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Technical features and Italian regulations for small hydropower plants: a case study in Southern Italy

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Abstract. The exploitation of small waterfalls to produce electricity is a topic of considerable interest today, not only for the benefit that it can draw the small community but also for the opportunity to further increase the electricity derived from renewable sources. Then, after a historical examination of hydropower in Italy, technologies, constructive features and guidance on best choice of sites with particular reference to small system will be shown, other than the main legal references and incentives. In conclusion, a study conducted in the late 80s, following an agreement between ENEL and seven Italian University, with the aim to examine in detail the feasibility and affordability of small hydropower in some Italian regions, will be described. In particular the results derived in this study for the Region Campania and Basilicata will be explored.

Key words

Small hydropower plants; technologies; Italian regulation; case study.

1. Story of hydropower in Italy

The use of potential water energy, available between two river cross sections, found back application, already in past centuries, to produce mechanical energy to activate machineries, as mills, rotating chains of small textile workshops, presses, forges and other industrial or seed-industrial applications.

With the following coming of electricity, mechanical uses disappeared without electric energy passage, probably because of problems of irregularities in the outflows distribution in time.

In the paper, the development of hydropower in Italy will be examined, in reference to last century.

In fact, the development of hydropower plants in Italy has tightly been tied to that economic and industrial one. The first run-of-river water hydropower plant was built in Italy in the late Nineteenth Century: the Tusciano river plant, in 1890.

In the '50, electric energy requirement was almost entirely satisfied by hydraulic resource, certainly the best of the renewable sources. The annual electric production was of around 50 GWh, of which 65% hydroelectric.

In the following Table I the budget of electric energy in Italy in 2008 is shown.

Table I. – Budget of electric energy [GWh] in Italy (2008)

A) Gross Production	317894
B) Auxiliary services Consumption	12354
C) Net Production (A-B)	305540
D) Production for pumping stations	7464
E) Received by foreign suppliers	42997
F) Surrendered to foreign clients	3431
G) Demand	337642

Many researches show the feasibility and the convenience of small hydropower plants, considered interesting in Italy and abroad too.

A high increase of energy, in fact, can be obtained, without building new big hydropower plants, using the not yet exploited potential of the micro and mini hydraulic, with small values of head and flow, up to a nominal power of 3000 kW (destined primarily to private operators according to the Italian Law 308/82 on energetic saving and the renewable resources).

2. Small plants: technical and economic features

Recent studies confirm that small plants could increase in Italy the hydroelectric power from 21.000 MW (actual value) to around 30.000 MW, with an increase, therefore, of 50%.

Incentives are expected for such plants: in this paper the current Italian law system will be shown.

For example, those ones with a power lower than 20 kW can exchange the produced electric energy on place; the "Green Certificates" are other kind of incentives that will be described in the full paper.

To evaluate better sites where install small plants, it is necessary to find suitable morphological, geological, hydrological and environmental conditions. These features will be analyzed together with the evaluation of the economic convenience of a plant ([1],[3],[4]). In fact it is necessary to calculate investment costs, management ones and proceeds for the produced energy. The main economic evaluation methods will be cited.

Further, electromechanical equipments most commonly used for small plants will be classified, together with range of head and flow.

The parts of a small hydropower plant, usually the run-of-river water one, tend to reduce dimensions and disappear sometimes, as the inflow channels. Plants, therefore, are much smaller than the classical ones. In the paper, technical and technological simplification for small hydropower plants are described together with new equipment available on the market.

3. Italian regulation

In 1999 the Decree requiring the approval of Parliament on liberalizing the electricity market (The Bersani Law Decree) was approved, with the aim of fostering a competitive system. This Decree is an important turning point in the promotion of renewable sources and, specifically, in the establishment of the obligation for producers or renewable sources electricity importers to put into the grid a share of electricity from new plants or repowering ones powered by renewable sources.

A demand for energy from renewable energy that can be satisfied by a Green Certificate certifying the production of energy from renewable sources available to the System Operator (GRTN), or from private plants. The latter is given the priority of sale. The GC of the plant give rise to the selling price of the grid, which should offset the additional costs incurred to the manufacturer for this type of intervention. The main feature will be shown.

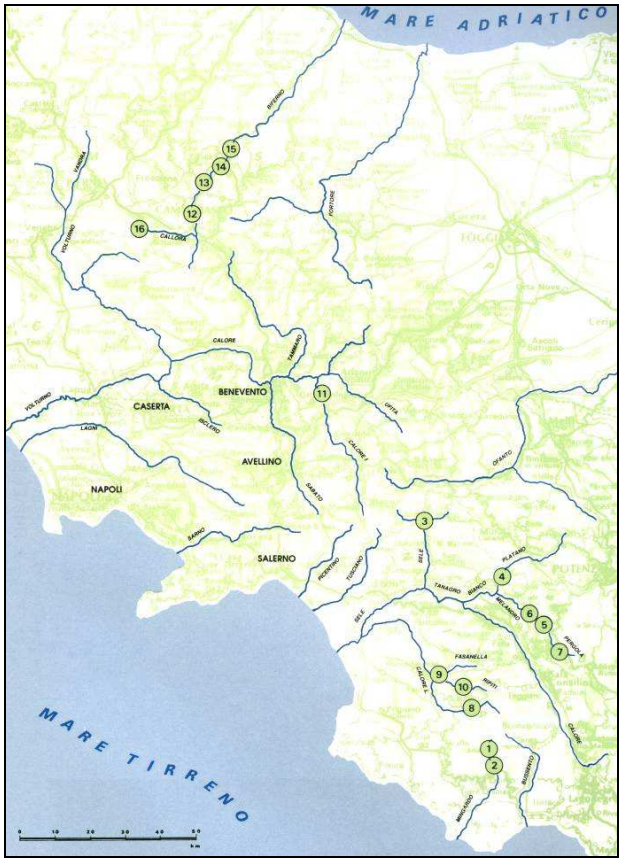
Further, the main financing methods, permits required and statements concerning the installation of hydroelectric power plants for energy recovery will be analysed.

4. Availability of sites for small plants in southern Italy: a case study

During an extensive survey sponsored by the EEC, which aims to identify the possibility of use for energy of small hydraulic resources in mountainous areas of southern Italy and in some regions of Central Italy, in 1989 it was stipulated a agreement between ENEL and seven Italian Universities with the aim to examine in detail the feasibility and affordability of small hydropower in the following regions: Abruzzo, Molise, Campania, Basilicata, Calabria, Puglia, Sicilia, Sardegna, Lazio and Marche.

Main results as regards Campania and Basilicata will be shown: the localization of hydropower plants, the operating ranges of turbines and the hydropower plant features (river, catchment, surface, inlet/outlet elevation, average flow, design flow, geodetic head, net head, max power, average feasibility). In Figure 1 the localization of the sixteen small hydropower sites by the research of University of Naples “Federico II”, in Campania; in Table II the relative turbines, net heads and design flows considered.

Figure 1. – University of Naples “Federico II”: Hydropower plants localization in Campania Region [2].



From these surveys in all above cited Regions, the realization of 70 small plants is possible, for a total capacity of 33.5 MW and a producibility of about 158 GWh per year.

All data relating to investigations carried out in these ten Regions were published by ENEL, in 1990, in the report "Survey on residual small hydroelectric resources in southern Italy. Proceedings of the National Conference sponsored by ASMEZ, ENEL, IASM” [2].

Table II. – Net heads, design flows and turbines [2].

n.	**River**	**Hu**	**Qp**	**Turbine**
n		***m***	***m^3/s***	***type***
1	Mingardo (1°jump)	46.04	1.57	F
2	Mingardo (2°jump)	23.13	2.07	F
3	Sele	62.24	0.50	F
4	Platano	12.90	10.70	T or B
5	Melandro (1° jump)	11.55	3.83	T or B
6	Melandro (2° jump)	53.61	4.01	F
7	Pergola	65.08	1.62	F
8	Calore L.	26.59	1.79	F
9	Fasanella	12.16	3.62	T or B
10	Ripiti	32.06	1.69	F
11	Calore I.	7.81	5.81	T or B
12	Biferno (1° jump)	7.74	5.65	T or B
13	Biferno (2° jump)	18.45	6.09	T or B
14	Biferno (3° jump)	9.98	6.54	T or B
15	Biferno (4° jump)	14.83	7.12	T or B
16	Callora	46.33	0.67	F
			F=Francis	
			T=T.A.T.	
			B=Banki	

5 Conclusion

This paper wants to show that nowadays a large number of small hydroelectric plants are still possible, especially in Italy, which can produce clean energy with the use of the best of renewable sources: the water.

As regards Campania, for example, sixteen plants were considered feasible in the ENEL study; it's possible to draw from them a total power efficiency of about 10 MW and an average annual production of about 47 GWh.

Therefore, few of small installations, individualized in the above study, have been fulfilled: the considerable interest in recent years directed to the use of hydropower energy can promote these neglected Italian research.

Main References

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