Fishfriendly Innovative Technologies for Hydropower (FIThydro)

IEA Hydropower, Brussels, Belgium
29-30 May, 2017

Peter Rutschmann
Technical University Munich
Key Facts

- 26 partners (13 research, 13 industrial) in 10 European countries
- Total **Budget**: 7.2 Mio. Euro
- FIThydro addresses **decision support** in commissioning and operating hydropower plants (HPP) by use of existing and innovative **technologies**.
- The project investigates **mitigation** measures and strategies to develop cost-efficient environmental solutions for **sustainable** and **fish friendly** hydropower.
- **Case study regions**: France/Belgium, Portugal/Spain, Scandinavia and the Alpine Region.

Homepage: [www.fithydro.eu](http://www.fithydro.eu)
Objectives

1. Bringing together **all disciplines** related to hydropower.
2. Assessing the response and resilience of **fish populations** in HPP affected rivers.
3. **Environmental** impact assessment and species protection.
4. Improving fish and fisheries impact **mitigation strategies** using conventional and innovative **cost efficient** measures.
5. Enhancing methods models and tools to cope with EU obligation.
6. Identifying **bottlenecks of HPPs** and deriving cost efficient mitigation strategies.
7. Risk based Decision Support System (**DSS**) for planning, **commissioning and operating** of HPPs.

P. Rutschmann (TUM), *IEA Hydropower, Brussels, Belgium, 30 May 2017*
Management Structure

- **The Coordinator (CO)**
- **General Assembly (GA)**
- **Steering Committee (SC)**
- **The Case Studies Management Board (CSMB)** which is responsible for the management of the case studies.
- **The External Expert Advisory Board (EEAB)**
## Work Packages

<table>
<thead>
<tr>
<th>WP Number</th>
<th>WP Title</th>
<th>Start month</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP1</td>
<td>Fish population development in HP effected environments</td>
<td>6 - FVB.IGB</td>
</tr>
<tr>
<td>WP2</td>
<td>The appraisal of existing solutions, models, tools and devices to assess (the) self-sustained fish population(s) at the test case HPP in each of the four regions</td>
<td>3 - CNRS</td>
</tr>
<tr>
<td>WP3</td>
<td>The innovation of solutions, models, tools and devices to assess self-sustained fish population(s) at the test case HPP in each of the four regions</td>
<td>2 – IST</td>
</tr>
<tr>
<td>WP4</td>
<td>Cost effective management strategies to improve the development of self-sustained fish populations at existing and new HPPs</td>
<td>8 - SER</td>
</tr>
<tr>
<td>WP5</td>
<td>Stakeholder involvement &amp; decision- support system</td>
<td>11 - EI</td>
</tr>
<tr>
<td>WP6</td>
<td>Communication, Dissemination and Exploitation</td>
<td>1 - TUM</td>
</tr>
<tr>
<td>WP7</td>
<td>Management of the Project</td>
<td>1 - TUM</td>
</tr>
<tr>
<td>WP8</td>
<td>Ethics requirements</td>
<td>1 - TUM</td>
</tr>
</tbody>
</table>
Work Packages

- **WP1** Fish population development in HPP affected environments
- **WP2** Appraisal of SMTDs to assess self-sustained fish populations
- **WP3** Innovation of SMTDs to assess self-sustained fish populations
- **WP4** Cost effective management for self-sustained fish populations
- **WP5** Stakeholder involvement & DSS
- **WP6** Communication, dissemination and exploitation

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# Test Cases

<table>
<thead>
<tr>
<th>HPP</th>
<th>River / Country</th>
<th>HPP Data</th>
<th>Fish species / species at risk</th>
<th>Test case topics</th>
<th>Innovative SMTDs</th>
<th>Main Partners</th>
<th>Comments</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freudenau</td>
<td>Danube</td>
<td>Discharge [m³/s] 3000.0 Head [m] 8.6</td>
<td>Barbel, Nase</td>
<td>Fish migration</td>
<td>Habitat improvement</td>
<td>Methods</td>
<td>Operation and maintenance optimization, beaver management</td>
<td><img src="Freudenau.png" alt="Picture" /></td>
</tr>
<tr>
<td></td>
<td>Operator Verbund</td>
<td>Austria</td>
<td>8.6</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Budget ca. 150000€</td>
<td>Capacity [MW] 172.0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>HPP Ham</td>
<td>Albert canal</td>
<td>Discharge [m³/s] 15.0 Head [m] 10.0</td>
<td>Bream, Roach, Perch, Pike, Pikeperch</td>
<td>Fish migration Innov. Devices Turbine mortality</td>
<td>Species at risk Self sustained populations</td>
<td>Methods Tools</td>
<td>VLAGEW INBO SJE Innovarive Archimedes screw HPP</td>
<td>![Picture](HPP Ham.png)</td>
</tr>
<tr>
<td></td>
<td>Operator NV de Scheepvaart</td>
<td>Belgium</td>
<td>10.0</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Budget 65 000€</td>
<td>Capacity [MW] 1.2</td>
<td>Atlantic Salmon, Eel</td>
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<tr>
<td>Gotein</td>
<td>Saison</td>
<td>Discharge [m³/s] 6.6 Head [m] 5.0</td>
<td>Brown Trout, Cyprinids, Salmon</td>
<td>Fish migration Attraction flows</td>
<td>Self sustained populations</td>
<td>Solutions Devices</td>
<td>CNRS VLAGEW INBO Test of bypass efficiency for salmon smolts. Low bar spacing (20mm) and low bar inclination (25%)</td>
<td><img src="Gotein.png" alt="Picture" /></td>
</tr>
<tr>
<td></td>
<td>Operator provided by ONEMA</td>
<td>France</td>
<td>5.0</td>
<td>Salmon</td>
<td></td>
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<tr>
<td></td>
<td>Budget ca. 75 000€</td>
<td>Capacity [MW] 0.32</td>
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<tr>
<td>Trois-Ville</td>
<td>Saison</td>
<td>Discharge [m³/s] 5.0 Head [m] 5.0</td>
<td>Brown Trout, Cyprinids, Salmon</td>
<td>Fish migration Attraction flows</td>
<td>Self sustained populations</td>
<td>Solutions Devices</td>
<td>CNRS VLAGEW INBO VOITH Test of bypass efficiency for salmon smolts. Low bar spacing (20mm) and low bar inclination (25%)</td>
<td><img src="Trois-Ville.png" alt="Picture" /></td>
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<tr>
<td></td>
<td>Operator provided by ONEMA</td>
<td>France</td>
<td>5.0</td>
<td>Salmon</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Budget ca.80 000€</td>
<td>Capacity [MW] 0.24</td>
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Test Case Challenges

1. Flow and habitat
   – Lack of wetted area
   – Lack of or distribution of spawning habitat
   – Lack of or distribution of rearing habitat
   – Downstream or attraction flow
   – Environmental flow in bypassed reach
   – Hydropoeaking

2. Sediments
   – Deficit of sediments
   – Surplus of sediments
   – Clogging of substrate
Test Case Challenges

3. Upstream migration
   - Missing fish pass
   - High drop
   - Missing monitoring
   - Fish pass discharge
   - Missing fishway data
   - Fish entrance
   - Other

4. Downstream migration
   - Missing fish pass
   - Turbine passage
   - Too wide trash rack
   - Missing monitoring
   - Missing fishway data
   - Fish entrance
Test Case Challenges

Flow and habitat  | Nature-like fishway  | Upstream migration  | Downstream migration

- Rearing habitat
- Downstream flow
- Attraction flow for UP
- Attraction flow for DOWN
- Environmental flow in bypassed reach
- Operational strategy
- Habitat in bypassed reach
- Hydropeaking
- Habitat
- Maintenance
- Missing fish pass
- Height drop
- Missing monitoring
- Fish pass discharge
- Missing fishway data
- Fish entrance
- Effect of cumulative dams
- Missing fish pass
- Turbine passage
- Too wide trash rack
- Missing monitoring
- Guidance device
- Fish entrance
- Maintenance
- Effect of cumulative dams

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FIThydro and AMBER

**AMBER:**
Adaptive Management of Barriers in European Rivers

*More effective ecosystem restoration in the EU*

**FIThydro:**
Fishfriendly Innovative Technologies for Hydropower

*Developing the next generation technologies of renewable electricity and heating/cooling*
Cooperation: FIThydro and AMBER

Technical Cooperation:
- The EU barrier atlas on hydroelectric dams
- Effect of hydropower plants/barriers on the upstream and downstream reach
- Habitat Assessment (Telemetry, Drones)
Cooperation: FIThydro and AMBER

Project Management:
1. Regular communication through their PM’s
2. FIThydro and AMBER: Participation in meetings and workshops of the other projects
3. Aim to host a joint meeting in 2020 in Brussels
4. Cooperate to organize additional event. (e.g: WFM)
5. Cooperate to organize Conference sessions
Cooperation: FIThydro and AMBER

Dissemination:

1. Website visibility as “related Project”
2. Exchange user networks and subscribe to newsletters to maximize reach and impact.
Hydro Shaft Powerplant – Eco Friendly Hydro

Eco-friendly HPP with testing of fish behavior and bypass use and turbine mortality probabilities. The powerplant is not visible and not audible.
Hydro Shaft Powerplant – Eco Friendly Hydro

Eco-friendly HPP with testing of fish behavior and bypass use and turbine mortality probabilities. The powerplant is not visible and not audible.
Hydro Acoustic Fish Tracking Concept

- **Pros**
  - High range of sound waves in water
  - Mobile and flexible measurement setup
  - Contactless monitoring
  - Chance for continuous monitoring

**Equipment**
- Hydrophones (transmitter and receiver)
- Electric generator
- Amplifier (transmitter and receiver)
- Digital oscilloscope

Flexible Hydro Acoustic Measurement Concept
Fish Habitat and Population Modeling

Before flood

After flood

Suitable spawning area for graylings
Fish Habitat and Population Modeling

\[
[Ni^{t+1}] = [M] \times [Ni^t]
\]

Matrix M changes with time

Changes in time

Spawning

No spawning

Life cycles of a population

Preference curves

P. Rutschmann (TUM), IEA Hydropower, Brussels, Belgium, 30 May 2017
Fish Motion in the Flow

PhD thesis Dzung Nguyen (TUM)

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Fish Habitat and Population Modeling - Colorado

- Brown trout (Salmo trutta)
- Rainbow trout (Oncorhynchus mykiss)
- Flannelmouth sucker (Catostomus latipinnis)

Graphs showing population trends for different species over time.

- Brown trout
- Rainbow trout
- Flannelmouth sucker

PhD thesis Yao Weiwei (TUM)
Slight off-peak mode operation of turbines (BAW)

PhD thesis S. Roenneberg (TUM)

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Thank you

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