

Research and Education in Electric Energy Systems

Wind



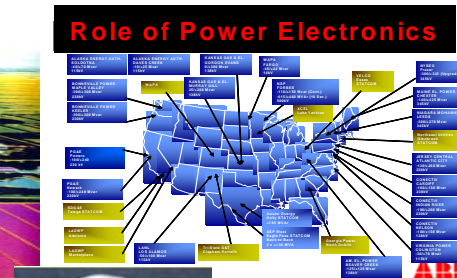
Solar



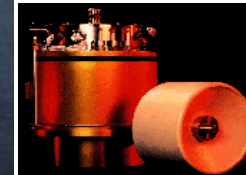
Hybrid



Fuel Cells



CFL

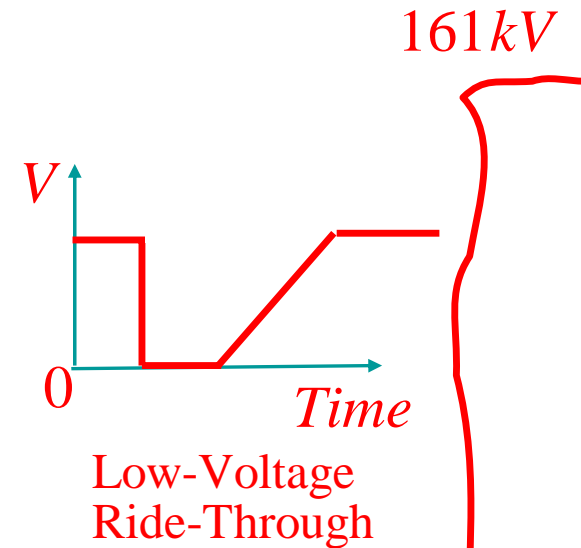
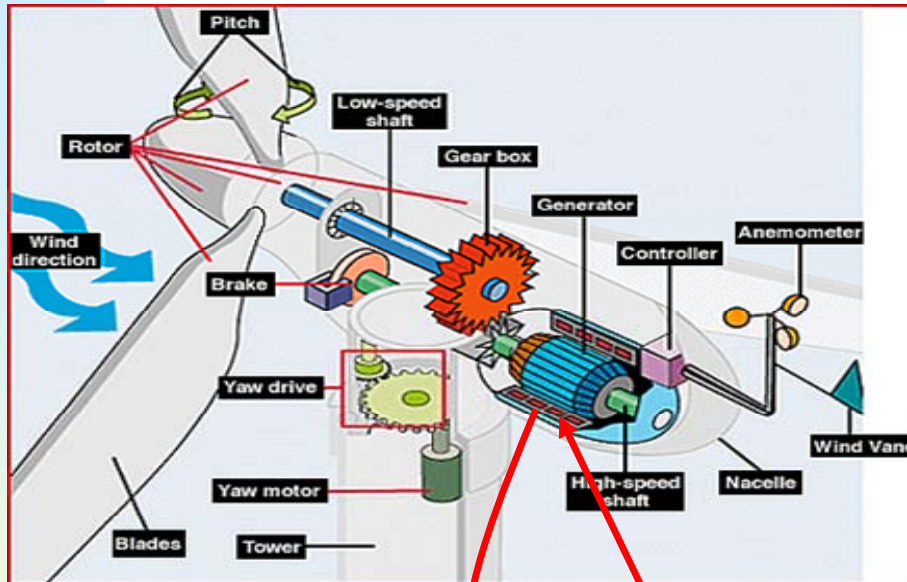


Flywheels for Storage

Session VII – Sources of Support
UWIG/NREL INDUSTRY-UNIVERSITY WORKSHOP
POWER ENGINEERING NEEDS FOR THE WIND INDUSTRY
May 7-8, 2008, Broomfield, CO

By:
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University of Minnesota
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Wind Generation: Example of an Integrated System



0 – 690V
10 – 60 Hz

Generator

Power Electronics
Converters

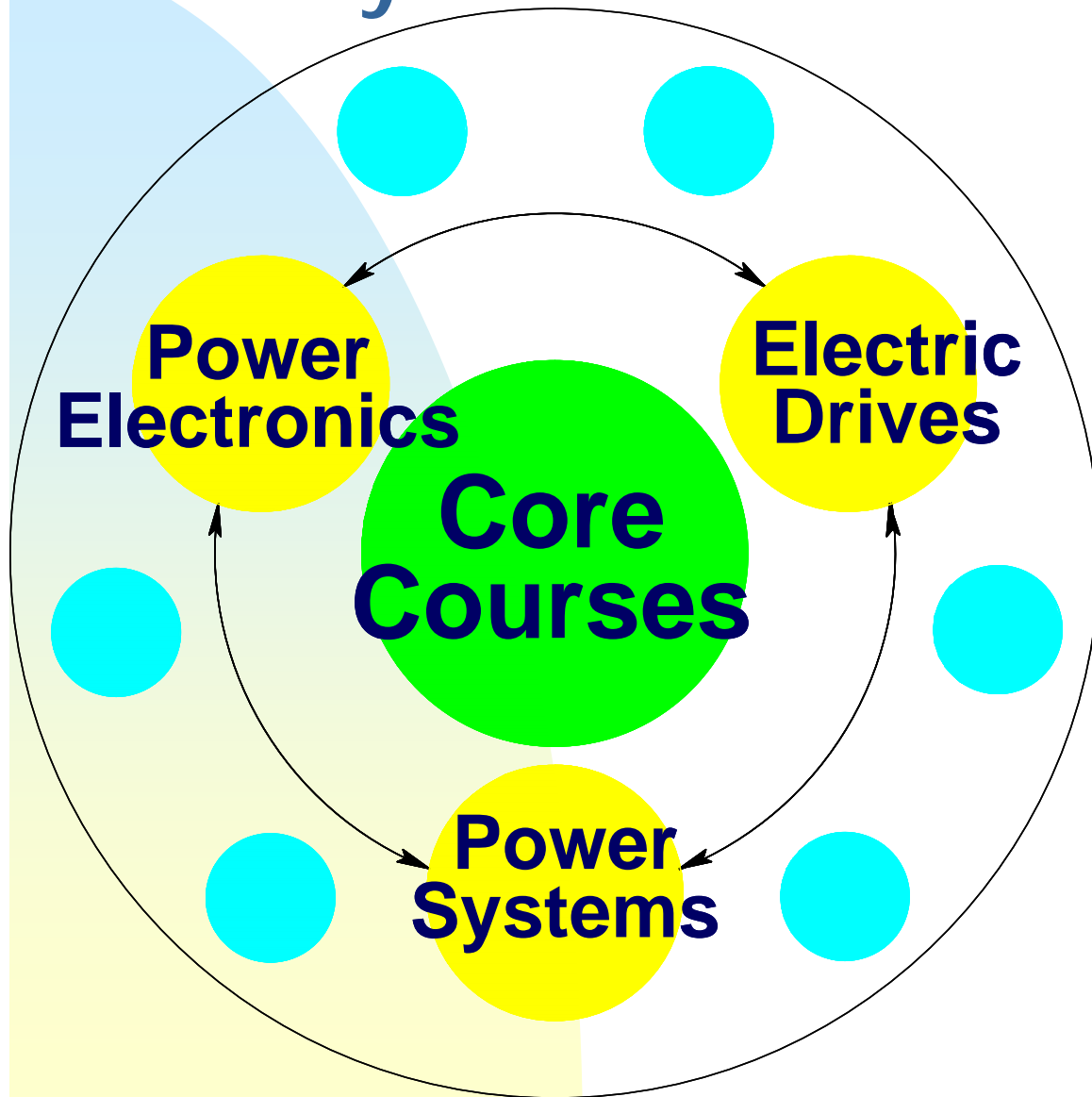


690V
60 Hz

34.5 kV



Our Integrated Curriculum – Only 3 Courses



**Increasing
Quality
and
Quantity of
Students**

Advantages of Increasing Student Enrollments:

- **Command Respect within the Dept**
- **Positive Environment**
- **Easier to Get Internal Funding**

Advantages of First-Rate Education:

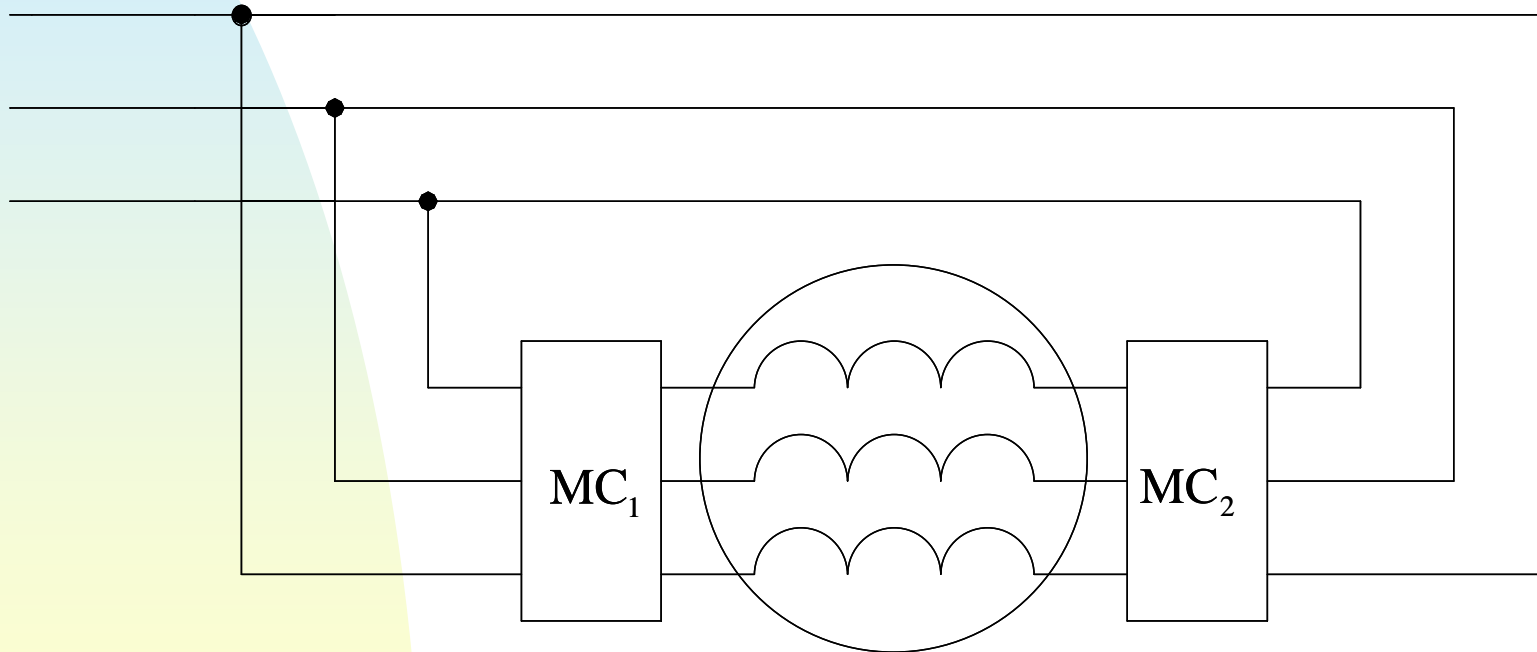
- **Better Trained Students**
- **Easier to generate Research Ideas**
- **Easier to Get External Funding**

Challenges in Getting Funding for Wind-Energy Research

- Considered a mature Technology
- No Special Pot of Money

Open-Ended AC Drives with Matrix Converters

Innovation Grant Award: U of M, \$50,000
ONR Award \$527,262



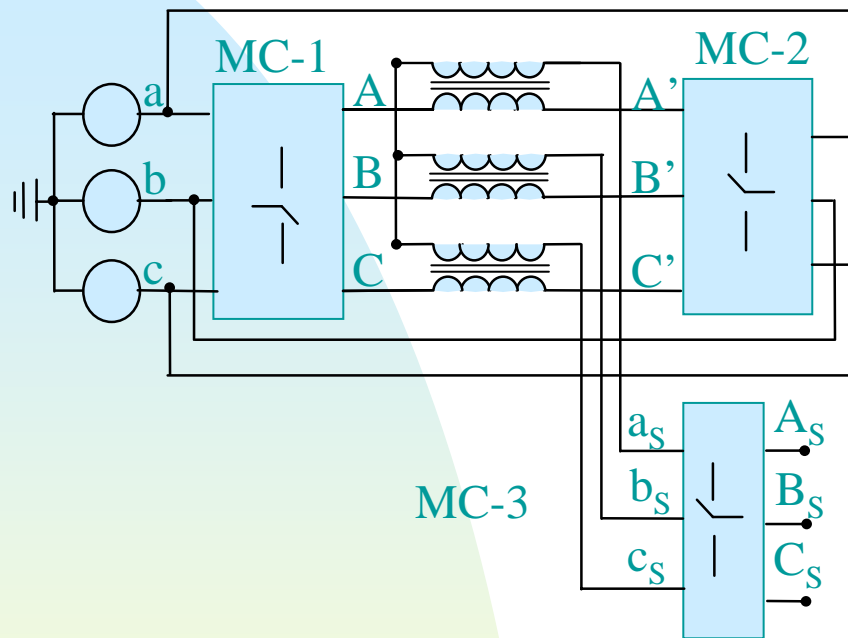
MC \equiv Matrix Converter

Open-Ended
AC Motor

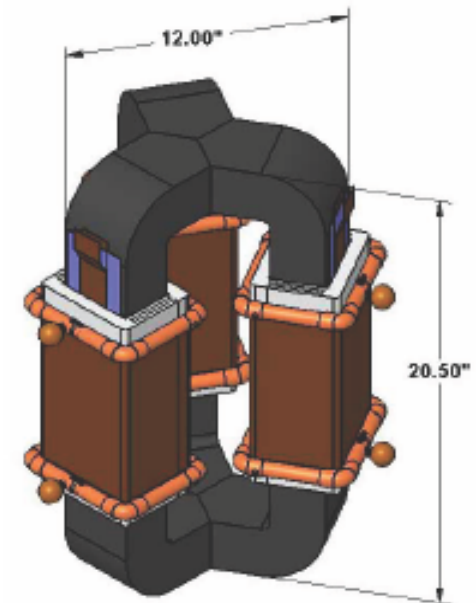
Patent Application filed by the University of Minnesota

Matrix Converters Based Power Electronic Transformers with Advanced Features

(ONR Award No: N000140710968, \$395,578)



Polyphase Y (2.7 MVA)



- Output voltage up to 1.5pu times the input
- Controllable Power factor
- High Efficiency
- Output frequency is controllable

Patent Application filed by the University of Minnesota

Nanocrystalline High Frequency Transformers Are Over 150 Times Lighter And Significantly Smaller

Typical H.V. Transformer



- 100 kV, 60 Hz
- 20 Amp RMS
- 2 MW Average
- 35 Tons
- ~30 KW Loss

HVCM Transformer



- 140 kV, 20 KHz
- 20 Amp RMS
- 1 MW Average (3) present use
- 450 LBS for 3
- 3 KW Loss At 2 MW

Sodium Sulfur Battery Energy Storage and its Potential to Enable Further Integration of Wind

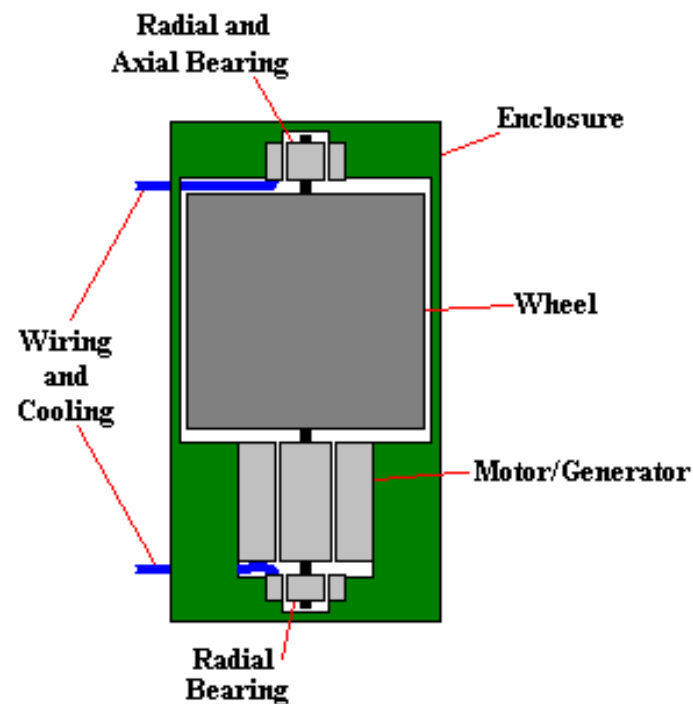
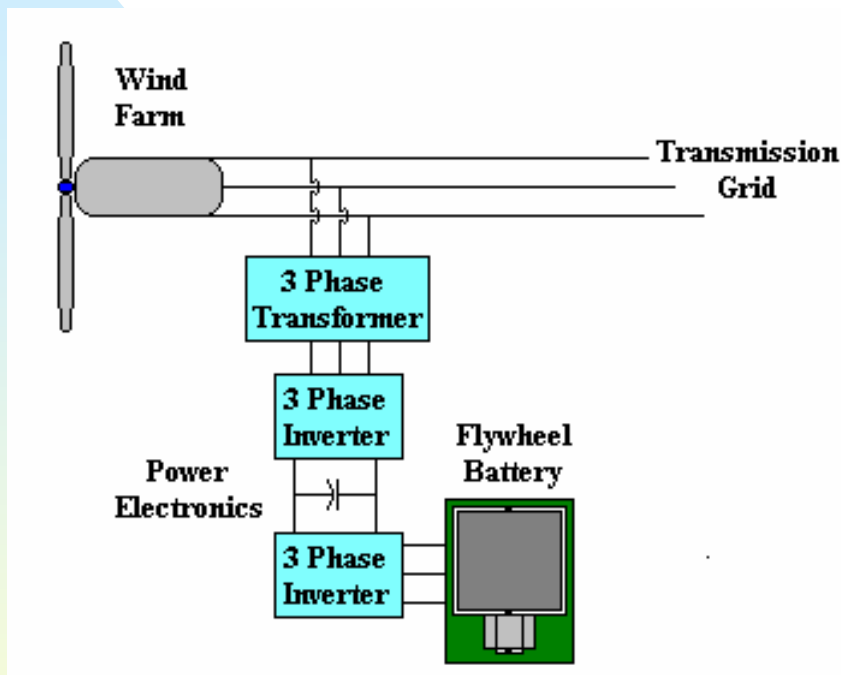
By Xcel Energy

Total Estimate Project Cost: 5 million dollars

RDF Grant (with U of M as a co-PI): 1 million dollars



Flywheel Storage Project (Xcel Energy/RDF: \$654k)



**Redesign of Machine
(Proposal: \$497,858)**