Svenska kraftnät

Power System Communications – Essential Parts of a Future Smart Grid

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Chalmers 2018-09-27

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Power system

- 15 000 km power lines
- 160 substations
- 16 international connections
- National Control Centre: Sundbyberg
- Nordic Monitoring center in Copenhagen, in operation 2017

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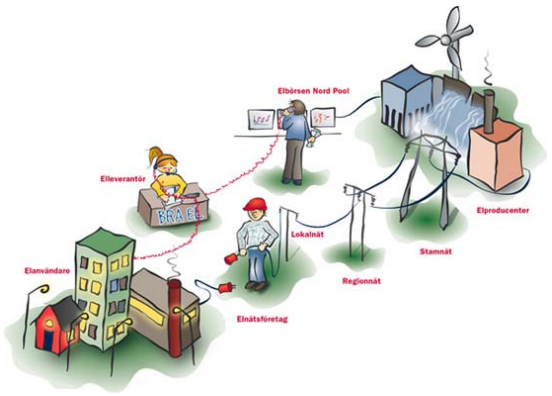
National – Regional and local networks

National Grid
- 400 and 220 kV
- Svenska Kraftnät

Regional networks
- 40 – 130 kV
- ~ 40 networks
- 10 companies

Local networks
- < 40 kV
- ~ 310 networks
- ~200 companies

Home
- 230 V



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Transmission system operators (TSO)

National grid =
Highway for eletricty

Highest voltage
(400 kV and 220 kV)

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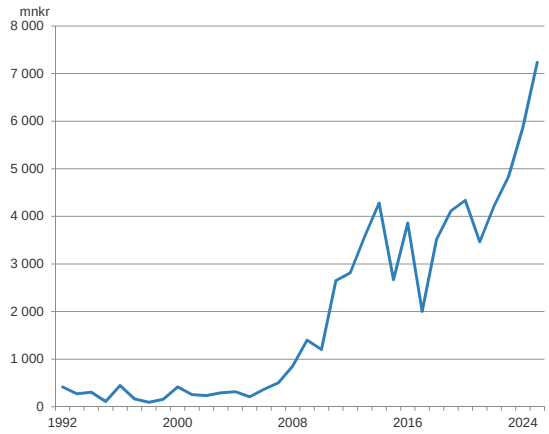
Investments



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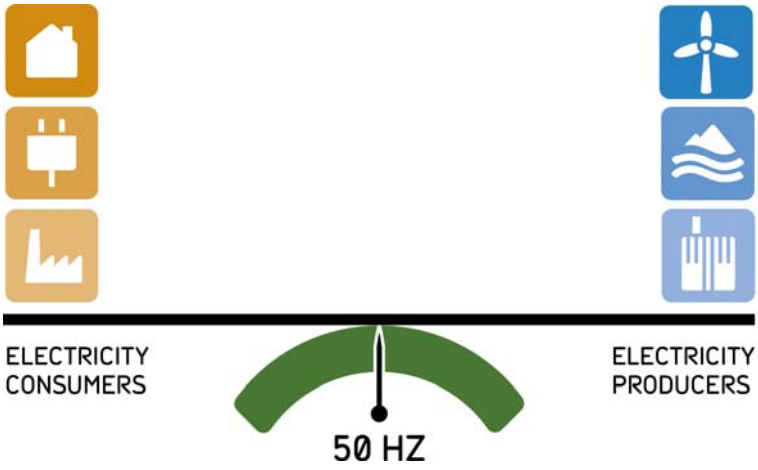
Balance between generation and demand



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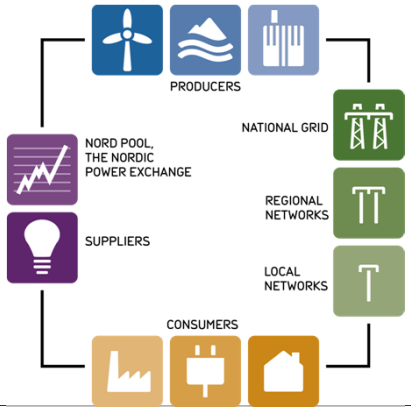
The route of electricity
– actors in the electricity market



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Electricity – Basis for a modern society

> Internet

> Mobile networks

> Payment systems

> …

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Broad scope

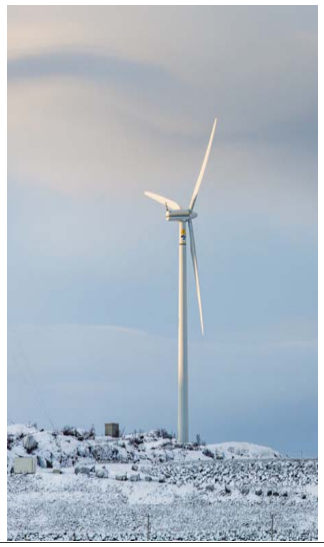
- Energy supply
- Infrastructure – critical for society
- Environment
- Technology
- Market issues
- National – Nordic – International

Deeper…

- Power flow – equations
- Technical solutions
- Price settings for the electricity market

Challenges

- ”Nybyggaranda” – Building new power grid infrastructure
- Decision process – can be extensive and long in time
- Renewables: Windpower, intermittent.
- Nuclear power reduced to 2020?



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Dam – Three Gorges China

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Transformer for Three Gorges-Shanghai

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Research

- KTH
- Chalmers
- Uppsala
- Lund
- Luleå

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Maintenance

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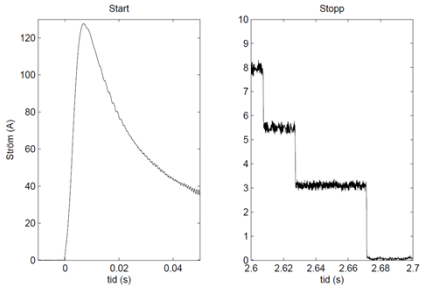
R&D project: Automated data collection for management purposes



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> Balance between production and consumption of electricity

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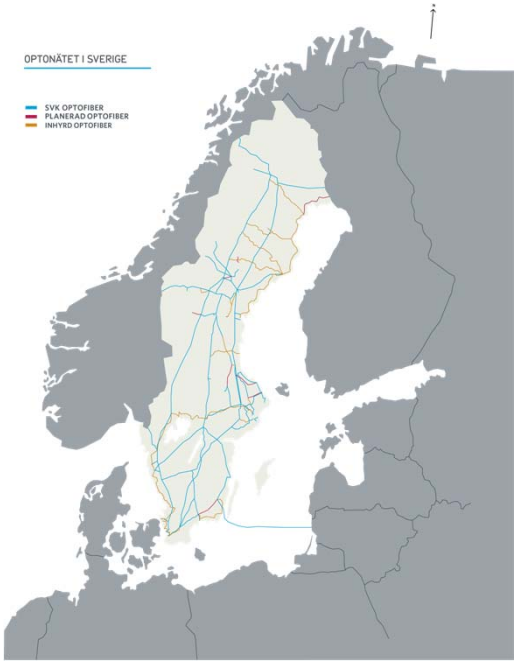

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Optical fibre network – to supervise and control the power network

- Approx 9500 km own optical fiber
- Dark fiber – surplus capacity is leased out
- Main customers: big telecom operators or energy companies (operation communication)'
- OPGW – OPtical Ground Wire: Most of the fibers are installed in the ground wire.
- Wrapping – not North of Dalälven (due to climate)

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Svenska kraftnät's optical fiber network

- From North (Ritsem) to South (Sege)
- Telecom operatots and city networks connect to technical sheds in the neteork
- High availability

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The fiber network is constantly being developed

During 2016 increase of 900km

Southwest link (approx 500km) for more secure power delivery in Southren Sweden

- Hallsberg – Motala - Nässjö- Värnamo – Hässleholm – Hörby
  - Technical sheds in Östansjö – Barkeryd – Lindstad - Hurva
  - Partly placed in the ground
  - 48 fibers

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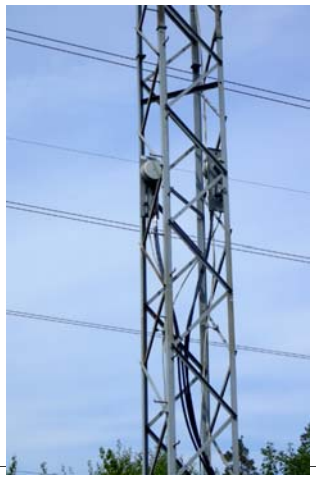
Connection points



- Splicing box mounted on pylon
- Technical sheds - Customers can access the equipment themselves

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Smart Grids (”intelligenta elnät”) Definitions

> ”**The application of digital technology to the electric power infrastructure**”

> ….and many more

’Smart Grids’ may be good – but who pays?

> The end-user always pays

> Smart Grids must be the smartest and most economical way of the solving the problems

> Smart Grids must be driven by sound business based incentives

> Smart Grids shall the support reduction – ~~not raise – of the energy price~~

What can be smart?

> Not the power lines themselves

But:

> The applications in the nodes (connection points)

> Protection, Control and Automation Equipments (Kontrollanläggningar)

> SCADA/EMS systems for supervisory control

> The customers!

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More digitalized

> Substations

> Advcanced supervisorty control systems

and

> Meter/equipment at customer premises

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Development of communication capabilities

> From

> Small, narrowband paths in the woods ("kostigar")

> To

> Broad, 7-lane highways

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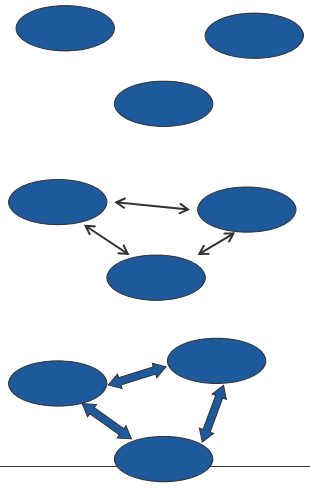
Development of Industrial Control Systems 1(2)



1. Islands of operation

2. Interconnected

3. Partially Integrated

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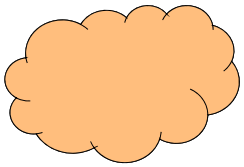
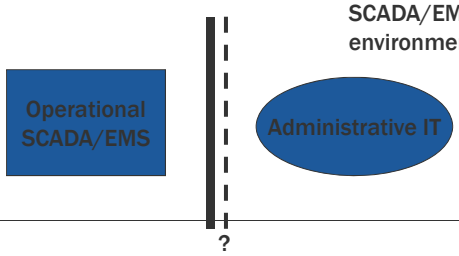
Development of Industrial Control Systems 1(2)



4. Today. Full integration system structure

5. De-coupling between Operational SCADA/EMS and Admin IT environments



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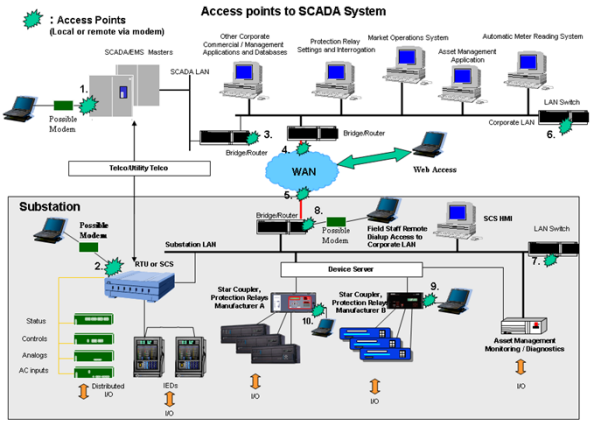
Access points to SCADA-system Threat and possibilities



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SCADA-system
Supervisory Contral And Data Acquisition

- Increasingly accessible via Internet
- Same technical solution as common administrative IT-systems
- Integrated with administrative IT-systems
- ***Same vulnerabilities for SCADA-systems as for administrative IT-systems! What to do?***
- Disturbances have impact on critical infrastructures
  - *Power, water, oil/gas, transport*
- CIP = Critical Infrastructure Protection
- CIIP = Critical **Information** Infrastructure Protection

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”AIC” rather than ”CIA” in electric arena – Delicate issues!

- Confidentiality (”Sekretess”)
- Integrity (”Riktighet”)
- Availability (”Tillgänglighet”)

  => Low priority for Confidentiality – Risk for Intrusion?
- SCADA Security
- Enormous need for education – awareness!

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Smart meters – How to deal with the cybersecurity issues?

- Technical possibilities. Broadband => faster, bulky
- From the households:
  - collect kWh-data, basis for billing
- To the households
  - Price information
  - **Controls** – opens up new cyber security issues
- ***"Which party will be responsible when, by mistake or by intentional digital tampering, a household is disconnected for two weeks, and that the owner of the house gets damages by destroyed food or water leakage, when he is away on two weeks of vacation?"***
  - The owner? The utility? …Who?
- These issues are clearly related to cyber security and they must be raised within the electric power arena.

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Concluding remarks – Questions?

- Climate goals => Introduction of renewables =>change in power transmission
- From islands-of-automation to fully integrated
- Openness. Communication capabilities – fiber networks
- Digital/Cyber security
  - New issue for the utility
  - Essential issue in a smart grid cirtical infrastructure
- Smart Grid –> Smart System

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Svenska kraftnät Trainee program

> Startad 1998. One year program. 80% still here!

> Every even year. 2016, 2018, 2020, …

> One ”home unit” & 10 weeks practice

> Personal and professional developm

> Internship @ other TSO possible

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Studie visit

VATTENFALL ABB Göteborg Energi SEABASED

Statnett ENERGINET.DK FINGRID

NORD POOL

International exchange of 3-6 months

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Why trainees like working at Svenska kraftnät

> Helpful colleagues

> Keen that we develop and our health

> 53 % female leaders

> Learn new things every day!

General

> Svenska kraftnät – authority/myndighet

> Security clearance – prerequistite for employment

> Fluent Swedish – documentations

> Swedish citizenship – at least Nordic

Svenska kraftnät

> 2018: 650 employees
(320 employees *(2010) -> 420* employees *(end 2011))*

> Exjobb: student@svk.se
All presented at www.svk.se

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Thanks for your attention!

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