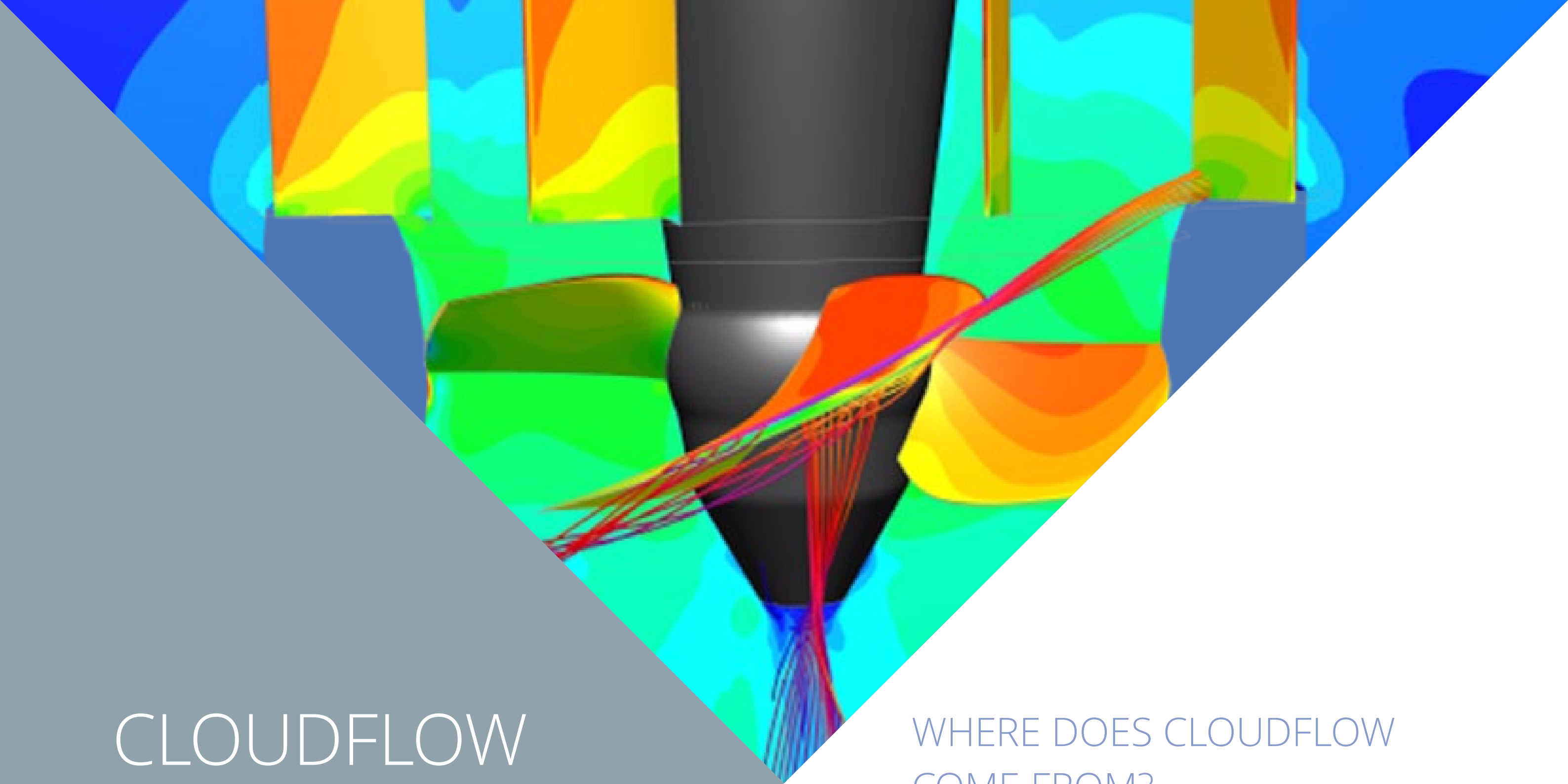
Cloudflow

SUCCESS STORIES FIRST WAVE

Computational Cloud Services and Workflows for Agile Engineering



CLOUDFLOW IN SHORT

WHERE DOES CLOUDFLOW COME FROM?

CloudFlow is a project of the European Commission. It is a part of the "I**CT Challenge 7**: ICT for the Enterprise and Manufacturing" and a part of the initiative "ICT for Manufacturing SMEs," short I4MS: **www.i4ms.eu**.

With this project and innovation initiative for the manufacturing sector the European Commission will enable high-tech SMEs to exploit the potential of ICT to help grow their businesses.

The **project duration** of CloudFlow is 42 months. It started on July 1, 2013 and ends on December 31, 2016.

WHAT´S THE IDEA?

The more products and product development integrate geometry, mechanics, electronics and software aspects, the more important workflows will become to development processes.

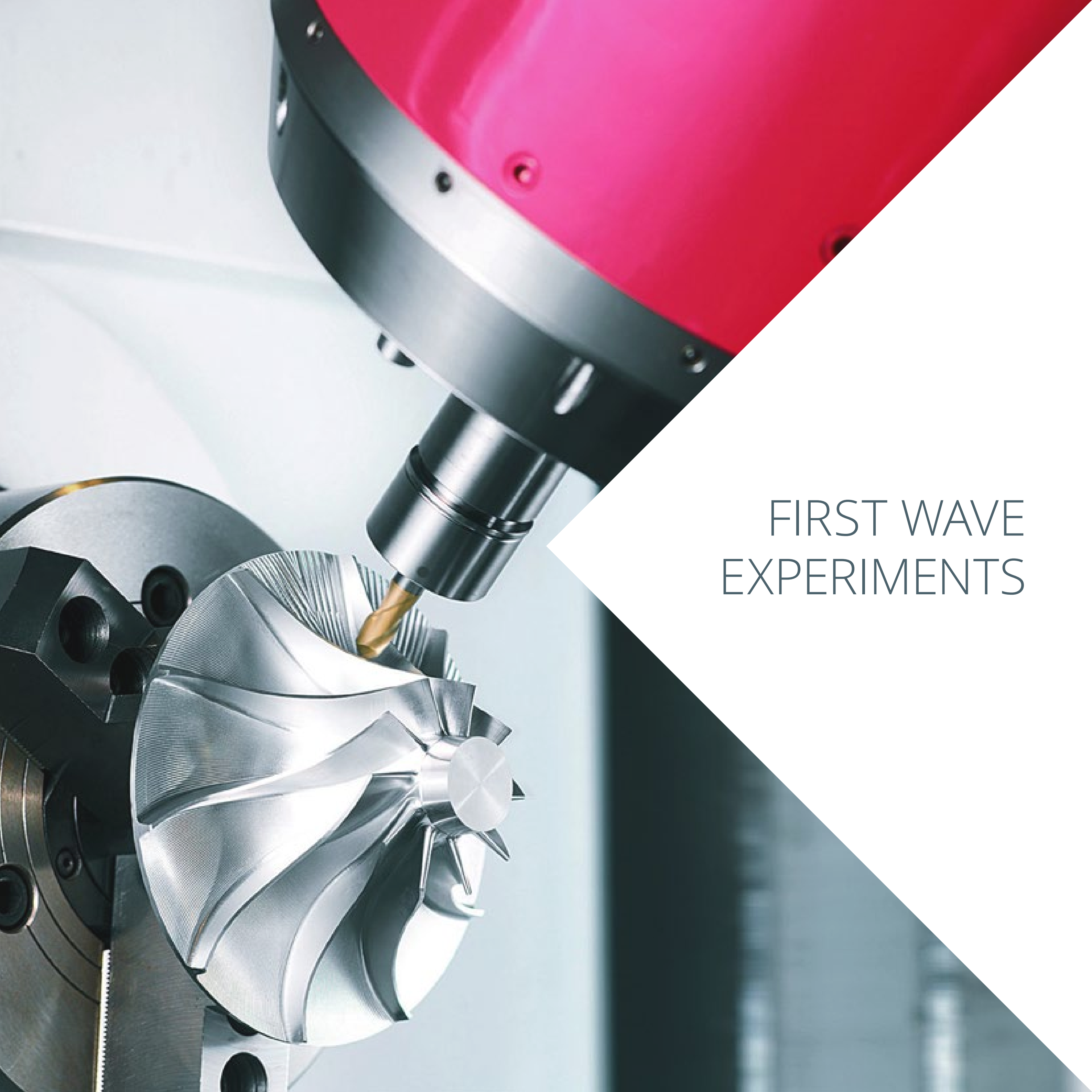
Such complex product development processes require multi-domain simulation, simulation-in-the-loop and synchronized workflows based on interoperability of data, services and workflows.

CloudFlow **integrates** computational services in the Cloud into the engineering workflows of manufacturing companies (SMEs).

CloudFlow **aims** at enabling engineers to access services on the Cloud spanning domains such as

- CAD
- CAM
- CAE (CFD) and
- PLM

Cloud Flow **combines** these domains to integrated workflows leveraging HPC resources.



FIRST WAVE EXPERIMENTS

WHAT ARE THE EXPERIMENTS ABOUT?

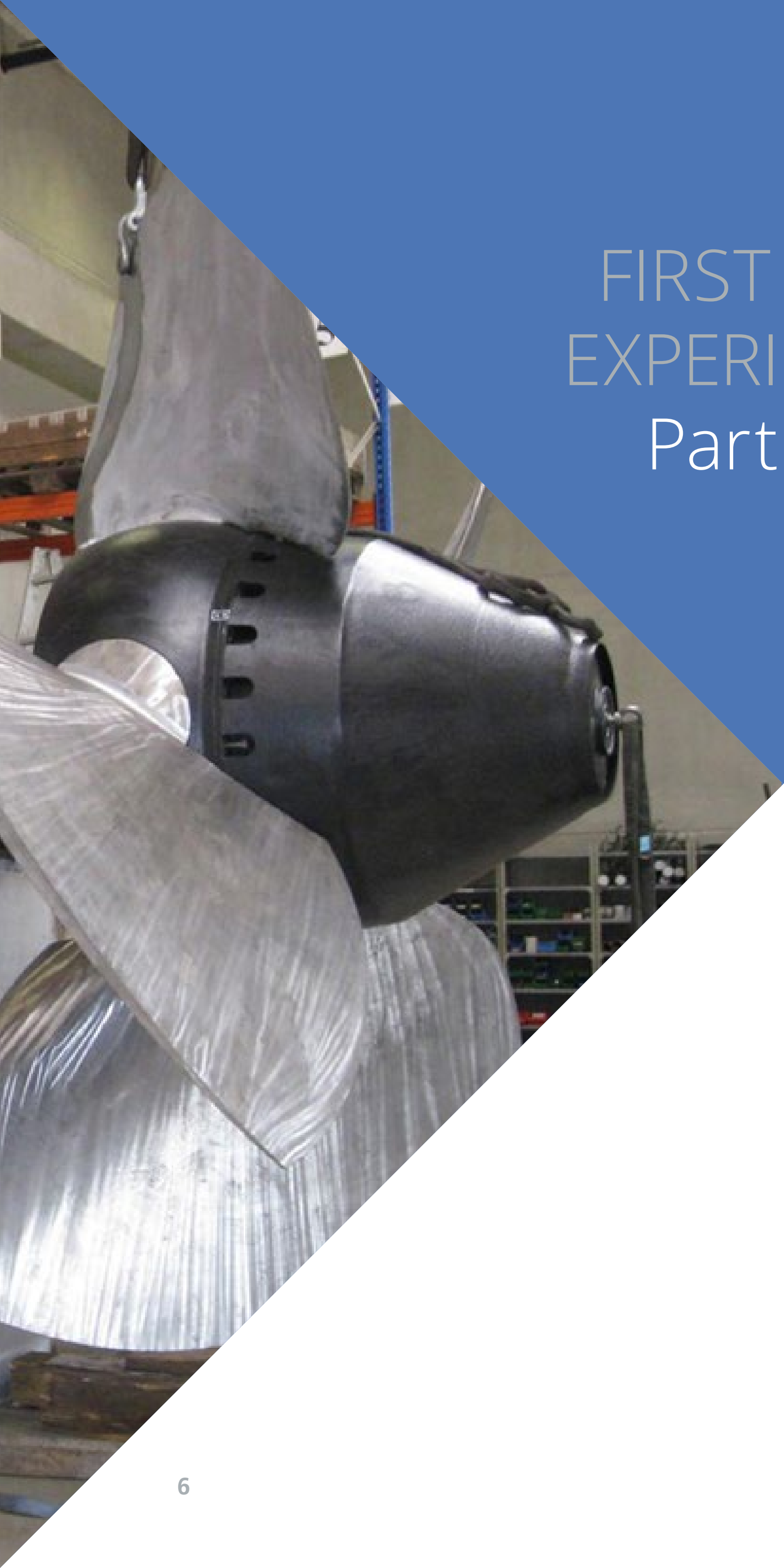
Experiments are an **integral concept** of the project. They are SME-driven use cases for the CloudFlow platform that is being developed.

CloudFlow is designed to execute application experiments in waves, generating a total number of **twenty experiments**. The experiments will be conducted in **three waves**.

In the first project phase the CloudFlow platform will be evaluated by implementing, executing and validating the **six “internal” experiments**:

- CAD on the Cloud,
- CAM on the Cloud,
- CFD on the Cloud,
- PLM on the Cloud,
- Systems simulation on the Cloud and
- Point cloud vs. CAD comparison on the Cloud.

The **infrastructure** will be maturing over the duration of the project so that experiments in the later waves can be more demanding with respect to workflow support and services than the first wave.



FIRST WAVE EXPERIMENTS Partners

Several **partners** of the CloudFlow project from different European countries contributing their expertise in Cloud Computing, simulation and visualization. All partners of the following case studies in short:

END USER

The central end user of all the following case studies is **Stellba Hydro GmbH**. Stellba is a Germany-based SME working on hydropower plant maintenance, repair and overhaul, engineering and manufacturing one-of-a-kind products for the green energy sector with the goal to optimize energy efficiency.

SOFTWARE PROVIDER

ITI GmbH is a German SME offering a commercial tool in system simulation.
Jotne AS is a Norwegian SME developing and distributing software for interoperability of industrial data and end-user applications with focus on product lifecycle management (PLM) functionality.
Missler Software is a French independent software vendor SME.
NUMECA is a Belgian independent software vendor SME.

HPC PROVIDER

The cloud **technology/platform provider** of the following experiments/impact case studies is the SME **Arctur d.o.o.** from Slovenia.

RESEARCH & DEVELOPMENT

CARSA is an innovation and technology consultancy firm and headquartered in Spain.
Deutsches Forschungszentrum für Künstliche Intelligenz GmbH (DFKI) is a non-profit contract research institutes and located in Germany.
Fraunhofer is the Europe's largest application-oriented research organization with 66 institutes in Germany.
SINTEF is the largest independent research organisation in Scandinavia and headquartered in Norway.
The **University of Nottingham** is in the Russell Group as one of the leading UK teaching and research institutions.

IMPACT CASE STUDY

Systems simulation on the Cloud

SIMULATING THE SAFETY OF A HYDROPOWER PLANT AS A SYSTEM ON THE CLOUD

Complex systems consist of components from various domains, such as mechanics, fluidics and control engineering. The interplay of these components should be analysed already during the design phase – long before any prototypes are built – to ensure not only that they work individually as expected but especially that they work together as a system. Systems simulation allows engineers to find optimal solutions in order to ensure

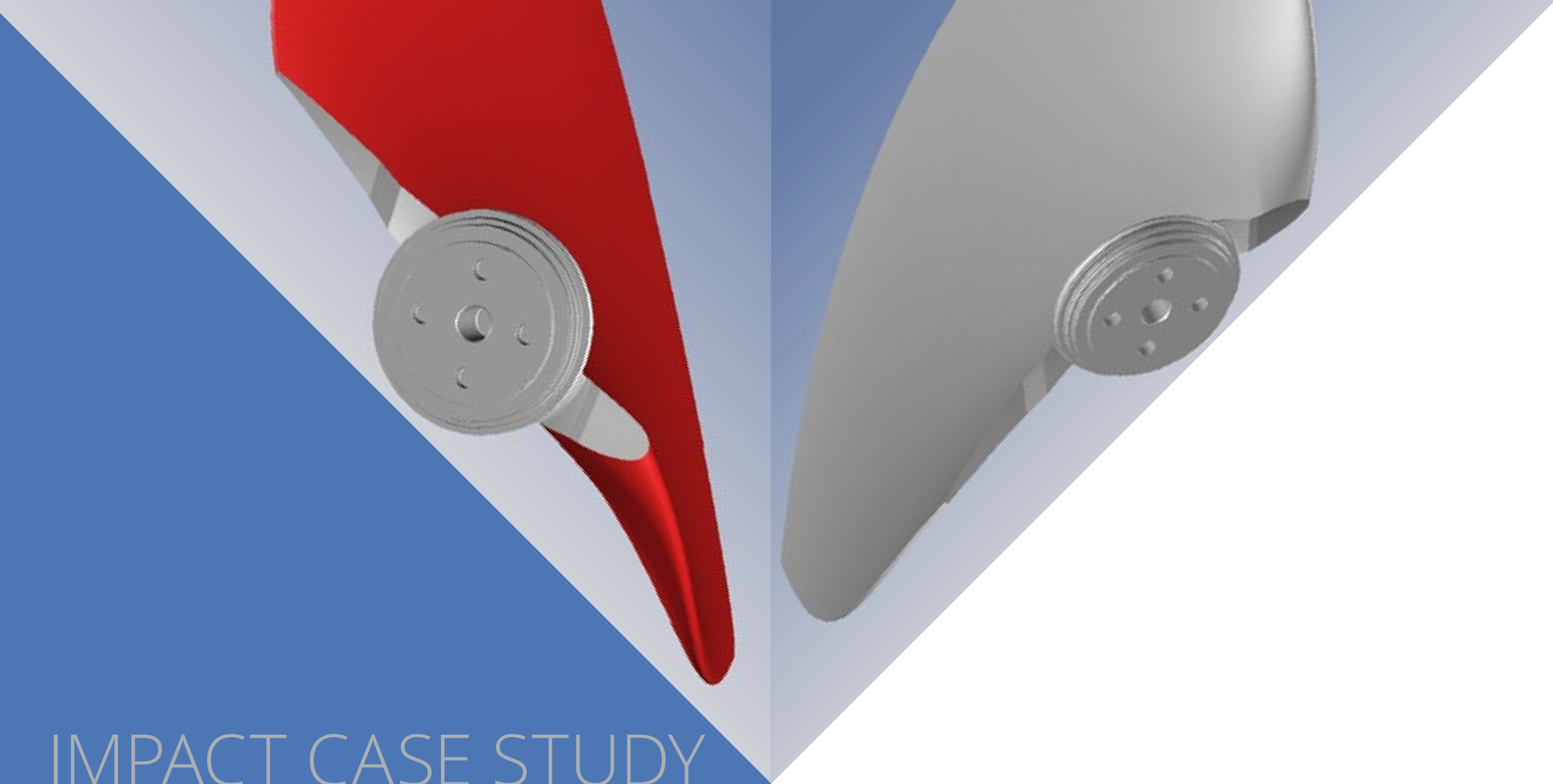
functionality and safety for complete multi-domain systems long before they can be tested in real life.

In the past, the **end user** of this case **Stellba** used an external engineering service provider which created a simulation model for the main components of a whole water energy plant, executed the simulation calculation and analysed the simulation results. Stellba paid approx. 10.000 euros per project for these external engineering services. Stellba did not build up local simulation resources (know-how, hardware and software), because the frequency of such a systems simulation was too low compared to the expected costs. Not being able to perform these simulations in-house has the negative effect of depending on a third party in terms of quality and delivery time. The goal in this study is to enable Stellba to apply a **systems simulation service developed by ITI** for hydropower plants for cost-effective simulation calculation and results analysis based on adapting existing models, thus reducing the turn-around times in comparison to outsourcing to a third party.

With the help of **Fraunhofer EAS** and ITI, Stellba can now run simulations themselves and is independent from external engineering consultancy services. No simulation software or hardware resources are needed on local computers. Simulations can be started from every device at every point in the world supporting Stellba in its commercial activities around the globe. The main cost benefit of Cloud resources lies in the missing initial costs for hard- and software. The used subscription business model enables Stellba to use Cloud resources on demand. The cost-effective scalable HPC resources in the Cloud provide the possibility to run parameter studies in parallel within a reasonable time frame.

The **services and applications provided by ITI** have been packaged as an easily accessible, usable and affordable workflow. The new approach of providing software to end users as Cloud services has enriched ITI's software functionality in terms of parallelization and accessibility, with the exploitation of Cloud resources also enabling ITI to offer a worldwide accessible service for simulation calculation and simulation data management. The new product is expected to create additional revenue through a subscription model. The expected additional revenue can enable ITI to hire up to two developers for optimizing and maintaining the simulation service.

Partners: Stellba Hydro GmbH (SME, GE), ITI GmbH (SME, GE), Fraunhofer EAS (R&D, GE)



IMPACT CASE STUDY
CAD on the Cloud

DESIGNING TURBINE BLADES FOR HYDROPOWER PLANTS WITH CAD FROM THE CLOUD

In the production process for any company, saving time during the design phase and optimizing the final product design are big challenges. Existing general-purpose CAD systems offer a way to create good designs for a multitude of products, but knowing the particular type of product in advance enables the development of dedicated functionality, thus minimizing design time and avoiding repetitive tasks and errors.

Due to the complexity of the underlying free-form shape, the 3D design of a hydraulic turbine blade at the **end user Stellba** is a long process. In the traditional CAD design approach it is necessary to use a lot of basic operations when modelling such a blade. These operations are mostly repetitive and similar for each design.

The goal of this case study is to reduce the amount of time needed to design a popular blade type called Kaplan blade. In Stellba's case, such a design process happens typically bi-weekly. An additional goal is to save, manage and share data by using the Cloud and a Cloud-based PLM system.

To meet the challenge, the **CAD system Topsolid by Missler** and **product lifecycle management software by Jotne AS** were used in a new approach where the design process is accelerated and optimized by using dedicated functionalities specific to turbine blades. These functionalities are added to the base CAD system via the Cloud. Before – in an error-prone process – the end user's specialist had to perform 40 different operations on each surface to get the desired solid model. Now, the designer is smoothly guided through the process with improved usability, resulting in fewer errors and helping to achieve good results with a minimum number of operations.

Stellba's process to design a new blade is in fact running roughly 25 times faster than before, reducing the design time from eight hours to less than 20 minutes. Consequently, Stellba is now able to create more designs in a given period and to try out more possibilities to improve the quality of their blades. In addition they can provide their design models to other applications via the Cloud-based PLM, e.g. for a successive simulation step.

For Missler the case study has opened up the opportunity to develop new "plug-ins" for other specific complex CAD design processes of high importance to different end users and to provide such "plug-ins" through the Cloud. This is creating additional revenue for Missler while end users can increase their productivity for a reasonable price. Another benefit of the Cloud approach for Missler is to simplify the process of providing always the latest version of applications and making maintenance easier.

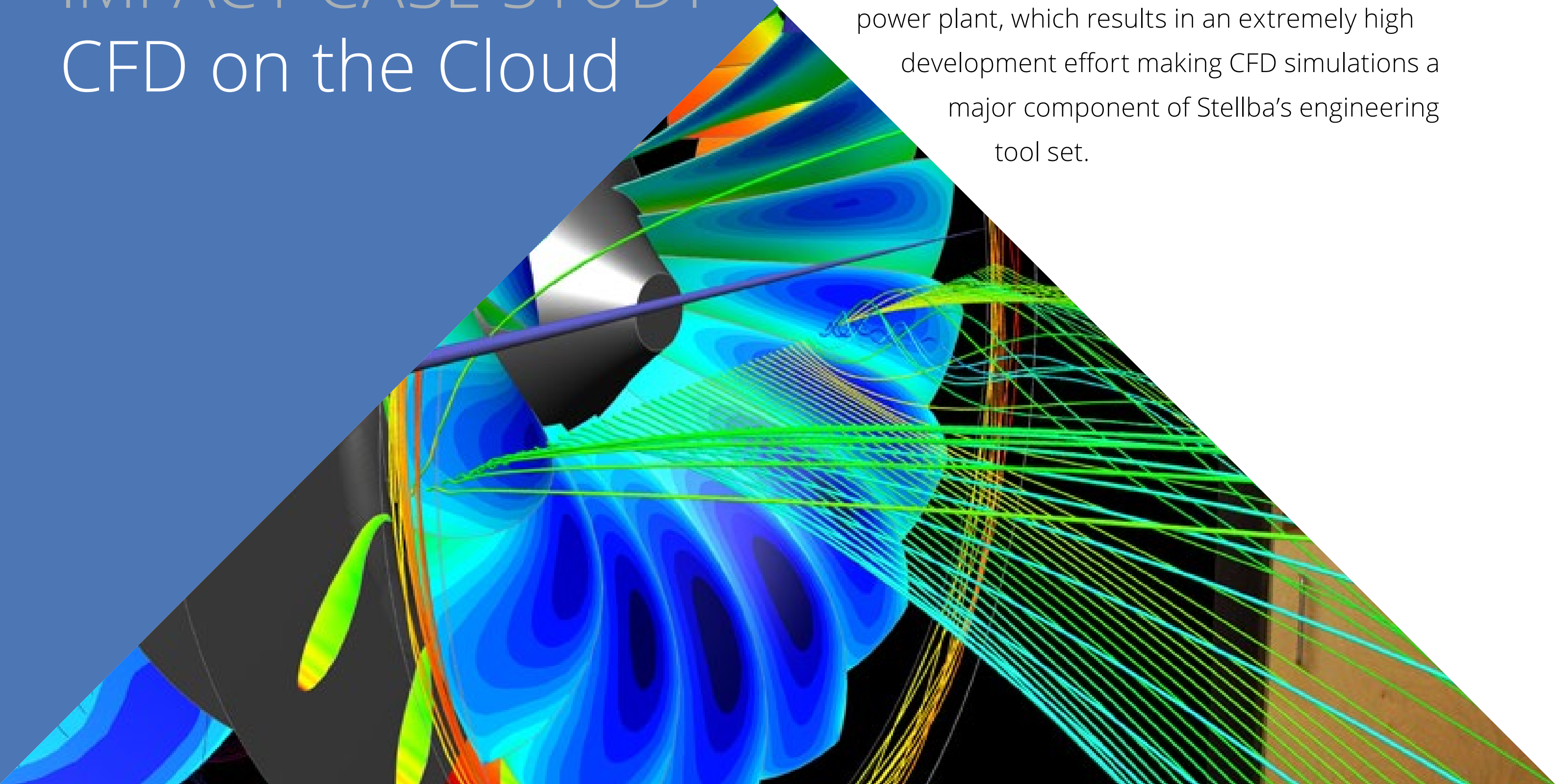
Partners: Stellba Hydro GmbH (SME, GE), Missler Software (SME, FR), Jotne AS (SME, NO)

IMPACT CASE STUDY
CFD on the Cloud

EFFICIENCY OPTIMIZATION OF A WATER TURBINE VIA CFD SIMULATION ON THE CLOUD

Checking and assessing the aerodynamic or hydrodynamic performance of newly designed geometric parts by using Computational Fluid Dynamics (CFD) is a common practice in large(r) industry.

Every turbine they engineer and manufacture is different and tailored to the needs of a given specific power plant, which results in an extremely high development effort making CFD simulations a major component of Stellba’s engineering tool set.



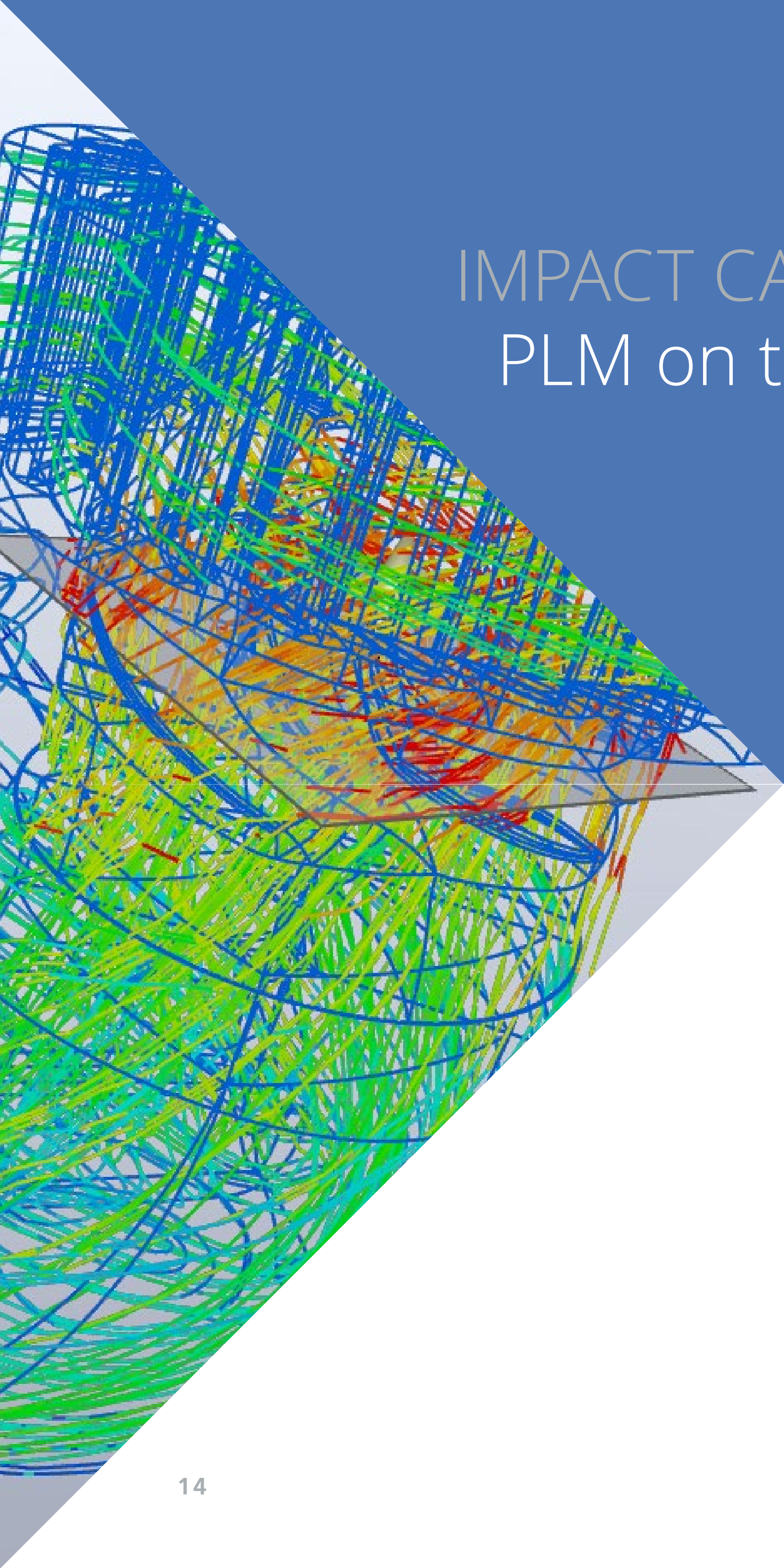
The evaluation of the hydrodynamic performance, e.g. the prediction of the increase in energy efficiency of a newly designed or repaired turbine blade, involves many CFD simulations. The full characterisation (hill chart) of a complex hydraulic turbine may require several hundreds of such simulations, where each simulation can take several hours to several days, depending on the available computing resources. Such a complete calculation is time and cost prohibitive when using traditional desktop machines.

Thus, so far the turbine characteristics are only calculated (simulated) partially. By leveraging cloud-based HPC power in conjunction with an automated process chain, this case study aims at enabling Stellba to calculate the full turbine characteristics in an economic manner. The ambition is to perform ten times more calculations in a third of the time currently being used for just a sub-set of the problem, resulting in an overall performance benefit of a factor of 30.

Using 'cloudified' **CFD software of NUMECA** and **Product Lifecycle Management (PLM) software by Jotne AS**, speeds up and simplifies the CFD process, thus reducing the development costs and increasing the competitiveness of Stellba by raising the product quality and reducing the development times (better time-to-market). By increasing the accuracy of the CFD, The **end user Stellba** can reduce the security margin for their efficiency guarantees, which increases the competitiveness in the market. If the efficiency of a 40 MW turbine can be increased by two percent with the help of efficient and sophisticated simulation, the turbine owner will gain more electricity output from his water plant worth 200.000 euros per year.

For NUMECA, the much higher accessibility of the cloud-based CFD solution, from virtually anywhere, will largely enhance the end-user experience in evaluating and using CFD solutions in design processes. Consequently it is expected that the number of SMEs using CFD will increase largely in the short and medium term, resulting in new customers for NUMECA. Due to this increase one or two new jobs will be created in the short term.

Partners: Stellba Hydro GmbH (SME, GE), NUMECA (SME, BE), Jotne AS (SME, NO)



IMPACT CASE STUDY

PLM on the Cloud

PRODUCT LIFECYCLE AND ENGINEERING DATA MANAGEMENT (PLM) ON THE CLOUD

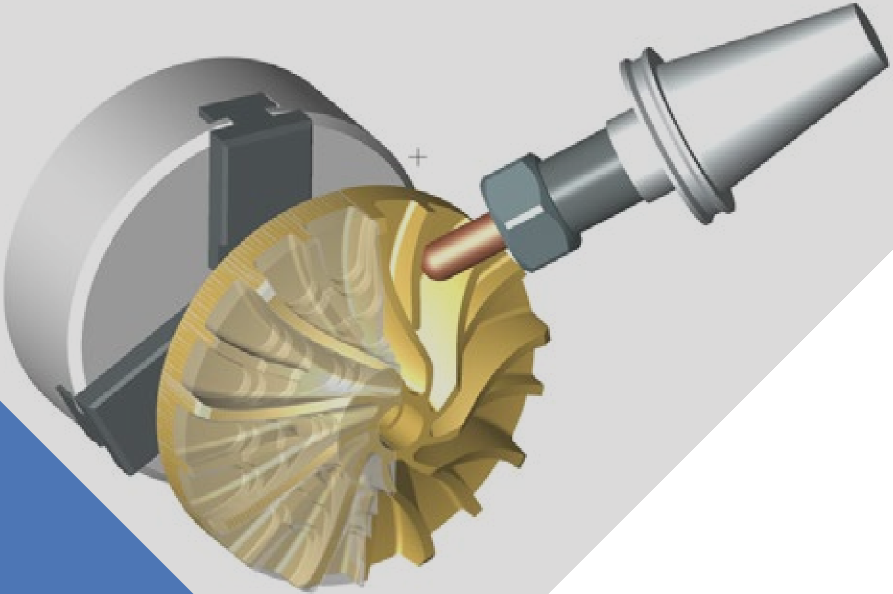
Engineering analysis processes include activities such as product design and product analysis, including mesh generation, definition of boundary conditions, simulation, and post-processing. In any engineering company the highly iterative simulation process results in huge amounts of files and data with many different representations of the 3D product model. For an engineer it is a challenge to keep an overview of related data (configuration control) and extract the essential information for product optimization, demanding a user-friendly overview over configuration controlled data sets and an easy and fast visual inspection.

For the process of managing evaluation results, the **end user Stellba** uses a multitude of different software packages with high license costs, training efforts and requirements towards human skills. The process is tedious and the locally installed software packages limit accessibility to the corresponding computers – there is no remote / web access. So, on average, Stellba spends four weeks on organizing and reviewing simulation results in parallel to running the simulations themselves. The goal of this case study is to reduce the amount of effort spent on reviewing and managing results by typically one week (i.e. by 25 percent), through the development of a dedicated solution with inter-application communication and by exploiting HPC resources for fast, accurate and optimized visualisation.

With the help of **Fraunhofer IGD** and **Jotne AS**, the time for reviewing and managing simulation results at Stellba is being reduced by saving about 40 person-hours of work for a medium-sized turbine optimisation project. By shortening the elapsed time for handling projects, Stellba's capacity for new projects increases and reduced product costs lead to better competitiveness. The ownership of data by Stellba is also improved as project data are archived in a standard format (STEP, ISO 10303). The introduction of these processes will help to preserve existing jobs.

The software components for analysis review and management are new HPC Cloud services provided by Fraunhofer IGD and Jotne AS, respectively, packaged into a workflow to be easily accessible, usable and affordable. With this new Cloud service approach, both software providers have enriched their software functionality for a more useful, usable and efficient presentation and analysis of simulation results. Since the topic of PLM and visualization addressed in this study is of high relevance for many manufacturing branches, in the future hundreds or even thousands of new usages of this software per year have become possible. The corresponding additional revenue can put Jotne AS into the position to hire five new sales and support persons for marketing the new solution and for supporting customers.

Partners: Stellba Hydro GmbH (SME, GE), Jotne AS (SME, NO), Fraunhofer IGD (R&D, GE)



IMPACT CASE STUDY
CAM on the Cloud

SIMULATING MACHINING PROCESSES IN THE CLOUD

Simulating and optimizing the manufacturing process before the machines actually start making a new product is one of the key stages in manufacturing engineering. The aim is to minimize manufacturing time, to avoid wasting raw material (resources) and to safeguard the machines from being damaged. One has to compute many possible tool paths, assess them, select an optimum one and finally generate the Numerical Control (NC) code to actually run the machine. All these steps are very time-consuming and minimizing the time to find the best possible solution is crucial concerning the costs for the company.

The relevant process for the **end user Stellba** in this study is the computation of the best tool path to machine a Kaplan turbine blade. To find an optimal tool path requires many selections and decisions by the engineer, e.g. material, methodology, and each chosen configuration requires a dedicated simulation run. As these simulations are basically independent from each other, using a parallel computing infrastructure should speed-up the iterative process and should allow computing more options to better explore the 'design space' and find 'uncommon' solutions.

The **GridWorker software tool by Fraunhofer EAS** is being used to parallelize computations as much as possible to reduce the overall time used. Through GridWorker the available HPC resources are deployed on a number of virtual machines to exploit the power of many computational cores at the same time.

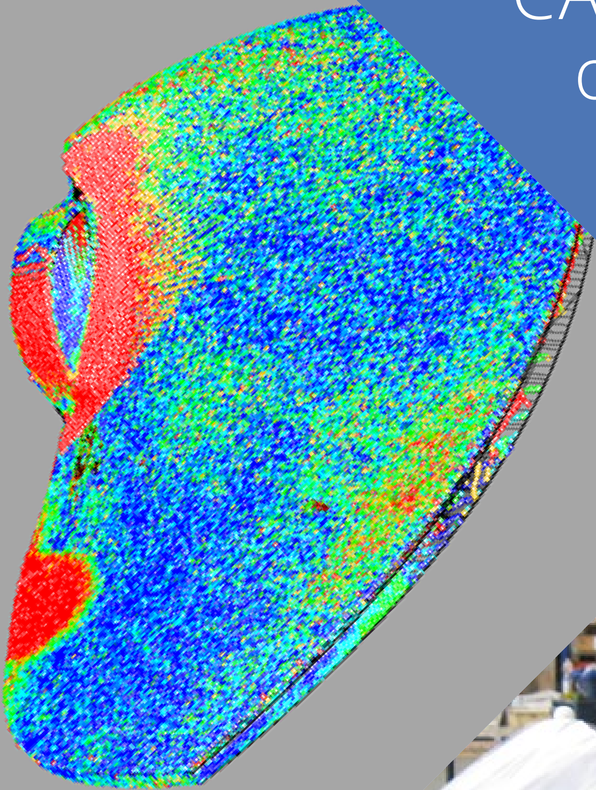
As a result, the HPC resources can enable Stellba to simulate more complex machining tasks more quickly. In fact, the time to compute a best possible toolpath is now only one third of what was necessary before. This provides the opportunity to increase the quality of the machining. Tool paths are now calculated in parallel. The CAM workflow allows the end user to prepare all data sets at once to produce a good machining plan and execute them at once and in parallel in the Cloud instead of having to wait for each individual result in front of his desktop before the next variant can be computed. No high-end number crunchers are needed locally by the end user since the computing power is provided in the Cloud.

The Cloud with its HPC resources also improves the portfolio of the offers that the software vendor **Missler** can provide to the market. Deploying the CAM simulation engine as a Cloud service ensures that users always work with the latest version. The maintenance of the application also becomes easier: Missler has to update the application only once for all their users. The sales process is being simplified with a pay-per-use approach developed in the CloudFlow project from which Missler can expect more revenue and also potentially new customers. This will allow Missler to hire new developers to further improve their Cloud-based functionality and also new technicians to provide training and support on the Cloud.

Partners: Stellba Hydro GmbH (SME, GE),
Missler Software (SME, FR),
Fraunhofer EAS (R&D, GE)

IMPACT CASE STUDY

CAD comparison on the Cloud



COMPARING CAD MODELS WITH 3D SCANNED MANUFACTURED PARTS ON THE CLOUD

Checking the quality and accuracy of a manufactured part against the ‘as-designed’ status of the corresponding ‘nominal’ CAD model is a common process in industry. For this purpose, the machined part is scanned

with a 3D acquisition device, e.g. a laser scanner, which results in several point clouds typically consisting of millions of measured, discrete 3D points. To determine where deviations between the CAD model and the point cloud exist, the two data sets need to be aligned and matched in a process called registration and distances between the closest points of both models need to be calculated.

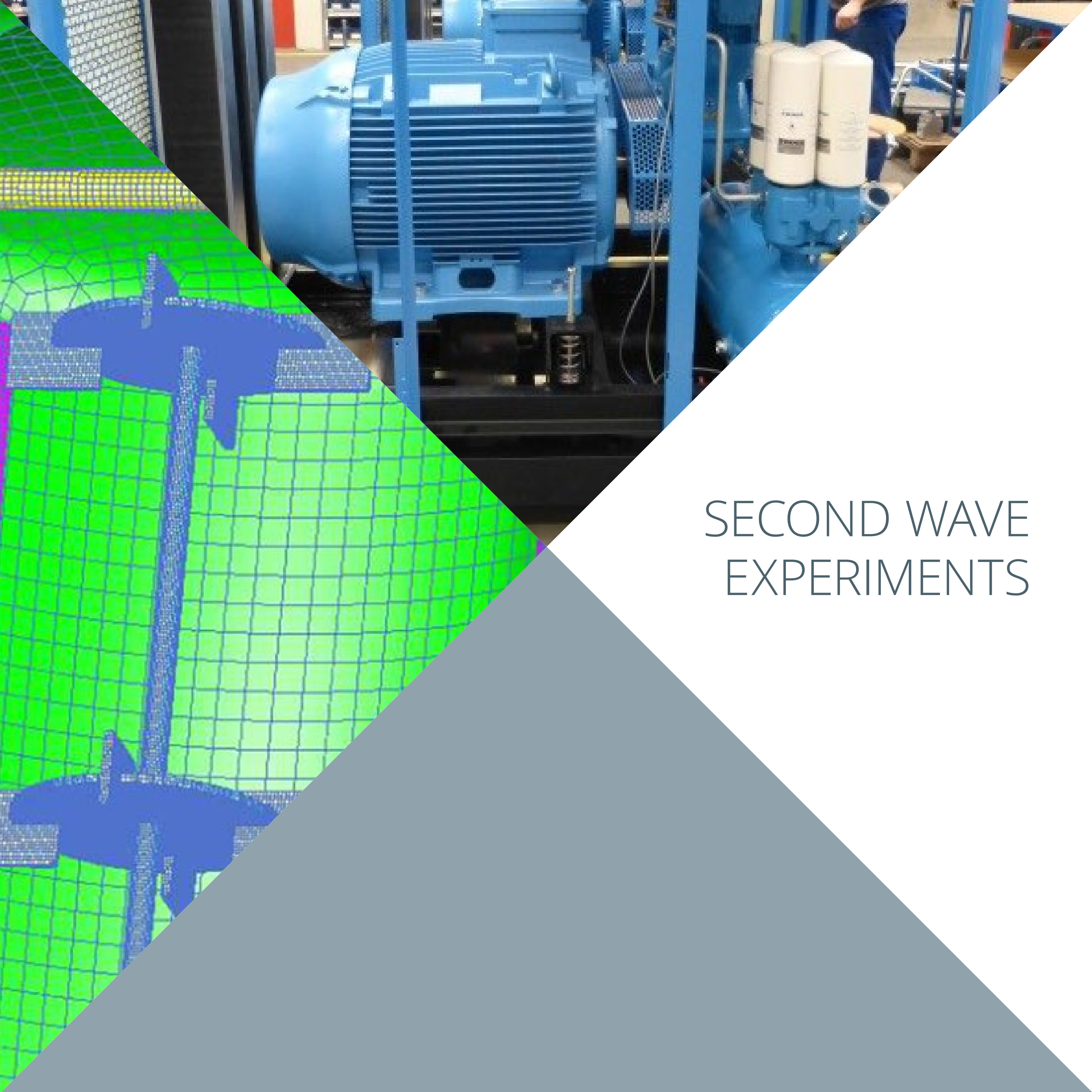
For the manually quite tedious quality checks **Stellba**, the end user of this case, so far uses a multitude of different software packages, implying high license costs and high training efforts to be able to handle all the different user interfaces. This created the demand to reduce the amount of time needed (currently eight hours) by at least a factor of five by developing a dedicated solution exploiting HPC resources for fast, accurate and optimized matching of point clouds versus nominal CAD models improving both accuracy and usability.

With the help of **SINTEF** and **Jotne AS**, the processing time of quality checks at Stellba is being reduced to less than 20 minutes saving more than seven person-hours of work. The ICT supported manual process containing error prone steps is being replaced by a validated software application that bridges domain barriers and enhances the achieved quality of the inspection. The operator at Stellba can now focus on the quality of the measurement and the produced parts while leaving most of the data processing to the new software application. In this particular case, shortening the elapsed time for point comparison quality checks increases Stellba's capacity for taking on new projects.

Since the addressed topic of accuracy checking is of high relevance for many manufacturing branches, hundreds or even thousands of other usages per year of the developed Cloud services are regarded as likely. The corresponding additional revenue can put SINTEF into the position to hire one or two new researchers for porting even more functionality to the Cloud.

Tackling the challenges of this experiment as a European endeavour has brought together partners from Norway (SINTEF, Jotne), Germany (Stellba) and Slovenia **(Arctur as the HPC/Cloud provider)** to develop an effective and efficient software solution together with the CloudFlow Competence Center that no single organization would have been able to offer on its own.

Partners: Stellba Hydro GmbH (SME, GE), Jotne AS (SME, NO), SINTEF (R&D, NO)



SECOND WAVE EXPERIMENTS

The first Open Call of CloudFlow was looking for **seven additional application experiments** to which 36 proposals have been submitted. The selected application experiments span the following topics:

- Electronics Design Automation (EDA): Modelling of MEMS Sensors
- Automobile Light Design: Thermal Simulation of Lighting Systems
- Plant Simulation: Optimization of Steel Structure Manufacturing
- SIMCASE: Discrete Event Simulation of Welding Lines
- Cooling Air-Flow Optimization for Compressors
- Multiphase Flow Simulation of Bioreactors
- CFD Design of Biomass Boilers

These seven application experiments bring **18 additional beneficiaries** to the CloudFlow project of which seven (39 percent) are new to EC projects.

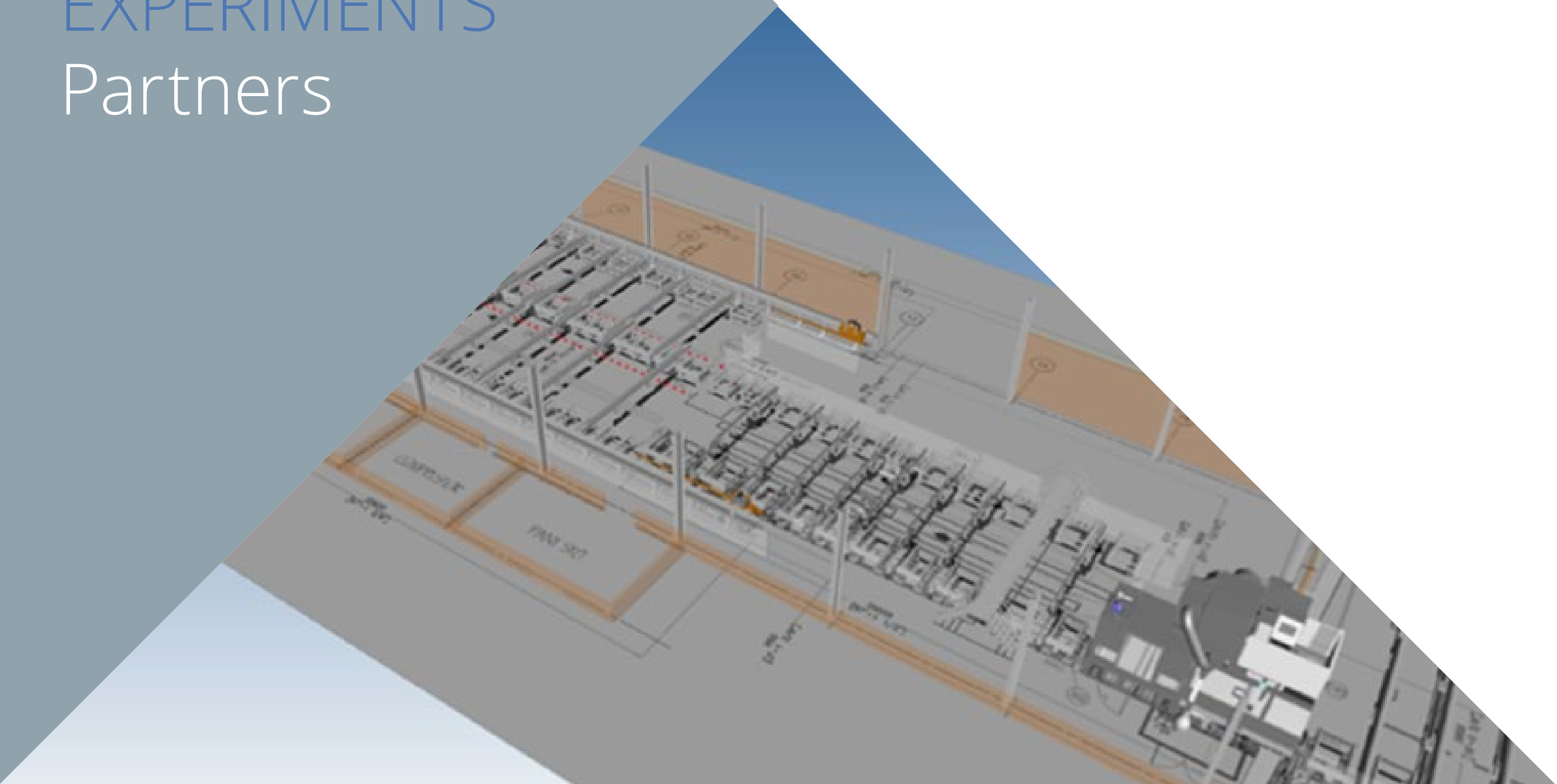
The role amongst the new participants are: seven end users (of which five are SME), three R&D institutions, six independent software vendors (of which five are SME) and two HPC center (one SME, one R&D). The SME rate amongst the new participants is higher than 60 percent.

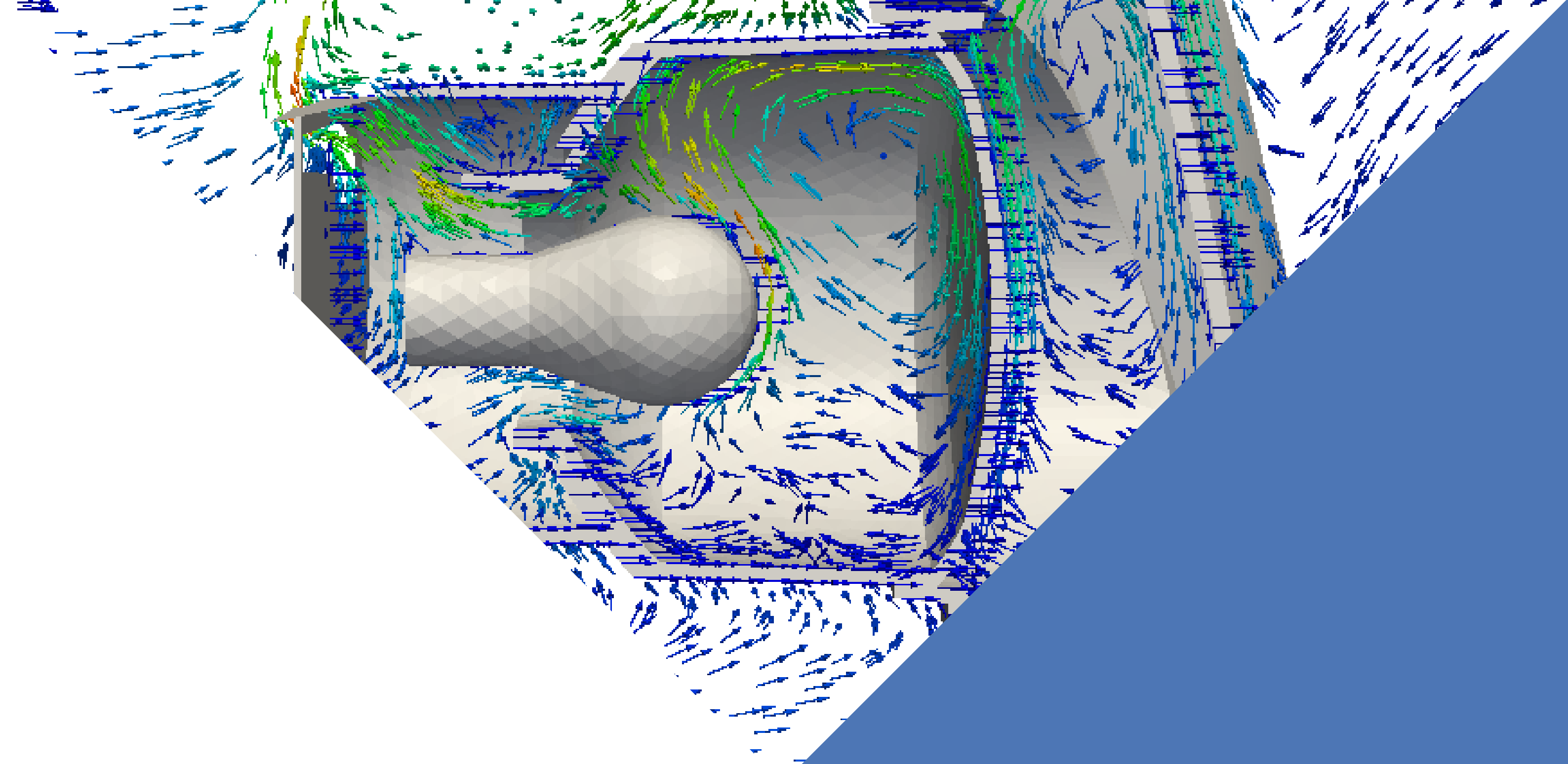
Those **18 partners** also bring five EC member states to the CloudFlow project which have not been represented in the consortium before. Each experiment is run ‘pan-European’ involving partners from more than one EC country, a situation clearly contributed to the support of I4MS – without I4MS such collaboration would not have happened.

SECOND WAVE EXPERIMENTS Partners

END USERS

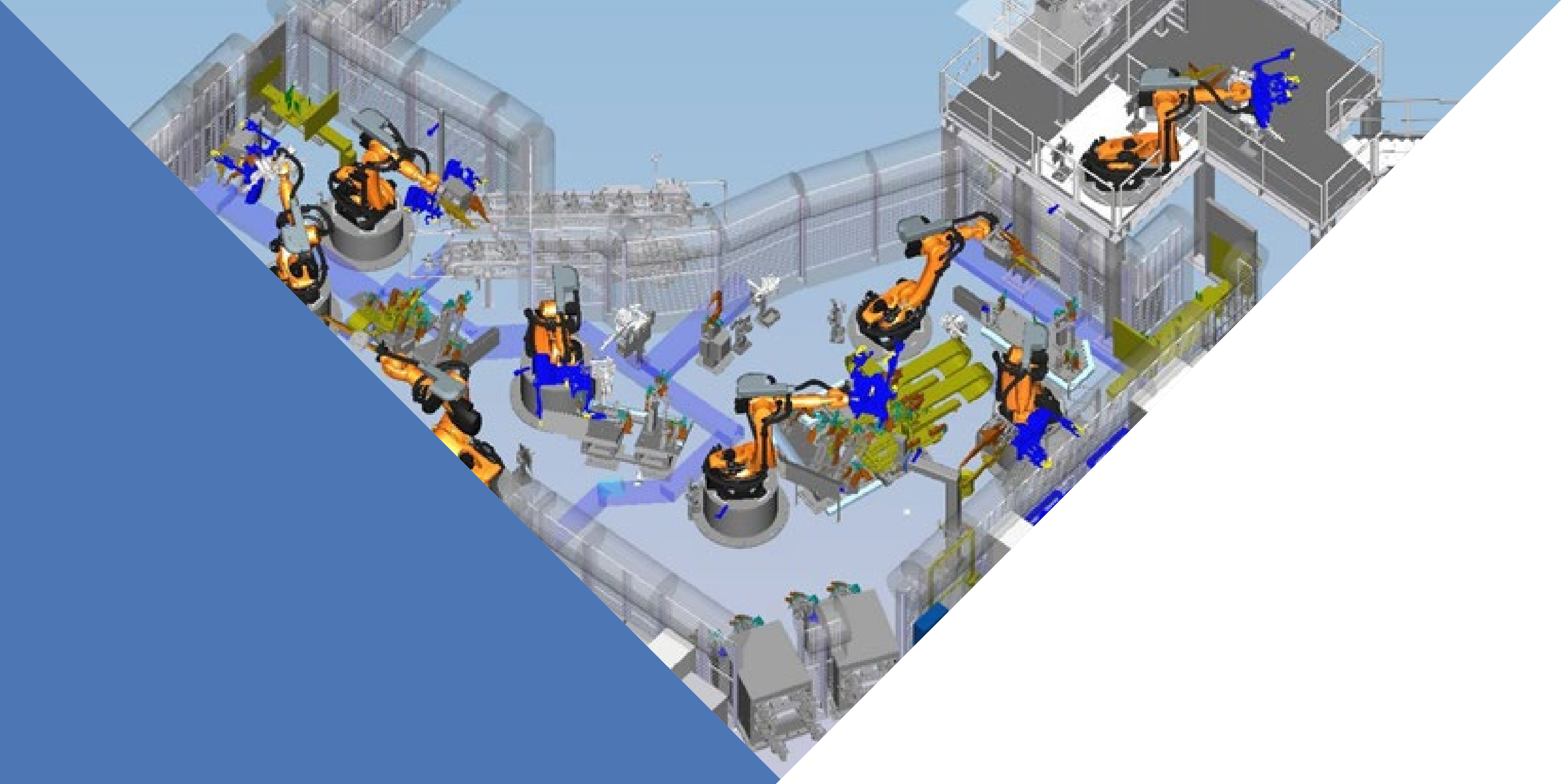
- **European Sensor Systems (ESS)** – SME, Greece
- **Barcelona Technical Center** – SME, Spain
- **FICEP S.p.a.** – industrial company, Italy
- **Introsys-Integration for Robotic Systems** – SME, Portugal
- **BOGE KOMPRESSOREN Otto Boge GmbH & Co. KG** – industrial company, Germany
- **SES-Tec OG** – SME, Austria
- **Biocurve**, S.L. – SME, Spain





SOFTWARE PROVIDER

- **Helic S.A.** – SME, Greece
- **Technology Transfer System (TTS) S.r.l.** – SME, Italy
- **SimPlan AG** – SME, Germany
- **Capvidia NV** – SME, Germany
- **AVL List GmbH** – industrial company, Austria
- **Nabladot S.L.** – SME, Spain



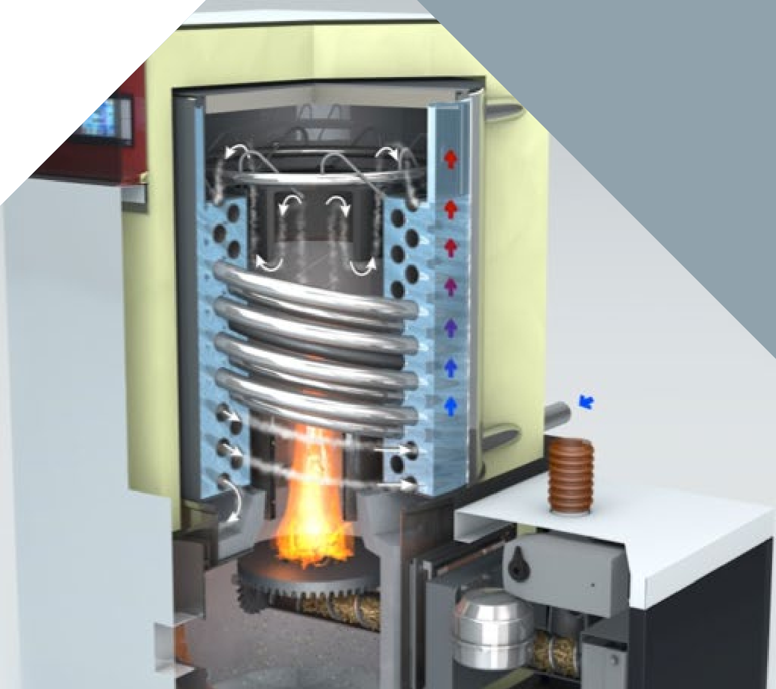
HPC PROVIDER

The cloud technology/platform provider of the following experiments/impact case studies are:

- **Arctur d.o.o.** – SME, Slovenia
- **Consorci de Serveis Universitaris de Catalunya** – SME, Spain
- **Universidad de Zaragoza** – R&D institution, Spain

RESEARCH & DEVELOPMENT

- **ATHENA Research & Innovation Center** – R&D institution, Greece
- **CARSA** – innovation and technology consultancy firm, Spain.
- **Scuola Universitaria Professionale della Svizzera Italiana (SUPSI)** – R&D institution, Italy
- **University of Kassel** Department of Organization of Production and Factory Planning – R&D institution, Germany



HOW YOU CAN PARTICIPATE?

CloudFlow is devised as an **open project**. It is open to new "experiments" carried out by new partners. The open scheme brings different advantages and challenges, like:

- new technology and market trends can be incorporated much better than with a consortium already fully fixed at the project start,
- the technology being developed has to show its flexibility and adaptability.

Thus, CloudFlow will launch **two open calls** where external consortia with **two to four partners** can suggest innovative experiments to be executed with a suitably adapted CloudFlow platform.

The partners of an experiment can include a user company, a software vendor and/or an HPC provider.

Do you want to know more about the open calls?
All informations you can find on:

http://www.eu-cloudflow.eu/open-calls

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www.eu-cloudflow.eu

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