



Coordinating the hydropower industry's research needs

Emma Hagner, Energiforsk

13/9 - 2023

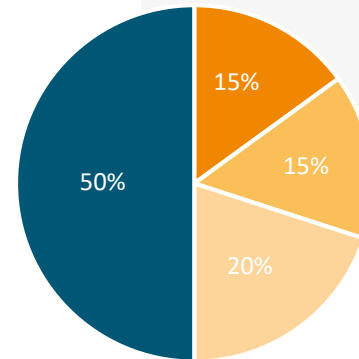
Vision

We are the hub of Swedish energy research

Through collaboration and dialog, we conduct energy research so that new knowledge creates value for industry, decision-makers and the whole society.

This is Energiforsk

- Politically neutral
- Non-profit making
- Four owners



■ Swedegas ■ Energigas Sverige
■ Svenska kraftnät ■ Energiföretagen



What Energiforsk do

We make the world of energy smarter!

- Initiates, coordinates, and conducts research and analysis
- Initiates, quality assures, and manages projects
- Leverages the industry's research resources
- Provides specialist services in the field of energy
- Communicates knowledge and research results
- Contributes to a robust and sustainable energy system





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Hydrological Development Program, Compensatory fish farming



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Hydropower and environment



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Hydropower Concrete Program, Hydropower Rock Engineering Research, Digitalization in Hydropower



Hydropower

- Conduct research for safe and cost-effective hydropower.
- Develop new knowledge for the environmental adaptation of hydropower.
- Ensure that hydropower continues enabling increasing shares of wind and solar power in the energy system.
- Around 30 active stakeholders, including the Swedish Energy Agency, Svenska kraftnät, hydropower owners, and technical consultants.
- 15 research and development programs
- Project budgets between 50,000 and 13 million SEK. An average of 80+ active projects..

Our R&D portfolio

Hydropower Concrete Program



Swedish Centre for Sustainable Hydropower



Hydropower and environment



Hydropower Rock Engineering R&D



Hydrological Development Program



Compensatory Fish Farming



Dam Safety Development Program



Digitalization in Hydropower



Applied Hydropower Technology



A photograph of a winter forest. The trees are heavily laden with snow, and the ground is covered in a thick layer of snow. A stream flows through the center of the forest, with snow piled up along its banks. The lighting is soft, suggesting a low sun, creating a serene and cold atmosphere.

Hydrological development program HUVA

Marc Girons Lopez

Hydrologist, Uniper

Member of HUVA

HUVA – Hydrological development program

Cross-industry network aimed at addressing common challenges and promoting the advancement of applied hydrological knowledge

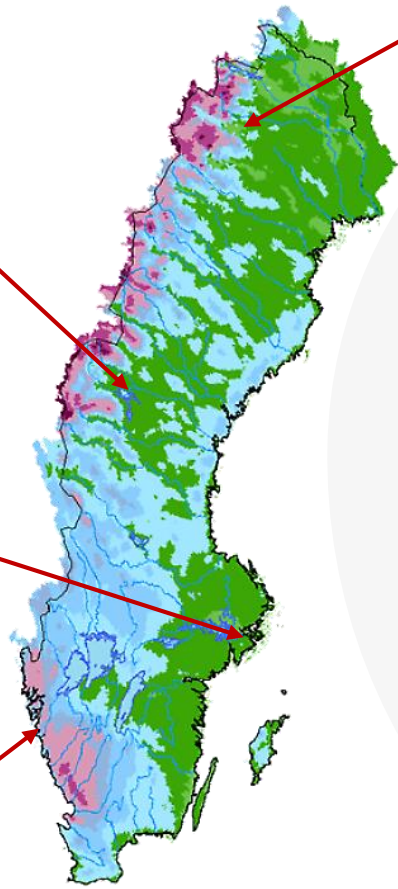
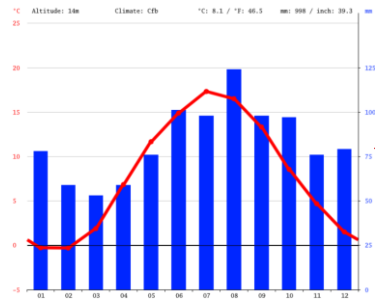
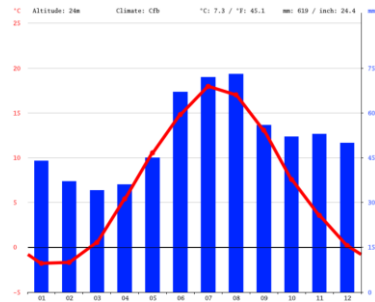
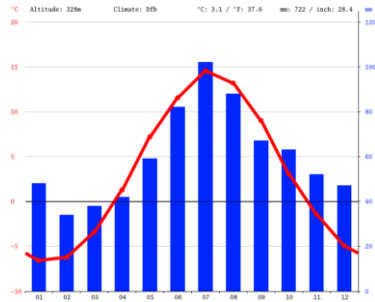
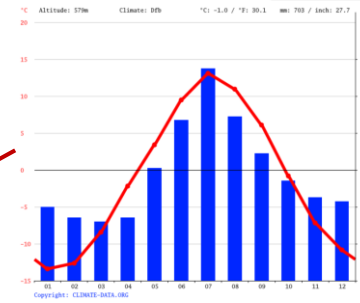
Strong focus on hydrological forecasting

Funding of applied hydrology R&D projects

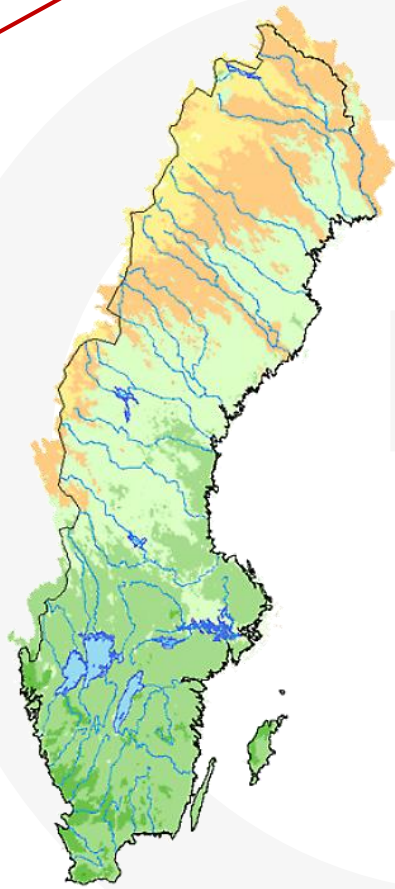
Hydrological constrains, operation, and development of Swedish Hydropower

Swedish hydrology

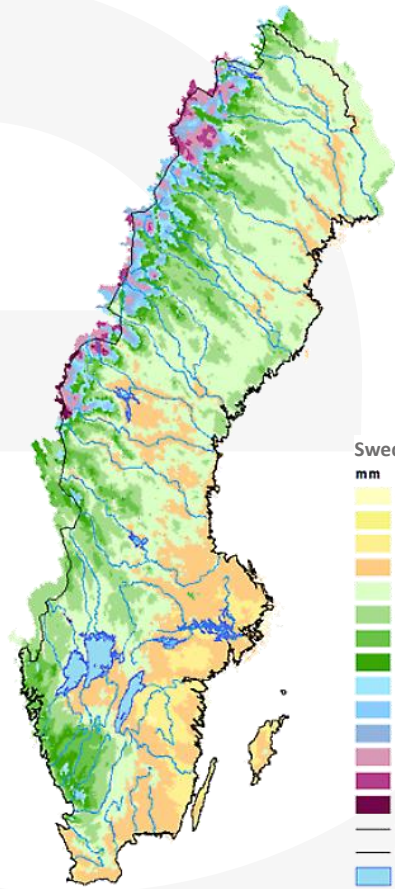
Annual water balance for the period 1981-2010



Precipitation

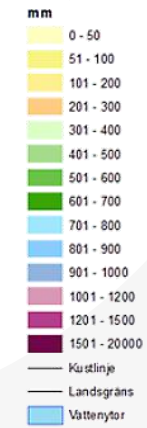


Evapotranspiration



Runoff

Sweden's water balance



SMHI

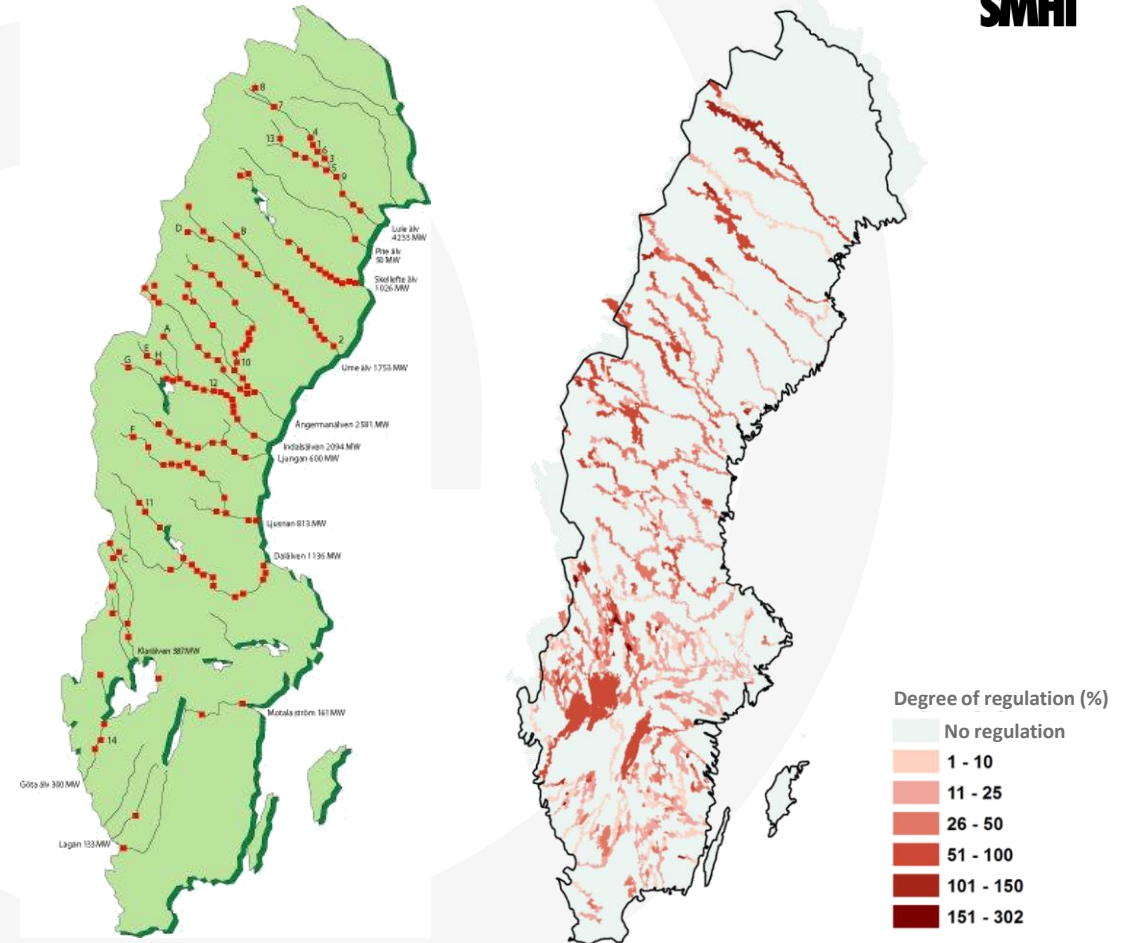


Swedish hydropower industry

Favourable conditions and long history of hydropower production.

Currently:

- About 2000 hydropower stations
- Total production of 65 TWh in a “normal year”, concentrated **mostly in northern Sweden**
- Production of about 45% of the electricity in Sweden



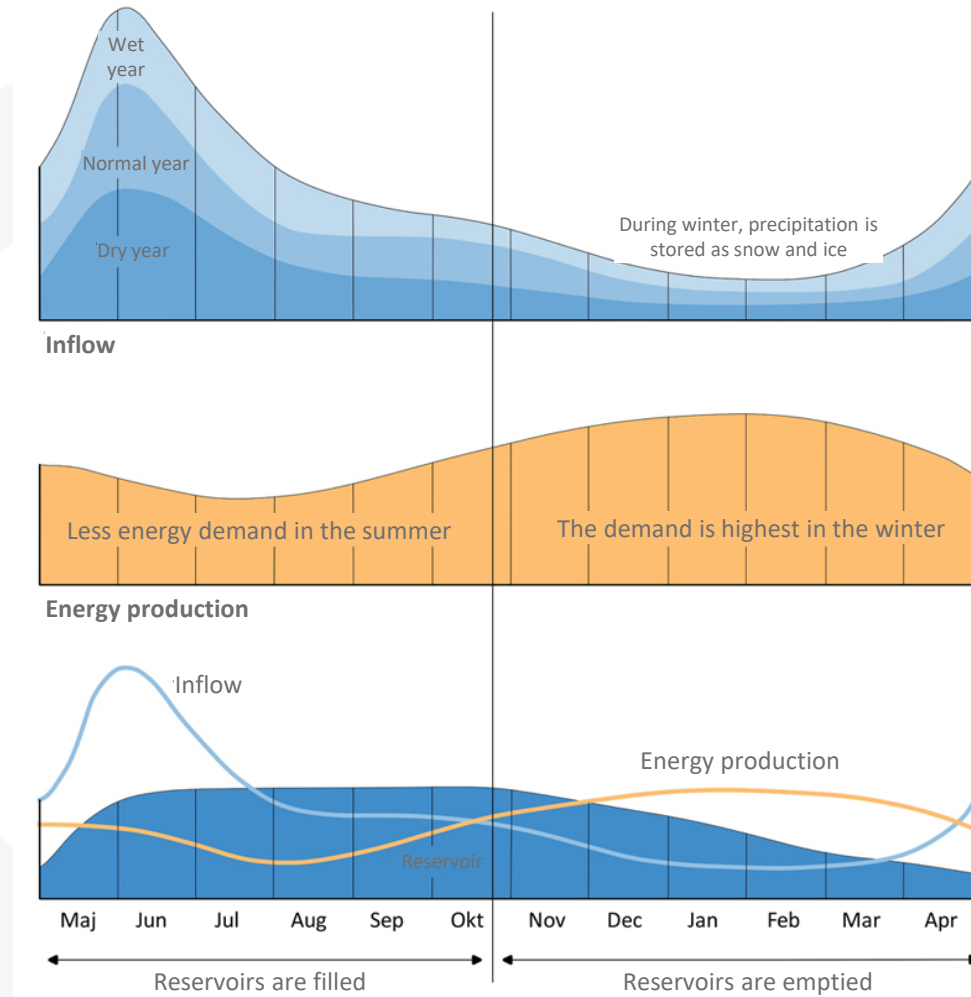
SMHI

Hydropower operation in Sweden

Hydrological cycle dominated by snow

Demand is highest in the winter months

Decoupling between production capacity and energy needs



Operational framework

Water Regulation Companies...

... coordinate the hydropower operation in co-owned rivers

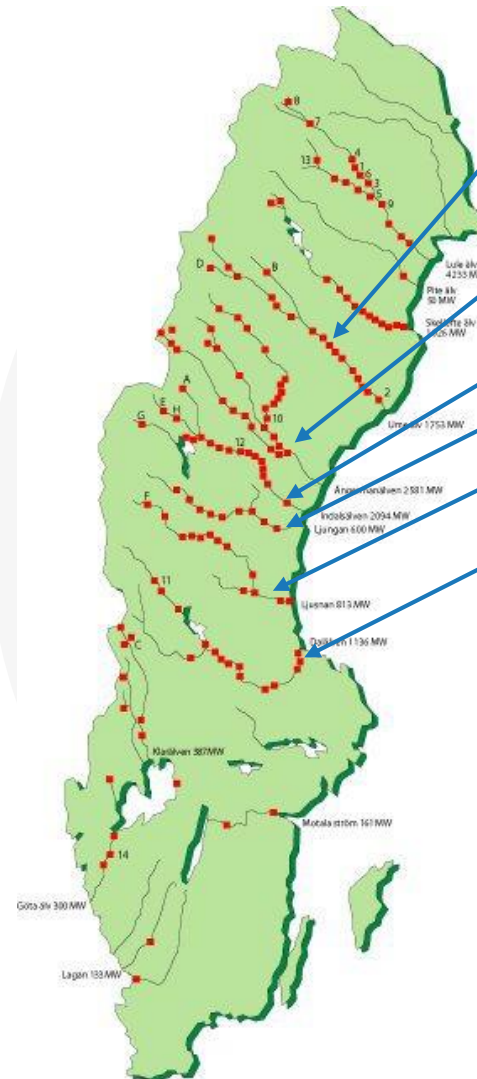
... produce hydrological forecasts on behalf of producers

This operational modelling setup and forecasting system is owned by SMHI and is operated through a license fee

SMHI is responsible for most research and development

WATER REGULATION COMPANIES

UMEÄLVEN • ÅNGERMANÄLVEN • INDALSÄLVEN • LJUNGAN • LJUSNÄN • DALÄLVEN



Hydrological modelling and forecasting in the hydropower industry

Focus on estimating the present and future **inflow** to reservoirs

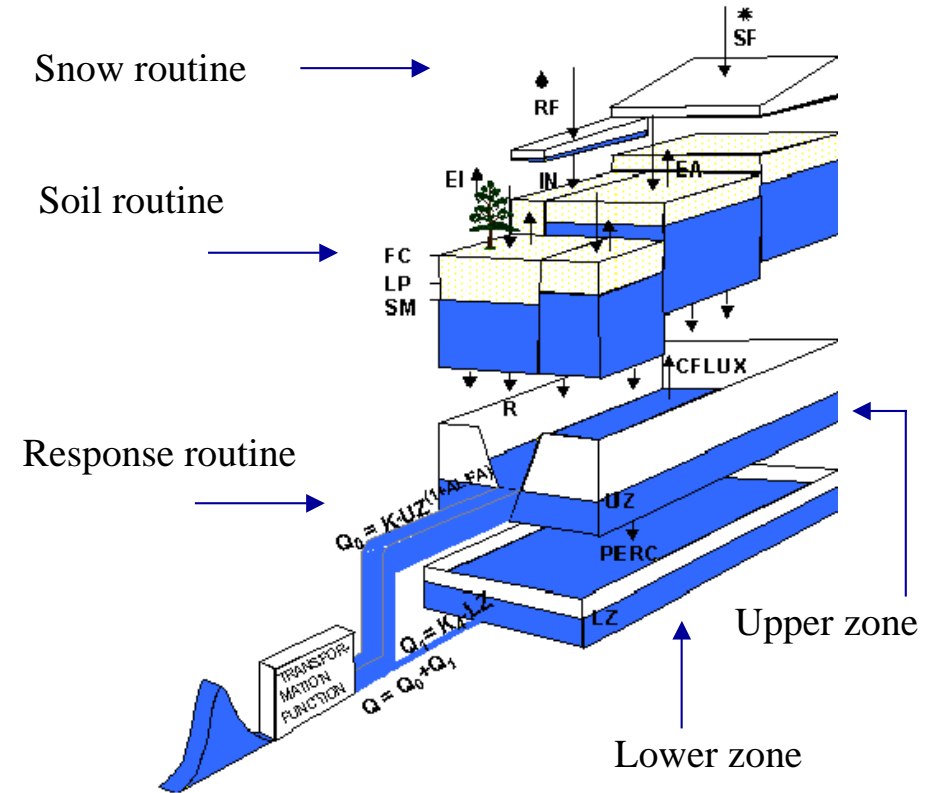
Inflow data is used for:

- **Optimization of production plans** for reservoirs
 - Spatial scale: local (sub-catchment) scale
 - Time horizon: real-time, day-ahead, up to 2 weeks
- **Price forecasting**
 - Spatial scale: mostly large-scale models including at least Sweden and Norway
 - Time horizon: from 2 weeks to several months

Short-range forecasting

- **HBV model** (Bergström, 1976)

- Conceptual, semi-distributed model with elevation and vegetation zones
- Precipitation and temperature as driving data
- Daily time step
- Production of deterministic and ensemble short-range forecasts based on NWP



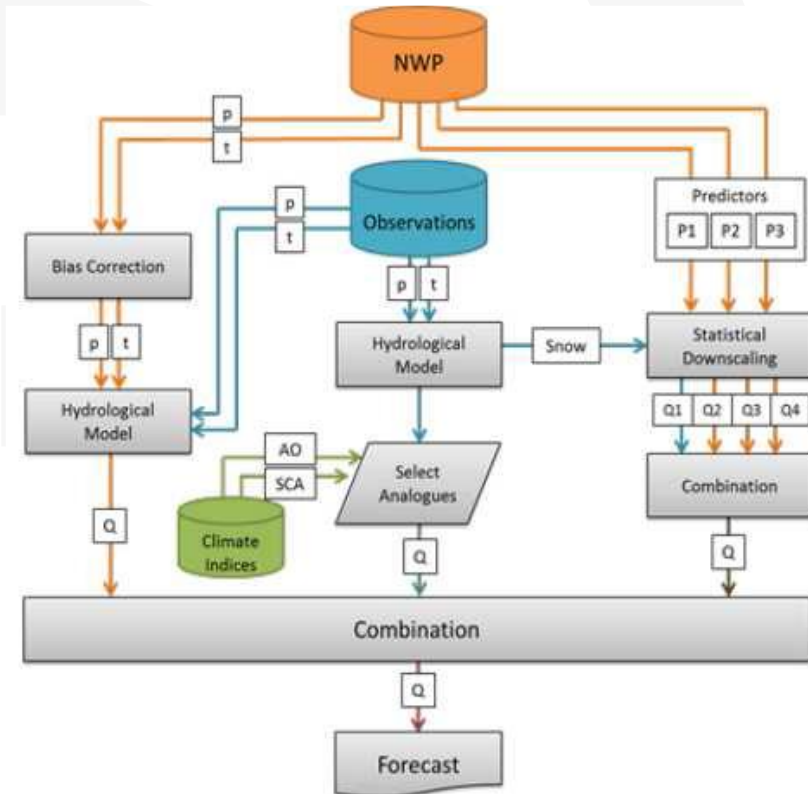
Long-range forecasting

- **HBV model**

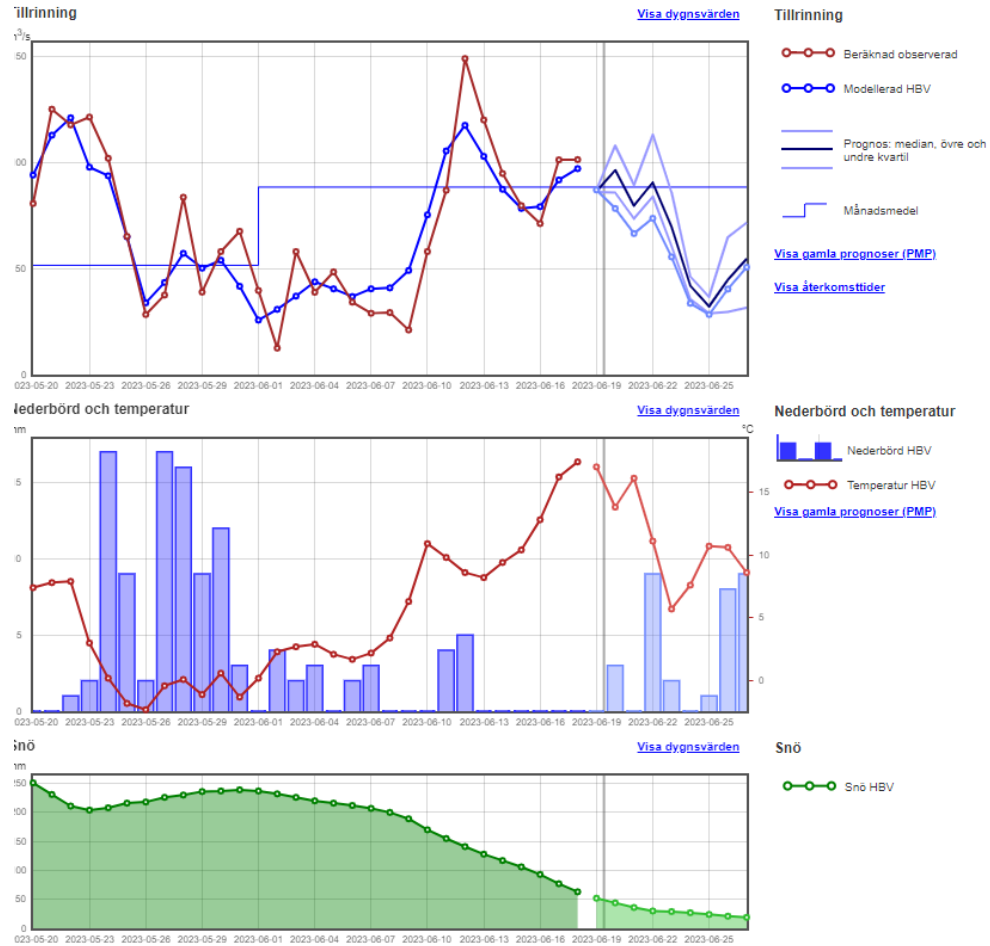
- Ensemble streamflow prediction (ESP)

- **Multi-method model** (Foster, 2018)

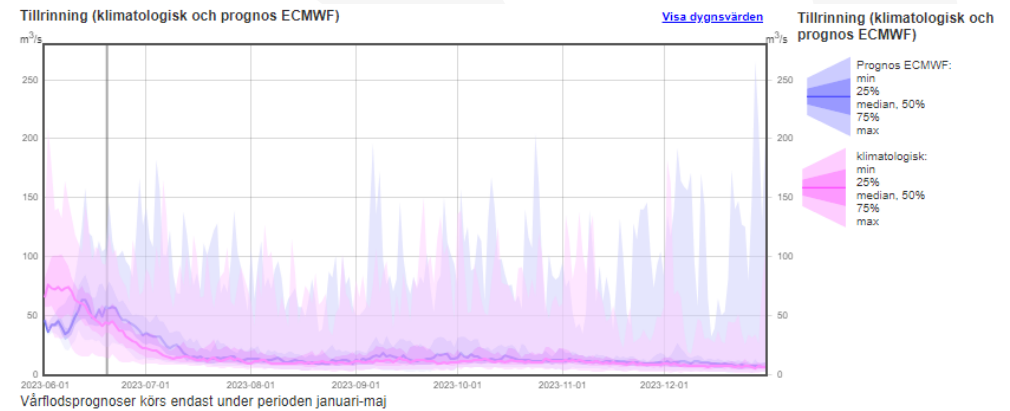
- Weighted combination of historical, statistical and dynamic forecasts



Information for operational planning



Short-range



Long-range

Current challenges

- Implementation of **distributed modelling** for a more realistic representation of key processes, such as snowpack dynamics.
- Short-range forecasting
 - **Hourly resolution** when necessary (spring flood onset, storms)
 - Data assimilation (e.g., satellite data)
- Long-range forecasting
 - Improve the understanding of **large-scale atmospheric patterns and teleconnections** to hydrological dynamics in Sweden
 - Consider **climate change** (i.e., non-stationarity) in ESP forecasts

Bridging the gap between research and operational use

HUVA programme period 2024-2026

Research fund of 2.4 MKr within the upcoming HUVA programme period

Call for proposals opening soon
Take a look at our poster this afternoon for more information!

Energiforsk

The Hydropower Industry's Hydrological Development Programme - HUVA

The HUVA working group has been around since 1981 with the purpose and goal to provide knowledge and methodological improvements on hydrology and hydrological applications, a basic prerequisite for the hydropower industry. This working group is the foundation for the research and development programme that is managed by Energiforsk. The group ensures that the field continues to progress so that hydropower can remain a successful part of the energy transition. HUVA is the only forum in Sweden where key hydrology-related questions for the hydropower industry are being addressed collaboratively, making it an important and unique network in the field.

Timeline:

- 1998:** Long history of hydrological R&D in the hydropower industry
- 2015:** Ongoing programme
- 2024-2026:** Future Programme

Research Funded by the HUVA Programme

The HUVA programme secures funding from the hydropower industry over three-year programme periods. Funded research and development projects mainly focus on the development of forecast strategies and models both to ensure an efficient management of water resources in power generation as well as to estimate the long-term effects of environmental measures. HUVA's activities take place in close collaboration between the hydropower industry, SMH and academia, which has resulted in valuable areas of cooperation. For example, SMH's HYV model was originally developed for the hydropower industry in the 1970s and its development has been ongoing since then. Results from the projects funded within the incoming programme period can be found on Energiforsk.se via the QR-code below.

Programme Period 2024 - 2026

HUVA continuously monitors developments in the field to ensure that the industry is well equipped to face current and future challenges.

- Efficient dam management to support production increases:** As the energy sector changes and investment costs for production increases, the regulatory aspects of hydropower become increasingly important. This leads to higher demands for hydro-meteorological observations, high accuracy inflow forecasts and faster model development.
- The impact of climate change on hydrological conditions:** There is increasing uncertainty regarding how representative historical data will be for a changing climate. Hydro-meteorological climate scenarios produced to forecast and plan for possible future hydrological conditions over a wide range of possible scenarios. It is still unclear how to transfer these uncertainties to risk management and production plans.
- Design flood & dam safety:** Hydrological inflow forecasts are of great importance for the operation of a river when dealing with high flows, which has a direct impact on maintaining dam safety.

Funding Opportunities

We are currently wrapping up the last projects of the ongoing programme period and are actively discussing the research and development needs to be addressed within the 2024-2026 programme period.

A research fund of 2.4 MKr is available for the upcoming HUVA programme period. Any organisation or institution that has project proposals in line with the HUVA programme description, is welcome to apply for funding.

For more information about funding opportunities within the HUVA programme you are more than welcome to get in touch with us. You can find more information about the programme and contact information via the QRcode below.

Some of Our Recent Publications

Meeting Places and Knowledge Dissemination

An important part of our activities are directed towards knowledge dissemination, mainly through projects, conferences and courses. Every year, HUVA hosts events and meetings aimed at promoting knowledge exchange and learning experiences for both senior and junior personnel from, among others, power producing companies or public institutions.

VATTENREGLERINGSFÖRETAGEN
VATTENFALL • STATKRAFT • MIKROENERGI • FORTUM • JÄMTKRAFT • HOLMEN • KARLSTADS ENERGI

Learn more and access our QR code