MOVING ELECTRONS:

Rethinking Transportation for a Cleaner World

What we're seeing in the early-stage clean energy startup market

May 2018

VillageCapital

Insight Report

in Association with

AUTODESK. FOUNDATION

TRANSPORTATION ISN'T GOING ANYWHERE.

We're never going to stop moving: transporting people, food and other goods from place to place. In fact, thanks to a growing global middle class, we're moving more than ever. But we can get smarter about it.

In the past century we've evolved from steam engines to gas-guzzling carburetors to electric motors, and now we're putting those electric motors in the sky. We're re-learning how to recycle things, and finding new ways to conserve energy.

Still, **this year transportation became the single biggest source of carbon dioxide emissions**. More children get asthma from cars, trucks and planes than from power plants. We need to keep innovating.

At Village Capital we've invested in clean energy innovations like solar panels and hydro generators. But the startups in our Energy US 2018 program are a bit different. They're focused not on the creation of energy, but on its application:

THE MOVEMENT OF ELECTRONS.

Allie Burns
Managing Director, Village Capital

VillageCapital

Village Capital's mission is to reinvent the system to back the entrepreneurs of the future.

Since 2009, we've run programs for more than 1,000 entrepreneurs that are creating an inclusive and sustainable world, and facilitated investment in more than 90 program companies.

Clean Energy is one of our five core sectors.

76 clean energy program graduates

18 clean energy investments

50 MILLION+ lbs of CO2 emissions offset

VilCap Investments - Clean Energy Portfolio highlights:

emrgy

Emrgy - Village Capital Energy US 2015
A 21st-century hydropower plant

America's hydropower infrastructure is crumbling. The average hydroelectric dam is over 50 years old, and new dams can take a decade to build.

Village Capital graduate Emily Morris has invented a new kind of hydropower plant - scalable, mobile and quick to set up and break down. Each 10 kw unit generates 200 kWh per day, enough to power seven homes. "We can't control when sun shines or wind blows, but we can utilize waterways at any time," she says.

iDLE SMART

Idle Smart - Village Capital Energy US 2016
A smart thermostat to cut down on truck idling

Tens of thousands of trucks sit idling every day, wasting fuel and polluting the air.

Village Capital graduate Jeff Lynch has created a smart thermostat that slashes idle time by 50% to 70%, by only running the truck when necessary to maintain cabin temperature, recharge batteries, or warm the engine. The smart controller is already preventing millions of gallons of fuel consumption and associated CO2 pollution.

LEARN MORE AT VILCAP.COM/ENERGY

Our 2018 Program

Our programs connect high potential, early-stage entrepreneurs with the people, institutions, and capital they need to scale.

WORKSHOP 1 - ATLANTA

Local host: ATDC
Local partners: ATDC and Engage Ventures

Focus: Customer discovery, market sizing and analysis, and milestone planning

WORKSHOP 2 - LOS ANGELES

Local host: LACI

Focus: Impact metrics, human capital strategy, and product demos

WORKSHOP 3 - BOSTON

Local host: MassChallenge and OpenView Venture Partners

Focus: Investment-readiness

Program Advisory Board:

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UPS

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Our 2018 Program - Companies

METRICS CATEGORIES:

Civic Infrastructure: Getting people to schools and hospitals more efficiently.

Recycling: Converting waste into new materials

Fuel Efficiency: Improved mileage for vehicles

Preventing Pollution: General reduction of CO2 emissions

Electric Vehicles: Innovations around battery-operated vehicles

Waste Reduction: Reducing waste from transportation

AMPAIRE

Ampaire is on a mission to provide the world with all-electric powered commercial flights that are affordable, quiet, and environmentally conscious.

Learn More

PEER-SELECTED

goKid

GoKid is the complete carpool solution for schools, teams, and active families—allowing parents to share driving responsibilities with other families they know and trust.

Learn More

Helix Power

Helix Power is building next generation advanced flywheels for megawatt scale power burst management in metro transit, and industrial applications.

Learn More

ONBOARD DYNAMICS

Onboard Dynamics seeks to lower fuel costs and carbon emissions by removing infrastructure barriers to driving natural gas powered vehicles.

Learn More

opconnect
Electric Vehicle Charging System

OpConnect provides EV charging infrastructure solutions that enable the owner/operator of chargers to manage, monetize, and leverage them.

Learn More

Sensatek
Propulsion Technology, Inc.

Sensatek Propulsion Technology offers a wireless solution that helps engine manufacturers save millions by extending maintenance intervals with real-time combustion data.

Learn More

UBICABUS

UbicaBus provides powerful analytics and data-driven insights that enable customers to cut transportation costs and manage their fleets more effectively.

Learn More

PEER-SELECTED

vartega

Vartega uses a chemistry-based recycling process to create high quality, low cost recycled carbon fiber for light-weight applications in automotive, aerospace, and more.

Learn More

Insights

The startups in Energy US 2018 were focused not on the creation of energy, but on its application - *the movement of electrons.*

Read on for trends that are driving the next big ideas across the energy-transportation nexus.

MAJOR SUBSECTORS

SUBSECTOR

Aviation

THE UPSHOT

The sector: Airline executives have a long collective memory of high-profile failures. Since 1979 more than 80 airlines have gone bankrupt due to high competition and low profit margins. New pressure from low-cost airlines has driven a race for new fuel-efficient technologies, with the goal to reach zero-emissions as soon as possible.

What it means for startups: There are rich opportunities for startups that operate, manufacture, and enhance low emission aircraft - whether commercial, government, military, or passenger. In the past twelve months incumbents have made major investments in enhanced manufacturing processes and electric propulsion. Still, battery technology lags behind other advances.

INVESTMENT ACTIVITY

Total Investment [1]

$2.53 BILLION total funding last year

27 EXITS

42 TOTAL DEALS

$60.2 MILLION average deal size

Major Exits in 2017 [2]

COMPANY	ACQUIRED	AMOUNT
Boeing	**Aurora Flight Sciences :** an aeronautics research company specializing in robotic aircraft	not disclosed
United Technologies	**Rockwell Collins:** an avionics and interiors maker	$30B
GE Aviation	**OC Robotics**: a manufacturer of commercial snake-arm software for engine inspections and repairs	not disclosed

THE SUPPLY CHAIN

Aircraft Manufacturers: Boeing, Airbus, Bombardier, Embraer, Tupoloev
Engine Manufacturers: GE Aviation, Pratt & Whitney, Rolls-Royce, Snecma, NPO Saturn, Honeywell
Parts Suppliers: Spirit AeroSystems, United Technologies, Precision Castparts, Héroux-Devtek
Airlines: American Airlines, Delta, Lufthansa, KLM, Southwest, International Airlines Group, United

DRIVERS OF INNOVATION

- **Growth of Air Traffic.** According to the International Air Transport Association, passenger air travel growth has outpaced global GDP growth for the past nine years, and air traffic worldwide is set to double over the next 20 years. [3] The trend is a product of a growing global middle class, deregulation and route expansions.
- **Lower Fares Boosting Demand:** Over the past decade airfares have decreased at an average of approximately 1% per year, [4] driven by the emergence of low and ultra low-cost airlines like RyanAir and Southwest. As demand has risen, airlines have focused on streamlining costs to sustain margins. This has reshaped industry dynamics, including new demand for single-class higher density planes and single-aisle fleets.
- **Emission Regulation:** Zero-emission technology is advancing with a burgeoning zero-emission regulatory framework. [5] The Air Transport Association is ten years into its promise to halve carbon emission levels by 2050, and in 2016 the United Nations corralled an agreement between 191 countries to curb CO2 emissions, though Russia, India and others did not sign on. [6]
- **Incumbent Partnerships:** Startups are partnering with incumbent firms and institutions to develop electric propulsion technology. Uber recently announced a partnership with Brazilian manufacturer Embraer to work on a line of air taxis.[7] Boeing bet on Zunum Aero to deliver hybrid-electric aircraft by 2022. NASA has teamed up with the University of Tennessee, the University of Pisa and the University of Cambridge for various R&D projects around electric propulsion. [8]

CHALLENGES

- **Battery Development:** Aviation startups rely on batteries, but they usually don't manufacture them (see next section). There are still limitations around semiconductor technology and circuit protection design, causing bottlenecks in battery development. To mitigate this problem, some startups are partnering with battery companies earlier on in the development process.

EXCITING COMPANIES

Ampaire
Ampaire designs and develops high performance zero emission aircraft that it sells to air carriers.

Sensatek
Sensatek Propulsion Technology offers a wireless solution that helps engine manufacturers save millions by extending maintenance intervals with real-time combustion data.

FGC Plasma Solutions
FGC Plasma Solutions uses plasma to stabilize combustion for a wide variety of lean combustion systems, leading to increases in efficiency and operability as well as decreases in emissions.

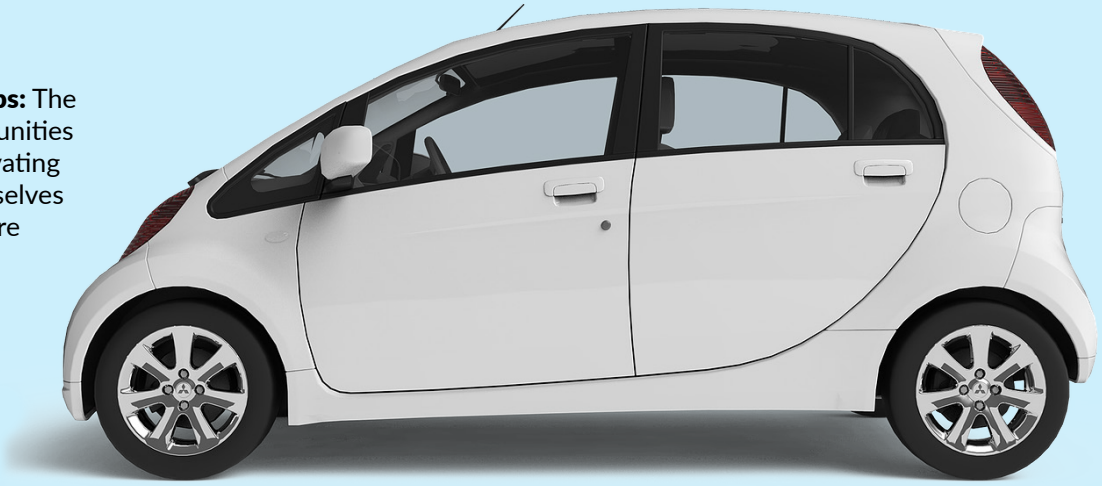
SUBSECTOR

Electric Vehicles

THE UPSHOT

The sector: The number of electric vehicles (EV) - defined as vehicles that derive all or part of their power from electricity supplied by the electric grid - has been growing steadily, passing the one million mark in 2015 and the two million mark in 2016. [9] The industry is positioned for sustained intermediate-to-long term growth, as governments commit to subsidize green technology and automakers continue to diversify their offerings. The global EV market, currently at $129 billion, is projected to grow to $393 billion by 2022. [10]

What it means for startups: The rise in EVs creates opportunities for startups that are innovating around the vehicles themselves as well as the infrastructure surrounding them. We'll focus on two markets: lithium-ion batteries and electric vehicle charging technology.



MARKET: LITHIUM-ION BATTERIES

For years, nickel-cadmium was the most popular material for batteries. But recently lithium-ion has replaced it as the battery chemistry with the most promising potential. Lithium-ion batteries are twice as dense as nickel-cadmium, have higher storage capacity, weigh less and have lower maintenance costs. This makes them popular for consumer electronics, but also particularly well-suited to charge and discharge electric vehicles, from cars to airplanes. The $31 billion market, currently dominated by China, Japan and Korea, is projected to grow to $68 billion by 2022. [11]

This rising demand creates opportunities for startups that manufacture the components of lithium-ion batteries, including the cathode, anode materials, separators, and electrolyte solutions. Still, there are challenges. Lithium comes from politically unstable regions, and despite advances, lithium-ion batteries are still very sensitive to heat.

MARKET: EV CHARGING TECHNOLOGIES

As the number of EVs on the road continues to rise, carmakers will need to simultaneously build the charging infrastructure. Charging stations are becoming much more common in cities, but they are still sparse in rural areas and expensive to install.

Government incentive programs have encouraged expansion of the grid, and so has improved cooperation between utilities, automakers, and consumers to manage energy flows. The market for EV charging technology is currently at $2.1B and projected to grow to $8.0B by 2022 at a CAGR of 30.7%. [12]

Startups are responding with technologies that ease the transition to smart grids and help utility companies, station managers, and consumers overcome grid stability limitations. Examples include mobile applications connecting EV users, SaaS-based models that monitor energy usage in a smart grid, and complementary platforms for charging fleets. Still, there are challenges, including regional variation in utilities.

Market: Lithium-Ion Batteries

INVESTMENT ACTIVITY

Total Investment [13]

$641.5 MILLION	55	$11.7 MILLION	3
total funding last year	TOTAL DEALS	average deal size	EXITS

Major Exits 2016 - 2017 [14]

COMPANY	ACQUIRED	AMOUNT
KPS Capital Partners	**C&D Technologies,** energy storage manufacturer	not disclosed
Warstila	**Greensmith Energy Management Systems**, a grid-scale energy storage software	not disclosed
Total	**Saft,** lithium-ion battery specialist	$1.1B, (2016)

THE SUPPLY CHAIN

Battery Manufacturers: Panasonic Corporation, Samsung SDI, LG Chem Power, GS Yuasa Technology, Toshiba, China BAK Battery

Cathode Suppliers: Shanshan New Material, Pulead, Reshine, Easpring, Jinhe, Tungsten,

Anode Suppliers: BTR, Shanshan Tech, Shinzoom, Sinuo, Zichen, HGL, CHNM

Electrolyte Solutions: Tagray, NEI Corporation, Silatronix, Sigma-Aldrich,

Separators: Hollingsworth & Vose, Daramic, Microporous, ENTEK Celgard

EXCITING COMPANIES

ADVANO

Advano
Advano is a material design company that enhances the energy density of batteries using scalable silicon nanotechnology for OEMs and battery manufacturers.

SiNode SYSTEMS

SiNode Systems
SiNode Systems sells anode materials to lithium-ion battery manufacturers and OEMs to enable longer lasting, faster charging batteries.

DRIVERS OF INNOVATION

Government subsidies funding production: Governments in America, Europe, Asia, and Australia are providing direct grants and subsidies to companies pursuing battery solutions to environmental problems. At the end of 2016, for instance, China announced a program to support domestic lithium prices, and in 2014, the European Union funded the LABOHR project, an initiative aimed at scaling up lithium-air batteries, which have longer range capabilities than traditional lithium batteries.

Lower Unit Costs: From 2015 to 2025, the cost of a single battery unit is projected to drop from $363 per kWh to $247 per kWh. [15] There are a number of factors: new technology, increased capacity utilization, and larger production volumes that disperse fixed costs like research and development.

Demand for Lithium-Ion Batteries in Grid-Connected Storage: Global sales of lithium-ion-based energy storage systems are projected to triple from 2015 levels of $2B to approximately $6B in 2020. [16] Battery manufacturers such as A123, Panasonic, Samsung, and Saft, are already producing grid-scale batteries.

CHALLENGES

Raw materials pricing is volatile. Modern lithium-ion batteries rely heavily on raw materials, and the nonferrous metals and minerals that power the batteries are valued at $7.7 billion.[17] These materials come from a small number of countries, and prices are vulnerable to regional developments. For instance, 65% of cobalt is sourced from Congo where conflict is common, 65% of flake graphite from China where labor mistreatment led to mines being shut down, and 75% of lithium is concentrated in Argentina, Chile, and Bolivia. The pricing volatility is counteracted somewhat by recent improvements in battery design and reduced processing costs.

Limited development of effective cooling systems. One major drawback of lithium-ion batteries is that they are extremely sensitive to high temperatures. Heat causes battery packs to degrade faster than normal. [18] Until this is resolved, lithium-ion batteries will continue to face challenges in warmer climates.

Market: Electric Vehicle Charging Technology

INVESTMENT ACTIVITY

Total Investment [19]

$396.4 MILLION	27	$15.2 MILLION	17
total funding last year	TOTAL DEALS	average deal size	EXITS

Major Exits 2016 - 2017 [20]

COMPANY	ACQUIRED	AMOUNT
Royal Dutch Shell	**NewMotion,** leading European EV charging provider	not disclosed
French multinational electric utility corporation	**EV-Box**, an international EV charging company with 40,000+ stations in 20 countries	not disclosed
Zapi	**Delta-Q Systems,** a battery charging provider for EVs	not disclosed

THE SUPPLY CHAIN

Software Solutions: EVBox, EVConnect, Chargetrip, Trilliant, Silver Spring Jet Charge, SKY Network, OpenEV, Coulomb Technologies

Charging Stations: Tesla, Car Charging Group, SemaConnect, PlugShare, ChargePoint, Envision Solar, Siemens, AeroVironment, BYD, Hong Kong EV Power, SORO Electronics, ABB

EXCITING COMPANIES

EVmatch

EVMatch
EVmatch is designed to serve urban and suburban EV drivers, including both battery electric vehicle (BEV) and plug-in hybrid electric vehicle (PHEV) drivers.

opconnect
Electric Vehicle Charging System

OpConnect
OpConnect sells IoT EV charging stations and a Platform as a Service (PaaS) to help utilities, municipalities, and employers manage charging stations and fleets.

DRIVERS OF INNOVATION

Rising electric vehicle adoption rates. The increasing penetration of EVs in the auto industry seems unavoidable. The United States government estimates annual plug-in EV sales of 1.3M by 2025, [21] and GreenTech Media predicts a total of 11.4M EVs will be on the road by that year. Bloomberg New Energy Finance projects that by 2040, 35% of all vehicles sold will be electric. [22]

Demand for smart grid solutions: The proliferation of EV chargers and charging stations is creating an increased need for smart grid solutions - electric grids that allow for two-way communication between a utility and its customers. Utilities, for instance, are actively investing in smart devices such as upgraded voltage regulators, communication networks, and capacitor banks.

Growing Chinese leadership. In the past several years the Chinese government has rolled out subsidies for EVs in an effort to reduce fuel imports and improve air quality, overtaking the US in the total number of EVs on the road (650,000) in 2016. [23] To support growing demand, the country has built 107,000 public EV charging outlets, significantly outpacing other countries. [24]

CHALLENGES

Regional variation in regulations and utilities. The EV industry is very dependent on regulation, and relies heavily on cooperation with local utilities. But regulations vary from region to region, and different utilities take very different approaches to infrastructure. The United States alone has several different models for charging infrastructure - company-centric (e.g., Tesla building a network of chargers), utility-centric (e.g., Pacific Gas & Electric), and third-party (e.g., NRG Energy). This makes it more burdensome for startups to expand regionally.

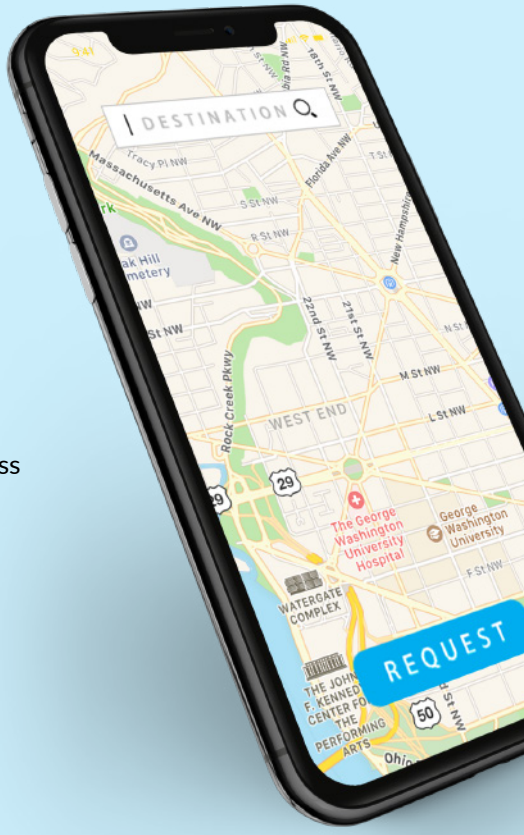
SUBSECTOR

Sharing Economy

THE UPSHOT

The sector: Ridesharing is becoming an integral part of our culture. The $36 billion[25] global ride sharing industry is poised for rapid, sustained growth, as governments continue to build out regulatory frameworks, consumers grow comfortable with self-driving technologies, and technologies like instant pricing and background check services become more efficient. The major players are exploring new services, like school carpooling, that involve cooperative partnerships with governments and civic organizations.

What it means for startups: This has created opportunities for startups that use data and machine learning to optimize the speed, logistics, and pricing of ridesharing operations. These opportunities will grow as ridesharing becomes even more integrated into civic life. There will be long-term challenges, like the cost-effectiveness of reaching rural areas.



INVESTMENT ACTIVITY

Total Investment [26]

$14.7 BILLION total funding last year

15 EXITS

189 TOTAL DEALS

$77.8 MILLION average deal size

Major Exits 2016 - 2017 [27]

COMPANY	ACQUIRED	AMOUNT
Gett	**Juno**	$200M (2017)
Didi Chuxing	**Uber China**	$7B (2016)

THE SUPPLY CHAIN

General: Uber, Lyft, Curb, Didi Chuxing, Grab, Ola

Carpooling: Carma, Zimride, BlaBlaCar, RelayRides, Sidecar, Ridejoy, Getaround

DRIVERS OF INNOVATION

- **Growth of ridesharing:** Ride-hailing right now comprises just 1% of total transportation. But consumer surveys show 63% of people [28] who use non-taxi ride-hailing services expect to increase their usage "a lot" in the next two years. There is also a large opportunity for applications like carpooling to school: approximately 57,000 schools in the US lack a bus system. [29]
- **Improved driver retention rates:** Turnover is rampant in the ridesharing industry, where drivers have a two-year turnover. Major ridesharing companies are hungry for ways to retain drivers, including startups that facilitate tipping, benefits, and coupons for drivers. In the long run, autonomous vehicle technology may virtually eliminate drivers, who currently make up roughly 50% of companies' costs. [30]
- **Civic partnerships:** Major ridesharing companies continue to get better at matching demand with supply. Several of them have begun working collaboratively with cities, schools and large employers to use big data and algorithms to solve pain points around group transportation. It is estimated that ride-sharing solutions for groups have the potential to capture one-third of the total addressable market of city commuting. [31]
- **Design improvements for specific categories of users:** Major companies have begun catering to new groups of users by modifying vehicle interiors. For instance, families require accommodations for children, and shoppers require space for baggage. OEM startups are beginning to innovate around interiors (e.g., foldable seats) to meet market needs.

CHALLENGES

- **Rural access**: For many consumers, driving yourself is still more cost-effective than sharing a vehicle. The average consumer break-even point is 3,500 miles per year [32] - driving more than this renders owning and using a vehicle more economical that using shared services. This is particularly true in rural areas: a McKinsey study found that the rural market composes 25% of underserved use cases. [33]

EXCITING COMPANIES

Go Kid
GoKid sells a mobile-first technology platform that facilitates carpool management directly to parents as well as schools, corporations, camps, and venues.

SUBSECTOR

Mass Transit

THE UPSHOT

The sector: The mass transit world has been buzzing with developments around Hyperloop, a system of reduced-pressure tubes that propel riders at speeds up to 700 mph. Meanwhile, IoT technology is leading to innovations around driverless cars, sensor-based technology and data applications that improve current mass transit options. The mass transit market is $72B and projected to grow to $104B by 2019. [34]

What it means for startups: There are countless opportunities for startups innovating around heavy rail, metro, subway, tube, or underground modes of public transport. Barriers include high capital expenditure, the importance of regulatory backing and municipal partnerships, and the ever-present questions of speed and safety.

INVESTMENT ACTIVITY

Total Investment [35]

$741.2 MILLION total funding last year

12 EXITS

5 TOTAL DEALS

$148.2 MILLION average deal size

Major Exits 2016 - 2017 [36]

COMPANY	ACQUIRED	AMOUNT
Alpenglow Rail	**VIP Rail :** a short line rail business	not disclosed
GE Transportation	**Iders Incorporation:** a data solutions company for the rail industry	not disclosed

THE SUPPLY CHAIN

Hyperloop: The Boring Company, WARR Hyperloop, Hyp-Ed, Swissloop

Small-Scale: Miovision Central, Swiftly, Moovit, Citymapper

DRIVERS OF INNOVATION

- **Growth of IoT into transit assets:** In 2016, Mercedes-Benz released the semi-autonomous Future Bus which employs radars and cameras to guide direction.[37] Intelligent, connected buses and shuttles are gradually becoming more common, paving the way for autonomous public transit by 2030.[38] Olli, the self-driving vehicle powered by Watson, is exploring possibilities to provide personalized shuttle services. And KONE, an elevator and escalator manufacturer, is investing in IoT technology that communicates real-time occupancy between buildings and transportation systems to help improve inner city mobility.[39]
- **Government incentives for mobility-as-a-service:** Big data and analytics tools have begun to improve the flow of information between pedestrians and providers of public transit, reducing congestion and waiting times. The US Federal Transit Administration recently launched a "Mobility on Demand" initiative to encourage cities and states to incorporate mobility-as-a-service into public transit systems in order to reduce congestion, which currently costs the country approximately $160B per year. [40]

CHALLENGES

- **Government roadblocks for large-scale projects:** Large-scale, cross-corridor infrastructure projects like Hyperloop need approval from multiple agencies (federal, state, city and county) just to reach the construction stage, including Environmental Impact statements and compliance with Federal Railroad Administration and Federal Highway Administration standards. The process is often met with delays. New Jersey and New York, for instance, have spent over 20 years to reach an agreement on building a single tunnel beneath the Hudson River.
- **Lack of reliable financing for large-scale projects:** Estimates show that updating the Northeast corridor railroad (run by Amtrak) would cost over $120B, not accounting for tunneling expenses.[41] Securing the financial backing for this type of project requires funding before execution, ideally from multiple sources. For example, the proposed five billion dollar XPressWest high-speed rail connecting Las Vegas and Los Angeles, announced in 2006, was sponsored by the private market, a federal loan, and a partnership with Chinese rail companies, but still has not gotten underway.

EXCITING COMPANIES

Helix Power

Helix Power
Helix Power is building and selling next generation advanced flywheels for megawatt power burst management to municipalities operating large subway systems.

INTEGRATED ROADWAYS

Integrated Roadways
Integrated Roadways incorporates sensor, data, and connectivity applications to build next-generation smart roads that pay for themselves for municipalities.

MAGNOVATE

Magnovate
Magnovate sells an alternative to today's expensive light rail system, a class of electrically powered autonomous vehicles that are magnetically levitated over lightweight guide ways.

Reach out to our team to learn more about our pipeline.

SUBSECTOR

Trucking & Logistics

THE UPSHOT

The sector: Government regulations, technological advances, and environmental concerns are driving innovation in trucking and logistics. Trucking revenues were $676.2B in 2016, and the global logistics market's revenues were $8.1T in 2015. [42]

What it means for startups: An increasing number of startups are working to improve energy efficiency in the trucking and logistics industries. We'll focus on two markets: hardware companies and software companies.

MARKET: ENERGY EFFICIENCY SOFTWARE

Major trucking and logistics companies often have the resources to develop software solutions in-house. Still, there is opportunity for startups offering software and telematics solutions addressing things like fleet management (i.e. vehicle monitoring) and operations (i.e. driver safety features). The global automotive telematics market is anticipated to produce 73 million units by 2020, growing at a CAGR of close to 34%. [43]

MARKET: ENERGY EFFICIENCY HARDWARE

There are also opportunities for companies creating hardware units to store, monitor, and redirect energy flows in trucking, mass transit, and aviation. Examples include, but are not limited to, innovations in auxiliary power units (APUs), flywheels, solar-based hybrid solutions, drones, and IoT sensors. The global market for energy efficient technologies was $227B in 2017, and is expected to grow to $360B in 2026. [44]

Market: Energy Efficient Software

INVESTMENT ACTIVITY

Total Investment [45]

$2.02 BILLION	104	1
total funding last year	TOTAL DEALS	EXIT in last year

THE SUPPLY CHAIN

Multinational companies with fleets and/or major logistics and supply chain operations: Amazon, Target, Walmart, UPS, FedEx, Alibaba, Walgreens, Kroger, Home Depot, etc.

Large transportation and logistics companies: YRC Worldwide, Schneider National, JB Hunt, and Con-Way.

Major original equipment manufacturers (OEMs) in automotive: Toyota, Volkswagen, Renault-Nissan, BMW, Hyundai, Daimler, Honda, Suzuki, GM, and Ford.

Automotive telematics: Agero, Airbiquity, Continental, Visteon, and Verizon Telematics.

EXCITING COMPANIES

Pitstop
Pitstop offers a predictive maintenance platform for dealerships, insurance companies, and automotive OEMs.

UbicaBus
UbicaBus provides a suite of transportation hardware and software to track and monitor school buses.

Reach out to our team to learn more about our pipeline.

DRIVERS OF INNOVATION

Fragmented industries: Logistics and transportation are still very fragmented industries, with little central infrastructure and many disparate players. Startups have an opportunity to build software platforms and telematics solutions that can collect data to help connect industry players.

Growth in e-retail purchases: Global e-retail sales added up to $1.9T in 2016 and projections show a growth of up to $4T by 2020. [46] Trucking and logistics companies will be looking for ways to effectively handle the enormous growth of shipped goods, including new solutions for inefficiencies in last mile delivery and new ways to speed up the delivery process.

Government regulations: From regulations on lower GHG emissions to safety regulations and compliance, government regulations are driving companies to look for technologies that make their operations more environmentally friendly and safer. Startups can fill that gap.

Reduction in the cost of telematics: The cost of built-in hardware and software for telematics is expected to decline due to economies of scale and technological advancements.

CHALLENGES

Driver shortages and workforce retention issues: In 2016 there was an estimated 50,000-person deficit of truck drivers. This driver shortage has been driven by several factors, including industry growth, a wave of retiring drivers, and a lack of qualified new candidates. If trends continue, the shortage could rise as high as 175,000 by 2024. This could put a damper on extra funds for innovation. [47]

Market: Energy Efficient Hardware

INVESTMENT ACTIVITY

Total Investment [48]

$1.65 MILLION
total funding last year

1 TOTAL DEAL

10 EXITS
in last year
+25% YoY Exit Growth

THE SUPPLY CHAIN

Flywheel market: Amber Kinetics, Energiestro, Beacon Power Corp, RailPower Tech Corp, and SatCon Technology Corporation.

Trucking fuel efficiency hardware market: ACEMCO Power Big Rig Products, Centramatic, Kohler, Life Force ClimaCab, Thermo King Corp, Volvo, and Navistar.

Cross-discipline efficiency providers: GE, Siemens, Honeywell, Noesis Energy and Digital Lumens.

Broader energy efficiency landscape: AeroScout, Foursquare, Apple, Google, Accuware, Polaris Wireless, Sprooki, and Verve Wireless.

EXCITING COMPANIES

Dash
Dash Systems sells airdrop technology to air cargo operators to enable immediate package drop-off from airplanes to remote areas.

Reach out to our team to learn more about our pipeline.

DRIVERS OF INNOVATION

Government incentives: Policy has played a large role in improving energy efficiency. From 2000 to 2016, the growth of final energy demand covered by mandatory efficiency policies grew by 20%.[49] During the same time period, the average performance levels mandated by policies increased 23%, delivering greater savings and contributing to energy savings ecosystems. The IEA Efficiency Policy Index, which covers policy coverage and strength, demonstrated 7% growth in the past decade, primarily driven by driving and building improvements. [50]

Global investments in energy efficiency: Investment in energy efficiency totaled $221B in 2015, growing at a CAGR of 6% from the previous year,[51] and outpacing investment in conventional power generation by more than 150%. The increased investment activity has been matched by increased M&A activity, driven by the inorganic strategies of utility and technology providers seeking to enter the rapidly growing space.[52]

CHALLENGES

Lack of infrastructure: A lack of proper infrastructure development has limited the growth of energy efficiency hardware. Recent studies rank the US highway infrastructure as 16th among developed countries, which has been marked by accidents and congestion. [53] The failure to revamp the 1950s-built highway systems has directly led to higher emissions and more accidents, and indirectly led to diminished driver health and poorer driver retention.

SUBSECTOR

Other: Recycling, Oil and Gas, Biofuels

THE UPSHOT

The sectors: We also found startups working in other sectors across the energy-transportation nexus. These include new methods to recycle carbon fiber and alternatives to fossil fuels that come from biofuel and compressed natural gas (CNG) and propane.

INVESTMENT ACTIVITY

Total Investment [54]

SECTOR	FUNDING	DEALS	EXITS
Plastics & Fibers	$55 Million	14	27 (+80% YoY Exit Growth)
Bio-Energy	$183 Million	39	9 (+12.5% YoY Exit Growth)
Natural Gas Utility	$301.9 Million	9	24 (+60% YoY Exit Growth)
Oil & Gas Refining & Distribution	$1.34 Billion	18	35 (+25% YoY Exit Growth)

THE SUPPLY CHAIN

Carbon Fiber: Original engine manufacturers and aerospace companies like Boeing, Airbus Dell, BMW, Toyota and Hitachi are getting involved in the recycled carbon fiber space. The major carbon fiber manufacturers include: Cytec Solvay Group, Hexcel Corporation, Toray Industries Inc., Formosa Plastics Corporation, Hyosung Corporation, Mitsubishi Rayon Co, Ltd.

Compressed natural gas: The global compressed natural gas market is fragmented across several geographies. Major players include: Indraprastha Gas Limited (IGL), National Iranian Gas Company, Mahanagar Gas Limited (MNGL), OAO Gazprom, Trillium CNG, GNVert, ANGI Energy Systems Inc., NeoGas Inc., China Natural Gas Inc. and J-W Power Company.

Propane: Major players in the market include: Chevron Corporation, British Petroleum, BASF, Evonik, Sinopec, PDVSA, Valero Energy Corporation, DCP Midstream Partners, AmeriGas, ExxonMobil, Shell, Reliance Industries Limited and PetroChina Company Limited.

Biofuels: Major players in the market include major manufacturers (Abengoa, Cosan, Green Plains, Novozymes, Poet, Renewable Energy Group) as well as some units of oil and gas companies (Chevron, Valero) and crop processors (Archer Daniels Midland, Bunge).

CARBON FIBER

DRIVERS OF INNOVATION:

- **Applications across multiple industries:** Carbon fiber is a useful lightweight, high strength material for sectors such as construction, aerospace, aviation, defense, automotive and more.
- **Increased fuel efficiency standards for vehicles and planes:** The recent increased focus on fuel efficiency has driven demand for carbon fiber in the automotive and aviation/aerospace sectors. Carbon fiber can also be embedded as a material in cars as a way to offset the heavy weight of EV batteries.

CHALLENGES:

- **Cost of Carbon Fiber:** Carbon fiber has a high cost of production, due to the labor and time intensive process required to make it. This has lead to slower adoption by industry.
- **Slow movement of major industry:** Major carmakers are often slow to embrace new materials. For example, Ford's initiative to change the F-150 pickup's chassis from steel to aluminum took six years and cost over one billion dollars.

COMPRESSED NATURAL GAS

DRIVERS OF INNOVATION:

- **Increase in number of natural gas powered vehicles:** There were approximately 24.5 million natural gas-powered vehicles in the world in 2016, compared with 19 million four years earlier. There is a particular focus on converting public transportation fleets.
- **Government incentives:** Government policies, incentives, and support have driven the growth of CNG use, particularly in Asia and Latin America. For example, the US government has introduced tax cuts to offset the cost of converting to a natural gas vehicle.

CHALLENGES:

- **Fueling/refueling infrastructure:** Although there are an estimated 24.5 million natural gas vehicles in the world, there are only 29,000 refueling stations for natural gas vehicles.
- **Cost of NG vehicles:** CNG cars, which include storage tanks, are generally more expensive than "traditional" vehicles and can be hard to find in the US market. However, since CNG is cheaper than traditional fuels, this cost can be offset over time. The most natural gas vehicles are found in Asia, Latin America, and Europe.
- **Electrification of transportation:** The projected increase and adoption of EVs over the next few decades could result in a decrease in demand for fuels such as CNG. Still, EV costs and limited infrastructure limit the risk this poses in the short-medium term.

PROPANE

DRIVERS OF INNOVATION:

- **Environmental concerns:** Propane is considered a clean fuel, with fewer greenhouse emissions, particularly carbon emissions, than diesel fuel or gasoline. It still releases GHG into the atmosphere.
- **Growth opportunities for propane use:** By 2020, propane consumption by internal combustion engines is expected to increase to one billion gallons, driven largely by the forklift market.

CHALLENGES:

- **Environmental concerns:** In addition to the GHG emissions from propane, there are also environmental concerns about the pipelines used to transport propane, which, if shutdown, could lead to challenges with access and increased prices. As a result, major players are shifting to transporting propane by rail.

BIOFUELS

DRIVERS OF INNOVATION:

- **Government Initiatives:** Biofuel production and use in the United States is driven by the EPA's Renewable Fuel Standard, which originated in 2005 and requires transportation fuel sold in the US to contain a minimum volume of renewable fuels. The Trump administration, catering to supporters in the middle of the country (e.g., states like Iowa that produce large amounts of corn) is unlikely to scale back the RFS program.

CHALLENGES:

- **Increased world food prices & land use:** Some biofuels (called first generation biofuels) are made from food crops such as corn and palm oil and some studies link the cost of biofuels to the cost in food prices. There are also concerns about the use of land to make biofuels and the greenhouse gas emissions from land clearing, agricultural inputs and management practices, etc. This has resulted in a push for biofuels that use food crop waste, algae, and alternatives to food crops (second, third, and fourth generation).
- **Fueling infrastructure:** There are currently ~24,000 alternative fuel stations in US. This number has increased from 10,000 in 2012, but is still significantly lower than the 168,000 traditional gas stations in the US.

EXCITING COMPANIES

Vartega
Vartega is a recycler of advanced materials – specifically strong and lightweight carbon fiber – used in the aerospace, automotive, wind energy, and sporting goods industries.

Onboard Dynamics
Onboard Dynamics seeks to lower fuel costs and carbon emissions by removing infrastructure barriers to driving natural gas powered vehicles.

Tank Utility
Tank Utility uses state-of-the-art technology to monitor propane tank levels.

Sea Change
SeaChange Group LLC is a highly innovative renewable bio-fuels company. SCG is beginning to introduce its patented, environmentally sustainable Bio-Eco-Hybrid™ fuels (Bio-EHF™) to the market as a drop-in fuel for the maritime, off-road construction, rail and heating industries.

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ENDNOTES

1 CB Insights

2 CB Insights

3 IATA. “IATA Forecasts Passenger Demand to Double Over 20 Years.” October 18, 2016.

4 Ostrower, Jon. “Its a Golden Age for Affordable Flying. No, Really.” CNNMoney. March 3, 2017.

5 7IATA. “Halving Emissions by 2050 - Aviation Brings Its Targets to Copenhagen.” IATA.

6 Briggs, Paul, Leo Fattorini, Joanna Ketteley, Veronica Webster, and William Ball. “CORSIA - A Global Market-based Measure to Offset Growth in Aviation Emissions.” March 08, 2018.

7 Haynes, Brad. “Embraer sees 2024 commercial launch for Uber flying cabs.” December 15, 2017 https://www.reuters.com/article/us-embraer-outlook-uber/embraer-sees-2024-commercial-launch-for-uber-flying-cabs-idUSKBN1E929N

8 University of Tennessee. “UT to Play Leading Role in NASA Aviation Revolution.” https://mabe.utk.edu/ut-to-play-leading-role-in-nasa-aviation-revolution/

9 IEA, “Electric vehicles have another record year, reaching 2 million cars in 2016.” June 7, 2017. https://www.iea.org/newsroom/news/2017/june/electric-vehicles-have-another-record-year-reaching-2-million-cars-in-2016.html

10 Statista

11 Statista

12 Statista

13 CB Insights

14 CB Insights

15 Statista

16 Statista

17 Statista

18 Plug In Cars, “Lithium Ion Batteries Can’t Stand the Heat”, June 22, 2012. http://www.plugincars.com/lithium-ion-batteries-can%E2%80%99t-stand-heat-122447.html

19 CB Insights

20 CB Insights

21 Carbon Tracker Initiative, “Electric Vehicle Tracker”, December 12, 2017. https://www.carbontracker.org/electric-vehicle-tracker/

22 Bloomberg New Energy Finance. “Electric Vehicle Outlook 2017” https://about.bnef.com/electric-vehicle-outlook/

23 Patrick Hertzke, Nicolai Müller, and Stephanie Schenk, “Dynamics in the global electric-vehicle market”, July 2017. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/dynamics-in-the-global-electric-vehicle-market

24 Ibid.

25 Statista

26 CB Insights

27 CB Insights

28 Anne Grosse-Ophoff, Saskia Hausler, Kersten Heineke, and Timo Möller, McKinsey and Co, “How shared mobility will change the automotive industry”. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/how-shared-mobility-will-change-the-automotive-industry

29 Wouldn’t You Rather Be in a Carpool?” AlleyWatch. August 23, 2017.

30 Rob Price, Business Insider, “Uber drivers keep just 50% of what you pay”. http://www.businessinsider.com/uber-customer-cost-breakdown-morgan-stanley-2015-2

31 Russell Hensley, Asutosh Padhi, and Jeff Salazar, “Cracks in the ridesharing market—and how to fill them”, July 2017. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/cracks-in-the-ridesharing-market-and-how-to-fill-them

32 Ibid.

33 Ibid.

34 Statista

35 CB Insights

36 CB Insights

37 Stu Robarts, “Mercedes-Benz shows off the sleek self-driving bus of tomorrow”, July 18, 2016 https://newatlas.com/mercedes-benz-future-bus-with-citypilot/44398/

38 Boston Consulting Group, “By 2030, 25% of Miles Driven in US Could Be in Shared Self-Driving Electric Cars”, April 10, 2017. https://www.bcg.com/d/press/10april2017-future-autonomous-electric-vehicles-151076

39 Freddie Roberts, Internet of Business, “Finnish elevator company Kone lifts profits with IoT.” https://internetofbusiness.com/20128-2/

40 Schrank, David et al. “2015 Urban Mobility Scorecard.” Texas A&M Transportation Institute and INRIX. August, 2015. Traffic-related car crashes alone cost $25B a year, see: Dutzik, Tony, Gideon Weissman, and Phineas Baxandall. “Who Pays for Roads?” USPirg, 2015.

41 Elise Young, Bloomberg, “Amtrak Needs $38 Billion for Northeast Corridor Repairs”. https://www.bloomberg.com/news/articles/2017-05-04/amtrak-maintenance-backlog-tops-38-billion-on-northeast-route

42 Statista

43 Statista

44 Statista

45 CB Insights

46 Statista

47 Trucking.org, “New Report Says National Shortage of Truck Drivers to Reach 50,000 This Year”, http://www.trucking.org/article/New%20Report%20Says-National-Shortage-of-Truck-Drivers-to-Reach-50,000-This-Year

48 CB Insights

49 International Energy Agency, Energy Efficiency 2017. https://www.iea.org/efficiency/

50 Ibid.

51 Statista

52 International Energy Agency, Energy Efficiency 2017. https://www.iea.org/efficiency/

53 Business Roundtable, “Road to Growth”, September 2015. http://businessroundtable.org/sites/default/files/2015.09.16%20Infrastructure%20Report%20-%20Final.pdf

54 CB Insights