

**DOCKETED**

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**Medium and  
Heavy Duty EVs –  
TransPower  
Progress &  
Perspectives**



**TransPower<sup>®</sup>**

**Mike Simon, CEO  
August 6, 2018**

- **Develops and manufactures electric vehicle components and systems for commercial vehicles**
  - On-road “semi” trucks
  - Cargo handling equipment
  - School buses
- **Secondary stationary energy storage business**
  - Traction energy storage (subways, light rail)
  - Distributed energy resource for renewable energy/microgrids
- **Basic factoids:**
  - Founded in 2010
  - Strategic partnership with Meritor initiated in Nov 2017
  - 75 employees (as of August 2018)
  - Projected 2018 revenue: \$15 million



## Core Technology Development (2011-2014)

- “Vertically Integrated” Manufacturing
- “Electric Drayage Demonstration”
- “Grid-Saver” stationary energy storage

*Resulted in deployment and testing of 7 electric drayage trucks and a 1 MW battery system*



## Expanded Demonstration (2015-2018)

- “Heavy-Duty Electric Vehicle Manufacturing”
- “Advanced Battery-Electric Port Vehicles”
- “Heavy-Duty Electric Yard Tractors”
- “Heavy-Duty Electric Refuse Trucks”

*Driving rapid company growth and deployment of another 13 vehicles*



## Commercial Scale-Up (2019-2023)

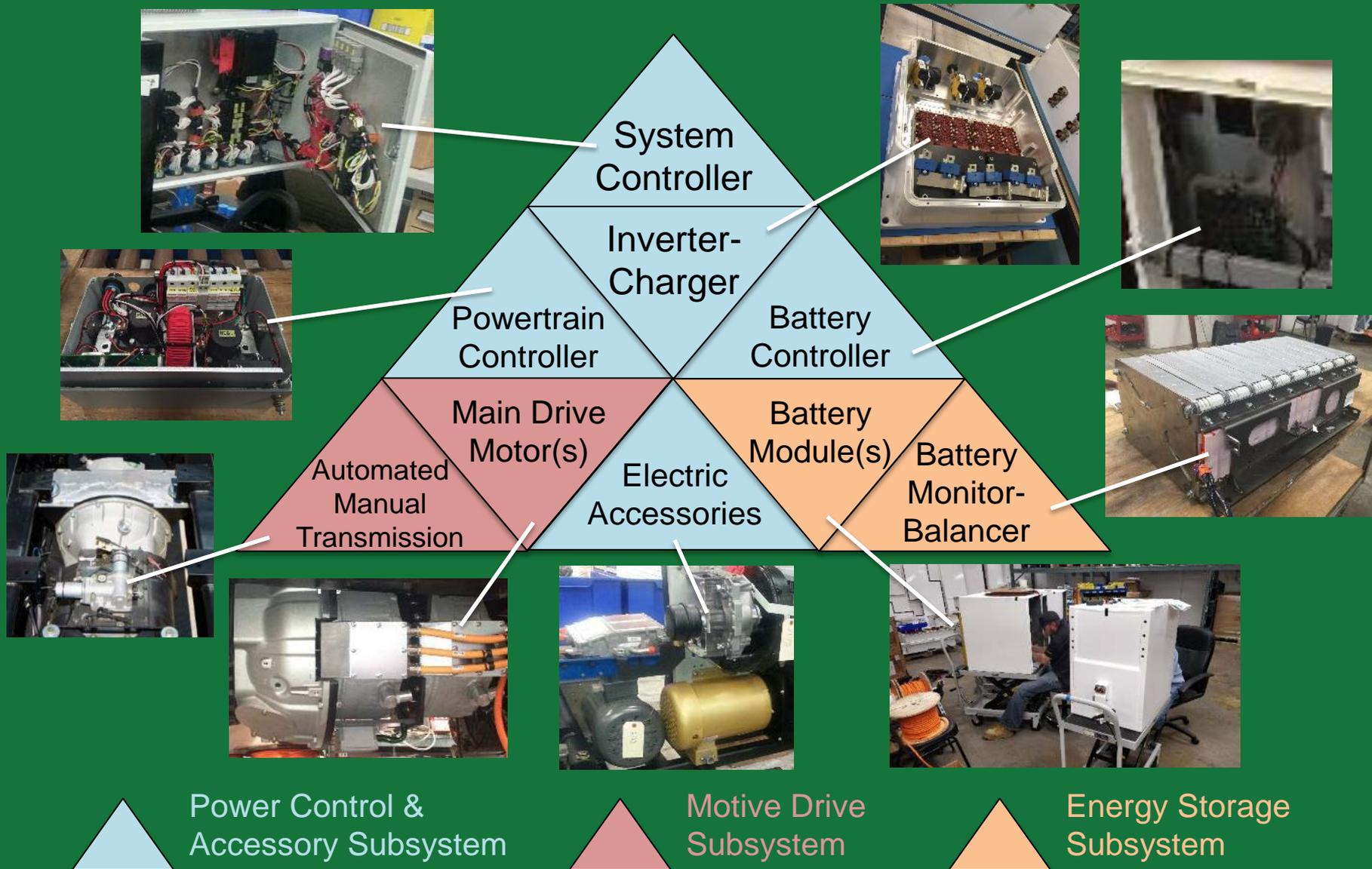
- Goal is 2,000 deliveries/year by 2023
- Meritor helping to drive industrialization and sales

*Envision CEC continuing to play a key role*



# Electric Vehicle Product Hierarchy

TransPower



# **IMPACT: Battery-Electric Port Vehicles** **(ARV-14-053)**

## **Immediate Impact**



- **5 electric vehicles operating at Port of San Diego**
  - **2 electric Class 8 trucks**
  - **2 electric yard tractors**
  - **1 electric reach stacker**
- **~50,000 miles accumulated to date – mostly in actual drayage service**

## **Long-Term Impact**



- **Port of San Diego awarded multiple follow-on EV projects**
- **TransPower awarded ARB grant for 7 EVs at Port of LA**
- **Dole Foods pursuing electrification of entire San Diego yard tractor fleet**

# **IMPACT: Heavy-Duty Electric Yard Tractors (ARV-14-054)**

## **Immediate Impact**



- **Electric drive system adapted to Kalmar's new T2 tractor model**
- **First adaptation of Nissan Leaf batteries to a heavy-duty vehicle**
- **5 electric tractors deployed in disadvantaged communities from Bakersfield to Sacramento**

## **Long-Term Impact**



- **5-Year OEM supply agreement signed with Kalmar in May 2017**
- **Kalmar marketing electric tractors using TransPower system worldwide**
- **Kalmar committed to electrifying its entire product line by 2021**

# **IMPACT: Heavy-Duty Electric Refuse Trucks** **(ARV-14-051)**

## **Immediate Impact**



- **Established partnership with Peterbilt to develop a new electric refuse truck**
- **3 trucks to be deployed during second half of 2018**

## **Long-Term Impact**



- **Expanded Peterbilt partnership**
  - **12 electric drayage trucks**
  - **2 fuel cell drayage trucks**
  - **7 beverage delivery trucks**
- **Proposing additional electric refuse trucks with Waste Management**

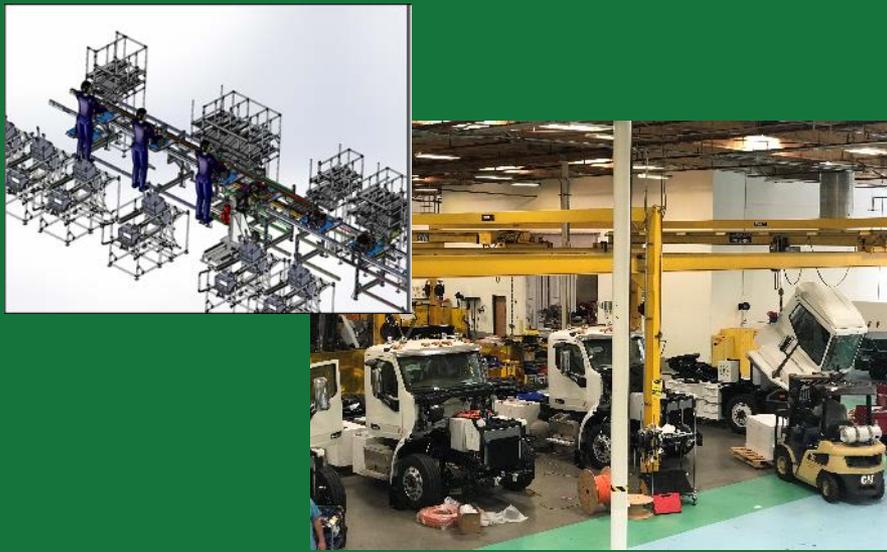
# **IMPACT: Heavy-Duty EV Manufacturing Initiative** **(ARV-14-045)**

## **Immediate Impact**



- **Acquisition of tools to fulfill vision of vertical integration**
- **Implementation of ERP system to support manufacturing transition**
- **Completion of low and high volume manufacturing test runs to validate new capabilities**

## **Long-Term Impact**

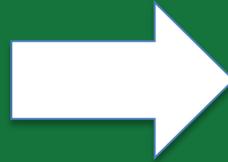


- **Establish foundation of scale-up to large-scale manufacturing in 2019-2020**
- **Return of manufacturing jobs to California**
- **Enable conversion of thousands of trucks to electric power**

# Vertically Integrated Business Model



# Stationary Energy: Another Example of Broad, Nationwide Impact of TransPower-CEC Collaboration



## **500 kWh Prototype “Grid-Saver” system (CEC-funded, 2011-2014)**

- Fast energy storage system using lithium batteries
- Largest battery system ever tested at Sandia National Laboratory
- Validated compact, low-cost method of battery integration and control

## **700 kWh Subway Traction Energy Storage system (Funded by New York City Transit, 2013-2018)**

- Initial system operating in New York City since mid-2016
- Recently expanded to full scale
- Reuses subway braking energy and provides backup power to move trains

## *Early Adoption Issues 2011-2014*

- Insufficient road performance
- Poor reliability

## *Current Adoption Issues 2015-2017*

- Lack of charging infrastructure
- Insufficient operating range
- High capital cost

***Electric trucks are better and more reliable, but need to have improved operating range and lower acquisition costs to stimulate broad market acceptance***

## *Improve truck operating range*

- Offer battery-electric trucks with higher energy nickel manganese cobalt (NMC) batteries
- Offer hybrid and fuel cell range extender options
- Expand battery charging infrastructure, including fast-charging options



## *Reduce truck acquisition costs*

- Evolve electric drive system design to reduce number and cost of EV components
- Strengthen cost-effective manufacturing and sourcing capabilities through strategic partnerships
- Scale up to large-scale manufacturing to take advantage of economies of scale



# Strategic Partnership with Meritor

Both parties bring valuable competencies to this relationship:



- Software / controls
- Battery integration & controls
- On road experience
- Commercial vehicle system integration
- E-Axle Innovation
- Sales
- Distribution & Aftermarket
- Supply Chain & Purchasing
- Operations

Class 8 Drayage



Terminal Tractor



Refuse



School Bus



Reach Stacker





- **Fully integrated electric motor** saves cost and weight and frees packaging space b/w frame rails
- **SPM motor technology** tailored for CV duty cycles is extremely power dense and efficient
- **Next Gen Brakes** optimized for EV duty cycles
- **2-speed automated shifting** enables smaller, lighter motor and higher system efficiency
- **Fits existing 14X axle housings** for easy vehicle integration
- **3 continuous power ratings** (150 / 180 / 200 kw) in the same package for appl. flexibility

## Current Product, 2018-2020

**150 Mile Range**  
**\$400,000 Price**



- Proven high-performance system
- Fills near term need for publicly-subsidized fleet deployments

## Mature Product, 2021-2025

**300 Mile Range**  
**\$200,000 Price**



- Simplified e-Axle architecture
- Provides competitive cost of ownership without subsidies

## *These technologies are not simple*

- Achieving reliability takes years of testing and product refinement
- Achieving low costs takes years of investments and requires high-volume manufacturing
- Critical skill sets are in short supply (e.g., software and controls engineering)
- Expertise building electric cars does not necessarily translate into electric truck mastery

## *Market acceptance will be gradual*

- Fleets want to evaluate different products before committing to large purchases
- Charging infrastructure and standardization is a major concern
- When companies that have never built trucks make outrageous promises and don't fulfill them, market confidence can be undermined



## *TransPower at the midpoint of a 12-Year plan*

- Phase 1, 2011-2015
  - Develop core technologies and components
- Phase 2, 2016-2019
  - Improve reliability
  - Demonstrate broader applications
  - Establish supply chain and strategic partnerships
- Phase 3, 2020-2023
  - Scale up to high volume manufacturing
  - Spur widespread medium and heavy duty EV adoption



## *Where resources are needed to stay on track*

- Continuation of small-scale vehicle demonstrations
  - System and vehicle concepts that can reduce costs
  - In-service demonstrations including phased vehicle and drive system improvements
  - Continue engaging new fleets and applications
- Supporting infrastructure
  - EV charging
  - Renewable energy and battery storage to reduce costs
  - Capital investments and training to increase production

