DP PUMPS
DRAKOS · POLEMIS
PUMPS MANUFACTURERS S.A

PROJECT PARTNER
National Technical University of Athens
Department of Mechanical Engineering
Laboratory of Hydraulic Turbomachines (LHT)

HYDROVIO

Development of reversible
pumps / hydroturbines
with optimized hydrodynamic
and environmental design
for high energy efficiency
and safe fish passage.

www.hydrovio.gr

SINGLE RTDI STATE AID ACTION 'RESEARCH – CREATE - INNOVATE'

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HYDROVIO

Project Code: T1EDK 01334

Δράση: Research - Create - Innovate

Project Budget: 1.000.000 Euro

Project, co-financed by the European Regional Development Fund of the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation.

Project Title: Development of reversible pumps / turbines with optimized hydrodynamic and environmental design for high energy efficiency and safe fish passage.

Duration of the Project: Three Years

Project Partners

- NATIONAL TECHNICAL UNIVERSITY OF ATHENS, Department Of Mechanical Engineering, Laboratory Of Hydrodynamic Machines (LHT) .

- DRAKOS- POLEMIS FLUIDUSTRIA S.A.

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EXPECTED PROJECT RESULTS

For the Company:

- Improvement or adoption of new procedures and practices in the field of research and production, work performance and environment improvement and reduction of production cost.
- Strengthening of the infrastructure regarding the research and development sector, attraction of young scientists and enriching with new technological and scientific knowledge
- Strengthening the ecological character of the company's products and its investment interest in innovative and environmentally friendly products, enhancing its business excellence
- Increasing the quality added value of the company's products and services, specialized expertize in renewable energy systems.

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For the Academic Partner:

- Enhancement of the computational and laboratory infrastructure of L.H.T.
- Expanding and enhancement of research team of L.H.T. with young scientists, phd candidates and post doctoral researchers, and improvement of its educational infrastructure for undergraduates
- Implementation of state of the art research in innovative areas, which will strengthen the scientific profile and international recognition of L.H.T, as well as the prospects of cooperation with international industries and research institutions in the field
- Creation of new innovative tools and methods for further theoretical and experimental research in the field of design and operation of hydrodynamic machines
- Transfering of Industrial knowledge on new products development, commercial value evaluation, application from the Company to the academic research and teaching.

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For the country and the environment

- Contributing to the improvement of the domestic added value by creating innovative industrial products, regarding the production of energy from renewable resources, environmentally friendly utilization of water resources, which are addressed to the international markets.
- Strengthening the cooperation of the Academic field with the extroverted Industry of the Country, and establishing a more permanent relationship of know-how exchange and mutual support
- Attracting and utilizing the exceptional potential of young scientists and researchers in domestic industrial research and innovation
- Creation of a new product that is environmentally friendly, which can cover a number of applications, both in the field of hydroelectric projects and energy storage units with pumped storage, as well as in aquaculture and drainage of water areas.
- Contribution to the effort to identify and establish general and reliable indicators for the assessment of environmental behavior and impact on fish fauna of hydrodynamic engines operating in natural environments and ecosystems.

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PROJECT OBJECTIVES AND GOALS

- Creation of environmentally fish friendly reversible turbine - pumps, of optimized design, to allow the safest possible passage of fish fauna in both operations, while maintaining with high degree of energy efficiency
- Application of modern environmental criteria and its integration in the design of hydrodynamic engines
- Investigation of the international market research and determination of the design and operation area (hydraulic height and capacity) of pumps and reversible machines ‘friendly’ to the fish fauna, which is of commercial interest.
- Creation of an innovative generalized methodology for the evaluation and quantification through appropriate indicators of the degree of 'friendliness’ or not to the passing fish fauna applicable to every hydrodynamic reaction engine
- Development and implementation of an integrated computational methodology for optimal and adaptable design of reversible machines, with two competing objectives: Maximizing efficiency and minimizing negative impact on fish fauna
- Creation of an innovative hardware-software system for reliable detection / diagnosis of cavitation in hydrodynamic machines, with easy adaptation and portability.
- Development and implementation of a telemetry system for monitoring the operation of models and large installed pumps and reversible engines.
- Publication and promotion of articles in international scientific journals and conferences international publications
- Commercial promotion in international markets of the new product, and the ability of the Company for specialized research and production of innovation

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PROJECT WORK UNITS

- Preliminary actions
- Numerical research
- Study and systems construction
- Monitoring and evaluation of the effects on fish fauna
- Laboratory evaluation
- Analysis, evaluation & utilization of results
- Publication - promotion

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Project Progress

Completed works:

- Bibliography research for the scientific and commercial needs of the project
- The choice of two reversible hydrodynamic engines in order to be of significant commercial interest, and in fact, to be located on the limits of two extreme areas of potential application, covering there areas further development and design of new engines is required
- The analysis of the technical requirements in hardware and software, in order to carry out the computer research
- The study of the specifications and procedures of the laboratory evaluations

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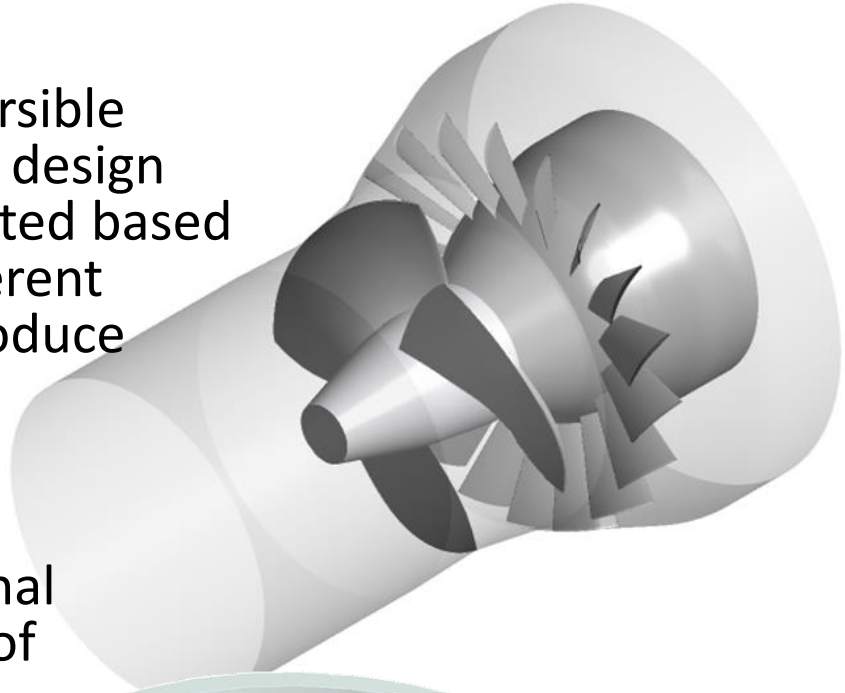
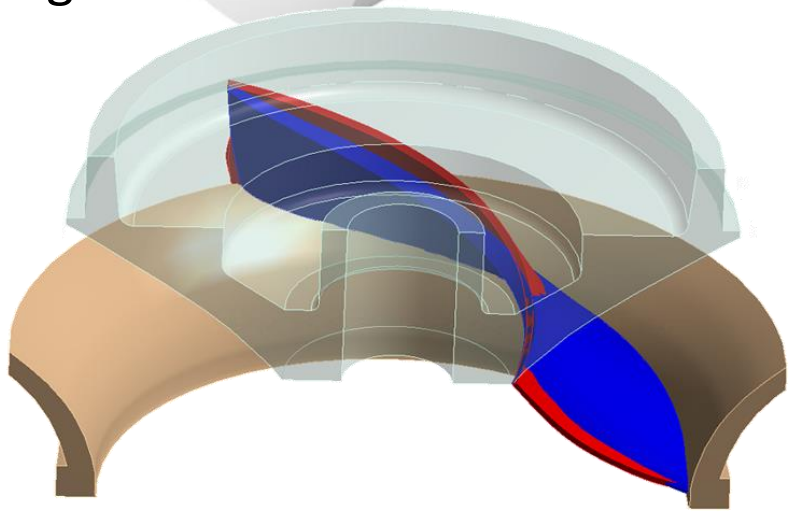
- The methodology and the parametric design of the two reversible pumps-turbines of radial and axial flow according to modern design methods. The defined geometric design variables were selected based on the ability to create and study of machines with very different hydrodynamic design features, as well as the flexibility to produce realistic modifications, in order to be evaluated by numerical optimization software
- The goal of the parametric design in order to maintain as few variables as possible, in order to reduce the computational cost of optimizing their design and to accelerate the finding of optimal values of variables





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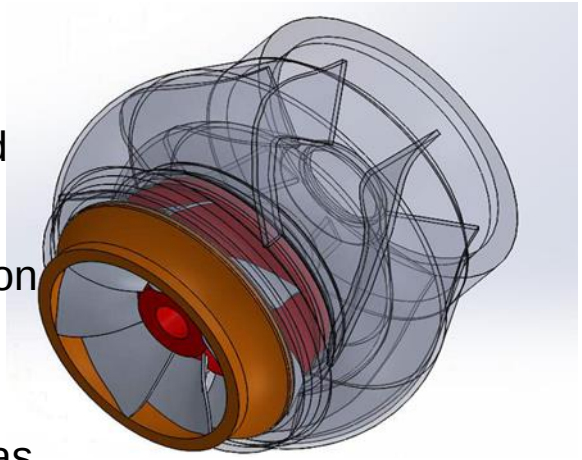
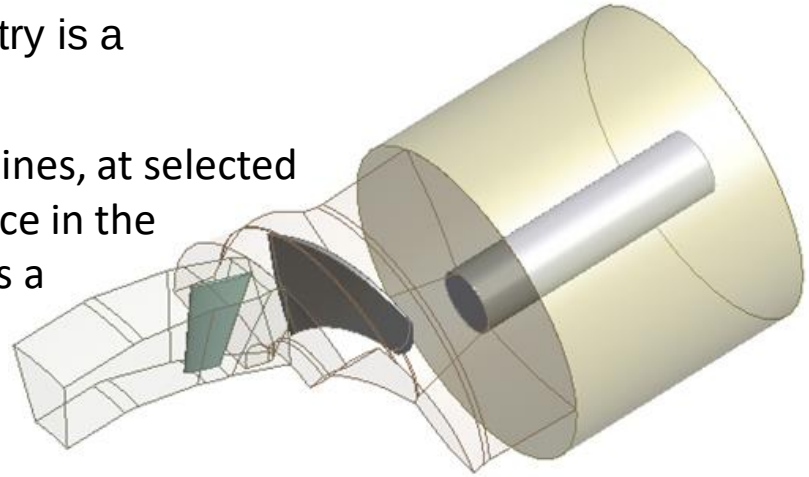
- The preliminary reference design of the two reversible turbine pumps, one mixed flow and one axial flow.
- Mechanical design modifications were incorporated to improve their behavior and operation as hydroturbines
- The characteristic curves of the two engines were plotted, both for pump and turbine operation, after numerical simulations and flow solutions at multiple operating points. It was found that the shape and behavior of these curves are consistent with the theory of hydrodynamic engines, while the maximum degree of efficiency achieved by both reversible engines is high enough for both functions. Therefore, their reference geometry is a satisfactory starting point for further investigation
- The analysis of the flow field and the pressure field formed inside the two engines, at selected operating points and it was found that there is considerable improvement space in the hydrodynamic design, for the pumping operation, but also for the operation as a turbine





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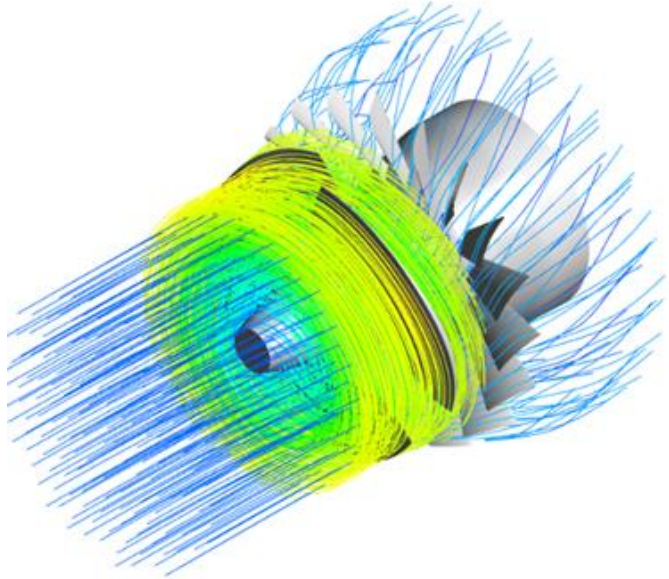
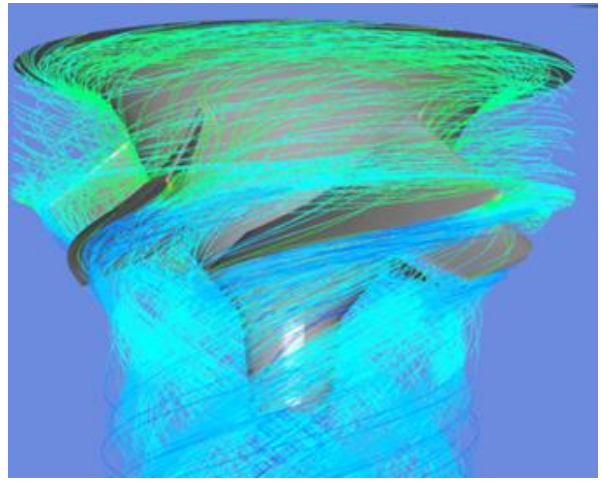
- The parametric research in order to use its results to assess the sensitivity of the energy and environmental performance of the reversible machines under examination, to the value of the various hydrodynamic design parameters and the selection of the most critical parameters that should be used at the stage of the
- The final selection of the two reversible hydrodynamic engines axial and mixed flow based on the data and results of the parametric research and design optimization of the two engines
- The innovative system (hardware and software) for the diagnosis of cavitation in hydrodynamic machines, the challenge of which can affect the safe passage of fish fauna.
- Οι μελέτες μηχανολογικής σχεδίασης των επιμέρους στοιχείων των δύο μηχανών καθώς και η μελέτη παραγωγής και κατασκευής τους
- The mechanical design studies of the individual components of the two machines as well as the study of the production and construction methods
- Articles have been written and published in international scientific journals and conferences





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Publications

- Numerical modelling of fish passage and flow interaction in a hydroturbine
  Published to: **Intl. Conference Hydro 2019, Concept to Closure: Practical Steps, Porto, Portugal**
- Vibration and acoustic emission monitoring of a centrifugal pump under cavitating operating conditions
  Published to : **IOP Conference Series: Earth and Environmental Science 2019, Stuttgart, German**
- The application os spectral kutosis at vibrations signals for the detection of cavitation in centrifugal pumps
  Published to : **Intl. Conference Hydro 2020, Strategies for Future Progress, Online event**
- Numerical analysis of the behaviour of a Deriaz versus a Francis reversible turbines in terms of their energy efficiency and fish – friendly characteristics pumps
  Published to : **Journal of Sound and Vibration (Elsevier)**

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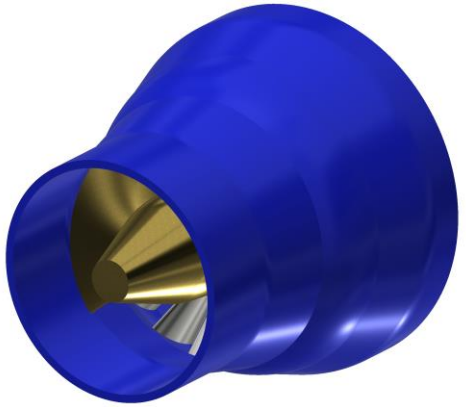
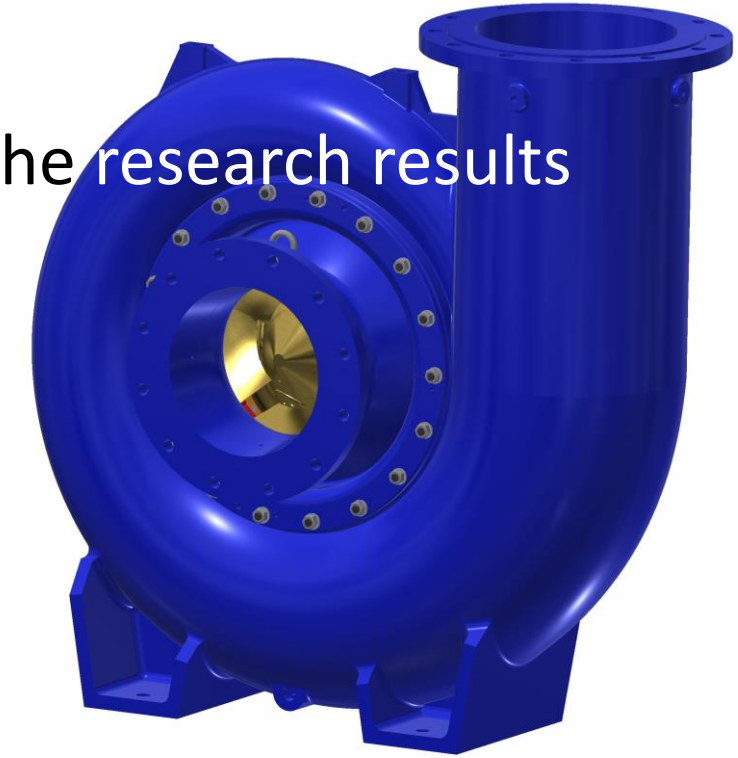
Ongoing Works



- Completion of the design and construction of the systems
- Monitoring and assessment of effects on fish fauna
- Laboratory evaluation
- Analysis, evaluation and utilization of the research results



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NATIONAL TECHNICAL UNIVERSITY OF GREECE

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