# PENTATONIC

## Battery System


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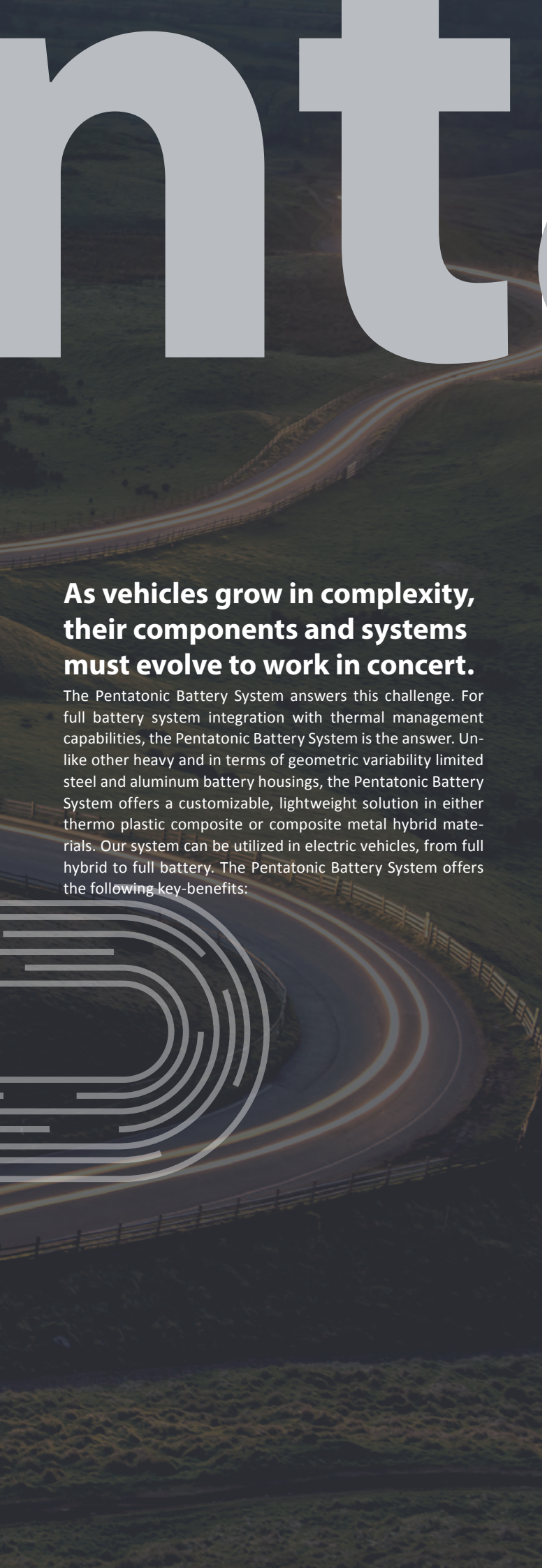


## As vehicles grow in complexity, their components and systems must evolve to work in concert.

The Pentatonic Battery System answers this challenge. For full battery system integration with thermal management capabilities, the Pentatonic Battery System is the answer. Unlike other heavy and in terms of geometric variability limited steel and aluminum battery housings, the Pentatonic Battery System offers a customizable, lightweight solution in either thermo plastic composite or composite metal hybrid materials. Our system can be utilized in electric vehicles, from full hybrid to full battery. The Pentatonic Battery System offers the following key-benefits:

### Feature Integration

Component reduction becomes vitally important. With the Pentatonic Battery System, features and thermal management components like cooling plates are integrated into one fully capable, lightweight system. This gives the opportunity to reduce your bill of material and therefore cost.

### Weight

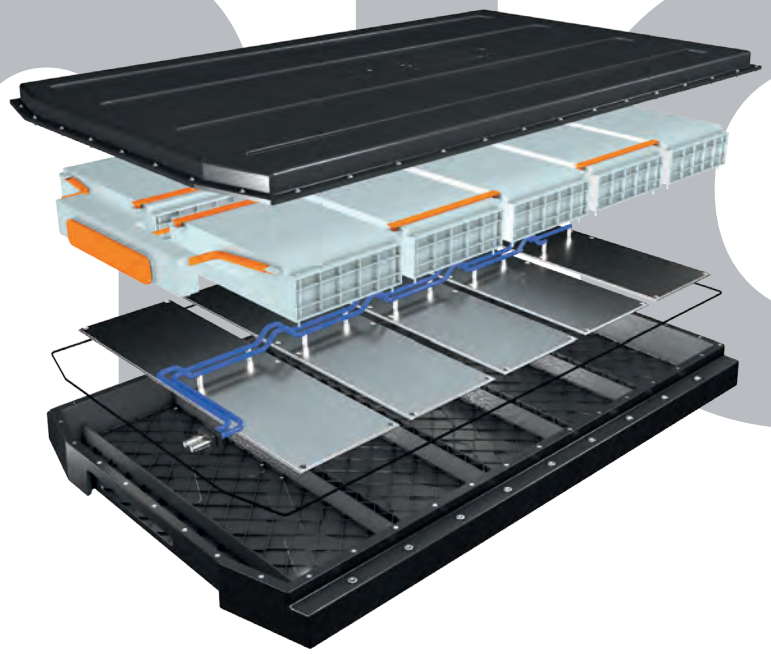
The Pentatonic Battery System weighs up to 50 % less than its steel and aluminum counterparts. This, in turn, improves the range of the battery-driven system, gives opportunities to adjust chassis components – such as suspension and brake system – or even use the advantage for maximum payload capacity. Besides these opportunities, this weight reduction also benefits $CO_2$ emissions as well as energy consumption (similar to a plastic fuel tank vs. a steel fuel tank today) and not only in the actual vehicle, but along the complete supply chain.

### Packaging

The Pentatonic Battery System improves the energy density of the entire battery system package in one primary way.

Volumetric advantages: The Pentatonic Battery System requires less clearance between the enclosure and the modules due to the isolating characteristics of our materials and the increased integration (e.g cooling plates) during the production process like thermal system components.

Given the same package size, a higher volumetric energy density means more energy is available to be used to power the vehicle.



### Manufacturing process

Using reinforced materials and integrating structural elements directly into our injection or compression molding process, we eliminate timely assembly steps at your facility. This “one shot” process means fewer secondary operations, such as welding and riveting, giving us shorter cycle times than our steel and aluminum counterparts, while offering better leak-tightness.

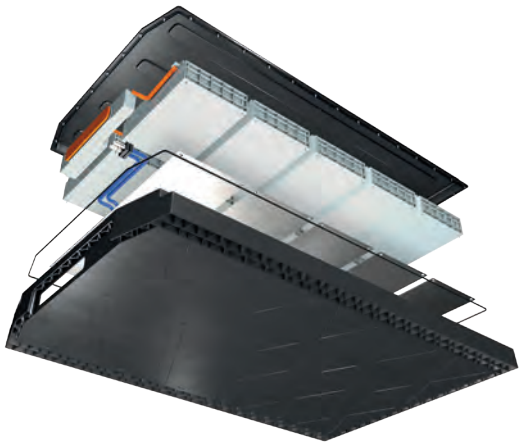
### Mass production capabilities

The scalability of our manufacturing process can meet your demands for increasing weekly volumes while offering extended tool life in parallel.

### Regulatory Requirements

Homologation: As the pioneers in plastic fuel tank production, our decades of expertise with fire tests, leak tightness proofing, and crash tests are utilized and extended to the requirements in designing as well as producing composite battery systems.

Range subsidies: With our lightweight solution, vehicles are able to increase their all-electric range, allowing for the possibility of government subsidies in applicable areas. These financial incentives typically depend on range, energy density and consumption in a test cycle (HEV/PHEV) – all of which are improved with a lightweight battery system.



### Thermal insulation

With our plastic composite materials acting as a natural insulator, the Pentatonic Battery System improves the temperature stability across the battery pack and reduces ambient losses of the thermal management under environmentally extreme conditions. The Pentatonic Battery System’s integrated cooling and heating benefits thus form a very effective temperature conditioning allowing for fast charging and efficient discharging.

### Structural integrity

The safety of a vehicle is always the number one priority for automobile manufacturers. The crash-worthyness also stays key element for battery systems. The Pentatonic Battery System as a thermoplastic composite/multi-material system means also no compromise on meeting the strict automotive standards.

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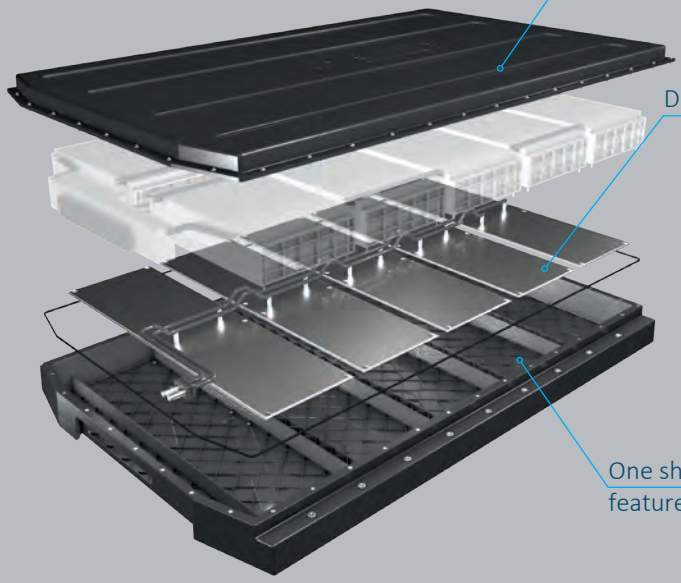
# Driving **the future**




**Benefits Overview**

**Weight**
Up to 50 % lighter
Improved vehicle dynamics
Maximized payload
Structurally strong

**Package**
Scalable
Optimized clearance
Cooling integration

**Assembly**
“One-shot”
Feature integration
Faster cycle times
Mass production capabilities

**Robustness**
Structural integrity
Thermal insulation
Leak-tightness

**Performance**
Improved range
Faster charging
Insulating capabilities
Lower emissions

**www.kautex.com**

**For more information about our battery systems, please contact battery.systems@kautex.textron.com**