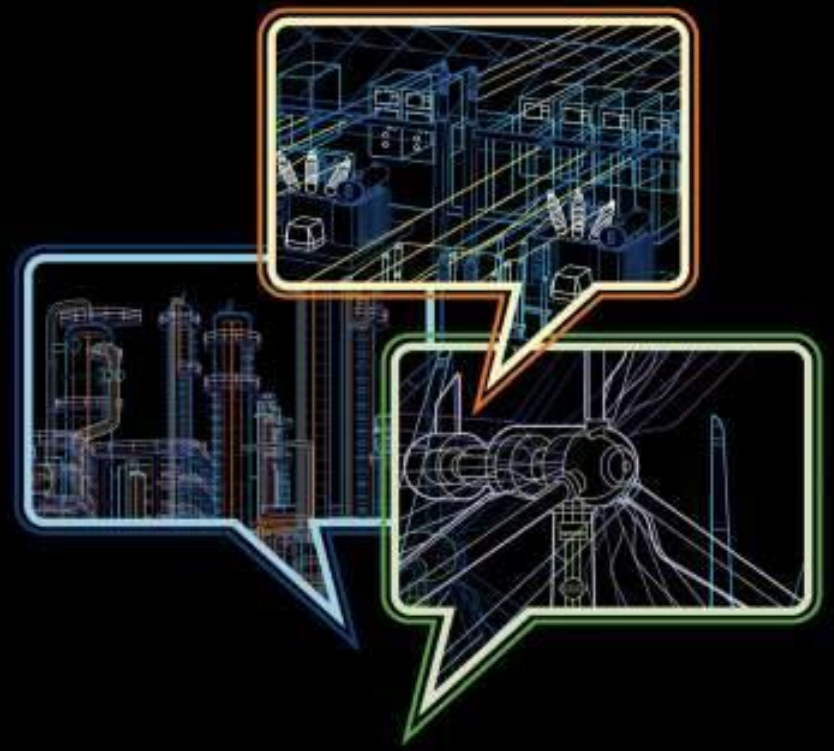


ABB Automation & Power World: April 18-21, 2011

EPO-148-1
How 38kV R-MAG Can Be Used in Wind Farm Applications

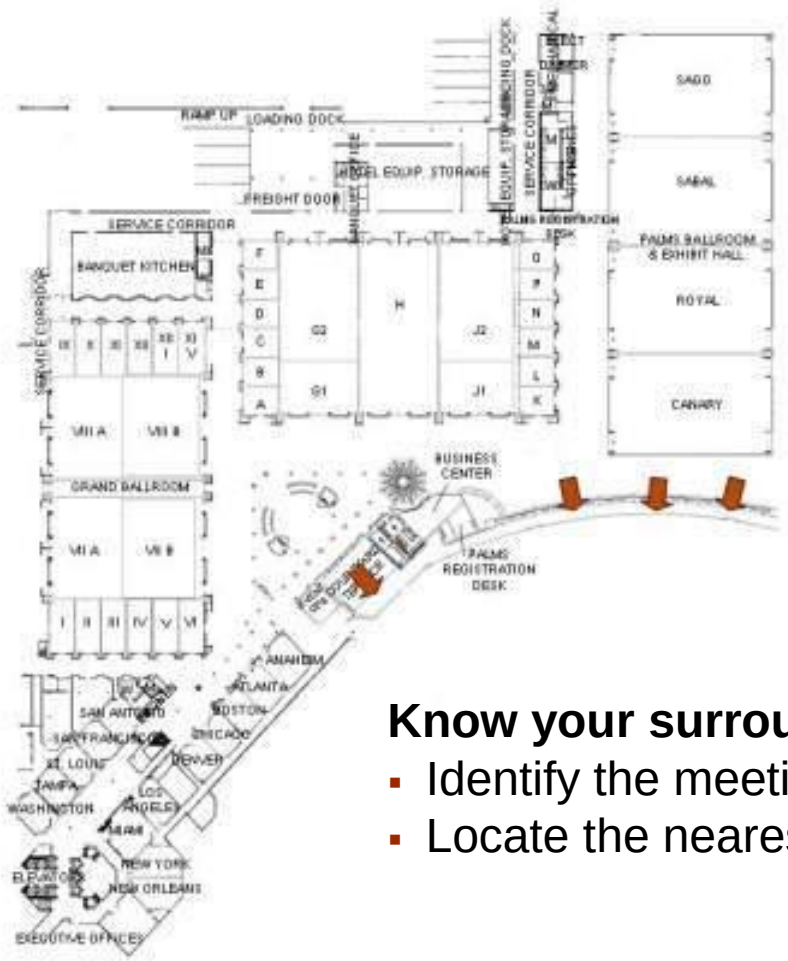
WCS-120-1
R-MAG in Wind Farms

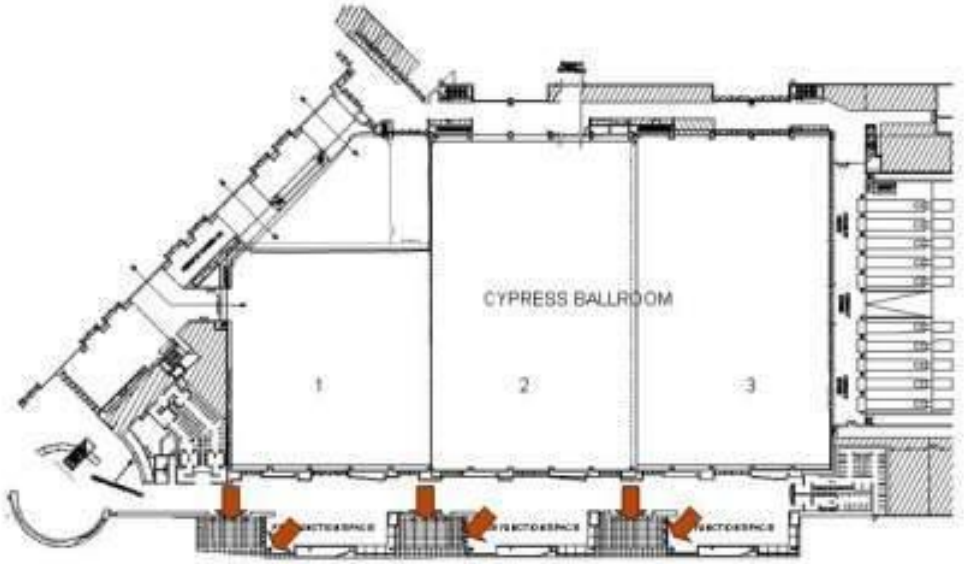
- Speaker name: Cleber Angelo
- Speaker title: Product Manager
- Company name: ABB PPMV
- Location: Lake Mary, FL

Your safety is important to us
Please be aware of these emergency procedures

- In the event of an emergency please dial ext. 55555 from any house phone. Do not dial 9-1-1.
- In the event of an alarm, please proceed carefully to the nearest exit. Emergency exits are clearly marked throughout the hotel and convention center.
- Use the stairwells to evacuate the building and do not attempt to use the elevators.
- Hotel associates will be located throughout the public space to assist in directing guests toward the closest exit.
- Any guest requiring assistance during an evacuation should dial “0” from any house phone and notify the operator of their location.
- Do not re-enter the building until advised by hotel personnel or an “all clear” announcement is made.

Your safety is important to us
Convention Center exits in case of an emergency

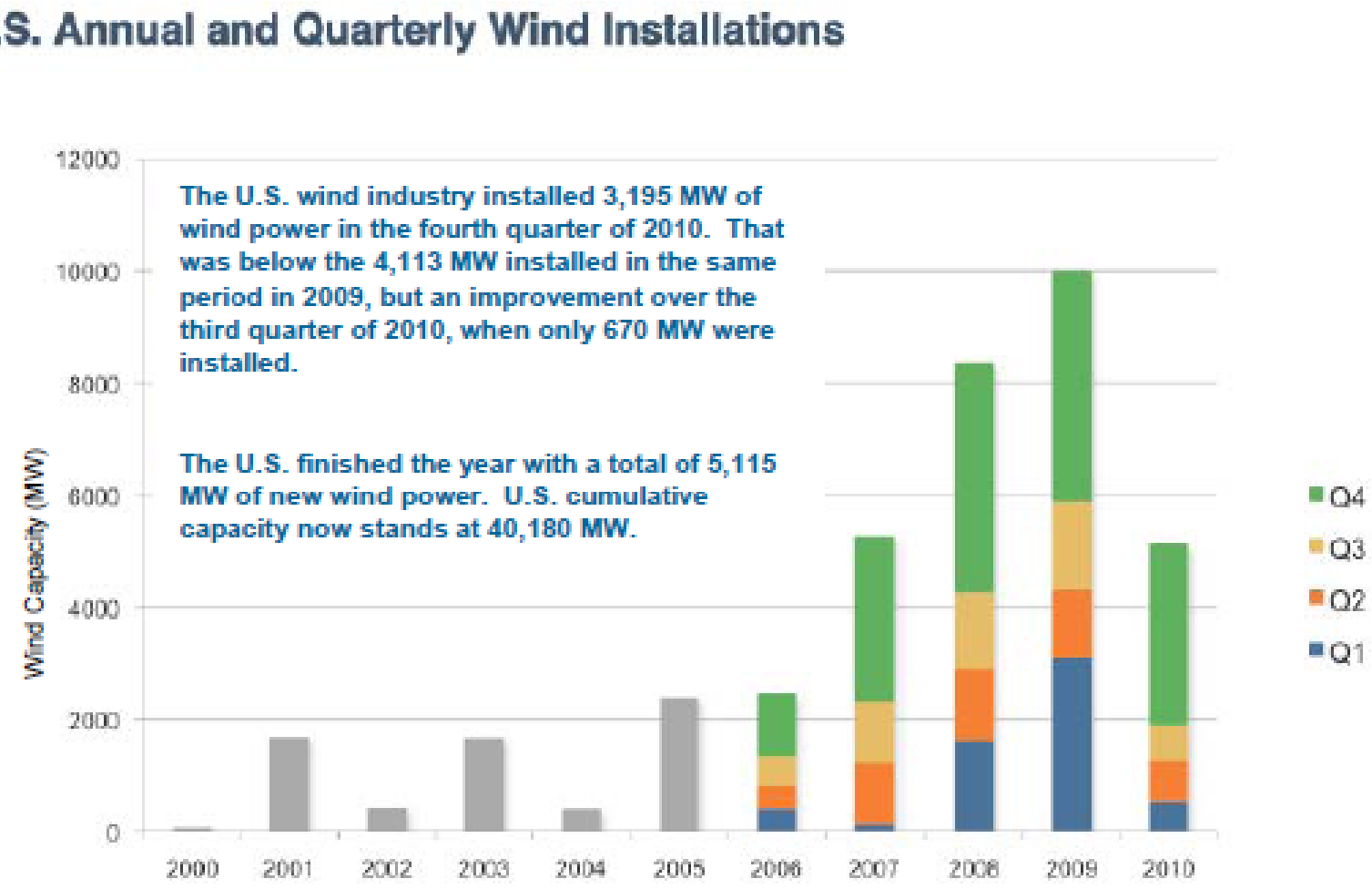




Know your surroundings:

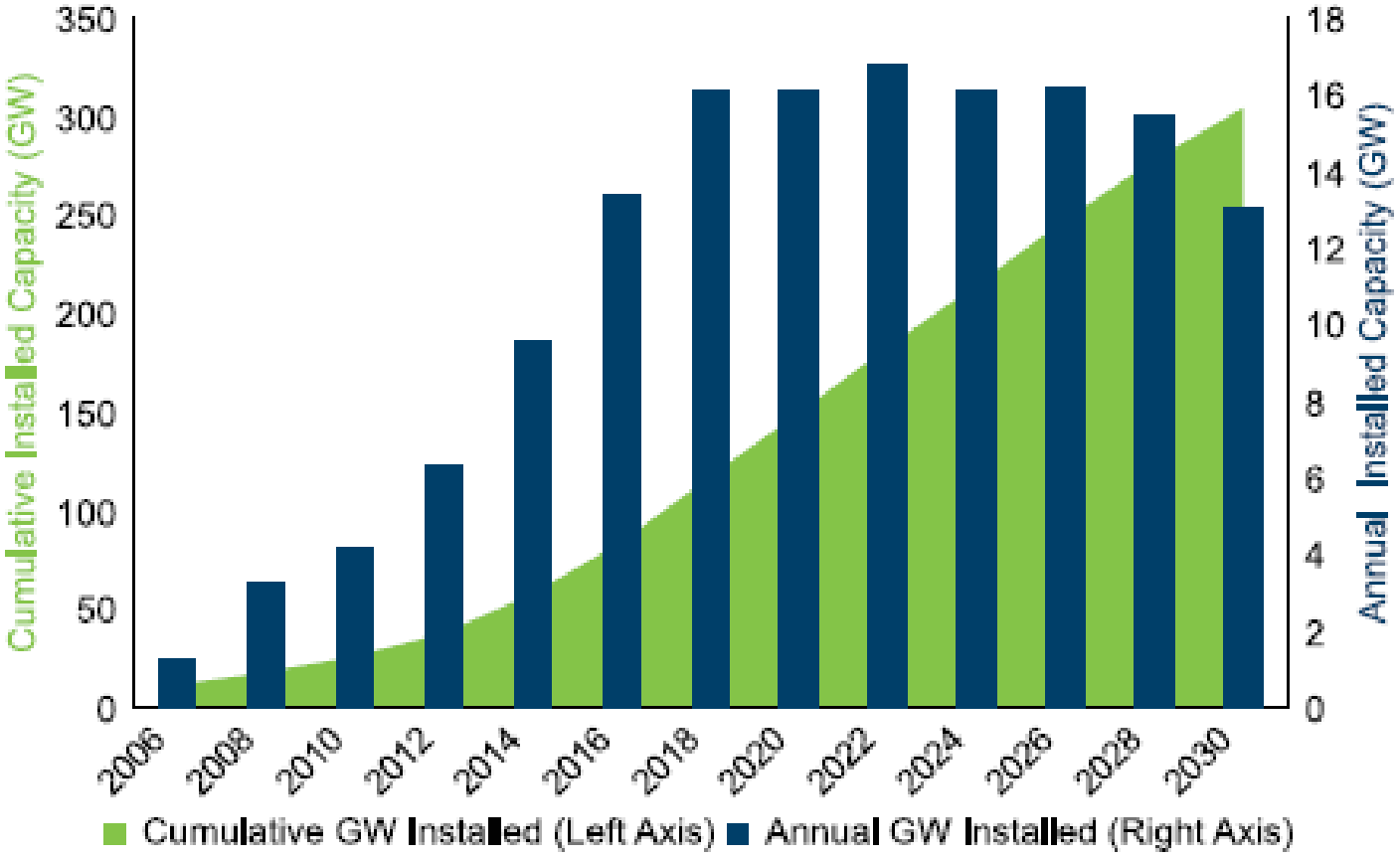
- Identify the meeting room your workshop is being held in
- Locate the nearest exit

Wind installations
What Happened in 2010?



Wind target is 20% by 2030

Figure A. Annual and cumulative wind installations by 2030



Wind challenges

Challenges

Major challenges along the 20% Wind Scenario path include these:

- Investment in the nation's transmission system is needed so that the electricity generated is delivered to urban centers that need the increased supply;
- Developing larger electric load balancing areas, in tandem with better regional planning, are needed so that regions can depend on a diversity of generation sources, including wind power;
- Significant growth is needed in the manufacturing supply chain, providing jobs and remedy the current shortage in parts for wind turbines;
- Continued reduction in wind capital cost and improvement in turbine performance through technology advancement and improved manufacturing capabilities is needed; and
- Addressing potential concerns about local siting, wildlife, and environmental issues within the context of generating electricity is needed.

The 20% Wind Scenario is not likely to be realized in a business-as-usual future. Achieving this scenario would involve a major national commitment to clean, domestic energy sources with minimal emissions of GHGs and other environmental pollutants.

The Wind Market - Size & Cost Structure

Total US wind power market in 2009 is estimated to be $2.5 billion*

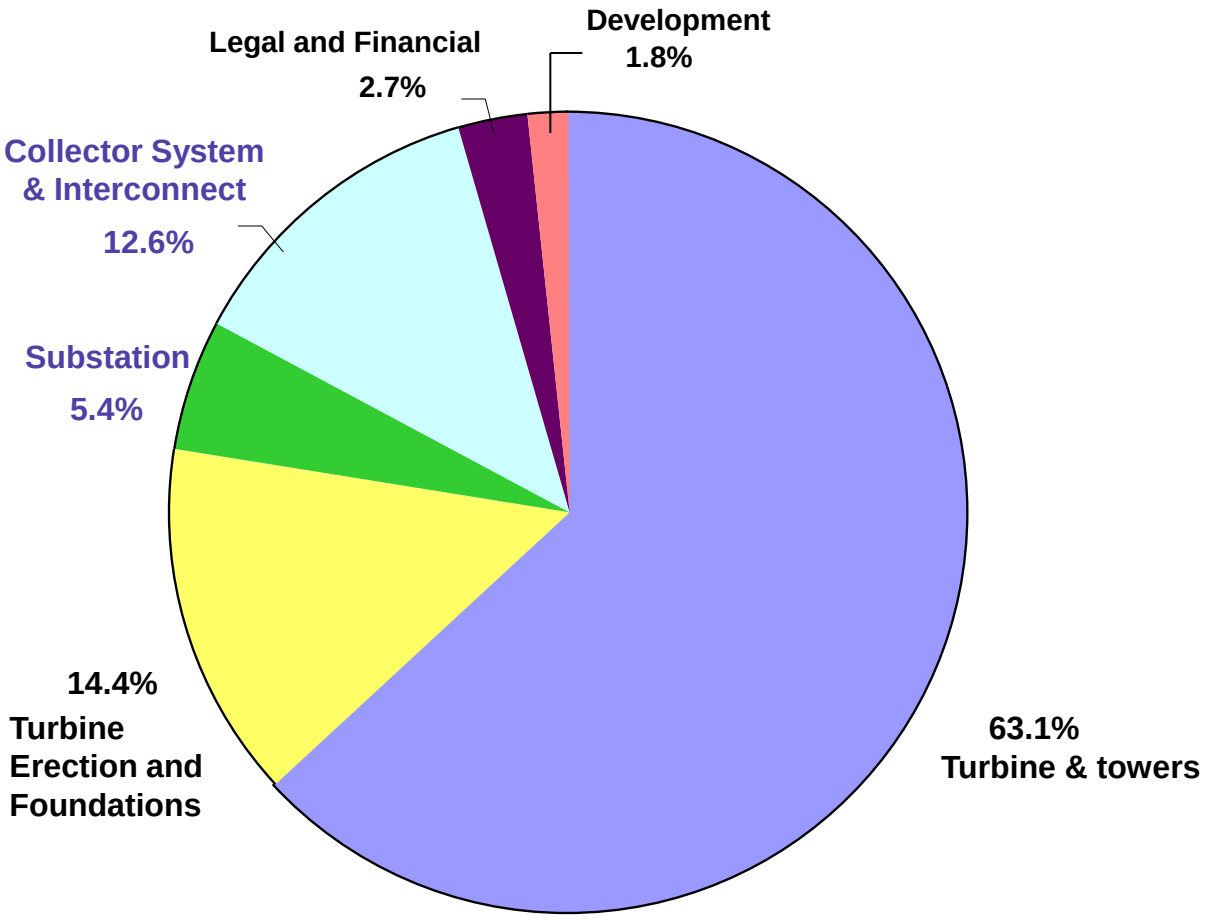
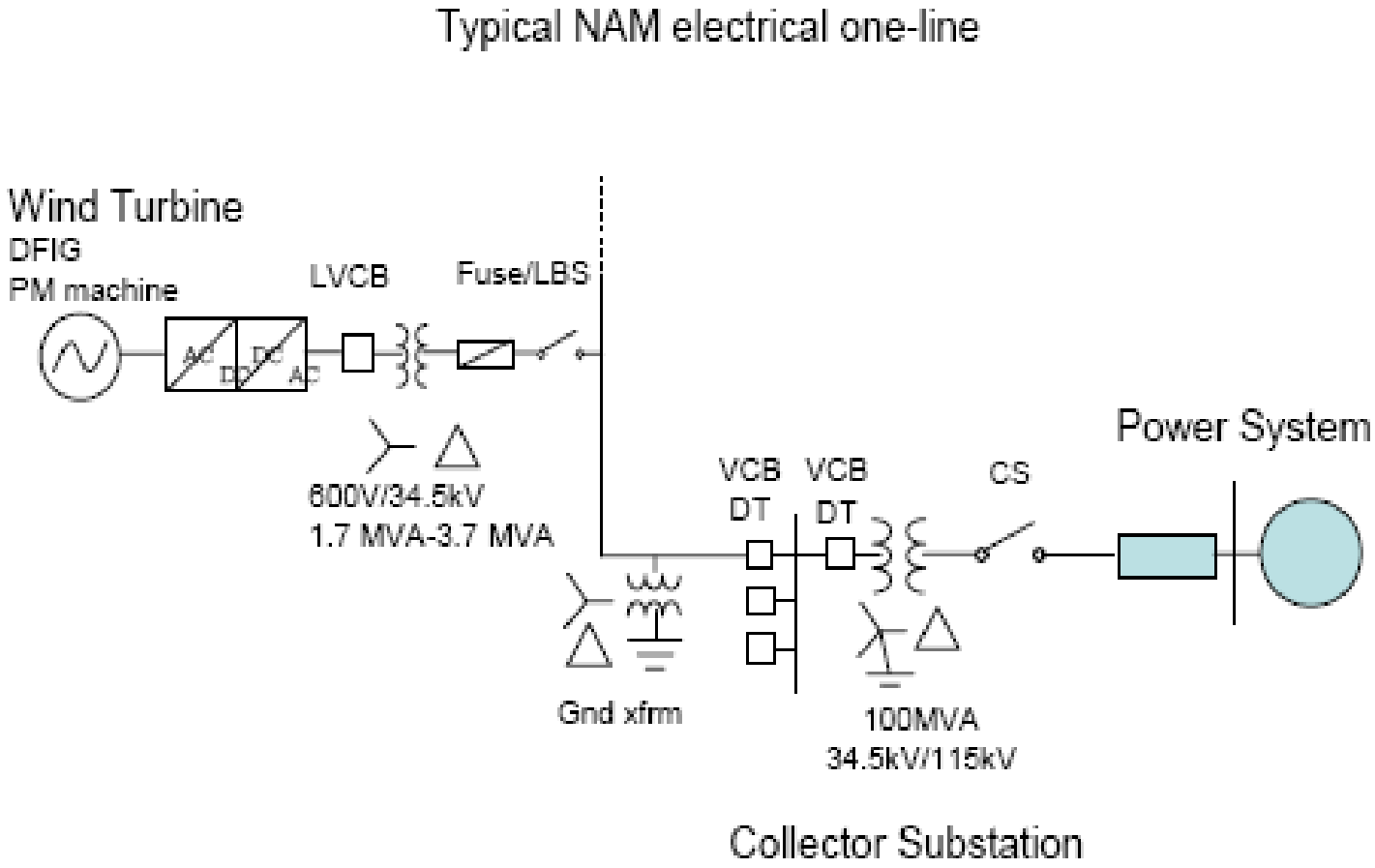


ABB in wind energy

ABB products in the collector circuit and substation

38kV R-MAG in Wind Farm Applications
Wind Farm Typical One-Line



38kV R-MAG in Wind Farm Applications
Where can the R-MAG be utilized?

- Wind farm collector
- Capacitor switching
- Reactor switching

38kV R-MAG in Wind Farm Applications
Where can the R-MAG be utilized?

- Wind farm collector
  - Critical element in power flow
  - Low frequency of operation

38kV R-MAG in Wind Farm Applications
Where can the R-MAG be utilized?

- Capacitor bank switching
  - Higher frequency of operation
  - Varying load and generation results in swings in reactive power component
  - Underground cables contribute to circuit capacitance
  - Low current 36kV, 10MVAR – 150A
  - Transient voltages on switching

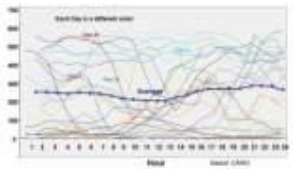
38kV R-MAG in Wind Farm Applications
Where can the R-MAG be utilized?

- Capacitor bank switching
  - Vacuum interrupters using Copper/Chromium composite material to minimize current chopping and mitigate it's effects

38kV R-MAG in Wind Farm Applications
Where can the R-MAG be utilized?

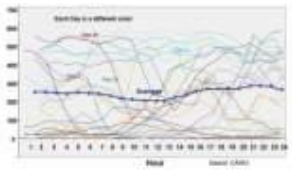
- Reactor switching
  - Higher frequency of operation
  - Low current
  - Transient voltages on switching
  - Highly dependent on system parameters
  - Analysis should be performed to determine reactance of circuit

38kV R-MAG in Wind Farm Applications
Key Challenges



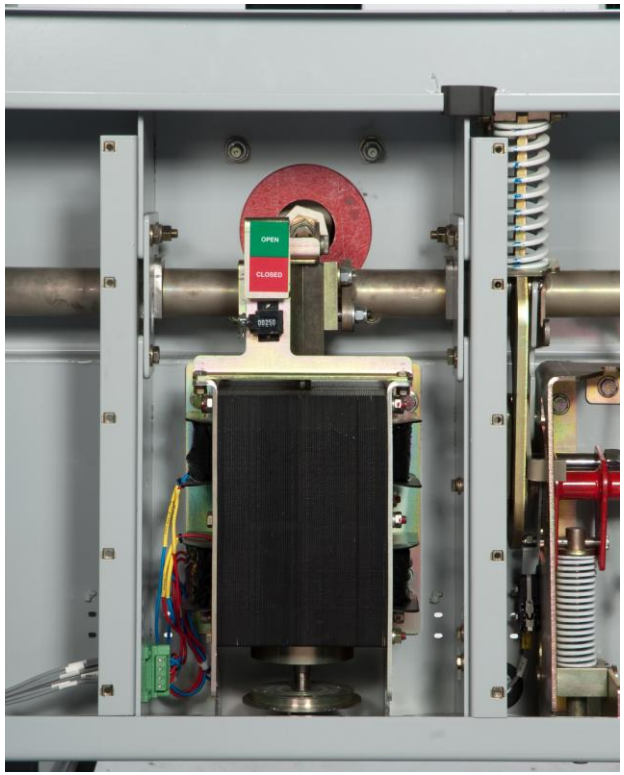
- Reliability
  - Tight margins on wind farm economics
  - Uptime is at a premium
- Maintenance
  - Remote and harsh environments lead to costly maintenance and repair costs

Key Challenges
Solution: ABB 38kV R-MAG



- Rated for 5 times the mechanical operations required by the standard, reducing maintenance and down time
- Reduced mechanical failure with only one moving part in the magnetic actuator
- Less maintenance lowers risk by reducing exposure to live parts and stored energy devices
- Service/Support ABB expanded customer service organization focuses on customer

38kV R-MAG in Wind Farm Applications
Reliability



- Magnetic actuator
  - Rated for 50,000 operations on 38kV breakers
  - Rated for 100,000 on 15/27kV breakers

38kV R-MAG in Wind Farm Applications
Reliability

Vacuum Interrupter Assembly

- ABB interrupters are rated for up to 30,000 mechanical or load operations

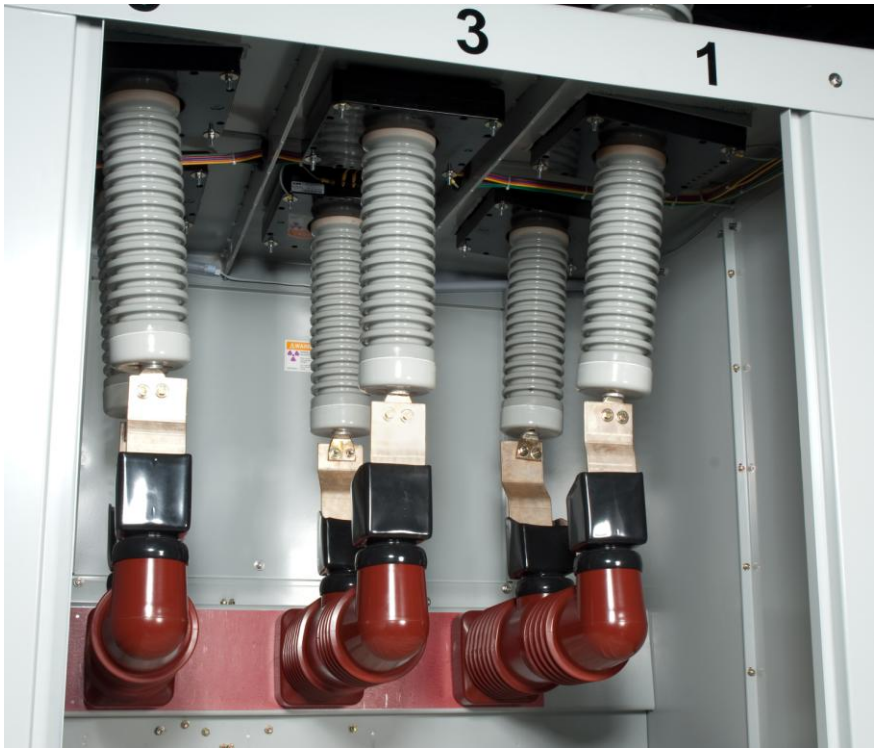
38kV R-MAG in Wind Farm Applications
Flexibility

- Actuator control board compatible with all forms of overcurrent, reclosing and control functions
- Control Voltages from 24V to 250V
- Built in trip & close coil features
- Built in breaker status indication
- Coil protection

38kV R-MAG in Wind Farm Applications
Ease of maintenance

- No maintenance required for the magnetic actuator
- Plug-and-play capability of the actuator control board
- No disassembly as common with spring mechanism

38kV R-MAG in Wind Farm Applications
Embedded pole design



- Proven technology used in switchgear breakers
- High field performance due to reduced contamination build up on vacuum interrupters
- Only one vacuum interrupter per pole.

Reminders
Automation & Power World 2011

- Please be sure to complete the workshop evaluation
- Professional Development Hours (PDHs) and Continuing Education Credits (CEUs):
  - You will receive a link via e-mail to print certificates for all the workshops you have attended during Automation & Power World 2011.
  - BE SURE YOU HAVE YOUR BADGE SCANNED for each workshop you attend. If you do not have your badge scanned you will not be able to obtain PDHs or CEUs.

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