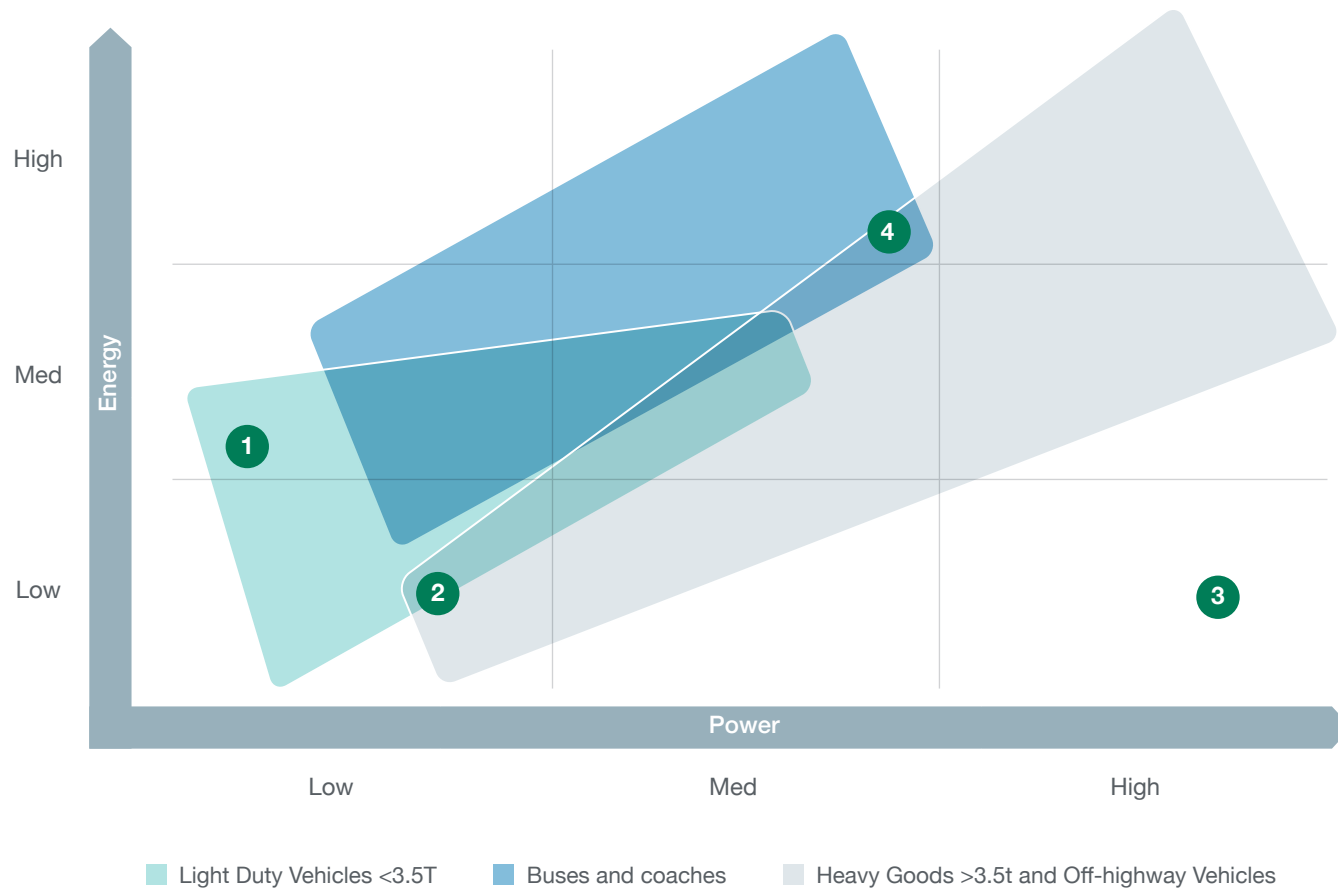




### Energy-power spectrum across applications

Propulsion systems are tailored to specific power and energy demands, based on their use case and duty cycle. The graph below presents an outline of principle mass-market products.



The 2020 roadmap provides values for (1) Energy focused, cost sensitive indicators.

Other values are available from the KTN Cross-sector Battery Systems ([CSBS](#)) Innovation Network.

- 1 Energy focused, cost sensitive**  
The key strategic drivers are for lower pack level costs and better continuous charge acceptance whilst maintaining or improving energy density levels. This is because a large capacity and faster charging are required to meet attribute requirements.
- 2 Power focused, cost sensitive**  
The key strategic driver for this cluster is transient power handling at an affordable price, the applications would benefit from increased power and energy density but not at the expense of cost.
- 3 Power focused weight sensitive**  
The key strategic driver for this cluster is power handling with minimal weight impact with a range of energy density requirements. Cost is less of a consideration than volume automotive.
- 4 Energy focused, weight and power sensitive**  
The key strategic drivers are better gravimetric energy density and achieving better continuous discharge power density for more repeatable performance with greater range or reduced vehicle weight.

**Technology indicators for energy focused, cost sensitive applications**

Technology indicators that industry is likely to achieve in a mass-market competitive environment. All the cost and performance metrics are ambitious, but relate to the same technology.

		2020	2025	2030	2035
<b>Cell Indicators</b>	Transient Discharge Power Density (W/kg)	1100	1180	1260	1340
	Gravimetric Cell Energy Density (Wh/kg)	280	300	320	340
	Volumetric Cell Energy Density (Wh/l)	720	770	850	900
	Cell Cost (\$/kWh)	85	70	58	48

		2020	2025	2030	2035
<b>Pack Indicators</b>	Transient Discharge Power Density (W/kg)	715	825	945	1070
	Charge Acceptance (Continuous C Rate)	1.5	2.5	3.5	4
	Gravimetric Pack Energy Density (Wh/kg)	185	210	240	275
	Volumetric Pack Energy Density (Wh/l)	470	540	640	720
	Pack Cost (\$/kWh)	125	97	77	63

**Notes:**

- Two roadmaps have been created, giving equal weighting to both cell and pack innovations. This reflects that developments in both are needed to achieve the future performance indicators.
- These indicators align with the **1 Energy focused, cost sensitive** category developed by Warwick Manufacturing Group (WMG) and the Faraday Battery Challenge as part of the KTN Cross-sector Battery Systems (CSBS) Innovation Network.
- The lowest costs of the CSBS Innovation Network targets have been adopted for this roadmap. This is to emphasise that low costs are prioritised for this technology.
- Assumed cell-to-pack ratios for energy and power density are: 65% for 2020, 70% for 2025 and 75% for 2030 and 80% 2035.
- C-rate has been added this year to reflect that cost effective chemistries, in addition to others, are expected to accept faster charging rates in the future.
- For specific product applications you will need to refer to page 1 on the energy-power map and find your relevant indicators on the KTN CSBS Innovation Network targets.



This roadmap represents a snapshot-in-time view of the global automotive industry propulsion technology forecast for mass market adoption. Specific application-tailored technologies will vary from region to region.



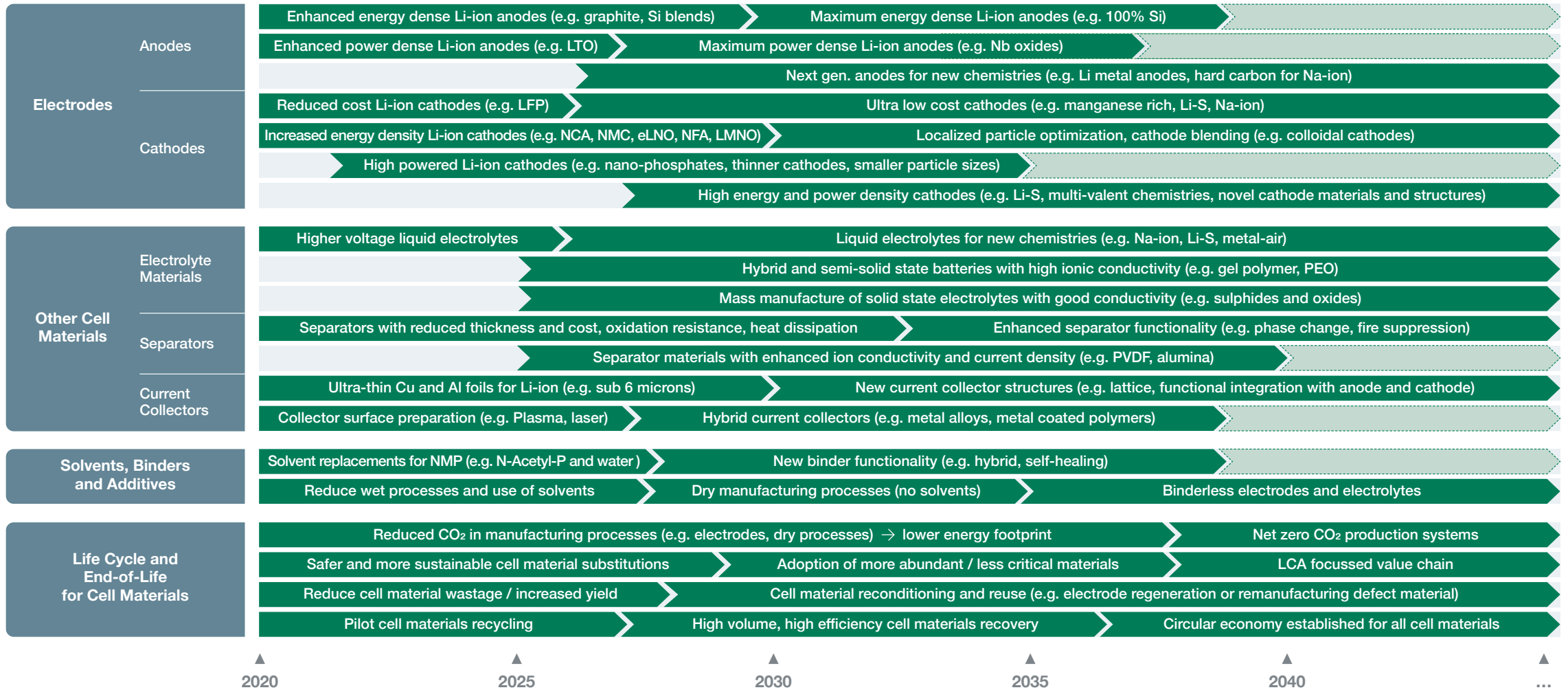
**Dark bar:**  
Technology is in a mass market application. Significant innovation is expected in this time frame



**Transition:**  
Transitions do not mean a phase out from market but a change of R&D emphasis



**Dotted line bar:**  
Market Mature – technology has reached maturity. Likely to remain in mass market until it fades out where it's superseded





This roadmap represents a snapshot-in-time view of the global automotive industry propulsion technology forecast for mass market adoption. Specific application-tailored technologies will vary from region to region.



**Dark bar:**  
Technology is in a mass market application. Significant innovation is expected in this time frame



**Transition:**  
Transitions do not mean a phase out from market but a change of R&D emphasis



**Dotted line bar:**  
Market Mature – technology has reached maturity. Likely to remain in mass market until it fades out where it's superseded

