HYDRO 2019

International Conference and Exhibition
Porto, Portugal
Alfândega Porto Congress Centre
14-16 October 2019

Concept to closure: Practical steps

Organized by:
Aqua~Media International, EDP and the Portuguese industry warmly welcome the international hydro community for three days of constructive discussions. Portugal’s hydro sector has plenty of experience to share about multipurpose hydropower, large and small dams, pumped storage and powerplant upgrading.

Supporting organizations include:

Regular updates will be posted on our website and published in Hydropower & Dams
Enquiries may be addressed to: Mrs Margaret Bourke, Email: Hydro2019@hydropower-dams.com • Tel: + 44 20 8773 7244
www.hydropower-dams.com/hydro-2019
SULTAN ALAM MEMORIAL PRIZE PAPER

In memory of world expert on sedimentation management, Sultan Alam, who frequently chaired sessions on the subject at the annual conferences, we launched last year a competition for students and recent post-graduates to submit papers on innovative research or development in the field of sedimentation management.

An international panel will review the papers submitted. The author of the winning paper will be invited to make a presentation in the Plenary session of HYDRO 2019, and runners up will be eligible for short presentations in the session on sedimentation management, and/or publication in Hydropower & Dams. The winner and two runners up will have registration fees waived and expenses paid towards their participation at HYDRO 2019.

Many factors are considered in the design and construction of the optimum hydropower project. All parts of a scheme are interrelated and interdependent. Change one component and all others will be affected.

This workshop, following successful ones held in Vientiane, Montreux, Marrakech, Seville, Danang, Gdansk and Namibia, is aimed at people who are, or will be, involved in hydropower development as part of rural electrification programmes. It will cover run-of-river hydroprojects in the ‘pico’ to ‘mini’ range (1 kW to 1 MW capacity).

As this is a diverse form of energy production, there are always areas which are unfamiliar to people, despite many individual specialisms. This workshop aims to fill in the gaps, and help people to gain a good basic grounding in the topic.

All relevant aspects will be covered, from rainfall to energy evaluation, including:

- Analysis of scheme location and definition of potential catchments
- Turning rainfall into an available flow range from a catchment and development of a flow duration curve
- Power and energy generated calculation
- Intake structures, channel and/or pipeline routes and sizing
- Powerhouse design and equipment
- Turbine selection
- Generator, controls and switchgear options
- Grids, national and local

This will be a ‘hands-on’ workshop, which will involve the participants, working in groups, to develop an actual hydropower project during the day. After presentations on the individual scheme aspects, the groups will put together the components of the project. This will follow through to the completed design.

The Fourth Roundtable on Large Hydroelectric Powerplant operation will be held on 13 October. Organized by Itaipu Binacional, Brazil/Paraguay, this full-day event will be an informal, exclusive, high-level forum to exchange knowledge about real-time operational challenges and experiences at some of the world’s major hydro plants.

The mission is to allow for discussion among senior professionals responsible for the daily operation of the plants. Participants will be invited to play an active role in the discussion. Interventions will be welcome on best practice, or on challenging issues where the opinions of other operators could be helpful in resolving problems.

After invited presentations, a facilitated discussion will take place. Specific topics will be agreed in advance. Examples could include:

- Human factors in real-time operation
- SCADA systems and associated apps
- Operational inspections
- Shift work challenges and practices
- Emergency action plans
- Operational risk analysis
- Dealing with flood forecasting
- Training and communication
- Quality control

Places are limited for the Roundtable; to express interest in securing a place, please email: hydros2019@hydropower-dams.com as soon as possible, giving details of your organization, role and responsibilities, and any powerplant you may like to discuss during the Roundtable.

PORTO AND THE DOURO RIVER

Departing from the Alfandega conference centre mid-morning (after registration) this excursion will be an orientation tour of the most scenic parts of the city, with a chance to see the most notable sites and different styles of architecture.

There will be a guided tour which will take participants to Torre dos Clérigos (a unique baroque work by Nicolau Nasoni); Avenida dos Aliados, recently renovated by the award-winning Portuguese architect Alvaro Siza Vieira; as well as the little buildings with colourful facades in the narrow streets of the Ribeira area.

There will also be a 60 minute private cruise along the Douro river, so that the picturesque riviera, port wine cellars and vineyards can be viewed from the river.

Lunch will be at the Casa de Montevideu, in the Foz do Douro, which offers a view over the Atlantic ocean.

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**Exhibition set-up for custom stands only**

**Tour of city landmarks and monuments**

**4th Large Hydro Operators’ Workshop**

**M. De Vivo, France**
**J-M. Devernay, France**
**D. Develay, Belgium**
**L. Deroo, France**
**V. Denis, Switzerland**
**T. Coe, UK**
**R.C. Charlwood, USA**
**R. Bucher, Germany**
**D. Brox, USA**
**R. Boes, Switzerland**
**P. Boeriu, UNESCO-IHE**
**L. Berga, Spain**
**E. Bellendir, Russian Federation**
**F. Avellan, Switzerland**
**M. Aufleger, Austria**
**Azeb Asnake, Ethiopia**
**I. Araki, Japan**
**G. Annandale, USA**
**H.I. Aker, Turkey**
**D. Aelbrecht, France**
**M. Abebe, Ethiopia**

**Sunday 13 October**

- **From 09.00 hrs:**
  - Conference Registration opens
  - Exhibition set-up for custom stands only

- **09.30 hrs:**
  - Small Hydro Seminar
  - 4th Large Hydro Operators' Workshop

- **10.45 hrs:**
  - Excursion departs for
  - Tour of city landmarks and monuments
  - (including lunch)

- **14.00 hrs:**
  - Access to stands for exhibitors

- **19.00 hrs:**
  - Chairmen's Meeting
  - followed by
  - 19.30 hrs:
  - Speakers' Briefing at the
  - Alfândega Congress Centre

**Monday 14 October**

- **08.30 hrs:**
  - **Opening Plenary Session:**
  - Welcome addresses
  - Keynote addresses

- **Coffee**

- **Parallel Sessions:**
  - 1 - Future development opportunities
  - 2 - Civil works: design, construction, upgrading
  - 3 - Financing hydropower: Innovation
  - 4 - Hydraulic machinery: Research and modelling

- **Lunch**

- **Parallel Sessions:**
  - 5 - Project planning
  - 6 - Civil works: Materials
  - 7 - Finance: Legal and contractual aspects
  - 8a - Hydraulic machinery: Operational aspects

- **Coffee**

- **Parallel Sessions:**
  - 8b - Hydraulic machinery: Environment, upgrades
  - 9 - Future trends in hydropower (IEA)
  - 10 - Expansive chemical reactions in concrete
  - 11 - Finance Workshop

- **19.30 hrs:**
  - Welcome Reception
  - Palacio da Bolsa, Porto
  - Co-hosted by:

**THE INTERNATIONAL STEERING COMMITTEE**

| M. Ababa, Ethiopia | O. Didry, France |
| D. Aebli, Switzerland | P. Duffen, France |
| H. I. Aksoy, Turkey | M.R.H. Durand, UK |
| G. Annandale, USA | I. Ekpo, Nigeria |
| T. Araki, Japan | P. Erdei, Brazil |
| Azs Admoke, Ethiopia | P. de Felice, France |
| M. Aufleger, Austria | J. Freitas, Portugal |
| F. Avellan, Switzerland | R. Grether, Germany |
| E. Bellendir, Russian Federation | K. Grubb, UK |
| L. Berga, Spain | P. Gruber, Switzerland |
| P. Boeriu, UNESCO-IHE | J. Gummer, Australia |
| R. Boes, Switzerland | W. Hakin, Australia |
| D. Brox, USA | C.R. Head, UK |
| R. Bucher, Germany | M. Holand, Germany |
| R.C. Charlwood, USA | A. Hughes, UK |
| T. Cee, UK | R.E. Israelson, USA |
| V. Denis, Switzerland | Jia Jinsheng, China |
| L. Deroo, France | Ø. Johansen, Norway |
| D. Develay, Belgium | H. Kling, Switzerland |
| J-M. Devernay, France | H. Kreuzer, Switzerland |
| M. De Vivo, France | A. Kumar, India |

**Tuesday 15 October**

- **08.30 hrs:**
  - **Parallel Sessions:**
  - 12 - Finance: Climate bonds
  - 13 - Tunnels for hydropower
  - 14 - Hydro plant and gate safety
  - 15(a) - Pumped-storage projects

- **Coffee**

- **Parallel Sessions:**
  - 15(b) - Pumped storage: Technical aspects
  - 16 - Climate change resilience
  - 17 - Dam safety management
  - 18 - Operation and control

- **Lunch**

- **Parallel Sessions:**
  - 15(c) - Pumped storage: Innovation
  - 19 - Challenging sites and climate conditions
  - 20 - Dam safety: Surveillance and monitoring
  - 21 - Operation and maintenance

- **Coffee**

- **Parallel Sessions:**
  - 15(d) - Pumped storage: Integration
  - 22 - Cross-border projects
  - 23 - Dam safety: Seismic risk; failure mechanisms
  - 24 - Electrical engineering and grid issues

**Wednesday 16 October**

- **08.30 hrs:**
  - **Parallel Sessions:**
  - 25 - Hydropower and the environment
  - 26 - Spillways
  - 27 - Hydro flexibility (IEA)
  - 28 - Small hydro innovation

- **Coffee**

- **Parallel Sessions:**
  - 29 - Environment: Fish protection
  - 30 - Upgrading and refurbishment
  - 31 - Innovation in hydropower
  - 32 - Sedimentation management

- **Lunch**

- **Closing Plenary Session:**
  - Summary and outcomes
  - Welcome to ASIA 2020, Kuala Lumpur
  - Malaysia

- **Coffee**

- **Closing Plenary Session:**
  - Summary and outcomes
  - Companhia Real Velha
  - Hosted by:

**EDP**
CONFERENCE SESSIONS

The following pages present the status of the HYDRO 2019 programme in September. Some additional invited speakers are to be announced. Please visit our website for regular updates.

Monday 14 October - Morning

Session 1 – Future hydro development opportunities
Chair: M. Abebe, Eastern Nile Technical Regional Office, Ethiopia

- Paradigm shift approach for reducing delays for power sector projects - Hon. Dilh Bahadur Singh, Electricity Regulatory Commission, Nepal
- Possibilities for future hydropower development on the St Paul river, Liberia - D.S. Gono, Liberia Electricity Corporation, Liberia; W.D. Hackin, Hydrotec Pty Ltd, Australia
- Optimization of cascading conduit hydropower plants in a water distribution system - M. van Dijk, S.J. van Vuuren and C.M. Niemuh, University of Pretoria, South Africa; G. Cavazzini, University of Padova, Italy; A. Santolin, 45 Engineering, Italy
- Improving hydropower flexibility by synergizing independently managed utilities - S. Chamoun, P.A. Manso and G. De Cesare, Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland; V. Goertter, Ernst Fuchs AG, Switzerland; S. Crettenand, FNW Reussa SA, Switzerland; C. Todde, Groupe E, Switzerland

Session 2 – Civil engineering: Design, construction and upgrading
Chair: M. Rogers, President of ICOLD, and Stantec, USA

- The design of the Alto Tâmega dam: A 106 m-high arch dam under construction - C.G. Ninot and C. B. Berrocaldo, Granoll Hydraulic Engineers, Spain; F. P. Matelana and L. de la Torre Abietar, Iberdrola, Spain
- BIM-building of a 250 MW powerplant extension - J.-P. Roca and A. Ougui, EDF Hydro, France
- The construction of the Alto Tâmega dam in Portugal - J. Jiménez Labado, Acciona Infrastructure, Spain
- General layout and construction challenges at the Caucu Cachapo hydropower project - M. C. Costa, G. Matus, A. Santos, A. Moragdo and A. Amador, COBRA, Engineering and Environmental Consultants, Portugal; A. Chico, GAMEK, Gabinete de Aproveitamento do Médio Kwanza, Angola
- Site C project: Construction in the north of British Columbia, Canada - J. Jiménez Labado, Acciona Infrastructure, Spain; F. Ortega Santos, Fonse Consulting Engineers, Germany
- Strengthening and seismic retrofitting of the Chancy-Pougny dam - J. Gastal, Freyssinet International & Cie, France

Session 3 – Financing hydropower: An overview including recent innovations
Co-Chairs: C.R. Head, Consultant, UK; M. McWilliams, McWilliams Energy, UK

- Presentations will demonstrate how the types and roles of various actors in hydropower financing have changed, and how new types of financing packages have emerged.
- The Nachtigal hydrop plant: Owner’s perspective on financing - S. Lebeau, EDF, France
- The role of the lender’s engineer and lenders’ perspectives on risk - A. Chaudhary, Most MacDonald, UK
- PPPs in Africa and AfDB’s role in promoting hydro PPPs - A. Holikka, African Development Bank, Côte d’Ivoire
- PPP financing of the Mpatamanga scheme, Malawi - C. Eberly and S. Deschler, Crossboundary, Energy
- Structuring bankable pumped-storage plants: Reflections from two on-going IFC advisory projects - W. Saperith, Internation Finance Corporation, USA
- The changing scene for hydro finance - M. McWilliams, McWilliams Energy, UK

Session 4 – Hydraulic machinery: Research and modelling
Chair: Prof F. Avellaa, EPFL-LMH, Switzerland

- A simple method for PV and flow observations in the guidevane chambers of a model pump-turbine - M. van Burg, S. Deniz, T. Tabushi and A. Del Rio, Lucerne University of Applied Sciences and Arts (HSUL), Switzerland
- Improvement of cavitation characteristics of the water passages at the Votkinskaya plant - A.V. Semionov, A.A. Varlamov, Yu.G. Georgieva, A.V. Zakharov and M.A. Sokolova, PJSC Power Machines, Russia
- Modelling of water-lubricated bearing in hydro unit dynamic stability: The rotor dynamics analysis of the shaft train with the aid of rotor dynamics module of MSC/Nastran - J. Ahlainen, Fortum Power and Heat Oy; Finland; P. Varaporn, PII Engineering Services, Finland
- Optimal design of a new isokinetic turbine with spiral shaped blades - J.-L. Kuery, OyHydro-Concept, Switzerland; Y. Perrenoud, Lambok, Indonesia
- Dynamic behaviour of hydro units in the rough load zone, with case studies - O. Hrusnik, O. Oreškovic and F. Tonkovic Vesić d.o.o., Croatia
- Influence of air admission place locations on a hydro unit switching to synchronous condenser mode on Francis hydro turbine model - R. Akulaev, M. Romanova and I. Roznetova, Power Machines PJSC, Russia

Session 5 – Project planning: Innovative approaches and tools
Co-Chairs: Dr G. Cloete, Namibia University of Science and Technology, Namibia; H.I. Aker, Dolars Engineering, Turkey

- A new hydropower inventory process using analytical geographic information systems - M. Osorio, D. Fernandes, P. Sá Pina and S. Silva, EDP - Gestão da Produção de Energia, SA, Portugal
- Comparison of methods to achieve robust design decisions for hydropower projects: Case study - F. Öberrasch, ïjeti Power, Switzerland Ltd, Switzerland; A.J. Schleiss, Honorary Professor and Consultant, Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland
- Portfolio assessment for hydropower project selection at basin scale: Criteria selection and weighting process - S. Tressart and B. Graff, CINR, France
- Planning the Kohramannara Helete (Düzba) dam project - M. Congas and I. Kalam, Dolars Engineering Inc Co, Turkey
- The application of BIM methodology for the Khlobamblo feasibility study - A. Amador, P. Serra, B. Santana and A. Pereira da Silva, COBRA, Engineering and Environmental Consultants, Portugal; K. Lungo, Ministry of Energy, Malawi
- Expanding the reach of Sarawak’s hydro resources: the Baleh hydroelectric project - Goh Chee Hui and H.L. Heng, Sarawak Energy Berhad, Malaysia
- Early phase hydropower studies: What did I learn and what did I contribute (A young engineer’s perspective) - F. Patelka, Multiconsort Ltd UK, UK

Session 6 – Materials for dams
Co-Chairs: Prof Xu Zeping, IWHR and CHINCOLD, China; Dr M.R.H. Dunstan, MD&A, UK

- New solutions to extend the lifetime of dense asphalt concrete impermeabilization in dams - I.R. Vasello, Rapol Electricidad y Gas, Spain
- Advances in rock-filled concrete and self-protected underwater concrete technology - F. Jin, Tsinghua University, China; E.L. Li, Sinoconfix Co. Ltd, China; Q.Y. Zhang, Zunyi Survey and Design Institute of Water Conservancy and Hydraulic Engineering, China; Y.B. Li, GuiZhou University, China
- Rock-filled concrete dam design for the Shanpi II hydropower project in Dada river - Yu Jian-Jun, Huang Wei, Wu Hong-Rong and Fu Cheng-Yi, PowerChina Huadong Engineering Corporation Ltd, China
- The new guide to grouting in dams - A. Hughes, Dams and Reservoirs Ltd, UK
- Recent progress in cemented material dams (CMD) in China - Jia Jinsheg, Cuixing Zhang and Shuangxi Li, Institute of Water Resources and Hydropower Research, China
- Concrete mix design for the Datovas dam - D. Riviere, Iberdrola, Spain; V.J. Monso, C.G. Sáez and S. Fernandes, Iberdrola, Portugal
hydro projects have already been developed globally, there are still opportunities for new work for assessing hydropower resilience to climate change and implications from the global There has been increasing concern about the consequences of climate change, and a frame
plants, providing climate change adaptation and mitigation capability and developing hitherto
energy systems. This role includes providing flexibility services, modernizing existing hydro
Session 7 – Finance: Legal and contractual aspects
Chair: P. Rae, P.J. Rae Consulting, Canada
Some key points of the decision to bid - - A. Palmieri, Independent Consultant, Italy
Hydropower risk mitigation during the development stage: EPC’s missing piece - K.I. Candie
Managing financial risk through the use of dispute boards and litigation funding in procurement
Is the FIDIC emerald book (Ed. 2019) the best contract for hydropower and dam construction projects? - S. Giraud, EGIS, France
The role of the subcontractor in large-scale projects: What to do, and not to do, in a contractual set-up for the erection of a hydropower plant - B. Geisseler, Geisseler Law, Germany

Session 8(a) – Hydraulic machinery: Operational aspects
Chair: J.H. Guummer, Hydro-Consult Pty Ltd, Australia
Prediction of the power consumption in a reversible pump-turbine operating in synchronous condenser mode - E. Vagnoni and F. Avellan, École Polytechnique Fédérale de Lausanne, Switzerland; P. Leroy, GE Renewables Energy, France
Automatic system for efficiency optimization and calculation of the combination curve of Kaplan and bulb turbines - H.A. Menarin, R.P. Gossuin and L.A. Weiss, ReaVax Automation and Control, Brazil; A. Quadrifoni, Emlen Green Power, Italy; C. Buhler and A.A. Benitti, Reusix of Switzerland (Ros), Switzerland; H.A. Costa, Federal University of Santa Catarina (UFSC), Brazil
Methodical basis for estimating the technical condition and residual life of metal water-conduit structures for hydro turbines - Y. Shevchenko and S.M. Levin, JSC Vedeneev VINIG, Russia
Reduction of shaft dynamical run-out and cloud monitoring for vibrations in hydropower equipment - J.M. Nieto Diaz and P.H. Teixeira, Veith Digital Ventures, Germany
Detection of harsh operating conditions on a Francis prototype based on in-situ non-intrusive measurements - V. Hasmatuch, J. Decaux, C. Münch-Allagné and D. Pacot, HES-SO Vaudois/Wollis, Switzerland; M. Titzschkau, Kraftwerke Oberhasli AG, Switzerland
Bulb units beyond standard for South East Asia - W. Ladstaetter, T. Eiper, J. Stechina and S. Milosančević, Andritz Hydro, Austria

Session 8(b) – Hydraulic machinery: Environmental enhancement and upgrading
Chair: J.H. Guummer, Hydro-Consult Pty Ltd, Australia
Influence of primary frequency control and environmental requirements on Kaplan runner designs - S. Krato and D. Dolenc, Ustnistr Power, d.o.o., Slovenia
Self-lubricating bearings design solutions to overcome the increasing flexibility of ecological Kaplan runner hub structure - P. Parreira and S. Krapf, Federal-Mogul Deva GmbH, Germany
The diagonal (Deriaz) turbine: From the systematization development to the first project implementations - V. Denis and A. Bullani, Mthlyab, Switzerland
Development of parallel relief valve synchronized with Francis turbine guidevanes - A. Žagar, D. Jasić, and M. Krusec, Kolktor TurboBoltnjet, Slovenia
A turbine replacement project: From Deriaz to Francis - S. Harkawka, Electric Power Development Co Ltd, Japan; Y. Tamura, Hitachi Mitsubishi Hydra Corporation, Japan
One of the world’s largest butterfly valves at Tarbela IV: New benchmark regarding size, strength and efficiency - T. Neidhardt and E. Rube, Veith Hydro Holding GmbH & Co. KG, Germany

Session 9 – Future trends in hydropower (IEA session)
Chair: N. Nielsen, Joint Secretary, IEA Hydro, Australia
Many countries are acknowledging the increasing importance of hydropower to electrical energy systems. This role includes providing flexibility services, modernizing existing hydropower plants, providing climate change adaptation and mitigation capability and developing hitherto untapped opportunities. The session on future trends will provide coverage of the latter two themes. There has been increasing concern about the consequences of climate change, and a framework for assessing hydropower resilience to climate change and implications from the global debate on GHG emissions will be presented. While a significant number of the most economic hydro projects have already been developed globally, there are still opportunities for new hydropower by utilizing unharvested water flow and head at both new and existing project sites, as well as improving the performance of existing facilities. The session will discuss ‘Identifying and developing the potential of hidden hydropower’.
Overcoming barriers to the development of hidden hydropower opportunities - N. Nielsen, IEA Hydro, Australia
Hydropower research and innovation: The European viewpoint - T. Schleker, European Commission, Belgium
Pushing the envelope: Switzerland’s approach to unlocking hidden hydropower potential - A. Müller, EPFL; C. Munch-Allagné, HES-SO; C. Niclot, Power Vision Engineering; V. Denis, Mthlyab; and F. Avellan, EPFL, Switzerland
Wastewater turbining before and after treatment: The example of Amman City, Jordan - V. Denis, Mthlyab, Switzerland
Hydropower in urban drinking water distribution networks - I. Samora and K. Essyad, BG Ingenieurs Consul SA, Switzerland; C.D. Binier, Institute of Systems Engineering, School of Engineering, HES-SO, Switzerland; Munch-Allagné, University of Applied Sciences and Arts Western Switzerland
Implications from the Global Debate on GHG emissions on the future of Hydropower - J. Damazio, A. M. Medeiros and A.C.G. Mele, Electric Energy Research Centre (CEPEL), Brazil; N.M. Nielsen, IEA Hydro TCP, Australia

Session 10 – Management of expansive chemical reactions in concrete dams and hydropower plants
Chair: Dr Robin Charlwood, Consultant, USA
Expansive chemical reactions, behaviour and diagnosis - M. Berra, Independent Consultant, Italy; R. Charlwood, Consultant, USA; E. Amborg, Lombardi SA, Switzerland
Physical effects and structural analysis of behaviour - F. Amborg and R. Stucchi, Lombardi SA, Switzerland; J. Salamon, USBR, USA; D. Caris, Holch, Canada; R. Charlwood, Consultant, USA
Case histories and management options - R. Charlwood, Consultant, USA; E. Amborg, Lombardi SA, Switzerland; M. Berra, Independent Consultant, Italy

Session 11 – Finance workshop
Co-Chairs: C.R. Head, Consultant, UK; M. McWilliams, McWilliams Energy, UK
During this two-part workshop, speakers from sessions 3 and 7 will form two consecutive panels; each will have two minutes to highlight the main points of their presentations, and there will then be a Q&A discussion with the audience.

Tuesday 15 October - Morning

Session 12 – Climate Finance
Chair: Dr J. Plummer Braeckman, University of Cambridge, UK
In 2016, the Climate Bonds Initiative launched a Hydropower Technical Working Group to explore how to identify and monitor hydropower investments, which deliver climate mitigation benefits and/or incorporates adaptation and resilience impacts. Their proposed green bond criteria for hydropower are currently under consultation before being finalized. This session will consider Green Bonds and other climate-related finance initiatives for hydropower, together with examples of hydropower financed in combination with other forms of renewable energy such as wind and solar. There will be speakers from the International Institute for Environment and development, The African Development Bank, the Ministry of Energy and Petroleum, Norway, and others.

Session 13 – Tunnels for hydropower schemes
Chair: D. Bros, Dean Bros Consulting Ltd, Canada
Hydropower tunnel failures: Risks and causes - D. Bros, Dean Bros Consulting, Canada
Lessons learned from first filling and emptying of a new pressure tunnel in Valais, Switzerland - G. Kayset, P. Heck, H. Deratza and M. Wickenhäuser, BG Consulting Engineers, Switzerland; M. Aeschbach, SRP Ingenieurs AG, Switzerland
Retrieval of a stranded TBM in adverse Himalayan geology - S. Dave and Y. Wazalwar, Hindustan Construction Company Ltd, India; G. Kelkar, Navayoga Engineering Co Ltd, India
Fuz Tuo hydroelectric powerhouse: Design of the power shafts and related construction sequence - M. Ribeiro, J.N. Figueiredo and M.E. Resende, EDP - Gestão da Produção de Energia SA, Portugal
CONFERENCE SESSIONS

Session 14 – Hydro plant and gate safety

Chair: O. Westberg, Consultant, Norway; P. Erbisi, Consultant, Brazil
Managing cyber security in dispatch centre networks - M. Santos and H. Pinto Alves, EDP, Gestão da Produção de Energia S.A., Portugal

Session 15(a) – Pumped-storage projects

Chair: B. Trouille, Matt MacDonald, USA
Pumped-storage pumped storage site screening in Kenya: Methodology and feedback - J. Prolang, J. Condet, N. Sosvat, D. Magam and B. Spannato, EDF Hydro, France; W. Ochung, KenGen, Kenya
Pumped-storage pumped power plants in Iraq and Kurdistan region - H.A. Hrawamany, Consultant, Iraq
Development of the tailrace surge tank of the Gouvães pumped-storage plant - J.C. Vera and L. de la Torre, Iberdrola, Spain; W. Richter, TU Graz Hydraulic Institute, Austria; C. Niclot, Power Vision Eng. Sàrl, Switzerland
Reduction of pump-noise emissions from penstock - J. Mayrhuber, Verbund Hydro Power GmbH, Austria
Quality and design aspects of the pump-turbine runner at the Tehri pumped-storage plant - H.L. Arora, K. Kishore, L. Kumar and S. Rawat, THDC India Ltd, India

Session 15(b) – Technical aspects of pumped storage

Co-Chairs: B. Trouille, Matt MacDonald, USA; R. Bucher, Tractebel Engin, Germany
Replacement of a horizontal Francis turbine by a pump-turbine with variable speed - J. Zouhar, J. Obrovsky, M. Abrahám and A. Skukat, Ustijná Engineering, Czech Republic
Practical applications of hot banded pipe (HBP) technology for steel penstocks and steel linings in high head hydro powerplants and pumped-storage plants - C. Curnis, Consultant, Switzerland; D. Bronzetti and S. Sayay, Lombardi Engineering Ltd, Switzerland
The main models of a generator-motor in pumped-storage plant - Shi Lei Ming and Zhao Zheng, Power China Huoudong Engineering Corporation Ltd, China
Experience and a proposal on a field efficiency test for an adjustable speed pump-turbine - H. Koyama and S. Tanaka, Takeshi Energy Systems & Solutions Corporation, Japan
Pumped-storage plants optimized with vacuum switching technology - G. Urquiola Frax, Siemens, Spain; H. Urbanek, R. R. Venny, W. Anger and E. Desplanche, Siemens AG, Germany

Session 16 – Climate change resilience

Chair: J.M. Demazio, CEPEL, Brazil
Managing financial risks in the Albanian hydropower sector - G. Daci, The World Bank, Albania
Mitigating climate change impacts for optimizing hydropower management strategies - E.R. Patro and C. de Michele, Politecnico di Milano, Italy
Hydrology for hydropower: Reduction of uncertainties - R. Mikovec and R. Fritzze, ILE Consulting Engineers Austria GmbH, Austria
Building climate resilience at Mopai dam in the Limpopo river basin, Mozambique: Coping with climate change, flood, droughts and demands for energy and water - M.J. Calhii, J. Arasii, P. da Silva, A. Mendes and M.G.P. Correia, COBA, Engineering and Environmental Consultants, Portugal; J.L. Teixeira, University of Lisbon, Portugal
The role of hydropower in mitigation and adaptation of climate change: A developing country’s perspective - F.H. Pathi, M.K. Bujap, M.I. Aman and D.U. Li Chung, Sarawak Energy Berhad, Malaysia
Accelerating climate action and transition to low carbon economy - M.I. Aman, I.K. Manor, D.Z. Aag Kassim, M.E. Ibrahim and Z.Z. Abidin, Sarawak Energy Berhad, Malaysia
Mitigating measures for H2S impact in Bakun hydropower plant - A.Z. Bin Abdul Taip and A. Gabriel, Sarawak Energy Berhad, Malaysia

Session 17 – Dam safety: Assessment, management and public safety

Co-Chairs: Dr H. Kreuzer, Consultant, Switzerland; Dr J-P. Tournier, Hydro-Québec, Canada
Risk classification of EDP dams in accordance with the new Portuguese dam safety legislation - P.M.A. Pinto, A.F.M. de Oliveira, J.A.G. Cunha Cubha, M.I. Ribeiro, F.M.G.K. Telles and V.R.C. Gaspar, EDP, Gestão da Produção de Energia S.A., Portugal
Dam safety during floods: Taking care of site condition? - M. Breysse and M. Antunes-Valleley, EDF Hydro, France
The comparison of dam safety management between Itaipu and Three Gorges dams - Cao Wenbo and Gong Jun, China Yangzte Power Co. Ltd, China; S.F. Maes and E.F. Farie, Itaipu Binacional, Brazil
Emergency measures to stabilise Toddbrock reservoir, UK - R.J. Robson, Matt MacDonald, UK

Session 18 – Hydro plant operation and control

Chair: H. Obermoser, AF-Consult, Switzerland
Range extension: Methods to increase operational flexibility of hydropower plants through digital control - F. André, V. Blouillet, P-Y. Lawy and H. Mollet, GE Renewable Energy Hydro, France; M. Roque, T. Marques, F. Duvarte and P. Almeida, Gestão da Produção de Energia, SA, Portugal
The achievement of increased generating power and frequency control capability by technology of adjustable speed - H. Tanaka, The Kansai Electric Power Co Inc., Japan
Methodology to determine the parameters of a turbine governor for primary control - C. Landry and C. Niclot, Power Vision Engineering Sarl, Switzerland; J. Gomes and F. Avenue, EPEP Laboratory for Hydraulic Machines, Switzerland
Improving frequency control from Kaplan turbines to fulfil grid codes - E. Dahlgob, P. Norrlund and U. Lundin, Uppsala University, Sweden; L. Sarren, Vattenfall AB, Sweden

Session 15(c) – Innovations in pumped storage

Chair: B. Trouille, Matt MacDonald, USA
Energy storage dome: A new energy storage technology in dams vs pumped-storage technology - B. Ghassam, Farah Co, Iran
Transformation of conventional hydro into pumped storage: A new future business line for the electricity sector - F. Perin Montero and A.S. Carrizo, Iberdrola Renewables, Spain

Tuesday 15 October - Afternoon

Session 15(c) – Innovations in pumped storage

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CONFERENCE SESSIONS

Session 15(d) – Pumped storage integration

Co-Chairs: B. Trouille, Mott MacDonald, USA; B. Martins, EDP, Portugal

- Pumped storage as an enabler for energy transition - P. Bauloher and M. Ziegler, TWAG, Austria
- Integrated renewable energy projects with a pumped-storage powerplant - C. Schmitt and K. Krueger, Voith Hydro Holding GmbH & Co KG, Germany
- Dinorwig upgrade: Balancing intermittent renewables with Europe’s largest pumped-storage plant - G. Yone and R. Clarke-Johnson, American Governor Company, USA
- Developing valuation guidance for pumped-storage hydropower - V. Koritarov, Argonne National Laboratory, USA; B. Trouille, Mott MacDonald, USA
- The use and values of pumped storage in Portugal - B. Martins, EDP, Portugal

Session 19 – Managing challenging sites and climatic conditions

Co-Chairs: Prof J. Reynolds, Reynolds International Ltd., UK; P. Pradhan, BPC, Nepal

- The impact of exceptional hurricane events in 2017 on rivers and water storage reservoirs in Puerto Rico - J. Reynolds, Reynolds International Ltd, UK
- Analysis of disastrous weather and early warning measures during construction of the Bulatan project - You Jiaxing, Quan Lianjun, Yu Jianghua, D a Hang and Ke Chuanfang, China Three Gorges Projects Development Co., Ltd, China
- The Keeyaks hydroelectric development: Designing for construction in cold climate conditions - I. Ainslie, Hatch Ltd, Canada; T. Tommer, Manitoba Hydro, Canada
- Hydrological drought early warning system development using risk-based deficit predictions on drought conditions - M.K. Tarkci and C. Simsek, Dolan Engineering Inc Co., Turkey
- Incorporation of macro climate indices in flood prevention studies in the operation planning of the Brazilian hydropower system - F.S. Costa, J.M. Damazio and P.D.S. Chan, Electric Energy Research Centre, Brazil
- Shock Transmitter Units (STU): An application on the piers located on the Gibe 3 dam crest - A. Cagiano, Studio Pietrangeli, Italy; A. Masciotta, A. Giammatteo and F. Mattei, Studio Masciotta Srl, Italy

Session 20 – Dam safety: Monitoring and surveillance

Co-Chairs: M. Lina, Consultant, France; Dr A. Chraibi, Consultant, Morocco

- The structural monitoring and behaviour of Fax Tua dam, Portugal - D. Silva Matos, A. Gomes, J.M. Figueiredo, A. Faria and D. Pimental, EDP Gerência da Produção de Energia, S.A., Portugal; A. Tavares de Castro, J.P. Gomes and J.I. Lima, LIPE – Laboratory of Civil Engineering, Portugal
- Slope monitoring using combined optical and drone survey tools - P. Natse, R. Frez and V. Crisp, Piëry Switzerland Ltd, Switzerland
- Technological innovation in dam safety and monitoring management - M. Damasceno, Lafcarr Project & Design, S.L., Portugal; A. Nogue, Lafcarr Project & Design S.L., Spain
- Fibre-optic structural health monitoring for tallings dams - J. Cottone and D. Inaud, Smartec SA, Switzerland
- Monitoring vibrations in large dams - A. Alegre and S. Oliveira, LIPEC, Portugal; E. Carvalho and B. Matos, Hidroeletrica de Cahora Bassa, Mozambique; P. Mendes, ISEL, Portugal; J. Proença, IST, Portugal
- EDP’s hydro repowering projects: Vibration monitoring systems of existing structures and equipment - the case of Alqueva II - V. Rodrigues, N. Plasencia and Ó. Liberal, EDP – Gestão da Produção de Energia, SA, Portugal; C. Garcez, EDP Internacional, Portugal; P. Mata, Spar Bâtiments, France

Session 21 – Operation and maintenance

Chair: L. Mouvet, Hydro Operation, Switzerland

- Operation and maintenance: A digital challenge - E. Parkinson, J-C. Marongiu, M. Neuhauzer and S. Pinada, Andritz Hydro SA, Switzerland
- Exploring the potential of digitalization at the Kríllad dam powerplant - C. Feurst, and P. Zacharias, Statkraft, Norway
- Use of fault tree analysis for an advanced reliability-based maintenance process - J. Urech and Y. Le Gahain, Alpiq SA, Switzerland; B. Gahant and E. Mateos, Oxand, Switzerland; R. Garcia-Vogel, M. Genoud and A. Bircher, Hydro Exploitation, Switzerland
- Launching an online monitoring and diagnostics program for a diversified hydro fleet: EDP’s challenges and experiences - A. Silva, N. Martins and T. Marques, EDP Gestão da Produção de Energia SA, Portugal
- Machine-learning methods for condition-based monitoring in hydro plant systems - J. Guilhen, CPFL Energia, Brazil; S. Lima, Dafos Intelligent Maintenance, Brazil; E. Marconi, MSE Inovação Tecnológica, Brazil; J. Pardoeas, Universidade Federal do Ceará, Brazil; M. Lunardi, CERAM, Brazil; R. Fibeiro, CPFL Renewables, Brazil
- Maintenance 4.0 and digitalization systems - H. Lippe and T. Juthe, Vathy Group, Division Digital Ventures, Germany; L. Lochschild, Voith Hydro Holding GmbH & Co KG, Germany

Session 22 – Cross border projects

Chair: J.M. Deverney, Consultant, France

For the third time, after Seville in 2017 and Gdańsk in 2018, the Hydro 2019 conference will include a session specifically devoted to the benefits and the challenges associated with the development of hydropower at the regional scale. About half of the world’s rivers flow in several countries, and many future large hydropower projects will be built on such transboundary rivers. At the same time, as large transmission systems develop further, more and more projects will generate electricity that will be partially or totally exported to neighbouring countries. For relatively small countries with a proportionally large hydropower potential, such as Nepal, Bhutan, Laos or Mozambique, this may become an essential component of their overall development. Pooling energy and water infrastructures at the regional scale will also increase the protection of the countries of the region against the hazards of climate change.

- The Arno Darya basin: Great opportunities after dark times - A. Palmieri, Independent Consultant, Italy
- Cross-border collaboration in the Mekong riparian countries - Thi Ho Chu, The World Bank, Vietnam
- On the need for transboundary management of gheozahards - J. Reynolds, Reynolds International Ltd, UK
- Additional contributions from the African Development Bank, and the Niger River Basin Authority

Session 23 – Dam safety: Failure mechanisms, seismic risk and case studies

Co-Chairs: Dr G. Zenz, Technical University of Graz, Austria; Dr Ali Noorzaad, Shahid Beheshti University, Iran

- Safety control of Aguieira dam using a hybrid HST-FEM models - M. Rodrigues, S. Oliveira, J. Proenza and A. Alegre, University of Lisbon, Portugal
- The seismic safety evaluation of gravity dams under MCE - Shengshan Guo, Haibo Wang and Deyu Li, China Institute of Water Resources and Hydropower Research, China
- A new method for dynamic displacement monitoring by GPS self-relative single positioning with carrier phase - M. Kashiyama, Electric Power Development Co., Ltd., Japan; W. Shimizu, Yamaguchi University, Japan; T. Masumari, Kokusai Kogyo Co., Ltd, Japan; K. Itani, Kobe University, Japan
- Seismic failure mechanism and safety evaluation of high arch dam-foundation system under MCE – Thig Bo Chu, The World Bank, Vietnam
- China, Institute of Water Resources and Hydropower Research, China
- Breach formation during the failures of small embankment dams case studies from Burkina Faso - A. Nombra and M. Kadane, IJEC, Burkina Faso

Session 24 – Electrical machinery and grid operation

Co-Chairs: J.F. Coelho da Rocha e Silva, REN, Portugal; Prof J-J. Simond, EPFL, Switzerland

- Accurate modelling of black start and island grid operation with deflector-controlled Pelton units - S. Polster, R. Schärhuber and H. Renner, Graz University of Technology, Austria; R. Scharrner, KUWIIS (Kärntner Netz GmbH), Austria; C. Rupp and C. Tengg, KIELAG – Kärntner Elektrizitäts-Aktiengesellschaft, Austria
- Rotor static eccentricity detection by site-gap magnetic field analysis in rotating AC machines - S. Trivi, M. Petruini and A. Elez, Končar – Electrical Engineering Institute Inc., Croatia
### Session 25 – Hydropower and the environment

**Chair:** Dr S. Sparkes, Statkraft AS, Norway

| Impact of European energy transition on a traditional design of hydropower | - M.M. Belknes, O. Wolfgang, J. Charmann, I. Grabak and A. Harby, Newt Energy Research, Norway; I. Holland, Norwegian Institute for Nature Research, Norway; M. Karpás, NTNU, Norway |
| GHG emissions | - M. Damarty and C. Debaisis, Europe |

### Session 26 – Spillways: Modelling, design and upgrading capacity

**Chair:** Dr P.J. Mason, Stanton, UK

| Provision of additional spillway capacities for safeguarding the dams of the Drin river cascade | - H. Hildebrand and P. Schäfer, Fichtner GmbH & Co KG, Germany; F. Bundo, KESH Sh.A. |
| Increasing the capacity of the Rojave river dam | - M. Kutija, D. Petec, and S. Stipetec, University of Zagreb, FER, Croatia; H. Keko, Koncar – Power Plant and Electric Transmission Engineering Inc, Croatia |
| Use of CFD analysis for design verification of a submerged roller bucket for the O Irri II hydropower project | - R. Heimel, Fichtner GmbH & Co KG, Peru |

### Session 27 – Valuing hydropower flexibility

**Chair:** A. Beckitt, Hydro Tasmania, Australia

| Hydropower and pumped storage are significant contributors to the stability of electricity systems globally. The majority of existing grid-based renewable power systems, which are not dependent on fossil fuels, rely on hydropower for energy storage and ramping flexibility. | - A. Harby, SINTES Energy Research, Norway |
| Flexible hydropower providing valuable renewable energy integration. Presentation of White Paper – Part II: How can hydropower contribute? What is the value of these services? | - L. Emelie Schöffer, SINTES Energy Research, Norway |

### Session 28 – Small hydro: Innovations and challenges

**Chair:** V. Denis, Mhylab, Switzerland

| First experiences with a 420 kV TUM Hydropower plant in the Bavarian Alps | - P. Rutschmann, EPFL ENAC IIC PL-LCH, Switzerland; A. Rey and A. Bonny, Hydro-Québec, Canada; P. Bodmer, P. del Giorgio, M. Garneau, Hydro-Québec, Canada; P. Couto, L. Benites, EDP – Gestão da Produção de Energia SA, Portugal |
| A novel concept for micro hydropower plants based on synchronous reluctance generators | - M. Kutija, D. Petec, and S. Stipetec, University of Zagreb, FER, Croatia; H. Keko, Koncar – Power Plant and Electric Transmission Engineering Inc, Croatia |
| Integrating hydropower in an existing water supply system: Mozambique 1 and 3 hydropower projects in Peru | - W. Reckendorfer, Verbund Hydro Power GmbH, Austria |
| Design and construction of a small hydro plant located in a highly sensitive environment of national nature heritage: the Bristen hydroelectric plant, Switzerland | - W. Reckendorfer, Verbund Hydro Power GmbH, Austria |
| Small hydropower development in Cameroon: The Manjo scheme case – R.P. Singh, UNIDO, Austria; M. Samora, TPF – Consultores de Ingenieria e Arquitetura, SA, Portugal |

### Session 29 – Environment: Fish protection

**Chair:** Prof M. Auflerger, University of Innsbruck, Austria

| Assessing and mitigating fish damage during turbine passage | - F. Geiger and P. Rutschmann, Technical University of Munich (TUM), Germany; M. Cuchet, Ecohydraulic Consulting, Germany |
| Downstream fish migration in a Kaplan turbine: Numerical simulation and experimental verification | - H. Benigni, J. Schneider, H. Jacoby and G. Zenz, Graz, University of Technology, Austria; W. Reckendorfer, Verbund Hydro Power GmbH, Austria |
| The fish protector: A hybrid fish protection system | - R. Tutzer and J. Haug, University of Innsbruck, Austria |
| Increasing generation revenue: Technical developments of materials used in debris, fish guidance and exclusion | - A. Peters, Pacific Netting Products |
| Minimizing the impacts of dams on biodiversity: The case of fresh water mussels | - W. Reckendorfer, Verbund Hydro Power GmbH, Austria |
| Assessing and mitigating fish damage during turbine passage | - F. Geiger and P. Rutschmann, Technical University of Munich (TUM), Germany; M. Cuchet, Ecohydraulic Consulting, Germany |
| Downstream fish migration in a Kaplan turbine: Numerical simulation and experimental verification | - H. Benigni, J. Schneider, H. Jacoby and G. Zenz, Graz, University of Technology, Austria; W. Reckendorfer, Verbund Hydro Power GmbH, Austria |
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| Minimizing the impacts of dams on biodiversity: The case of fresh water mussels | - W. Reckendorfer, Verbund Hydro Power GmbH, Austria |
CONFERENCE SESSIONS

Fish pass on the Revoca river - M. Kedrović, J. Kedrović and M. Janikova, Vodotíka, a.s., Slovakia
Cost-effective environmental mitigation measures on hydropower rivers - A. Harby, A. Advea Bustes and B.I. Hansen, Sintef Energy Research, Norway; R.A.A. Noble, University of Hull, UK; T. Rutkowski, Technical University of Munich, Germany

Session 30 – Hydro plant refurbishment and upgrading
Chair: W. Hakin, Hydrotec Pty Ltd, Australia
Research on extreme upgrading of existing hydropower systems - K. Vereide, L. Lia, O.G. Dalhauge and A. Nyvooen, NTNU, Norway; B. Me, Sintef, Norway; T. Forsath, NIWA, Norway
The Paradola II repowering project: Feasibility studies - P. Sá Pina, S. Silva and N. Osório, EDP, Gestão da Produção de Energia, S.A., Portugal
La Rance tidal powerplant: Enhancement of the bulk unit load-rejection mode - A. Libaux and A. Many, EDF Hydro, France
Rehabilitation of the electromechanical equipment at the Kainji hydropower plant in Nigeria - Sha Bin, Ji Jianfeng, Zhang Baoyong, Zhou Yida, Yu Guangming and Hu Dingguo, PowerChina Huadong Engineering Corporation Ltd, China
Introduction of building information modelling in brownfield secondary systems refurbishment - M. Rebernik and D. Taštan, Drava River Power Co, d.o.o., Slovenia; R. Jamišič, HSE Invest, d.o.o., Slovenia

Session 31 – Innovation in hydropower
Chair: L. Deroo, ISL, France
On the market readiness of AI applications and digital solutions for hydro - F.F. Jrad and R. Bucher, Tractebel Engineering GmbH, Germany
Digitalization in hydropower: ‘The smart plant’ of the future - J. Goodenough, Hydrogrid GmbH, Austria
Use case: A cloud-based monitoring system and data driven services for hydro - R. Muench and I. Aliaz, Yuht Digital Ventures, Germany; A. June, Yuht Hydro GmbH & Co KG, Germany
Development of a new ecological and economical solution for dredging sediment: The Nessie robot - S. Caffo, EDF Hydro, France; R. Gaillard and F. Gauch, Watertracks, France
Applied research on a wall-climbing robot for inspecting the flow surface in hydropower stations - Xie Huaidong and Zhong Hong, China Yangtze Power Co, Ltd, China
Renovation of the protective layer on the asphalt facing of the Almendra dam - A. Vaquero Mataos and C.M. Renedo, Iberdrola, Spain
The first hydropower project to be fully designed and constructed with building information modelling (BIM) is in operation - O. Lilhelld and H. Bergodden, Norconsult AS, Norway
Two innovative civil engineering designs - E. Lempiäriére and J.P. Vigny, Consultants, France

Session 32 – Sedimentation management
Chair: Prof A.J. Schleiss, Hon President of ICOLD, and Consultant, Switzerland
Impact characterization of the transit of fine sediments through hydroelectric turbines - S. Caffo and P.Y. Couzon, EDF Hydro, France
Planning and implementation of dredging and upland disposal areas for the Kapichira plant - N. Efthymiou, Y. Lama, R. Enderle, P. Schäfer and S. Palt, Fichtner GmbH & Co KG, Germany; A. Kandoje and K.W. Liabunya, EGENCO Malawi Ltd, Malawi; D. Mauambeta, Malawi
Results-monitoring framework for capacity building projects in the hydropower sector - L.A. Hagen, International Center for Hydropower (ICH), Norway; S. Dhillion, Enviro-Dev, Norway
Planning for ‘generation Y’ to work in power stations: A study of employees at the Murum hydro plant - D. James, Sarawak Energy Berhad, Malaysia
Institutional capacity building for hydropower development: Examples of successful programmes - J. Sandgren, Norwegian Water Resources and Energy Directorate (NVE), Norway

Session 33 – Social aspects
Chair: Dr K. Laksiri, CEB, Sri Lanka
Address closure at the beginning: Social mitigation and monitoring in the project cycle - S. Sparres, Statkraft AS, Norway
Why safeguard cultural heritage in hydropower development? Lessons from cases in Uganda - J. Asimwe, Geotropics Consult Limited, Uganda
Biodiversity as a regional strategic development tool - L. Benites and V. Batista, EDP - Gestão da Produção de Energia, SA, Portugal; R. Dias and J. Pereira, Assoc. of Nature Conservation and Rural Heritage, Portugal; M. Múnoz, AEIGA, Portugal; and J. Machado, APPN, Portugal
Remedial measures to safeguard the whitewater rafting sport affected by the implementation of Broadlands hydropower project - T. Wickramaratna and Dr K. Laksiri, Ceylon Electricity Board, Sri Lanka
The evolution of approaches to the provision of improved social labour conditions at hydropower projects in Ukraine: Recent experience - V. Vaskresensky and A. Blokhin, Ukrhydroproject PJSC, Ukraine

Session 34 – Aesthetics of water infrastructure
Chair: Dr B. Pelikan, University of Natural Resources and Applied Life Sciences, Austria
The aesthetic aspects of dam design - P. Mason, Damsolve Ltd, UK
The Foz Tua hydropower powerhouse: Geotechnical input for minimized visual impact - J-M. Figueraredo and M.E. Rosende, EDP - Gestão da Produção de Energia, SA, Portugal
Aspects of two aesthetically designed small dams for urban areas - P. Diggelmann, T. Schneider and F. Oberauer, Pöyry Switzerland Ltd, Switzerland
Geomembranes and the environment - A. Scorzo and G. Vescocchi, Carpi Tech, Switzerland

Session 35 – Capacity building and training
Chair: A. Nombre, Hon President of ICOLD, and Consultant, Burkina Faso
We are training people properly: But there are still fundamental problems - A. Hughes, Dams and Reservoirs Ltd, UK
An advanced training programme for a hydropower plant in Uganda - Feng Xingcheng and Zhou Zhihuan, China Yangtze Power Co Ltd, China
Planning for ‘generation Y’ to work in power stations: A study of employees at the Murum hydro plant - D. James, Sarawak Energy Berhad, Malaysia

Session 36 – Reservoir operation
Chair: Prof B. Popa, Polytechnic University of Bucharest, Romania
The Gibe-Omo cascade hydropower projects development - Aziz Asmake, Consultant, Ethiopia; M. Teshome, EEP, Ethiopia; V. Boinay and S. Camilleti, Tractebel Engineering S.A, France; J. Binequet, Consultant, France; R. Ravetta and A. Amodeo, ELC, Italy
Headrace tunnels used as short-term reservoirs for hydropower - T.E. Berg and L. Lia, NTNU, Norway; E.H. Bårgard, Sognekraft AS, Norway; W. Richter, TU Graz, Austria

Wednesday 16 October - Afternoon

Plenary closing session
Summaries of session outcomes
Welcome to ASIA 2020 in Kuala Lumpur, Malaysia
Conference Closing
A package of three cultural excursions has been arranged for family members and partners accompanying delegates.

**Monday 14 October**

The first trip is designed to contrast contemporary Porto with traditional artefacts. Two guides will accompany the group first to two spectacular gardens, at the Palácio de Cristal, and the Serralves Foundation; the next stop will be the Museum of Contemporary Art. There will also be a chance to see and learn about the grand Avenida do Boavista and the Casa da Música, designed by Rem Koolhaas, and to see the stunning Livraria Lello bookshop, (an example of neo-gothic design with a hint of art nouveau).

After lunch in an elegant restaurant, the tour will move on to the Cantinho das Aromáticas, in the region of Vila Nova de Gaia. This is an agricultural organisation founded in 2002, which is dedicated to the production of aromatic, medicinal and spicy plants. This was the first organization of its kind in Portugal, and inspired many farmers to follow this kind of work. There is an area of about 2.5 ha for outdoor production. The company has won international awards for its infusions, herbal teas and condiments. The owner will guide the group, and explain about the varieties of plant, and he will offer a tasting of some of the infusions. The group will return in good time for the HYDRO 2019 Welcome Reception at Palácio da Bolsa in the evening.

**Tuesday 15 October**

On the second day of the conference, there will be a full-day excursion to visit two outstanding cities of historical interest. The first is Guimarães; this was the first capital of Portugal, from which the first King, Don Afonso Henriques, ruled the Kingdom. There will be a chance to walk through medieval streets, and squares where important battles took place.

After lunch, the group will travel on a short distance to reach Braga, which was founded by the Romans around 2000 years ago, when it was named Bracara Augusta. There will be a tour of the historic centre, to view some important monuments. Braga Cathedral houses a sacred art museum, and the Gothic-style Kings’ Chapel. Nearby, the imposing Archbishop’s Palace overlooks Santa Barbara Gardens.

**Wednesday 16 October**

Portugal has 14 wine-growing regions, with unique soil and climatic conditions, producing award winning terroir wines. Close to Porto is the region for the famous Vinho Verde wine.

The excursion on Wednesday will be to the Quinta da Avelada (vineyard and farm) to learn about the soil, the grapes, and to visit the winery for a tasting not only of the wines, but of local delicacies for lunch. The famous Avelada olive oil is also made there. For those preferring not to drink alcohol, some appealing alternatives will be available to accompany the lunch, in beautiful surroundings.

The group will return in time to relax before the HYDRO 2019 Farewell Gala Dinner.

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**ACCOMPANYING PERSONS’ PROGRAMME**

**WELCOME RECEPTION**

Monday 14 October

This year’s welcome reception, generously co-sponsored by Statkraft with entertainment co-sponsored by Končar, will take place in the elegant Palácio da Bolsa, close to the Aliénaga conference centre and many of the HYDRO 2019 selected hotels. There will be a chance to taste local wines from the Douro region, and a buffet supper will be served. This will be the first chance to relax with colleagues, after the opening day of the conference.

**EXHIBITION NETWORKING**

Tuesday 15 October

On the second evening, the two exhibition halls will have extended opening hours, so that after the conference sessions international delegates can take time to tour the halls at a leisurely pace, meet old friends, make some new business contacts, and enjoy drinks and light refreshments. The rest of the evening will be free for private parties or to walk around Porto: the riverside is recommended.

**FAREWELL GALA DINNER**

Wednesday 16 October

The Farewell Dinner, co-hosted by EDP, will take place in the banqueting hall of a traditional Port wine cellar, the Companhia Real Velha, close to the river. It will be a seated dinner, with Portuguese specialities and wines of the Douro region, accompanied by some musical entertainment. It will provide a memorable ending to three days of hard work.

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**CULTURAL AND SOCIAL PROGRAMME**
TOUR A - NORTH
Two nights, three days (17-19 October)
On the first day the group will leave Porto after breakfast, and travel northeast by coach, stopping in the historic town of Amarante, for coffee and a tasting of local sweets at the Confeitaria da Ponte. Then the tour will continue to the 108 m-high Foz Tua concrete arch dam and 270 MW powerplant on the river Tua. The plant is equipped with two reversible units. There will be a technical briefing and tour around the facilities.
After lunch at Calça Curta, the second technical visit will be to the recently completed Baixo Sabor scheme. Originally planned as a single facility, Baixo Sabor now comprises a cascade development of two dams and pumped-storage plants. The group will be briefed on the design of this project.
The overnight stay will be in the picturesque town of Régua, in a Port wine producing area by the Douro.
On the second day the group will travel on, via the picturesque town of Pinhão (a UNESCO World Heritage Site) to the Frades I and Frades II plants, which are part of the Cávado-Rabagão-Homem cascade development. Frades II is equipped with two 390 MW variable speed pump-turbines, the largest and most powerful of their type.
After lunch the tour will continue to the Alto Rabagão powerplant. This is the world’s first scheme where floating solar panels have been installed on the reservoir, which work in tandem with the hydro plant.

TOUR B - SOUTH
Three nights, four days (17-20 October)
The tour will begin with a short visit to EDP’s Telecommand centre in Porto, from which 80 hydro plants are controlled.
The group will then travel on to the 89 m-high, 400 m-long, Aguieira multiple arch dam and 336 MW pumped-storage plant on the Mondego river. Completed in 1981, the dam serves for hydropower production, flood control, irrigation and water supply.
The group will then continue to the beautiful town of Coimbra for lunch, and an afternoon walking tour which will include a visit to the country’s oldest and most prestigious university. Dinner and the overnight stay will be in Coimbra.

Prices (see Booking Information) include meals throughout the tour, transport by luxury coach, accommodation, all entrance fees, and English-speaking tour guides.
A major element of the HYDRO 2019 event will be the Technical Exhibition, running for three days alongside the conference (14 to 16 October). The exhibition pavilions will be the main hub for business networking between delegates and industry representatives who will be exhibiting their supplies and services. Exhibitors typically comprise consultants, contractors, manufacturers, developers and professional associations.

All lunch and refreshments will be served in the exhibition, with catering points arranged to ensure that delegates will move around the whole area regularly during the three days. Feedback from previous events indicates that delegates maximize the opportunities to circulate in the exhibition, and that valuable contacts are made, which are maintained after the event.

The exhibition will remain open for a networking reception after the conference sessions on Tuesday 15 October, to provide extra opportunities for business meetings in an informal atmosphere.

Exhibition space is generally sold in units of 6 m², and multiple units can be combined to create larger displays including custom-built stands.

Sponsorship packages are available and provide an excellent way of standing out among competitors (such as coffee breaks, lunches, social events and more).

Please contact: Sales@hydropower-dams.com or visit: www.hydropower-dams.com/hydro2019/exhibition-plan
EXHIBITION STANDS BOOKED

Stands reserved, as of September 2019:

Kolektor Turbomotivităț d.a.o., Slovenia
Koncar, Croatia
Künz, Austria
Laferney, Project & Design, S.L., Portugal
Laray, France
Lisistrat Power, Slovenia
Mapa, Italy
Marel a.s., Czech Republic
MC - Monitoring SA, Switzerland
Megfit, Switzerland
Miflyf, Switzerland
Milko Trillo Galicia, S.A., Spain
MIV d.d., Croatia
Montgomery, USA
Murah, Germany
Multihydro, Turkey
National Electric Co, USA
Nord-Lock AG, Switzerland
Norwegian Energy Partners, Norway
Numeca International, Belgium
Obermeyer Hydro Inc, USA
Oiles, Germany
Omacons, Greece
Poolmeccanica Lorenzen Srl, Italy
Power Machines, Russia
Power Vision Engineering, Switzerland
Pöyry, Switzerland
Promote Iceland
Prozinc, SA, Portugal
PWS, Sweden
Rakon, Austria
Rittmayer AG, Switzerland
Ruberrat, Brazil
Rufus Systemhydro, Germany
Sihlhandel Grollitz, Germany
Schiebel Antriebstechnik, Austria
Sedico, Norway
Schmiedewerke Gröditz, Germany
SIEK, Austria
Simec wonka, Germany
Skef, Slovakia
Smarterc, Switzerland
Sogia-Satom, France
Sovinco, Switzerland
STE Energy, Italy
Simec winila, France
Simepamena, Italy
Smyck Ltd, Switzerland
Sokutan, Japan
Taquet Industries, France
Talleres Arzat, Spain
TD Power Systems Europe GmbH
TÉVES, Hungary
Thordon Bearings Inc, Canada
TÉVES Saar, Hungary
Trento, Italy
Trezzini, Switzerland
Trelleborg, Sweden
Trelleborg Bohemia, a.s., Czech Republic
Troyer SpA, Italy
Umeco, France
Ultraflux S.A., France
Unifin International, Canada
University of Technology Graz, Austria
Vantek, USA
Vapotech, India
Vinci, France
Voith, Germany
Vortex Hydro, Italy
WestGen Consult, UK
Whessoe Sun Bhd, Malaysia
Williottson Technology, LLC, USA
Worthington Products, USA

(Bold type denotes a Conference Sponsor)
BOOKING CONDITIONS

The Conference HYDRO 2019 - Concept to closure: Practical steps, is being organized by The International Journal on Hydropower & Dams with event management by The Conference Collective.

On-line Registration
You can register on-line via the Hydropower & Dams website at: www.hydropower-dams.com. This is a secure site. Registrations will be handled by The Conference Collective on behalf of Aqua-Media. You will receive an acknowledgement of registration on completion of this process; however, this is not a confirmation (until payment is received).

We encourage all delegates to register on-line, using the newly upgraded system which provides more information during the registration process. Pre-registration is required.

In the unlikely event of any difficulties using this system, please contact The Conference Collective (see contact details below).

Picking up conference documents and badges
The registration desk will be open from 08.30 hrs on Sunday 13 October 2019, at the Alfândega Porto Conference Centre, and delegate bags can be collected from 09.00-11.00 hrs, and from 14.00 to 19.00 hrs.

Payment
Payment for all services (fees, hotels, tours) must be made in Euros (€) and received in advance of the conference. Payment is possible by the following methods:
- On-line by Visa or Mastercard, or,
- By bank transfer (see details on the registration form).
All fees paid by credit card will be charged in Euros (€). Please include your hotel booking and passport details, and proposed dates of arrival and departure.

Accommodation
The Conference organizers have negotiated rates at hotels in several price categories in Porto. Accommodation bookings are being handled by The Conference Collective. Please include your hotel booking at the time of registering (using the on-line booking system). Beware of scam accommodation bureaux who are operating as usual, falsely claiming to represent HYDRO 2019. We recommend that you do not pass credit card details to them. Hotel bookings should be made as soon as possible, and at least by early September. Payment must be made in full at the time of booking.

Disclaimer
All best endeavours will be made to present the programme as printed. The HYDRO 2019 organizers and agents reserve the right to alter or cancel, without prior notice, any arrangements, timetable, plans or other items relating directly or indirectly to HYDRO 2019 for any cause beyond its reasonable control. The organizers and agents are not liable for any loss or inconvenience resulting from such alteration. The Conference and Tours are subject to minimum numbers. Tour places are subject to availability on a first-come-first-served basis. Full payment for tours must be received at the time of registration.

Cancellations
Cancellations must be made in writing to The Conference Collective. Cancellation charges will be payable as shown in the Table below. Substitution of delegates after a reservation has been made is acceptable before the Conference, and no extra fee is payable. Any necessary refunds (see Table below) will be made after the Conference.

Liability/Insurance
The registration fees do not include the insurance of participants against personal accidents, sickness, cancellations by any party, theft, loss or damage to personal possessions. The organizers accept no responsibility for death, injury, loss or accident, delays arising from any act or default of any person, or any other matter arising in connection with Conference services or transport. The organizers make no warranty in this connection.

All services provided are subject to local laws. Arrangements for the Conference have been made in accordance with UK and Portuguese Law.

Delegates, exhibitors and tour participants are strongly advised to take out adequate personal insurance to cover risks associated with travel, accommodation, cancellation and theft or damage to personal belongings.

The organizers reserve the right to amend any part of the Conference programme or arrangements, if necessary. In the very unlikely event that it is necessary to cancel any of the Conference arrangements, an appropriate refund will be made and thereafter the liability of the organizers will cease.

The organizers reserve the right not to accept applications for attendance (for example, but not exclusively, if applicants are not working in the field of hydro, or if there could be a conflict of interest with the mission of the conference, the organizers, or any policy of the host country).

Passport and Visa Requirements for Portugal
Portugal is a member of the European Union, and is a signatory to the Schengen Agreement. It is the responsibility of all participants to check their own passport and visa requirements. Please contact the Portuguese embassy or consulate in your country if in doubt about requirements, or visit: https://portugal.com/portugal/travel-tips/entering-portugal

Applying for a letter of invitation to support a visa application
In some cases, letters of invitation from Aqua-Media in the UK and one of our partner organizations in Portugal may be necessary, as well as special clearance from the relevant authorities.

The process could take several weeks, so we strongly urge participants requiring visas to start the application process in good time.

If you require a letter of invitation to facilitate your visa application, please let us know at the time of registering. Please note that letters to assist with obtaining visas can only be provided to registered or invited participants, and these letters do not imply an invitation to the Conference without payment of registration fees. If you need a letter from the host country, as well as the organizers, please notify us as soon as possible and supply your full name, date of birth, passport details, and proposed dates of arrival and departure.

As soon as a registration is confirmed, a number of expenses are incurred by the organizers; therefore the following cancellation conditions apply:

<table>
<thead>
<tr>
<th>Date cancellation received</th>
<th>On or before 24 August 2019</th>
<th>From 25 August to 21 September 2019</th>
<th>On or after 22 September 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration for the Conference</td>
<td>10% of fee will be forfeited</td>
<td>50% of fee will be forfeited</td>
<td>No refund</td>
</tr>
<tr>
<td>Technical Excursions (Study Tours)</td>
<td>10% of fee will be forfeited</td>
<td>No refund unless place can be resold</td>
<td>No refund</td>
</tr>
<tr>
<td>Accommodation</td>
<td>10% of fee will be forfeited</td>
<td>No refund unless place can be resold</td>
<td>No refund</td>
</tr>
</tbody>
</table>

NB: Separate booking conditions apply to Exhibition Stands, and these will be sent directly to Exhibitors by our Sales & Marketing Department.

A reduced registration fee is available for current subscribers to Hydropower & Dams. See booking information form for details.

CONTACT DETAILS
For enquiries concerning registration and accommodation, contact:
HYDRO 2019 Secretariat, The Conference Collective Ltd. hydro2019@conferencecollective.co.uk  •  Tel: +44 (0) 20 8977 7997

For further details of the programme, please contact: Mrs Margaret Bourke at: Hydropower & Dams, PO Box 285, Wallington, Surrey SM6 6AN, UK.

Tel: +44 (0)20 8773 7244  •  Fax: +44 (0)20 8773 7255  •  Email: hydro2019@hydropower-dams.com

Regular updates and on-line registration via: www.hydropower-dams.com
The online HYDRO 2019 registration is open, and bookings can be made via: www.hydropower-dams.com
The system is simple to use, but in the event of any difficulties, please contact Conference Collective.
Email: hydro2019@conferencecollective.co.uk  ~  Tel: +44 (0) 20 8977 7997
Prices for each delegate category and conference activity are given below.

FULL DELEGATE FEE: Includes attendance of the Conference and Exhibition; documentation; conference papers on a USB stick; morning and afternoon refreshments; lunches during the Conference; full social programme
€ 1085 (until 24 Aug)  € 1190 (from 25 Aug)

REDUCED DELEGATE FEE: For existing subscribers to Hydropower & Dams.
€ 1015 (until 24 Aug)  € 1120 (from 25 Aug)

FEE INCLUDING NEW SUBSCRIPTION TO H&D: (6 issues from No. 6, 2019 + Atlas + Maps)
(This represents a saving of about 35 per cent on the normal H&D subscription rate).
€ 1215 (until 24 Aug)  € 1320 (from 25 Aug)

SPEAKER FEE: Includes all facilities described above for Full Delegates, plus an additional reception on Sunday 13 October.
NB: This fee applies to one person per paper (main author or presenter).
€ 615

FIRST EXHIBITOR FEE: (One full participant fee is included with exhibition booking).
€ 0

SECOND + THIRD EXHIBITOR FEE: (Fee per person for up to two additional exhibitors).
(Includes all benefits available to full delegates).
€ 775

SMALL HYDRO TRAINING SEMINAR: (Full day on Sunday 13 October - Design a small plant in one day).
€ 50

ACCOMPANYING PERSON FEE: (For family members, partners or friends not colleagues attending the Conference or Exhibition).
The fee includes the excursions each day, with lunch, and the evening social events. The cost for registering as an accompanying person is € 450.

HALF DAY EXCURSION: The details of this are presented on a previous page. The cost for joining the tour including lunch, is € 135 per person.

OPTIONAL DONATION TO THE AMI HYDROPower FOUNDATION: As in past years, there will be opportunity when registering online to make a donation to the AMI Hydropower Foundation. This is a charitable foundation, set up by Aqua-Media and governed by a board of international trustees. It exists to facilitate the participation of delegates from the less developed countries at the annual Hydro Conferences.

TECHNICAL TOURS: Prices include all transportation, meals, guides, entrance fees during sightseeing trips, and accommodation.

Tour A - 3 days, North to Foz Tua, Baixo Sabor, Frades I & II, Alto Rabagão  € 910 per person, single room; € 745 per person sharing a double room
Tour B - 4 days, South to Aguieira, Castelo do Bode, Alqueva, ending in Lisbon  € 1130 per person, single room; € 920 per person sharing a double room

DIETARY REQUIREMENTS: These may be specified on the online registration system (including, for example, vegetarian, vegan, gluten free, etc).

VISA REQUIREMENTS: These may be specified on the online registration system (including, for example, vegetarian, vegan, gluten free, etc).

NB: Attendance of the Welcome Reception and Farewell Dinner are included within the registration fees for all participants. However, we request a nominal contribution of € 15 per event for those wishing to attend, to encourage a firm commitment to participate. This is important to enable us to assess numbers for catering, and avoid food wastage.
Vila Gale Porto Ribeira, 4 *
Location: Cais das Pedras 17 to 22 - Lordelo do Ouro and Massarelos, 4050-465 Porto, Portugal
Distance to Alfândega: Approx. 14 min walk.
Check in: from 14.00 hrs / Check out: by 12.00 hrs

A few minutes away from the historical centre and the main tourist attractions, Vila Gale Porto Ribeira is a charming hotel resulting from the rehabilitation of four buildings in the area of Cais das Pedras. Free WiFi is available and rooms are equipped with a TV, safe, kettle and ensuite with shower.

A buffet breakfast is included.
Single occupancy: €143
Double occupancy: €178
www.vilagale.com

Pestana Vintage Porto, 5 *
Location: Praça da Batalha, nº1, 4050-513, Porto, Portugal
Distance to Alfândega: Approx. 5 min drive; 14 min walk.
Check in: from 15.00 hrs / Check out: by 12.00 hrs

Overlooking a picturesque stretch of the Douro river, the hotel has a modern interior, but is designed to look like a row of traditional houses with a vintage architectural style. All rooms include free WiFi, TV and a safe. Parking is available in a garage 200 m away. A buffet breakfast offering a wide selection of hot and cold items is included.

Double occupancy: €235
Single occupancy: €255
www.pestanavintageporto.com

Hotel Vincci Porto, 4 *
Location: Alameda de Basílio Teles, 29, 4150-127, Porto, Portugal
Distance to Alfândega: Approx. 4 min drive; 15 min walk.
Check in: from 14.00 hrs / Check out: by 12.00 hrs

Vincci Porto, a hotel in Porto’s historical region, located in the building known as the ‘Fish Market’, boasts a unique contemporary style. The hotel offers an indoor and outdoor pool, spa and fitness centre. Free WiFi is available in all rooms and a buffet breakfast is included.

Single occupancy: €195
Double occupancy: €205
www.vincicollection.com

Mercure Porto, 4 *
Location: Praça da Batalha 116, Nº de Registo:3244, 4049-028 Porto, Portugal
Distance to Alfândega: Approx. 6 min drive.
Check in: from 14.00 hrs / Check out: by 12.00 hrs

The Mercure Porto Centre is a 4-star hotel located in the centre of Porto. There is free WiFi in all rooms and a buffet breakfast is included.
Single occupancy: €185
Double occupancy: €200

HF Tuela Porto, 3 *
Location: R. Arquitecto Marques da Silva 200, 4150-483, Porto, Portugal
Distance to Alfândega: Approx. 7 min drive.
Check in: from 14.00 hrs / Check out: by 12.00 hrs

The HF Tuela Porto Hotel is well located for exploring the city. There is free WiFi in all rooms, and a buffet breakfast is included.
Single occupancy: €120
Double occupancy: €138
www.hfhotels.com/hotels/hf-tuela-porto-pt

HF Fenix Porto, 4 *
Location: Rua Gonçalo Sampaio, 282, 4150-365, Porto, Portugal
Distance to Alfândega: Approx. 6 min drive.
Check in: from 14.00 hrs / Check out: by 12.00 hrs

The HF Fenix Porto is a distinctively designed contemporary hotel with free WiFi in all rooms. A buffet breakfast is included.
Single occupancy: €135
Double occupancy: €155

Hotel Legendary Porto, 3 *
Location: Praca Da Batalha 127-130, 4000-102, Porto, Portugal
Distance to Alfândega: Approx. 14 min drive.
Check in: from 14.00 hrs / Check out: by 12.00 hrs

The Hotel Legendary Porto is a comfortable 3-star hotel located on one of the main squares in Porto: Batalha Square. The hotel offers parking and free WiFi in all bedrooms. Breakfast is included.
Single occupancy: €105
Double occupancy: €115
www.legendary-porto-hotel-1-rez.com

Sheraton Porto, 4 *
Location: Rua do Tenente Valadim 146, 4100-476, Porto, Portugal
Distance to Alfândega: Approx. 9 min drive.
Check in: from 15.00 hrs / Check out: by 12.00 hrs

The Sheraton Porto Hotel & Spa is located in the heart of the business district. The Sheraton Porto provides parking and free WiFi. A buffet breakfast is included.
Single occupancy: €165
Double occupancy: €185

Porto Palacio, 5 *
Location: Av. da Boavista, 1269, 4100-130 Porto, Portugal
Distance to Alfândega: Approx. 7 min drive.
Check in: from 15.00 hrs / Check out: by 12.00 hrs

The Porto Palacio Hotel and Spa is located in the business district of the city and offers a panoramic view over the city of Porto. The Porto Palacio Hotel and Spa has a business centre and free WiFi. A buffet breakfast is included.
Single occupancy: €155
Double occupancy: €170
www.shotelscollection.com/en/porto-palacio/

Ibis Porto Gaia, 3 *
Location: Rua Marítir de São Sebastião, 247, Nº de Registo: 540, 4400-499, Vila Nova de Gaia, Portugal
Distance to Alfândega: Approx. 12 min drive.
Check in: from 12.00 hrs / Check out: by 12.00 hrs

The Hotel Ibis in Vila Nova de Gaia is close to the centre of Porto. The hotel offers free WiFi, 24 hr bar and snack service, an on-site restaurant and parking. A buffet or continental breakfast is included.
Single occupancy: €65
Double occupancy: €75
www.accorhotels.com/gb/hotel-1274-ibis-porto-gaia

Novotel Porto Gaia, 4 *
Location: Rua Marítir de São Sebastião, Afurada, Nº De Registo: 303, 4400-499, Vila Nova de Gaia, Portugal
Distance to Alfândega: Approx. 10 min drive.
Check in: from 14.00 hrs / Check out: by 12.00 hrs

The Novotel Porto Gaia is located in Vila Nova de Gaia. The hotel is close to points of interest such as Fundação Serralves, the Vinho do Porto caves and beaches. Free internet access and parking are available and a buffet breakfast is included.
Single occupancy: €115
Double occupancy: €125

Hotel Solverde Spa & Wellness Centre, 5 *
Location: 212, Av. Liberdade, 4410-154 S.F . Marinha, Portugal
Distance to Alfândega: Approx. 20 min drive.
Check in: from 14.00 hrs / Check out: by 12.00 hrs

The Hotel Solverde Spa & Wellness Center is located in Greater Porto and the only 5 star hotel in the north of the country. The hotel has free WiFi and parking. A buffet breakfast is included.
Single occupancy: €110
Double occupancy: €120

Shuttle buses will serve the hotels not within easy walking distance. Further details of the hotels are on the registration site.

Contact: HYDRO 2019 Secretariat, The Conference Collective Ltd.
Tel: +44 (0)20 8977 7997
hydro2019@conferencecollective.co.uk
London, UK