Power Electronics Innovation Opportunities for the UK

Stephanie Morton
Strategic Trends Manager, APC



Automotive Council UK roadmaps 2024

Two System-level Roadmaps



Private

Shared



Mobility of Goods



- Long-haul
- Off-highway (including NRMM)

Six Technology Roadmaps

Hydrogen Fuel Cell and Storage



Lightweight Vehicle and Powertrain Structures



Power Electronics



Electric Machines

Electrical Energy Storage



H₂ Fuel Cell H₂ storage

Digitalisation, software and control systems

Materials and manufacturing / circularity and life cycle impact

Energy and infrastructure





Innovation priority





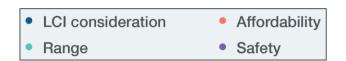
2 Filter innovations by Feasibility score

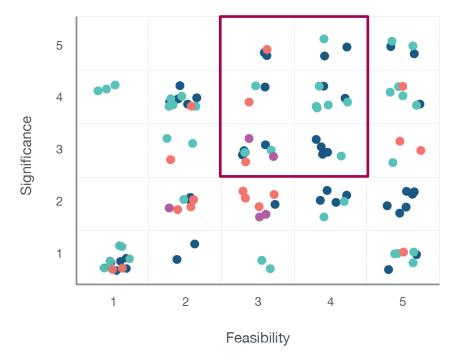
Filter refined list by Significance score

> Filter by estimated commercialisation dates

> > Consider the UK's capability or competitiveness

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Significance-feasibility matrix for power electronics innovations

System safety

Software and hardware innovations that detect, predict and manage faults

GaN-based systems

Use in OBC's as well as in multi-level inverters

Technologies that enable higher device yield

Larger wafers and higher voltage devices

Thermal management

Cooling efficiency improvement and reduce system level costs

Special mentions

Inverter optimisation, integration, V2X and LCI considerations

Power electronics priority innovations for the UK



System safety

Key innovations

- Software defined vehicles and CAM enabling significant improvements
- Device reliability is critical
 - Continuous monitoring and predictive maintenance
 - Self-diagnosis

Significance and feasibility

- Cost of sensors and predictive control vs. savings over vehicle life
- Ability to leverage and build upon UK software expertise

GaN-based systems

Key innovations

- Higher switching frequencies
 - On-board charger
 - GaN inverter

Significance and feasibility

- Potentially lower cost and marginal performance gains in inverters
- On-board charger opportunity
- Opportunity for three-level inverters
- Low current devices well proven
- Superior substrate access

Technologies that enable higher device yield

Key innovations

- Larger wafers
 - > 8" SiC wafers
 - ➤ 12" Si wafers
 - > 8" GaN wafers
- Enable improved current density and reduce die size
 - 1200V devices for 800V systems

Significance and feasibility

- Increase device yields
- Increase device current density
- Larger wafers likely to dominate

Thermal management

Key innovations

- Enabler for higher power densities and switching frequencies
- Packaging and design
 - Embedded device cooling
 - Copper sintering
 - Dielectric immersion cooling

Significance and feasibility

- Performance improvements and cost reduction potential
- UK has significant capability in packaging

Commercial opportunities well established in the UK

Focus and investment required to reach commercial potential in the UK

Special mentions



Inverter optimisation

- Reduce inverter cost and improve performance
- Leverages UK inverter manufacturing
 - Fusion inverters
 - In-wheel inverters
 - X-in-1 inverters

Integration

- Continued importance in reducing cost and weight
- Encompasses multiple "innovations"
 - Smaller and lighter converters
 - Smaller and cheaper subcomponents (e.g. modules)
 - > Reduced component count
- One-size-fits-all solutions may not be optimal for all use cases

Vehicle-to-X

- o Requires onboard power electronics systems
- Opportunity to leverage UK EV fleet for grid storage and balancing
 - Unlock revenue potential for EV owners
- Collaboration between relevant stakeholders needed

LCI considerations

- Critical in creating circular economy
- Broad consideration which cuts across all aspects of power electronics with multiple supporting innovations

Power electronics benefits and challenges



Innovation Theme	Benefits	Challenges
System safety	 Reduction in EV cost of ownership Plays to UK strengths in software Supports Automotive Council UK's CAM strategy 	 Potentially high upfront-development cost Cybersecurity risk needs to be considered Limited data sharing between OEMs
GaN-based conversion systems	 GaN is cheaper than SiC when grown on Si Higher switching frequency operation, enabling smaller and cheaper power converters UK has significant GaN expertise 	 GaN-based power inverter technology is immature 800V inverters require three-level topology Potential risk associated with gallium supply
Technologies that enable higher device yield	 Allows increased die yield and therefore reduced die cost Enables cost savings at the system level 	 Limited existing WBG semiconductor manufacturing capabilities in the UK Significant upfront cost in building new capacity Significant competition on the global market
Thermal management	 Operation at higher device temperatures, enabling higher power densities and switching frequencies Enable improved system performance 	 As chips shrink, removing heat from hotspots is critical Cooling improvement, particularly at device level, is an enabler to optimize SiC and GaN devices





ENABLING TRANSFORMATION

Automotive Transformation Fund

ACCELERATING SCALE-UP

Scale-up Fund

Feasibility Studies

SUPPORTING INNOVATION

Collaborate

Demonstrate

Mobilise





Thank you for listening

Check out our Knowledge Base

Contact:

stephanie.morton@apcuk.co.uk