DISTRIBUTION R&D

2016-09-29, Dr Fredrik Carlsson

VATTENFALL'S HISTORY

From a domestic Swedish hydro power generator
to a European energy company

1909
The Swedish State Power Board is founded

1951
Inauguration of Harsprånget, A hydro power plant in Sweden

1999–2009
Acquisitions in Germany, Poland and Netherlands

2010-
Inauguration of UK offshore wind farm Thanet (300 MW)

1909–1950
Part of developing the Swedish energy system

1950–2000
Organic growth and national market deregulation

2000–2009
Major expansion in Europe

2010–
New strategic direction

1909–1916
First large hydro power plants: Porjus, Olidan, Älvkarleby, Sweden

1970–1980
Construction of 12 nuclear reactors in Sweden

2011–2014
Divestments of operations in Belgium, Germany, Finland and Poland

VATTENFALL

FRÅN ETT SVENSKT

TILL ETT EUROPEISKT

ENERGIFÖRETAG

Vattenfall 1999

- Nettoomsättning: 27 754 miljoner SEK
- Rörelseresultat: 5 435 miljoner SEK
- Elproduktion: 87 TWh

Vattenfall 2012

- Nettoomsättning: 167 313 miljoner SEK
- Rörelseresultat: 26 175 miljoner SEK
- Elproduktion: 178 TWh

NORDIC SYSTEM

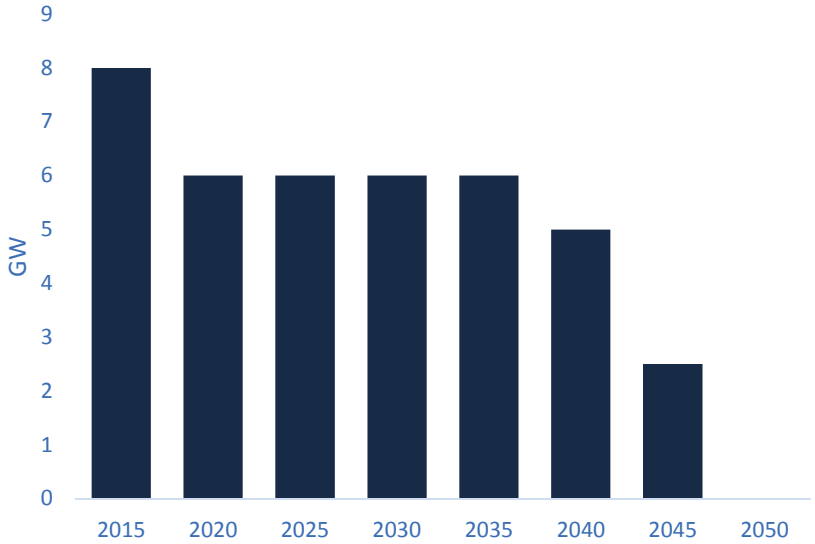
- Production Nordic: 400 TWh
- Production Sweden: 150 TWh

Source	Trend	Power	Energy	Utilisation Capacity
Hydro	→	16 GW	65 TWh	50%
Nuclear	↓	8 GW	60 TWh	80%
Heat	→	8 GW	15 TWh	20%
Wind	↑	6 GW	15 TWh	30%

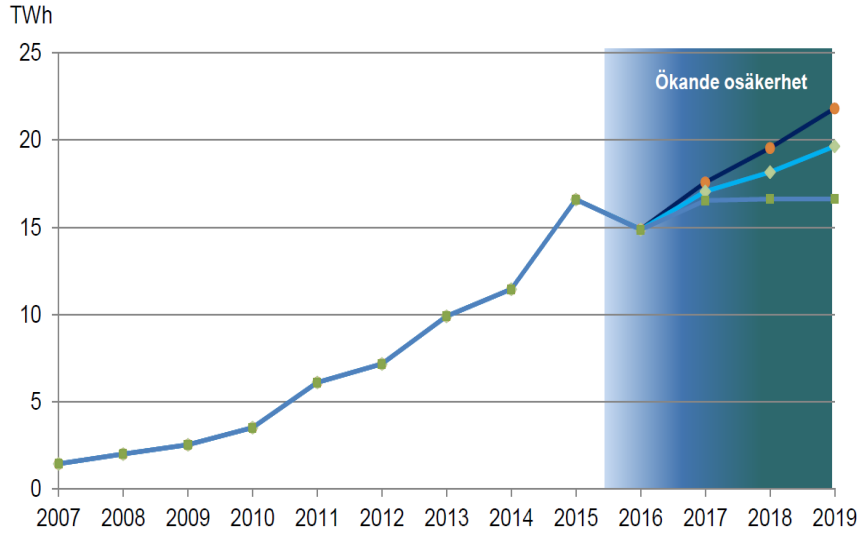
VATTENFALL

EXPECTED CHANGES

- Reduced nuclear power



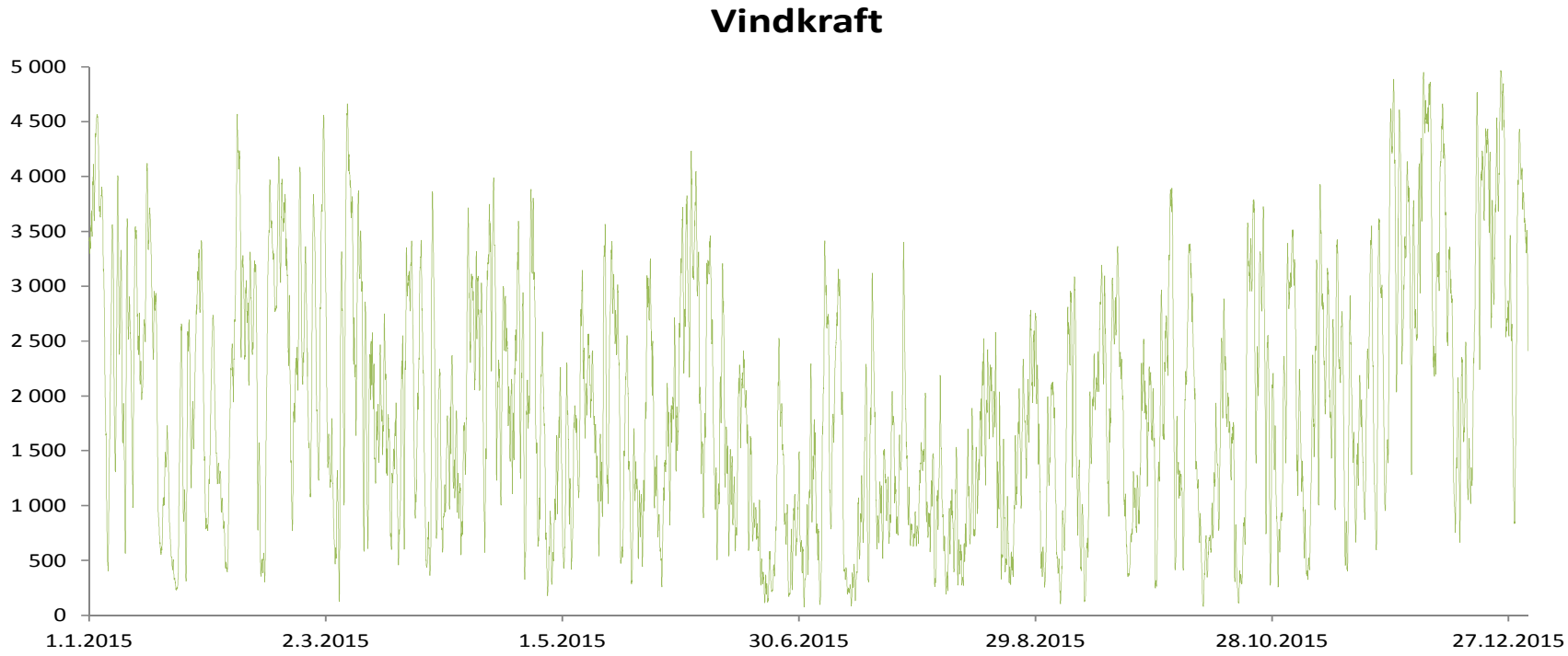
- New wind power



VATTENFALL

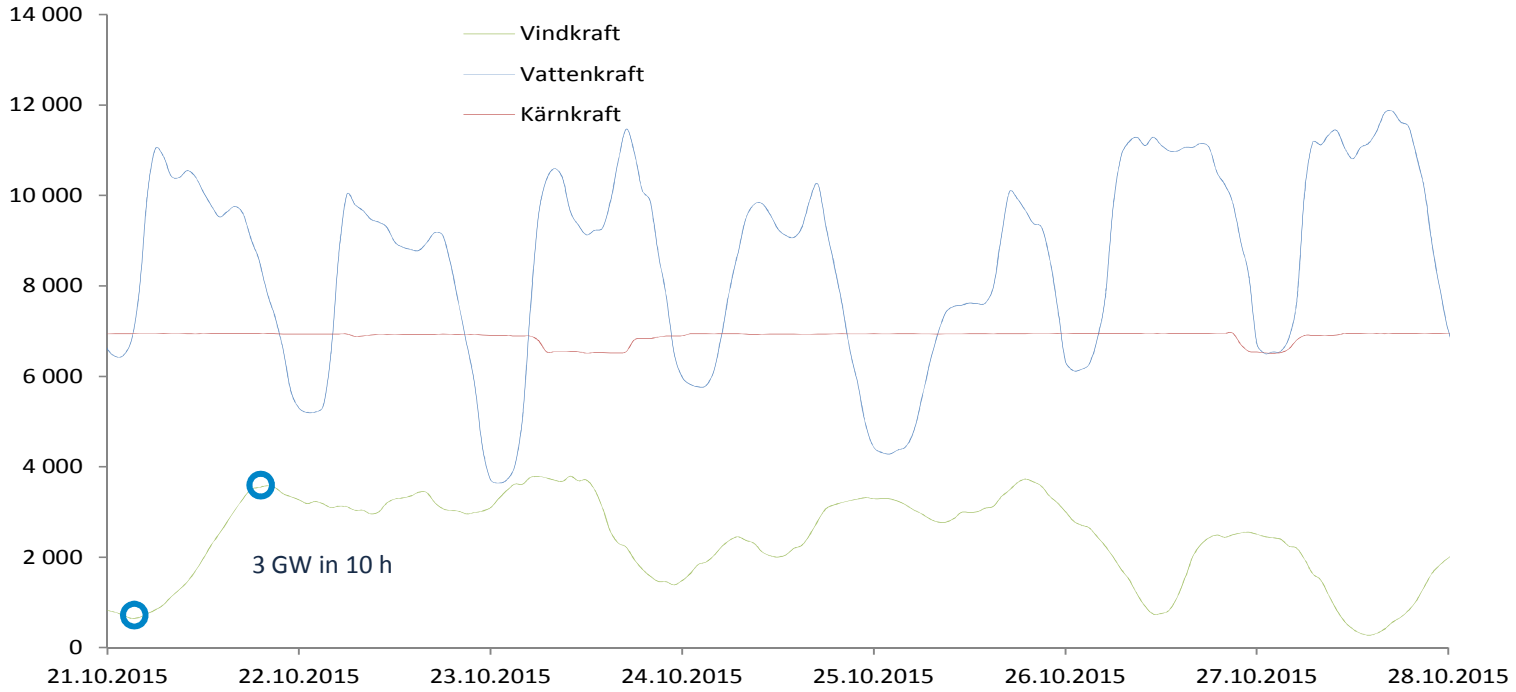
WIND POWER 2016

CHALLANGE OF VARIATIONS ?



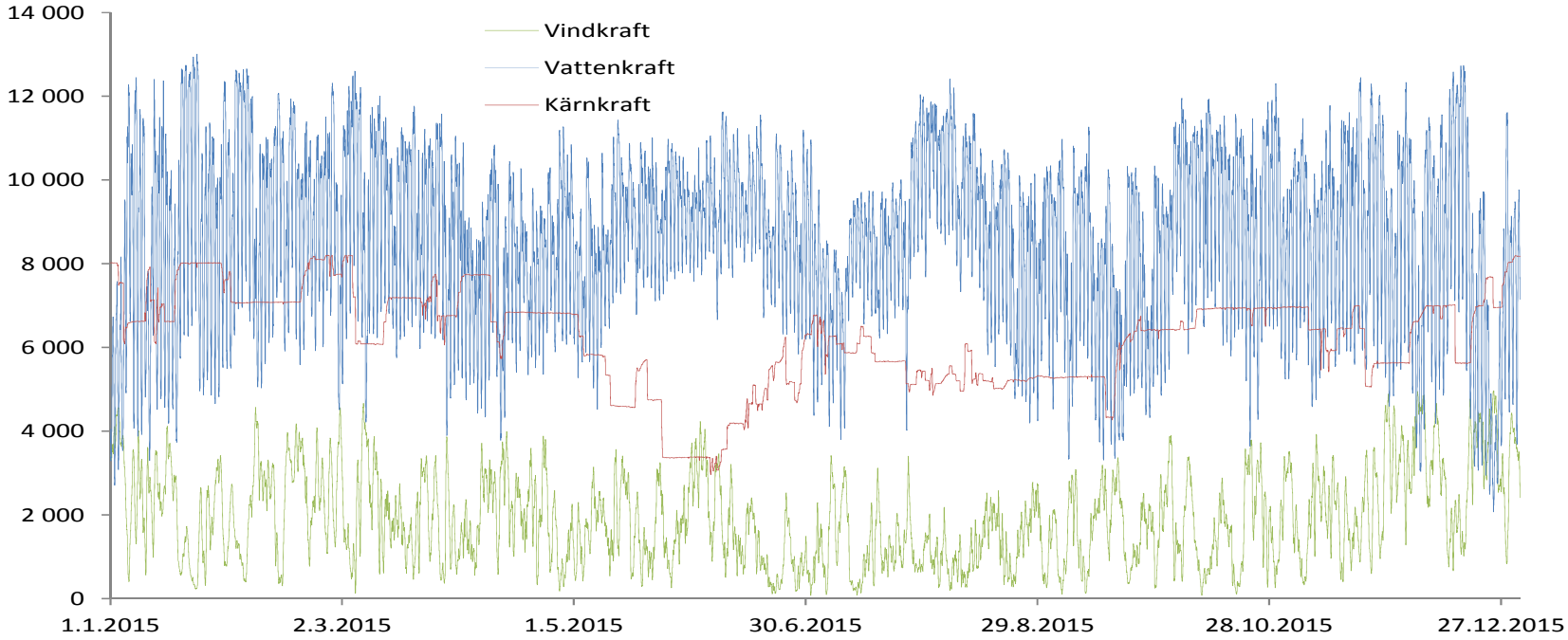
VATTENFALL

HYDRO POWER IS VERY FLEXIBLE



VATTENFALL

POWER SOURCES



VATTENFALL

DISTRIBUTION R&D SCOPE

- Asset management
- Network quality
- Network balance

- Smart meters
- Energy services
- Digitalisation

VATTENFALL

SMART GRIDS GOTLAND

Integration of Wind Power

Cost-effective increase in the maximum acceptable wind power production in existing power lines

Security of supply

Show that modern technology can help to increase power quality in rural networks

Smart Customer Gotland

Enables active customer involvement with the intent to displace 10% grid load

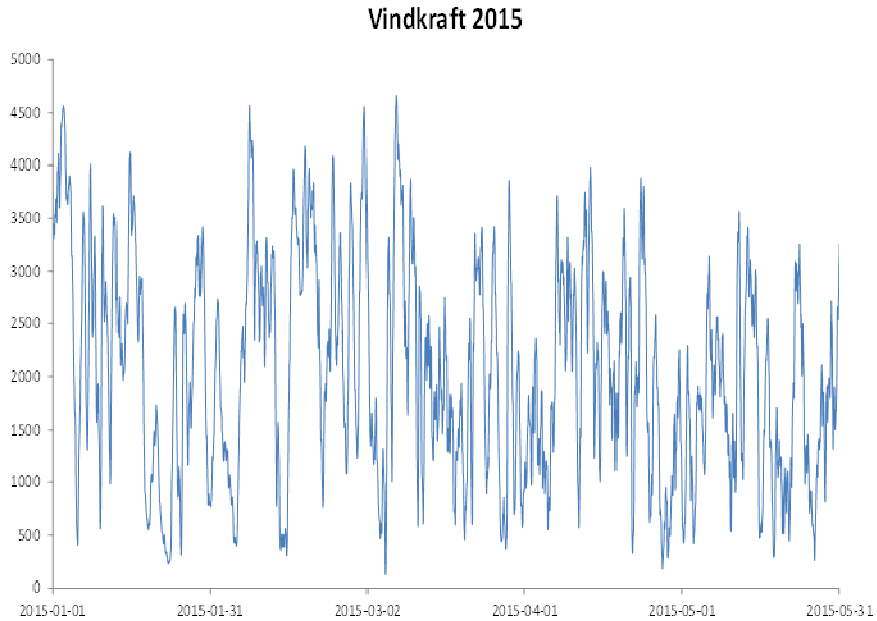
VATTENFALL

INTEGRATION OF WIND POWER

Hosting capacity

- There is always a limit on hosting capacity and network reinforcement is expensive.

- By increasing demand during peak wind production, more wind can be hosted.

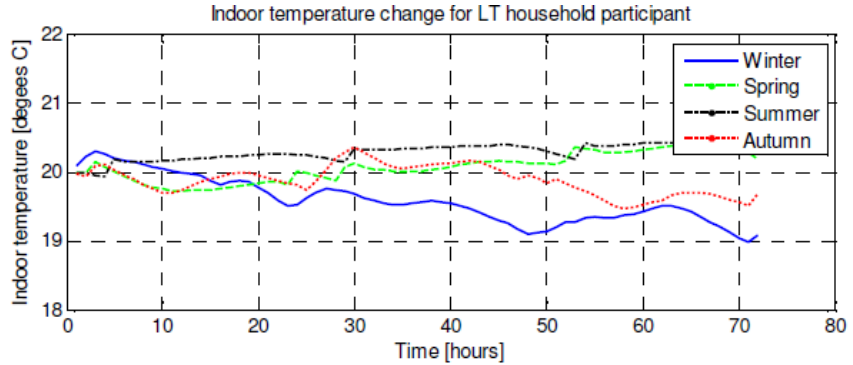


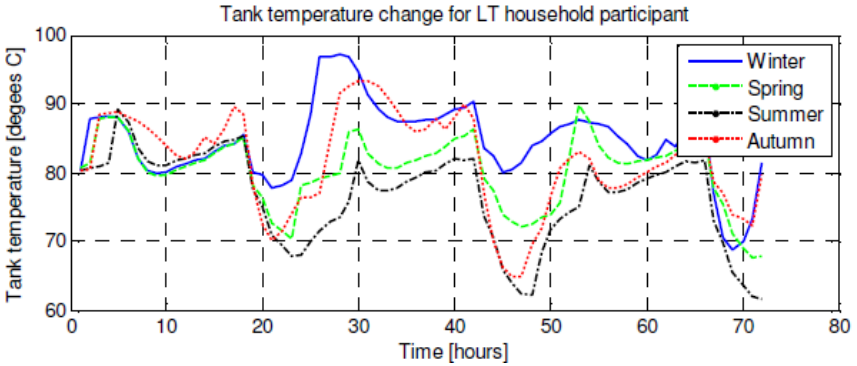
VATTENFALL

INCREASE OF THE HOSTING CAPACITY OF WIND POWER

Load shifting during critical transmission periods

- Study a Demand Response Controller (DRC) for domestic loads and industry.
- By controlling heat boilers and direct heating.
- When peak wind power occurs, boilers and direct heating is turned on.

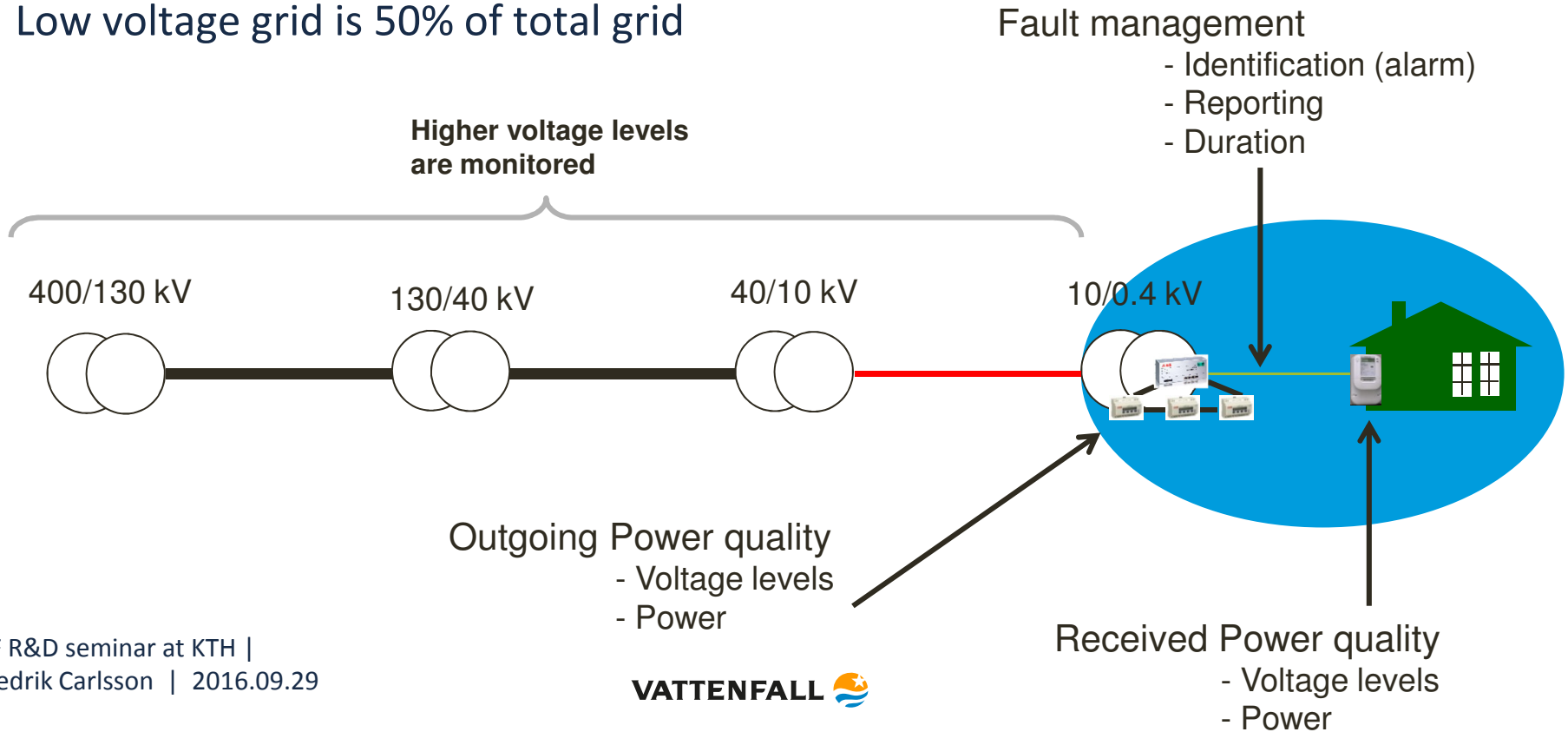




VATTENFALL

RELIABILITY - NETWORK MONITORING

- Low voltage grid is 50% of total grid



VATTENFALL

RELIABILITY

Surveillance on low voltage network

- Traditionally, the low voltage grid is not surveyed, the meter is used only for billing.
- The awareness of faults in the low voltage grid may be hours.
- Automatic and bi-directional communication

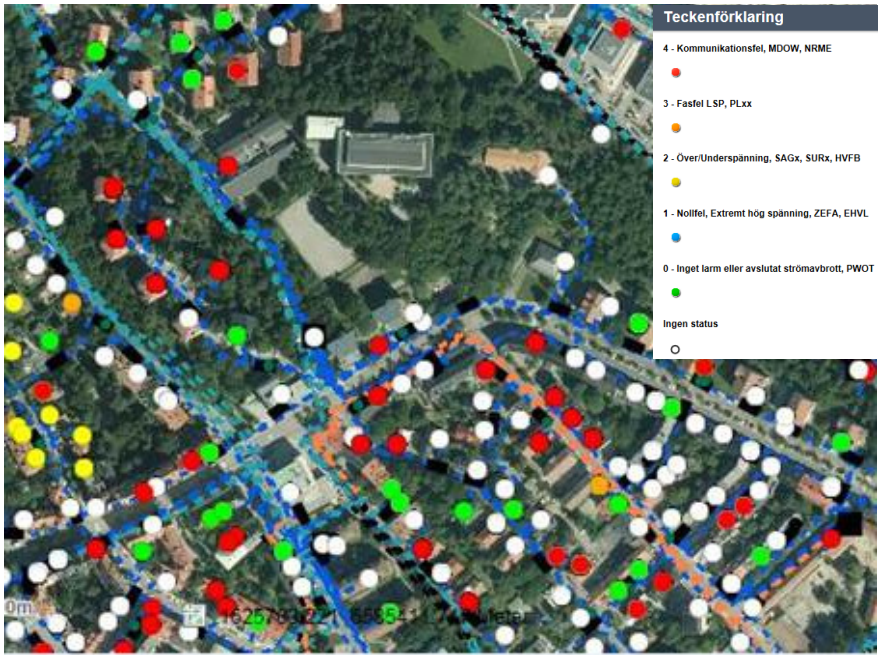
VATTENFALL

IMPROVED SECURITY OF SUPPLY

Low voltage network

- Fault and Power Quality Management

- Visualization of faults for both single feeders and Smart Meters

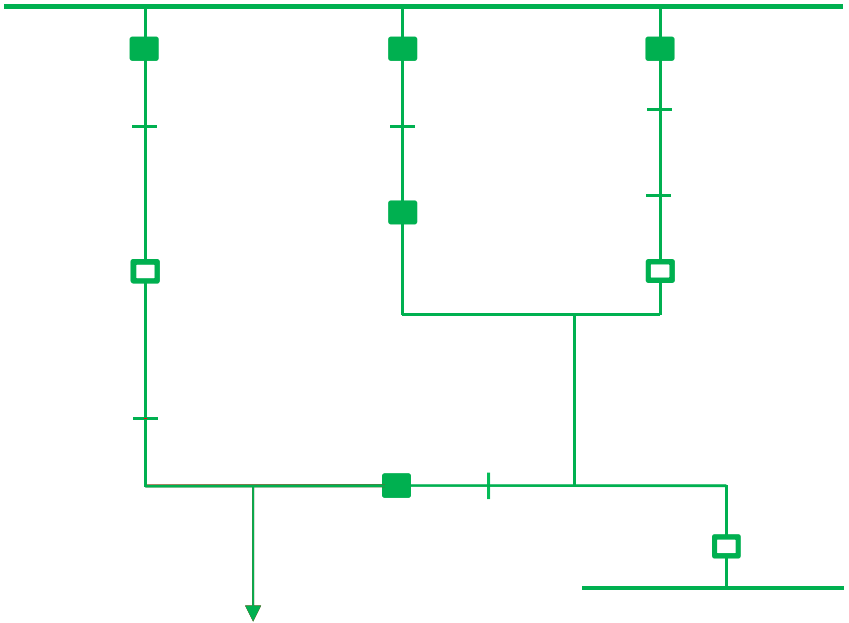


VATTENFALL

IMPROVED SECURITY OF SUPPLY

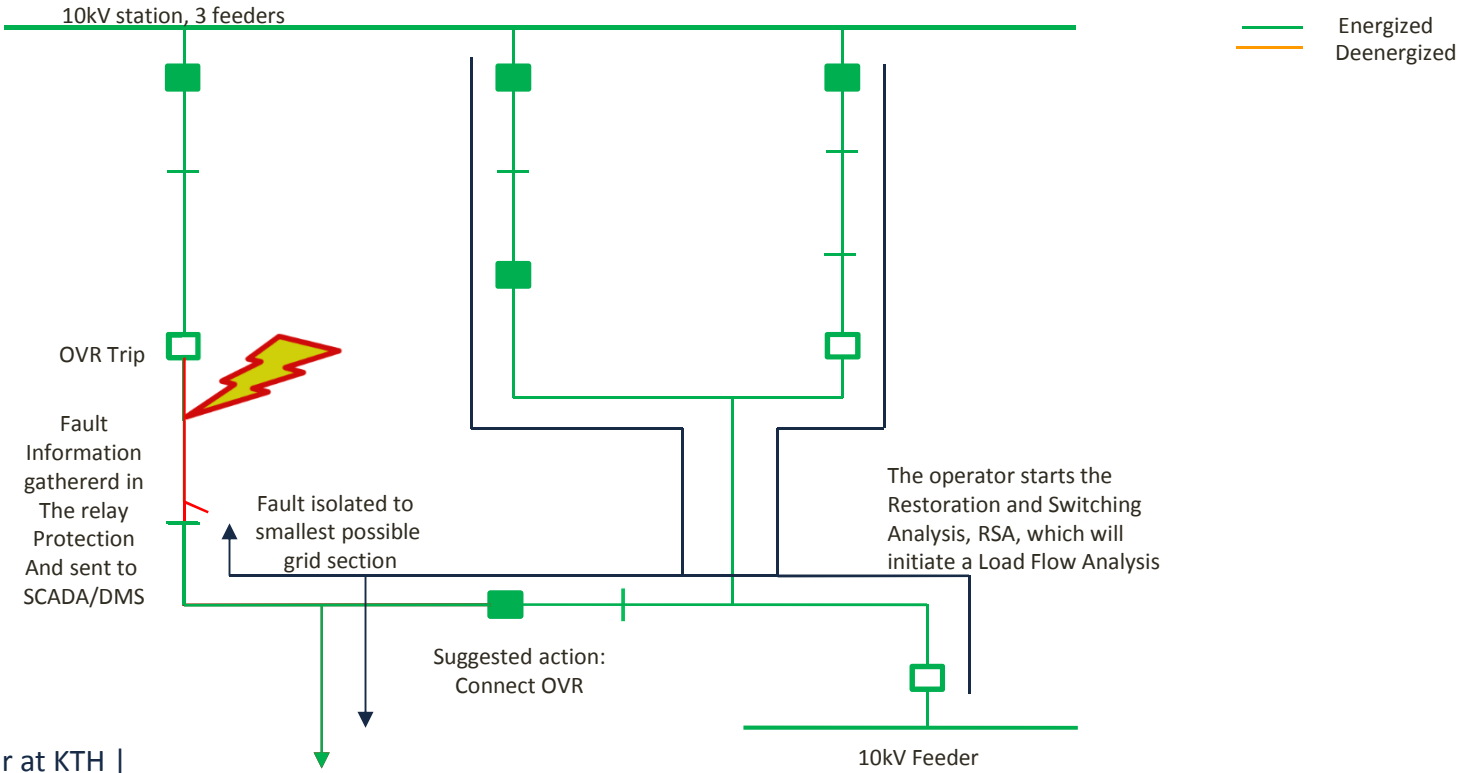
Medium Voltage network

- Faults in the medium voltage grid results today in disconnection of whole radial.
- Fault localisation and automatic disconnection schemes method reduces number of disconnected customers.
- Self-healing network is the goal.



IMPROVEMENT OF THE POWER QUALITY

ZONE CONCEPT WITH CENTRALIZED INTELLIGENCE



VATTENFALL

SMART CUSTOMER GOTLAND

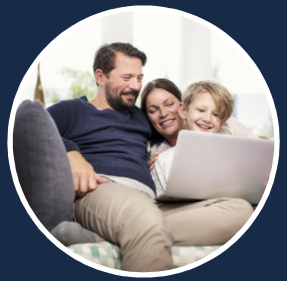
Active customer participation

- Enables active customer involvement
- Customer focused optimization
- Hourly prices and time of use tariff

SMART CUSTOMER GOTLAND

Develop technical platform

-Energy Watch



Recruit customers

-Saving
-Technology
-Environment

- 214 auto
- 50 manual

Run trial

Maintain customers

-Info
-Events
- Support

Analyse

Three questionnaires

Decom-missioning

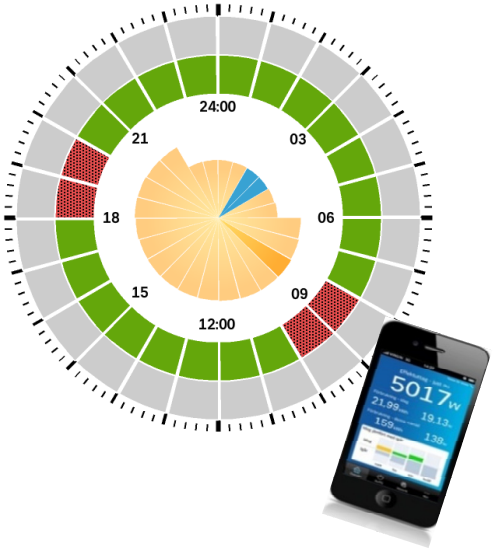
-Control
-Visualisation
-End

Autumn 2012 → 2016-05-01

VATTENFALL

ENABLE DEMAND SIDE PARTICIPATION ON THE ELECTRICITY MARKET – THE CUSTOMER OFFER

Price signals and automatic control of heat and warm water



Energy Watch real time visualization of electricity consumption

Customer support

Smart Kund web portal

Monthly bill

Energy Advice

SMART CUSTOMER ENGINE

- Nordpool Spot-price
- Wind prod forecast
- Temp forecast

Next-day forecast

Desired comfort level

- Economy +
- Economy
- Normal
- Comfort

Daily price signal

Real time

- Hot water boiler
- Electric boilers
- Heat Pump (Water)
- Direct electric heating
- Floor heating (electrical)

Type of heating system

”Over-ride” control

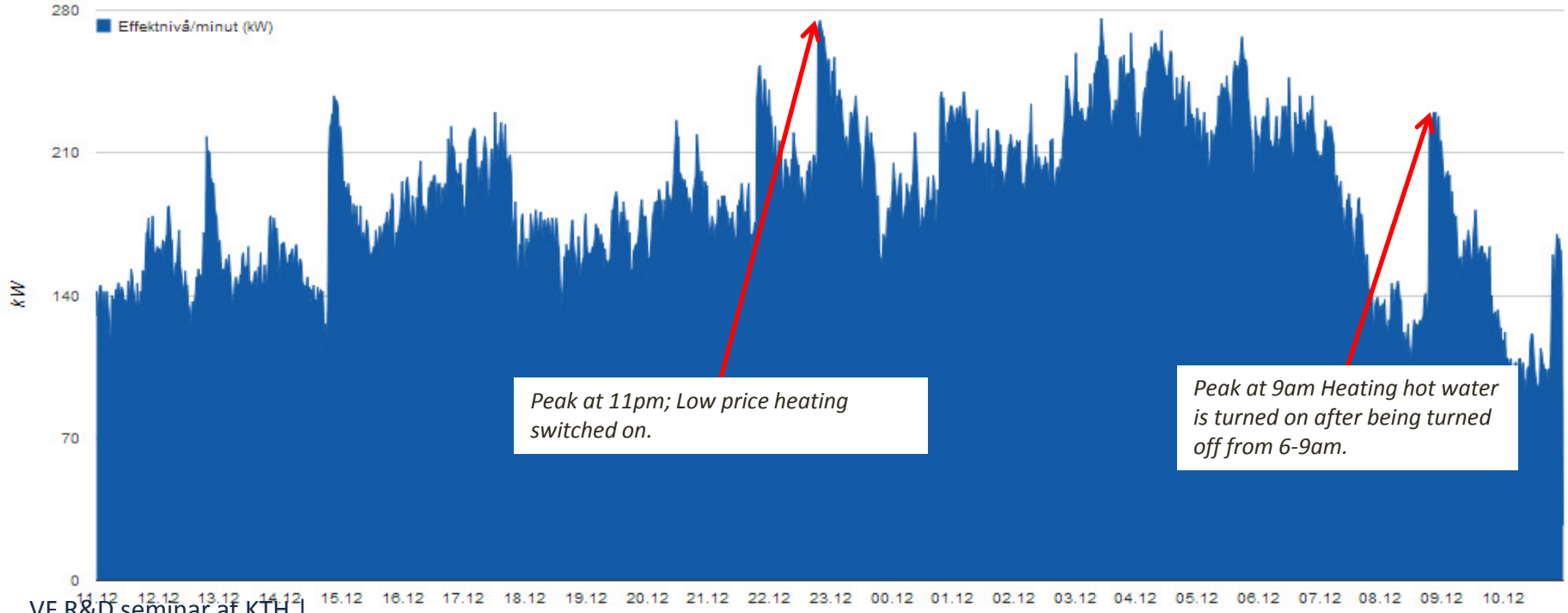
- Temp guard
- Customer controls on/off
- Temp guard or lost contact

VATTENFALL

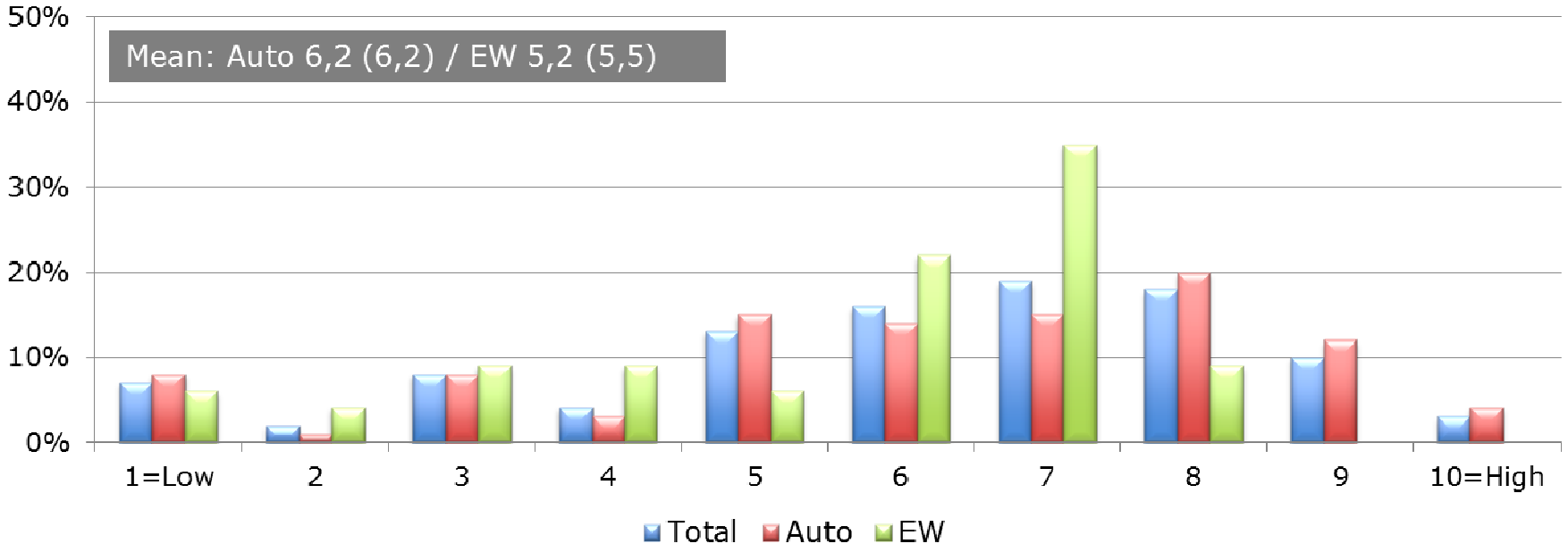
GEAB

sgg.energywatch.se/TotalChart

Effektuttag just nu: 298,6 kW Antal enheter: 217

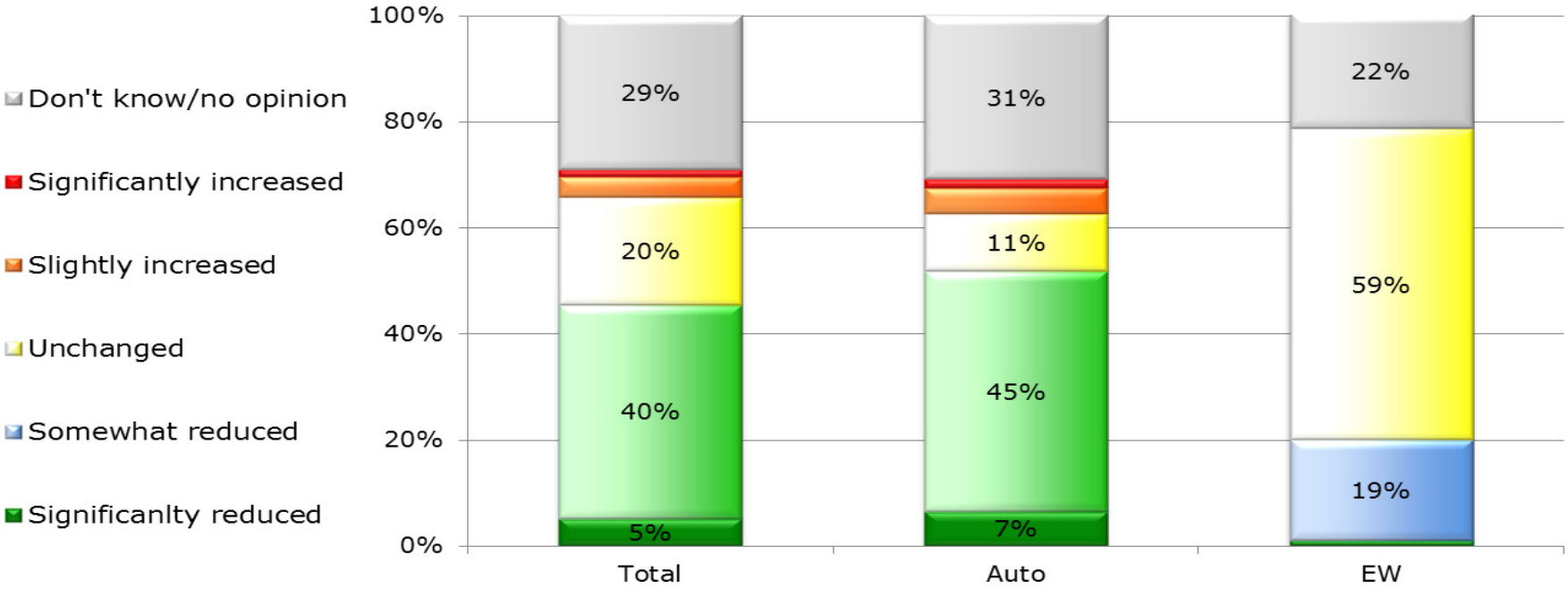


SUBJECTIVE INCREASE OF AWARENESS



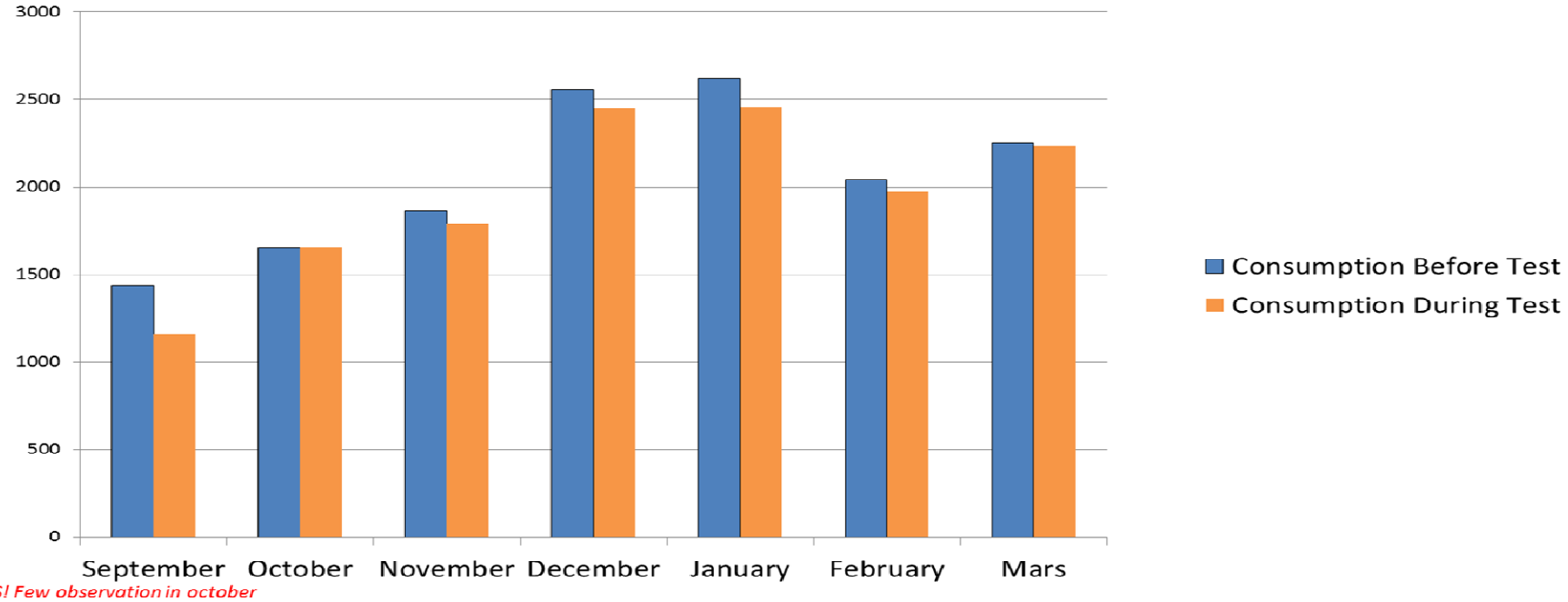
VATTENFALL

SUBJECTIVE COST REDUCTION



VATTENFALL

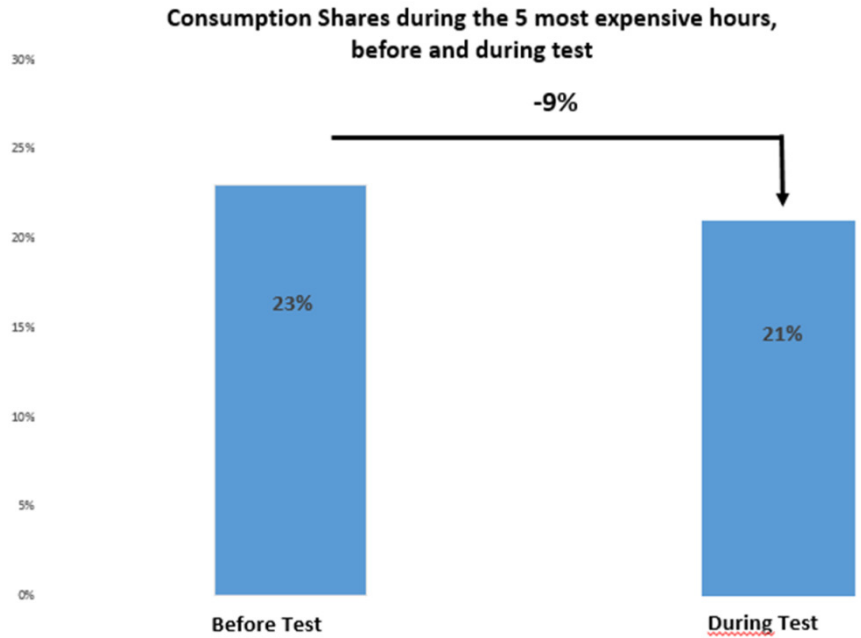
REAL CONSUMPTION CHANGE



OBS! Few observation in october

VATTENFALL

LOAD SHIFT



Consumption shares during the 5 most expensive hours

VATTENFALL

SUCCESS OR NOT?

	**Market Test - Contract**	Reinforced spot price, time of use tariff and used wind discount
	Market Test - Technology + Support	Commercial product with extra heat control component – expensive. A lot of extra support
	**Load shift 10%**	To reduced load – Works To increase load – Challenging
	**Satisfied customers**	No comfort problems. About 50% will continue after the trial
	**Reduced cost**	Yes, mostly thanks to time of use tariff. Spot price to flat

PARTICIPANT CHARACTERS

Smart Economic Family

Strive to lower cost

Smart Tech family

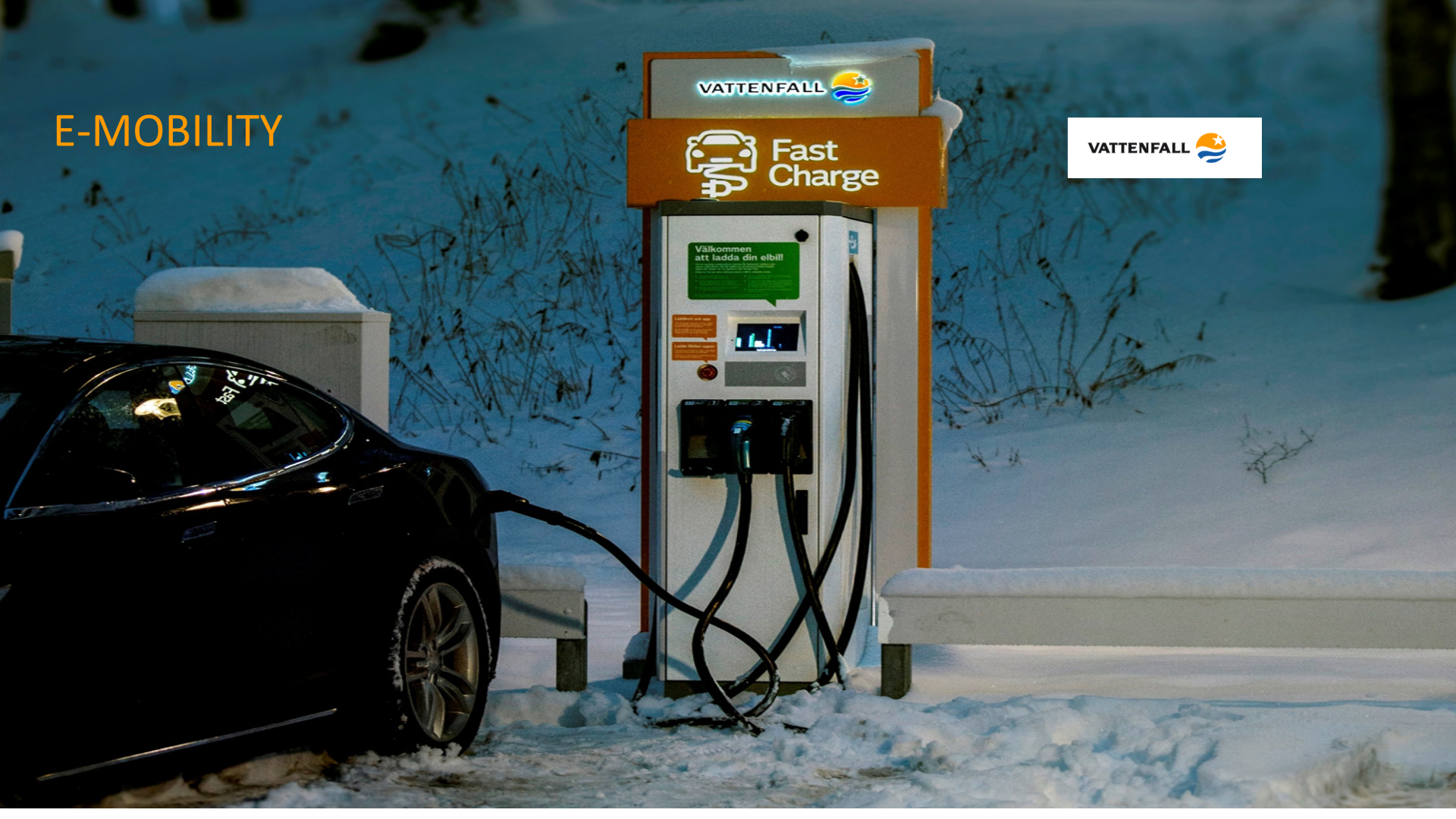
Like to test technical gadgets

Smart Environment family

Care for the environment

VATTENFALL

E-MOBILITY



VATTENFALL

DEMONSTRATIONSPROJEKT

- Från mars 2015 trafikeras linje 73 Ropsten-Karolinska med åtta laddhybridbussar.
- Pågår till årskiftet 16/17. Fortsättning diskuteras nu.
- Syftet är att visa att laddhybrider är ett fullgott alternativ till andra busstyper samt att tekniken kan sänka utsläpp, buller och energiförbrukning samtidigt som den ökar attraktiviteten, har hög prestanda och är ekonomiskt effektiv
- Parterna är SLL TF, Volvo Buss, och Vattenfall i samarbete med Keolis. Delfinansiering från EU.
- Ordinarie avtalsvillkor för linjetrafiken gäller.
- Bussarna drivs av förnybar el och HVO biodiesel

VATTENFALL

SNABBLADDNING

- Snabbladdas med ca 100 kW vid ändhållplats i Ropsten och Karolinska Institutet samt långsamladdas 11 kW över natt på depå
- Laddtid för fullt batteri 6 minuter.
- Laddningssekvensen startar automatisk när föraren stannat vid påstigningsmarkeringen för synskadade och satt an parkeringsbromsen.

The charging station has been procured and installed by Vattenfall. Vattenfall is also operating the stations during the project period incl. First Line Service.

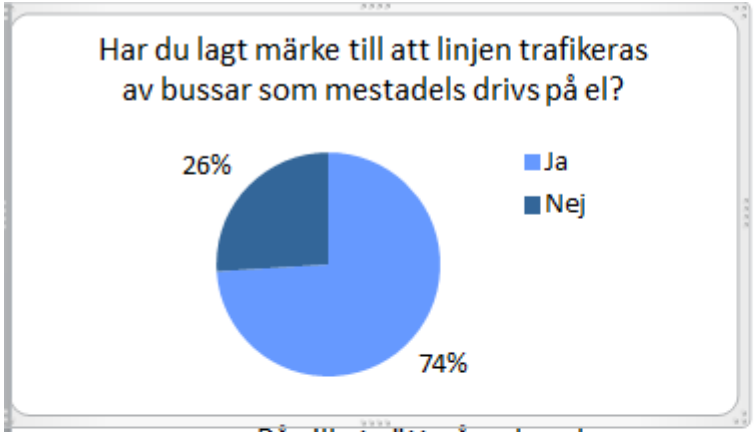
Fast charging at end stations

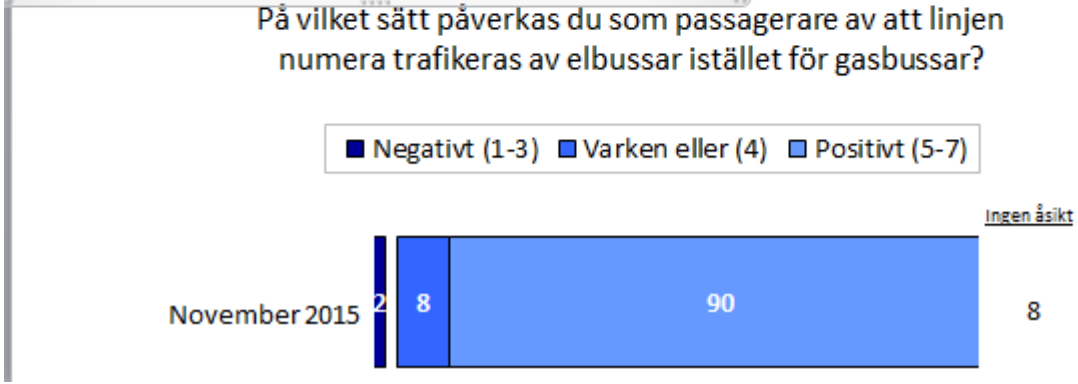
ERFARENHETER FRÅN EN ”BRA DAG”

Results from a ”Good Day” *(6/5 2016)*

- 74% of distance in electric mode, *i.e. no hybrid operation*
- 86% of time in electric mode (incl. idling)
- 11,4 l/100 km HVO consumption (total distance)
- 192 kWh/100 km (*HVO + electricity, total distance*)
- Energy savings (*ref Stockholm city bus fleet*)
  - 49 % lower than RME/diesel-hybrid
  - 74 % lower than biogas buses
- CO_2 reductions
  - ~ 93 % lower than diesel bus (*Swedish electricity mix*)

RESENÄRSUNDERSÖKNING

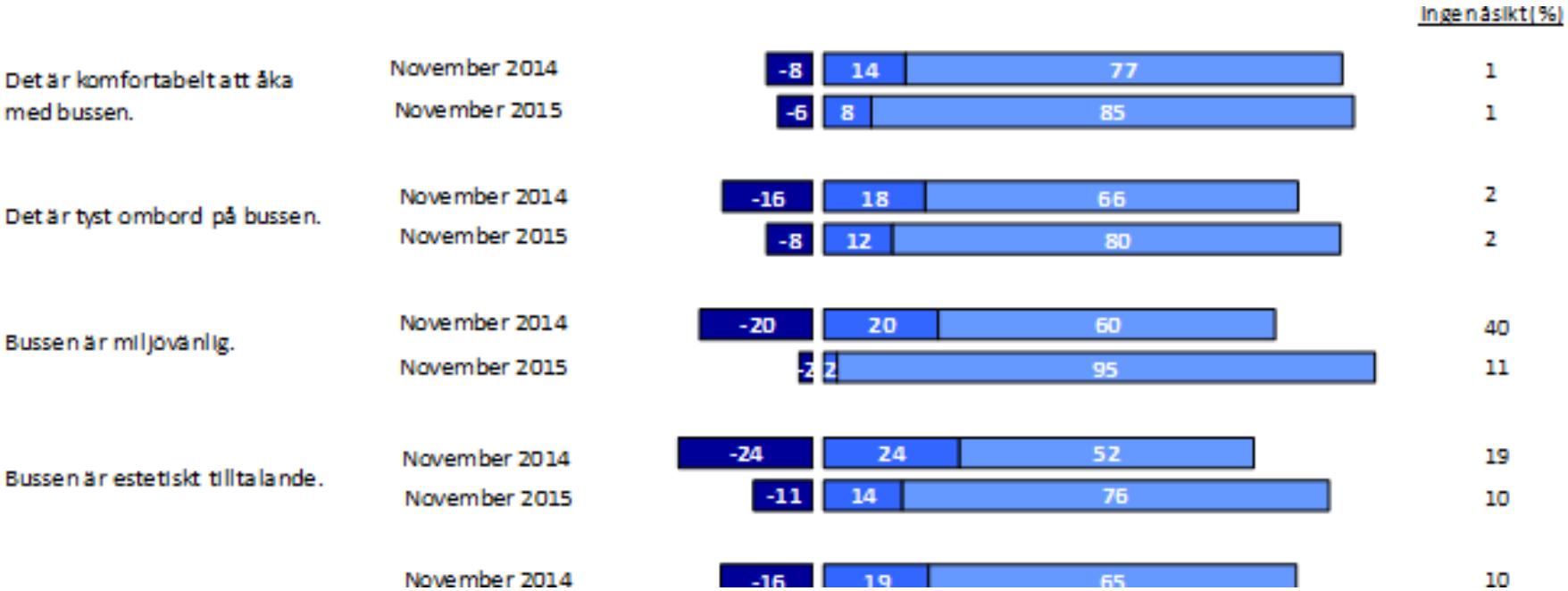




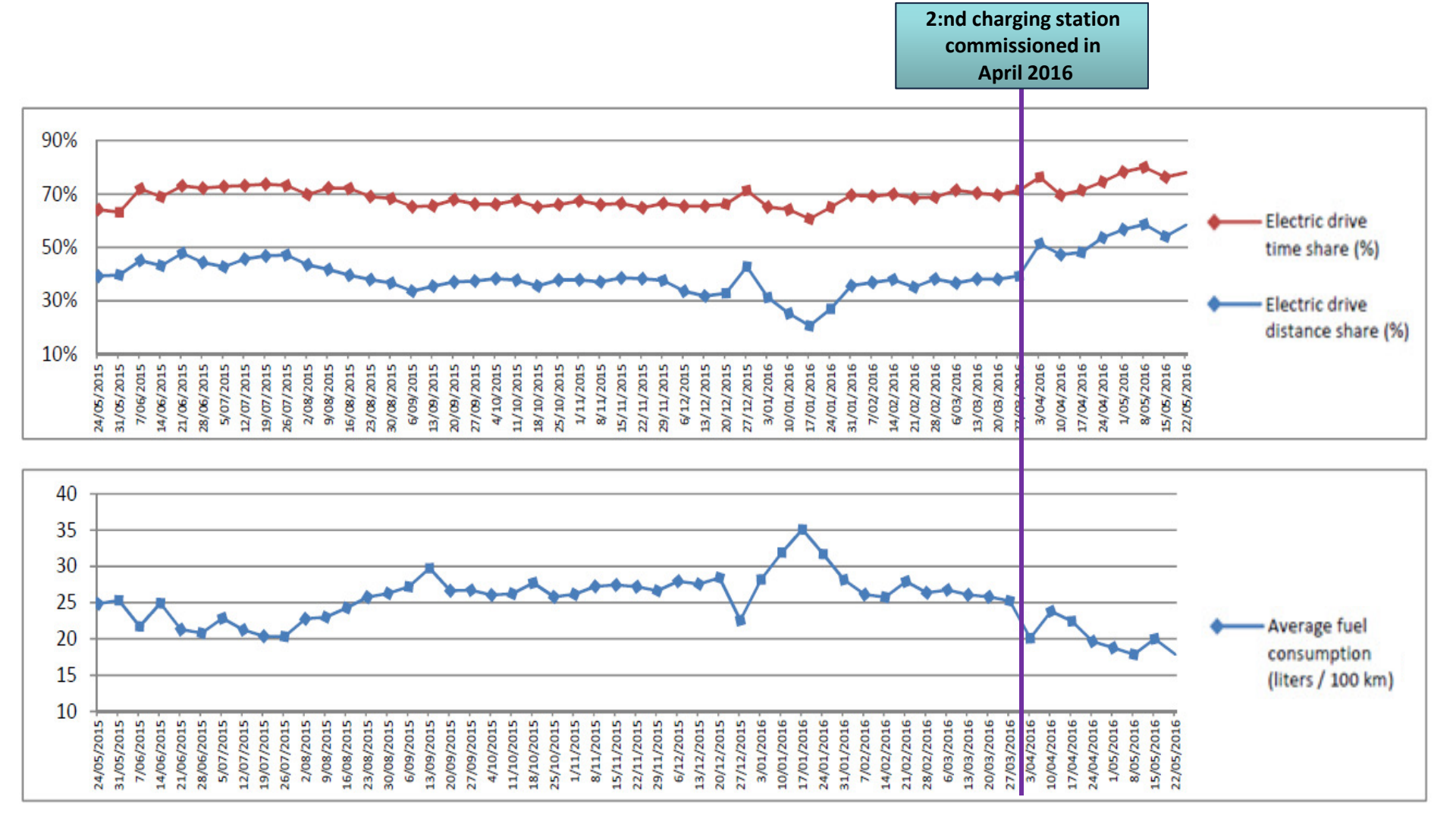
VATTENFALL

RESENÄRSUNDERSÖKNING

2014 avser biogasbuss



VATTENFALL


2:nd charging station commissioned in April 2016
90%
70%
50%
30%
10%
Electric drive time share (%)
Electric drive distance share (%)
40
35
30
25
20
15
10
Average fuel consumption (liters / 100 km)
24/05/2015
31/05/2015
7/06/2015
14/06/2015
21/06/2015
28/06/2015
5/07/2015
12/07/2015
19/07/2015
26/07/2015
2/08/2015
9/08/2015
16/08/2015
23/08/2015
30/08/2015
6/09/2015
13/09/2015
20/09/2015
27/09/2015
4/10/2015
11/10/2015
18/10/2015
25/10/2015
1/11/2015
8/11/2015
15/11/2015
22/11/2015
29/11/2015
6/12/2015
13/12/2015
20/12/2015
27/12/2015
3/01/2016
10/01/2016
17/01/2016
24/01/2016
31/01/2016
7/02/2016
14/02/2016
21/02/2016
28/02/2016
6/03/2016
13/03/2016
20/03/2016
3/04/2016
10/04/2016
17/04/2016
24/04/2016
1/05/2016
8/05/2016
15/05/2016
22/05/2016

STOCKHOLM DEMO OF ELECTRIC BUS LINE 73

Summary: Charging infrastructure provider for 8 plug-in hybrid electric buses with two automatic end stop fast chargers, including installation, operation, service and maintenance and supply of energy - wind power.

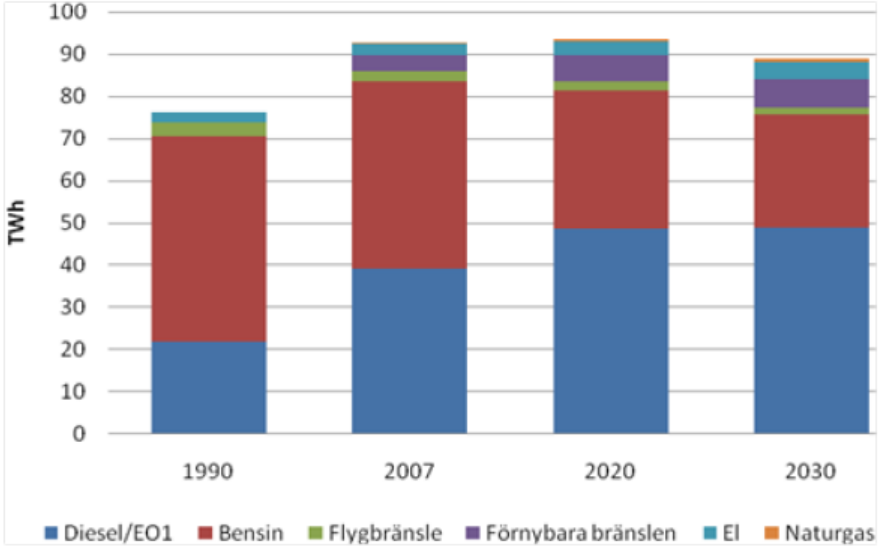
Results: Up to September 2016: Operation of 120 bus-month, 22 charge-month, aprox **20 000 separate fast charging occasions**. Conclusion at international seminar in Stockholm June 2016: ”Technically, it is now demonstrated that it is viable to operate plug-in buses in regular full-scale traffic” (SLL, Stockholms län Transport Administration)

Implementation: Vattenfall bus charging operator services is now offered by Vattenfall E-mobility Nordic, installations offered by Vattenfall Services .

ENERGIÅTGÅNG FÖR TRANSPORTER

- Verkningraden för bensinbil är cirka 20%.
- Cirka 10 TWh el behövs för all privatbilism.
- All transport förbrukar idag 100 TWh.

Figur 8 Energianvändning för inrikes transporter 1990, 2007 samt för prognosåren 2020 och 2030



VATTENFALL

SLIDE-IN PROJECT

- Vad krävs för att elektrifiering E4:an?
  - Hur långt mellan matningspunkter?
  - Parallellt 130 kV nät?
  - Hur långa sträcker behöver elektrifieras om fordonen har batterier?
  - Storlek på batteri?

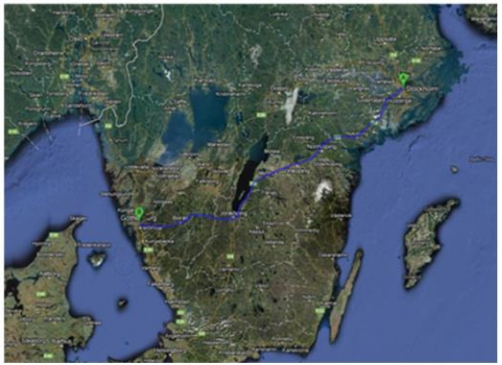


Figure 14 The highway from Stockholm to Gothenburg via Jönköping.

VATTENFALL


THANK YOU!