EFFECTIVE VOLTAGE CONTROL AND OPERATIONAL COORDINATION OF REGIONAL REACTIVE POWER RESOURCES – CASE STUDY OF WESTERN PART OF SE3 AREA

2020-10-13

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Agenda

- Aim/Background
- Method
- Theory
- Transmission system – Area, resources, routines
- Ringhals – Capability, routines
- Result from data
- Key findings
- Future situation
- Conclusion, observations and suggestions

Aim/Background

- This report aims at explaining both the physical reality, the operational routines and interaction between Ringhals NPP and the transmission system in the west part of SE3 area
- Resulting in an increased understanding for the parties involved

Method

- Data gathering
- Data processing
- Analysis

Theory – Low/high voltage/reactive power

Low voltage

- Stability issues
- Increased transmission losses
- Reduced transmission capacity

High Voltage

- Equipment risks
- Corona losses

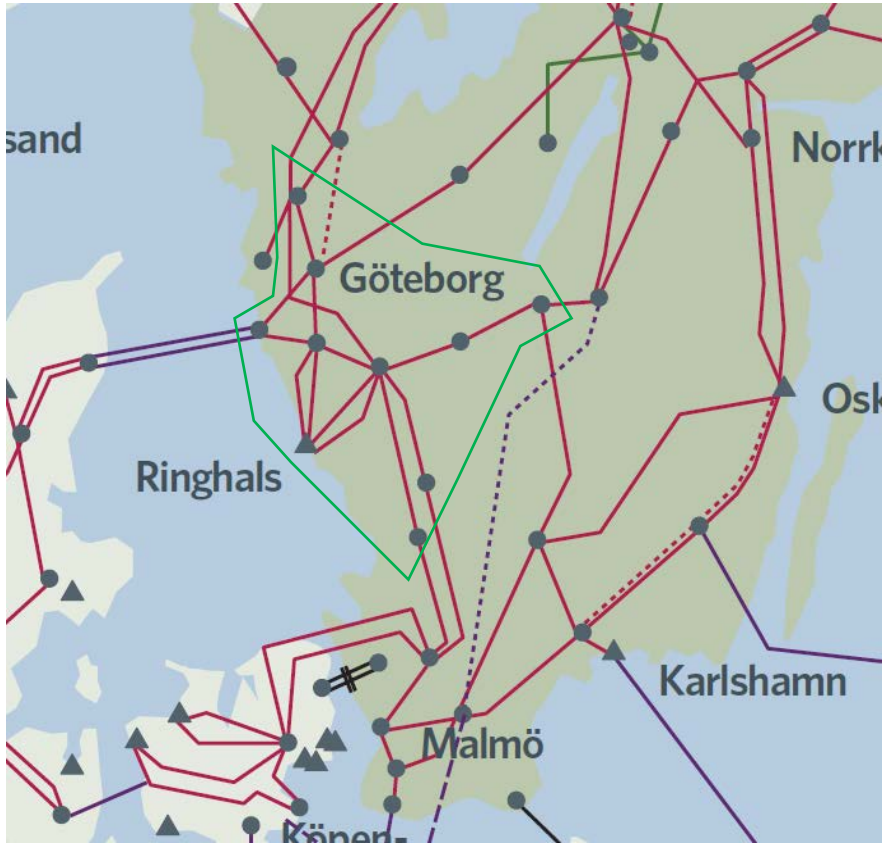
High reactive power absorption

- Weak electromagnetic coupling

High reactive power production

- Heating (rotor & stator)

Area of interest – west part of SE3



Reactive resources

Station	Shunt	Size (negative value means reactive consumption)	Reference voltage	Commissioning year	Decommissioning year
Kilanda	X1	-200 Mvar	400 kV	1999	
Kontiskan 1 (XT30)	ZK10	-66 Mvar	420 kV		
Kontiskan 1 (XT30)	ZK11	-66 Mvar	420 kV		
Kontiskan 1 (XT30)	ZK12	-45 Mvar	420 kV		
Kontiskan 2 (XT20)	EK1	56,2 Mvar	145 kV		
Kontiskan 2 (XT20)	EK2	56,2 Mvar	145 kV		
Kontiskan 2 (XT20)	ZK3	-56,2 Mvar	145 kV		
Kontiskan 2 (XT20)	ZK5	-11 Mvar	145 kV		
Strömma	EK1	150 Mvar	400 kV	2018	
Strömma	X1	-165 Mvar	420 kV	2012	
Stenkullen SVC		-200 to 200 Mvar			2019
Tenhult	X1	-150 Mvar	400 kV	2006	

Transmission system voltage

The transmission network shall normally be operated between 400 kV to 415 kV. The voltage at Ringhals is usually at the higher end of this range.

High voltage in the area occurs during low loading situations (nights during summers being a typical scenario for high voltage)

Transmission system voltage - Actions

To increase voltage:

- Connect disconnected lines
- Disconnect shunt reactors
- Order a decrease of reactive power output from the transmission grid
- Connect shunt capacitors
- Order infeed of reactive power at connection points up to the established requirement
- Increase reactive production from synchronous condensers and adjust the reactive power output from SVC

To decrease voltage:

- Decrease reactive production from synchronous condensers and adjust the reactive power output from SVCs
- Order a decrease of reactive power input to the transmission grid
- Order output of reactive power at connection points up to the established requirement
- Disconnect shunt capacitors
- Connect shunt reactors
- Operate synchronous condenser in under-excited mode and adjust SVCs to minimum
- Disconnect lines

Ringhals – Reactive capability

Produce reactive power equivalent to 1/3 of the maximum continuous active power as well as being able to reduce the reactive power production to 0.

No obligations to absorb reactive power.

Unit	Maximum active power [3]	Reactive power according to [2]
Ringhals 1	881 MW	294 MVAr
Ringhals 2	852 MW	284 MVAr
Ringhals 3	1063 MW	354 MVAr
Ringhals 4	1103 MW	368 MVAr

Ringhals – Voltage demands

Ringhals must be able to operate continuously at 90-105 % grid voltage with full power production as well as for at least one hour with slightly reduced production at 85-90 % and 105-110 % grid voltage.

Ringhals – Voltage Control

- All units in Voltage Control Mode
- Setpoint for generator voltage is set after request from Svk

Grid data

- 2017-08-23 – High voltage levels
- 2017-08-27 – High voltage levels
- 2017-09-15 – Low end of normal voltage levels
- 2018-01-10 – High reactive power export from Ringhals
- 2018-01-20 – High reactive power export from Ringhals
- 2018-02-09 – High reactive power export from Ringhals
- 2018-11-04 – High reactive power import to Ringhals

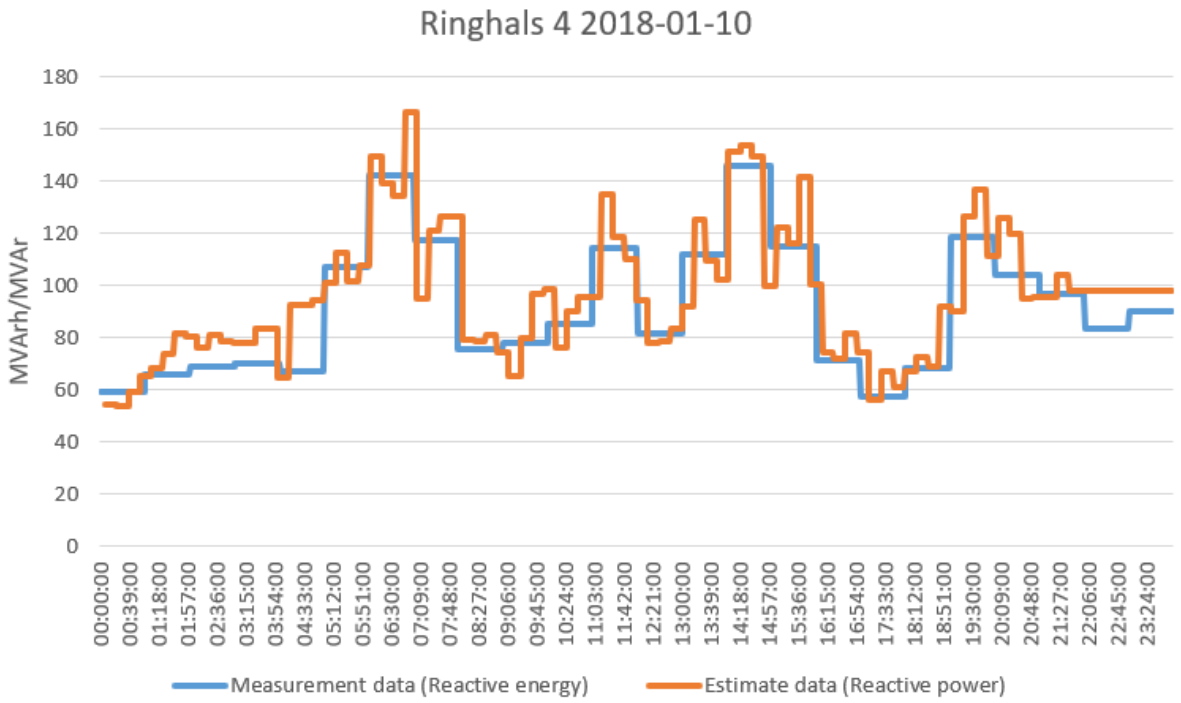
Data verification

Main data from SvK

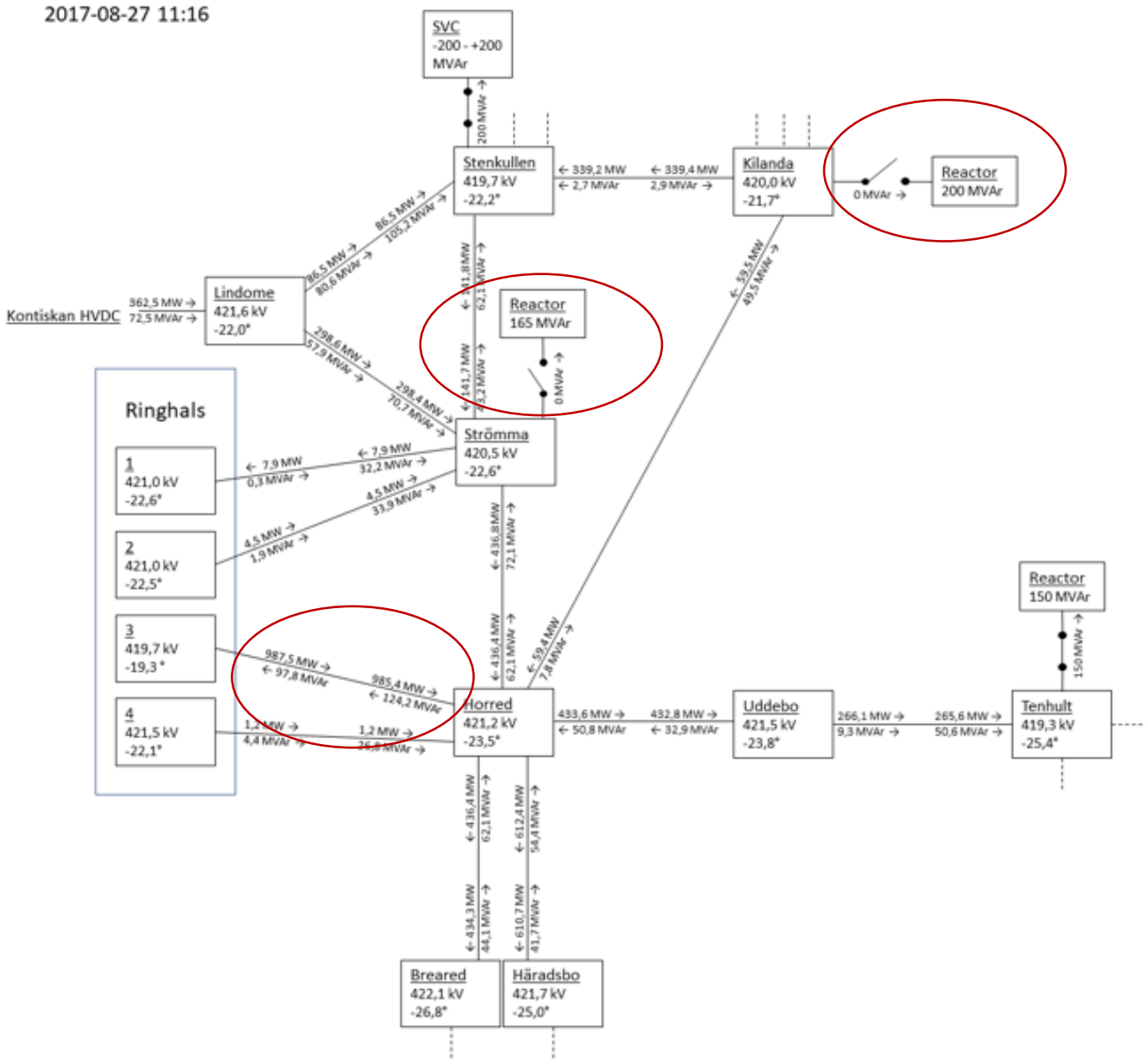
- Instantaneous values
- Some data is estimated

Compared with measurement data to verify accuracy

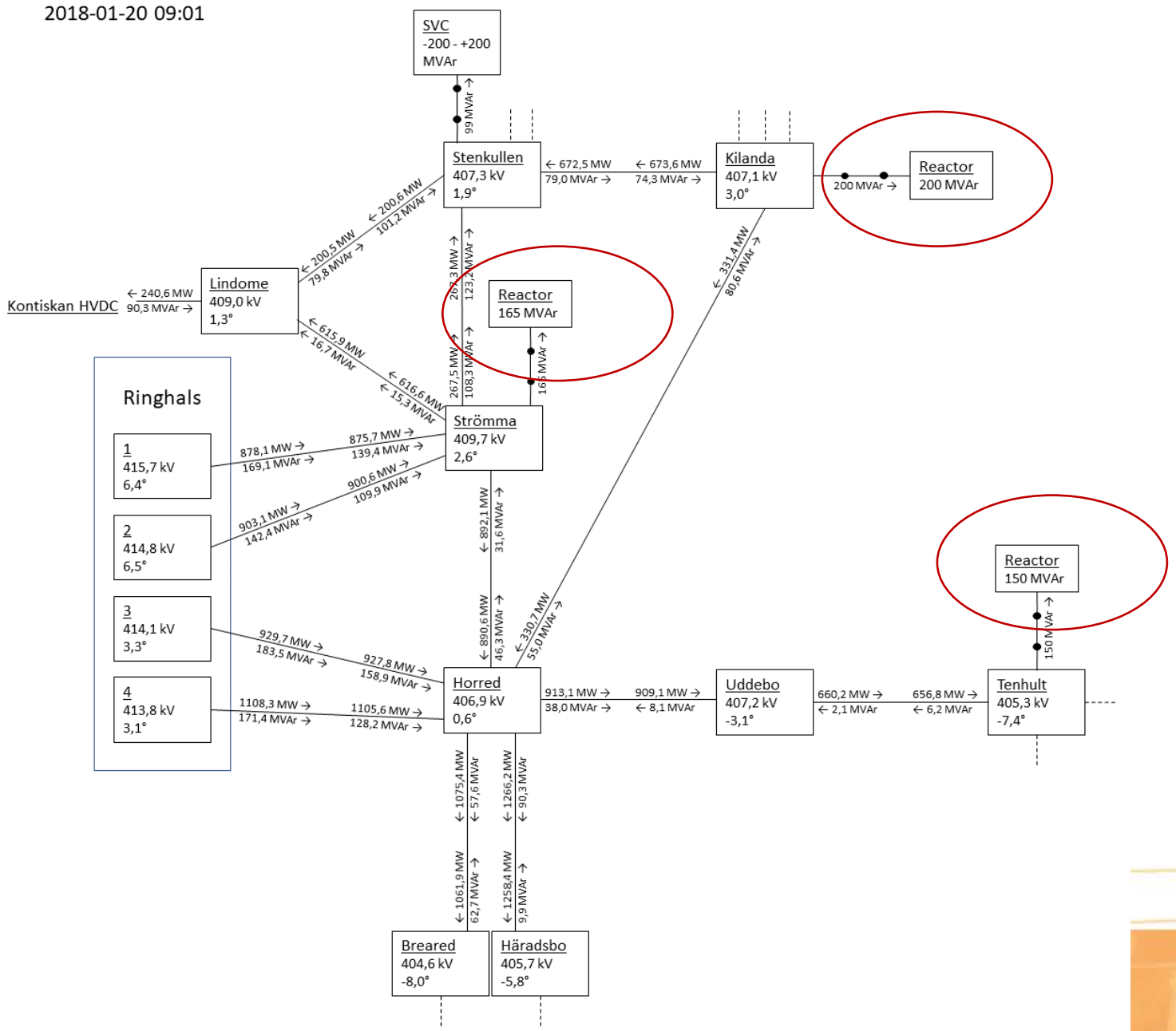
- Accuracy in general sufficient



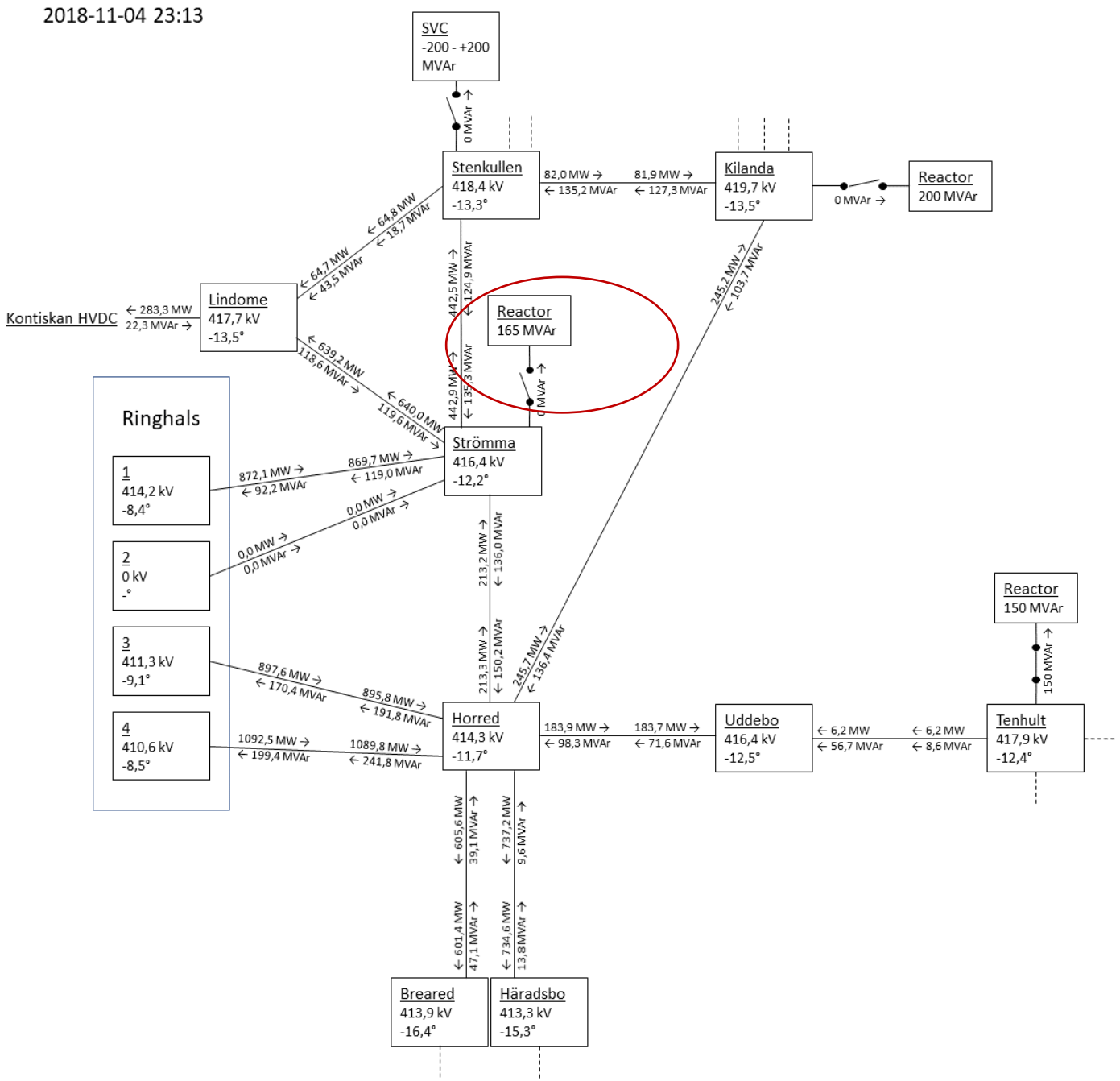
High voltage



High Reactive power export



High Reactive power import



Key findings

- During low load situations Ringhals absorbs reactive power
- Inefficient use of reactive resources
- SVC at Stenkullen either disconnected or absorbing reactive power

Future situation

- Decommissioning of Ringhals 1 and 2
  - Reactive power capacity
  - Short-circuit power
- Commissioning of STATCOM at Stenkullen
- Commissioning of South-West link

Conclusion, observations and suggestions

- Decommissioning of Ringhals 1 and 2
- Shunt control
- Distribution grids
- Reactive power capability
- Voltage control
- Communication between Svk and Ringhals

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