



Statkraft

Smartplant Hydro

A cloud connected powerplant

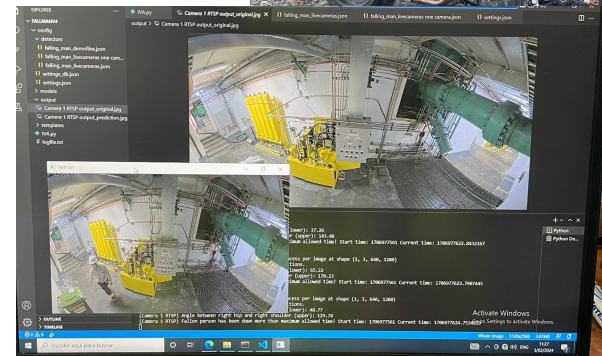
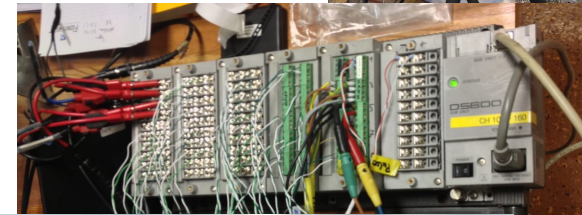
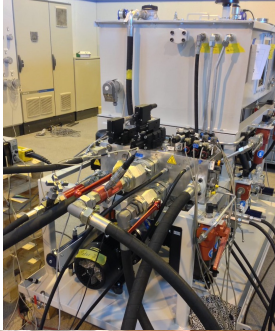
ANDREAS FRID

UMEÅ 2024-04-23

Who

Andreas Frid

- Digitalization Engineer / Digital Lead at Statkraft
- Background
 - Mechanic working with turbines and generators, Waplans Mekaniska Verkstad
 - Commissioning engineer, Andritz Hydro
 - Automation engineer, Nord-Lock
 - Digitalization engineer, Statkraft
 - Privat business owner
 - Electronics and embedded systems design and prototyping
- Östersund, Sweden



Why

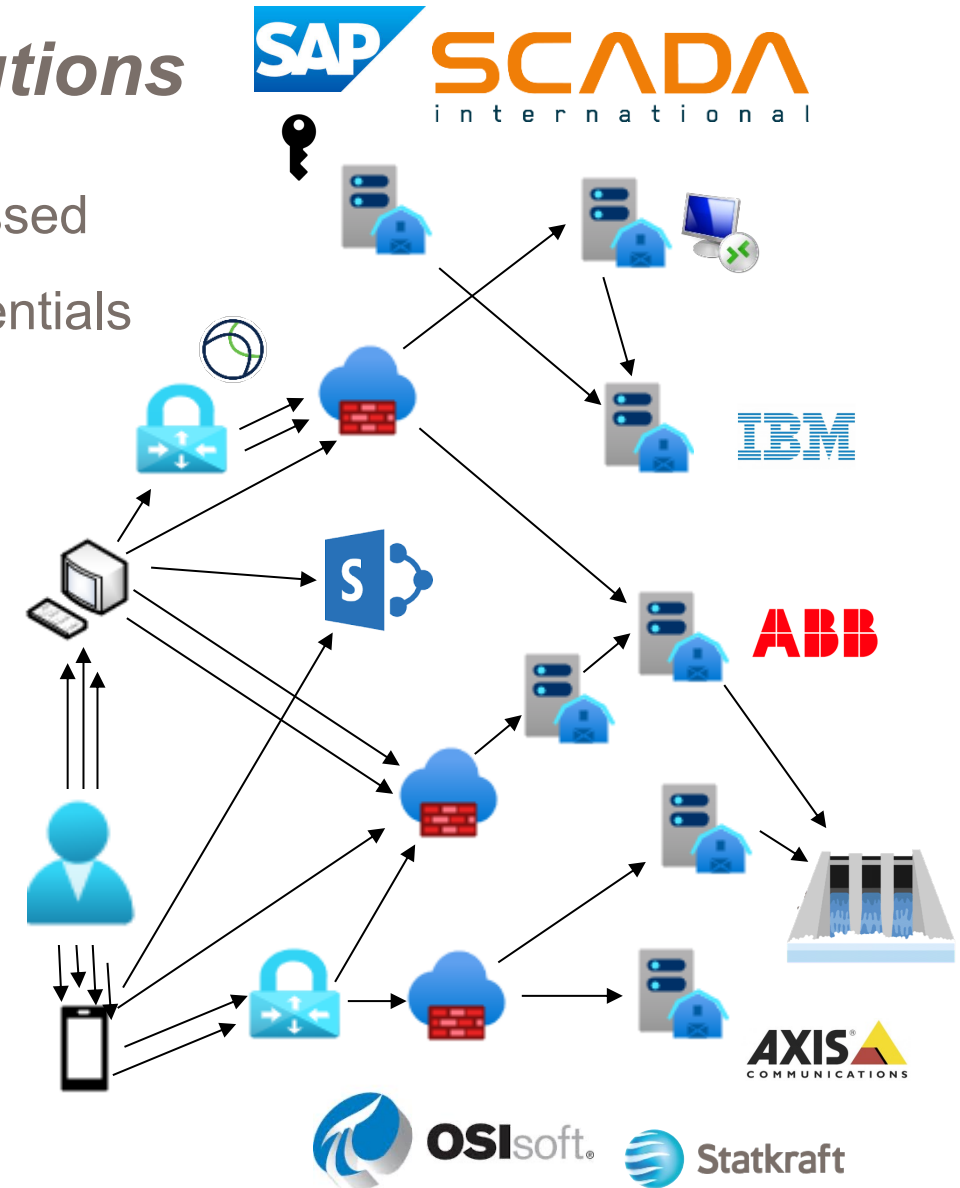
Use technology as technology is intended in Statkraft

- Internal survey, focusing on small asset optimization
 - High costs and low contributing margins
- Pain points in Statkraft related to technology and asset digitalization.
 - Not using new and current technologies optimally in Statkraft
 - Internal requirements for infrastructure and security is limiting the use of technologies
 - Time consuming processes for implementation of new technologies
 - Security requirements with little or no flexibility
 - Infrastructure with high cost and low bandwidth
 - Limiting the use of high bandwidth technologies
 - **Restricted or no access to information and solutions for users**
 - Information not reachable for user
 - Complex login and security for accessing information
 - Inefficient tools for working with information

Why

Access and information – Current solutions

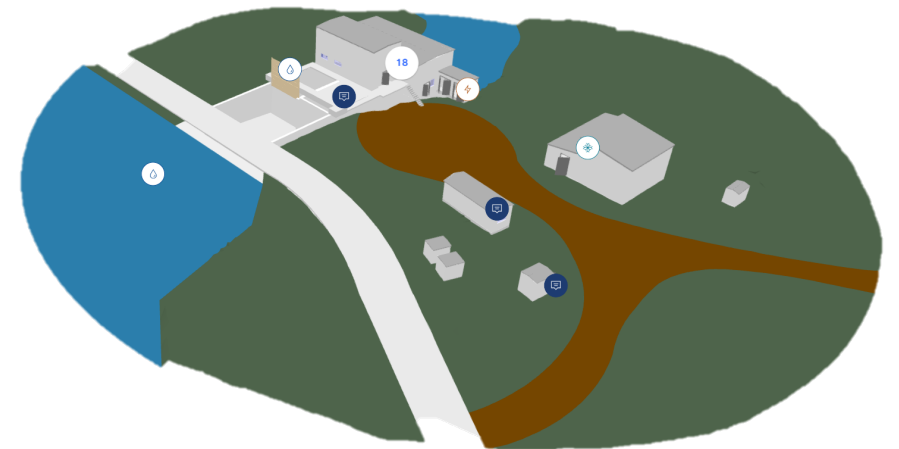
- Multiple systems where information is stored and processed
- Access to systems requires different solutions and credentials
- Different systems with different requirements
 - Locally installed clients on PC systems
 - Remotely installed solutions on remote systems
 - VPN and bridging solutions for connectivity
 - Multiple apps for user on end devices
 - Multiple MFA and token solutions for security
 - Complex license solutions and systems



What

Concept conditions for a development project

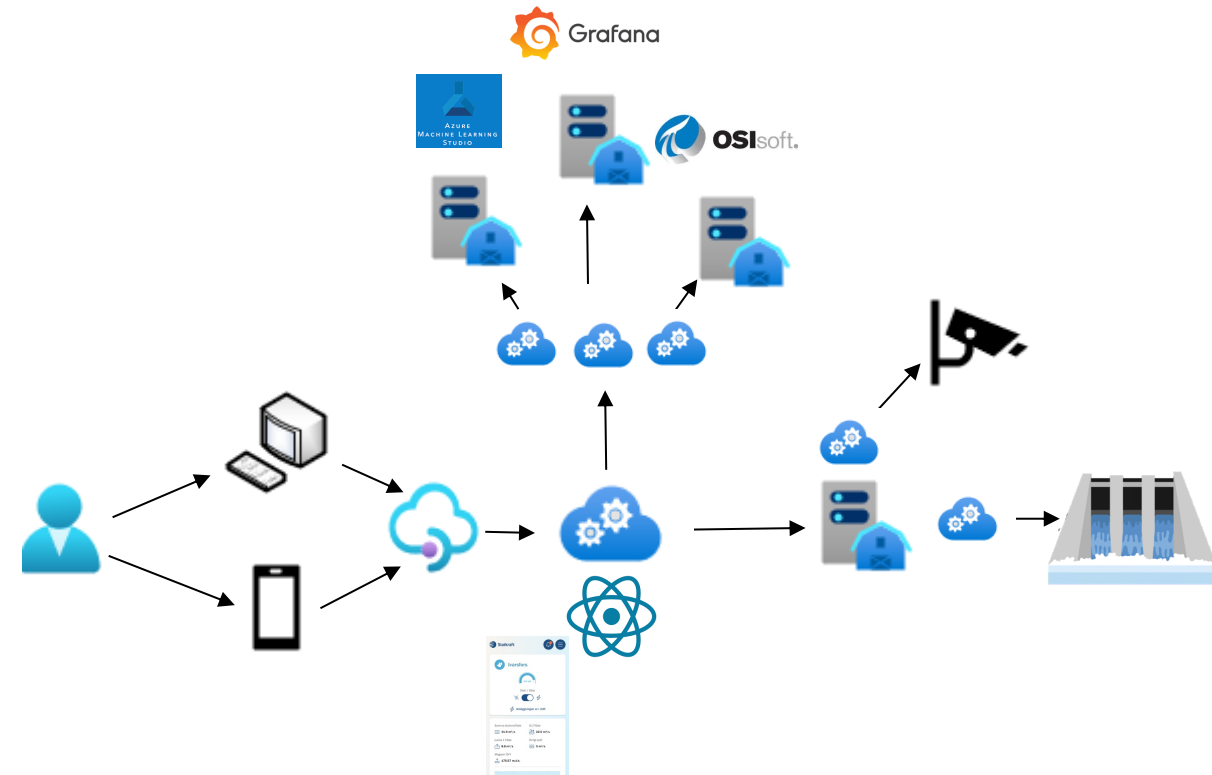
- Get access to a fully operational small hydro power plant for PoC testing
- Develop a baseline solution for continuing to run the powerplant safe
- Use the result from the survey and IT industry to design a new solution
- Develop this solution for further testing and expansion in future phases
- Develop this solution for testing technologies to be used in all categories of power plants later



What

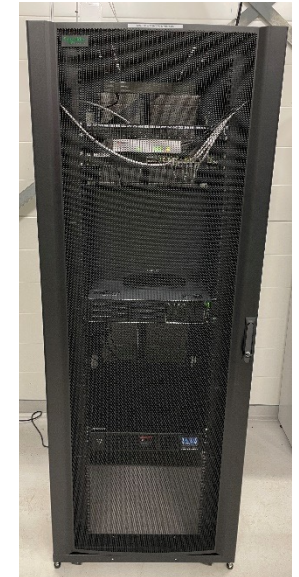
Solution concept

- Single user interface
 - Risk based authentication
 - Role based access
- Single Interface to multiple data sources and functions
- Centrally managed
 - Central solution management
 - Central User and security management
- Module based platform
 - Add or remove functions depending on plant or user
- Modern security and monitoring for solution
- Cloud deployment
 - Flexibility
 - Cost reduction



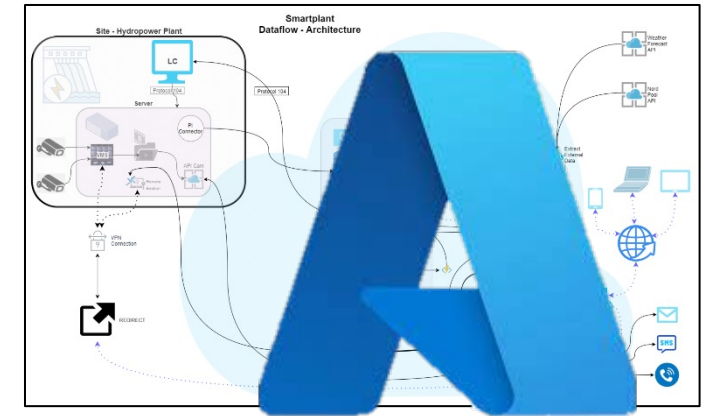
What *Requirements*

- Internal requirements
 - Network and security
 - Internal requirements are connected to network, disconnect the power plant from Statkraft and start fresh
 - No risk of interference with other assets
- Operations
 - Full production as normal, no changes to the control system
 - Replaced old operations / SCADA interface with a modern API solution
 - Hybrid cloud solution. Plant will still run with no connection
- Connectivity
 - Redundancy with multiple standard 4G/5G/Local Fiber/etc. connections
 - High speed
 - Low cost
- Architecture
 - Zero Trust security architecture, for modern security



How *Toolset, same but different*

- Cloud platform, same as Statkraft
 - Microsoft Azure
 - Strategic partner
 - User management, use Statkraft resources for management
- Data collection with the same tools as Statkraft
 - Aveva PI suite.
 - Data collection and buffering
 - Data modeling / structuring
- Visualization, same as Statkraft
 - Grafana
 - Embedded graphing
 - Standalone interface for deep dive in data
- Wireless sensor network, same as Statkraft
 - LoRaWAN
 - Technology suited for power industry
 - Well-known and developed by leading suppliers



How *Development*

- Small development team
 - Full-stack developer
 - Backend functions in cloud and in power plant
 - Front end application
 - Network architect
 - Development of virtual and physical networking
 - Monitoring and security implementation
 - UX designer
 - Initial interviews with users
 - Project management
- Development timeframe
 - 6 months from start of development to commissioning
 - Only one test on a powerplant before commissioning
- Smartplant Hydro operational December 2022

Smartplant Hydro

Smartplant Hydro Ivarsfors
(MVP)

Aktiv effekt MW	NVY	ÖVY	Luckläge
168,63	175,52	0,113	
1,32	m.ö.h.	m.ö.h.	m

Turbine

Start Stop

Water Level Regulation (NVR)

175,35 Send

Update message list

Ivarsfors message list

Idag	Magasin ÖVY updated to: 175.56
00:00	
I går	Summa luckflöde updated to: 0.84332
23:51	
I går	Aktiv effekt T2 updated to: 0.08
23:33	



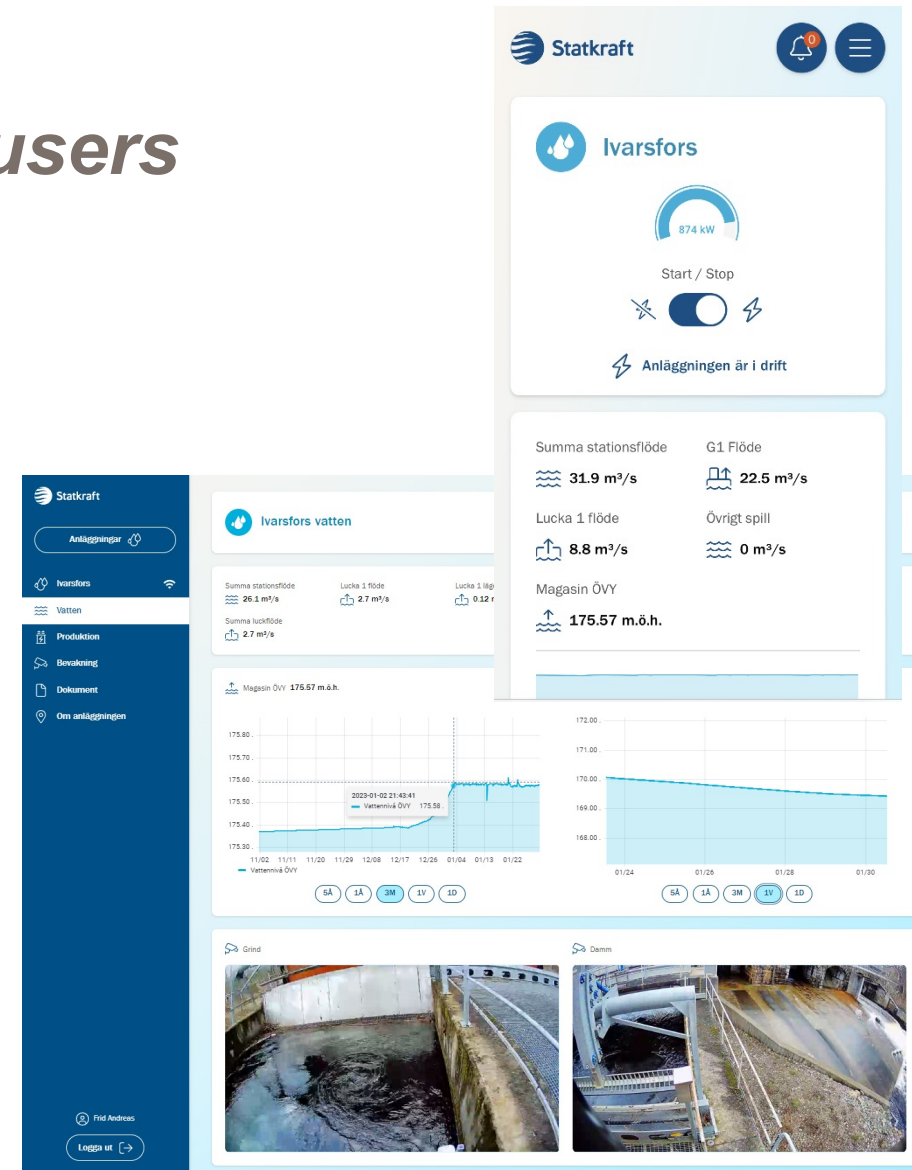
```
});  
  
if (builder.Environment.IsProduction())  
builder.Configuration.AddAzureKeyVault(  
    new Uri(builder.Configuration["AppSettings:KeyVaultUri"]),  
    new DefaultAzureCredential(new DefaultAzureCredentialOptions  
    {  
        ManagedIdentityClientId = builder.Configuration["AppSettings:ManagedIdentityClientId"]  
    }));
```



How

Result - information in the hands of the users

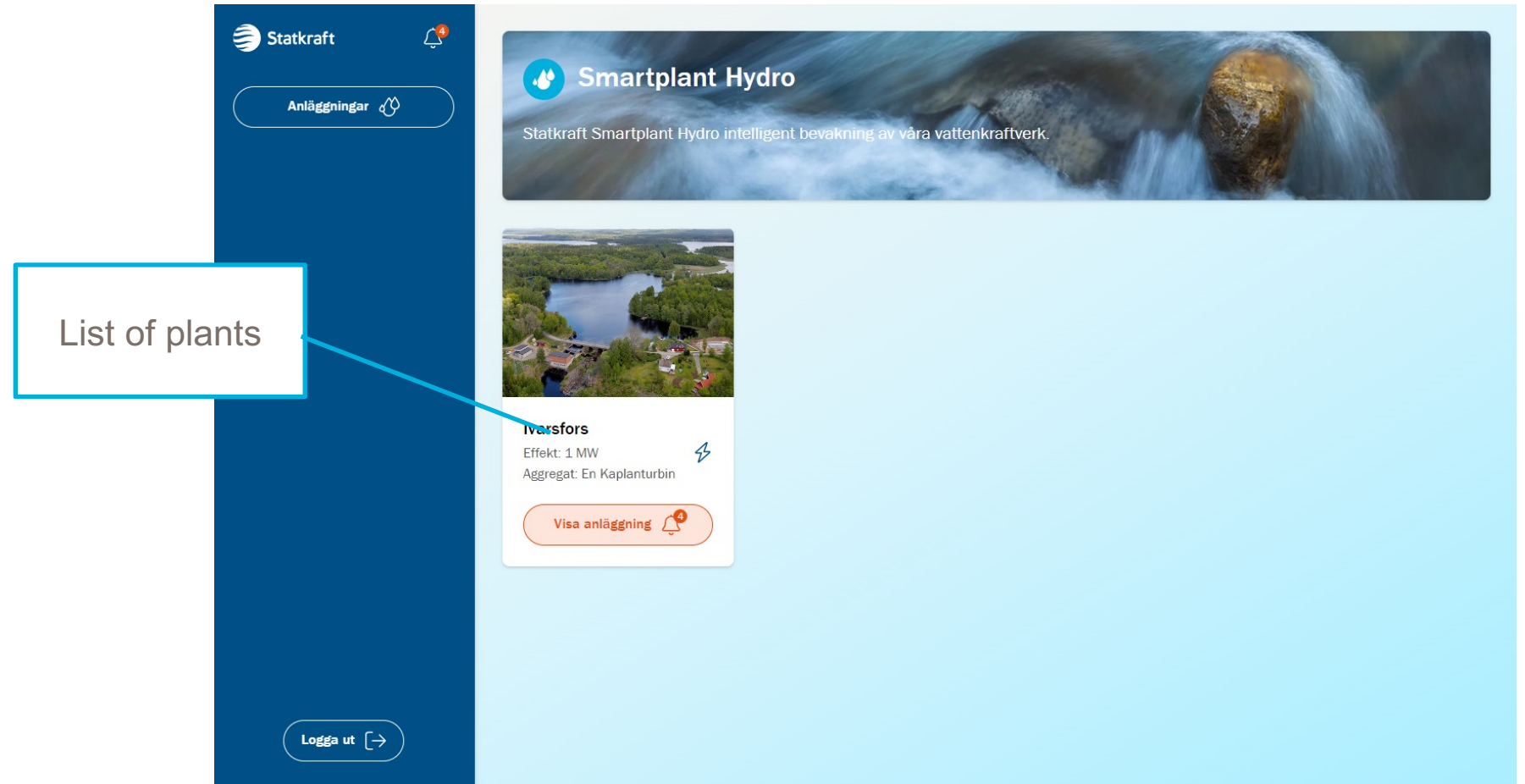
- A single app reachable from any type of device
 - Send commands to plant. Start/Stop, Setpoints, Control modes
 - View live values from production and sensors
 - Alarm and event logs with details from local control systems
 - Documentation and files related to asset
 - Live camera feeds from plant
 - Trends and historical values
- Notifications
 - Alarms and events is sent to users by SMS and Phone call
 - New setpoints sent to plant with information for verification and history
- Combination of data sources
 - Local sensor data and external data is stored in the same way



How

An easier way of using technology

- Plants overview



The screenshot displays the Statkraft Smartplant Hydro interface. On the left is a dark blue sidebar with the Statkraft logo, a notification bell icon with a red '4', a button labeled 'Anläggningar' with a water drop icon, and a 'Logga ut' button with an arrow icon. The main content area features a header banner for 'Smartplant Hydro' with the text 'Statkraft Smartplant Hydro intelligent bevakning av våra vattenkraftverk.' Below this is a card for the 'Iversfors' plant, which includes an aerial photo of the site, the name 'Iversfors', 'Effekt: 1 MW', 'Aggregat: En Kaplan turbin', and a 'Visa anläggning' button with a notification bell icon. A white box with a blue border and the text 'List of plants' is connected to the sidebar by a blue line, pointing to the 'Anläggningar' button.

How

An easier way of using technology

- Plant main page
Normal user

Control modes

Grafana Graphs

Weather prediction

Live external sensor values

User management and roles

The screenshot displays the Ivarsfors plant control interface. At the top, the Statkraft logo and a notification bell are visible. Below this is a navigation bar with 'Anläggningar' and a water drop icon. The main content area is divided into several sections:

- Control modes:** A button labeled 'G1 VNR Från' and 'L1 VNR Till' is shown next to a gauge displaying '737 kW'. A callout box points to this area.
- Grafana Graphs:** A callout box points to a graph area on the right side of the interface.
- Weather prediction:** A callout box points to the 'Väder' section, which shows 'Idag 22 apr 02:53' and a weather icon.
- Live external sensor values:** A callout box points to the 'Utomhus temperatur' section, which shows '-1.3 °C'.
- Alarms and events:** A callout box points to the 'Händelser' section, which lists several events with timestamps and descriptions, such as 'Tillslag värme NVY-pegel: FRÅN' and 'Stänga Utskovslucka 1: FRÅN'.

The interface also includes a sidebar with navigation options: 'Vatten', 'Produktion', 'Bevakning', 'Anläggning', 'Dokument', 'Trender', 'Ansvar & beredskap', and 'Andreas Frid'. At the bottom of the sidebar is a 'Logga ut' button.

How

An easier way of using technology

- Plant main page
Plant operator

The screenshot displays the Ivarsfors plant control interface. A dark blue sidebar on the left contains the Statkraft logo, a notification bell, and a menu with options: 'Anläggningar', 'Ivarsfors', 'Vatten', 'Produktion', and 'Bevakning'. The main content area is light blue and includes a header with the plant name 'Ivarsfors', a status indicator 'Anläggningen är i drift' with a 708 kW gauge, and a 'Start / Stop' toggle switch. Below this are two control panels for 'Ställ om L1 VNR' and 'Ställ om G1 VNR'. A 'Reglera börvärden' section features a dropdown menu for 'Välj börvärde'. A data row shows various flow and level metrics: Summa stationsflöde (18.5 m³/s), G1 Flöde (16.1 m³/s), Lucka 1 flöde (2.5 m³/s), Övrigt spill (0 m³/s), Magasin ÖVY (175.57 m.ö.h.), and Börvärde ÖVY (175.58 m.ö.h.). A weather and environmental data section provides details for 'Idag 22 apr 03:48', including wind (2 m/s), precipitation (0 mm), and temperatures (outdoor: -1.3 °C, maskinsal: 21.8 °C). At the bottom, there is an 'Händelser' section showing '4 Larm' and a 'Logga ut' button.

Control modes

Start / Stop

Setpoints

How

An easier way of using technology

- Camera feeds

PTZ Camera & controller

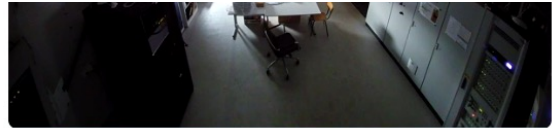
Thermal camera image

Thermal camera overlaid image

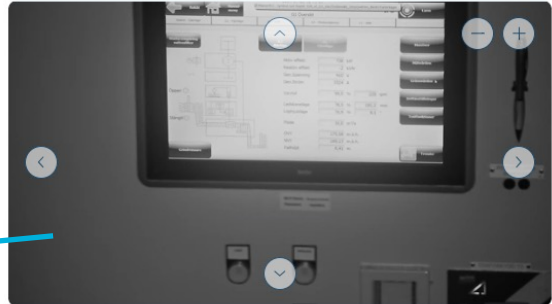
Statkraft

- Anläggningar
- Ivarsfors
- Vatten
- Produktion
- Bevakning
- Anläggning
- Dokument
- Trender
- Ansvar & beredskap
- Andreas Frid

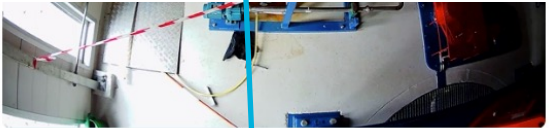
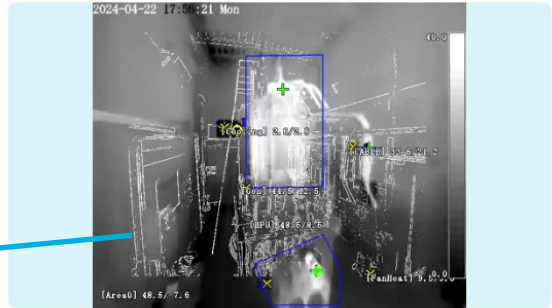
Logga ut



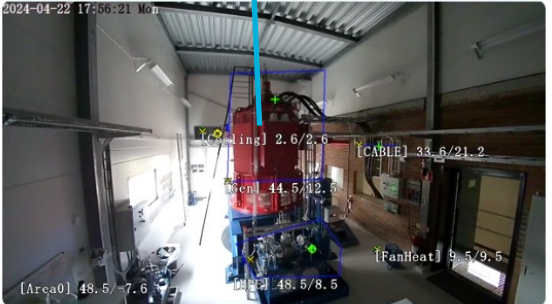
Maskinsal 2 PTZ



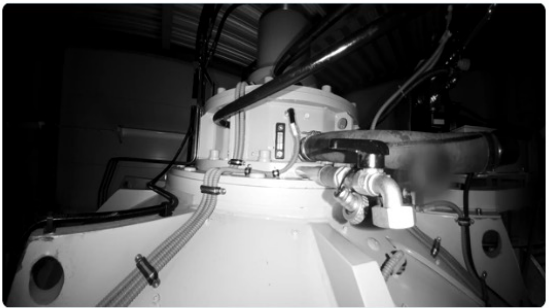
Maskinsal Värmekamera IR



Maskinsal Värmekamera Bild



Turbinstylager



How

An easier way of using technology

- Document pages

Electrical schematics and documents

The screenshot displays the Statkraft web application interface. On the left is a dark blue sidebar with the Statkraft logo and a notification bell. The sidebar menu includes: 'Anläggningar' (with a leaf icon), 'Ivarsfors' (with a leaf icon and a Wi-Fi signal icon), 'Vatten' (with a water wave icon), 'Produktion' (with a factory icon), 'Bevakning' (with a camera icon), 'Anläggning' (with a house icon), 'Dokument' (with a document icon), 'Trender' (with a line graph icon), 'Ansvar & beredskap' (with a group of people icon), and 'Andreas Frid' (with a person icon). At the bottom of the sidebar is a 'Logga ut' button with a right arrow icon. The main content area is titled 'Ivarsfors dokument' and shows a folder structure. A folder 'Ivarsfors / EI & Kontroll - IETV' is expanded to show a list of documents and folders. The items in the list are: 'Pärm 1 Manualer, protokoll, listor, godkännande', 'Pärm 2 Elschemata, Apparatlista, kabellista' (highlighted in blue), 'Pärm 3 Datablad, manualer', 'Pärm 1 Alfabet.xlsx', 'Pärm 1 Framsida.docx', 'Pärm 2 Alfabet.xlsx', 'Pärm 2 Framsida.docx', 'Pärm 3 Alfabet.xlsx', 'Pärm 3 Framsida.docx', and 'Pärmrygg.xlsx'. Each item has a trash icon on the right. At the bottom of the main content area, there is a 'Lägg till ny mapp' button and a text input field labeled 'Namn'. At the bottom right of the page is the Statkraft logo and another 'Lägg till mapp' button.

How

An easier way of using technology

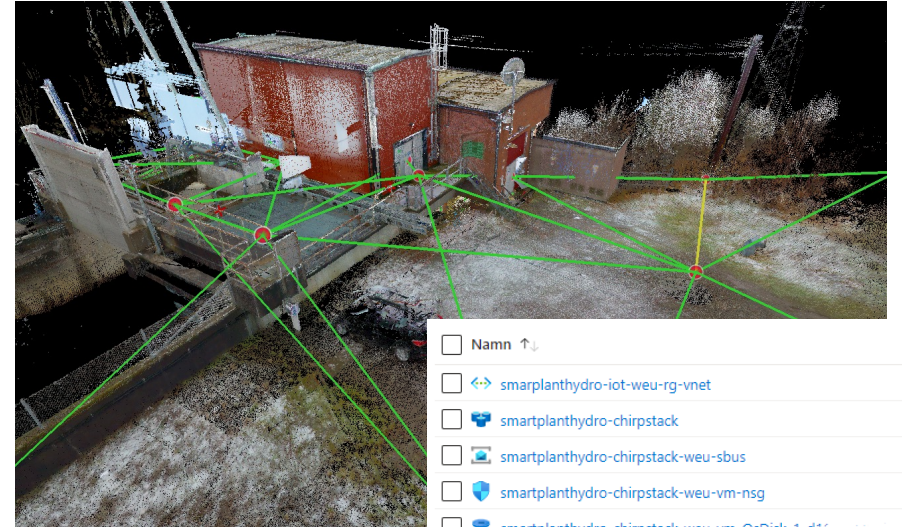
- Water related live values, trends and cameras

The screenshot shows the Statkraft mobile app interface for 'Ivarsfors vatten'. The interface is divided into a dark blue sidebar on the left and a main content area on the right. The sidebar contains the Statkraft logo, a notification bell, and a menu with options: Anläggningar, Ivarsfors, Vatten, Produktion, Bevakning, Anläggning, Dokument, Trender, Ansvar & beredskap, and Andreas Frid. At the bottom of the sidebar is a 'Logga ut' button. The main content area features a header for 'Ivarsfors vatten' and a dashboard with various data points and graphs. The dashboard includes a summary row with metrics: Summa stationsflöde (18.5 m³/s), Lucka 1 flöde (2.5 m³/s), Lucka 1 läge (0.11 m), Station fallhöjd (6.42 m), Börvärde ÖVY (175.58 m.ö.h.), and Övrigt spill (0 m³/s). Below this are two line graphs: 'Magasin ÖVY 175.57 m.ö.h.' and 'Station NVY 169.13 m.ö.h.', both showing a steady trend over a 15-hour period. At the bottom of the main area, there are sections for 'Grind' and 'Damm' with corresponding camera feeds. Three callout boxes on the left point to specific features: 'Live values' points to the summary row, 'Trending graphs' points to the two line graphs, and 'Related camera feeds' points to the 'Grind' and 'Damm' sections.

How

An easier way of using technology

- Easier access to systems and information
 - Better and faster decision making
 - Unified overview for all types of users
- Faster deployment of new and other technologies
 - Less engineering for implementation
 - Faster results
 - Less complicated requirements
 - IIoT standards for data transfer
- Power of cloud services
 - Fast and easy scaling
 - Easy deployment of new services and systems
 - Monitoring and security solutions included in cloud platform

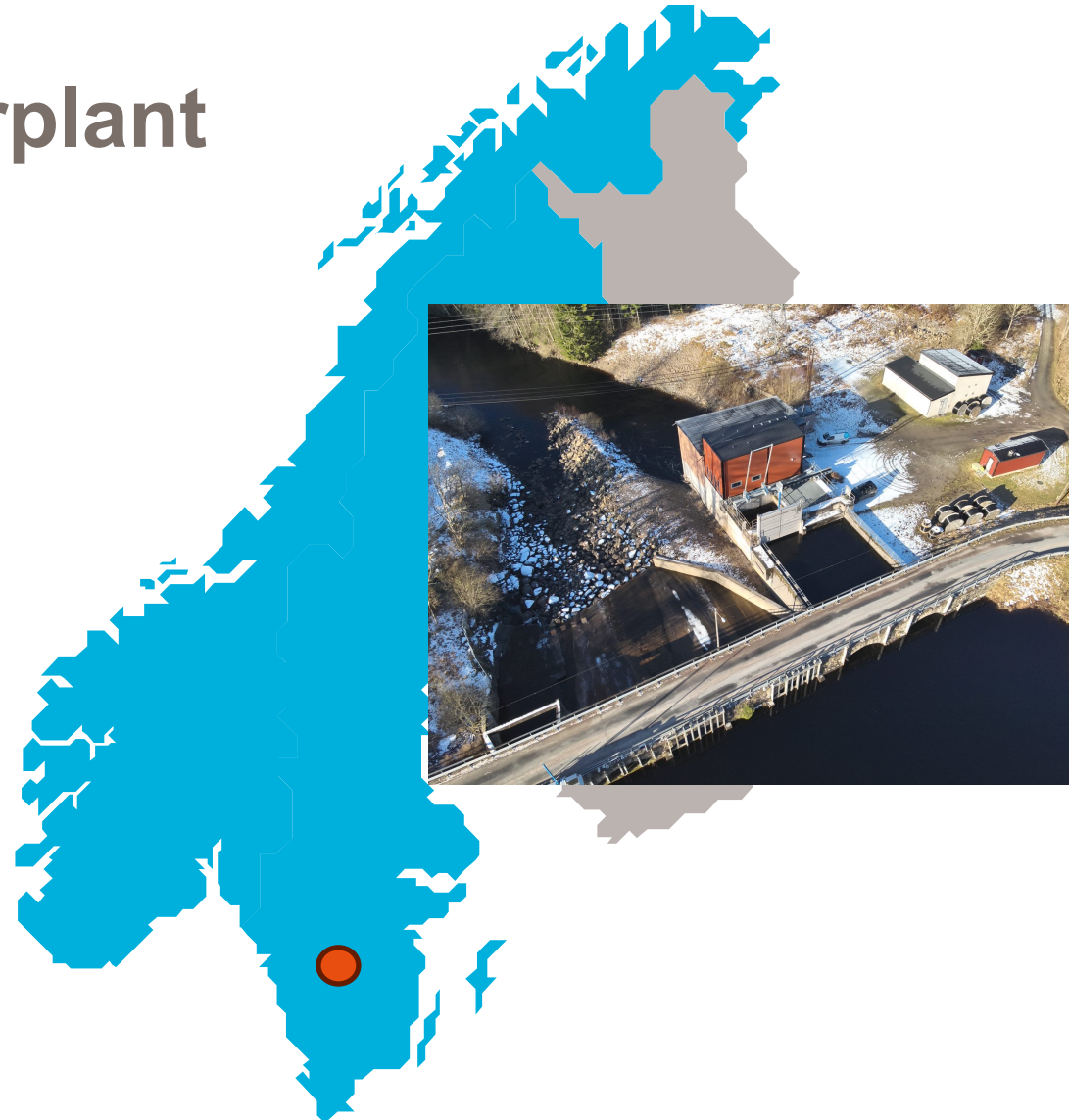


<input type="checkbox"/>	Namn ↑↓
<input type="checkbox"/>	↔ smarplanhydro-iot-weu-rg-vnet
<input type="checkbox"/>	smartplanhydro-chirpstack
<input type="checkbox"/>	smartplanhydro-chirpstack-weu-sbus
<input type="checkbox"/>	smartplanhydro-chirpstack-weu-vm-nsg
<input type="checkbox"/>	smartplanhydro-chirpstack-weu-vm_OsDisk_1_d*
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<input type="checkbox"/>	smartplanhydro-weu-psql
<input type="checkbox"/>	smartplanhydrochirpstackweuvmnsg
<input type="checkbox"/>	vm-chirpstack-01
<input type="checkbox"/>	vm-chirpstack-

Where?

Ivarsfors hydroelectrical powerplant

- Selection criteria
 - Good technical status
 - Powerplant was refurbished 2018
 - New turbine
 - New generator
 - New local control system
 - Suitable turbine technology for optimization
 - Single Kaplan turbine, 1MW
 - Low contribution margin
 - Far away from other locations and plants
 - Dam is without classification according to RIDAS



Next

Future development

- Smartplant 2.0
 - Semi disconnected power plant.
 - All benefits from the platform but without the disconnection from Statkraft
- Smartplant Lite
 - Electrical cabinet sized deployment on small assets (pumps, water level sites, camera)
 - Modular system
 - Cameras
 - Digital and analog input / output modules for connecting sensors directly
 - Standalone communication
- Production optimization for small hydro planning
- AI models on subsets of data
- Remote robotic monitoring
- Eel monitoring and analytics
- BIM 2.0





[statkraft.com](https://www.statkraft.com)

