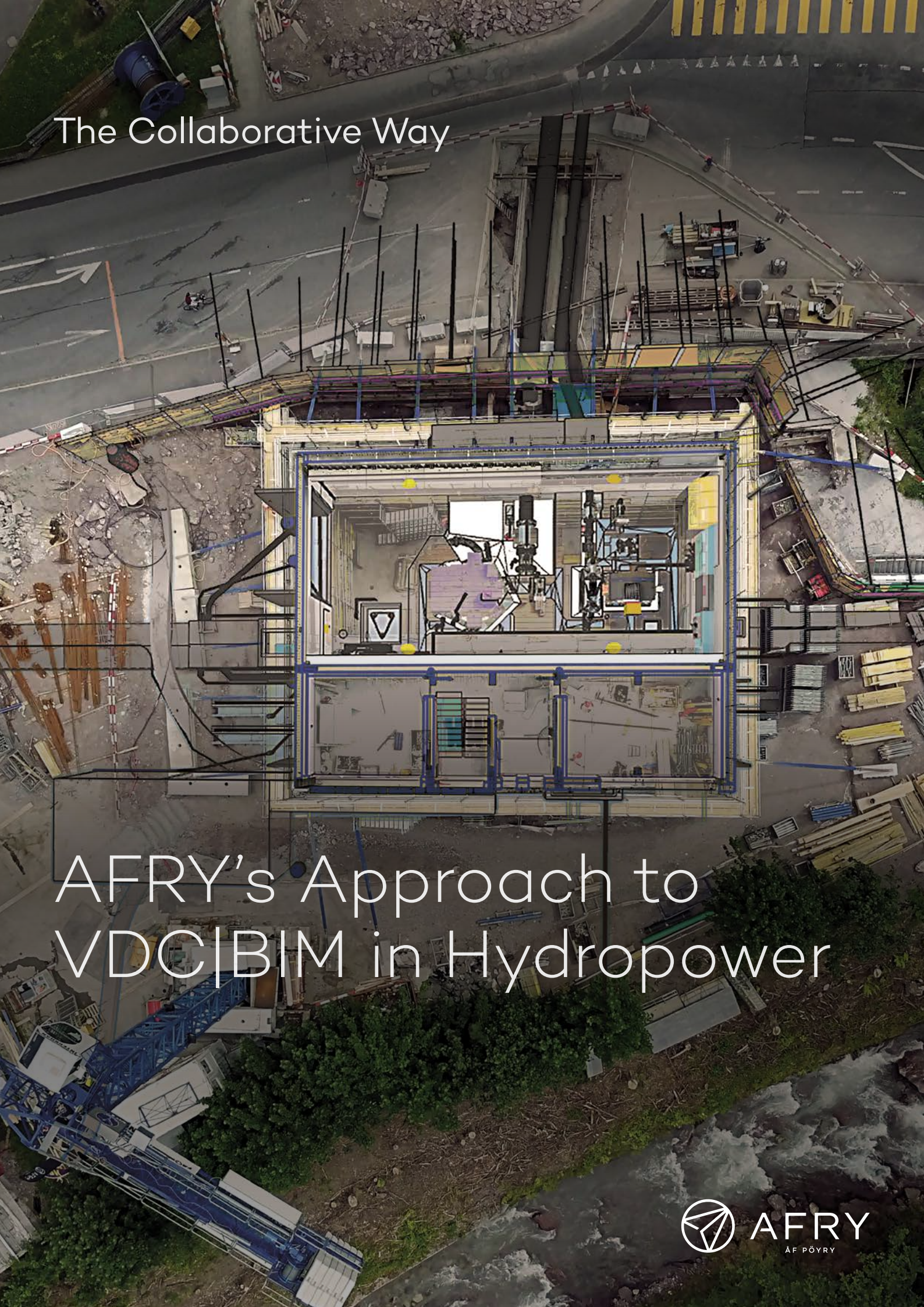
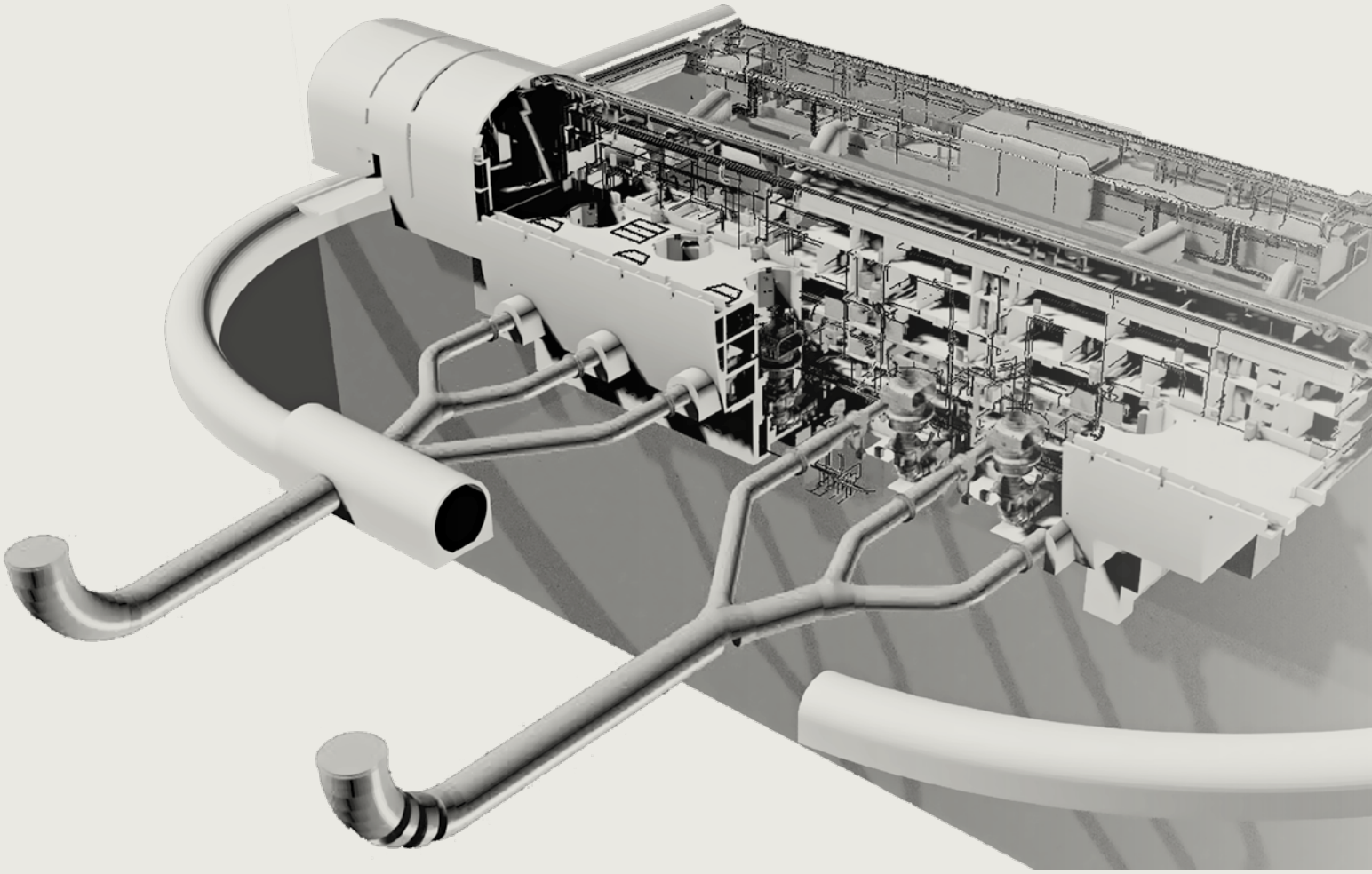


The Collaborative Way

AFRY's Approach to VDC|BIM in Hydropower

AFRY
ÅF PÖYRY

VDC|BIM: the Collaborative Way



3D models and BIM form the essential basis for VDC – also known as the BIM Method. However, VDC goes very much beyond that. VDC fundamentally changes the way projects are developed, coordinated and optimized.

Owners, designers, equipment suppliers and civil contractors join forces. They develop, coordinate and optimize a project in a collaborative way. This unleashes a vast potential, not possible with a classical design approach. Projects are deeply optimized and thoroughly coordinated using BIM models.

VDC|BIM simplifies the coordination of interfaces and enhances communication. By applying VDC|BIM, problems are identified and resolved with the help of models, early on, before anything is built.

VDC|BIM increases reliability in design, which reduces problems only detected on site and minimizes last-minute changes during execution. This leads to less change orders and greater reliability in scheduling and cost – and added value to the project.

What is VDC?

What is BIM?

VDC (BIM Method)
(Virtual Design and Construction)

The collaborative way

— Owners, designers, suppliers and contractors jointly develop a project
— This unleashes a vast potential not seen before
— The project is deeply optimised and thoroughly coordinated using BIM models

BIM
(Building Information Modelling)

Models enriched with information

Examples:
— Automated clash detection
— Operation and maintenance information
— Project life cycle information
— Progress reporting site supervision
— BIM 4D, 5D etc.
— Models used for communication

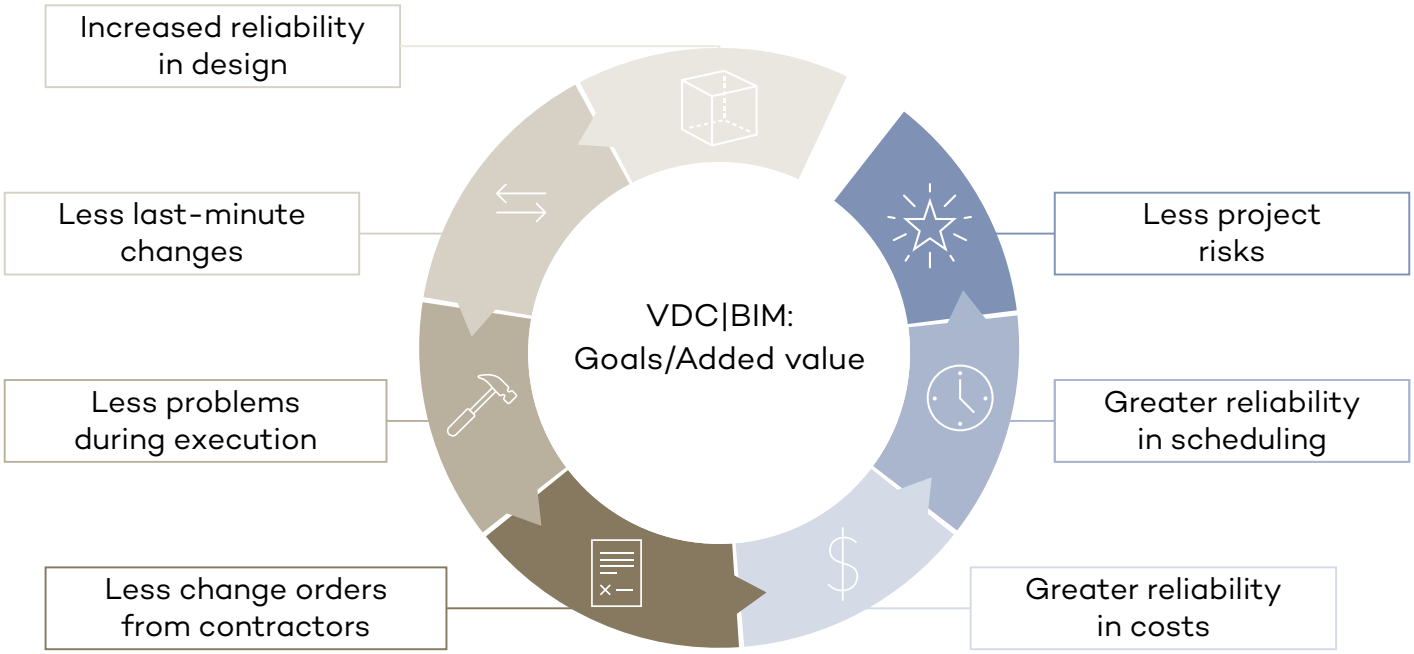
3D models

Basis

Examples:
— Laser scans of existing structures
— DTM (digital terrain models)
— Visualisations for stakeholders
— Drone surveys
— Reinforcement models

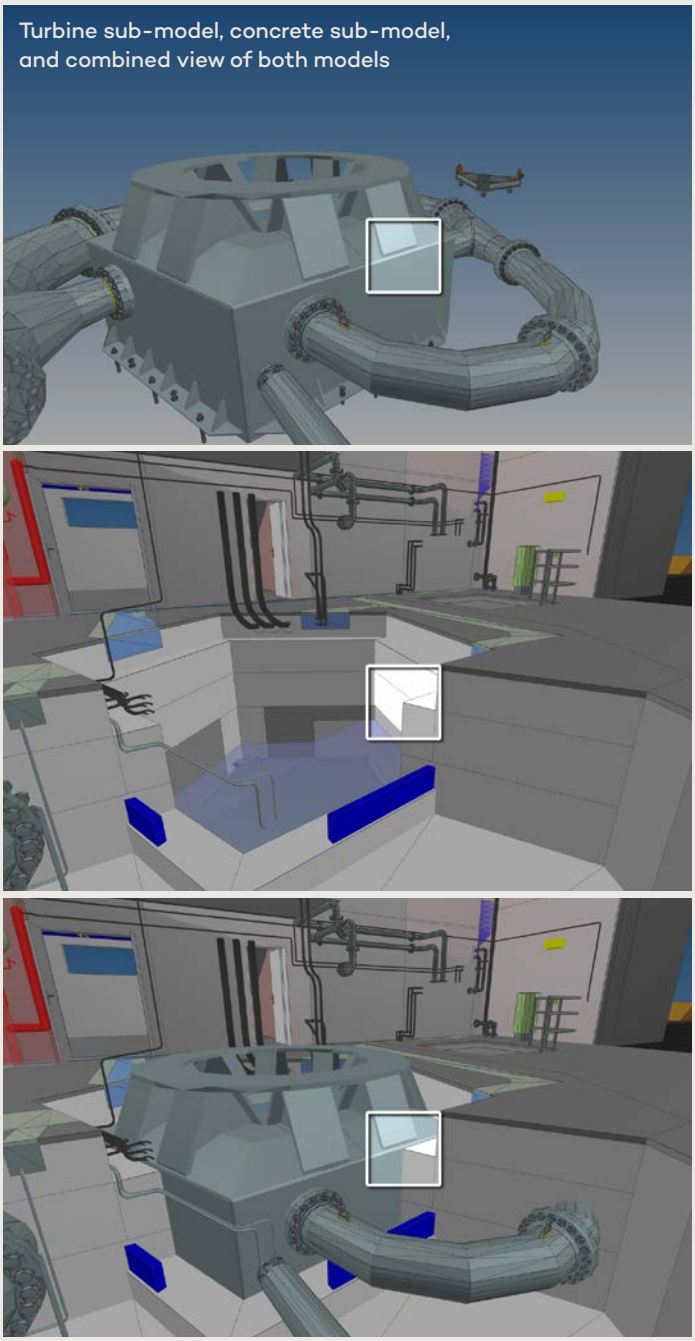
AFRY's Approach

AFRY has developed a standard approach of how to apply VDC|BIM in daily engineering work. It has been successfully implemented in several infrastructure and energy projects. Generally, new hydropower projects in Switzerland designed by AFRY are executed with this approach only.



AFRY's approach is based on the five main columns:

1. Working with sub-models in IFC standard
2. Synchronized model updates on a weekly basis
3. Software-based issue management
4. Collaboration workshops (ICE Sessions)
5. Sticking to a sequential design process.



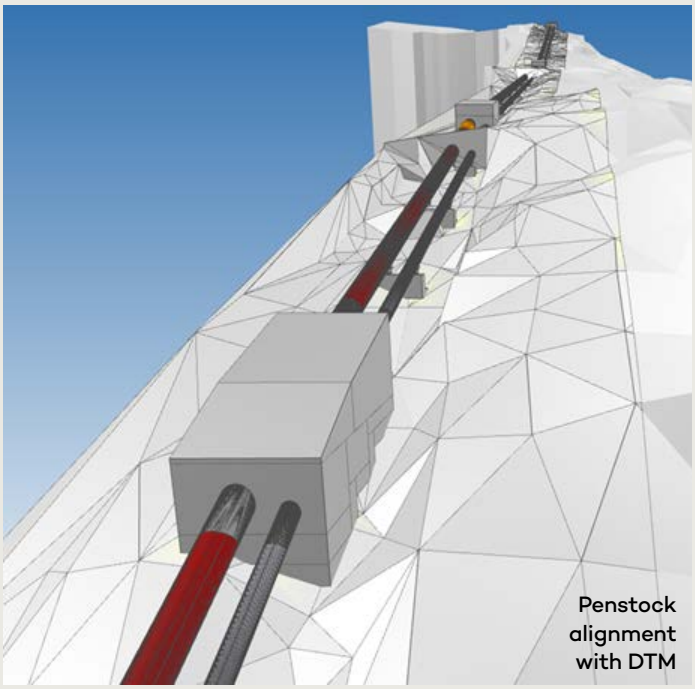
Turbine sub-model, concrete sub-model, and combined view of both models

1. Working with sub-models in IFC standard

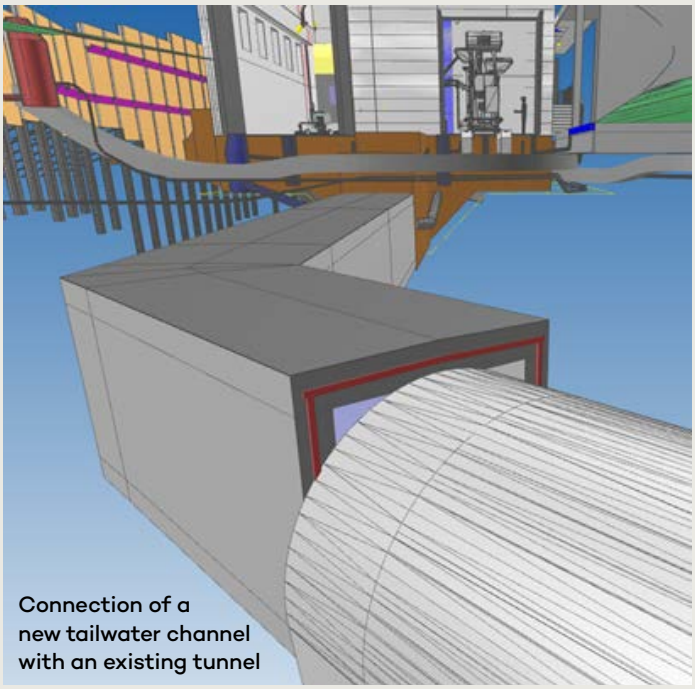
Each party participating in the design coordination process is responsible for the sub-models representing their scope. There is no overall model that covers the entire structure. Rather, the various sub-models are displayed assembled together in a viewer, e.g. BIMcollab Zoom.

Hence, there is no copying and pasting of partial models into an overall model, and no dilution of responsibilities. The responsibilities for each model are clearly defined. There is also no coordination in native formats. All sub-models are IFC-exports from the software programs of the different designers.

Apart from newly planned elements, sub-models can also visualize basic information. Existing structures are captured with laser scans, terrains are modelled as digital terrain models (DTM) based on drone survey campaigns, water levels are modelled, and geological surfaces are modelled in 3D. These are then converted into IFC-standard sub-models.



Penstock alignment with DTM



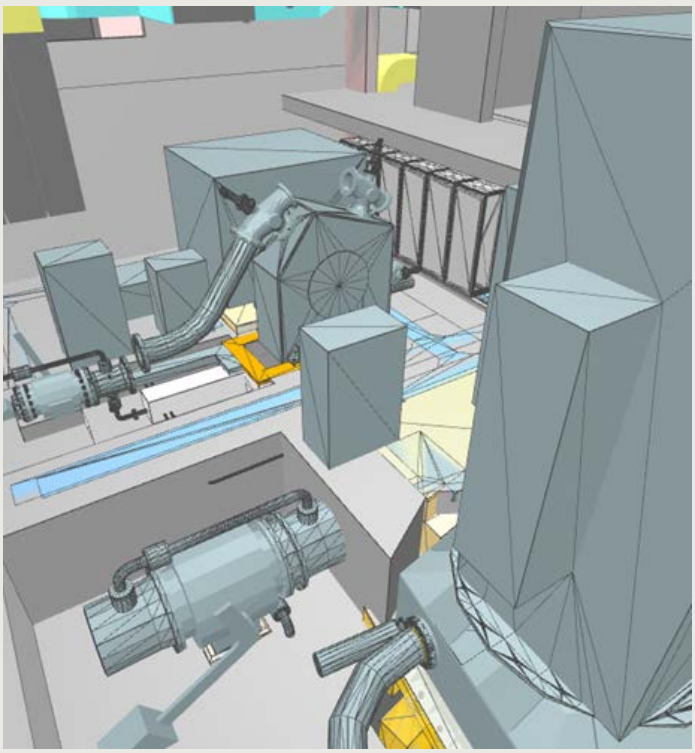
Connection of a new tailwater channel with an existing tunnel

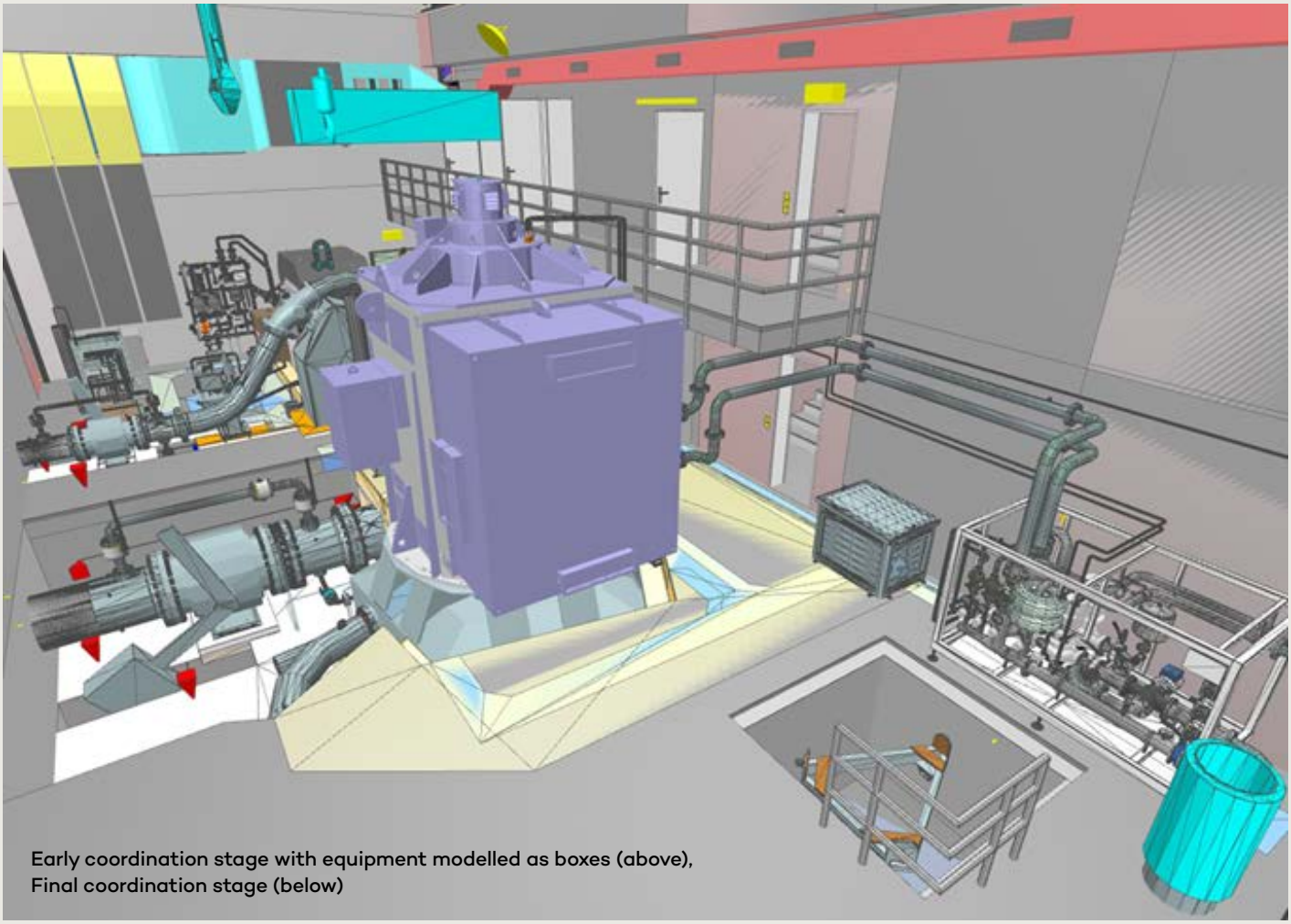
2. Synchronized model updates on a weekly basis

The model is updated on a weekly basis throughout the design phase. On a specific day of the week, all parties involved upload their current design status to the cloud. From this moment on, the updated sub-models are available to all other participants. The outdated models are archived, which ensures the traceability of changes.

Structures grow and get more detailed as they are developed together with the client, designers, equipment suppliers and the civil contractor.

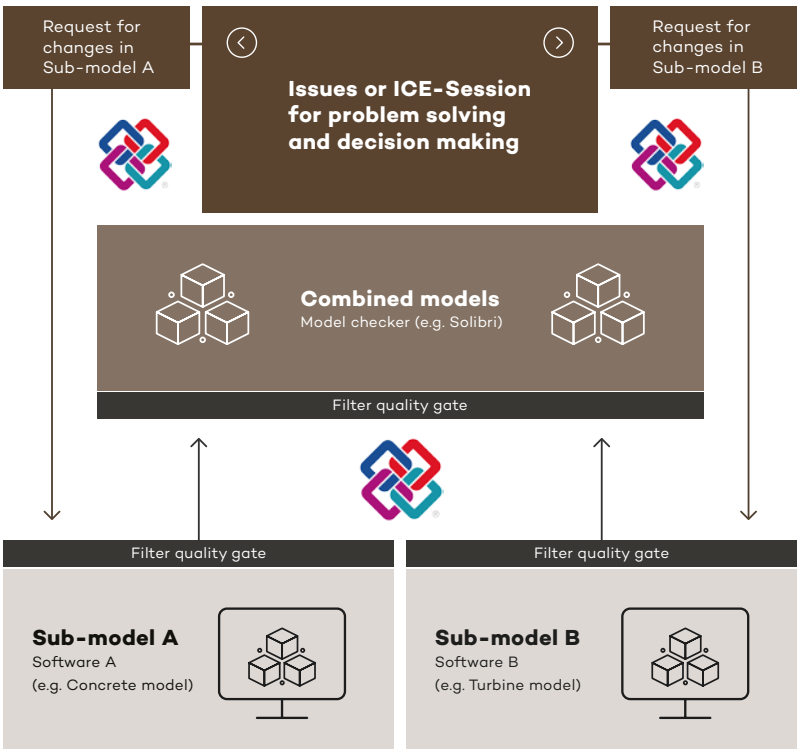
In the first part of the coordination phase, the focus is on the joint development and optimization of a structure. The arrangement and design of the equipment, the static requirements of the civil structure, the requests of the client and the requirements for the execution are coordinated. In the second part of the coordination phase, the focus is on optimization of details and resolving collisions. The first step is done visually and the second step is automated. The attributes stored in the models, such as the name of the equipment, material of pipes, purpose of embedded parts or type of concrete, support the coordination.





Early coordination stage with equipment modelled as boxes (above), Final coordination stage (below)

3. Software-based issue management



Specialized coordination software, e.g. BIMcollab Zoom, allows the recording and management of so-called "issues", which include collisions, change requests and other problems.

Parallel to the scheduled model updates, these issues are processed and updated by communicating adjustments to the models or suggesting alternative solutions.

All parties involved in an issue must then check and approve the solution in the models before the issue is closed.

Coordination Process with Issue Management and ICE-Sessions

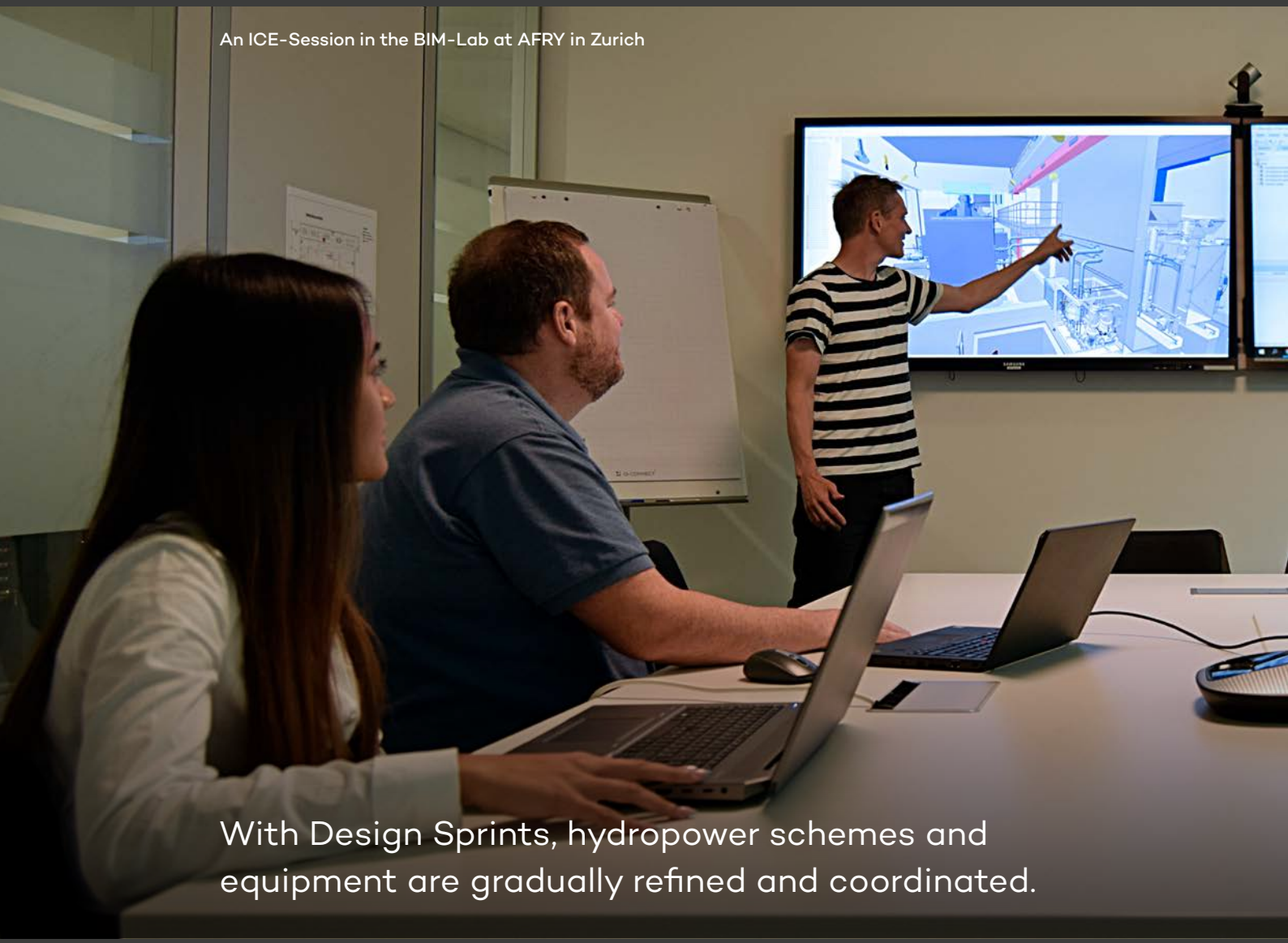
Visualisation of new intake with fish ladder, Waldemme HPP, Switzerland

4. Collaboration workshops (ICE Sessions)

While simpler issues are discussed and resolved using issue management software, the more complex ones are dealt with by ICE Sessions (Integrated Concurrent Engineering). All parties involved are present at the ICE Sessions, and advantages and disadvantages of proposed solutions can be directly and efficiently discussed. Quite often new ideas emerge which lead to improved solutions.

ICE Sessions work with the concept of design sprints, known from software development. Common work alternates with coordinated individual work. The purpose of ICE Sessions is problem solving and decision making, hence milestones are never reached during ICE Sessions. ICE Sessions need proper preparation, the various preparation and postprocessing steps usually cover one week.

After this week the issues discussed at the ICE Session are usually resolved, the respective sub-models are updated and the solutions are ready to be visually checked by all parties involved.

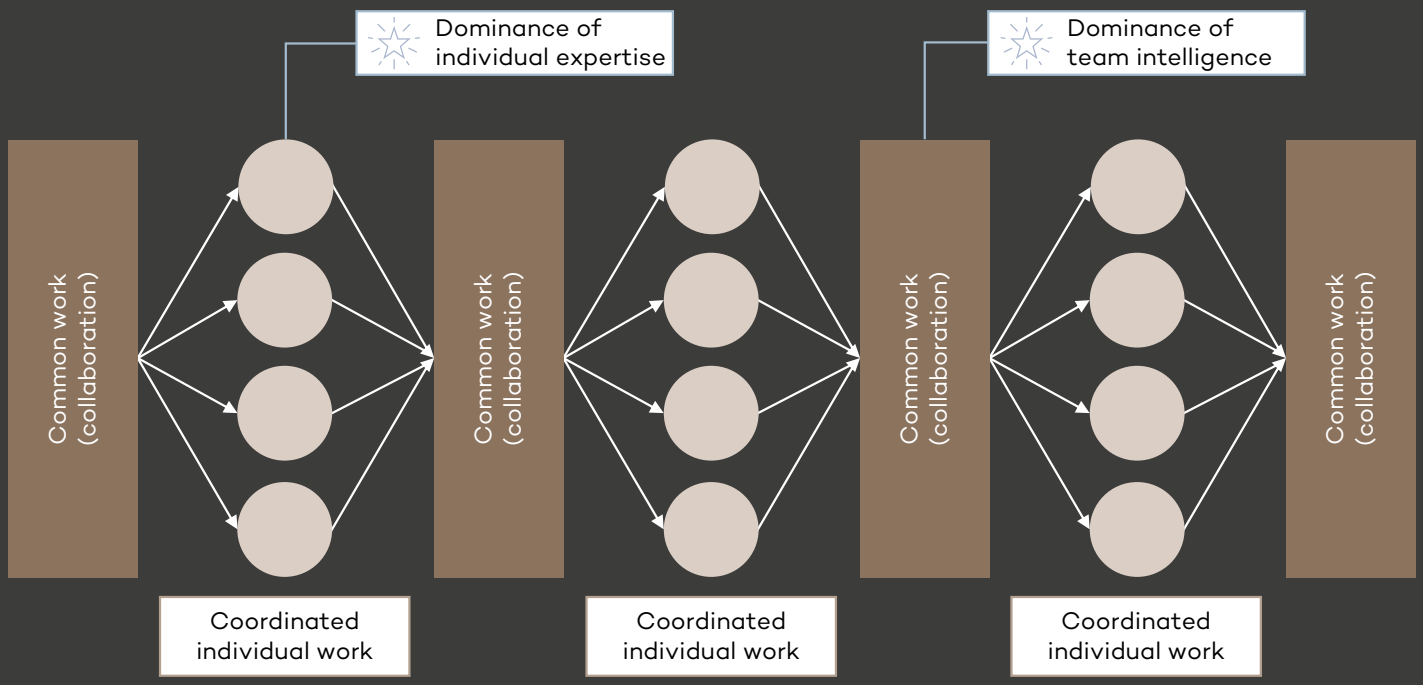


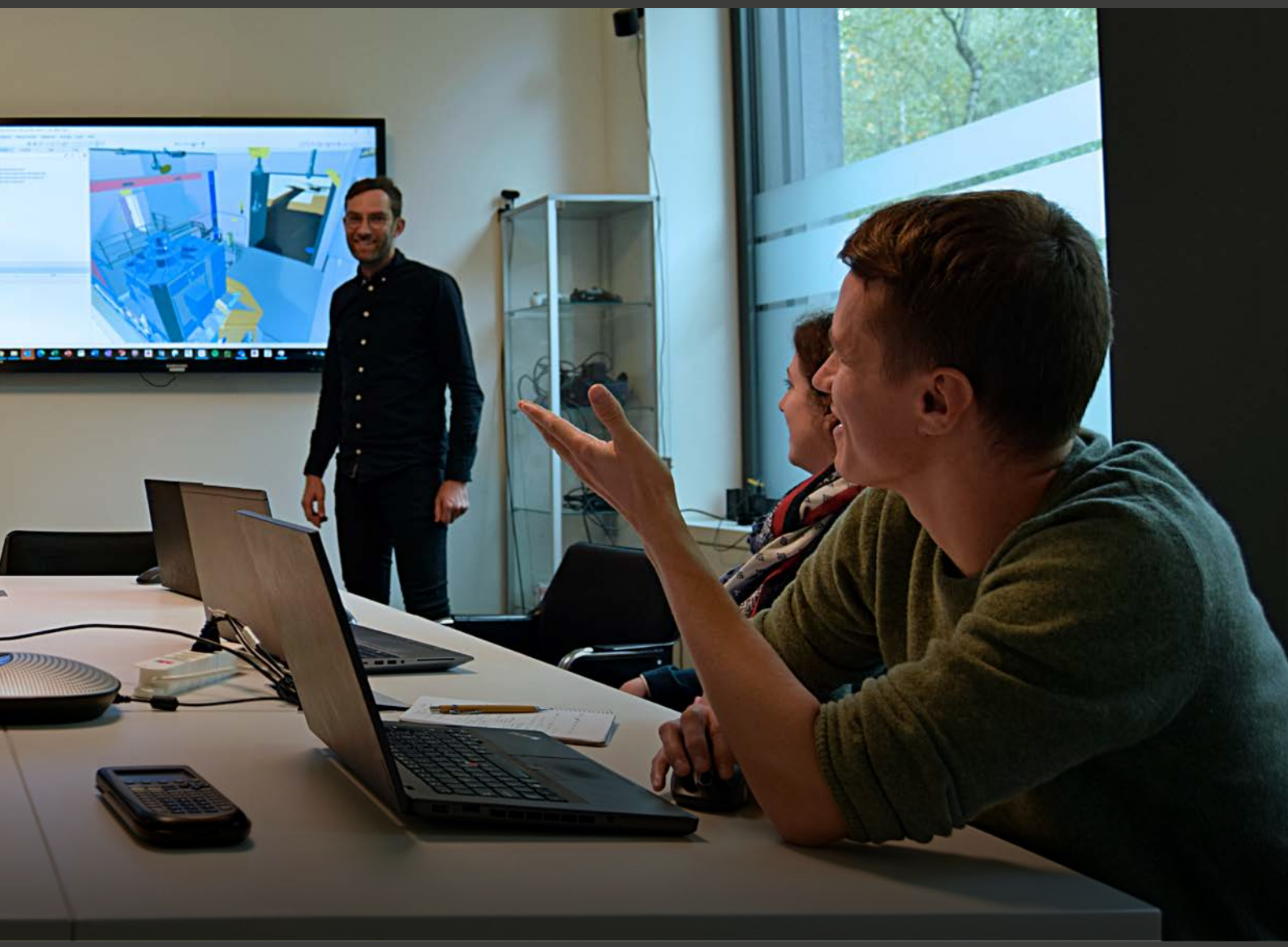
An ICE-Session in the BIM-Lab at AFRY in Zurich

With Design Sprints, hydropower schemes and equipment are gradually refined and coordinated.

Design Sprints

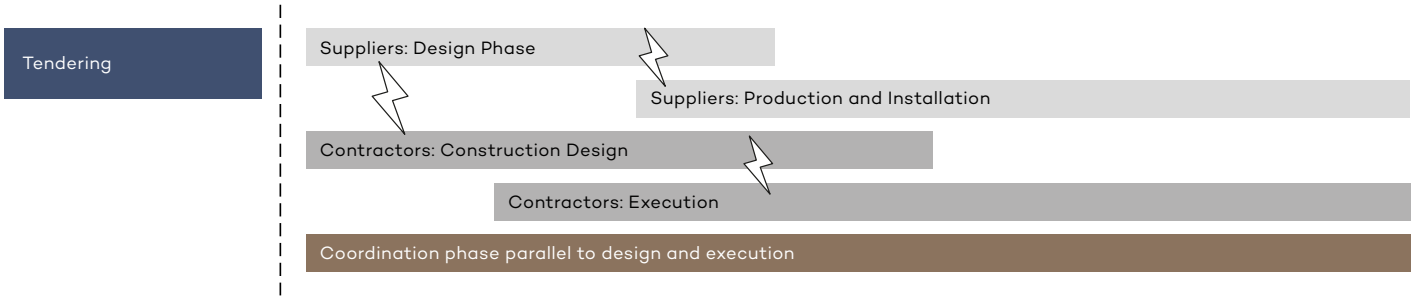
Source: thconsulting



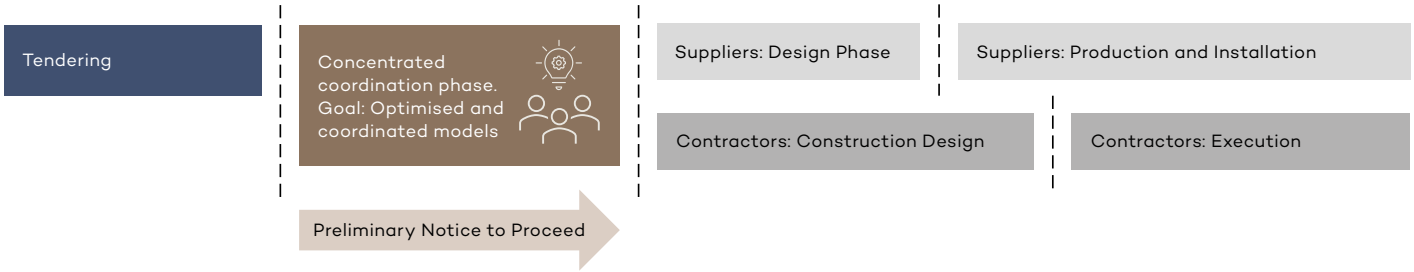


5. Sticking to a sequential design process

Classical way



VDC|BIM



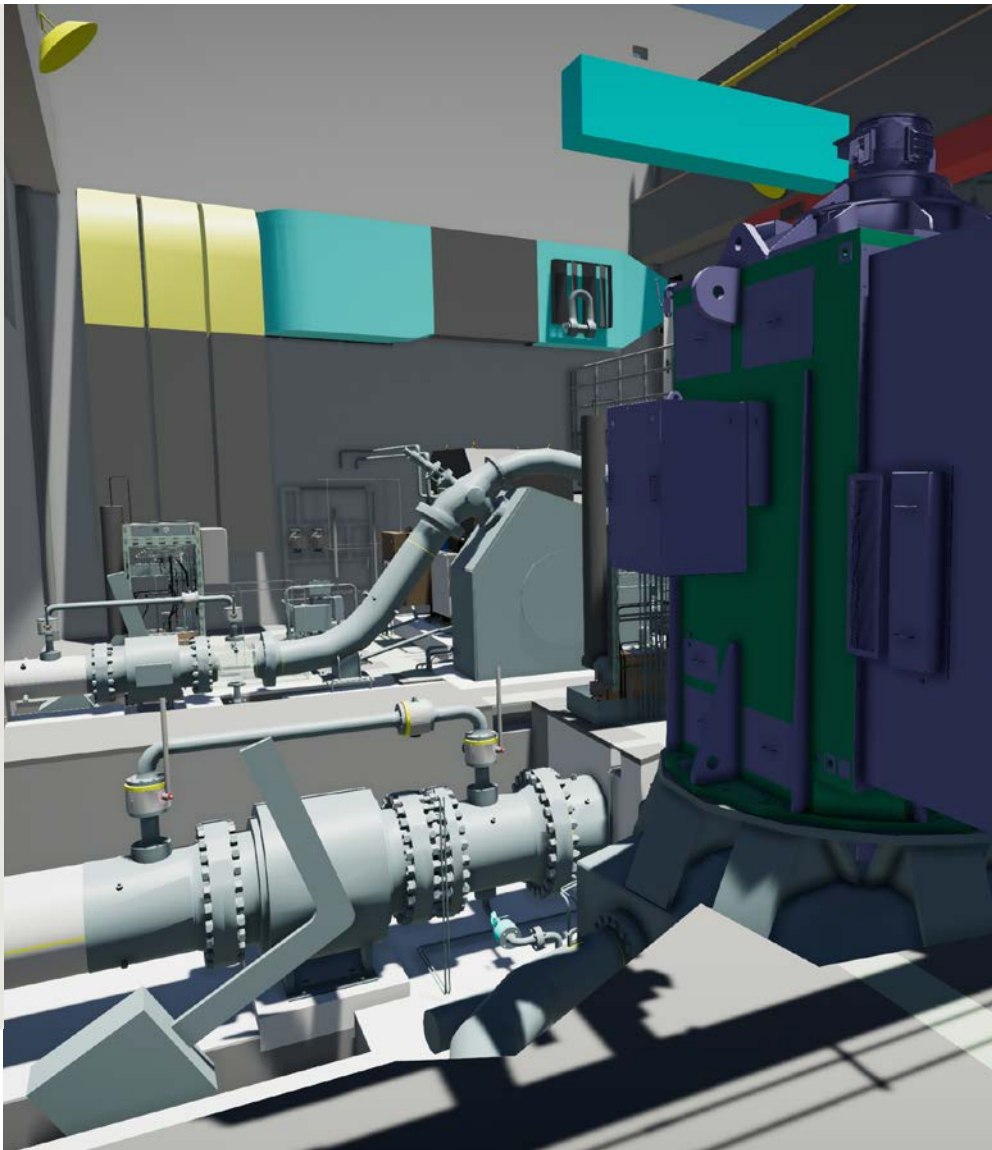
Coordination phase with VDC|BIM

In hydropower, some designers come on board after tendering only. This is different than in other infrastructure projects.

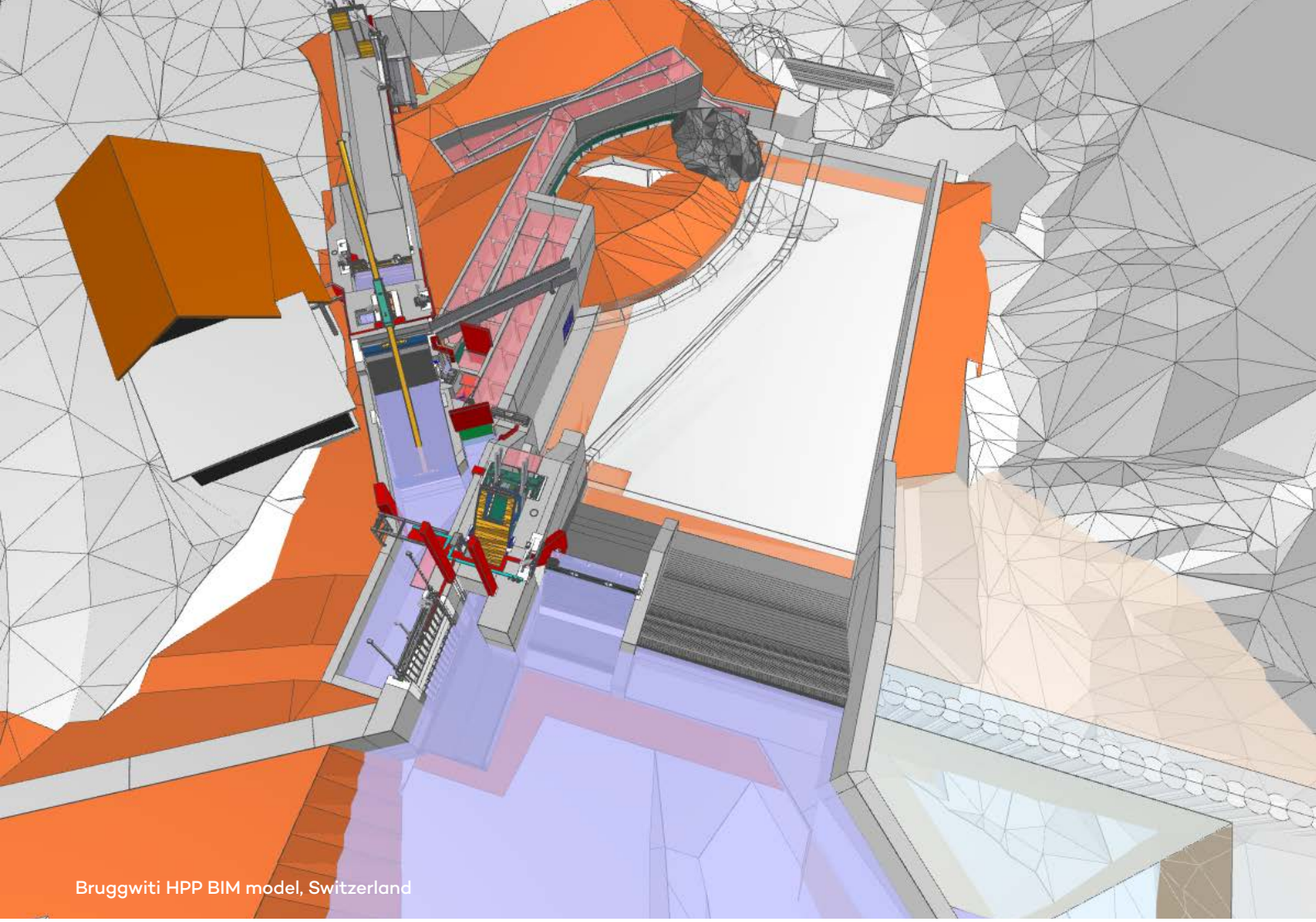
With VDC|BIM, a coordination phase is introduced before the start of the detail design of suppliers and civil design engineers. The aim of the coordination phase is to ensure that all interfaces between structures and equipment are coordinated. At the end of the coordination phase, the concrete outlines of the civil structures, including all block-outs and embedded parts, are finalised.

In a classical coordination setup, detail design of suppliers and civil design engineers often start directly after the tendering phase, without proper coordination.

Only after the coordination phase has been completed, does the detailed design by suppliers and civil design engineers begin. For example, executing detailed structural calculations and creating reinforcement models.

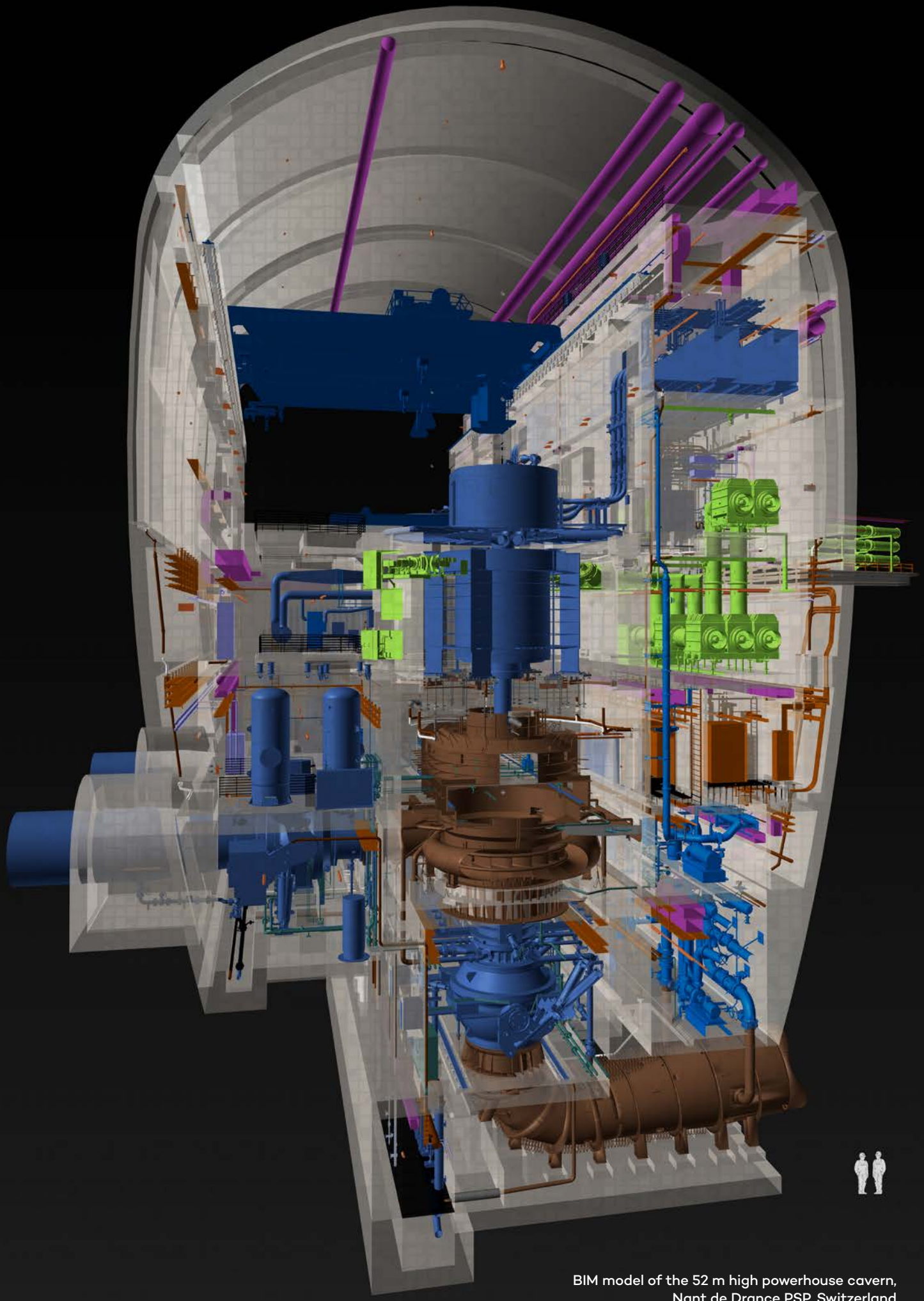


Schils HPP powerhouse, Switzerland



Bruggwiti HPP BIM model, Switzerland

Bruggwiti HPP weir and fish ladder, Switzerland



BIM model of the 52 m high powerhouse cavern,
Nant de Drance PSP, Switzerland

BIM2Field

The model-based construction site

For the renewal of the 100 year old Schils Hydro Power Plant in the Swiss Alps, VDC|BIM was consistently implemented, using VDC (BIM Method) for the entire coordination and BIM2Field during execution.

Three different civil contractors worked completely model-based, with no drawings needed or produced. Once the coordination had been completed, the detailed models for excavation, retaining wall, concrete outlines and reinforcement were prepared for the construction site by the AFRY office in Zurich and uploaded into the cloud. They were then immediately available for use by the contractors to construct the power plant.

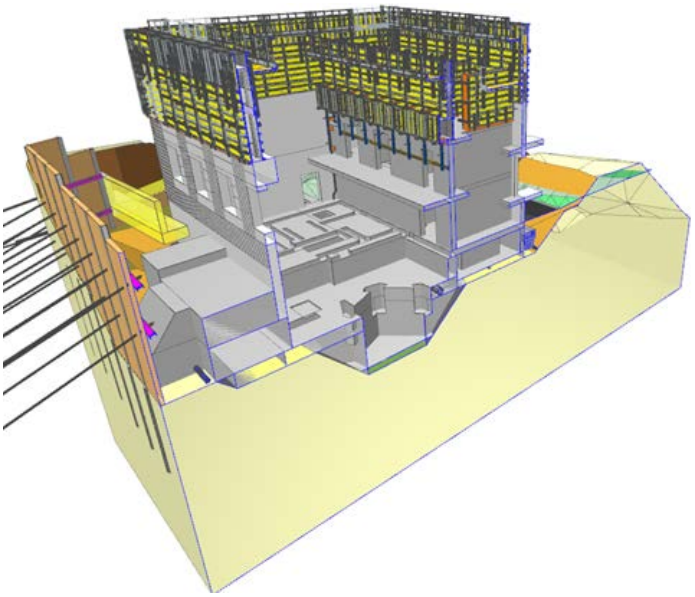
Not a single drawing was printed for these construction sites. One of the advantages is that there is no loss of information between the design office and the construction site. All required information is transmitted digitally throughout and is immediately available to all parties everywhere. With the permanent use of digital models, all information is always up to date, there are no inconsistent drawings or misinterpretations of drawings.

Schils power plant was successfully commissioned in spring 2021. It demonstrates that VDC|BIM can be successfully applied in hydropower and that the consistent implementation of VDC|BIM results in significant advantages, both for coordination and for execution through BIM2Field.

A video was produced covering the topics of this brochure. The video gives a very close and illustrative insight into the topics VDC|BIM and BIM2Field.

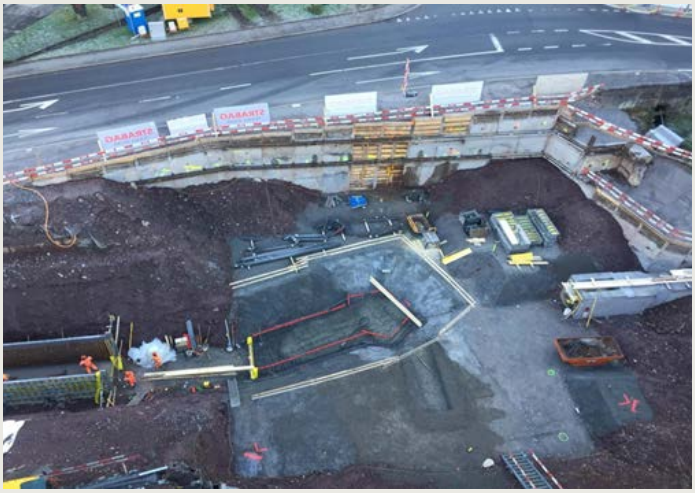
Model-based formwork design

The model for the first stage concrete was further used by the civil contractor to design the model-based formwork. Formwork elements including supports could thus be optimally assembled and delivered to the construction site just in time and without changes on-site.



Model-based excavation

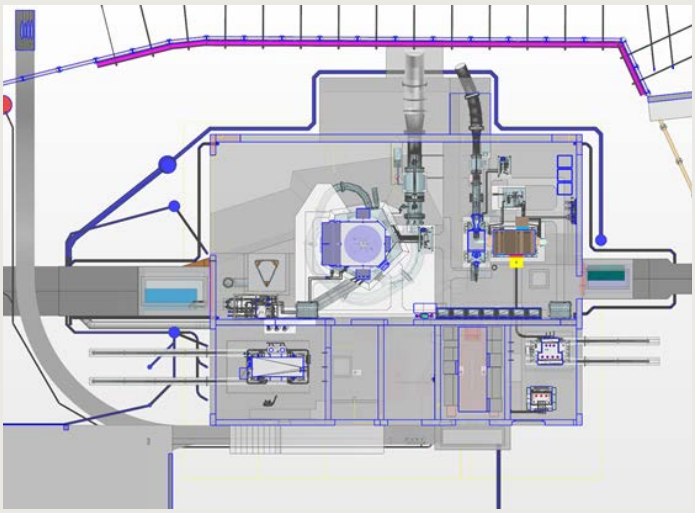
The models for the excavation were loaded directly onto the computer in the operators cabin of the excavator. Thus, the excavator bucket could be precisely navigated by the machine operator using the model as a basis.



Staking-out with total station

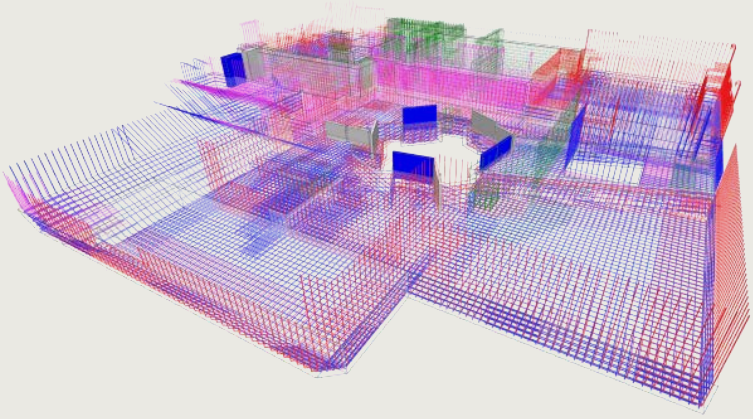
The stake-out points required for placing the formwork, for positioning embedded parts in the concrete or for placing the anchors of the retaining wall were prepared directly from the model and synchronized with the total station.

Instead of defining such points by measuring tape, these points were prepared directly from the model and synchronized with the total station. If a point was selected on the total station, its laser pointer indicated precisely where the point was located.



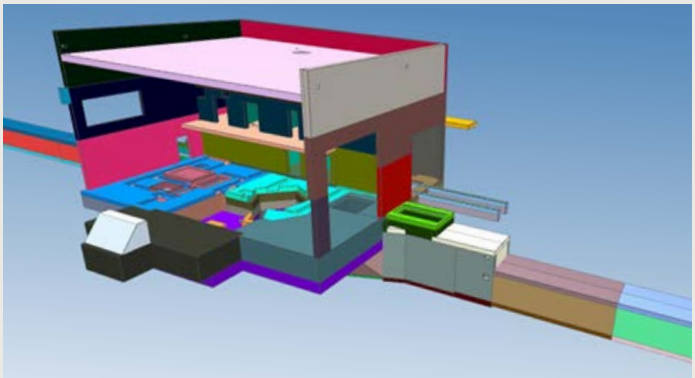
Placing of reinforcement with tablets

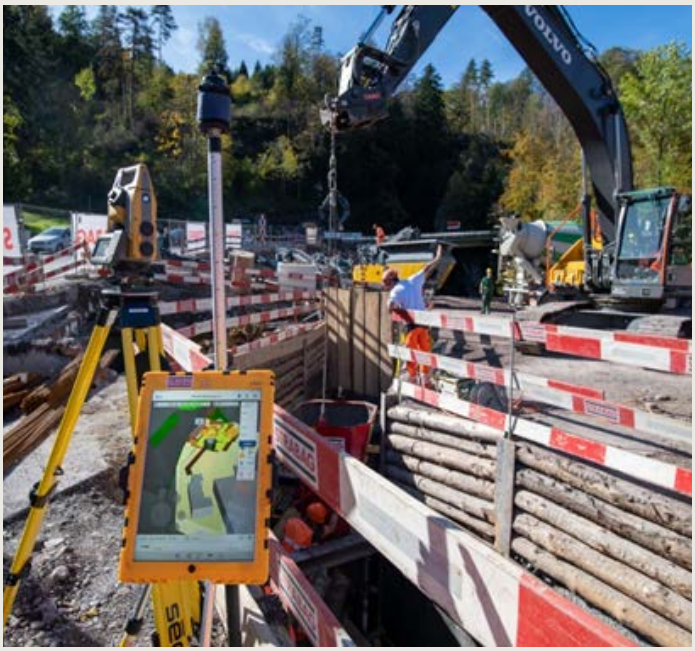
The reinforcement models were loaded directly onto the foreman's tablet. The reinforcement bars were displayed layer by layer and all necessary information was displayed for each stage of the work.



Work preparation

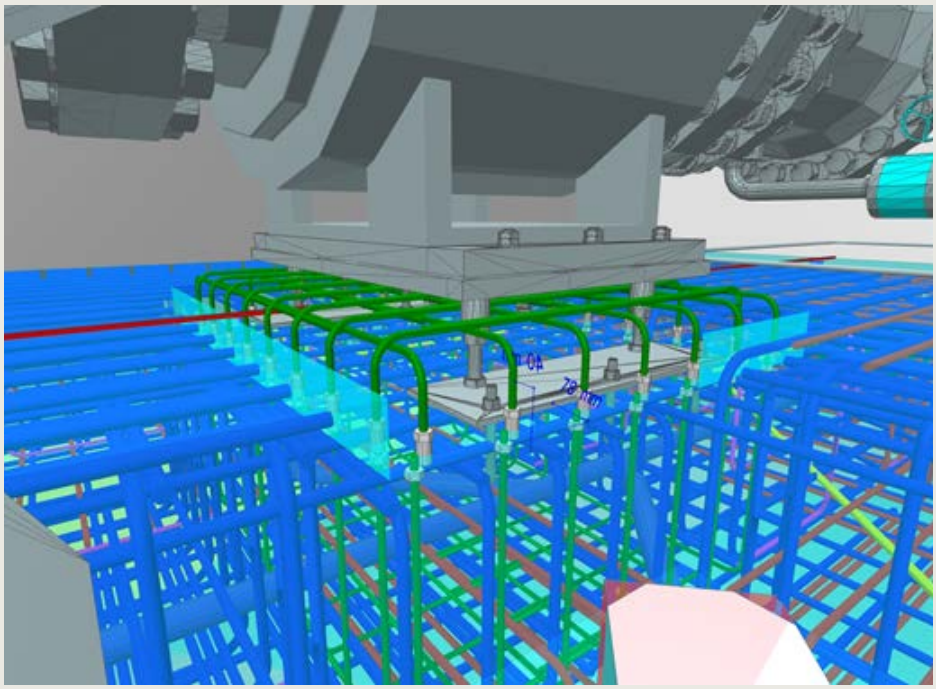
Work preparation took place in the main office of the contractor and in the site offices of the foremen. The various models were analysed in detail digitally, and quantity take-offs were read out. Rather than walk around the site with rolls of drawings, the foremen simply used their site computers or tablets.





Quality check: Field2BIM

Field2BIM, i.e. the returning of as-built measurements back into the models, provided the necessary basis for quality check. Tolerances of concrete elements or embedded parts can be checked, and mistakes can be detected early on.



Visualisation of Waldemme HPP, Switzerland

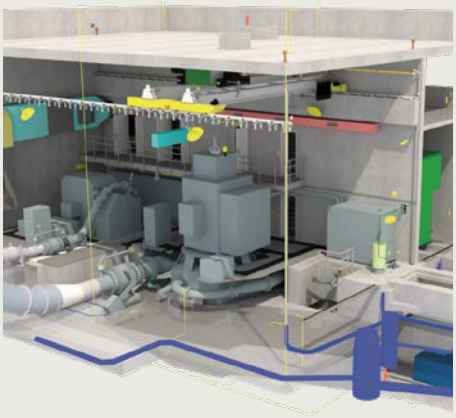
Selected key references

Nant de Drance PSP, Switzerland

2009–2019

Power cavern with 6 pump-turbines, total installed capacity of 900 MW

— 3D
— BIM



Schils HPP, Switzerland

2016–2021

Penstock and powerhouse, 2 pelton turbines, 500 m pressure head, total installed capacity of 13 MW

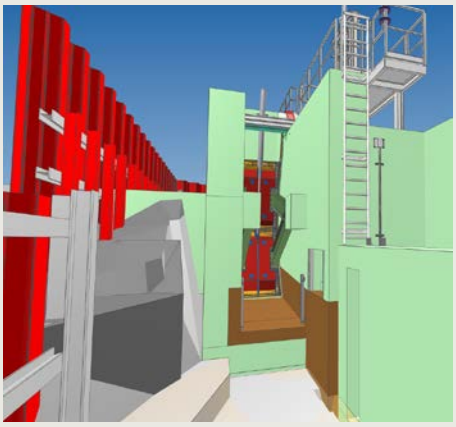
— 3D
— BIM
— VDC (BIM Method)
— Extended BIM-Use-Cases, BIM4D, BIM5D
— BIM2Field (model-based construction site with no 2D drawings) with 2 different civil contractors

Bruggwiti Intake, Switzerland

2018–2021

Replacement of an existing intake with 3 m^3/s design inflow in an alpine river with mud flows, including structures for fish migration

— 3D
— BIM
— VDC (BIM Method)
— Extended BIM-Use-Cases, BIM4D, BIM5D
— BIM2Field (model-based construction site with no 2D drawings)



Waldemme HPP, Switzerland

2019–2023

Complete new scheme with intake, penstock and powerhouse with installed capacity of 1.4 MW, including structures for fish migration

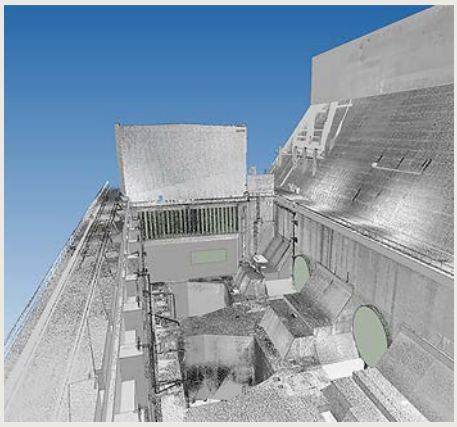
- 3D
- BIM
- VDC (BIM Method)
- Extended BIM-Use-Cases, BIM4D, BIM5D
- BIM2Field (model-based construction site with no 2D drawings)

Emmenweid HPP, Switzerland

2019–2025

Replacement of an existing weir, including new structures for fish migration

- 3D
- BIM
- VDC (BIM Method)
- Extended BIM-Use-Cases, BIM4D, BIM5D



Kainji HPP, Nigeria

2020–2025

Addition of two new units with installed capacity of 100 MW each into existing empty turbine pits

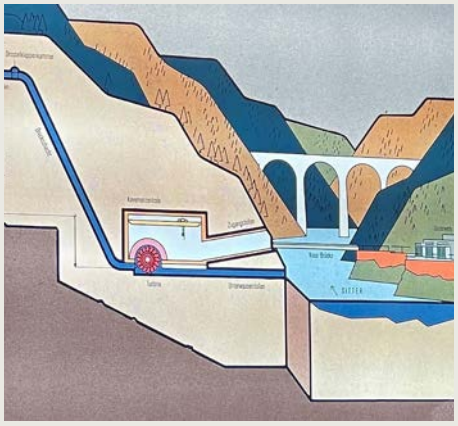
- 3D
- BIM

Piottino HPP, Switzerland

2021–2028

Replacement of 3 units with total installed capacity of 67 MW, replacement of balance of plant and adaptations of civil structures

- 3D
- BIM
- VDC (BIM Method)
- Extended BIM-Use-Cases, BIM4D, BIM5D



Kubel HPP, Switzerland

2022–2028

Addition of a compensation reservoir and underground connection structures, replacement of 2 turbines in an existing power cavern

- 3D
- BIM
- VDC (BIM Method)
- Extended BIM-Use-Cases, BIM4D, BIM5D

Wassen HPP, Switzerland

2022–2028

Replacement of one unit with total installed capacity of 20 MW, replacement of balance of plant and adaptations of civil structures

- 3D
- BIM
- VDC (BIM Method)
- Extended BIM-Use-Cases, BIM4D, BIM5D

AFRY provides engineering, design, digital and advisory services to accelerate the transition towards a sustainable society.

We are 19,000 devoted experts in industry, energy and infrastructure sectors, creating impact for generations to come. AFRY has Nordic roots with a global reach, net sales of 24 BSEK and is listed on Nasdaq Stockholm.

Making Future

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07/23