American Listed Infrastructure
You're The One That I Want

First Sentier Investors

Climate change is the challenge and renewable energy is the solution.

Renewable energy is key to enabling decarbonization of electricity, transportation and hydrogen.

Market share shift away from fossil fuels to electricity has only just begun.

US electricity demand could increase 40% by 2050 creating a $1 trillion investment opportunity[1].

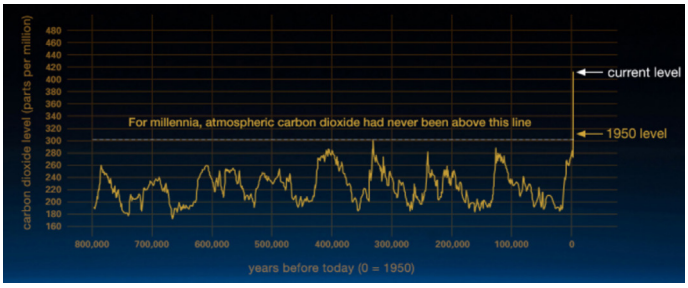
This creates multi-decade investment opportunities for American listed infrastructure's electric utilities.

I got chills, they're multiplying
And I'm losing control
'Cause the power you're supplying
It's electrifying!
– You're The One That I Want, Grease

Introduction

Climate change is the challenge of our time. In order to reduce man made global warming, humanity is working to decarbonize the global economy. Decarbonization involves reducing the use of carbon heavy fossil fuels[2] and replacing them with less carbon intensive alternatives. This decarbonization process is driving a massive market share shift in how we energize the economy towards electricity and away from fossil fuels.

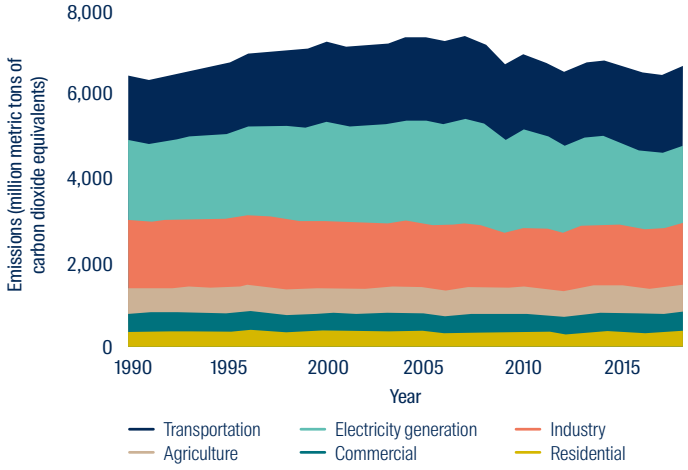
Scientific evidence for climate warming is unequivocal



Source: NASA

The United States (US), as the world's largest economy, is a key driver of the planet's decarbonization efforts. The two largest greenhouse gas emitters in the US are the transportation and electricity generation sectors, accounting for 28% and 27% of emissions respectively[3]. The US's decarbonization of electricity, followed by electrification of transportation, will require massive investment in renewable energy and significantly increase the demand for electricity.

US greenhouse gas emissions by economic sector



Source: US Environmental Protection Agency (EPA)

[1] First Sentier Investors forecast
[2] Fossil fuels are hydrocarbon-containing material of biological origin that can be burned for energy including oil, coal and natural gas. When fossil fuels are burned to create energy they release carbon dioxide and other greenhouse gases into our atmosphere.
[3] US Environmental Protection Agency

At the center of this process is the US electric utility industry which is leading this energy transition to renewable energy. Electric utilities account for just under 50% of the American Listed Infrastructure (ALI) asset class[4]. Hence this multi-decade, structural investment opportunity in renewable energy and increased electricity demand has significant positive implications for ALI.

The following paper reviews the future decarbonization of electricity, the electrification of transportation, green hydrogen's potential to energise parts of the economy that can't be electrified and outlines the investment implications for the US electric utility sector and the ALI asset class.

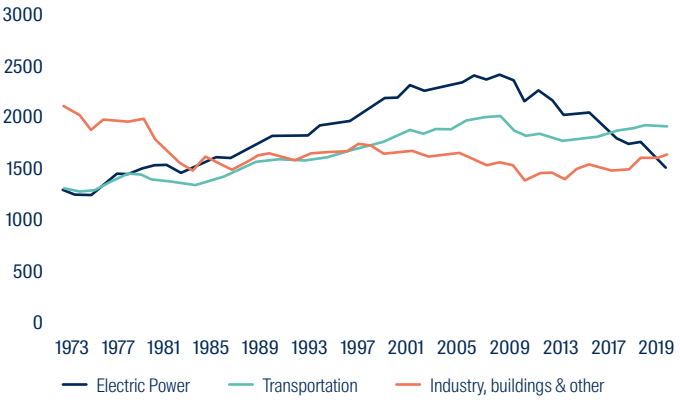
Decarbonization of electricity

Electricity can be generated from multiple different fuel sources. For its first 80 years (1880s-1960s), electricity generation was dominated by water (hydroelectricity) and steam (produced by boiling water from burning oil and coal). Nuclear power joined the generation mix starting in the 1960s, followed by natural gas in the 1990s, wind in the 2000s and solar in the 2010s. The carbon heavy electricity sources are those that burn fossil fuels (oil, coal and natural gas) while hydro, nuclear power and renewables (wind and solar) are carbon free.

Carbon dioxide emissions from the US electric power sector have been in almost constant decline since peaking in 2007. This decline in emissions was initially caused by lower cost natural gas fired power plants replacing older, inefficient coal and oil plants. Electricity from natural gas produces around half the carbon dioxide of coal or oil. The expansion of carbon free renewables in the 2010s, again at the expense of coal, drove a further reduction in carbon dioxide emissions.

By 2019, carbon dioxide emissions from the US electricity sector were 33% below their 2007 peak[5]. As the below chart illustrates, the decline in US carbon dioxide emission has been driven by the electricity sector with emissions from transportation and the rest of the economy remaining broadly unchanged.

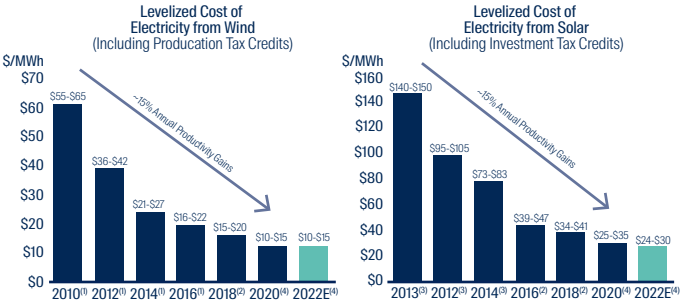
US Carbon Dioxide emissions by sector (mmt)



Source: US Energy Information Administration (EIA)

This growth in carbon free electricity can be attributed to the building of more wind and solar farms. Hydro and nuclear generation levels are broadly unchanged over the last decade. This large expansion of wind and solar generation has been driven by state based Renewable Portfolio Standards (RPS), government investment subsidies, large cost declines, productivity improvements, capacity factor increases and corporate purchases of renewable electricity.

Declining cost of US wind and solar

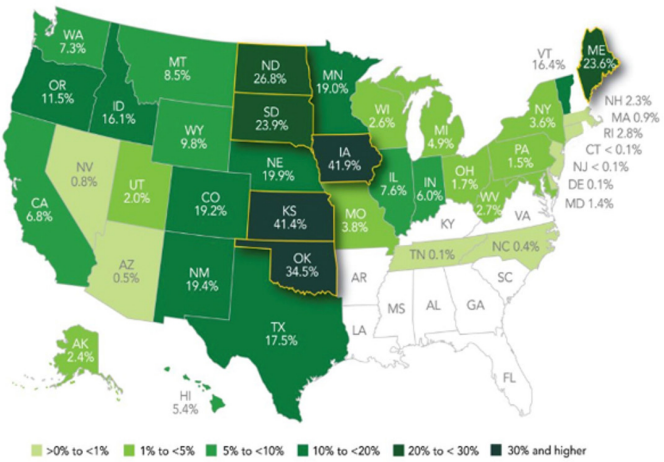


1) Source: U.S. Department of Energy, Wind Technologies Market Report
2) Source: Bloomberg New Energy Finance
3) Source: IHS Markit. The use of this content was authorized in advance. Any further use or redistribution of this content is strictly prohibited without written permission by IHS Markit. All rights reserved.
4) Energy Resources' estimate

Source: NextEra Energy October 2020 Investor Presentation

Until several years ago, wind power was significantly cheaper than solar in most parts of the US. This saw wind capture large market shares of electricity generation in many states with strong wind resources. In 2019, Iowa, Kansas and Oklahoma each generated over 30% of their electricity from wind.

Wind energy's share of electricity generation (2019)

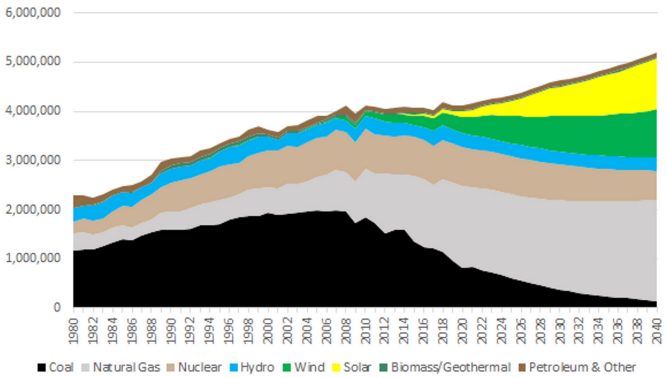


Source: American Wind Energy Association (AWEA)

Today renewable energy (wind, solar and hydro) accounts for 28% of generation capacity and 20% of electricity output. As the following chart illustrates, we forecast renewable energy to increase its share of generation capacity and electricity output to 45% and 36% respectively by 2030; and to 50% and 46% respectively by 2040[6]. This will be driven by many factors.

[4] FTSE USA Core Infrastructure Capped Index
[5] US Energy Information Administration (EIA) data
[6] First Sentier Investors forecast

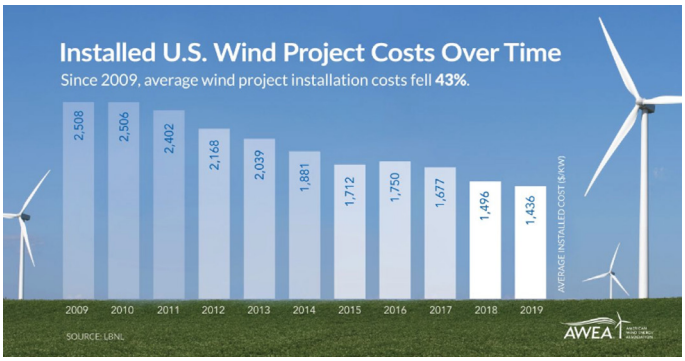
US electricity generation output by fuel (MWhrs)



Source: EIA history, First Sentier Investors forecasts

Firstly, we believe wind and solar will dominate new-build capacity given their status as the lowest cost new generation. With costs forecast to continue to decline at 5-10% p.a. this is expected to further entrench solar and wind as the lowest cost options. While we expect subsidy cuts in the 2020s, the economics of renewables now work without subsidies. As the CFO of one of the US' largest electric utilities said recently "The politics around renewables is less important today given the economics".

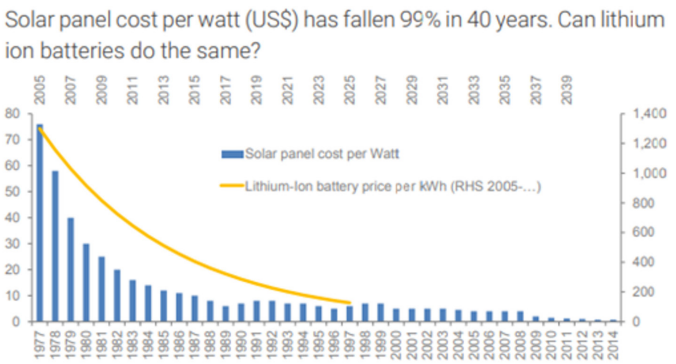
Renewables economics trumps ideology or politics



Source: American Wind Energy Association (AWEA)

Secondly, the 2020s appears likely to be the decade that battery storage becomes economic to deploy and be widely deployed. In November 2020, WEC Energy's highly respected Executive Chairman said "For the first time we're adding battery storage for our regulated businesses. The data shows that battery storage is now a cost-effective option for us"[7]. The ability of battery storage to provide dispatchable power, peak shave and load shift; and to manage frequency and voltage fluctuations; will be key to increasing renewables' penetration of the electric grid.

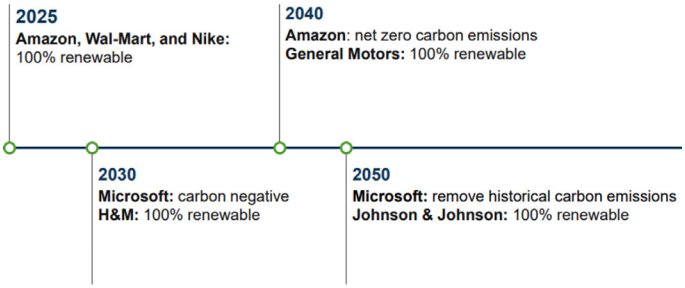
Cost declines driving economics of solar and batteries



Source: CleanTechnica, Morgan Stanley Research

Thirdly, we believe state and company based renewable energy, carbon reduction, coal closure and net zero targets remain supportive of carbon free electricity at the expense of fossil fuel based electricity. With initial RPS easily met, states are increasing decarbonization targets for the 2030s and 2040s. Company purchases of renewable energy are also expanding and being driven by strong customer support from millennial consumers.

Consumer and tech firm have ambitious decarbonizing goals



For illustrative purposes only. Reference to the names of each company mentioned in this communications is merely for explaining the investment strategy and First Sentier Investors does not necessarily maintain positions in such companies. Any fund or stock mentioned in this presentation does not constitute any offer or inducement to enter into any investment activity nor is it a recommendation to purchase or sell any security.
Source: Brookfield Renewable Partners

Fourthly, multiple East Coast US states are subsidizing the construction of offshore wind, which is due to come online from 2023. We forecast this will add ~1% to total US electricity capacity. This new subsidized capacity is likely to have a significantly negative effect on the viability of existing fossil and nuclear generation facilities in the US Northeast and Mid-Atlantic.

In summary, we believe that the economics of battery storage and its ability to firm up intermittent renewables will accelerate the (1) virtuous cycle of renewable energy expansion and (2) vicious cycle of fossil fuel contraction. To paraphrase Winston Churchill: US renewable energy investment is at the end of the beginning, not the beginning of the end.

[7] Third quarter 2020 earnings conference call

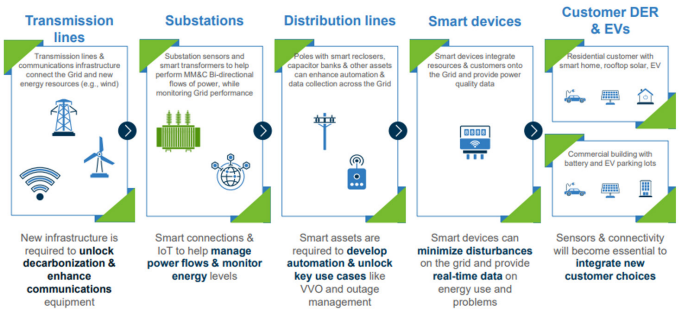
Investment implications from decarbonization of electricity

The investment implications from the decarbonization of the US electricity sector for US electric utilities and the American listed infrastructure asset class are significant.

Firstly, we forecast this renewable energy transition will create a $500 billion investment opportunity for new wind, solar and battery generation assets over the next decade. We expect this will be followed by a further $200 billion in the 2030s.

Secondly, new renewable generation investment would require capital expenditure on (1) transmission grids as electricity generation evolves from a highly centralised to a decentralised system and (2) distribution grids which will need to cope with two-way flow of power. These grids need to become harder, smarter, more connected, integrated and resilient.

Building a connected grid

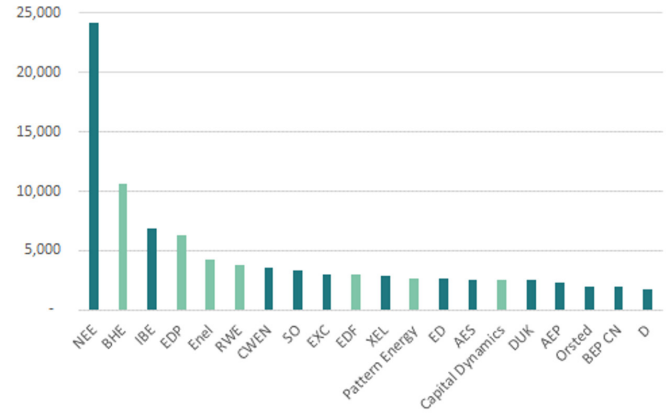


Source: Evergy Grid Modernization Dec 2020

Thirdly, the cost of new solar and wind generation assets is declining significantly, meaning electricity prices should also decline over the next decade. Lower electricity prices means lower customer bills which in turn reduces political and regulatory risk.

As the following chart illustrates, the largest wind and solar owners today in the US are dominated by ALI's electric utilities (dark green) including industry giant NextEra Energy.

Twenty largest wind and solar owners in US (MWs)

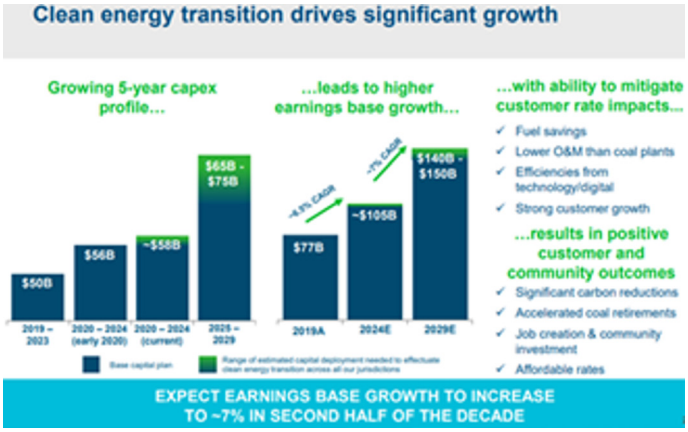


Source: Company reports, First Sentier Investors

For the US electric utility sector, we are forecasting net investment (capital expenditure less depreciation) of $300 billion over the next decade. This translates into an annualized rate base growth rate of ~5%, with risks to these growth forecasts on the upside. Rate base growth should roughly translate into Earnings Per Share (EPS) growth after adjusting for dilution from additional equity and lower allowed Return on Equity (ROE).

Several large US utilities are already forecasting an acceleration in their capital expenditure and rate base growth in the latter half of the 2020s. The following slide is from Duke Energy, one the US's largest electric utilities, which now expects its rate base growth to accelerate from ~5% p.a. from 2020-2025 to ~7% p.a. from 2025-2030.

Duke Energy acceleration in capex and rate base forecasts

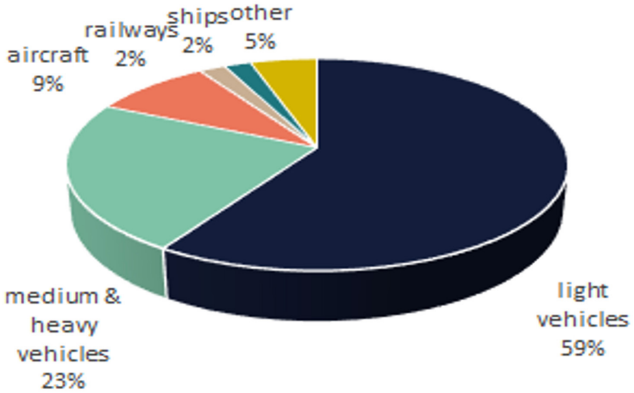


Source: Duke Energy ESG investor presentation, October 2020

Decarbonization of transportation

With the decarbonization of the electricity sector well under way, the decarbonization of the transportation sector can now begin. Around 80% of greenhouse gas emissions from the US transport sector come from vehicles. Hence, the electrification of vehicles is key to decarbonizing the sector.

Split of US transport sector greenhouse gas emmissions



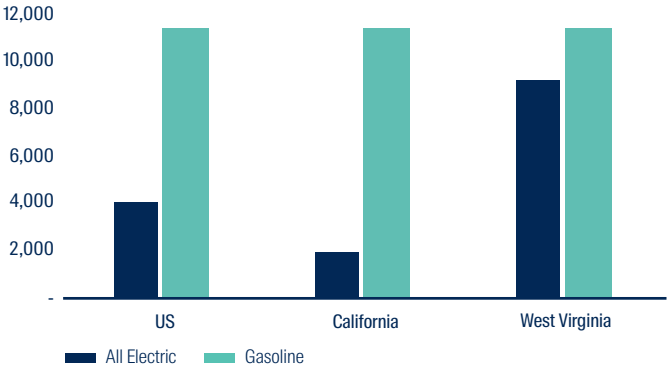
Source: Environmental Protection Agency (EPA) 2018

Electric vehicles (EVs) have two advantages over fossil fuel powered internal combustion engines (ICE). Firstly, the electric engine uses less energy as it converts energy to power more efficiently than ICEs. The US Department of Energy states "Electric drivetrains are mechanically more efficient than internal combustion engines; EVs convert about 59%–62% of the electric energy from the grid to power at the wheels, while conventional gasoline vehicles only convert about 17%–21% of the energy stored in gasoline to power at the wheels."[8]

Secondly EVs do not produce tailpipe emissions whereas ICEs do. Obviously EVs use of electricity means they indirectly produce carbon dioxide but the amount depends on how carbon intensive the electricity generation process is.

The combination of these two factors means that EVs produce 60% less carbon emissions than ICEs, based on US national average electricity mix[9]. The chart below illustrates the vast differences in EV emissions from coal free Californian electricity compared to West Virginian electricity which is 90% from coal[10]. As the US electricity sector continues to decarbonize, the reduction in greenhouse gas emissions from EVs relative to ICEs will increase further.

Annual emissions per vehicle (pounds of CO2 equivalent)

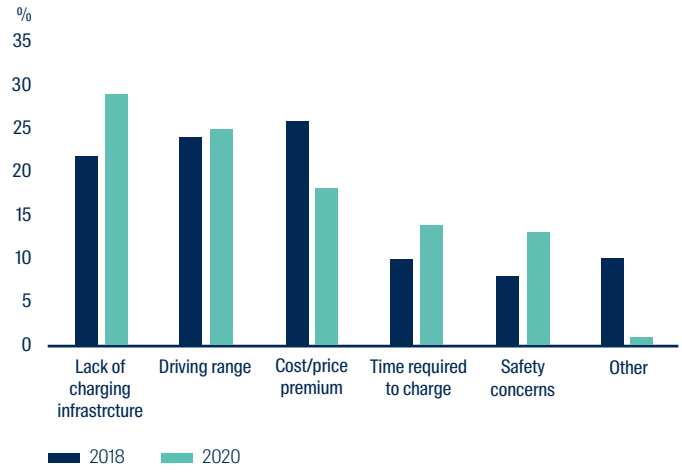


Source: US Department of Energy

The US has an EV fleet of ~1.7m vehicles and currently accounts for ~2% of new vehicle sales. This lags Europe, which has an EV fleet of ~2.7m vehicles. The highest take up in the US is on the west coast with EVs accounting for 8% of all new vehicle sales in California, 4% in Washington and 3% in Oregon. In fact, California accounts for around 50% of the US EV fleet with only 12% of the nation's population. The key impediments to EV take up are the lack of product, price premium to ICEs, lack of charging infrastructure, driving range / range anxiety, charging times and safety concerns around batteries.

Source: Evadoption.com, "EV Market Share by State", as at 31 December 2018

What is the greatest concern regarding electric vehicles?



Source: Deloitte Global Auto Consumer Study

Over the 2020s we expect EV ownership will accelerate for multiple reasons. Cost declines in battery technology should see EV prices reach parity with ICEs in the mid-2020s. The number of EV models available are expected to increase from around 50 today to 130 models by 2023 (including an electric version of the bestselling vehicle in the US, Ford F-150, in 2022[11]). Strong public policy support for EVs will drive expansion of charging station infrastructure with technology driving down charging times[12]. Government incentive payments may also be increased or expanded into new states. Some states are trying to phase out ICEs altogether with California mandating all new cars sales must be EVs by 2035.

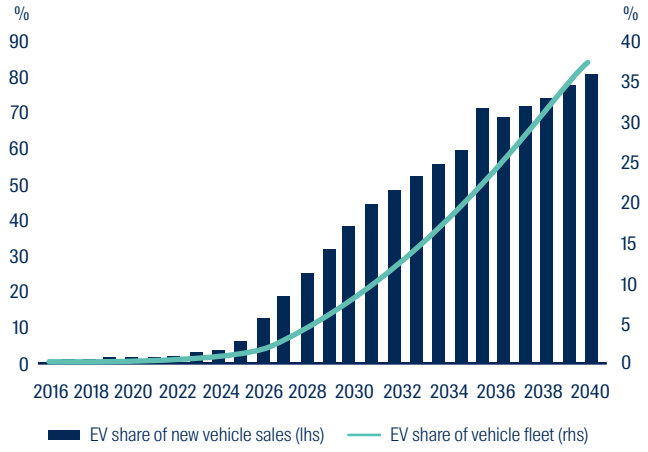
All electric Ford F-150 pick up truck due for release in 2022

Source: Ford

We forecast a robust take-up of EVs in the mid-to-late 2020s as pricing, product range and technology improve significantly. From a fleet of 1.7 million EVs today, we forecast this to grow to 6 million by 2025 and a significant expansion to over 25 million by 2030. These forecasts assume a 'tipping point' of EVs going mainstream in the late 2020s and are more optimistic than those of most forecasters.

[8] US Department of Energy's Office of Energy Efficiency and Renewable Energy
[9] US Department of Energy data
[10] US Department of Energy data
[11] Ford Motor Company
[12] Direct Current (DC) fast charging stations are essential for quick turnaround in long distance travel. These stations provide DC power directly to the battery whereas slower AC chargers have to convert power to DC to enter the battery.

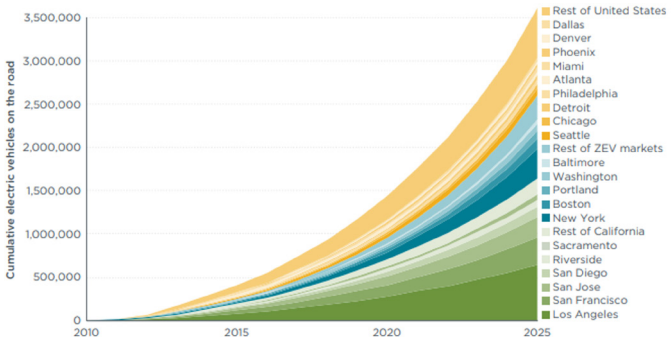
EV market share in US



Source: First Sentier Investors

We expect EVs to achieve mass market appeal in the mid-to-late 2020s with the 2030s seeing them dominate new vehicle sales and growing to over 35% of the total US vehicle fleet by 2040.

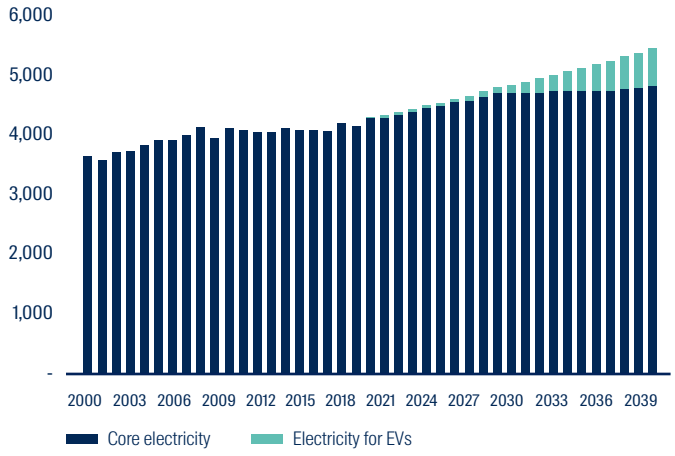
Coastal cities dominate EV uptake



Source: The International Council on Clean Transportation

We forecast that this mass electrification of the US vehicle fleet will significantly increase demand for electricity. From 2000 to 2020, electricity demand grew at a CAGR of 0.8% or flat on a per capita basis[13]. Over the next 20 years we forecast this growth to accelerate to a CAGR of 1.2% from the incremental demand from EVs. We forecast electricity demand from EVs will grow at a CAGR of 26% from 2020 to 2040. This will see EVs account for 12% of total US electricity demand by 2040. This forecast is not signfinatly different from BloombergNEF which assumes EVs account for 17% of US electricity demand by 2050[14]. It is also consistant with NextEra Energy's SVP of Development's recent statement "the conversion away from internal combustion engines could drive over one fifth of US energy demand by 2050".[15]

US electricity demand to accelerate in 2030s (MMWhrs)



Source: First Sentier Investors

Investment implications from decarbonization of transportation

The investment implications from the decarbonization of the US transportation sector for US electric utilities and the ALI asset class are significant.

The initial impact from EVs on electric utilities will be from investment in infrastructure for EV charging stations for residential, fleet and public use. Today the US has 28,000 charging stations[16]. This is expected to grow to over 50,000[17] by 2025 and to over 100,000 in time[18] with significantly more DC fast chargers needed. McKinsey estimate that $11 billion will be required in the US to fully build out an EV charging network[19].

While the EV charging stations themselves will mostly be owned by private companies (ChargePoint, EVgo, Tesla, Electrify America[20], Blink), the connection to existing electric distribution infrastructure will be the domain of electric utilities. It should be noted that the charging stations themselves only account for 20-25%[21] of the investment. The remaining 75-80% will be spent on up-to-premise and on-premise infrastructure. We expect electric utilities will be allowed to rate base this investment and earn a fair ROE.

Portland General Electric EV charging stations

Source: Portland General Electric

[13] US EIA
[14] BloombergNEF New Energy Outlook 2020
[15] NextEra Energy press release 8th December 2020
[16] US Department of Energy's Office of Energy Efficiency and Renewable Energy
[17] "Quantify the electric vehicle charging infrastructure gas across US markets", January 2019. The International Council on Clean Transportation.
[18] By way of comparison, there are 115,000 gasoline stations in the US today.
[19] "Charging ahead: Electric-vehicle infrastructure demand" August 2018
[20] Electrify America was created by Volkswagen as part of the settlement of its diesel scandal. It has committed $2 billion to create a network of EV charges across the US.
[21] Xcel Energy estimate 24% and PG&E Corporation estimate 20%.

US electric utilities are already factoring charging station infrastructure into their rate bases. The below table lists over $2 billion in EV investment plans by electric utilities by 2025. Morgan Stanley estimate "$5.4b in utility infrastructure will need to be built in the US between today and 2024 to enable EV growth" and "$13.4b in total by 2030".

Electric vehicle EV infrastructure investment programs

Utility	State	Investment ($m)
PG&E	CA	383
Edison International	CA	357
Sempra Energy	CA	200
Xcel Energy	MN & CO	500
Consolidated Edison	NY	314
Avangrid	NY	147
Public Service Enterprise Group	NJ	300
Duke Energy	NC, SC	100
Eversource Energy	MA	45
Eversource Energy	CT	55
Avangrid	CT	20
Total		**2,421**

Source: First Sentier Investors

The most significant long term effect on electric utilities from the decarbonization of transportation will be increased electricity sales volumes. Based on the above EV penetration forecasts, we believe transport electrification will increase electricity volumes by 10-15% by 2040 and another 5-10% by 2050.

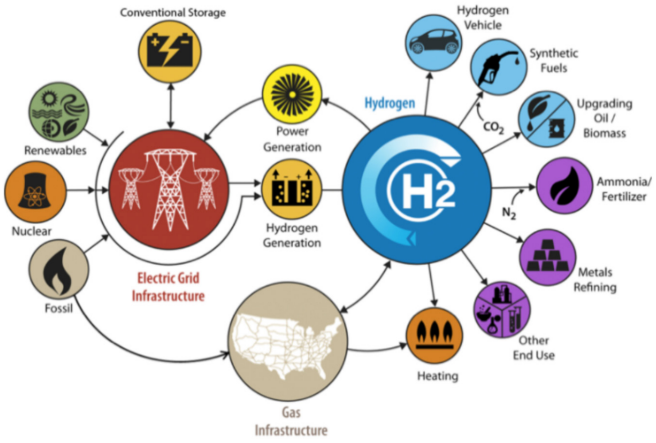
We should start to see EVs positively impact electricity volumes in the mid-to-late 2020s in high penetration areas like the West Coast, Northeast, Colorado, Minnesota, Illinois, and in select progressive cities like Austin, Phoenix, Madison and Raleigh. Californian utility PG&E Corporation stated "The average EV consumes about half the electricity of a typical home each year"[22]. Xcel Energy expects EVs to add 0.6% to 0.7% p.a. in the 2020s to retail sales growth in their Minnesota and Colorado utilities[23].

This increased electric demand will see higher capacity utilisation of power plants, spread fixed grid costs across greater volumes (reducing all-in electricity cost to all end users) and create investment opportunities for more renewable generation.

Hydrogen

Hydrogen is an abundant element and has a wide variety of potential applications within the US economy. Any serious discussion around achieving a net-zero 2050 outcome needs cost competitive hydrogen to replace the 20-25% carbon-heavy parts of the economy that can't be electrified.

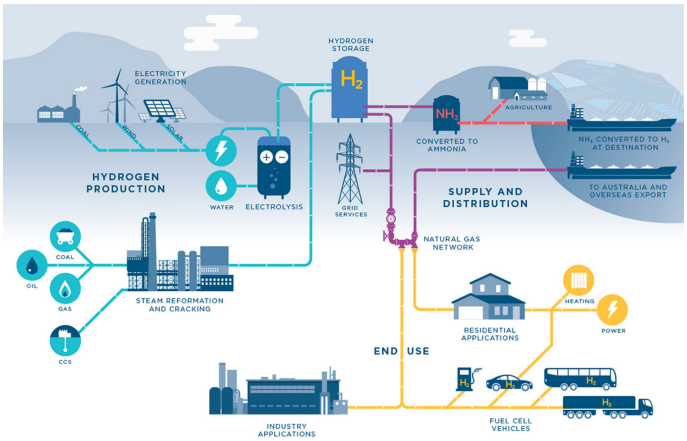
Hydrogen has a wide variety of potential applications



Source: US Department of Energy

Carbon free green hydrogen is created by electrolysis which splits hydrogen and oxygen from water using carbon free electricity (nuclear, hydro, wind and solar). For this process to become economic, electrolyser costs and renewable energy prices must fall significantly. Most forecasters don't expect green hydrogen to become economic until late 2030s or early 2040s. While hydrogen is the 'topic du jour', we caution that this technology has been around a long time and has failed to make significant advances. Its road to cost competitiveness is less clear than renewable energy and electric vehicles.

Can hydrogen become a carbon free energy saviour?



Source: Herbert Smith Freehills

[22] Various PG&E Corporation investor presentations

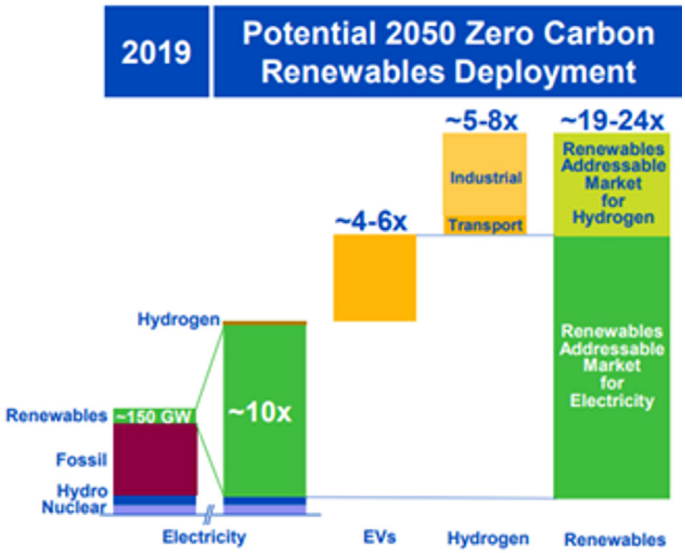
[23] Various Xcel Energy investor presentations

Investment implications from hydrogen

For US electric utilities and the ALI asset class, the potential mainstream use of hydrogen in the 2030s and beyond has several implications.

The most significant investment implication from hydrogen is the need for greater renewable energy generation. BloombergNEF estimate that green hydrogen will require over a 30% increase in electricity demand to achieve a 2050 net zero carbon outcome[24]. This means electric utilities will have increased investment opportunities to invest in wind and solar. Hydrogen could also act as a lifeline to nuclear power plants which today are in decline due to high costs[25]. The graphic below shows that the hydrogen creation process may consume as much electricity as EVs in a 2050 zero carbon world.

Zero carbon US requires massive renewable investment



Source: NextEra Energy

Hydrogen has the potential to act as a long life storage battery (think days not hours) for electricity through hydrogen fuel cells. This increases the ability of utilities to dispatch intermittent renewables and improve grid stability and reliability.

Hydrogen also has the potential to replace natural gas as feed stock for gas-fired power plants, which would further decarbonize the electricity sector. It could also reduce or replace natural gas used for home heating and cooking, again decarbonizing the economy.

Conclusion

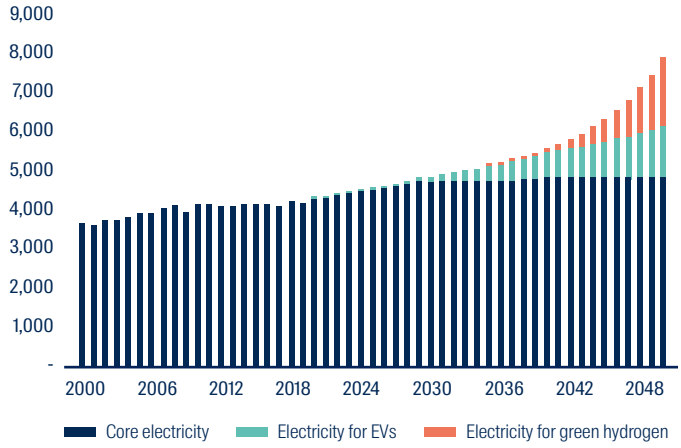
Renewable energy investment will accelerate through the 2020s to decarbonize the electricity sector. This will enable the decarbonization of the transportation sector in the 2030s, which will increase electricity demand by 10-15%. The 2040s could see green hydrogen add 25-30% - with continued EV penetration adding a further 5-10% - to electricity demand.

By 2050 US electricity demand could increase by over 40%, creating massive renewable energy and related electric grid investment opportunities. We estimate these investment opportunities to be over $1 trillion[26]. ALI's electric utilities are the dominant investors in US renewable energy and electric grids. Decarbonization of electricity, transport and hydrogen create a multi-decade investment opportunity and underpin low risk, 5% plus earnings growth for the foreseeable future.

Climate change is the challenge and renewable energy is the solution. Renewable energy is key to enabling the decarbonization of electricity, transportation and hydrogen. The massive market share shift away from fossil fuels to carbon free renewable electricity has only just begun.

American listed infrastructure is electrifying and the one that I want!

EVs and green hydrogen to drive large growth in US electircity demand (MMWhrs)



Source: First Sentier Investors

[24] BloombergNEF New Energy Outlook 2020
[25] Xcel Energy is partnering with Idaho National Laboratory to use the Prairie Island nuclear plant's steam and electricity to produce hydrogen using high temperature steam electrolysis.

[26] This compares to the BloombergNEF estimate that North America will spend $1.7 trillion over 2020-2050 time frame.