



# Zero Emission Vehicle (ZEV) Transit Buses at RDU

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# Agenda

- 01** Introductions
- 02** RDU and Operational Asset Management (OAM)
- 03** Shuttle Bus Operation
- 04** Electric Bus Operation
- 05** Performance/Experience/Observations
- 06** Tour of Bus and Charging Stations

## State of RDU

- Since 2011
  - Added 5 new airlines
  - 29 new non-stop destinations
- Record 12.8 million passengers in 2018
- Projected growth of at least 10% this year



# Economic Impact on the Region



**\$12.5 Billion** in Economic Output



**\$450 Million** in State and Local Taxes

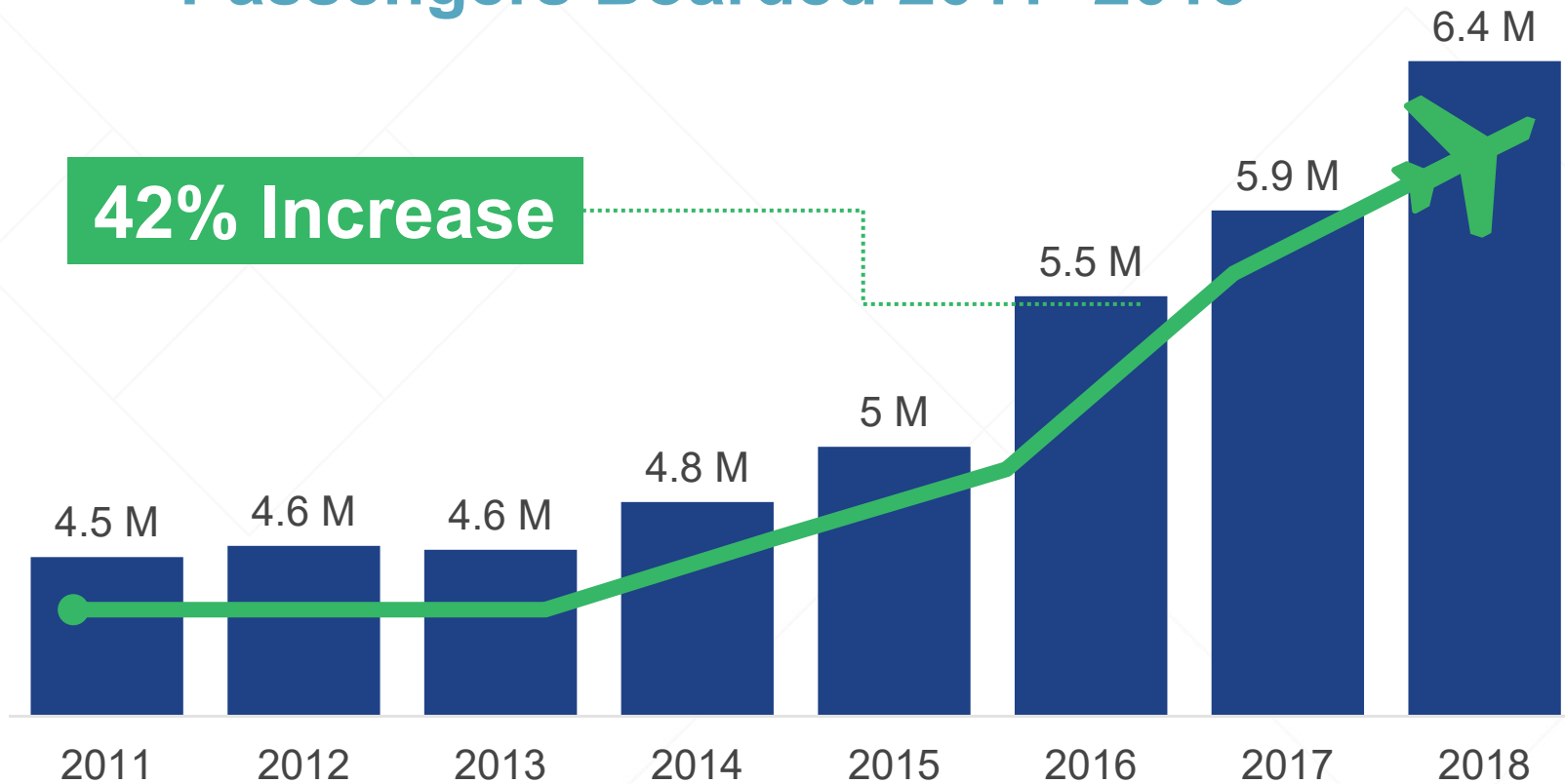




# 62 Nonstop Destinations



## Passengers Boarded 2011- 2018



# OAM Responsibilities

- Maintenance
  - 24/7/365
  - 1.5-2 Billion in Assets
- Three Runways
  - 5L/23R, 5R/23L, 14/32
    - Airfield Pavements
    - Signage
    - Airfield Lighting
    - Infields





## OAM Responsibilities

- Terminals (T1/T2) & Authority Buildings
  - 1.1M Sq Ft in Terminal Complexes
  - 45 Passenger Boarding Bridges \*
  - 2 Baggage Handling Systems \*
- Airport Grounds
  - Roadways, Parking Decks/Lots, Utilities
- Fuel Farm – Storage Tanks & Hydrant System. 10M gallons per month flowage
- Fleet - 133 Vehicles, More Than 100 Pieces of Equipment





# RDU Transit Bus Operations

- Current Fleet:
  - 40 ft Gillig Diesel (12 total)
  - Proterra Electric (4 total)
    - Fleet owned and maintained by RDU
    - Shuttles driven by contract drivers – SP+
    - Serve T1/T2 and Park Economy 3 and Park Economy 4 Lots
    - Average 50,000 miles per bus each year
    - Average about 126,000 riders per month
      - 90,000 Airline Passengers
      - 36,000 Employees

Approximately 8-10  
year life span with  
500,000 miles clocked  
before replacement

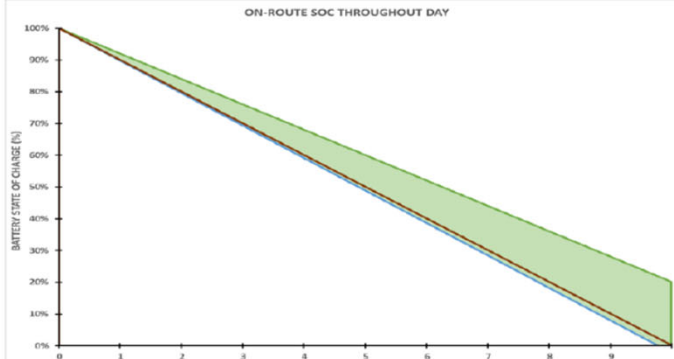


# Transition to Electric Buses



- Viability for RDU
  - Cost
  - Needed Range
  - Height
  - Route vs Depot Charging
  - Location for Charging
- Grant and Purchase Process
- Charging Infrastructure
- Real World Experience

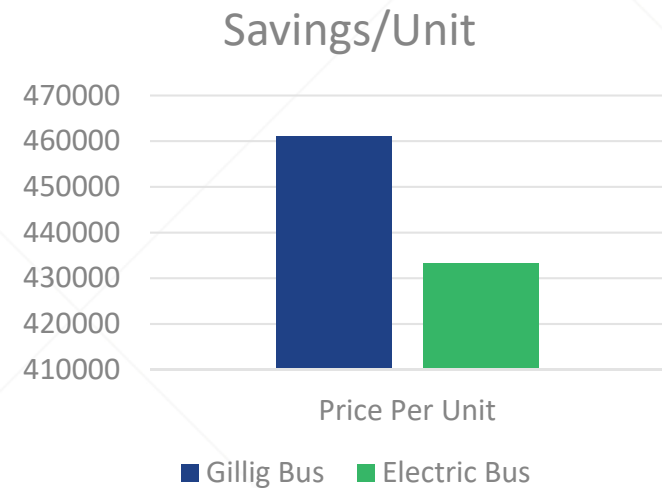
## Route Simulation Results - RDU Airport - E2



Route Information	
Route Name	Terminal
Distance	5 miles
Duration	20 minutes
Average Speed	14.8 mph
Maximum Speed	44 mph
Vehicle Configuration	E2
Average Day Results	
Passenger Count	40
Ambient Temperature	60.5°F
Efficiency	1.874 kWh/mi
MPGe	20.09
Total Energy Consumed	9.37 kWh
Auxiliary Accessories Energy	0.40 kWh
HVAC Energy	0.51 kWh
Powertrain Energy Recaptured	31%
1 Lap Final SOC	97.3%
Estimated 1 Lap Recharge Time (On-route charger)	N/A
Environmental and Operating Impact	
Hot Day	
Passenger Count	77
Ambient Temperature	97F
Efficiency	2.341 kWh/mi
MPGe	16.08
Cold Day	
Passenger Count	77
Ambient Temperature	14F
Efficiency	2.397 kWh/mi
MPGe	15.70

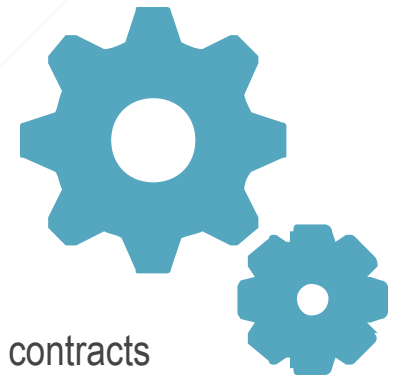
# Cost Benefit to RDU

- Current RDU Gillig Bus Unit Cost - \$460,988
  - Annual Fuel Cost - \$14,059
  - Annual Maintenance Cost - \$42,925
- Electric Bus Cost ( 50% FAA Grant ) - \$433,275
  - Annual Electric Cost - \$9,171
  - Annual Maintenance Cost - \$23,624
- Total Savings over Life of 4 Buses - \$1,271,924
  - (Proterra TCO Analysis - \$1,769,435 )



# FAA ZEV Grant Application

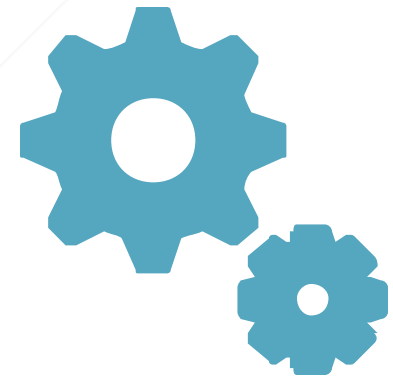
- Request to Purchase 4 Electric Buses and Depot Charging Infrastructure
- Pre-Application approved by FAA in January 2017
- Original Project Estimate was \$3,622,000
- Technical Specification/Bid Package Reviewed by FAA Prior to Advertisement
  - Had to fully compete. Could not piggyback, sole source or use cooperative contracts
  - FAA required fully open specifications
- RFB Advertised on 5/29/2017
- Public Bid Opening on 6/20/2017





# FAA ZEV Grant Application

- Three Bids Received
  - Low Bidder was Proterra, Inc. for \$3,381,000.
  - New Flyer and BYD were other Bidders
- Bid Items Ineligible for Grant Funding
  - Training - \$15,000
  - Bridge Technology System - \$99,800
- Total Eligible for Grant Funding - \$3,266,600
- FAA Share 50% - \$1,633,300



# Specification Highlights



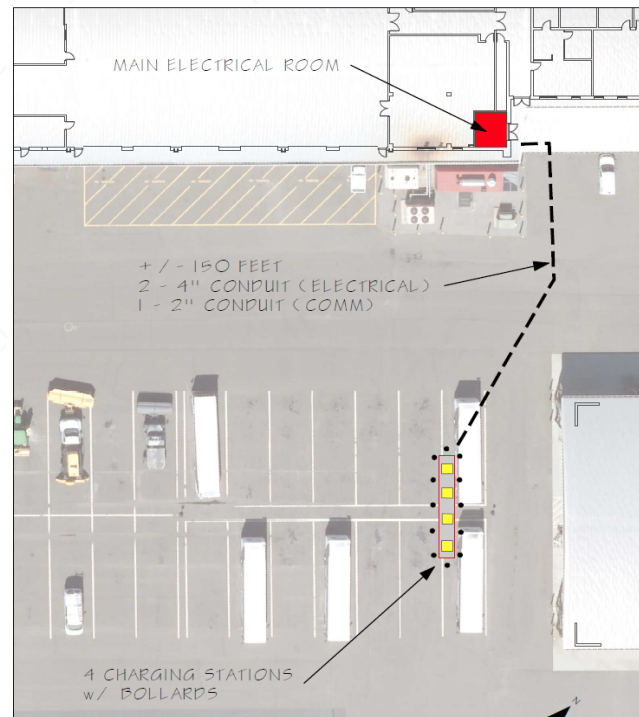
- Proterra 40' Catalyst E2 Battery Electric Buses
- 440kWh On-Board Battery Storage (Four– 110kWh Packs) to Meet 175 Mile Specified Range
- 220kW Peak Power Traction Motor/Two-Speed Transmission
- SAE J1772 CCS Plug-In Charging
- Regenerative Braking
- Composite Construction

# Charging Infrastructure

- Turn-Key Design and Installation for Four Charging Stations Included in Bid Price
- Originally Scoped for Four- 120kW Chargers (charge in 3-4 hours ) to Keep on Schedule
  - Initial engineering determined transformer not large enough to support that load
  - Revised charging infrastructure to 4 – 60kW chargers with provision to install 1 – 120kw charger later
  - Current 120kW chargers on market are automotive style and not recommended by Proterra for buses
  - Proterra is developing a 120kW depot style charger
- Operational Experience with the Buses will Help Make Future Charging Infrastructure Decisions.
  - Many questions - charge at night only? Run 2/Charge 2?, charger to bus ratio?, future growth of electric fleet?, real world range and charge times?



# Charging Infrastructure



# Order/Delivery Timeframe

- Order Placed – August 28, 2017
- Customer Kickoff Meeting– October 17, 2017
- Configuration Meetings Started November 11, 2017
- Original Delivery Anticipated for End of November 2018
  - Schedule slipped to March 2019 due to production delays on other orders
- Pre-production Meeting Held at Factory on October 3, 2018





# Order/Delivery Timeframe

- Buses Delivered March 2019
- Training and commissioning started in March 2019
  - Temporary generator/charger provided by Proterra
- Final commissioning of chargers in May 2019
- Buses placed into active service on May 28, 2019



# Launch Process

- Pre-Arrival
  - Four Weeks Prior to First Bus Arrival – Full Day On-Site Meeting
- Bus Arrival and Inspections
  - Four Weeks Prior to Launch
- Training – Maintenance and Driving
  - Two Weeks Prior to Launch
- “Shadow Service”
- Launch
- Post-Launch Support for One Week



# Order Information

- Factory Inspections
- Recommended Spares
  - List is much shorter due to proximity to Greenville, S.C.
- Recommended Tools – Non-traditional mechanics tools ( insulated tools, high-voltage gloves, etc. )
- Unique Items
  - Overall height of bus was limited due to tunnel under taxiway
  - Regen Lights on Rear of Bus
  - Consider USB Ports at Seats
  - Wrap on exterior





## Real World Experiences

- To Date – 42,824 miles on the four electric buses
- Estimated 11,380 gallons of diesel not used
- Range – 175 Miles Specified
  - Routinely exceed
  - Have seen estimated range 200+ miles on single charge
  - Weather dependent-hot and cold days
- Charge Times
  - Depending on SOC
  - Recharge 4-5 hours



# Real World Experiences

- Initial Driver Apprehension
- Driver Training with Charging Procedures
- Pre-Conditioning of Bus While Charging
- Maintenance Cost/Warranty Issues/Vendor Responsiveness
- APEX System – Beta Version (Charger and Bus Information)





# 40 FT RDU PROTERRA BUS





QUESTIONS?