# Technologies For Using Hidden Hydropower Potential

## Cristian Purece [1], Valeriu Panaitescu[2]

*[1](Department of Renewable Energy INCDE ICEMENERG, Romania)*
*[2](Department of Hydraulics, Hydraulic Machinery & Enviromental Engineering, Politehnica University of Bucharest, Romania)*

***Abstract:*** The paper aims to present some new hydropower technologies that use the hidden hydro potential of small and very small head, the investigation of locations with significant hydropower potential such as urban water supply systems, irrigation systems and small rivers in Romania (including small dams and non-energy dams) but also of other possible locations with significant hydropower potential. Even if this hidden hydropower potential is not significant in terms of contribution to the national energy system (SEN), this potential could be useful for reducing electricity demand in various locations/area within smart cities, including raw water treatment facilities and waste water. Also, the efficient exploitation of this hidden hydro potential could contribute significantly to rural electrification, a challenge that still persists. We also mention that in EU the potential of diversion run-of-river hydropower plants (DROR) is 79 TWh/y under the strictest environmental onstraints considered, and 1710 TWh/y under the laxest constraints.

***KeyWord:*** Hydropower potential, Run-of-river, Hidden hydro, Small hydropower plants, Hydrokinetic turbines

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## I. Introduction

Within the European Union (EU), recently passed legislation details how decentralization of energy production from renewable resources can be enabled. According to Article 17 of Regulation (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable resources, "small-scale installations can significantly contribute to increasing the degree of public acceptance and ensuring their implementation related to energy from renewable sources, especially at the local level". According to article 1- paragraph 65, "the transition to a decentralized energy production has many advantages, including the use of local energy sources, increasing the security of energy supply on the plan locally, reducing transport distances and reducing losses caused by energy transport. Decentralization stimulates community development and cohesion at the local level, by creating jobs and implicitly sources of income". According to article 15-paragraph 4, "When establishing these measures or within their support schemes, Member States may take into account, if appropriate, national measures regarding the significant increase in self-consumption of energy from renewable sources, local energy storage as well as energy efficiency, in matter of cogeneration and matter of passive buildings or with low or zero energy consumption".

In accordance with the previously mentioned documents, starting from December 2018, European legislation specifies that the development of micro-installations becomes a priority in energy policies. In this context, the use of hydraulic microturbines in electrical micro-installations with hybrid architecture must be analyzed both from a technical and economic point of view.

Nowadays understanding of the effects of environmental constraints on hydropower development is essential to help policy makers to define future strategies. However, this nexus is rarely evaluated [1]. Estimate how environmental constraints affect the small hydropower potential, depending on the environmental discharge and the spatial density of small hydropower plants it is a priority at the moment.

Since the possibilities to develop new large hydro plants are limited, the focus has shifted to new minimally invasive opportunities for hydropower development that are hidden in plain sight. Currently, there are many new hydropower systems which use the potential hidden hydropower potential and which can be located in already existing structures (for example, dams or unfed pipelines, weirs, canal and systems Irrigation) to provide electricity.

In the specialized literature, this potential hydropower hidden is known as hidden hydro. This hidden hydro term generally refers to the part of hydropower potential that is either based on data not included in national hydropower potential studies or can be used in a more rational way than at present. The goal of such development is to increase hydroelectric production with little or no environmental/social impact.

Considering the above, this paper aims to present some new hydropower technologies that use the hidden hydro potential of small and very small head, the investigation of locations with significant hydropower

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potential such as urban systems, canal and irrigation systems and rivers (including weirs and non-energy dams) but also of other possible locations with significant hydropower potential.

## II. Material And Methods

According to Italian researcher Emanuele Quaranta [2] potential production of electricity through diversion run-of-river hydropower plants and hydrokinetic turbines in EU can be calculated using a Geographic Information System (GIS) based model [3].

Also, the potential in water distribution network and in wastewater treatment plant was calculated by generalizing the results the results presented in the work [4].

The Geographic Information System model computes the annual potential energy production (kWh/y) of a diversion run-of-river hydropower plants according to (1):

$$ \tag{1} $$

where:
– $Q_{nat}$ is the river discharge at the site (m$^3$/s), with frequency of exceedance $\tau$;
– $T$ is the number of annual hours of operation;
– $Q_E$ is the environmental flow considered (m$^3$/s);
– $Q_{10}$ is the discharge with an exceedance frequency of 10% during the year. Considered to be the maximum discharge allowed through the turbines;
– $H$ is the head (m);
– $\gamma$ is the specific weight of water (9.81kNm$^{-3}$);
– $\eta$ is the overall efficiency of the hydropower piant.

In the case of the hydrokinetic turbine, the kinetic power $P_K$ (W) in a certain river section can be calculated with the equation:

$$ - \tag{W} \tag{2} $$

or

$$ \tag{W} \tag{3} $$

where: $Q$ (m$^3$/s) is the discharge, $v$ (m/s) is the water velocity and $\rho$ is the water density (1,000 kg/m$^3$) and $A$ (m$^2$) area of the turbine in flow.

Depending on the slope ($J$) and discharge ($Q$), Equation (2) can be rewritten as follows:

$$ \tag{W} \tag{4} $$

The stream power calculated according to (2) or (3) has to be multiplied by the power coefficient $C_p = P_m/P_k$, where $P_m$ is the mechanical power output, to estimate the power output of the hydrokinetic turbine. Calculations with $C_p = 1$ represent the maximum theoretical potential, dar results must be scaled by an appropriate $C_p$ correspond to the actual performances of hydrokinetic turbines. According to specialized literature, we may assume $C_p = 0.2$ for standard turbines currently available as commercial pr ducts, and $C_p = 0.4$ for available well optimized turbines (e.g. enclosed in hydrodynamic structures).

The calculated kinetic power $P_k$ with (2) or (3) refers to the power available in 100% of the river section. If only a percentage of the cross section is exploited, results have to be multiplied by the percentage of the cross section is exploited. The portion of the exploited cross section strictly depends on local factors, for Europe it can be assumed a constant maximum occupation of 25% of the cross section [5].

In the work [4], the hydropower potential in water distribution network and in wastewater treatment plant was calculated for for different locations in Europe (Portugal, Spain, Ireland, Scotland), on the basis of wastewater treatment plants and other locations within these systems suitable for hydropower installation. The plant efficiency was considered as equal to 50%. The hydropower potential from water distribution networks was found to be 2.89 kW per 1000 people in Scotland and in general by $0.29 \pm 0.12$ kW per 1000 people in the other countries. This high hydropower potential may be attributed Scotland, because the Scotland territory is highly mountainous.

The models represented by (5) and (6) can be used in analyze/determining the hydropower potential:

$$ P_{WDT} = 0.29 \text{ kW if elevation} < 700 \text{ m and } P_{WDT} = 2.89 \text{ kW if elevation} > 700 \text{ m} \tag{5} $$

$$ P_{WWTP} = 44.2 \cdot N \quad \text{(kW)} \tag{6} $$

where: $P_{WDT}$ is the power potential from water distribution networks for every 1000 people (kW/people), $P_{WWTP}$ is the power potential from wastewater treatment plants (kW/people), $N$ is the served population (million), and elevation is the elevation range of each Functional Urban Areas for which the hydropower potential is determined.

Should be mentioned that the Equation (6) refers to regions in non-alpine environment, and the coefficient would be 353 instead of 44.2 to well reproduce estimate in the case of Switzerland for example of 9.3 GWh/y (9.3 GWh/y corresponds to 8760h and 35% of average capacity factor). Therefore, similarly to Equation (5), these two coefficients are used based on the elevation range [6].

In Table no 1, [2] summarizes the results and related investment costs, specifying which kind of potential referring to (technical or economic). The economic potential is the potential that can be developed cost-effectively, while the technical potential is the potential that can be developed based on the available technical knowledge, and it is higher than the economic one. It should be mentioned that both potentials reduce when considering environmental constraints.

**Table no 1**: Hydropower potentials and related investment costs [2]

| No. | Small hydropower technology | Estimated potential (TWh/y) | Investment costs |
|---|---|---|---|
| 1 | Diversion run-of-river hydropower plants | 79 ÷ 1790 | 1,500–2,000 €/kW, $P > 1,000$ kW<br>1,700–2,700 €/kW, $250 < P < 1,000$ kW<br>2,500–3,700 €/kW, $P < 250$ kW<br>0.04 and 0.2 €/kWh |
| 2 | Hydrokinetic turbines in rivers | 0.17 ÷ 1.2 | Average 5,000 €/kW<br>0.04–0.1 €/kWh (single installation) and 0.3–0.8 €/kWh for a hydrokinetic turbine array |
| 3 | Pump as turbine in pressurized water distribution networks and in wastewater treatment plants | 3.0 + 0.38 | Use of existing infrastructure replacing pressure reduction valves.<br>Average 5,000 €/kW [7]<br>0.1–0.3 €/kWh for wastewater treatment plants [6] |

*Referring to Diversion run-of-river hydropower plants*. As environmental constraints affect small hydropower potential from 79 TWh/a to 1,710 TWh/a, it follows that the potential for small hydropower is strictly dependent on environmental protection objectives. Also, climate changes can reduce the production of electricity obtained with run of river in the alpine environment by 3% [8].

According to data from specialized literature [9], the economic potential in Europe is 60% of the technical one. If the environmental constraints are taken into account (the economic discharge is 30% of the mean annual discharge), the potential is 70% of the unconstrained one. European Small Hydropower Association [10] estimated that the EU's technically feasible potential for small hydro is 150 TWh, and the residual potential available for development is approximately 50 TWh, which would reduce to 105 TWh and 35 TWh, respectively, having considering environmental constraints according to [9].

*Referring to hydrokinetic turbines*. The potential of hydrokinetic turbines in rivers ranges from 0.17 TWh/y to 1.2 TWh/y considering installed power above 0,75 kW, respectively, with $C$p = 0.3 and 25% of the occupied river cross section. Also, it is expected that the requirements of future optimized hydrokinetic turbine will be less stringent due to the continuous improvement of this technology, e.g. variable pitch hydrokinetic turbines or new bearing types. Hydrokinetic turbine development may be especially relevant for hydrokinetic exploitation of tidal flows [11] and at the tailrace of large hydropower plants [12].

*Referring to water distribution networks and in wastewater treatment plants*. According to the specialized literature the potential in water distribution networks was estimated as 3 TWh/y, and the average investment cost can be assumed 5,000 €/kW. The cost of hydropower plants in wastewater treatment plants can be assumed ranging between 0.1 and 0.3 €/kWh, with a potential of 0.38 TWh/y in the EU. We considered 8,760 of annual operating hours, for water distribution networks this can be considered quite reasonable, since the flow is almost constant throughout the year, while the average capacity factor of small hydropower plants in wastewater treatment plants is 35% [13]. Therefore, the hydropower technical potential from wastewater treatment plants in EU reduces to 136 GWh.

## III. Possible locations for small and low head hydropower

Depending on the physical characteristics of the different types of hydraulic structures, but also on the net head and the available discharge, the appropriate hydro units (turbine and generator) will be chosen for installation.

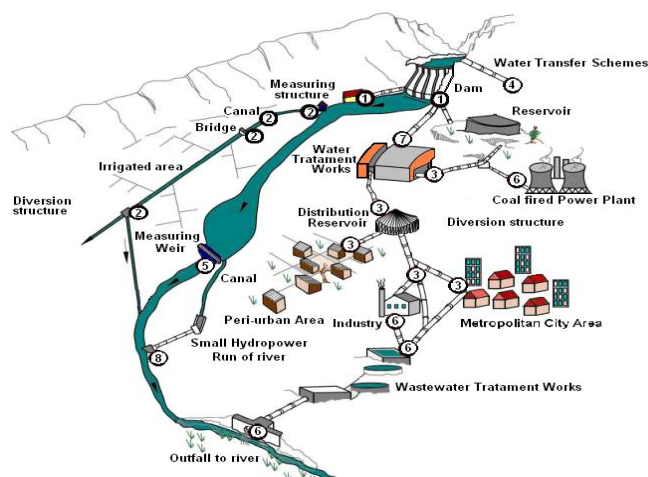Figure 1 schematically shows possible locations for the siting of small and low head hydropower.

**Figure. 1. Small hydropower locations**

**Dams and barrages -1**

Generally large dams are normally associated with significant environmental impacts and only built for major projects, there may exist many opportunities for using small dams and weirs for the generation of green electricity.

Instead of dams being constructed for the purpose of hydropower and then having different functions, reservoirs that are already in existence for other purposes can be fitted with hydro turbines to produce the electricity needed during peak hours. The application of this form of hydropower is limited as there are a fixed number of dams in existence, but the advantages are numerous, because the energy is there waiting to be harnessed with minimal additional environmental impacts.

Hydro turbines are usually built into new dams or retrofitted to existing infrastructure. Type turbines Kaplan, bulb, or propeller are easier to install during dam construction. Also type turbines siphon could be adapted to some low head dams, and smaller dams releasing only small volumes for ecological purposes could consider kinetic turbine type or Archimedean screw turbine type.

An example could be the "Lacul Morii" dam (Figure 2), on the river Dâmbovița, for using servitude discharge and avoiding energy waste [14].



**Figure 2. "Lacul Morii" dam**

**Irrigation systems – 2**

Hydro turbines can be installed in irrigation canal systems to generate electricity, either through diversion or in the canal system itself. Irrigation canal systems are in general normally high-discharge, low-head installations [15].

In general, irrigation systems use diversion systems to canalise water from natural rivers to irrigation canals.

We consider these these diversion systems, could may be ideal sites for the implementation of small power hydropower projects, because the existing infrastructure can be used to lower construction cost and because many diversion structures span right across rivers, allowing for the utilisation of all the discharge for the production of electricity.

Hydro turbines can be implemented the diversion structure wall, or constructed right next to the structure. Siphon turbines or screws turbines can also be located in many existing structures.

In this category, irrigation systems also include chute. These are regularly used for water transportation down hills. Depending on the head available at a particular chute, it can either be bypassed using a pipe and conventional turbine or the existing structure can be used to place a screw turbine, a inline turbine or similar turbine.

Vehicular and pedestrian bridges (Figure 3) can provide many opportunities for easy installation of hydrokinetic turbines and very low height turbines in irrigation canals. These structures can provide anchorage especially for different types of hydrokinetic turbines. The electricity produced by these turbines is based on water velocity and turbine surface area, instead of height and discharge.



**Figure 3. Vehicle and pedestrian bridges**

Atlanta-based Emrgy has developed a way to harness the power of water flowing in irrigation canals. Figure 4 shows the placement of two micro hydrokinetic turbines in a irrigation canal.



**Figure 4. Placement hydrokinetic turbines in a irrigation canal**

In general, the irrigation canals are also equipped with a discharge measurement station (Figure 5), they can provide an opportunity for the generation of micro hydropower. But, it is important that the discharge through the measuring structure is not affected, so as to guarantee effective discharge readings.



**Figure 5. Canal discharge measurement telemetry system**

**Water Distribution Systems (WDS) – 3**

A source of hydropower is found in pipelines, where pressure reduction stations are installed to dissipate excess energy (Figure 6). The energy dissipated by these devices could be captured as hydroelectricity if hydro turbines are installed in the pipelines. These could be located either by replacing the pressure relief valves with a turbine or by installing the turbine in parallel with the pressure relief valves.



**Figure 6. Water pressure reduction station in the Alexandria city, Romania**

In the specialized literature [16], the potential and application of hydro turbines in pipelines is considered in detail, especially at high pressure points and pressure reduction stations in water distribution systems. Also pipe outlets in canals or dams could have potential for low head hydropower applications.

The choice of hydro turbine for this type of hydropower application would depend on both the height available and the layout of the discharge pipe. Pelton or cross-flow turbines can be used when discharging to atmospheric pressure, i.e. when the turbine is placed above the reservoir. Francis turbines could be used when there is back pressure, i.e. when placed at ground level, which discharges into an above ground reservoir.

**Water Transfer Schemes (WTS) – 4**

In certain areas, due to the uneven distribution of rainfall and population, water transfer schemes have been built, many of which can offer hydro-energetic opportunities by placing hydro turbines. The infrastructure of these schemes includes pipes, canals, diversion structures, metering barriers and other infrastructure also found in irrigation systems. Therefore, the types of applicable turbines are similar to those discussed for irrigation systems, screw turbines, inline turbines or different types of hydrokinetic turbines.

**Measuring wiers (discharge) – 5**

Measuring wiers can provide an example of infrastructures built in rivers that can be used to place hydro turbines. The challenges at this type of location are the installation of hydro turbines that do not affect the accuracy of the metering dam and at the same time can be protected during peak flood events.

Hydro turbines at dams and wiers are normally located in the dam wall or built right next to it dam with a short diversion. Kaplan, bulb or propeller turbines would be the easiest to install during dam construction. Siphon turbines or screw turbines can be installed at many of the existing dams.

Small hydro microturbine schemes can be retrofitted or retrofitted for dams that have been built for other purposes such as metering, irrigation, water capture, flood control.

**Wastewater treatment works (WWTW) – 6**

Wastewater treatment works are viable sources of hydropower due to the high volume and constant discharge of water that generally flows from these industrial installations. The discharge at these treatment works are in general constant so that no dam or reservoir is required.

In compliance to the European Small Hydropower Association - ESHA [17], there are two opportunities for hydropower generation at Wastewater treatment works, is at the inlet to the works and at the outflow from the industrial facilities.

If a hydro turbine is placed at the inflow of water treatment works, a forebay with trash rack should be included and the hydro plant should be situated as close as possible to the treatment plant, to maximise the operational head [17].

The resulting discharge from wastewater treatment works is usually released into natur al streams or manmade channels which transport the water to the river system downstream. Because these systems transport water by gravity, they can allow all the extra energy it carries to be extracted.

Also, at these industrial installations, the difference in head between the upstream and downstream levels could be between 1 and 10 m, which, combined with high discharges, result in a high potential for electricity generation.

### Water treatment works (WTW) – 7

Often water treatment works have pressurised incoming pipelines from the feeding reservoir. The reservoir water level will in many cases cause excess pressure in the pipeline, these pressure has to be dissipated before the water can enter the water treatment works facilities (Figure 7). Taking into account the above mentioned, hydro turbines can be installed to generate electricity from the excess pressure result, in a similar way as hydropower from bulk pipelines and and water distribution systems.



**Figure 7. Example of water treatment works facilities in Vaslui city, Romania**

### Run-of-river, small hydropower plant – 8

In present, run-of-river schemes have become conventional hydropower systems and involve the diversion of either a portion the discharge of river or all of a discharge of river through a hydro turbine to generate electricity; or hydrokinetic turbines which are installed directly in a river [18]. In the usual way, in run-of-river schemes, a canal/conduit normally feed a fore bay tank connected to a pressurized pipe/penstock (Figure 8). The design of these system hydropower depends on the topography, water discharge and costs of materials used in the structures associated with the hydropower scheme.

As run-of-river schemes have no storage capacity, it is important to determine and to predict the discharge of river with as much precision as possible.

Turbines used for these run-of-river schemes typically include crossflow or propeller-type turbines, Kaplan turbines, hydrokinetic turbines.



**Figure 8. Typical run-of-river hydropower schemes**

Hydropower is based on the principle that water pressure is used to rotate a mechanical shaft in the hydro turbine. This rotation is used to power a generator that converts the potential energy of water into electricity. The potential power output of a hydropower installation is directly proportional to the discharge ($Q$) and available head ($H$) as illustrated in (7), according [19].

$$P=\rho \cdot g \cdot Q \cdot H \cdot \eta \quad \text{(W)}$$
(7)

where:

*P* is  mechanical power output (W);

*ρ* is density of water (kg/m$^3$);

*g* is gravitational acceleration (9.81 m/s$^2$);

*Q* is discharge through the turbine (m$^3$/s);

*H* is effective pressure head across the turbine (m);

*η* is hydraulic efficiency of the turbine (%).

The design a run-of-river hydropower plants depends on the topology, water discharge and costs of materials used in the structure associated with of micro hydropower scheme.

## IV. Examples of using the hidden hydro potential in Romania

For south-east European countries, including Romania, hydropower is the most important source for renewable electricity generation. However, the potential for hydropower sector development in the future is hampered due to difficult approval of new projects and allocation of leases and permissions. Three viable alternatives are to upgrade the capacity of existing turbines, add new turbines at existing facilities or add hydropower generation to non-powered dams.

Romania currently has 380 hydropower plants in operation with a total installed capacity of 6,453 MW. About 46% are small plants (less than 1 MW installed capacity), 25% are medium-sized (1 MW to 10 MW), and 29% are considered large plants (more than 10 MW). Of this, 90% of the capacity comes from large hydropower plants (6,058 MW) and only 10% (395 MW) is from small or medium-sized installations.

Romania's energy strategy for the years 2023 - 2035 provides that the hydropower potential represents a sustainable development alternative, considering the limited raw materials available in the country for the production of electricity and the need to obtain cheap energy that does not produce greenhouse gases

**Small hydropower plant Zavoiul Orbului**



**Figure 9. Downstream view of Zavoiul Orbului Dam**

The Zavoiul Orbului dam (Figure 9) consists of two side dams and a central spillway. The dam impounds a reservoir with a total volume of 12 million m$^3$, including 1.9 million m$^3$ flood control volume. The spillway has five spillway bays equipped with five gates and 10 bottom outlets equipped with spill gates. The side dams have a maximum height of 7.8 m and total length of about 7.400 m. The dam has an upstream concrete flat slab, 39.5 m long and 2.75 m thick.

The small hydropower plant Zavoiul Orbului consists of two banks of six Archimedes screw turbines. The hydropwer project is adjacent to the dam spillway and the water intake is cut into the embankment dam body. Small hydropower plant are it has a total installed power of 2.6 MW and an energy generated annually between a minimum of 18.2 MWh/year and a maximum of 22.2 MWh/year.

**Craiova Restituție micro hydropower plant**

Craiova Restituție micro hydropower plant is located on the cooling circuit of the CTE Craiova II thermal power plant, and was designed to operate with 3 EOS type microturbines (Propeller turbine, horizontal shaft, S-shaped 1100 mm runner diameter).

The main characteristics of the Craiova Restituție microhydropower plant are:

- two EOS 1100 turbines with a nominal power of 400 kW and a GA 100/85-20 generator;

- an EOS 1100 turbine with a nominal 630 kW and a GA 120/85-20 generator;

- an installed power of the microhydropower plant of 1450 kW;
- an average annual energy of 6.5 GWh.

**Mintia Restituţie micro hydropower plant**

The Mintia Restituţie micro hydropower plant  (Figure 10) is located on the exhaust channel of the CTE Mintia-Deva thermal power plant, and includes a Kapalan turbine with a nominal power of 1.35 MW.
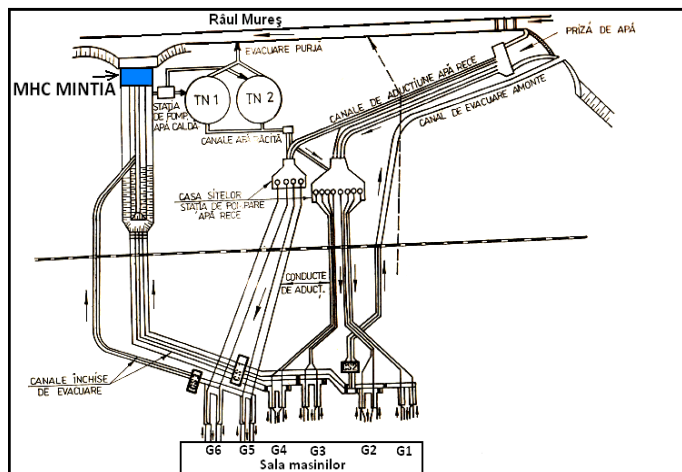


**Figure 10. Scheme of the cooling circuit of CTE Mintia Deva and Mintia micro hydropower plant**

The main characteristics of the Mintia Restituţie micro hydropower plant are:
- a Kaplan turbine type KVS 1.4 – 5.35 with a speed of 100 rpm, a nominal power of 1.35 MW and an efficiency of 89.2%;
- a calculated net head of the turbine of 5.35 m;
- an electric generator type HVS 478/30-90 with an efficiency of 93.2%;
- an average annual energy of 6.5 GWh.

**Iernut micro hydropower plant**

The Iernut micro hydropower plant (Figure 11) is located on the exhaust channel of the CTE Iernut thermal power plant, and consists of two Kapalan turbines with a nominal power of 0.57 MW.
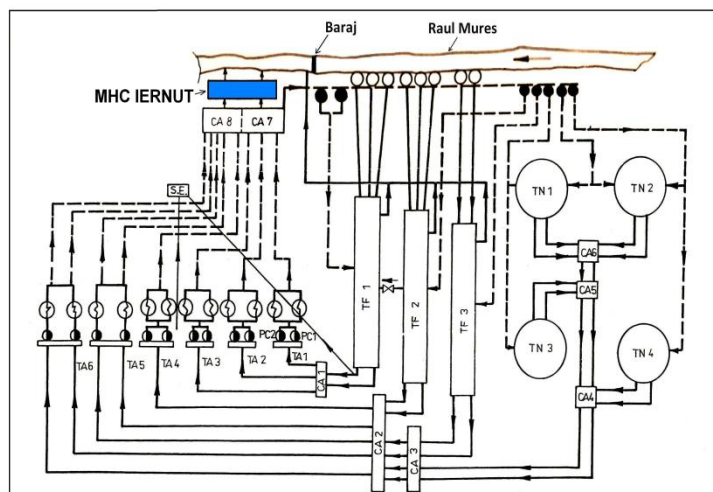


**Figure 11. Scheme of the cooling circuit of CTE Iernut and Iernut micro hydropower plant**

The main characteristics of the Iernut micro hydropower plant are:
- two Kaplan turbine type KVS 0.57 – 7.2 with a speed of 250 rpm, nominal power of 0.57 MW and an efficiency of 88.5% at the nominal head;
- a calculated net head of the turbine of 7.2 m;
- an installed power per microhydropower plant of 1.02MW at the nominal head;
- an average annual energy of 5.5 GWh.

For the rational use of microhydropower plants/small hydropower plants and the correlation of electricity production with the satisfaction of cooling water requirements of thermoelectric power plants, it is useful for the operating personnel of the hydropower plant to know: the daily cooling water requirement, the availability of thermoenergeticgroups (planning of operation and repairs of thermoenergetic groups) with weekly anticipation.

## V. Conclusion

This paper wants to highlight the fact that there is a significant potential for the development of small power hydropower both in perennial flows and within the existing water supply (urban, agricultural) and wastewater treatment infrastructure. This micro-hydropower potential is not necessarily significant in terms of contribution to the national energy system, but it is significant in terms of the potential reduction in electricity demand by consumers.

Hidden hydro offers an excellent opportunity for local municipalities to use their existing infrastructure and reduce their operational costs, for wastewater treatment works, for water distribution systems, for water treatment works, as well as for the irrigation system.

Also, the paper aims to make administrators and operators aware of the means and ways of identifying and evaluating low-discharge hidden hydro in their systems, along with the benefits that generation would have, even in small amounts of energy from own sources.

In parallel with the new projects, small hydro plants from existing structures can be promoted as cost-effective solutions with a low environmental impact. The financial viability of small hydropower plants is further improved by studying and demonstrating how extending their operating range allows small hydropower plants to provide ancillary services to the electricity system. Also, currently significant efforts are being made to optimize the exploitation and gradual renewal of the existing hydropower park and new types of innovative turbines are being designed for use in drinking water networks in cities and in open channels, and last but not least are being developed powerful decision-making tools to select the ideal solution among many, taking into account all relevant technical, financial and environmental aspects.

An additional production of electricity will alleviate to some extent dependency of particularly the water supply utilities on the already stressed national energy system and keep their energy costs lowered. The retrofitting of the low-head hydropower at existing infrastructure will to initiate a process of the water supply and wastewater system optimisation.

Pico and micro hydropower is a broom technology with an age of over 50 years still operating today. Currently, a wide range of hydro turbines are available, each having a varying head and discharge range, thus allowing for the selectin of a high efficiency hydropower plant. Also, there a various locations where low head hydropower could be successfully installed as described in paragraph 2 of the paper.

We find that most dams in the world, but also in Romania, do not have a hydropower component, and adding hydropower capacities at non-powered dams can offer a way to create new energy resources with minimal impact on the environment. Also, adding hydropower plants for electricity production to non-powered dams in Romania, can help maximize the country's renewable energy potential and reduce dependence on energy imports.

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