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IN THE CONTEXT OF ENERGY POLICY ON TURKEY; EVALUATION OF ENVIRONMENTAL IMPACT OF HYDROELECTRIC POWER PLANTS (HPP)

Abstract:

The way to become a powerful state in today's world passes through having a robust economy and using of underground-overground resources efficient. In parallel with rapid population growth, urbanization and socio-economic development, need for electric energy of Turkey increases rapidly. Increasing of electricity need causes the growing importance of Hydroelectric Power Plants (HPP) in terms of being renewable and cheap.

In the study, impacts of Hydroelectric power plants, which are brought state policy into overcoming energy deficit in Turkey, on flora and fauna, socio-economic structure and climate have been discussed. In addition, following the legal operation process of HPP, hydroelectric energy policy in Turkey has been examined HPP in private

Keywords:

Energy policy, Renewable energy, Hydroelectric power plant (HPP), Turkey

JEL Classification: Q25

Introduction

Having more needed energy, the main indicator of social and economic development, day after day in our country and world ,being limited of energy resources and being widely understood of consuming constantly reality have led countries to review energy policies and to use energy efficiently. Population growth, economic growth and efforts to capture higher living standarts, move away of mankind from the habits on saving are important factors that influence the increase in energy consumption.

World energy demand is constantly increasing on a global scale with being at different rates in each country (Table 1). Global energy investments has been increasing every year to meet this demand. According to UEA data, on the energy sector between 2035 and 2012 at a total investment of 37.4 trillion dollars, particularly in two-thirds of non-OECD countries on global scale are expected to do. The investments are planned below;

- 16.9 trillion dollars for electricity sector,
- 10.2 trillion dollars for oil,
- 8.7 trillion dollars for gas industry,
- 1.2 trillion dollars for the coal sector,
- 0.4 trillion dollars for the biofuels industry (MENR, 2014).

According to CIA World Factbook 2010, today electrical consumption of the country is also an indicator of development of the country. While the electricity consumption is 8900 KW per hour in the developed countries, the average of the world is 2500 Kw per hour (MEF, 2011).

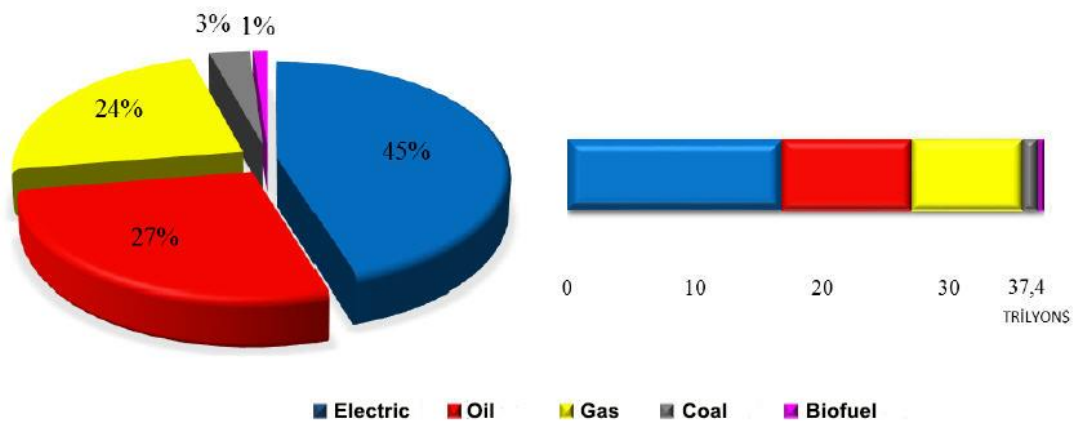
Tablo 1. Growth in Energy Demand

COUNTRIES	ANNUAL DEMAND GROWTH (%)
Average of the world	2.4
Average of the developed countries	< 2.0
Average of the developing countries	4.1
Turkey	6-8

Source: General Directorate Of State Hydraulic Works (MEF, 2011).

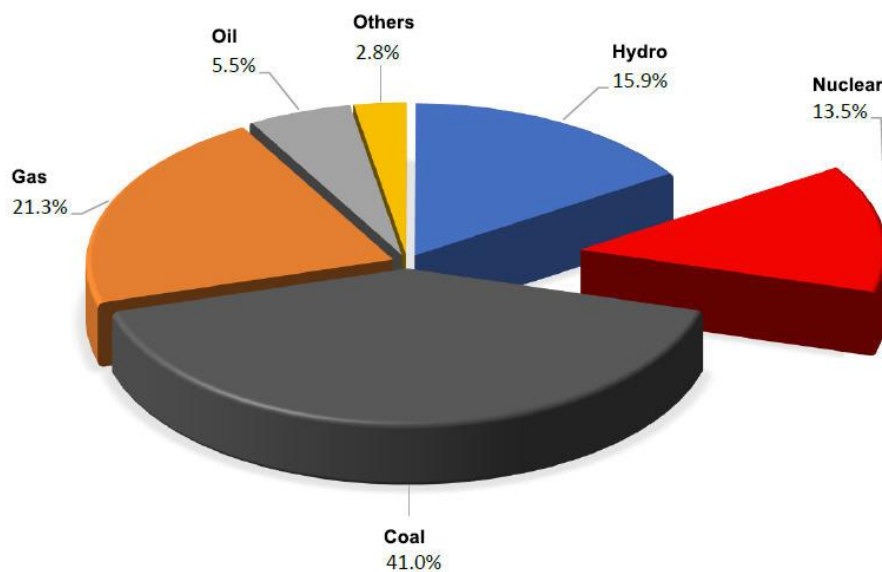
Between the years 2012-2035, considering the scenario of new policies, the overall situation of investments in energy supply infrastructure by resources is presented in Table 2, the distribution of the resources of the world's electricity production is presented in Table 3. (MENR, 2014).

Table 2. Investments in infrastructure for energy supply in the world



Source: Ministry of Energy and Natural Resources (MENR, 2014).

Table 3. Distribution of the World Electricity Generation by Source



Source: Ministry of Energy and Natural Resources (MENR, 2014).

Hydroelectric energy sources are more renewable and environmentally friendly source of energy than energy produced from fossil fuels such as coal, natural gas and oil because of being clean and renewable ,using of local natural resources, low level of maintenance and business costs, consisting of long physical life (Aksungur et al., 2011; Acar and Doğan, 2008). In general, this type of power plant consists of regulator, sedimentation pool, water transmission channel and road, penstock pipes, powerhouse and switchyard (Figure1).

A hydroelectric power plant (HPP) has been working by converting of water potential energy to kinetic energy leaving from a certain height, mechanic energy by water turbines, and electric energy by generators. HPP projects are structures generating electricity by utilizing the energy of the water (Akpınar, 2005; Şekkelı and Keçeciođlu, 2011).



Figure 1. Hydropower (HPP) applications rehabilitation project (Ispir-Coruh basin)

Overview of the River Type Hydroelectric Power Plants;

Hydroelectric power station can be classified according to the power board as well as the types of energy production. According to classification determined by Nations Industrial Development Organization UNIDO and accepted by many countries in the world;

Installed capacity,

- between 0-100 kW micro power plants,
- between 101-1000 kW mini power plants,
- between 1001 to 10,000 kW are defined as small HPP

Small hydroelectric power plants produce electricity (SHPP) by converting the energy available in the water flowing in rivers, canals and streams. Capacity and energy production of a SHPP generally depends on two factors: current flow and fall height. Small hydroelectric power plants are important besides their contribution to total energy production from hydro power plants in terms of political and social matters. Through this kind of power plants, small industrial energy is generated with the illumination of small settlements and the development of the region by providing in agriculture , the development of handicrafts are contributed (MEF, 2011; Panic ETA II, 2013).

Advantages of Small Hydroelectric Power Plants;

- Economic life is long
- Prevalent throughout the world,
- According to other sources of energy non-renewable, environmentally friendly,
- Low operation and maintenance costs,
- Non-fuel costs,
- The repayment period is short (5-10 years),
- High efficiency (over 90%),
- Ability to meet peak demand, providing flexibility and convenience in the business,
- Providing economic and social contributions to the local people,
- Native source independent on external sources.

Disadvantages of Small Hydroelectric Power Plants;

- Negative Impacts Resulting in the Construction Phase: Environmental impacts such as noise, visual destruction, dust, etc. occurred during material transportation. In addition, it is seen that the negative effects on the aquatic environment. Increased water turbidity and suspicious-unknown substance density may also lead to environmental destruction although minimizing with a well-planned operation.
- Changes of the river-bed stream: Agricultural activities in the region affect local infrastructure, social life, archaeological sites or protection zones.
- The construction of embankments or dams: may cause ecological damage in the water flora and fauna.
- In some applications (eg reinforcement work on the dam) ventilation levels are reduced and negative influences can have in water life. Changes in the amount of water oxygen affects growth of fish negatively while reducing the reproduction of fish and may lead death in some rare species.
- Water quality deteriorates hitting turbine blades with high speed and therefore live life in the region can be affected negatively.
- Changes occurring in water flow: leads to expansion of the waterbed of rivers, streams flowing since Millennium, regularly decreasing of the flow of water can also lead death of fish that live in these regions. Specific species living in the area only (endemic) can vanish. Nitrogen saturation caused by changes in water flow (nitrogen super-saturation), leads to gas bubble disease in fish and can cause their death.
- Hydroelectric projects can cause erosion, visual impairment, damage in aquatic ecosystems giving rise to the formation of suspected solid in the river bed (Buttanrı, 2006; Kaya, 2011).

Materials and Methods

In the study, in addition of positive sites, the negative effects of the river type hydropower plants, brought the state policy to prevent energy deficit in Turkey, increasing numbers rapidly in recent years, on ecological systems, climate, the socio-economic structure, flora and fauna are discussed. In addition, following the legal processes of operation of hydroelectric power plants, hydroelectric energy policy in Turkey has been examined in private. Turkey's geographical coordinates are 36°- 42° north latitude and 26°- 45° east longitude. It has a total area of 814,578 km². Turkey's geographical location makes it a natural bridge between the energy-rich Middle East and Central Asian regions (Figure 2).

Energy plays a vital role in the socio-economic development and in raising the standard of living. Turkey is a rapidly growing country where both its population and economy are expanding each year, resulting in a corresponding increase in its energy demand. This increasing demand has to be met to keep a sustainable development in the economy and to raise the living conditions of the people (Dursun and Gokçol, 2011).

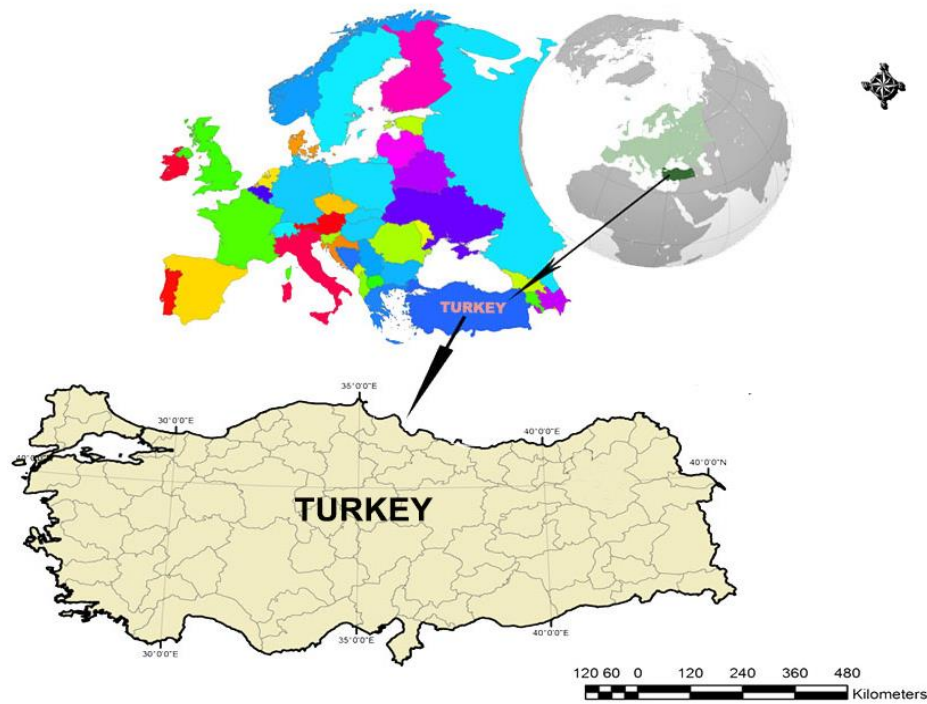


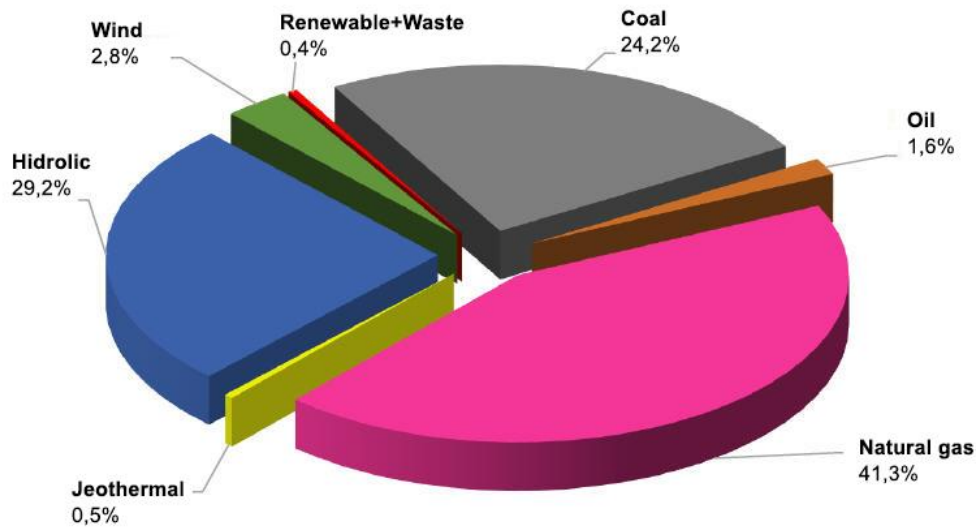
Figure 2. Turkey location

Hydroelectric energy needs in Turkey

It is clear that electrical is necessary for life and development in all areas of energy sectors is a rapid increase in demand as a result of high economic growth and rising prosperity in the last 10 years in Turkey.

Turkey, in the Organization for Economic Cooperation and Development (OECD), is a country where energy demand growth is the most rapid in the last 10 years. We expect that demand for energy will rise 2 times in the next 10 years. Turkey has become the second largest economy after China, with the highest increase in demand of electricity and natural gas in the world since 2000. According to the most likely scenario it is expected that the annual electricity consumption will reach 450 billion kWh with increase of about 8 %, according to the unlikely scenario, it is expected 372 billion kWh with increase of about 6 %. Distribution (%) of electricity production according to primary energy sources in 2013 (%) is given in Table 4. (Atış et al.,2014; MENR, 2014).

Our country's electricity production in 2013 is derived from natural gas in the rate of 41.3%, hydropower (29.2%), coal (24.2%) while the remaining (5.3%) from renewable waste sources such as the wind, the oil and the geothermal. Turkey's average elevation is around 1,300 meters above sea level. Considering the topography and morphology our country is among lucky countries in terms of both fall and flow. Our country has such advantages in terms of water resources, unfortunately there is not at the level needed to reach at the point of evaluation of these resources.

Table 4. Turkey's electricity distribution according to energy sources in 2013

Source: Ministry of Energy and Natural Resources (MENR, 2014).

A small hydroelectric power plant has a significant potential for hydroelectric power generation in our country (Uzlu et al., 2008). Hydropower potential feasible as technical and economically has been estimated 140 billion kilowatt hour in our country. By the year 2010, 53 billion kWh hydropower production potential per annum was put into operation. This value is only 37.85% of total hydropower as feasible potential technically and economically. When we look at the world situation, US developed 86% of the hydroelectric potential, Japan 78%, Norway 68%, Canada 56%. When the ongoing HEPP projects are completed about 80 billion kWh per year of electricity generation will be provided and the rate of use of our existing hydroelectric potential is planned to be increased approximately 90%.

Hydropower potential of rivers generally depends on fall and flow of the water where topographical conditions were provided. As known water flow energy is transformed into mechanical energy by water turbines in the hydropower plants and mechanical energy is transformed into electric energy through the turbine generator that is moved by the water turbines. It is necessary to be dropped water from a certain height to generate the electric power, which is the potential energy of the water must be converted into kinetic energy. In this regard, the Black Sea basin and the environment where altitude difference is at short distance and quite good in average rainfall in Turkey, is seen as areas where Hydro power plants are established intensely (Çapık, et al., 2012). Figure 3.

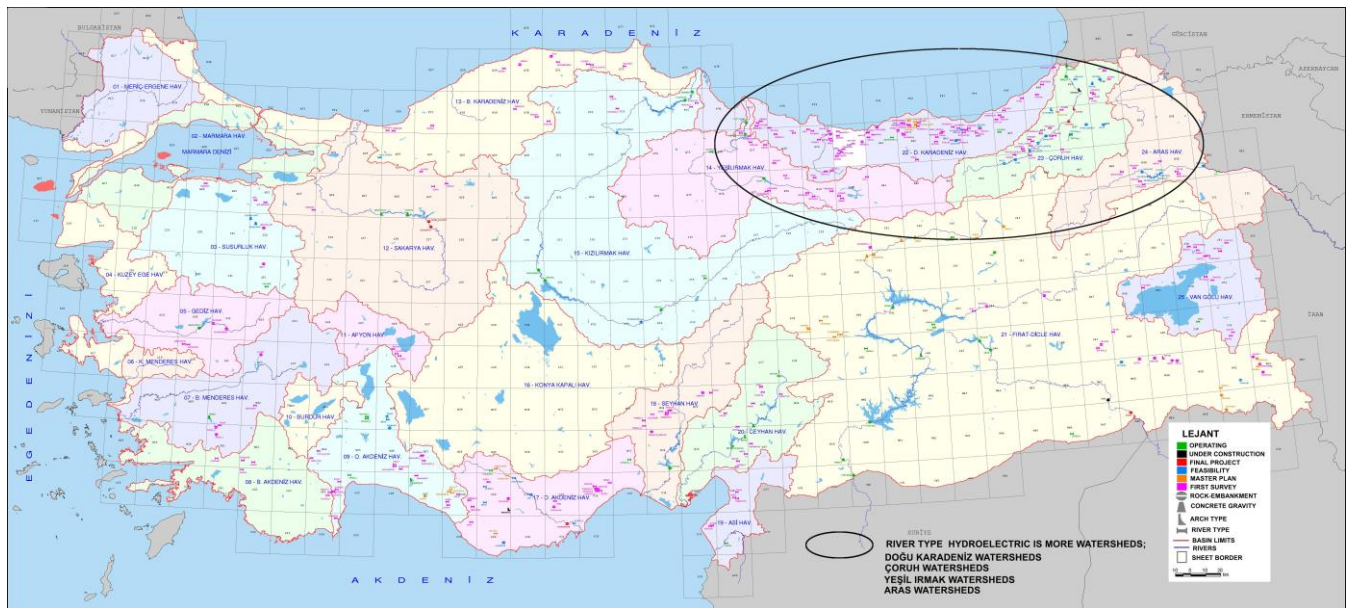


Figure 3. Turkey Hydroelectric Energy Potential Map

Source: Turkey's Energy and Natural Resources Ministry (ENRN, 2015)

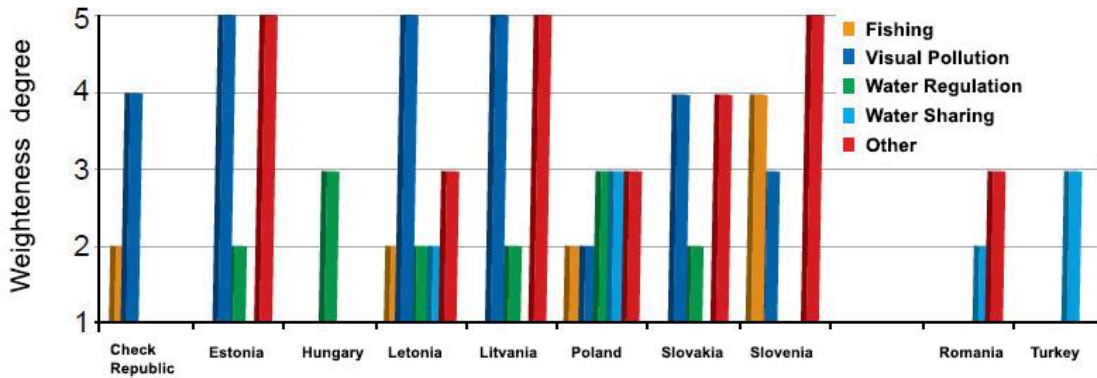
Hydropower in terms of the Environment in Turkey;

Growing water needs and using methods of water resources comes up often in Turkey. However, in Turkey, an integrated water policy and a "Water Framework Act" setting out the framework of the principles and methods related to water management are not available. In these cases, policies for water management in Turkey lead to the formation of a series of contradictions (Ürker and Çoban, 2012).

There are many effects of production of hydroelectric energy on the natural, historical and cultural heritage and socio-economic environment, varying from project to project. It is assumed that hydroelectric power is one of the energy production methods environmentally damaging the nature minimum. It does not consist of any toxic waste at the stage of operation and greenhouse gas emissions are quite low according to hydropower plants using fossil fuels in energy production. For this reason, it is most widely used form of renewable energy with the solar, wind and geothermal resources in recent years.

However, hydroelectric plants are not so clean in terms of causing damage to nature. Primarily in the construction phase, they may have big environmental impact according to the area. A regulator with water intake structures has disrupted the integrity of river acting like a small river dam. They change the natural flow of the river with water intake structures by taking a very large amount of water between the areas where the water has been given to stream. In particular, some environmental criticism has been brought intended for HEPP in the new and candidate EU countries which has a significant potential in terms SHEPP. Some of these issues are visual pollution, fisheries impacts, water-sharing and demand for water in the other areas (Table 5).

Table 5. Criticism Heads towards SHEPP in the New and Candidate Countries of the European Union (1- No Effect, 5-Serious Effect).



Source: Ministry of Energy and Natural Resources (MER, 2014).

The most important influence on the construction phase of the hydroelectric generation projects is represented as dust, noise and traffic. However, the disposal of excavation during construction and how to move can be problem. In particular, the effects as vegetation damage because of falling out the excavation during the construction of water transmission lines in the slopes and deterioration of the river bed structure may also be (Figure 2). The impact on business is water reduction as a result of using water between regulator and HEPP building stages founded on the river bed section (Ürker and Çobanoğlu, 2012).



Figure 2. Landscape Restoration Project

Source: Baybah Regulator Material Area . Landscape Restoration Project (Kardeniz et al; 2014)

When we sort out the effects of HEPP; generally its water intake structures (regulators) affect transition and migration of the fish by disrupting the integrity of the river, the water transmission lines made as open channel format leads to habitat division of land by affecting animals crossing, construction made in all areas consists

of enormous destruction and exposed to erosion because of the earth surface stripped, all aquatic life is threatened due to changes in flow rates and flow. Depending on this, agricultural production declines due to agricultural irrigation shortages and microclimate changes due to water retention. Also, depending on the of large quantities of trees cutting in the project area forest quality declines, as correlated with changes in the amount of water, groundwater levels, so this case changes in groundwater impacts both the geological structure as well as forests (Berkün et al.,2008; Kurdoğlu and Özalp, 2010; Karadeniz, et al., 2011; Ürker and Çobanoğlu, 2012; Kocabaş, et all, 2013).

With HEPP construction, It has been utilized from environmental impact assessment (EIA) report about what are the environmental impacts and how the dam will be affected as the existing flora and fauna in this area.

HEPP Environmental Impact Assessment (EIA) process;

All HEPP go through a thorough editing and review process before the start of construction in Turkey. The firms entitle to sign Electricity Generation and Water Usage Rights, start to prepare the report Environmental Impact Assessment (EIA). Environmental impact assessment reports are reports describing the interaction of structures with the environment. EIA is a process where significant impacts of a specific project or development on the environment are determined. This process is not only a decision-making process itself, but also it developes with decision-making process and supports it.

In the earlier according to Environmental Impact Assessment Regulation, river power plants with capacity of 50 MW and above are installed in Appendix I listing of the EIA regulations, 10 MW and above 10 are in Appendix-II listing, but then capacity of 10 MW and above has been exempted from the EIA process. Again all the hydroelectric project has been taken in the EIA process with new EIA regulations dated 17 July 2008. 0.5-25 MW hydroelectric projects are covered by Annex II. Annex II projects have preliminary EIA and do not require public consultation and disclosure process (Aksungur, et al., 2011; Ürker and Çobanoğlu, 2012).

Hydroelectric projects are presented Nature Conservation and National Parks General Directorate for pre-EIA; The main topics are reviewed below.

- Ecologic needs in the ecosystem where the project area is
- Sensitive, endemic and endangered plant and animal species
- Whether or not the protected area is near the project, borders, relations and management plan
- The project's domain (tunnel length, the downstream values, the future reservoir area, etc.).
- Flow of the river
- Environmental Flow Assessment
- Environmental Flow Quantity

Also, it is requested "evaluation report" and "Landscape restoration assessment report" for hydroelectric projects and other hydraulic activities demands by the same ministry.

Some of the matters in the prepared report format;

- Walkthrough in the Protected Areas
- Hydrogeological evaluation, River-Section Reviews
- Meteorological Evaluation and Flow Relationship

- Assessment of Aquatic Life
- Evaluations with Terrestrial Flora and Fauna
- Evaluation of Fish Passage
- Evaluation of Materials and Excavation Site
- Calculation of Environmental Flows
- At least 3 science: Hydrogeology, Hydrobiology or Seafood, Ecology

Compensation measures, necessary for each condition separately under the influence of activity, are required according to Environmental Impact Assessment format by the Ministry. Financing activities for the fulfillment of all required measures are carried out by the owners (Meriç, 2013).

Results and Discussion

Increasing energy demand in a developing country such as Turkey and external dependence on energy today are reality. There is much tendency to hydroelectric power in Turkey to meet this ascending demand and to reduce dependence on foreign in recent years has turned into a major.

Today, many scientists, environmental experts, academics and some civil society organizations think that, the hydroelectric power plants have major negative impact on the environment, but some people put forward that hydroelectric power plants have no negative impact on the environment. On the other hand, according to the International Energy Agency, hydroelectric power plants are reported to have many negative effects, and it is accepted. In this context; point of view of public for investment projects based on natural resources, which economic, social and environmental impacts are more, have great importance.

In Turkey, when several license are given for HPP projects by the Energy Market Regulatory Authority, it cannot be asked comments of the local population, public institutions and civil society organizations. In this case, people look suspicious to the project, oppose the investment. Even stakeholder meetings made by the relevant companies during the construction of power plants, this case can not address the concerns. Even so occasional clashes between company officials and local people has emerged an example of social integration investment (Karadeniz, et al., 2011). Recently, a large number of opponents actions are carried out regarding to hydroelectric power plants and the establishment of these plants in our country.

It is very important how much water will be released in the natural bed of the river after opening river type HEPP construction to operation, in other words, how much will be compensated for water or life water is important. Life water rate is defined as at least 10% of the average of the last ten years flow according to the Water Use Agreement Regulation 4.paragraph 2. chapter. However, of course it cannot be expected that life water ratio is not same for each stream. Essentially, the determination of this amount of water should be based on the analysis of data related to the flow of water in rivers and streams regime, usage by local people, creeks of vegetation, very long gathered to many different factors, such as aquatic organisms and wildlife (Kurdoğlu and Ozalp, 2010; Karadeniz, et al.,2011).

it is worth to discuss socio-economic impacts of hydroelectric power plants. In Turkey, when completed hydroelectric projects in planning and installation stages, paying the foreign amount of energy a year will fall \$ 15 billion, 85 billion kWh energy will produce annually and 38% potential will be increased by approximately to 90%. The amount of private sector investment for this project will be about 40 billion US dollars. Those,

claims managing the energy sector, merit serious concerns about that contribute to the local economy with increasing investment following the HEPP, commercial life enrichment, improvement in agricultural activities, developments in sectors such as forestry and tourism. About 50-60 people work during construction phase and opening of the land in HEPP project, an average of 8-10 people work during business phase, they come from outside the general area that has mostly technical and qualifications in this staff (Ürker and Çoban, 2012).

As in the world and Turkey, two key problems of the hydropower projects are life water and damage and these problems have great importance. Water identify studies in the streams conducted HEPP project must include long-term monitoring, must include the amount of seasonal water use of people. These rates compare with the amount of life water planned leaving in the project file, qualification must be questioned whether the ecosystem needs to be involved. Calculation methods of life water made without taken into account the of global climate change factors should definitely be revised and the rate must be improved. Otherwise, irreversible environmental losses are inevitable.

Also; integrated watershed planning should be done in regions where HEPP project was planned and various values and use components of the basin should be determined. The number of projects to be in the area should be considered. Also it is encountered several shortcomings and errors in the preparation process of the EIA report. Report made by consulting firms should be examined in detail. However, in the light of the result, it is also recommended increasing the academic project to illuminate the individuals in the community with accurate information about environmental issues such as HEPP.

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