

# 2011 DOE Vehicle Technologies Program Review Presentation

Smith Flectric Vehicles:

Advanced Vehicle Electrification + Transportation Sector Electrification

Robin Mackie-Presenter & Principal Investigator
Smith Electric Vehicles- US Corp
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#### Overview

#### **Timeline**

- >Start- April 2010
- >Finish- October 2013
- >27% Complete to date

#### Budget

Total Project Funding-

- >DOE \$32M
- >Smith US \$36M
- >DOE funding received to date \$8.7M

#### **Barriers & Risks**

- >Immature supply chain
- >Component cost vs diesel
- >Development of data transfer system

#### Partners/Collaborators

- >Smith UK
- >Initial customers
- >Suppliers
- >Institutions



# 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-**

- Manufacture and sell to customers 510 medium duty commercial All Electric Vehicles (AEVs) operating under various conditions in several geographical regions of the US;
- <u>Collect and submit</u> to the National Renewable Energy Laboratory (NREL) 2 to 3
  years of performance data from the Smith-developed telemetry system;
- <u>Develop Second Generation</u> powertrain, battery and charging systems to enhance performance and reduce overall vehicle cost.
- <u>Create 225 new jobs</u> at Smith US.



# **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	10/31/2011
Initial customer vehicle initial data capture and reporting to DOE	Send complete data set to DOE for initial vehicles	11/1/2010	6/30/2013
Customer vehicle final data capture and reporting to DOE	Final data receipt from vehicles and final report submission to the DOE	10/31/2010	10/4/2013
255 Vehicles Deployed under program	Halfway point of vehicle deployment	4/1/2010	3/31/2011
Vehicle Deployment Complete	Final Vehicle deployed under program	4/1/2010	10/31/2011



# **Approach**

- <u>Transfer the technology</u> and expertise of Smith UK to the Smith US through deployment of proven processes and training of US employees.
- Obtain purchase orders from key major US customers from various industries to purchase the vehicles and participate in the demonstration project.
- <u>Complete the homologation</u> of the current Newton platform to Department of Transportation (DOT) requirements.
- <u>Establish technical teams</u> focused on development of second generation vehicle systems using a "stage and gate" project management approach.
- Establish an ISO 9001 Quality Assurance plan.
- Environmental (NEPA status) and Safety- build vehicles that meet California Air Resources Board Zero Emissions Standards and NHSTA safety requirements. NEPA approval was obtained February 2010 (Categorical Exclusion CX-B).



# Approach (continued)

- <u>88% of the \$32M DOE/ARRA Grant</u> will be paid to commercial AEV buyers participating in the DOE Electric Fleet Data Collection Program.
  - Upon signing an agreement at the time of purchase order, the customer agrees to participate in either a two or three year data collection program.
  - The amount paid to each participation client is based upon the duration of participation and the value of the vehicle.
  - Data is transmitted wirelessly real-time via the Smith telemetry system to secure servers located at the Smith US Missouri facility.
- The remaining 12% of the Grant is a 32.3% reimbursement of Project Development costs.



### Technical Accomplishments and Progress

- Homologation of the Smith UK Newton platform to DOT requirements.
- <u>Successfully transferred</u> to Smith US the Smith UK proven <u>technology</u> to design and build AEVs on the existing Newton platform.
- Successful <u>localization of the supply base</u> where applicable.
- Initiated <u>second generation development programs</u> for battery, drivetrain and charger systems.
- <u>Established a manufacturing facility</u>.
- Obtained confirmed program related orders from qualifying customers for 235 vehicles, of which 147 have been delivered.
- Successfully developed, implemented and gained <u>NREL approval of the Smith Data Acquisition and Reporting System</u>. Data transfer to the NREL commenced November 2010.
- Established ongoing cost down and quality improvement initiatives.



### Technical Accomplishments and Progress- Products



Smith US Boom Truck for P,G&E



Smith US refrigerated box for Down East



Smith US stake-bed, flat bed for KCP&L



Smith US box vans for AT&T, Coca Cola, Staples



# Collaborations/Partnerships

#### **Collaborations:**

- Smith UK- Smith US initially obtained a license in perpetuity for Smith technology within North America.
- Smith US- acquired Smith UK at January 1, 2011, thus securing all Intellectual Property internationally to the product.
- Institutions- colleges and universities assistance on technological research & development, education and training.

#### Partnerships:

- Customers who have purchased vehicles and are working directly with Smith US in specifying product improvements and developing customer-centric options:
  - Geographically dispersed
  - Varying market sectors
- Suppliers
  - First Generation product suppliers working with Smith US on continuous improvement
  - Second Generation product suppliers



#### **Future Work**

- Meet the 510 vehicle deployment milestone of October 31, 2011;
- Transfer vehicle operating data monthly to the NREL-DOE to contract completion;
- Develop and validate the Generation 2 systems;
- Continue recruiting and training of key technical and operating staff;
- Continue to improve the production and assembly processes, and product quality;
- Continue to develop and improve the telemetry system;
- Develop regional service support;
- Strengthen the supply chain and reduce costs;
- Attend and demonstrate at local, regional and national exhibitions and conferences to advance interest in AEV technology.

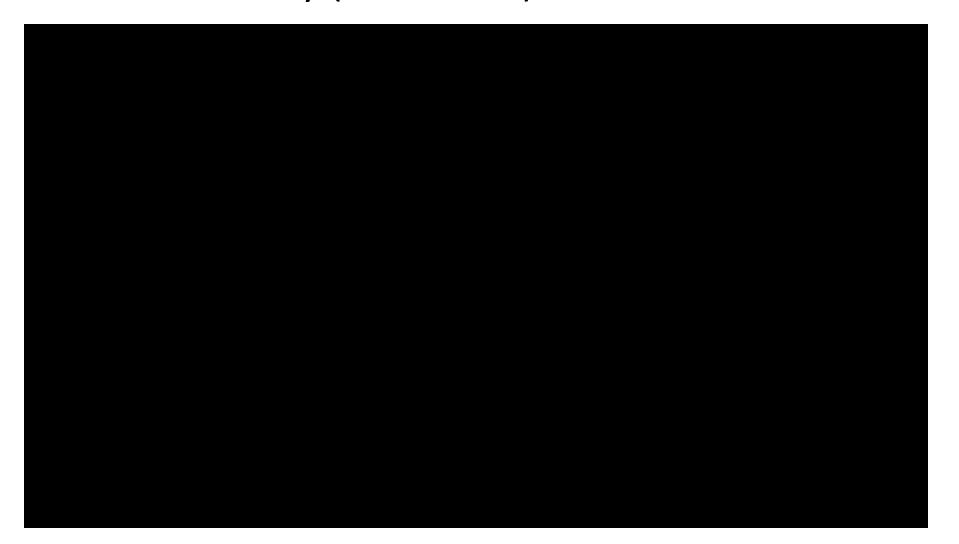


# Summary

- Objectives/Relevance- Manufacture and sell 510 commercial all electric vehicles in 18 months, 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 225 new US jobs.
- <u>Approach</u>- Utilize existing Smith UK technology and systems to develop a Smith US DOTcompliant all electric commercial vehicle for various industries in several geographical regions of the United States.
- <u>Technical Accomplishments</u>- Developed GPS-based operational monitoring system; made significant progress towards Generation 2 AEV drive, charging and battery systems; created 95 new US jobs; reduced supplier costs.
- <u>Collaborations/Partnerships</u>- Licensed with Smith UK for technology transfer and engineering/manufacturing training and assistance; worked with educational institutions on technology, education and training; made agreements with commercial industry leading companies to purchase Gen 1 vehicles; worked with vendors to improve supply chain.
- <u>Future Work</u>- Continuous improvements to existing manufacturing processes; hire and train new US workers; meet order/delivery milestones for the 510 vehicle demonstration; complete the Gen 2 projects and secure intellectual property; drive down purchase and manufacturing costs of primary and secondary components.



# Summary (Continued)- Meet the Team





# Technical Backup Slides



# **Technical Backup**

#### Carbon Footprint Comparison



# Select Vehicle and Area Smith Vehicle kWh Comparable Vehicle Class State 80 Class 6 US

#### Electric Vehicle GHG emissions are:

9.10	%	of	Gasoline	Vehicle
11 20	91	~	Diorel Ma	bleler

- 16.98 % of CNG Vehicles
- 17.80 % of Propane Vehicles
- 14.77 % of Diesel Hybrid Vehicles

#### Electric Vehicle GHG emissions are:

90.90	% cleaner	than	Gasoline	Vehicles

- 88.64 % cleaner than Diesel Vehicles
- 83.02 % cleaner than CNG Vehicles
- 82.20 % cleaner than Propane Vehicles
- 85.23 % cleaner than Diesel Hybrid Vehicles

#### Glossary:

SEV - Smith Electric Vehicles

GHG - Greenhouse Gas

CNG - Compressed Natural Gas-

CO<sub>2</sub> - Carbon Dioxide, a greenhouse gas.

CH<sub>6</sub> - Methane, a greenhouse gas.

NO<sub>2</sub> - Ntrogen Dioxides, a greenhouse gas.

#### Pounds (lbs.) - Unit of mass, 16 ounces.

Short Tons - A unit of weight equal to 2000 pounds, distinct from the measure of metric tons (1000 kilograms).

Vehicle	<b>Englariats</b>	by Foel and	Daily Range

# Smith Electric Vehicle Carbon Footprint Total pounds GHGs emitted per daily range 30.33965614 Total short rons GHGs emitted per daily range 0.015169828

Gasoline Vehicle Footprint							
	Total short rons GHGs emitted per daily range						
333,4049409	0.16670247						

Diesel Vehicle Footprint					
Total pounds GHGs emitted per daily range	Total short zons GHGs emitted per daily range				
267.0676692	0.133533835				

CNG Vehicle Footprint						
	Total short zons GHGs emitted per daily range					
178.7197609	0.08935988					

Propane Vehicle Footprint							
Total pounds GHGs emitted per daily range	Total short rons GHGs emitted per daily range						
170.4611415	0.085230571						

Diesel Hybrid Footprint					
	Total short zons GHGs emitted per daily range				
205.4366686	0.102718334				

Edmid Se	
3EV	GHGs = (KWH*Emissions Factor Coal*Percentage Coal) + (KWH*Emissions Factor Olf*Percentage Olf) + (KWH*Emissions Factor Gases* Percentage Gases) + (KWH*Emissions Factor Nuclear*Percentage Nuclear) + (KWH*Emissions Factor Renewables*Percent Renewable) + (KWH*Emissions Factor Biomass*Percent Biomass)
Gas and Diesel	GHGs = (Miles Driven/ Miles per Gallon) * CO2 Emissions Factor * CH4 & NO2 Emissions Factor
CNG	GHGs = ((Miles Driven / Fuel Economy) * Pounds CO2 ) + (Pounds CH4/Mile * Miles) + (Pounds N20/Mile *Miles)

Propane GHGs = (Miles Driven / Effective Fuel Economy)\* (Pounds CO2) + (Pounds CH4Mile \* Miles) + (Pounds N20Mile \* Miles)

Disease
Hybrid CO2 Equivalent = (Miles Driven/Net Fuel Economy)\*(CO2 Emissions Factor)\*(CH4 & NO2 Emissions Factor)



# Technical Backup (Continued)

One 80 kWh Newton vehicle, operated for 1 year (260 days) on a normal daily range, will emit approximately 61,500\* fewer pounds of greenhouse gases than a similar Class 6 diesel truck.

<sup>\*</sup> This statistic is calculated from the data on the previous slide.



### Technical Backup (Continued)-Data Sources

	Sources and Assumptions Full CO2AWh* CH4AWh* NO2AW*h			NO2MATE	Sources:				
ı	Coal	0.769986496	0.0000118	0.0000208	The state of the s	Fectors: PCC Quidelines for National Greenhouse Gas Inventories;			
	Oil	0.614298047	G G G G G G G G G G G G G G G G G G G	UNUNUSE		iges or joylubilio/2006gifndex html			
	Genera	0.445245584	"All in pounds			National Lab GREET 1.8c.0; http://greet.es.ani.gov/			
	Nuclear	0	~ sipus		State Energy Mit: U.S. Energy Information Administration; http://www.eia.doa.gov/cned/electricity/apm/lable1_6_a.html				
ı	Renewable	0	1						
ı	Blomess	0.812976637	1						
-	CO, Content of Diesel CO, Content of		of Gasoline	Gasoline Fuel Efficiency Penalty:					
ı	Grams CO <sub>2</sub> Per Gallon - 2778 Gram Oxidation Factor - 0.99 Oxida			er Gelon - 2421	Gasoline vehicles are assumed to have a 30% fuel economy penalty. This				
١			Oxidation Fact		figure is widely used, and studies such as Baker et al (2004) suggest this				
J				git of CO <sub>2</sub> - 44	figure may be higher (although that study looked at lighter-duty vehicles).				
	The second second	eight of Carbon		Molecular Weight of Carbon - 12		http://pubs.acs.org/doi/full/10.1021/es/034029d			
١	Total Grams CO, in Califon Diesal - 10,084			Total Grams CO, in Gallon Gas - 8,788					
1		CO, in Gallon I		Total Pounds CO <sub>2</sub> in Callon Gas - 19.4					
s and Die		missions (Gas							
		multiplied by 1							
١	Sources :		7.						
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-		of Natural Gar			N.O Content of CNG				
ı			et Cubed - 54.08			Grams per Mile - 0.175			
U		-				Pounds per Mile - 0.000385808050			
١	Pounds CO <sub>2</sub> per Cubic Foot - 0.11113 GGE Uncompressed in Cubic Feet- 126.6 GGE Compressed at 24:00 PSI in Cubic Feet- 0.77 CN <sub>2</sub> Content of CNG				Fuel Economy  Gallon Can Equivalent is based on energy properties of fuel required to operate vehicles regardless of				
				0.77					
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	ICH, Content	LOF CNG			TORN SOUTOR, P'OF EYES IN	each the diesel fuel economy is multiplied by the emissions factor of CNG			
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### Technical Backup (Continued)

#### 80 kWh Newton Model: Technical Specifications

Wheelbase WB (in)	GVW (lbs)	Chassis Curb Weight (lbs) *	Payload (lbs)	Overall Length OL (in)	Overall Height OH (in)	Overall Width OW (in)	Deck Length DL (in)	Cab to Axle CA (in)
	16,500	9,392	7,121	268	94-98	87	191	126
154	22,000	9,700	12,324	268	94-99	87	191	126
	26,400	9,771	16,663	266	94-99	87	189	126
	16,500	9,412	7,101	307	94-98	87	231	149
177	22,000	9,678	12,346	307	94-99	87	231	149
	26,400	9,881	16,552	305	94-99	87	229	149
	22,000	9,824	12,200	346	94-99	87	270	173
201	26,400	10,121	16,312	344	94-99	87	268	173

<sup>\*</sup> Values based on 80kwh model

Cab

Wheels

Motor 120 kw induction

Controller Vector control AC system with regenerative braking

Batteries Lithium-Ion Iron Phosphate
Charger Fully automatic - cable included

All steel two door with hydraulic lift, zinc coated panels with wax filled cavities and thermal insulation

Interior Drivers seat, dual passenger seat, Sony stereo CD

Steering Hydraulic PAS monoblock

Suspension Front & rear, parabolic springs with transverse torsion bar stabilizer, hydraulic double acting shock absorbers

Brakes Dual circuit, air brake system with WABCO ABS, air dryer parking brake, fail safe spring operated park brake to rear axle

Chassis Ladder type, cold riveted and bolted with U-section side members and open profile cross members-steel

17.5 x 6.00 steel rims (16,500 lbs - 22,000 lbs), 245/70R17.5 tires on 17.5 x 6.75 steel rims, 8 stud fixing (26,400 lbs)

Tires 215/75R 17.5

Warranty 36 months bumper-to-bumper, 36 months drive train