

“A Generator”: A Mini Hydroelectric Apparatus as Renewable Source of Energy

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Abstract—The matter is considered in the scope of sustainability and initially the basis and content of the term is defined. Based on this definition, the qualities of water and water energy are inspected as water is one of the most important type of clean energy source. Water energy is a time-honored renewable energy whose use dates back to earliest periods in history. The subject titled “A Generator” is a small but significant support to environmental protection as it defines a patented object which generates energy from water with a mini apparatus.

Protection of future lives of creatures and keeping them in infinite existence necessitate taking measures in advance. Concepts such as environment protection, sustainability, green energy, green economy etc. have also been under consideration by the UN since the 1970s. The subject is very comprehensive. This paper inspects as required hydroelectric power plants which produce clean energy and date back to ancient times. Water, as main source of hydroelectric power plants, is collected in proper basins and thus provided with potential energy. Water is then dropped from heights to trigger its kinetic energy and canalized to turbine wheels, moving which it turns kinetic/mechanical energy into electric power. This basic characteristic of water is evaluated in a mini apparatus this time. And an apparatus of unaccustomed size is obtained, which could support electricity production in household wet areas.

Keywords—“A Generator”, water, hydroelectric power plants, sustainability.

1 Sustainability and the context of clean energy production

Sustainability, which is said to have “emerged with earth goddess Gaia” in ancient Greek mythology [1], was defined in the earliest periods of history as a value of life in the scope of protection of nature.

According to [2]¹, "*Sustainable development*" as a concept was first used in the laws that were enacted to prevent destruction of Black Forest (Schwarzwald), in Baden, West Germany in late 18th and early 19th centuries. For the sustenance of wood supply and to protect forests' good qualities such as prevention of winds and supply of water and recreation fields, it was thought to be necessary to regenerate forests to enable them to serve not only for our requirements today but also for future generations. Sustainability also found use both in English and German as sustained yield and *nachhaltiger Ertrag* in the 19th century. From the beginning of the 19th century on, especially in Germany, sustainability was used to emphasize the ecological and aesthetical functions of forests.

In mid-20th century, people were beginning to notice the menaces of industrial revolution and related excessive industrialisation. For instance, "the fact that around 4000 people died in a week in London due to pollution"[3] triggered some right-minded people to act and in early 1960s Rachel Carson, who considered environmental pollution, wrote her work, *Silent Spring*. Most influential in the formation of an awareness on environment, her book:

"Gives an account of the grim havoc wrought on nature by giving examples from pest control chemicals used chiefly in agricultural production in almost all states of the US... In the chapter titled "One out of every four people" she goes on to say that not only chemicals but also radiation is the direct reason of cancer growth by providing examples... These warnings attracted attention of American people and American Congress soon prohibited the use of DDT and later similar chlorinated hydrocarbon insecticides." This was "followed in 1970 by the establishment of Environment Protection Association, 'EPA' in the US" [4].

Unnatural changes in the climates and related natural calamities triggered by global warming are proliferating day by day and they threaten human life. Following the issue of Rachel Carson's *Silent Spring* 1962, [5] some warning factors developed and these belatedly warned United Nations to take action and led to consecutive meetings. After WW2 and in late 1960s people realized the problems in ecologic balance caused by rapid capitalist development and the links between development and environment were revealed. Accordingly, discussions about the basic principles of sustainable development started in the second half of 1970s.

With the initiative of the United Nations (UN), a great number of meetings have convened globally in both developing and developed countries in the 1970's to raise awareness and take precautions in issues such as environmental protection, sustainability, green production, and sustainable development: World Commission on Environment and Development (WCED) convened for the first time in 1984.

Brundtland Report was issued in 1987: the report titled "Our common future" defined the concept "sustainable development" for the first time. The report bore the

¹ For this information Ayşegül Kaplan quoted the following sources:

Hermann Hill, "Die neue Verwaltung nachhaltige entwickeln," *Die Öffentliche Verwaltung*, Heft 2 (Januar 1993), p. 56.

Hans G. Nutzinger, "Langzeitverantwortung im Unweitzstaat aus ökonomischer Sicht," Carl F. Gelhmann, Michael Klopfer, Hans G. Nutzinger (Hrsg.), *Langzeitverantwortung im Umweitzstaat*, Bonn, Economica Verlag, 1993, pp. 63-67.

phrase “a world in which inequality is endemic will always be prone to ecological and other catastrophes” [6].

Convened in Rio de Janeiro in 1992, the United Nations Conference on Environment and Development (UNCED) included representatives from 179 countries. The conference concluded that the ongoing deterioration of environment was chiefly caused by the unsustainable models of production and consumption practised especially in industrialized countries. The conference resolved upon some strategic preventive measures such as “use of energy and sources in cleaner production processes”, “research on cleaner production methods” and “minimization of waste during production and use” [7].

United Nations Framework Convention on Climate Change, UNFCCC, was signed in 1994.

In 1997, Kyoto Protocol was developed as an extension to UN Framework Convention on Climate Change. Entered into force only in 2005, the rules of the protocol requires “the signatory nations to reduce greenhouse emission levels in 1990 by at least 5% from their levels between 2008 and 2012” [8]. The signatory nations from then on had to use environment-friendly technologies.

Technologies that minimize all factors that threaten environmental and human health, that considers human life together with economy and that utilize natural resources most efficiently are known as “environment-friendly” technologies. Yücel and Ekmekçiler [9] generally categorized these technologies under four main headings:

- a) Technologies that aim to eradicate the harmful effects that resulted from a certain procedure: these are ones that do not change manufacturing processes but treat resulting waste and other hazards.
- b) Technologies that change processes to minimize raw materials, auxiliary materials, natural source input while minimizing waste: These aim at changing production process and type. They are processes and end products whose operation/production require less energy, water, and chemicals and which work more efficiently and give out less waste.
- c) Recycling and reusing technologies: Technologies that turn waste into new materials to ensure reuse and environmental protection, thereby decrease the consumption of natural sources.
- d) Old and conventional environment-friendly technologies: Technologies that are characteristically environmental-friendly, in other words not harming environment.

Hydroelectrical power plants come to mind first when it comes to production of energy with old, conventional and environment-friendly technologies.

These technologies tempts one to think about minimizing the use of “water” or resorting to alternative methods in “water” usage, or looking for alternatives to old and traditional environment-friendly “hydroelectrical” technologies.

Another noteworthy concept in the context of sustainability is “Green Design”. Clad with an environmentalist approach, this concept may diminish processes that could cause pollution and modify them entirely into clean production processes while

considering product life cycles. In the open and closed cycles of product life, first, put forward by [10] and these works studied by [11], recycling, material and energy flows are all mentioned in a process. All the stages in this process incorporate material and energy flows. Keoleian, Koch, Menerey considered and developed the following concepts [12] :

- Raw material extraction,
- Material processing,
- Product design, decision-making stages, production and assembly,
- Product storage, or direct logistics in made-to-order production,
- Product use and service,
- Product consumption, wear and tear, obsolescence, preparation for recycling,
- Getting rid of product waste or recycling.

When recycling happens during the period from material processing to obsolescence this cycle is considered as a closed cycle. When the wear and tear and consumption of the product result in a waste, this is considered as an open cycle. A remanufacturing could be possible during product design at manufacturing stage. Such a production highly increases the costs. On the other hand, through decisions made during design, reuses and multiple uses of the product could be possible on the part of the user. This supports the notion of green production. Green production should be initially be considered as businesses and developed systematically.

2 Water is a source of energy for hydroelectric power plants

Water is a solvent. With positively and negatively charged molecules water has a polarity. For instance, oil and similar substances have one pole and therefore they have a nonpolar structure and do not dissolve in water.

Kahya [13] defined the forces of water as main and secondary forces. Erkek, Ağırlioğlu, defined the main forces as “Hydrostatic pressure (at highest level of tide) and the pressure of the dam itself and buoyance force”, and the secondary forces as “downstream water pressure, earthquake power, suction and pressure force of spilled water, ice pressure, soil and silt pressure, dynamic effect of water passing over sluiceway, crash and vibration strains, reaction forces resulting from different settles, impact of temperature changes, etc.”[14].

Hydroelectric power plants vary according to water capacity, height of the water fall, whether they have dams, dam construction materials, water capacity of the basin, and the value of the power to be produced. Accordingly, hydroelectric power plants fall into two main groups, namely with a large basin or with a small basin. Further, without a water basin, it is possible to produce electric power from rivers. Our project can be said to have been inspired by the structures that generate power from rivers.

Derived from Greek words meaning water and pipe, hydraulics is a branch of engineering that deals with the mechanical properties of fluids, in other words, fluid mechanics. In this context, the potential energy of still water takes on a dynamic

dimension when it is caused to fall from a height; it makes turbines turn and transform into electrical energy in the generator.

In the world, some countries, for example “Norway meets 99% of its energy needs from hydro-electrical power plants (HEPP). Developed countries use almost all their hydro-electrical potential in our day [15]. Construction of hydro-electrical power plants with large catchments may lead to cutting down trees, extermination of living organisms, sinking historical buildings and thus harm the environment or the rivers that feed the catchment may be weak, resulting in inefficiency. Therefore, hydro-electrical power plants with smaller catchments are worth considering as they are thought to be more efficient in the global distribution of energy. Hydro-electrical power plants, which “turn the turbines with the energy resulting from water falling from high”, have “the lowest operation costs, longest life of operation, and highest output compared to other types of production” [16].

The main principle of hydro-electrical power plants, is that: “To turn the potential energy of the water into mechanical energy and then to electric power. Water at a certain level is conveyed into turbines at lower level. Water striking fast to the wheels of the turbine turns the shaft of the turbine and starts the generator. When water falls from a certain height, its gravity potential energy is converted into kinetic (mechanical) energy and with the turn of turbine wheel connected to the generator engine, it is converted into potential electric power” [17].

In the other hand, some other researchers said that “*hydro-electrical power plants are generally classified as linear and nonlinear models.*” *In such a description, “models could be grouped among themselves as “elastic hydraulic head” and “inelastic hydraulic head” in penstock pipe. When control system stability is in question, linear models are important. Linear models are defined as models in which “hydraulic resistance (pressure losses) is negligible, penstock pipe is inelastic, water is incompressible and the velocity of water is directly proportional to the squareroot of turbine distributor span and net water column while mechanical efficiency of the turbine is directly proportional to the product of water column and velocity of water” [18].*

Linear models of hydro-electrical power plants have the principle to make use of water falling from heights to produce electric power. This inspired us to conceive of “A Generator”, the idea behind the patent application.

Although studies on energy throughout the world vary according to R&D budgets of nations of different organization, researchers report a steady increase until 1997. “From 1997 on, with global climate change discussions partly on the foreground, R&D expenditures on power took on an increasing trend with the rapid increase in global demand for power”... “the US and Japan take the lead in R&D activities on power. And in terms of hydraulic power “the US, Norway, Switzerland and Finland primarily support R&D on high-capacity hydroelectric plants while Canada, Switzerland, Spain, Finland, Japan, and Sweden preferred smaller-capacity water technologies”[19]. Accordingly, Switzerland and Finland preferred both high capacity hydraulic power plants and smaller-capacity water technologies.

Forming the subject matter of this paper, the patent titled “A Generator”, and mini sized design innovation developed according to the patent are based on “linear model”.

3 A patented mini apparatus: “A Generator”

Our patented mini apparatus works according to a linear model. Rivers produce natural potential power; electric power could be manufactured from their viscosity. Generally small hydroelectric power plants make use of this viscosity of rivers. Our invention makes use of the potential energy in the viscosity of compressed oriented water in a narrow penstock pipe.

The patent application at Turkish Patent Institute (TPI) for the invention titled “A Generator” is dated August 2008. Long before our application to TPI, it was essential to prove for ourselves that the idea we conceived was correct and working. For this end, we conducted numerous laboratory experiments. Our invention gave us workable results, however the output was low. When narrowing the entry funnel to increase the output, the diameter of the mini pipe was important. A narrow diameter increased the water pressure. Our invention could be installed in standard water pipes in homes, kitchens, bathrooms, around garden faucets and wet spaces in hotels, industrial kitchens, and public toilets, etc.

Our invention works with the water pressure in standard water pipes and in initial experiments, it yielded 1 ampere of electric power from one tonne of water in one hour. In following experiments we obtained 1,5 amperes of electric power with 1 tonne of flowing water in 1 hour. With the main principle of our invention, electric power is produced by transforming the water pressure over 3 bars in standard water pipes. According to this main principle, yield increases with the pace of the water. Technical drawings of our patented invention:

3.1 Summary of the Invention for Patent (Figures: 1, 2, 3):

The objective of the present invention is to realize a generator that converts water energy of the water at a standard pressure and rate in water pipes in buildings into electrical energy. Kinetic and mechanical energy are generated simultaneously as kinetically in the rotor of the generator and mechanically when the belt bearing is rotated by the rotor shaft.

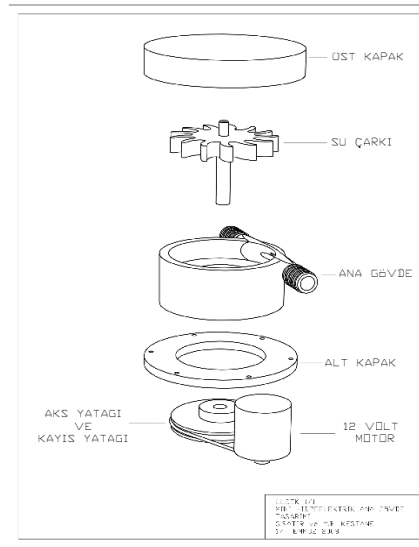


Fig. 1. Patent drawing

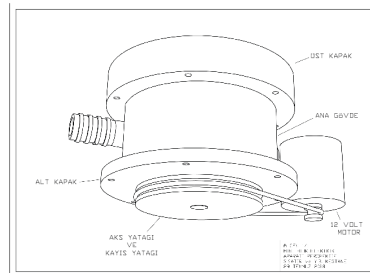


Fig. 2. Patent drawing

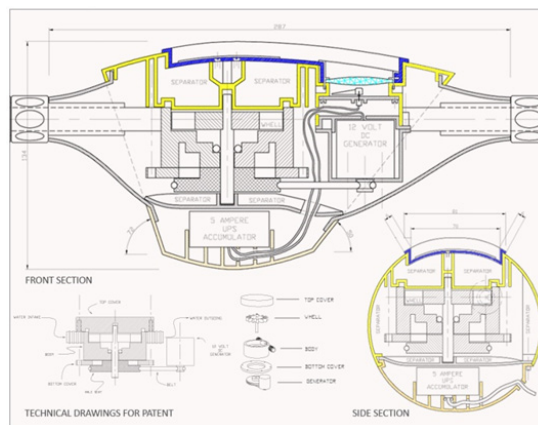


Fig. 3. Patent drawing

Another objective of the invention is to realize a generator that enables to generate electrical energy without requiring any cooling system.

A further objective of the invention is to realize a generator that uses water system pipes of houses, buildings or mobile or public toilets as water channel.

A further objective of the invention is to realize a generator that can produce power which is at least 1 ampere by using 1 m³ of water per hour.

Starting from a linear model and inspired by the viscosity of flowing water in the rivers, the process that resulted in patenting “A Generator” is the successful outcome of the transfer of a very simple and plain idea. Attaining even such a simple result requires trials and errors, and experimenting and practising for years on end. Thought system should be fed primarily with theoretical and practical knowledge. When new information is synthesized with the information already stored in mind, it is conceived and expressed as a new idea. This plain and simple idea was conceived in a similar process.

Patent application was made in August 2008. Patent receiving process took nearly 5 years and only in February 2013 were we able to receive the patent. Russian Patent Office was chosen for the inspection as it was an economical option. However, we rejected the models which were sent and claimed to be similar by the Russian Patent Office. This was because the models suggested by the Russian Patent Office were giant size models such as hydroelectric power plants. However, when creative and original ideas are transferred from giant sizes to mini sizes and vice versa it requires quite different parts and compositions, thus resulting in unusually dissimilar ideas and objects. For this reason, we demanded our invention to be inspected by Austrian Patent Office as well. In the meantime, we had our application documents translated by officials from Ankara Patenting Firm, who we believed could translate technical matters most accurately. Results was a success. Austrian Patent Office affirmed the originality of our idea, and sent the information that no other patent existed in this matter. We succeeded but unfortunately so far we have not been able to take our invention into production stage. Our consolation is that, in the years that passed, we were able to increase the power output further with different points of view.

3.2 Electricity obtained from water pressure

It is used with the water pressure from water running at kitchen, bathroom, garden, dishwasher and washing machine faucets at home, as well as at laboratory faucets etc. at the work place. The electric power obtained is stored in accumulators. The generator with the following specs was developed as an invention and could previously generate 1 Ampere of electric power from 1 hour/tonne of water and this output was increased as a result of an experiential study to 1,5 Amperes of electric power, resulting an increase in efficiency. The main principle is to use the water pressure over 3 bars in the water pipes and convert it into electrical power. These mini sized water turbine experiments are being enhanced; the output increased in line with the increase in the velocity of water.

In order for an invention to become an innovation, it should be readied for production. The invention titled “a generator” was later patented and developed

further and turned into an innovative design under the name "hydral". The prototype was called "hydral" because it was in the form of a miniaturized hydro-electrical power plant which used the velocity and pressure of the water in a standard pipe.

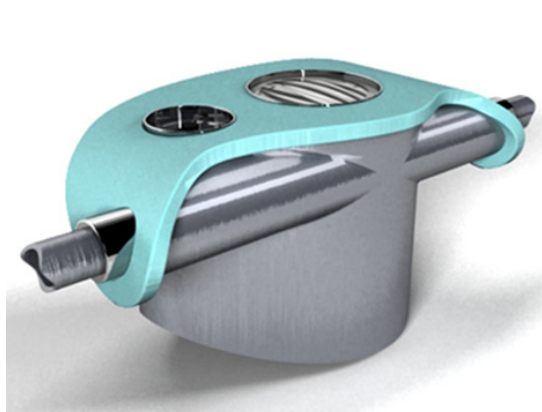


Fig. 4. It's a new product called "Hydral" by "A Generator".

'Hydral' is a product designed with a water pipe passing across it. The product is an energy generator the location of whose components are reflected on the outside. The top surface which holds the indicators give the impression that it is installed between the entry and exit of the water pipe.

3.3 Technical Specs of "A Generator" and "Hydral"

1. A duplicate similar to the penstock pipes in hydro-electrical power plants was obtained by narrowing the water entry for a length of 30 mm and a diameter of 4mm. The funnel-shaped part at the entry from water pipe to the narrowed section eases water intake.
2. Turning wheel has the same functionality with the snail type turbine wheel used in hydro-electrical power plants. However, a simpler clutch of water is obtained by fine tunings.
3. Main body is the wheel bearing while providing waterproofing. It also has a space which fine tunes and balances water pressure. It well-calculatedly eases the wheel to clutch the water.
4. Top and bottom lids both ensure that the body is a closed construction, while the top lid enters 1.5 mm to the body to prevent movement to sideways and provides waterproofing.
5. The part functioning as wheel shaft bearing and belt bearing is the part rotated by the wheel shaft. It transfers to the motor (acting as generator) the kinetic-mechanical energy produced by the wheel shaft from running water.
6. The 12V direct current bc motor converts the kinetic-mechanical energy transferred to it by the turning of belt bearing and belt into electric power. An available mini motor was used here.

Such a design provides a more economical production and accordingly an easier intake power. Many trials were made with the patented “A Generator” invention. Trials are still ongoing with wheels of different dimension and other related functioning parts.

4 Findings and result

Sustainability, in fact, is a concept that was valued in ancient times for the protection of environment and forests. When it became a necessity to consider sustainability with more significance, the several conventions by UN attracted interest to the concept in developed and developing countries. It is compulsory today to protect the environment damaged by excessive and non-clean industrialization, to search clean energies, to ensure their use and also to protect balanced, clean or green production systems. With the stricter decisions of Kyoto Protocol the global society is increasingly getting closer to the required developments and we have to warn every part of our society and every citizen should play their part about it.

Research show that the most typical and easy to apply clean energy has since ancient times been electric power obtained from hydroelectric power plants. The stationary potential energy of water accumulated in basins or the potential energy arising from viscosity of flowing water in rivers could generate electric power. This led to the definition of “A Generator”, which forms the original subject matter of this paper, and to its patenting process.

Besides obtaining an invention that led to a patent, the project “A Generator” was also a step towards “green production” which is a significant subject considered in the context of sustainability. A waterproofing cover (figure: 3, figure 4) that could be attached onto the invention and a mini apparatus that can be used without problems in wet spaces can manufacture power in site, and support available electrical power. Our patented “A Generator” is an unusual type, a mini sized hydro-electrical power plant, or to put it more rightly, an innovation in the form of knowledge transfer.

With this project, the experimental studies of the research process were long and difficult. Similarly difficult was experiencing the processes of patent preparation, patent application, and the long await during inspection, creating hope after a hopeless period, etc. Although we could not accomplish mass production, experiencing an invention and a patent process was significant.

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