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WHITEPAPER

The Future of *Mobility*

JUNE 2020

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Abstract

This paper identifies transformational shifts within mobility by considering the movement of both people and goods, and by looking at the three principal components of the mobility ecosystem: vehicles, fuel and infrastructure. The paper sets this in the context of the historic evolution of land, sea and air transportation, to discuss and analyze current economic and structural models, and provide insights and expectations regarding the future of mobility and investment opportunities. Changes or accelerations of these trends based upon possible scenarios—post-COVID-19—are discussed.

What is Mobility?: People and Goods

When looking at the topic of mobility at a global scale, much of the discussion tends to revolve around the transportation of people, rather than looking holistically at the movement of people and goods. Similarly, there tends to be a primary focus on vehicles alone rather than the interplay between ***vehicles, fuel and infrastructure,*** which forms the trifecta of the mobility ecosystem and is the lens through which this paper is written.

It is our assertion at Anthemis that this interplay is a catalyst in creating an energy network that operates in ways that are similar to the internet which will, in turn, drive faster adoption of high-renewables electric systems.

The History of Mobility

Looking at the history of transport through the lens of land, sea and air, and the economic and structural models that have been created around them, helps gain an understanding of how transportation will evolve.

Land: Horse | Rail | Automobiles

For most of settled human history, people did not stray far from home; walking speed determined travelling distances. Prior to the Industrial Revolution, domesticated livestock—particularly horses—were too valuable to be used as personal transportation for ordinary people, beyond instances of migration to new territory.







Horse: Freedom of Movement

Before the Industrial Revolution, the use of the horse as a means of personal transportation was seldom an option for any but the elite. The technical progress and increased wealth of the period led to further innovations in transportation. This process of development is a recurring theme throughout its history.

Not only did horse transportation for the masses represent economic progress, it was also a cultural shift. The horse came to symbolize freedom and individuality becoming, along with the cowboy, an icon of the 'Wild West'. Under the increasing cultural influence of the United States (US) in the 19th and 20th centuries, the individualism that defined the American experience was exported worldwide. From cowboy, to biker, to driver, horses and—eventually—motorcycles and cars represented freedom and control, offering the ability to travel anywhere, any time.

This was in marked contrast to the other technological feat of the era, the railway, which increasingly represented a communal approach to mobility. The cultural differences between these two modes of transportation continue to be key factors in dictating mobility infrastructure and policy today.

Rail: Connecting Points

Representing a completely different approach to the social use of vehicles and infrastructure, rail was hierarchical, commonly tied to a single provider and operating within a system that lent itself more naturally to planned environments.

In terms of utilization, there are two principal use cases where rail works best: as high-speed arteries between major destinations or as public transportation within large urban areas.

In terms of utilization, there are two principal use cases where rail works best: as high-speed arteries between major destinations or as public transportation within large urban areas. Traditionally in these high-density, long-distance environments, rail transport offered a superior service to cars in terms of speed and efficiency, but also required large scale infrastructure investment, often at the cost of pushing freight onto roads and highways.

This is most notable in the French model, where high-speed public rail systems focus primarily on transporting passengers, while outsourcing freight to their private freeways. This is in contrast to the American model, where public highways are largely passenger, while rail is used primarily for freight transport, with very few high-speed passenger lines.

Percent of passenger travel, by mode[1]	EU-27	USA
Auto	74%	85%
Bus	8%	3%
Rail	6%	0%
Tram/Metro	1%	0%
Water	1%	0%
Air	9%	11%

"As New York University historian Peter Baldwin notes, 'Ecologically speaking, there is no advantage in sending passengers by rail if freight is sent by road.' Because the difference in energy consumption between rail and truck freight is far greater than the difference between passenger rail and cars, the US saves more energy shipping freight by rail rather than truck than Europe saves by moving passengers by rail rather than by car or air."[2]

While the French model may seem superior in many respects, the end result of this infrastructure spend and transport prioritization has led to a surprisingly low percentage (>10 percent) of passenger travel, as well as rigidity in implementation. For instance, rail travel between Paris and other large cities works well, but is almost unusable point-to-point between second tier destinations.

France's high-speed rail network is hub-and-spoke, hugely expensive and does not serve tier 2 to tier 2 cities.

The TGV is intrinsically a hub-and-spoke system with Paris as the central hub. To go from Lyon to Bordeaux requires completing two sides of a triangle and going via Paris.



Automobiles: Finding the Balance with New Mobility

Automobiles were invented and refined by German and French engineers in the late 1800s but, until the late 20th century, it was America that came to dominate the industry through the development of new forms of mass production via the assembly line. With an entire interstate highway system dedicated to this mode of transport, automobiles quickly became the most popular form of travel.

Lower infrastructure costs and the ability to travel from anywhere to anywhere at any time in vehicles of various sizes and capacities enabled road travel to offer more flexibility—but, in cities, created less human scale and more urban sprawl.

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Sea: Cogs and Caravels | Steamships and Fuel

Cogs and Caravels: Harnessing Tradewinds

With water used for transportation for almost the entirety of human civilization, for much of that time, most of the infrastructure and fuel was natural, with innovation in mobility coming primarily from ship design itself.[3]

Two examples of revolutionary innovation in ship design were the Cog and the Caravel. The pragmatic cost and efficiency tradeoffs of the Cog drove prolific Baltic trade, while the ability of the Caravel to sail into the wind opened up routes down the west coast of Africa, leading ultimately to the discovery of the New World and the unleashing of massive new trade flows.[4]

Steamships and Fuel: Global Movement

The proliferation of trade was given an even more substantial boost in the early 1800s with the introduction of the steamship, a self-powered vessel that further revolutionized society by better utilizing canals and waterways. This led to more efficient transportation of goods, a further explosion of trade and the large scale move west by North American settlers.[5]

When oil entered the equation as a fuel source, the impact was truly global, going as far as to change geopolitics in the process. A prime example of this was Britain's decision to send one of their very first deployments of soldiers in the First World War to Basra, Iraq, in order to secure the oil for their fleet.[6]

Air:
Hub-and-Spoke versus Point-to-Point | Drones

When airports were first proposed, in the early 20th century, the assumption was that they would look like railway termini: a series of runways, in parallel, like tracks, and a concourse at one end, located in city centers. That model did not work for multiple reasons; the scale and logistics required for modern airports make them large, sophisticated and noisy, so they are located on the periphery of urban centers. Although there is technically no infrastructure cost—beyond air traffic control—between departure and destination, for air travel, economies of scale for large airport operations have created a hub-and-spoke system where certain airports dominate. It was only with

the advent of low cost airlines that regional and second tier airports made a comeback and allowed for many more, point-to-point routes.[7]

Hub-and-Spoke versus Point-to-Point

The hub-and-spoke versus point-to-point model is reflected in approaches to aircraft design and, notably, in the different strategies taken recently by Boeing and Airbus, with the development of the Boeing Dreamliner as an aircraft capable of long haul, point-to-point transport between almost any destination versus the high capacity Airbus 380, capable of serving major hubs.[8]

Potentially, the COVID-19 pandemic has damaged the ability for low cost, low margin airlines to compete with premium or state-subsidized carriers while, at the same time, premium carriers such as Emirates may reduce nearly half of their A380 services except for routes between major hubs such as London and New York.

In terms of fuel, large electric commercial airlines are unlikely to ever be widespread due to the inevitable weight of batteries.[9] The carbon dioxide (CO_2) emission savings from biofuels can be significant, but these require newer aircraft at a point when there will be a large excess supply of older aircraft, post-pandemic.

Packet switched model is already happening to air travel

- Dreamliner was very much a bet on point-to-point versus hub-and-spoke
- Airbus phasing out A380 is validation of Boeing's bet on the network versus hub-and-spoke model



BOEING® DREAMLINER



AIRBUS A380

Electricity will play a part in aviation via drones but, like 1950s visions of a Jetpack future that never happened, drones are unlikely to be used for personal transportation. Their sweet spot will be places that are 'off-grid' from normal transportation infrastructure, such as remote rural Central Africa or Australia, and for items with high value to weight ratios, such as medicines.

Drone technology also has the potential to bridge infrastructure gaps as mobility is continually evolved, providing low cost, high volume and automated movement of goods and services independent of traditional limitations.[10]

Economic and Structural Models

Taking the insight gained from discussing the origins of the three modes of transport, these legacy systems can now be viewed from an economic and structural perspective, with the goal of using the observations to understand how they foster what comes next.

Economic Model: The Production Line and the Fordist Model of Consumer Capitalism

The factory assembly line, pioneered in car manufacturing, represented a second phase of the Industrial Revolution, heralding an era of mass production. The process of mass production helped to develop current business environments, giving rise to large corporations and providing an efficient structure for divisions of labor. With fixed expenses in place, the organization of production lines reduced unit costs greatly and, due to the scale and efficiency this provided, for the first time in history, from machines to movies, the potential purchasing power of the masses exceeded that of the elite.

This market evolution gave labor a more powerful voice, along with the ability to better safeguard their interests through stronger union protections. American capitalism had, in effect, created a new form of social pact between workers and owners. This went beyond collective bargaining, all the way to the provision of decent wages, largely borne out of the self-interest of the employers themselves. Henry Ford was one of the first to understand this, realizing that the buyers of his cars included his employees who, therefore, had to be paid enough to afford them.[11]

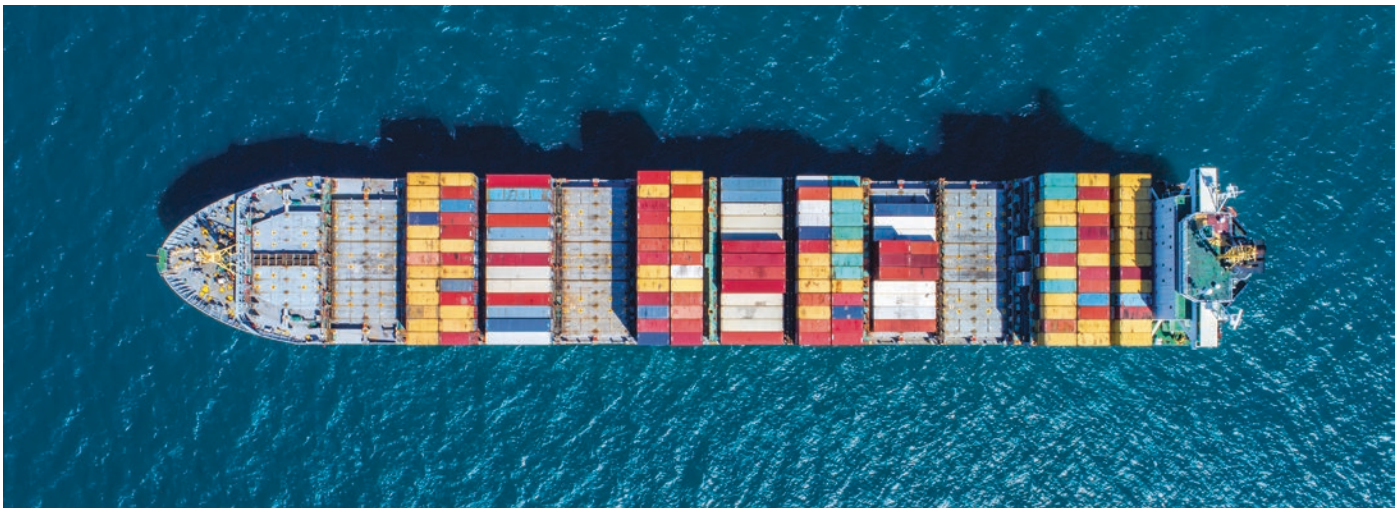
The Next Industrial Revolution: Driven by Data and Demand

As we move toward what is variously called the Third or even Fourth Industrial Revolution (if the Information Age is to be split between computers and the internet), we are entering a phase in which these dynamics are changing even more rapidly. The primary driver of this paradigm shift has been the ubiquitous access to information via smart devices, which has fostered a transformative effect on the global economy.[12] [13]

This new economic era will be fundamentally different to the past, as scarcity will shift to the demand side from the supply side, leading to an even stronger social pact between consumers and providers.

For instance, rather than physical manufacturers of products, the equivalent of Fordist model car companies in this emergent economy will be those capable of utilizing technology to harvest data from large numbers of users.

For this reason alone, the role of Original Equipment Manufacturers (OEMs) will become more reliant on the ability to develop and own vehicle operating systems. This is a critical piece of core competency; existing OEMs are lagging well behind new entrants, most notably tech-forward EV companies such as Tesla, Inc.



Structural Model: Container Shipping—The Original Internet

While land mobility infrastructure has expanded massively since the 1870s, sea transportation is still the dominant method for moving goods, accounting for 90 percent of global trade. This structural model has been buoyed greatly by China opening its economy to outside markets, along with the standardization of freight via the intermodal International Organization for Standardization (IOS) shipping container.[14] [15]

The containerization and intermodality of shipping has had a profound effect, allowing trade carried by sea to grow fourfold since 1970 and providing a model remarkably similar to the way in which the internet operates, where standard packets of information move from network to network.[16]

What Comes Next?

The concept of intermodality could point to how mobility infrastructure is going to change in the future. This will be looked into in greater detail later.

At Anthemis, we believe that the mobility shift from hierarchical to network-driven will trigger a structural change to energy systems, to the extent that the trifecta of vehicles, energy and infrastructure will operate in a similar way to the packet model that revolutionized digital transmission and the container shipping industry. In other words, the modular nature of road vehicles mimics the packet transfer protocol better and, therefore, presents several fundamental advantages when compared to rail systems, making this a long term shift.

Emerging Changes and Trends

Having examined how modern systems began and how they operate today, we possess the insight to properly analyze what comes next. By looking at emerging trends from a perspective that places them into the system within which we currently operate (as well as are trying to influence), their viability and potential can be assessed accurately.

This is critical as we are seeing an increasingly complex picture of global order developing on the heels of rapid globalization followed by the disruption of that very system due to the COVID-19 pandemic. While, previously, it was conventional wisdom that this expansion of globalized trade would continue relatively unabated, a potent mix of pandemics, populist movements, environmental volatility and retaliatory trade wars demands a shift in perspective.

While, previously, it was conventional wisdom that this expansion of globalized trade would continue relatively unabated, a potent mix of pandemics, populist movements, environmental volatility and retaliatory trade wars demands a shift in perspective.

As such, mobility flows in the future are going to be very different to those expected even a few years ago, particularly for supply chains and air transportation, where the resiliency, cost burden and safety of these systems are of paramount concern in the post-COVID-19 era.

Micromobility: Going Solo

One of the key takeaways from the COVID-19 pandemic is the fragility of public transportation systems. Capital costs combined with a renewed focus on the health and safety vulnerabilities of mass transit has strengthened the push towards individual and micromobility. With more than a quarter of the world's population living in cities of 1 million+ inhabitants and traffic commutes averaging speeds as little as nine miles per hour, micromobility offers a solution in terms of both efficiency and public health.

Much of the excitement around micromobility in particular has been centered on the shift from big infrastructure concepts like docked bikes, to a dockless model, where networks and application-based technology converge to offer a hybrid, multimodal transportation option in cities.

This has been most prominent in the growth and margins of electric scooter services based on the Uber/Lyft model. For instance, by utilizing the key elements of this system adeptly, Bird, a last mile scooter rental service, became the fastest company in history to reach a $1 billion valuation—for good reason considering its unit economics were orders of magnitude better than the leading ride-hailing services.[17] [18]

While there are still questions related to the financial viability of these first generation ventures, particularly in the form of insurance costs and product durability, the base concept is sound and will play an important role in mobility going forward. This is particularly apparent in urban settings, where the insights derived from this initial scaling up of micromobility made clear the realities of existing vehicle infrastructure.

What micromobility growth demonstrated was that the size of both the vehicle and the infrastructure required to move people around in cities, where average trips were less than a mile, was vastly less than people imagined. Not only were bikes more efficient than cars, dockless bike rental was far more efficient than planned systems provided by local authorities. Where, effectively, the latter limited itself with fixed locations and expensive hardware, the former's app-based system merely required a painted line, or even less.

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The permanent lesson from micromobility is that the amount of physical infrastructure required will continue to reduce over time through efficiencies offered by software and data. This will apply to both public and private transportation.

Electric Vehicles: The Impact Driver

In terms of design, superficially, electric vehicles (EVs) look similar to their internal combustion engine (ICE) counterparts and are less futuristic than the notion of self-drive. Despite this, the ripple effects EVs will have on the world's economy are profound and, unlike fully autonomous transportation, are a near certainty.

Evolving OEMs

One of the most notable indicators is vehicle parts. EVs have substantially fewer, with the parts themselves completely different from traditional ICE vehicles. Considering traditional dealer models rely heavily on post-sale maintenance, the OEM and dealership model—a regulatory requirement in the US—will be under strain.

Traditional OEMs expertise is centered around the management of large supply chains as well as internal combustion engine know-how. Increasingly, this will shift to the management of direct distribution and expertise in software and battery-based technology.

Fuel Fundamentals

Clearly, one of the biggest impacts of EVs on mobility ecosystems is the use of a different type of power. An entirely different fuel source will require an equally different system. The oil industry as a whole, from drilling and refining to shipping and end-user delivery, will be forced to reconfigure independently of climate change pressure. Such a fundamental shift will affect all aspects of the oil ecosystem from drilling and refining to distribution.

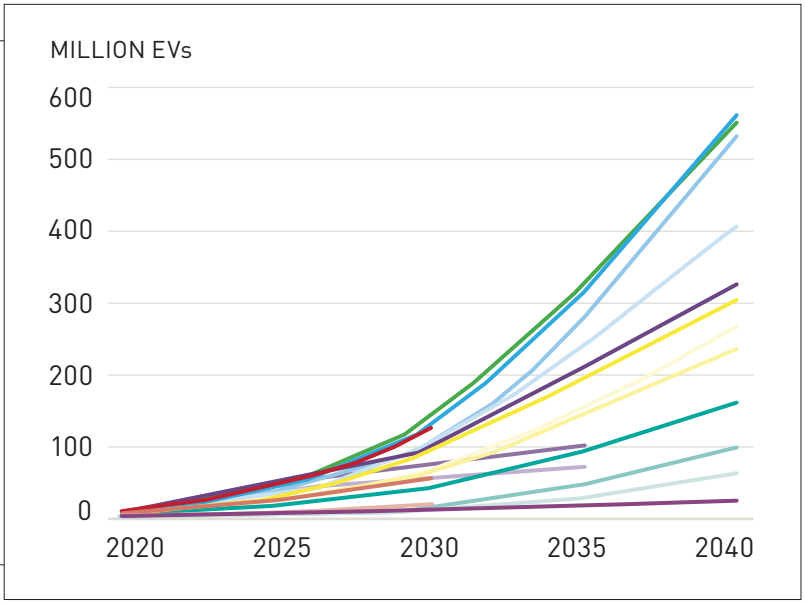
This evolution has been incentivized further by the inability of the industry to respond adequately to global demand shocks and oil producer price wars. The 2020 pandemic has laid bare the inefficiencies of a fossil fuel-reliant energy system, showcasing what can occur when oil-producing nations engage in price-war gambits—namely Russia and Saudi Arabia's ill-timed supply dispute, followed by a further cratering of demand that produced such a supply glut that even West Texas Intermediate (WTI) oil futures turned negative temporarily for the first time in history.[19] [20]

This brings to light yet another reason why EVs play a vanguard role in fostering this renewable fuel future. With the proliferation of EV increasing demand for batteries, the development of low cost batteries will offer a solution for the problems associated with the storage of renewable generated, non-continuously available or unpredictable power such as wind and solar.

According to McKinsey's 2019 Global Energy Perspective, electricity consumption will double until 2050 and, by 2035, renewables will account for over 50 percent of total generation. Further, economists estimate that EVs will reach cost parity with ICE counterparts in the early 2020s, while their share of sales will grow to 57 percent of the sum total by 2040 (including 81 percent of municipal bus receipts), resulting in an oil demand reduction of over 13 million barrels a day.[21] [22]

EV outlooks then and now[23]

- BNEF, 2019
- BNEF, 2018
- BNEF, 2017
- BNEF, 2016
- BP, 2018
- BP, 2017
- BP, 2016
- OPEC, 2018
- OPEC, 2017
- OPEC, 2016
- Exxon, 2018
- Exxon, 2017
- Exxon, 2016
- IEA, 2018
- IEA, 2017
- IEA, 2016
- EIA, 2019 (US)



We consider these conservative estimates. In fact, when all factors are taken into account, including potential secondary effects and requisite resiliency gains, EVs could help lead to a full 10 percent shift of the world's economy, with accompanying disruption that rebalances both the global economic and geopolitical axes.[24]

EVs could help lead to a full 10 percent shift of the world's economy, with accompanying disruption that rebalances both the global economic and geopolitical axes.

EV's impact on 10 percent of world's economy:

- Disrupt all dealers as cannibalizes profits from maintenance
- Different OEMs and parts manufacturers
- Different supply chain
- Different energy supply chain
- Oil extraction refinement, shipping, distribution.

Significant percentage of world economy will be disrupted.

Towards an Internet of Energy

Such large impact potential must also be measured against the infrastructure that it will rely upon eventually. The current grid infrastructure will not be able to cope with the demands of EV charging. This means that a proliferation of EV tech must coincide with a modernization of electrical grids.

On the surface this may seem like a near-insurmountable task, but the reality is that the rise of EV itself could be the catalyst to a cost-effective grid upgrade. With large scale battery production comes requisite efficiency gains, and the ability to store electricity in batteries adequately will result in more renewable energy flowing into the grid without concern over intermittency or negative rate scenarios. In doing so, what was considered a vulnerability, ultimately providing efficient on-demand energy, will be bolstered.

In effect, this will push us towards an energy ecosystem that looks less like a traditional hierarchical national grid (the energy equivalent of a rail system) and more like a fractal network of interconnected microgrids, whose topology looks more like the internet than today's grid. This will make use of the same model that has made the movement of goods via container shipping or information via the internet massively efficient i.e. modular units (packets or batteries) able to travel from anywhere to anywhere.

Additionally, beyond the obvious (and necessary) environmental benefits of a transition to electrictrified mobility, the operating systems and supply chains needed to maximize the effectiveness of this transition will also provide supplementary benefits through more extensive data collection and usage, realtime analysis and secondary markets for commodities like excess energy to be sold back to the grid itself. Consequently, this provides the building blocks to create a true free market for energy.

Projections see this occurring relatively quickly, with European researchers noting that the decentralized approach to energy system control and operation that is offered by what they themselves termed the "Internet of Energy" is likely to become ubiquitous as early as 2030.[25]

Self-Drive Transportation: The Infrastructure Play

Although high-speed passenger rail has traditionally strong political capital, particularly in Europe and China, with the latter undertaking recent large scale developments, at Anthemis, we do not see this as the ideal future scenario.

...it is the building of more roads between cities that will provide equally fast and ecologically sound transportation, while being more adaptable and much cheaper to implement.

Partly informed by the recent rapid shift in public health concerns—which, inevitably, include the safety of public transport—it is Anthemis' contrarian view that, rather than continuing to expand the hierarchical system of passenger rail as the long term solution, it is the building of more roads between cities that will provide equally fast and

ecologically sound transportation, while being more adaptable and much cheaper to implement.

Our reasoning? Primarily, it is related to the potential (and realities) of self-drive technology within the EV systems that we see as the future of global mobility.

First, the potential: self-driving can provide automated travel that maximizes safety while minimizing human effort and error and, as self-driving can deliver people and goods more directly than rail or air, all with attractive travel times.

Now, the reality: while self-driving has come a long way in a short amount of time, currently, there is an enormous gap between fully automated vehicles and those at Level 4, the second most sophisticated self-drive mode. In fact, we are highly unlikely to see fully autonomous (Level 5) vehicles on the road any time soon—if ever. The Waymo chief himself echoes this view by stating that "Level 5 fully autonomous vehicles will never exist."[26]

This is where infrastructure comes into play.

Why self-drive may never happen:

- Not really an incremental technology
- Levels 1, 2, 3 and 4 are fancy cruise control—the level of automation can be frustrating
- Level 5 is everything
- Level 5 is much, much harder than Level 4
- But there may be a way...

Robo-Roadways

With the understanding that fully autonomous transportation is improbable on existing roads, yet still extremely valuable for mobility over the long term, the logical roll out for self-driving vehicles will be in constrained environments where the equivalent of full autonomy can be reached with current technology.[27]

These environments in urban settings can include campuses, docks and other structured, semi-closed systems, but the most notable use case is in the form of dedicated high-speed lanes on highways, which the Chinese have already built between Beijing and one of its satellite cities.[28]

These autonomous lanes would allow compatible smart vehicles with self-driving transponders to access this intelligent highway. Dedicated high-speed lanes would allow for speeds of more than 120 mph at far less cost and disruption to existing communities than its high-speed rail counterpart, along with greater adaptability in routing due to less severe radii and grade levelling constraints.[29]

What would it cost?

Hyperlane vs high-speed rail infrastructure costs

$139 million per mile

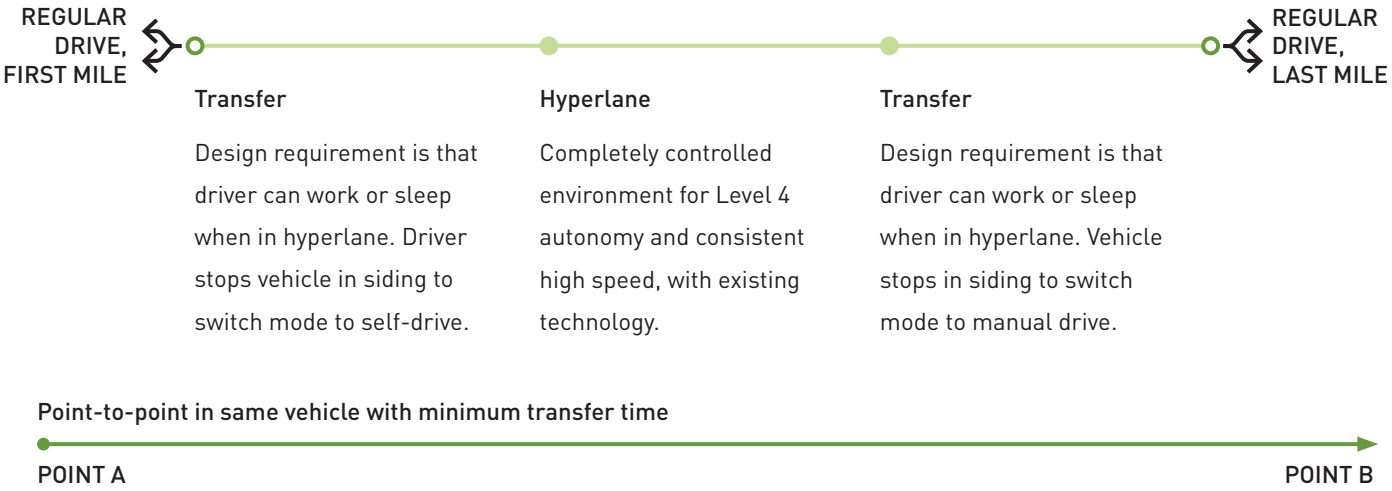


$12 million per mile*



* June 2017

How it would work:



Further, since transition sidings would allow switching from self-drive to driven mode, the same vehicle could be used point-to-point, in a somewhat similar way to the Channel Tunnel model, allowing for times from departure to destination between cities to rival that of short haul flights.

Autonomous 18-Wheelers

One of the most immediate and impactful uses of self-drive technology and autonomous infrastructure will be the trucking industry. An $800 billion sector in the US alone, trucks are critical to the movement of goods and, by automating this movement, extensive benefits will be seen in the form of increased safety standards, lower fuel consumption and optimized traffic management and route planning, amongst others.

Part of the push for autonomous trucks is their ideal operating parameters. Commonly systematic and predictable—and influenced by straightforward business objectives versus complex personal ones—trucking movement tends to be a simpler process. This has led strategists to assume that the freight industry could skyrocket revenue while saving nearly $170 billion in operating costs annually.[30]

Many established companies and startups have taken note of this advantage and are investing heavily in autonomous trucking. One of the major players is Volvo, a legacy automaker that is looking closely at new mobility trends and positioning itself to take advantage of this new mobility future.

The company views automation as a key evolution in logistics and supply chains, and has developed several autonomous initiatives, most notably its Vera system, which focuses on short-distance EV coordination—beginning with port transportation—and with the goal of expanding to highways and interstates.[31]

Infrastructure, Logistics and Services: The Last Mile

Investing in Infrastructure

As oil becomes largely obsolete rather than running out, large scale reinvestment from oil producing states takes place.

The world's largest sovereign wealth fund, Norway's $1 trillion oil proceeds-based pension fund, has officially ceased investments in fossil-fuel related companies currently, implementing a new directive that calls specifically for investment in renewables infrastructure, even where the companies are non-listed.[32]

Similarly, revenues from the world's largest company, Saudi Aramco, are being used to fund renewables-based infrastructure projects, which can be considered hedge investments to the increasingly at-risk oil profits they have enjoyed over the past century. The energy sector governing much of the Middle East and North Africa (MENA) will also gather nearly $1 trillion in investments over the next five years, largely driven by a pivot to renewables.[33] [34]

However, the biggest of the infrastructure projects is China's Belt and Road Initiative (BRI). Launched in 2013 as "one belt, one road", the BRI involves China underwriting billions of dollars of infrastructure investment in countries along the original Silk Road linking it with Europe. The initiative aims to improve connectivity and cooperation on a transcontinental scale. Potentially, this massive undertaking could herald a macro shift from West to East as significant as the discovery of the New World and the closure of the Silk Road.[35]

A Closer Look at Logistics: Services and Shipping

At a smaller—but nevertheless still globally significant—scale, logistics innovation is occurring in unison with infrastructure investment as corporate entities look to improve efficiency and, increasingly, the post-pandemic resilience of supply chains.

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Much of this corporate innovation is coming from three areas: the large scale platform technology companies (notably Amazon and Alibaba), organizations with novel approaches to supply chains (such as Apple or Inditex) or tech-driven startups, such as Flexport.

The lion's share of the opportunity for the use of data and services for mobility is in supply chains and the movement of goods, as opposed to passenger mobility. The latter has received more attention, such as Bird's integrated payments systems being broadened to purchase things outside of scooter rental although, from the viewpoint of Anthemis' investment thesis, a strategy such as Bird's may not work as it is trying to use embedded finance for distribution i.e. to expand its market.

1. Invest in distribution via financial—or more likely non-financial—services applications that have large markets and low customer acquisition costs, and/or

2. Invest in plumbing via financial services that can serve efficiently a fragmented market of distribution providers with something that increases customer lifetime value.

For mobility providers looking to create strategic advantage, a sweet spot may be the overlap between embedded financial services in business (logistics and supply chains) served by those with software platform expertise. An example of this would be fourth generation enterprise resource planning (ERP) software, which integrates ledgers over an entire supply chain, across providers.

All this considered, it is on shipping where innovation in data and logistics can have the most immediate impact. This makes sense for three primary reasons:

1. Container shipping means that the network model for shipping lends itself naturally to innovation

2. Lack of transparency in shipping due to maritime law means that there is substantial room for innovation in data

3. The vast majority of the world's goods (90 percent) are shipped by sea, so the market is the largest—and therefore the most predictably scalable.[36]

Unlike air freight, where high transparency allows for leverage of data to create supply chain efficiencies, maritime law makes this data capture difficult. Until recently, it was not practical or cost-effective to have per container or per package continuous tracking globally in real time, but one of the few IoT use cases that transcends the hype is the ability to integrate data from the world's shipping network into its own supply chains to reduce waste and greatly boost efficiencies.

Future of Finance: Embedded Opportunities

Insurance and the Shifting Risk: Smaller Markets | Realtime | On-Demand

As passenger mobility patterns change in several ways from ICE car ownership to EVs and to a range of lighter EVs for an ever-increasing percentage of the world's urban populations, mobility insurance will coincide with that shift and create unique opportunities for startups. Meanwhile, post-pandemic there may be a reversal of the trend to mobility as a service as people are less likely to want to share spaces.

Primarily, the market opportunity for innovators will rely on expertise in the two areas of competitive advantage for the auto industry: car operating systems and batteries. These opportunities can be focused both on systems and supply chains or be completely left field and serve secondary changes to the wider ecosystem e.g. changing patterns of energy generation and use triggered by the widespread use of batteries.

Primarily, the market opportunity for innovators will rely on expertise in the two areas of competitive advantage for the auto industry: car operating systems and batteries.

As vehicle sensors and telemetry increase, and maintenance and usage data is more available, financial services will become more directly embedded in mobility products and services, eventually providing seamless realtime financing, maintenance and insurance.

In terms of driver/passenger coverage, new market entrants will be able to insure on a much more granular per-use basis as well as across multiple modes of transport for single trips.

For insurance incumbents, particularly those with existing business lines, the story is more complicated. Since the efficiency of vehicle use and safety will increase, while the number of moving parts in vehicles will decrease, the result is that there may be less risk to insure per capita. Expanding market opportunity will require moving into growing markets comprised of emerging middle classes that are more mobile.

Despite this longer term trend, there may be short-term volatility. It is likely that risk will continue to enter the system through novel products that carry more uncertainty, in addition to the unfortunate trend of driver distraction cultivated through the ubiquitous use of devices and products that compete for people's attention, even on the road.

For freight, logistics and business transportation, the insurance opportunities are interesting—yet largely overlooked—due to a more complex and less seductive story than the exciting promise of a self-drive, on-demand future. For instance, the ability to track inventory through an entire chain will allow for unique opportunities through the transportation of perishables, parts or any goods reliant on special environmental conditions, such as unbroken cold chains.

Further, there is an opportunity to improve both the efficiency and resiliency of logistics and supply chains, the latter a primary concern following the extensive supply and global health shocks caused by the COVID-19 pandemic. For example, secondary inefficiencies in supply chains, such as parts being late for delivery, can be insured better through vast improvements in visibility and tracking, with competitive advantage going to the next-generation ERP system providers that serve integrated supply chains as a whole, rather than company-by-company.

This market will expand on a per capita basis as more goods are delivered via online services, where there is plenty of room to grow, considering its current 15 percent market share of commerce. This will be amplified greatly by the new vehicles and delivery mechanisms that will appear particularly for the last mile both in rural (e.g. drone delivery of medicine) and urban situations (e.g. fleets of reduced size electric delivery vehicles).[38]

The Microinsurance Process

Today, we have insurance on the stuff we own. But the autonomous and ride-sharing shift moves us from 'car-as-property' to 'car-as-service', removing the need for consumer-facing auto insurance altogether. This transition is independent of whether cars as a service means many users of the same vehicle or one user—as may happen more, post-pandemic. Companies such as Waymo provide passengers with insurance automatically every time they step inside one of their vehicles. And it is an assessment made with a confidence that comes from big data.[37]

The process operates by providing modern fleets and multimodal transportation with on-demand insurance that utilizes realtime data from connected vehicles to match each moment's level of risk with the appropriate level of insurance coverage, down to the second.

Commonly, this is supplemented with end-to-end digital claims management accessible on any smart device and can be tailored to fit a wide range of transportation methods, from scooters to cargo and freight.

In terms of resiliency, providing transparency and data-driven insights will allow stakeholders to adapt to adversity at a much faster pace. Identifying pain points in real time and having direct access to shared databases will provide a critical backstop to what Anthemis has observed to be extremely fragile systems when met with unintended adversity.

In terms of resiliency, providing the transparency and data-driven insights will allow stakeholders to adapt to adversity at a much faster pace.

Financing New Infrastructure Models: Capped Returns

While data-driven financial services will be a critical element of new mobility, another key consideration is the financing of the infrastructure that will help increase further the efficiency of these systems.

In this case, the French model of private investment in and operation of freeways, with capped returns before the infrastructure is returned to the state, would be a suitable model for financing innovative systems such as dedicated self-drive lanes. Secondary trading of securitized instruments would allow for broad investment in green infrastructure through the policy of building more, not fewer, roads for electric vehicles between cities.

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With the understanding that car use drops dramatically in dense urban environments, there will be growth in intelligent mobility systems with less visible infrastructure but, between these cities, an ideal path to develop smart systems on a larger scale is evident, leading ultimately to one of Anthemis' contrarian investment theses that self-drive systems are an infrastructure opportunity.

New Vehicle Sales and Ownership Models: Wholesale versus Retail

Traditionally, car sales have relied on a wholesaler-retailer model where, in the US, states prohibit direct OEM sales through franchise laws requiring new cars to be sold only by licensed, independently owned dealerships.

Although gross profits from each sale can be around $2,000, actually, this results in a net loss, requiring car dealers to make money from financing (approximately 2.8 percent net profit from new cars, 3.7 percent from used) and after-sales maintenance (15.9 percent net profit).[39]

With the complexity of the automobiles themselves, dealers have been able to maintain healthy margins up to this point, but the rise of electric cars has completely changed the landscape. Since EVs have 80 percent fewer moving parts, the margins around maintenance are threatened existentially yet, even so, there are some compelling opportunities around financing, specifically when it comes to batteries.[40]

Currently, electric cars are more expensive to purchase but much less expensive to run. With the battery being the single most costly part of an EV (currently 35–4 percent%), making it a rental cost would essentially create a CapEx/OpEx split for EV ownership more in line with traditional ICE cars, allowing therefore an apples-to-apples cost comparison. Selling cars with the battery broken out as a rental expense was an early-stage model experimented with by Renault; although it was abandoned, it remains potentially viable as technology scales.[41]

Supply Chain Financing, Logistics and Payments: Software, Batteries and Subscriptions

As noted, traditional OEM competitive advantage has been centered on hardware design, parts assembly and management of supply chains, all of which revolved around expertise related to internal combustion engines. As the number of car parts decrease rapidly and systems and sensors become ever more important, companies like Tesla have shown that the principal areas of future advantage are in software and batteries, while also highlighting that many existing car manufacturers will be unable to compete on either front.

Software Ecosystem

While a sufficiently large and sophisticated software development ecosystem exists in the US, this is not quite the case in Europe, where many OEMs are at risk of struggling to create the kinds of future telemetry and sensor-enabled car operating systems that are required. This situation has the potential to lead to a repeat of the recent past when they failed to keep pace with innovation in car entertainment and navigation interfaces, overtaken by much more user-friendly and cost-effective IOS and Android smartphones with similar capabilities.

Direct-to-Consumer Model

While another adverse effect of franchise laws is the barrier to entry for new entrants and startups, some have figured out how to carve their own niche. Selling direct is the model championed by Tesla, who got around US law by opening showcase stores in city centers with a highly experiential design, much like Apple stores. Rather than traditional salespeople, Tesla employs non-commissioned Product Specialists who do not negotiate price directly.

This is something that some OEMs have tried in a limited way—but they also have to be careful to keep their existing dealerships happy. By rejecting the traditional limitations created by the hierarchical franchise model, rising carmakers like Tesla are redefining the industry by becoming a 'one-stop-shop' carmaker, hardware manufacturer and tech platform.

Battery Manufacturing

On the battery side, 97 percent of planned gigafactories are located in Asia, whereas only 1 percent are planned in Europe, meaning that a core component of the car manufacturing ecosystem is dependent on Asia—more specifically China—running the risk of traditional Western powers losing their influence in global supply and innovation chains. This could be due partly to Europe's risk-averse nature, in addition to the large price tag, where it is estimated that the 1,200 gigawatt-hours per year required by 2040 will require a total investment of approximately $150 billion across Europe to manufacture the necessary cells.[42]

Subscriptions: Finance, Supply Chains and Logistics

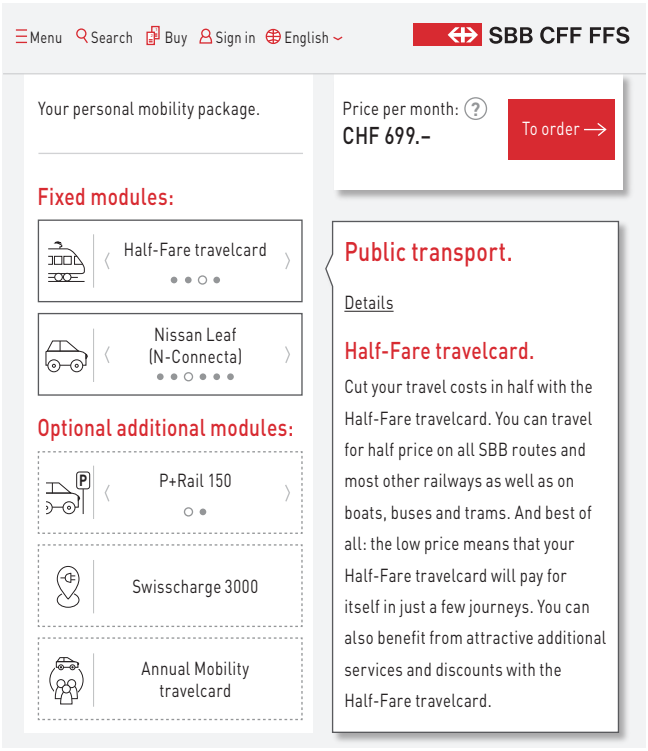
The innovation in urban mobility (Uber, Bird) has led to many car OEMs looking at broadening their offering into packaged subscriptions and multimodal mobility services. In this model, a flat fee takes a passenger from A to B for a fixed cost, via a variety of means or on-demand local car rental services such as BMW's Drive Now.

This begs the question as to what the core competency of OEMs is—whether a car company is better set up to run a local bus service or to manage a supply chain and assembling complex products.

The Swiss Model

Multimodal transportation offerings already exist, such as in Switzerland, where a flat fee gives access to an electric car, unlimited rail, parking, taxis and micromobility options, all with bundled insurance, offered by the Swiss national rail service (SBB).[43]

The SBB Green Class card gives Swiss residents the option to choose public transport with an electric car model of their choice. Car servicing, toll stickers, tax and insurance are all included in addition to select modules such as car charging stations, car or bike sharing, all while helping the environment with these sustainable options.



Swiss national rail service's bundled mobility offering.

120 mph Appliances

Taking a broader view of OEM expertise in sourcing, managing and financing complex supply chains allows for expansion into the broader area of supply chain financing and logistics. For example, as cars switch to electric, the expertise of the OEMs is less around the production and design of ICE engines and more about the assembly, management and procurement of complex products that become more and more similar to appliance manufacture.

These synergies drove Gree Electric Appliances Inc., the world's third largest home appliance manufacturer and China's largest air conditioner maker, to place an offer on EV company Zhuhai Yinlong New Energy Company to diversify its business and take advantage of future trends.[44]

The Future of the New Mobility Ecosystem

Taking the past into account, as well as secular changes such as climate change, a realistic vision of the new mobility ecosystem can be developed, its implications and how to get there; however, current uncertainty caused by the pandemic means that there is now a range of scenarios for the future.

Reimagining the Mobility Ecosystem

As shown, industrial-era, hierarchical structures have dominated energy and transportation up to this point. But, we are now in an era defined by networks—structurally different from rigid hierarchies. This may be the model seen throughout future mobility ecosystems, from manufacture to infrastructure.

More specifically, the internet is not one network but a network of smaller, connected networks (hence the name); the traffic that flows on the internet is in modular packets.

The closest thing to this in mobility is container shipping, which revolutionized the world of trade. It is likely that these characteristics will play out in future mobility ecosystems and is why cars and roads—despite their association with CO_2 emissions, sprawl and waste—are a better model than rail for a future of autonomous, electric transportation.

The Internet of Energy

There is no true free market for electricity as the existing grid does not allow for it. However, EVs may help create it and it may result in something that looks structurally more like the internet than the current grid. This may happen because the current electricity grid will not be able to cope with the demand from EVs. However, EV use will drive down the costs and increase the supply of batteries. Since much of the new capacity that comes into the grid will be from renewables, and since renewable energy from things like wind and solar needs to be stored in batteries to make it available on-demand, EVs will create

a feedback loop that solves the problem they create and helps both create a new, smarter electricity infrastructure and hasten onboarding of renewables.

Eventually the cost-efficiencies of this model will make legacy systems of environmentally damaging energy sources, such as coal, prohibitively expensive, rendering them obsolete.

This is why the less conceptually seductive proliferation of EV tech is likely to be much more revolutionary than the—admittedly more exciting—prospect of a self-drive future. While autonomous vehicles capture the imagination, EVs are the ones that offer a real opportunity to disrupt up to 10 percent of the world's economy and help combat climate change.

Progress versus Cutting Back

Much of existing sustainable policy traces back to the period before climate change became the dominant issue, when pollution reduction was paramount. As such, it is based on a mindset, not just of sustainability, but of cutting back consumption.

It is now known that cutting back energy consumption will not be enough to prevent climate change and, despite the dramatic improvements in carbon emissions due to widespread lockdowns, there is empirical data to show that even shutting down the entire global economy would not be enough and that it could cause extreme hardship to millions of the most vulnerable people in developing countries.

So, we need to still use energy and create working economic systems but this needs to be done sustainably and as an absolute imperative, with dramatic reductions in carbon emissions. And we need to do it quickly. The world needs to switch to renewables as swiftly as possible—this will require an acceleration of progress and technology.

A seemingly contrarian view, this idea relies on the educated assumption that more demand will force swifter change due to the

financial and environmental stakes involved. While this is a complete shift in mindset from traditional green thinking, it has gained traction, recently being championed in a Financial Times op-ed by Martin Wolf, who asserted and endorsed the idea of solving climate change through growth and increased energy consumption.[45]

In Anthemis' view, the large scale switch to EVs creates a suitable catalyst for this switch to renewables at a faster rate and so is of huge societal importance beyond mobility.

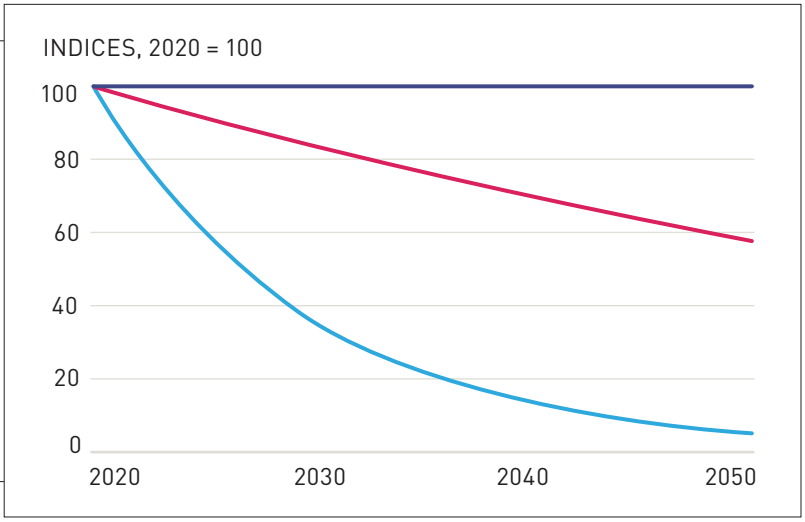
The Logic for Consuming More

1. Cutting back will not solve climate change.

Global economic stagnation would not solve the climate challenge

- Stagnant GDP
- Total emissions, if emissions per unit of output fall at 1990–2018 rate
- Total emissions, with emissions per unit of output falling at 9.5% pa

Source: FT analysis. ©FT

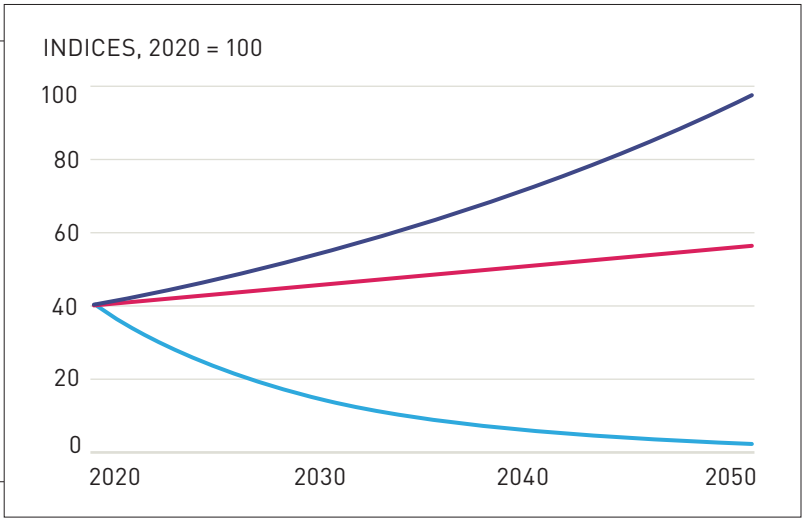


2. Massive technological transformation is needed, which does not just correlate with, but is a direct result, of energy consumption.

Eliminating emissions requires a huge technological transformation

- GDP with 3% growth pa
- Total emissions, if emissions per unit of output fall at 1990–2018 rate
- Total emissions, with emissions per unit of output falling at 12% pa

Source: FT analysis. ©FT

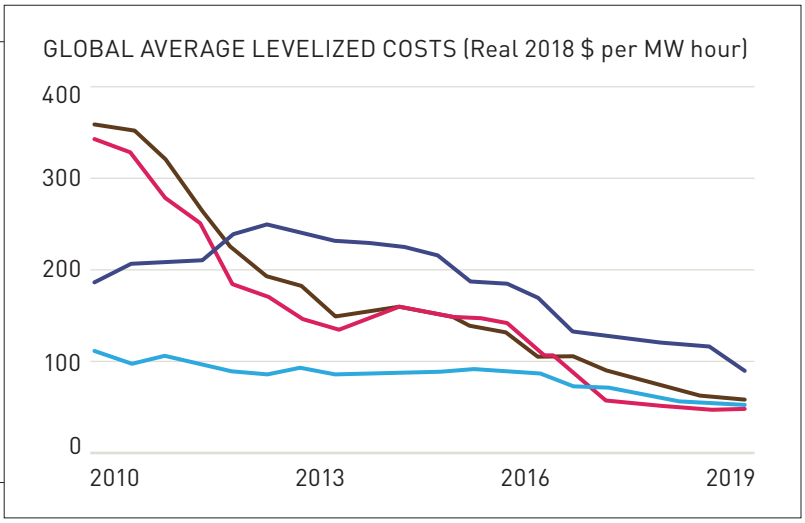


3. With demand, the switch to renewables has to accelerate and the most sustainable way to do this is to innovate to make them cost-effective.

The falling costs of renewable electricity

- Offshore wind
- Onshore wind
- Solar (utility PV), no tracking
- Solar (utility PV), tracking

Source: Energy Transitions



Post-pandemic

In many ways, the future of mobility was relatively straightforward before the COVID-19 pandemic. It was largely about EVs and to what extent self-drive was going to happen.

Although nobody knows yet whether the effects of the pandemic will be medium or long term, it now looks as though there will be large scale changes to air travel, public transport, where people live, work and vacation, and where goods are sourced and manufactured. By implication, this changes the way people and goods move around.

Video conferencing software is now a bigger sector than large parts of the airline or automotive sector. People may make partial commutes, occasionally from exurban areas around major cities and this may be by car rather than train. Within cities, active legislation may move to large scale pedestrianization and cycling but, if public transport capacity is reduced massively then other forms of lightweight EVs from e-bikes to low-speed, compact electric scooters and cars may become more prevalent and result in new designs and form factors.

These are just some of the threads of the many scenarios that are emerging, which will not crystallize into known trends until more is known about the societal and economic impacts of the pandemic.

Conclusion

The future of mobility is smarter, networked and modular, fueled by renewables and operating on reduced, equally smart infrastructure for transportation, energy storage and transmission, to achieve both efficiency and resilience in travel and logistics.

In Anthemis' view, achieving this end relies on two primary tenets:

1. Cars and roads may disappear from city centers, but will become more important elsewhere, particularly between urban environments.

2. The secondary effects of EV technology are transformative.

In summary:

In city centers, privately owned cars may disappear altogether, replaced by a whole range of different options from ride-hail to e-bikes. If the pandemic creates long term reduced use of public transport, bicycles and scooters will not be sufficient for older or more vulnerable people or many families, so newer types of non-shared, low-speed EV will be needed. Outside cities, cars and roads are more important than people realize and, to meet future energy demand, car transportation between cities may be preferable to rail, which is costly. Although full Level 5 self-driving may never happen, autonomous vehicles may. Developing dedicated lanes on intercity highways could allow for cars and freight to compete with rail, even match timelines of regional short haul flights.

Adding to this is the flywheel effect of EVs, which will allow for low-emission travel, scaled battery production and integration with car operating systems and larger networks. In turn, this will bootstrap the process of transformation of current energy grids to those compatible with renewable transmission and a wider range of providers and flexibility that, structurally, looks much more similar to the internet than today's grid—which Anthemis refers to as the 'Internet of Energy.'

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OFFICES

London
3rd Floor
25 Soho Square
London, W1D 3QR, UK
+44 20 3653 0100

New York
122 Hudson, 3rd Floor
New York, NY 10013, USA
+1 646 757 1310

Luxembourg
15, Boulevard F.W. Raiffeisen,
L-2411 Luxembourg,
Grand Duchy of Luxembourg

Geneva
Quai de l'Ile 13,
1204 Genève, Suisse