



Cost Improvements Through Innovation for Electric Traction Drive Systems

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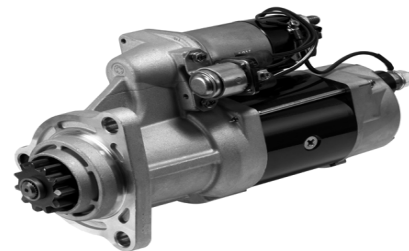
Remy Electric Motors

Engine Expo 2011

May 18, 2011

Remy International, Inc.

- Manufactures Starters, Alternators, Propulsion Motors
- 5,500 Employees, 23 Facilities in 10 Countries
- Over 100 years experience in rotating electrics
- Over 17 Million Units Produced Annually



Business Description

- High output traction motors & generators for Hybrid and Electric Vehicles



High Performance Products

- 30-300 kW Output
- 200 -1800 Nm Torque
- High Efficiency
- Zero Defect Philosophy

Customer Value

- Unique Technology - Highest Power Density
- Durable Motors:
 - 90,000+ motors produced
 - 3 Billion kilometers of proven reliability
 - 2 warranty returns to date
- Broad Experience - Application support

Key Milestones

- 1959 First HVH alternator produced
- 2002 Produced 1st eMotor for electric bus
- 2003 Developed & patented HVH technology
- 2006 Launched Dual-mode Hybrid with GM
- 2008 Contract for Daimler ML 450 & BMW X6
- 2009 Won \$60M US Dept of Energy Grant
- 2010 Launched Remy Electric Motors, LLC

\$120 Million Investment in Hybrid/ Electric Vehicles

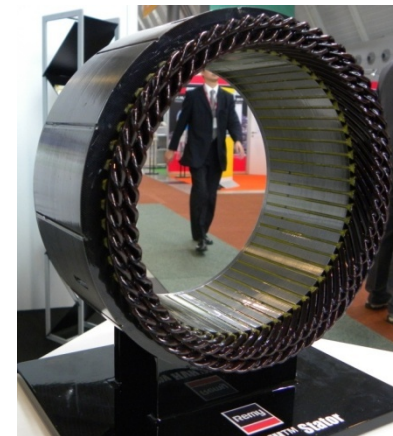
We Make Electric Traction Motors & Generators . . .



HVH 410



HVH 250

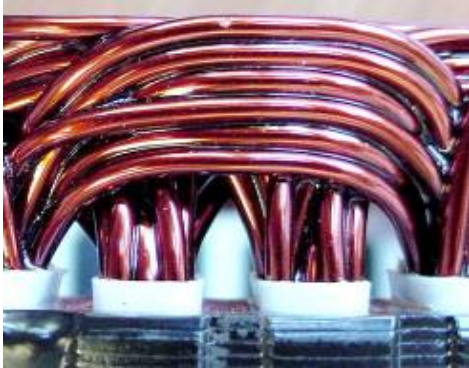


HVH Stator

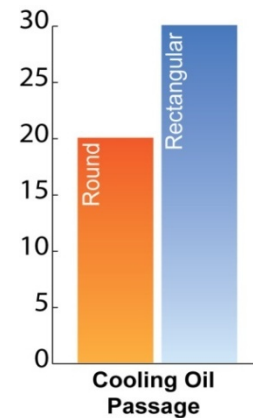
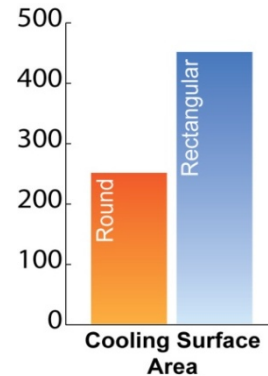
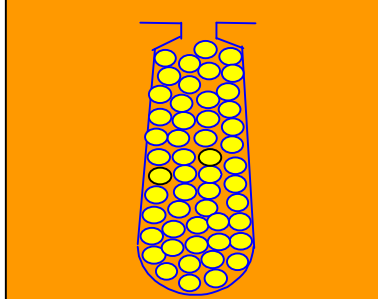
Feature Patented HVH Technology for Superior Power Density / Torque

Remy HVH (High Voltage Hairpin) Motor Design

Round Wire



Conventional Winding
45% - 50% Slot Fill

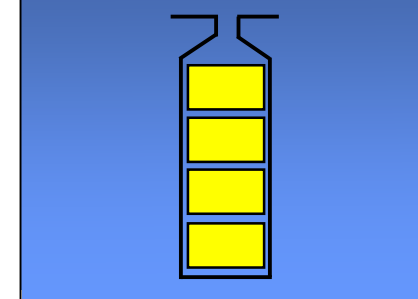


Improved heat
conduction to slot wall

Rectangular Wire



HVH Design
68% - 73% Slot Fill

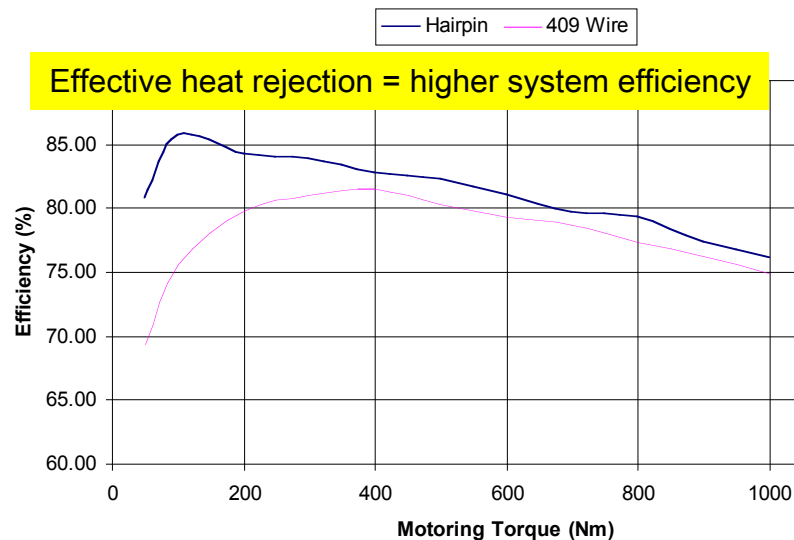


No Sacrifice in Performance or Efficiency for Standardization

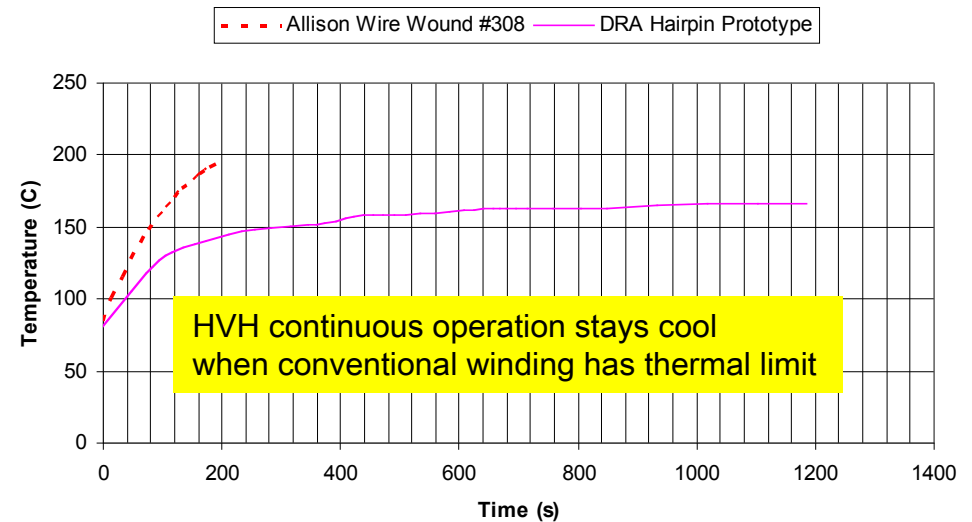
HVH Stator Construction Advantages



System Efficiency at 1000rpm

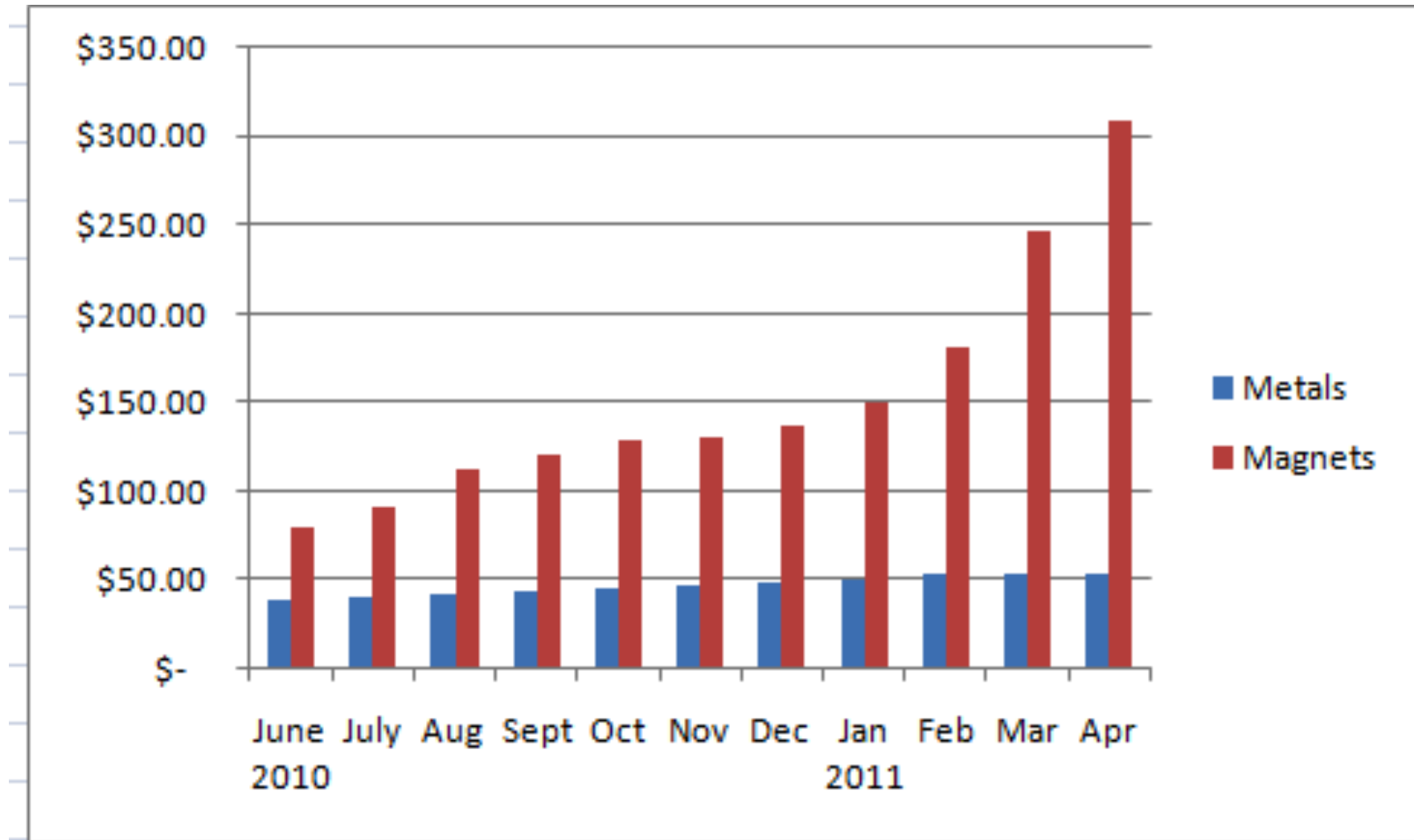


Temperature comparison at output torque of 3100Nm



Hairpin Allows Operation at Higher Power Levels via Cooling / Efficiency Benefit

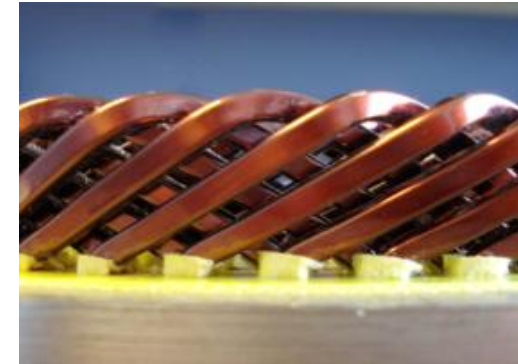
Rare Earth Materials Cost Rising Rapidly



Source: www.metal-pages.com

Factors That Facilitate PM to AC Induction Change

1. A distributed stator winding
 - Concentrated wound stators will not provide an efficient or quiet induction machine.
2. Low loss stator and rotor design
 - Rectangular wire stator winding provides lowest loss and most effective heat transfer
 - Copper IM rotor provides lowest rotor loss
3. Spray oil cooling of machine
 - Provides most effective heat removal from rotor

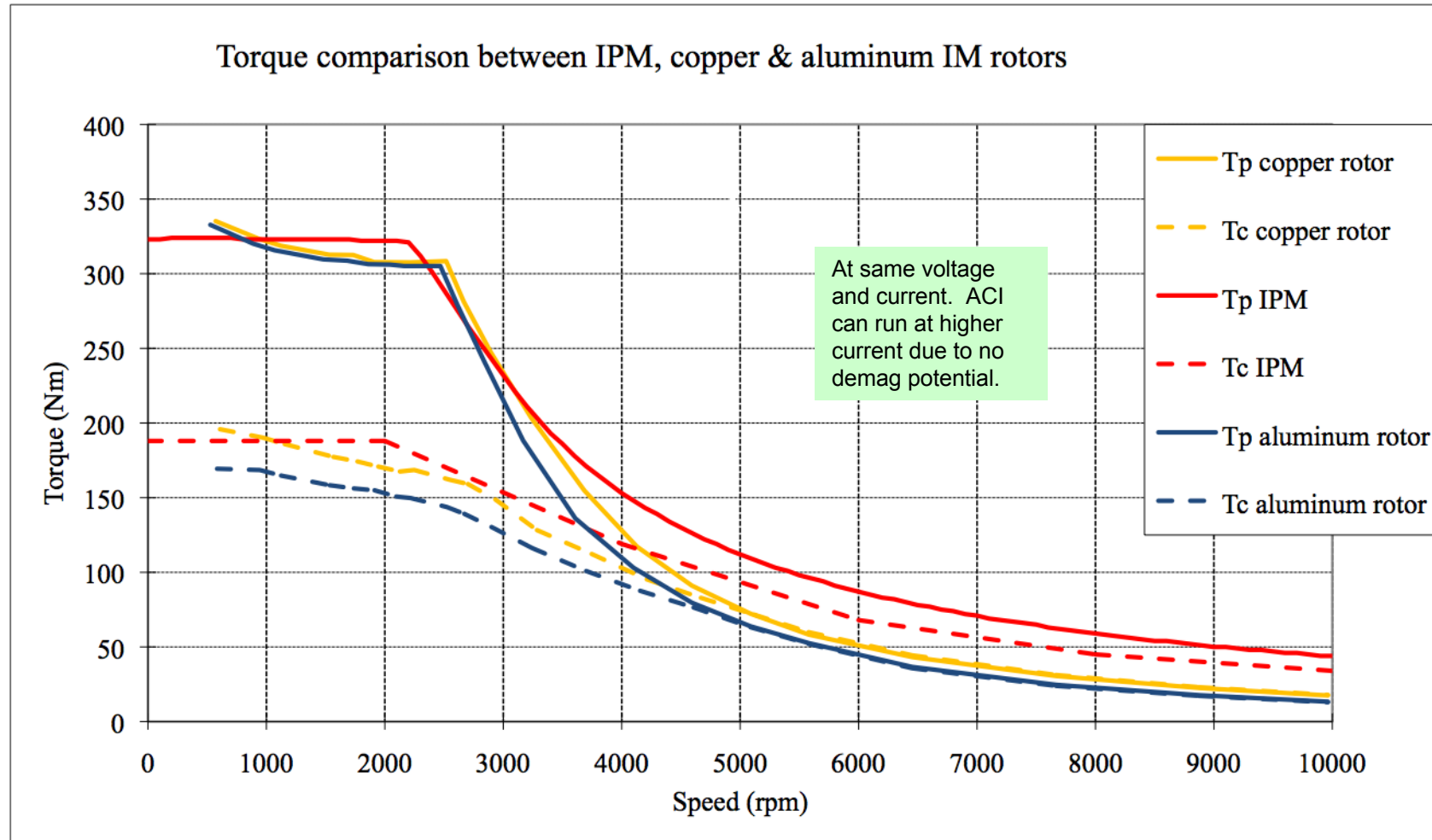


Distributed Stator Winding



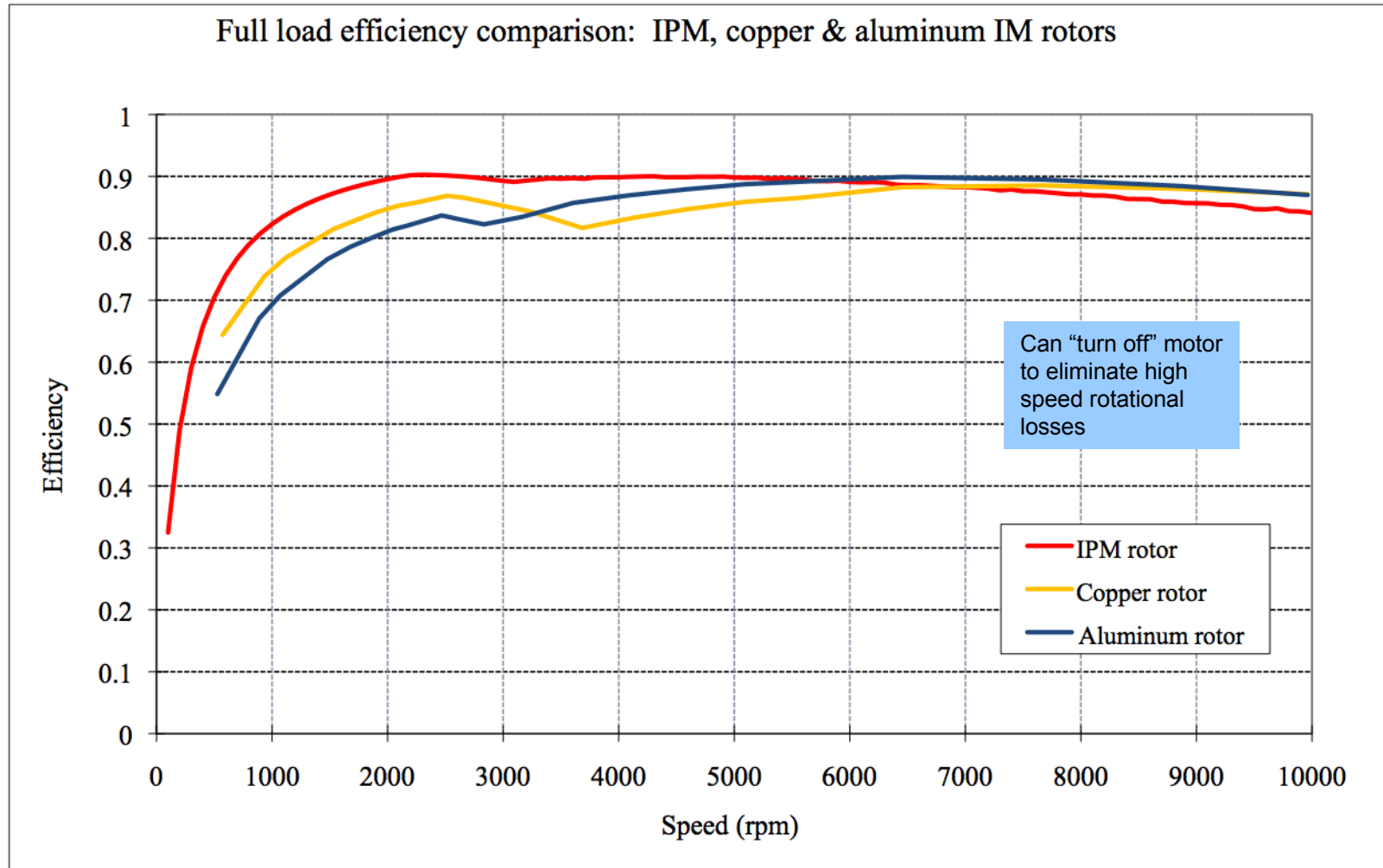
Concentrated Wind Stator

Options for Coping with Rare Earth Metals



Remy HVH -- Can Change Rotors without Redesign

Minimal Efficiency Loss With AC Induction Motors



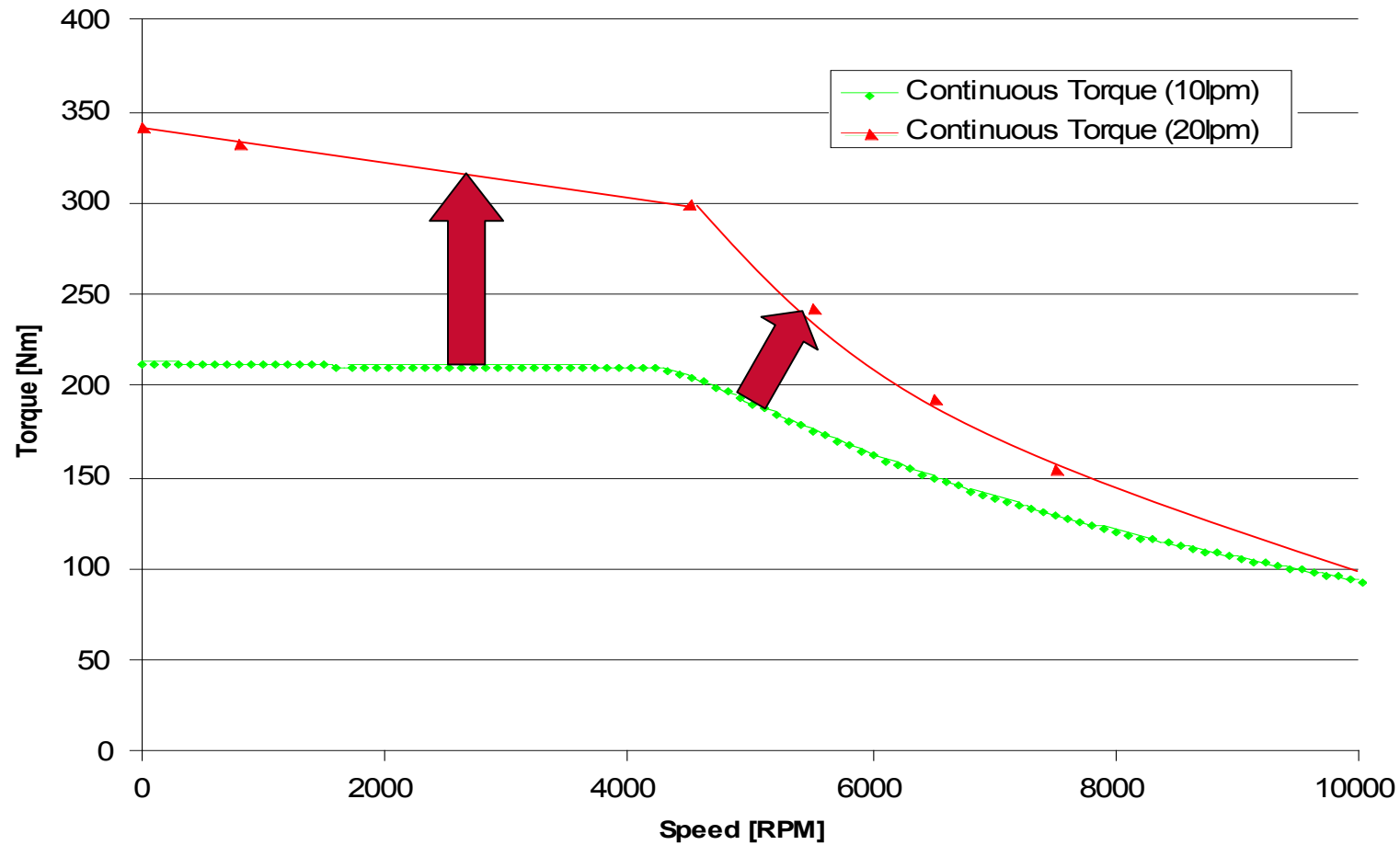
Using Technology To Mitigate Supply Chain Concerns

A Motor's "Best Friend" . . .



Proper Cooling Enhances Motor Performance

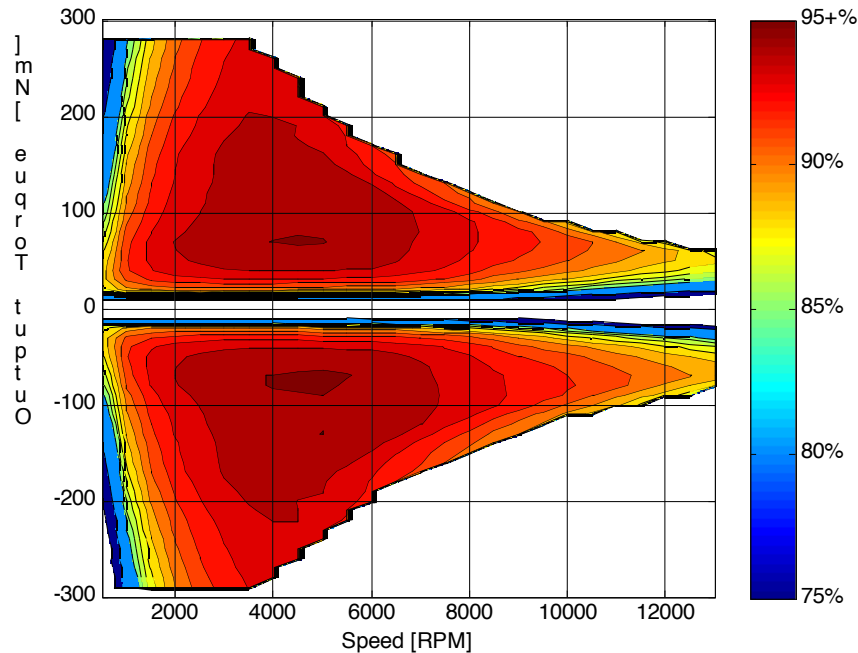
HVH250-115 Performance @ 650V DC



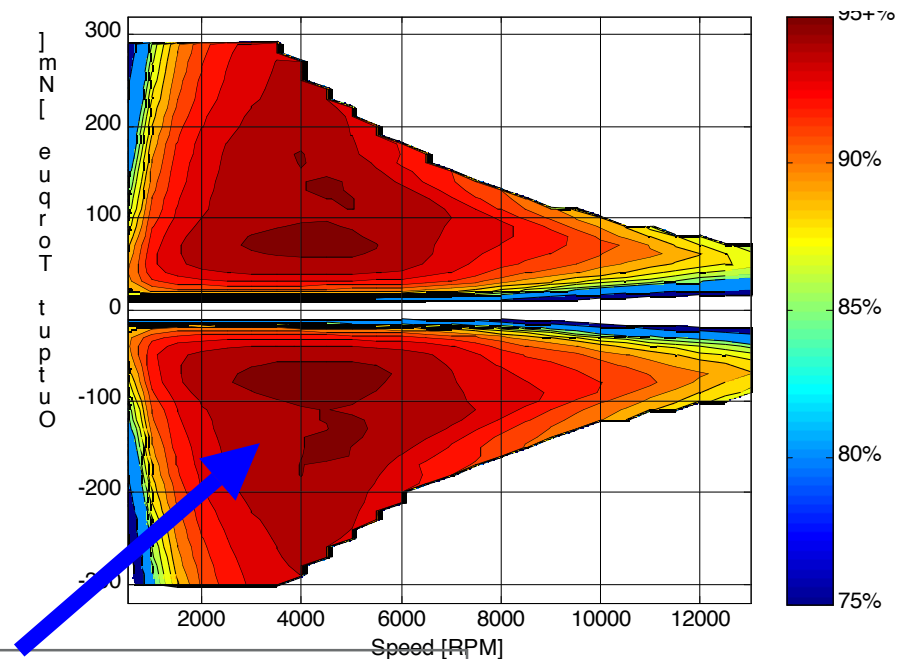
More Cooling Flow = More Torque & Power

Efficiency Comparison – Hot vs. Cool Motor

140 C Stator Temp



100 C Stator Temp

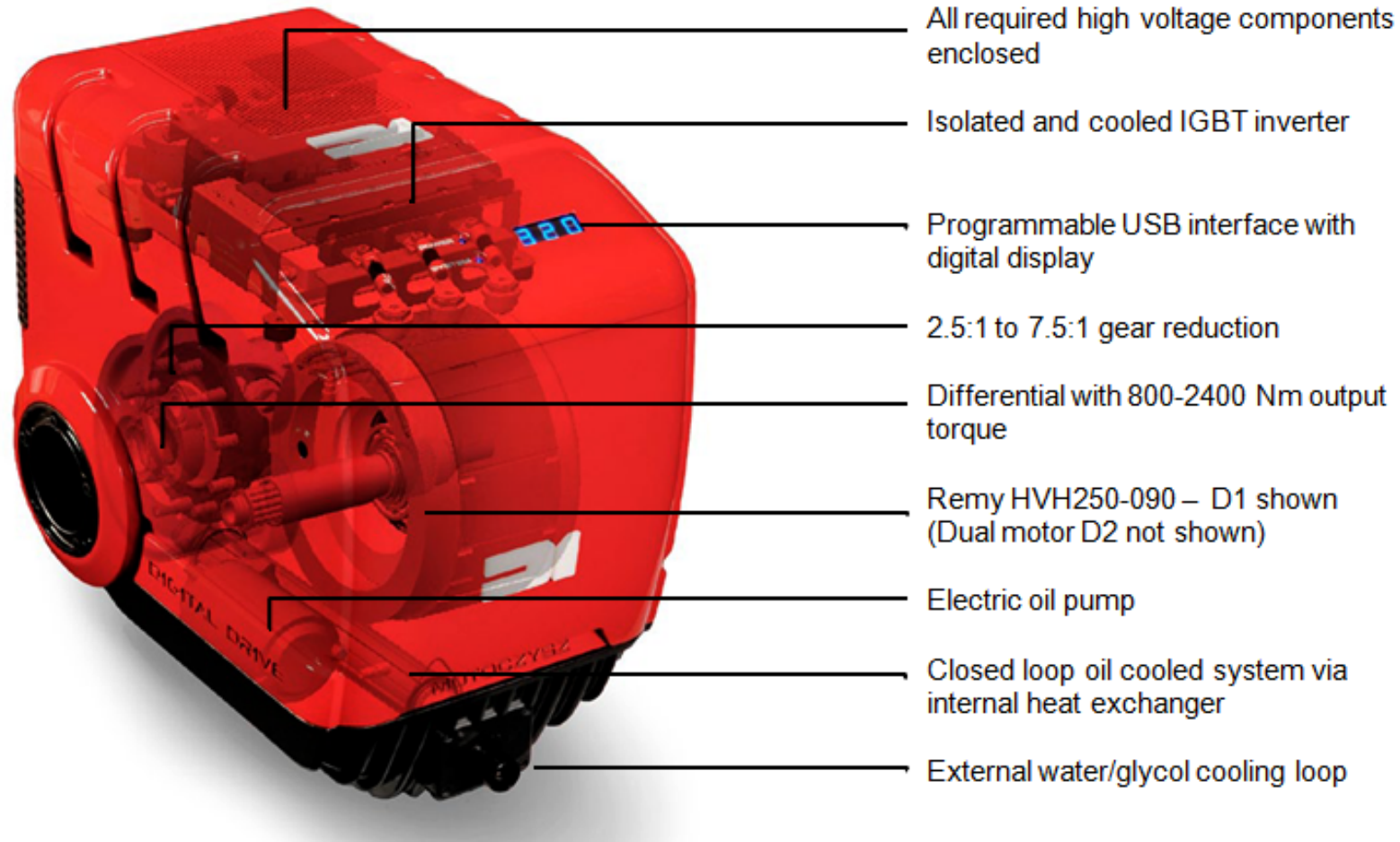


Larger and Higher Efficiency “Islands”

**Cooler Motor = More Power / Higher Efficiency /
Less Power Consumed / Longer Life**

HVH Cools Better and Can Exploit Improved Cooling Benefits

MotoCzysz Integrated System



Shorter system development time reduces engineering cost



Thank You
Danke Schoën
Merci
Gracias
Obrigado
Hvala
Takk
Dziekuje
Jag tackar
Diolch yn fawr
Spasibo

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