Decarbonization of Bus Depots
Strategic Opportunities and Challenges
June 30, 2023
Agenda

› Welcome
› An Overview of US Long Term Net Zero Strategy
› Transportation Industry Decarbonization Trends
› Strategies for the Decarbonization of Bus Depots
   › Opportunities
   › Challenges
   › Considerations for Mixed Fleet Operations
Introduction

Atkins is a leader in the design and delivery of the built environment, we play a unique role in influencing what gets built, and how technologies and methods can be used to create and operate infrastructure assets, while minimizing the impacts they have on society.
Enhanced value-chain

A more comprehensive end-to-end service offering

- Arrange financing, invest equity, undertake complex financial modelling and manage infrastructure investments for optimal returns
- Expert consultancy covering the full lifecycle
- Plan, design and enable major capital projects
- Extensive engineering and master planning capabilities
- Digital products and tools to enhance delivery
- IoT, mobility services and strategic digital asset management solutions
- Concept, feasibility and design services
- Human-centered innovative digital design tools and techniques
- End-to-end offering, from initial regulatory approvals to final build
- 20+ years of experience offering simulation consultancy and advice
- Procurement Management
- Contract Administration
- Purchasing
- Expediting
- Material Management
- Logistics
- Quality Assurance
- Inspection, Material Control
- Multi-disciplinary construction and technical field services
- Construct, commission, maintain, and enhance assets
- Self-performed construction using a qualified labour force
- Consultancy services and entire program management
- Business change programs
- Around-the-clock support for mission-critical activities
- Operate and maintain major public-private partnership (P3) projects
- In-depth review of end-to-end operations, asset portfolios and value chain
- Asset management and solutions to reduce costs and improve productivity
Transportation is our Core Business

Policy Advisory

Green Integration
Strategic Carbon Planning
Green Infrastructure
Clean Energy Systems
Multimodal Transition Planning

Climate Resilience
Smart Asset Management
Sustainable Travel Patterns
Net Zero Masterplanning
The Long-Term Strategy of the US to Reach Net-Zero Emissions by 2050

PERIOD OF STRATEGIC SHIFT

17% BELOW 2005 LEVELS IN 2020

26-28% BELOW 2005 LEVELS IN 2025

50-52% BELOW 2005 LEVELS IN 2030

Net-Zero IN 2050
US Pathways to 2050 Net Zero
US Key Goals by Economic Sectors

➢ **Electricity**
   › 100% carbon pollution free electricity by 2035

➢ **Transportation**
   › 50% of all new light-duty cars sold in 2030 to be zero-emission vehicles
   › Produce 3 billion gallons of sustainable aviation fuel by 2030

➢ **Buildings**
   › Rapidly improve energy efficiency
   › Increase the sales share of clean and efficient electric appliances

➢ **Industry**
   › Energy efficiency; electrification; low-carbon fuels, and industrial CCS

➢ **Agriculture, Forestry, and Land Use**
   › Expand and protect forests, integrate trees into urban areas, scaling up climate-smart agri-practices
Highest emitting sector, representing **29%** of all US emissions

- Transforming fleets to Zero Emission Vehicles (ZEVs)
- Infrastructure to support inter-modal public transit
  - Electrifying segments of the **rail system**
  - Enabling **electric grid** along railroad “right of way”
  - “**Vehicle to grid**” innovations for grid services
- Accelerated R&D to decarbonize **aviation**, **marine**, and **trucking** segments
  - Biofuels
  - Hydrogen
Overview of the Mass Transit (Buses) Sector in the US

- Over 1,500 local, regional, and state level transit authorities in the US.
- In 2020 there were approx. 967,450 registered buses nationwide (Per Bureau of Transportation Statistics)
- Based on the # of passenger trips, some of the nations’ largest transit authorities include:
  - Metropolitan Transportation Authority (MTA) - New York City ~5,700 buses
  - Los Angeles County Metropolitan Transportation Authority (LACMTA) ~2,200 buses
  - Chicago Transit Authority (CTA) ~ 1,800 buses
  - Washington Metropolitan Area Transit Authority (WMATA) ~1,500 buses
- On the private side companies like Greyhound operates, approx. 1,700 in the US, Coach USA operates approx. 2,250, and Student First operates approx. 44,000

Average Co2 per gallon of fuel burned.

- Diesel: 22.4lbs
- Gasoline: 19.6lbs
- CNG: 15.7lbs
Key Strategies to Decarbonize Bus Depots

- **Zero Emission Fleet:** Transformation to Zero Emission Vehicles
- **Renewable Energy Integration:** Procurement and generation of renewable energy
- **Energy Efficiency Measures:** Optimizing building and equipment energy usage
- **Battery Energy Storage Systems:** Deploying BESS can store access energy
- **Green Infrastructure and Landscaping:** Green spaces, water management, bio-diversity etc.

Funding and supportive policies to enable and accelerate decarbonization efforts.
Decarbonization of Bus Depots: Opportunities

- **GHG Reduction**: Dependent on technology selection
- **Air Quality Improvements**: No Nitrogen Oxides (Nox) or Particulate Matter (PM)
- **Fuel Cost Savings**: Low fuel price fluctuations, and potential lower fuel costs
- **Operational Cost Savings**: Lower maintenance and operational cost predicted
- **Noise Reduction**: Low urban noise pollution, especially electric buses
- **Resilience and Energy Independence**: Low exposure to geopolitical risks etc.
Decarbonization of Bus Depots: Challenges

- **Higher Initial Costs**: Higher capital costs for zero emission vehicles
- **Limited Driving Range**: Limited range could add to operational inefficiency
- **Charging Infra**: Building reliable charging infra can be complex and costly
- **Longer Refueling Times**: Longer refueling time may impact scheduling
- **Limited H2 Infrastructure**: H2 infra can be complex, time consuming, and costly
- **Technology Constraints**: Specialized maintenance and workforce training
Fleet Transformation: Technological Uncertainties

- Policies
- Regulations
- Standards
- Econometrics

- Planning
- Feasibility
- Alt. Fuels
- Alt. Infrast.
- CAPEx/OPEx

- Transport
- Logistics
- Supply Chain
- Econometrics

- Technology
- Generation
- Decarbonize
- CCS
- Econometrics

- Specifications
- Materials
- Design
- Construction
- Workforce

- Operations
- Maintenance
- RCM
- IO&T
- Reporting
# Technology Solutions for Travel Modes to Reach Net Zero

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**Technology Solutions**

<table>
<thead>
<tr>
<th>Travel Mode</th>
<th>Battery/Electric</th>
<th>Hydrogen</th>
<th>Sustainable Liquid Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Duty Vehicles (49%)*</td>
<td>![3 icons]</td>
<td>—</td>
<td>TBD</td>
</tr>
<tr>
<td>Medium, Short-Haul Heavy Trucks &amp; Buses (~14%)</td>
<td>![2 icons]</td>
<td>![1 icon]</td>
<td>![2 icons]</td>
</tr>
<tr>
<td>Long-Haul Heavy Trucks (~7%)</td>
<td>![1 icon]</td>
<td>![2 icons]</td>
<td>![1 icon]</td>
</tr>
<tr>
<td>Off-road (10%)</td>
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<td>![1 icon]</td>
<td>![1 icon]</td>
</tr>
<tr>
<td>Rail (2%)</td>
<td>![2 icons]</td>
<td>![1 icon]</td>
<td>![1 icon]</td>
</tr>
<tr>
<td>Maritime (3%)</td>
<td>![2 icons]</td>
<td>![1 icon]</td>
<td>![1 icon]</td>
</tr>
<tr>
<td>Aviation (11%)</td>
<td>![2 icons]</td>
<td>![1 icon]</td>
<td>![1 icon]</td>
</tr>
<tr>
<td>Pipelines (4%)</td>
<td>![2 icons]</td>
<td>![1 icon]</td>
<td>![1 icon]</td>
</tr>
</tbody>
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**Additional Opportunities**

- Stationary battery use
- Grid support (managed EV charging)
- Heavy industries
- Grid support
- Feedstock for chemicals and fuels
- Decarbonize plastics/chemicals
- Bio-products

**RD&D Priorities**

- National battery strategy
- Charging infrastructure
- Grid integration
- Battery recycling
- Electrolyzer costs
- Fuel cell durability and cost
- Clean hydrogen infrastructure
- Multiple cost-effective drop-in sustainable fuels
- Reduce ethanol carbon intensity
- Bioenergy scale-up

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* icons represent limited long-term opportunity:
  - 1 icon = limited long-term opportunity
  - 2 icons = large long-term opportunity
  - 3 icons = greatest long-term opportunity

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Courtesy: The US National Blueprint for Transportation Decarbonization (Fact Sheet) – January 2023
<table>
<thead>
<tr>
<th>Attributes</th>
<th>Key Consideration</th>
</tr>
</thead>
</table>
| Fueling Technology & Infrastructure | • Availability & Accessibility  
• # of Fueling Stations  
• Fuel Suppliers  
• Government and Industry Plans & Partners |
| Vehicle Performance and Range    | • Driving Range  
• Refueling Times  
• Reliability |
| Safety and Training              | • Safety Protocols  
• Training Programs  
• Handling, Fueling, Maintaining, Emergency Response etc. |
| Fleet Size and Scalability       | • Fleet Size  
• Future Expansion  
• Funding Options  
• Hybrid Operations |
| Total Cost of Ownership          | • Procurement Costs  
• Infrastructure Costs  
• Maintenance Costs  
• Fueling Costs |
| Partnership and Support          | • Stakeholder Support  
• Fuel Suppliers  
• Manufacturers  
• Research Institutions |
| Environmental Impact             | • Life Cycle Emissions  
• Whole Life Carbon Modeling |
Key Considerations during Mixed Fleet Operations

- **Infrastructure requirements**
  - Dual/multiple refueling infrastructure may be needed for the selected technologies
- **Training and maintenance**
  - Specialized training for maintenance personnel for each fleet type
- **Inventory and sparing**
  - Inventory of different parts, tools, equipment specific to bus type
- **Operational planning and scheduling**
  - Driving ranges, refueling times, emergency response etc.
- **Training and transition of operators**
  - Operator training to handle specific technologies
- **Fleet transition and integration**
  - Coordination between internal and external stakeholders