High-Power Electric Systems for Transportation and Energy Storage

December 2016
TransPower Business Synopsis

- Global leader in electric vehicle technologies for large commercial vehicles
  - Class 8 on-road trucks
  - Yard tractors and other cargo handling equipment
  - School buses

- Secondary stationary energy storage business
  - Wayside traction energy storage (subways, light rail)
  - Distributed energy resource for microgrids and renewable energy systems

- Business model:
  - Near term (thru 2018): turnkey vehicle conversions, largely government supported
  - Longer term (2019-): high volume sales of systems/components to OEMs
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<th>Member</th>
<th>Years of Experience</th>
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Progression of TransPower EV Business

2011-2013
Product Development & Proof-of-Concept

2014-2016
Product Testing & Refinement

2017-
Commercial-Scale Manufacturing
Scalable, modular drive train, power and battery storage technology
Electric Vehicle Product Hierarchy

System Controller

Inverter-Charger

Powertrain Controller

Battery Controller

Main Drive Motor(s)

Battery Module(s)

Electric Accessories

Battery Monitor-Balancer

Automated Manual Transmission

Power Control & Accessory Subsystem

Motive Drive Subsystem

Energy Storage Subsystem
TransPower Sells Products...

By Component:

As Fully Integrated System Kits:

By Major Subsystem:

As Turn-Key Vehicle Conversions
## Market-Leading Products and IP

### Motive Drive Subsystem
- Advanced motors integrated with proprietary automated manual transmission
- Best performance and lowest cost of any system in its class

### Power Control and Accessory Subsystem
- Integrated controls featuring unique inverter-charger unit
- Simplifies assembly, operation, and charging while enhancing reliability and energy efficiency

### Energy Storage Subsystem
- Unique modular design with advanced battery management
- Greatest operating range and battery life at lowest cost
Adaptable to Many Applications

Class 8 On-Road Trucks

Yard Tractors

School Buses

Cargo Handling Equipment
Heavy-Duty Applications: We’re on the road today!
Only fully-functional electric trucks of this class

- 9 electric port drayage trucks on the road and hauling goods today
- 20 additional port drayage trucks funded, including CNG and fuel cell hybrids
- 3 electric refuse trucks funded
- Partnerships with Navistar and Peterbilt
- Primary funding sources to date:
  - ARB: $8M
  - CEC: $8M
  - South Coast AQMD: $8M
- Various incentive programs will stimulate commercial adoption starting in 2017
Most proven, efficient electric yard tractors in use today

- First commercially produced tractor has completed 26 months of use at IKEA’s California distribution center (~30,000 mi)
- Four additional tractors currently in use
- Primary funding sources to date:
  - ARB: $4M
  - CEC: $4M
- Have received customer inquiries for 200+ electric tractors
  - 8 different ports on both coasts
  - Many private fleets
Most capable electric school buses, proven in service

• One 40’ Thomas Built bus approved by California Highway Patrol and utilized by two San Diego area high schools in 2014

• Four mid-sized (26’) International buses built, out of six to be operated by California school districts by mid-2017

• In discussions with a major school bus OEM regarding a possible long-term partnership for large-scale electric school bus co-manufacturing
Stationary Energy Storage

Adapting our vehicle technologies...
- Battery integration
- DC to AC conversion
- Energy management controls

To new stationary applications
- Renewable energy integration
- Disaster preparedness
- Wayside energy storage for trains
Major Projects Underway

**Grid-Saver Prototype**
- $2M contract, California Energy Commission
- Largest battery system ever tested at Sandia National Laboratory (660 kWh, 1MW)

**Subway Traction Energy Storage**
- $2M in contracts from NYC Transit and NYSERDA
- First segment of 800 kW hour battery system installed in midtown Manhattan in early 2016

**US Navy renewable energy storage system in California**
- Displaces diesel generators on remote islands
- Navy objective: produce 50% of shore based energy from alternative sources

**Pursuing additional projects**
R&D demonstrations | Wayside storage systems | Commercial scale energy storage for Utilities and IPP’s
Business Case for E-Trucks: Energy Savings

$378,000 in energy savings over 300,000 miles

$121,500 in energy savings over 150,000 miles

Source: UC Riverside/CE-CERT Dynamometer Lab.
First to market with a zero-emission Class 8 truck system that works reliably and matches diesel performance

Favorably positioned in United States
  • $50M in funding commitments to date
  • Cap & Trade and other incentives can drive growth for years

IP advantages in multiple areas
  • Controls
  • Power electronics
  • Battery management
  • Propulsion
  • Electrical and mechanical integration

Long-term market assured by offering greatest fuel savings and emission reductions

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