
SVENSKA KRAFTNÄT
Strategic Research Priorities for the Future Transmission System
2026-02-17
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Where Svenska kraftnät needs research excellence

1. **Stability in inverter-dominated systems**
   a. Grid-forming interaction and system-wide dynamic behavior
   b. Protection in low short-circuit strength environments
   c. AC/DC oscillatory modes and stability margins

2. **HVDC and Power Electronics in Highly Interconnected Systems**
   a. Control behavior in multi-terminal and interconnected HVDC systems
   b. Converter interaction across vendors and network boundaries
   c. Semiconductor stress, harmonic stability and long-term reliability

3. **Physics-based and AI-enhanced system operation under weather uncertainty**
   a. Forecasting system state under weather driven variability, including topology, voltage profile and reactive resources
   b. Adaptive operating limits reflecting real-time system conditions
   c. Digital twins and probabilistic security assessment supporting operational decisions across time scales

4. **System resilience and restoration**
   a. Cascading failure propagation in AC/DC systems
   b. Black start in inverter-dominated grids
   c. Cyber-physical interaction under disturbance

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System-Level Research Challenges Beyond Traditional Power Engineering

1. **Infrastructure materials and ageing physics**
   a. Low lifecycle carbon materials for transmission infrastructure
   b. Insulation degradation under electrical and thermal stress
   c. Accelerated ageing modelling under climate change
2. **Human-machine interaction in safety-critical environments**
   a. Decision making under uncertainty and severe time constraints in control rooms
   b. AI assisted operational tools with transparency and human feedback
   c. Defining the boundary between automation and human authority in critical situations
3. **Market mechanisms interacting with grid physics**
   a. Market induced flow volatility and emerging congestion patterns
   b. Physical consequences of pricing design, including zonal and nodal structures
   c. Capacity calculation under uncertainty and strategic market behavior
4. **Long-Term System Integrity and Critical Technology Dependencies**
   a. Semiconductor lifecycle modelling and dependency risks in power electronics
   b. Hardware security and robustness in protection and control systems
   c. Scenario-based network development and open planning tools within confidentiality constraints

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