ALPINE SIGNALS FOCUS 1

COMMON GUIDELINES
FOR THE USE OF SMALL HYDROPOWER
IN THE ALPS

ANNEX 1

GOOD PRACTICE EXAMPLES
FOR THE USE OF SMALL HYDROPOWER

INDEX

1. AUSTRIA 1

Revitalisation Programme Upper Austria 1
List of Criteria (Draft) - Further Development of Hydropower in Tyrol 3
Refurbishment of HPP Magerlmühle 5
Refurbishment HPP Cumberland – River Alm 7
Refurbishment and Optimisation of the HPP Steinbach 9
Refurbishment – Optimisation of the HPP Agonitz 11
Automatic regulation of residual flow e.g. SHPP Thurn – River: Saalach 13

2. GERMANY 15

Innovative Hydroelectric Concept 15
Infrastructure Power Plant Esterberg Gde. Garmisch-Partenkirchen 17
ILUP-Project: Hydropower Plant Vils, Municipal utilities of Vilshofen 20
Extension of a diversion plant in Oberstdorf 23

3. ITALY 27

Territorial Plan for the Provincial Coordination; water balance plan of the Province of Sondrio 27
Italy and Slovenia: CH_2OICE - Certification for HydrO: Improving Clean Energy 30
The refurbishment of the Tartano valley electricity production system through the use of a small hydropower plant (increase of productivity and best/optimal environment outcomes) 32

4. PRINCIPALITY OF LIECHTENSTEIN 36

Small hydropower plants on drinking water supply systems 36

5. SWITZERLAND 37

Evaluation and management of the hydroelectric potential of the Canton of Fribourg 37
Water-Agenda 21: Working group "Dialogue Hydropower" 39
Small Hydropower plant– Drinking water supply of Troistorrents 41
Small hydropower station Buchholz 43
Small hydropower plant using a wastewater network - Le Châble - Profay in Bagnes 44
Strategy "Water Use" of the Canton of Berne 46

1. AUSTRIA

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Revitalisation Programme Upper Austria

Description:

The increase of electricity production by environmental-friendly development and modernisation of the hydroelectric power is goal of this support program. Thus, the Revitalisation Programme Upper Austria provides two options to achieve this goal:

- Modernisation of power plants in place
- Installation of new power plants at environmental acceptable locations

Status in Upper Austria:

- 616 small hydro power plants (installed capacity up to 10 MW)
- SHP bottleneck capacity of more than 130 MW in total

There is a need for financial incentives for small hydro power plants (< 1MW). Ecological measures can be realised faster with financial support schemes.

Method:

- Small hydro power operators get advised about the optimisation potential (since April 2003)
- Development programme especially considering ecological issues
  - Enforcing modernisation of small hydro power plants up to 1 MW
  - Installing new small hydro power plants up to 1 MW
- Subsidy rates:
  - Investment grant of 25% maximum (one-time)
  - Maximum of 50.000 Euro per hydro power plant/operator

Criteria:

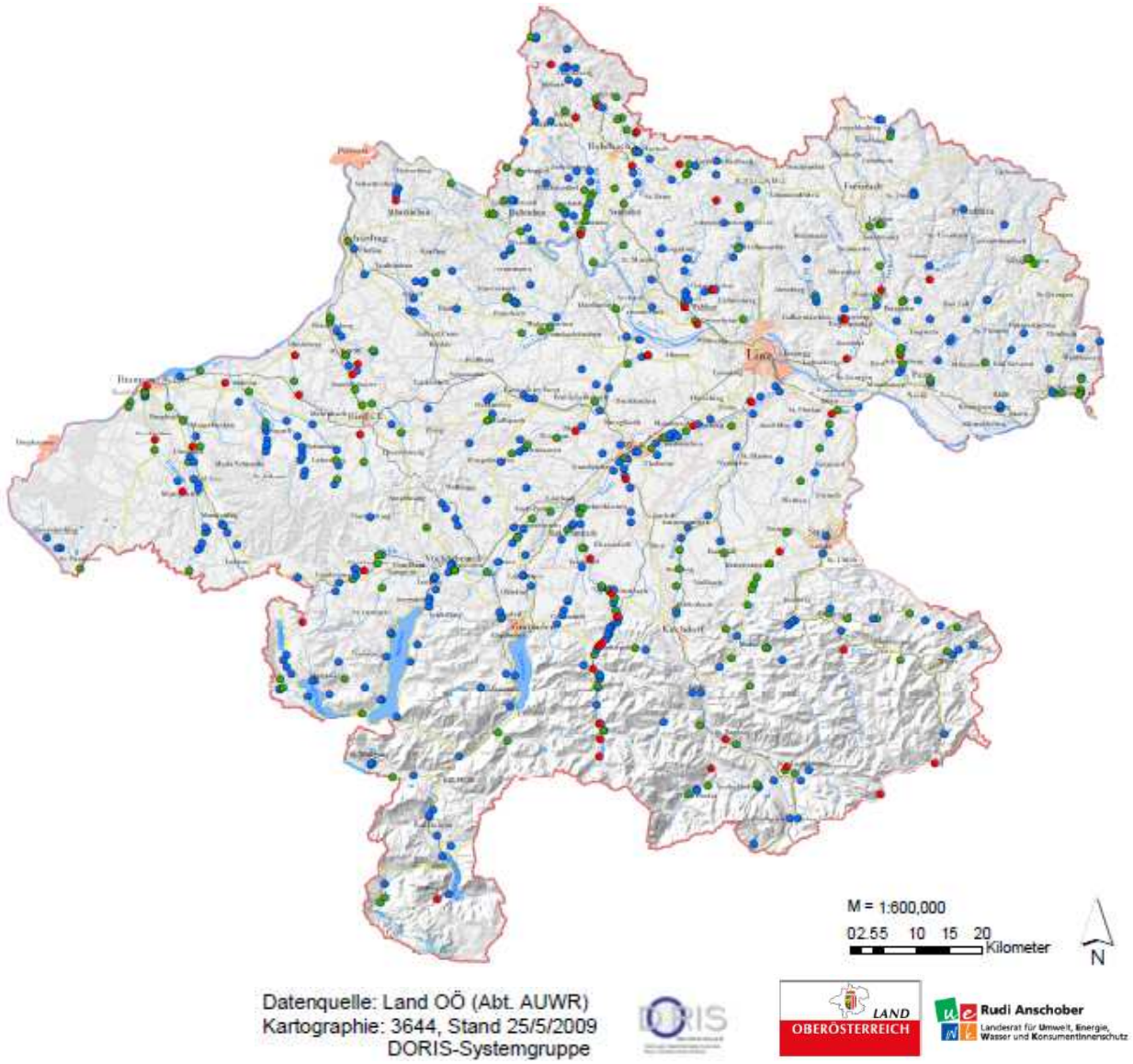
- Small hydro power generation ≤ 1 MW
- Relevant investment costs have to be at least 7.500 Euros
- The power plant has to be designed in an environment-friendly way

Results:

Achievements of the Revitalisation Programme Upper Austria (Summer 2009)

- 258 small hydro power plants have been either modernised or completely new installed(2004-2009)
- Total investment of 45 million Euros
- The electricity production of these plants has been increased on average by more than 40%
- Total increase in electricity production: 76 GWh/year
- Ecological improvement of the rivers in Upper Austria due to obligatory ecological measures

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Revitalisation Programme Upper Austria



Legend:

- 358 small hydro power plants in place
- 202 refurbished small hydro power plants (increase of energy production by 15% up to 50%)
- 56 new small hydro power plants (Complete new installations or revitalisations which are comparable with new installations)

Figure 1: Revitalisation Programme Small Hydropower in Upper Austria (2009)
© Amt der OÖ. Landesregierung

Status: ☐ Idea ☐ Project ☒ Realized ☐ Enacted ☐ .....

Milestones:

- Consulting provided for operators
- ecological and economical optimisation
- Subsidy rates up to 25% of total costs

Links:

http://www.esv.or.at/foerderungen/oekostrom/oekop-kwkw/ (DL Folder, FAQs, ...):

www.energiesparverband.at O.Ö. Energiesparverband, Landstraße 45, A-4020 Linz

www.land-oberoesterreich.gv.at Amt der OÖ. Landesregierung, Kärntnerstraße 12, A - 4021 Linz

Country:	Province / Canton:	Name of the project:
Austria	Tyrol	List of Criteria (Draft) - Further Development of Hydropower in Tyrol

Description:

- The Tyrolean Ministry of Environment establishes criteria as basis for an assessment of the compatibility of new hydropower plants with ecological requirements; this is in line with provisions already in place for exemptions of the provision of "non deterioration".

Method:

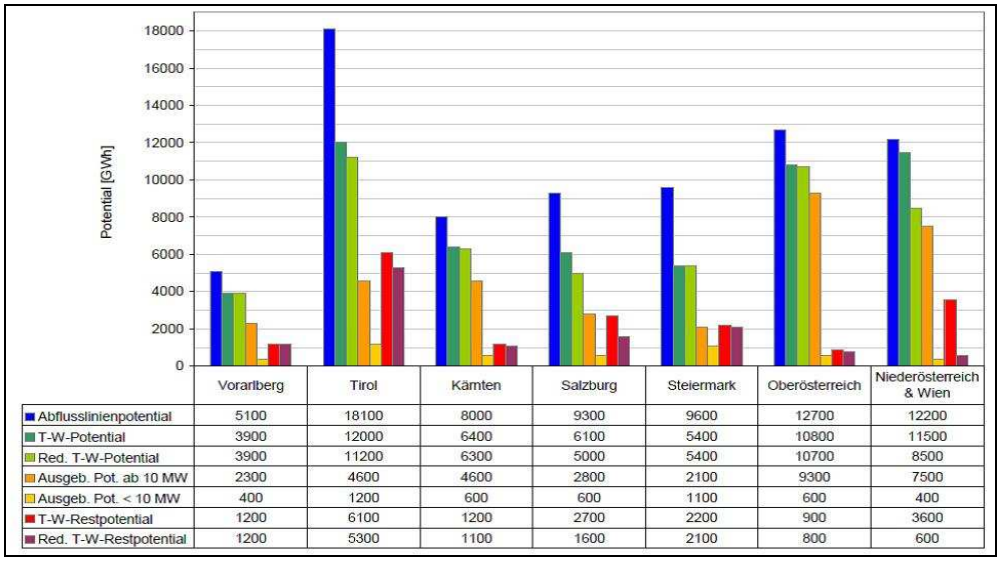
- Development of criteria for 5 special issues by a multidisciplinary group of 15 experts and 1 coordinator
- Further development of this list for future development of Hydropower in Tyrol including all relevant stakeholders

Criteria:

Specification of 5 topics/criteria with following weighting	Quantification
1. Criteria of Energy management	25 %
2. Criteria of Water management	18 %
3. Criteria of Spatial planning	12 %
4. Criteria of Water ecology	22 %
5. Criteria of Nature protection	23 %

Results:

- A concept to solve conflicts between hydropower generation and prevention of water degradation
- Each considered project should be assessed in a fully transparent way by weighting the results of the criteria groups



	Vorarlberg	Tirol	Kärnten	Salzburg	Steiermark	Oberösterreich	Niederösterreich & Wien
Abflusslinienpotential	5100	18100	8000	9300	9600	12700	12200
T-W-Potential	3900	12000	6400	6100	5400	10800	11500
Red. T-W-Potential	3900	11200	6300	5000	5400	10700	8500
Ausgeb. Pot. ab 10 MW	2300	4600	4600	2800	2100	9300	7500
Ausgeb. Pot. < 10 MW	400	1200	600	600	1100	600	400
T-W-Restpotential	1200	6100	1200	2700	2200	900	3600
Red. T-W-Restpotential	1200	5300	1100	1600	2100	800	600

Legend:

- total run off (hydrograph) potential
- technical-economic potential
- reduced technical-economic potential
- "large" hydropower potential (≥ 10 M W) already in place
- "small" hydropower potential (< 10 MW) already in place
- Unexploited hydropower potential
- Reduced unexploited hydropower potential

Figure 2:Overview of Hydropower Potentials in the different provinces of Austria
© Amt der Tiroler Landesregierung

Status: ☐ Idea ☒ Project ☐ Realized ☐ Enacted ☐ .....

Milestones:

- Installed expert group proposed criteria

Country:	Province / Canton:	Name of the project:
Austria	Tyrol	List of Criteria (Draft) - Further Development of Hydropower in Tyrol

- The proposal was presented to the general public (December 2009) and was opened for comments

Next steps:

- Discussion of proposal incorporating the public comments with relevant stakeholders and politicians
- Finalise the list of criteria

Links:

http://www.tirol.gv.at/fileadmin/www.tirol.gv.at/regierung/downloads/Nutzen_Kriterienkatalog_Website_final.pdf

http://www.tirol.gv.at/fileadmin/www.tirol.gv.at/regierung/downloads/kriterienkatalog.pdf

Amt der Tiroler Landesregierung

Eduard-Wallnöfer-Platz 3

A-6020 Innsbruck

Photo 1: List of Criteria Tyrol (Draft) © Amt der Tiroler Landesregierung

Country:	**Province / Canton:**	**Name of the project:**
Austria	Upper Austria	Refurbishment of HPP Magerlmühle

Description:

Hydro Power Plant: Wagner KG
River: Große Mühl
average discharge - MQ = 9 m³/s
minimum discharge - NNQ= 0,8 m³/s

Status before refurbishment:

River Power Station at the "Große Mühl" has been operating since 1922. Wagner KG purchased the power station in 2004.

Technical Data (before 2004):

Francis turbine

vertical with cogwheel and belt drive

- capacity: Q = 5,5 m³/s
- head: H = 2,6 m
- turbine output: 110 KW
- capacity: 95 KW
- production/year: 450.000 KWh

Total production/year: **450.000 KWh**

Ecology:

- minimum flow:
  residual flow reach of 300 m
  no minimum flow
- fish pass
  no fish pass built

Status after refurbishment:

Initial Operation: 30.3.2004

Technical Data (since 2004):

Kaplan turbine

Vertical, double regulated

- capacity: Q = 6,0 m³/s
- head: H = 2,5 m
- turbine output: 135 KW
- capacity: 120 KW
- production/year: 750.000 KWh
- The old installation is still in use and produces 350.000 KWh

Total production/year: **1.100.000 KWh**

Ecology:

- minimum flow:
  not necessary
- fish pass
  Vertical slot fish pass with 150l/s

Method:

- Investment costs: 520.000 €
- Subsidy: 50.000 € by Revitalisation Program Upper Austria

Criteria:

- Revitalisation, ecology, increase in efficiency

Results:

- Increase of power production in average by 650.000 kWh/year

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Refurbishment of HPP Magerlmühle

Figure 3: Vertical slot SHPP Magerlmühle
© Christoph Wagner

Figure 4: Power station SHPP Magerlmühle
© Christoph Wagner

Status: ☐ Idea ☐ Project ☒ Realized ☐ Enacted ☐ .....

Milestones:

- Increase in efficiency from 450.000 KWh/year to 1.100.000 KWh/year
- Ecology – fish pass constructed

Links: http://www.esv.or.at/foerderungen/oekostrom/beispiele/kleinwasserkraftwerk-magerlmuehle/

www.wws-wasserkraft.at

Wagner KG, Christoph Wagner, A - 4171 St. Peter, Auberg 13

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Refurbishment HPP Cumberland – River Alm

Description: Hydro Power Plant: Cumberlandstiftung

River: Alm

Status before refurbishment:

Hydro power plant has been in operation since 1899.

Status of refurbishment:

Initial operation: 20.12.2005

Technical Data (before 2005):

Francis turbine

vertical with cogwheel and belt drive

- Capacity: Q = 2,0 m³/s
- Head: H = 2,5 m
- turbine output: 35 KW
- capacity: 28 KW
- production/year: 170.000 KWh

Technical Data (since 2005):

Kaplan turbine

vertical double regulated

- capacity: Q = 8,0 m³/s
- head: H = 3,0 m
- turbine output: 214 KW
- capacity: 197 KW
- production/year: 1.000.000 KWh

Ecology:

- minimum flow: no minimum flow

Ecology:

- minimum flow: 800 to 1400 l/ s

Fish pass:

- no fish pass built

Fish pass:

- bypass channel at weir to allow migration of fish

Method:
- Investment costs: 960.000 €
- Subsidy: 50.000 € by Revitalisation Program Upper Austria

Criteria:
- Revitalisation, ecology, increase in efficiency

Results:
- Increase of power production in average by 800.000 kWh/year

Figure 5: Power station SHPP Cumberland
© Herzog von Cumberlandstiftung

Figure 6: Weir system SHPP Cumberland
© Herzog von Cumberlandstiftung

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Refurbishment HPP Cumberland – River Alm

Status: ☐ Idea ☐ Project ☒ Realized ☐ Enacted ☐ ……..

Milestones:

- Increase in efficiency from 170.000 KWh/year to 1.000.000 KWh/year
- Ecology – fish pass constructed

Links:

http://www.hydro-energy.com/_downloads/pdf/Referenzen_Zek/Auingersaege_Juni07.pdf

http://www.neueenergie.net/index.php?id=1515

Herzog von Cumberlandstiftung, Helmut Neubacher, Landstraße 17, A - 4645 Grünau

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Refurbishment and Optimisation of the HPP Steinbach

Description:

Hydro Power Plant: Steinbach

River: Steyr

Status before reconstruction:

- The old HPP consisted of two separate plants. One was built in 1910, with an installed capacity of 25 kW and the other one in 1942, with an installed capacity of 75 kW. With gross head of 2.8 m and a maximum discharge of 4.1 m³/s per plant, an annual average of 0.8 GWh was produced.
- River continuum disrupted - Fish migration not possible (=Ecological shortcoming)
- Due to poor condition and the long life-span of the facility a refurbishment study was carried out in 1999. The results proposed following measures:
  - Removal of the old plants and replacement by a single power-station with two generators. Increase of maximum discharge from 4.1 m³/s to 50 m³/s and enhancing capacity from 100 kW to 1.000 kW
  - Alteration of bottom weir gate

Method: Reconstruction by refurbishment / ecological mitigation measures

Criteria: Reconstruction, ecology, increase in efficiency

Results:

- Increasing maximum discharge and enhancing efficiency have resulted in an average annual power generation of 5,3 GWh - more than six times the production before refurbishment.
- Total costs: 5.000.000 € (several floods during construction period resulted in extra costs of 1.200.000 €).

Execution of measures:

Hydromorphological improvements:

- River continuum established

Ecological improvements:

- Providing fish migration ensured by a vertical slot fish pass

Assessment of ecological efficiency:

- Experts of limnology assisted designing the plant and supervised the construction process of the fish pass
- The fish pass is integrated in the partition wall between bottom weir gate and powerhouse. Tests proved functionality of fish ladder.

Effects on operator:

- Costs for ecological improvement have been compensated by increasing power generation

Costs of the measure (€):

- Investment: Fish pass: approximately € 70.000

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Refurbishment and Optimisation of the HPP Steinbach

Figure 7: Vertical slot SHPP Steinbach
© Energie AG Oberösterreich

Status:	☐ Idea	☐ Project	☒ Realized	☐ Enacted	☐ ……
Milestones:	Increase in efficiency Ecology – river continuity ensured by fish pass				
Links:	http://www.energieag.at/eag_at/resources/257501226587649392_399384431324350784.pdf Energie AG Oberösterreich, Böhmerwaldstr. 3, A-4021 Linz				

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Refurbishment – Optimisation of the HPP Agonitz

Description:

Hydro Power Plant: Agonitz

River: Steyr

Status before reconstruction:

- The HPP was built in 1924.
- The old plant had a gross head of 7 m and a maximum discharge of 20 m³/s. It used two generators with an installed capacity of 990 kWand produced an average of 6,4 GWh/year.
- River continuum disrupted - Fish migration not possible (=Ecological shortcoming)
- Due to poor condition and long life-span of the facility a refurbishment study was carried out in 2001. The results of the study proposed the following measures:
  - Replacement of power station and generators. Increase of maximum discharge from 20 m³/s to 45 m³/s
  - Alteration of bottom weir gate
  - Increase of hydraulic head to 8,3 m by an excavation of river bed downstream by 1,3 m
  - Total costs: 7.600.000 €

Method: Reconstruction by refurbishment / ecological mitigation measures

Criteria: Reconstruction, ecology, increase in efficiency

Results:

- Increasing the maximum and hydraulic head has resulted in an average annual power production of 15,8 GWh - more than twice the amount before refurbishment.
- Ecological measures were planned by experts of limnology who also supervised the construction works.

Execution of measures:

Hydromorphological improvements:

- River continuum established

Ecological improvements:

- Fish migration provided by setting in place a fish pass designed as a combination of nature orientated creek and a vertical slot fish pass.

Assessment of ecological efficiency:

- High

Effects on operator:

- Costs for ecological improvement have been compensated by increasing power generation

Costs of the measure (€):

- Investment: Fish pass: 380.000 €.

Country:	Province / Canton:	Name of the project:
Austria	Upper Austria	Refurbishment – Optimisation of the HPP Agonitz

Figure 8: SHPP Agonitz
© Energie AG Oberösterreich

Status:	☐ Idea	☐ Project	☒ Realized	☐ Enacted	☐ .....
Milestones:	Increase in efficiency Ecology – fish pass constructed				
Links:	http://www.energieag.at/eagat/resources/257501226587649392_326146398573391687.pdf Energie AG Oberösterreich, Böhmerwaldstr. 3, A-4021 Linz				

Country:	Province / Canton:	Name of the project:
Austria	Salzburg	Automatic regulation of residual flow e.g. SHPP Thurn – River: Saalach

Description:	• Prevention of malfunctions and controlling residual flows are the prerequisites for good ecological status of rivers. • Inspections revealed that the specified residual flow was frequently not observed by the owner in the past. An automatic system for the regulation of the residual flow has been considered. • Installing a technical regulation system ensured the required residual flow. • The protocol system documents the residual flow values.
Method:	• Automatic regulation of residual water • Technical solution – no manipulation possible
Criteria:	• Regulation of residual water
Results:	• better ecological status for the river

Country:	Province / Canton:	Name of the project:
Austria	Salzburg	Automatic regulation of residual flow e.g. SHPP Thurn – River: Saalach

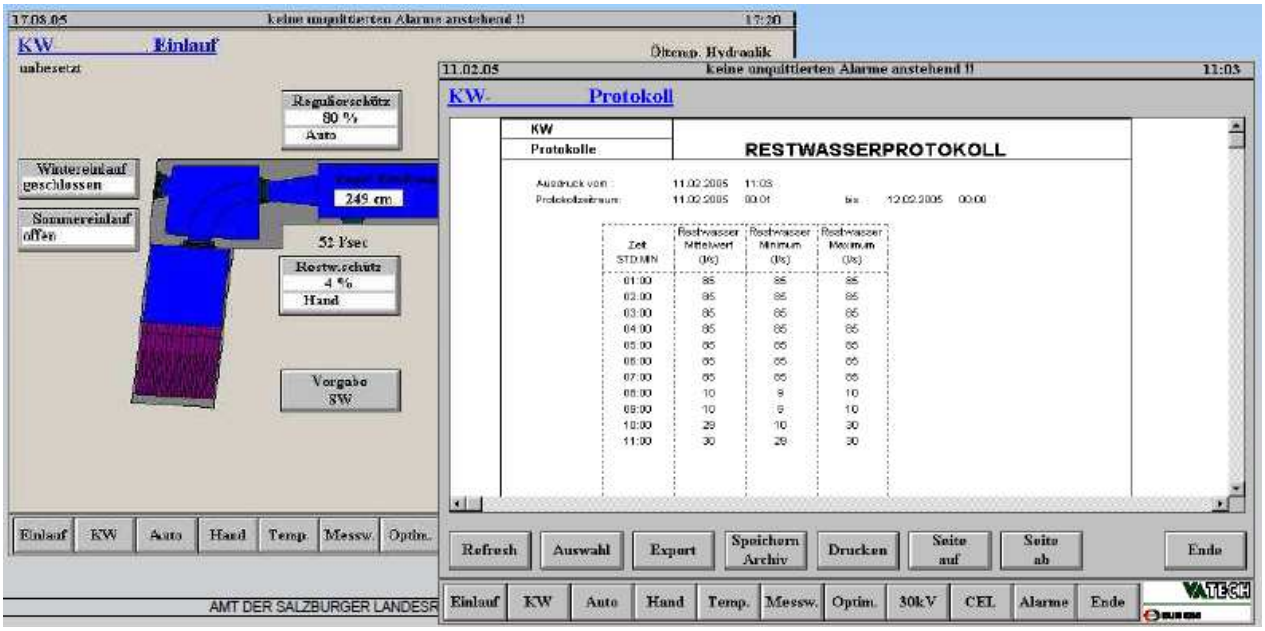


Figure 9: Interface of the programme regulating the residual water including data recording
© Land Salzburg

Figure 10: Regulation of residual flow
© Land Salzburg

Figure 11: No residual water
© Land Salzburg

Status: ☐ Idea ☐ Project ☐ Realized ☒ Enacted (Salzburg) ☐ .....

Milestones:

- No manipulation by operators possible because of technical solution including a protocol tool
- Guaranteed residual flow

Links:

http://www.salzburg.gv.at/jaeger_automatische_restwasserregulierung_und_fischpassdotation_grafik_komprimiert-3.pdf

http://www.salzburg.gv.at/gewaesserschutz

Land Salzburg, Referat 13/04 - Gewässerschutz
Mag. Renate Schrempf, Tel:+43(0)662 8042-4492, e-mail: renate.schrempf@salzburg.gv.at
Dr. Andreas Unterweger, Tel:+43(0)662 8042-4582, e-mail: andreas.unterweger@salzburg.gv.at

2. GERMANY

Country:	Province / Canton:	Name of the project:
Germany		Innovative Hydroelectric Concept

Description:

At the TU Munich development work is ongoing to create a new inlet concept particularly suited to existing, fixed weirs. The new concept's main innovation is a change from the vertical to the horizontal inlet plane, resulting in significant economic, hydraulic, noise-emission and aesthetic advantages. An additional and important benefit lies in the special consideration of ecological components in the flow and bed load regions. Fish-friendly flow conditions in the inlet plane can be achieved with an increase of the effective surface area of the rake without affecting the third dimension.

The power plant is situated in front of and within the weir, submerged, equipped with a DIVE turbine, requires no powerhouse and no intervention on the banks. Furthermore it is inconspicuous and emits no noise. To prevent vortices drawing air into the vertical shaft a flap gate positioned at the face will be over-flowed. This will also allow fish migrating downstream a wide corridor.

Method:

So far the concept is designed theoretically and a rough hydraulic dimensioning has been done. In the course of a research project the design will be tested in a physical model equipped with turbines. In a second phase a large pilot project will be built. Applicable hydraulic and construction assessments can be expected in the summer of 2010.

Criteria:

More efficient and therefore economically viable even at weirs with small heads of water, at the same time achieve high ecological standards.

Results:

Figures:

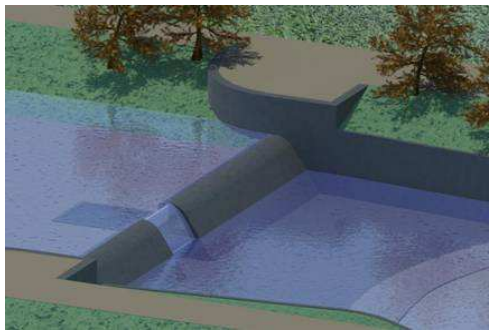


Figure 12 and Figure 13: Existing weir (left), and the corresponding power house at this location (right)
© Department of Hydraulic and Water Resources Engineering TU München

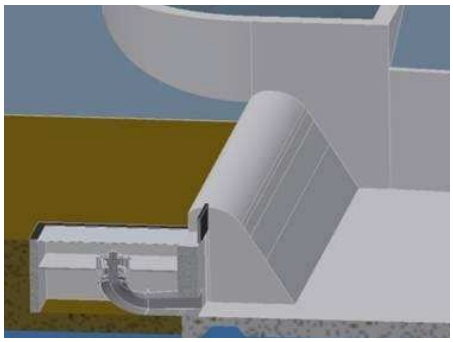


Figure 14 and Figure 15: Section of the powerhouse (left) and physical model (right)
© Department of Hydraulic and Water Resources Engineering TU München

Country:	Province / Canton:	Name of the project:
Germany		Innovative Hydroelectric Concept

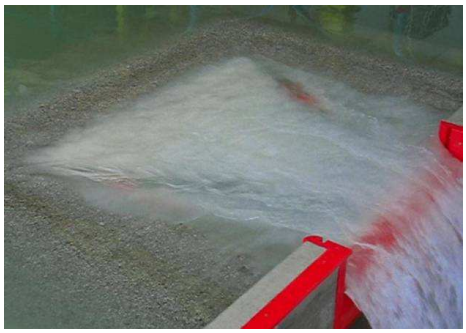


Figure 16 and Figure 17: Position of shaft power plant within the weir
© Department of Hydraulic and Water Resources Engineering TU München

Figure 18 and Figure 19: Transversal structure with power plant
© Department of Hydraulic and Water Resources Engineering TU München

Remarks:

Status: ☐ Idea ☒ Project ☐ Realized ☐ Enacted ☐ .....

Milestones:

Links:

Country:	Province / Canton:	Name of the project:
Germany		Infrastructure Power Plant Esterberg Gde. Garmisch-Partenkirchen

Description: On behalf of the Bavarian State Ministry of Economic Affairs, Infrastructure, Transport and Technology experts of the Technical University Munich, Dep. Hydraulic Engineering and Water Management, have been examining the potential of existing water supply systems for generating electricity. Result: the water supply structure of Esterberg Springs, which has been in existence for many decades, is suitable.

Method:

Criteria:

Results: Hydropower plant Esterberg
Construction of a new infrastructure hydropower plant for using the discharge of drinking water springs.

Data:

- former drinking water supply system (3,6 km pressure pipeline DN 400 newly run)
- head max. 502 m (highest in Bavaria)
- twin-jet Pelton turbine with 44 -154 l/s
- capacity 636 kW, electrical work 3,1 GWh p.a.
- Costs about 1,7 Mio. €
- built in 2008
- very good acoustic insulation of the power plant
- in case of power failure isolated operation possible
- inconspicuous integration within townscape

Figures:

Figure 20 and Figure 21: Power house
© Bavarian Environment Agency © Gemeindewerke Garmisch-Partenkirchen

Figure 22: Pelton turbine
© Gemeindewerke Garmisch-Partenkirchen

Figure 23: Interior panorama (Hydroelectric generating set with Pelton turbine, synchronous alternator and electrical equipment)
© Gemeindewerke Garmisch-Partenkirchen

Remarks:

Status: ☐ Idea ☐ Project ☒ Realized ☐ Enacted ☐ ……..

Milestones:

Links:

Country:	Province / Canton:	Name of the project:
		ILUP-Project: Hydropower Plant Vils, Municipal utilities of Vilshofen

Description:	ILUP (Integrated Land Use Planning and River Basin management) is a project initiative within the loan programme INTERREG III B of the European Union. Austria, Czech Republic, Hungary and Bavaria want to compile transferable results for a European-wide river basin management. The Free State of Bavaria has selected the two rivers Vils & Rott belonging to the catchment area of the Danube as planning areas of the ILUP. One component is an investigation for sufficient residual water delivery and re-establishment of river continuity as criteria in order to achieve „the good status of water bodies " after European Water Framework Directive (WFD). In the underflow of the river Vils these specifications are already implemented on a length of approx. 10 km. Municipal utilities of Vilshofen also made a substantial contribution to modernisation of their Hydropower Plant Vils .
Method:	In many places fish migration is obstructed by technical structures, as for instance hydroelectric power plants. This is a serious problem in the conflict between river ecology and renewable energies. The evaluation of technical, hydrologic and economic data helps to provide suitable technical and economic proposals to re-establish river continuity. In the project area there are 147 transversal structures within the river Vils, 102 of these are a serious obstacle to fish migration. At the river Rott there are 114 transversal structures, 75 of those are classified as being problematic. On the Vils 35 of them are hydroelectric power plants, on the Rott 26. For each individual hydroelectric power plant and transversal structure applicable solutions have been examined on the basis of an evaluation pattern. For the most favoured option a draft plan has been compiled.
Criteria:	For hydroelectric power plants the energy and financial consequences of a residual water delivery were evaluated as well as the effects of an increased feed-in tariff after the renewable energy Act (EEG). Thus the cost effectiveness has been examined from the plant operator's point of view.
Results: (Example)	In coordination with the specialised authorities for fishery, nature protection and water management the ecological condition of the Vils within the range of the HPP Vils HPP (municipal utilities of Vilshofen) was substantially improved. Now 1,300 litres per second of residual water are delivered into the previously dry river-bed between the existing weir system and the inlet of the tailwater channel. A river stretch of approx. 210 m has been revitalised and ecologically enhanced. The discharge is provided by a residual water turbine and by a fish ladder, which at the same time provides continuity for aquatic organism migrations. The 85 m long fish ladder is designed for a discharge of 300 litres per second, so that existing fish and water organisms can reach the headwater. With the help of 27 small basins they can overcome the difference in height of 4 meters in order to reach the traditional spawning grounds upstream. The new residual water turbine was implemented as a reversed water auger and is considered to be very fish friendly, causing no harm to passing fish. The plant (electrical output 26.5 KW, discharge of 1.000 litres per second) is operated all year. On the one hand it guarantees the ecologically necessary minimum water discharge in the old river bed and on the other produces renewable energy from hydro power. The new hydropower snail produces additional renewable, CO2-free electricity of more than 200,000 kWh per year. Together with the existing production plant, municipal utilities of Vilshofen calculate the generation of 2.2 million kWhof electricity per year from renewable hydropower of at this location. This quantity of electricity is sufficient to supply about 630 households with renewable energy.

Country:	Province / Canton:	Name of the project:
		ILUP-Project: Hydropower Plant Vils, Municipal utilities of Vilshofen

The described measures were supplemented with a fish-suited transformation of the screening unit. In the future small organisms sticking to the floating debris remain in the water and can thus survive. Moreover the flat iron bars were provided with welded on round steel bars, in order to minimize the danger of fish injury.

The ecological improvements by providing residual water discharge and re-establishing river continuity fulfil the condition for an increased feed-in tariff after the EEG. The transacted investments will thus amortise in the medium term.

The modernisation of the HPP Vils is a very good example of how ecological and economic interests can be brought together.

Figures:

Figure 24: Fish ladder

Country:	Province / Canton:	Name of the project:
		ILUP-Project: Hydropower Plant Vils, Municipal utilities of Vilshofen

Figure 25: Reversed water auger
© State Office for Water Management Deggendorf

Remarks:

Status:	☐ Idea	☒ Project	☒ Realized	☐ Enacted	☐ .....
Milestones:					

Links:

Country:	Province / Canton:	Name of the project:
Germany	Bavaria / Oberallgäu	Extension of a diversion plant in Oberstdorf

Description:

EVO GmbH requested permission for the extension of an existing hydroelectric power plant at the river Faltenbach. Both the length of the diverted river stretch and the diverted discharge should be extended. The max. diverted discharge of the existing power plant was intended to be increased from 100 l/s up to 1.0 m^3/s.
MQ of the Faltenbach is about 345 l/s, MNQ 30 l/s, HQ_1 approx. 10 m^3/s.

Method:

For the determination of the ecologically necessary minimum discharge in the diverted river stretch of Faltenbach (a trained torrent), a privately owned expert office for river ecology accomplished a limnological investigation from July 2005 to April 2006. The emphasis of the investigation was mainly upon the collection of hydraulic-morphologic parameters at different discharges and the stocktaking of the aquatic river-bed fauna (macro zoo benthos).

Criteria:

The extension of the hydroelectric power plant has to consider the abiotic boundary conditions to an extent widely compatible for the occurring species of the macro zoo benthos in order to ensure the good to very good ecological status after EU-WFD (AQEM-method). This can only be the case by providing a minimum discharge appropriate both in amount and dynamics.

Results:

The limnological expert report resulted in a dynamic minimum discharge of 40 l/s in the winter half year (mid of Nov. to mid of March) and of 100 l/s plus an additional 20% of the overall supply in the Faltenbach in the summer half year. The delivery of the fixed contingent is attained by appropriate openings in the Tyrolean weir, the dynamic 20% by appropriate cover of the grid bar surface.
After evaluation of the survey by the official expert (= State Office for Water Management Kempten) and consensus on the proposed arrangement of minimum discharge, the district administration authority completed planning approval despite former civil protest against this project.
This year construction of the new power plant will take place.

Country:	Province / Canton:	Name of the project:
Germany	Bavaria / Oberallgäu	Extension of a diversion plant in Oberstdorf

Figures:

For investigation the torrent stretch was divided into 14 characteristic sections.

Examples:

Figure 27: Section 1

Figure 28: Section 5

Figure 29: Section 6

Figure 30: Section 8

Figure 31: Section 14

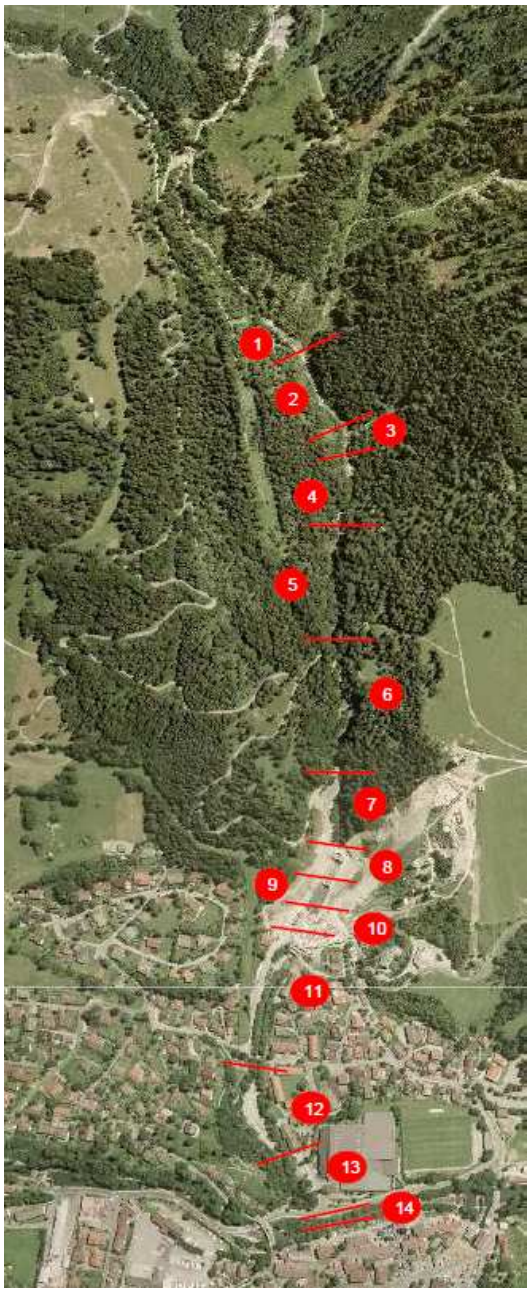


Figure 26: Torrent stretch

Country:	Province / Canton:	Name of the project:
Germany	Bavaria / Oberallgäu	Extension of a diversion plant in Oberstdorf

Foto documentation: section 1 with different discharge

Figure 32: 20 l/s

Figure 33: 40 l/s

Figure 34: 100 l/s

Figure 35: 250 l/s

Country:	Province / Canton:	Name of the project:
Germany	Bavaria / Oberallgäu	Extension of a diversion plant in Oberstdorf

Figure 36: 400 l/s

Parameter	Verbaute Staffelstrecke		Unverbaute Fließstrecke	
	Winter	Sommer	Winter	Sommer
Benetzte Breite	40 l/s	100 l/s	40 l/s	40 l/s
Mittlere Wassertiefen	40 l/s	k.A.	40 l/s	150 l/s
Fließgeschwindigkeiten				
bodennahe Fließgeschwindigkeiten	40 l/s	150 l/s	20 l/s	150 l/s
Häufigkeitsverteilung Strömungsklassen (bodennah)	40 l/s	zwischen 100 und 250 l/s	40 l/s	150 l/s
Mittlere Fließgeschwindigkeiten	40 l/s	250 l/s	40 l/s	100 – 150 l/s
Grenzwert 30 cm/sec (LAWA)	-	(250 l/s)	-	150 l/s
Verweildauer	40 l/s	100 l/s	40 l/s	100 l/s
„Optik" - Landschaftsbild	40-100 l/s	150 l/s	40 l/s	150 l/s
Sonstiges:				
Wasserfall:	40 l/s (Winter) / 150 l/s (Sommer)			
Ökomorphologie:	hohe Ansprüche wegen des streckenweise hohen Natürlichkeitsgrades			
Aquatische Bodenfauna:	hohe Ansprüche wegen zahlreichem Vorkommen von Rote-Liste-Arten und Dominanz rheophiler/rheobionter Taxa			
Versickerungsstrecke:	ab 40 l/s zumindest durchgehend benetzt			

Figure 37: Overview of minimum discharge to ensure parameters most similar to natural conditions

Remarks: Also nature protection aspects could be met by the limnological investigation, e.g. to protect 10 Bavarian red list species. Fish fauna could be ignored due to many (natural) drop offs.

Status: ☐ Idea ☐ Project ☒ Realized ☐ Enacted ☐ .....

Milestones:

Limnological investigation

Links:

www.limnologie.at

http://www.wwa-ke.bayern.de/

3. ITALY

Country:	Province / Canton:	Name of the project:
Italy	Province of Sondrio	Territorial Plan for the Provincial Coordination; water balance plan of the Province of Sondrio

Description:

The territory of the Province of Sondrio is characterised by a very high water exploitation rate due to the presence of a large number of hydropower plants. The risk of deteriorating water quality and the protests by the population over a long time period prompted local authorities to implement a new legislative instrument to better regulate authorisations for the water use.

Because the Plan represents the first Italian example of application of the 2000/60/EC principles at local scale, an ad-hoc working group was established with all the authorities involved in the concessions grant process (Ministry for the Environment, Po river basin Authority, Lombardia Region, Province of Sondrio and APAT). All the authorities signed the Agreement "for the sustainability of the uses of water in the Province of Sondrio through the integration of the planning instruments" and participated in the implementation of the necessary steps.

The Agreement envisaged integration of the "Territorial Plan for the Provincial Coordination" with an "at small scale" water balance, the individuation of a set of indicators suitable for the implementation of the WFD principles and the submission of this new plan to Strategic Environmental Evaluation, as expected from the national legislation.

The new plan, adopted on July 2009 and approved the 25 January 2010, with the associated set of rules will constitute the instrument used by the water authorities for the grant of new concessions.

Method:

The authorisation of new applications is subject to an ad-hoc set of rules that takes into account both hydrological, environmental and morphological aspects, the used indicators are carried out using the WFD clues.

The adopted method is based on a multi-criteria evaluation intended to exclude or limit new concessions in those parts of the basin where there is a significant detrimental risk to the water quality status or failure to reach the good ecological status required under the 2000/60/EC directive. The aggregation approach used for the implementation of the multi-criteria procedure was the overlapping of five different maps, where any of these maps represented the risk of failing to reach the good ecological status due to a single critical aspect. In those part of the basin where at least one of the critical aspects show a high risk rate the water concessions were refused, while in the areas showing a medium or a low risk rate the water concessions were allowed, but only if there would be no deterioration to the ecological status of the river stretch.

The method provides a simple evaluation scheme that consists of a "risk map" whereby different colour represent the risk of river streches not reaching the good ecological status by 2015.

Criteria:

The five indexes used to identify the different river stretch criticalities are listed below:

a) An index representing the impact of the cumulated withdrawals with respect to the mean annual natural discharge;

b) An index representing the impact of the cumulated withdrawals with respect to the mean annual low flow considering the human activities impact;

c) An index representing the interruption risk in the river regime due to the presence

Country:	Province / Canton:	Name of the project:
Italy	Province of Sondrio	Territorial Plan for the Provincial Coordination; water balance plan of the Province of Sondrio

of discharges from reservoirs;

d) An index representing the LIM pollution risk in the "mean annual low flows considering the human activities impact" scenario;

e) The FFI (Fluvial Functioning Index), for the connectivity and the ecological functionality.

Results: Results from this method have been integrated into the Territorial Plan for Provincial Coordination and have also updated the Water Quality Protection Plans at regional level and the Transitional plan for the Hydrogeological Settlement (PAI) with regard to granting water use concessions..

Figures:

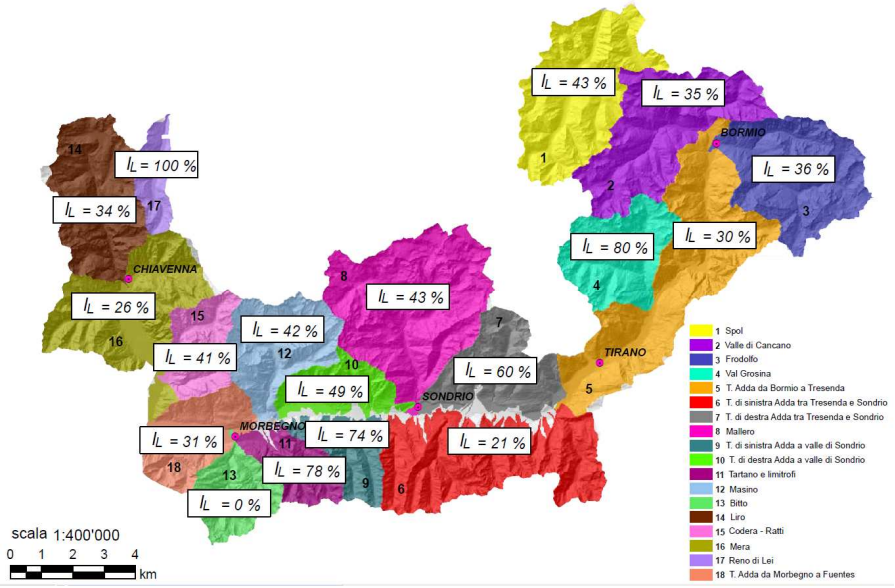


Figure 38: Map indicating for each sector the percentage of river stretches (length) free from hydroelectric water withdrawals.
© Province of Sondrio

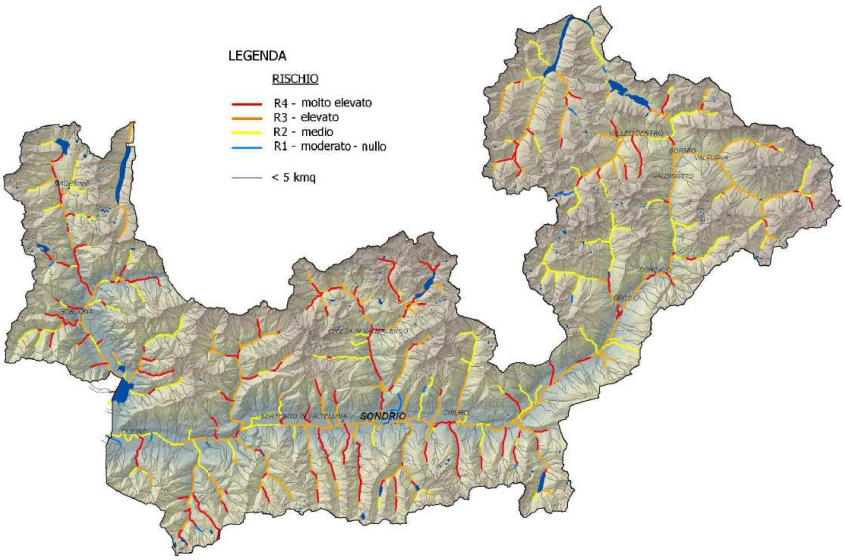


Figure 39: "Risk Map" where the different river stretches colour represent the risk of not reaching the good ecological status by 2015 (river basins < 5 km2 excluded).
© Province of Sondrio

Country:	Province / Canton:	Name of the project:
Italy	Province of Sondrio	Territorial Plan for the Provincial Coordination; water balance plan of the Province of Sondrio

Remarks:

Status: ☐ Idea ☐ Project ☐ Realized ☒ Enacted ☐ .....

Milestones:

Spring 2006: Establishment of Working Group;
Spring 2006-spring 2008: Development of the methodology;
Summer 2007-end of 2008: Water uses analysis and Strategic Environmental Evaluation;
July 2009: Adoption of the Plan
January 2010: Approval of the Plan by the Province of Sondrio
Spring 2010: Adoption of the Plan with the function of ordinary planning instrument

Links: http://www.provincia.so.it/territorio/piano%20territoriale/default.asp

Country:	Province / Canton:	Name of the project:
Italy	Different places	Italy and Slovenia: CH_2OICE - Certification for HydrO: Improving Clean Energy
Slovenia	Different places	

Description:

The CH_2OICE project aims at developing a technically and economically feasible certification procedure for hydro power generation facilities of a high environmental standard in line with the requirements of the Water Framework Directive. It is to be implemented in labeled electricity products and integrated, as much as possible, with existing EU tools such as EMAS, EIA and SEA. The project is co-founded by Intelligent Energy Europe Working Program 2007.

Method:

After a preliminary review of national HP laws of the countries involved in Ch2oice project (IT, ES, FR, SK, SL) a draft methodology for certification has been defined, based upon the literature review and on the results of dedicated workshops. During the year 2010 this methodology will be tested on several HPPs in Italy and in Slovenia in order to finalise the operational methodology.

The testing phase, started in January 2010, may bring new insights and so at the end of this period (around October 2010) there will be a new discussion and debate on contents of the methodology developed, based upon the results of the experimentation. The certification methodology will primarily refer to existing plants. However, to allow a wider use of the results of the project, the issue of new hydropower plants licensing is being considered. Following the same logical approach used for the certification of existing plants, a set of guidelines was produced to help decision makers during planning and licensing procedures and HP developers in their EIA and SEA studies.

Criteria:

The developed methodology provides two kinds of procedures: a standard and a simplified procedure. For some types of hydropower plants operating in totally artificial networks and not entailing impacts on water-related ecosystems, for examples HPPs in sewage and aqueduct networks, it is possible to adopt a simplified procedure in order to facilitate certification. All the other types of plants have to follow the standard procedure. The certification procedure is strictly in line with the requirements of the WFD and integrated as far as possible with existing EU tools such as EMAS.

Results:

Expected results:

- Reports on main technical tools and regulatory frameworks related to hydropower certification
- General methodological approach for WFD-coherent certification agreed by project partners
- Guidelines for Decision-makers and hydropower generation companies for siting, construction and management of new hydropower plants of higher environmental standard
- Analysis document for Spain including a roadmap for the development of volunteer certification of hydro power generation facilities of high environmental standard in Spain
- Proposals and feasibility analysis on the integration of the label scheme in existing procedures, with focus on Italy and France.
- Proposals for rules and criteria for an independent body issuing the hydro power label

Country:	Province / Canton:	Name of the project:
Italy Slovenia	Different places Different places	Italy and Slovenia: CH_2OICE - Certification for HydrO: Improving Clean Energy

Figures:

Remarks:

Status: ☐ Idea ☒ Project ☐ Realized ☐ Enacted ☐ ……..

Milestones: Begin: September 2008
January 2010: starting of the testing phase

Links: www.ch2oice.eu

Country:	Province / Canton:	Name of the project:
Italy	Sondrio	The refurbishment of the Tartano valley electricity production system through the use of a small hydropower plant (increase of productivity and best/optimal environment outcomes)

Description:

The Tartano river basin was characterised by the presence of a complex electricity production system founded by two large hydropower plants: the Talamona power plant, connected to the Campo Tartano dam, and the Monastero power plant, fed by the Ardenno reservoir. The two dams were built by two different companies in two different periods (Campo Tartano dam was built in the 1920s, while the Ardenno reservoir only in the 1960s). The result was a less than optimal energy production scheme. The scheme was also characterised by some environmental deficiencies, such as the presence of fish migration barriers, and by some difficulties in guaranteeing an adequate ecological flow along the river stretch.

Therefore the key aims of the project, using a comprehensive perspective on all the river basin aspects, were:

- to enhance the production scheme in order to obtain an economically profitable investment without increasing the amount of the water exploited,
- to guarantee the presence of the ecological flow and study the bed load transport mechanism in the river stretch (Interreg project),
- to solve the fish migration obstruction in the Ardenno reservoir (Interreg project).

Most of the production increase has been obtained by better exploitation of the fall between the Campo Tartano dam and the Ardenno reservoir (refurbishment of the existing Talamona 1 plant and building a new large hydropower plant, Talamona 2) (see figure1). A further increase was obtained by a new small hydropower plant. The small plant, although providing only a limited production increase, performs an essential ecological role, representing the only point were ecological flow is returned to the river (see figure 2).

Two specific Interreg Projects were launched on fish migration and bed load transport.

Method:

Utilisation of an unexploited fall.

Agreements with the institutions involved in the water concessions release process, participation in an internationally financed research project with research institutes and other institutions to deepen the environmental aspects.

Application of a participative process with the institutions to gain a comprehensive perspective on the discharge of the ecological flow (with the agreement of the Lombardia Region a cost/benefit analysis regarding the environmental aspects on the whole water path has been performed instead of applying the existing laws on the single concession).

Criteria:

Production increase:

Before the refurbishment:		**After the refurbishment:**	
Talamona 1		Talamona 1 (modified),	
installed capacity	10.5 Mw	installed capacity	18.5 Mw
height of fall	498 m	height of fall	577 m
		Talamona 2 (new)	
		installed capacity	2.9 Mw
		height of fall	106 m
		Talamona ecological flow station (new)	
		installed capacity	0.6 Mw
		height of fall	5.5 m
Total:		Total:	
installed capacity	10.5 Mw	installed capacity	22.0 Mw
height of fall	498 m	height of fall	688.5 m

Country:	Province / Canton:	Name of the project:
Italy	Sondrio	The refurbishment of the Tartano valley electricity production system through the use of a small hydropower plant (increase of productivity and best/optimal environment outcomes)

Ecological flow

The analysis referred to the Ardenno dam section of the river Adda (just after the discharge of the Valmasino and Valtartano plant schemes and the starting point of the pipeline that feeds the Monastero powerplant) that represents the releasing point for the ecological flow in the river Adda. The choice was made in order to enhance the environment of the main corridor of the Adda river and the lateral Masino valley (kept as at high natural value) (see the Ardenno junction plan).

Bed load transport

In respect of the Campo Tartano dam an experiment on the water splays management was agreed between the Lombardia Region, the Sondrio Province and hydropower companies (Enel , A2A , Edipower). It aimed to define the operational parameters of the water releases and the consequent effect on the bed load movement and transport (management project, Ministerial decree 30/06/04).

The experiments and monitoring lasted two years and included a large area that comprises the Tartano valley and a wide area of Valtellina above the city of Sondrio. Parameters and reference conditions will be used to write a management plan for the dams involved.

The first results have been presented to the institutions and to the population with a conference and an ad-hoc publication by the Sondrio Province.

Currently, some of these activities are in progress within an Interreg Project (Parteners: Lombardia Region, Sondrio Province, Grigioni Canton, Enel , A2A , Edipower).

Removal of the fish migration barriers

The project also comprised a fish migration ladder. The Province of Sondrio specified the type and the features of the pass while the producer decided its location in connection with a small hydropower plant that releases the ecological flow. These and other actions regarding the specific criticalities in the Ardenno suburbs are in progress within an Interreg Project.

Results:	Nearly 20 Gwh/year of production increasing. Solving of the fish migration and ecological flow problems.

Country:	Province / Canton:	Name of the project:
Italy	Sondrio	The refurbishment of the Tartano valley electricity production system through the use of a small hydropower plant (increase of productivity and best/optimal environment outcomes)

Figures:

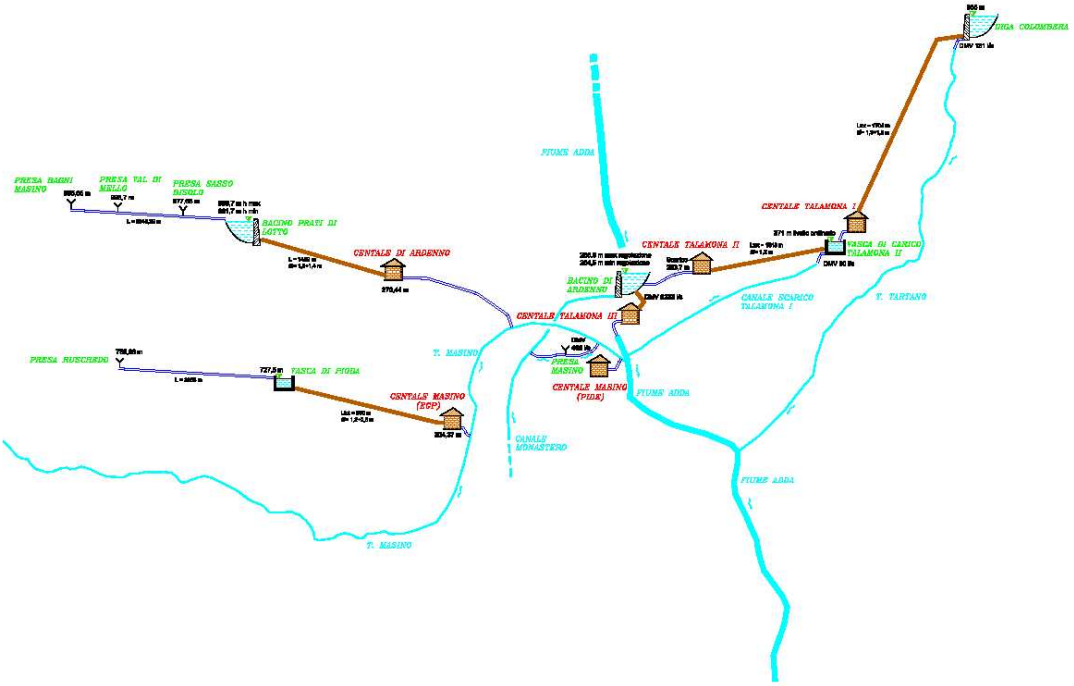


Figure 40: power plants scheme
© Enel S.p.A.

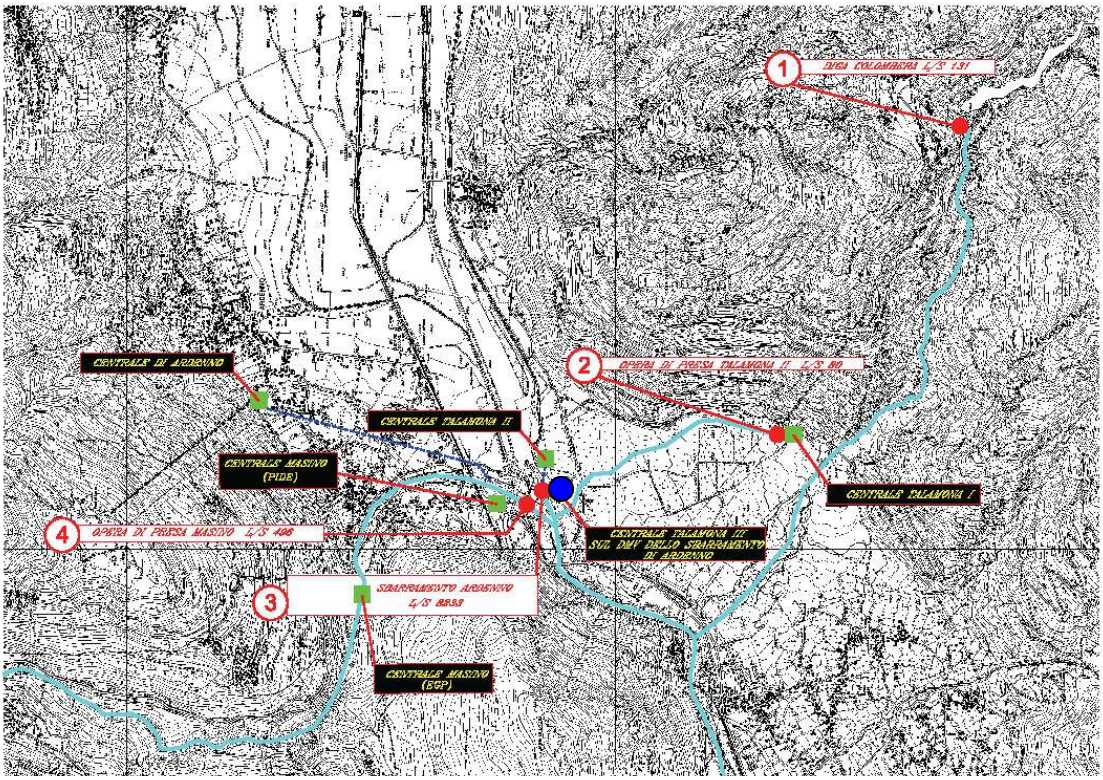


Figure 41: Ardenno junction plan (ecological flow release point in blue)
© Enel S.p.A.

Country:	Province / Canton:	Name of the project:
Italy	Sondrio	The refurbishment of the Tartano valley electricity production system through the use of a small hydropower plant (increase of productivity and best/optimal environment outcomes)

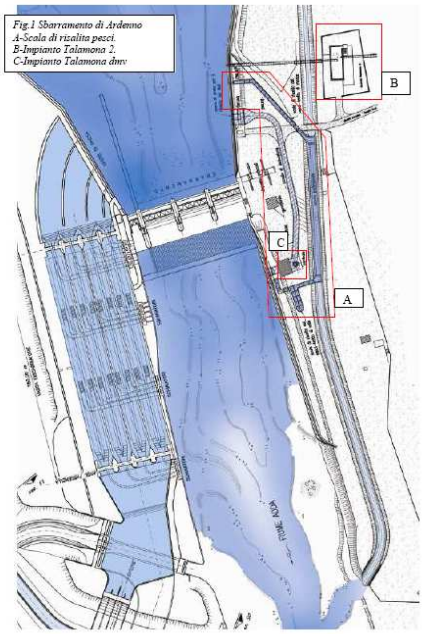


Figure 42: fish ladder scheme
© Enel S.p.A.

Remarks:

Status: ☐ Idea ☒ Project ☒ Realized ☐ Enacted ☐ ……..

Milestones:

Links:

4. PRINCIPALITY OF LIECHTENSTEIN

Country:	**Province / Canton:**	**Name of the project:**
Liechtenstein		Small hydropower plants on drinking water supply systems

Description: In 2009 in Liechtenstein there were seven small hydropower plants on drinking water supply systems, producing annually a total amount of 2.5 Mio KWh of renewable energy. A further plant of this type was being realised in 2010.

Method:

Criteria:

Results:

Figures:

Trinkwasser-Kraftwerke in Liechtenstein produzieren naturemade Ökostrom

Bezeichnung, Ort	Baujahr	Durchfluss max in l/s	Bruttohöhe m	Jahres-Stromproduktion Kilowattstunden
Schlosswald, Vaduz	1994	70	808	2'000'000
Steia, Maurerberg	2000	30	234	170'000
Stieg, Vaduz	2007	55	94	110'000
Maree, Vaduz	2007	42	94	100'000
Wissa Stä, Planken	2008	10	246	65'000
Wisseler Quellen, Schaan	2009	8	199	52'000
Rudabach-Quellen, Schaan	2009	4	82	12'000
Efiplanken Quellen, Schaan	geplant 2010	16	323	170'000
TOTAL				**2'679'000**

Mit dem produzierten Strom können zirka 550 Einfamilienhäuser mit Strom versorgt werden.
(durchschnittlicher Stromverbrauch eines Einfamilienhauses 5'000 kWh/Jahr)

Remarks:

Status: ☐ Idea ☒ Project ☒ Realized ☐ Enacted ☐ ……..

Milestones:

Links: Example: The hydropower plant on the drinking water supply system of Schlosswald, Vaduz/FL
http://www.lkw.li/CFDOCS/cmsout/admin/index.cfm?GroupID=159&MandID=1&meID=152&

5. SWITZERLAND

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of Fribourg	Evaluation and management of the hydroelectric potential of the Canton of Fribourg

Description:

With the introduction of the Cost-Covering Remuneration for Feed-in to the Electricity Grid (CRF) an increase of the water concession applications was observed. The Canton of Fribourg received 10 applications for small hydropower plants during the last quarter of 2008. In order to cope with both, energy and environmental requirements, natural water bodies with high ecological value have to be identified and protected, and the hydroelectric potential of the remaining water bodies has to be used in the most efficient way. For this, the standard method for the evaluation of the concession applications is no longer sufficient: a global management of the water resources is needed.

Method:

The assessment and authorisation of applications is suspended and an evaluation method based on exclusion criteria and on a multi-criteria evaluation is under development. This method will allow for evaluation of applications by a four-step approach:

1. **Evaluation of the water bodies**: Identification of exclusion areas (exclusion criteria) and evaluation of the hydroelectric potential of the remaining water bodies
2. **Preliminary project analysis (feasibility)**: Multi-criteria analysis of the projects (evaluation criteria) and classification into favourable, favourable under conditions, and not favourable.
3. **Concession project**: Evaluation of the preliminary analysis and technical reports of the projects. Definition and designation of specific conditions.
4. **Decision about the application**

Criteria:

Exclusion and evaluation criteria are defined for a range of themes. Exclusion criteria allow the identification of river stretches where hydroelectric utilisation will be excluded. Evaluation criteria are used for the comparison of different projects. The criteria are listed below:

Theme	Exclusion criteria	Evaluation criteria
Hydrology	River stretches with residual flow	Hydrological regime; Respect of residual flow; Influence on flood protection
Water quality	Drinking water protection (groundwater protection zones S1,S2)	Dilution of effluents of wastewater treatment plants
Morphology	Revitalised river stretches; river stretches to be revitalised.	Influence on bed-load transport; Eco-morphology of the river stretch; Respect of river space; Influence on river management
Biotopes	National biotopes; Seriously threatened animal or plant populations	Natural reserves; Cantonal or local biotopes; threatened animal or plant populations
Fish	Nationally inventoried spawning areas	Free migration; threatened species; Fish yields; Fish biodiversity
Landscape	National landscapes, sites and monuments; Rarity of the site	Natural parks
Hydroelectric potential	Energy efficiency: Recuperation of the energy used for the construction of the installation within < 5 years; Efficiency > 75%; Specific power < 0.1 kW/m	Efficient site use

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of Fribourg	Evaluation and management of the hydroelectric potential of the Canton of Fribourg

Results:

Results from this method will be integrated into the following instruments:

- integrated in the cantonal master plan (binding for the administration)
- Maps indicating river stretches excluded from hydropower use and the hydroelectric potential for other stretches
- Classification of the projects into favourable, favourable under conditions (like "naturmade star") and not favourable.

Figures:

Remarks:

Status: ☐ Idea ☒ Project ☐ Realized ☐ Enacted ☐ ……..

Milestones:

Begin 2010: Development of the methodology
Spring 2010: Validation of the methodology with the 10 applications

Links: http://admin.fr.ch/spc/fr/pub/lce.htm

Country:	Province / Canton:	Name of the project:
Switzerland	--	Water-Agenda 21: Working group "Dialogue Hydropower"

Description:

Water-Agenda 21 (www.wa21.ch) is a national platform in the form of an association, bringing together the most important actors of the water resources management sector. The goal of this network is to support the actors in providing answers to the major challenges.

One of the challenges is the development of hydropower use as a renewable, almost emission-free source of energy, frequently conflicting with the interests of water protection. In order to find possible solutions to this conflict of interests, Water-Agenda 21 founded the working group "Dialogue Hydropower", bringing together stakeholders from both, the energy and the environmental side: national and cantonal energy and environment administrations, hydropower representatives of the Swiss Water Management Association and environmental NGO's (pro Natura and WWF).

The working group aims at developing, at a national level, ideas and concepts of how to better deal with hydropower related conflicts between the use of renewable energy and the protection of the aquatic ecosystems and landscapes.

The strategic goals of the working group "dialogue hydropower" are:

- Improve the information exchange between the stakeholders.
- Establish a solution-oriented dialogue between the stakeholders and develop a common problem understanding
- Develop, initiate and work on approaches for solutions.

To that end, the conflicting domains were identified and the general conditions allowing a "dialogue on hydropower" were established. These are:

- Need of continuity and a certain binding character of the work
- Solution-oriented approach: fair and transparent conflict resolution
- Focus on macro-economic considerations, not on business/commercial aspects
- Establish and supervise the "dialogue hydropower" professionally.

Results:

The working group "dialogue hydropower" of the Water-Agenda 21 worked out the evaluation method: "classification of river stretches – protection versus use, as basis for spatial prioritisation of hydropower", where ecological and economic criteria are considered by an integral approach (see link below). This project aims at evaluating conflicts of water use for hydropower by means of broadly supported solutions. Furthermore the method should support the cantonal authorities for the weighing procedure of use and protection interests.

Figures:

Remarks:

Alongside the project of classification of river stretches, the working group "dialogue hydropower" focused its activities in the year 2009 on hydro-peaking.

Status: ☐ Idea ☐ Project ☐ Realized ☐ Enacted ☒ Active

Milestones:

End 2008	Foundation of the working group "dialogue hydropower"
09.03.2009	Expert conference „Hydro peaking - conflicts between power industry and ecology"
27.04.2009	Seminar „How to deal with applications for hydropower – weighing of use and protection interests"
Oct. 2009	Evaluation method for the classification of river stretches – Final report
09.11.2009	Expert conference „cost-covering feed-in remuneration and new hydropower installations – Ideas for the spatial coordination"
2010	Developing a position paper on "Hydropower use in Switzerland in 2030"

Country:	Province / Canton:	Name of the project:
Switzerland	--	Water-Agenda 21: Working group "Dialogue Hydropower"

Links:	Working group „dialogue hydropower": http://www.wa21.ch/index.php?page=213 Classification of river stretches: http://www.wa21.ch/index.php?section=media9&path=/media/archive9/D_Wasserkraftnutzung/

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of Valais	Small Hydropower plant– Drinking water supply of Troistorrents

Description:

This small hydropower plant is located on the territory of the municipality of Troistorrents, in the Canton of Valais, Switzerland. The installation is set on the drinking water network of Troistorrents and works on the high difference in levels between the catchment chamber and the surge tank, as a pressure regulator device. The installation includes also an energy destruction by-pass, guaranteeing the water supply whenever the turbine stops. This may be the case when the flow rate is insufficient, or during the revision of the power group. The equipment has been manufactured by a SME of 35 employees, located at 55 kilometers from the site. Electricity from this completely automatic power plant is delivered into the local distribution grid. Regarding the drinking water quality, rigorous specifications were met so as to avoid any negative impact.

Technical data:

Pelton turbine with one nozzle; Vertical axis

Net head:	242.3 m
Maximal discharge:	35 l/s
Installed capacity:	75 kW
Output:	230'000 kWh/year

Environmental Measures:

- The plant is set on a drinking water network, which implies that the infrastructure was already built and that the power plant operation does not imply more environmental impact (no need of fish ladders) than a usual drinking water network.
- As the plant is located in a semi agricultural area, a special effort has been made to integrate the power plant to the landscape. Looking from outside, nothing appears to be different from a traditional chalet.
- Because of nearby housing, a low ambient noise was required. The generator can be heard only when the plant door is open.
- The power plant is set in the charge chamber that provides the pressure in the water supply network and extracts energy that was previously wasted through a pressure reducer.
- Energy is generated with almost no environmental impact which may be expressed in a CO_2 emissions reduction of 110 t per year.

Figures:

Figure 43: The small hydropower plant of Troistorrents.
© MHyLab

Figure 44: 75 kW power group.
© MHyLab

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of Valais	Small Hydropower plant– Drinking water supply of Troistorrents
Remarks:	Owner, contractor and operator: Manufacturer:	Municipality of Troistorrents, Valais, Switzerland ELSA SA, Sion, Switzerland : mechanical design; MHyLab, Switzerland : hydraulic design
Status:	☐ Idea ☐ Project	☒ Realized ☐ Enacted ☐ ….
Milestones:	Year of commissioning:	1998-1999
Sources:	© MHyLab: http://www.mhylab.ch/pages/pdf/despro6_Troistorrents.pdf; © ESHA: http://www.esha.be/fileadmin/esha_files/documents/publications/publications/Brochure_EN.pdf	

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of St. Gallen	Small hydropower station Buchholz

Description:

In the canton of St. Gallen, at the border between the two municipalities Gossau and Flawil the river Glatt is interrupted by a 15 meter high, over 100 year-old dam. During more than 90 years of inactivity the initial basin of 250'000 m3 has been reduced by siltation, forming a wetland of national ecological interest.

With time, the dam became more and more unstable and something had to be done to ensure the safety of the downstream municipalities. Instead of partly demolishing the dam, it was decided to rehabilitate it and to integrate a small hydropower installation. The dam is reinforced and the powerhouse and a fish ladder are directly integrated in the dam.

Technical data:

Two propeller turbines with 5 rotors

Effective head:	14.5 m
Nominal discharge:	1.35 m³/s
Installed capacity:	140 kW
Output:	680'000 kWh/year
Duration of concession:	60 years

Environmental Measures:

- A fish ladder (water gate system) is installed to ensure fish migration. Because there is no space available for a fish ladder around the dam, an integrated technology, which has never been applied in Switzerland, was used and now serves as a showpiece. For the first time in 150 years fish migration is again possible in this part of the Glatt river.
- If the dam had been destroyed, the wetland upstream would have been lost forever. The rehabilitation of the dam allowed conservation of this wetland of national interest.
- Power production is located inside the dam; therefore no additional structures had to be built (e.g. powerhouse) and no downstream stretch of residual flow is created.

Results

The project is environmentally friendly and was well accepted by the municipalities and the environmental protection associations. Because of those reasons this project received special funding from the Swiss Federal Office of Energy (SFOE).

Figures:

Figure 45: The entire installation
© SFOE

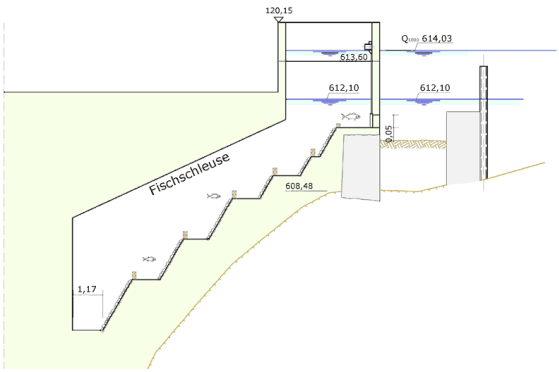


Figure 46: Schema of the fish ladder with a water gate system, integrated inside the dam.
© Naturschutzverein Flawil

Remarks:

Operator:	Glattstrom Buchholz AG
Constructor:	Entegra Wasserkraft AG

Status: ☐ Idea ☐ Project ☒ Realized ☐ Enacted ☐ ….

Milestones:

Initial construction of dam:	1892
Year of rehabilitation:	2006

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of St. Gallen	Small hydropower station Buchholz

Sources:
© Entegra AG:
http://www.entegra.ch/entegraweb/index.php?option=com_content&view=article&id=8&Itemid=17
© SFOE:
http://www.bfe.admin.ch/php/modules/enet/streamfile.php?file=000000009164.pdf&name=000000270024.pdf
© Naturschutzverein Flawil: http://www.nvflawil.ch/projekt6-seite2.htm

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of Valais	Small hydropower plant using a wastewater network - Le Châble - Profay in Bagnes

Description:
The turbine is set in a wastewater treatment plant that operates on the outlets from a ski resort (Verbier) (photo 1). The wastewaters are collected in a decantation basin equipped with a 6 mm filter, used as a loading chamber for the penstock that goes to the treatment plant (photo 2). The first turbine set in 1993 was a prototype: horizontal axis, 2 nozzles, 240 l/s, 450 m, 665 kW. But it's dimensions were for the same maximal discharge as the wastewater treatment plant. Thus, the wastewaters had to be accumulated to reach the discharges in the range of the turbine operation. Such a constraint was not optimal for the water treatment. Therefore in 2007, the turbine was replaced by a new one with dimensions for a maximal discharge of 100 l/s, avoiding any accumulation.

Technical data:
The main turbine specifications are: no jet deflectors, no guiding stars for the nozzles, manholes to clean the turbine, suppression of obstacles and zones where the wastes can accumulate.

Effective head:	449 m
Nominal discharge:	0.100 m^3/s
Installed capacity:	380 kW
Output:	825'000 kWh/year
Investments:	375'000 €

Results:
Apart from a too high dimensioning discharge, the first turbine has been operating properly for 14 years. The maintenance made by the treatment plant team is circa 40 hours per year. An important abrasion has been observed due to the particles from runoffs.

Figures:

Figure 47: Water intake in Verbier
© MHyLab

Figure 48: Wastewater network, from collection to the wastewater treatment plant
© MHyLab

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of St. Gallen	Small hydropower station Buchholz

Remarks: Operator: Services Industriels de Bagnes
Manufacturer : Gasa SA, Switzerland : mechanical design; MHyLab, Switzerland : hydraulic design

Status: ☐ Idea ☐ Project ☒ Realized ☐ Enacted

Milestones: 1993 : Installation
2007 : Replacement of turbine

Sources : © MhyLab : http://www.mhylab.ch/En/index_en.html
© Services Industriels de Bagnes: http://www.sibagnes.ch/services/eaux_egouts/production_energie.cfm

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of Berne	Strategy "Water Use" of the Canton of Berne

Description:

The Canton of Berne aims to increase hydropower production by approx. 10% (300 GWh/a) by 2035. Furthermore, water resources should be used in conformity with the requirements of sustainable development, maintaining near natural river conditions as they are important habitats and recreational spaces.

Hence, the Canton of Berne established a strategy "Water Use". The aim is to provide a decision-making aid based on a transparent and coherent weighting of utilisation and protection interests, established from a strategic, cantonal point of view.

Method:

In addition to the legal regulations for hydropower plants, the strategy "Water Use" of the Canton of Berne lays down that for a deliberate and selective granting of concessions certain requirements for prioritisation of suitable locations and prioritisation of larger plants have to be respected. Hence, the following decision making aids are provided:

- **A map representing the appropriateness of the water bodies for hydropower use:**

  As base information a "map of actual conditions" has been produced indicating for individual water bodies the hydropower potential, the ecological value as well as the importance as waters suitable to sustain natural fish populations. On this basis, a map representing the „hydropower exploitation categories" has been created. It details the appropriateness of the water bodies for hydropower exploitation according to the following classes:

  Green: Water bodies where, under observance of the legal requirements, hydropower is realisable

  Yellow: Water bodies where hydropower is realisable but additional requirements have to be met.

  Red: Water bodies where hydropower is not realisable. Interest for protection prevails.

- **Sustainability evaluation of the individual installation:**

  For hydropower installations (new plants but also already existing ones) – and apart from the aspects already mentioned - an evaluation of sustainability has to be realised in an early planning phase (preliminary study). This evaluation considers further aspects of society, economy and environment based on 22 criteria and indicators.

Along with a spatial prioritisation of suitable locations the strategy also comprises a prioritisation of larger power plants: The strategy proposes that new hydropower plants must have a minimum capacity of 300 kW, avoiding the impediment of more efficient exploitation by larger plants at suitable water body locations. Concessions for smaller hydropower plants are only given in justified cases (e.g. Alpine huts). Exempted are drinking water power plants.

The action plan of the strategy "Water Use" further defines that the optimisation of the hydro-electrical potential from existing installations is generally promoted.

Criteria:

- **Aspects specific to water bodies and corresponding criteria:**

  Theoretical hydro-electric potential, calculated for 50 m river stretches

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of Berne	Strategy "Water Use" of the Canton of Berne

being based on hydraulic head and average monthly runoff.

Ecological importance, being based on the following criteria: Hydrology (20%), Water quality (10%), Rarity value of the water body (50%) and morphology/structure (20%) (percentages indicate the relative weight)

Importance as waters suitable to sustain natural fish populations, based on the following criteria: priority species (30%); species spectrum (20%); fish water (20%), importance as habitat (20%) and potential for rehabilitation (10%).

- **Installation specific aspects and corresponding criteria:**

  For the project-specific sustainability evaluation further aspects of society, economy and environment on the basis of 22 criteria and corresponding indicators are considered. Such criteria are e.g. nature and landscape, flow regime, income for public bodies, noise pollution, recreational importance, added economical value for the region….

Results:

Results from this method are essentially the map of „ hydropower exploitation categories" and a sheet for the sustainability evaluation.

According to the Water Use Strategy, the exploitation of hydroelectric power can be further increased. From the 12'600 km rivers of the canton, 10'600 km are not interesting for hydro-electric exploitation. 230 km are already exploited. Theoretically another 1'800 km would be suitable for hydropower. Of these, 570 km are classified as "green" and 770 km as "yellow". From these river stretches an additional annual electricity production of 300 GWh might be obtainable.

Along 440 km (classified as "red") no hydropower exploitation is possible because of prevailing conservation objectives.

Figures:

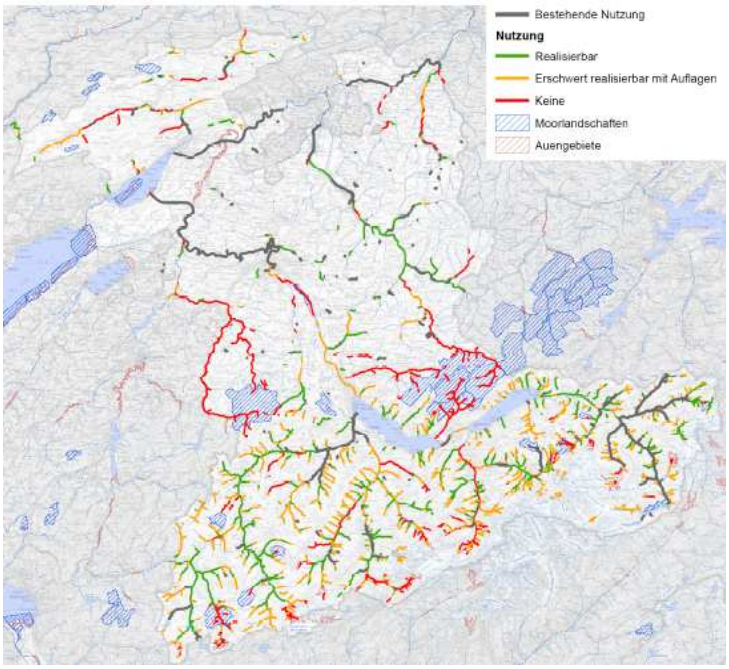


Figure 49: Map "hydropower exploitation categories ".
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	Zielbereich	Kriterien	Indikator
UMWELT	Biodiversität	Lebensraumtypische Artenvielfalt (Gefässpflanzen)	Anzahl lebensraumtypischer Arten (Gefässpflanzen) / Grad der Beeinträchtigung durch das Vorhaben
		lebensraumtypische gefährdete-/ geschützte Arten (Gefässpflanzen)	Anzahl belegter Vorkommen lebensraumtypischer gefährdeter / geschützter Arten (Gefässpflanzen)
		Lebensraumtypische Artenvielfalt (Fische)	Prioritäre Arten und Artenvielfalt
	Natur und Landschaft	Schützenswerte Lebensräume nach NHV	Vorkommen schützenswerter Lebensräume nach NHV / Grad der Beeinträchtigung durch das Vorhaben
		Inventare	Vorkommen von Inventarobjekten / Grad der Beeinträchtigung durch das Vorhaben
		Kantonale und kommunale Naturschutzgebiete	Vorkommen von Naturschutzgebieten
		Aquatische Lebensraumqualität (Fische)	Lebensraumqualität und Aufwertungs- / Entwicklungspotenzial
	Klima	Klimaneutrale Energieproduktion	Stromproduktion
	Energiequalität	Jahreszeitliche Schwankungen in der Produktion	Anteil Stromproduktion Oktober bis und mit März (Winterstrom) an der Jahresproduktion
	Wasserhaushalt	Restwassermenge	Zusatzabfluss
		Restwasserstrecke	Gewichtete Restwasserstrecke
WIRTSCHAFT	Steuern, Öffentlicher Haushalt	Einnahmen der öffentlichen Hand	Gebühren, Steuern und Wasserzinsen
	Volkseinkommen	Wertschöpfung durch Anlage	Bruttoertrag
	Arbeitsmarkt	Kraftwerkinduziertes Arbeitsvolumen	Arbeitsplätze in der Region
	Investitionen	Investitionen	Gesamtinvestitionen
	Ressourceneffizienz	Wirtschaftlichkeit der Stromproduktion	Gestehungskosten
GESELLSCHAFT	Lärm und Wohnqualität	Lärmbelastung	Bewohnte Gebäude in Anlagenähe
	Partizipation	Lokale Beteiligung an Anlage	finanzielle Beteiligung der Standortgemeinde
	Kultur	Landschafts- und Ortsbild	Qualität der Landschaft (oder des Ortsbilds) / Einsehbarkeit der Anlage
	Freizeit	Fischerei	fischereiliche Nutzung
		Kanusport	Beeinflussung der Nutzung als Kanu- / Raftingstrecke
	Überregionale Solidarität	Regionales Steueraufkommen	Steuersitz der Betreibergesellschaft

Figure 50: Evaluation of sustainability
© Bern - AWA

Country:	Province / Canton:	Name of the project:
Switzerland	Canton of Berne	Strategy "Water Use" of the Canton of Berne

Status:	☐ Idea	☐ Project	☐ Realized	☐ Enacted	☒ In public consultation
Milestones:	2009 – Elaboration of the strategy "Water Use" Mid January – mid march 2010 – Public participation and consultation process December 2010 – Decision on the water-strategy by the members of the Cantonal Council				
Links:	© Bern – AWA: http://www.bve.be.ch/site/wassernutzungsstrategie.pdf http://www.bve.be.ch/site/index/awa/-14.content_awa-newpage				