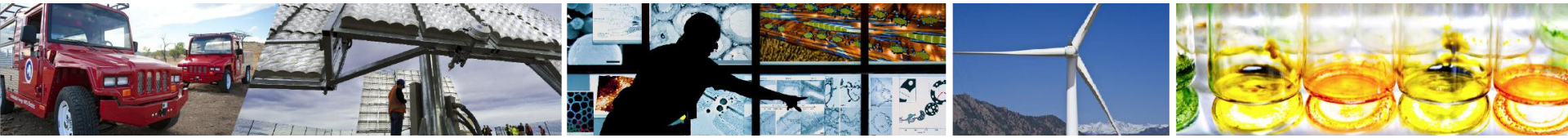
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

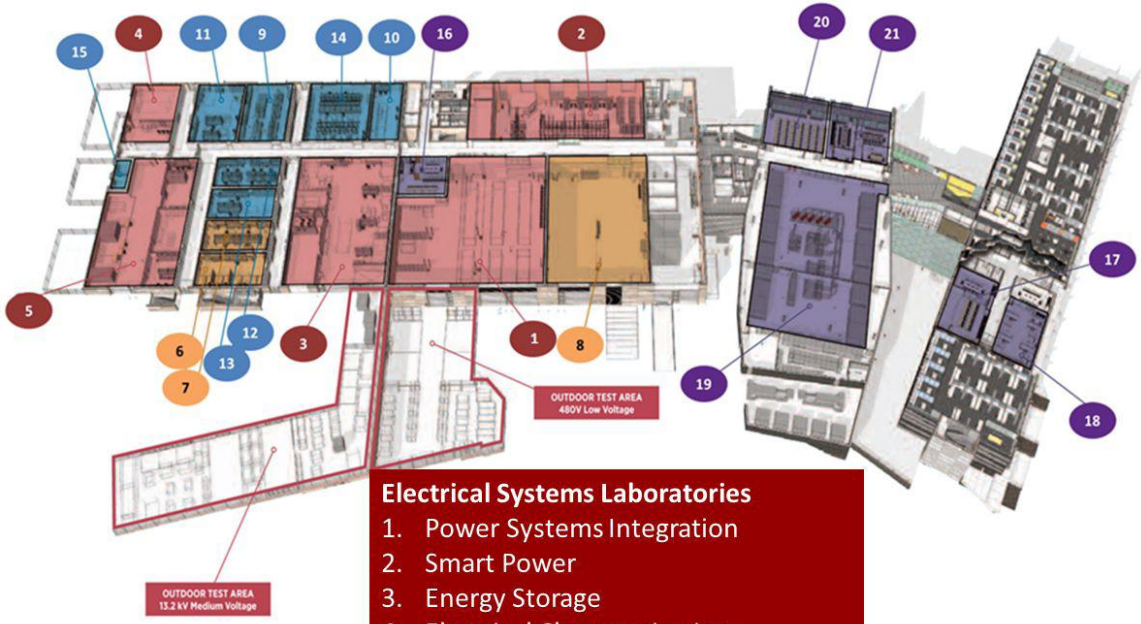
An Integrated Approach to Design and Analysis of Future Energy Systems



Brian Johnson

March 13th, 2014

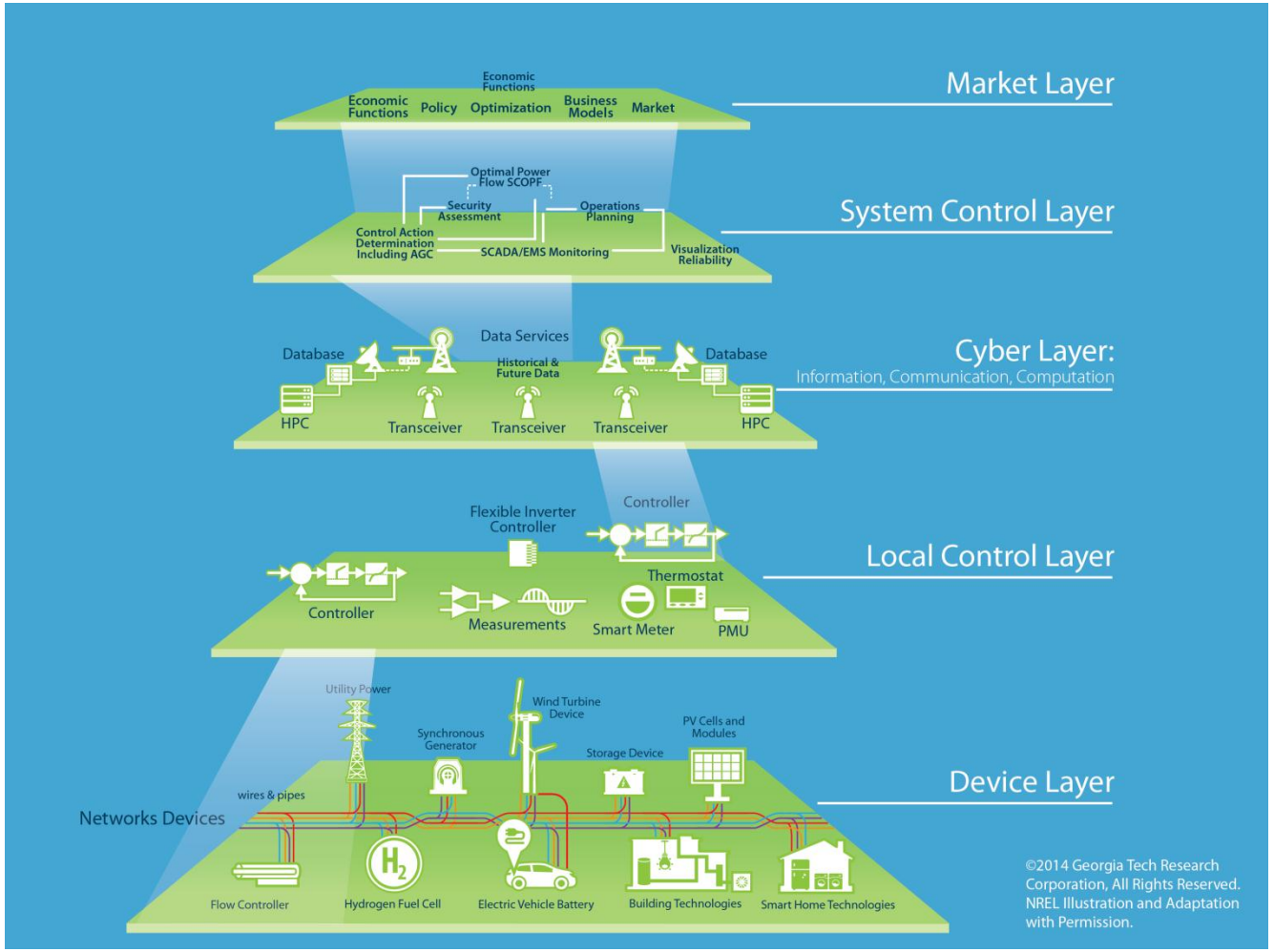
The Energy Systems Integration Facility (ESIF)



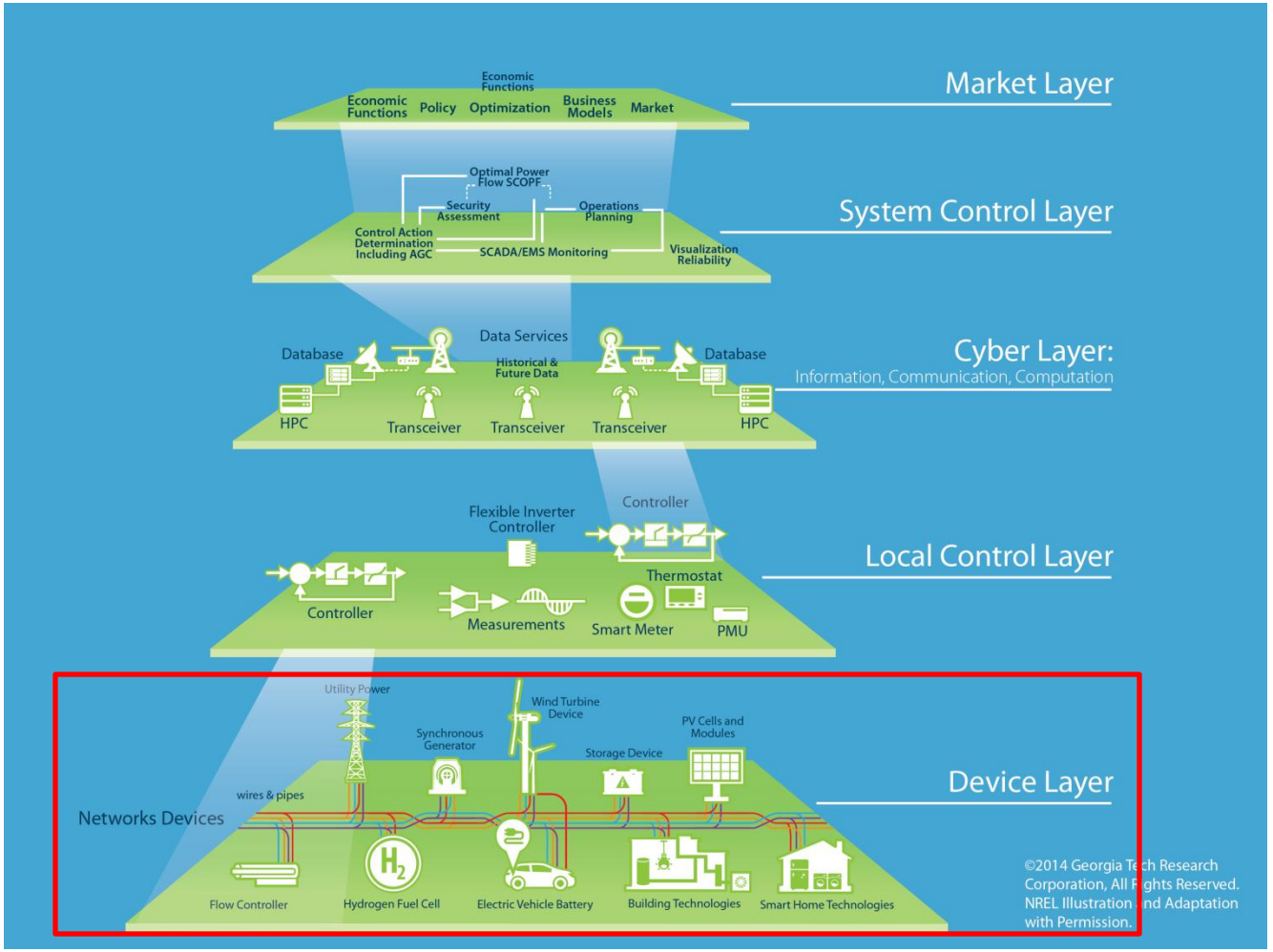
Electrical Systems Laboratories

1. Power Systems Integration
2. Smart Power
3. Energy Storage
4. Electrical Characterization
5. Energy Systems Integration

Future Cyber-Physical Power Systems

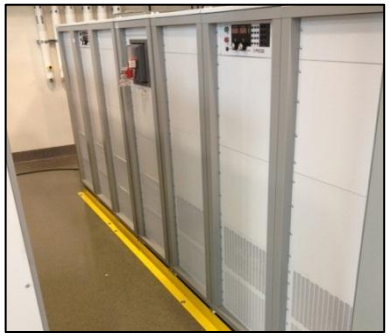


Future Cyber-Physical Power Systems



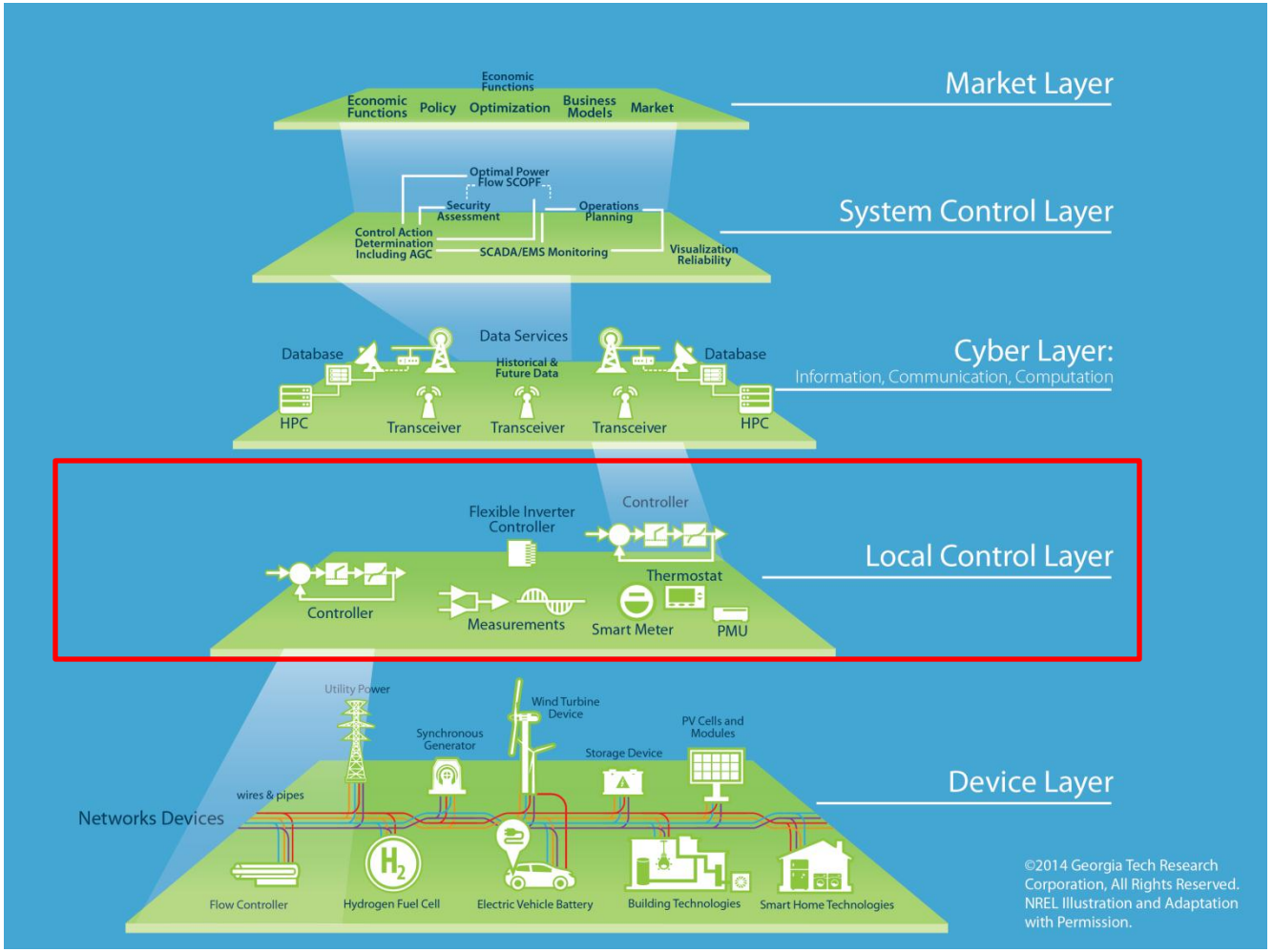
Power System Integration Laboratory

AC Grid Simulator
(1MW, 600V)

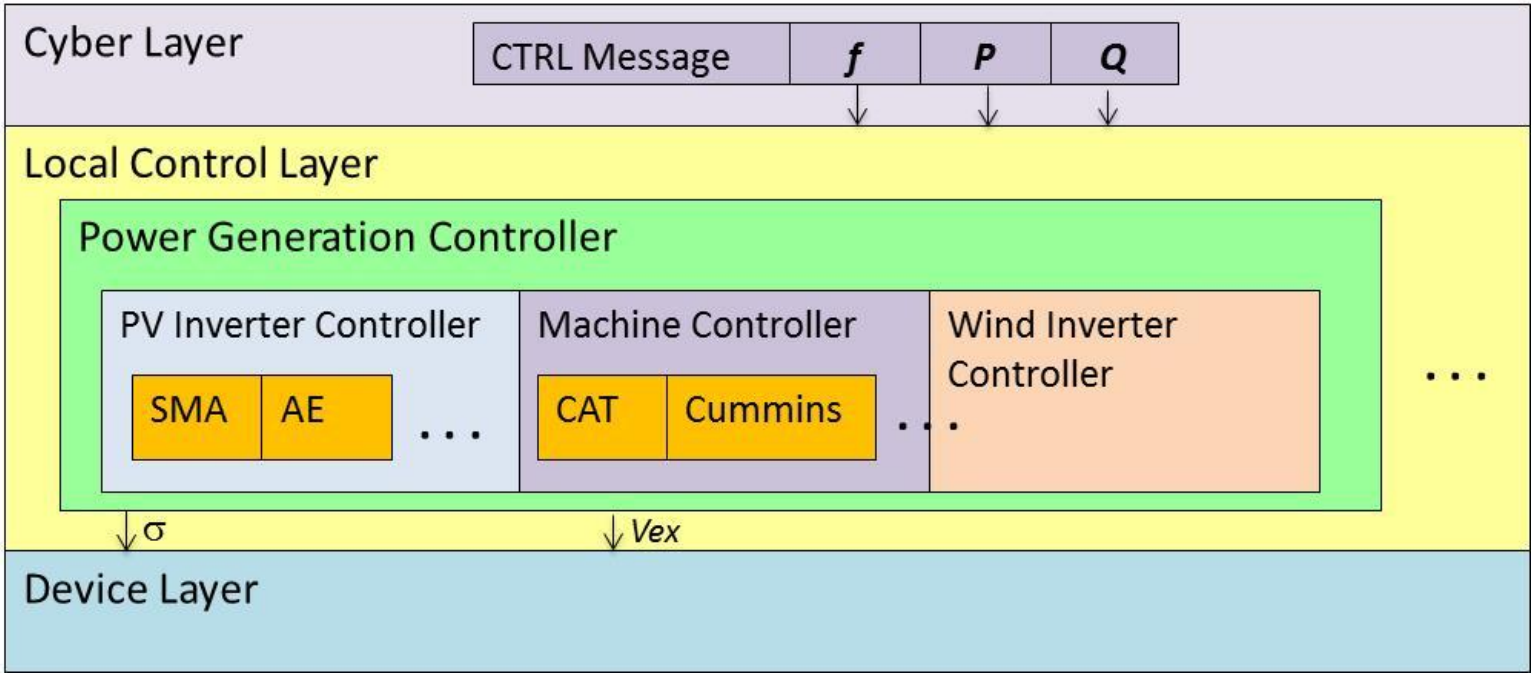


PV Array Simulator
(1MW, 1000V)

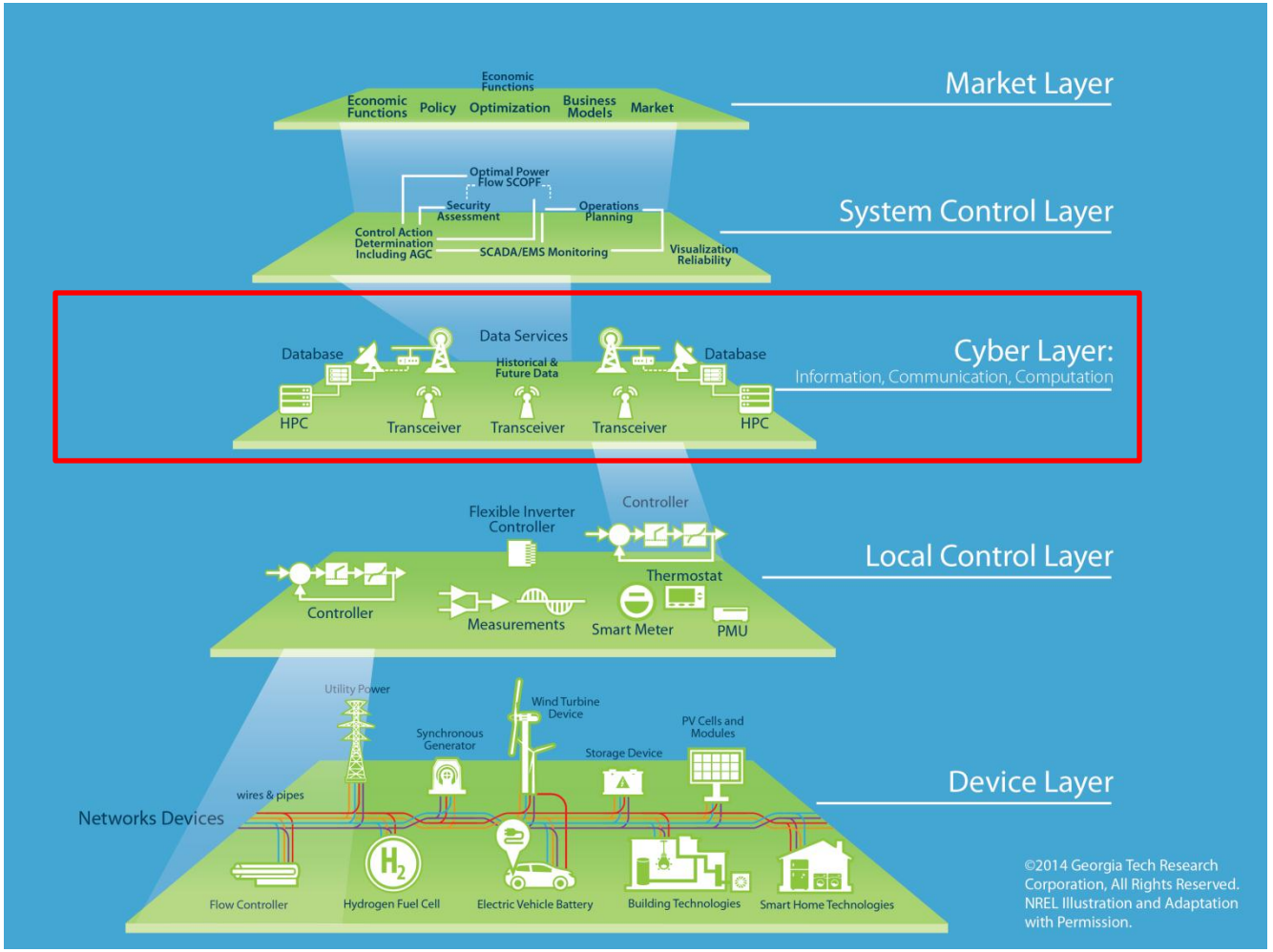
Future Cyber-Physical Power Systems



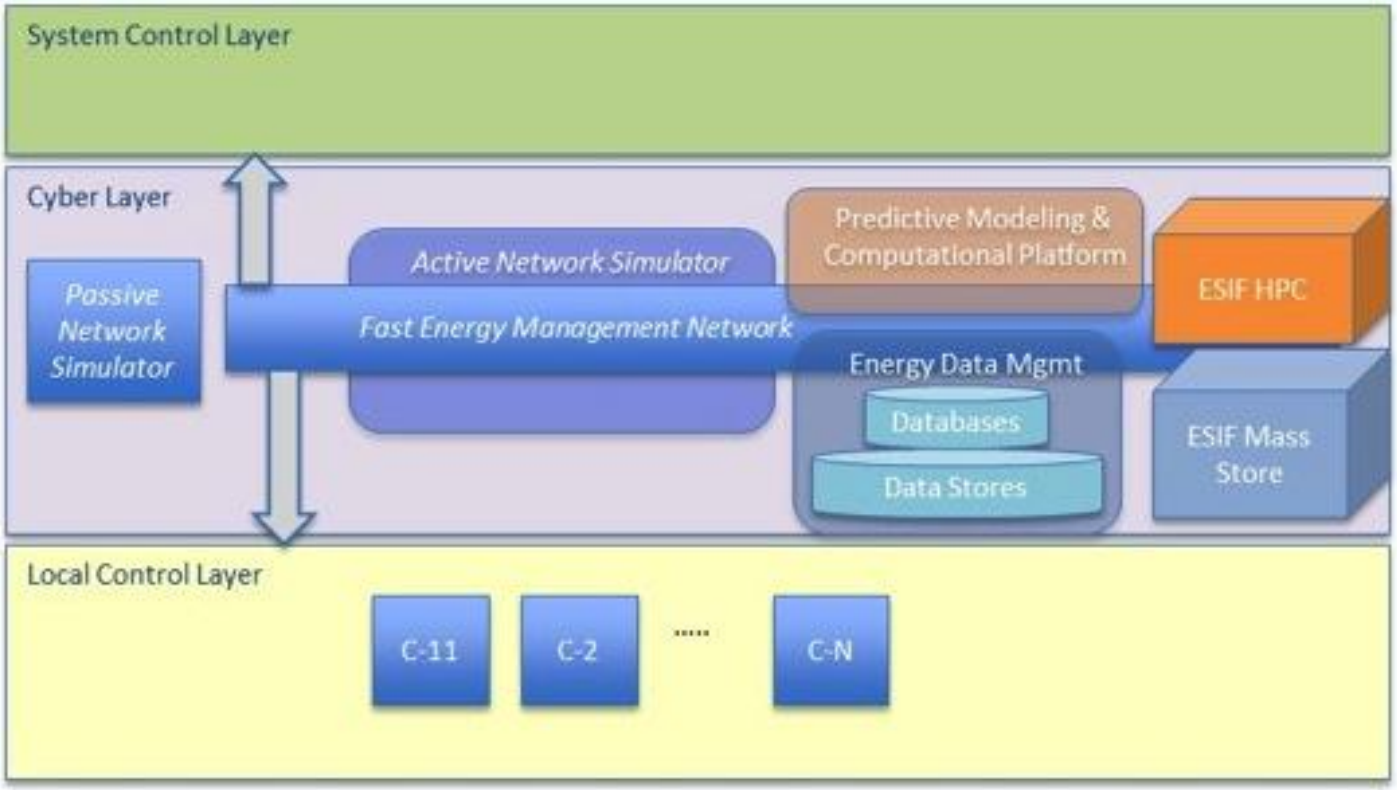
Local Control Layer



Future Cyber-Physical Power Systems

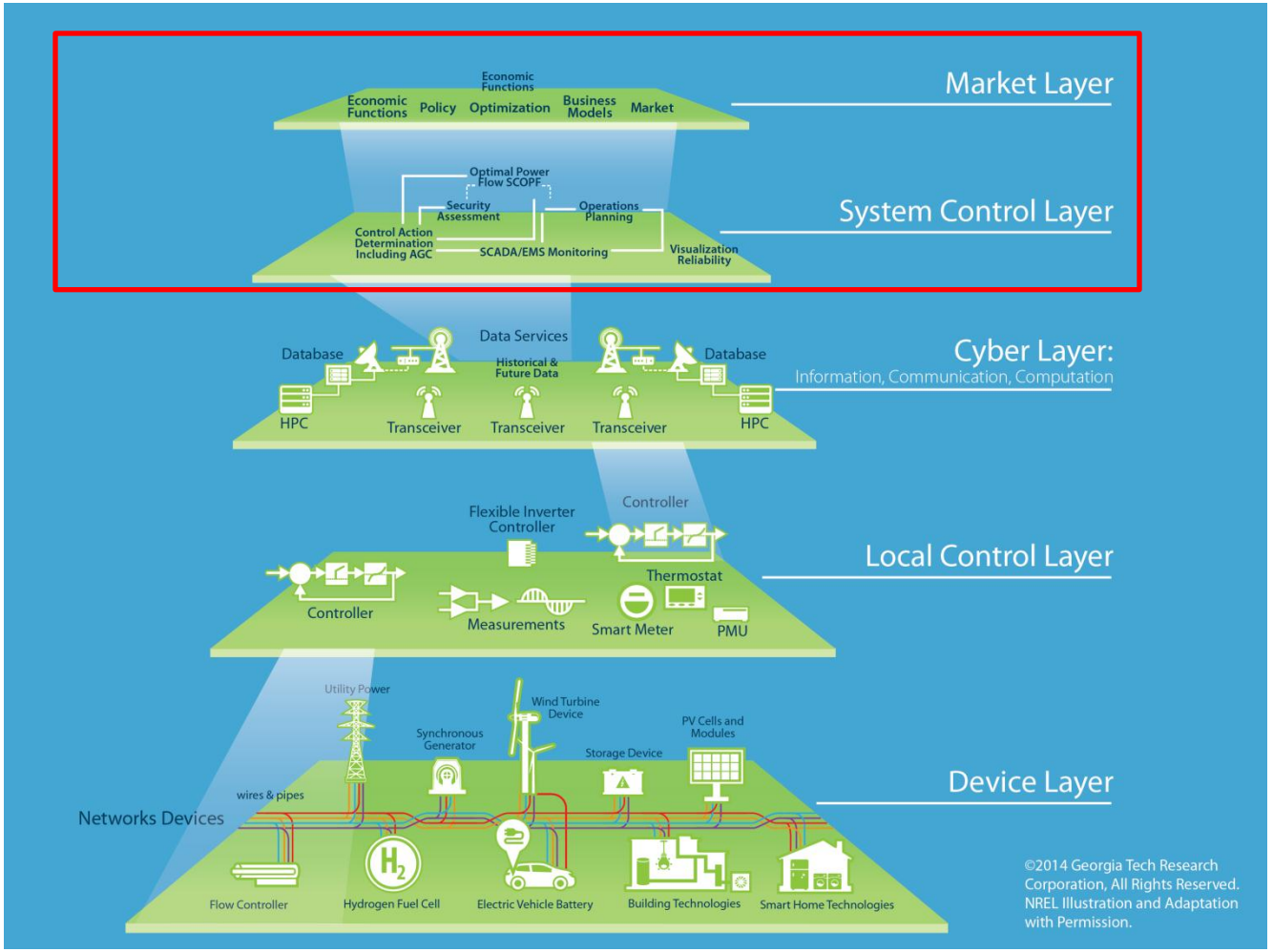


Cyber Control Layer

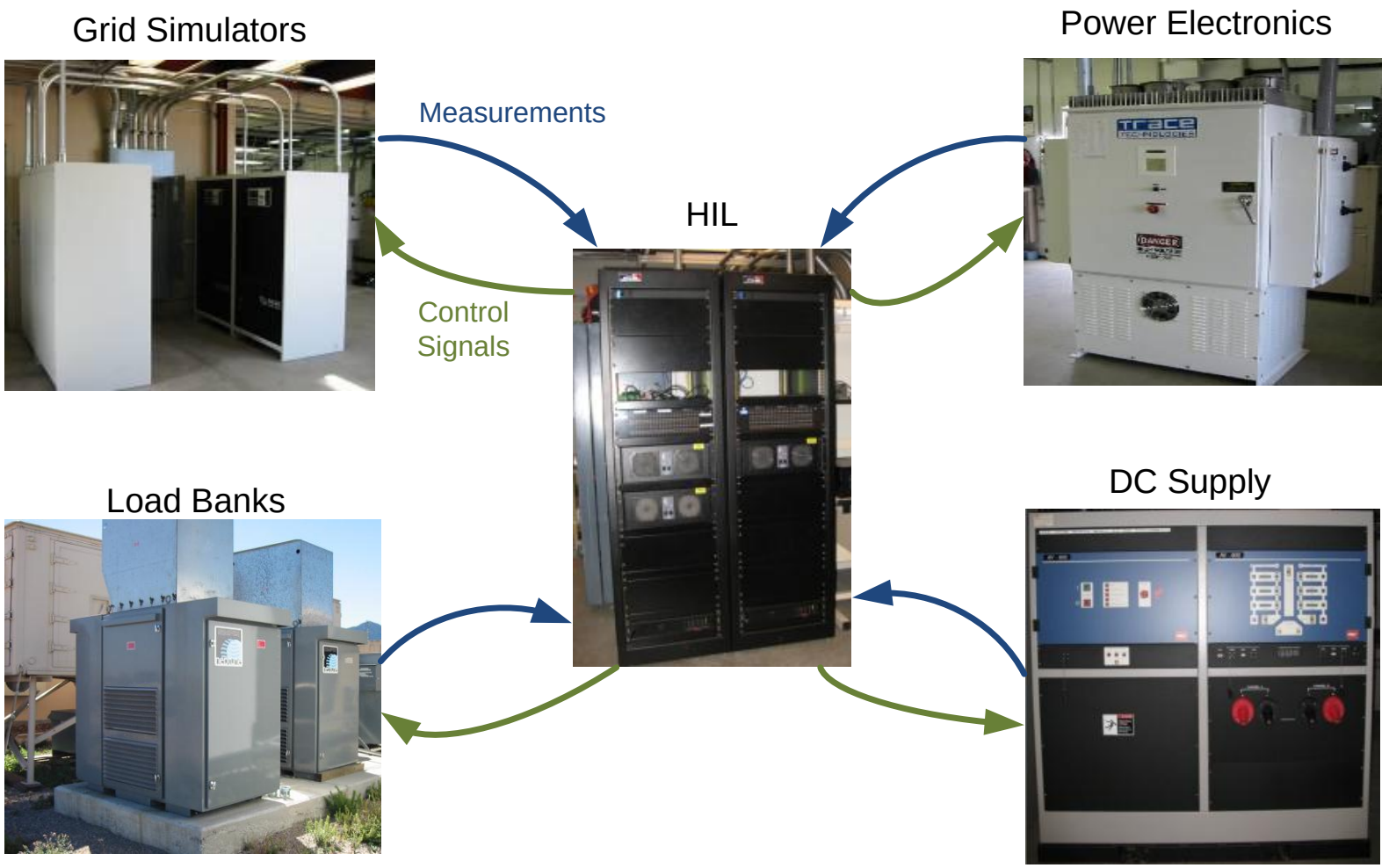


SCADA-equipped control center to coordinate experiments in multiple laboratories

System and Market Layers



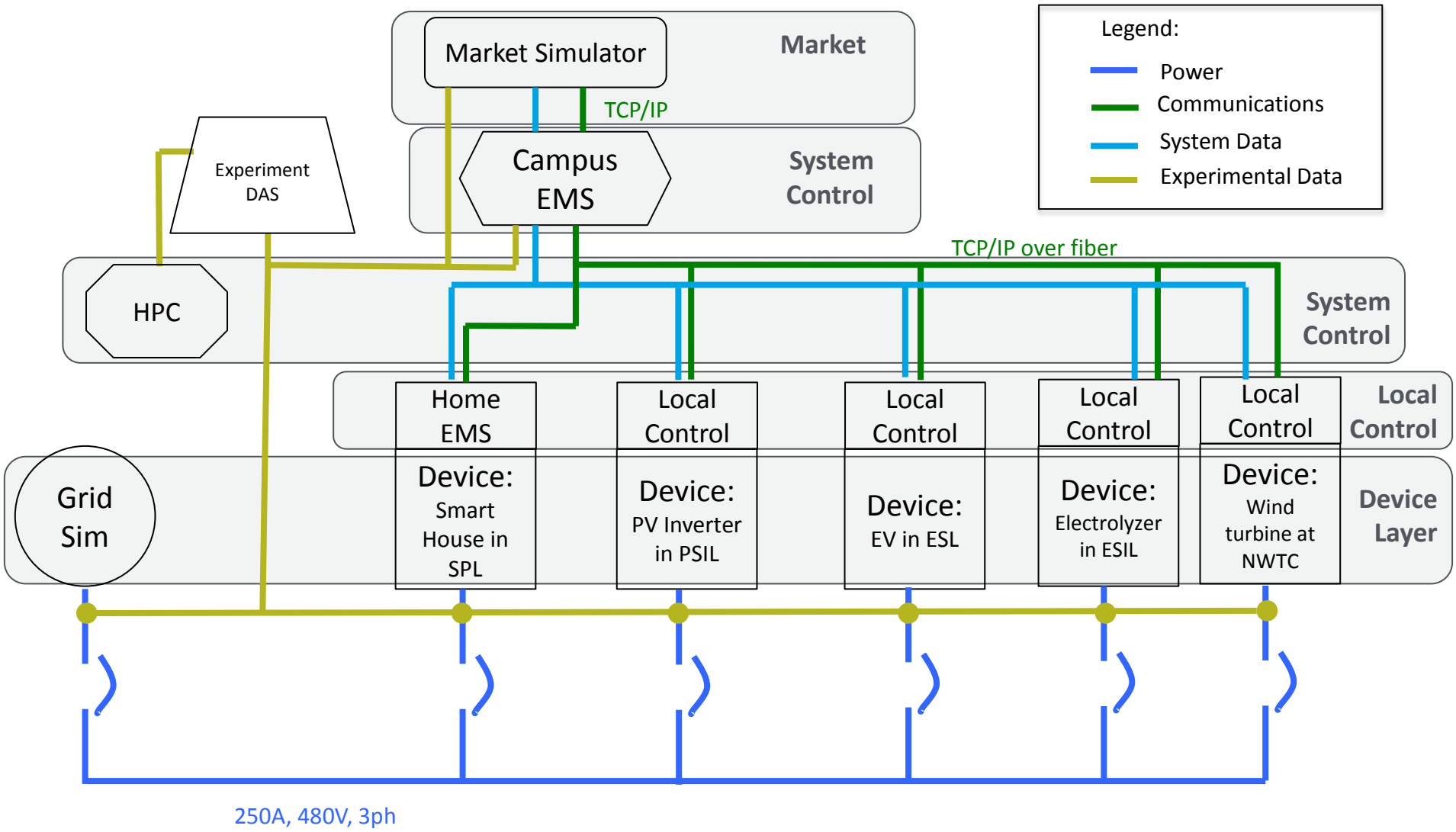
Integration: Hardware & Co-Simulation



Transmission & system-level behavior: Real-time hardware-in-the-loop (HIL)

Distribution & local-level behavior: Physical energy system hardware

Campus Testbed



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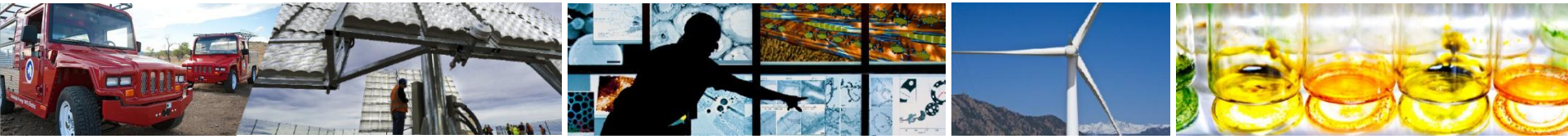

Thank you for your attention!