2014 DOE Vehicle Technologies Program Review Presentation

Smith Electric Vehicles:

Advanced Vehicle Electrification + Transportation Sector Electrification

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This presentation contain no proprietary, confidential, or otherwise restricted information

OVERVIEW

Timeline
- Start: Apr 2010
- Completion: May 2015
- Completion status: @ April 15 2014
  - Vehicles supplied 88% of target
  - Jobs created 58% of target
  - Project spend 91% of target

Budget
- Total Project Funding
  - DOE $32M
  - SMITH US $37.5M
  - DOE funding received $29.2M

Barriers & Risks
- Finance
- Supply chain
- Customer Adoption
- Service Support

Partner & Collaborators
- SMITH Europe
- Customers
- Technical Partners
- Suppliers
- Institutions
- Other DOE Funded Projects

OBJECTIVES/RELEVANCE

Relevance to American Recovery and Reinvestment Act

- Accelerate the development, production and acceptance of AEV's in the US commercial market to substantially reduce petroleum consumption, reduce vehicular emissions of greenhouse gases, increase energy security, and create US jobs.

Project Objectives

- Supply to customers 500 medium duty commercial All Electric Vehicles (AEVs) operating different duties in different regions of the USA.
- Collect and submit to the National Renewable Energy Laboratory (NREL) 2 to 3 years of performance data on each vehicle sold.
- Develop Second Generation Smith Power, Smith Drive, Smith Link and Smith Charging to enhance performance and reduce costs.
- Develop an e-stripped chassis to support the introduction of- step van, school and shuttle bus configurations.
- Create 225 new jobs at Smith USA.

PROJECT MILESTONES

Milestone Title	Milestone Description	Planned Start Date	Planned End Date
Initial Customer Program Vehicle Build Complete for Project	Initial vehicle deliveries as part of the project	4/1/2010	4/30/2010
Installation of telemetry system on initial customer program vehicle	Vehicle data received on Smith Servers	9/1/2010	12/31/2014
Initial customer vehicle initial data capture and reporting to DOE	Send complete data set to DOE for initial vehicles	11/1/2010	5/31/2015
Customer vehicle final data capture and reporting to DOE	Final data receipt from vehicles and final report submission to the DOE	10/31/2010	5/31/2015
255 Vehicles Deployed under program	Halfway point of vehicle deployment	4/1/2010	1/31/2012
Vehicle Deployment Complete	Final Vehicle deployed under program	4/1/2010	12/31/2014

To date Smith has placed 439 of an agreed-upon 500 Newton all-electric commercial vehicles in service, and plans on delivering the final 61 vehicles by the end of 2014, 14 months after the originally agreed upon date of October 2013. This delay is due to Smith's temporary shutdown of its Kansas City production facility in order to facilitate the transition of its supply chain and complete the capitalization of its business. Smith is transitioning the supply of key electrical components – batteries, motors, controllers and battery management systems – to world class manufacturing facilities able to provide consistent high quality components, in volume, and in line with the cost-down pricing required to meet future profitability.

PROJECT APPROACH

- Maintain fund raising activity to support corporate goals.
- Complete knowledge transfer from Smith UK to Smith USA.
- Secure US purchase commitments and participation agreements to support the demonstration project-
  - 84% of the $32M DOE/ARRA Grant will be paid to AEV buyers participating in the DOE Electric Fleet Data Collection Program.
  - On order placement and completion of the participation agreement at the time the customer agrees to a two to three year data collection program.
  - The amount paid to each participating company is based upon the duration of participation and the value of the base vehicle.
  - The encrypted performance data is collected via Smith Link, held and processed on secure servers for transmission to NREL monthly.
  - The remaining 16% of the Grant is a 32% reimbursement of Project Development costs.
- Establish technical teams to
  - Deliver Homologation approvals.
  - US Platform Development and Introduction.
  - Develop Second Generation Smith Power, Smith Drive and Smith Link systems.
  - Deliver Corporate cost down targets in line with project objectives.

PROJECT APPROACH

- Establish US facilities.
- Establish Service and Training resource to support customer adoption.
- Achieve ISO accreditation.
- Achieve and maintain compliance:
  - NHTSA,
  - FMVSS
  - NEPA

2013/14 TECHNICAL ACHIEVEMENTS

QTR2 2013 to QTR2 2014- (Note: these are calendar quarters)

Completed or In Process

- Initial operation of V-to-G system at TARDEC.
- Engineering and validation of Smith Power Gen 1.75 system (Prismatic Cell).
- Engineering of Smith Power Gen 2 system (Pouch Cell).
- Delivery of first AEV Shuttle Bus to Department of Defense installation (TARDEC).

Planned for Q3 and Q4 2014

- Introduction of Smith Power Gen 1.75 system (Prismatic Cell).
- Completion of 500 vehicle fleet target.
- Engineering and validation of Smith Power Gen 2 system (Pouch Cell).
- Completion of Smith Power Gen 2.0 battery system (Pouch Cell).

2013/14 Progress

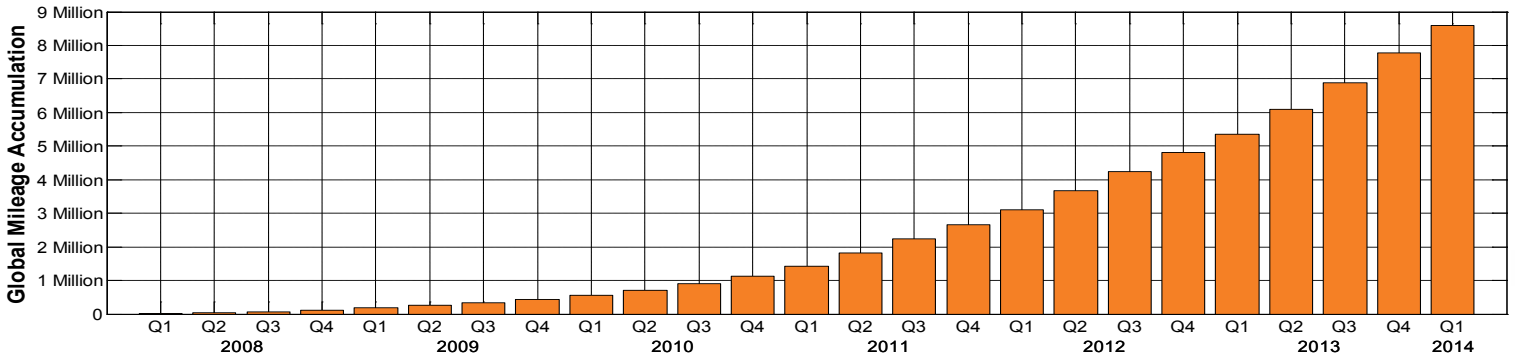
Project Progress at 15th May 2014

- 439 vehicles delivered to date- an increase of only 17 vehicles since last AMR. Smith suspended production of new vehicles Q4 2013. Re-vamping of the assembly process and developing improved components to reduce costs and increase quality continued.
- Smith management has used this time to infuse additional capital into the business, needed to move from boutique, low volume suppliers to high volume, high quality vendors, and secure the cost down strategy.
- Total Smith U.S. employees-52. Reductions in force were necessary to preserve cash until additional funding could be obtained. Ramp up in hiring will occur rapidly when the supply chain is renewed.
- Gen 2 Smith Drive volume supplier motor/controller prototype in test validation at Smith KC plant.
- Cost down activity targeting 28% cost reduction by end of Q4 2014.

Annual Vehicle Performance Statistics

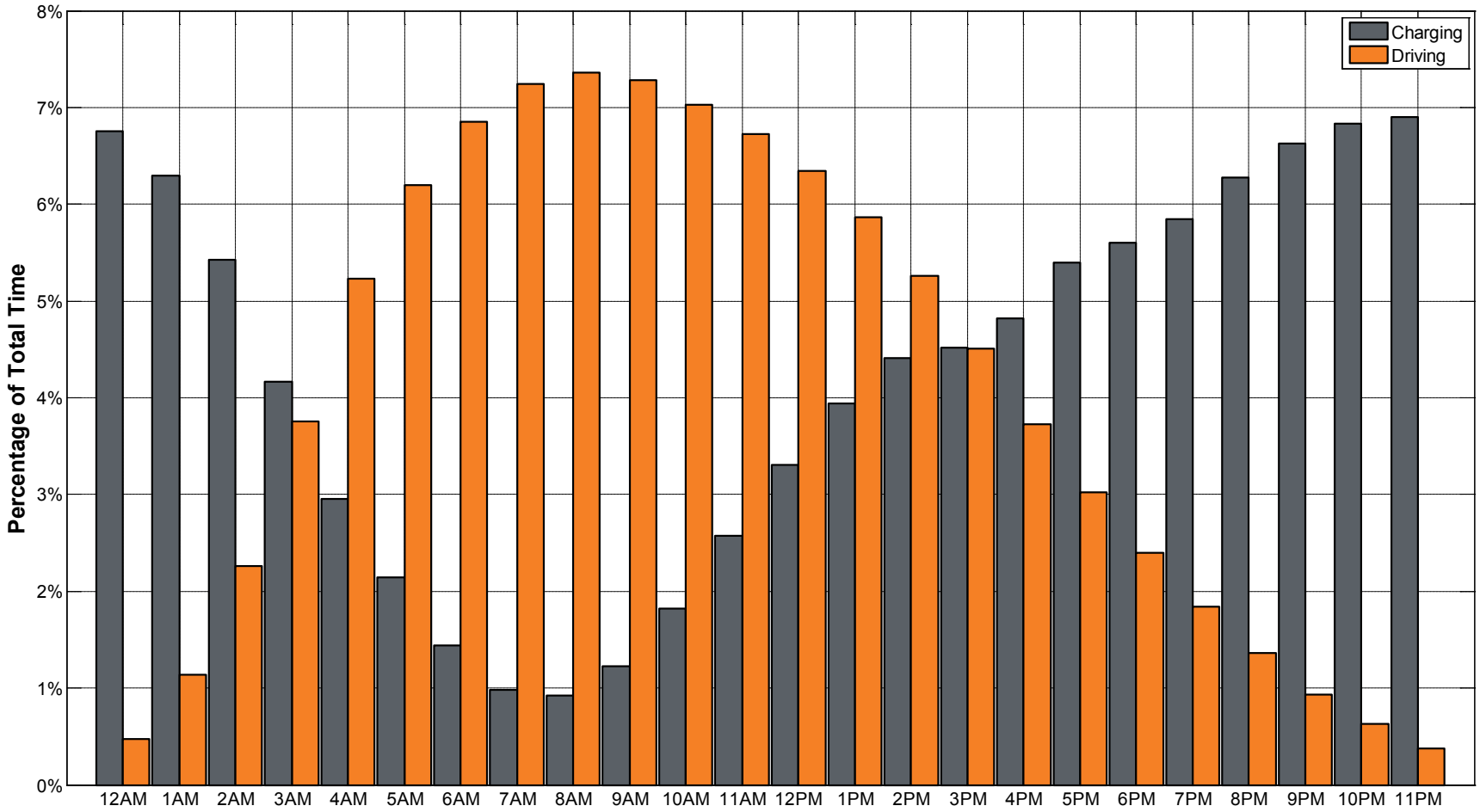
All Operational US Fleets			
	2013	**2012**	**Annual Increase**
Routes Completed	85,063	56,183	51.4%
Annual Distance Traveled	2,542,737 miles	1,760,859 miles	44.4%
Energy Consumption	3,384,053 kWh	2,309,121 kWh	46.6%
Energy Regenerated	434,459 kWh	274,229 kWh	58.4%

Global Mileage Accumulation – 8,591,262 Total Miles



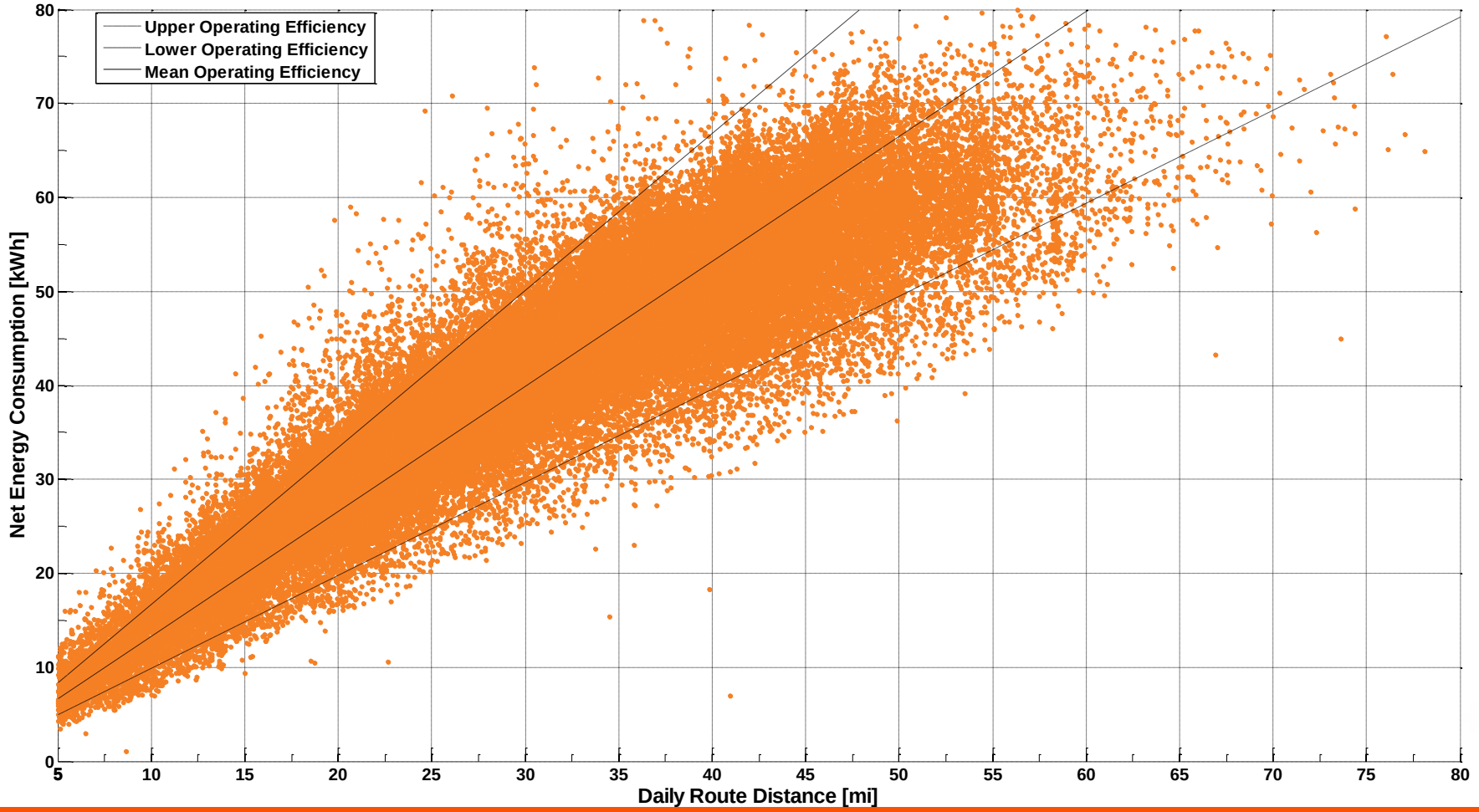
All energy numbers assume DC energy

Daily Charging and Driving Profile



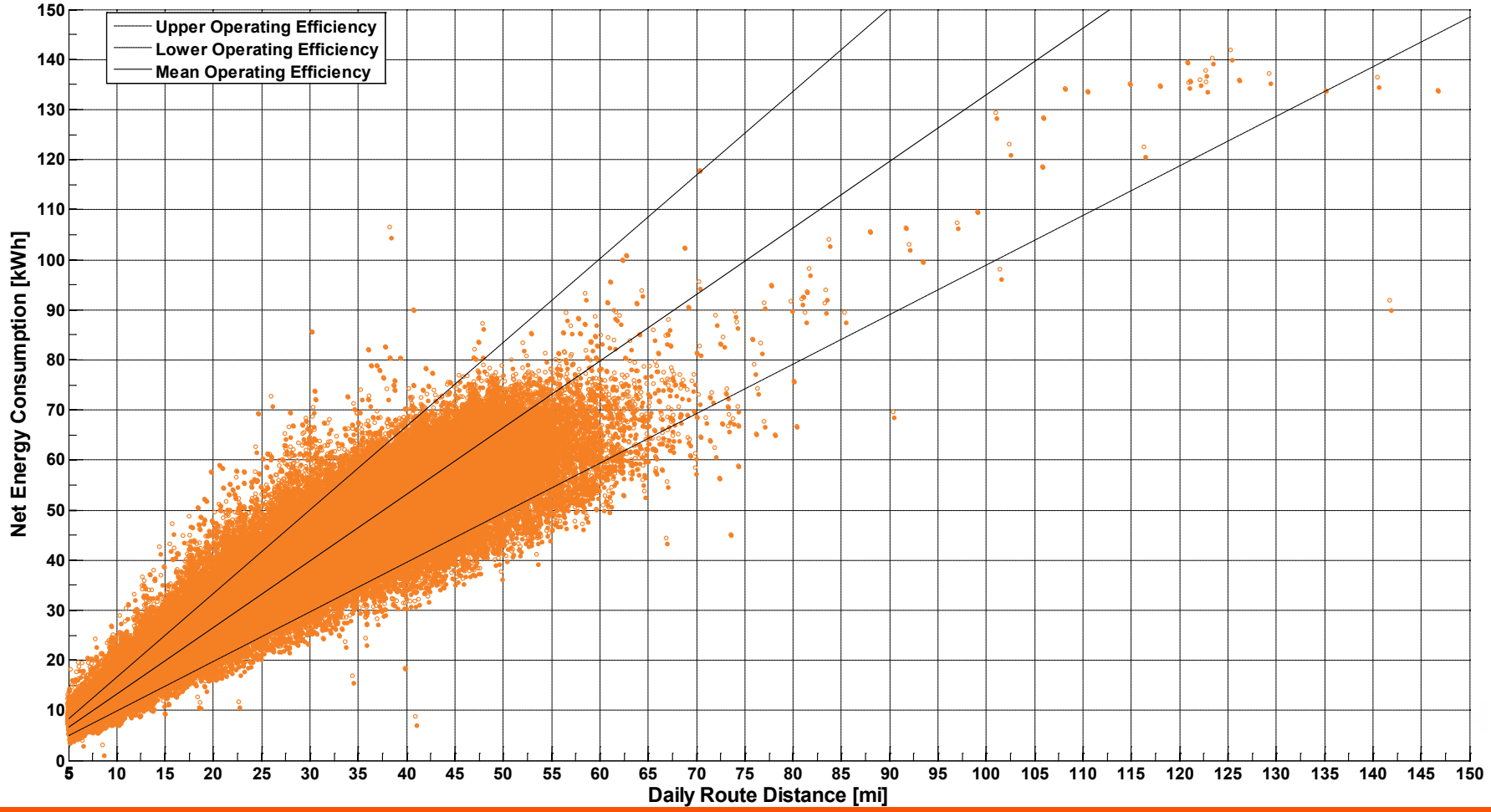
Analysis Courtesy of National Renewable Energy Laboratory (NREL)

Distance and Energy Consumption
Typical Operational Profile



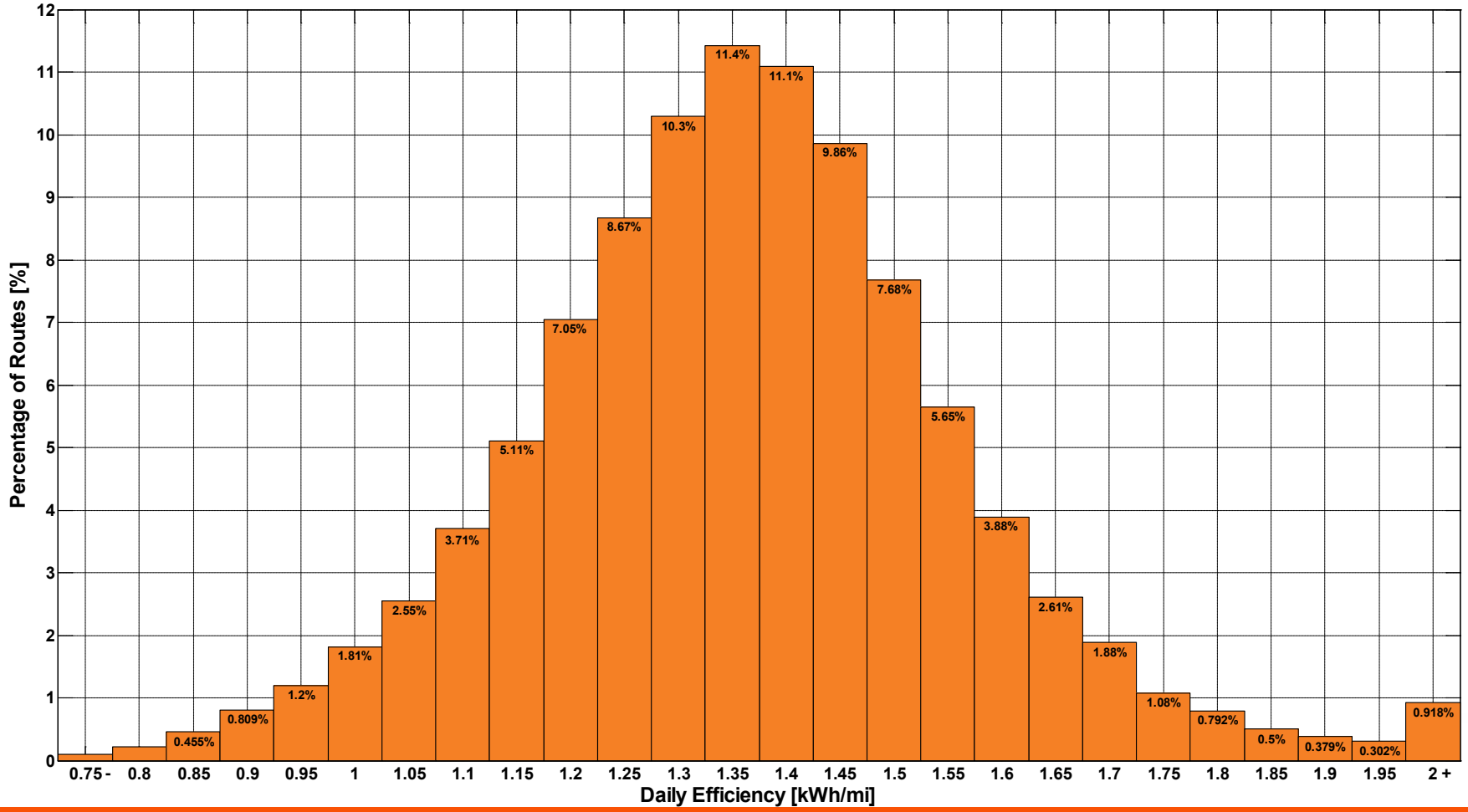
All energy numbers assume DC energy

Distance and Energy Consumption Including Opportune Charging Fleets



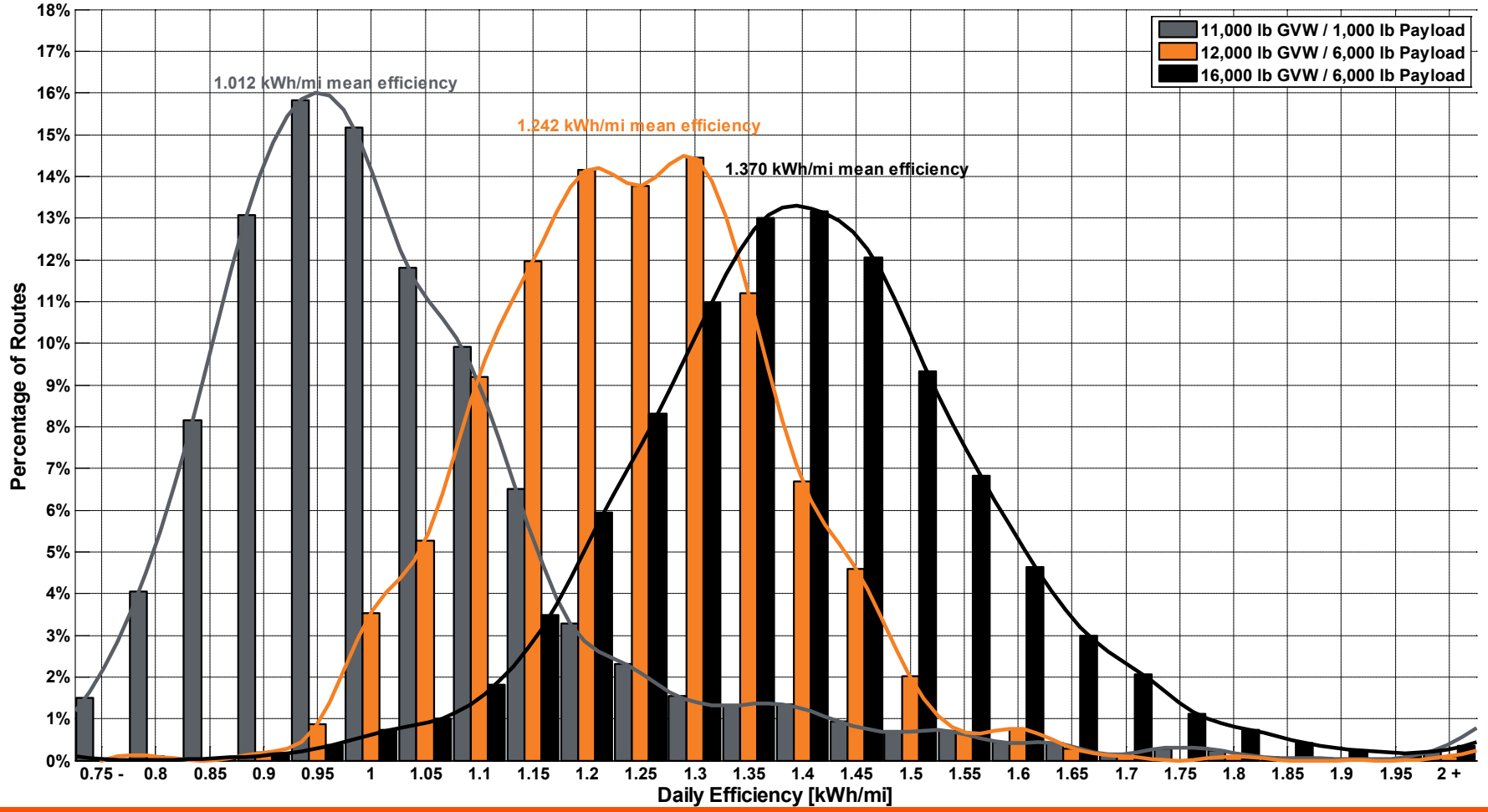
All energy numbers assume DC energy

Daily Energy Efficiency Distribution



All energy numbers assume DC energy

Daily Energy Efficiency Distribution By Application



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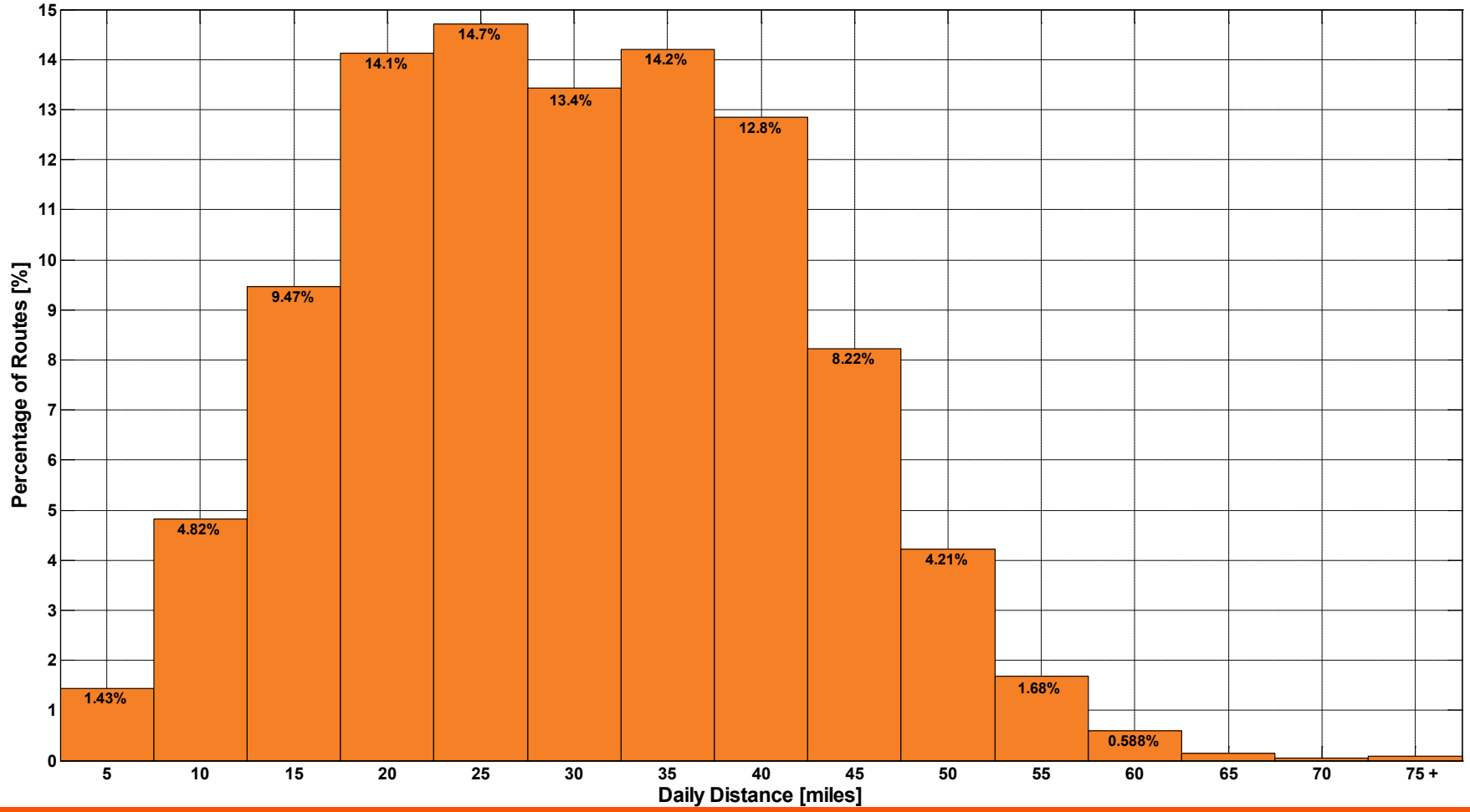
Daily Distance Distribution



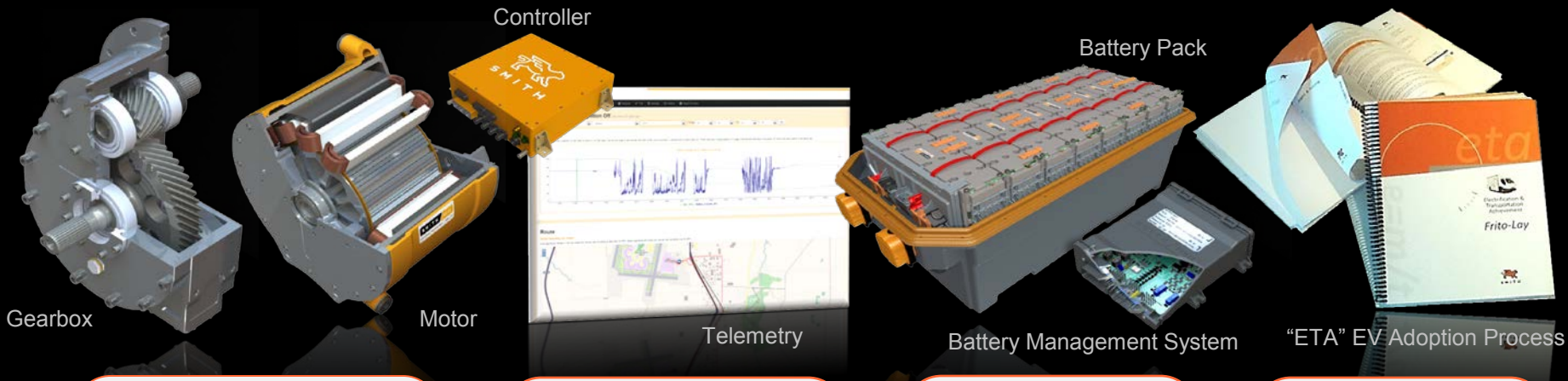
Annual Emissions Impact

Energy Consumption			
	All Operational US Fleets		*Global*
	2013	**2012**	**Total Accumulation**
Diesel Fuel Offset *Assumes 8 MPG Equivalent Vehicle*	317,842 gallons	220,107 gallons	1,073,908 gallons
Electricity Consumption	3,722 MWh	2,540 MWh	11,813 MWh

Well-to-Wheels Greenhouse Gas (GHG) Emissions Impact			
	All Operational US Fleets		*Global*
	2013	**2012**	**Total Accumulation**
Equivalent Diesel GHG *13.116 kg per gallon (28.916 lb per gallon)*	9,190,575 lbs	6,364,522 lbs	31,052,616 lbs
Electricity GHG *Based on top 5 US markets for SMITH* *0.384 kg per kWh (0.847 lb per kWh)*	2,867,810 lbs	1,956,861 lbs	9,100,812 lbs
GHG Offset	6,322,765 lbs	4,407,662 lbs	21,951,803 lbs

All emissions factors courtesy of Argonne National Laboratory Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model

SMITH PROPRIETARY SYSTEMS LINKS



Proprietary vehicle drive and control system, which features a configurable drive controller with integrated inverters for the management of auxiliary systems, resulting in better driver performance, feel and overall diagnostics.

Telemetry is an onboard system that monitors and transmits the vehicle's vital statistics every 1.5 seconds to a central server, allowing diagnostics, reporting and optimization.

Smith's BMS solution has enabled it to become "battery agnostic" giving the company a powerful advantage in both operations and cost reduction.

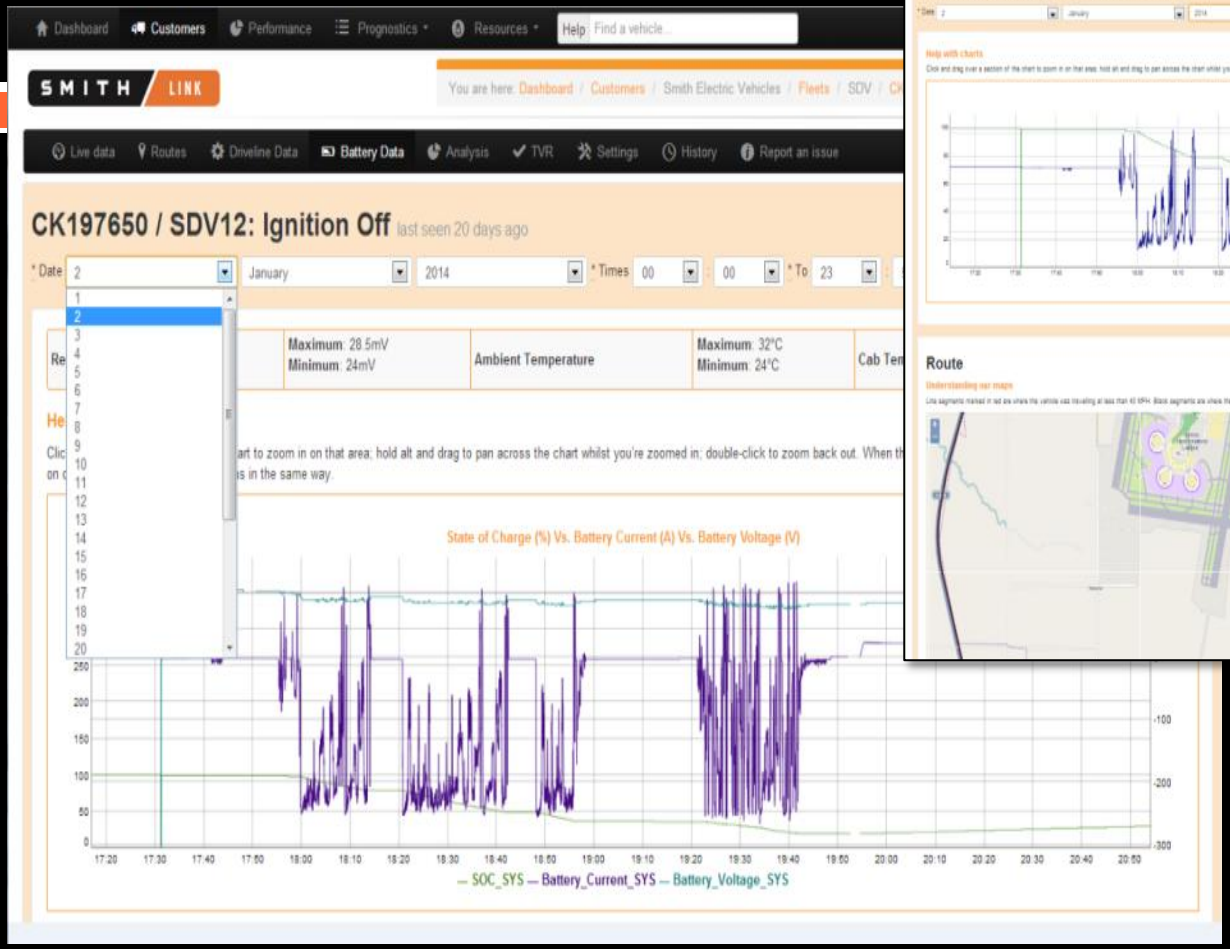
Change management is central to our approach. We design extensive process to work in parallel with both our product designs and our customers' barriers to scale.

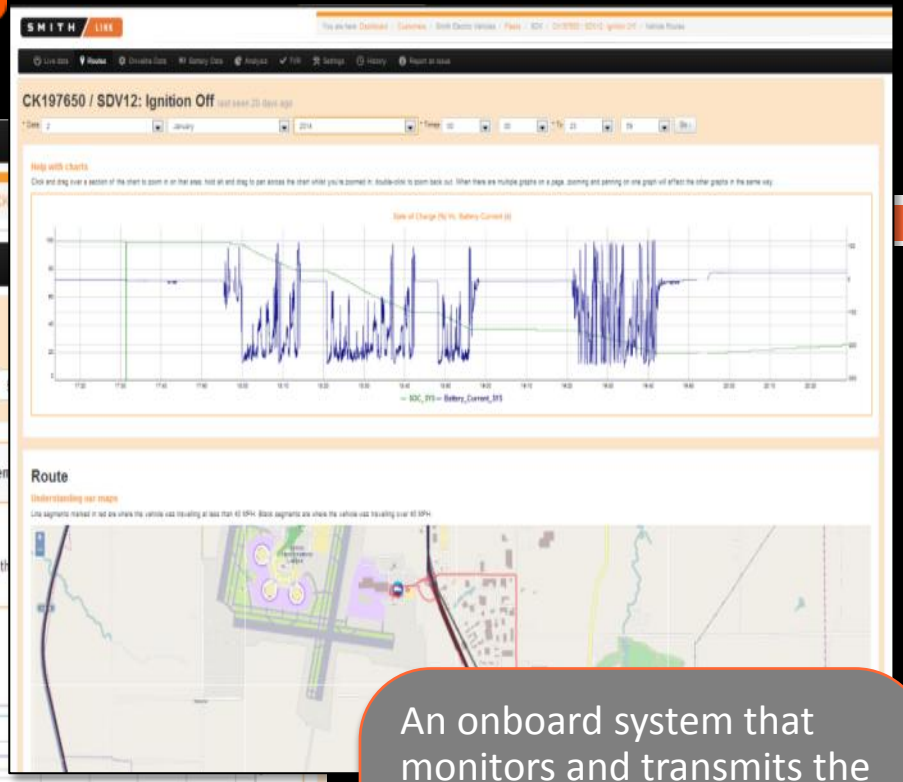
SMITH LINK

Developed specifically for the DOE project to collect real time performance data from customer vehicles participating in the project.

- Now utilized across all Smith Vehicles (USA and ROW).
- System metrics
  - Approx 2500 data points collected per second per vehicle.
  - Approx 1.8 billion data points per day.
  - All data is encrypted.
  - All data consolidation and processing is carried out on secure Smith servers.
  - 22 Gb of data transmitted to NREL each month.
- Data utilized by the following
  - Smith Service- support customer calls.
  - Smith Engineering- continuous improvement.
  - Smith Business Development- pre sales duty cycle analysis.
  - DOE- research and justification support.
  - Customers- Fleet performance.

SMITH LINK

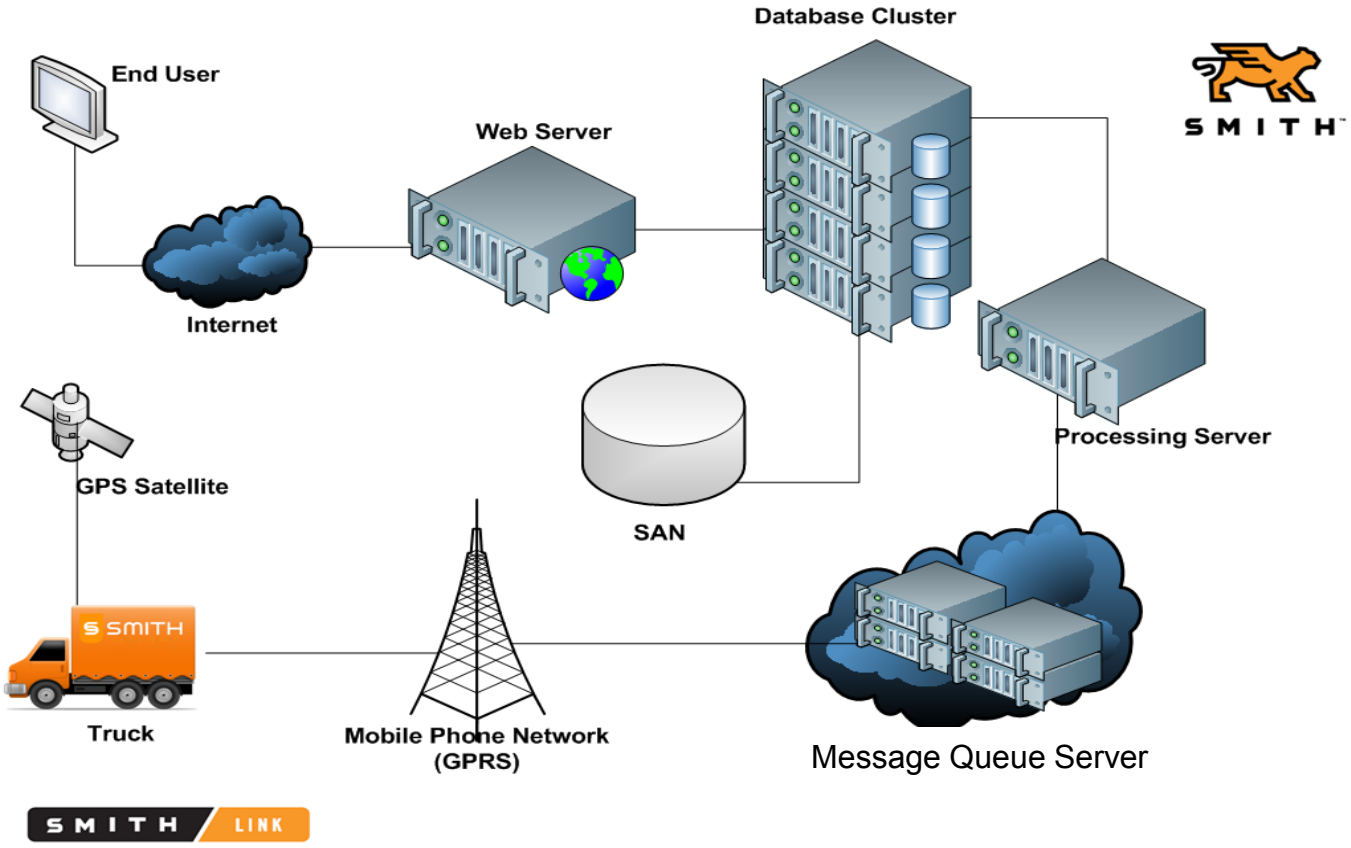




An onboard system that monitors and transmits the vehicle's vital statistics every 1.5 seconds to a central server, allowing remote vehicle monitoring, diagnostics, reporting and optimization.

SMITH

SMITH LINK SYSTEM OVERVIEW



SMITH DRIVE

Project Delivery- QTR3 2014

Objectives of Project

Continuous Improvement Initiative, cost down and scalable production

- Technological-Keep pace with drive train developments.
- Commercial- Support value management and Cost Down.
- Quality- Improve specification, design, validation, manufacture.

Project Features and Benefits

- Technology
  - PM Machine- Support Energy Efficiency, and Weight out.
  - Greater Power- Improved acceleration.
  - Greater Torque- Improved launch feel.
  - Greater Max RPM- Support future proofing, Vmax.
  - Modular Motor/Gearbox- Support future proofing, Vmax, Gradeability.
  - Operational Environment -20 Deg to +50 Deg C.

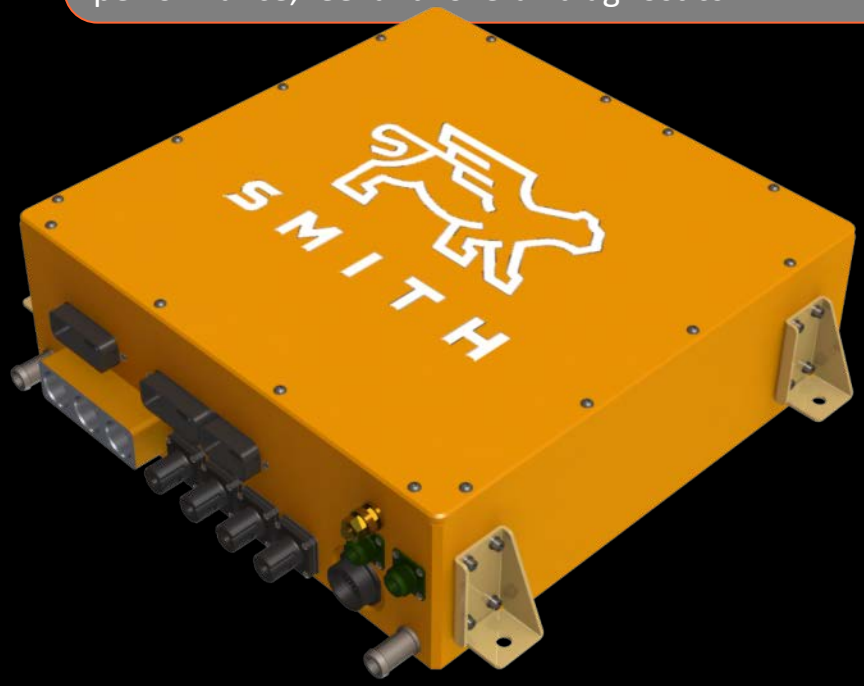
SMITH DRIVE

Proprietary vehicle drive and control system, which features a configurable drive controller with integrated inverters for the management of auxiliary systems, resulting in better driver performance, feel and overall diagnostics.

Controller

Purpose:

- 150kW 6 IGBT Gate Drive and Power throttle
- 2.5kW Integral Steering Inverter
- 2.5kW Integral Brake assistance Inverter
- 1.2kW DCDC 24v support unit
- Pre-charge and safety control system
- CAN, Digital and Analogue Communication Hub
- Water/Glycol cold plate
- Integral HV sealed Connections and LV connections

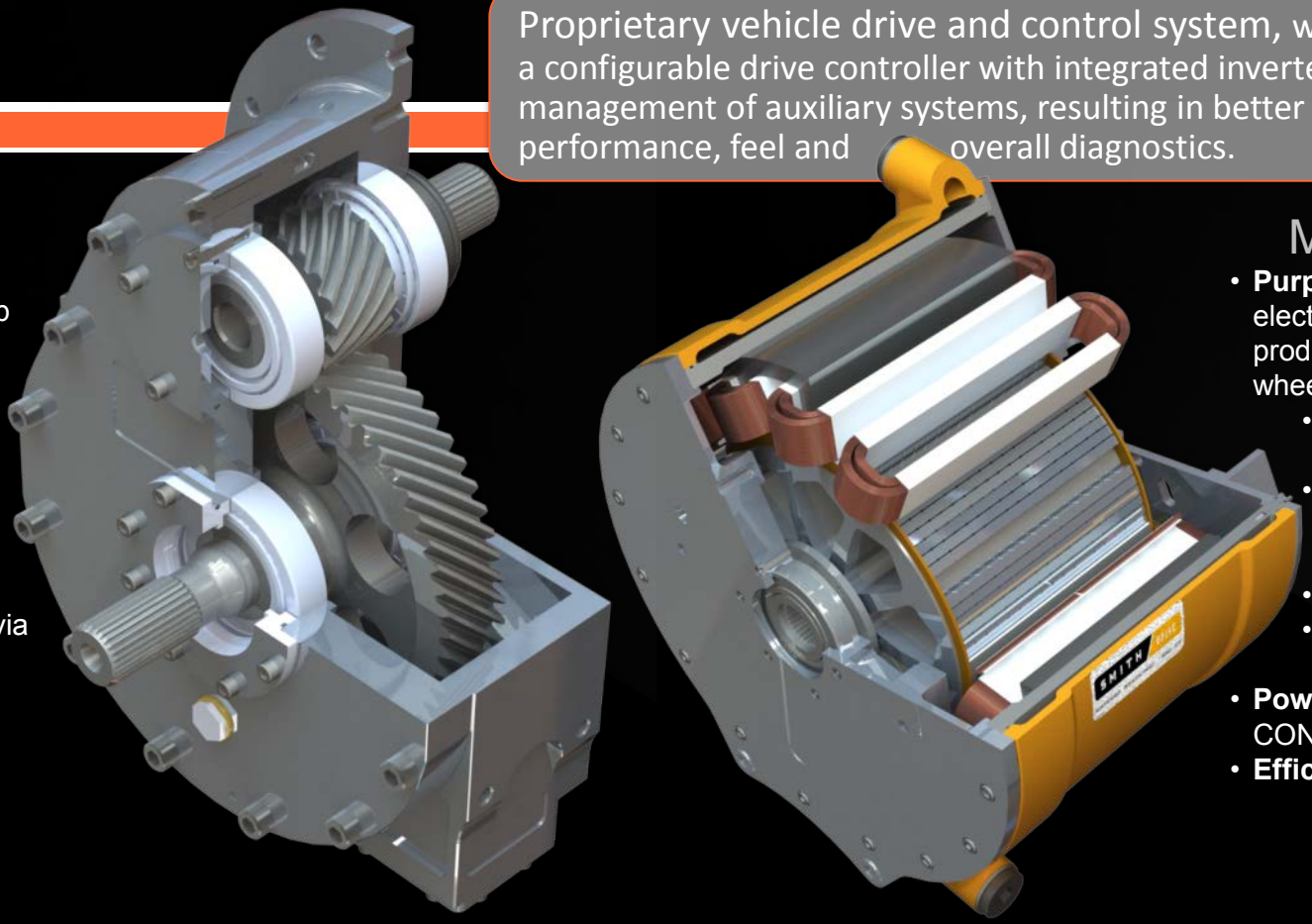


SMITH DRIVE

Proprietary vehicle drive and control system, which features a configurable drive controller with integrated inverters for the management of auxiliary systems, resulting in better driver performance, feel and overall diagnostics.

Gearbox

- **Purpose**: Torque multiplication, prop speed reduction
- **Type:** Single ratio (3.4:1) , parallel shaft, helical cut
- **Lubrication:** Oil, Splash lubricated
- **Mating Flange:** Supports Stock Avia
- **Tachograph Supported:** Yes



Motor

- **Purpose**: Manage HV electrical energy and produce useful work at the wheels
  - **Type:** Permanent Magnet
  - **Cooling**: Water/Glycol jacket cooled
  - **Weight**: 97Kg
  - **Torque**: PEAK 600 Nm, CONT 400 Nm
- **Power**: PEAK 150 kW, CONT 80 kW
- **Efficiency**: 93%

SMITH

SMITH POWER

Project delivery - Qtr 3 2014 Gen 1.75- Qtr 4 2014 Gen 2.0

Objectives of Project

Continuous Improvement Initiative

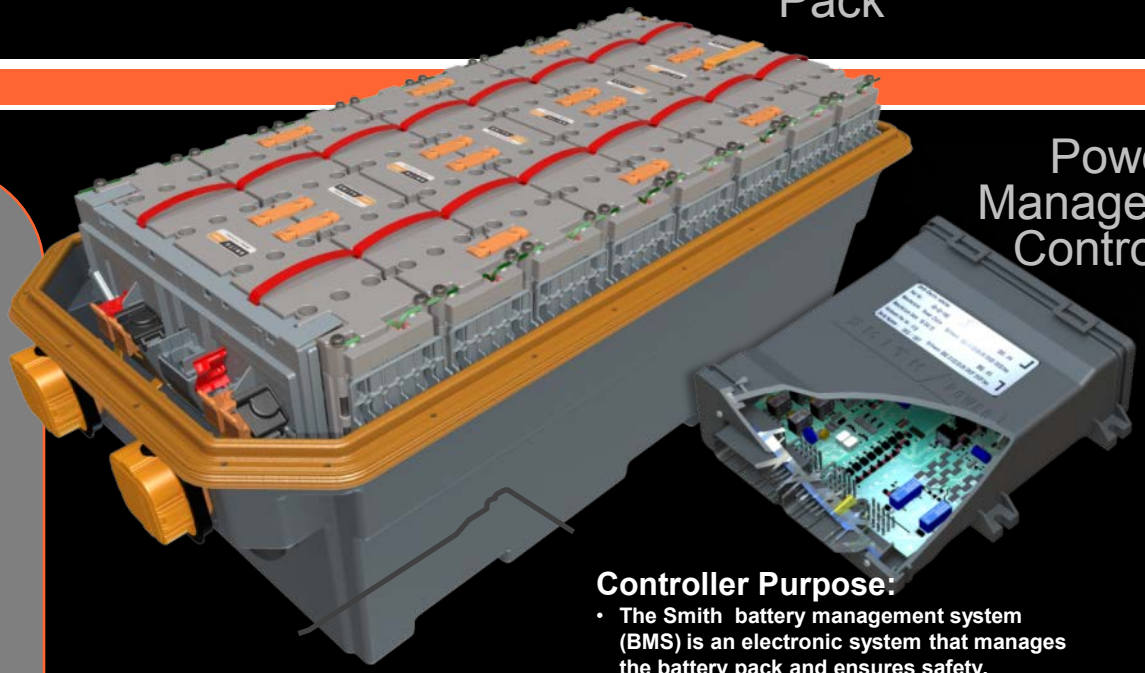
- Technology - Keep pace with cell and integration developments.
- Commercial- Reduce reliance on a single cell provider – capability to compete on price.
- Quality- Influence specification, design, validation, manufacture.

Project Features and Benefits

- Transition from Cylindrical cells to Prismatic and Pouch configurations.
- Development of Smith cell agnostic Battery Management Systems and components.
- Mechanical integration strategy for Smith Module to accommodate both Prismatic and Pouch cell.
- Modular pack sizing to meet customer duty cycles.

SMITH POWER

Power Pack



Power Management Controller

Networked Battery Management System (BMS).
Smith's BMS solution has enabled it to become "battery agnostic" giving the company a powerful advantage in both operations and cost reduction. The next gen of SMITH POWER BMS will feature the company's proprietary "battery cloud" technology, enabling Smith to manage networks of batteries and return energy to the grid.

Controller Purpose:

- **The Smith battery management system (BMS) is an electronic system that manages the battery pack and ensures safety, optimum operation and performance.**
- **String Battery Server (SBS)**
- Electronics to monitor the battery cells associated with an individual string
- **Multi Battery Server (MBS)**
- Electronics module that ultimately controls and manages a number of battery strings

COLLABORATIONS/PARTNERSHIPS

- Duty Cycle Forecast Model- Kansas University Center for Research.
- E-Van Ultra Efficient System development UK DFT TSB funded program
  - High Efficiency Drive Train- Bristol University (UK).
  - Controller programming Leicester University (UK).
- QM Power on an ARPA-E project to develop electric motors using non-rare earth magnets.
- FedEx Express, Plug Power & NYSERDA joint project to demonstrate a hydrogen fuel cell range extender on an AEV.
- Partnership with NREL, Burns & McDonald, Schneider Electric, TARDEC to develop Vehicle-to-Grid charging systems for the DOD.
- TARDEC V2G Performance Analysis - Missouri University of Science &Technology.

Future Work

Finalize the 500 vehicle deployment milestone with delivery of the final 61 vehicles.

Smith Link

- System data efficiency improvements.
- Bi -Directional data transfer.
- Load sensing.
- Prognostics.

Smith Drive

- Complete the transition to high volume manufacturer.
- The development and introduction of both a Light and Medium duty multispeed transmission.

Smith Power

- Development of cell agnostic Smith Power Gen 1.75 and Gen 2.0.
- Development of active thermal management.
- Continued development and optimization of the Smith BMS.

Responses to 2013 Reviewer Comments

Reviewer Remarks	SMITH RESPONSE
The reviewer indicated that the picture on the financing and how the project team will complete the project was unclear.	TBD
The reviewer mentioned a variety of collaborations, especially for ancillary programs of the project, but cautioned that there does not appear to be much in the way of collaborations on the main project, the re-design of the Smith EV. The project would perhaps benefit from more partners in this area…	TBD

SUMMARY

- **Objectives/Relevance** Manufacture and sell 500+ commercial all electric vehicles, and deliver to the NREL 2 to 3 years of operating data in order to accelerate the development and production of electric drive vehicle systems in the US to reduce petroleum consumption, reduce vehicular emissions of greenhouse gases, promote US energy security, and create new US jobs.

- **Approach-** Utilize existing Smith UK technology and systems to develop a Smith US DOT-compliant all electric commercial vehicle for various industries in several geographical regions of the United States.

- **Technical Accomplishments** Developed and improved GPS-based operational monitoring system; Gen 2 AEV drive and battery systems; created 131 new US jobs (temporary reduction due to plant work stoppage; cost reduction strategy in place.

- **Collaborations/Partnerships** NREL, DOE, KUCR, Bristol University, Leicester University, QM Power, TARDEC, Missouri University of Science & Technology, Burns & McDonnell, Schneider Electric.

- **Future Work** Hire and train 95 new US workers; meet delivery milestones for the 500 vehicle demonstration fleet; further improve the Gen 2 products and secure intellectual property; drive down purchase and manufacturing costs of primary and secondary components; continuously strive to improve quality.

TECHNICAL BACKUP SLIDES

SMITH DRIVE

Motor: Manage HV electrical energy and produce useful work at the wheels
Type: Permanent Magnet
Cooling: Water/Glycol jacket cooled
Weight: 97Kg
Torque: PEAK 600 Nm, CONT 400 Nm
Power: PEAK 150 kW, CONT 80 kW
Efficiency: 93%

Gearbox: Torque multiplication, prop speed reduction
Type: Single ratio (3.4:1) , parallel shaft, helical cut
Lubrication: Oil, Splash lubricated
Mating Flange: Supports Stock Avia
Tachograph Supported: Yes

SMITH POWER

Gen I,

- 40 KWh String
- 40 80 120 Configurations.
- 24 Mod / String
- 320 VDC Nominal
- 1 string per charger
- Fuse/controls in Battery Pod
- Master/Slave Battery Pod
- Manually intensive sealed box
- No Interlock Pins for HVDC
- Common power cables
- Pre-charge circuit in Batt Pod
- Battery Supplier BMS

Gen II,

- 20 KWh String
- 40 60 80 100 120 KWh Conf
- 4 Mod / String
- 346 VDC Nominal
- 2 strings per charger unit
- JB- Accessible fusing/controls
- Master Distribution Box
- Full gasket sealed ox
- Interlock-Pins for HVDC
- Power Shielded cables/ferrites
- Pre-charge circuit in CEU
- Smith BMS

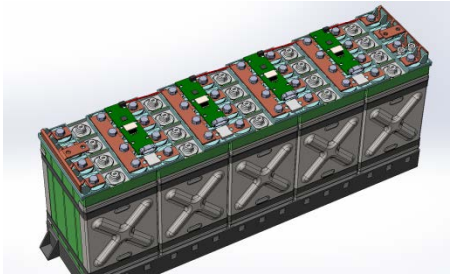
SMITH POWER – GEN 1.75 AND GEN 2.0 CONCEPTS

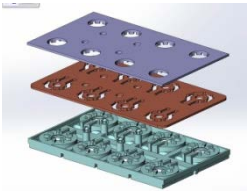
Gen 1.75

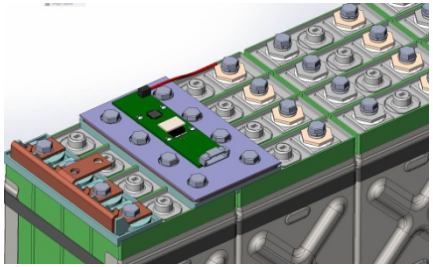
Module

Fusing and Measurement Concept

Stacking Concept

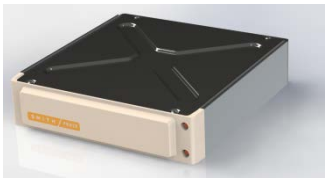




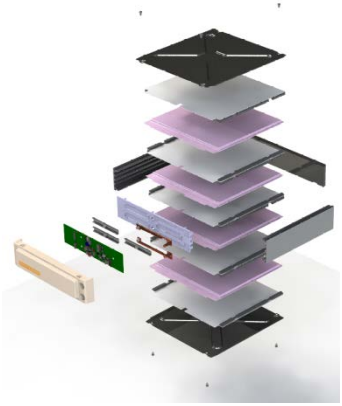


Gen 2.0

Module



Exploded View



Stacking Concept

TECHNICAL BACKUP SLIDES

Smith Newton Coca-Cola

Smith Newton Frito-Lay

TECHNICAL BACKUP SLIDES

Smith Newton Stake Bed

Smith Newton Military Troop Transport

TECHNICAL BACKUP SLIDES

Smith Newton Shuttle Bus

TECHNICAL BACKUP SLIDES

Smith Newton School Bus

Smith Newton Step Van