Applied philosophy
Can the utilities sector afford the "green revolution"?

The utilities sector is increasingly seen as a beneficiary of the conversion into a low-carbon economy. However, to reach alignment with the Paris Agreement, annual investment must increase by 75% from current levels. We doubt the sector has the immediate capacity to do that on its own and worry that energy consumption growth is expected to remain below historical norms. However, given time, we believe they have the potential to reach those investment levels. Though they may underperform during economic upswings, we believe utilities have the potential to provide good long-term exposure to the zero-carbon theme, but we would wait until there is more visibility on how they will finance both higher capital expenditure and dividends.

We find utilities fascinating, for they do something almost mythical. They convert elemental forces into pure power, something we can use to run our devices, heat our homes and transport ourselves. We depend on them for almost everything we do, and they will take centre stage in the debate on how to achieve a sustainable future for our planet. Nevertheless, they remain unloved among investors.

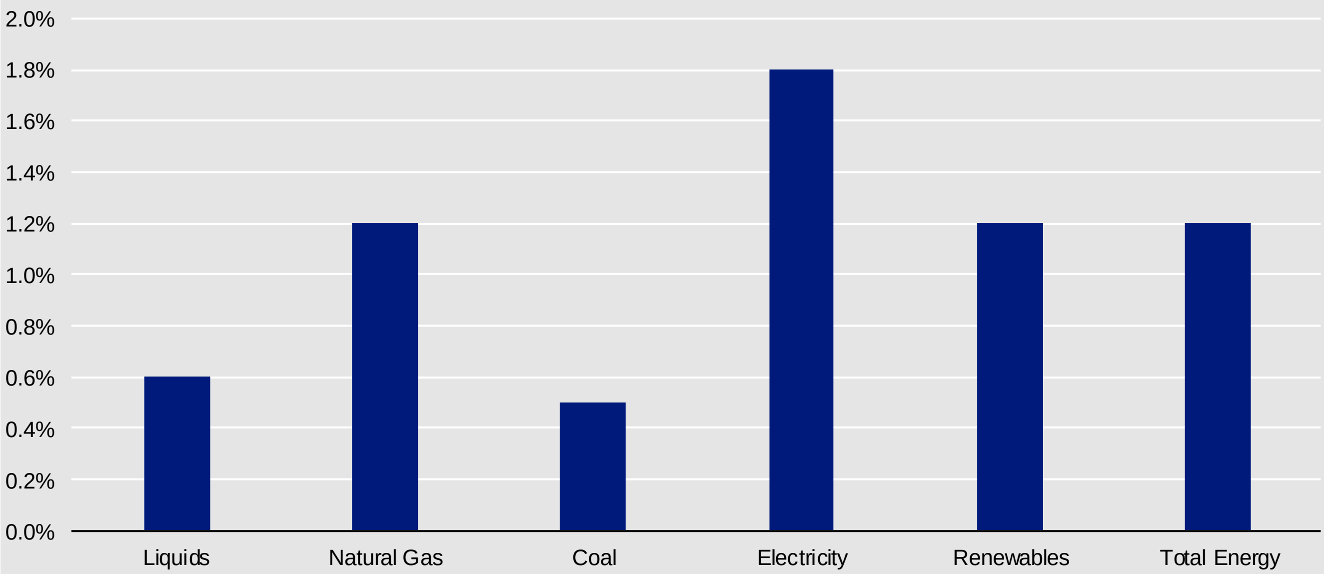
If we are serious about preserving our climate as close to its current state as possible, we will have to change how we produce the energy we need, because population growth will lead to more energy consumption. According to forecasts by the United States Energy Information Administration (EIA), global energy consumption will grow by an annualised 1.2% between 2018 and 2050. Even though they expect renewables to be the fastest growing segment, fossil fuels (petroleum, natural gas and coal) will still generate about two-thirds.

They also assume that electricity will be the fastest growing type of end-use fuel with 1.8% annualised growth between 2018 and 2050 (**Figure 1**). However, its main use will be restricted to the residential and commercial sectors and to a smaller extent to the transportation sector with increasing use of electric vehicles, which may allow renewable sources to supply energy to meet this extra demand. This will require a huge amount of investment in extra generating capacity, substitution of existing fossil fuel-based power plants, and a wholesale rethinking of distribution and storage networks.

According to the International Energy Agency (IEA), the power sector (which we will take as the equivalent of the utilities sector) saw the largest amount of investment at just under $800bn for the third year running in 2018 (out of $1.8tn total global energy investment). Most of that investment went into renewable power, networks and battery storage, which confirms our view of the likely direction of investment flows. Nevertheless, power sector investment remained largely stagnant between 2010 and 2018, although lower renewables installation costs meant that implied investment at constant 2018 costs rose by 55%.

Unfortunately, that will not be enough if we are serious about mitigating the impacts of climate change. The IEA has modelled how much investment will be necessary in its Sustainable Development Scenario

Figure 1 – Annualised expected growth rates of power consumption (2018-2050)



Source: United States Energy Information Administration and Invesco

(SDS), which is based on the Paris Agreement's main goal of limiting global warming to well below 2°C compared to pre-industrial levels. That scenario implies $1.349tn worth of total annual investment in the power sector between 2019 and 2050, which would be an almost 75% increase compared to the 2014-18 annual average of $0.774tn. The listed utilities sector, using the Datastream Utilities World index, had capital expenditures of $289bn on average between 2014 and 2018 (we assume this to be the equivalent of investment). If we apply the 75% uplift required to reach SDS goals, the sector would have to raise capex to $505bn. Can they afford it?

The big attraction of the sector has been its relatively high dividend yield and ability to generate cash throughout the economic cycle. A massive increase in capex would put its generous dividends in jeopardy, especially if it turned out that the sector does not have the extra cash to cover both. One way of calculating free cash flow available to investors is to deduct capex from earnings before interest, taxes, depreciation and amortisation (EBITDA).

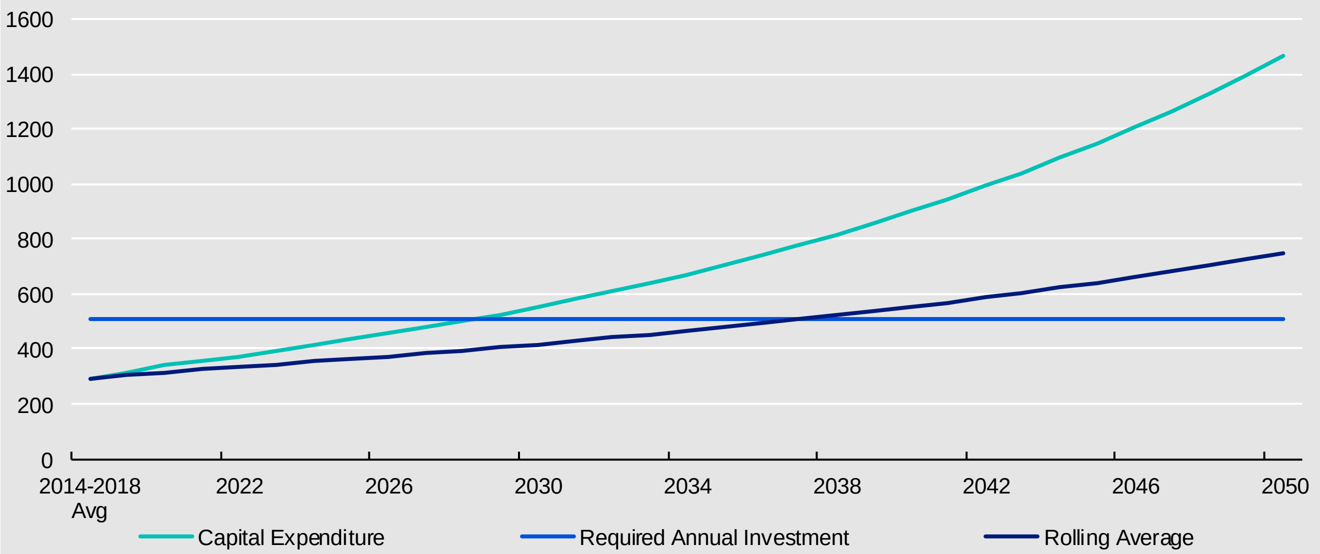
The sector's average EBITDA between 2014 and 2018 was about $388bn. If we deduct the $289bn of average capex, that leaves $99bn to pay interest on bonds and loans and dividends to shareholders. According to our calculations based on Worldscope numbers, the sector paid $82bn in dividends on average in the 2014-2018 period, which leaves about $17bn to pay interest and potentially add to cash reserves on balance sheets. In order to finance the $505bn investment target, the sector would have to cut dividends and interest costs to zero (difficult with a net debt/EBITDA ratio of 4.4x) and find an extra $117bn every year to cover all capex needs.

Based on this, if utilities were to contribute to our shift away from a fossil fuel-based economy in a rapid enough fashion, outside investors (including governments) would have to step in to fill the annual $200bn capex void, assuming dividends are maintained. Cutting dividends is an option, although that would make the sector significantly less attractive as an investment.

However, if we take a long-term view, and assume that the sector can maintain real revenue growth around its historical annualised average at 5% (we assume a 2% annual rate of inflation), this issue does not seem insurmountable. If we also assume that they can achieve a 22% EBITDA margin, lower than their average of 25% since 1980 and a touch higher than the 21% they realised in the 10 years to the end of 2019, this extra capex requirement does not seem out of reach. The sector has had a capex-to-sales ratio of 17% in the past 40 years. If they maintained that and raised their capex gradually, they would surpass the $505bn annual investment by 2029 and would make up the investment gap by 2037 reaching the investment goal on average (**Figure 2**). At that point, they could, in theory, reduce their capex to $505bn and increase dividends or pay off debt.

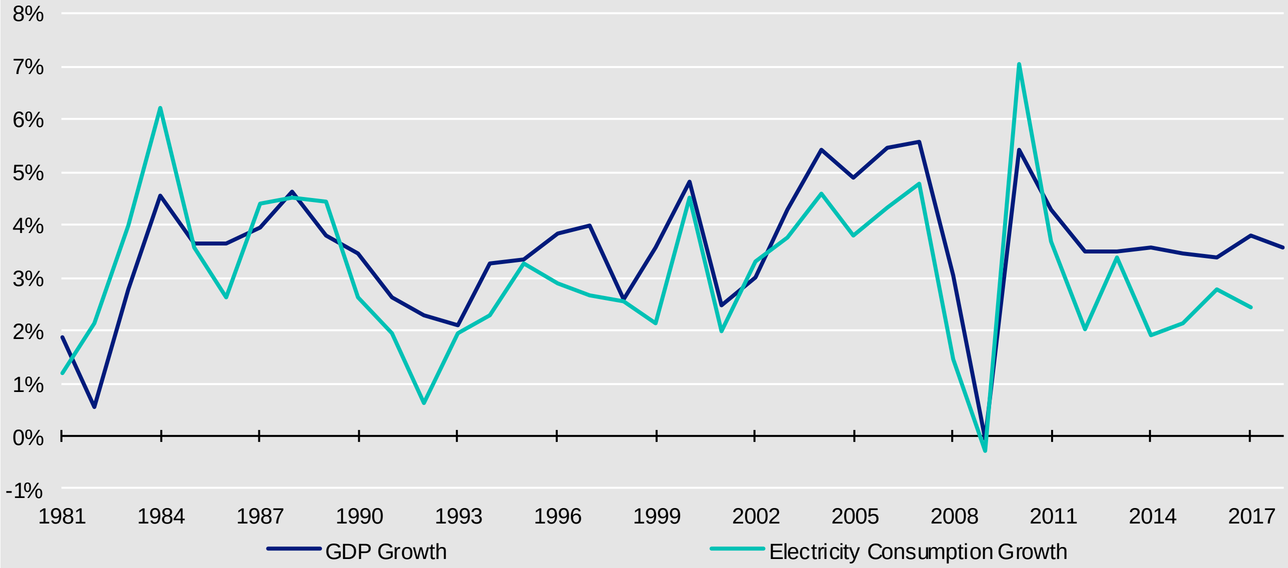
What may work in utilities' favour to maintain revenue growth is the shift towards electricity if the EIA's forecasts prove correct. Even if the growth of energy

Figure 2 – Global utilities sector projected capital expenditure (billion USD)



Notes: Annual data from 2014-2018 average level to 2050. We show how the capital expenditure of the global utilities sector would evolve if we assumed an annualised revenue growth rate of 5% (adjusted for inflation) and capital expenditure/sales ratio of 17%. Rolling average shows the average from the 2014-2018 average up to and including each year. Source: Refinitiv Datastream and Invesco.

Figure 3 – Global real GDP growth and electricity consumption growth (%, year-on-year)



Notes: Annual data from 1981 to 2018. Past performance is no guarantee of future results.
Source: Refinitiv Datastream, United States Energy Information Administration and Invesco.

consumption slows from an annualised 1.9% (1980-2018) to 1.2% (2019-2050), the shift to electricity will allow utilities to monetise more of that demand than anyone else. However, based on the same forecasts, electricity consumption growth at 1.8% will be lower than the historical annualised rate of 3.1% between 1980 and 2017. This makes sense considering the link between real GDP growth and electricity consumption, assuming future GDP growth will be lower than the annualised 3.5% from 1980 to 2018 (**Figure 3**).

This suggests that utilities may capture more of a shrinking pie, the "shrinking" part of which means that a more sustainable future would not magically transform utilities into a "growth" sector. It also implies that without government support, they may even struggle to maintain their historical 5% real revenue growth rate, also jeopardising their historical 3.5% dividend growth rate since 1980. Their margins may also come under pressure if regulators reduce the allowable profit margins, especially when the conversion to renewables reduces the marginal cost of generating electricity to near zero.

With all that in mind, we believe there is a chance that the above EIA forecasts may be unduly pessimistic. There seems to be a real change in sentiment towards renewables and a push towards electrification of heating and transportation. Utilities will have an opportunity to "outsource" generation to households through distributed energy resource management systems, which would allow them to manage their grids better.

We believe that current valuations may turn out to be too pessimistic, implying (as they do) a perpetual 0.8% decline in dividends (as of 30th November 2020). There is renewed vigour and hope for international cooperation with the incoming US administration, which may convince governments that investing in renewable electricity generation infrastructure is a good way of providing fiscal stimulus while helping with the conversion to a zero-carbon economy.

Undoubtedly, the potential for innovation and transformation is huge. It is an industry that has not been forced to change how it works and it still relies on old technology to a large extent. We expect the sector to underperform in the short term if the economic recovery continues, but its solid cash generation and high dividend yield may continue to make it a useful defensive hedge in the next cyclical downturn. On a longer-term view, we think utilities may be a good way to gain exposure to the structural change towards a more climate-conscious economy, but we would wait until there is more visibility on how both their investment needs and dividends will be financed and would look for ESG exposure elsewhere for now.

Invesco

Figure 4 – Asset class total returns (%, annualised)

Data as at 11/12/2020	Index	Current Level/RY	Total Return (USD, %) 1w	1m	QTD	YTD	12m	Total Return (Local Currency, %) 1w	1m	QTD	YTD	12m
Equities												
World	MSCI	630	-0.5	4.2	11.8	13.7	17.4	-0.5	3.4	10.4	12.2	15.2
Emerging Markets	MSCI	1258	0.5	6.7	16.4	15.4	21.9	0.4	5.4	13.0	16.4	21.4
China	MSCI	105	-1.2	1.2	8.2	26.2	33.7	-1.1	1.1	7.8	24.9	32.0
US	MSCI	3572	-0.8	3.5	10.1	18.1	21.6	-0.8	3.5	10.1	18.1	21.6
Europe	MSCI	1785	-1.2	3.6	12.2	2.7	6.5	-0.6	1.3	8.8	-3.1	-0.7
Europe ex-UK	MSCI	2242	-1.0	3.8	11.4	7.9	11.3	-0.8	0.8	7.8	-0.2	1.6
UK	MSCI	1013	-2.0	2.9	14.7	-12.1	-7.6	-0.1	2.8	12.3	-11.9	-7.9
Japan	MSCI	3768	0.5	5.2	12.6	12.2	12.9	0.3	3.6	10.9	7.3	8.0
Government Bonds												
World	BofA-ML	0.20	0.6	2.3	1.7	8.6	8.6	0.7	1.0	0.2	5.1	4.6
Emerging Markets	BBloom	3.98	0.1	2.1	5.1	5.4	7.4	0.1	2.1	5.1	5.4	7.4
China	BofA-ML	3.23	0.0	1.4	4.4	8.4	10.2	0.2	0.2	0.3	1.8	2.5
US (10y)	Datastream	0.89	0.8	0.7	-1.8	12.7	11.5	0.8	0.7	-1.8	12.7	11.5
Europe	Bofa-ML	-0.26	0.5	4.2	4.9	13.8	14.2	0.7	1.2	1.6	5.5	4.6
Europe ex-UK (EMU, 10y)	Datastream	-0.64	0.6	4.3	4.3	12.9	12.8	0.9	1.3	1.0	4.7	3.3
UK (10y)	Datastream	0.19	-0.2	2.6	3.0	6.8	6.9	1.8	2.5	0.8	7.1	6.7
Japan (10y)	Datastream	0.02	0.3	1.9	1.6	4.5	4.8	0.1	0.2	0.1	0.0	0.2
IG Corporate Bonds												
Global	BofA-ML	1.46	0.3	2.5	3.4	9.4	9.8	0.4	1.6	2.2	7.3	7.3
Emerging Markets	BBloom	3.75	0.7	3.2	5.5	11.2	12.7	0.7	3.2	5.5	11.2	12.7
China	BofA-ML	4.16	0.0	1.3	4.8	9.3	10.8	0.1	0.1	0.6	2.6	3.0
US	BofA-ML	1.91	0.3	1.8	2.3	9.1	9.1	0.3	1.8	2.3	9.1	9.1
Europe	BofA-ML	0.28	0.1	3.9	5.5	11.0	12.2	0.4	0.9	2.2	2.9	2.7
UK	BofA-ML	1.46	-0.3	4.0	6.0	8.3	9.0	1.7	3.9	3.8	8.6	8.8
Japan	BofA-ML	0.43	0.3	1.9	1.9	4.8	5.0	0.1	0.3	0.3	0.3	0.4
HY Corporate Bonds												
Global	BofA-ML	4.95	0.1	2.8	6.3	6.8	8.4	0.2	2.2	5.6	5.4	6.6
US	BofA-ML	5.14	0.1	1.9	5.5	5.2	6.6	0.1	1.9	5.5	5.2	6.6
Europe	BofA-ML	3.18	-0.3	5.2	8.7	10.6	12.7	0.0	2.2	5.2	2.5	3.2
Cash (Overnight LIBOR)												
US		0.08	0.0	0.0	0.0	0.4	0.5	0.0	0.0	0.0	0.4	0.5
Euro Area		-0.58	-0.1	2.8	3.2	7.4	8.2	0.0	0.0	-0.1	-0.5	-0.6
UK		0.04	-1.6	0.0	2.4	-0.1	0.4	0.0	0.0	0.0	0.2	0.2
Japan		-0.09	0.1	1.3	1.3	4.3	4.2	0.0	0.0	0.0	-0.1	-0.1
Real Estate (REITs)												
Global	FTSE	1746	-1.5	0.7	10.4	-11.1	-9.0	-1.2	-2.2	6.9	-17.6	-16.7
Emerging Markets	FTSE	1957	-1.1	-4.3	6.4	-17.5	-12.6	-0.8	-7.1	3.1	-23.6	-20.0
US	FTSE	2765	-2.5	0.7	10.5	-11.6	-10.5	-2.5	0.7	10.5	-11.6	-10.5
Europe ex-UK	FTSE	3609	0.4	4.0	11.3	-1.5	2.0	0.6	1.0	7.8	-8.7	-6.6
UK	FTSE	1268	-5.2	-2.5	12.9	-18.6	-13.7	-3.3	-2.6	10.5	-18.3	-14.0
Japan	FTSE	2576	-0.2	0.8	6.2	-11.7	-11.4	-0.4	-0.8	4.6	-15.5	-15.3
Commodities												
All	GSCI	1901	1.1	6.1	10.1	-26.7	-23.8	-	-	-	-	-
Energy	GSCI	258	1.3	9.9	13.0	-48.1	-45.8	-	-	-	-	-
Industrial Metals	GSCI	1420	0.3	9.1	15.5	16.5	18.1	-	-	-	-	-
Precious Metals	GSCI	2125	0.1	-1.3	-2.6	18.8	23.1	-	-	-	-	-
Agricultural Goods	GSCI	366	2.3	1.2	9.1	5.3	10.4	-	-	-	-	-
Currencies (vs USD)*												
EUR		1.21	-0.1	2.8	3.4	8.0	8.8	-	-	-	-	-
JPY		104.03	0.1	1.3	1.3	4.4	4.4	-	-	-	-	-
GBP		1.32	-1.9	0.1	2.2	-0.3	0.3	-	-	-	-	-
CHF		1.12	0.3	3.1	3.5	8.8	10.5	-	-	-	-	-
CNY		6.55	-0.2	1.3	3.7	6.4	7.5	-	-	-	-	-

Notes: *The currency section is organised so that in all cases the numbers show the movement in the mentioned currency versus USD (+ve indicates appreciation, -ve indicates depreciation). Past performance is no guarantee of future results. Please see appendix for definitions, methodology and disclaimers.
Source: Refinitiv Datastream and Invesco

Invesco

Figure 5 – Global equity sector total returns relative to market (%)

Data as at 11/12/2020	Global				
	1w	1m	QTD	YTD	12m
Energy	**0.7**	**3.2**	**2.6**	**-30.4**	**-30.4**
Basic Materials	**0.8**	**4.9**	**5.1**	**6.6**	**6.6**
Basic Resources	1.4	7.7	8.3	9.9	9.9
Chemicals	0.1	1.6	1.3	2.9	2.9
Industrials	**-0.3**	**-0.4**	**1.3**	**-1.1**	**-1.1**
Construction & Materials	-0.7	-1.6	1.6	-3.1	-3.1
Industrial Goods & Services	-0.2	-0.2	1.2	-0.8	-0.8
Consumer Discretionary	**0.2**	**0.9**	**-0.2**	**10.0**	**10.0**
Automobiles & Parts	0.5	10.1	13.5	30.1	30.1
Media	4.7	7.6	8.5	4.5	4.5
Retailers	-0.7	-4.1	-9.5	17.8	17.8
Travel & Leisure	-1.2	1.4	4.8	-14.6	-14.6
Consumer Products & Services	0.6	1.2	2.7	11.1	11.1
Consumer Staples	**0.7**	**-2.4**	**-4.8**	**-6.6**	**-6.6**
Food, Beverage & Tobacco	0.7	-1.2	-3.0	-8.7	-8.7
Personal Care, Drug & Grocery Stores	0.6	-4.5	-8.0	-2.7	-2.7
Healthcare	**0.2**	**-2.3**	**-5.4**	**3.5**	**3.5**
Financials	**-0.8**	**0.8**	**6.7**	**-15.8**	**-15.8**
Banks	-0.4	2.6	12.1	-20.7	-20.7
Financial Services	-1.2	0.2	2.7	-8.3	-8.3
Insurance	-1.1	-1.7	1.8	-14.2	-14.2
Real Estate	**-0.7**	**-4.4**	**-4.3**	**-16.6**	**-16.6**
Technology	**-0.2**	**0.8**	**-0.6**	**27.8**	**27.8**
Telecommunications	**0.5**	**0.0**	**-1.4**	**-3.6**	**-3.6**
Utilities	**0.1**	**-5.4**	**-2.3**	**-7.2**	**-7.2**

Notes: Returns shown are for Datastream sector indices versus the total market index. Past performance is no guarantee of future results.
Source: Refinitiv Datastream and Invesco

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Figure 6a – US factor index total returns (%)

Data as at 11/12/2020	Absolute					Relative to Market				
	1w	1m	QTD	YTD	12m	1w	1m	QTD	YTD	12m
Growth	-1.1	5.3	14.8	26.2	29.2	-0.1	2.6	5.0	9.4	8.8
Low volatility	-0.3	-0.5	5.3	14.0	16.3	0.7	-3.1	-3.6	-1.2	-2.1
Price momentum	-0.7	2.8	8.1	16.3	18.3	0.3	0.0	-1.1	0.8	-0.4
Quality	-0.6	4.9	13.3	11.0	14.4	0.4	2.1	3.6	-3.8	-3.6
Size	-1.1	12.7	30.8	5.0	8.5	-0.1	9.7	19.7	-9.0	-8.7
Value	-1.4	14.6	34.7	2.5	6.8	-0.4	11.6	23.3	-11.2	-10.1
Market	-0.9	2.7	9.3	15.4	18.8					
Market - Equal-Weighted	-1.1	5.5	16.3	10.8	13.8					

Notes: All indices are subsets of the S&P 500 index, they are rebalanced monthly, use data in US dollars and are equal-weighted. Growth includes stocks in the top third based on both their 5-year sales per share trend and their internal growth rate (the product of the 5-year average return on equity and the retention ratio); Low volatility includes stocks in the bottom quintile based on the standard deviation of their daily returns in the previous three months; Price momentum includes stocks in the top quintile based on their performance in the previous 12 months; Quality includes stocks in the top third based on both their return on invested capital and their EBIT to EV ratio (earnings before interest and taxes to enterprise value); Size includes stocks in the bottom quintile based on their market value in US dollars. Value includes stocks in the bottom quintile based on their price to book value ratios. The market represents the S&P 500 index. Past performance is no guarantee of future results.
Source: Refinitiv Datastream and Invesco

Figure 6b – European factor index total returns relative to market (%)

Data as at 11/12/2020	Absolute					Relative to Market				
	1w	1m	QTD	YTD	12m	1w	1m	QTD	YTD	12m
Growth	0.2	-0.2	9.5	18.6	22.0	1.2	-0.8	1.0	23.2	23.8
Low volatility	0.5	-1.8	2.0	-1.3	-0.3	1.5	-2.3	-5.9	2.6	1.1
Price momentum	0.8	1.4	3.3	11.6	15.3	1.8	0.9	-4.6	16.0	17.0
Quality	-1.4	2.0	12.2	1.0	4.4	-0.5	1.4	3.6	4.9	5.9
Size	-1.7	3.3	14.7	-2.1	0.8	-0.8	2.7	5.9	1.7	2.2
Value	-3.1	7.1	28.0	-11.9	-9.1	-2.2	6.6	18.2	-8.5	-7.8
Market	-1.0	0.5	8.3	-3.7	-1.4					
Market - Equal-Weighted	-1.4	1.8	10.8	-1.6	1.1					

Notes: All indices are subsets of the STOXX 600 index, they are rebalanced monthly, use data in euros and are equal-weighted. Growth includes stocks in the top third based on both their 5-year sales per share trend and their internal growth rate (the product of the 5-year average return on equity and the retention ratio); Low volatility includes stocks in the bottom quintile based on the standard deviation of their daily returns in the previous three months; Price momentum includes stocks in the top quintile based on their performance in the previous 12 months; Quality includes stocks in the top third based on both their return on invested capital and their EBIT to EV ratio (earnings before interest and taxes to enterprise value); Size includes stocks in the bottom quintile based on their market value in euros; Value includes stocks in the bottom quintile based on their price to book value ratios. The market represents the STOXX 600 index. Past performance is no guarantee of future results.
Source: Refinitiv Datastream and Invesco

Invesco

Figure 7 – Model asset allocation

	Neutral	Policy Range		Allocation	Position vs Neutral
Cash Equivalents	**5%**	**0-10%**		**10%**	
Cash	2.5%			10%	
Gold	2.5%			0%	
Bonds	**40%**	**10-70%**	↓	**20%**	
Government	25%	10-40%		15%	
US	8%		↓	2%	
Europe ex-UK (Eurozone)	7%		↑	4%	
UK	1%		↑	2%	
Japan	7%		↓	3%	
Emerging Markets	2%			4%	
China**	0.2%			1%	
Corporate IG	10%	0-20%	↓	0%	
US Dollar	5%		↓	0%	
Euro	2%		↓	0%	
Sterling	1%		↓	0%	
Japanese Yen	1%		↓	0%	
Emerging Markets	1%		↓	0%	
China**	0.1%			0%	
Corporate HY	5%	0-10%	↑	5%	
US Dollar	4%		↓	4%	
Euro	1%		↓	1%	
Equities	**45%**	**20-60%**	↑	**50%**	
US	25%		↑	18%	
Europe ex-UK	7%		↑	12%	
UK	4%		↑	6%	
Japan	4%			6%	
Emerging Markets	5%		↑	8%	
China**	2%			3%	
Real Estate	**8%**	**0-16%**	↑	**16%**	
US	2%		↑	3%	
Europe ex-UK	2%		↑	4%	
UK	1%			3%	
Japan	2%		↓	3%	
Emerging Markets	1%		↑	3%	
Commodities	**2%**	**0-4%**	↑	**4%**	
Energy	1%		↑	2%	
Industrial Metals	0.3%		↑	1%	
Precious Metals	0.3%			0%	
Agriculture	0.3%		↑	1%	
Total	**100%**			**100%**	

Currency Exposure (including effect of hedging)				
USD	48%	↓	36%	
EUR	20%	↑	23%	
GBP	7%	↑	12%	
JPY	15%	↓	13%	
EM	9%	↑	15%	
Total	**100%**		**100%**	

Notes: **China is included in Emerging Markets allocations. This is a theoretical portfolio and is for illustrative purposes only. See the latest The Big Picture document for more details. It does not represent an actual portfolio and is not a recommendation of any investment or trading strategy. Arrows indicate the direction of the most recent changes.
Source: Invesco

Invesco

Figure 8 – Model allocations for Global sectors

	Neutral	Invesco	Preferred Region
Energy	**6.0%**	**Neutral**	**US**
Basic Materials	**4.1%**	**Neutral**	**Europe**
Basic Resources	2.2%	Underweight	Europe
Chemicals	1.9%	Overweight	US
Industrials	**12.6%**	**Underweight**	**US**
Construction & Materials	1.6%	Neutral	Europe
Industrial Goods & Services	11.1%	Overweight	US
Consumer Discretionary	**16.3%**	**Underweight**	**Japan**
Automobiles & Parts	2.3%	Underweight	Japan
Media	1.3%	Underweight	US
Retailers	6.9%	Neutral	EM
Travel & Leisure	2.0%	Underweight	Japan
Consumer Products & Services	3.9%	Neutral	Japan
Consumer Staples	**7.0%**	**Overweight**	**Europe**
Food, Beverage & Tobacco	4.5%	Overweight	Europe
Personal Care, Drug & Grocery Stores	2.5%	Underweight	US
Healthcare	**10.9%**	**Neutral**	**Europe**
Financials	**12.8%**	**Neutral**	**EM**
Banks	5.8%	Neutral	EM
Financial Services	3.8%	Overweight	US
Insurance	3.2%	Underweight	Japan
Real Estate	**3.7%**	**Overweight**	**Europe**
Technology	**18.9%**	**Overweight**	**US**
Telecommunications	**4.2%**	**Neutral**	**US**
Utilities	**3.5%**	**Neutral**	**Europe**

Notes: These are theoretical allocations which are for illustrative purposes only. They do not represent an actual portfolio and are not a recommendation of any investment or trading strategy. See the latest Strategic Sector Selector for more details.
Source: Refinitiv Datastream and Invesco

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Appendix

Definitions of data and benchmarks for Figure 4

Sources: we source data from Datastream unless otherwise indicated.

Cash: returns are based on a proprietary index calculated using the Intercontinental Exchange Benchmark Administration overnight LIBOR (London Interbank Offer Rate). The global rate is the average of the euro, British pound, US dollar and Japanese yen rates. The series started on 1st January 2001 with a value of 100.

Gold: London bullion market spot price in USD/troy ounce.

Government bonds: Current levels, yields and total returns use Datastream benchmark 10-year yields for the US, Eurozone, Japan and the UK, and the Bank of America Merrill Lynch government bond total return index for the World and Europe. The emerging markets yields and returns are based on the Bloomberg Barclays emerging markets aggregate government bond index.

Corporate investment grade (IG) bonds: Bank of America Merrill Lynch investment grade corporate bond total return indices. The emerging markets yields and returns are based on the Bloomberg Barclays emerging markets aggregate corporate bond index.

Corporate high yield (HY) bonds: Bank of America Merrill Lynch high yield total return indices

Equities: We use MSCI benchmark gross total return indices for all regions.

Commodities: Goldman Sachs Commodity total return indices

Real estate: FTSE EPRA/NAREIT total return indices

Currencies: Global Trade Information Services spot rates

Factor index definitions

We focus on relatively large-cap stocks, as we suspect that most investors will be conscious of liquidity constraints when implementing such strategies. We have chosen six factors, that we think cover the classic definitions used by most investors. We aim to capture roughly a fifth of the market in each of our factor indices using the historical constituents of the STOXX 600 since August 1999 and the S&P 500 since September 1989, with monthly rebalancing. All our rankings are based on data in euros for Europe and in US dollars for the US. All factor indices are equal-weighted. We use the following definitions:

Growth: stocks in both the top third based on their 5-year sales per share trend and the top-third based on their internal growth rate (the product of the 5-year average return on equity and the retention ratio).

Low volatility: stocks in the bottom quintile based on the standard deviation of their daily returns in the previous three months.

Price momentum: stocks in the top quintile based on their performance in the previous 12 months.

Quality: stocks in both the top third based on their return on invested capital and the top third based on their EBIT to EV ratio (earnings before interest and taxes to enterprise value). This follows Joel Greenblatt’s “magic formula” from his 2005 book: The little book that beats the market.

Size: stocks in the bottom quintile based on their market value.

Value: stocks in the bottom quintile based on their price to book value ratios.

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Data as of 9th December 2020 unless stated otherwise.

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