sustainable Energy fund (Class Y, 0.67% OCF) delivered a return of -9.3% in the month, while the MSCI World Index (net return) delivered -8.3% (all in USD terms).

Past performance does not predict future returns.

	Ytd	1year	3 years	5yrs	10 Years *
Fund (Class Y)	-17.3%	-10.8%	81.7%	110.0%	130.2
MSCI World NR Index	-13.0%	-3.5%	34.6%	62.3%	160.6
Out/Underperformance	*-4.3%*	*-7.3%*	*47.1%*	*47.7%*	*-30.4*

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%.*

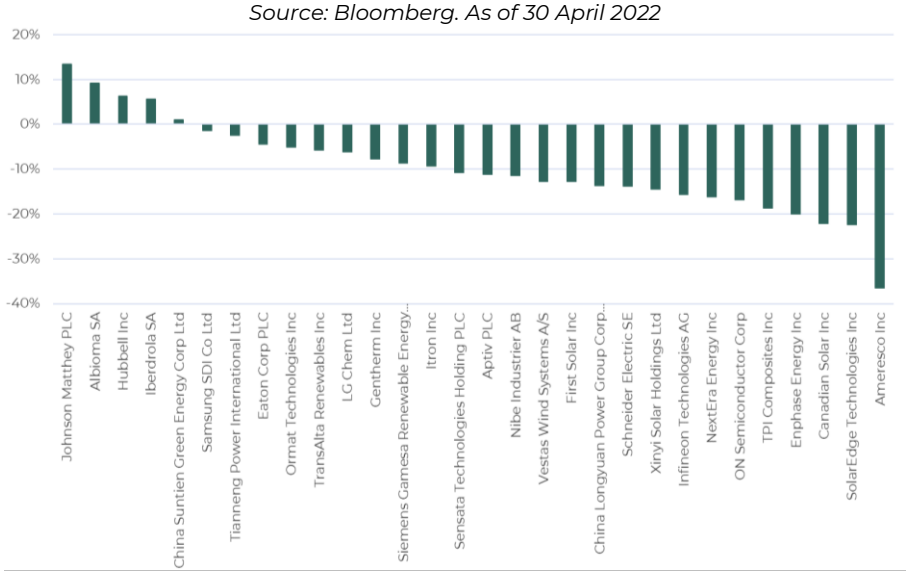
Source: Financial Express, bid to bid, total return.

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 0.67% 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 Johnson Matthey, Albioma, Hubbell, Iberdrola and China Suntien while the weakest performers were Ameresco, SolarEdge, Canadian Solar, Enphase Energy and TPI Composites.

Stock by Stock performance over the month, in USD

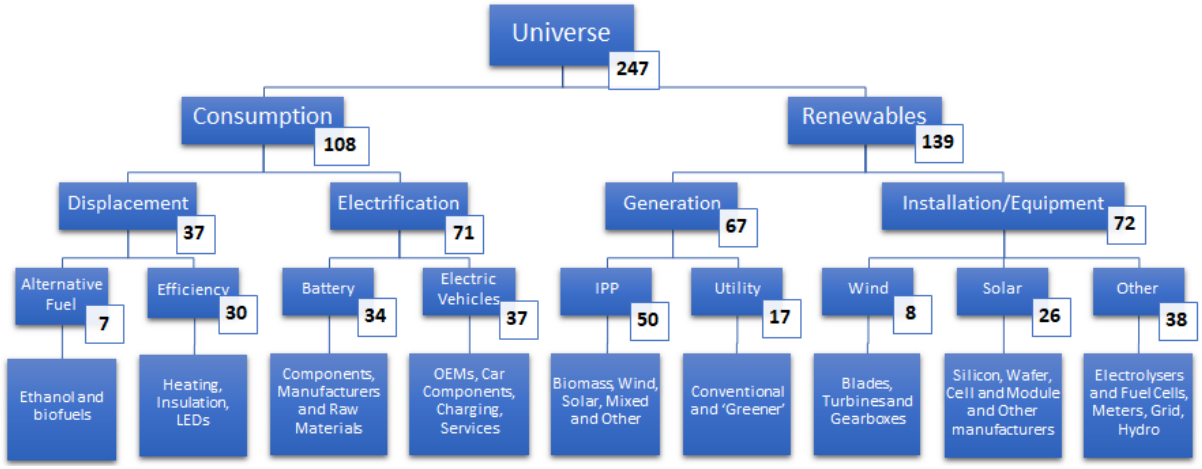
Source: Bloomberg. As of 30 April 2022



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:

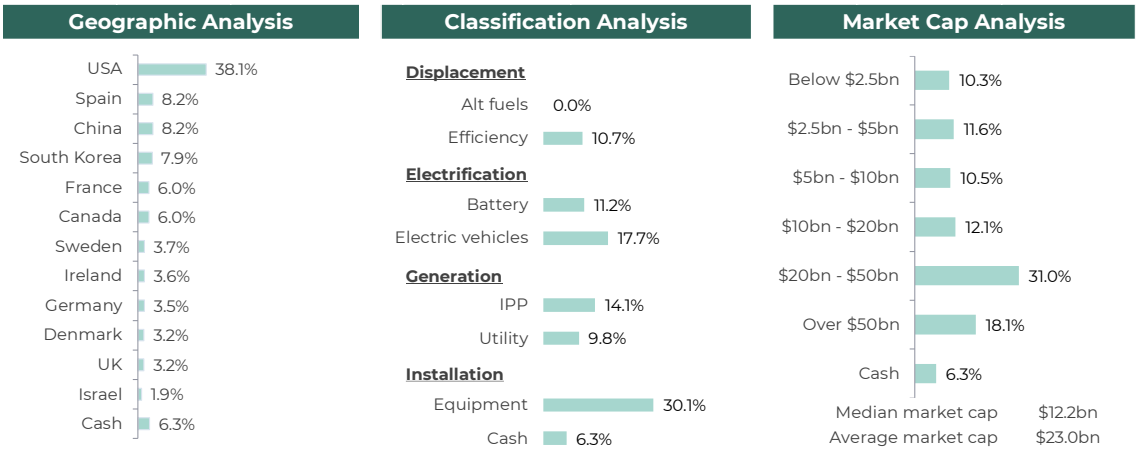
Signatory of:

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	
	Apr-22		Dec-21	Dec-20	Dec-19	Dec-18
Consumption	**39.6%**	***-3.8%***	**43.4%**	**36.7%**	**41.7%**	**26.5%**
Displacement	10.7%	*-1.1%*	11.8%	9.9%	13.4%	16.4%
Alternative Fuel	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*3.9%*
Efficiency	*10.7%*	*-1.1%*	*11.8%*	*9.9%*	*13.4%*	*12.5%*
Electrification	28.9%	*-2.7%*	31.6%	26.8%	28.2%	10.1%
Batteries	*11.2%*	*2.3%*	*8.9%*	*10.8%*	*12.6%*	*3.9%*
Electric vehicles	*17.7%*	*-5.0%*	*22.8%*	*16.0%*	*15.7%*	*6.2%*
Renewables	**54.0%**	***2.7%***	**51.3%**	**60.4%**	**54.1%**	**69.7%**
Generation	23.9%	*0.8%*	23.1%	24.6%	22.2%	27.3%
IPP	*14.1%*	*-0.4%*	*14.5%*	*17.0%*	*18.9%*	*26.7%*
Utility	*9.8%*	*1.2%*	*8.6%*	*7.6%*	*3.2%*	*0.6%*
Installation	30.1%	*1.9%*	28.2%	35.8%	32.0%	42.5%
Equipment	*30.1%*	*1.9%*	*28.2%*	*35.8%*	*32.0%*	*42.5%*
Cash	6.3%	*1.1%*	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 April 2022	P/E			EV/EBITDA			Dividend Yield		EPS Growth (%pa)		CFROI*	
	2021	2022E	2023E	2021	2022E	2023E	2022E	2023E	2014-21	2021-23	2021E	2022E
Guinness Sustainable Energy Fund	23.5x	22.4x	18.2x	13.4x	12.8x	10.6x	1.4%	1.5%	5.1%	18.4%	6.2%	7.5%
MSCI World Index	18.6x	16.8x	15.6x	12.3x	11.2x	10.6x	2.0%	2.2%	6.7%	10.3%	8.6%	9.0%
Fund Premium/(Discount)	*26%*	*33%*	*17%*	*9%*	*14%*	*0%*						

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

Source: Guinness Global Investors, Bloomberg

Portfolio holdings, as at end April 2022

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

We hold c.40% weight to companies associated with the consumption (or demand) of sustainable energy. Our largest exposure here is to companies involved in the electrification of demand, either via the creation of new batteries (11%) or the electrification of transportation (18% weight) while we have 11% weight to those companies involved in either displacing existing energy sources or improving overall energy efficiency.

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

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

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

In terms of the supply of sustainable energy, we hold a 24% weight to companies involved in the generation of sustainable energy and 30% weight to those exposed to the installation of or equipment used in the process of sustainable energy generation.

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

We hold exposure to the solar and wind equipment and manufacturing value chains. Xinyi Solar is the world's largest supplier of the glass used in solar cell modules and both EnPhase and SolarEdge manufacture the inverters required to convert DC solar power into consumable A/C 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 April 2022

	Theme	Example holdings	Weighting (%)
1	Electrification of the energy mix	TransAlta renewables, NextEra Energy	24.3%
2	Rise of the electric vehicle and auto efficiency	Sensata Technologies, APTIV	20.9%
3	Battery manufacturing	Samsung SDI	8.0%
4	Expansion of the wind industry	Siemens Gamesa Renewable Energy, Vestas	11.8%
5	Expansion of the solar industry	CanadianSolar	12.7%
6	Heating, lighting and power efficiency	NIBE Industrier	10.7%
7	Geothermal and biomass	Ormat, Albioma	5.2%
8	Other (inc cash)		6.3%

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

Guinness Sustianable Energy Fund (31 March 2022)			P/E			EV/EBITDA			Price/Book			Dividend Yield		
Stock	**% of NAV**	**Market Cap USD**	**2021**	**2022E**	**2023E**	**2021**	**2022E**	**2023E**	**2021**	**2022E**	**2023E**	**2021**	**2022E**	**2023E**
Displacement/Efficiency														
Hubbell Inc	3.9%	9,960	21.8x	20.2x	18.3x	14.9x	13.9x	12.7x	4.5x	4.4x	4.2x	2.2%	2.4%	2.5%
Nibe Industrier AB	3.9%	22,629	63.4x	58.5x	51.7x	36.8x	34.0x	30.6x	10.1x	8.9x	7.9x	0.4%	0.5%	0.6%
Ameresco Inc	3.5%	4,112	55.9x	42.0x	37.4x	30.7x	22.5x	20.3x	6.1x	5.2x	4.6x	n/a	n/a	n/a
	11.3%													
Electrification/Battery														
LG Chem Ltd	3.3%	30,931	10.2x	15.7x	12.2x	5.8x	6.5x	5.4x	1.8x	1.5x	1.4x	2.1%	2.0%	2.2%
Samsung SDI Co Ltd	4.2%	33,755	34.0x	28.0x	22.3x	17.7x	14.5x	11.7x	2.8x	2.5x	2.3x	0.2%	0.2%	0.2%
Johnson Matthey PLC	2.6%	4,572	10.0x	8.9x	8.4x	6.0x	5.9x	5.8x	1.2x	1.4x	1.3x	3.2%	4.0%	4.2%
Tianneng Power International Ltd	0.1%	969	3.0x	2.5x	2.2x	0.6x	0.5x	0.5x	0.5x	0.4x	0.4x	5.9%	6.6%	7.1%
	10.1%													
Electrification/Electric Vehicles														
Aptiv PLC	3.7%	32,431	45.7x	28.3x	18.9x	16.6x	13.1x	10.2x	3.9x	3.5x	3.1x	0.1%	0.1%	0.3%
ON Semiconductor Corp	4.1%	27,079	22.1x	15.0x	14.0x	13.8x	9.3x	9.2x	5.9x	4.8x	4.0x	n/a	n/a	n/a
Infineon Technologies AG	3.8%	44,842	26.5x	18.2x	16.7x	13.2x	10.3x	9.4x	3.5x	3.1x	2.7x	0.9%	1.0%	1.2%
Sensata Technologies Holding PLC	3.7%	8,016	14.6x	12.8x	11.1x	11.3x	10.4x	9.3x	2.6x	2.3x	2.1x	n/a	n/a	n/a
Gentherm Inc	3.0%	2,412	27.4x	24.6x	17.5x	15.0x	13.4x	10.0x	3.5x	n/a	n/a	n/a	n/a	n/a
	18.4%													
Generation/IPP														
China Longyuan Power Group Corp Ltd	3.4%	28,602	19.1x	16.3x	13.6x	13.6x	11.7x	10.0x	2.0x	1.7x	1.6x	1.0%	1.3%	1.5%
Ormat Technologies Inc	3.3%	4,587	66.4x	61.7x	42.2x	16.1x	14.4x	12.2x	2.3x	2.3x	2.2x	0.6%	0.6%	0.6%
TransAlta Renewables Inc	3.6%	3,951	31.0x	25.5x	23.0x	13.2x	12.0x	11.4x	2.4x	2.5x	2.6x	5.0%	5.0%	5.0%
Albioma SA	1.5%	1,566	24.9x	24.2x	20.8x	11.2x	11.1x	10.1x	2.9x	2.7x	2.5x	2.0%	2.0%	2.3%
NextEra Energy Inc	4.7%	166,264	33.5x	30.3x	28.0x	23.0x	19.1x	17.6x	3.9x	3.8x	3.6x	1.8%	2.0%	2.2%
China Suntien Green Energy Corp Ltd	1.9%	5,888	6.4x	6.4x	5.8x	8.7x	7.7x	6.8x	0.9x	0.7x	0.6x	5.7%	5.3%	5.8%
	18.4%													
Generation/Utility														
Iberdrola SA	4.7%	70,770	16.6x	15.1x	13.8x	10.7x	10.1x	9.3x	1.6x	1.4x	1.4x	4.5%	4.7%	5.1%
	4.7%													
Installation/Equipment														
Schneider Electric SE	4.5%	95,953	25.2x	21.9x	19.8x	17.2x	15.3x	14.1x	3.8x	3.3x	3.1x	1.9%	2.1%	2.2%
Eaton Corp PLC	3.9%	60,639	22.9x	20.1x	18.1x	18.9x	16.1x	14.8x	3.8x	3.5x	3.4x	2.0%	2.1%	2.2%
Itron Inc	2.5%	2,373	43.6x	37.4x	18.3x	19.3x	19.7x	11.1x	2.0x	2.0x	1.9x	n/a	n/a	n/a
Xinyi Solar Holdings Ltd	3.1%	15,688	22.3x	22.3x	17.5x	17.0x	15.5x	12.0x	4.0x	3.6x	3.2x	2.0%	2.2%	2.7%
SolarEdge Technologies Inc	2.2%	17,768	64.2x	48.2x	34.4x	51.0x	38.9x	26.3x	13.6x	9.7x	7.7x	n/a	n/a	n/a
Enphase Energy Inc	2.3%	27,026	87.4x	63.5x	49.7x	76.3x	51.0x	37.0x	40.6x	33.7x	21.8x	n/a	n/a	n/a
First Solar Inc	3.8%	8,904	20.1x	634.4x	38.7x	14.5x	44.5x	17.5x	1.5x	1.5x	1.5x	n/a	n/a	n/a
Canadian Solar Inc	2.8%	2,250	24.6x	15.3x	10.0x	7.4x	5.0x	4.0x	1.1x	1.0x	0.9x	n/a	n/a	n/a
Vestas Wind Systems A/S	3.4%	30,054	69.4x	118.6x	40.6x	19.1x	21.7x	14.6x	5.5x	5.6x	5.2x	0.4%	0.3%	0.7%
Siemens Gamesa Renewable Energy SA	2.8%	12,059	n/a	n/a	65.1x	25.0x	86.4x	13.4x	2.3x	2.8x	2.8x	n/a	n/a	0.1%
TPI Composites Inc	0.6%	523	n/a	n/a	n/a	12.1x	22.1x	4.4x	1.8x	2.8x	2.9x	n/a	n/a	n/a
	31.9%													
Cash	**5.2%**													

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

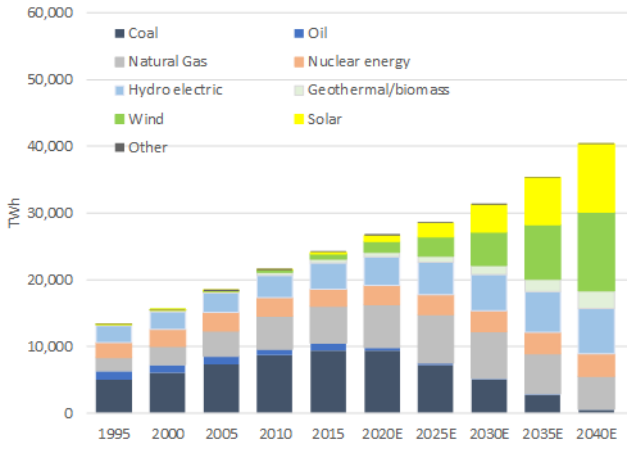
Over the next thirty years, the world will continue its transition to a sustainable energy system. The key factors driving the transition are:

- **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.

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

Policy support for decarbonisation

After very strong policy support in 2020, we witnessed further policy commitment in 2021. The path has not always been smooth, however, with US's return to the Paris Agreement, for example, butting up against resistance to key clean energy spending plans. The most significant policy milestones in 2021 included:

- **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.** Mid-year, the Intergovernmental Panel on Climate Change (IPCC) published their 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, 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.

- **Post COVID stimulus and infrastructure plans.** While policy towards stimulus plans continues to be positive, the passage of actual investment into the energy transition has been slower than expected. The influential US "Build Back Better" (BBB) infrastructure package is the clearest example of the delay between policy announcement and actual investment. After passing the House of Representatives in November, Democratic Senator Joe Manchin announced on December 19th that he would not be supporting the $1.75trn bill (as currently written) thus delaying the passage of the BBB bill through the House of Congress. A compromise bill is likely in our opinion.

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.

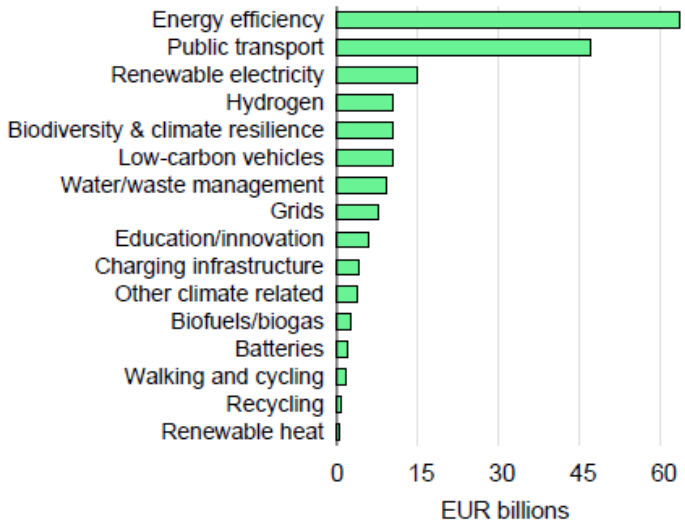
Energy efficiency measures are typically employment-intensive and offer a cheap form of carbon abatement. These factors help explain why the efficiency sector has received around US$144bn of stimulus spending since the start of COVID, the largest allocation within clean energy spending globally. The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



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. 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.

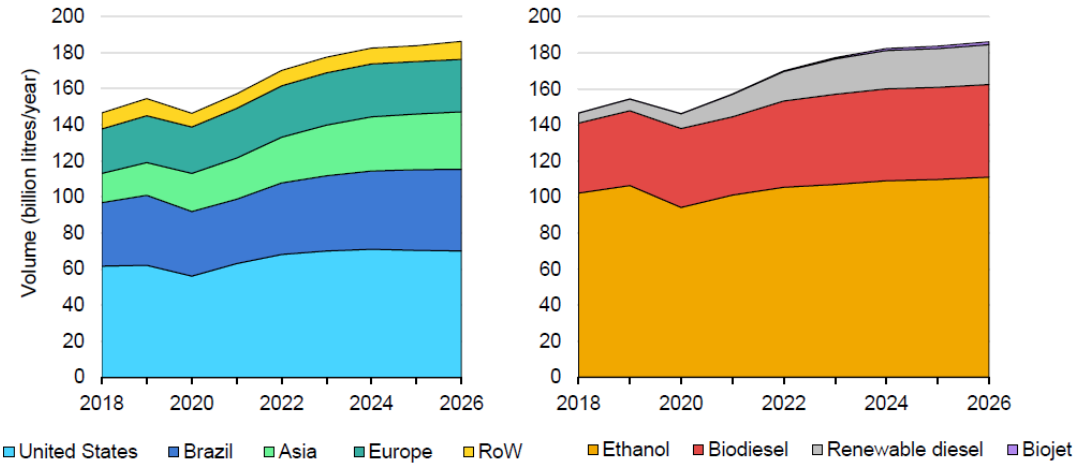
Alternative fuels consumption in 2021 grew by 10% versus 2020 and 3% versus 2019. Demand growth was significantly stronger than the underlying 6% increase in global oil demand, underlining the policy support for increased blending of alternative fuels in the transportation mix. Renewable diesel demand 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



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.

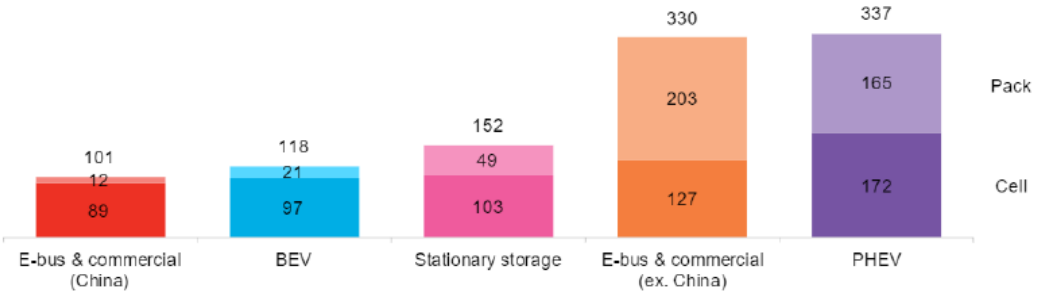
Batteries

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



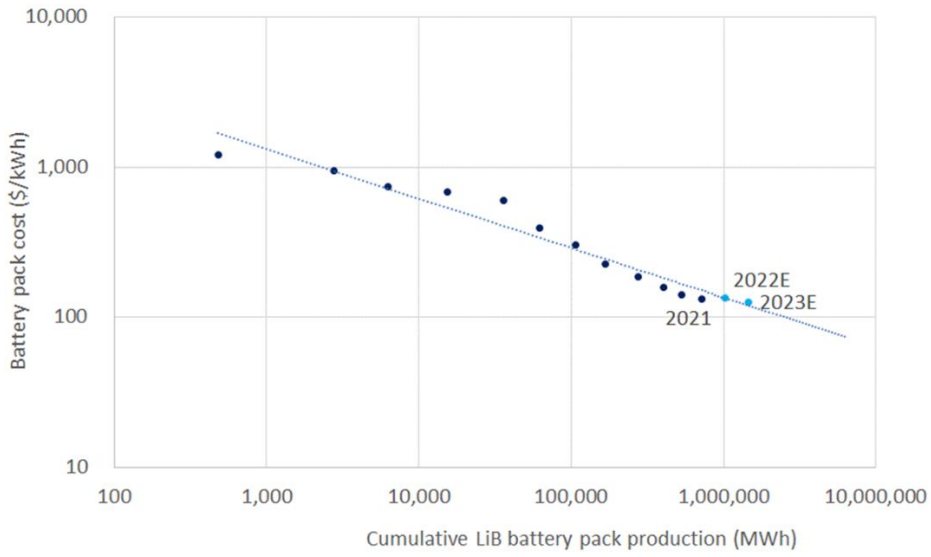
Raw materials make up around 50% of the cost of a lithium-ion battery pack, with cathode materials alone representing around 20% of the total cost. The key catalyst material is lithium carbonate, whose price in China rose by 270% in 2021. While battery manufacturers have long-term contracts and approaches 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, maybe a year or so 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 Asset Management



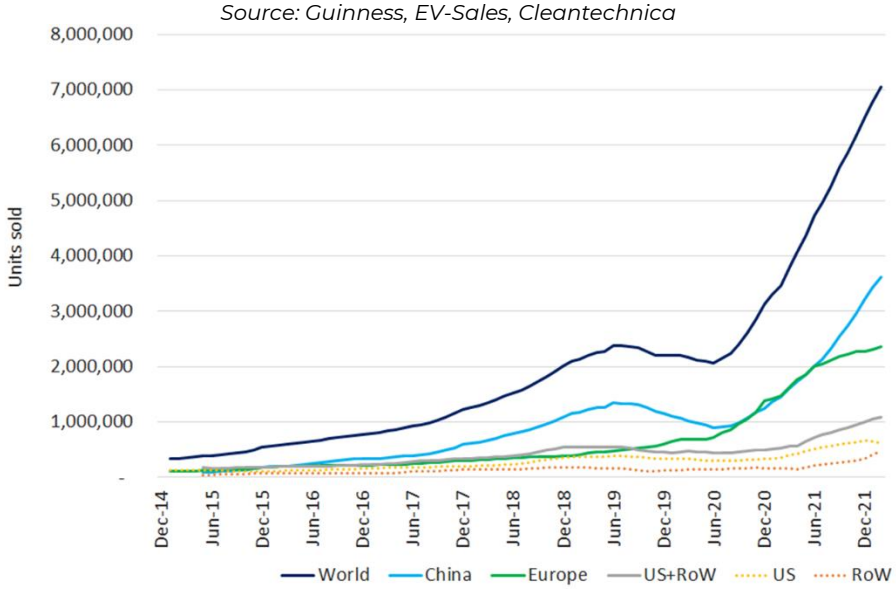
Electric Vehicles

Strong momentum in EV sales growth continued through 2021. On our estimates, nearly 6.5m new EVs were sold in 2021, more than double the sales in the same period twelve months earlier (affected by COVID) and 178% higher than the same period in 2019. This growth compares very favourably to overall global light vehicle sales growth of 6.8%% and -9.4% for the same periods in 2021 and 2020 respectively. Accordingly, the market share for EVs has increased to around 8% for 2021 versus 4% and 2.4% in 2020 and 2019 respectively.

Regionally, China has regained its position as the largest EV market with total sales of new EVs of around 3.0m in 2021, up 150% on 2020. Europe, which overtook China to be the largest EV market at the end of 2020, saw total new EV sales of 2.27m units, up 94%. The US still lags Europe and China with new EV sales of 0.6m, up 95% on the same period twelve months earlier.

Global EV sales (rolling 12-month basis up to December 2021)

Source: Guinness, EV-Sales, Cleantechnica

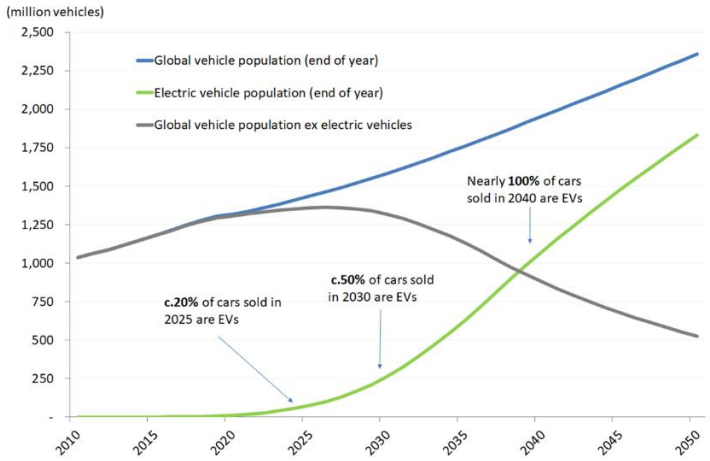


Government support for EVs will reduce in 2022. Europe will continue rolling back its EV "super-credits", and China plans to reduce EV subsidies further. Despite this, we expect global EV sales to exceed 9 million in 2022, representing around 10% of total passenger vehicle sales, taking the global EV stock from 16m vehicles to 25m vehicles.

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 current global population of around 15m EVs. 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 Asset Management



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.

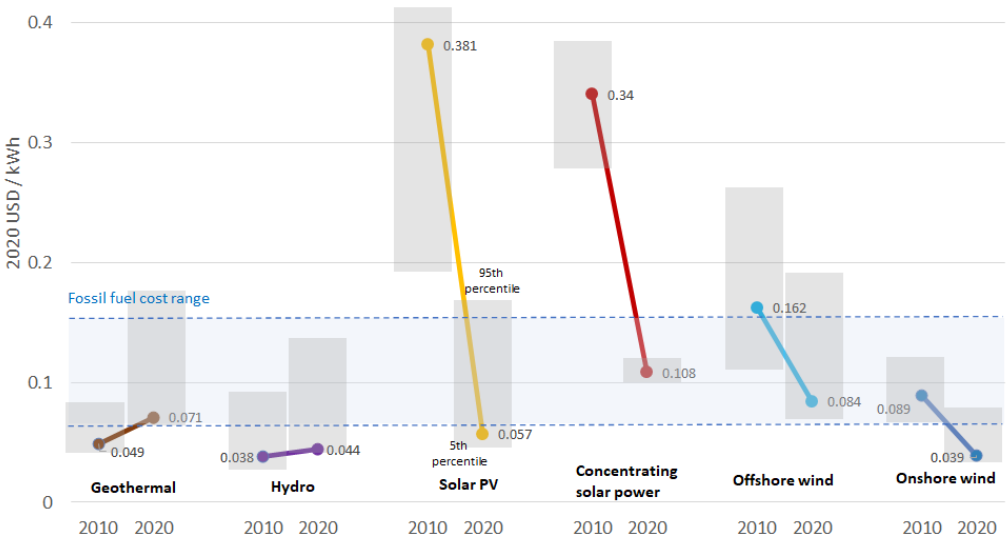
Generation & installation (equipment)

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 (2010–2020)

source: IRENA, Guinness Asset Management 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 us to forecast 173 GW for 2021. Even so, it is level comfortably above our 155 GW forecast for 2021 that we made at the start of 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.

Our initial estimate for 2022 installations is 215 GW (up 42 GW on 2021) and we note that the factors creating uncertainty around 2021 installations will also impact 2022 installations. Most projects being installed today utilise projects with modules purchased some months earlier, so full effect of higher costs in 2021 is still to be witnessed in 2022. On the other hand, our checks generally show that affected projects are being delayed rather than cancelled, so projects falling out of 2021 are likely to be delivered in 2022. Based on current activity at the end of April 2022, it appears that our estimate for 2022 will be exceeded.

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

Source: BP, BNEF, IEA and Guinness Asset Management estimates

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021E	2022E
OECD solar installations (annual)													
North America	1	2	4	6	7	8	14	11	10	11	19	30	25
Germany	7	7	8	3	2	1	2	2	4	4	5	5	6
Spain	0	0	0	0	0	0	0	0	0	5	3	4	5
Rest of Europe	3	4	5	5	5	6	4	3	4	6	8	15	19
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**	**75**
Change in OECD annual installations	*10*	*7*	*0*	*0*	*2*	*4*	*0*	*-3*	*5*	*9*	*11*	*19*	*5*
Non-OECD solar installations (annual)													
China	0	3	3	14	13	19	30	53	44	33	52	55	75
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	36	46
Total Non-OECD	**2**	**5**	**8**	**18**	**21**	**27**	**46**	**72**	**77**	**78**	**93**	**103**	**140**
Change in non-OECD annual installations	*1*	*3*	*2*	*11*	*2*	*6*	*19*	*26*	*5*	*1*	*15*	*10*	*37*
Total solar installations (annual)	**19**	**29**	**31**	**42**	**46**	**56**	**75**	**98**	**108**	**118**	**144**	**173**	**215**
Change in world annual installations	*11*	*10*	*2*	*11*	*4*	*10*	*19*	*23*	*10*	*10*	*26*	*29*	*42*

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 poly silicon, wafers, cells and modules.

- **Poly-silicon** is a key raw material for a solar wafer. This was the tightest part of the solar market in 2021, evidenced by poly-silicon prices nearly trebling over the year to end the year at around US$30/kg. The price strength allowed poly-silicon manufacturers to realise super normal profits and is incentivising a supply response. Capacity averaged around 460 MT in 2021 but around 190 MT of new Chinese supply (representing 40% of 2021 capacity) has either recently started or is about to start production.

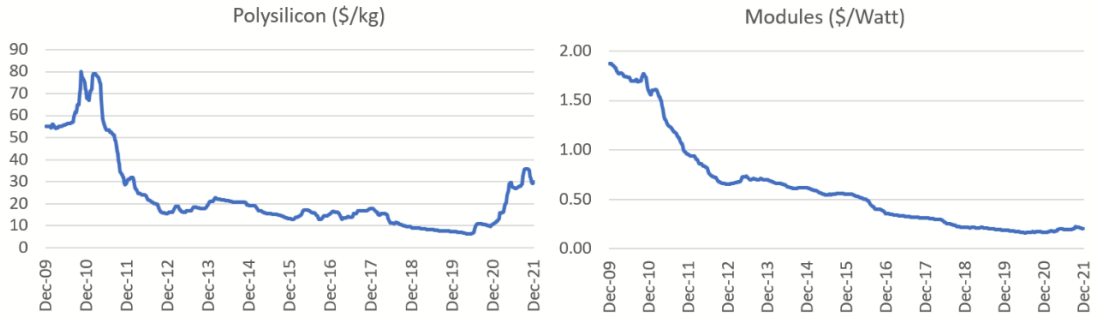
- **Wafer and solar cell** manufacturing capacity increased by over 60% in 2021 while mono wafer prices have increased by around 75%. The increase in capacity leaves this part of the value chain as oversupplied in 2022 as it was in 2021 although 78% of 2022 wafer capacity is in the hands of the five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

- **Solar module** prices have increased around 25% during 2021 (to around US$0.28/Watt according to BNEF) – back to where they were in mid-2018. 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.

Poly-silicon and solar module pricing

source: Bloomberg



Solar installations by region

Installations by country and region are affected by a wide range of factors:

- **China**, which represents around one third of global solar installation demand, is likely to see lower installations in 2021 than initially expected. Cost inflation could therefore cause actual 2021 installations to be biased lower. Any shortfall is expected to be only a short-term delay and to be delivered in 2022, leading to an upside bias here. Recent comments from President Xi at COP15 indicate that annual Chinese solar installations could rise to 130-150GW (versus around 50GW in 2020).

- **India** is still small in terms of global solar installations (4GW in 2020 and potentially 12GW in 2021) but installations could grow by around 50% in 2022. The Indian market has good potential and is being driven by the large conglomerates such as Ambani, Tata Power and Adani Green that publicly stated plans to install 100GW, 30GW and 45GW respectively by 2030, thus forming a large part of India's overall 450GW installation plan for 2030.

- Solar installations in the **United States** continued in 2021 to surprise to the upside. The estimated 30GW of installation in 2021 has been supported by the investment tax credit (ITC) and support for local manufacturing of clean power equipment.

- The new coalition government in **Germany** has a target of installing 200GW of solar by 2030, biased to residential projects.

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 84GW.

However, the wind industry is suffering short-term pressures as recent sharp peaks in installation demand (a 50% increase to 98GW 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 Asset management estimates

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021E	2022E
Onshore wind installations (annual)															
North America	9	11	6	8	15	2	7	10	9	8	8	10	17	16	8
Latin America	0	0	0	0	0	0	5	3	3	3	4	4	2	5	5
Europe	6	9	9	10	12	11	11	11	12	13	8	9	12	16	18
China	6	14	17	18	14	15	21	29	22	17	19	26	54	29	31
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	9	5
Total onshore	**27**	**38**	**35**	**40**	**46**	**33**	**49**	**61**	**55**	**49**	**46**	**55**	**91**	**78**	**71**
Change in onshore annual installations		*12*	*-3*	*5*	*6*	*-14*	*17*	*11*	*-6*	*-6*	*-3*	*9*	*36*	*-13*	*-7*
World ex China	*21*	*24*	*18*	*22*	*32*	*18*	*29*	*32*	*33*	*32*	*27*	*29*	*37*	*49*	*40*
Offshore wind installations (annual)															
China	0	0	0	0	0	0	0	1	1	1	2	3	4	5	3
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	3	6
Total offshore	**0**	**0**	**1**	**0**	**2**	**2**	**1**	**4**	**1**	**4**	**4**	**8**	**7**	**11**	**13**
Change in onshore annual installations		*0*	*1*	*-1*	*1*	*1*	*-1*	*4*	*-4*	*3*	*0*	*3*	*-1*	*4*	*2*
World ex China	0	0	1	0	1	2	1	3	0	4	3	5	3	5	10
Total wind installations (annual)	**27**	**38**	**36**	**40**	**48**	**35**	**50**	**65**	**56**	**53**	**50**	**63**	**98**	**89**	**84**
Change in world annual installations		*12*	*-2*	*4*	*8*	*-13*	*16*	*15*	*-9*	*-3*	*-2*	*12*	*35*	*-9*	*-5*

Onshore wind

Global onshore wind installations in 2021 were around 78GW, down 13GW from the record level seen in 2020 but still up 23 GW on the pre-pandemic installation level of 55GW in 2019.

Onshore wind installations had been growing very steadily since 2008, averaging an increase of around 3GW 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 30GW of installations in 2022.

Outside China, onshore installations reached a new high in 2021, averaging 49GW, up 12 GW on 2020 levels. Onshore installations outside China are expected to be lower in 2022, averaging around 40GW, as the surge of policy and tax incentive-led demand falls off and post-COVID supply chain issues and cost inflation start to impact the value chain. A level of 40GW is still higher than any year prior to 2020.

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 14% of the size of onshore (by annual installations in 2021), but one where the growth trajectory is becoming increasingly visible.

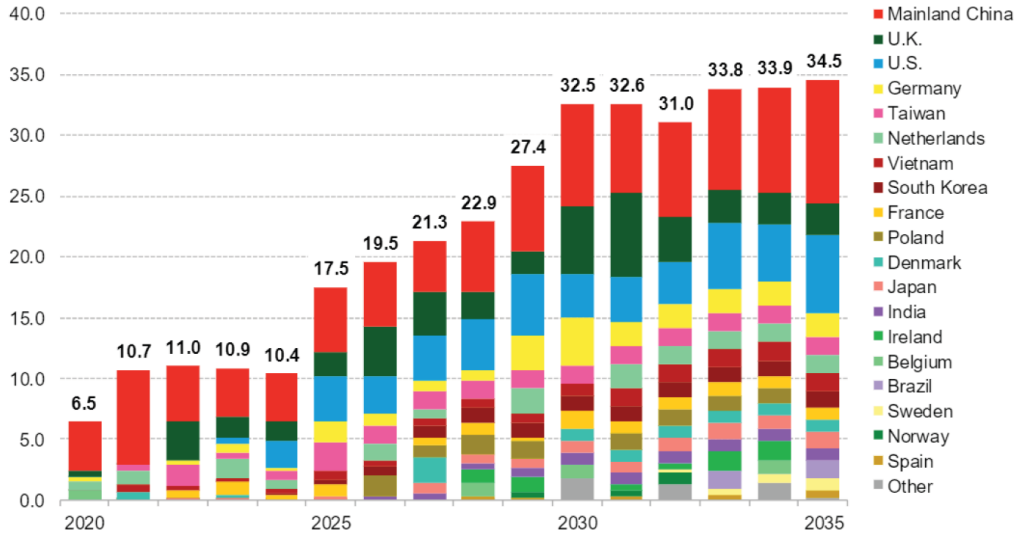
Annual installations of offshore wind capacity have increased from 0.9GW in 2010 to a new high of 11GW in 2021. Chinese offshore installations reached 5GW in 2021 while ex-China installations are likely to grow from 5GW in 2021 to a new high of 10GW in 2022.

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 140GW. A broader spread of countries including the United States, Chinese Taipei, Korea, Vietnam and Japan means that cumulative installations will be split around 30GW in the Americas, 90GW in Europe, Middle East and North Africa and around 20GW 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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