Power Electronics and Electric Machinery Research Center Research Areas

- **Silicon Carbide (SiC)-based power electronics circuits**
- **Soft-switching inverters** (motor drives) and **dc-dc converters** (boost of battery voltages to run fuel cell compressor motor expanding unit)
- **Multilevel converters** for utility applications (interface with **distributed energy resources** such as photovoltaics and fuel cells, static var compensation, high voltage dc interties) and transportation applications (large variable speed drives)
- **Simulation, modeling and analysis of power electronics** and components for transportation and utility applications
- **Harmonics, power quality**, and **power filters** (active, passive, and hybrid)
- **Novel electric machine technology** - many advances and patents for permanent magnet, switched reluctance, induction, and dc machines
- **Motor efficiency, control, and diagnostic techniques** - induction machine efficiency models, failure diagnostic techniques, “sensorless” motor drive techniques

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- Advanced Brush Technology for DC Motors

**Other Transportation Applications**
- Hybrid Electric Vehicle Motor Modeling
- Automotive Electric Motor Drive (AEMD)
Cascade Multilevel Inverter for Utility Applications

Description
Cascade multilevel inverters use single-phase H-bridges and separate dc sources to synthesize single-phase or polyphase ac waveforms.

Technology Importance
• Circuit topology is modular and compact, which leads to lower manufacturing costs.
• Operation of multilevel inverter with fundamental frequency switching enables high efficiency and much lower EMI.
• Easy to incorporate redundant levels into design to significantly increase operating reliability.

Technology Applications
• Interface between distributed generation sources such as photovoltaics or fuel cells and an ac utility.
• Var, sag, and harmonic compensation or power flow control on a medium or high-voltage ac utility system.
• AC traction motor drive in an electric vehicle (EV) or hybrid electric vehicle (HEV).

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Fang Peng (left) and Cliff White demonstrate how the ORNL cascade multilevel inverter interfaces between low-voltage renewable energy modules (simulated by five 48Vdc power supplies) and users on a high-voltage utility grid (simulated by a 120 Vac fan motor).
Compact Diode-Clamped Multilevel Converter

Description
Diode-clamped multilevel inverters can synthesize a desired waveform from several levels of dc voltages. Their unique structure allows them to span high voltages without the use of transformers and with no voltage sharing problems. All three phases share a common dc bus, which can minimize system capacitance requirements.

Technology Importance
• The diode-clamped multilevel converter provides a high-efficiency (99%) because a fundamental frequency switching frequency can be used for individual devices.
• Suitable for large VA-rated motor drives.
• The large reduction in dV/dt significantly lessens EMI and hardens motors against bearing failures and insulation breakdown.

Technology Applications
• Medium-voltage, high-power motor drives
• Static var compensation
• Back-to-back intertie of asynchronous AC electrical systems
• Interface between high voltage DC (HVDC) and AC electrical systems
• Medium-voltage active filter to improve power quality
• Interface between DC distributed generation sources and AC utility

Leon Tolbert (front) and Fang Peng apply power to a multilevel-converter-based bidirectional adjustable speed drive for a 50-kW axial gap permanent magnet motor.

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Multilevel Universal Power Conditioner

Objective
Improve the power quality of both the utilities and their customers at the point of common coupling (PCC).

Goal
Develop multilevel PWM strategies for active filtering by a back-to-back diode-clamped multilevel inverter connected in a series-parallel arrangement to the utility.

Technology Uses
A multilevel universal power conditioner can improve the quality of the voltage delivered by a utility to the customer and reduce the harmonic and reactive current demanded by customers from the utility.

Project Accomplishments
- Novel multilevel PWM techniques have been developed to minimize the number of switchings in multilevel inverters.
- Methods have been identified to balance device usage and increase the effective switching frequency of multilevel inverters operated at low amplitude modulation indices.

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A prototype 10 kW, back-to-back, six-level, diode-clamped inverter.
Multilevel DC/DC Converter for Dual-Voltage Systems

Goal
Develop a compact, reliable, low-cost dc-dc converter for future automotive electrical systems that have both 12 V and 42 V systems.

Background
The next generation automotive electrical systems will likely require a higher voltage electrical system (42 V) because of the tremendous increase in electrical demands in future vehicles. At the same time, some legacy 12-V components will likely remain a part of the vehicle.

Advantages of ORNL’s Dual-Voltage Approach
- No bulky magnetics (transformers or inductors) are used
- Multilevel cells can be easily manufactured in large quantities like IC chips
- Design has inherent redundancies and is highly reliable
- The multilevel converter design has a high efficiency (>99%)
- Multilevel converter has much lower EMI than conventional converters
- Low cost components (low voltage MOSFETs) can be used
- Design is modular, compact, and lightweight

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Voltage Sag Supporter
Collaboration with Southern States, Inc.

Goal
Improve quality of service for electric power users such that they are not as susceptible to voltage harmonics or sags.

Background
The major power quality problem facing industry today remains voltage sags. Although infrequent in nature, a voltage sag can cause plant outages and equipment malfunction that cost industry millions of dollars in lost product and restart time.

Capabilities of Sag Supporter
• Supports voltage sags of 30% for 30 seconds
• Approximately 90% of problem sags will be eliminated
• Suppression of voltage harmonics and distortion
• Applicable from 4.6 kV to 25.7 kV
• Unit design is modular, transportable, and has self-control and protection
• Economical solution for most of a customer’s power quality needs

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A 140A/60V (2kW) Multilevel Cell prototype with a self-powered gate drive.
100 kW Transit Vehicle Power Inverter
Auxiliary Resonant Tank (ART) Technology

Objective
Rapid transfer of new ORNL inverter technology into the commercial automotive and transit vehicle marketplace.

ART Soft-switching Technology Importance
- Allows simpler controls and higher reliability using lower component count compared with other soft-switching methods
- Provides improved switching for controlling dv/dt while reducing EMI
- Auxiliary devices undergo lower stress compared to other soft-switching topologies
- Easy retrofit adds flexibility and reliability to hard-switched inverters

Goals
- Advance state-of-the-art for transportation applications by reducing volume and weight
- Improve reliability and cost with component and system improvements

Technology Use
Installation in automotive and transit vehicles for improvement in energy efficiency and reliability, where reduced cost, weight, and volume are important.
**Auxiliary Resonant Tank (ART) Inverter**

**Objective**
To provide an alternative soft-switching topology that utilizes simpler control and enables more reliable operation.

**Technology Importance**
Provide soft-switching benefits for controlled dV/dt with reduced EMI and less stress on resonant devices.

**Technology Uses**
- Adjustable speed drives
- Frequency changers
- Power electronic building blocks

Don Adams (left) and Fang Peng inspect one of the soft-switching inverters developed at ORNL’s Power Electronics and Machinery Research Center.

100 kW prototype of ART inverter used in an electric bus.

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Magnetic Stereotaxis System
Collaborating Institution: Stereotaxis, Inc.

Objective
To resolve problems with acoustic and electrical noise related to inverter switching in the magnetic stereotaxis system (MSS) using ORNL-developed inverter technology.

Technology Importance
- Resolution of problems with existing MSS technology including
- Control of rate of increase and decrease of SCC current
- Energy savings, heat reduction
- Increase of components’ life expectancy
- Reduction of audible noise
- Reduction of voltage spikes preventing false SCC energy dumping
- Prevention of SCC voltage oscillation while changing voltage
- Reduction of SCC energy dumping time

Technology Uses
- Neurosurgery applications
- Catheter-based drug applications used in neurodegenerative diseases

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Isolated Bi-directional DC-to-DC Converter for Fuel Cell Energy Management

Objective
Create converter technology to assist electric power management for fuel cell vehicles.

Goal
Evaluate novel topologies of bi-directional isolated DC-to-DC converters for fuel cell systems and build prototype of selected design.

Converter Specifications
- At fuel cell startup, converter can boost voltage from 12-volt auxiliary battery to power a high voltage (288 volt) DC bus until fuel cell voltage is established.
- Converter can recharge auxiliary battery to store the regenerative power from the motor drive.
- Efficiency during charging and discharging modes greater than 90 percent with a peak efficiency of 94 percent.
- 5 kW peak power (20 seconds) and 1.6 kW continuous power.
- Soft startup for discharge mode operation.
- Active clamp circuit to eliminate voltage spikes and minimize EMI.

Technology Use
Converter powers compressor motor expanding unit from auxiliary battery for startup operation of fuel cells and recharges battery from drive motor regenerative power.

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Soft-Switching Snubber Inverter

**Goal**
Create a converter that minimizes the additional cost required to achieve soft-switching.

**Objective**
Operate the inverter like a conventional hard-switched inverter with no limitations on switching timings or additional control complexity.

**SSSI Features**
- Only passive components are needed to achieve soft-switching operation
- No additional control is required to operate in a soft-switching mode
- Any traditional PWM methods can be used with the inverter
- Design has a reduced dV/dt and di/dt than hard-switched inverters
- Concept is a low-cost, reliable option for motor drives
- No need for a large planar dc bus
- Inherent circuit parasitics are incorporated into the soft-switching circuit

**Project Status**
- Simulation and proof of concept have been completed
- A 100 kW prototype is being assembled and tested
- Patent application has been filed and interested collaborators with industry are presently being sought

**ORNL’s soft-switching snubber inverter circuit diagram.**

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Soft-Switching Bi-Directional DC/DC Converter for Fuel Cell Energy Management

**Objective**
Create converter technology to assist electric power management for fuel cell powered hybrid electric vehicles.

**Goal**
Develop compact, low cost topology of bi-directional, isolated DC/DC converter for fuel cell systems that can power a high voltage compressor motor expanding unit from a low voltage battery until fuel cell voltage is established.

**ORNL Converter Advantages**
- Converter has half the component count as other similar converters
- Soft-switching is possible without any additional component costs
- Low cost design is lightweight, compact, and reliable
- The design has less control and accessory power needs than similar converters

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Automotive Integrated Power Module (AIPM)

ORNL’s Project Objectives
- To provide technical support to the DOE contract officer
- To provide electrical and environmental test and evaluation of preliminary and production design test articles
- To validate conformance to established specifications
- To assist in the determination of the suitability of the AIPM technology for automotive applications

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Hybrid Electric Vehicle Converter Modeling

Goal
Develop a physics-based dynamic computer model for determining losses, efficiencies, and temperatures in the electric and electronic system for a hybrid electric vehicle.

Approach
Develop a user-interactive graphics-based executable that is application independent.

Technology Applications
• Supports optimization by calculating cost and performance as design parameters change
• Calculates environmental response of a drive system as load conditions are altered
• Aids interpretation of experimental drive system data.
• Provides a technical tool for selection of HEV drive systems that can meet PNGV targets

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Fiber Optic Microsensors for Automotive Power Electronics Measurements

Goal
Develop an inexpensive approach to voltage and current measurement with potential for high volume production.

Objective
Combine micro electromechanical machine technology and fiber optics and/or light emitting diodes and fiber optics to develop inexpensive, precise voltage and current measurements.

Technology Description
• One method uses a microcantilever unit to respond to the presence of an electric field or current-induced magnetic field by flexing and then sense the motion of the cantilever by use of a single optical fiber.
• A second method uses a fiber optic probe to sense the ultraviolet and blue light emission from a light emitting diode (LED) to detect the magnitude of a current and/or voltage.

Technology Importance
Microsensor technology is inexpensive, small in size and mass, compatible with high volumes, non-interfering with other components, and easy to install and use.

ORNL has developed measurement techniques to detect flexing in a 100 micron length microcantilever.

Atomic-force-microscope cantilever and single mode fiber core.
Silicon-Carbide Power Electronics

Goal
Optimize the atoms-to-systems development of high-temperature MOSFET-based power electronic circuits for use in high-power commercial applications.

Objective
Integrate SiC-based power electronics fabricated using state-of-the-art processing technology developed at ORNL into power management modules to increase system performance.

Technology Description
- ORNL’s Solid State Division has developed a novel low-temperature processing technique that minimizes roughening of the interface during activation annealing
- Collaborator Vanderbilt University has developed a method to reduce damage during ion implantation
- UT and ORNL will develop novel circuit and gate-driver topologies to take advantage of the special properties of SiC-based power switches

Technology Importance
- SiC-based power electronics will allow the reduction in size/weight of modules by 3X
- Operating temperature range up to 500°C
- Reduces losses by a factor of 10X
- Increase power capabilities by a factor of 100X

Vanderbilt University holds the world record for minimum interface defect density in SiC materials.

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A Hybrid Electric Vehicle Drive for a Dual Stator Brushless DC Motor

Objective
Develop a modular design for an axial gap permanent magnet machine so that multiple modules can power a common HEV drive shaft.

Modular Advantages
• Power rating scalability - increase or decrease the number of modules to meet different power requirements.
• Increased fault tolerance - failure of one module or drive does not immobilize vehicle.
• Easy repair or replacement.

Project Description
Visual Computing Systems developed a PM motor with two separate sets of three-phase stator coils. ORNL developed two modular inverters and the control and PWM strategies necessary to control the motor. The University of Tennessee installed this drive system in a converted Chevy Suburban (shown right).

ORNL researchers developed the dual brushless motor drive pictured above for use in the University of Tennessee’s FutureTruck pictured below.

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Alternator and Inverter for Advanced Military Mobile Power Generator Sets

Objective
To develop a versatile, lightweight, reliable family of mobile diesel generator sets to meet military requirements in the 5 - 60 kW range.

Goals
- Develop generator sets that are lighter, quieter, and more compact, reliable, and efficient than existing military tactical quiet generator sets.
- As a logistics savings, reduce the number of family members required to meet military requirements in the 5-60 kW range.

New Technologies
- Lightweight permanent magnet alternators will be driven at variable speeds at the most efficient engine operating point.
- Inverter allows each generator set to produce selectable fundamental frequency of 50 Hz, 60 Hz, and 400 Hz and selectable voltage configuration of single phase, dual phase, or three phase.
- A bi-directional dc-to-dc converter will charge the battery during normal operation and use battery energy to maintain high voltage dc link when large loads are added to generator set.
- An integrated digital control, diagnostics, and prognostics system will be part of gen-set package.

Proof of concept 7.5 kW generator set.
Cost Sensitivity to Battery-Pack Voltages in Hybrid Electric Vehicles

Goal
The AEMD must be designed and manufactured to overcome cost, volume, weight, thermal and reliability barriers in order to meet technical targets. This project will verify the suppliers/developers success in accomplishing these ends.

Project Description
Provide technical and evaluation support to subcontractors developing an AEMD that meets the goals and schedule of the Partnership for a New Generation of Vehicles (PNGV).

ORNL’s Project Objectives
- To provide electrical and environmental test and independent evaluation support to AEMD developers/suppliers of preliminary and production design test articles.
- To validate conformance to established specifications.
- To assist in the determination of the suitability of the AEMD technology for automotive applications.
- To promote the use of newly developed technologies from DOE’s national laboratory programs.

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Dual Mode Inverter Control for Extended Constant Power Range of Brushless DC Motors

Objective
To develop an inverter that can drive low-inductance brushless dc motors at high speeds (field-weakening region) without a large increase in component costs.

Goals
• Cost less than existing inverters for driving low-inductance permanent magnet motors above base speed.
• Compatible with electrical requirements in hybrid electric vehicles.
• Minimize current and voltage rating requirements of inverter components.

Technology Importance
• Compatible with low-inductance motors including rare earth PM motors
• Retains rated current at base speed
• Can regenerate at many times rated power for brief periods during braking
• Functions over a wide range of voltages or battery voltage fluctuations
• Requires transistor rating only against dc supply voltage
• Safe operation against a fault (cutoff in 1/6 of a cycle)
• No pulse width modulation switching losses above base speed
• Can be controlled with simple digital signal processor

The DMIC jointly developed by University of Tennessee and ORNL researchers was used to drive the PM motor above at high speeds.

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Low Inertia Permanent Magnet Machines

Objective
To develop and test a low-inertia permanent magnet motor and drive system with lightweight rotor and high power density.

Technology Importance
• Provides rapid responses for servo applications.
• Reduces heat losses for motors with frequent starts and stops.
• Reduces kinetic energy storage for ultrahigh-speed motors.

Applications
• Control systems requiring rapid responses
• Flight simulators

ORNL researchers Cliff White (left) and John Hsu operate a low inertia permanent magnet motor and drive system.
Axial Gap, Permanent Magnet Motor Technology


Objective
To refine the design of axial gap, permanent magnet motors employing segmented electromagnetic array technology and to demonstrate system capabilities for use as flywheel energy storage drives.

Technology Importance
Provides a low-cost, high-speed, efficient, high-power-density motor/alternator that substantially advances the development of commercially competitive flywheel energy storage systems.

Results
• B-3 motor was driven to 6000 rpm with a line-to-line voltage constant of .0258 V/rpm.
• B-3 was operated as an unloaded generator.
• A load was then switched on, and B-3 was operated in regenerative mode generating 14.3-kW peak output power at 3860 rpm.

Technology Uses
• Utilities: high-power-density generators for large flywheel energy storage systems
• Aerospace companies: high-speed motors for advanced aircraft use as turbine starters and main generators.
• Navy: constant torque motors with high power density for shipboard use.

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Radial Gap, Permanent Magnet Motor-Assisted Turbocharger

Objective
To reduce the acceleration time of turbochargers by using electric motor assistance.

Goal
Evaluate different sizes and types of motors for their ability to reduce turbocharger lag in diesel engines. Build a prototype motor to demonstrate the technology.

Technology Uses
• Significantly reduces soot emissions from diesel engines.
• Increases power during turbocharger transient conditions by improving the air-fuel combustion ratio.

Project Accomplishments
A 10 kW radial gap, permanent magnet motor prototype designed to run at 100,000 rpm has been fabricated and run at 60,000 rpm. Higher speeds will be run during the summer of 2000.

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Ultracompact Permanent Magnet Motor and Self-Sensing Motor Drive

Objective
To develop an advanced highly efficient electric motor and controller for a mobile air-conditioning compressor for electric vehicles.

Technology Uses
Replacement for traditional engine-driven air conditioning compressors:
• Less noise
• Smaller size
• No polluting emissions

Technology Importance
• Advancement of high speed permanent magnet motor technology saves weight and volume on an electric vehicle.
• Improvement of the air conditioning system efficiency extends the range of electric vehicles.

Project Accomplishments
An axial gap PM motor prototype and compact self-sensing inverter have been built.

ORNL researchers examine PM motor and inverter components for an air-conditioning compressor drive on an electric vehicle.
Direct Control of Air-Gap Flux of Permanent Magnet Machines

Objective
To directly control the output voltage of a permanent magnet (PM) generator to provide a wide speed-variation ratio for electric vehicle drives without demagnetizing the PMs.

Goals
Design and build a prototype PM generator that has wide output voltage variability at a constant speed.

Other Application
Field weakening of PM motors.

Technology Description
A direct brushless field winding and novel rotor design allow for the regulation of the air-gap flux, and subsequently output voltage, of a PM generator. Higher than a 10:1 field weakening ratio has been obtained. No position sensor is necessary for inverter control.

Technology Importance
This PM motor/generator field-weakening method improves reliability and reduces cost, weight, and volume for the motor and associated controls in a hybrid-electric vehicle.

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ORNL researchers have developed a new permanent magnet generator with auxiliary field control for voltage regulation.
Flux Enhancement of Permanent Magnet Machines

Objective
Achieve high power density PM motors and generators.

Goals
Use low cost magnets in PM machines yet achieve high power density through effective flux enhancement techniques.

Technology Description
The higher effective flux as a result of the flux enhancement techniques enables a more compact stator to be used. Where low cost is the primary objective, a lower grade magnet material can be used. Where high power density is desired, a high grade magnet material can be used.

Technology Importance
This PM motor/generator flux enhancement method reduces cost, weight, and volume for the motor and associated controls in a hybrid-electric vehicle.

ORNL researches have devised flux guides for large or small gap areas and for high or low grade magnets to improve the performance of PM machines.
Permanent Magnet Alternator for Advanced Military Mobile Power Generator Sets

Objective
To develop a versatile, lightweight, reliable family of mobile diesel generator sets to meet military requirements in the 5-60 kW range.

Goals
• Develop generator sets that are lighter, quieter, and more compact, reliable, and efficient than existing military tactical quiet generator sets.
• As a logistics savings, reduce the number of family members required to meet military requirements in the 5-60 kW range.

New Technologies
• Lightweight permanent magnet alternators will be driven at variable speeds at the most efficient engine operating point.
• Inverter allows each generator set to produce selectable fundamental frequency of 50 Hz, 60 Hz, and 400 Hz and selectable voltage configuration of single phase, dual phase, or three phase.
• A bi-directional dc-to-dc converter will charge the battery during normal operation and use battery energy to maintain high voltage dc link when large loads are added to generator set.
• An integrated digital control, diagnostics, and prognostics system will be part of gen-set package.

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Switch Reluctance Motor and Drive

Objective
To develop a switch reluctance (SR) motor and drive system with lower noise and mechanical vibration than existing systems.

Project Description
• Four-phases of H-bridges drives the SR motor.
• Optical encoder is used for position sensor.

Technology Uses
Replacement for adjustable speed drives that require superior starting performance with relatively small inrush currents compared to commonly used induction motors.

Technology Importance
Provides further improvements on robust and cost-effective switch reluctance motor technology. Optical encoding of position sensor enables better control over motor torque.

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ORNL researchers operate ORNL’s innovative switch reluctance motor and drive.
Superconducting Generator

Objective
To develop a superconducting generator with a stationary cryostat.

Technology Importance
- Great reduction in size dimensions from that of conventional generators.
- Increased efficiency.
- Simpler structure for generator involving fewer moving parts.

Applications
- The replacement of large motors and generators where size and efficiency are important considerations.
- The future more-electric navy is considering using superconducting generator technology to increase efficiency of their propulsion systems.

Researchers John Hsu (left) and Mike Jenkins view the prototype of a superconducting generator with a stationary cryostat.
Manufacturing Technology of Copper Rotors for Electric Machines

**Objective**
To increase the efficiency of induction machines used in hybrid electric vehicle drives.

**Goals**
Develop a cost effective production method for manufacturing all-copper or part-copper rotors in electric machines.

**Project Description**
ORNL researchers have analyzed the use of copper bars with aluminum rings in the rotor of a large induction motor and have determined that a cost-effective production method is possible that will achieve a higher efficiency machine than those with all-aluminum rotors. Future research will be directed toward building a large prototype motor with an all-copper rotor and further study of the joint properties between aluminum and copper.

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*A magnified photograph of a defect-free aluminum/copper joint.*

*ORNL researchers have developed a cost-effective production method for copper rotors in electric machines.*
Soft-Commutated Direct Current (DC) Motor

Objective
To develop a DC motor that has a higher reliability and less maintenance than traditional DC motors.

Technology Use
The energy associated with the residual current of the commutated coils is dissipated in an attenuation circuit that can be recycled back to the DC power supply. This reduction in spark generation extends the brush life.

Technology Application
An inexpensive, more reliable, and quieter drive system for hybrid electric vehicles is possible. A robust low voltage variable speed drive can be built without an expensive inverter or dc/dc converter. The motor also will have high overload capability.
High-Power-Density Homopolar Motors

Objective
Develop a motor that will have high power density at low voltages, such as those proposed for some hybrid electric vehicle systems.

Technology Description
Homopolar motors are dc motors that do not require commutation.

Homopolar Machine Advantages
• Dual rotors for low mechanical speed and high power density
• No commutation is required in a homopolar machine
• New brush developments can be used in machine designs

Technology Importance
This new type of homopolar technology could double the power density of conventional homopolar motors, making it an attractive low-cost option for use with low-voltage electric vehicle systems.
Advanced Brush Technology for Direct Current (DC) Motors

Objective
To develop a high power DC motor that can be used at low voltages on future hybrid electric vehicles.

Technology Use
A low voltage (<50 V) motor and electrical system on a hybrid electric system is a lower liability risk that high voltage system.

Technology Application
A high-power, low-voltage motor can be used in a hybrid electric vehicle. This would allow variable speed control and eliminates the need for expensive inverters or dc/dc converters.

ORNL researchers have built a 13-V, 4500-A, 55 kW prototype DC motor using brushes designed for high current capability.

Graphite with lubricant
Graphite no lubricant
ORNL brush with lubricant

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Hybrid Electric Vehicle Motor Modeling

Goal
Develop a physics-based dynamic computer model for designing and evaluating electric machines for hybrid electric vehicles.

Approach
Develop a user-interactive graphics-based executable that is application independent.

Model Features
- Control module for time response of motor to variations in load and motor inertia.
- Road test module for study of time response of motor to variations in speed, load, and ambient temperature.
- Performance map module.
- Design module for parametric studies and optimization.
- Drawing module for stator/rotor visualization and construction.

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Automotive Electric Motor Drive (AEMD)

Goal
The AEMD must be designed and manufactured to overcome cost, volume, weight, thermal and reliability barriers in order to meet technical targets. This project will verify the suppliers/developers success in accomplishing these ends.

Project Description
Provide technical and evaluation support to subcontractors developing an AEMD that meets the goals and schedule of the Partnership for a New Generation of Vehicles (PNGV).

Objectives
• To provide electrical and environmental test and independent evaluation support to AEMD developers/suppliers of preliminary and production design test articles.
• To validate conformance to established specifications.
• To assist in the determination of the suitability of the AEMD technology for automotive applications.
• To promote the use of newly developed technologies from DOE’s national laboratory programs.

AC dynamometer for testing of AEMD units.

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