Resilient Digital Sustainable Energy Transition (REDISET)

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RISK and Resilience Day

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Project details

Institution	Country
KTH-Project leader	Sweden
Norwegian Defence Research Establishment (FFI)	Norway
University of Vaasa	Finland
The Norwegian SmartGrid center	Norway
Statnett	Norway
Svenska Kraftnät	Sweden
Fingrid	Finland

BUSINESS FINLAND

Nordic Energy Research

Swedish Energy Agency

Duration: 15.3.2022 – 15.3.2025

Budget: 1 600 000€

REDISET
Resilient Digital Sustainable Energy Transition

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Advancing the Cyber-Physical Resilience of Energy Infrastructures in Digital Era

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- Digitalization
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- The proposed model by the REDISET
- Dependencies and interdependencies
- Transmission/distribution infrastructure systems
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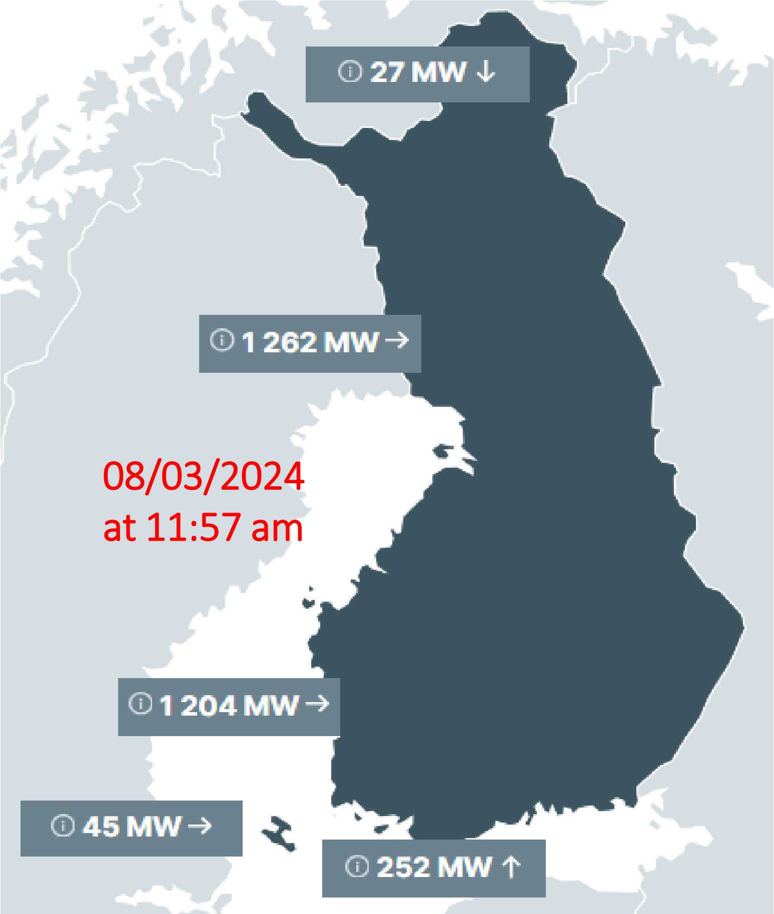
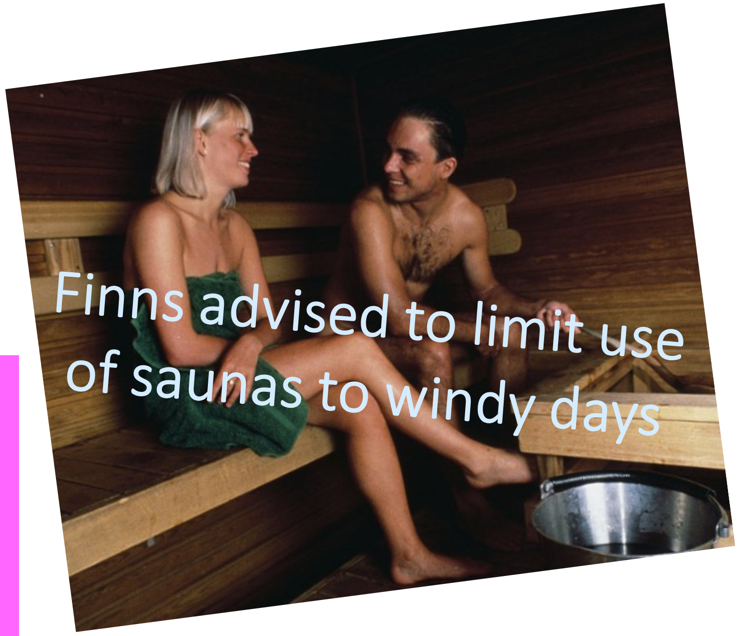
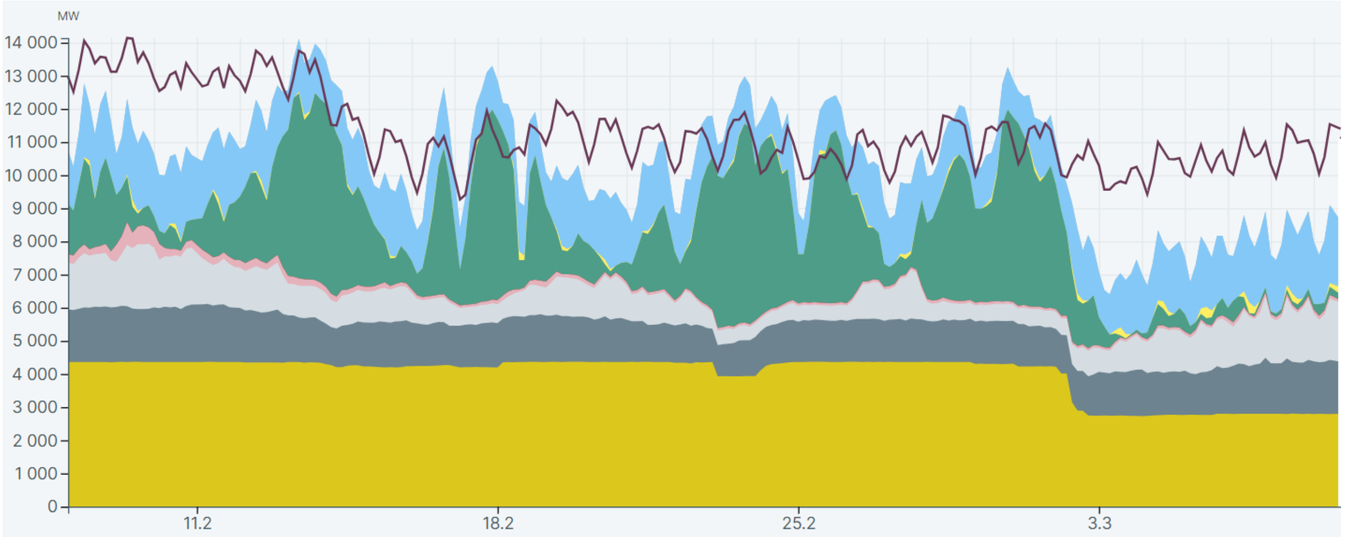
- Impact estimation

Overview on Fingrid state



Fingrid:
"We secure reliable electricity for our customers and society, and we shape the clean and market-oriented electricity system of the future"





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Digitalization

Digitalization will revolutionize the power system

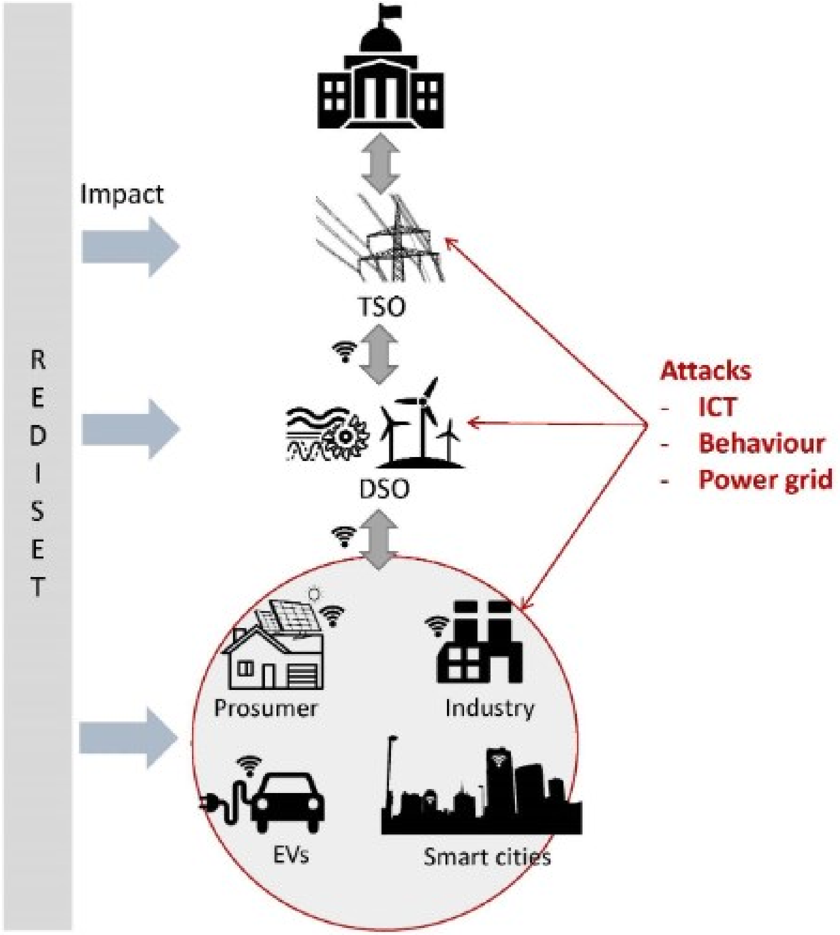
It will empower real-time monitoring, intelligent fault detection and location, and advanced active network management schemes

For enhancing reliability and resilience in our modern energy landscape

Artificial Intelligent Fault Prediction system for distribution & transmission networks based on Centralized Protection Concept and Virtualized Protection Automation and Control architectures utilizing edge computing is under development

Project objectives

- Address concerns by TSOs/DSOs through a holistic approach to security, recognizing complex system dependencies
- Identify vulnerabilities, analyze threats, and threat scenarios in the future digitalized power system
- Analyze and propose mitigation for digital security weaknesses in a highly integrated power system
- Develop competences and methods to enhance power system resiliency in the Nordic region



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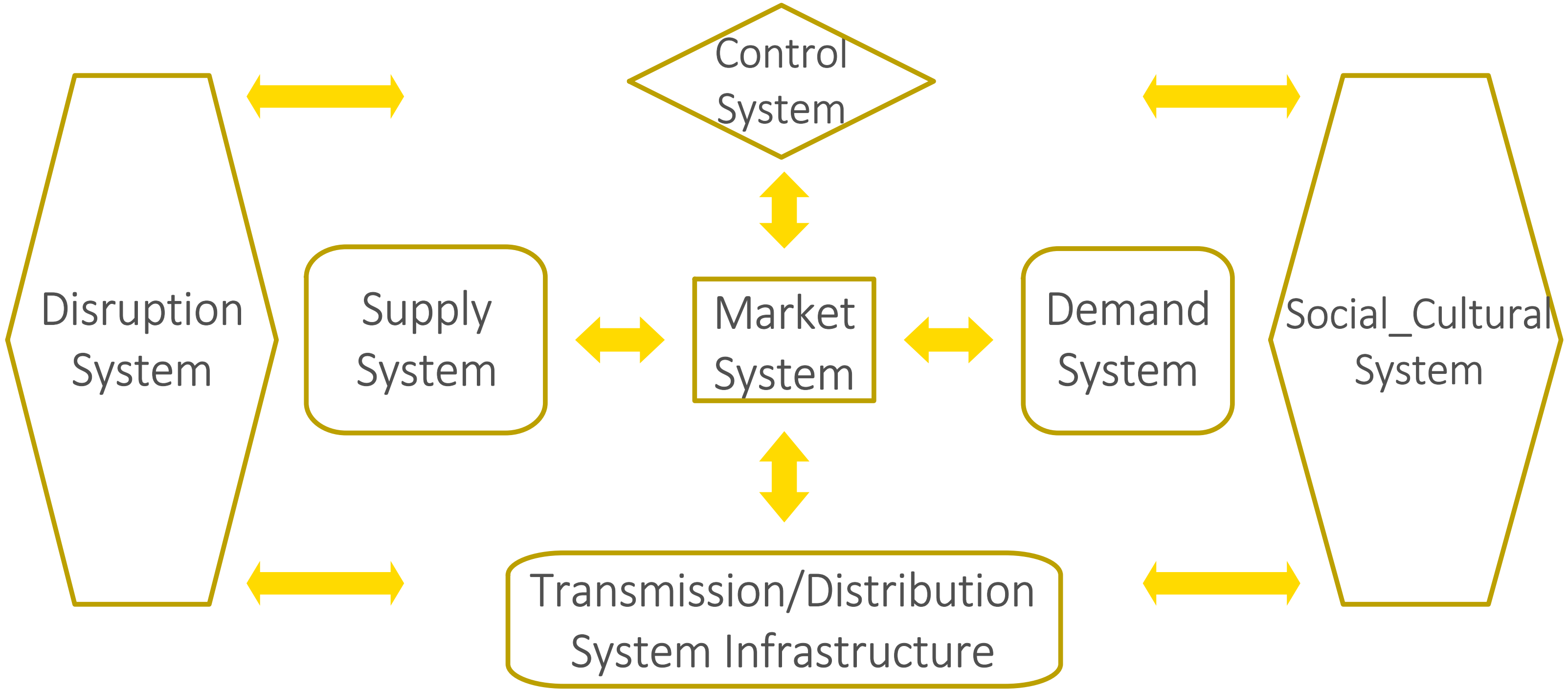
The proposed model by REDISET

- European and the Nordic TSOs/DSOs have all expressed a common need for ensuring integrity of data and cyber security in a future, fully digitalized power system
  - Complexity of the power system increases
  - Digitalization of the energy system is progressing
  - Frequency of unexpected events will increase at the same time as the inertia in the system is shrinking and challenges the reliability
  - A digital energy system is vulnerable for cyber and physical attacks
  - Security of energy infrastructure and resilience is crucial for the functionality of our societies



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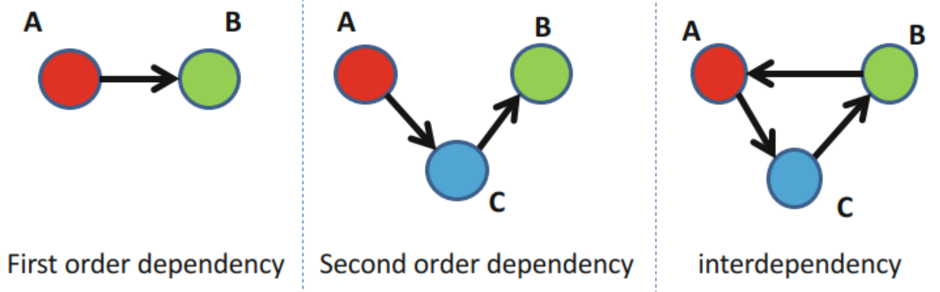
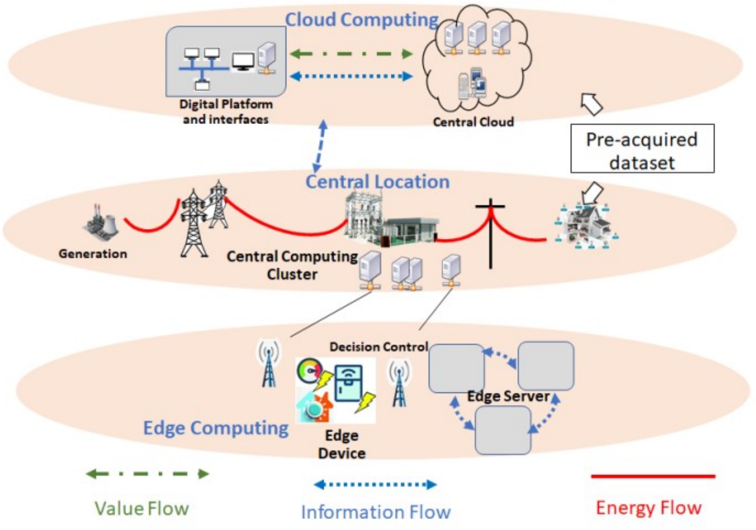
Dependencies and interdependencies

- In the past, the critical infrastructures were mostly separated and did not rely much on each other
- However, as technology has advanced, these critical infrastructure have become more integrated and connected
- Nowadays, these critical infrastructures are coupled and show large numbers of dependencies
- In fact, they are more vulnerable to equipment failure, human error, weather and other natural causes, and physical and cyber attacks

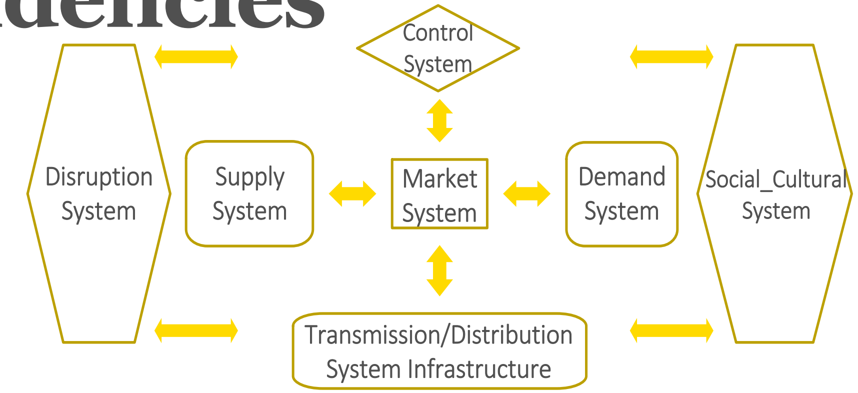




(Ref: Setola, Roberto, et al. Managing the complexity of critical infrastructures: A modelling and simulation approach. Springer Nature, 2016)

Dependencies and interdependencies

- Identifying the critical infrastructure dependencies leads to a more accurate assessment on the criticality level of a single infrastructure element, or even of a whole sector
- In this way it becomes possible to identify the 'most' critical among the infrastructures and adopt more cost-efficient security controls, so as to reduce overall risk



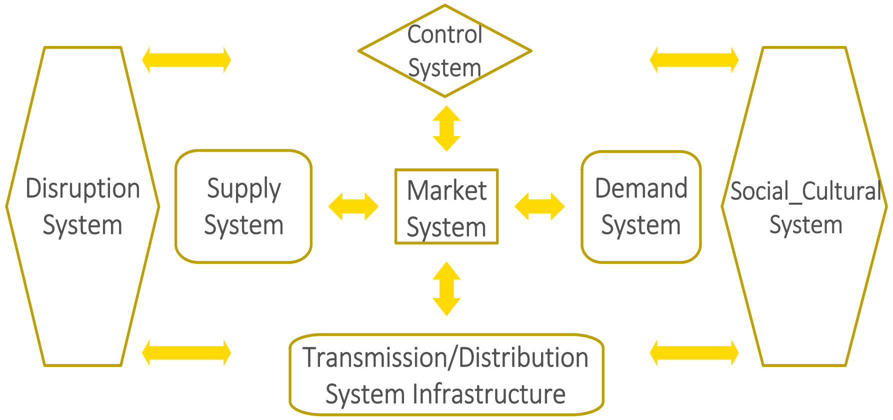
Timescale
≥ 2 hours
12 hours
1 day
≤ 3 days
≥ 7 days

Impact	Description	Score
Nothing	No loss of operability	0
Very limited	Very little loss of operability	1
Some degradation	Some loss of operability	2
Significant degradation	Significant loss of operability	3
Provide only some sevices	Certain essential operability remain	4
Complete stop	Complete loss of operability	5

Fuzzy logic! We cannot have a perfect answer, so, it will be estimated according to our present knowledge

Transmission/distribution infrastructure systems

- The main task of the grid system is to transport electricity and information and also measure the parameters necessary for optimal grid capacity operation
- Functions, e.g.:
  - Power transmission
  - Power distribution
  - Combine power generation sources
  - Transmit data
  - Grid monitoring of grid variables
  - Grid interconnections/grid support
  - Asset management
  - Grid planning



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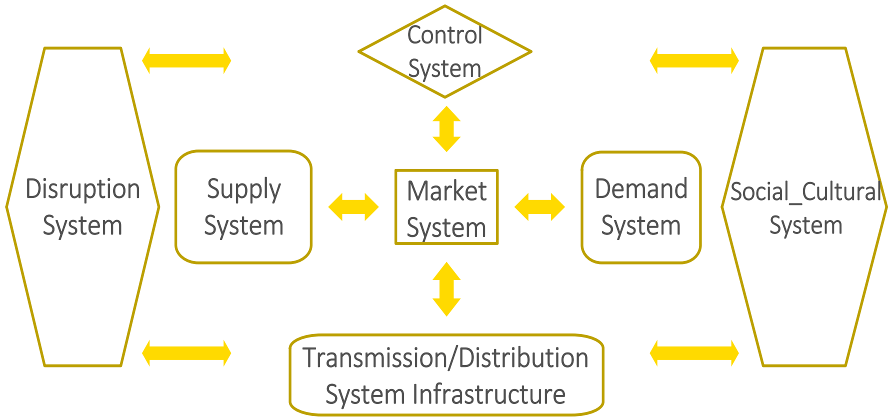
Control systems

- The main task of the control system is to ensure the reliable and stable operation of the electrical grid. This involves managing the generation, transmission, and distribution of electrical power to meet the demand while maintaining system stability and safety.
- Functions, e.g.:
  - Receive information from lower level control
  - Control action-balance supply and demand
  - Control action-grid protection
  - Control action-V regulation + reactive power
  - Control action-commands lower level



Impact estimation

Functions		Average	Median	Variance
Transmission/distribution infrastructure systems	2 h	1.272321	1	1.555175
Control system	2 h	1.7625	1.625	2.114967
	12 h	1.875	1.125	3.667763

Transmission/distribution infrastructure systems

	power transmission	power distribution	combine power generation sources	transfer data	grid monitoring of grid variables	grid interconnections/grid support	asset management	grid planinng
power transmission	X	4 4 2 / 2 / 3	2 3 0 / 2 / 1.75	1 1 1 / 1 / 1	1 1 1 / 2 / 1.25	4 4 4 / 4 / 4	0 0 1 / 0 / 0.25	0 0 0 / 0 / 0
power distribution	1 1 0 / 1 / 0.75	X	3 1 3 / 2 / 2.25	2 1 1 / 1 / 1.25	1 0 1 / 1 / 0.75	2 1 3 / 2 / 2	1 0 1 / 0 / 0.5	0 0 0 / 0 / 0
combine power generation sources	2 2 1 / 3 / 2	1 1 1 / 1 / 1	X	2 0 0 / 1 / 0.75	0 0 0 / 1 / 0.25	1 2 3 / 2 / 2	0 0 0 / 0 / 0	0 0 0 / 0 / 0
transfer data	3 4 2 / 3 / 3	3 1 3 / 3 / 2.5	4 3 4 / 2 / 3.25	X	5 5 5 / 5 / 5	3 2 4 / 2 / 2.75	2 1 2 / 1 / 1.5	1 0 1 / 0 / 0.5
grid monitoring of grid variables	3 4 2 / 3 / 3	3 1 2 / 2 / 2	1 2 3 / 2 / 2	0 0 1 / 1 / 0.5	X	3 3 3 / 3 / 3	2 1 1 / 1 / 1.25	0 0 0 / 0 / 0
grid interconnections/ grid support	2 4 4 / 3 / 3.25	3 3 2 / 2 / 2.5	2 2 4 / 2 / 2.5	0 0 1 / 0 / 0.25	0 0 1 / 0 / 0.25	X	0 0 0 / 0 / 0	0 0 0 / 0 / 0
asset management	3 1 2 / 1 / 1.75	3 0 1 / 1 / 1.25	3 1 3 / 1 / 2	1 0 1 / 0 / 0.5	1 0 0 / 0 / 0.25	1 2 3 / 1 / 1.75	X	0 0 0 / 0 / 0
grid planinng	0 0 0 / 0 / 0	0 0 0 / 0 / 0	0 0 0 / 0 / 0	0 0 0 / 0 / 0	0 0 0 / 0 / 0	0 0 0 / 0 / 0	0 0 0 / 0 / 0	X

Graded Color Scale

Impact: ***less=0 .... High=5***

Score of operability impact for transmission/distribution infrastructure systems

Control system

	Receive information from lower level control	Control action-balance supply and demand	Control action-grid protection	Control action-V regulation + reactive power	Control action-commnds lower level
Receive information from lower level	X	5 3 4 / 4 / 4	5 5 4 / 4 / 4.5	4 3 3 / 4 / 3.5	2 1 2 / 1 / 1.5
Control actionbalance supply and	0 0 1 / 0 / 0.25	X	0 0 1 / 1 / 0.5	2 1 3 / 1 / 1.75	0 0 0 / 0 / 0
Control action-grid protection	0 1 0 / 1 / 0.5	2 2 4 / 3 / 2.75	X	2 2 3 / 3 / 2.5	1 1 0 / 1 / 0.75
Control action-V regulation + reactive power	0 0 1 / 0 / 0.25	2 3 3 / 2 / 2.5	1 1 1 / 1 / 1	X	0 0 0 / 1 / 0.25
Control action-commnds lower level	0 0 1 / 0 / 0.25	4 3 4 / 4 / 3.75	3 2 0 / 2 / 1.75	3 3 3 / 3 / 3	X

Graded Color Scale

Impact: ***less=0 .... High=5***

t < 2 h

Score of operability impact for control system

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