Iceland Liechtenstein Norway grants

Norway grants

HIDROELECTRICA

SINTEF

EEA & NORWAY Grants 2014-2021

Project: "Networking, exchange, sharing, and transfer of knowledge, technology, experience, and practices in the field of electricity production in hydropower plants between Hidroelectrica and SINTEF."

Working together for a green, competitive and inclusive Europe

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EEA&Norway Grants
Funding Call – Bilateral Cooperation

Key Elements of the Funding Call

EEA&NORWAY GRANTS

Funds provided by Iceland, Liechtenstein, and Norway, with the following objectives:

- **Reducing economic and social disparities within the European Economic Area (EEA).**
- **Strengthening relations between Iceland, Liechtenstein, Norway, and beneficiary states in Europe.**

Instrument: EEA Financial Mechanism 2014-2021

Program: Energy Program in Romania

Call - Bilateral Cooperation in the Green Transition

Publication Date: 18.03.2024

Total Budget: 2 million EUR

Funding Rate: 85%

Purpose: To enhance cooperation between Romania and Norway, Iceland, or Liechtenstein in the transition to green energy.

Eligible Participants: Entities from Romania, Norway, Iceland, and Liechtenstein.

Fields: Renewable energy and other clean energy solutions, Resource efficiency and circular economy, Sustainable blue economy, Energy storage(including batteries), Zero-emission transport(including eco-friendly maritime transport), Smart and sustainable urban solutions, Carbon capture and storage

Activities: Networking, knowledge exchange, sharing, and transfer of technology, experience, and practices; Development of green technologies, products, or services; Feasibility studies; Training, capacity building, and awareness-raising.

Deadline for Funding Applications: **31.05.2024**

2

2024 / 392262
Project / Financing Contract

Key Elements of the Project/Financing Contract

214.459 EURO
Grant Value

252.304 EURO
Total Costs

85%
Intensity

21.10.2024
Start project

28.02.2025
Project Completion

1
Reimbursement

""Networking, exchange, sharing and transfer of knowledge, technology, experience and practice in the field of electricity generation in hydropower plants, between HIDROELECTRICA and SINTEF"

Project Promoter: HIDROELECTRICA

Project Partener: SINTEF Energi As (Norway)

The main project objective: knowledge transfer of SINTEF expertise and application of SINTEFs digital solutions in a new geographical area and market setting. This exchange includes capabilities and solutions for optimization of hydropower scheduling to cover Hidroelectrica needs for testing the digital state-of-the-art solutions in parts of its current activity and sharing exchange about the Romanian power energy market and hydropower generation field with SINTEF.

Result indicators:

- 1 Workshop organized in Norway (5 days);
- 1 Workshop organized in Romania (5 days);
- Development of the case study (one watercourse with up to three hydropower plants) on Hidroelectrica hydropower plants for improving the existing scheduling models,
- Testing the first digital model for a three-months period and the combined two digital models for a six-weeks period (i.e. doing a back testing of selected period with manual data transfer to the SINTEF vLab solution and comparing results with recorded operative decisions of Hidroelectrica in order to analyse the results, benefits and also the need for improvement for a proper implementation at Hidroelectrica level).

Completed Activities:

05.07.2024 - Approval of the funding application

23.07.2024 - Directorate decision approving the financing contract

31.07.2024 - Signing of the financing contract by Hidroelectrica

21.10.2024 - Signing of the partnership agreement

13.12.2024 - Completion of Workshop 1 organized in Norway

01.02.2025 – Completion of Workshop 2 organized in Romania

25.02.2025- Completion of the Final Case Study Report

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Activity 1 - Workshop Norway

Workshop 1 - Norway

- The first workshop was organised in Norway, by SINTEF.
- 7 specialists from Hidroelectrica, from the energy management and dispatch department, were participated in a 5 days workshop.
- There were been organised site visits to Norwegian companies around Oslo, acting in the energy field (electricity producers, market regulators etc.), as well as to at least one Norwegian company in Trondheim and/or to hydropower plants located in the area.
- SINTEF was exchanged and shared knowledge, experience and practice on their own concept and solutions developed for energy power market modelling and on their own concept and solutions for long and mid-term planning of hydropower generation.

Program Workshop 1 – Norway

Meetings of Hidroelectrica and SINTEF Specialists

1. NVE – December 9

- Presentation of NVE (Linn-Kaja)
- Project Presentation (Michael)
- Hidroelectrica Presentation (Manuela)
- Use of the Model in NVE (Anders Sivertsgård): Energy Security, Energy System Development
- Hydraulic Forecasting in Hidroelectrica (Ionuț Bogdan Stoenescu)
- Working with Hydraulic Forecasting in NVE (Erik Holmqvist)
- Q&A Discussions

2. Hafslund - December 9

- Presentation of Hafslund (Tor Halvor Bolkesjø)
- Project Presentation (Michael)
- Presentation of Hidroelectrica (Manuela)
- How Hafslund Uses SHOP
- Daily Planning Tasks: Where and How SHOP is Used
- SHOP in Research and Improvement Activities
- Q&A Discussions

3. Statkraft – December 11

- General Presentation of Statkraft
- Presentation of the Leifossene Power Plant from the Cascade of 17 Hydropower Plants in Trondheim – PIF 2008 (Head of Trondheim Section)
- Operation and Maintenance: Handled by a team of 35 people ensuring all necessary interventions and work
- Maintenance Optimization: Use of SAP and ongoing implementation of an Asset Management solution
- Q&A Discussions

Program Workshop 1 – Norway (2)

SINTEF Sessions December 10-13

December 10

- Introduction to SINTEF Models (Michael, Fredrik): The model chain, energy systems model, medium-term stochastic planning.
- SHOP Lectures Part I (Christian, Jiehong, Fredrik): Introduction to SHOP, iterations and linearization in SHOP, the hydropower production function in SHOP, SHOP research projects.

December 11

- SHOP Lectures Part II (Christian, Jiehong, Fredrik): water values in SHOP, bidding strategies, River course module in SHOP

December 12

- Use of Vlab Part I (Christian, Fredrik, Jiehong): Practical implementation work with Hidroelectrica
- Use of Vlab Part II (Bjørnar and Jiehong): Practical implementation work with Hidroelectrica

December 13

- Presentation of SINTEF results and the joint project (Michael)
- Planning of the next steps (Hans Ivar, Jiehong)

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Activity 2 - Workshop Romania

Workshop 2 - Romania

- Workshop 2 will be organised in Romania by Hidroelectrica, as a follow up to the first workshop, with SINTEF support and contribution.
- The objective of Workshop 2 is to apply knowledge and experience from Workshop 1 with the goal of testing digital models on a real watercourse.
- Results from testing will be discussed and the plan for the case studies study will be revised according to the experiences from workshops 1 and 2.
- The intention is for one person from SINTEF to attend this workshop physically, while other SINTEF experts may participate via Teams and share knowledge with expert modellers and schedulers from SINTEF and Hidroelectrica.
- 7 specialists from Hidroelectrica, from the energy management and dispatch department, and 3 specialists from SINTEF, will contribute to preparations and participation in Workshop 2.

Program Workshop 2 - Romania

Day 1

09:30 -11:30 Meeting with Hidroelectrica management
11:30 Lunch
13:00 – 15:15 Travel to Râmnicu-Vâlcea Branch
15:15 – 16:30 Meeting with Râmnicu-Vâlcea Branch management
16:30 Travel to Sibiu

Day 2

09:00 Travel to Lotru Hydropower Development
10:00 -12:00 Technical visit Dorin Pavel HPP
12:00 Lunch break
13:30 – 16:00 Technical visit Brădisor HPP and Mălaia HPP
16:00 – 17:00 Travel to Sibiu

Day 3 + 4

09:00 Using SHOP and VLAB – HE + SINTEF representatives, inclusive online participants from Norway
12:00 Lunch break
13:30 Using SHOP and VLAB – HE + SINTEF representatives, inclusive online participants from Norway

Day 5

09:00 Technical visit Sadu HPP + museum
12:00 Lunch break Sibiu
13:30 Conclusions
Planning off the next steps (Michael + Manuela)
Summary and QA

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Activity 3 – Case studies
SINTEF Solutions Applied to Hidroelectrica Lotru-Ciunget Hydropower Development

Activity 3 - Case Studies

- The goal is to test the first, short-term digital model for a three-months period and the combined two digital models for a six-weeks period (i.e. doing a back testing of selected period with manual data transfer to the SINTEF vLab solution) and comparing results with recorded operative decisions of Hidroelectrica in order to analyse the results, benefits and also the need for improvement for a proper implementation at Hidroelectrica level.

- During the case study development period there will be collaboration between experts on modelling in SINTEF and experts on operation in Hidroelectrica.

- At the end of this activity, Hidroelectrica will have a case study with the digital scheduling models for one watercourse with up to three hydropower plants, the report on the testing period as well as the knowledge and experience gathered during the entire project implementation.

SINTEF Digital Solutions

SINTEF Energy Virtual Lab (vLab)

- A set of collaborative cloud-based tools for energy models.
- vLab is a digital laboratory accessible online anytime and from anywhere.
- Built on a robust, secure, and scalable state-of-the-art infrastructure.
- Serves as a user-based virtual environment for researching, developing, running, and interacting with your own models, as well as many of SINTEF Energy's hydropower models, in an intuitive and easy-to-use manner.

SHOP (Short-term Hybrid Optimization Program)

- The program is based on an optimization algorithm that can model complex hydraulic configurations of watercourses.
- The program can manage any number of cascaded watercourses.
- Optimization is based on successive linear programming and can include formulations of optimization models with mixed variables or stochastic models.
- CPLEX is used as the solver for optimization processes.
- The general objective of the program is to utilize available resources and maximize profit during the considered period by exploiting optimal sales options on the spot market while adhering to firm loading obligations.
- It can also be used after understanding contractual obligations for the effective scheduling of production for the following day.

About the SHOP Model

Objectives

Potential for improving energy production scheduling at Hidroelectrica based on testing SHOP on the Lotru Hydropower Development (AHE Lotru).

Hidroelectrica

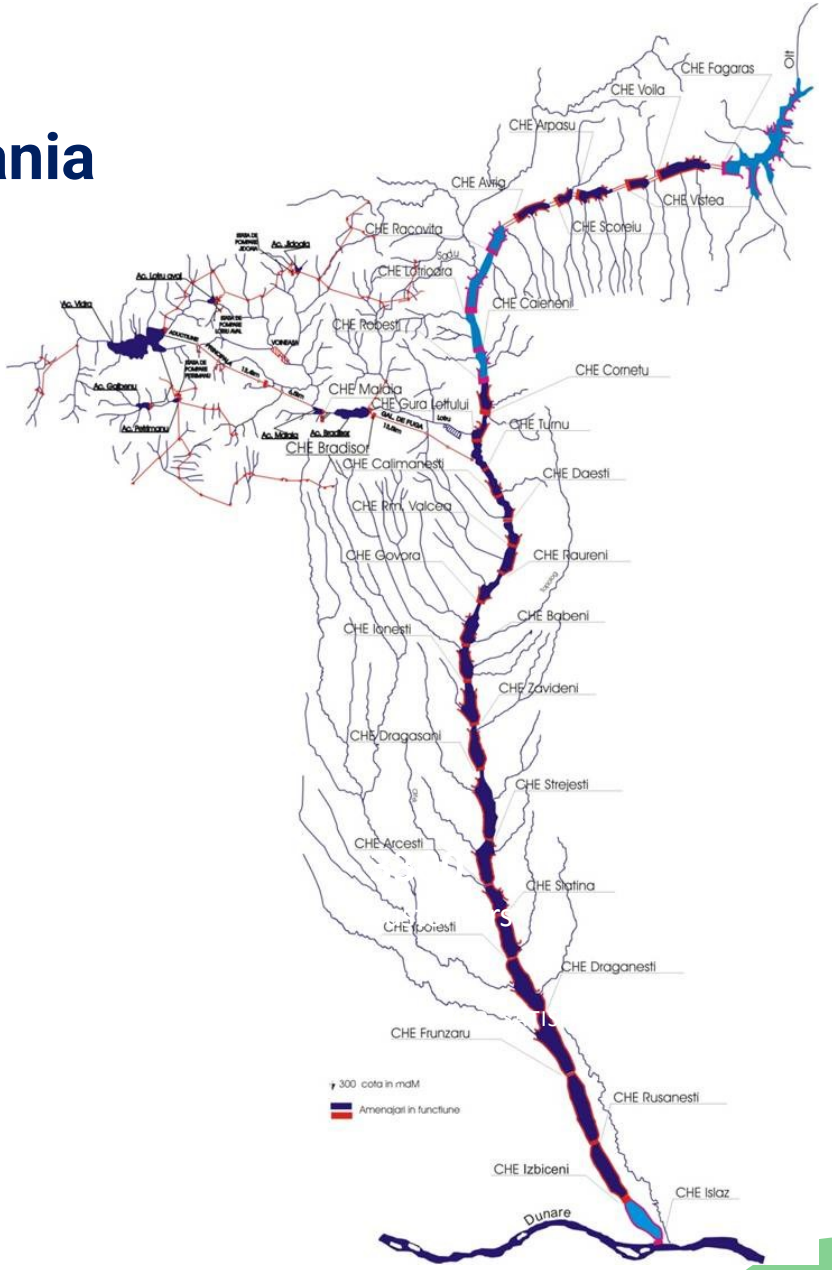
- Development of SHOP usage competencies.
- Identification of restrictions and requirements for using SHOP at Hidroelectrica:
  - Hardware and software resources, including the development of a custom user interface.
  - AHE modeling competencies in SHOP.
  - Updated/validated technical data (efficiencies, load losses, volume curves, transit times).
  - Availability of price and inflow forecasts.
- Evaluation of the benefits of using medium- and short-term optimization models and comparison with the current operation of facilities.
- Assessment of optimal operation scenarios for AHE Lotru in cases where the secondary regulation (RRFa) service is taken over by other units/BESS.

SINTEF Energy

- Necessary developments in SHOP.
- Development and testing of SHOP as a medium-term model and performance comparison with ProdRisk (the current medium- and long-term optimization model).

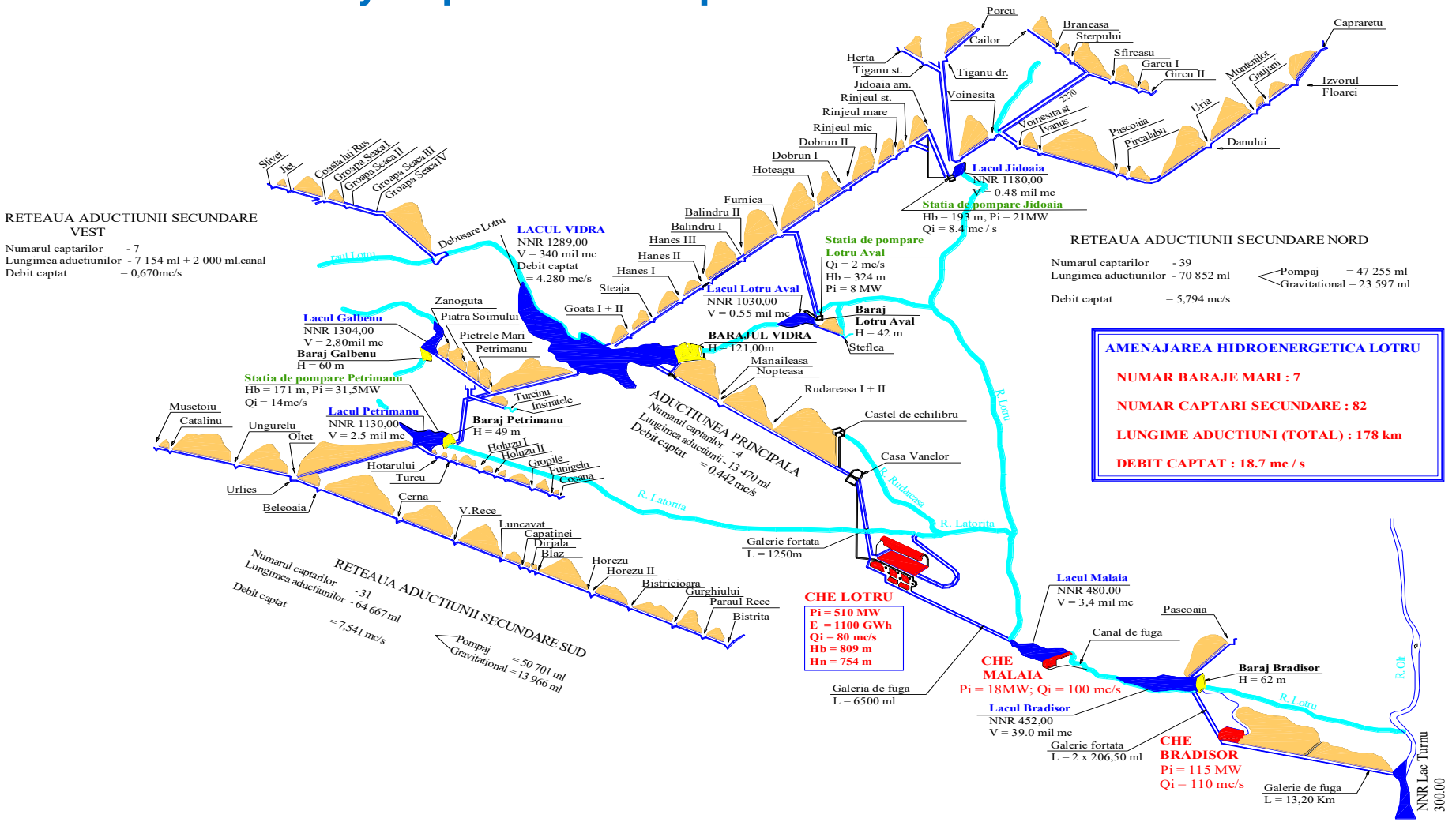
Case studies:
Lotru Hydropower Development - Romania

The Lotru hydropower development is the most complex of the inland rivers of Romania, being unique at the same time due to the adopted development scheme, which is based on the principle of the concentration of water flows and falls.



AMENAJAREA HIDROENERGETICA LOTRU

Lotru Hydropower Development



HPP LOTRU – CIUNGET

Years of commissioning: 1972 – HA1, 1973 – HA2, 1975 – HA3

This is an underground Power Plant located in a cavern with the following dimensions: L = 106 m, l = 18 m, H = 36 m;

Parameters of HPP Lotru:

- Type = UNDERGROUND POWER PLANT
- Installed Capacity= 510 MW
- Utilizable Discharge = 80 m³/s
- Gross Head = 809 m

It is equipped with 3 hydro aggregates, with "Pelton" type hydraulic turbines:

- Turbine type: PV-188-788 with 6 injectors
- Nominal speed = 375 rpm
- Electric generator type = HVS 560/245-16 – 185MVA
- Rated active power / unit : 170 MW

Main functions of the development:

- Production of renewable electricity
- Flood control - multiannual regularization

RESERVOIR AND HPP MALAIA

Year of commissioning: 1978

Parameters of HPP MALAIA:

- Type = STREAMLINE POWER PLANT
- Installed Capacity= 18 MW
- Utilizable Discharge = 100 m³/s
- Gross Head = 22.5 m

It is equipped with 2 hydro aggregates, with vertical “Kaplan" type hydraulic turbines:

- Turbine type: KVB 9.3-21
- Nominal speed = 214.3 rpm
- Electric generator type = HVS 380/90-28
- Rated active power / unit : 9 MW

The retention front consists of:
- non-spill concrete dam (H=30 m, L=48 m)
- spillway concrete dam (H=30 m, L=22 m)
- earthen dam (L=294 m);

The reservoir MALAIA has a total volume of 2,4 mil.m³

Main functions of the development:

- Production of renewable electricity
- Flood control

RESERVOIR AND HPP BRĂDIŞOR

BRĂDIŞOR DAM is a Double arch concrete dam with H = 62 m
The reservoir BRĂDIŞOR has a total volume of V = 40 mil.m³
The elevation of the crown – 457 mASL

The underground escape gallery with free level is the longest escape gallery made in Romania, L= 13.2 km

Main functions of the development:

- Production of renewable electricity
- Flood control
- Water supply of Ramnicu Valcea City

Parameters of HPP BRĂDIŞOR:

- Type = UNDERGROUND POWER PLANT
- Installed Capacity= 115 MW
- Utilizable Discharge = 110 m³/s
- Gross Head = 128.5 m

It is equipped with 2 hydro aggregates, with vertical “Francis" type hydraulic turbines:

- Turbine type: FVM 57.5-128.5
- Nominal speed = 375 rpm
- Electric generator type = HVS 423/167-16
- Rated active power / unit : 57.5 MW

Year of commissioning: 1982

Results

- Evaluation of the benefits of using medium and short-term optimization models and comparison with the current operation of AHE Lotru.
- Configuration of SHOP as a medium-term model and potential improvements.
- Identification of optimal operation scenarios for AHE, considering the specifics of the National Energy System (SEN).
- Identification of the need for new functionality developments in SHOP.
- Two joint seminars – one in Norway and one in Romania.
- Case study for the three hydropower plants: Dorin Pavel, Brădișor, and Mălaia.

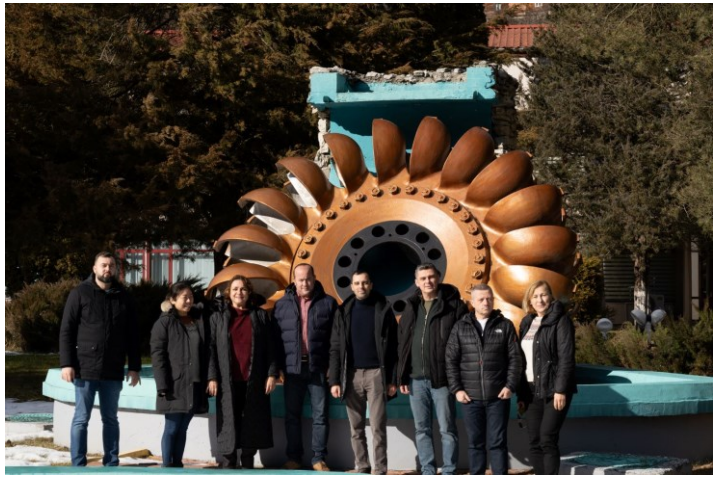
Conclusions

- Using digital tools for modelling hydropower operation has provided Hidroelectrica personnel with valuable experience and insights into the use of SHOP software and HPPs modelling.
- The main advantage of this digital solution is that it creates a comprehensive digital model of complex hydropower developments, taking into consideration all the parameters, input data, and constraints. This allows specialists to simulate various scenarios for asset planning and choose the most suitable solution for the business model.
- Within this successful bilateral cooperation project, Hidroelectrica, with SINTEF's expertise and support, conducted a case study on one of its most important assets groups – the Lotru Hydropower Development. Using SINTEF's dedicated tool (SHOP), a digital model was created to improve existing hydropower scheduling.
- The results obtained are very promising, but they are sensitive to the market price forecasts for the day-ahead market and inflow forecasts. The 11% income increase in revenues have been obtained based on historical inflow and DAM prices, assuming 100% forecast accuracy. Therefore, the model should be further tested with forecasts.
- The forecasts currently used by Hidroelectrica must be improved, and the results re-verified to ensure that the benefit demonstrated by using SHOP will also be realized in real-world operations.
- The results provide an overview of the Vidra lake planning with a lower share of production in the balancing market and for the coverage of FRR in the ancillary services market.
- The software should be tested with more reservoirs and power plants, and the results and SHOP calculation time should be compared with those obtained in the current project. This testing should encompass all Hidroelectrica assets as a whole, with the goal of optimizing the entire fleet, except for the joint operation Iron Gates HPPs.
- The applicability of this software increases with the share of energy sold in DAM, with higher income being obtained for an increasing share in DAM.
- Considering the results and benefits, both parties recommend future investigation into the use of SINTEF solutions for optimization and simulation of schedules for Hidroelectrica assets.
- Hidroelectrica will internally analyze the opportunity to use SINTEF platforms and services, but further testing and improvement in forecasts are needed.

Photos


Hafslund


HIDROELECTRICA
HIDROELECTRICA
HIDROELECTRICA



Thank you for your attention!

Manuela Horvath
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