Chargers for Plug-in (Hybrid) Electric Vehicles - IREE
(IP disclosure to UMN)

Enhancing End-Use Efficiency
(from <20% to >60%)

Research in Power Electronic Systems
Dept of ECE
University of Minnesota

Emphasis on:
- Renewables/Storage
- Smart Delivery
- Efficient End-Use

NaS Battery Storage
(Xcel Energy)
Project Cost: 5 M$ (IREE)
(U of M: co-PI)

Research Group:
2 Post-docs
11 PhD Students

Advisor: Professor Ned Mohan
(mohan@umn.edu)

Research Sponsors:
- U.S. Navy (ONR)
- NSF
- Xcel Energy
- Norway/North America Collaboration
- University of Minnesota
  - UMCCEE
  - IREE

Radial & Axial Bearings
Motor/Generator Unit

Flywheel Storage
Radial Bearing
Thrust Bearing

Power-Electronics based Transformers

(IP disclosure to UMN)

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Beyond Silicon: New Materials

<table>
<thead>
<tr>
<th>Key Parameters</th>
<th>Si</th>
<th>4H-SiC Diamond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandgap</td>
<td>1.1</td>
<td>5 eV</td>
</tr>
<tr>
<td>Breakdown field</td>
<td>0.3</td>
<td>10 MV/cm</td>
</tr>
<tr>
<td>Max electron velocity (g)</td>
<td>2</td>
<td>10^7 cm/s</td>
</tr>
<tr>
<td>Thermal conductivity (T)</td>
<td>1.5</td>
<td>20 W/cmK</td>
</tr>
</tbody>
</table>

Silicon Carbide exceeds the fundamental limitations of Silicon by a factor 10-100 in improved device properties.

Present Generation System

Heavy Cables
80-100 m

690 V, 60-Hz

34.5 kV, 60-Hz Underground

Heavy Transformer
60 Hz

Proposed Generation System

Open-end winding ac machine

High-Frequency Transformer and Converter

Light Cable at 34.5 kV

34.5 kV, 60-Hz Underground

U.S. Patent Application filed by the University of Minnesota (pending)
UMN&ONR Grant on Open-Ended Machines supplied by Matrix Converters: $577,262
ONR Grant on Power Electronics based High Frequency Transformer: $395,578

Power Loss reduced by a factor of 10.