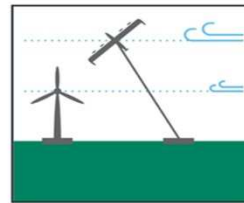
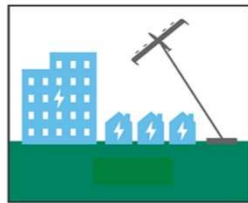
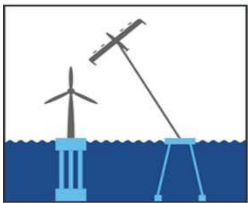




iea wind

Topical Expert Meeting TEM#102

Airborne Wind Energy



Session 3F: Electrical system

23-24 September 2020

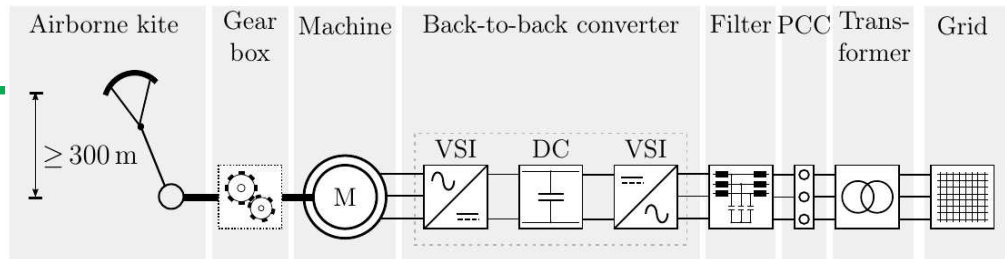
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Overview of topics



Electrical machine

1. “Best” machine design (PMSM, EESM, RSM)?
2. Fault-tolerance, reliability & redundancy (multi-phase machines)?
3. Optimal operation & Efficiency?

Power electronics

4. New semiconductor materials (SiC, GaN, etc.)?
5. Fault-tolerance, reliability & redundancy (multi-level converters)?
6. Optimal operation & Efficiency

Storage & Grid integration

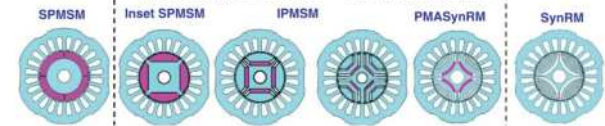
7. Constant & planable power flow?
8. Grid-feeding/-supporting/-forming mode?
9. Intelligence & Flexibility



Electrical machine

1. “Best” machine design (PMSM, EESM, RSM)?

- Extreme operation conditions (e.g. low speed/high torque during reel-in; high-speed/low torque during reel-out)
- With gear or „direct-drive“?
- No-out-of-the-box solution / individual machine design required
- Goal: Optimal machine design

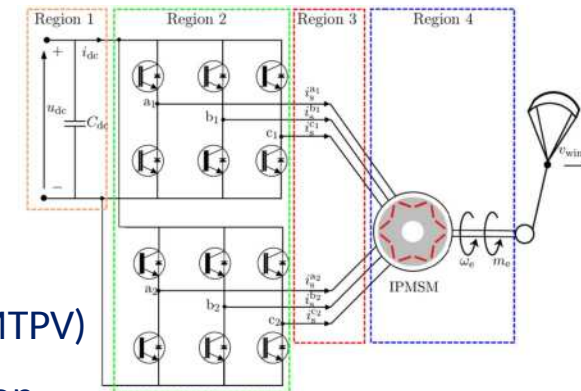


2. Fault-tolerance, reliability & redundancy (multi-phase machines)?

- Crucial component
- Operation must be assured even under faults
- Goal: Fault-detection and fault-tolerant control

3. Optimal operation & efficiency?

- Optimal control for all operation modes (e.g. MTPC, MC, FW, MTPV)
- Goal: Minimization of copper & iron losses, wide-range operation

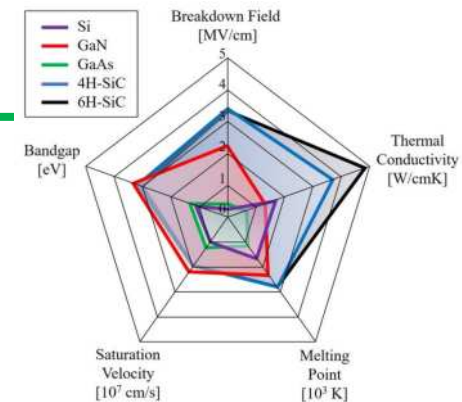




Power electronics

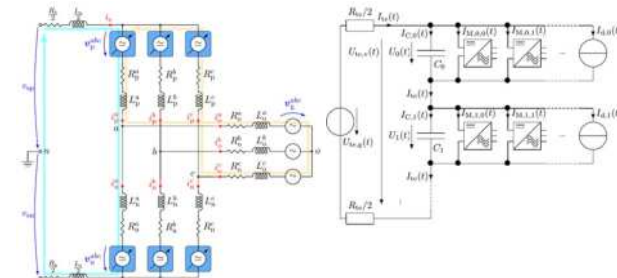
4. New semiconductor materials (SiC, GaN, etc.)?

- Faster switching & lower losses
- Better voltage / current ranges
- Goal: Next generation power electronic components



5. Fault-tolerance, reliability & redundancy (multi-level converters / parallelization)?

- One of the most fragile components (e.g. in wind turbines)
- Non-stationary operation
- Harsh operation conditions (e.g. offshore)
- Goal: Fault-detection, isolation and reconfiguration (online!)



6. Optimal operation & efficiency?

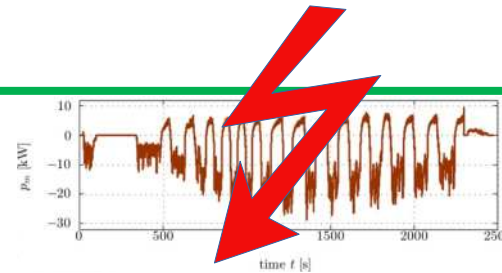
- Optimal control required (e.g. optimal pulse patterns)
- Minimization of heat dissipation = losses (conduction & switching)
- Goal: Reduction of levelized cost of energy



Storage & Grid integration

7. Constant & planable power flow?

- Weather prediction/monitoring
- Short-term buffer capacity & long-term storage or energy conversion
- Optimal & parallel operation of several lift power systems (with pumping mode)
- Start-up energy for “drag power systems”



8. Grid-feeding/-supporting/-forming mode?

- Accommodate for weak(er) grid conditions
- Black-start capability
- Operation in/of micro-grid(s)

9. Intelligence & Flexibility?

- Goal: Smooth transition between modes
- Goal: Power stability and quality

