

Electrification Study

- Funded by US Army TARDEC
- TARDEC vehicle automation and efficiency initiatives require the electrification of commercial vehicle systems (in particular the steering and braking systems)
- Investigation into the domestic industrial (truck, auto, and bus) base is needed to support these new technology areas

Electrification Study

- Who are the current industry leaders
- What are the capabilities of current technology developers and suppliers
- What does the commercial investment planning schedule look like
- What are potential pathways forward for increased electrification
- What is the likely timing of different stages of greater electrical integration

Electrification Study

- Preliminary Report June 24, 2016
- Final Report December 2016

Electrification Study

Technology Readiness Levels (TRLs)

- Identify TRLs for technologies
- Important – TRLs only valid for application for which developed
- New applications for existing technologies will drop TRL down to ~5-6

Technology Readiness Levels

Component	Truck OEM	Powertrain Supplier	System Supplier
Electric drive motors - induction, PM, and switched reluctance	4	9	9,9,6
Inverters	4	9	9,9,6
Ultracapacitors	4	9	9
Electric power steering / drive-by-wire	3-4	9	N/A
Integrated starter-generators	3 - for engines larger than 2 liters	7	9
Electric brakes	4	6	N/A
Advanced batteries - Lithium-titanate, NMC, etc.	3	N/A	9
Chargers - on-board and off-board	3	6	9
Electric auxiliary motors	4 - when applying to new component	9	9
Electric hydraulic pumps	4	9	9
Electric water pumps	8	7	9
Electric fans	8	7	9
Electric heating and cooling	3 - due to specific usage	7	9
IGBTs	N/A	9	9
24V architecture	5 - used in EU, 12/24V is simpler	9 (EU)	9
Silicon carbide electronics	N/A	6-7	3
DC-to-DC converters	4	6	9

Current Suppliers – Motors e.g.

Sector	Company	Notes	Links
Car	Tesla	Induction motor technology unique in their market segment	https://my.teslamotors.com/roadster/technology/motor
Truck/Bus	US Hybrid	Induction motor geared towards heavy-duty and off-road uses	http://www.ushybrid.com/documents/PDF/EDU240.pdf
Car/Truck/Bus	Protean Electric	In-wheel electric motors in production for prototype vehicles	http://www.proteanelectric.com/
Car	AC Propulsion	A/C induction motor and integrated powertrain manufacturer	http://www.acpropulsion.com/
Truck	UTS	Developing switched reluctance motors along with industry partners and demonstration customers.	http://www.utseng.com/
Truck	Artisan	Electric and hybrid powertrains, mostly heavy-duty	http://artisanvs.com/
Truck/Bus	UQM	Inverter/motor integrated systems for medium and heavy-duty applications	https://www.uqm.com/

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Next Steps

- Work with industry partners to vet technology conclusions
- Final Report in December 2016