Digitalization – a key enabler of the energy transition

Ambra Sannino
Vice President R&D

2024-05-16

Outline

- General intro – myself and Vattenfall
- Vattenfall R&D
- 3 D’s of the energy transition
- Why is digitalization a key enabler?

What is this picture on the right?

“Future energy system according to Vattenfall” – at least if you ask Dall-E 3 integrated in Bing

Introduction

About myself
Ambra Sannino

M.Sc. Electrical Engineering, 1997
Ph.D. Power Systems, 2000

2001-2004: Post-doc > Assistant Professor > Associate Professor

2004 – 2018:
Corporate R&D: Project Manager > Team Manager
R&D / Technology Manager, for FACTS, Substations,
Product Manager for Power Quality Solutions

2019 – 2023:
Business Director, Power System Analysis
Head of Department Power Systems, Northern Europe

VATTENFALL

Since August 2023:
Vice President,
Research and Development

IEEE Senior Member
Cigré member

Board member
of Kraftkvinnorna
and Power Circle

KRAFTKVINNORNA

POWER CIRCLE
Electricity for sustainable energy

This is Vattenfall

Activities in the Value Chain ● Active ● Inactive

Upstream | Production | Transmission | Distribution | Trading | Retail | Services

In Brief

- A leading European energy company
- We want to enable the **fossil freedom that drives society forward**
- We are driving the transition to a more sustainable energy system through **growth in renewable production** and **climate smart energy solutions** for our customers
- **100% owned by the Swedish State**

8.0 Million
Electricity customers

2.1 Million
Heat customers

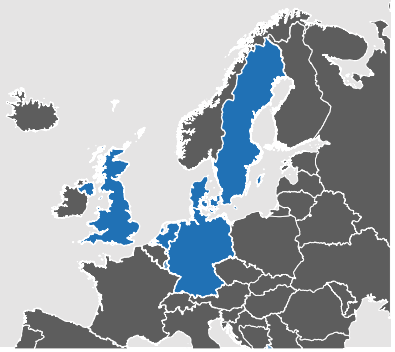
1.0 Million
Electricity grid customers

2.3 Million
Gas customers

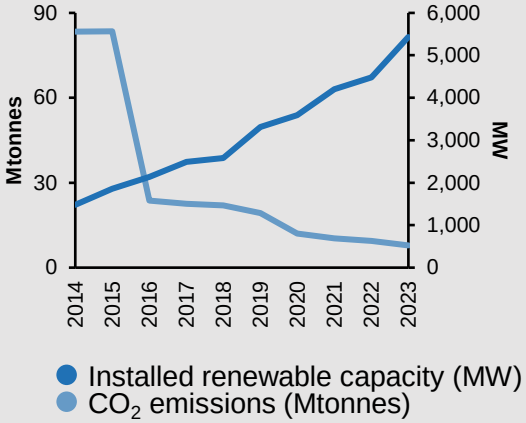
20 995
Employees

Main markets

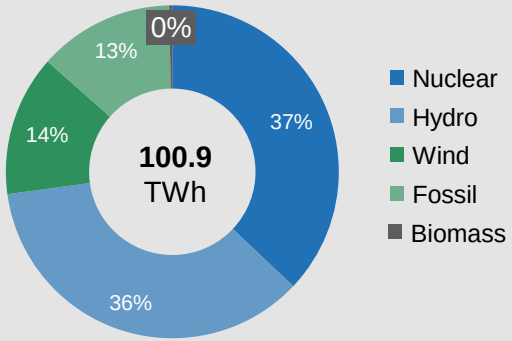
- Sweden
- Netherlands
- Denmark
- UK
- Germany



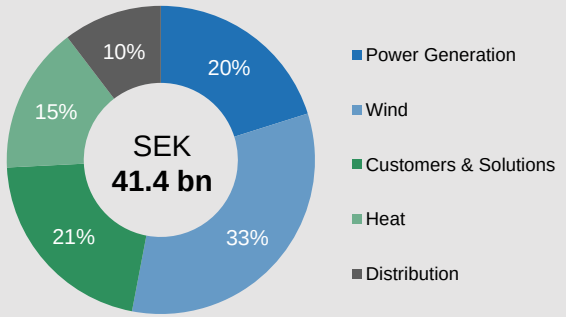
CO_2 emissions & renewable capacity



Electricity generation breakdown by technology, 2023



Underlying EBITDA breakdown by segment, 2023[1]



1 Breakdown excludes other and eliminations

Introduction

Location of our operations and major plants

Click on energy source to show locations

Wind

Biomass

Hydro

Gas

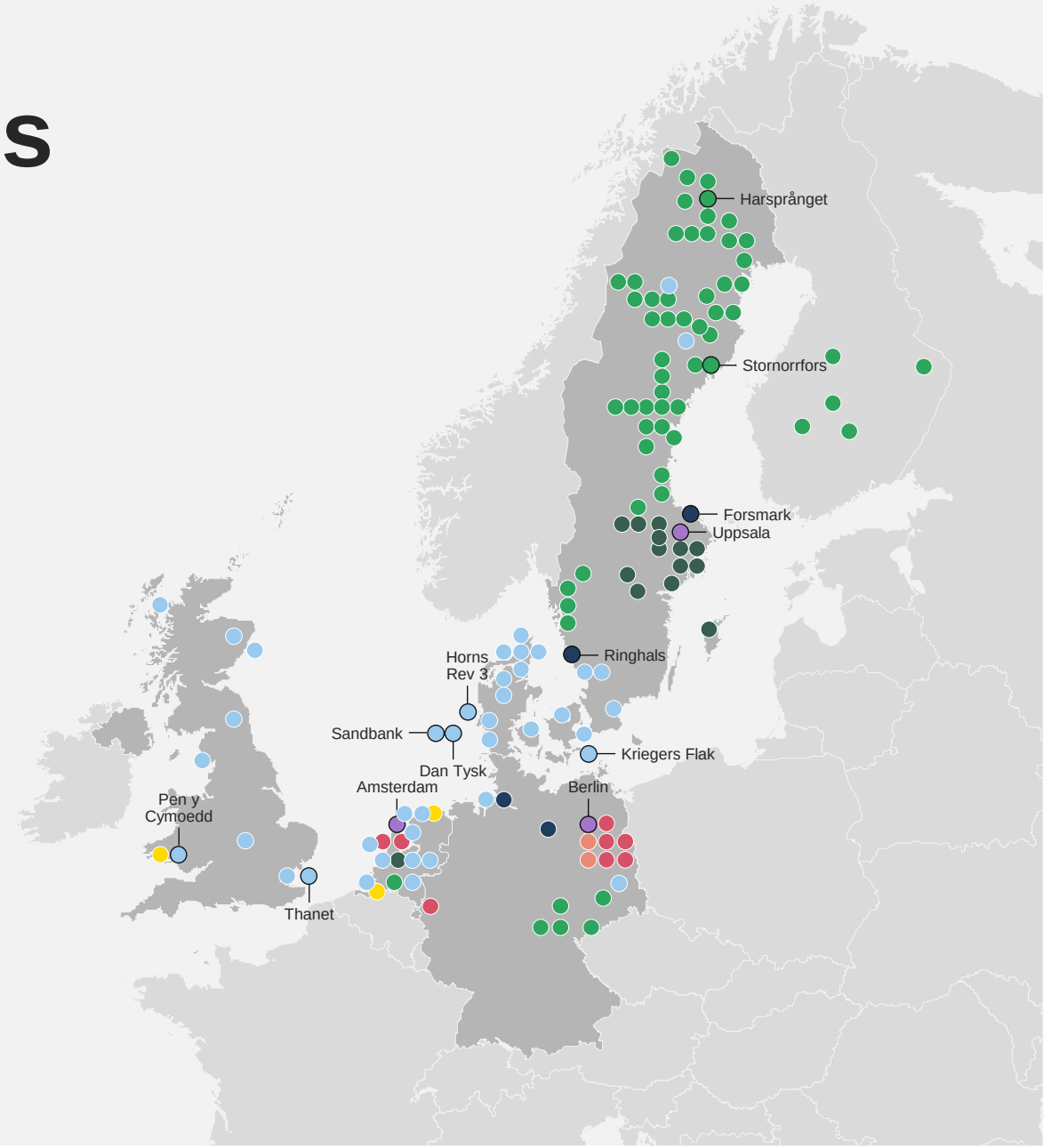
Nuclear

Coal

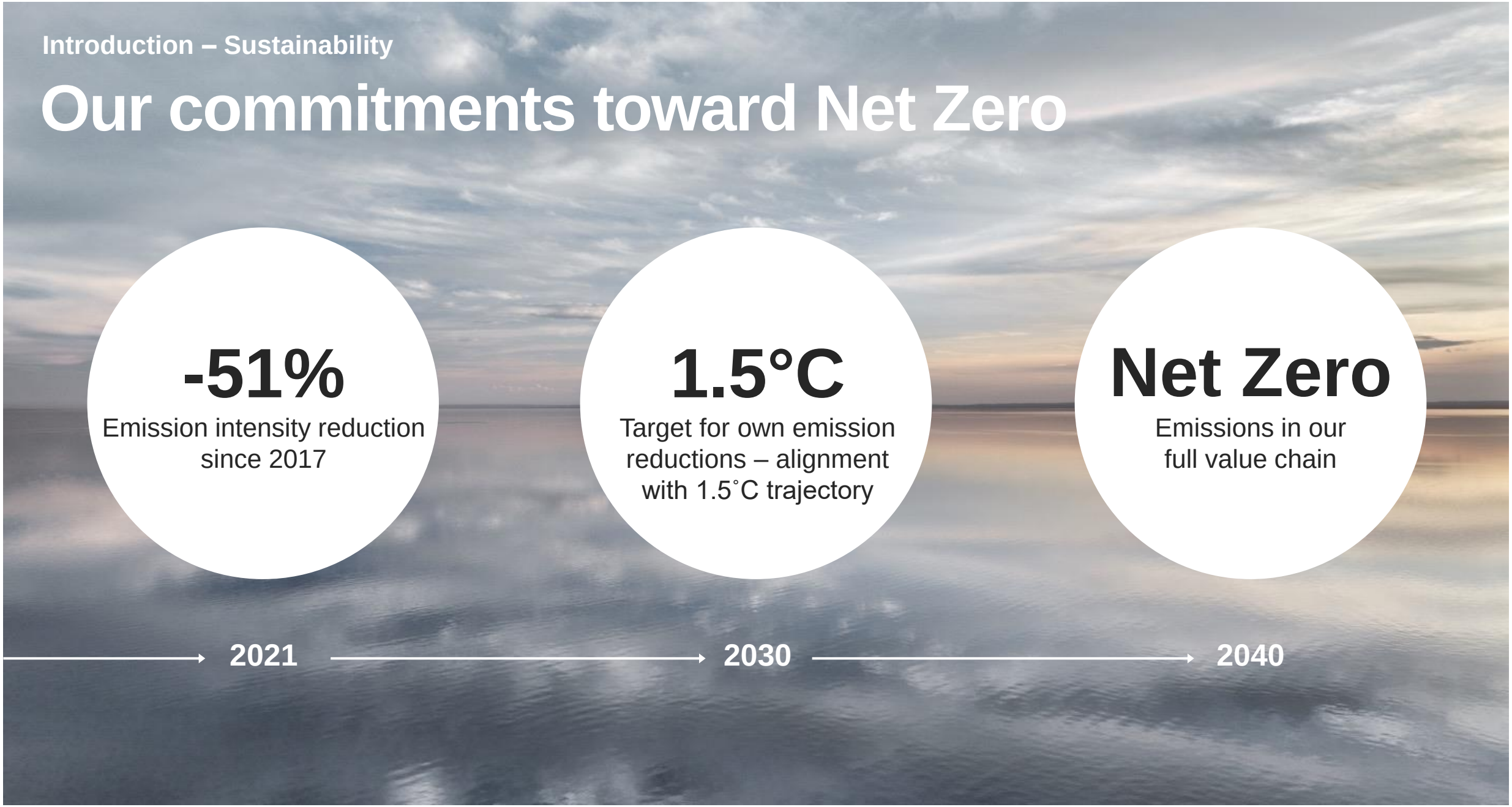
Solar

District heating

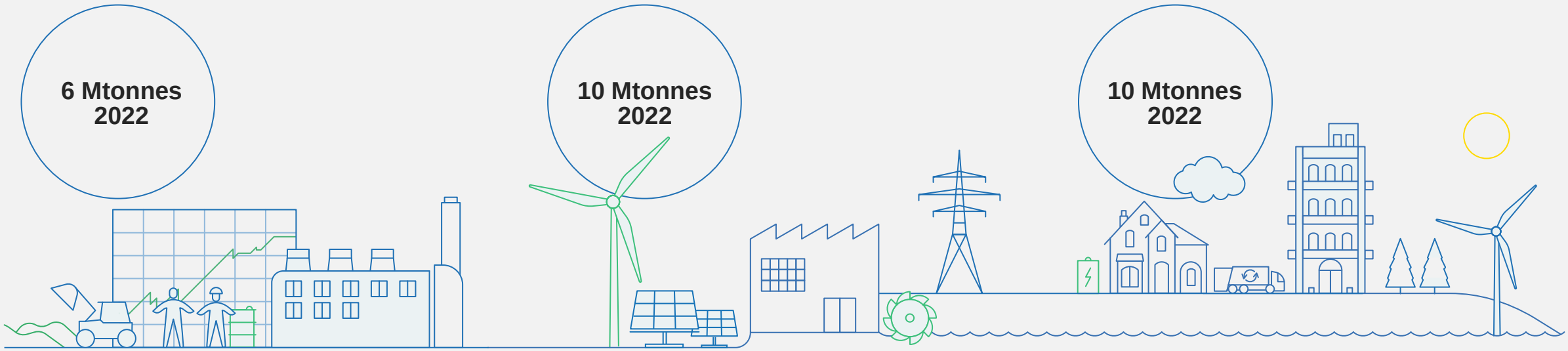
Largest facilities marked with a circle



Our commitments toward Net Zero



Cut CO_2 emissions throughout the value chain



Suppliers

Supplier dialogues and sustainability requirements in tenders

Lifecycle Assessments

Industry collaborations

Own operations

Reducing emissions in line with climate science

Growth in renewables

Reducing emissions from employee travelling

Customers

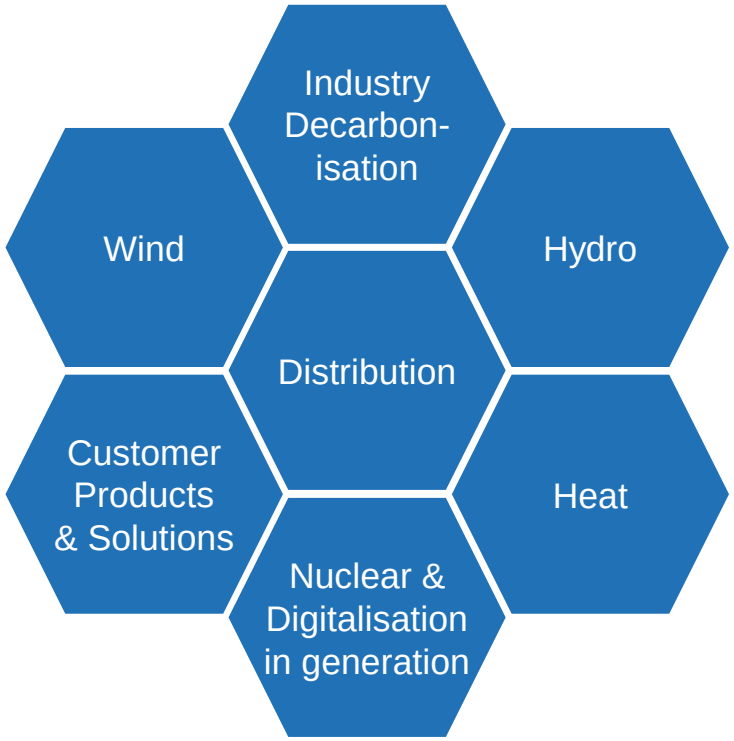
Climate smart solutions for homes and cities

City partnerships

Environmental product offerings

Vattenfall R&D: Portfolios and sections

7 R&D Portfolios

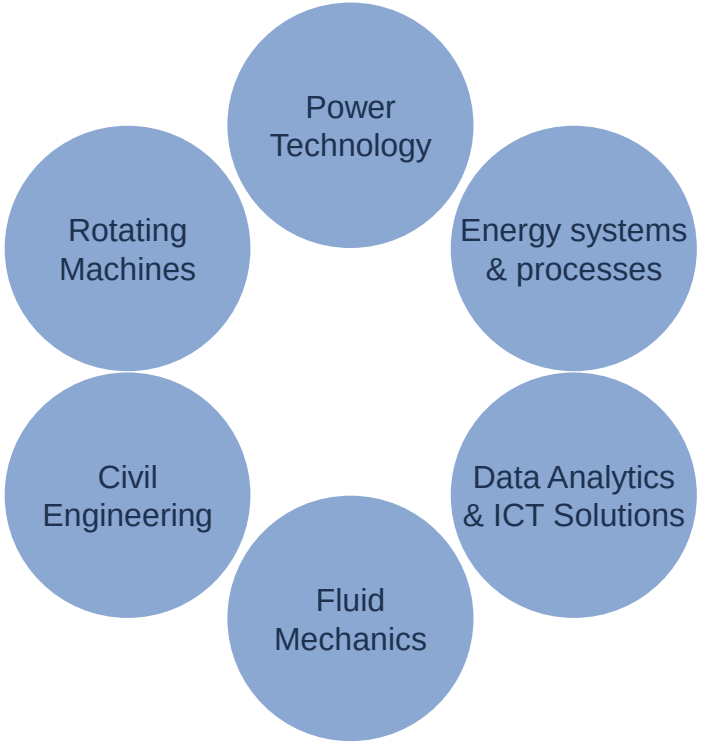


Staff: 145 employees

Business-driven R&D (market pull): Support all units with ***competitive and verified solutions*** for the specific businesses

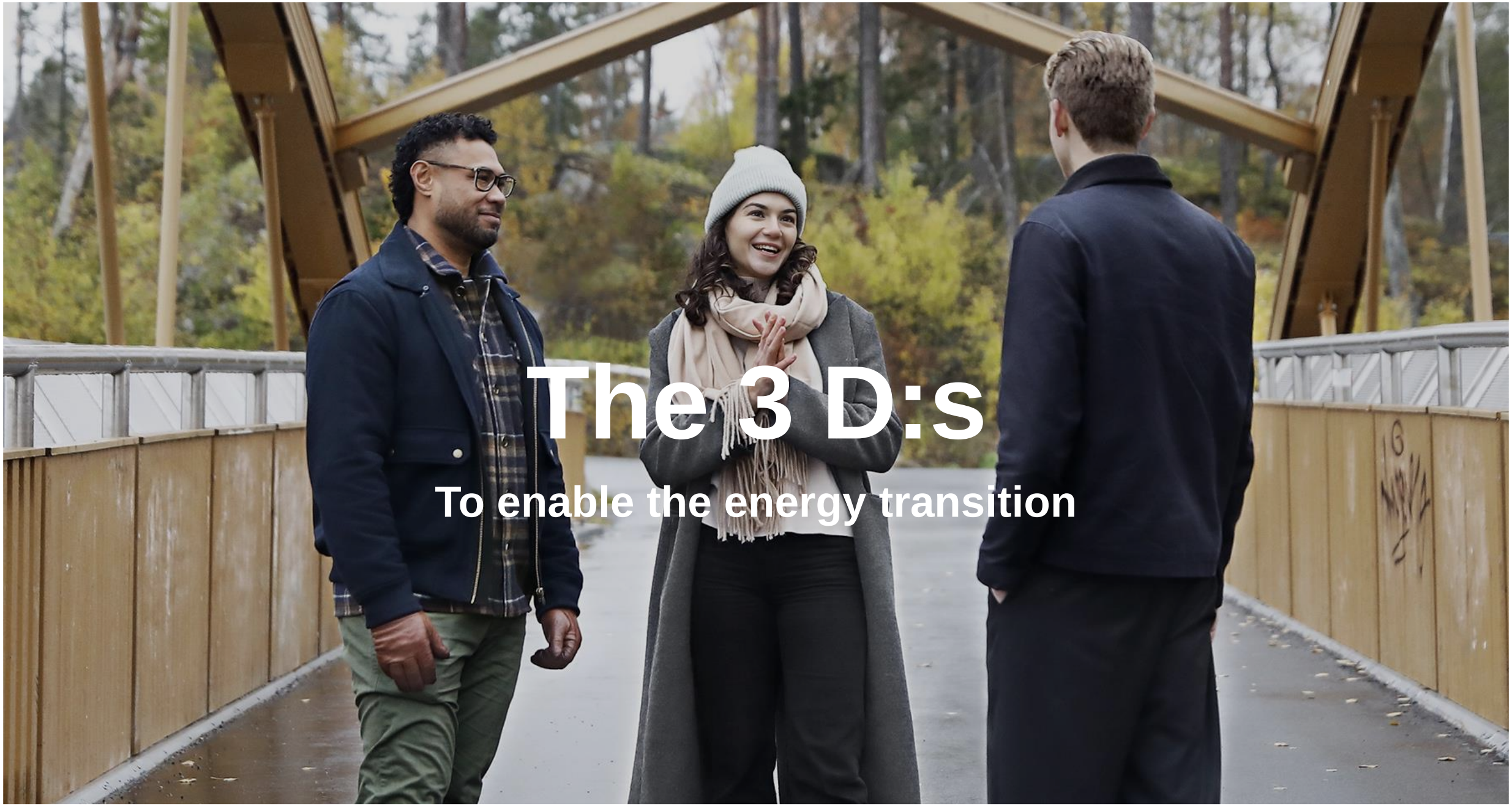
Strategic R&D (technology push): Speed up the adoption of ***new technologies*** and ***realize synergies*** across businesses

6 Depts / Sections



Vattenfall's R&D supports execution of the strategy

CPS*	DIG* & Nuclear	Distribution	Heat	Hydro	Wind	Industry Decarb.
•Smart Energy Solutions	•Advanced Asset Analytics	•Data Driven DSO	•City Energy Systems	•Dam Safety & Infrastructure	•Control & Optimisation	•Refineries
•Energy Management	•Digital Inspections	•Digital Customer	•Digital Acceleration Heat	•Environment	•Lifetime & Operation	•Cement
•E-mobility	•Nuclear Thermal Hydraulics & Concrete	•Local Grid Control	•Fossil Free Heat	•Hydropower Machines	•Foundations	•Petro-chemicals
•Analytics		•Flexible Grids	•Heat Business Beyond 2030	•Flexible Generation	•Offshore Power Technology	•Steel
		•Arholma Micro Grid	•Bio-CCS			•Thermal Storage
		•Uppsala Battery				
*Customer Products & Solutions	*Digitalisation in Generation					



VATTENFALL

Trends

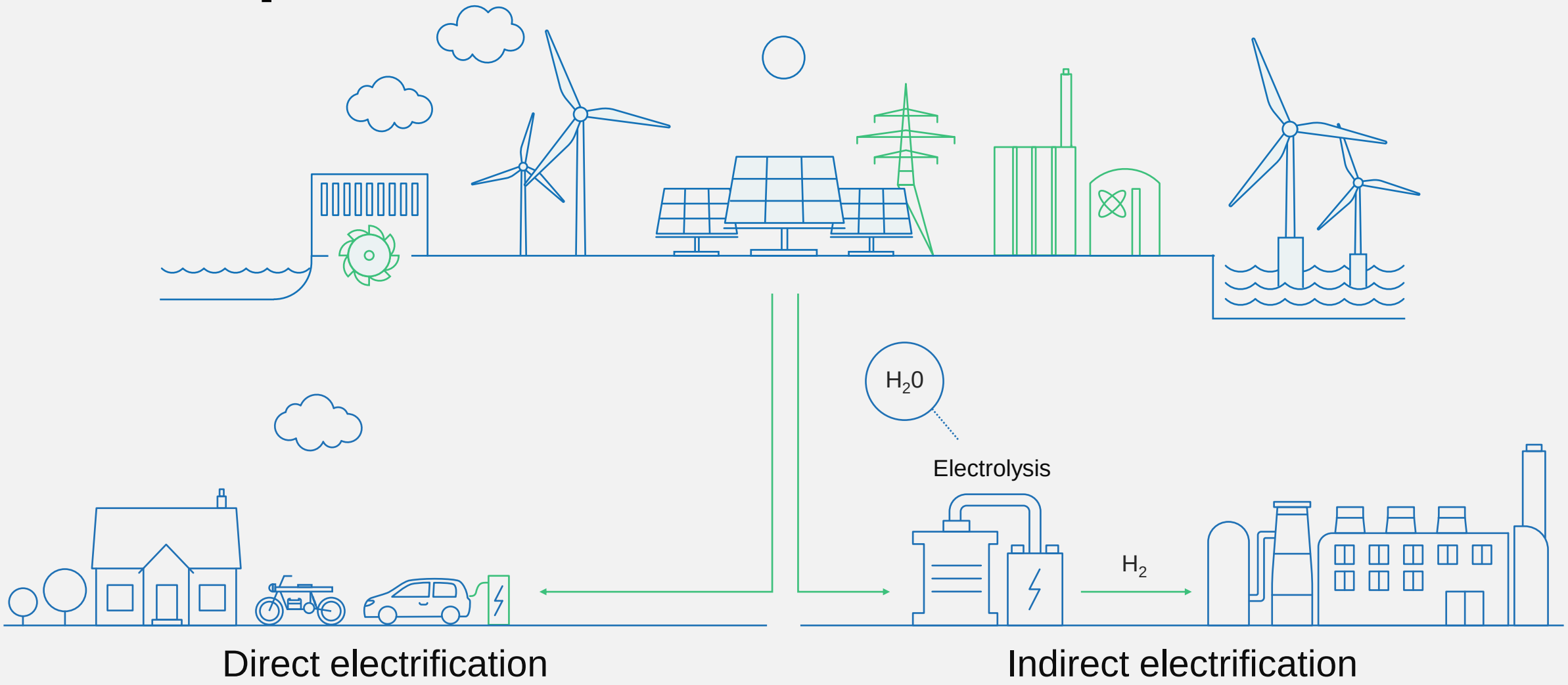
The 3 D’s of the energy transition

Decarbonization through **Electrification**

- New generation → renewables
- New load → electric vehicles, heat pumps, etc

Industry Decarbonisation

From a power source to a source of innovation



Industry Decarbonisation

HySkies

Jet fuel from fossil free H_2 and captured CO_2

R&D: concept and support for successful EU application

Preem & ST1

Collaboration agreements with Preem and ST1 on H_2 production from offshore wind

Hybrit H_2 Storage

Flexibility in a volatile market

R&D: concept selection, engineering

VATTENFALL

Press Release

16.10.2023

HYBRIT: Hydrogen storage reduces costs by up to 40 per cent

HYBRIT's hydrogen storage has now been tested commercially on the electricity market. Its excellent results are important for the industry's transition. Fossil-free hydrogen is a prerequisite for producing fossil-free steel. By also adding storage, the variable cost of hydrogen production can be significantly reduced, by between 25 to 40 per cent. HYBRIT is a collaboration between SSAB, LKAB and Vattenfall that started in 2016.

The hydrogen storage facility was used specifically on the electricity market for about a month. The mission was to produce hydrogen using fossil-free electricity at a variable electricity price with the lowest possible cost, for example during certain parts of the day or for longer periods when weather-dependent electricity generation was in good supply. The hydrogen was delivered in a steady flow to SSAB.

Trends

The 3 D’s of the energy transition

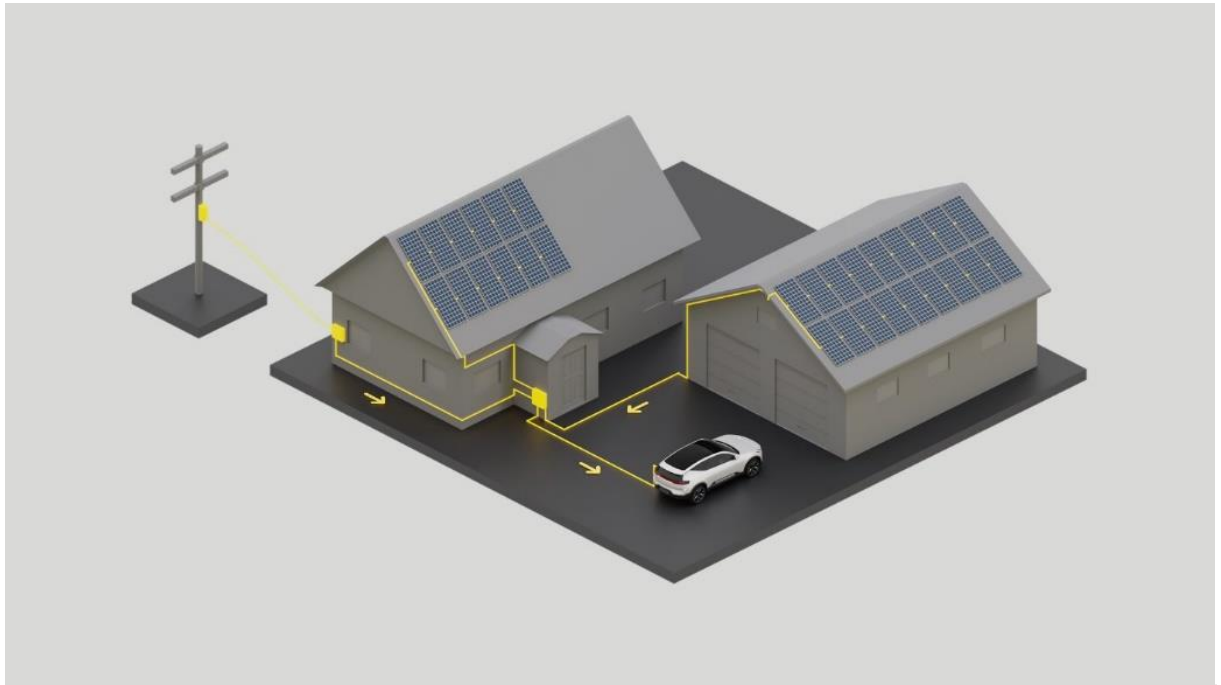
Decarbonization through **Electrification**
- New generation → renewables
- New load → electric vehicles, heat pumps, etc

Decentralization
- Distributed generation (rooftop PV), storage and **flexibility**
- From consumer to **prosumer**

Decentralization

PAVE: Bidirectional Charging (V2G) pilot

- V2G initiative based in Gothenburg, focused on exploring viable business models for V2G and piloting practical applications with potential for scalability and relevance across regions
- One of Europe's largest V2G pilots including a substantial number of Polestar 3 vehicles, co-funded by Swedish innovation agency Vinnova
- Vattenfall Distribution's focus: Analysis of standards and regulations from grid connection
- Vattenfall R&D's focus: commercial framework to ensure viability of V2G for all stakeholders



Standards and Regulations Vattenfall	Customer Management Polestar	Virtual Power Plant Polestar	Analytics Chalmers	Technical Easee	Business Model Vattenfall	Interface between Markets Svk	Demo Fleet Polestar

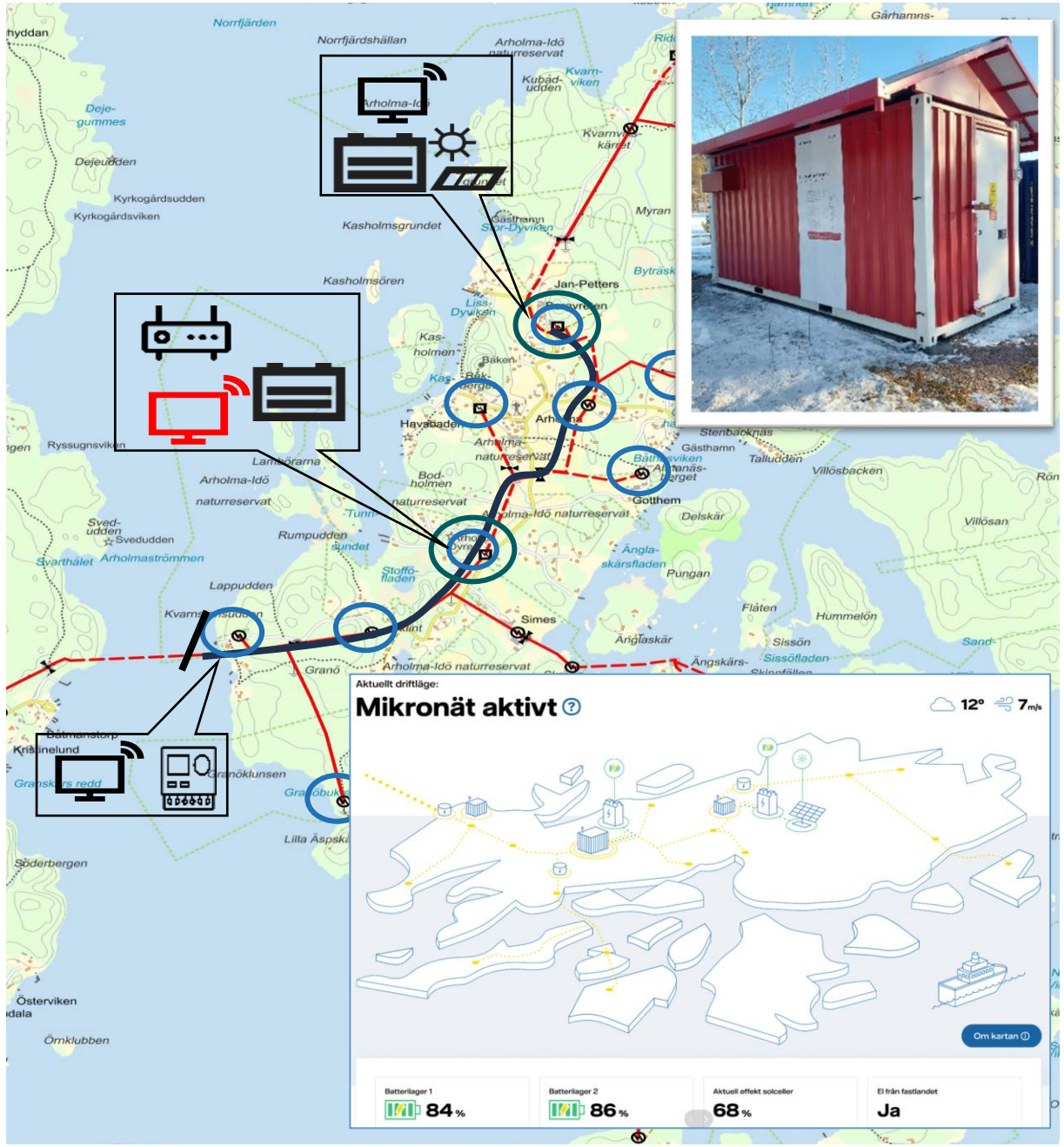
Project Management Polestar

Vattenfall	Svk	Göteborgs Energi	Chalmers	Easee	Polestar

Decentralization

Microgrid on Arholma island

- Voltage regulation in weak grids with lots of solar power or seasonal heavy loads
- Connected to mainland with one cable
- Island operation to minimize interruption times
- Battery solution as a quick improvement option
- Battery storage x 2, 160 kVA and 330 kWh
- In operation since 2023
- R&D: design, engineering, control & protection



Decentralization

Vattenfall's battery installations (examples)

Boliden Bergsöe

1 MWh
0,5 MW

Haringvliet

12 MWh
12 MW

Uppsala

20 MWh
5 MW

Amsterdam Charging Hub

0,34 MWh
0,24 MW

Jungheinrich

0,23 MWh
0,24 MW

Voltpack

0,28 → 1,4 MWh
0,3 MW

Trends

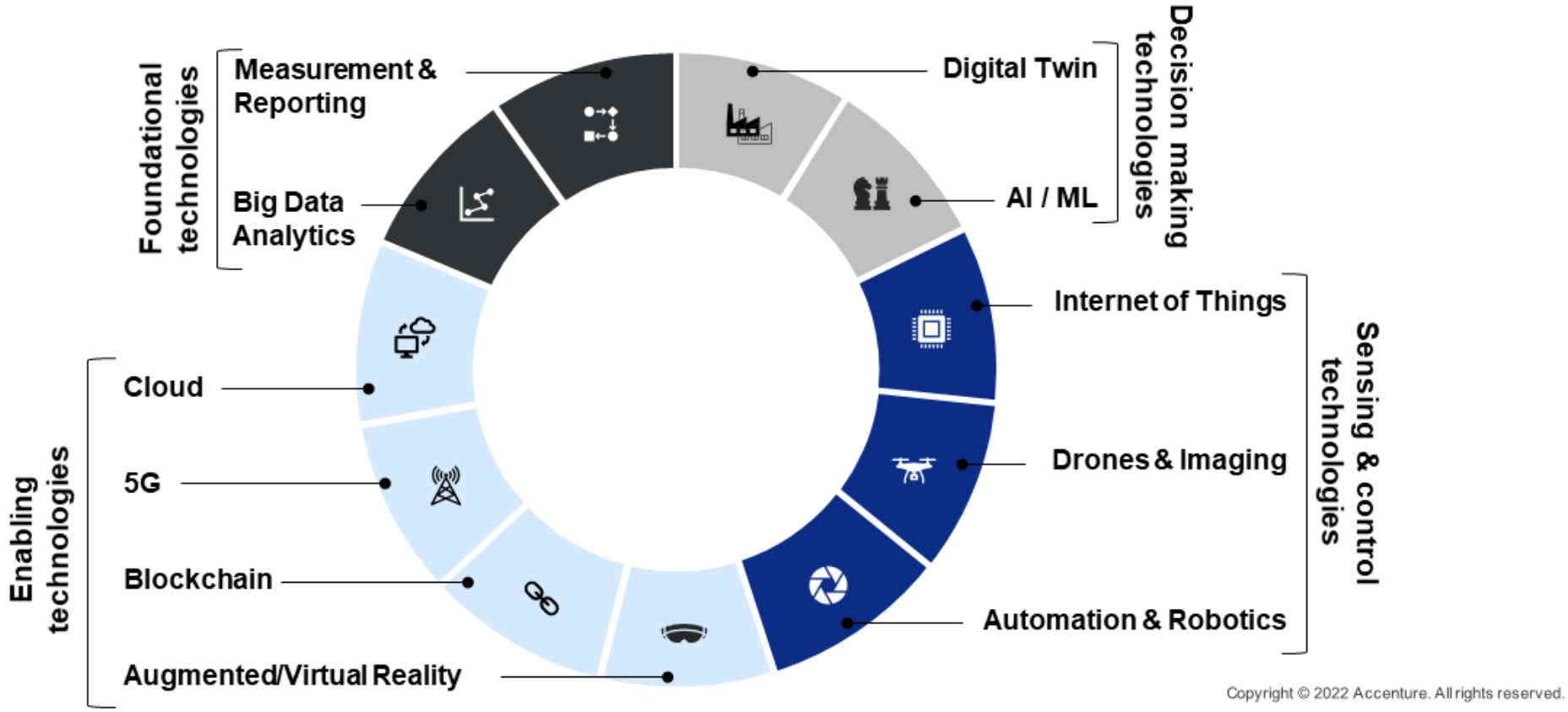
The 3 D’s of the energy transition

Decarbonization through **Electrification**
- New generation → renewables
- New load → electric vehicles, heat pumps, etc

Decentralization
- Distributed generation (rooftop PV), storage and **flexibility**
- From consumer to **prosumer**

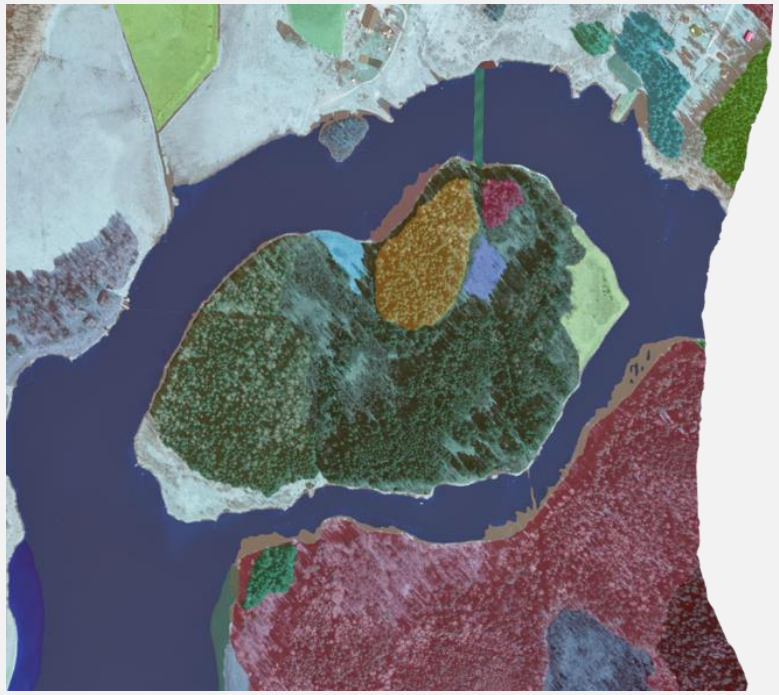
Digitalization
- Higher volatility, higher complexity, “more events with less time to react”
- Decisions to be taken automatically

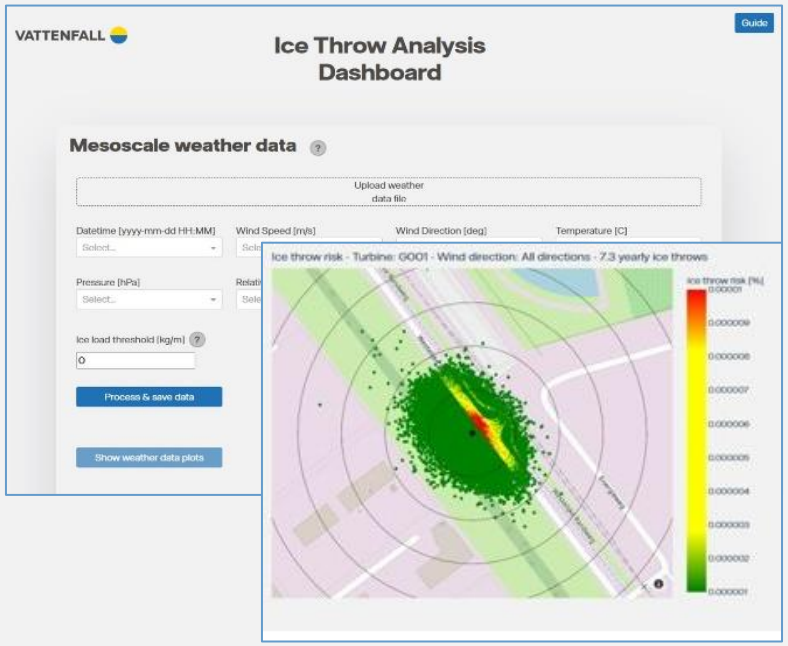
Digitalization
A broad umbrella term covering many technologies

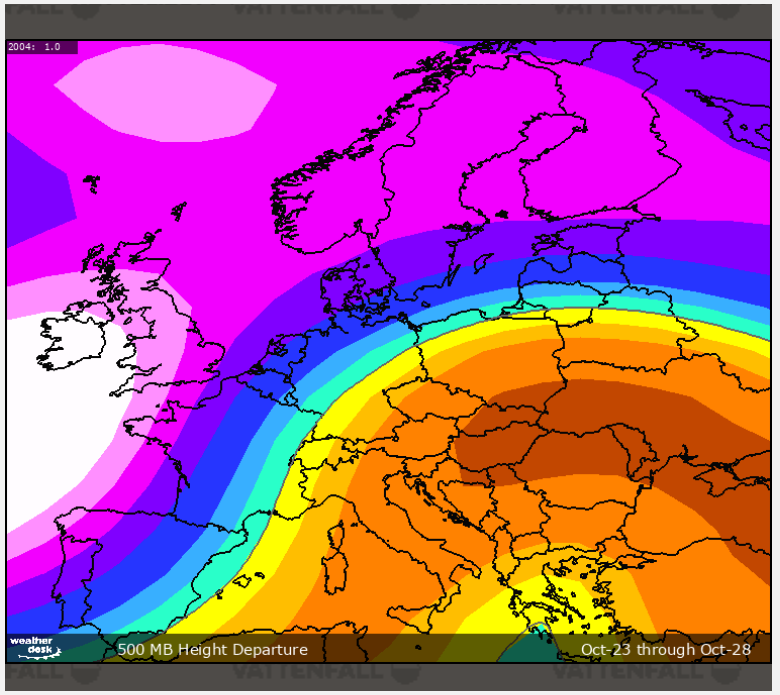


Source: Accenture

Digitalization & AI – Project Examples







Satellite data analysis

Automatic identification of geographical and environmental segments. Monitor change over time.

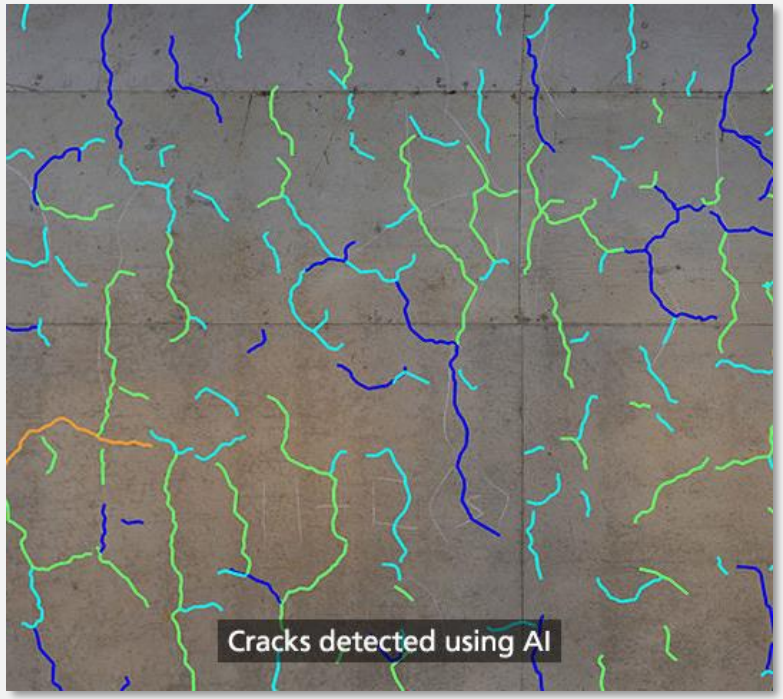
Ice throw simulation

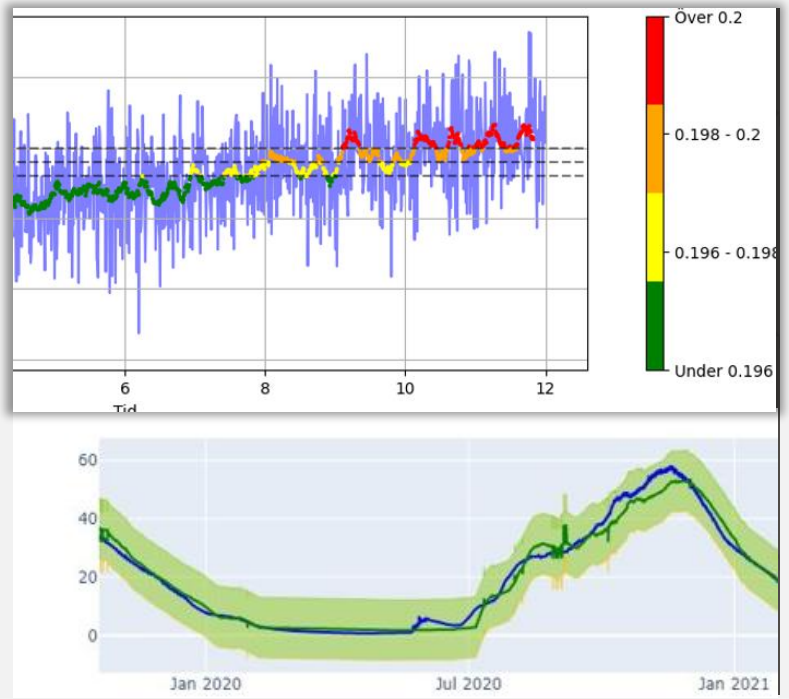
Forecast risk for ice throws on wind turbines based on historical weather data.

Weather patterns

Identify weather patterns to better predict production from wind power

Digitalization & AI – Project Examples (2)





Crack Detection

Automate charting of mineral veins in bedrock and concrete

AI-assisted search

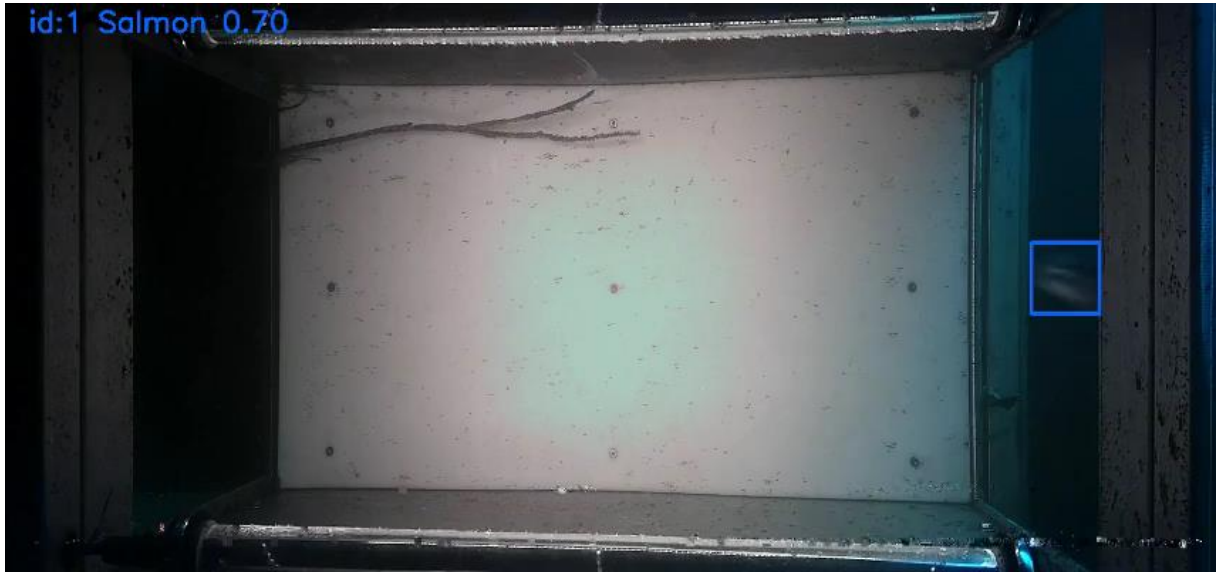
Make use of Large Language Models (LLMs) to search through a large unstructured amount of docs

Monitoring

Condition-based monitoring of hydro power plants through sensor and smart algorithms

Examples, AI for biodiversity research

- Real-time monitoring based on image recognition:
  - eg species (salmon vs trout), origin (wild vs farmed), sex (male vs female), state of heath
- Implemented in the fish ladder at Stornorrfors
- Next step (ongoing): identifying individuals based on spot patterns on the head of the fish



- Capercaillie is an indicator of a good habitat
- AI-based real-time monitoring – combining both image and sound recognition
- Based on third-party tools, adapted (eg Birdnet)
- Implemented in wind power project Bruzaholm

Digitalization – Examples Drone Inspections

Aerial inspections

Outdoor inspections, eg of overhead lines or other assets, perimeter surveillance, including different types of cameras

Confined spaces

Indoor inspections, in non-accessible or unsafe areas, including water-filled tunnels, boilers, or no-go zones in NPPs

Underwater

Outdoors, eg hydropower dams, sea- or riverbed inspection and data collection, or indoors in NPP

Digitalization – Examples Drone Inspections (2)

Bird flapper

Commercial drone adapted by Vattenfall R&D to mount bird deterrents on overhead lines, semi-autonomous

Drone in a box

Tested as remote-controlled and autonomous solution, for >250 missions around assets, in various weather conditions

Robot dog

Tested as remote-controlled, and as a possible resident solution for remote grid stations and power plants

Trends

The 3 D’s of the energy transition

Decarbonization through **Electrification**
- New generation → renewables
- New load → electric vehicles, heat pumps, etc

Decentralization
- Distributed generation (rooftop PV), storage and **flexibility**
- From consumer to **prosumer**

Digitalization
- Higher volatility, higher complexity, “more events with less time to react”
- Decisions to be taken automatically