

EV Everywhere Workshop
July 24, 2012

POWER ELECTRONICS AND THERMAL MANAGEMENT

Breakout Session #1 – Discussion of Performance Targets and Barriers

Comments on the Achievability of the Targets

- Performance: Is achievable with these assumptions
 - Production Cost: \$8/KW is achievable for PHEV40 and BEV300, \$14/KW is okay for BEV100
 - Production Efficiency: 95% system efficiency might be achievable
- It is easier to achieve performance than cost targets
- Integration of the different functionalities can help with achieving the targets
- What is efficiency worth? What price do we place on it?

Barriers Interfering with Reaching the Targets

- Capacitors and magnetics (materials, performance, temperature, size, frequency, packaging)
- Material cost, capacitors and magnetics are the priority
- New processes for capacitors
- Optimized thermal solutions
- WBG supply chain investment
 - More devices, larger wafers, reliability/qualification, availability, packaging

Breakout Session #2 – Discussion of Breakthroughs and Research Needs to Overcome Barriers and Reach Performance Targets

Technology Breakthroughs Needed

- Magnetics and Capacitor materials
 - Benign failure for capacitors
 - Higher dielectric constant
 - 400microfarads or greater, at 125C proportional to the dielectric constant 20% of the current capacitor size
 - Heterogeneous integration of magnetics and capacitance
 - Better passive cooling of passive components
 - 50% less in cost than today's cost
 - 200KHz operation for capacitance
- High power density high efficiency power module
 - Efficiency: 99% or above
 - Temperature: 200 – 250 C junction temperature
 - Less than 1mm²K/W in effective thermal interface resistance
 - Gate drives within the power module

Breakout Session #2 – Discussion of Breakthroughs and Research Needs to Overcome Barriers and Reach Performance Targets

“Out-of-the-Box” Ideas

- Active power filter
- Other WBG materials
- WBG based capacitors, high K and low K dielectrics

Research Suggestions

- Alternative topologies, current source inverter or resonant inverter
- Passive two-phase cooling and air cooling, phase change materials
- Vertical GaN device, normally on / normally off
- WBG transistor with low on resistance, 1-2 mOhms/cm² at 200 - 250 C
- Heterogeneous integration
- High power density power module

Breakout Session #3 – Discussion of Action Plans and Next Steps

Comments Regarding the Other Technical Areas Being Discussed

- Build a Better System (Battery, Power Electronics, Traction Drive, Thermal Mgmt)
- Synergies may come from other areas (solar, wind, grid)
- Thermal Management
- Electro-magnetic compatibility/interference
- Motors like higher voltages but devices losses increase
 - Other components costs increase

Next Steps for Reaching Targets (including roles for DOE and industry, e.g., lead or support)

- DOE's role is a convener role – bring people from different areas together in meetings or as part of a systems project
- DOE's role: Roadmap developer
 - Rules of engagement (J1349 standard, 28908 systems rating) harmonizing the industry decisions
 - Look at weak links for reliable operation – reliability roadmap
- Ensure interoperability
- DOE Role: Make sure our international competitors don't get there first, adjust accordingly
- Industry role: Manufacturing and reducing costs, DOE can help with developing advanced manufacturing technologies
- DOE role: faster commercialization of technologies and developing a supply base