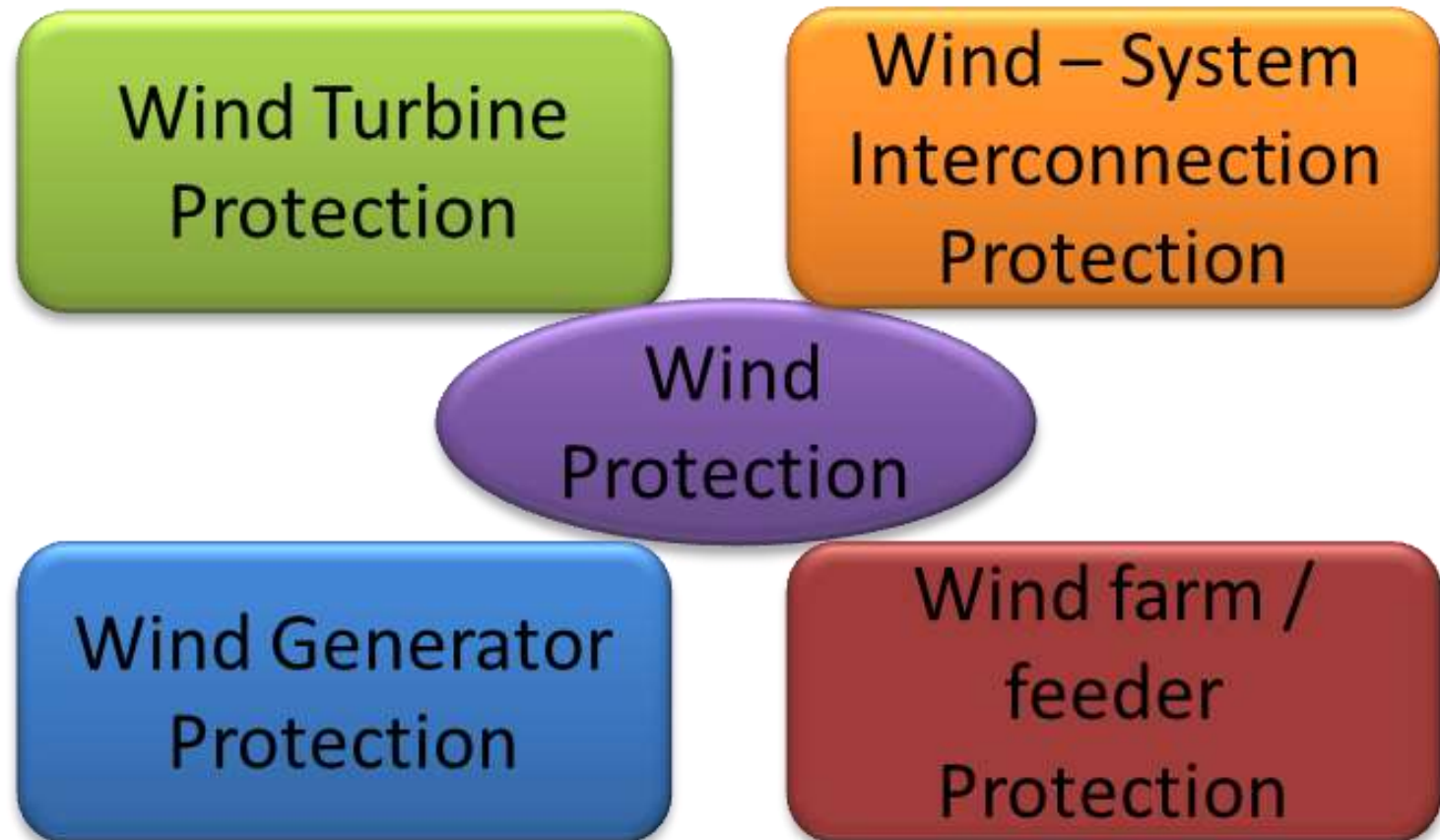


Advancements & Future Trends in Protection of Wind Energy

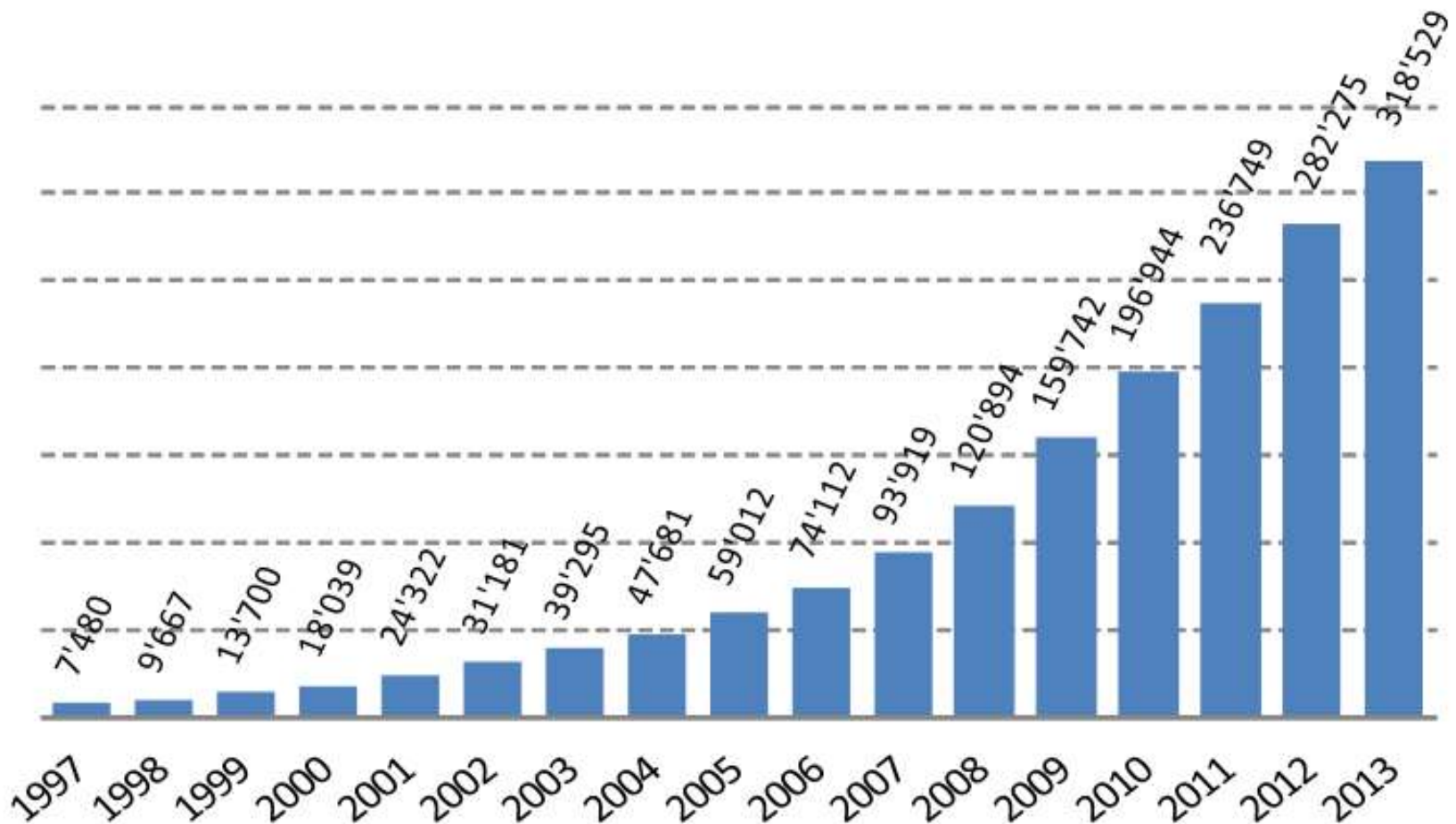
Mital Kanabar, Jorge Cardenas, David Menendez
GE Digital Energy
Spain

ACTUAL DISTANCE PROTECTION SCHEME



EVOLUTION OF WORLD TOTAL INSTALLED CAPACITY

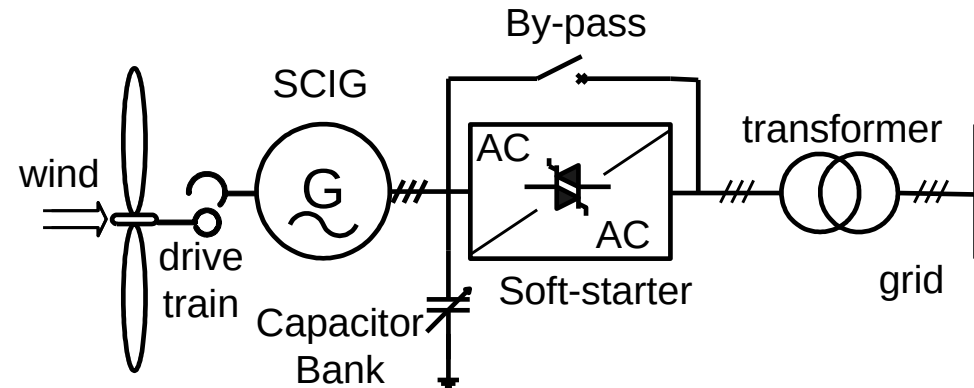
World Total Installed Capacity [MW]



MOST COMMON WIND TURBINE TYPES (1)

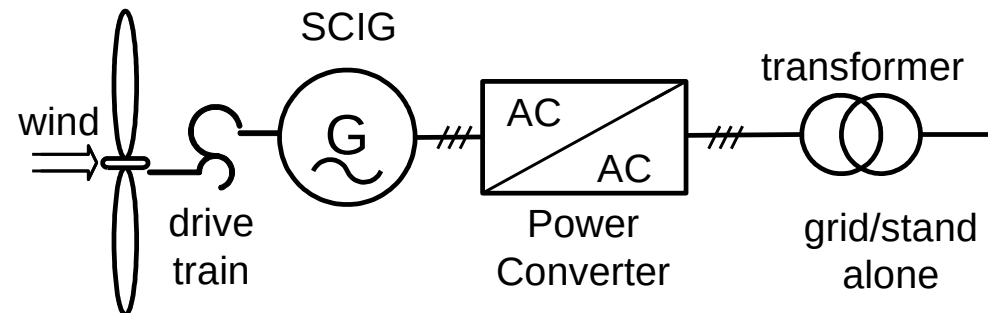
Active stall/stall wind turbine

- Fixed Speed
- Squirrel-Cage Induction Generator
- Soft-starter, Capacitor Bank



Pitch control wind turbine

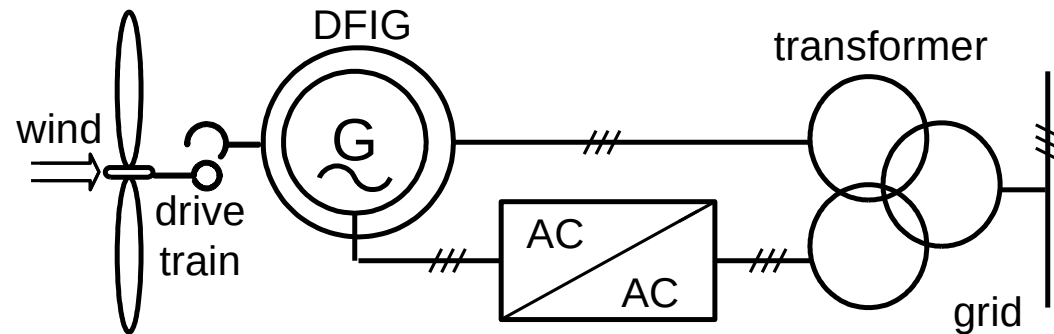
- Variable Speed
- Squirrel-Cage Induction Generator
- Back-to-Back Power Converter



MOST COMMON WIND TURBINE TYPES (2)

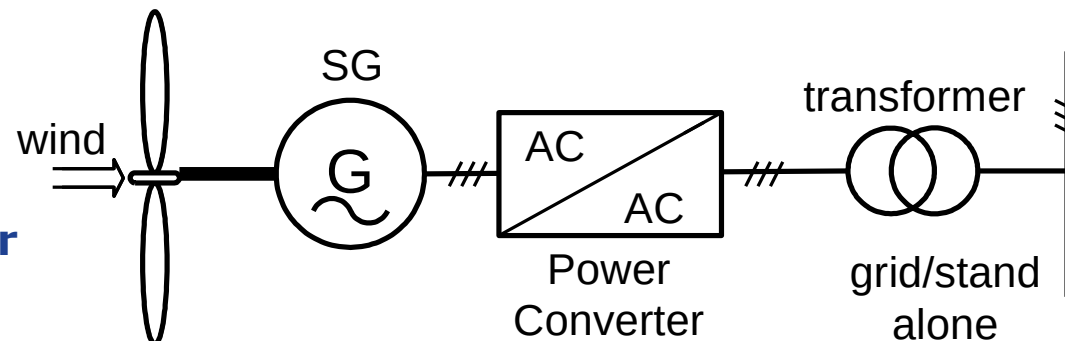
Pitch control wind turbine

- Variable Speed
- Double-Fed Induction Generator
- Back-to-Back Power Converter

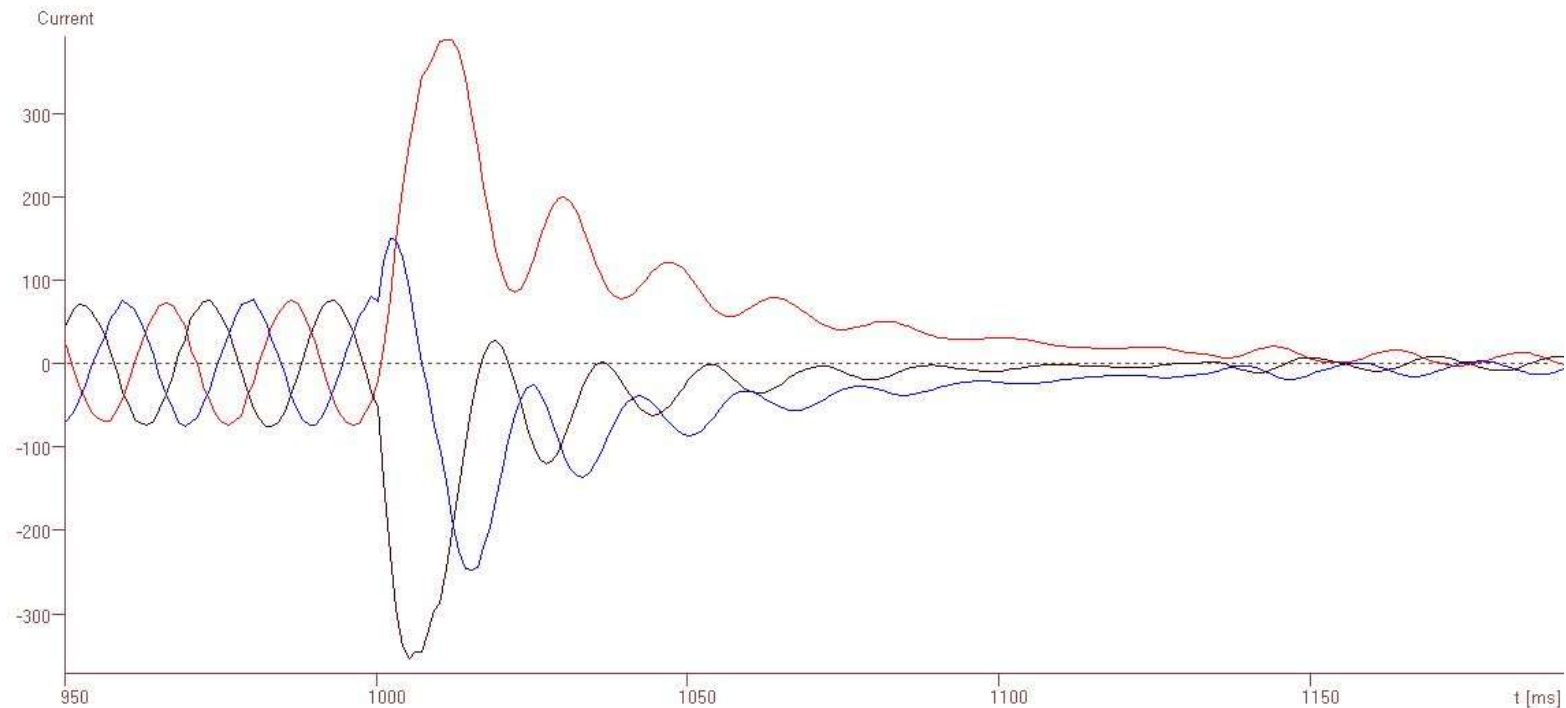


Pitch control wind turbine

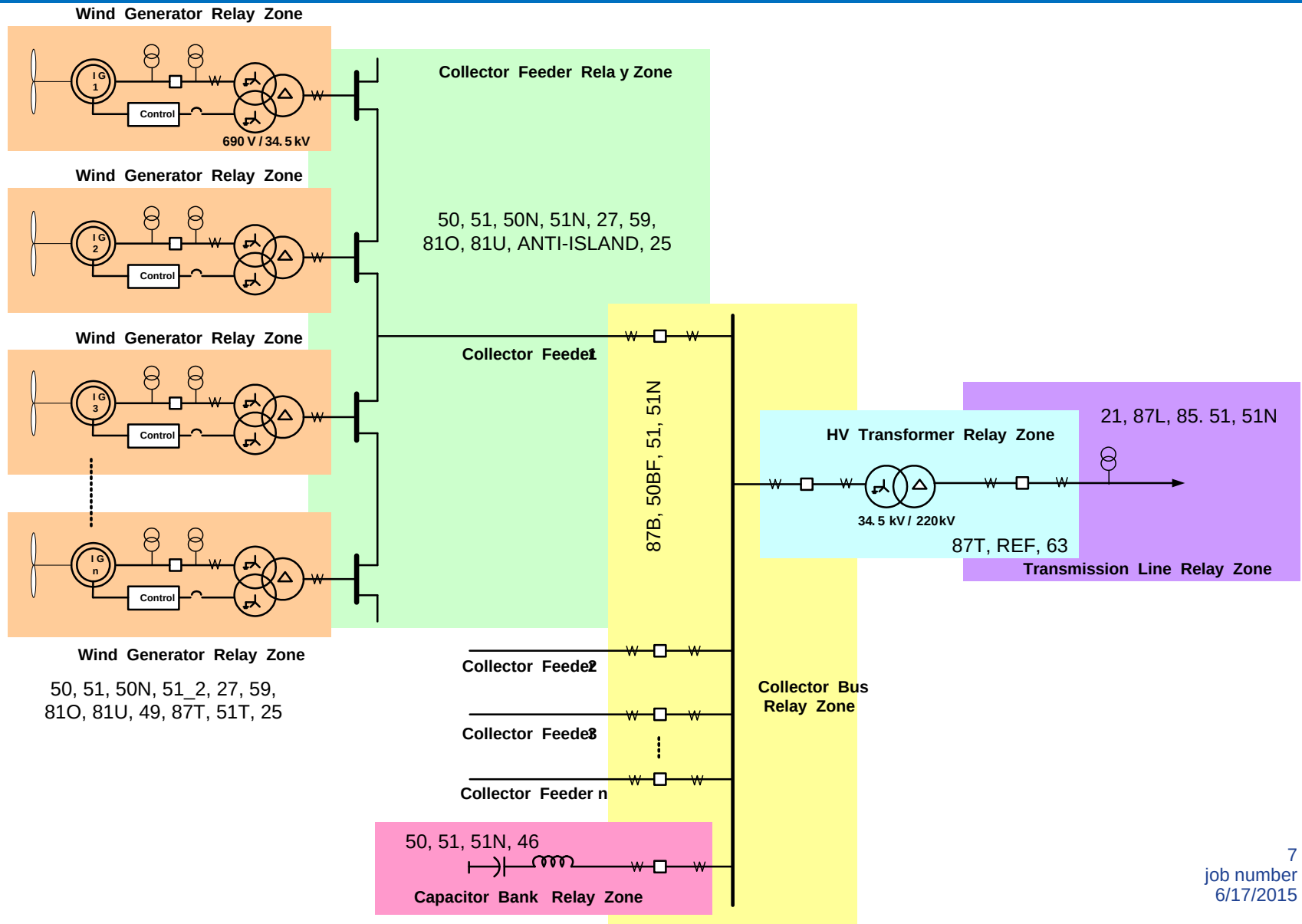
- Variable Speed
- Multi-Pole Synchronous Generator – direct driven
- Rectifier + Inverter



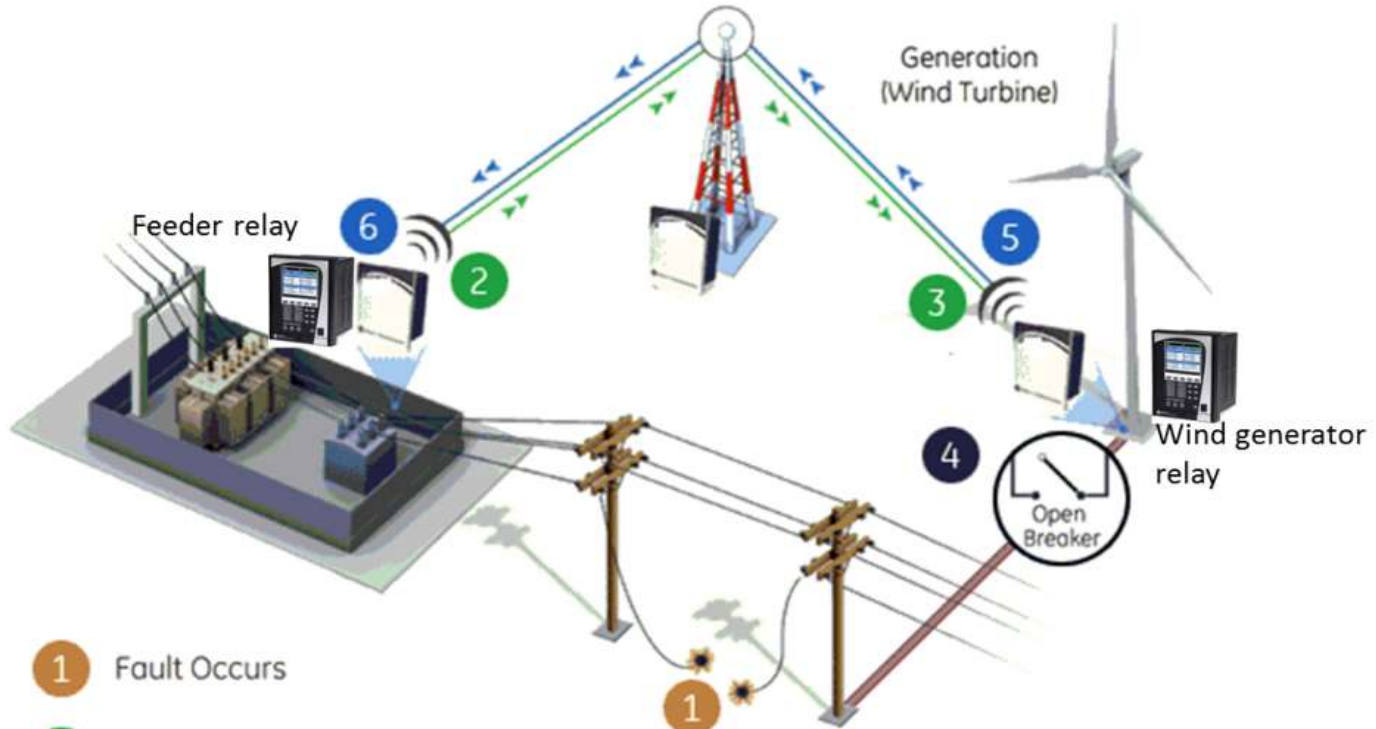
CURRENTS EVOLUTION DURING A THREE-PHASE SHORT CIRCUIT



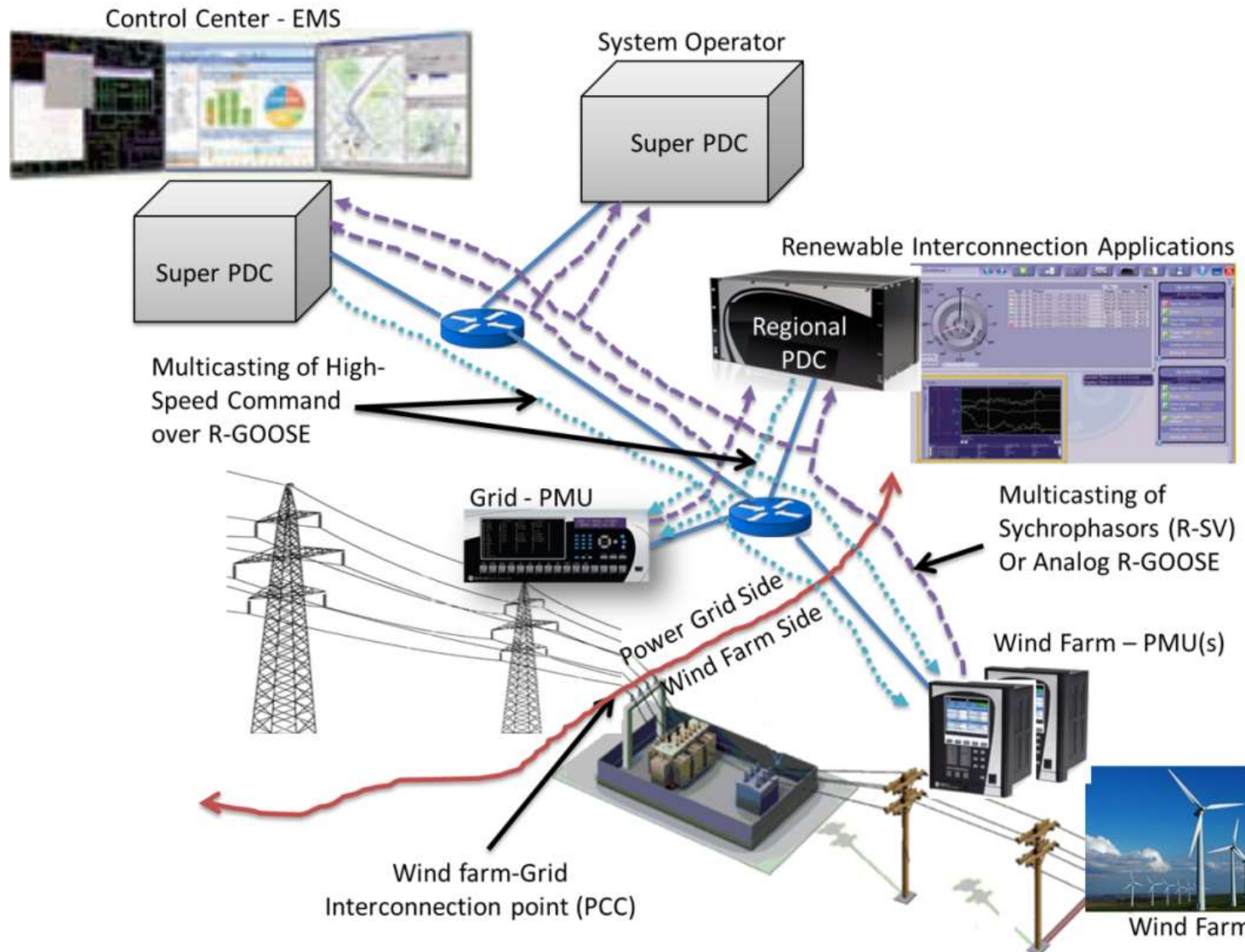
PROTECTION FUNCTIONS



INTERTRIPPING

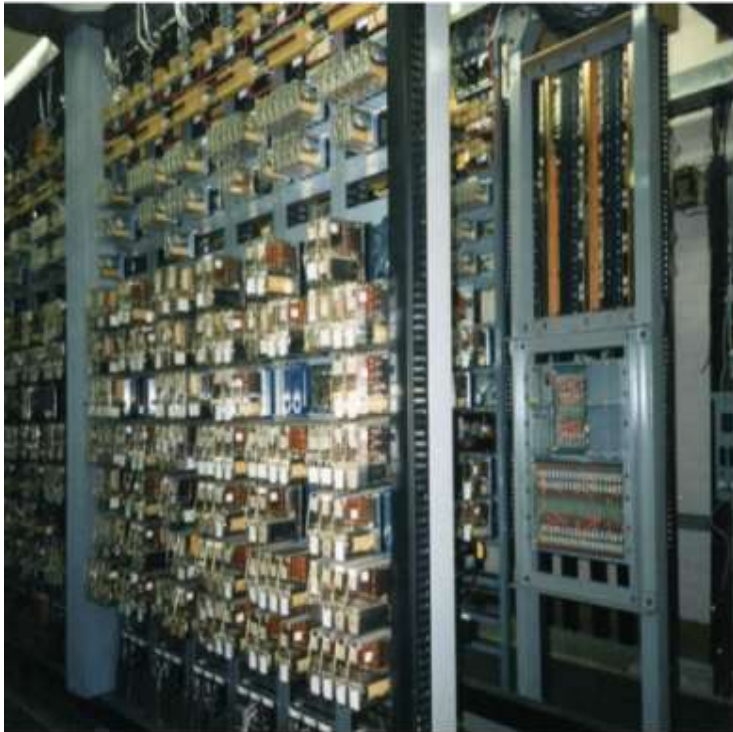


NEW VISION OF BACKUP PROTECTION



NEW LINE PROTECTION CRITERIA

Before



**Substation Electro-mechanical
Relay panels with multiple
rows**

Today



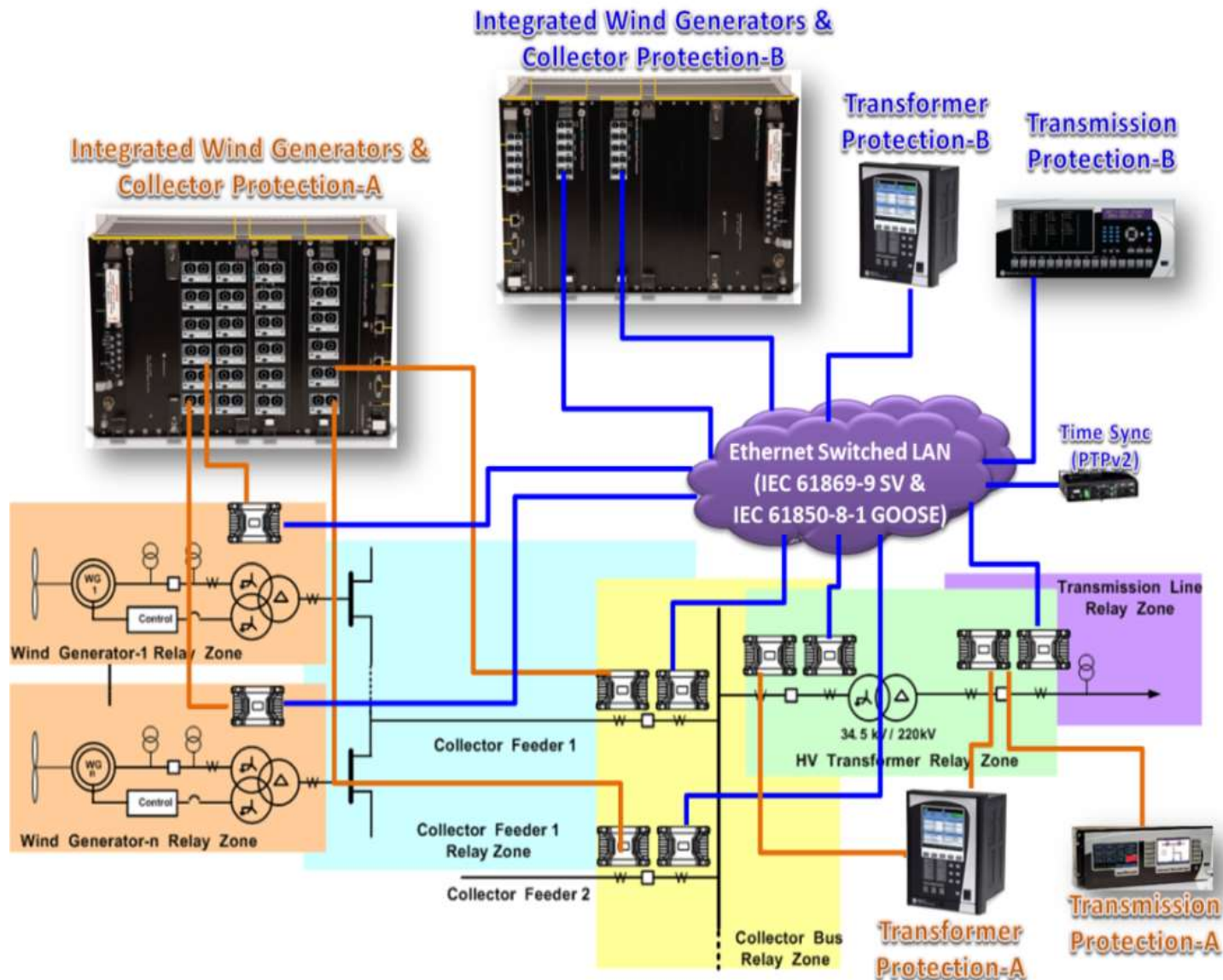
**Multifunctional Digital
Relay panels in a row**

Tomorrow



**Integrated Digital
Systems
in a panel**

ENVISIONED OF A NEW PROTECTION ARCHITECTURE



SUMMARY

- Advanced communication enabled digital protection devices/systems are more necessary now than before with low wind energy penetrated with limited or no grid codes.
- The Robust and reliable communication infrastructures and maturity of interoperability standards are opening up many new trends to be achieved in near future.
- Synchrophasors and/or Ratable-GOOSE based wide area protection & monitoring may play important role in addressing complex wind integration issues and grid code compliance challenges. Furthermore, the concept of centralized/fully-integrated wind generator-collector feeder protection system over process bus is now a real possibility