Fossil-free living within one generation

Vattenfall – Presentation at Chalmers

2019.09.25

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Who am I?

About me

- Chalmers alumnus (K 2001)
- 43 years old, born in Nossebro (on ‘Väschöttschlätta’)
- Living in Stockholm with fiancée and daughter
- Previously lived in Sydney, Porsgrunn (NOR), Edinburgh, Nottingham and Berlin
- Joined Vattenfall in 2009 as a flue gas treatment expert

Vattenfall at a glance

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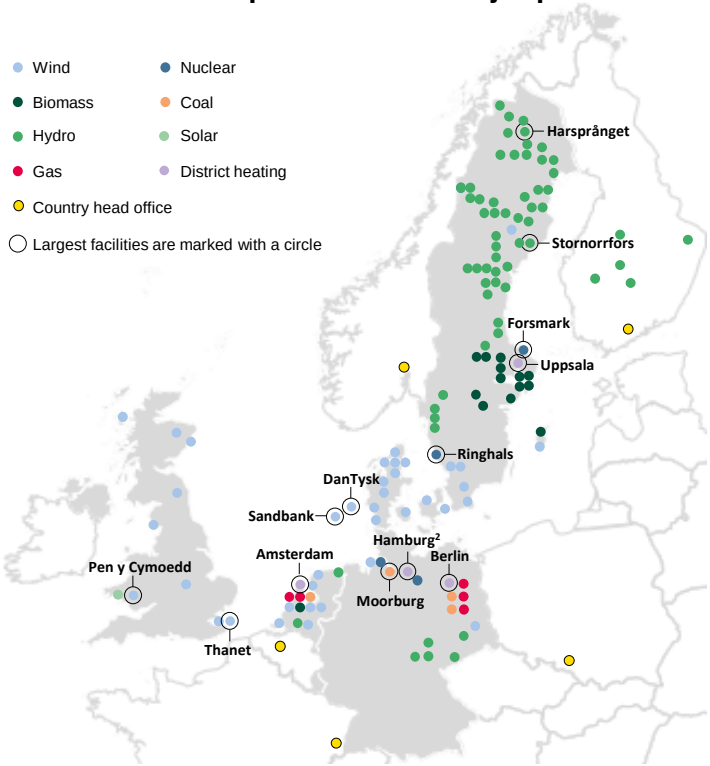
This is Vattenfall

Basic facts

- One of Europe’s largest producers of electricity and heat
- 100% owned by the Swedish state
- Main products: electricity, heat, gas and energy services
- Main markets: Sweden, Germany, Netherlands, Denmark and the UK
- About 20,000 employees

Location of our operations and major plants



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Vattenfall’s value chain

Production

Production from
- Hydro
- Nuclear
- Coal
- Natural gas
- Wind
- Solar
- Biomass
- Waste

Actively phasing out fossil-based production

Electricity distribution

- Guarantees secure supply via well-functioning distribution networks and smart network solutions
- Enables customers to feed self-generated electricity into the grid (“prosumers”)

Sales of electricity, heat and gas

- Sells electricity, heat and gas to consumers and business customers
- Focuses on various price and service models, and gives customers the opportunity to reduce their environmental impact

District heating

- Drives the transformation towards fossil-free heating and cooling solutions together with cities and regions
- One of Europe’s largest producers and distributors of district heating

Energy services & decentralised generation

Offers energy services
- Heat pumps
- Solar panels
- Charging solutions for electric vehicles
- Battery storage
- Network services
- Smart meters

Provides marketplaces and access to marketplaces where customers can buy and sell electricity

Vattenfall's journey (of late); From big baddie…

Tyska protester mot Vattenfall

Vattenfall continues to buy coal from conflict zones & emit high CO2 emissions despite climate goals; company response provided

Överpriset för Nuon: 53 miljarder

Vattenfalls köp av Nuon visar gång på gång att det är en rejält dålig idé. Det statligt ägda elbolaget betalade 53 miljarder för mycket för kolkraftsbolaget, visar Vattenfalls senaste kvartalsrapport.

…to purpose driven industry transformer!

Press release • 2019-09-23

HYBRIT highlighted as one of the most ambitious initiatives at UN Climate Action Summit

Press release • 2019-09-16

Vattenfall and Federal State of Berlin: Coal exit in Berlin by 2030 is possible

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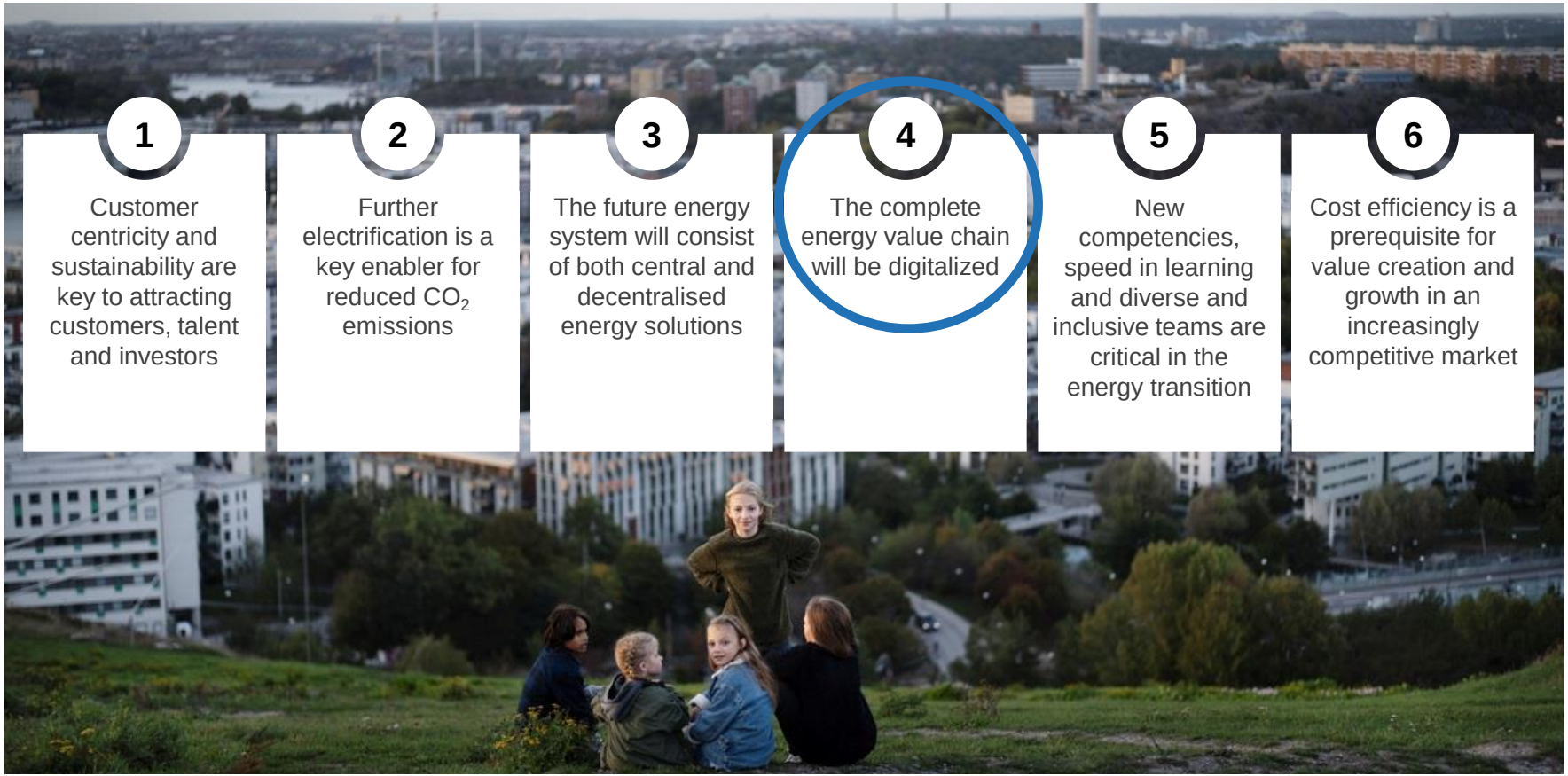
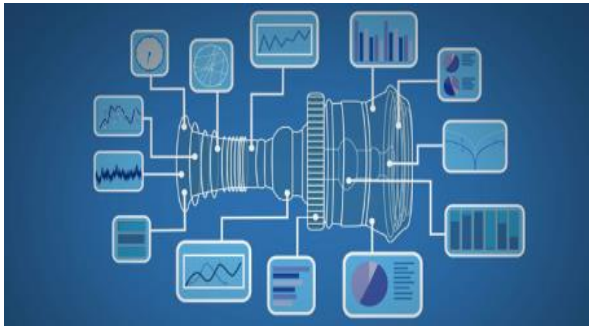
Core beliefs



1. Customer centricity and sustainability are key to attracting customers, talent and investors
2. Further electrification is a key enabler for reduced CO_2 emissions
3. The future energy system will consist of both central and decentralised energy solutions
4. The complete energy value chain will be digitalized
5. New competencies, speed in learning and diverse and inclusive teams are critical in the energy transition
6. Cost efficiency is a prerequisite for value creation and growth in an increasingly competitive market

Digitalization is relevant for all parts of Vattenfall



Customer experience

Operational excellence

New business models

We don’t have a digital strategy

WE HAVE A *STRATEGY FOR THE DIGITAL WORLD*

Digital is moving to the core of business strategy.

Investing in **disruptive business models**

Smart meter roll-out in district heating grids in Germany

Focus on **digital customer journeys**

Agile business development and sales forces

Advanced analytics, VAP and forecasting

Digital DSO

Recruit and retain **key competences incl. new digital competencies**

Digitalization of processes

Internal **innovation** competitions

Data governance and **information security**

Staff function 4.0

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Introduction

Vattenfall R&D - The movie

Mission

- Our premier mission is to create value by supporting Vattenfall’s business areas in achieving their strategic objectives and operational targets

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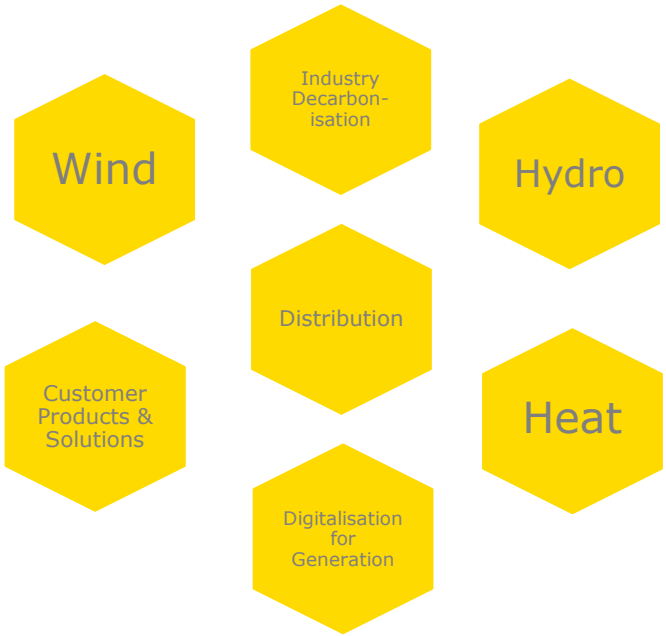
Organisation

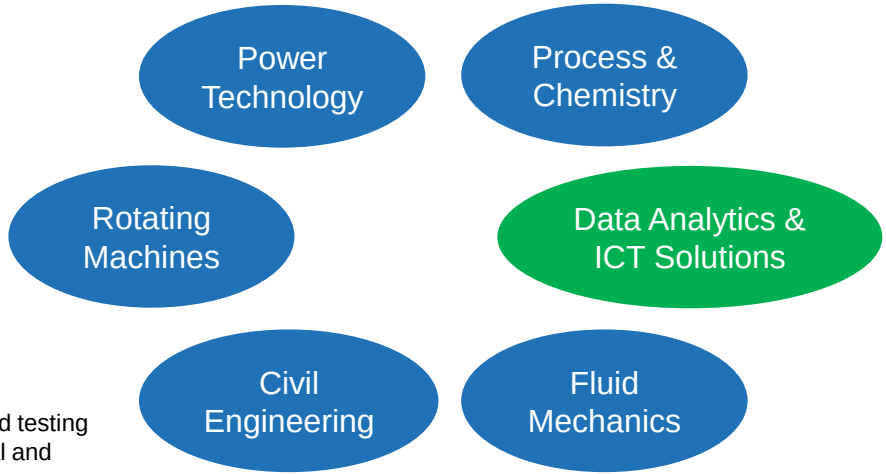
Overall budget: Roughly 190 MSEK
Employees: ~ 115

7 R&D Portfolios (what?)



6 Depts / Sections (how and whom?)

Strategic R&D:
Development, Demonstration, Deployment



Tactical R&D:
Problem solving, qualified testing and validation for internal and external customers

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Laboratories

Fluid mechanics laboratory

Hydraulic machinery laboratory

Accredited byproduct laboratory

Combustion and fuel laboratory

Materials technology laboratory

ICT labs

Accredited concrete technology laboratory

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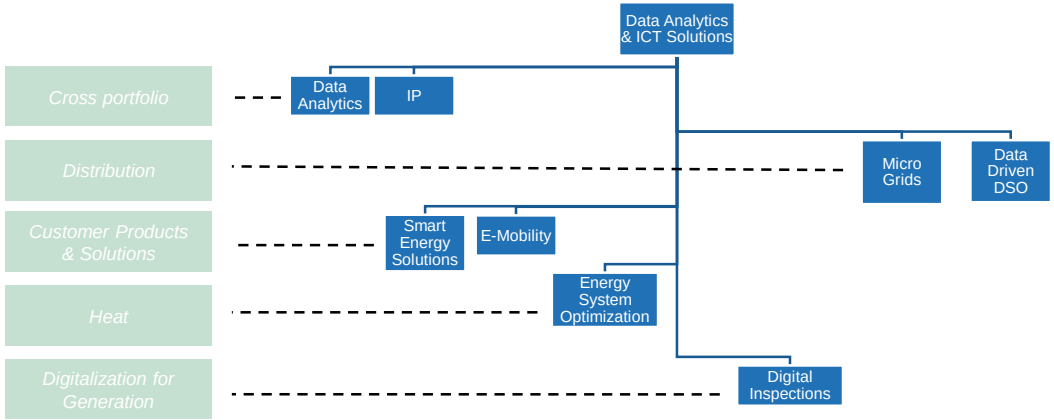
My department
(Data Analytics & ICT Solutions)

People

- 22 full time employees
  (incl. Head of Department)
- 4 trainees on secondment
- 12 consultants
- 1 master’s thesis student
- 72% male, 28% female
- 9 different nationalities
- Offices in Stockholm, Älvkarleby, Edinburgh (UK), Kolding (DK)

General profile

- Eight running agile teams with DA & ICT staff;
  - Data Analytics
  - Data Driven DSO
  - Digital Inspections
  - E-Mobility
  - Energy System Optimization
  - IP
  - Micro Grids
  - Smart Energy Solutions
- First-rate technical acumen within;
  - Data Engineering, Data Science & Machine Learning / AI
  - ICT, IoT & IT Integration
  - AR / VR
- Expertise in;
  - Business Analysis
  - Intellectual Property (IP) Processes
- A mix between technical specialists, business analysts and assignment / project managers



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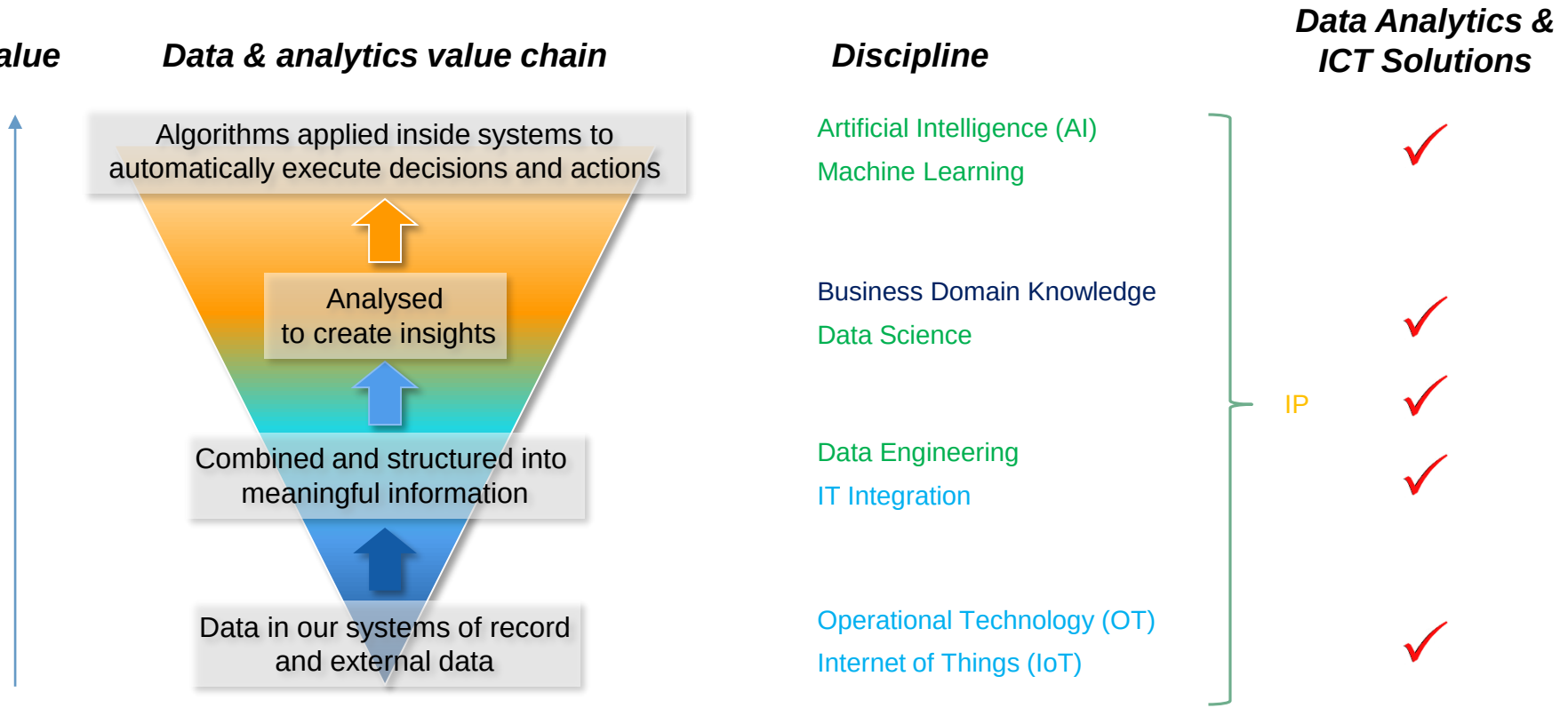
Expertise along the entire data & analytics value chain



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Lab facilities

- **ICT Labs**
  - Smart Home i-Lab
    - A flexible integration lab designed as a modern studio flat, for testing and demonstration of;
      - Decentralised energy solutions, e.g. batteries, PV, EV charging
      - Digital energy management systems
      - Smart home technologies
  - XR Lab
    - Space for experience and testing of AR / VR equipment
  - ICT Workshop
    - Multipurpose ICT and low voltage laboratory
      - Pre-testing and development of all of the above on a individual basis
  - Battery Container
    - Isolated test bed for battery testing
      - Separated for fire safety purposes
  - Server Room
    - TestNet
      - Flexible and secure IT environment
      - Network connecting server room with Smart Home i-Lab and ICT Workshop
      - Mail server, data storage, clientless VPN access, VPN bridges to external sites
      - Prototyping, mock-ups and demos, vendor proofing and testing
    - Älvkarleby Computing Cluster
      - Modelling, forecasting and calculations
- **R&D Azure Account**
  - R&D's own sandbox environment underneath VF's enterprise agreement

Microsoft Azure

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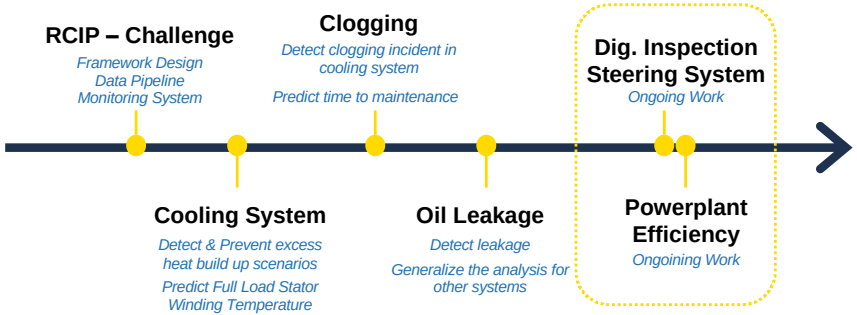
Examples of recent activities

Data Analytics - Predictive maintenance

- Machine Learning & Advanced Analytics to determine the condition of powerplants
  - 100% data-driven approach
  - Close collaboration with domain experts
  - Design of experiments (data-labeling)
  - Ä-by G6 , Laxede G3, Ligga G3
- Current work
  - Automated digital inspection of steering system (runner & guide vane)
  - Powerplant operation efficiency



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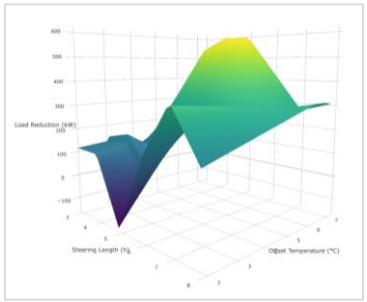
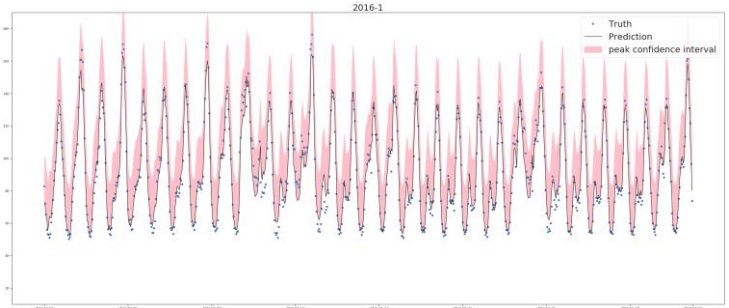
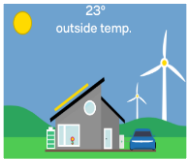
Data Analytics - Forecasting

- Intelligent optimisation & control → Energy savings & availability
- Machine learning & advanced analytics
  - EV forecasting
  - PV forecasting
  - Electricity forecasting
  - Heat load/consumption forecasting
  - Disaggregation and insights





E-Mobility PoC



HEM PoC

Haga PoC

Jungheinrich PoC

Showcase Gustavsberg

RPC PoC

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Smart Energy Solutions – Energichecken customer app

Value

- Support Vattenfall needs to gradually shift towards offering differentiated energy solutions and EaaS to our customers.
- Digital offerings and the customer journey.
- First step towards selling value added and data driven HEM services that we can charge with different revenue set ups

Objectives

- Install and test new market hardware (“real time” measurement) and develop a customer friendly user interface.

Stake-holders

- Receiver: C&S, DES Nordic
- Partners: Vattenfall IT, Sigma Consulting, potentially Digital Development CS

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Smart Energy Solutions – Consumer flexibility

Value

- Additional revenue to Vattenfall by delivering FCR
- More sustainable profile - Vattenfall and customers

Objectives

- Support BU to:
  - continue to implement FCR for large customers
  - roll-out FCR in Sweden with partner Sympower
  - influence SvK to implement feasible requirements

Stake-holders

- Customers: B2B in Sweden and Finland
- TSOs/FCR market open: Fingrid Jan 2017, SvK May 2019
- Technology partners and type of load:
  - Sympower – small/medium, Empower - large

Examples of customer segments with flexibility

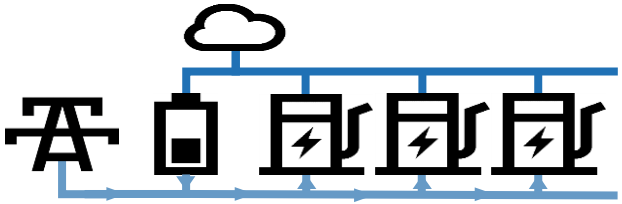
E-Mobility - Energy storage and smart steering

Value

- Meet increased customer demand for charging in city centre
- Develop Vattenfall controller through implement steering of charging stations and increase level of sophistication in operations
- Understand secondary income streams from e.g. FCR and intraday trading through aggregation and steering of batteries and charging stations

Objectives

- Commission a battery powered charging hub in Amsterdam
- Develop controller for optimizing economics of operations
- Pre-develop battery powered charging hub product from BU E-Mobility



E-Mobility – eRoad Arlanda

*ERS – Electric Road Systems

Value

- Key business intelligence (technology supplier & OEMs, logistic & commercial partners) in ERS*
- Surveillance & learnings from operational/ demo phase (e.g. technology readiness, commercial readiness)

Objectives

- Support BUs in taking strategic position in Swedish ERS opportunity
- Via national stakeholder platforms, pre-commercial innovation pilots (e.g. eRoadArlanda) & system level pilot(s)

Demonstration phase inauguration (April 2018) – captured international media attention

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All of these activities require ICT and data analytics competences in some shape of form! ☺

How to start with Vattenfall?

- Job portal
  - https://careers.vattenfall.com/

- Master theses
  - Published in the job portal

  - A good entry point

  - But don’t wait for something to be published, think through what you want to do and pitch it to us!


Thank you for you attention!