NREL
Transforming ENERGY

Current Technological Trends in Sustainable Aviation

Brett Oakleaf
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November 2021

NREL at-a-Glance

2,926

Workforce, including

219 postdoctoral researchers

60 graduate students

81 undergraduate students

World-class

facilities, renowned technology experts

More than **900**

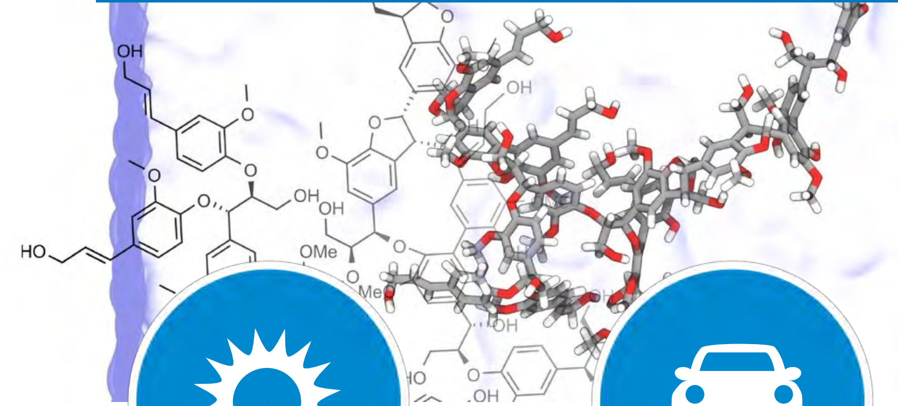
Partnerships

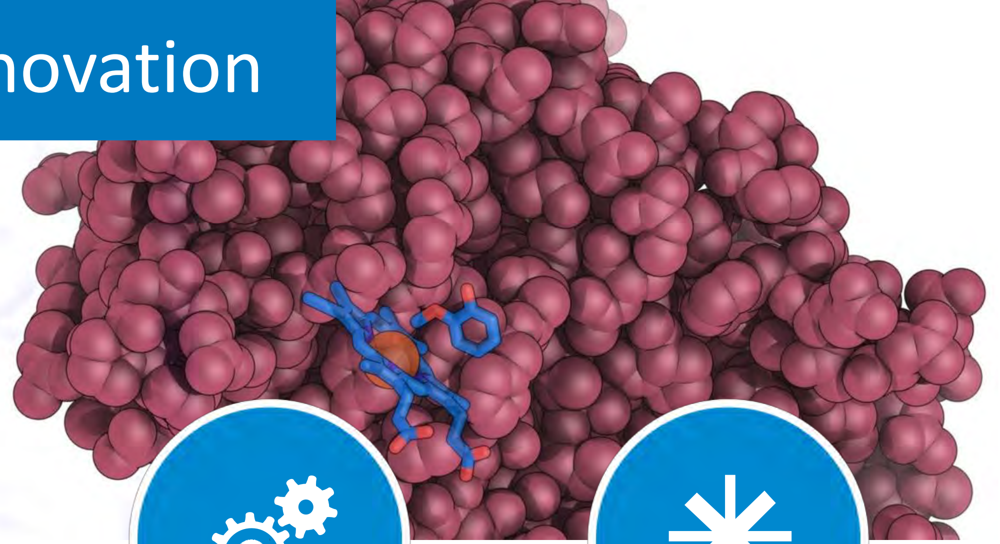
with industry, academia, and government

Campus

operates as a living laboratory

NREL Science Drives Innovation





Renewable Power

Solar

Wind

Water

Geothermal

Sustainable Transportation

Bioenergy

Vehicle Technologies

Hydrogen

Energy Efficiency

Buildings

Advanced Manufacturing

Government Energy Management

Energy Systems Integration

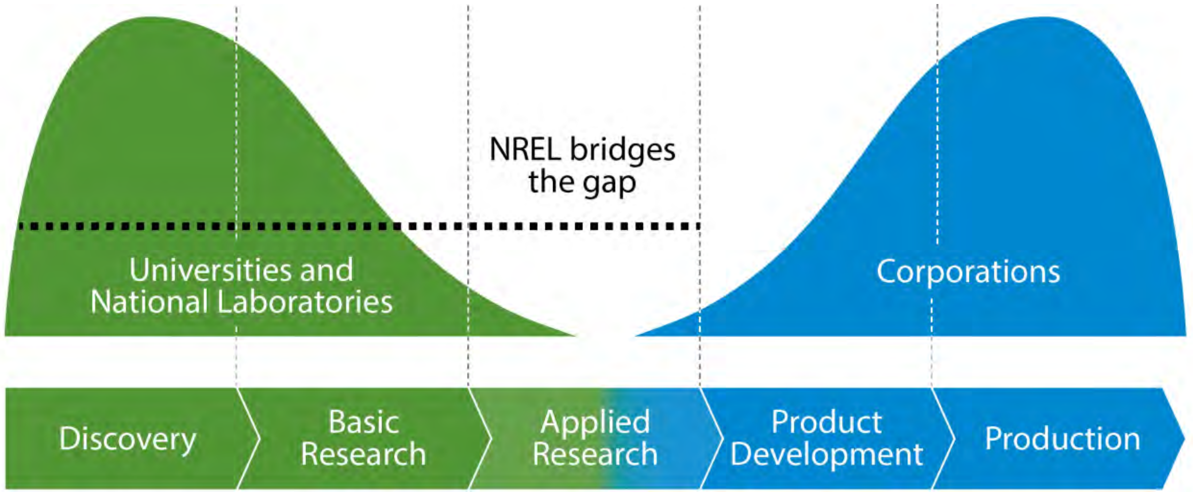
Grid Integration

Hybrid Systems

Security and Resilience

We Reduce Risk in Bringing Innovations to Market

- NREL helps bridge the gap from basic science to commercial application
- Forward-thinking innovation yields disruptive and impactful results to benefit the entire U.S. economy
- Accelerated time to market delivers advantages to American businesses and consumers



Answering **crucial questions** about:

Technologies

What electric technologies are available now, and how might they **advance**?

Consumption

How might electrification impact electricity **demand** and **use patterns**?

System Change

How would the electricity system need to **transform** to meet changes in demand?

Flexibility

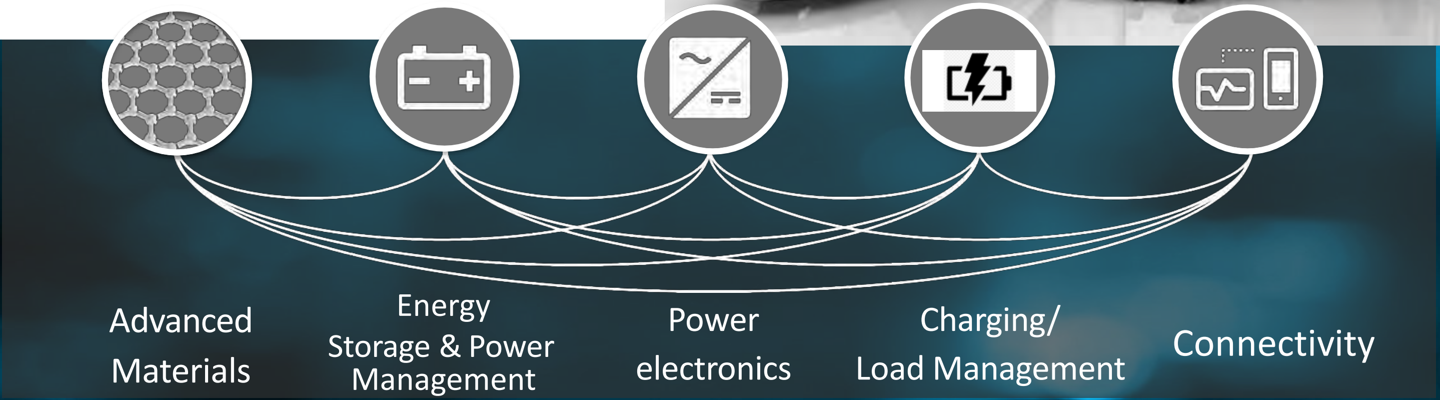
What role might **demand-side flexibility** play to support reliable operations?

Impacts

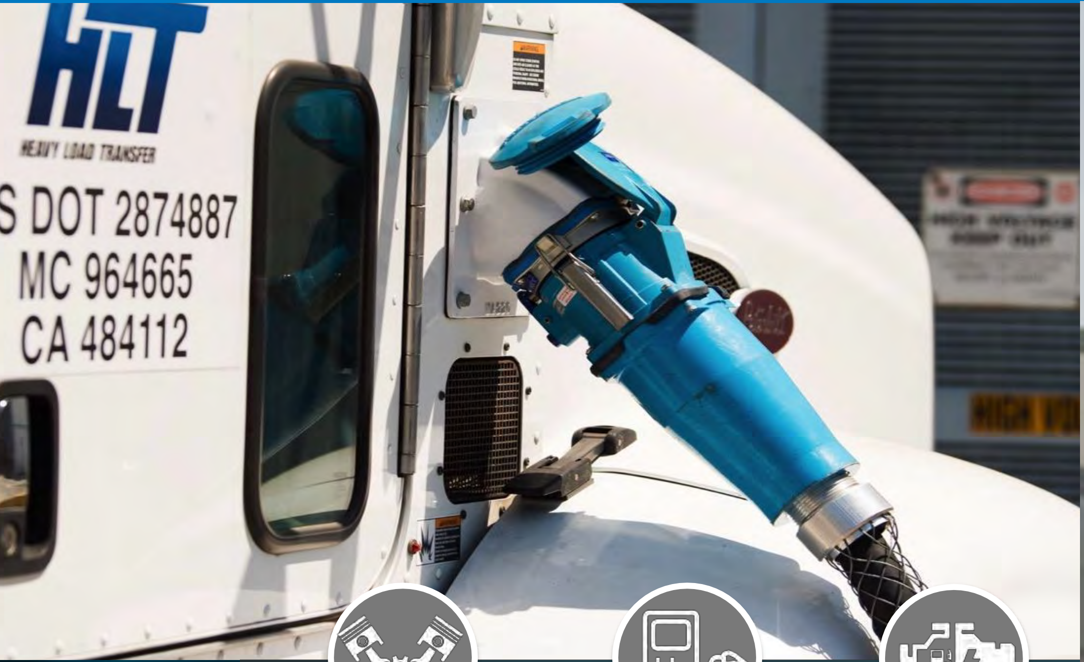
What are the potential **costs, benefits, and impacts** of widespread electrification?

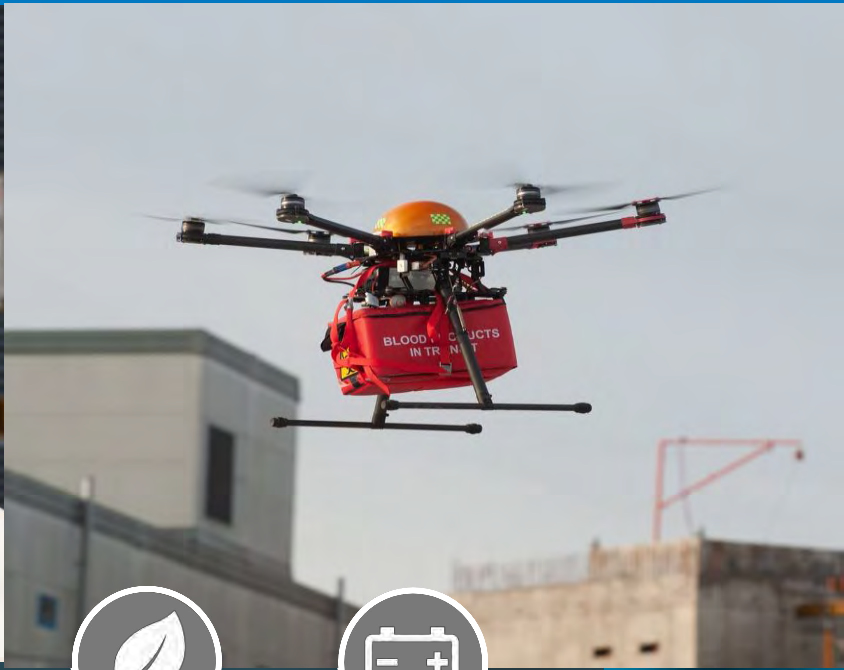
Four Elements of Sustainable Mobility

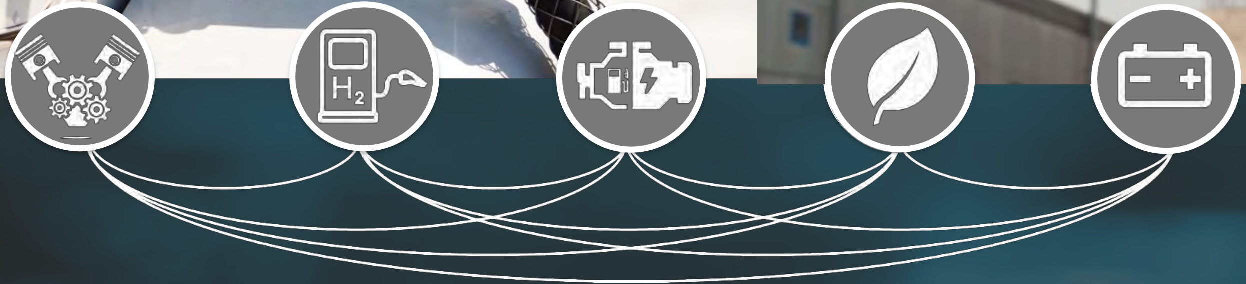
Moving people



Moving goods







Advanced Combustion

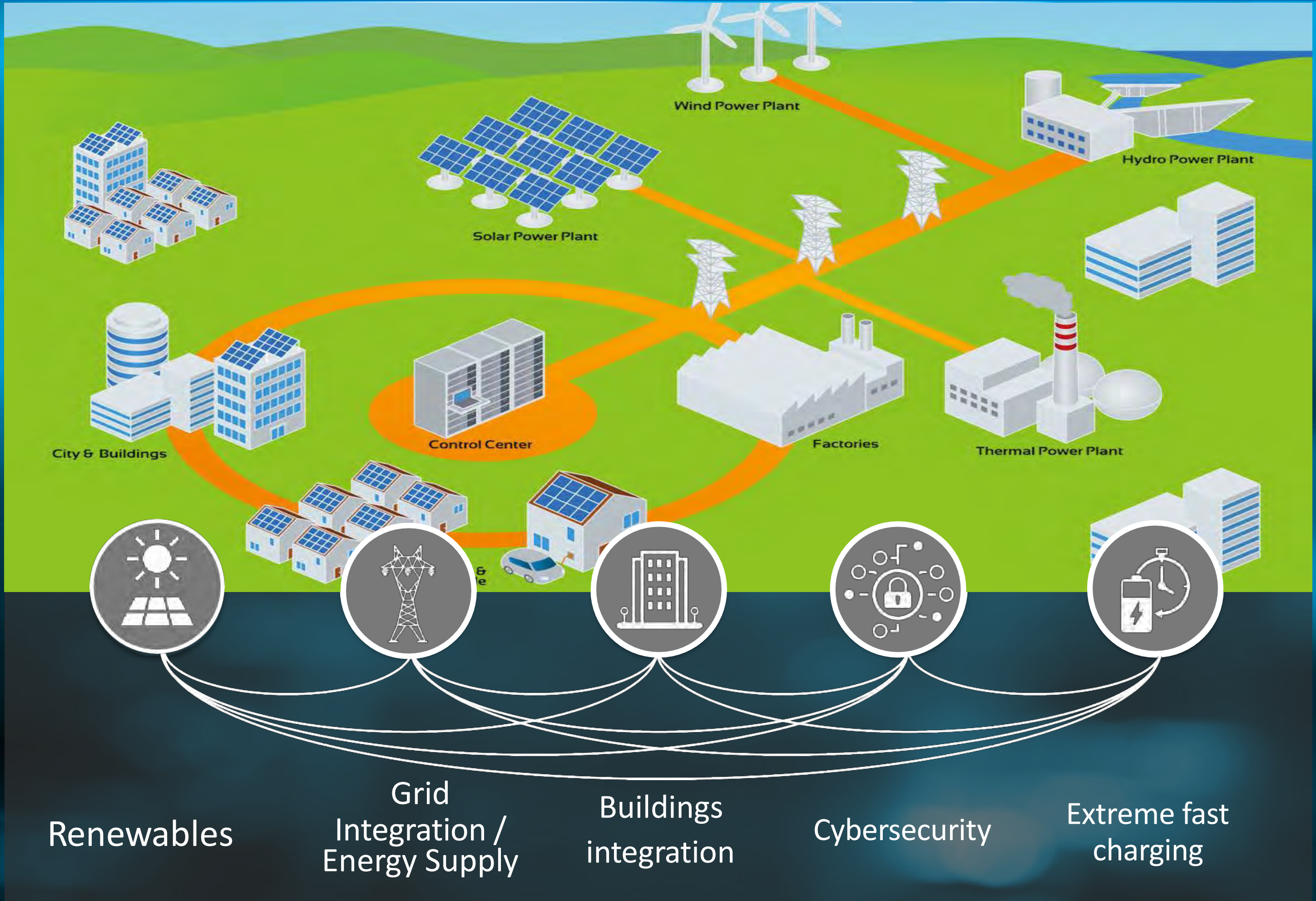
Hydrogen

Hybridization & Electrification

Biofuels

Energy storage

Powering mobility



Transformative technologies

Automation

PHIL - Testing

Wireless charging

Big data/ analytics

Deep learning

Global Transportation System

https://i.imgur.com/MItUKcO.jpg

Transportation Megatrends

Seven key megatrends are poised to **transform our transportation system**.

These trends have begun to affect our mobility behaviors, and impact how we, and the goods we need, will travel sustainably in the coming decades.

1. Rapid technology change
2. Customer demand
3. Live, work, and study anywhere
4. Environmental sustainability and energy security
5. International trade
6. Our growing and aging population
7. The need for healthier lifestyles

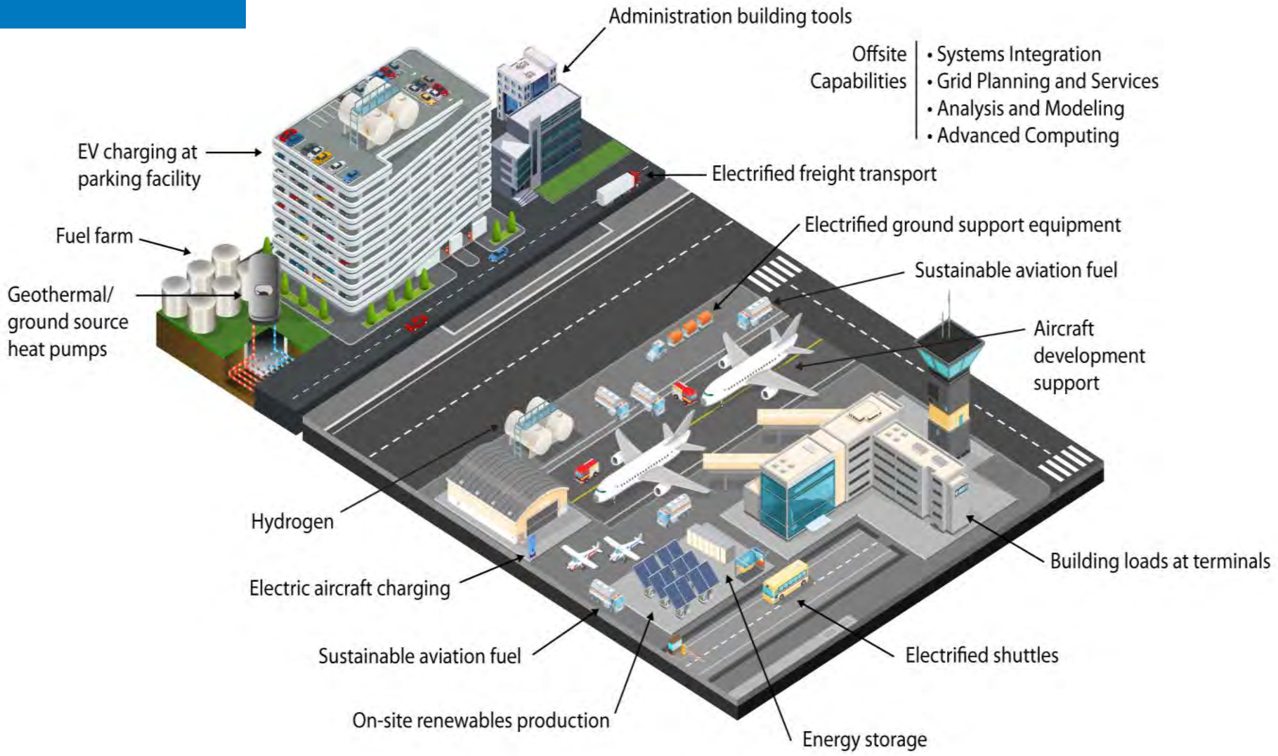
Implications for Research Needs

- **Rapid changes in vehicle technologies** – electrification (batteries and fuel cells), connectivity, automation
- **Global drive for increased transportation efficiency** – reducing emissions and decarbonizing transport across the light-, medium-, and heavy-duty vehicle, rail, aviation, and marine sectors
- **Maximizing future use of renewable electrons through time and sector shifting** – storing as H_2, liquid fuels, chemicals (long-term storage)
- **Realizing the system-wide benefits** of optimally integrating transportation with buildings, grid, renewables.

Scott Cary

GHG - Scope 1-2 Airport Pathways

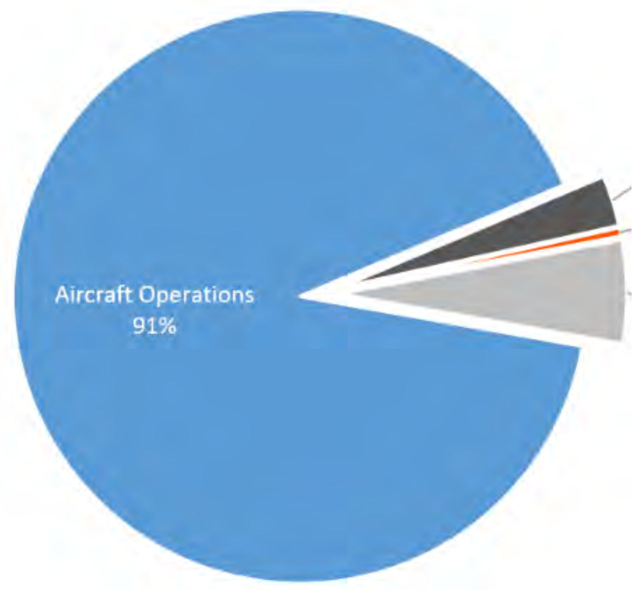
- Efficiency
  - Landside
  - Building
  - Airside
- Ground Fleet Improvements
  - Green energy sources
- Clean energy/resiliency
- Grid Interactive Efficient Buildings (GEB)
- Energy Source/Storage Diversity



But what about Scope 3 emissions?

- 9% of global emissions from aviation
- Airport Controlled Emissions
  - 9-20% of total emissions
- To meet industry goals, Scope 3 (aircraft, passenger, and tenant emissions) are the next step.

Sample Large Hub Emissions profile



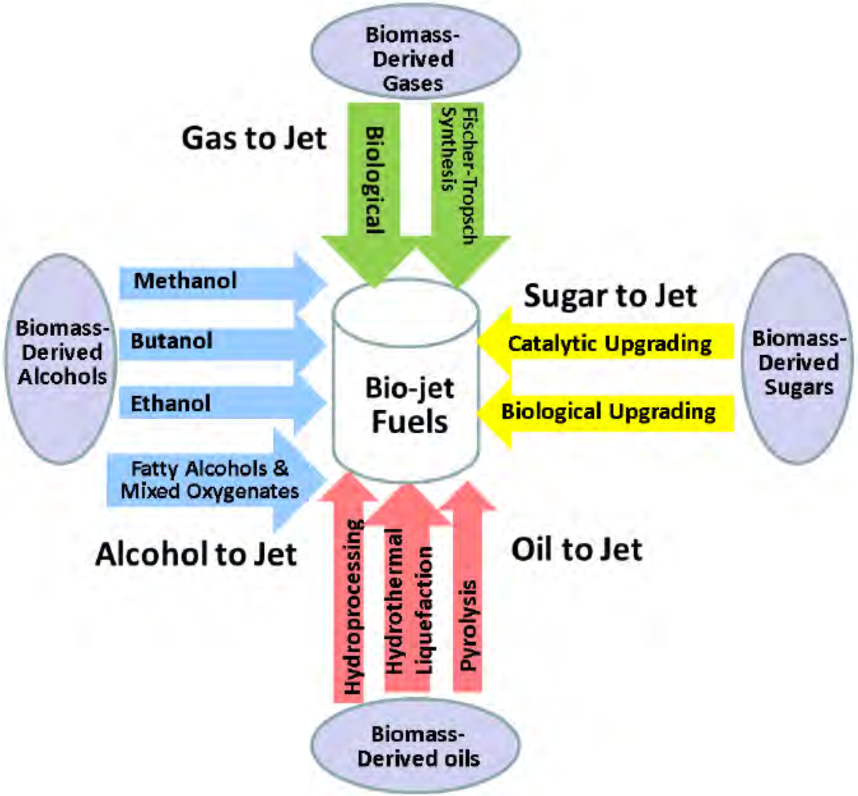
Aviation Low- and Zero-carbon energy sources

					2040	2045	2050
Commuter » 9-50 seats » <60-minute flights » <1% of industry CO2	SAF	Electric and/or SAF	Electric and/or SAF	Electric and/or SAF	Electric and/or SAF	Electric and/or SAF	Electric and/or SAF
Regional » 50-100 seats » 30-90-minute flights » ~3% of industry CO2	SAF	SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF
Short haul » 100-150 seats » 45-120-minute flights » ~24% of industry CO2	SAF	SAF	SAF	SAF	Electric or Hydrogen combustion and/or SAF	Electric or Hydrogen combustion and/or SAF	Electric or Hydrogen combustion and/or SAF
Medium haul » 100-150 seats » 60-150-minute flights » ~43% of industry CO2	SAF	SAF	SAF	SAF	SAF	SAF	SAF Potentially some Hydrogen
Long haul » 250+ seats » 150+ minute flights » ~30% of industry CO2	SAF	SAF	SAF	SAF	SAF	SAF	SAF

Source: ATAG Waypoint 2050 Report

Sustainable Aviation Fuel (SAF) Development

- Strong US focus
  - Drop-in replacement
  - Multiple pathways
    - Waste product
    - Biomass
    - E-fuels



More information from:
http://www.nrel.gov/docs/fy16osti/66291.pdf

What about Electrified Aviation?

- Case Study – Essential Air Service – Denver
  - Four routes served by Pilatus PC-12

Figure 2. Case study area

Illustration by Emma Robertson, NREL

Essential Air Service Subsidies

Table 2. Essential Air Service Subsidies (2019–2022)[a] and 2020 Enplanements for Markets Served within 280 Miles of Denver International Airport

Airport[b]	2019	2020	2021	2022	2020 Enplanements[c]
MCK	$2,462,456	$2,511,705	$2,561,939	$2,613,178	1,269
CDR	$2,456.787	$2,518,208	$2,737,716	$2,808,159	2,462
ALS	$2,891,307	$2,949,133	$3,505,574	$3,505,574	4.742
CEZ	$3,579,703	$3,669,195	$3,760,925	$3,854,948	5,603

[a] "Essential Air Service," Department of Transportation Accessed August 2021. https://www.transportation.gov/policy/aviation-policy/small-community-rural-air-service/essential-air-service, accessed August 2021. Data for 2022:, MCK: USDOT 2018-5-10 Order Re-Selecting Air Carrier and Establishing Subsidy Rates; CDR: USDOT Order 2021-4-6 Selecting Air Carrier: file:///Users/aschwab/Downloads/DOT-OST-2000-8322-0160_attachment_2.pdf, ALS: USDOT 2020-9-17 Order Extending Contract, https://www.regulations.gov/document/DOT-OST-1997-2960-0193; CEZ: 2018-8-1 Order Re-Selecting Carrier and Establishing Subsidy Rates, https://www.regulations.gov/document/DOT-OST-1998-3508-0062

[b] MCK = McCook Ben Nelson Regional Airport; CDR = Chadron Municipal Airport, ALS = San Luis Valley Regional Airport; CEZ = Cortez Municipal Airport

[c] "Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports," FAA, last modified August 12, 2021, https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/.

Essential Air Service Subsidies

Table 3. Information for Select Flights from Denver (DEN) for Liquid-Fueled and Electric Aircraft

Destination	Flights /day	Miles	Flight Time (mins)	Fuel Use (gals)	Fuel Costs[a]	$kgCO_2$ /PAX[b]	kWh (approx.)	Electricity Cost[c]	$kgCO_2$ /PAX Coal[c,d]	$kgCO_2$ /PAX Solar[c,d]
ALS	4	179	80	88	$440	36	334	$43	34	2
CEZ	3	277	80	88	$440	56	516	$66	53	3
MCK	2	217	65	72	$358	44	404	$52	41	2
CDR	2	222	70	77	$385	44	414	$53	42	2

[a] Assuming a $5/gallon fuel cost [14]

[b] PAX= number of passengers carried by an airline, assuming eight passengers.

[c] Based on commercial electricity costs for Cortez, Colorado; these values provide a conservative estimate of the electricity costs. Industrial electricity cost pricing could provide a 50% reduction in these costs.

[d] kg CO2 calculated from the use of coal and utility scale solar to produce the needed amount of energy ("IPCC Working Group III – Mitigation of Climate Change, Annex II Metrics and Methodology" IPCC https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-ii.pdf#page=26).

Initial finding – high subsidies in place where a new technology can reduce operating cost, emissions, and potentially noise. Infrastructure cost, energy demand models needs more analysis.

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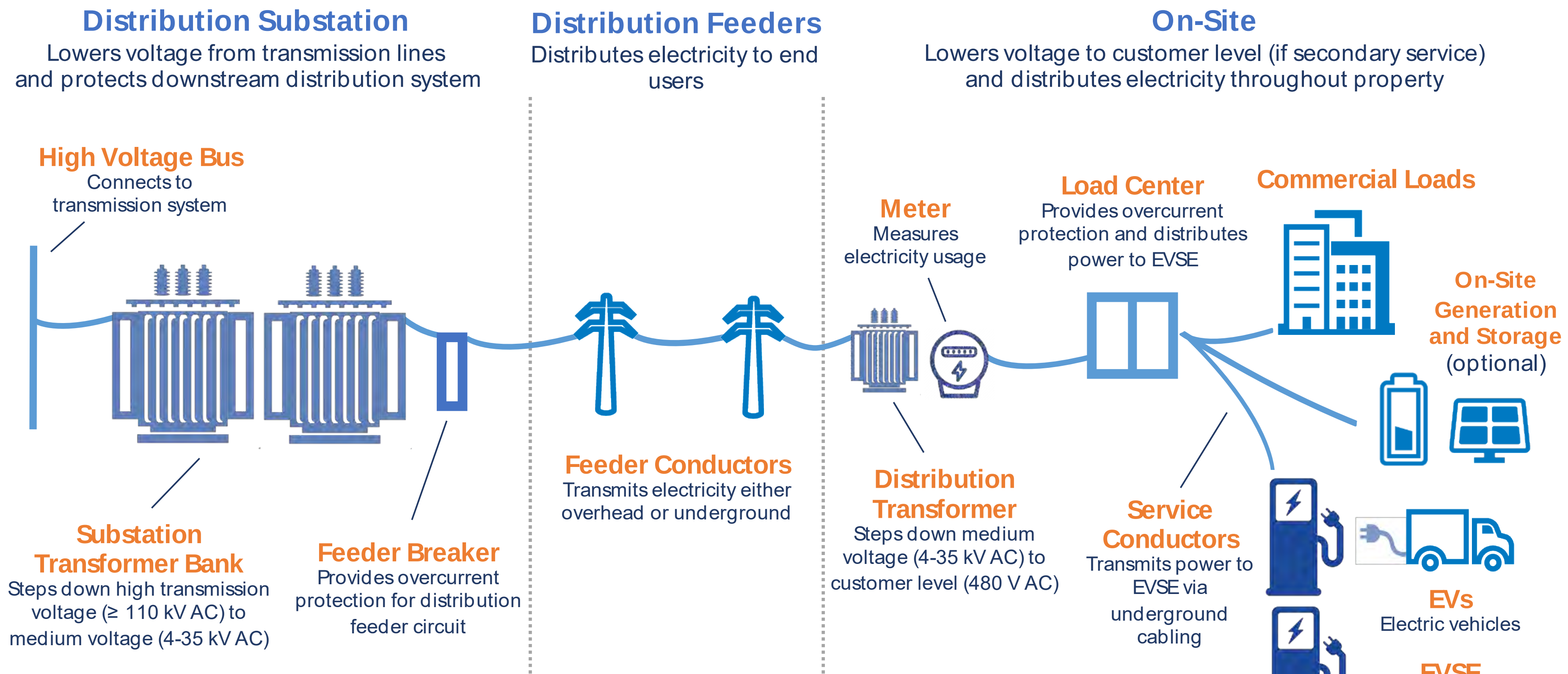
Delivering Power to Electric Vehicles

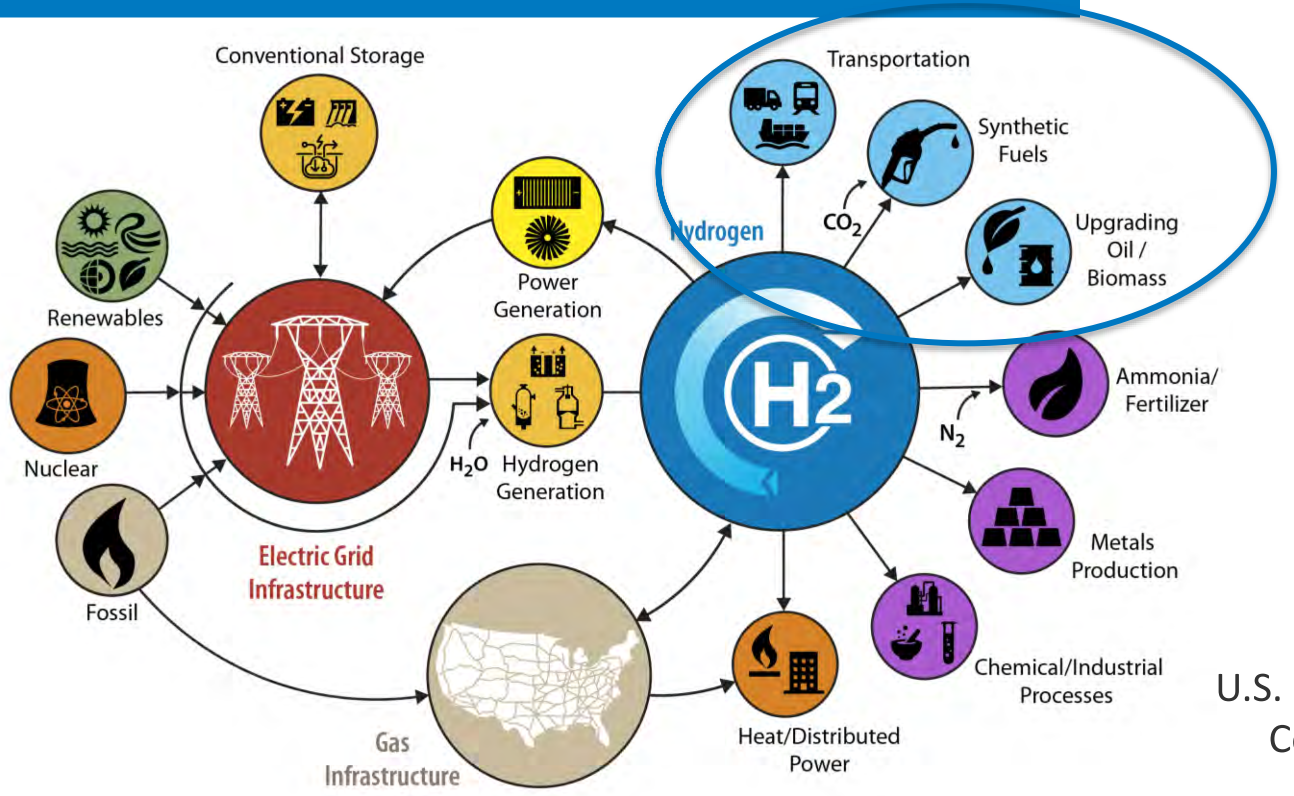


SOURCE: Borlaug et al., “Heavy-Duty Trucks: Opportunities for Electrification and the Electricity Distribution System Requirements for Depot Charging”, Forthcoming.

Infrastructure Peak Loads

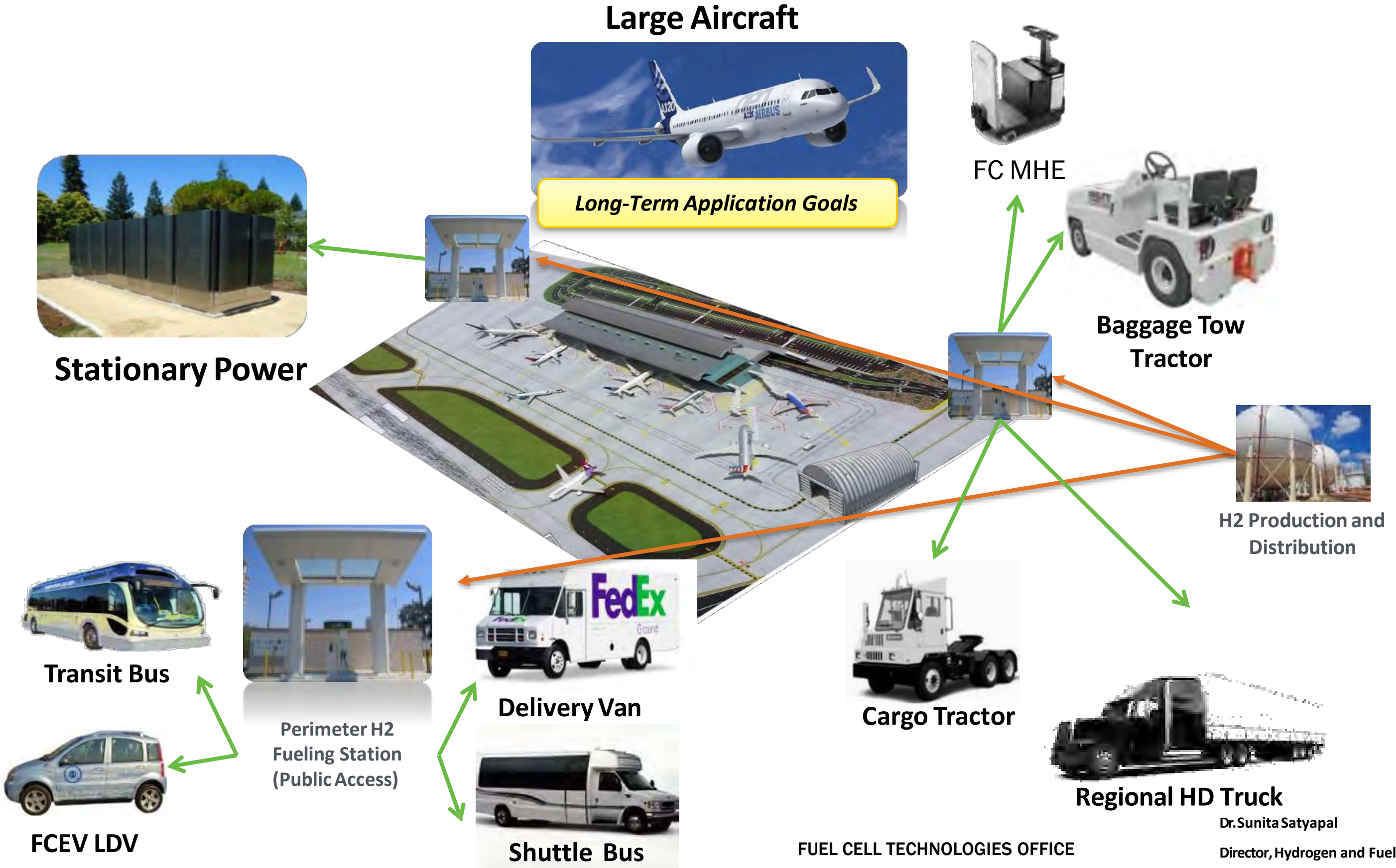
Potential load impacts of 2019 flight schedule between DEN and ALS, CDR, CEZ, and MCK

Hydrogen



U.S. DOE Hydrogen and Fuel Cell Technology Office H2@Scale Vision

The Opportunity: Clustering Fuel Cell Applications To Drive H2 Demand At Airports



Dr. Sunita Satyapal
Director, Hydrogen and Fuel Cell Technologies Office
H2@Airports Workshop November 4, 2020

Hydrogen

- Department of Energy announced Earth Shot – 2021

- Multiple OEM’s
  - Airbus/Universal Hydrogen/ZeroAvia/Cranfield Aerospace
- FAA – currently focusing upon SAF
- Growing interest and energy delivery models growing

- https://www.energy.gov/eere/fuelcells/hydrogen-shot

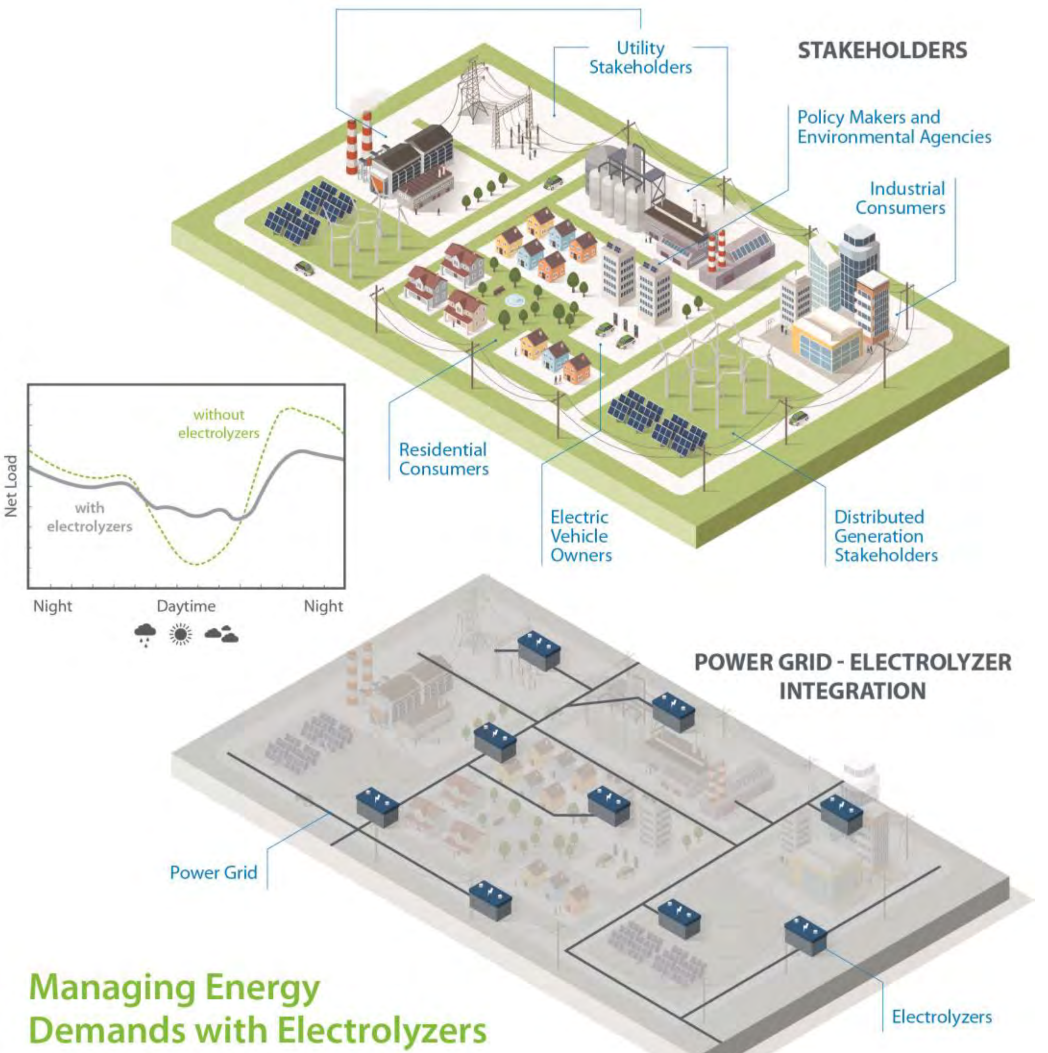
Potential Benefits of Electrolyzer Grid Integration

Reduce energy usage and emissions in end-use applications

- Petroleum displacement
- Chemical processes (metals refining, fertilizer production)
- Natural gas supplementation
- Combined heat and power with fuel cell systems

Improve grid performance, reliability, and resiliency

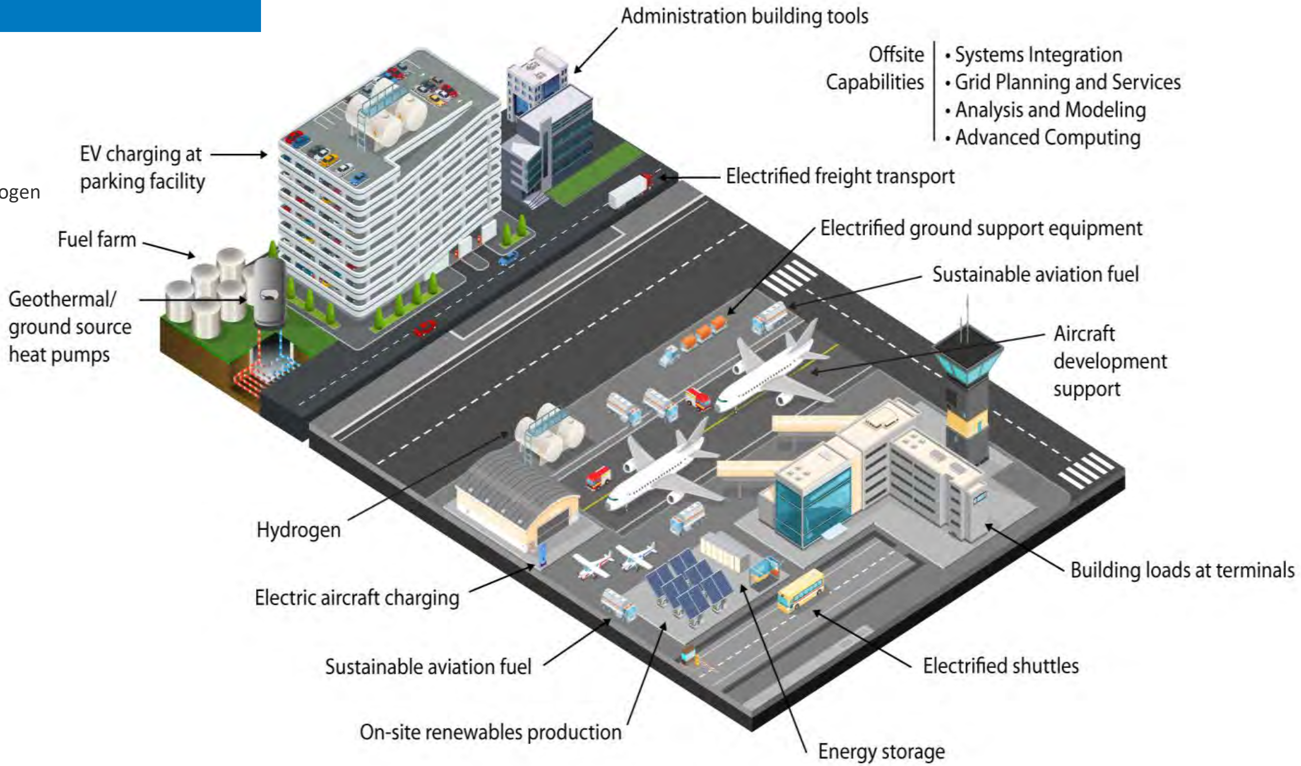
- Avoid curtailment of renewables
- Mitigate voltage/frequency disturbances



M. Koleva, K. Nagasawa, J. Kurtz, "California Hydrogen Integration Report," 2020

Who is working on solutions to assist industry?

- ICAO
- IATA
- FAA
  - Sustainable Aviation Fuel/Electrification /Hydrogen
- Department of Defense
  - AFWERX – Agility Prime
  - AFRL
- Department of Energy/NREL
  - Sustainable Aviation Fuel
  - Grid Modernization
  - Onsite energy solutions
  - Charging system fundamentals
  - Cybersecurity/Energy Resilience
  - Battery technologies
- NASA
  - Prototype aircraft
  - Regional Air Mobility –
    - Regional Energy Analysis – Pending
  - Grand Challenge
- State DOT/Cities



Resources

- A sampling of resources/activities:
  - NASA RAM study https://sacd.larc.nasa.gov/ram/
  - WSDOT electrification study https://wsdot.wa.gov/sites/default/files/2020/11/18/Electric-Aircraft-Feasibility-Study-Nov2020.pdf
  - NREL
    - SAF Delivery https://www.osti.gov/biblio/1768316-airport-infrastructure-sustainable-aviation-fuel- Partner with PANYNJ
    - SAF Production https://www.nrel.gov/news/program/2021/from-wet-waste-to-flight-scientists-announce-fast-track-solution-for-net-zero-carbon-sustainable-aviation-fuel.html – Partners with Alder Energy, Southwest, etc.
    - Extreme Fast Charging – Lessons underway in Class 8 trucking https://www.nrel.gov/docs/fy20osti/75705.pdf – Partner with multiple OEM's
    - Electrification of Aircraft: Challenges, Barriers, and Potential Impacts https://www.nrel.gov/docs/fy22osti/80220.pdf
    - FAA/NASA/DoD – recurring Aviation efforts – Batteries, SAF, H2, Electric, Power Electronics
    - State/Local – assisting early adopters accelerate adoption
    - OEM's – Component, Infrastructure and Life Cycle Support
  - DOE
    - SAF Grand Challenge - https://www.energy.gov/eere/bioenergy/sustainable-aviation-fuel-grand-challenge
    - Grid Modernization Initiative - https://www.energy.gov/gmi/grid-modernization-initiative
    - H2 @ Airports - https://www.energy.gov/eere/fuelcells/h2airports-workshop
  - CAMI - https://www.communityairmobility.org/resources
  - Future efforts – ACRP, FAA, NREL, NASA, SAE, DOE, etc.

Thank You

www.nrel.gov

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NREL – Airports/Seaports
https://www.nrel.gov/workingwithus/partners/partnership-airports-seaports.html

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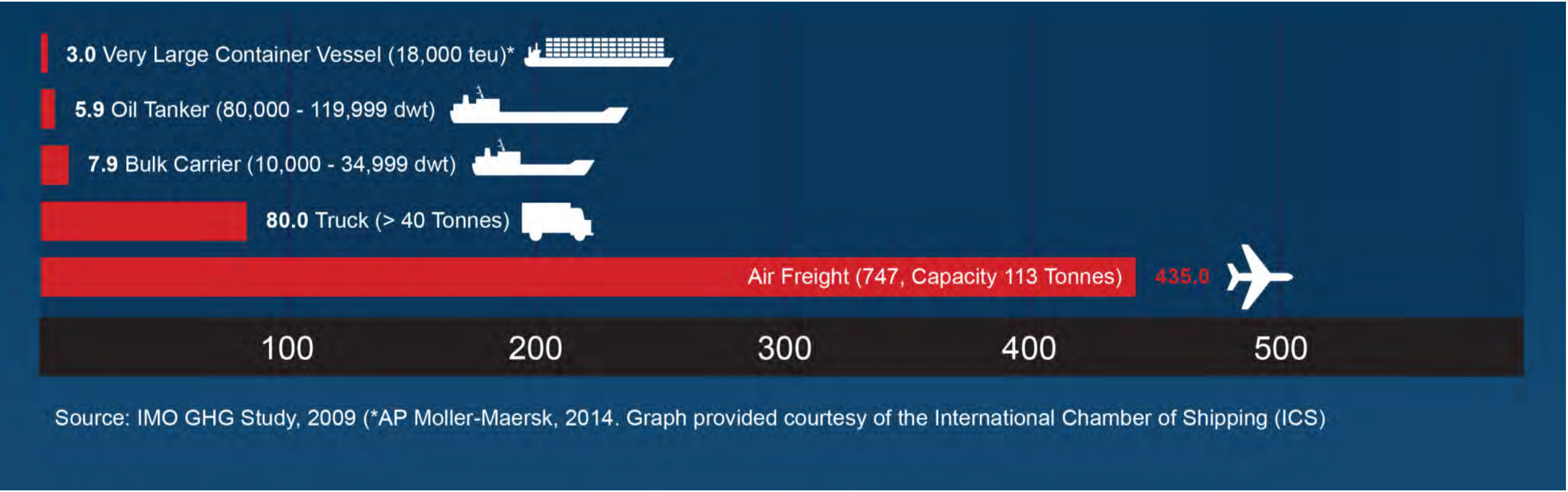
GHG Emissions Intensity

Grams CO_2-e per tonne-km for transport of goods by sea, land, and air



http://www.worldshipping.org/industry-issues/environment/air-emissions/carbon-emissions

Initial charging implications

- Charging capabilities
  - Current High power charging – maxes at 350kW
  - Class 8 Truck – 1MW Charging Analysis underway
  - CHARin- Testing 3.75MW testing standard
  - Initial deployments possible
  - Scale and battery improvements are focus area
- No Standard currently exists in Aviation
  - eVTOL – focusing upon existing technologies with potentially cooling of cables, batteries, etc.
  - RAM – appears targeting 1MW level and higher to meet ops pace

Fuel cells may be promising for UAVs, UAM-air taxis, UAM-helicopters, and regional planes

H_2 fuel cells can provide competitive TCO in UAV, UAM-air taxis, UAM-helicopters, and regional planes

UAVs

- Longer lifetime and lower maintenance cost than ICE and battery-powered UAV
- Longer mission times than batteries, allowing for a smaller fleet and lower TCO

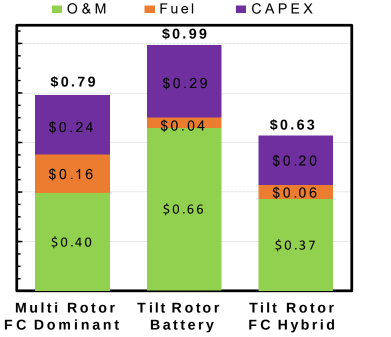
UAMs

- Air taxis: Fuel cells provide longer durability than batteries as the duty cycle has rapid charge and discharge rates
- Helicopters: Can replace aviation gasoline and piston engines on the basis of gravimetric energy density

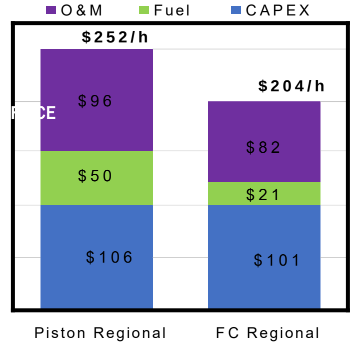
Small regional planes

- Can replace aviation gasoline and piston engines on the basis of gravimetric energy density
- Fuel cells have lower specific power (W/kg) than turbine engines, but hydrogen can replace aviation gasoline
- Hydrogen has lower volumetric energy density than aviation gasoline

TCO ($/PAX.mile) for battery powered UAM more expensive than FC versions



TCO ($/h) for FC regional plane less than that for piston engine plane



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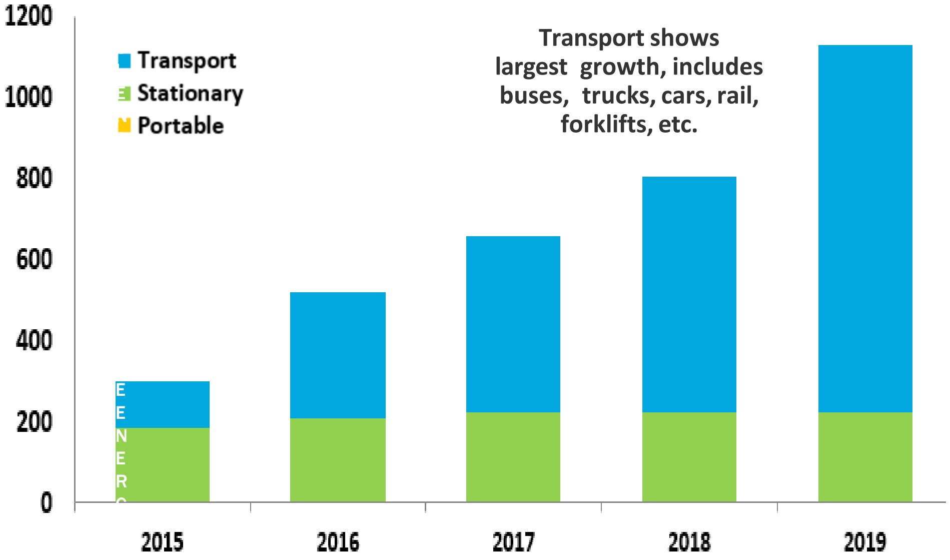
Hydrogen and Fuel Cell Technology Growth Worldwide

Global fuel cell shipments surpass 1 GW



Source: E4tech for DOE analysis project

25-fold increase in electrolyzers deployed in the last decade

<1MW in 2010 to >25 MW by the end of 2019

Global FCEVs doubled to >25,200 >12.3K sold in 2019 vs. 5.8K in 2018

470 H_2 fueling stations worldwide

> 20% increase from 2018

Source: IEA (2020), Hydrogen, IEA, Paris, https://www.iea.org/reports/hydrogen

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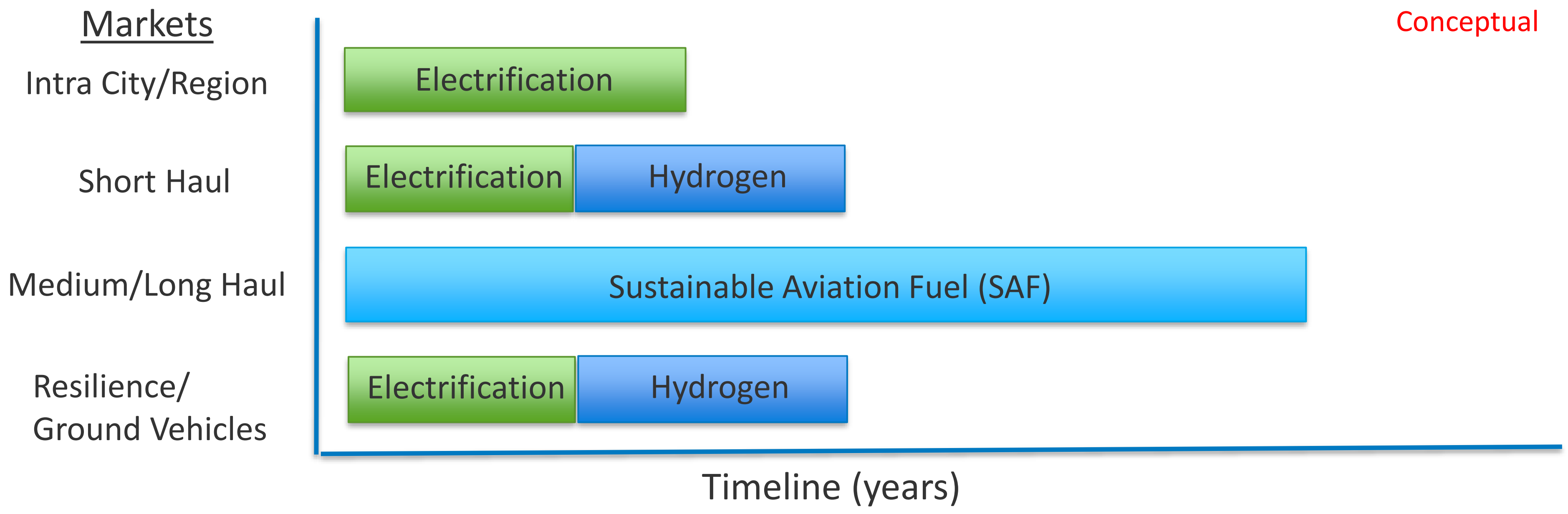
NREL focus areas across multiple segments



Significant challenges exist today for fully electrified aviation (especially long haul)

- *Sufficient battery size (energy capacity) for flights over >500 miles*
- *Energy storage need to "refuel" plane would be astronomical (TWhs of energy)*
- *Charging Infrastructure poses very high hurdles to deliver energy in 30-45 minutes for each plane*

➢ ***Research ongoing in various segments of aviation market with SAF, electrified, and hydrogen solutions***

SAF - An "All of the Above" Approach Will Have To Be Used To Achieve 35 BGPY of SAF

ASTM Approved Pathways Address a Broad Range of Feedstock To Achieve Scale

Feedstock	Pathway	Approved Name	Blending Limitation
Municipal solid waste, agricultural and forest wastes, energy crops	**Fischer-Tropsch Synthetic Paraffinic Kerosene**	FT-SPK, ASTM D7566 Annex **A1**, 2009	50%
Municipal solid waste, agricultural and forest wastes, energy crops	**FT-SPK with Aromatics**	FT-SPK/A, ASTM D7566 Annex **A4,** 2015	50%
Oil-based feedstocks (e.g., jatropha, algae, camelina, and yellow grease)	**Hydroprocessed Esters and Fatty Acids**	HEFA-SPK, ASTM D7566 Annex **A2**, 2011	50%
Algal oil	**Hydrocarbon-Hydroprocessed Esters and Fatty Acids**	HC-HEFA-SPK, ASTM D7566 Annex **A7**, 2020	10%
Fatty acids or fatty acid esters or lipids from fat oil greases	**Catalytic Hydrothermolysis Synthesized Kerosene**	CH-SK or CHJ, ASTM D7566 Annex **A6,** 2020	50%
Sugars	**Hydroprocessed Fermented Sugars to Synthetic Isoparaffins**	HFS-SIP, ASTM D7566 Annex **A3**, 2014	10%
Cellulosic biomass, waste gas, syngas	**Alcohol-to-Jet Synthetic Paraffinic Kerosene**	ATJ-SPK, ASTM D7566 Annex **A5**, 2016	30%

Ground Infrastructure for Complex UAS Operations: The Role of Network Alliances

November 30th, 2021

Trends driving advanced UAS operations

Regulatory enablement	Enabling BVLOS regulation settling in place (Part 92 / Part 135) Part 107 rule mature. Focus shifting to Part 91, BVLOS NPRUM FCC/FAA spectrum policy maturing; shift from Part 15 to C-band, LTE, Satcom Industry standards slowly emerging (RTCA, ASTM)
Technology	BVLOS-ready UAV's proliferating – 10+ aircraft pursuing certification First generation of UTM network (Vantis) turned BVLOS operational in 2021 Testing of LTE for use in commercial drone application is growing
Customer demand	Line-of-sight growth continues unabated – building momentum for BVLOS Package delivery, industrial, public safety, and security accelerating Public UTM networks poised to open up new applications (ND, NY, OH)

Momentum building up for accelerating advanced operations in 2022 and beyond

End customers are increasingly embracing UAS

Timing is opportune to implement and validate UAS networks to enable BVLOS operations

Capabilities needed to commercialize advanced UAS operations

Conduct various UAS flight operations utilizing the UAS network and related services

Define the operational requirements (CONOPS)

Determine pricing for flight and technology services

Design and manufacture aircraft meeting customers' operational needs

Integrate UAS network elements on the aircraft (C2 radios, surveillance sensors)

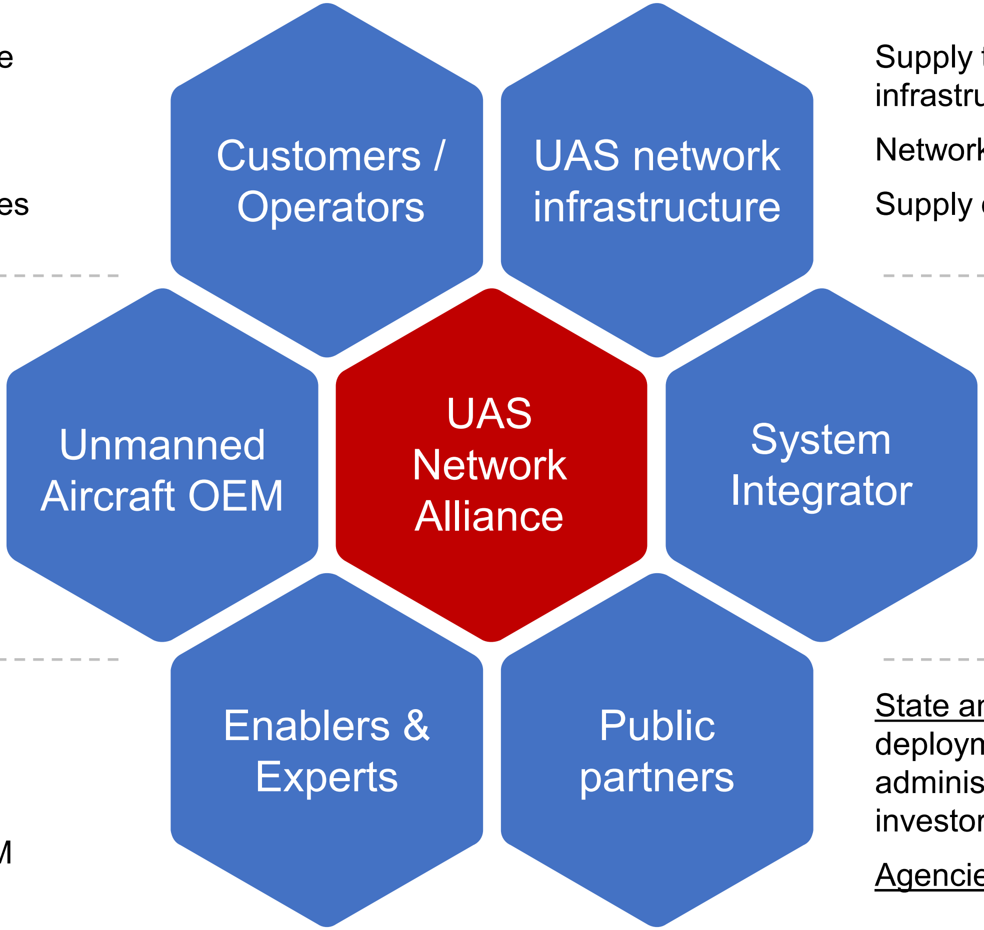
Secure aircraft type certification

Support UAS network operational authorization / certification

Federal regulators: FAA, FCC

Consultants/Experts: UAS test sites and industry players with capabilities to facilitate the projects

UAS value-added services: USS and related UTM services supporting UAS aviation



Supply the foundational telecommunications infrastructure and services to host the UAS network

Network operations, maintenance, and expansion

Supply data feeds to UAS operators and USS's

Design, develop, and deploy the UAS network

Lead system certification with FAA and FCC

On-going technical support and maintenance

NextGen system development

Network operations partner

State and local governments: facilitate UAS network deployment and acceptance through policy, administrative, and regulatory actions; potential co-investors

Agencies: provision of drone-enabled public services

Goals for a UAS Network Alliance (UNA)

Technology: Identify, mature, and validate the stack of UAS technologies that can enable efficient and advanced commercial drone services

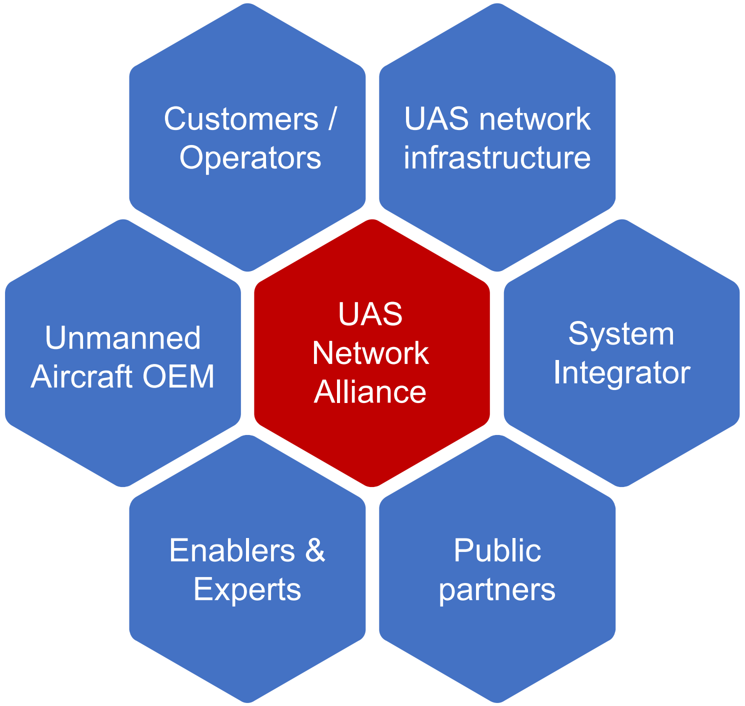
Regulatory approvals: Secure regulatory authorizations for launching commercial network operations

Business model: Demonstrate customer value creation and profitability of the core business models supporting advanced UAS operations

Business Plan: Develop a robust business plan for rolling out the UAS network and related supporting UTM services across the country

Operating entity: Define the long-term operational business model and structure partnerships to execute the business plan

Market development: Coordinate alliance activities in maturing public and private implementation opportunities



Enable drone commerce and public services across the country

Crown Castle wireless and fiber solutions

Towers

40,000 towers in 100 markets (49 states / 1 US territory)

Additional access to 10,000 rooftop sites

Wireless voice/data/broadband, TV, radio signals, hub for remote transmitters and monitors (IoT)

Small cells

80,000 small cells in indoor, outdoor, and mixed-used areas

Coverage in 700 municipalities

Extending core tower network coverage and adding density

24/7 monitoring by Network Operations Center

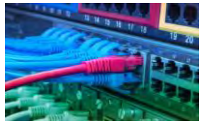
Dark fiber

80,000 route miles – one of the largest/densest networks

25 years of experience in building DF network solutions

Customized networks – single and multi-site, from individual strands to complex multi-site designs

Ethernet



High-performance, efficient, and fully restorable networks

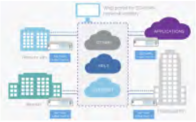
Carrier Ethernet + metro-area transport solutions – *MAPL* (Metro-E Advanced Private Line), *E-Line, EVPL* (Ethernet Virtual Private Line), and *E-LAN* (Ethernet Private LAN)

Wavelength

Private, point-to-point wavelength service over DWDM network and Managed Private Optical Networks

Data-intensive applications, data center backup and recovery, cloud services

SD-WAN



Turnkey managed SD-WAN providing highly secure, scalable, and reliable virtual network

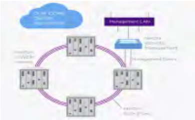
Leveraging 80,000 route miles of fiber, 900 connected data centers, PoP's, and CO's

Internet access

Enterprise-class fiber optic Internet access service – at CCI facilities, dedicated IA, and Burstable Internet Access

Supports full range of applications: cloud connectivity, VPN, email, IM, social media traffic, VoIP and video, etc.

Private network

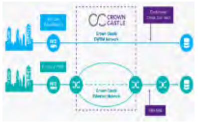


Turnkey, dedicated, private network with custom-designed dark fiber routes, DWDM equipment, and 24/7 NOC

Managed Private Optical Network (MPON) supporting multiple technologies, protocols, and applications

Crown Castle value-added solutions

Cloud Connect



Fast, secure and direct connection between main offices, data centers, and colocation environments and the cloud

A range of bandwidth and interface options to access public, private, and hybrid clouds (AWS, MS Azure)

Bandwidth on demand

Agility and control to upgrade bandwidth as needed across the Internet and Ethernet platforms

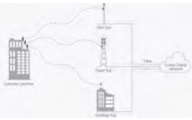
Ability to increase near real-time circuit capacity to port speeds in standard increments

Optical encryption

Federal Information Processing Standards (FIPS)-certified encryption of in-flight data from end-point to end-point

Maximum protection and throughput while optimizing latency by encrypting data at optical level

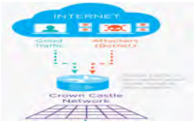
Fixed wireless



Complementary to fiber, enterprise-grade solutions for high-speed broadband Internet and ethernet access

Technology connects two fixed locations with line-of-sight radio link (network diversity, service in challenging areas, temporary services)

DDoS defense



Best-in-class security technology to monitor traffic, detect threats, and alert key personnel to mitigate the attacks

Combines network monitoring centers, threat analysis and defense systems, 24-7 available security experts

Ultra-low latency

Enables transport of critical data between key data centers and interconnected facilities

Leveraging Crown Castle's state-of-the-art wavelength (DWDM) technology and nationwide fiber network

Managed security

Portal access to real-time analysis, monitoring, threat-detection and alert notification for suspicious activities

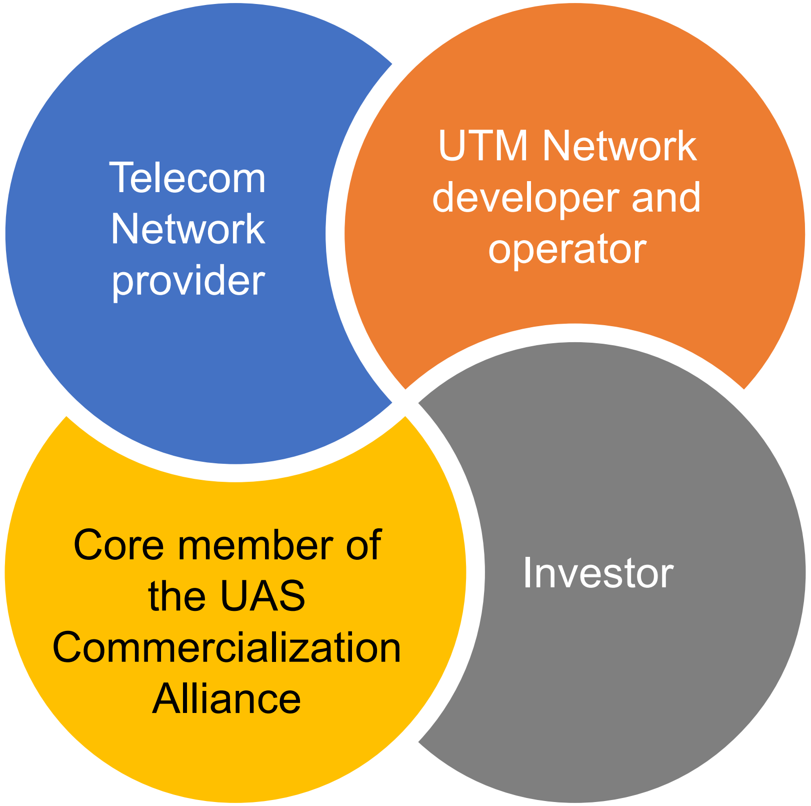
Best-in-class Security Operations Center SOC with AI machine learning platform

Video transport

High-capacity transport for HD and 4K video (ASI, SD-DI, HD-SDI, and 3G-SDI video formats)

Leveraging Crown Castle's industry leading fiber network

Crown Castle's potential contributions to UNA



Deep expertise and experience in **mission-critical networks**

The country's leading portfolio of **communications infrastructure and related value-add services**

Low-cost and commercial business model for network financing and operations

Thought leadership in UAS strategy and business development

Strategic and growth **capital**

Brand and credibility

Next steps: assemble a team to drive implementation in a particular area

Engage UAS thought leaders in a forward-leaning region to align on vision and goals

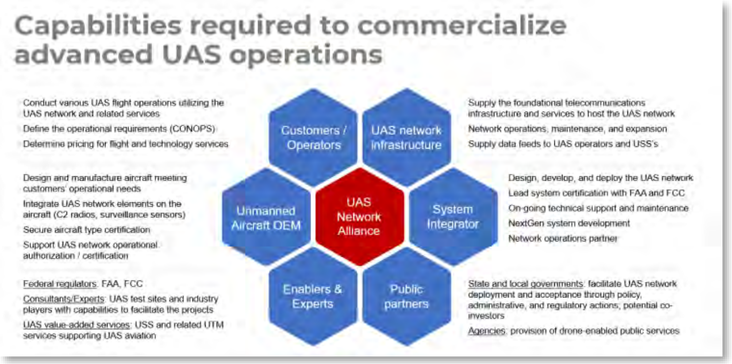
Develop a pragmatic network solution to meet the UAS industry's operational needs

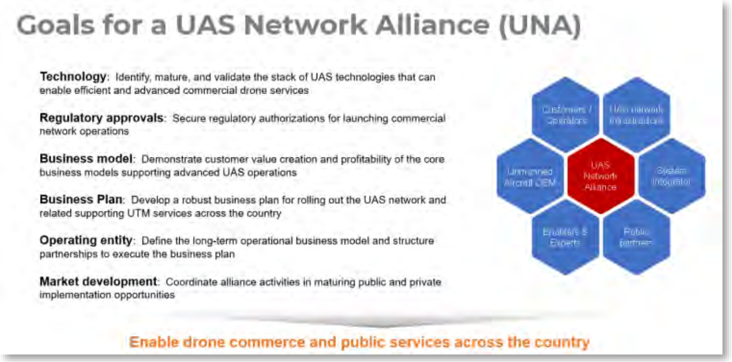
Conduct a focused pilot to validate the concept

Outline a long-term implementation roadmap

Identify potential long-term partners to execute the roadmap

Industry growth, innovation, and economic development





Advanced Air Mobility (AAM)

Market Update for the North Texas UAS Safety and Integration Task Force

Service | Innovation | Results

AAAE Regulatory Affairs Team

November 30, 2021

EHang's COVID Relief Efforts Continue Amidst Second Wave in Guangzhou

- 06/04/2021 – Successively deployed multiple autonomous aircraft for COVID-19 prevention and control efforts

- Completing multiple support tasks in the quarantine and containment zones of Guangzhou

- Aerial logistics, emergency transportation, aerial inspections, transporting necessary daily household supplies to residents and implementing AAM systems in emergency transportation scenarios

Image // EHang

Joby Aviation Announces Infrastructure Partnership With Largest Mobility Hub Operator in North America

- Partnership with REEF Technology and Neighborhood Property Group to develop takeoff and landing sites
- Largest parking garage operator focused on transforming these underutilized assets into multi-use mobility hubs
- Joby gains access to rooftop locations across key metropolitan areas in the US
- Los Angeles, Miami, New York, Bay Area

Image // Joby

DHL Orders 12 Eviation Planes, Plans First Electric Network

- Ordered 12 electric cargo aircraft for delivery in 2024 and plans to build the world's first electric air cargo “eCargo” network
- First company in the world to order Alice aircraft from Eviation
- Alice can be flown by a single pilot and can carry over 2,600 pounds of cargo
- Charging time per flight hour is approximately 30 minutes, and the maximum range is 440 nautical miles
- Charged while loading and unloading operations occur

Image // Eviation

EHang and Spanish Police to Collaborate on AAV EMS and Security Applications

- Coordination with Spanish National Police to explore potential use cases
- Emergency situations such as rescue, surveillance, and other missions
- EMS & Security application may be ready sooner than commercial transport (overcoming regulatory approvals, public/societal benefit)

Image // EHang

Kaman Corporation to Develop Commercial and Military Use eVTOLs

- KARGO UAV is the only system of its class that is purpose-built to provide deployed Marines, Sailors, Airmen, Soldiers and Coast Guard autonomous resupply
- Rugged design for easy transport and deployment
- System's compact form-factor fits in a standard shipping container and is designed to be unloaded/operated by as few as two people
- Demonstration

Image // Kaman Corporation

Archer Receives Certification Standards Approval in G1 Issue Paper from FAA

- G-1 Issue Paper establishes the airworthiness and environmental requirements necessary to achieve FAA Type Certification
- Focus turns towards G-2 Issue Paper, which sets forth the means of compliance to meet the requirements set forth in G-1
- Become the third air taxi company to be listed publicly since August 2021 after successfully completing a merger with SPAC Atlas Crest Investment Corp.

Image // Archer Aviation

ABB to Provide Charging Infrastructure for Lilium

- Provide development, testing, and supply services for the MegaWatt fast charging systems that will be used in Lilium's network
- Charging points designed to be capable of bringing batteries to full charge within 30 minutes
- Services in Brazil, Germany, and the US with plans to expand further
- Another vital step in the fight against climate change and building a more sustainable future

Image // Lilium 'The Lilium Jet'

Several EU Airports Partner on Vertiport Development

- Urban Blue - a joint venture between airport operators and administrators that will oversee the construction and management of eVTOL vertiports
- Transport airline customers on the final leg of their journey from their passenger jet to the city center
- eVTOL routes operated by Volocopter beginning in Summer 2024 in conjunction with the Summer Olympics hosted in Paris
- 2022 - Conduct technical and economic studies and begin master plans for vertiports

Image // Volocopter

Vertical Aerospace & Heathrow Airport to Collaborate on Future of Urban Air Mobility

- Gearing up to operate its electric vertical takeoff and landing aircraft at Heathrow by mid-2020s
- Has the potential to reduce congestion and pollution on local roads
- Transport 4 passengers from Heathrow to London in 12 minutes, with zero operating emissions and at a cost similar to a taxi
- Partnering with Ferrovial to build 25 vertiports across the UK. This will allow Vertical's eVTOL to operate from these sites for the proposed launch of its UK services with Virgin Atlantic
- Significant milestone for Britain's zero-emissions aviation industry

Image // Vertical Aerospace

Service | Innovation | Results

Updates

- Texas Urban Air Mobility Advisory Council
  - Voted on today
  - Task Force Members Listed
    - Chad Sparks – Bell
    - Chris Ash – Hillwood/Alliance
    - Michael Hill – Cumulus Technologies
    - Gus Khankarli – City of Dallas

Updates

- **Infrastructure Investment and Jobs Act**
  - Airport Funding
    - 25 Billion over the next 5 years
  - The Promoting Services in Transportation Act
    - 5 Million a year to promote Transportation Careers
  - The Strengthening Mobility and Revolutionizing Transportation program
    - $100 Million a year over the next 5 years
    - To help cities conduct “smart city technologies” demonstrations that include supporting advanced air mobility initiatives.

Updates

- **NASA Community Planning and Integration Annex**
  - Workshop #4 tomorrow
    - Planning and Multimodal Integration
    - Interoperable Infrastructure and Operations
    - Workforce Development
- **Regional Conference with Choctaw Nation**
  - February 8th
  - Still determining the duration
- **Building Back Better Communities Grant**
- **Working Groups meetings next week**
  - December 7th
- **Know Before You Fly Your Drone Workshop -** https://www.youtube.com/watch?v=SFdemmexMXE
  - Saturday December 4th
  - UAS Rules and Regulations
  - Tyler Dicks – Airspace Link's Pilot App
  - Mark Colburn – Notify and Fly
  - Evan Merelli – UAS Mapping

Updates

- **Community Integration Working Group Update**
  - **Cities interested in UAS Pilots and Operations**
    - City of Arlington
    - City of Carrollton
    - City of Dallas
    - City of Fort Worth
    - City of Frisco
    - City of Lakeside
    - City of Plano
    - City of Richardson
    - Duncanville
- Next Meeting
  - January 25th, 2022