GUINNESS ATKINSON FUNDS

2021 Outlook for Sustainable Energy

The Guinness Atkinson Alternative Energy Team, January 2021

Highlights

2020 IN REVIEW

2020 was a banner year for the sustainable energy sector as policy makers globally promoted an acceleration of the energy transition to facilitate global decarbonization, to support economic recovery via post-COVID stimulus packages and to satisfy social demand for a cleaner sustainable energy future. We are in the early stages of a long-run growth trend of the decarbonization of the energy industry that is likely to provide many attractive investment opportunities.

The dominant themes in the sustainable energy sector for 2020 were:

- **The energy transition likely accelerates as a result of COVID.** While global energy demand fell by more than 5% in 2020, demand growth for renewable energy was positive. While COVID lockdowns dampened the delivery of renewable growth in 2020, government stimulus packages have focused on sustainable energy activities. They provide local employment, have a material economic multiplier effect, and they look increasingly attractive in a low interest rate environment. Significant policy announcements from China, the EU (with its Green Deal) and President Biden demonstrated major political momentum and investment to support an acceleration towards energy efficiency, electrification and clean energy generation.
- **Electrification growing rapidly but energy efficiency still below required rate.** Lithium-ion battery manufacturing grew rapidly, bringing the average cost of a battery pack down to $137/kilowatt-hour (kWh). Electric vehicle sales benefited, rebounding hard in the second half of the year with electrified vehicles outselling diesel vehicles in Europe and Europe becoming the largest EV market globally. The rate of global energy efficiency improvement halved versus 2019, predominantly as a result of COVID, although efficiency improvement remained a critical component of the major policy announcements and future capex plans.
- **Solar installations grow while growth in wind moves offshore.** After a weak first half of the year, the solar industry returned to growth and installations grew to 129 gigawatts (GW) (+11 GW on 2019) with China surprising to the upside and India disappointing. Wafer, cell and module manufacturing remained oversupplied but niche markets such as poly silicon and solar glass saw significant pricing improvements as a result of supply disruptions, as demand recovered. Global wind installations totaled 77 GW (+17 GW on 2019) with China again leading the growth. The potential for offshore wind became more tangible as we saw a number of subsidy-free offshore wind projects sanctioned in Europe.

In 2020, sustainable energy equities delivered the strongest returns that we have seen for many years. The Guinness Atkinson Alternative Energy Fund delivered 86.45% (in USD) total return, versus the MSCI World Index at 15.9%, benefitting from the significantly improved long-term growth outlook and, like all global equities, the current ultra-low interest rate environment. The cash returns for sustainable energy companies took a COVID-related cyclical downturn in 2020 (to 5.8% from 6.9% in 2019) but expectations are for a recovery to 8% in 2021 in line with a global economic recovery and government support and stimulus for an accelerated energy transition.

Performance data quoted represents past performance; past performance does not guarantee future results. The investment return and principal value of an investment will fluctuate so that an investor's shares, when redeemed, may be worth more or less than their original cost. Current performance of the Fund may be lower or higher than the performance quoted. Performance data current to the most recent month end may be obtained by visiting www.gafunds.com or calling 800-915-6566.

OUTLOOK FOR 2021

- **We expect the "energy transition" theme to remain central to the political and post-COVID stimulus debate in 2021 as it offers an economic solution to energy security, urban pollution and carbon emissions for most countries.**

- Global **energy efficiency** measures are likely to be below the required long-run trend again in 2021, as a result of low energy prices and weaker global economic activity. Contrasting this, efficiency efforts will remain central to government policy announcements and we expect a particular focus on buildings efficiency. A concerted effort in getting energy intensity improvements back to pre-pandemic levels would save the world economy around $2.5trn in 2021.

- Within the **electrification** sector**,** we see upside to our expectation of 1,200 gigawatt hours (GWh) of lithium-ion battery manufacturing capacity by 2023 as new capacity is increasingly added outside China. Battery raw materials are likely to be a focus, but government policy around greater lithium-ion recycling could alleviate future demand concerns. Electric vehicle sales are likely to increase over 50% to more than 4mn sales in 2021, representing c.5% of total light vehicle sales. Battery manufacturers will also see increased demand from solar developers, providing "solar + storage" developments that provide fully dispatchable power for grids.

- **Solar installations** are likely to average around 155 GW globally, up 26 GW on 2019 levels. The start of grid parity projects under the 14th Five Year Plan in China, the world's largest installer, means that demand will be more sensitive to module prices this year. Solar manufacturing likely stays oversupplied all year with new capacity being added at lower marginal costs throughout the value chain, potentially keeping module prices lower and skewing global installation rates higher.

- **Wind installations** potentially reach a plateau level of around 73 GW in 2021 with decline in onshore China (as a result of grid parity demands) and growth ex-China (helped by recent

US tax credit changes). Significant subsidy free offshore tenders are expected in 2021, especially in Europe, heralding the economic development of a substantial new renewable energy form that could reach 200 GW of installed capacity by the end of the decade.

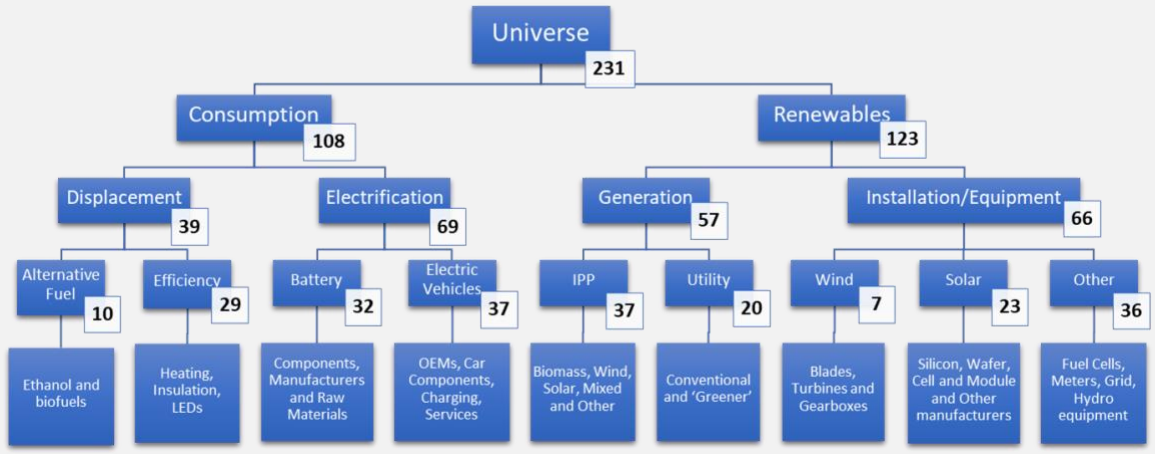
- **Improving economics and government support** for decarbonization technologies will continue in 2021 and will remain drivers of future growth for the sector. Long term sector growth will, typically, outstrip global economic growth rates and, therefore, we expect the growth of sustainable energy equities to outstrip the growth rates of global equities as well.
- The Guinness Atkinson portfolio of sustainable energy equities provides exposure to these growth themes and recently traded at a 13% premium to the MSCI World on 2021 P/E multiples and broadly in line on 2021 EV/EBITDA multiples. In aggregate, we expect investor interest in sustainable energy equities to grow further in 2021 as a result of increased individual, social and government pressures for consumers to become more energy efficient and for producers to increase their share of sustainable energy generation.
- We believe that the **Guinness Atkinson Alternative Energy portfolio offers reasonably valued, concentrated exposure to this attractive secular trend**.

A guide to our 2021 outlook for sustainable energy

This document reviews the sustainable energy sector in 2020 and provides an outlook for 2021 and beyond. Since there is no GICS sector for sustainable energy, we have identified a universe of 231 companies (market capitalization of over USD$500m) that are most directly exposed to the sustainable energy theme. We have classified the investment universe using the structure shown below. Our outlook follows the same structure.

Guinness Atkinson Sustainable Energy Universe

Numbers represent number of companies in each sub sector



- The outlook starts on page 5 with "**the long-term outlook for sustainable energy and the short term effect of COVID",** covering our long-term outlook, why post-COVID government stimulus packages are focused on clean energy technologies and their effect on accelerating the transition to a sustainable energy future.
- We then lead into a review of 2020, followed by short-term and long-term outlooks for each of our four main subsector classifications. On the "demand" side, pages 8-10 deal with **energy** displacement, while pages 10-14 consider the **electrification** sector (batteries and the EV supply chain). The "supply" side of the equation looks at the **generation** and **installation** of sustainable energy**.** We analyze these segments together, looking at the changing economics of renewable energy (on page 14), before turning to the specifics of **solar power** generation (pages 15-18) and **wind power** generation (pages 18-21).
- After the review of these key macro themes, we turn our attention to the performance and valuation of our **sustainable energy equity** sector (pages 21-24). We assess recent share price performance and the sensitivity of valuation to the growth potential of the sector
- After considering the valuation of the sector, we consider the key themes and valuation of the Guinness Atkinson Alternative Energy Fund on page 25. We highlight that the fund is an equally weighted selection of 30 positions covering a range of sustainable energy sub sectors which screens as trading at a c.10% premium to the MSCI World across a range of valuation methodologies.
- We hope that you find the document a useful review of 2020 and outlook for the fund and sector.

Sustainable energy: the long term and the effect of COVID

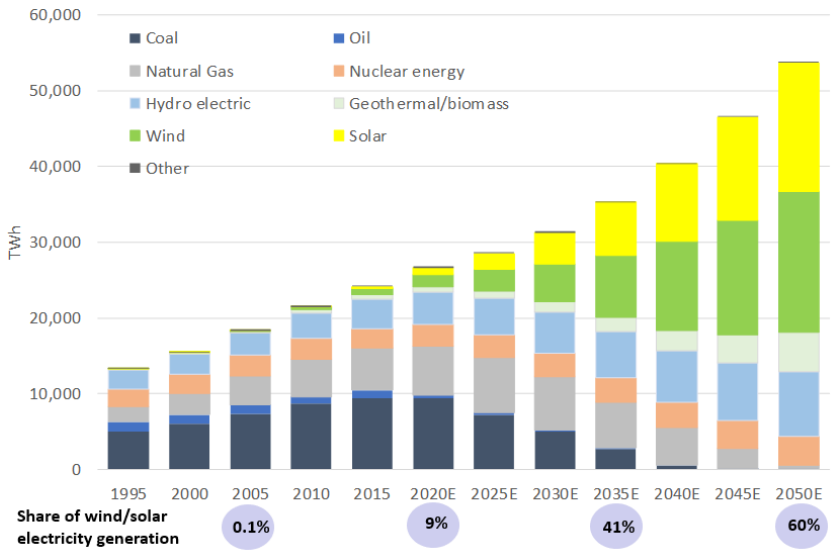
Over the next thirty years, the world will continue its transition to a sustainable energy system. The key factors driving the transition are:

- **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), while 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)

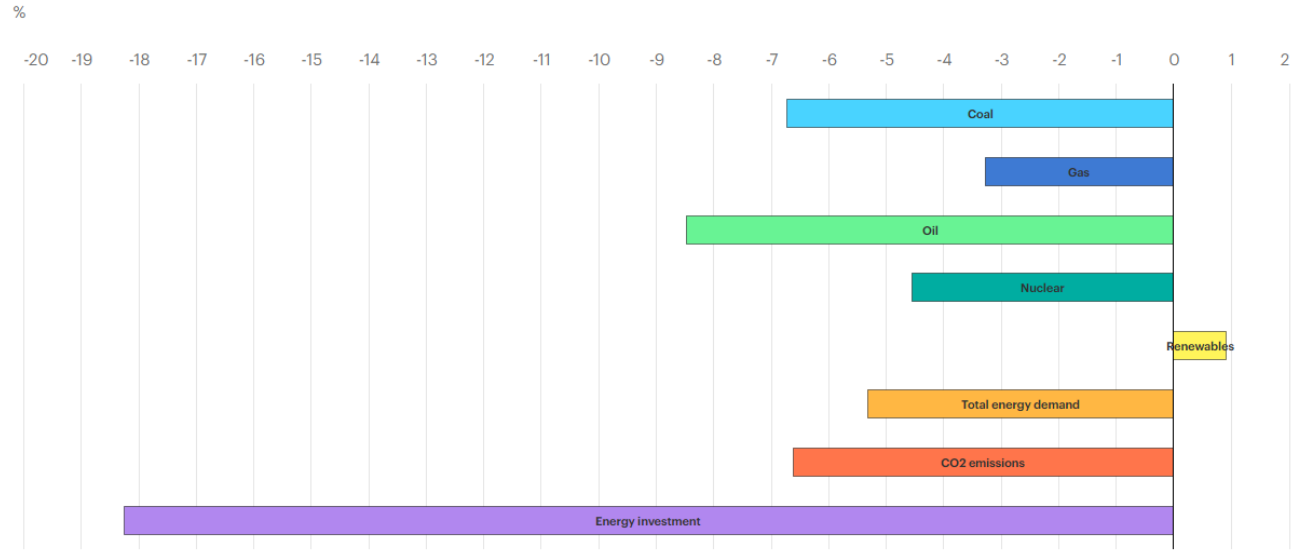


Sources: BP Statistical Review; Guinness Atkinson Asset Management forecasts

The effect of COVID-19 on the energy industry and the energy transition

The COVID pandemic has had a number of short-term and long-term effects on the global energy market and the energy transition, most notably causing global energy demand to contract by over 5% in 2020 vs 2019 as a result of lockdowns and reduced transportation. Renewable energy sources have performed better in the weaker demand environment (since operating costs are close to zero) and we expect that renewable energy demand will have increased by around 1% in 2020 relative to coal demand (down around 7%) and crude oil (down around 9%). A net benefit of COVID lockdowns and reduced global transportation has been lower CO2 emissions (down nearly 7% on 2019 levels) although these emissions will rebound once economies unlock and transportation resumes. More worrying on a longer-term basis is the fact that investment across the entire energy industry is likely to be down 18% in 2020 versus 2019; energy investment was already at the low end of the required range to facilitate the energy transition.

Key estimated energy demand, CO2 emissions and investment indicators, 2020 relative to 2019 (%)



Source: International Energy Agency (IEA) World Energy Outlook 2020

Governments across the world are agreeing on stimulus packages to kick start their economies back into growth-mode post-COVID. These investment programs have been heavily focused on sustainable energy technologies and activities because they satisfy near-term post COVID government and social needs on a number of levels, including:

- **Employment** investment in low carbon infrastructure tends to be more up front capital-intensive and local economy/employee-intensive than traditional energy developments. A recent analysis by the International Renewable Energy Agency (IRENA) estimated that 40m jobs could be created in the area globally by 2050.
- **Economic materiality** the same analysis estimates that investments in the energy transition could have a 5x multiplier effect on GDP.

- **Interest rate sensitive** low carbon infrastructure projects require greater upfront capital (and have lower operating costs) so they are more sensitive to the cost of financing. They are more likely to benefit relative to conventional projects in the post-COVID ultra low interest rate environment.

The near-term economic benefits of sustainable energy combined with increasing decarbonization commitments to trigger several key government policy commitment announcements during the year. The three most significant announcements, in our opinion, came from China, the US and the EU. China announced plans to become "carbon neutral" by 2060; clean energy and infrastructure targets were central to US President Biden's manifesto; and the long-awaited EU Green Deal was proposed, with its plan to achieve "climate neutrality" by 2050.

Combined, these three commitments represent major political momentum and investment to support an acceleration globally towards energy efficiency, electrification and clean energy, all of which are core themes in the energy transition.

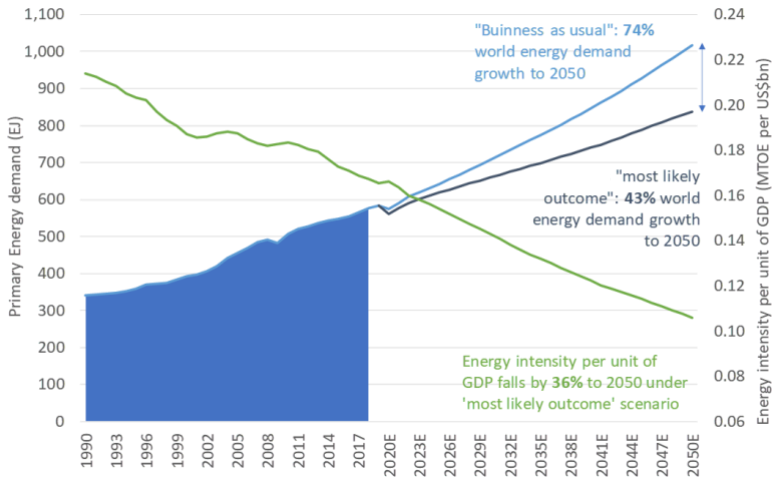
Displacement: energy efficiency and alternative fuels

Our "big picture" view: being energy efficient is as important as producing cleaner energy

It is a common misconception that achieving rapid growth in renewable power generation will be enough to deliver government pollution, energy security and de-carbonization targets. Renewable 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 immediately.

We carry out two demand scenarios as part of our modelling of long-term world energy demand. Our "business as usual" case sees world energy demand growing by 74% to 2050 as per capita energy demand and the energy intensity of GDP follow - historic patterns. The level of global energy demand implied by "business as usual" looks unsustainable, in our opinion. We believe that a more likely outcome for world energy supply and demand is one where energy demand growth is moderated substantially via the displacement and more efficient use of existing sources.

Guinness Atkinson Energy demand scenarios



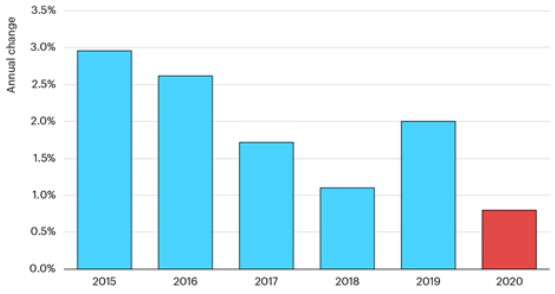
Source: BP Statistical Review, Guinness Atkinson Asset Management

Our "most likely outcome" scenario reflects this view and sees global energy demand grow by 43% from 2019 to 2050 despite the global population growing by 26% and global GDP more than doubling. While per capita energy demand stays broadly flat at 1.8-1.9 tons of oil equivalent (TOE), we see every $1bn of global GDP requiring only 95 tons of oil equivalent (Toe) in 2050 relative to the current intensity of 170 Toe in 2018. Delivering on energy efficiency is worth tens of trillions of dollars to world GDP by 2050; there are clear economic, as well as climate-related reasons, for the world to consume energy more efficiently.

Review of 2020: efficiency efforts fall further behind long term required levels

The COVID pandemic has had a substantial impact on energy efficiency activity in 2020, likely leading to 2020 being another year of energy efficiency improvements that are well below the required long term run rate to deliver on Paris de-carbonization goals. Energy efficiency is difficult to measure, and the pandemic will make the measurement of efficiency gains even harder, but initial indications from the IEA are that energy intensity is expected to improve by only 0.8% in 2020, roughly half the weather-adjusted rates seen in 2019 (1.6%) and 2018 (1.5%).

Primary energy intensity improvement rate (2015-2020)



source: IEA

The pandemic also delayed investment in future energy efficiency projects, with investment here likely to fall by 9% versus 2019. Globally, we find Europe leads the way in energy efficiency investment, with the continent representing 86% of the US$66bn of funding for energy efficiency-related measures announced as part of governments' stimulus packages at end of October 2020.

The actual delivery of energy efficiency in 2020 contrasts significantly with the many government de-carbonization and energy transition announcements that were made during the year, such as:

- US President Biden's announced plans to accelerate energy upgrades to buildings, targeting a 50% reduction in the carbon footprint of buildings by 2035 via the upgrading of c.4m commercial buildings, creating 1m new construction, engineering and manufacturing jobs.
- The EU Green Deal focus on building efficiency, described in "A renovation wave for Europe" that plans to double annual energy renovation rates in buildings over the next ten years.

Outlook for 2021 and beyond: buildings still a focus but more government policy required

The near-term outlook for improving energy efficiency continues to look weak. Energy intensity improvements typically track global GDP with a one-year delay and, with global GDP likely to have fallen by 4.4% in 2020 according to the IMF, we expect that energy efficiency measures in 2021 will still be impressive in certain areas but below the long term required level globally. Moreover, current low energy prices make it even more difficult to justify investing to save energy on a purely economic basis.

Government intervention, along the lines of what was announced in 2020, will be required to make the saving of energy a necessity for companies and individuals rather than an optional extra. We note that government standards and specifications on energy efficiency cover only 35% of global energy end use.

We expect that building efficiency will be a key focus in the near term as, amongst other aspects, investments in the efficiency of buildings are estimated to create around 15 jobs for every US$1m spent. Buildings account for ~30% of global final energy consumption and energy-related CO2 emissions and in order to achieve the goals of the Paris Agreement, energy intensity (consumption per unit of floor area) of buildings needs to fall by >2.5% per year, more than double the current rate of 0.5-1% pa.

The economic benefit of achieving greater energy efficiency is very significant in the near term. The 0.8% improvement in energy efficiency in 2020 meant that the world generated around US$1trn more GDP for the same amount of energy used in 2019. Had the 2019 level of energy efficiency been sustained, at 2%, the GDP saving could have been closer to US$2.5trn.

Electrification: lithium-ion batteries and electric vehicles

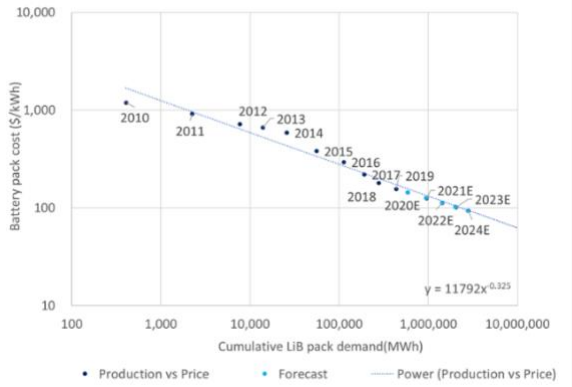
Our "big picture" view: rapid growth in battery storage and electrified transportation

The energy transition will see energy demand being "electrified" as it moves away from predominantly hydrocarbon fuels and gases towards the consumption of electricity directly. Our "electrification" sector includes those companies involved in the key enablers of this transition: the lithium-ion battery and the electric vehicle. 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.

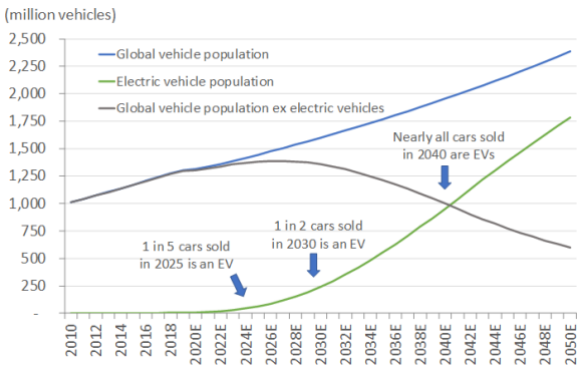
The catalyst for greater **lithium-ion battery** use has been sharp falls in the cost of manufacturing. According to BNEF, battery costs are down 89% over the decade from 2010 to 2020 (an implied "learning rate" of around 18%) with the average cost being $137/kWh in 2020. Significant economies of scale from mass battery manufacturing have lowered costs and, as these continue, the average cost of producing a lithium-ion battery for an EV is likely to fall towards $100/kWh in the mid-2020s. Of note, BNEF reported the first instance of a sub $100/kWh battery pack being manufactured for an e-bus in 2020.

This would allow **electric vehicles** to compete on price with internal combustion engine vehicles without subsidies. We expect an acceleration in the uptake of new EVs, with around 20% of new passenger vehicles sales being electric in 2025, rising to around 50% in 2030. On this basis, there will be nearly 300m electric vehicles on the world's roads by 2030. This level of electric transportation would displace nearly 4m barrels of day of world oil demand in that year.

Lithium-ion battery costs and cumulative capacity



Electric vehicle Update



Source: BNEF, Guinness Atkinson Asset Management, OPEC, Woodmac

The demand for lithium-ion batteries in **grid (stationary) storage** is likely to grow very rapidly as the cost of delivering a "renewable + storage" power system improves. Higher levels of variable renewable power in

many electricity grids are resulting in low intraday power prices and incentivizing developers to make new renewable power projects fully "dispatchable" (via the addition of storage) in order to supply electricity at different points in the day and benefit from higher power prices. In 2019 there was 173 GW of grid storage globally (representing maybe 2% of global power generation capacity) and around 90% of this was in the form of pumped hydro.

Review of 2020: very strong growth across batteries, EVs and stationary storage

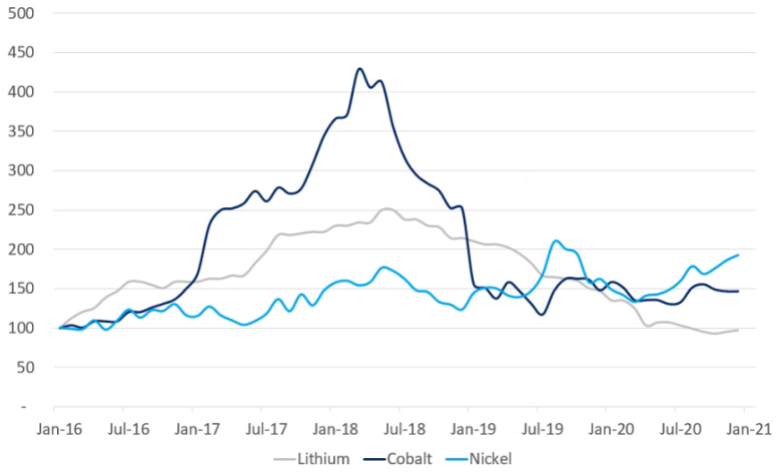
2020 was another year where **lithium-ion batteries** took more share of both the global auto and global grid (stationary) storage industries as investment and capacity of lithium-ion battery manufacturing continued to ramp.

According to Bloomberg New Energy Finance, **lithium-ion battery** manufacturing is expected to have reached 470 GWh in 2020 (up from 352 GWh in 2019 and 249 GWh in 2018) with most of the capacity additions being taken by auto manufacturers for their new EV models. At around 70% market share, China dominates manufacturing capacity but in 2020 we saw many new lithium-ion battery factories outside China being announced. Lithium-ion batteries typically degrade during long distance seaborne travel, hence new manufacturing facilities are being planned closer to auto manufacturing plants and to customer demand centers.

While already dominant in battery manufacturing technology, Tesla announced in September that it was planning to invest in lithium mining (securing the rights to a 10,000-acre lithium clay deposit in Nevada) as well its intention to build a cathode facility. Both these actions indicate likely long-term pressure on the upstream side of battery manufacturing that could occur in the coming years.

Despite the growing demand, the prices of the main raw materials were reasonably flat during 2020. Cobalt and Nickel (at $31,400/ton and $13,700/ton respectively) in 2020 were broadly flat on 2019 levels while Lithium carbonate (at $6,800/ton) was down around 40% on average versus 2019. While nickel prices were flat on average in 2020, there was strong positive price momentum into year end.

Lithium Carbonate, Nickel and Cobalt prices ($/metric ton, indexed to 100, Jan 2016)

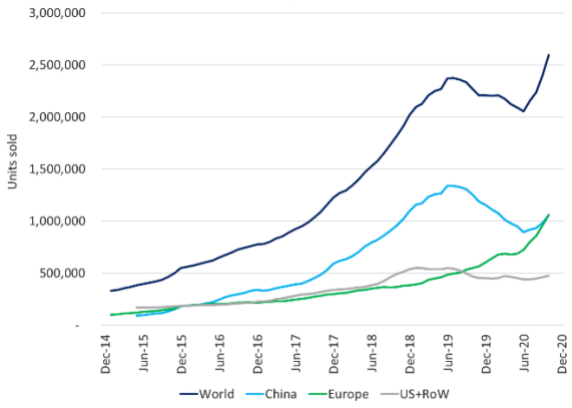


source: Guinness Atkinson Asset Management, Bloomberg

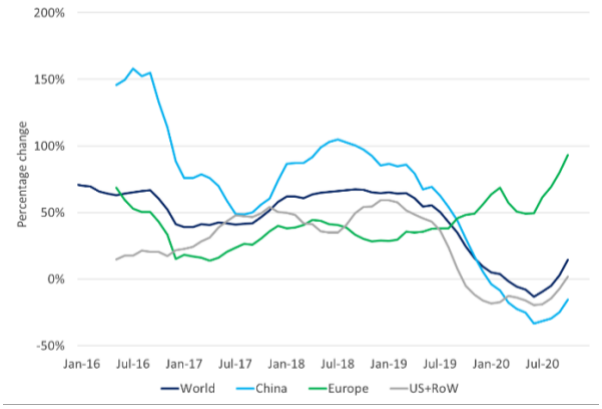
By our estimates, the total global **electric vehicle** passenger vehicle fleet reached nearly 10m vehicles at the end of 2020 with new sales in 2020 being about 2.8m vehicles, a growth of around 25% versus sales of 2.2m in 2019. This growth compares very favorably to overall global light vehicle sales of around 75m vehicles in 2020, down 16% on 2019 levels.

The global auto industry suffered due to COVID lockdowns at the start of 2020, but global electric vehicle sales growth recovered quickly after the initial lockdowns and turned positive at the end of Q3 2020. The sharp recovery in EV demand was dominated by Europe, with the European EV market being the biggest globally at the end of 2020.

Global EV sales (rolling 12-month basis)



Global EV sales growth (rolling 12-month basis)

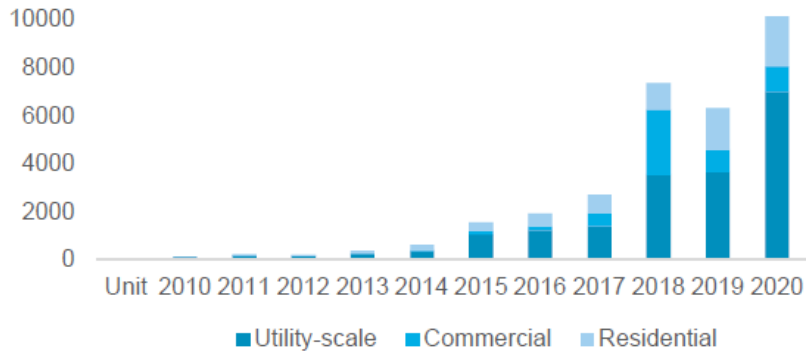


Source: Guinness Atkinson, EV-Sales

The strength in Europe was driven by new generous EV incentives offered by Germany and France (among other countries) and stricter emissions standards that went into effect at the start of the 2020, which incentivized auto manufacturers to either increase their EV offerings and sales levels or purchase emissions credits to make up for carbon shortfalls. A key milestone was achieved in Europe during 2020 as new registrations for the broader category of "electrified vehicles" - including light-hybrid cars (HEVs) as well as PHEVs and BEVs – reached 25% and overtook that of diesel vehicles. After stagnating in 2019, the Chinese market also saw a rebound in EV sales activity by the third quarter leaving the market broadly flat over the year.

The market for **grid (stationary) lithium-ion battery storage** also grew handsomely in 2020, with deployments expected to have reached around 10,000 MWh, up around 50% on the levels seen in 2018/2019. The reduction in manufacturing cost spurred demand for batteries for use in a variety of grid-attached ancillary services, and the falling cost of large-scale renewables-plus-storage means that grid operators and utilities started to see credible paths to replacing coal and gas generators, justified by economics during the year. The market is dominated by utility scale operations, which are the most economic application, but 2020 saw a very strong uptake in US residential where solar installers are selling "solar + storage" packages. As much as 30% of new US residential systems are now being sold with lithium-ion batteries, around double the rate that was seen in 2019.

Deployment of grid storage (MWh):



Source: JP Morgan

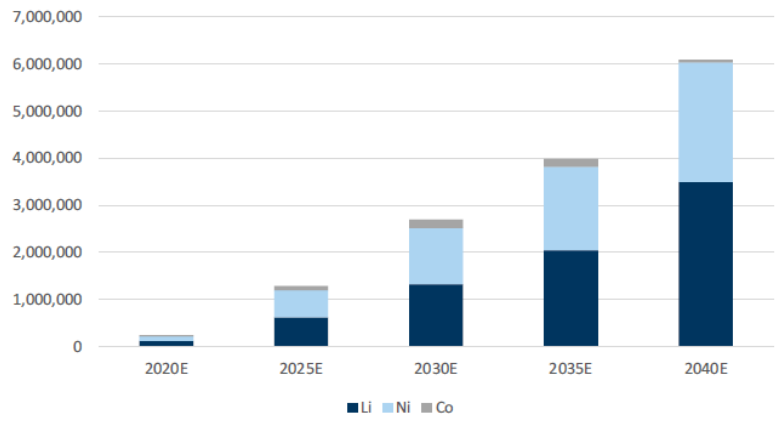
Outlook for 2021 and beyond: rapid growth across batteries, EVs and stationary storage

We expect sustained growth in **lithium-ion battery manufacturing** capacity in 2021 and beyond, taking large scale manufacturing capacity to more than 1,200GWh in 2023 and then significantly higher by the end of the decade. These facilities are being built globally, but China will still maintain its dominance, with its share of global capacity staying in the 65-70% range.

As an illustration of the scale of the potential growth and the volatility around long-term forecasting, Tesla recently indicated that its annual battery needs alone will reach 3,000 GWh by 2030 - from 44 GWh currently. While this target also includes batteries for storage and other applications, if it is achieved, it would imply an overall lithium-ion battery market of around 6,000 GWh (based on 50% market share). This implies a dramatic impact on the demand outlook for lithium-ion battery raw materials as shown in the scenario from Goldman Sachs below.

Long term demand outlook for lithium, nickel and cobalt (tons per annum)

source: Goldman Sachs



To help fulfil demand, we also expect to see increasing focus in the coming years on the recycling of lithium-ion battery raw materials. Current recycling rates are estimated to be very low (around 10%) because

recycling old batteries is a complex and expensive task. In the coming years, we expect government funded and mandated support for the battery recycling industry to bring about growth and economies of scale and, with the evolution of a re-use market, lithium-ion battery recycling will become a mainstream activity thus alleviating pressure on raw material production.

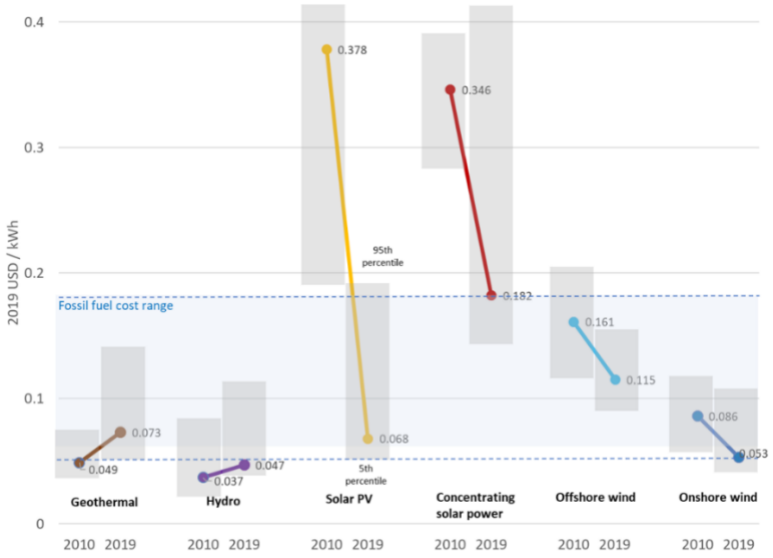
The recent growth trends for **electric vehicles** will continue through 2021 supported by clear commitments from governments towards the electrification of transportation. We expect new EV sales to be in excess of 4m vehicles in 2021, up over 50% versus 2020 sales and representing around 5% of global total light vehicle sales of 83m units (up 11% in 2020 levels). Looking longer term, we expect that predominantly all passenger vehicle sales will be EVs by 2040.

While starting from a lower base, the outlook for **stationary lithium-ion battery storage** continues to look very strong in 2021 and beyond as utility scale solar developers focus more on "solar + storage" projects in order to benefit from higher power prices at certain times of the day. While residential deployment in areas like the US is still dependent upon tax credits, we expect utility scale operations to grow rapidly and to be more economic than other large-scale storage options (for example hydrogen) on an unsubsidized basis.

Generation and installation: renewables versus fossil fuels

Before considering the detailed dynamics of key renewable power generation markets of wind and solar, it is worth considering the significant changes that have been seen across 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 the cost range for new fossil fuel power generation. As we will highlight in the coming sections, however, there is still further room for both wind and solar power generation technologies to deliver further cost reductions.

Global levelized cost of energy (LCOE) of utility-scale renewable power generation technologies (2010–2019)



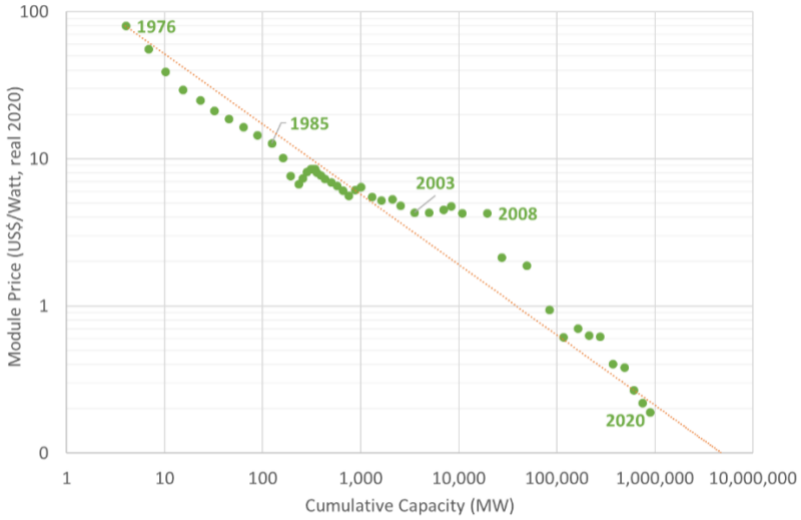
Source: IRENA; Guinness Atkinson Asset Management

Generation and installation: solar power

Our "big picture" view: solar module cost reductions continue to support rapid growth

The fact that solar PV is being taken seriously today as a variable renewable energy source owes much to the significant fall in the price of crystalline silicon PV modules. In their infancy, in the late 1970s, a PV module cost around $80 per watt ($/W). By 2010, this had been reduced to around $2/W, a rapid decrease but one that still left solar as being uneconomic versus most other energy generation sources. Critically, the learning rate this decade (the cost reduction for every doubling of cumulative industry capacity) continued at a similar level – around 28% - bringing us to a module cost of around $0.18/W in 2020, around 90% lower than the cost in 2010.

Solar module prices and manufacturing capacity (1976-2020)



Source: IRENA; Guinness Atkinson Asset Management

Falling costs have caused rapid growth, with annual solar installations growing from 19 GW in 2010 to an estimated 129 GW in 2020. In the initial years (2010-2014) Organization for Economic Cooperation and Development (OECD) countries dominated the market but, by 2015, non-OECD countries (predominantly China) increased their rate of new installations and brought the global market to a 50/50 balance between the OECD and non-OECD. China's annual installations grew by 34 GW p.a. over the subsequent two years, representing nearly all of the 42 GW p.a. of growth in installations globally over that period. Growth has been more balanced since then, with the OECD increasing its installation rate by 16 GW p.a. and the non-OECD increasing by 23 GW pa. As of 2020, China still dominated the global solar module installation market, at 40 GW in a global total of 129 GW.

Global solar module installations, 2008-2021E (GW)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021E
OECD solar installations (annual)														
North America	0	1	1	2	4	6	7	8	14	11	10	11	15	24
Germany	2	4	7	7	8	3	2	1	2	2	4	4	4	5
Italy	0	1	4	8	4	1	0	0	0	0	0	1	1	1
Spain	3	0	0	0	0	0	0	0	0	0	0	5	3	3
Rest of Europe	0	1	3	4	5	5	5	6	4	3	4	6	8	9
Australia	0	0	0	1	1	1	1	1	1	2	4	4	3	4
South Korea	0	0	0	0	0	1	1	1	1	1	2	3	3	4
Japan	0	0	1	1	2	7	10	11	8	8	7	7	7	7
Total OECD	**6**	**7**	**17**	**23**	**24**	**24**	**25**	**29**	**29**	**26**	**31**	**40**	**44**	**56**
Change in OECD annual installations	*4*	*0*	*10*	*7*	*0*	*0*	*2*	*4*	*0*	*-3*	*5*	*9*	*5*	*11*
Non-OECD solar installations (annual)														
China	0	0	0	3	3	14	13	19	30	53	44	33	40	45
India	0	0	0	0	1	1	1	2	5	10	11	12	5	10
Rest of non-OECD	0	1	1	3	3	4	6	6	11	9	22	34	40	44
Total Non-OECD	**0**	**1**	**2**	**5**	**8**	**18**	**21**	**27**	**46**	**72**	**77**	**78**	**85**	**99**
Change in non-OECD annual installations	*0*	*1*	*1*	*3*	*2*	*11*	*2*	*6*	*19*	*26*	*5*	*1*	*6*	*15*
Total solar installations (annual)	**7**	**8**	**19**	**29**	**31**	**42**	**46**	**56**	**75**	**98**	**108**	**118**	**129**	**155**
Change in world annual installations	*4*	*1*	*11*	*10*	*2*	*11*	*4*	*10*	*19*	*23*	*10*	*10*	*11*	*26*

Sources: BP, Bloomberg, Guinness Atkinson Asset Management

Review of 2020: COVID and cyclical tightness in solar manufacturing slows demand growth

The cost reductions discussed above have come from a number of technological and economic improvements, including more efficient use and lower pricing of polysilicon, the shift from multi-crystalline to mono-crystalline polysilicon and scale/manufacturing improvement across the other parts of the solar PV system. Further technology and manufacturing improvements were made in 2020 across the various components of the solar value chain:

- **Poly-silicon** is the initial raw material for a solar wafer. Poly prices hit record lows in the middle of 2020 as a result of oversupply and then, in Q3, an explosion and floods disrupted supply from some Chinese factories, forcing poly prices up nearly 50%. Capacity is now normalizing with a number of key producers poised to deliver aggressive capacity expansions towards the end of 2021.
- **Poly silicon wafer manufacturing** remained significantly in excess of poly silicon capacity throughout the year, keeping manufacturing margins under pressure. Capacity continues to switch to mono silicon wafers (now at 180 GW capacity) and away from multi silicon wafers (capacity down from 55 GW in 2019 to 24 GW in 2020).
- **Solar cell and module manufacturing** saw significant capacity expansion in 2019 (maintaining a high level of oversupply) with new larger diameter cell capacity coming online. Higher cost producers shut in production leaving even the Tier 1 manufacturers and vertically integrated companies facing very challenging manufacturing economics. Solar glass prices increased by around 50% in the second half of the year as a result of limited supply and growing demand from bifacial panels (which utilize larger amounts of solar glass) further compressing module margins.

Solar module installations on a global basis were much less affected by COVID than initially feared. In the middle of the crisis, it was mooted that the rate of global installations would decline in 2020, registering the first year of module installation rate declines in recent history. Ultimately, new installations likely increased by 11 GW in 2020, to reach 129 GW. **China** was the largest market globally with installations averaging around 40 GW in 2020 (up from 33 GW in 2019) as the country recovered from COVID faster than other countries. **India** was the weakest of the larger markets, suffering weak demand due to the impacts of COVID-

19, border conflicts at the China-India border and a clearer demand response to higher module prices. **OECD** demand, at 44 GW, was 10% higher than 2019 with North America dominating the growth (+4 GW versus 2019) predominantly resulting from continued attractive tax credits in the United States.

Outlook for 2021 and beyond: global demand becomes more price sensitive

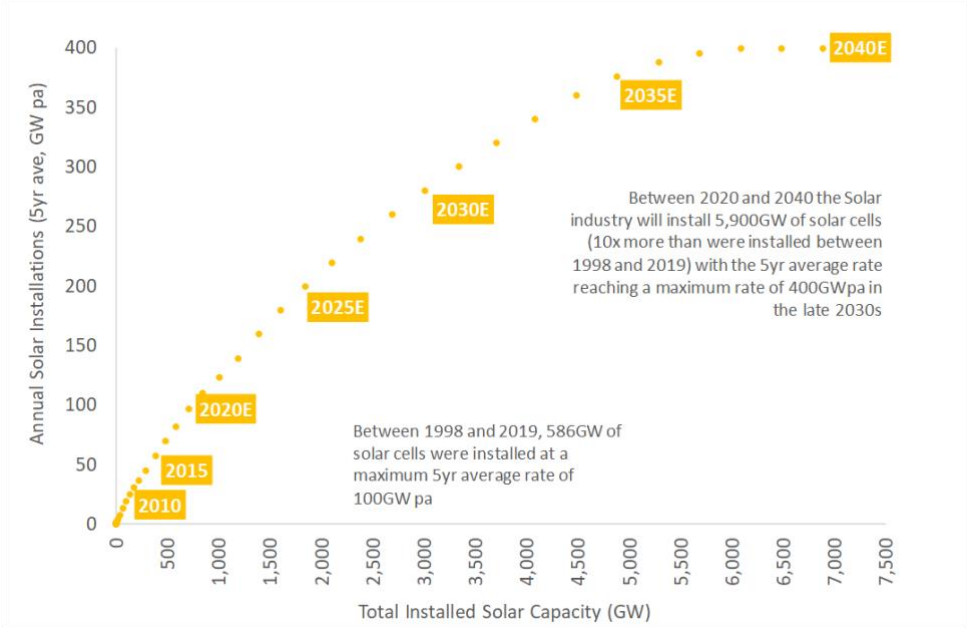
The outlook for solar installations in 2021 depends very much on solar module pricing and how it is affected by the developments in the polysilicon, wafer, cell and module (including solar glass) markets.

- **Poly-silicon** capacity will grow to 630k million metric tons per year (mtpa) at the end of 2021 (growing 80k mtpa in 2021) with the marginal cost of new capacity being in the region of $4-6/kg. Prices should weaken, alleviating margins for module manufacturers. A key risk exists stemming from a US House of Representatives bill, passed in September 2020, that seeks to block imports of goods made with forced labor in Xinjiang. Nearly half of the world's poly silicon is manufactured in Xinjiang and such a ban would exclude Chinese module manufacturers from selling any modules that include Xinjiang poly within them.
- **Poly-silicon wafer manufacturing** capacity is likely to increase further in 2021, leaving the wafer industry even further oversupplied (and probably price pressured) than it was in 2020. With the start of a large plant from GCL during the year, the industry will effectively complete its transition to mono-grade manufacturing by the end of 2021.
- **Solar cell and module manufacturing** New capacity additions will increase oversupply again with cell and module prices likely to remain under pressure. With limited new solar glass capacity planned for 2021 (and therefore prices unlikely to recede) there will be more module margin pressure bringing the risk of price cutting to defend market shares.

Solar module installations are expected to reach around 155 GW in 2021, up 26 GW on the level achieved in 2020. **China** will implement the 14th Five-Year Plan starting in 2021, under which solar projects will no longer be subsidized and the move to grid parity will be completed. With strong government support and individual installation targets for each province (rather than subsidy allowances), the key factor affecting demand will be module price, with upside risk to our 45 GW estimates if prices fall. **India** solar module demand is likely to be around 10GW, up 5 GW on the 2020 activity that was held back by COVID. In the **United States**, a Biden presidency leads to installations of around 22 GW in 2021 driven by the solar Investment tax credit (ITC) which has been extended for a further two years as part of the country's COVID stimulus. **Europe** will register around 25-30 GW of new installation demand in 2021, broadly unchanged on 2020 levels.

In **conclusion**, the global outlook for solar looks robust and the improved cost competitiveness of solar energy opens the way for a rapid expansion of solar in the global electricity grid. Between 2020 and 2040, the solar industry will install 5,900 GW of solar cells (10x more than were installed between 1998 and 2019) with the 5yr average rate reaching a maximum rate of 400 GW p.a. in the late 2030s

Annual and cumulative solar installations (2005-40)



source: Guinness Atkinson Asset Management estimates, BP

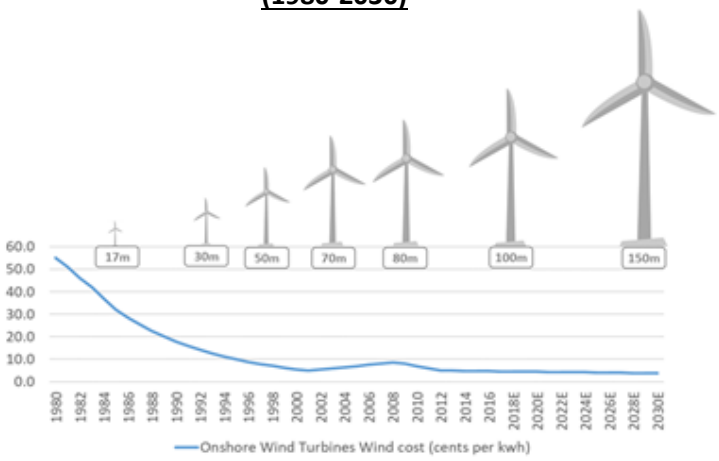
Generation and Installation: wind power

Our "big picture": a lower growth industry with great offshore potential still to come

The decline in the cost curve for wind power installations over the last ten years has not been as dramatic as solar, but it started from a lower base that was already competitive with some fossil fuel power generation. Indeed, the overall learning rate for the development of wind turbines since the early 1980s has been around 11%, versus a learning rate for all-in wind project capex of round 7%, implying a shallower pricing decline for other wind plant components.

The success of the wind industry is being driven by turbines becoming larger. The median size of onshore turbines in 2010 was around 2GW, and today this has risen to around 3.5GW. By 2050, BNEF estimate that the median size will be over 5GW. The scale improvements offshore are even more striking, with a move up from 7GW today to around 19GW by 2050. Larger wind turbines bring overall economies to the installation process because less foundation work and less cabling is needed and there are fewer parts to install and maintain. Improved performance

Onshore wind power costs vs turbine height (1980-2030)



source: Openenergymonitor, Guinness Atkinson Asset Management

monitoring systems are increasing the efficiency of installation and maintenance work.

The greater scale and improved design of turbines has set onshore wind costs on a path of declining costs. In 2008, onshore wind power cost an average of 8.5c/kwh, falling to a below 4.5c/kwh in 2020 and expected to fall further to 3.8c/kwh by 2030.

Having peaked in 2015 at 63GW of newly installed wind capacity (versus 36GW in 2010), the world wind market looks to have accelerated again (to around 72 GW), making 2020 a record year for installations and the highest year-on-year increase in new capacity.

Annual onshore and offshore wind installations (GW)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021E
Onshore wind installations (annual)														
North America	9	11	6	8	15	2	7	10	9	8	8	10	15	15
Latin America	0	0	0	0	0	0	5	3	3	3	3	4	5	6
Europe	6	9	9	10	12	11	11	11	12	13	8	9	12	16
China	6	14	17	18	14	15	21	29	22	17	19	26	32	25
India	2	1	1	1	1	1	1	1	2	3	2	2	1	3
RoW	3	3	3	4	4	3	4	5	5	5	6	5	6	8
Total onshore	**27**	**38**	**35**	**40**	**45**	**32**	**48**	**59**	**54**	**48**	**45**	**52**	**71**	**73**
Change in onshore annual installations		*12*	*-3*	*5*	*5*	*-13*	*16*	*11*	*-6*	*-6*	*-2*	*7*	*19*	*2*
Offshore wind installations (annual)														
China	0	0	0	0	0	0	0	1	1	1	2	3	4	5
UK	0	0	1	0	1	1	0	1	0	1	2	2	1	0
Germany	0	0	0	0	0	0	0	2	0	2	0	2	0	0
RoW	0	0	0	0	0	1	0	0	0	1	0	1	2	3
Total offshore	**0**	**0**	**1**	**0**	**2**	**2**	**1**	**4**	**1**	**4**	**4**	**8**	**6**	**9**
Change in onshore annual installations		*0*	*1*	*-1*	*1*	*1*	*-1*	*4*	*-4*	*3*	*0*	*3*	*-1*	*3*
Total wind installations (annual)	**27**	**38**	**36**	**40**	**46**	**34**	**49**	**63**	**54**	**52**	**50**	**60**	**77**	**82**
Change in world annual installations		*12*	*-2*	*4*	*6*	*-13*	*15*	*14*	*-9*	*-3*	*-2*	*10*	*17*	*5*

Source: Bloomberg, BP and Guinness Atkinson Asset Management

Review of 2020: onshore installations likely to be plateauing; offshore still hopeful

The wind industry likely generated around 6% of world power generation in 2020, with about 95% of the installed capacity being onshore turbines. Here we will separately consider the key factors for the onshore and offshore wind markets in 2020.

Comparing the **onshore wind** industry to other high growth parts of the sustainable energy industry, it is interesting to think that the installation rate of onshore wind likely started to reach a near term plateau level in late 2020. Total onshore installations were around 71 GW (up 19 GW on 2019 and 26 GW on 2018 levels respectively) and, while likely to grow again somewhat in 2021, the momentum has slowed. Installations in China surprised to the upside during the year, consistent with the Q3 carbon neutrality announcement, while similar to solar, the extension of tax credits in the United States helped to sustain further onshore demand growth.

There was constructive cost data for the **offshore wind** industry suggesting that the LCOE for offshore wind has fallen over 30% from 2010-2020, from $161/MWh to less than $115/MWh, putting it well within the cost range of fossil fuel generation. Despite these improving economics, much of the offshore industry still relied on some form of subsidy to be economic in 2020. Grid parity is starting to appear and during 2020 we saw subsidy-free offshore wind projects being signed in the UK, Germany, and the Netherlands. These underline

the significant potential of the offshore industry which benefits from better operational and visual characteristics as well as being close to key demand areas which are often coastal.

Annual installations of offshore wind capacity increased from 0.9 GW in 2010 to 8 GW in 2019 before receding a little, predominantly as a result of COVID, to 6 GW in 2020. According to Bloomberg, at the end of 2020, total installed offshore wind capacity was estimated to be 36 GW with China leading at nearly 11 GW, followed by the UK at 10 GW and Germany at 7.5 GW.

Offering the largest and most reliable turbine is a critical competitive advantage for offshore wind turbine companies. In our Global ex-China market, we saw Siemens Gamesa unveil its new 14MW turbine model during 2020, raising the stakes on GE's 12MW Halidade model and leaving Vestas a distant third in terms of turbine size, at 10MW. Vestas has historically competed in the offshore space via its joint venture with Mitsubishi Heavy Industries (MHI) and it has, so far, been unable to replicate its leading onshore position. In Q4 2020, Vestas announced its intention to take control of the MHI JV by buying out Mitsubishi Heavy Industries.

Outlook for 2021 and beyond: Onshore plateau; offshore suffers COVID related decline

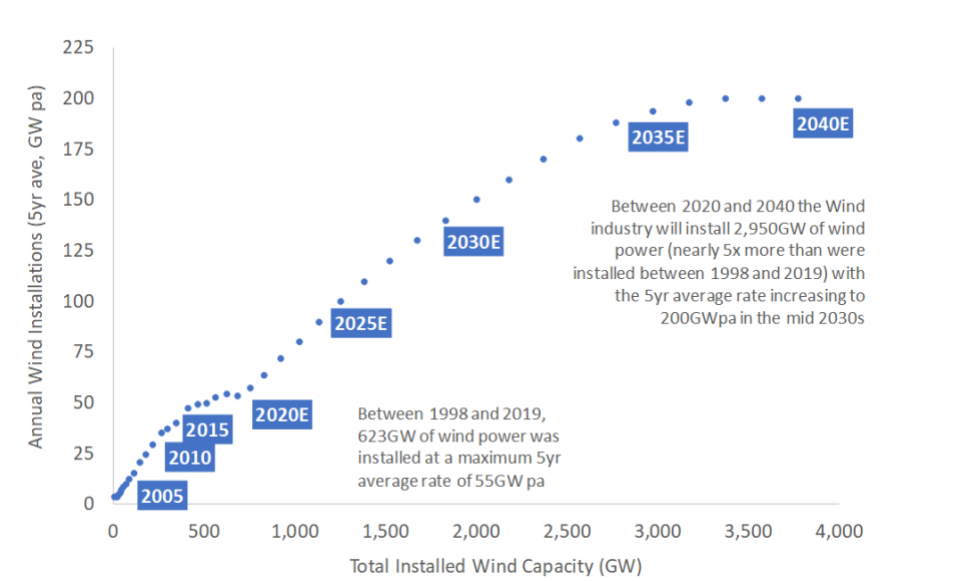
In 2021, global **onshore wind** installations are expected to plateau at around 73 GW (up around 2 GW on 2019 levels). The reason for the decline is mostly China, where wind projects have yet to fully reach the grid parity requirements that are necessary within the 14th Five Year Plan. Excluding China, the global onshore market will see strong growth, driven by delays due to COVID-19, and installations could reach nearly 50 GW in 2021 (versus 39 GW in 2020), marking a similar increase to that seen in 2019. Within this, the outlook for installations in the United States has improved as a result of the twelve-month extension of the 60% Production Tax Credit (PTC) for wind projects.

Despite the improving long term growth outlook, new **offshore wind** capacity additions in 2021 will likely be lower than those seen in 2020 as a result of project delays stemming from COVID lockdowns in 2020. Ultimately, COVID is likely to act as a significant stimulus to longer term offshore wind growth as offshore projects are more capital intensive and project economics will benefit from the current environment of ultra-low interest rates. We can see over 20 GW of offshore project tenders to be awarded in 2021.

Looking longer term, increasing scale and larger turbine power capacities should allow the offshore sector to grow faster than onshore in the years ahead with new installations increasing every year from 2021 to 2030, reaching 12-15 GW p.a. in 2025 and more than doubling again by 2030. By the end of the decade, offshore installed capacity could be close to 200 GW and will likely be dominated by China, the UK, the United States and Germany but with the addition of new entrants such as the Netherlands, Taiwan, Japan, France, Korea, Denmark and India. The EU alone is targeting 60 GW of offshore wind capacity by that time, with some of it dedicated towards the new hydrogen economy.

In **conclusion**, putting our views for the onshore and the offshore together, we expect the wind industry to install a further 2,950 GW of new capacity between 2020 and 2040, reaching a peak installation rate of around 200 GW pa in the mid-2030s. The total installed capacity would be around five times as much as was installed between 1998 and 2019.

Annual and cumulative wind installations (2005-30)



Source: Bloomberg, BP, Guinness Atkinson Asset Management

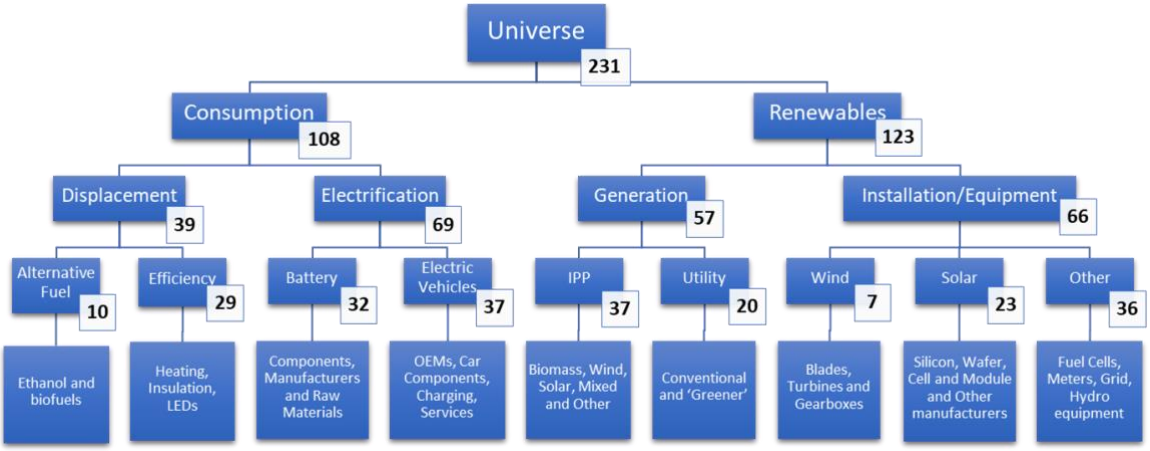
Sustainable energy sector – performance and valuation

The Guinness Atkinson Alternative Energy Fund is positioned to benefit from the many opportunities associated with the sustainable energy transition that we have discussed. As part of our investment process, we have identified a universe of 231 companies (market capitalization of over USD$500m) that are most directly exposed to the theme, and classify them into the following four sub-sectors:

- **Displacement** includes companies involved in the displacement or more 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
- **Generation** includes companies involved in the generation of sustainable energy, either pureplay companies or those transitioning from hydrocarbon-based fuels
- **Installation (Equipment)** includes companies involved in the manufacturing of equipment for the generation and consumption of sustainable energy

Guinness Atkinson Sustainable Energy Universe

Numbers represent the number of companies in each sub sector



IPP stands for independent power producer

Sustainable Energy equities delivered a very strong return in 2020 with the Guinness Atkinson Alternative Energy Fund delivering 86.45% return in USD terms while the MSCI World Net Return index delivered 15.9% in 2020. This was the strongest return in recent history and there were some very notable differences to long term performance dynamics.

To analyze these dynamics, we present below the annual total rate of return (TRR) of the median stock in each of the key sub sectors between 2010 and 2020, with calculations for overall TRR, annualized TRR and annualized volatility. The share price rally in solar and wind equipment over the last two years is quite clear and the contrast versus a very weak and volatile history for solar equipment is evident. In contrast, the weaker performance of efficiency and EV companies in the recent couple of years contrasts with the longer-term attractive return and lower volatility traits.

Total annual return of the median stock in each subsector

TRR of the median stock in each subsector (% per annum-%pa)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	TRR 2010-2020	TRR %pa 2010-2020	Volatility 2010-2020
Alternative Fuel	9%	0%	0%	39%	-10%	-14%	28%	0%	-2%	20%	12%	101%	6.6%	16%
Efficiency	30%	-12%	25%	60%	4%	3%	20%	34%	-20%	40%	34%	492%	17.6%	24%
Battery	25%	-18%	1%	2%	-4%	1%	15%	53%	-18%	9%	27%	98%	6.4%	21%
Electric vehicles	25%	-12%	26%	56%	17%	1%	6%	49%	-27%	26%	38%	416%	16.1%	25%
IPP	-8%	-26%	9%	10%	-4%	-10%	12%	28%	0%	40%	52%	113%	7.1%	23%
Utility	12%	-8%	-3%	8%	9%	-6%	11%	18%	6%	34%	2%	113%	7.1%	12%
Equipment	4%	-28%	7%	36%	-6%	-1%	6%	32%	-20%	44%	58%	161%	9.1%	27%
of which:														
Solar equipment	-2%	-50%	-9%	72%	-18%	-11%	-20%	72%	-32%	57%	98%	65%	4.6%	50%
Wind equipment	-49%	-37%	-21%	203%	21%	70%	-7%	15%	-11%	42%	101%	330%	14.2%	73%
Other equipment	16%	-19%	24%	33%	0%	-5%	21%	30%	-17%	41%	21%	231%	11.5%	20%

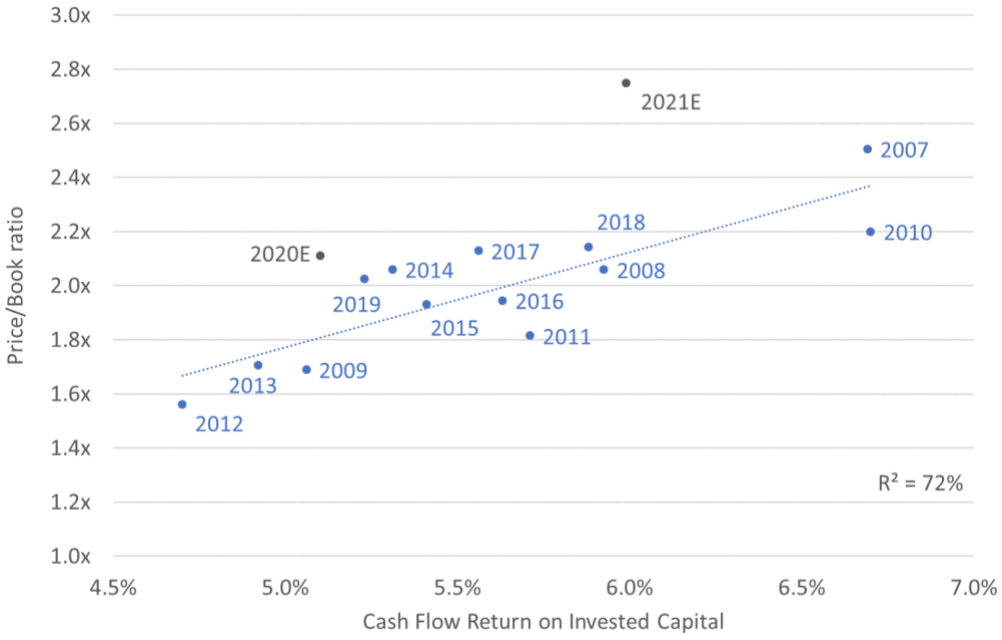
Source: Bloomberg; company data; Guinness Atkinson Asset Management

Volatility is measured by standard deviation.

Strong performance contrasted with weaker profitability

Despite the differing businesses of the companies within the sustainable energy universe, the aggregate valuation of the universe over time has been very well explained by underlying business profitability. Between 2007 and 2019, there was a 72% r-squared between the cash flow return on investment (CFROI) of the median stock in the universe and its Price/Book valuation multiple. The most recent years (2017-2019) have seen valuation start to trend to a small premium to the long-term relationship (moving "above the line") as the market has started to pay increasingly for future growth and this trend accelerated in 2020, predominantly around COVID, as strong share price performance was met with weakening cash returns. Allowing for improved cash returns in 2021, valuation now appears to be at around a 20% premium to the 2017-2019 history of the sustainable energy equity universe. We see the premium reflecting the assumption of lower interest rates (relevant for the sustainable energy sector but a factor that is apparent across all global equities) as well as the assumption of greater long-term growth.

Cash flow return vs Price/Book valuation of the median stock in the Alternative Energy Fund Universe



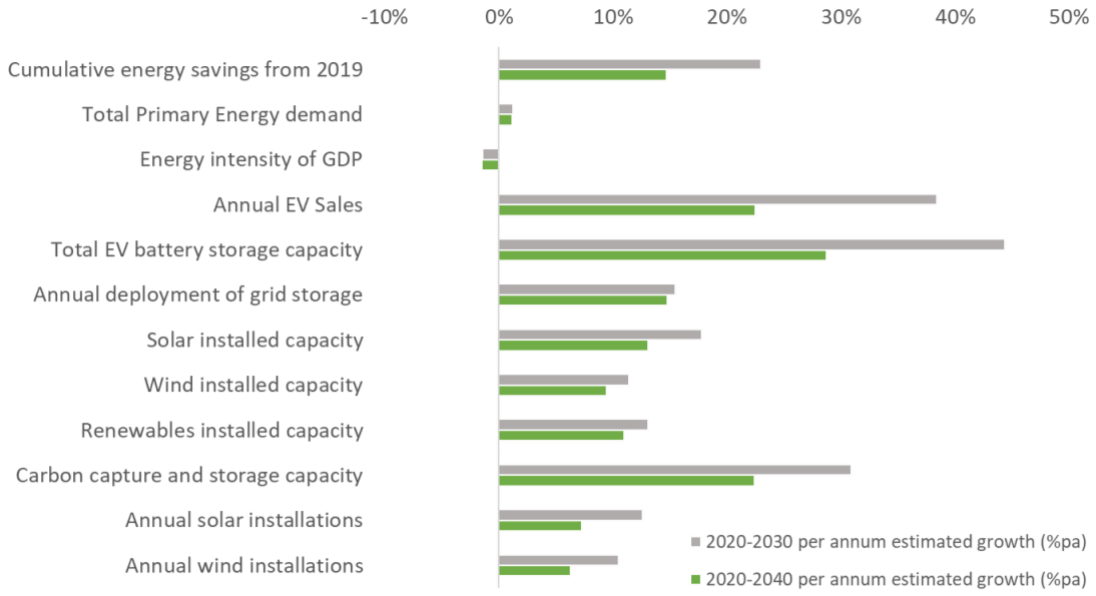
Source: Bloomberg; company data; Guinness Atkinson Asset Management

Allowing for the growth potential of the sustainable energy equities in our valuation work

Improving economics and government support for decarbonization technologies are key drivers of growth for the sector. We believe that the long-term growth outlook for the sector has become increasingly attractive and it is a factor that should be accounted for in valuation sensitivity work.

From our global energy macro model, we project some very attractive per annum sub sector growth rates over the next ten or twenty years and they are presented in the exhibit below. We believe that these growth rates will, typically, outstrip global economic growth rates and, therefore, expect sustainable energy equities to outstrip the growth potential of global equities as well.

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



Source: Company data; Guinness Atkinson Asset Management

Premium growth should command a premium valuation. For example, a company that grew its cash flows at a 2%pa faster rate than its peer over a ten-year period would mathematically be worth about 10% more than its peer. If that excess growth were maintained for 20 years, the valuation premium should expand from 10% to around 20%. Similarly, a 4% growth premium over 10 years would warrant a 20% valuation premium while a 4% growth premium for 20 years would justify a 50% premium. As mentioned earlier, we believe that the sustainable energy universe has a significantly more attractive growth outlook than global equities and that this growth could be sustained for a 20-30-year view. If this happens, a premium valuation is more than justified.

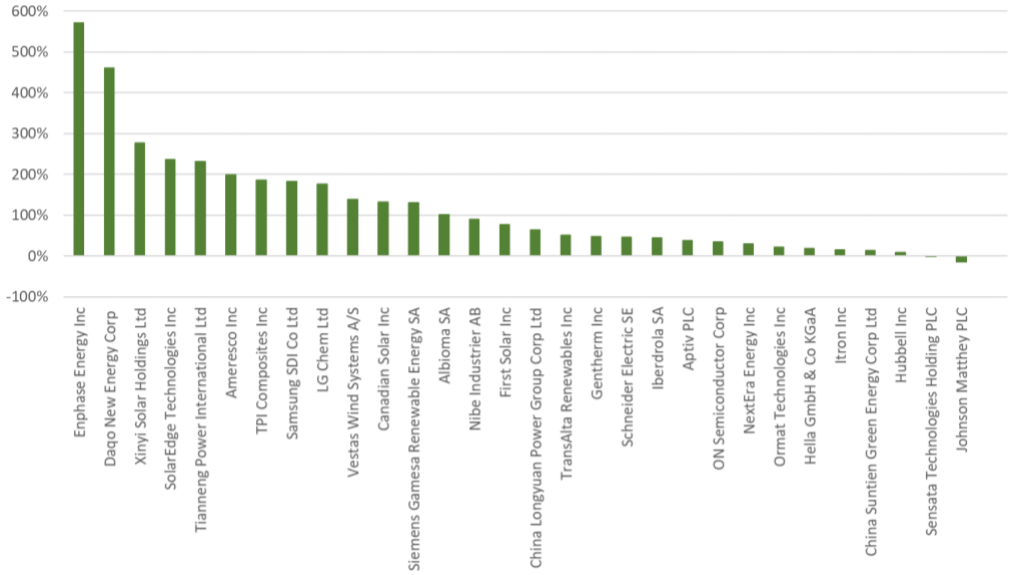
A focus on the Guinness Atkinson Alternative Energy Fund

The Guinness Atkinson Alternative Energy Fund is an equally weighted portfolio of 30 "best equity ideas[1]" taken from our sustainable energy universe. The fund delivered a total return of 86.45% in 2020 versus the MSCI World total net return of 15.9%, outperforming in ten months of the year and delivering outperformance in months where MSCI World Index returns were both positive and negative.

In terms of individual stock returns, the performance of the portfolio (as it stood at the end of December 2020) was as follows:

Total return in 2020 of all stocks held in the fund at the end of the year

Enphase, SolarEdge, NextEra, Itron and Hubbell all added intra-year



Source: Bloomberg

We now provide a tour of the four key sustainable energy equity subsectors to highlight share price performance trends in 2020, profitability trends and some highlights on the exposure of the Guinness Atkinson Alternative Energy Fund.

Displacement sector

Cash returns for companies in the **Displacement** sector fell in 2020 as a result of COVID-related business slowdowns. Efficiency businesses such as insulation, heating and lighting are exposed to the broader construction business cycle while alternative fuel businesses (of which nine were held in the fund) suffered profitability pressures from lower transportation fuel demand. Consensus estimates indicate that cash returns will rebound substantially in 2021 as COVID vaccines take hold and the business cycle recovers, taking

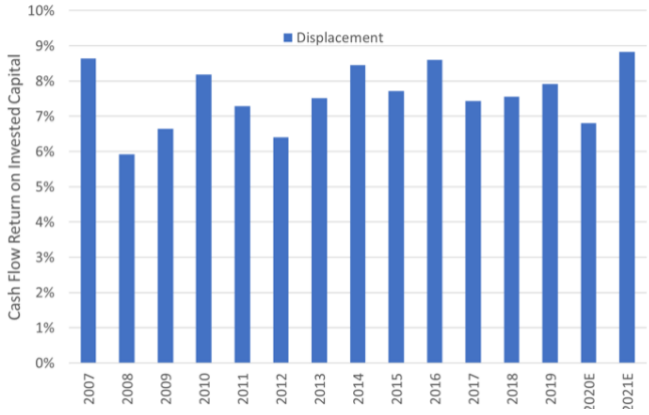
[1] The determination of "best equity ideas" is solely the opinion of the Fund's portfolio management team and such opinion is subject to change. Those companies that hold value, quality, positive earnings momentum, positive stock price momentum, and ESG incorporation are generally considered to be "best equity ideas".

cash returns back to match historic high levels at around 9%. The Displacement subsector has historically delivered the most stable cash returns within the SEF universe.

Within **Efficiency**, the strongest performers were in the heating and insulation subsectors (up 53% on average) while the lighting and LED subsectors were weaker (up only 27% on average). The fund hailed a number of strong individual performers, including Ameresco (benefitting from increasing investment into US renewable energy efficiency and building upgrade projects), Kingspan (seeing improving outlook for their insulation products as building efficiency becomes a focus for governments) and also Nibe Industrier (benefitting from strongly increasing demand for ground source and air source heat pumps to replace conventional natural gas boilers).

Cash returns for Displacement sector as a whole have been as follows:

Displacement universe equities – Cash flow return on invested capital



Source: Bloomberg; company data; Guinness Atkinson Asset Management

Electrification sector

The cash returns of the **Electrification** sector have been more volatile than the other subsectors as a number of the companies here are exposed to either the global auto manufacturing cycle or the battery metals commodity cycle. This cyclicality was particularly extreme in 2019 and 2020 as the auto cycle slowed and ultimately cash returns are likely to match the levels seen in the middle of the Financial Crisis in 2009. The cyclical weakness together with improving lithium-ion battery costs will help to accelerate the transition to EVs and this should result in a cash flow return on investment (CFROI) recovery in 2021, albeit to levels slightly below the long run average level.

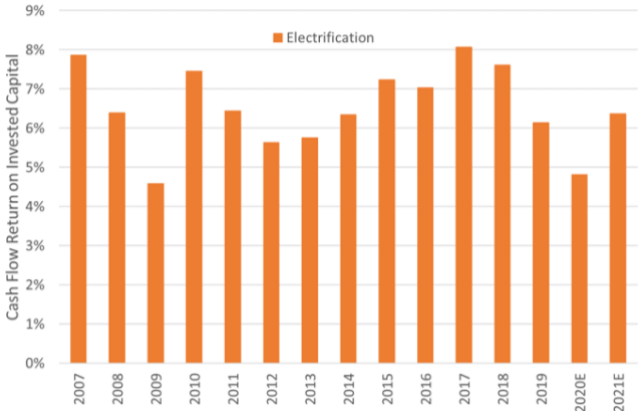
Within our **Electric Vehicles** sub sector, the weakest performers were the car component suppliers that suffered in the COVID-related auto slowdown although a recovery in the second half of the year led this group to average 26% TRR in 2020 while those companies focused on EV electronics fared better. The fund held five companies in this broader space (Aptiv, ON Semiconductor, Sensata, Hella and Gentherm).

Within our **Battery** sub sector, lithium-ion battery manufacturers were the strongest performers, delivering a TRR of 108% on average in 2020. The fund benefitted from exposure to LG Chem and Samsung SDI here. Battery component suppliers were the weakest (+7%) with half of the group suffering negative TRR on

average over the year while battery metal commodity companies, such as lithium, cobalt and nickel producers, delivered an average of 58% TRR.

Cash returns for Electrification sector as a whole have been as follows:

Electrification Universe Equities - Cash flow return on invested capital



Source: Bloomberg; company data; Guinness Atkinson Asset Management

Generation sector

The Generation sector of our investment universe contains 49 equities with key business areas being either IPPs (independent power producers) or utilities. The Generation sector was the second worst performer in 2020, delivering a total return of around 48%, with the IPPs delivering an impressive 74% TRR and Utilities delivering only 3% TRR on average.

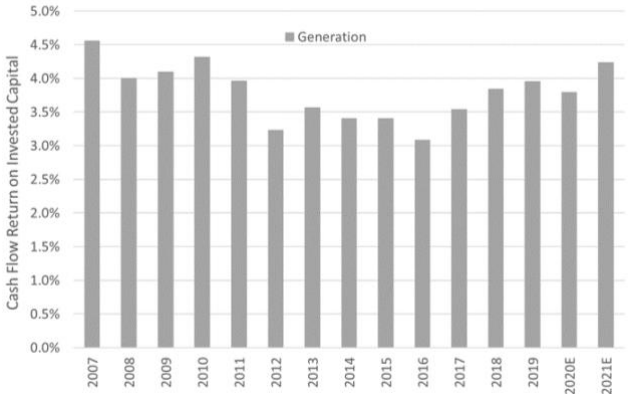
The **Generation** sector delivered the most robust cash returns in 2020, although it was still down in absolute terms on the 2019 level. Generation has historically delivered the lowest and most stable CFROI since 2007 as utility and power generation businesses typically enjoy longer term pricing stability and are therefore more immune to business cycles. Nonetheless, CFROI should still improve further in 2021, reaching levels last seen in the late 2000s.

Within Generation, **IPPs** were noticeably the strongest performers (+74%) with solar-dominated IPPs leading the pack and European IPPs noticeably better than global wind IPP peers. It was not a positive market for all companies; however, a number of Latin American hydro IPPs and all of the waste-to-power IPPs in the universe delivered negative returns for 2020. The fund benefitted from its exposure to Albioma and China Longyuan during the year.

The **utility** sub sector fared less well, delivering 3% TRR on average, with stronger performance coming from the larger European utilities that are well progressed in their energy transition plans (such as ENEL, Iberdrola and Enel) and weaker performance coming from Brazilian and Japanese utilities. The fund held only two utilities, Iberdrola and NextEra Energy, during the year.

Cash returns for Generation sector as a whole have been as follows:

Generation Universe Equities - Cash flow return on invested capital



Source: Bloomberg; company data; Guinness Atkinson Asset Management

Installation (Equipment) sector

The **Installation** subsector has historically delivered the most volatile cash return trend as many of the companies are subject to specific and often volatile supply, demand and pricing dynamics. While 2020 saw a clear acceleration in longer term demand expectations for renewable power equipment, the actual operating environment in 2020 worsened, with cash returns falling to just over 5%. Expectations are that demand growth will lead to an improvement in cash returns, with the measure reaching 7.5% and exceeding the most recent peak, seen in 2016.

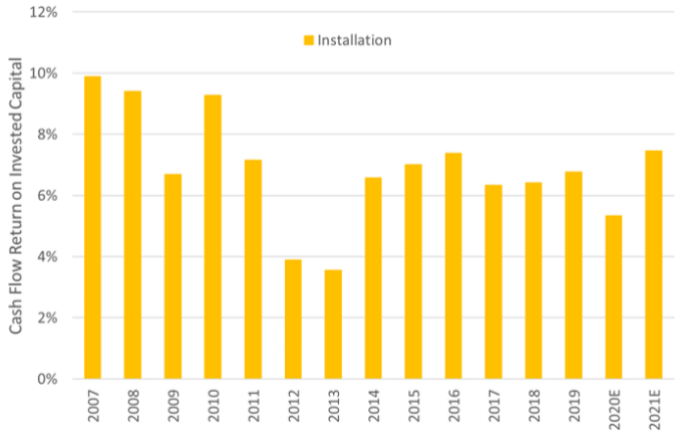
The average TRR for solar equipment companies was a very impressive 175% in 2020, with Daqo New Energy, Enphase, SunPower and Flat Glass each delivering in excess of 400% TRRs over the year. The fund benefitted from positions in Daqo and EnPhase during the year.

The wind subsector also delivered very well, with an average TRR of 108%. Performance was strong across all of the seven companies in this concentrated subsector with blade manufacturer. The three holdings in the fund (TPI Composites and wind turbine manufacturers Vestas and Siemens Gamesa) delivered the strongest returns in the sub sector.

Other non-solar and wind equipment manufacturers delivered TRRs of 77% on average in 2020. The overall performance was dominated by exceptionally strong returns from the hydrogen and fuel cell-oriented sub sector driven by growing enthusiasm for the hydrogen economy. While all subsectors delivered positive TRRs, there were some pockets of weakness including meter and hydro equipment manufacturers (up only 12% and 9% respectively).

Cash returns for the Installation (Equipment) sector as a whole have been as follows:

Installation universe Equities - Cash flow return on invested capital



Source: Bloomberg; company data; Guinness Atkinson Asset Management

Attribution of fund performance versus the key universe sub sectors

Fund attribution analysis versus the MSCI World Index is not particularly relevant for this fund, so we present here some attribution analysis of the fund versus our sustainable energy equity universe. The exhibit below shows our key sub sectors with our fund weight, universe weight and an indication of whether we have been overweight, underweight or neutral weight over 2020. We have then assessed our attribution within each of sub sectors. For example, the Batteries subsector has been a poorer performer within the universe, so it was "positive" to be underweight and our stock selection was "positive" in that the battery names in the fund outperformed the battery names within the universe.

Attribution of Guinness Atkinson Alternative Energy Fund vs Universe in 2020

Subsector	Universe weight (%)	Fund weight (%)	Fund positioning vs Universe	Indicative attribution	
				Sector allocation	Stock selection
Alternative fuels	4.3%	0.0%	Underweight	Positive	n/a
Efficiency	12.6%	10.2%	Underweight	Positive	Positive
Batteries	13.9%	11.2%	Underweight	Positive	Positive
Electric vehicles	16.0%	16.3%	Equalweight	Neutral	Negative
Generation: IPPs	16.0%	17.3%	Equalweight	Neutral	Negative
Generation: utilities	8.7%	8.2%	Equalweight	Neutral	Positive
Equipment	28.6%	36.7%	Overweight	Positive	Positive

Source: Company data; Bloomberg; Guinness Atkinson Asset Management

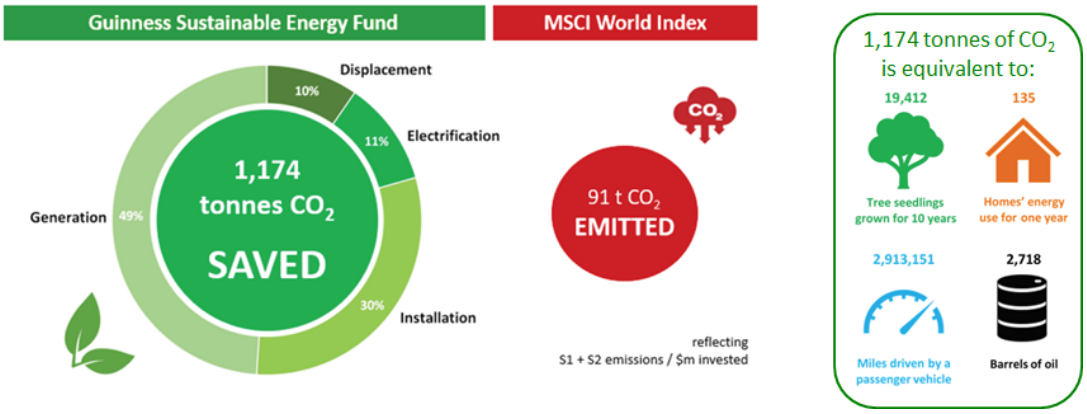
Positive decarbonization impact of the alternative energy fund

As well as share price returns, the performance of the portfolio can also be measured in terms of the positive impact that our companies have on global decarbonization. The Guinness Atkinson Alternative Energy Fund is impact-aligned "by design" in that it prioritizes returns while delivering concentrated exposure to companies

playing a key role in global decarbonization, providing a positive environmental solution for investors' portfolios.

We conclude that the companies in our portfolio in 2019 helped to deliver around 23,000,000 MWh of energy savings, 49,000 million miles of electrified travel, 95,000 MW of clean energy capacity and 148,000 GWh of low carbon energy generation.

Portfolio impact – Carbon dioxide emissions avoided



Source: Company data; Guinness Atkinson Asset Management

Current portfolio positioning

In our portfolio, we currently reflect the Displacement, Electrification, Installation and Generation sectors by combining them into the following investment themes:

Key themes in the Guinness Atkinson Alternative Energy Fund

	Theme	Example holdings	Weighting (%)
1	Electrification of the energy mix	TransAlta renewables, NextEra Energy	18.6%
2	Rise of the electric vehicle and auto efficiency	Sensata Technologies, Aptiv	18.7%
3	Battery manufacturing	Samsung SDI	8.0%
4	Expansion of the wind industry	tpi Composites, Vestas	17.4%
5	Expansion of the solar industry	Daqo New Energy Corp.	17.7%
6	Heating, lighting and power efficiency	NIBE Industrier	9.9%
7	Geothermal and biomass	Ormat, Albioma	6.7%
8	Other (inc cash)		3.0%

Source: Bloomberg, Guinness Atkinson Asset Management estimates

Example holdings reflect current or past holdings of the Fund and are subject to change. Holdings are subject to change without notice.

The current portfolio has a CFROI of around 5.8% for 2020 and we expect that to rise towards 8.0% for 2021, eclipsing the pre-COVID level of 6.9% delivered in 2019. The 2021 expected cash returns would place the fund at a small premium to global equities in general (as measured by the MSCI World index). The improvement in profitability reflects improving economics and the benefits of manufacturing scale within the sector and we would expect an attractive level of profitability to be sustained longer term.

Considering other valuation characteristics, we see the portfolio trading at a 13% premium to the MSCI World on 2021 P/E multiples and broadly in line with the MSCI World on 2021 EV/EBITDA multiples.

As of December 31, 2020	P/E			EV/EBITDA			Dividend Yield	EPS Growth		CFROI*		
	2019	2020E	2021E	2019	2020E	2021E	2020E	2014-19	2019-22	2019	2020E	2021E
GAAEX	27.7x	31.3x	24.3x	15.1x	15.9x	13.5x	1.1%	7.4%	12.5%	6.9%	5.8%	8.0%
MSCI World Index	23.6x	33.3x	21.5x	13.7x	16.8x	13.4x	1.8%	3.8%	7.1%	7.8%	6.9%	7.9%
Fund Premium/(Discount)	*17%*	*-6%*	*13%*	*10%*	*-5%*	*1%*						

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

In aggregate, we expect investor interest in sustainable energy equities will grow further in 2021 as a result of increased individual, social and government pressures for consumers to become more energy efficient and for producers to increase their share of sustainable energy generation. We believe that the Guinness Atkinson Alternative Energy portfolio of 30 equally weighted equities, chosen from our universe of 231 companies, provides concentrated exposure to the theme at attractive valuation levels.

Jonathan Waghorn and Will Riley

January 2021

Performance

as of 12.31.2020 (in USD)	YTD	1 year	3 years	5 years	10 years
Guinness Atkinson Alternative Energy Fund (GAAEX)	86.45%	86.45%	27.06%	15.45%	2.06%
MSCI World NR USD	15.90%	15.90%	10.53%	12.18%	9.86%

All returns after 1 year annualized.

Inception 03.31.2006 Expense ratio* 1.98% (net); 3.00% (gross)

Performance data quoted represents past performance; past performance does not guarantee future results. The investment return and principal value of an investment will fluctuate so that an investor's shares, when redeemed, may be worth more or less than their original cost. Current performance of the Fund may be lower or higher than the performance quoted. Performance data current to the most recent month end may be obtained by visiting www.gafunds.com or calling 800-915-6566.

*The Advisor has contractually agreed to reduce its fees and/or pay Fund expenses (excluding Acquired Fund Fees and Expenses, interest, taxes, dividends on short positions and extraordinary expenses) in order to limit the Fund's Total Annual Operating Expenses to 1.98% through June 30, 2024. To the extent that the Advisor absorbs expenses to satisfy this cap, it may recoup a portion or all of such amounts absorbed at any time within three fiscal years after the fiscal year in which such amounts were waived or absorbed, subject to the expense cap in place at the time recoupment is sought, which cannot exceed the expense cap at the time of the waiver. The expense limitation agreement may be terminated by the Board of the Fund at any time without penalty upon 60 days' notice.

Total returns reflect a fee waiver in effect and in the absence of this waiver, the total returns would be lower.

Opinions expressed are subject to change, are not guaranteed and should not be considered investment advice.

The Guinness Atkinson Alternative Energy Fund's investment objectives, risks, charges and expenses must be considered carefully before investing. The statutory and summary prospectuses contain this and other important information and can be obtained by calling 800- 915-6565 or visiting www.gafunds.com. Read and consider it carefully before investing.

The Fund invests in foreign securities which will involve greater volatility and political, economic and currency risks and difference in accounting methods. The risks are greater for investments in emerging markets. The Fund also invests in smaller and mid-cap companies, which will involve additional risks such as limited liquidity and greater volatility than larger companies. The Fund's focus on the energy sector to the exclusion of other sectors exposes the Fund to greater market risk and potential monetary losses than if the Fund's assets were diversified among various sectors.

Cash Flow Return on Investment (CFROI) is a valuation metric that acts as a proxy for a company's economic return. This return is compared to the cost of capital, or discount rate, to determine value-added potential. CFROI is defined as the average economic return on all a company's investment projects in a given year.

Top 10 Holdings as of 12/31/2020:

1.	TransAlta Renewables Inc	4.18%
2.	Siemens Gamesa Renewable Energy SA	3.99%
3.	Samsung SDI Co Ltd	3.92%
4.	Nextera Energy Inc	3.77%
5.	Iberdrola SA	3.73%
6.	Nibe Industrier AB - B Shares	3.69%
7.	First Solar Inc	3.60%
8.	LG Chem Ltd	3.59%
9.	Xinyi Solar Holdings Ltd	3.57%
10.	Schneider Electric SE	3.56%

Fund holdings and/or sector allocations are subject to change at any time and are not recommendations to buy or sell any security.

One cannot invest directly in an index.

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