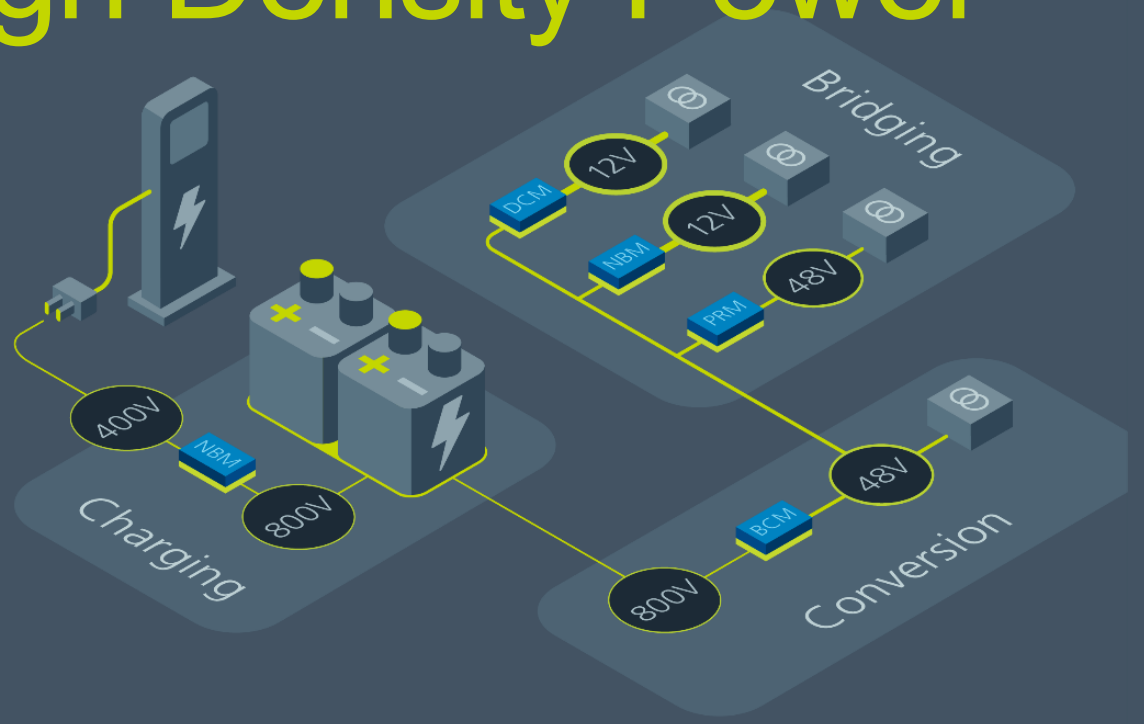
Maximizing Vehicle Weight Reduction with High Density Power DC-DC Modules

July 4, 2024

Gregory Green

Director of Automotive Marketing



EVs have a weight problem

Increased weight decreases operating range

Tesla Model 3 is 15% heavier than the average mid-size sedan (194kg)

GM Silverado EV is 1,300-1,800 kgs heavier than the non-electric version

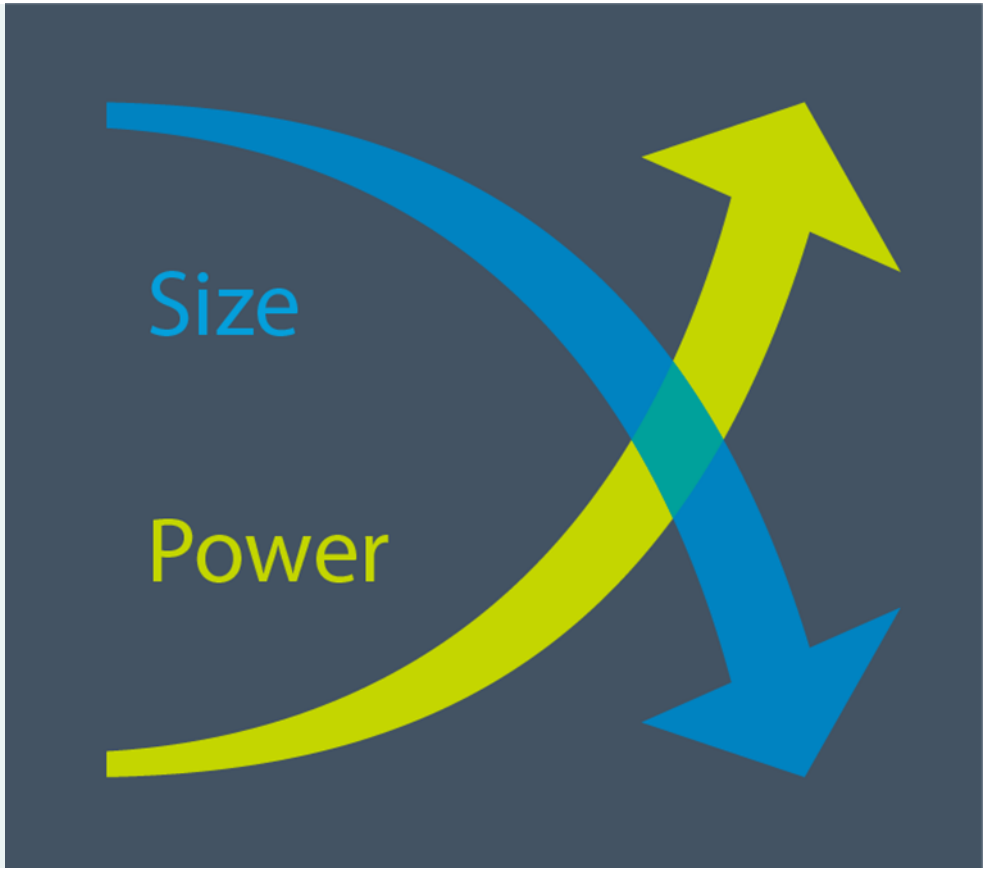
Adding 450kg extra to a vehicle's weight increases accident fatality risk by ~47%

The National Bureau of Economic Research

Excess EV weight is stressing parking deck structures and increasing road wear

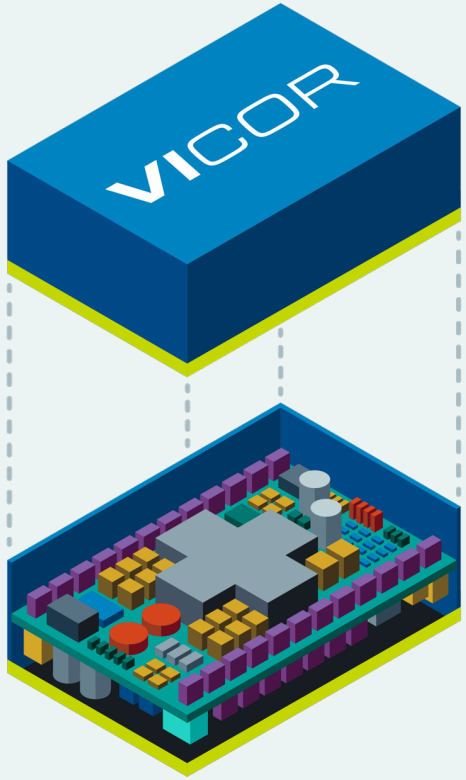
Vicor Overview - Innovating for over 40 years in Power Conversion

- Established in 1981 in Andover, Massachusetts
- 2023 Sales of $400M
- Solving the toughest problems
- Modules with 5x power density
- Highest power density for over 40 years
- Able to achieve up to a 30-50% reduction in weight and size



Vicor Technology for Automotive DC-DC Voltage Conversion

Enabling technology – Vicor power modules

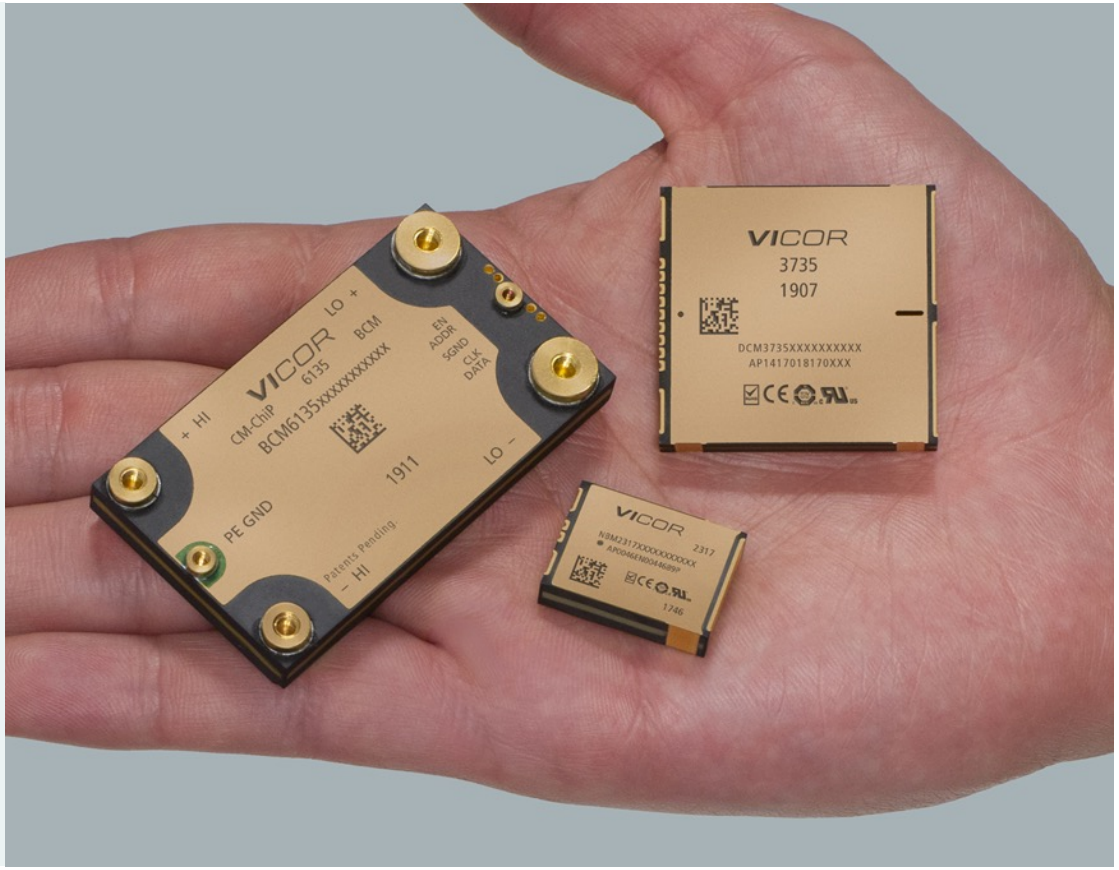


Highly integrated DC-DC converters

Extended variety of input and output voltages available

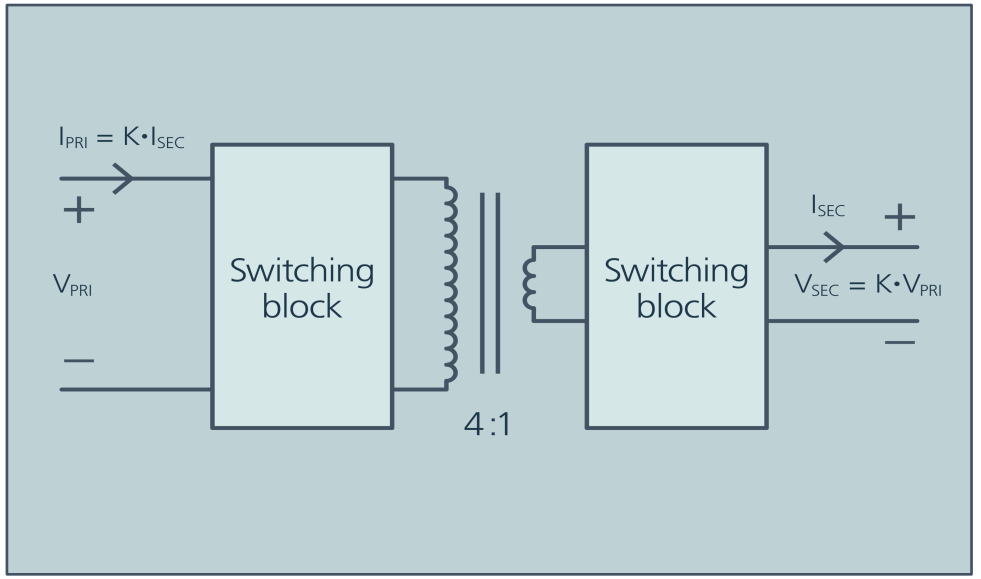
Isolation, regulation, conversion and transformation integrated in different combinations

Hundreds of components are tightly arranged within a miniature footprint



Sine Amplitude Converter technology/topology

- Sine Amplitude Converter topology:
  - Zero Voltage Switching
  - Zero Current Switching
- Fixed Ratio Conversion:
  - Divide/multiply the voltage/current
- Extremely fast transient current capability
- Ideal transformer behavior
- No inductor usage
- Not dependent on internal energy storage
- Capacitance multiplication



K factor	1/16	1/4	2/1	4/1
V_{PRI}	800	48	800	12
V_{SEC}	48	12	400	48
I_{PRI}	1	1	2	4
I_{SEC}	16	4	1	1

Automotive Product Line Modules

Model	PPAP Date	Application	Peak Power
BCM6135 A06	Submitted	800V <–> 48V Unregulated	2.5 kW
DCM3735 AN2	Complete	48V –> 12V Regulated	2.0 kW
PRM3735S AB4	Complete	48V <–> 48V Regulated	2.5 kW
NBM9280 A02	3Q 2025	800V <-> 400V Unregulated	37.5 kW

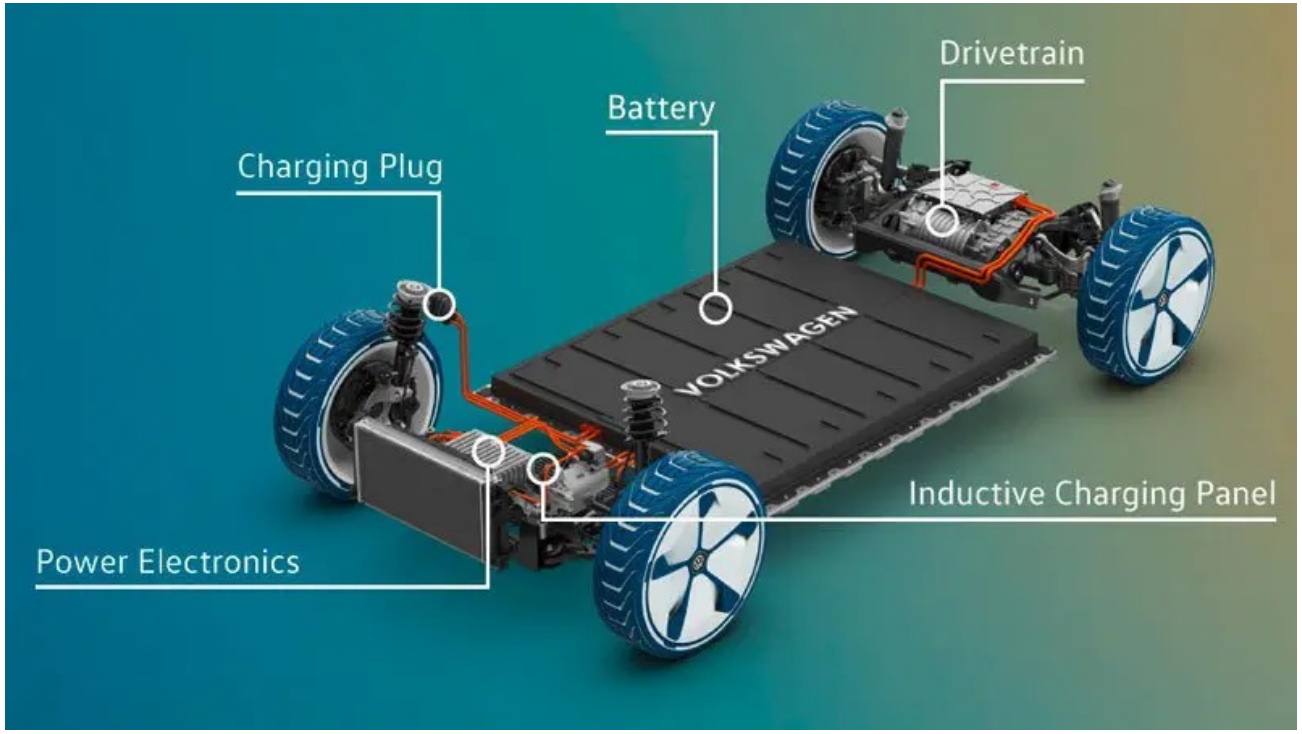
These products can be applied in over 300 configurations to address specific power distribution needs

Benefits of Vicor Miniaturized DC-DC Converters

Dave McChesney, Strategic Account Manager

Reducing xEV Weight Requires a Holistic PDN Architecture Approach

- Downsizing DC-DC Converters
- Integrating smaller DC-DC into the Battery Housing
- 48V Primary Vehicle Electrical Bus
- 48V Zonal Architecture
- Eliminate LV Batteries
- Downsizing Charge Compatibility Converters (150 kW 800 ↔ 400V)



Downsizing the High Voltage to Low Voltage

HV to LV 4kW system

2 – BCM6135

Flexible and scalable building blocks

4kW DC-DC 800/48/12V Prototype

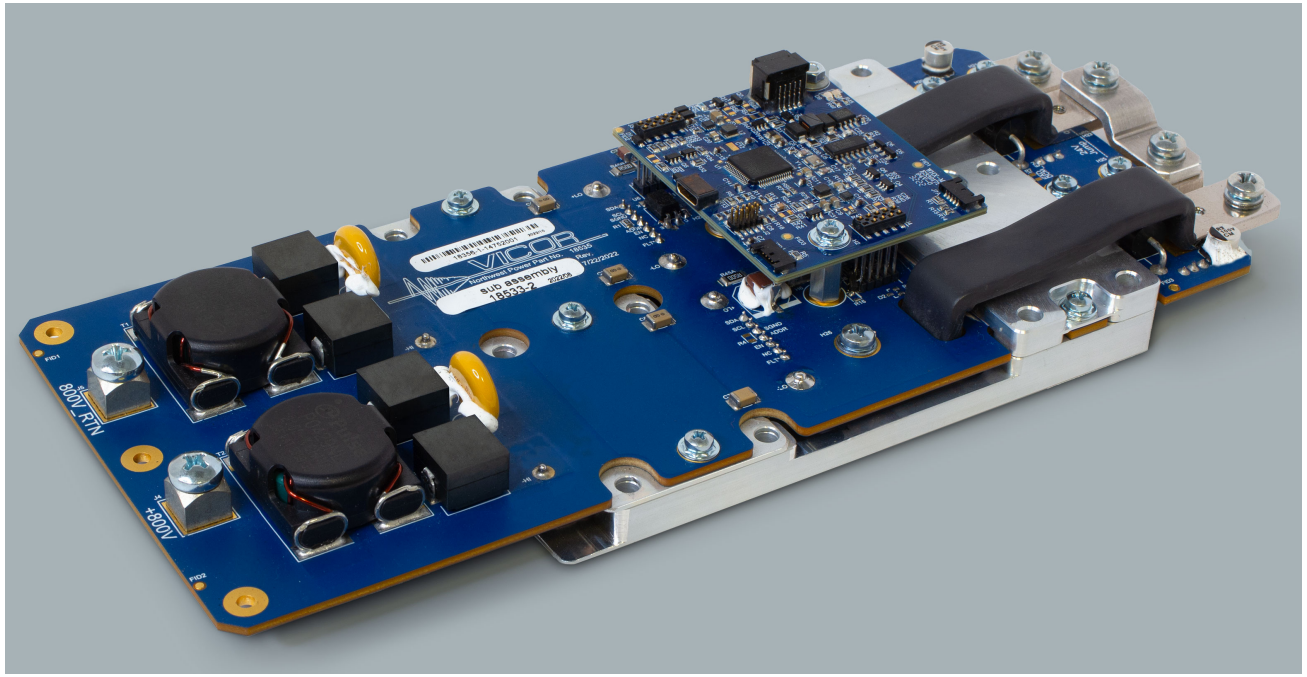
Isolated and Regulated

2 output Bus – each 2kW regulated

Mass = 1.5 kg

Envelope = 1.1 L

CAN Bus

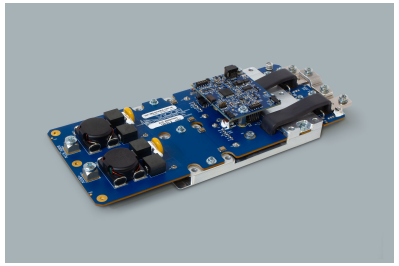


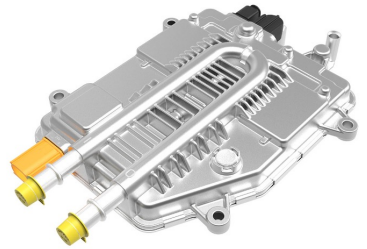
Designed and developed with a

N. American Tier 1

3 – 4x Improvement in Power Density

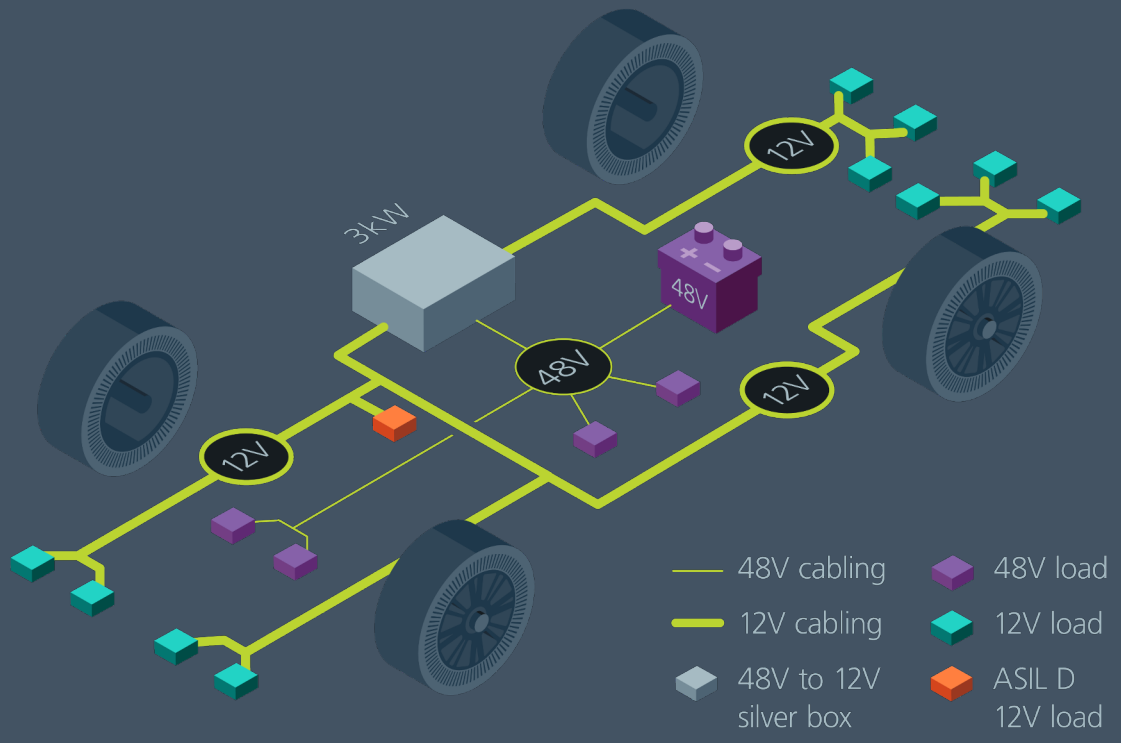
	Vicor Concept	Tesla Model X	Vitesco 4th Generation
Pout W (Output Power)	4000 @ 13.8V	2300 @ 12 V	3500 @ 14.5V
Output Current A	290	193	240
Weight kg	**1.4**	**2.1**	**2.6**
Footprint mm²	**24500**	**30520**	**50000**
Volume L (w/o connectors)	**1.1L (245 x 100 x 40)**	**1.8L (140 x 218 x 60)**	**2.5 L (250 x 200 x 50)**
Efficiency	**95%**	**93% Estimate**	**96% Estimate**
Power Density kW/liter	**3.63**	**1.3**	**1.34**
Gravimetric Power Density kW/kg	**2.85**	**1.1**	**1.5**



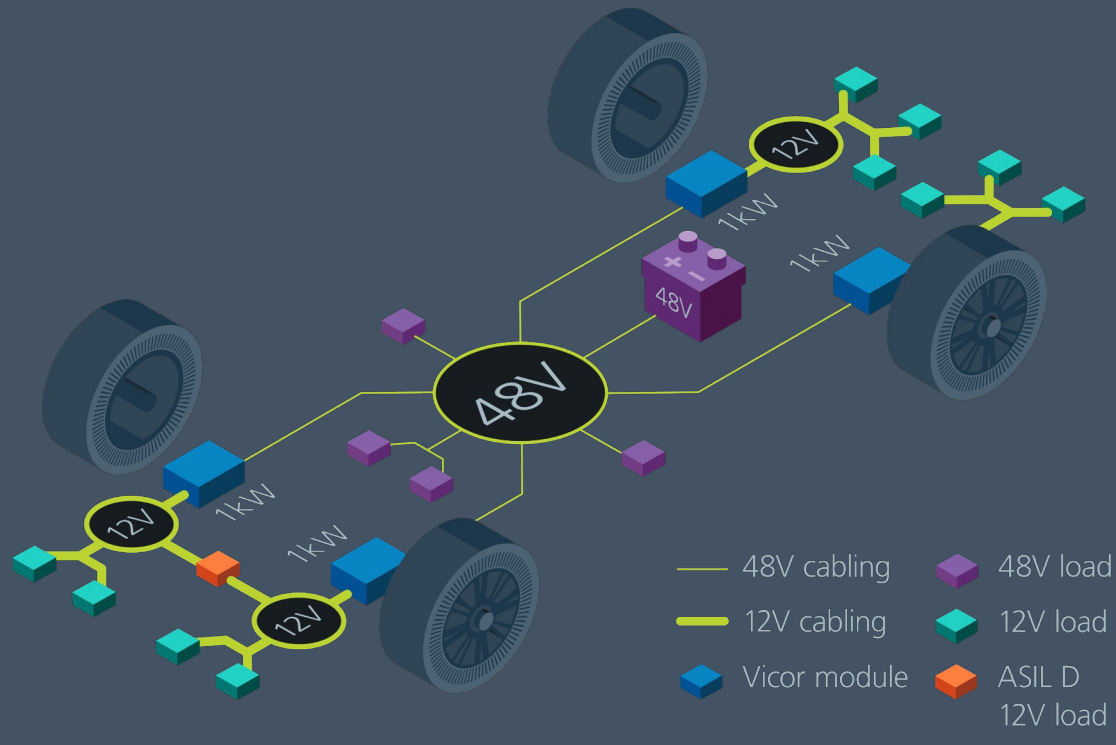


Architecture: Centralized vs Zonal

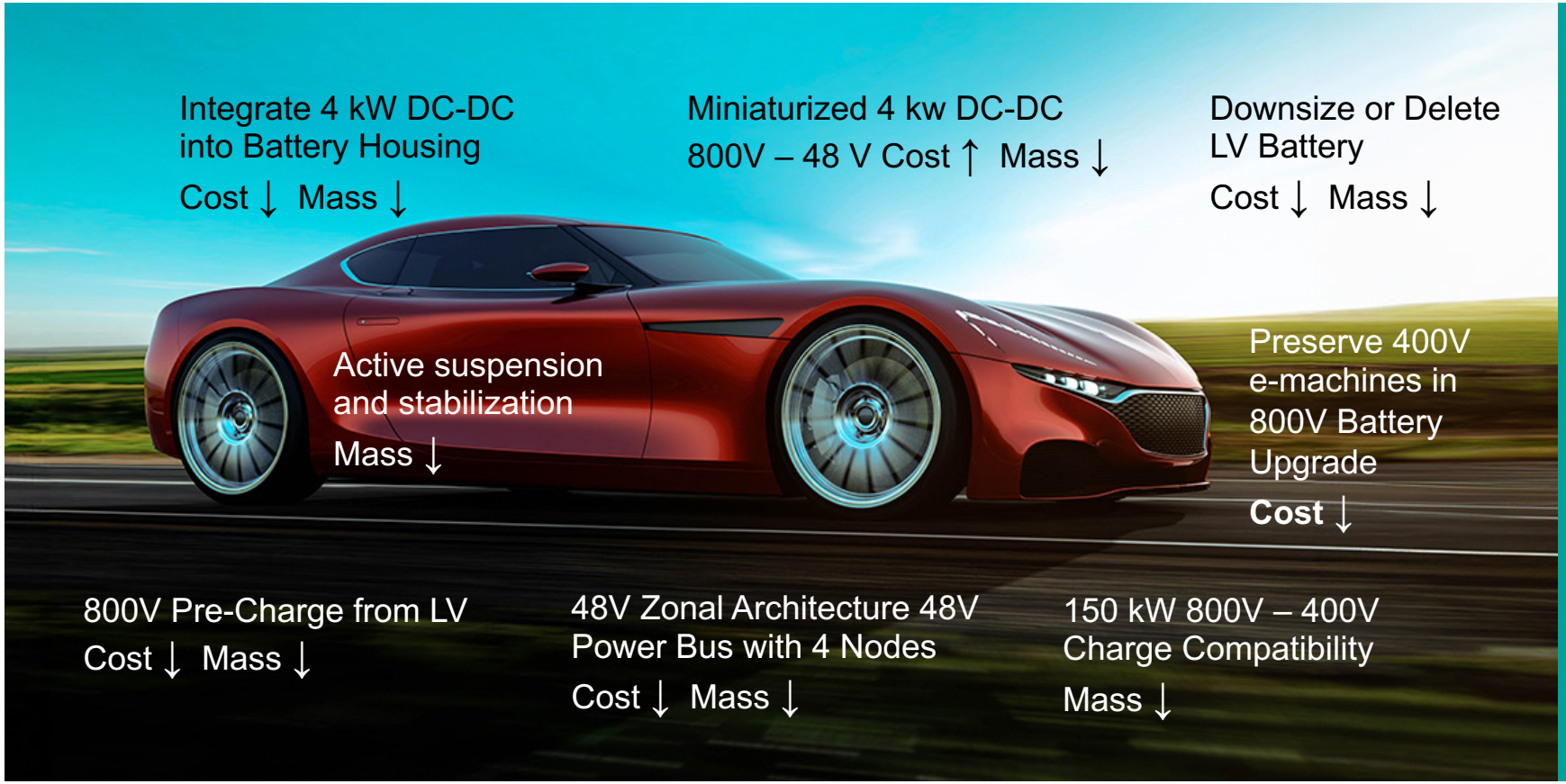
Centralized



Zonal



Vehicle Level Cost and Mass Reduction Enabled through Vicor Modules



Total Vehicle Cost Reduction
$75 -$100

Total Vehicle Mass Reduction
20 – 25kg