NREL Overview
NREL at a Glance

- **1,998** Employees, plus more than **600** early-career researchers and visiting scientists
- **World-Class** facilities, renowned technology experts
- **Nearly 820** Partnerships with industry, academia, and government
- **Campus** operates as a living laboratory
- **National Economic Impact**: $1.1B annually
Spectrum of Energy Innovation

From Science through Deployment

- Comprehensive approach to innovation
- Collaboration with private industry
- Connect science to the marketplace
- Deliver market-relevant technologies and competitive clean-energy products
- Guide with leading analysis
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**
- High-Performance Computing
- Data and Visualizations
NREL Core Capabilities: Foundation for Innovation

Analysis and System Integration
- Decision Science and Analysis
- Systems Engineering and Integration
- Policy and Markets

Innovation and Application
- Biological and Bioprocess Engineering
- Chemical Engineering
- Mechanical Design and Engineering
- Power Systems and Electrical Engineering

Foundational Knowledge
- Applied Materials Science and Engineering
- Biological Systems Science
- Chemical and Molecular Science

Crosscutting
- Advanced Computer Science, Visualization, and Data
- Large-Scale User Facilities
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?
Need for Decarbonization
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\textsubscript{2}, liquid fuels, chemicals (long-term storage)
- Realizing the system-wide benefits of optimally integrating transportation with buildings, grid, renewables.
NREL’s Vision for Decarbonizing the Transportation Sector
Aviation Revolution
An Aviation Revolution is underway.
An Aviation Revolution - Background

- **2018:** 4.8 *Billion* passengers & 58 *Million* tons of freight
  - Both could more than **double** by 2035
  - **US** – Passenger aircraft energy usage: 89GW of equivalent energy

- Market for Advanced Air Mobility (e.g. flying taxis, drones, etc) should continue to mature during this decade, growing to $1.5 trillion globally by 2040

- Driving this trend: fully autonomous vehicles, more efficient batteries and advanced manufacturing techniques.

- Driving forces: FAA, NASA, Numerous private companies
Four Elements of Sustainable Mobility

Movement of people

Movement of goods

Powering mobility

Transformative technologies
Moving people

Advanced Materials

Energy Storage & Power Management

Power electronics

Charging/Load Management

Connectivity
Moving goods

- Advanced Combustion
- Hydrogen
- Hybridization & Electrification
- Biofuels
- Energy storage
Powering mobility

- Renewables
- Grid Integration / Energy Supply
- Buildings integration
- Cybersecurity
- Extreme fast charging
Transformative technologies

- Automation
- PHIL - Testing
- Wireless charging
- Big data/ analytics
- Deep learning
The Challenge
The challenge:

**Airports/Airlines** are under transformational pressures on emissions and electrified aviation

**Cities** are searching for clean energy and advanced mobility options

**Rural communities** are in need of mobility, commerce, and energy resilience opportunities

Sustainable Aviation (SA) will bring together NREL’s experience, expertise, and capabilities to codevelop and help implement options that address stakeholders’ unique energy-mobility goals and diverse priorities.
Sustainable Aviation

- Multiple pathways to carbon neutrality
- SAF easiest pathway utilizing existing infrastructure and long-haul flight viability
- Electrification applicable to Urban Air Mobility, Drone, short haul (<500 miles), and ground support vehicle use cases
- With growing electrification, the need for vastly improved electrical resilience need for continuity of operations
Initiative Summary

- Influence a generational shift that will affect mobility, energy, climate, commerce
- Transitioning the aviation industry’s energy needs towards a cleaner and lower cost future
- Utilization of existing industry infrastructure to advance deployment and lower cost (SAF)
- Utilization of unique NREL capabilities around Sustainable Aviation Fuel (SAF) and Electrified Aviation (e.g., generation, delivery, storage, usage)
- Alignment of: Biden Administration; Public (DOE, DOT, USDA); Govt Agency (FAA, NASA, AFWERX) and Private (Airport Consortium) strategic goals
Accelerate transformation of the Advanced Air Mobility through integrated analytics and physical/virtual testing.
NREL already has partnership with many of these key stakeholders (FAA, NASA, AFWERX, and Multiple Airports/Airport Consortium) in/nearly in place, and now we need bring in DoD, EPA, FEMA, DOT, and USDA to support larger vision

- **ASTM**: To expedite SAF approval process
- **FAA**: Task 1 (underway now) Electrified Aviation Energy and Infrastructure analysis. Task 2 (proposing) Energy Self Sufficient Airports
- **NASA**: Task 1 (working towards IAA) Energy supply and infrastructure analysis for electrified aviation – regional and airport level. Task 2 (proposing) Integrating ARIES capabilities virtually into NASA models
- **AFWERX (US Air Force’s R&D center)**:
  - Hydrogen systems research
  - Electric Mobility fueling infrastructure planning
  - Grid modernization (focus on issues such as renewables integration and vehicle charging optimization)
  - Energy storage and electric motors
  - Technical system validation
- **Airport Consortium**: Previously negotiated but never executed (COVID) consortium of Dallas-Fort Worth, Port Authority NY-NJ airports, Los Angeles, Denver, and Atlanta airports on areas of SAF, energy resilience, and electrification
Alignment with Biden Administration Initiatives

100% Clean Energy & Net Zero by 2050

Stronger, More Resilient Nation

Address Climate Change

Build Modern Infrastructure

Clean Energy Innovation

Investment in Sustainable Agriculture
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

➢ NREL addressing various segments of aviation market with SAF, electrified, and hydrogen solutions
Existing regional interest in collaborations

- WA State Aviation
- SEA-TAC airport
- Portland airport
- Moses Lake airport
- Salt Lake City airport
- CO State Aviation
- Denver airport
- Los Angeles airport
- Phoenix airport
- DFW airport
- New Orleans airport
- HI State Aviation
- GE Research
- NY-NJ airports
- Dulles/Reagan airports
- Cape Air
- Atlanta airport
- Embry Riddle Aeronautical University
UAS Safety and Integration Task Force Meeting

June 29, 2021

DFW Area Heliports
DFW AREA HELIPORTS
Source: NCTCOG
General Aviation & Heliport System Plan - Mapping Tool
DFW AREA
PUBLIC HELIPORTS
Source: NCTCOG
General Aviation & Heliport System Plan – Mapping Tool
DFW AREA
PUBLIC HELIPORTS
1. Garland/DFW Heliport
2. Dallas CBD Vertiport
3. Heliport DeSoto
4. Ferris Red Oak Heliport
Ferris Red Oak Heliport
Ellis county
Dallas CBD Vertiport
Downtown Convention Center
DFW AREA
PUBLIC HELIPORTS
with FBO Services, Hangar & Fuel Sales
480V 3Φ Power
Fiber Internet
Garland/DFW HELIPORT
FAA-Approved Public Facility
Opened 1989
Initial Build-out 1993
Expanded 2005
Expanded 2012
Garland/DFW HELIPORT
SKY Helicopters - FBO
8 Acres - Long-Term Land Lease
part 145 Repair Station
part 135 Air Carrier
part 141 Training
HELIPORT DeSoto

FAA-Approved Public Facility  SKY Helicopters – FBO
HELIPORT DeSoto
EMS, Maintenance Base
HELIPORT DeSoto
19 Acres, Long-Term Land Lease
HELIPORT DeSoto
Easy Metroplex Access, I-20/I-35/I-45
Questions?
Contact Info:

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(214) 349-7000
www.skyhelicopters.com
Can Texas lead Advanced Air Mobility?

Dan De Clute-Melancon - SkyStations
Intro

- AAM – Advanced Air Mobility
  - RAM – Regional Air Mobility
  - UAM – Urban Air Mobility
DoD interest & support – Agility Prime / SBIR / STTR

- Round 1 – Drones
  - $42 billion by 2025

- Round 2 – eVTOL aircraft
  - $9 trillion by 2050
eVTOL Aircraft

Joby Aviation $5.7B SPAC - $RTP

Beta Technologies

Lift Aircraft – Austin, TX

Vertical Aerospace $2.2B SPAC - $BSN

Lilium $3.3B SPAC - $QELL

Wisk Aero (Boeing JV)

Ehang NASDAQ: EH

Archer Aviation $3.8B SPAC - $ACHR

Kitty Hawk + 3D Robotics

Airbus

Volocopter

SkyStations™
Texas - AAM / RAM / UAM
AAM Infrastructure – Need Electrification

Airports: +EVSE

Heliports: +EVSE

Vertiports: Parking Garage, Barge

Vertistations

Private: Airparks, Ranch

"Dallas Skyport" by The Beck Group, Dallas
Dallas-Fort Worth - AAM Ecosystem

SkyStations™

North Central Texas Council of Governments

Joby/Uber 125+
DFW locations
Houston - AAM Ecosystem

- Evolve Houston
- Innovators
- Finance / Investors
- City Governments
- Area Councils
- Power & Utilities
- Drones / eVTOL aircraft
- Infrastructure, ATM & PSUs
- Battery Manufacturers
- Research Institutions
- Consultancies
- Regulators
- MaaS Firms
- Consultancies
- Research Institutions
- Battery Manufacturers
- Power & Utilities
- Drones / eVTOL aircraft
- Infrastructure, ATM & PSUs
- City Governments
- Area Councils
- Finance / Investors
- Innovators
- Houston EXPONENTIAL

Black & Veatch
189 aerodromes
195 helipads
100 mile radius
Austin – Urban Air Mobility

Existing Heliports & Airports

4 Vertiports
INRIX Research (2019)

9 Vertiports
UT Austin Research (2020)
Ohio Advanced Air Mobility Opportunity

$13B Economic Activity
15,000 Additional Jobs
$2.5 Billion Tax Revenues

1st AAM Charger
$226,000 in grant from JobsOhio’s Ohio Site Inventory Program (OSIP) to the Springfield-Beckley Municipal Airport (SGH)

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<thead>
<tr>
<th></th>
<th>Ohio</th>
<th>Texas</th>
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<tbody>
<tr>
<td>Area</td>
<td>44,825 mi²</td>
<td>268,597 mi² (6x)</td>
</tr>
<tr>
<td>Population</td>
<td>11.8 million</td>
<td>29.1 million (2.5x)</td>
</tr>
<tr>
<td>GDP (2020)</td>
<td>$0.59 trillion</td>
<td>$1.76 trillion (3x) (world’s 9th largest)</td>
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Interested in Joint Industry Partnership for Texas AAM Economic Analysis?

Can Texas Lead AAM?
What's the next step?

Daniel De Clute-Melancon

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87th Legislative Session

**HB 1758 (Krause)** - Relating to the operation and use of an unmanned aircraft.
- Defines “drone”
- HB 1758 also ensures that law enforcement agencies seeking to use drones must adopt written policies detailing the agency’s use of force via drone and transmit those policies to the Texas Commission on Law Enforcement annually.

**SB 149 (Powell)** - Relating to the prosecution of the offense of operation of an unmanned aircraft over certain facilities.
- Also adds airports and military installations to the list of critical infrastructure
Questions and Comments

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