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Abstract: While the growth of Turkey brings many prosperities, the required energy for this development creates a dependency that goes up to 80% of total energy consumption. In order to have a resilient energy system that adapts to sudden changes in an area where political and social conditions are not stable, Turkey needs a renewable energy source produced by domestic resources. This study shows that the abundant resources in agriculture sector for biomass energy production, especially biogas production, can be that energy source however, this will require a new rural development model that uses cooperatives in its centre. Further research and interviews suggest that, the cooperatives have the capacity, but not all of them have the opportunity and the support to take upon this task.

Keywords: Sustainable Development, Renewable Energy, Cooperatives, Turkey, Local, Farming, Agriculture, Biogas, Resilience, Energy, Manure, Residues, Rural Development,

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Summary: The numbers show that, Turkey is 90% dependant on coal consumption, 94% dependant on oil consumption and 98% dependant on natural gas consumption for energy production, with an overall 80% of the energy consumed for energy is dependant to other countries. Considering the economic pressure and the political condition of the region that Turkey is in, creating a resilient energy system by diversification of energy production through renewable energy sources using indigenous resources is the main goal, with three aims. The first aim is to find the renewable energy alternative source for Turkey, while the second aim is that this alternate renewable energy source must fit in the structures of Resilient Energy Systems Theory in order to create the much needed sound energy sector. On the other hand, since it is going to using the indigenous resources, the alternate renewable energy source must help the rural areas and its development in the process, which builds the background of the third aim.

In order to fulfil the first aim and find the renewable energy alternative for Turkey, the study by Barış and Küçükali was chosen, evaluating the renewable energy sources under economic, environmental and social aspects. This study finds out biomass as “the most appropriate renewable energy source” for Turkey considering its high social benefits resulting from public acceptance and job creation and high capacity factor. This paper later focuses on biogas production, realizing its use of high renewable indigenous sources for substrates, high energy production possibilities and socio-economic advantages. It is found out the theoretical biogas production of Turkey can replace 31% of the natural gas consumption and will be able to cover 10% of the total energy consumption. Biogas also fits perfectly to Resilient Energy Systems Theory through the farmers, an actor who can be the producer and the user of the energy technology by harvesting the “indigenous intermittent renewable resources”. These sources then will be used in a localized renewable technology, using anaerobic fermentation and co-generation plants for energy. In addition, the small settlements of the farmers will be provide the diffused system of ownership aspect of the theory. In this way, biogas fulfils the answer for our second aim; “Can the renewable energy alternative be considered as a resilient energy source?”

The third aim which looks for rural development through economic diversification led by biogas production which creates a diverse economy from the beginning, by uniting the energy and agricultural sector. In addition, the new employment possibilities and diverse income will help the different sectors in the rural area. The theory also calls for a new administrative system of partnerships and cooperation for the new rural development, however the biogas production plants itself does not give us a new system for administration. In order to complete the principles of the theory, the suggestions of Kayhan Kalelioglu and Tolay is used. They argue that a 15 km circle of waste management system in the rural parts, that also suits with the Resilient Energy System’s search for a community owned renewable energy technology can be used if the cooperatives can be the new partnership system. The seven principles of cooperatives promotes a democratic participation of the members, provides education, training and information to its members to work for the sustainable development of their communities. However, in the Turkish case, the cooperatives that aims for rural development are high in number; nearly 2% of all cooperatives in the world and according to the Turkish government they have many problems regarding the seven principles. They propose a new centralized system that manages the cooperatives.

Although this is all and well, the two cooperatives that was interviewed; The Union of Husbandry Cooperatives for Şanlıurfa and the Toslak, Yeniköy, Hackikerimler Villages Agricultural Development Cooperative in Alanya points out that the rather than the centralized management, a better auditing system must be formed that promotes the good work of the cooperatives in order to create a better cooperative image. In conclusion the cooperatives provide a new administrative partnership system for rural development theory, however in the Turkish case, in order for this ideology to be spread, the successful examples like the Toslak, Yeniköy, Hackikerimler Villages Agricultural Development Cooperative in Alanya, who had plans to build its own biogas plant, must be promoted and provide a concrete example of a farmer’s democratic cooperative that can build its own resilient energy production system.

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Dedicated to people who were defending their rights in the Gezi Park, around Turkey and all around the world, to Abdullah Cömert, Ali İsmail Korkmaz, Ethem Sarısülük, Mehmet Ayvalıtaş, who were killed by police brutality and mob violence, to police officer Mustafa Sari who died because of the overwork policy of the security forces, to Ahmet Gündüz, Şükrü Kahraman and Mahsun Ertaş who were living in Ceylanpınar by chance and died because of a civil war of another country and to the working class people and the cooperatives who is working for the development of their areas.

August, 2013
1. Introduction

1.1 Problem Background

If there is a need for explanation for the “developing” part in the “developing countries” term, Turkey is one of best suited countries for the example. A population of 73.7 million people, where the citizens younger than 15 years old are 31% of the total population, and being one the world’s 20 largest economies with a GDP of 742 billion $, have created a fast growing middle income country. Turkey’s annual population growth has an average of 1.8%, resulting in the doubling of the population since 1970s. One of the results of this growth was the high rates of migration from the rural provinces to the urban centres, particularly from the eastern part of the country to the west. On the other hand, while 24% of the total population still lives in the rural areas, they have lost their population of working age citizens in this migration process. This large population of young workers have created an economy that has lived through a remarkable recovery from a deep economic crisis in 2001, with increasing total export and import values leaving to the young workers a 10,440 $ GDP per capita tripling since the 2001 crisis and increasing nearly tenfold since 1986 (OECD, 2011).

![Domestic Energy Production Chart](image)

Table 1: Domestic Energy Production in Turkey adopted from (Ministry of Energy and Natural Resources, 2012)

However, this fast growth of industrialisation, urbanisation and population requires a considerable amount of energy. The energy demand has risen more than 150% since 2001, reaching to 114,480 ktoe (Thousand Tonnes of Oil Equivalent) (Ministry of Energy and Natural Resources, 2012) (Table 3). This demand is met with different kind of sources by the domestic production (Table 1), where the biggest resource is lignite, which is also called the brown coal, with characteristics in between coal and peat. More than half of the total energy production from Turkish resources comes from coal and lignite, which is burned right alongside the mines because of its transport and trade inefficiency resulting from its low energy density and high moisture content. Together they produce 17,446 ktoe per year, with a possible capacity to produce more energy, since Turkey has significant reserves scattered to all the regions reaching 10.4 billion tons; nearly 1.5% of the entire world’s resources and enough for sustaining the current Turkish production level for 157 years (Balat, 2010). Lignite is followed by hydropower energy production, which is also the biggest renewable energy source in Turkey. Low investment costs of labour and construction, has increased the energy production 15% since 2006, reaching 4,501 ktoe (Barış & Küçükali, 2012). Wood, crop and animal residues, which is generally burned for creating the energy, are the third biggest energy source for Turkey, producing, 3,554 ktoe. Although it is the second biggest renewable energy source, the handling of these residues is problematic and creates ecological and health related problems (Alkaya, et al., 2010). Oil production in Turkey equals a 2,551 ktoe of energy resource, however, as it will discuss further, this production is not nearly enough, which is the
case also for natural gas production of Turkey, which comes up to 652 ktoe. The following energy productions are renewable energy sources such as geothermal, 2,060 ktoe, solar energy; 630 ktoe, and biofuel 17.7 ktoe. These renewable sources will be the focus of the following chapters.

Even though these sources create 32,288 ktoe of energy, they meet only 20% of the energy consumption in Turkey. Most of the energy consumed comes from imported fossil fuel sources such as petrol and natural gas, which meets up nearly half of the energy demand creating 67,407 ktoe of energy (Table 2). The consumption of petrol and natural gas is followed by imported coal and lignite, producing 33,086 ktoe; making these four big energy sources the 87% share of all the energy consumed in Turkey (Ministry of Energy and Natural Resources, 2012).

<table>
<thead>
<tr>
<th>Total Energy Consumption</th>
<th>Natural Gas</th>
<th>Petrol</th>
<th>Coal</th>
<th>Lignite</th>
<th>Renewable Energy Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>33%</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Table 2: Total Energy Consumption in Turkey (Ministry of Energy and Natural Resources, 2012)

1.2 The Problem

However, three of these four big energy sources’ consumption can only be met through imported resources that comes from countries such as Russia, Iran, Saudi Arabia, Libya, Iraq, Syria and Algeria. The most important reason of this continuous increase in the energy import dependency is the high level of natural gas and oil consumption, for heating and transport, even though they are in the lower ranks of the energy production with national resources. Since 1995, the share of natural gas in energy consumption has rapidly increased while petrol’s share has decreased (Balat, 2010). This process can result from the migration to the urban areas, which has transformed its heat energy production to mostly natural gas by the residences, rising to 28,868 ktoe, 26% of all energy consumed in 2008. Even though this is the case and its share is going down, petrol production in total has been rising slowly. However, 94% of the petrol consumed is still imported by Turkey. With growth of urban migration, the natural gas is the fastest growing energy source and the biggest energy resource consumed however, the natural gas produced in Turkey is less than 2%; 1.7%, resulting in an appealing dependency of 98.3%.

Furthermore, while the coal production in Turkey is the highest in these three resources, it amounts for the 10% of all consumption, while 90% of all energy consumption demands by coal is imported. This puts Turkey where nearly 80%; 78.8%, of all of the energy consumed is dependant to other countries, in a region where stability has not been its strongest definition (Ministry of Energy and Natural Resources, 2012). Considering the governmental plans, the future of this problem seems also ambiguous. Since the 100th birthday of Turkish Republic is closing by in 2023, the current government is planning to install 33 lignite, 27 natural gas, 12 coal, two nuclear, and 113 hydroelectric energy plants, to double its energy supply. The renewable energy sources are aimed to be increased to a share of at least 30%, by utilizing the economically feasible hydro, wind and geothermal potentials and encourage and expand the utilization of solar energy until 2023. In addition, Vision 2023 aims to search for different biomass technologies, such as seed development and improvement of energy crops with biogas systems in rural and urban applications and gasification and obtaining energy from waste and waste management (Deutsches Biomasse Forschungs Zentrum, 2011). On the other hand, the projected energy situation in 2020 is expects an increase in the production of lignite, hydropower, wind and solar energy
sources while the consumption numbers for coal, petrol, natural gas is still on the rise. The total energy consumption is expected to increase to 222,424 ktoe, while the energy produced rises to 65,704, still leaving a 70% of dependency. (Ministry of Energy and Natural Resources, 2012).

The level of import dependence, which comes up to 98% on natural gas and 94% on oil, and the possibility of continuation of import dependency in the future creates a risky option for Turkey. The share of importing energy resources in the finances has risen up to 22.46%, spending 54,113 billion $, an increase of 40.56% compared to last year (Institute of Energy, 2012). In addition, a dependency of the 63% of Turkey’s natural gas imports on Russia harbour both an economic and political risk for the biggest energy producer resource (Balat, 2010). The problem constitutes a system that does not have the ability to deal with important changes and persist, hence unresilient. For example, problems with Russia in 2006 and 2009, has proved the storage capacities is not enough for the Turkish consumption. A resilient energy policy, exhibits an adaptive capacity to cope with and respond to disruptions like Russia’s. It minimises vulnerabilities and exploit beneficial opportunities through socio-technical co-evolution by using indigenous resources for energy service delivery (O’Brienn & Hope, 2010). Increasing the resilience of energy supply is essentially a strategy to reduce the risks on the energy use, production and imports. It is generally argued that in order to solve this problem the countries should inspect; increasing the diversification of energy sources, energy efficiency, the use of renewable energy and focus on indigenous intermittent renewable resources (Balat, 2010) (O’Brienn & Hope, 2010).

Considering these options, this paper aims to propose solutions and arguments for the diversification of energy production through renewable energy sources using indigenous resources in rural areas, with the theoretical perspectives of energy resilience and rural development.
<table>
<thead>
<tr>
<th>ENERGY SOURCE</th>
<th>PRODUCTION (106SM3)</th>
<th>IMPORT (THOUSAND TONNES)</th>
<th>TOTAL CONSUMPTION (KTOE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NATURAL GAS (106SM3)</td>
<td>790.3</td>
<td>43,874.5</td>
<td>36,909</td>
</tr>
<tr>
<td>PETROL (THOUSAND TONNES)</td>
<td>2,433.4</td>
<td>34,492.1</td>
<td>30,498</td>
</tr>
<tr>
<td>COAL (THOUSAND TONNES)</td>
<td>2,528.4</td>
<td>23,679.5</td>
<td>16,666</td>
</tr>
<tr>
<td>LIGNITE (THOUSAND TONNES)</td>
<td>72,549.8</td>
<td>0</td>
<td>16,420</td>
</tr>
<tr>
<td>HYDROPOWER (GWH)</td>
<td>52,339</td>
<td>0</td>
<td>4,501</td>
</tr>
<tr>
<td>WOOD (THOUSAND TONNES)</td>
<td>8,154</td>
<td>0</td>
<td>2,446</td>
</tr>
<tr>
<td>GEOTHERMAL (KTOE)</td>
<td>2,060</td>
<td>0</td>
<td>2,060</td>
</tr>
<tr>
<td>ANIMAL AND WOOD RESIDUES</td>
<td>4,745</td>
<td>0</td>
<td>1,091</td>
</tr>
<tr>
<td>SOLAR (KTOE)</td>
<td>630</td>
<td>0</td>
<td>630</td>
</tr>
<tr>
<td>WIND (GWH)</td>
<td>4,724</td>
<td>0</td>
<td>406</td>
</tr>
<tr>
<td>TOTAL (KTOE)</td>
<td>32,228.9</td>
<td>90,292</td>
<td>114,480.2</td>
</tr>
</tbody>
</table>

Table 3: Energy Sources in Turkey and their production, import and total consumption values (Ministry of Energy and Natural Resources, 2012)
2. Theoretical Background

2.1 Aims and Limitations

As mentioned earlier this paper will focus diversification of energy production through renewable energy sources using indigenous resources, with the theoretical perspectives of energy resilience and rural development. In the following chapters, current renewable energy sources will be revised in order to answer these questions:

1. What is the renewable energy alternative for Turkey?
2. Can the renewable energy alternative be considered as a resilient energy source?
3. Does the renewable energy alternative provide an alternative development for the current rural conditions?

This thesis will not consider the questions of efficiency and energy created from each Renewable Energy Source. Although the main analysis will be on their current situation and future plans. However, after fulfilling our first aim by focusing on a study made in order to find the renewable energy alternative source, the main focus of the thesis will be on biogas, whose reasons will be explained in the following chapters. Then, the thesis will explain how biogas is produced, its main resources and the current condition of the biogas energy production facilities of Turkey. This will help to move in and answer the 2nd and 3rd aims of this paper, which will provide results for the thesis.

Although there is a good number of international sources, scientific research for biogas production has been unexplored for this topic over the years in Turkey (Deutsches Biomasse Forschungs Zentrum, 2011). However, as the interest for renewable energy sources rise and imported energy sources have become more expensive, the number of articles has also risen in the current years (Klass, 1998). On the other hand, lack of data collection techniques and the lack of an connected database for the rural area has been problematic for the estimations has been made in the articles, some consider the numbers are quite uncertain, especially for the estimated numbers of the agricultural sector residues (Deutsches Biomasse Forschungs Zentrum, 2011). In addition, the estimated numbers were also unstable and scientifically wrong. At the German Biomass Research Centre’s paper has mathematical errors, such as wrong decimal us, the paper also had no consistent energy value, varying from PJh to MW, making it harder to understand and follow. However, compared to the mistake of the Turkish Ministry of Energy and Natural Resources those problems may seem acceptable. The Ministry have used tonnes of oil equivalent (toe) instead of thousand tonnes of oil equivalent (ktoe), making the conversions from other papers completely dissociated, until this problem was realized. This shows the importance of double checking, especially if you are working with the government.

Another limitation comes from the unavailability of the cooperatives for interviews, whom did not want to be included in the paper, even anonymously, for political reasons. They have feared the current situation of the governmental factors, a strict political and social rule after the Gezi Events, can affect their business. Other cooperatives, who were not an expert about the subject has contacted, however, they were unresponsive because they lack the information and felt as not the responsible organization. In addition, some of them did not wanted to talk at all for no reason. At the end, travelling to locations and meeting the persons of interest face to was the only way to talk and raise confidence to make the interviews. Meeting with these people has proved also problematic sometimes, resulting from the heavy workload of these people.

In addition, the socio-political locations of these research areas have also been limiting. One plan was to go the Ceylanpinar Biogas Facility, which is in the Syrian border, to photograph and get more info for the needed numbers. However, these plans were cancelled after the news that Ceylanpinar was under ricochet and miscalculated fire of bullets and mortars that comes from the combatants of the ongoing Syrian Civil War. These bullets and mortars has killed three people so far, destroying two houses and damaging the biogas facility. After these events, the plans to visit this town and the biogas centre was cancelled.

In the following chapters, the theoretical backgrounds of the second and the third aim of this paper will be explained in order to provide a deeper understanding of the questions.
2.2 Energy Resilience

Resilience is a rather new concept introduced by Crawford Stanley Holling in 1973. The concept was about the ecological aspects and ability of a system to absorb certain changes and still persist. However, it is distinguished from the ability of the system to return to an equilibrium state, which was explained as stability. Although some authors defined stability closer to resilience theory’s definition of the time required for a system to return to an equilibrium or steady-state after a perturbation after Holling’s studies, Holling referred to such a return time definition as “engineering resilience”, and to his own definition of systems’ ability to absorb changes and persist as “ecological resilience” (Zhu & Ruth, 2013).

On the other hand, the existence of alternative states that are subject to change, creates a more dynamic system. This system has the capacity to absorb the disturbance as well as reorganize and keep nearly the same function, structure identity and feedbacks while undergoing change continues. It should be pointed out that these systems in itself includes sub-systems, operational dynamics at certain organizational scales. These are what households to villages and villages to nations are, and defines the “state space” of the system by the amount and values of the three dimensional space of all possible combinations of these variables. The systems generally tend to remain in a particular state space, which is called the “basin of attraction”. The attractor is the equilibrium state of this system, which they tend to move and the basin of attraction constitutes all initial conditions that will tend toward that equilibrium state (Holling, et al., 2004) (Zhu & Ruth, 2013).

However, Holling points out that, Socio-ecological Systems are subject to disturbances and stochasticity, which is unpredictability factors that includes the decisions of actors, which moves the system off the attractor. In this case, a Socio-ecological system is thought as moving within a particular basin of attraction, rather than tending directly toward to attractor. These systems may have more than one basin of attractions and the combinations of variables define them (Holling, et al., 2004). These basins that the system might occupy, creates a “stability landscape” with their boundaries that separate them. The boundaries can change in these stability landscapes through exogenous drivers, that is affected from outside of the selected landscape such as exchange rates or endogenous processes, which is in the system, such as management practices. These effects can change the number of basins of attractions, their position in the stability landscape or the depth of the basins, which is accounted from the difficulty of moving the system around within the basin. However, it is also possible that some people inside of these systems can consider some basins more desirable than the alternate, undesirable basin from which it may be difficult to recover through social agreements (Holling, et al., 2004).

These factors will be the basis points of the Resilient Energy System Theory mentioned in the research paper written by Geoff O’Brien and Alex Hope, as they explain a resilient energy system in a very descriptive method. Following the explanation given in the introduction; they argue that a resilient energy system brings together two decision actor groups. These groups are formed by the ones who own the energy sources and use the energy produced and the others who develop and deploy the production technologies. To be resilient, the user should be able to interact with energy capture technologies, and use and manage resources to meet the needs of these technologies (O’Brienn & Hope, 2010). However, capturing intermittent and diffuse resources is a considerable challenge, and using them inefficiently makes little sense. A community owned renewable energy technology can supply the needed energy services with existing technologies. However, this process relies on technological development to use them efficiently and the willingness of the user to manage these resources within recognised constraints. The technological challenge is the design of a system that will produce more energy than it is needed. In this way, storage capabilities provide a buffer against source variability, which will move the system out of the boundaries of the attractor. In addition, resilience building progress if the new and existing stocks should be conceptualised the technology combinations that will maximize resource capture. Many combinations of autonomous, interconnected users at small level is possible to help to build the system, which means a shift from the concentrated ownership of energy production and distribution to a more democratic model with numerous stakeholders (O’Brienn & Hope, 2010). A model of this system of production (fig.1) and ownership (fig. 2) is given in the figures below.
The representations of these energy systems will be important in order to answer the resiliency questions and provide and answer for our second aim. Since Resilient Energy Systems Theory argues about a diffused ownership that can create a new system for rural development, by improving the discussion for indigenous intermittent renewable resources input in the system and make sure the such potentials of wood, animal and crop residues are utilized in rural Turkey, this theory will be supplemented with Rural Development Theory to create theoretical background for our 3rd aim tries to find out.

![Diagram](image1)

**Figure 1**: Conceptual representation of a resilient energy system. Adopted from (O’Brienn & Hope, 2010) pg. 7553

![Diagram](image2)

**Figure 2**: Conventional and distributed energy systems. Adopted from Adopted from (O’Brienn & Hope, 2010) pg. 7553
2.2 Rural Development

It is argued that while discussing rural development, the critics should accept that there is no comprehensive definition of rural development, since this argument involves the controversial topic of agriculture and the countryside. It is highly possible that the new arguments will create new controversies as rural development policies are believed to be either the process that will end with the final expropriation of the farmers or the force that will revitalize the agriculture (Ploeg, et al., 2000).

The importance of agriculture and rural development come from their generally accepted pillar role for the system that would stop rural poverty and enhance food security. Within its wide sector, it provides a large source of employment and income in addition with ‘off-farm’ activities. For more than 50 years, the priorities of the policies that would develop the rural areas is being discussed. Different type of academic principles have provided concepts and methodologies to asses and manage the rural change not only in technological, managerial and centralized approaches but also in more systemic approaches of constructionist, participatory and decentralized perspectives of rural change (Ambrosio-Albalá & Bastiaensen, 2010). Spatial and temporal historical considerations are highlighted with their interrelations of social, economic and institutional arguments, leading to policies and strategies that are context specific for the individual countries and their local areas by enabling them to take responsibilities of policy and executive issues about these arguments. In this way, joint action among rural agents, coordination between the different administrative levels of government and articulation of addressing the different problems in different sectors is promoted (Ambrosio-Albalá & Bastiaensen, 2010).

Since the 1990s, scale enlargement, intensification, specialization and even industrialization has been applied to the rural sector of agriculture (Ploeg, et al., 2000). However, we have seen that these policies and market mechanism has failed to address the regional imbalances, especially in developing countries, where the rural areas generally fall behind the national averages of economic development of their countries. This problem is coupled with their lack of ability to create enough employment and income opportunities resulting in rural out-migration of particularly jobless young people, aging population, a decline of agricultural activities and productivity of the rural labour has been the dominant problems (Ambrosio-Albalá & Bastiaensen, 2010).

On the other hand, new academic approaches and the new international and national context is forming new scenarios for rural development. The new development paradigm is avoiding the earlier modernization techniques without being the new “blue print” for the rebuilding, in order to create different solutions for different problematic issues that are built in the core principles of this new system (Ploeg, et al., 2000). One of them is the environmental issues focusing on exploitation of natural resources; externalities such as land and water use, biodiversity and forestry. In addition, international trade issues of failed negotiations that resulted in restricting the number and the way of policies for agriculture gave importance to the diversified output of agriculture and rural areas dealing with the security, employment and production problem of the rural land. Furthermore, the decentralization and deconcentration has enabled the local actors to engage while defining the priorities and the use of resources to tackle the inequalities of presuppositions. However, this also led to a realization by the local people that their daily life is not under their hands (Ambrosio-Albalá & Bastiaensen, 2010).

In order to solve these problems; economic diversification is discussed as the best choice, generating opportunity for the farmers to complement their incomes while it will create new opportunities for the other labour segments (Ambrosio-Albalá & Bastiaensen, 2010). This can create and operational model based on the individual farms whom focuses under what conditions, reasons and application can be the way in which activities are combines in a rural enterprise that positively effects costs, benefits, risks and prospects (Ploeg, et al., 2000). This new economic approach requires also and institutional change at the level of central and local administration and their interplays. While decentralization became successful in the transfer of responsibilities by creating new spaces for policy making and increasing the territorial autonomy, the limited tax and high cost of delivering services still requires the financial and managerial support of the central administration or local actors. Especially the engagement of local actors has created a way of rural populations to engage in the decision making process of the
transformation of their territory. These new actors emphasize a change in the governance, a mechanism to help the local agents to articulate and exchange their values in order to build strategies to carry out productive transformation. This mechanism should also create and effective coordination among the international and national actors to create economic and public service opportunities (Ambrosio-Albalá & Bastiaensen, 2010). Considering the goals this mechanism is argued to be a partnership, which will identify the poeems of the territory and put a set of desirable goals and changes that are needed. This partnership model should be different from the modernization of the 1990s that focused on continuous specialization and segregation of agricultural activities from rural activities. This partnership process should look for mutual benefits and win-win situations between different activities that are strategic and desirable. The process should start from an analysis of the new forms of cooperation and contradiction that are emerging from agricultural ad non-agricultural actors. As a result, this process will create a rural development theory that is not about the world as it is but rather the possibilities of agriculture and countryside transformations. (Ploeg, et al., 2000).

In order to answer our third aim, the energy system’s ability to provide these possibilities will be the focus of the analysis. The energy system will be analysed from the perspectives of diversification in economy, providing power to the local authorities and the producers, and their coordination between them. With this analysis the complete theoretical analysis of the renewable energy alternate will be explained and create a background for the analysis of its real world applications.

3. Method

This chapter will explain the analysis techniques for this paper, which is divided under literature reviews and interviews in order to understand a complex social system based on actors.

3.1 Literature review

Although the topic has been argued to be general, literature review has been the base for specifying the theoretical and empirical framework for this paper and gathering the introduction and background information needed.

The databases used for this method was Uppsala University library database, JSTOR, Elsevier, SpringerLink and Twitter. Although Twitter might seem an unorthodox source, the existence of many NGOs and activists in its membership list, it has an excellent information source. Some opinion pieces and two main articles have been found from this source. In addition, the governmental reports and newspaper articles have been resourceful to build a general argument and get a popular information. Another important source was the previous theses done in related subjects of this paper to ensure the quality and uniqueness of this project, while broadening the literature overview.

In the end, the literature sources were broad and diverse to create a balanced outlook but some sources were rather the most important ones. The theoretical perspectives was built on the studies of Crawford Stanley Holling’s resilience ideas and later the Energy Resilience System Theories by Geoff O’Brien and Alex Hope for Energy Resiliency and for Rural Development Theories of Jan Douwe van der Ploeg and Mateo Ambrosio-Albalá and Johan Bastiaensen. In addition, the study made by the Zonguldak and Çankaya university to evaluate the different renewable energy sources; “Availability of Renewable Energy Sources in Turkey: Current Situation, Potential, Government Policies and The EU Perspective” and the Ministry of Commerce and Trade’s Turkish Cooperatives Strategy and Action Plan 2012-2016 has become the main sources for the discussion part of this thesis. In addition, since there is limited document about biogas energy production in Turkey, the study made for Turkish biogas production possibilities by the German Biomass Research Centre in association with Turkish Ministry of Environment and Urban Planning, has become the main source for data collection.

3.2 Interviews:

For the interviews, it was important to encourage the interviewee to tell their own stories in the beginning, in order to understand their personal perception of the situation. In addition, the following questions in the interviews were created by the literature review, which has helped me to understand
their political and social understanding of these concepts. During my time in Uppsala, most of the persons of interest did not favour the interviews, however when travelling to their location and offering face to face interviews three interviewees has accepted the offer. In addition, the locations have provided me with the understanding of the rural areas that I am examining through the “chit-chat” with the local people. Introducing myself as a researcher for university have created a semi-official argument space between me and the local people and the interviewees, however especially for the local people explanatory comments; especially for biogas production, was the starting points for some of the questions. This situation was the same for the cooperative executives, who needed explanation for the Turkish Cooperatives Strategy and Action Plan; some concepts were explained before the questions.

The interviews were done in three locations. First in Adana, a 40 minute interview was done by Chemical Engineer (MSc.) Dr. Mustafa Tolay; who is an expert on biomass production systems. In this interview, information about current biogas production and the planned and approved biogas production plant in Ceylanpınar, Şanlıurfa have been analysed and discussed. The second part of this interview was developed by a TV interview of Kayhan Kaleioğlu, who is Energy Systems Engineer and Consultant for Green Energy Investments for Solea Energy Company. Although Kaleioğlu was contacted for an interview, his busy time plan did not provide an opening for it. However, his theory about the 15 km cycle of Waste Management by Cooperatives was introduced, discussed and developed with Dr. Tolay. The second and the third interviews, which lasted approximately 90 minutes each, took place in Alanya with Toslak, Yeniköy, HACKERMILNER Villages Agricultural Development Cooperative executive Mustafa Özen and in Şanlıurfa with the executive of The Union of Husbandry Cooperatives for Şanlıurfa, Cihan İzol. The interviews consisted of similar questions, focusing on their local conditions and situation, what they think about biogas production in their area and their ideas about the Turkish Cooperatives Strategy and Action Plan by the government. In the end, the information gathered by these interviewees were used in different parts of the thesis giving a broader understanding of the problems, concepts and solutions.


Rising problems in energy security, coupled with the rising prices of energy imports and the environmental concerns have renewed the interest in renewable and sustainable energy sources. Globally the renewable energy technologies and industries has been growing 20% to 60% every year, attracting investments more than 100 billion $ in production, manufacturing, research, and development in 2007. This has created a renewable energy source supply of 14% of the total world energy demand and with the rising energy consumption and prices, it is argued in 2030 it can reach to 20% (Balat, 2010).

The geographical conditions of Turkey have provided her with seacoasts of over 7200 km and an average elevation of 1132 m, giving a significant hydropower and wind energy potential. In addition, the geological structure of Turkey has a volcanic origin; creating more than 600 hot water sources whose temperature reach almost 100°C gives a powerful source for producing geothermal energy (Barış & Küçükali, 2012).

On the other hand, renewable energy production is only equal to the 10% of total energy consumption in Turkey. About 40% of the renewable energy produced is obtained from hydroelectric energy while the rest is mainly from biomass (crop, animal and wood) sources. (Figure 3). Although some future projects are aimed at rising the share of the renewable energy sources in production to 30% in Vision 2023, current energy investments mainly focus on hydropower, which is creating social and environmental problems for the local area. In this section, the current situations and planned investments of the renewable energies will be explained.
4.1 Hydropower

A mature technology that has been used in Turkey for decades, the hydropower technology has a high efficiency with low investment and CO2 emissions. Although, hydropower plants are known to be quite expensive, low construction and labour costs with the government policies applied by the government, especially for foreign investors, the hydropower plants have the lowest investment cost among other renewable energy alternatives (Barış & Küçükali, 2012). As a result, hydropower is the biggest renewable energy source in Turkey increasing 15% since 2006, reaching 4,501 ktoe. In addition, Turkey has the 14% European hydropower potential in which 28% of it is economically exploitable. However, the amount reached right now is only the 37% if this economically feasible hydropower source. (Balat, 2010). The largest hydropower plants are on the Euphrates River in the South East of Turkey, including the biggest hydropower plants of Atatürk, Karakaya and Keban, which is responsible for 30% of Turkey’s hydropower production. On the other hand, 20% of the new projects are done in the Black Sea region, especially in the Eastern Region where the geological factors of steep and rocky mountains create the highest capacity of operating hour per year (Barış & Küçükali, 2012).

On the other hand, hydropower in Turkey has created general concern over the last years about the connection of upstream and downstream of the built facilities. Since prevention of this will lead to blockage of fish passages and interruption of sediment transport, the end result will be the loss of natural assets, protected areas and ecological life. These problems have connected many NGOs and protesters against the hydropower plants, especially in the Eastern Black Sea Region of Northeast Turkey, where 20% of all planned projects are. This area includes one of the most forested areas in Turkey and the “Fırtına Valley” which is one of the 200 ecological regions of top priority in the world. In order to minimize the effects, the Water Usage Rights Act has been enacted. However since the planned power plants’ licences have been granted before, they do not have to sign the Water Usage Act which leads to more violent discussions against the hydropower production (Barış & Küçükali, 2012).

4.2 Wind and Solar

Both wind and solar energies are ready for energy production not more than a year after their construction begins, which makes them easy to install and lower costing wind energy is one of the

![Figure 3: Current Renewable Energy Sources and their percentages on the energy production adopted from (Ministry of Energy and Natural Resources, 2012).](image)
fastest growing energy sources, rising from 11 ktoe in 2004 to 406 ktoe in 2011. However, since this is only the 1% of Turkey’s economically feasible wind energy potential, there has been 175 successful licence applications to tap into 25% of the wind energy potential since 2005. (Barış & Küçükali, 2012). If we investigate the solar energy production, one sees that, while solar photovoltaic energy has no licenced power plant, Turkey has one of the highest solar energy potentials reaching 32,674 ktoe/year (Barış & Küçükali, 2012), of which 40% can be, used economically (Balat, 2010). If this economically feasible potential is used, 75% of its potential will be efficient for thermal use and the remainder for electricity production (Balat, 2010). The current situation follows this trend, where most of this potential is used for hot water generation systems. With 1 million square meters of solar collector capacity and more than 100 producer companies employing approximately 2,000 workers, Turkey is fourth biggest company in terms of thermal energy production, even exporting its technology to many countries. (Balat, 2010) (Barış & Küçükali, 2012).

On the other hand, with its current condition the electrical grid of Turkey is not adoptable to the integration of solar and wind energy, especially in the Aegean and Mediterranean regions of Turkey. In order not to limit their input; this upgrade should be implemented, however these projects will not be done by the governmental organizations, since the investments of wind and solar energy projects are done by private companies. Changing this huge grid area, with a population of 19 million people and an area covering 180,000 km2; 6 times the area of Belgium, will not be economically feasible to the companies (Barış & Küçükali, 2012).

4.3 Geothermal

One of the countries located in the Alpine-Himalayan belt; Turkey has an estimated potential of 23,726 ktoe of geothermal energy, seventh among the world’s richest countries. However, even if this is the case, this potential is not effectively used by the Turkish energy policies, utilizing only 2% of this potential, where most it is used for residential, thermal facility and greenhouse heating while the rest is used for tourism purposes for spas. On the other hand, if these policies change and fully utilize the geothermal energy use, it is calculated that geothermal energy can support 14% of Turkey’s total energy demand since it has a more than 70% efficiency (Balat, 2010) (Barış & Küçükali, 2012).

This energy potential has attracted the interest of the government, resulting loan support by the Ministry of Environment. With these supports and governmental and private interest geothermal energy is expected to rise, since 33 geothermal fields and 32 geothermal wells are being auctioned to the use of the private sector. Current investments for geothermal energy have reached 1.5 billion $ and if the investment trends continue, investing 2.7 billion $ more will provide employment for 250,000 people, bringing a 5 billion $ profit every year. This will increase the use of geothermal energy to 6300 ktoe by the year 2020, heating 1,250,000 residences, lowering down the dependency on natural gas imports (Balat, 2010).

4.4 Bioenergy

The bioenergy production includes biodiesel, bioethanol, biogas and biomass 80% of which (by volume) was accumulated in last 10 years (Balat, 2010). Although the biomass potential of Turkey is calculated as 32,000 ktoe, currently bioenergy creates 3,555 ktoe of energy. Almost all of the biomass energy is consumed for cooking and heating purposes, wood being the main heating fuel for 5.5 million residences in Turkey, mostly in rural areas. The rural populations also use the animal wastes to provide more heating, however the amount is limited since they are mostly used for fertilizers in agriculture. In the industrial sector, paper production companies use wood waste to provide nearly 60% of their energy needed (Balat, 2010) (Barış & Küçükali, 2012).

In addition, there is only one bioethanol production facility, although 52 companies have applied for licence. These companies can produce electricity by direct combustion, but the potential is generally used for liquid fuels for the transportation sector, the third biggest sector in total energy consumption with an 99.5% dependency on oil. An estimated 15 million tons per year can be produced in Turkey, which makes her the second highest bio-diesel producer in Europe, however currently there is a production of 60,000 tons per year. Considering the total diesel fuel consumed is 12.07 million tons in 2006, there is a high chance Turkey can meet its biodiesel production. If there will be a rise in
consumption this can be met by the transformation of 1.5 million of cooking oil which is illegally dumped into the rivers and landfills, causing environmental pollution (Barış & Küçükali, 2012) (Balat, 2010).

Another application for bioenergy; biogas has a huge potential in Turkey. Current sources for biogas production is animal manure, crops, landfills, wastewater from municipalities and organic waste from the food industry with a potential of 11,615 ktoe. However, as of 2011, Turkey has 36 biogas plants that is in operation producing 83.3 ktoe of energy, with only tapping a small percentage of the potential (Deutsches Biomasse Forschungs Zentrum, 2011).

5. Finding the Renewable Energy Alternative for Turkey

Although the energy consumption has increased, the investment for the natural resources has followed in a rather slow pace. Turkey needs to spend 128 billion $ on energy, 91 billion of it to the new power generation facilities in order to keep the pace of the rapidly growing economy. On the other hand, the government can only set aside $500 million a year from its budget, which creates a need for foreign capital and private investments (Balat, 2010). Considering this is the case, one should argue which of the renewable energy sources should be the focus of these investments. Currently, the most favourable renewable energy source seems to be the hydropower energy, however some studies might argue that they have their high risks.

Although, there has been many discussions over which renewable source is an alternative for the fossil fuels. Most of the studies give different results and values, however one of the studies made by the Zonguldak and Çankaya University members, Assistant Professor Kemal Barış and Associate Professor Serhat Küçükali, evaluate the different renewable energy sources under technical, economic, environmental and social aspects. The study tries to find “the most appropriate renewable energy alternative for Turkey” by taking into account their large aspects and criteria.

The study argues, since these criteria generally conflict with each other, such as the technical aspect of reliability can cause an increase in economic aspects in the implementation costs, the selections are multi criteria problems with conflicting issues. However, if their advantages and disadvantages are taken into account of the alternative renewable energy sources, the evolution process will be hard and vague. In this study, multi criteria method was used in order to analyse the decision maker’s process, where there is exact numerical values but subjective policy criteria for the evaluation of the data of the alternative energy producers. It should be also pointed out that this study was also chosen, since the similar and large number of research projects have been created in order to choose the most appropriate renewable energy alternatives also use the multiple criteria decision-making methods in energy-related environmental studies since 1995 (Cebi, et al., 2009).

The study takes the factorial aspects, economic, environmental and social, were taken as equal, since the definition of sustainable development accepts them as equal collaborator of the solution. However, they all have different criteria to assess the most appropriate renewable energy alternative for Turkey in an objective way to give the best score 3, and the worst score 1 to the criteria based on the study’s literary and technical review (Barış & Küçükali, 2012). The criteria which can be seen in table two include 3 factors and 10 different topics (Table 4). Under technical factor, the reliability evaluates the technology’s maturity as well as its penetration in the international market of the renewable energy. The reliability criteria are divided into their process where they will get scores depending on the fact that, they may have been only tested in laboratory or only performed in pilot plants, or it could be still improved, or it is a consolidated technology.. The second topic is the efficiency, which considers the ratio of the power output that can be turned into energy by the power that was put into. The topic gets their scores depending, from 1 to 3, if their efficiency is between 10% and 40%, between 40% and 70%, if the efficiency is higher than 70%. The third topic under the technical criteria is the simplicity of the technology focusing on their construction and installation periods. If the technology requires more than 2 years they get 1, if it is between 1 and 2 they get 2 and if it is less than 1 year they get 1 point (Barış & Küçükali, 2012) (Cebi, et al., 2009).

The second criteria is the economic factors for the Renewable Energy Systems. The first topic is the investment costs of the Renewable Energy System, which explores the total costs of a Renewable
Energy System Project from planning to grid connection. According to the study if the systems costs higher than 4000 $/kW, the project will get 1 point and be called a high cost technology, if the investment cost is between 2500–4000 $/kW it will get 2 points, and if the investment cost is between 1000–2500 $/kW, it will get 3 points and will be a low cost technology (Barış & Küçükali, 2012). The second topic under the economic criteria involves the investment risks, which shows the degree of uncertainty in investment cost. If the project involves various uncertainties such as geology, civil works, environmental issues and legal context, it will have 1 point in the end. If there are some barriers and risks in project development, that involves the previous predicaments, the project will get 2 points but if the project involves few uncertainties, the project will get 3 points. The following and the last topic under the economic criteria is the capacity factor of the renewable energy system which looks at the actual production of a power plant in relation to its production at full power in a year (Barış & Küçükali, 2012). If the capacity factor is between 10% and 40%, the renewable energy system will get 1 point, if the capacity factor is between 40% and 70%, it will get 2 but if the capacity factor is higher than 70%, it will get 3 points.

The economic criteria is followed by the environmental criteria formed for the Renewable Energy Systems. Under this criteria, the amount of CO₂ emission of a power plant during energy generation is the first topic the Renewable Energy Systems are inspected. According to the study if the CO₂ emission is higher than 50 t/GWh, this system will get 1 point. The 2 points will be given to the system that has emission is less than 50 t/GWh. However the highest point, 3, will be given to the system that has no CO₂ emissions, since it is a possibility for this current situation. The second topic under the environmental criteria is the systems’ impact on ecosystem, which is their degree of habitat destruction and biodiversity loss of a power plant during operation (Barış & Küçükali, 2012). When compared, if the system has significant impact on existing wildlife habitat and populations that lead to biodiversity loss it will get the lowest 1 point and the highest 3 point will go to the system with the minor impact on ecosystem, while 2 point goes for the systems in the middle. The last criteria for the Renewable Energy Systems is the Social part, which involves the topics of Public Acceptance and Job Creation. For Public Acceptance the status of the local community to accept the project must benefit the community economically to get the highest 3 points. The 2 points will be given to the system which has important noise and visual pollution and the 1 point will be given to the system which stops or limits local community ability to utilize surrounding lands to provide a livelihood. For job creation, the systems must create an average employment over a life of facility in operation. If this average is less than 0.5 jobs/MW, the system gets 1 point. If the average is between 0.5 and 1 jobs/MW the system gets 2 points, but if the average is higher than 1 jobs/MW, the system will get the highest point under this topic, 3 (Barış & Küçükali, 2012).

According to the study, the most appropriate renewable energy source was biomass, for its high social benefits resulting from public acceptance and job creation (Table 4). The wind and geothermal energy sources takes a second rank followed by solar photovoltaic and hydropower, hydropower losing the factor numbers in social and environmental factors. It must be pointed out the study conducted by Zonguldak and Çankaya Universities has taken solar photovoltaic energy production while considering the most feasible energy production in Turkey. Further research about this subject should include this potential that was well in practice in Turkey, since before the growth of European interest. On the other hand, even without further research, this paper will accept this detailed study and its conclusions, since when investigated other literature also suggested the potential of biomass is wasted in Turkey. The next chapter, explain the biomass and biogas production, its current situation in the world and Turkey and investigate the theoretical potential for total biogas production for energy in the next chapter of this paper.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Score - 1</th>
<th>Score - 2</th>
<th>Score - 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>T1. Reliability</strong></td>
<td>Represents the technology’s maturity rate as well as its penetration percentage in the international market</td>
<td>Prototype and demonstration stage technologies</td>
<td>Gap technologies: technologies that could still be improved</td>
<td>Mature technologies: technologies that are close to reaching the theoretical limits of efficiency</td>
</tr>
<tr>
<td><strong>T2. Efficiency</strong></td>
<td>The ratio of useful power output to the power input</td>
<td>Efficiency is between 10% and 40%</td>
<td>Efficiency is between 40% and 70%</td>
<td>Efficiency is higher than 70%</td>
</tr>
<tr>
<td><strong>T3. Simplicity</strong></td>
<td>Construction and installation period of the power plant</td>
<td>Higher than 2 years</td>
<td>Between 1 and 2 years</td>
<td>Less than 1 year</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EC1. Investment cost</strong></td>
<td>The total costs of a RES Project from planning to grid connection</td>
<td>High cost technology: Investment cost is higher than 4000 $/kW</td>
<td>Investment cost is between 2500–4000 $/kW</td>
<td>Low cost technology: Investment cost is between 1000 and 2500 $/kW</td>
</tr>
<tr>
<td><strong>EC2. Investment risk</strong></td>
<td>The degree of uncertainty in investment cost</td>
<td>The project involves various uncertainties such as geology, civil works, environmental issues and legal context</td>
<td>There are some barriers and risks in project development</td>
<td>The project involves few uncertainties</td>
</tr>
<tr>
<td><strong>EC3. Capacity factor</strong></td>
<td>The actual production of a power plant in relation to its production at full power in a year</td>
<td>Capacity factor is between 10% and 40%</td>
<td>Capacity factor is between 40% and 70%</td>
<td>Capacity factor is higher than 70%</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EN1 CO2 emissions</strong></td>
<td>The amount of CO2 emission of a power plant during energy generation</td>
<td>The CO2 emission of scheme is higher than 50 t/GWh</td>
<td>The CO2 emission of scheme is less than 50 t/GWh</td>
<td>There is no CO2 emission</td>
</tr>
<tr>
<td><strong>EN2- Impact On Ecosystem</strong></td>
<td>The degree of habitat destruction and biodiversity loss of a power plant during operation</td>
<td>The facility has significant impact on existing wildlife habitat and populations that lead to biodiversity loss</td>
<td>The facility has impact on ecosystem</td>
<td>The facility has minor impact on ecosystem</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S1 Public Acceptance</strong></td>
<td>The status of the local community to accept the project</td>
<td>The facility stop or limit local community ability to utilize surrounding lands to provide a livelihood</td>
<td>The facility has important noise and visual pollution</td>
<td>Local community has economic benefit from the facility</td>
</tr>
<tr>
<td><strong>S2 - Job Creation</strong></td>
<td>Average employment over a life of facility in operation</td>
<td>Less than 0.5 jobs/MW</td>
<td>Between 0.5 and 1 jobs/MW</td>
<td>Higher than 1 jobs/MW</td>
</tr>
</tbody>
</table>

Table 4: Evaluation matrix for the comparison of RES power plants. Adopted from (Barış & Küçükali, 2012) pg.389
6. Introduction to Biomass and Biogas Production

6.1 Introduction to Biomass

All plants and animals in the ecological system consists of or produced from biomass, which also includes the nutrients, excrements and bio waste from households and industry. As part of the biomass energy conversion, all biogas and biomass sources are rich in carbon but are not yet a fossil material (Deublein & Steinhauser, 2008).

The process is named biomass energy conversion, because of the fact that the energy stored in the biomass sources is solar energy captured via photosynthesis. This process involves the fixation and conversion of carbon dioxide into organic compounds. This growth of biomass is represented by the equation of:

\[ \text{CO}_2 + \text{H}_2\text{O} + \text{Light} \rightarrow (\text{CH}_2\text{O}) + \text{O}_2 \]

Carbohydrate (CH₂O) is the primary organic product from this process, absorbing 470 kJ (112 kcal) for each mole of carbon fixed. Oxygen is also emitted in the process, which comes exclusively from the water molecules. The biomass can be distributed through nature in various ways such as, being harvested for food, fibre and materials of construction by humans. It can also be left in the growth areas as waste or waste products from harvesting or processing biomass, completing the natural decomposition (Klass, 1998). The renewability of biomass comes from capturing the solar energy and carbon from atmospheric CO₂. This energy is then later converted to other fuels or used directly for thermal energy. This is equal to releasing the solar energy and returning the carbon fixed during the photosynthesis to the atmosphere (Klass, 1998).

One large source of biomass is waste based materials, such as municipal solid wastes and sewage, industrial wastes, animal manures, crop and forestry residues. If the amount is large enough, these wastes can cause serious health and environmental problems unless they are disposed properly. The amount of municipal solid waste is larger than the total amount of agricultural waste; however, the problem of utilization by centralized disposal of agricultural waste causes this conclusion. It is well know that the agricultural wastes are left in the field to be dried and the collection costs of this huge amounts of waste is a limiting cause for this problem. This problem can be solved by the localized development for biomass sources in order to be used as energy supply. The inventoried materials can be assessed for commercial energy utilization, which can provide the initiation of programs that uses waste biomass as a source (Klass, 1998).

6.2 Introduction to Biogas and Biogas Production

One of these initiation programs includes biogas production. Biogas is produced by the decomposition of biomass sources in the absence of free oxygen, which is also called fermentation. This process creates a (bio) gas, which contains 40 to 70 % of methane, and the rest contains mostly CO₂ and some traces of other gases. Biogas has a good calorific value, though lesser than liquefied petroleum gas, whose ignition is similar to this fossil fuel, which burns cleanly with no soot or foul smell (Abbasi, et al., 2012). Technically, the usage of the term biogas is not correct, because the product of aerobic decomposition, CO₂, is also a “biogas”, because it is the result of biodegradation. However, this term
is now widely used to describe the CH$_4$–CO$_2$ mixture, generated by the anaerobic decomposition of organic matter (Abbasi, et al., 2012).

It must also be mentioned that a mixture of CH$_4$ and CO$_2$ is not the only gas possible by anaerobic degradation of organic matter. Since methanogenic bacteria are used during this specific anaerobic decomposition, methane is the resulting product. However, if other species of micro-organisms were used, gases such as hydrogen and hydrogen sulphide might be generated. Nevertheless, methanogenic bacteria occur very commonly in nature and CH$_4$-CO$_2$ is predominantly the result of the anaerobic digestion, so this mixture is called “biogas” (Abbasi, et al., 2012).

The process of anaerobic digestion leads to the breakdown of complex biodegradable organics and the production of the CH$_4$-CO$_2$ (Figure 4). In the first stage of the breakdown the large protein macromolecules, fats, and carbohydrate polymers, which includes cellulose and starch, are broken down to amino acids, long-chain fatty acids and sugars by hydrolysis. This is followed by the acidogenesis which ferments these products and forms the volatile fatty acids. This leads to the consumption of the fermentation products by the bacteria and as a result the acetic acid, carbon dioxide, and hydrogen is formed. Later, these products are consumed by the methanogenic organisms to produce methane (Abbasi, et al., 2012). The biogas produced at the end, theoretically contains equal volumes (50-50) of methane and carbon dioxide. However, the overall biogas yield and methane content varies for different substrates (Table 5), so the methane content of the biogas can range from 40 to 70%, mostly in the 55-65 % range (Kaya & Öztürk, 2012).

The substrates that can be used for biogas production varies, but as long as they contain carbohydrates, proteins, fats, cellulose, and hemicellulose as main components, they can be used as biogas sources. These substrates can be divided under three groups and the following topics will explore them.

### Biogas Yield From Different Substrates

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Yield of Biogas (Mio m³/a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill</td>
<td></td>
</tr>
<tr>
<td>Municipal and industrial sewage water</td>
<td></td>
</tr>
<tr>
<td>Wastes from households and markets</td>
<td></td>
</tr>
<tr>
<td>Wastes from trade and industry</td>
<td></td>
</tr>
<tr>
<td>Excrements from animals and humans</td>
<td></td>
</tr>
<tr>
<td>By-product of agriculture and food</td>
<td></td>
</tr>
<tr>
<td>Landscape Conservation</td>
<td></td>
</tr>
<tr>
<td>Energy Crops</td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Biogas yield From Different Substrates. Adopted from (Deublein & Steinhauser, 2008) pg.24
Figure 4: Anaerobic Fermentation Process adopted from (Abbasi, et al., 2012) pg.3

Complex organic matter
(carbohydrates, proteins, fats)

Hydrolysis

Soluble organic molecules
(sugars, amino acids, fatty acids)

Acidogenesis

Volatile fatty acids

Acidogenesis

Acetic acid

Methanogenesis
(acetotrophic)

CO₂, H₂

Methanogenesis
(hydrogenotrophic)

CH₄, CO₂

Acidogenesis

Volatile fatty acids

Acetic acid

CO₂, H₂

Methanogenesis
(acetotrophic)

Methanogenesis
(hydrogenotrophic)
6.2.1 Animal Sources:

Animal waste is widely used in the anaerobic digestion systems. They include the urine, faeces and residues from meat production from poultry, ovine and bovine husbandry. These substrates can be stored, since during the storage their pH values stays the same. They can also be used with feed residues from animals, although if they include any fodder they must be separated. The fermentation of animal wastes produce a high nitrogen valued product that has a stable organic material. The problems from pathological bacteria can be lowered to nearly zero in the fermentation period, however it is not fully eradicated (Kaya & Öztürk, 2012).

6.2.2 Crop Sources:

Straws, shells, seeds, stalks, leaves and molasses of every plant and residues from the treatment of agricultural products, such as food mashes from juice productions are considered to be agricultural substrates for biogas production. However, since the fermentation process requires a more attentive control for correct fermentation of agricultural residues in relation to animal substrates, the use of crop residues is not considered to be suitable for small rural producers (Kaya & Öztürk, 2012).

6.2.3 Organic based City and Industrial Sources:

Food waste from kitchens, sewages of the municipal areas and the residues from industrial process of organic products, such as paper pulps are highly efficient substrates for biogas production, especially for municipalities and big industrial facilities who can gather well installed technological systems. These technologies should be able to separate the cleaning water from the houses, that has chemical substances and stabilize the pH values in food wastes, which will disrupt the methane production (Kaya & Öztürk, 2012).

6.3 Advantages of Anaerobic Degradation

The anaerobic degradation of waste products, which leads to the production of biogas and its by-product (organic fertilizers) have these advantages (Tolay, 2013):

1. Economic benefits from producing electricity and heat together and lowering the dependency on expensive fossil fuels.
2. The fermented manure, used as organic fertilizer, have created more valuable fertilizer than the conventional fertilizers and direct use of the residues.
3. The effect of greenhouse gasses are limited since the methane emitted from the waste products is burned and turned into CO2
4. A wide selection of substrates that can be used together, lowers the health and environmental threats and the smell of these products if left alone.
5. Building and operating the biogas plants, will employ or create local workforces according to the needs such as construction, mechanical and electronic part builders and engineers. In addition, during operation the biogas plant will need at least one engineer and 3 workers.

6.4 Applications of Biogas

The advantages of anaerobic degradation and the application of the mix of CH4- CO2 can be in various ways. Since its first discovery, biogas is used in cooking and illumination through very basic technologies. Later on, by burning the biogas with a mix of 1/7 air in special ovens and burning units, it started to be used for heating for larger areas. Biogas can also be used as fuel for petrol using cars without adding any additives or refining its methane content (Kaya & Öztürk, 2012). In addition, there is also the possibility of using the biogas in low pressure natural gas networks by adjusting the biogas’ pressure, density and sulphur, oxygen and humid content while separating methane and carbon dioxide. Even if the biogas might not be compatible with natural gas distributed in the gas network, the calorific value is adjusted by calculation the feed able biogas rate through a system called the Wobbe Index. In Denmark, 25% biogas mix is fed to the natural gas network with a methane content of 90% and in Sweden, Laholm, biogas is added to the stream with 60-65% methane content. However, for obvious safety reasons, the biogas must be odorized before feeding into the network.
This process is rather expensive, so they are only installed in large biogas plants, or for the smaller plants, the main natural gas stream is odorized after adding the biogas feed (Deublein & Steinhauser, 2008).

On the other hand, the general and most efficient use of biogas is in the cogeneration units. The cogeneration units use the combined cycle facilities that benefit from the residual heat resulted from the electricity production in the plant. This residual heat is captured to be used for electricity production again in the same plant. As a result, the heat and electricity is produced together, giving the users both needs from the same plant (Figure). The vapour from the turbines can be used as heating source for local areas and in the factory, and if not, the heat efficiency of the plant reaches 85-90% through electricity production. This high efficiency, drastically reduces the emissions for electricity production, since methane, which is nearly 20 times more effective as a greenhouse gas than CO₂ is burned and turned into CO₂ (Kaya & Öztürk, 2012).

Figure 5: Main and By-products of Biogas Production (Own Source)
6.5 Applications of the Fermentation By-products

The fermentation process involves products, which is called fermented manure that has nitrogen, phosphorus, potassium and other trace elements inside. This manure can be used as liquid and through compost, solid organic fertilizers for farming areas. As a result of the anaerobic process, 95% of all wild grass seeds are decomposed in this organic fertilizer, which helps the farmer with the cost of fighting it. In addition, since the methane is taken out from the first product the fertilizer is smell free. Anaerobic process also cleans the by-product from the pathogenic microorganisms and insects by 90%. All these aspects makes the organic fertilizer produced through the anaerobic fermentation 10% much more efficient compared to the conventional fertilizers and conventional application of manure and residues (Tolay, 2013).

6.6 A Brief History of Biogas:

For most of the twentieth century, the general perception was that biogas was a poor man’s fuel. This perception comes from the initiative of China and India which has utilized the need of energy by farmers from animal manure. However, compared to petroleum based fuels which were abundant and cheap, biogas was too lean and inconvenient. This has changed during the period of 1973 and 1979, when the “oil shock” crisis hit the developed countries. Biogas started to be considered as a potential fuel and biogas power plants started to be built, but this has not lasted that long when the prices dipped though the 1980s (Deublein & Steinhauser, 2008) (Abbasi, et al., 2012). The debates for biogas application has gone down in the developed world, just as the other renewable energy sources. As the global research and development realized methane, if captured as fuel, provides one of the cleanest sources of energy, and however, if left untouched, it is the second biggest contributor to global warming. This realization brought biogas into the debate table again, making it a “global priority” rather than the “poor man’s fuel”. The animal manure that has been used to create biogas in rural China and India has spread and developed, where municipal solid waste, crop waste and other forms of bio waste is used as a substrate.

In 2010, Europe’s biogas production rose to 10,900 ktoe, an increase of 31% since 2009. The biogas production centres uses 27% landfill sources, 10% sewage sludge and the rest, 67%, uses agricultural plants, municipal solid waste as substrates to use in co-digestion, and multi product plants such as co-generation plants. The biggest biogas producer in Europe, Germany has over 7,000 biogas plants with about 61% of total biogas production in Europe (Foreest, 2012). The investments are raising the number of biogas applications 15-20% every year, employing more than 100,000 people in different branches such as planning, engineering and management (Tolay, 2013).

Maize, corn and wheat are the main substrates for biogas production in Europe, while manure constitutes less than 50%, leading to some criticism that food crops are being diverted to energy production in developed countries, while millions in the developing world do not have enough food to eat (Deublein & Steinhauser, 2008). While this might be very strong argument, agriculture sector is seen as a rich source of biomass worldwide. Studies show, the crop wastes alone can enable more than 220,000 additional individual plants and communal facilities. This will provide farmers the much needed opportunity to become more independent from the food trade and get additional income (Klass, 1998).

6.7 Background and Current Situation of Biogas Production in Turkey

Turkish biogas applications and research started in 1957, which lead to government lead projects after 1975. These projects were also supported by international funds, however after 1987 all these investments and research had been cut and the progress did not continue. The research and some applications continued in small scales (Tolay, 2013). The big applications started to be seen in factories such as Süttaş, a milking company, who provides 15% of its factories’ energy through fermenting animal manure and milk production residues or operations that is run by university-government agreements like İZAYDAS in Kocaeli, which uses both animal and crop sources as substrates (Deutsches Biomasse Forschungs Zentrum, 2011).
Currently there are 36 biogas plants in operation; 2 in the agricultural sector using animal waste and crops, 17 in the food industry using waste water and organic waste, 17 of them operated by the municipalities; 13 of them uses landfill gas and 4 of them uses wastewater as substrate. As we can see, majority of these plants are operated by the municipal and industrial sector, using substrates such as landfill gas or water waste treatment plants. However, since they are not licenced, the exact amount of biogas plants within the agricultural sector, cannot be defined exactly (Deutsches Biomasse Forschungs Zentrum, 2011).

The potential substrates are high in number and ready to be collected however, planned biogas plants are only 49 in total, 12 in the agriculture sector, 2 in the food industry, 12 in the municipal sector and there are 23 undefined licence applications (Table 6). However, these planned plants is not close to using the even %1 of the potential of Turkish biogas production. It is been argued, a potential of 2000 biogas plants are available just only with animal manure, so the following topic will explore this potential from animal, crop and municipal solid waste sources (Deutsches Biomasse Forschungs Zentrum, 2011).

<table>
<thead>
<tr>
<th>Biogas Plants in Operation</th>
<th>Biogas Capacity in Operation (ktoe)</th>
<th>Biogas Plants in Planning</th>
<th>Biogas Capacity in Planning (ktoe)</th>
<th>Biogas Plants Total</th>
<th>Total Capacity (ktoe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture (animal waste, crops)</td>
<td>2</td>
<td>0.51</td>
<td>12</td>
<td>8.96</td>
<td>14</td>
</tr>
<tr>
<td>Food Industry (waste water, organic waste)</td>
<td>17</td>
<td>10</td>
<td>2</td>
<td>2.92</td>
<td>19</td>
</tr>
<tr>
<td>Municipality (Landfill Gas)</td>
<td>13</td>
<td>70</td>
<td>9</td>
<td>24.12</td>
<td>22</td>
</tr>
<tr>
<td>Municipality (Wastewater)</td>
<td>4</td>
<td>2.8</td>
<td>3</td>
<td>2.02</td>
<td>7</td>
</tr>
<tr>
<td>Undefined</td>
<td>0</td>
<td>0</td>
<td>23</td>
<td>46</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>83.3</td>
<td>49</td>
<td>84.02</td>
<td>85</td>
</tr>
</tbody>
</table>

Table 6: Biogas Plants that are currently in operation and being planned in Turkey as 2011 (Deutsches Biomasse Forschungs Zentrum, 2011) pg.7

6.7.1 Animal Sources

A study made for Turkish biogas production possibilities by the German Biomass Research Centre, have taken the cattle, broiler and laying hen numbers under consideration for potential animal sources, since their manure is easy to collect and they constitute the highest share in the livestock animal
numbers. It is estimated that nearly 100 million animals, 11.5 million cattle, 16.4 million broiler and 71 million laying hen, live in possible conditions for manure collection (Deutsches Biomasse Forschungs Zentrum, 2011).

With this high number of animals, the manure amount in Turkey, mostly from dairy cattle, can reach to 84 million tons a year (Alkaya, et al., 2010). However, manure collection may differ from farm to farm, such in the east, there is more open grazing with backyard farming and in the west, the animals are put in the stables without grazing days. Although the stables are easier to control, in both of the farms, the manure is not properly managed, most of it burned for heating process and applied as a soil fertilizer, and the rest is left as it is or flood to the nearest water environment, creating ecological issues such as the pollution of groundwater and soil (Deutsches Biomasse Forschungs Zentrum, 2011).

When these improper manure management conditions are put under consideration, it is calculated that 50% of cattle manure is usable in the western part, while the eastern part only 15% is available. This available manure has a potential of 3,449 ktoe of energy every year. However if the manure collection is managed properly, the calculations show that the potential is two times the natural gas production of Turkey based on the 2007 numbers (Deutsches Biomasse Forschungs Zentrum, 2011).

In addition to the manure from animals, the animal industry producing cheese factories and meat produces enormous amounts of residues from their production. These residues, although it is not a common practice for meat production, can be an additional substrate for biogas production. It is estimated that the total potential of biogas production from meat and cheese factory residues can come up to 74 ktoe of energy. However, the data of these residues are not well inspected and an additional study might be required (Deutsches Biomasse Forschungs Zentrum, 2011).

**Case Study: Planned Biogas Facility in Ceylanpınar, Urfa**

One of the biggest projects for biogas production from animal substrates, takes place in Ceylanpınar, Şanlıurfa, a city renowned for its farming and husbandry. The project is built on a farming facility built near the Syrian border (Figure 6). With 1.761km² land area, the farming facility is one of the biggest in Europe, covering 10% of all Şanlıurfa city, which is 30,000 times more than the average farming land in Turkey. This land area is also 40 times larger than Uppsala city and 4000 larger than Vatican. The facility’s Syrian border is also covered by a 7 km² mine field, left from the Turkish army to protect its borders against PKK attacks (Tolay, 2013). However, the current Syrian Civil War has affected the area, leaving 3 dead in the Ceylanpınar town and had made financial damage to the farming facility.

This facility currently produces many farming products such as an endemic pistachios, wheat and cotton. In addition, it hosts 3,000 milking cattle in the stables, making it easier for the collection of their manure. In the winter there are also 60,000 sheep and goats are hosted in the stables. The number of animals area also expected to raise, since the facility is also planning to raise the number of cattle to 6000 (Tolay, 2013)
During an interview with Chemical Engineer (MSc.) Dr. Mustafa Tolay; who has been building and working with energy production systems for biomass, more than 30 years in five different countries with his Tolay Energy Company; he has pointed out that the farming facility is building a biogas production plant to manage its waste and produce its own energy and Tolay has been hired as the leading engineer of the project. Dr. Tolay has made the following calculations for an estimation for the farming facility, however, the 60,000 sheep and goats and the planned 6000 milking cattle is not involved in these official calculations. His official estimations calculate, through the rural knowledge and on site research, 50 kg of urine and faeces produced per cattle per day, totalling 54,750 tonnes of manure every year in the facility (Tolay, 2013). The biogas plant separates the faeces in the manure, which comes up to 10% of the total manure, 5,475 tonnes of substrate for the production of biogas per year in total. The rest of the manure is processed for producing 730,000 kg of organic fertilizer every year (Table 7) (Tolay, 2013).

The farming facility plans to solve its odour problem resulting from the huge amounts of manure produced with anaerobic fermentation. It will also help the environmental effects such as the air pollution from the fossil fuels and contamination of water sources around the farming facility and the area, keeping them healthy and boosting the yield farming products. This boost will also be supported by the organic fertilizer produced from the manure. Although most of it will be used in the farming facility, the organic fertilizers and the compost will be sold in to the market, in addition to the lowering the facilities dependency, this will also help the finances and sustainability of the facility (Tolay, 2013).

<table>
<thead>
<tr>
<th>Total Production of Manure</th>
<th>54,750 tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Amount of Substrate</td>
<td>5,475 tonnes</td>
</tr>
<tr>
<td>Total Biogas Production</td>
<td>1,642,500 m³</td>
</tr>
</tbody>
</table>
Table 7: Total Production numbers from the Official numbers in Ceylanpınar Facility adapted from (Tolay, 2013).

With the profits produced from the electricity and heat market, the payback time for the biogas plant have been calculated as 6 years at most. The planners also expect an increase in the animal numbers and the purchasing prices, which may take payback time to 4 years. In addition, UNEP and the Turkish government has promised a much needed support, since the biogas plant have the benefits of heat, electricity and organic fertilizer production, which may also be an example for the middle and big husbandries, which is the 30% of the producers in the local area (Tolay, 2013).

This example may be strengthen if the 60,000 sheep and goats and the planned 6000 cattle will be available in the farming facility, more than doubling the effects of the current plans. One can calculate the production of manure from 6000 cattle, using the same values for the official calculations, which is equal to 109,500 tonnes. In addition, the 60,000 sheep and goats will produce of 38,400 tonnes of manure (Batzias, et al., 2005). These sources will create 10,950 tonnes of biogas substrate from cattle and 13,320 tonnes from sheep and goats; in total 24,270 tonnes of biogas substrate per year.

When these manure sources are mixed, it is argued that the biogas yield will be equal to the biogas yield from cattle, which is 300 m³ biogas/per tonne substrate (Kanwar & Kalia, 1993). So, at the end with the total biogas yield will be 3,298,320 m³ biogas, which is equal to 21,439,080 kWh of energy every year. With 38.5 % efficiency for electricity production, total electricity production will be 8,254,045 kWh of electricity per year, which is equal to 0.70 ktoe. In addition, the cogeneration plant’s heat efficiency is equal to 44%, which will make the total heat production 9,433,195 kWh and since the 2,190,000 kWh will be used in the biogas plant, the available heat production is 7,242,195 kWh, which is equal to 0.62 ktoe. It is also possible to produce, 18,202 tonnes of organic fertilizer per year from the available biogas substrate(Table 8).

Table 8: Projected Calculations for The Ceylanpınar Biogas Facility adapted from (Tolay, 2013)
Considering the numbers, it will be possible to produce more than all biogas power plants currently working in Turkey, which will increase the profits with doubled electricity production, tripled available heat production and more than doubled the organic fertilizer production. However, this calculation does not include the additional enlargement of the mechanisms for the handling of the increased manure. If they are put under consideration, the payback time which would have been lowered from the increased profits may take longer, since the expenses will possibly increase.

Nevertheless, when finished the project will lower the prices for electricity in the long run for the area, encouraging and educating about the use of new technologies and increasing the area’s competitiveness with other local economies. The biogas plant will strengthen the local economy by creating new employment possibilities such as construction, engineering, mechanics, empowering the population in the area. This will also be supported with the high possibility of carbon credits that it might get, since it can be a centre for leading the area for using modern biomass technologies for dealing with its waste. The organic fertilizer from this waste will also help the farming sector in the area, boosting the yield and empowering the farmers (Tolay, 2013).

6.7.2 Crop Resources:

In Turkey, agricultural land which is mostly larger in Centre Anatolia are being used for cereals, and fruits and vegetable productions are generally in the southern and the western Anatolia. Distribution of the products differs from region to region due to different climatic and soil conditions. These products produce a high number of crop residues such as straws, nut-shells, fruit shells and seeds, plant stalks, green leaves and molasses (Demirbaş, et al., 2006), perennial residues of pruned trees and shells and agro-industrial residues from seed, olive, kernel oil and wine. Currently, residues such as cereal straws from maize, sorghum and barley are used for animal breeding or burned after a drying period and residues from tomato, eggplant and pepper are processed in very outdated methods to be used as soil feed (Deutsches Biomasse Forschungs Zentrum, 2011).

In their study to find out the biogas production potential in Turkey, German Biomass Research Centre, uses cereal straws, tomato production residues and sugar beet leaves as the example of residues from most used plants and calculates that the potential energy production is 7237 ktoe of energy (Deutsches Biomasse Forschungs Zentrum, 2011). In addition to the crop residues from cultivation, the agro-industry in Turkey can be a valuable resource for substrates. The 2.5 million active businesses produces different products ranging from sugar beet, olives and nuts to apples, grapes and oranges. It is estimated that, if only the sugar beet, olive and juice production residues are used for biogas substrates, the potential energy production reaches to 330 ktoe. It is also possible to produce energy crops; the crops that are produced only for biogas production in fallow lands, however this possibility is not put in action and has a considerable amount of problems in front of it, such the soil quality of the unused lands, climate conditions and seed prices and the small size of the farmlands (Deutsches Biomasse Forschungs Zentrum, 2011).

Case Study: A Study for a Possible Biogas Plant in Bursa

In order to understand and evaluate the capacities of biogas production in Turkey; University of Uludag conducted a study for utilizing waste from tomato and pea paste production and cattle manure. The study takes place in Bursa; the fourth most populous province with nearly two million people, located in the Marmara Region of Turkey. The province has 429,323 hectares of fields and 40% of these lands are suitable for agriculture of almost all kinds of agricultural products (Ulusoys, et al., 2009).

In 2006, a total of 906,000 tonnes of tomatoes for tomato paste were grown where, 10-15 % of tomato waste, 90,000 tonnes, was produced in the process. In addition, the pea production in the area produces 60,000 tonnes of waste according to the questionnaires administered at the pea production factories in the Bursa Region. In Karacabey district, a part of the province, the amount of waste reaches to 9,000 tonnes of tomato waste and 3,000 tonnes of pea paste per year. This district was given as an example, since it has a milk processing plant with 1000 milk cows and the study considers a
biogas power plant that is designed for creating electricity for this milk processing plant (Ulusoy, et al., 2009).

The study then gives us two scenarios; while milk cow manure is kept, one scenario uses tomato waste and the other uses pea paste. In the scenario that uses tomato waste the created energy reaches 0.24 toe of electric energy, while the pea waste produces 0.19 toe of electric energy (Ulusoy, et al., 2009). Considering that Bursa province has consumed more than 860 toe of electricity (Anadolu Ajansı, 2012), this number may seem low but it should be pointed out that these numbers are for a district of a province. If the system is spread into the province, the production will help considerably to lower the dependency on imported energy sources.

### 6.7.3 Sources from Municipal Waste

Sadly, even though it may have the resources and the capacity to collect the solid waste and solve its disposal problems, Turkey’s traditional method of disposing of solid waste has been duping it to open sites, burning in an open area and even disposing at the sea, lake and rivers. Currently, most of the municipalities control their landfill and take it to a municipal dumping site however, there are municipalities, 187 municipalities that is still burning and disposing their solid waste into the sea, lake or river (Deutsches Biomasse Forschungs Zentrum, 2011).

Turkish Statistical Institute calculated the total amount of municipal solid waste (MSW) is 24.360.863 tons/year for whole Turkey in 2008. From this solid waste, bio waste, which is mostly kitchen waste can be used as a good substrate for biogas production. It is estimated that 34% of MSW is kitchen waste (biowaste), constituting 8,282,693 tons of waste per year with a biogas potential of 525 ktoe of energy every year (Deutsches Biomasse Forschungs Zentrum, 2011). However, the study made by the German Biomass Research Centre, did not include the municipal wastewater in its calculations, which can be a great source in a city such as Istanbul, with 15 million inhabitants. On the other hand, it can be also extremely expensive to build these centres, again, considering the population and the capacity of these plants.

### 6.8 Analysis of the Biogas Potential in Turkey

The aforementioned topics tries to find out the potential of energy production through different sources for substrates. It is estimated that the energy created from animal sources will be 3523 ktoe, from crop sources 7567 ktoe and from municipal solid waste, it will be 525 ktoe. In total, the total estimation reaches to 11,615 ktoe of energy, more than doubling the current hydropower energy production (Table 9). In another study, made by Emrah Alkaya and his colleagues, it is argued that the crop residues should be mixed into animal manure as biogas substrates to create an optimal biogas production, increasing the efficiency of the process. They calculate that the technical potential, with the current conditions of waste management, can produce 15,500 ktoe of energy, nearly half of the energy produced from natural gas (Alkaya, et al., 2010).

<table>
<thead>
<tr>
<th>Substrates</th>
<th>Theoretical Potential (ktoe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal</td>
<td>3523</td>
</tr>
<tr>
<td>Crop</td>
<td>7567</td>
</tr>
<tr>
<td>Municipal Solid Waste</td>
<td>525</td>
</tr>
<tr>
<td>Total</td>
<td>11,615</td>
</tr>
<tr>
<td>Total Technical Potential</td>
<td>3,351</td>
</tr>
</tbody>
</table>

Table 9: Total Theoretical and Technical Potential of Biogas Production with Different Sources adopted from (Deutsches Biomasse Forschungs Zentrum, 2011)
However, the study made by the German Biomass Research Centre argues that the technical biogas production from all these sources can only come up to 3,351 ktoe, given the current technical possibilities as well as structural and ecological restrictions. Even with the technical potential of biogas production, the produced biogas can cover 2% of all energy consumption, which is equal to 30% of all current renewable energy production and 9% of the natural gas consumption in Turkey (Deutsches Biomasse Forschungs Zentrum, 2011). Considering, this will be the second biggest renewable energy source in Turkey and can be used to lower the 98% dependency on natural gas, these numbers should not be taken as disappointment. One should remember the technical potential is affected enormously from current waste management system in Turkey. If this problem is solved, the theoretical potential of the biogas can replace 31% of the natural gas consumption, and will be able to cover 10% of the total energy consumption, more than all of the current renewable energy systems combined (Deutsches Biomasse Forschungs Zentrum, 2011).

6.8.1 Political and Legal Framework

The legal and political possibilities for this future is currently underway in Turkey; since 2006, renewable energy sources which will be used in the agricultural facilities in rural areas are granted by 50% (Tolay, 2013). In addition, since 2011, an enacted law for expanding the deployment of renewable energy sources for electric power production sector, renewable energy producers that produces energy less than 500 kWh (4 ktoe) will be able to benefit from 85 % discount for power transmission line permits, leases, rights of easement and usage permit costs during the first 10 years of their investment and operation (Deutsches Biomasse Forschungs Zentrum, 2011). This law also hosts a specific law for biogas production, that exempts the tariffs and value added tax for importing the mechanical equipment (Tolay, 2013). These legal frameworks support the political project for the 100th birthday of Turkey called the “Vision 2023”, which is aims to build biogas systems in rural and urban applications, gasify the biomass sources and clean them in order to use in the natural gas lines, and obtaining energy from waste and waste management (Deutsches Biomasse Forschungs Zentrum, 2011).

After investigating the biogas production and its potential in Turkey, in the next chapter, this paper will focus on the Theoretical Aspect of biogas production, its missing points and how these points can be further developed.

7. Applying the Energy Resilience and Rural Development Theories for Biogas Production in Turkey:

Until this point, this paper answered the first aim of the thesis “What is the renewable energy alternative for Turkey?” It has been pointed out that one absolute potential for Turkish renewable energy alternative is hard to define, considering the different sources of renewable energy and their high theoretical energy production. However, the study of Barış and Küçükalı, find a solution through broadening the selection criteria, pointing out the conflicting criteria and using a multi criteria method to evaluate the renewable energy sources under economic, environmental and social aspects.

According to their study, biomass was chosen as “the most appropriate renewable energy source” for Turkey considering its high social benefits resulting from public acceptance and job creation and high capacity factor that comes from efficient production through all year. This paper, focused on one of the many biomass energy production possibilities, which is biogas. Although, through our research it is easy to realize the reason for this paper’s selection for biogas, considering its high renewable sources for substrates, high energy production possibilities and socio-economic advantages, this selection was made also taking the theoretical background of this paper under consideration. If one goes back to the theoretical background topic of this paper, it will be realized there is two theories under focus; one is the Energy Resilience and the other is the Rural Development, the following section will explain the biogas selection reasoning by analysing the characteristics of these theories.
7.1 Biogas’ Role in Energy Resilience:

As pointed out, Resilient Energy Systems theory builds itself on the resilience theory, which focuses on the system’s ability to absorb certain changes and return to an equilibrium or a steady state, reorganizing by nearly keeping the same function, structure identity and feedbacks while the undergoing change continues (Holling, et al., 2004). With this foundation, Resilient Energy Systems theory focuses on two decision actors that will absorb changes in energy use and production; one is the owner and energy sources and use the energy produced and the others who develop and deploy those technologies. The system is resilient when the user is able interact with the energy capture and use and manage the resources to meet his needs (O’Brienn & Hope, 2010).

Although the main sector is agricultural sector for biogas production, the topic’s connections to the energy sector creates a rather wide collection of actor. One of the important actors is the government since it is responsible for law making and in charge of the enforcement of this created legal framework. Even though, they create the laws; the demand for this action comes from the chambers, associations and cooperatives, which are responsible for civil acts as raising public awareness and finding suitable investors in the energy and agricultural sector (Deutsches Biomasse Forschungs Zentrum, 2011). The investors come from national and international arena, responsible for creating economically feasible projects for themselves by developing the technology. This development is done by the research centres and universities, who might also cover the lack of knowledge and data about biogas technology data. Another investor can be the farmers themselves or they can gain from the investments done for their farms just as the users, who only benefit from the energy produced (Deutsches Biomasse Forschungs Zentrum, 2011).

Since the resilience of the system is defined interacting with the energy capture and managing the resources, the farmers are the most suitable actors in this sense, whom will be the investors and the users who interact with the energy capture and production and manage the resources, such as the substrates from crop and animal. If we revisit our Figure 1, we would see the model of a resilient energy system, farmers, who deals with agriculture will be able to create the Indigenous Intermittent Renewable Resources, either by raising the animal for its manure or plant the crops that will be used by energy crop or a residue. After this, they will be in possession of the technologies that can capture the manure and residues and/or harvest the crops and store them. In addition, since agricultural sources are needed to be stored and used in close locations, the producing technology will be able to be embedded and localized renewable technology which is the biogas production plants, using anaerobic fermentation and co-generation plants for energy.

These characteristics, will create a system that is not too reliant on centralized generation and transmission and the substrate availability will not be vulnerable such vulnerable as oil and natural gas to economic shocks or political problems. The ability to resists and recover from disturbance will be provided just as the diversity of ecosystems, by a mix of small or large producers (Enviromental Defense Fund, 2012). This diversity is also suitable for the second part of O’Brienn & Hope’s Resilient Energy Sytems theory, providing the diffusion of only large producers and creating many combinations of autonomous, interconnected users at small level. The system created by farmers and biogas production centres will shift the concentrated ownership of energy production and distribution to a more democratic model with numerous stakeholders (O’Brienn & Hope, 2010).This diffusion was also discussed by Mustafa Balat, writer of “Security of Energy Supply in Turkey: Challenges and Solutions”. Balat argues, the transformation to small scale production facilities can provide the local sources a much needed energy source to tackle the widespread energy poverty in rural areas caused by the limited access to modern energy sources. (Balat, 2010).

With this current topic, we have answered our second aim “Can the renewable energy alternative be considered as a resilient energy source?”. As pointed out, the renewable energy alternative, biogas has fit perfectly in our resilient energy system theory by using substrates that can be managed and harvested by the users in addition, being consisted of production technologies that can be deployed and developed by the users. In the next topic we will try to answer our next aim; “Does the renewable energy alternative provide an alternative for the current rural development conditions?".
7.3 Biogas and Rural Development

As argued in our theoretical background section, rural development is quite controversial. At one point it is seen as the development process that has the goal of finishing farmers as we know it and at another point it is seen as the revitalize of agriculture. Although those two things is not supposed to be unrelated goals, the main goal of enhancing food security and stopping rural poverty (Ploeg, et al., 2000).

However the application of the market structure of 1990s; scale enlargement, intensification, specialization and even industrialization to the rural sector of agriculture have created problems such as regional imbalances and unemployment which also affected the mainly agricultural Turkish rural areas (Ambrosio-Albalá & Bastiaensen, 2010) (Ploeg, et al., 2000) (İzol, 2013). It is hard to deny the importance of the agricultural and the rural sector in the Turkish economy and social life. Even though their employment rate is dropping, the agriculture sector employs 5.2 million people, which is 24% of the total employment in Turkey (Deloitte, 2010). On the other hand, the share of agricultural production in Turkey’s GDP has decreased from 10.1 percent in 2000, to 8.3 percent in 2009 and employment in agriculture has been steadily declining, by approximately 33 percent from 2000 to 2010 (Deloitte, 2010). In most of the eastern parts people who are dealing with small scale agriculture, has been in debt for a really long time, selling their lands that belonged to their families for over 1000 years (İzol, 2013).

The core problematic issues such as exploitation of natural resources and international trade issues and the inequalities resulting from administration issues, are planned to solve by economic diversification, which gives farmers to complement their incomes and create new opportunities for the rural area (Ambrosio-Albalá & Bastiaensen, 2010). In addition to the economic change, the administrative changes, which is created by the engagement of local actors, are also important for tackling these problematic issues. A new partnership model that builds itself on mutual benefits between different activities that are strategic and desirable, cooperating the agricultural and non-agricultural actors will be the new administrational status of the rural development models (Ploeg, et al., 2000) (Ambrosio-Albalá & Bastiaensen, 2010).

Considering the challenges of economic diversification, the advantages of biogas production seems to be very suitable. As Dr. Tolay points out, connecting the energy and agricultural sector, biogas plants in itself connects different areas. It will strengthen the rural economy by creating new employment possibilities such as construction, engineering, mechanics and their side jobs. These jobs will be open to the rural community who might get a higher education and does not want to stay in the rural area. The absence of young population that has been educated or wants to follow the opportunities in the cities is one of the biggest problems that is affecting the Turkish and global rural areas (Ambrosio-Albalá & Bastiaensen, 2010) (Tolay, 2013)

The new income that comes in from these jobs will improve the condition of service sector such as markets, restaurants in the rural area too. With lower prices for electricity by decreasing the dependency on imported materials, the area’s competitiveness with other local economies will increase (Tolay, 2013).In addition, the economic benefits of the biogas plants, such as the use or selling of the by-products will help the farmer boost their yield from their products and complement their income. This income boost will be can also be supported by the carbon credits or grants from governmental or EU projects, since these projects are their priorities (Özen, 2013).

This argument is also supported by the collaborative work of Berna Türkekul from Ege University and Gökhan Unakıtan from Namık Kemal University. The study shows that electricity consumption and GDP shows a causal relationship and if the governments improve the infrastructure and subsidizes rural and agricultural electricity. This process is found to significantly enhance and increase the GDP and agricultural sector’s share on it. In addition, energy conversation measures and regulatory reforms can be implemented without affecting the GDP of the agricultural area, ensuring the economic and social sustainability by increasing the sector’s competitiveness and quality of life in the rural (Türkekul & Unakıtan, 2011). This process sounds logical also from biogas production point, since it would also be economically feasible, if the grants are created by extra resources from the imports due to decrease in oil and coal imports, increased
income and tax revenues due to employment benefits of construction, maintenance and running the plant, and their spending in the local sector. (Deutsches Biomasse Forschungs Zentrum, 2011)

Other than the economic benefits, the Rural Development Theory argues a new administrative system of partnerships and cooperation should be formed for the new rural development. Support for rural areas from the administrative point of view, has been a political concern over the years in Turkey, built on the promises of the politicians rather than the economic demand from internal and external markets (Türkekul & Unakıtan, 2011). It will be hard to believe that this condition will change in the future, considering the importance that the agricultural and energy sector plays in the economy. However, until this point biogas production does not offer a solution to this problem. Currently, the biogas plants are generally built on big farms, the food industry and municipal sectors (Table 6). This might result from the fact that, in order to produce electric energy and heat together, the farmers who deal with husbandry will need 1000 cattle to make the biogas plant economically feasible (Tolay, 2013). In addition, even the numbers are supplied the widespread, outside grazing should be changed into stall feeding (Gripentrog, et al., 2004). This change might put extra economic strain on top of the relatively expensive biogas plant system for the farmer. This problem also exists for the crop producing farmers, who mostly deals with the residues by burning or leaving in the field and puts the responsibility on a bigger organization, which generally means the rural administration, to collect their residues (Tolay, 2013).

Figure 7: The theoretical circle of waste management and biogas production for rural areas adapted from (Kalelioğlu, 2012)

However, currently no rural administration has a proper waste management system, since the rural centres and the farming areas are far and widespread. The average area occupied by a Turkish farm is 6.1 hectares while only 57 of the farms bigger than 500 hectare, which would requires a lot of investments, oil use and many transport vehicles by a municipality, if the residues are planned to transport to one central location (Deloitte, 2010) (Kalelioğlu, 2012). This problem has been argued in a TV programme about farming and biogas systems by Energy Systems Engineer and Consultant for Green Energy Investments for Solea Energy Company, Kayhan Kalelioğlu. Kalelioğlu discusses the problem of collecting and every individual farming biogas production means a loss in the efficiency for energy production, which can be produced in the local area. He mentions that, according to his experiences and calculations, in the Turkish rural areas, potential of the manure and residues produced are enough for the economic efficiency in a 15 km area of the residue and manure collection centre, which is 1 km away from the rural centre (Figure 7). If this system is suitable for the rural area, farmers together can form cooperatives to collect the residues and bring it to the specified land
(Kalelioğlu, 2012). This argument is also supported by Dr. Tolay who has also worked in many rural areas for field work. He argues that many places in the rural areas need a system like this, which will benefit greatly not only from an administrative point of view but also from an ecological point of view (Tolay, 2013). In addition, the storage of the residues without any efficiency loss in a small circle, suits perfectly with the Resilient Energy System Theory’s search for a community owned renewable energy technology can supply the needed energy services with existing technologies (O’Brienn & Hope, 2010).

In summary, the biogas production in Turkey can be complement farmer’s, who is the rural actor; income and provide diversification for the rural area, however, in itself it does not provide an alternate partnership and administrative model, other than the current market solutions. On the other hand, Kalelioğlu points out that cooperatives formed by the farmers can provide the needed administrative structure for the farmers. Following this proposal, the following chapter will inspect the current conditions of cooperatives in Turkey and provide an answer for our third aim; Does the renewable energy alternative provide an alternative development for the current rural conditions?”
8. Cooperatives for a New Administrative Partnership

8.1 Introduction to Cooperatives:

A cooperative is defined as an autonomous association of persons, who are united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012). They are generally active in agriculture (manufacture, purchase and sell) sectors, but there are also cooperatives in wholesale and retail trade, construction of houses, water, electricity and health sectors, banking and insurance fields. However, answering to the current market situations, new cooperatives organizations are increasingly established in the sectors such as information and communication technology, maintenance service, handicrafts, tourism and culture (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

The formation of cooperatives were also defined as the market structure of the times. During the middle of the 19th century, rapid changes and transformation as a result of the Industrial Revolution; have changed the structures of employment, domestic migration, urbanization. Sadly, these changes have created economic and social problems in inequalities in income distribution. Cooperatives in that were introduced as a flow of consumers’ cooperatives by the workers in England. The people gathered voluntarily with the motivation of protecting or improving their individual economy. This new system and their determination have had significant economic and social gains not only for themselves but also for their societies (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012). Wherever the cooperatives are, they have always been living and surviving together with their society. The progresses such as infrastructure, has eased the life of their society was used by the cooperatives and it has helped them too considerably, giving the cooperatives a responsibility for their society that they have grown (Tchami, 2009).

This responsibility have created a base of values for the cooperatives, consisting of self help, self responsibility, democracy, equality, equity and solidarity. These values are put into action in seven principles. First one is voluntary and open membership, opening cooperatives to all persons without gender, social, racial, political or religious discrimination. Second principle is democratic member control, which leaves the control of the members under the active members of its organization. Every member has one vote and all votes are equal putting the elected representatives not responsible but accountable for the organization’s decisions. Participation in Economic decisions for the members is the third principle and puts the members in control of the economic decisions. Member contribute equitably and democratically control the capital and the revenues, which is used to limited compensation for the members and mainly to develop the cooperative by setting up reserves. The fourth principle is characteristics of autonomy and independence of the cooperatives. Even if they go under agreements with other sectors of the society such as governments or corporations, they maintain the democratic control by their members and co-operative autonomy. The fifth principle is providing education, training and information for members, elected representatives and managers of the cooperative. In this way all members are able to contribute to the development of their cooperatives much more efficiently. This also serves as education and information for the general public, especially for young people and opinion leaders, about the characteristics and benefits of cooperation. Cooperation among cooperatives, so that they can serve their members most effectively and strengthen the cooperative movement by working together in local, national, regional and international structures is the sixth principle of the cooperatives. The last principle, cooperative’s concern for community, shows the unity to their society as they will work for the sustainable development of their communities through policies approved by their members. (International Co-operative Alliance, 2013)

Ayhan Çıkın, Professor of Agricultural Economics, argues that farmers should be used as a rural development tool in the places where it can, by addressing the special needs and conditions of that area. Cooperatives can be the tool to learn about these special conditions rather than a place to implement centralized ideas. However, while keeping their local knowledge, cooperatives that use up to date farming technologies should gain more benefits than the others. As they benefit and gain their experience. They will be the moderators of supply & demand between agricultural input markets and agricultural product markets and if the ideology is kept the cooperatives can be useful in order to
diminish the importing addiction of oil in the agricultural sector by promoting and providing tools for renewable energy options (Çıkın, 2006). In this way, the cooperatives are the tool of “existing together” for the rural communities, since cooperatives are argued as the force against the “finishing” policies of the modern market structures for the farmers.

Agricultural cooperatives are the main agent in this struggle and serve as the diversified organization for the diverse polycultural rural areas. The cooperatives answer to the diverse inputs of their members, who will realize the different needs of the rural and urban areas. However, this realization will not divide the rural development from urban development, rather the cooperatives will bring the problems and the unionized power of the rural populations, not just the agricultural community, into the table when the administrative units are making a decision, since they focus on working for the sustainable development of their communities through policies approved by their members (Tuncay, 2012). This puts the individual member beyond the basic economic relationship of customer, worker or producer. In this way the right of participation in the decisions of their daily lives gives them a collective power through democratic arrangements as they participate in its governance. In addition, individually they have a right to information, a voice, and representation (International Co-operative Alliance, 2013) In the end, the administrative partnership that was missing in the application of the rural development theory for biogas production where the main actors are the farmers, have been developed thusly, building itself on joint action among rural agents, coordination between the different administrative levels of government and articulation of addressing the different problems in different sectors (Ambrosio-Albalá & Bastiaensen, 2010).

Under the following topics, we will analyse the Turkish cooperatives, their problems and the possibility of building a partnership model for biogas production under the cooperative’s flag.

8.2 Background of Turkish Cooperatives

The history of modern cooperatives in Turkey starts alongside the foundation of the Turkish Republic, with the creation of the "Agricultural Production and Trade Cooperatives" in 1923. Newly formed laws had put importance on the idea of cooperativism as the new economic idea of the Republic began to settle with private industrialization, free export and import, and banking systems (Serinikli & İnan, 2011). Even the founding father Mustafa Kemal Ataturk, who has always thought cooperatives are the best way to distribute wealth into the rural areas, has become a member of the Civil Servant Cooperatives in 1925 (Uras, 2003). However as the crisis in 1929 has grown, the importance was rather given to the establishment of a stronger banking system and a widened private industrialization, that follows the ideology of statism and until 1961 the localized cooperativism ideology was nearly disbanded (Serinikli & İnan, 2011).

With the coup of 1960, the constitution was given to the technocrats to be written and since the economic ideology of these era was a mixed public-private economy with import substitution; the local economy became important. The cooperative ideology put into the constitution and became part of the "5 Year Economic Plans", where they had given rather broad rights in which they were free to unite within themselves or under superior organizations and a free foreign currency usage in during a time when the foreign currency was anti-liberal and the limited amount of currency was distributed (Serinikli & İnan, 2011). On the other hand, with the oil crisis of 1970s, the need for foreign currency has dramatically risen and the economic problems that it has brought had not been dealt properly. This had created a more liberal approach to the import substitution until the 1980 military coup, where the economy was planned to be dependent on less public sector and state intervention, leading to the closing of the small cooperatives that were owned by the villagers and privatization of the superior cooperative organizations formed by the state (Serinikli & İnan, 2011).

Even though it has problems, the cooperatives are still an important part of the rural economy in Turkey. There are 13,384 agricultural cooperatives, which constitutes the 2% of all cooperatives in the world, with 2,003,037 members. With agricultural production, rising since 2000 with an economic capacity of 79 billion TL (~ 33 billion €) in 2009, the agricultural cooperatives numbers are also rising with an increase of 1082 cooperatives during the time between 2006 and 2010. (Deloitte, 2010) (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012). However, the Turkish
government states that, with their growing numbers the problems they bring also grows (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012)

8.2.1 Current Problems and Solutions from Government’s Point of View

Since 2012 was the Year of Cooperatives, The Ministry of Customs and Trade, and its Directorate for Cooperatives has created a document called “Turkish Cooperatives Strategy and Action Plan 2012-2016” after meeting with 104 representatives from 47 organizations. The report gives detailed information about the current condition of cooperatives and a basis for an action plan in order to create a new environment where the problems of cooperatives are solved under 7 topics.

8.2.1.1 Troubles Faced In Terms Of Providing Service to Public and Establishing an Atmosphere Convenient For Cooperatives

The main reason for this problem is pointed out as the lack of convenient atmosphere for action. This problem first created by the ideology of the governments that has controlled every aspect of the cooperatives in finance and organization, even the cooperatives that should be an effective member of the free market, such as the agricultural sales and credit cooperatives. This control has created dependency to the governments for the farmers rather than uniting under independent cooperatives. The 34% of the cooperative members think that the cooperatives should be a part of the public sector, as a part of the governmental administration (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

Therefore, the Directorate General of Cooperatives argues that, rather than solving their own problems, the members depend on the government to solve the cooperatives’ problems and with the lack of proper bureaucracy, the solutions focus more on the routine works like completing the formalities of establishment and carrying out the works related to a general policy. These two problems create an untrustworthy environment to the cooperatives since they are seen as incompetent; resulting in lack of authority and respect while decision making and create the inability (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

The report proposes to solve this problem by fixing the necessary public management structure within this framework. Furthermore, since this topic carry great importance; keeping up with the problems related with the implementation, the economic conditions, and markets in which cooperatives operate, and the domestic and foreign economic developments; and retaining the information at the corporate level are considered to be dealt with sufficient research, collection of data-information, and creation of new policies, solutions and information (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

8.2.2.2 Inadequacies in Training, Awareness Raising and Research Activities

The current conditions of the cooperatives training is not at the required level or has not been institutionalised yet in Turkey like in Germany or England. In these two countries, the organizations of Cooperative Colleges educate the cooperative members on cooperative ideology and management. As a result, the uneducated members or executives of Turkish cooperatives lack the awareness about the cooperative ideology, which undermines the cooperatives’ entrance to the new markets and rural economy. This process results in conditions where they lose the possibility of new funds, which they desperately need. With limited funds and limited knowledge the cooperatives lack the ability to create awareness and research topics, which is vital for an economic organization. (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012)

In order to solve this problem the report mentions the Promotion and Training Fund established to solve these problems, however they also mention that this fund has not achieved the required aim, where insufficient importance attached to the cooperatives courses and research on cooperatives, and lack of emphasize in the written and visual media which is an important part of the trainings. The report mentions Turkey is also in great need of organizational structure or structures based on Research and Development in order to develop cooperatives. The research, analyses, and publishing regarding the cooperatives, business methods and financing opportunities are considered areas where there should be increased and supported. These solutions are also theorized with widespread world-wide research which will produce and provide information regarding the cooperatives, economy,
finance, legal structures and business management for the cooperatives, managers, members, workers and in general for the cooperatives sector (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

8.2.2.3 Weak Cooperative to Cooperative Relations

The main indicator of this problem can be seen in the lack of social capital, which deals with confidence, cooperation and solidarity values that brings human and physical capitals together. One of the main nominators is the interpersonal confidence; trusting other people, has come in 6.5% in positive answers. This number is drastically low when compared to other countries, in which the cooperatives have strong foundations, such as in Norway; 65.3% and Sweden; 59.7% (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

The idea of cooperatives has become an easy way to get access to state funds and economic profits rather than synergy, solidarity and cooperation (Uras, 2003). This trend can be seen in the growing numbers of the cooperatives as they follow the times where there is state funds distributed or there is an agricultural boom. On the other hand, even though the voluntary collaboration based on solidarity is a culture that is long standing in the Turkish rural areas, the cooperativism movement itself did not start automatically; it was rather a top down economic approach from the start as previously mentioned. Indeed, it is hard to deny the governments approach’s result in the farmer's ideology where they seek cheap inputs and guarantee from state (Gun, 2005).

These conditions have also brought the rate of participation of the cooperatives to superior organizations down to 25%. However, even with these low participation rates, the superior organization based on voluntary principle may often disrupt the activities to be performed such as leaving the costs of training and publishing activities embarked by the member cooperatives while the unit cooperatives that are subject to audit, prefer to disunite from the superior organization, avoiding participation (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012). In this respect, eliminating the lack of organizational ability, which also covers values like solidarity and confidence is introduced as a solution. In order to achieve this, renewing the institutional, legal and practical infrastructure of the cooperatives in line with the international principles and requirements are given great importance. Superior organization structure in the cooperatives sector in Turkey is considered not at the required level and resulting in insufficient technical support, training and audit for the unit cooperatives. The report follows through these problems with the incapacies of achieving large-scale tasks, research and development, guidance and pressure groups. International practices are shown in order to enable the cooperatives system function well and to enable cooperatives act in line with the cooperatives principles and values, This organization is self-administrative and planned to participate in the decisions concerning regulations, providing all kinds of service to its members and audits its members based on compulsory membership (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

8.2.2.4 Lack of Capital and Problem in Access to Finance

Even though the goal of cooperatives is helping their members, their financial importance is undeniable. However, the non-profit and contribution based nature of cooperatives creates a more diversified problem for cooperatives when compared to other financial institutions. The physical assets are less important than human assets, since cooperatives focus on achieving the aimed targets rather than maximizing the profit. In the end the priority is given to retention of profits due to nature of the cooperatives and the limited capital contribution of the members are not able to provide resource as the financial assets like equities and securities. The most important result of this is the lack of capital. Even there is a governmental or organizational aid, the temporary financial assets do not help this lack as the systematic and institutional structure needed to operate the capital is inadequate. (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

The report is not considering to solve these financial problems with the current market conditions, since the cooperatives cannot provide a guarantee for the banks due to their weak structures, making it impossible for them to take credits. However, they propose to change the membership share from every member entering into a cooperative, raising its price to 100 TL (42 €) changing the limit of maximum shares more than 5000. However these changes thought to be revised periodically in order
to adapt to the new economic conditions (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

On the other hand, the report mentions the first solution is banks established by the cooperatives, to solve the financial problems of the cooperatives, through cooperating and collaborating among themselves, as many examples in the world suggests. The banks are considered to provide operational capital and credit with low interest rates to help its members by informing them about the economic developments, carrying out usual banking transactions like collecting deposits, and issuing bonds. Despite its advantages, the report proposes to create a common fund by the cooperatives and their superior organization, since forming a bank is found to be difficult. This common fund is also intended to be supported by loans that are taken by other means; such as national and international organizations and regional integration organizations provide credits in suitable conditions, on the basis of projects. In that end, the report intends to improve the suitable conditions by developing the Project-making capacities of the cooperatives, informing the cooperatives and their superior organizations about these national and international loans and helping them during the process of participation to these projects (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

8.2.2.5 Problem of Audit and Image

One can discuss though, the cooperatives’ access to capital is mainly the result of their problems of image and audit. The name “cooperatives” in Turkey is mostly associated with the housing cooperatives, where many people were swindled through fraud (Uras, 2003) (Özen, 2013). Misconducts and failures in the audits, such as in the housing cooperatives, have created an image of an uncontrolled cooperative institution in public, negatively affecting the attitude towards the other cooperatives. The problem of these audits result from an executive board composed of non-experts who are not informed about their duties and responsibilities to law and their master contracts and practice them. In line with this, the information rights of the members are not practiced, where they can learn about the works and activities’ progress within the year. The superior organizations that might help with this process are not at the required level, lacking the strategy of guidance and inspection for audits, making the troubles in transactions and the performance assessments worse (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

In order to solve this problem; the report advises to help the audit of the cooperatives by sending controllers and inspectors of the related ministries. However, state audit remains limited because of the large number of cooperatives. On that point, the auditing practices in the European Union by independent audit mechanisms are considered to provide information periodical suggestions to the cooperatives. These suggestions should include accounting, legal and administrative operations, business plans and operational performance to make internal audit system is more effective (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

8.2.2.6 Lack of Institutional and Professional Management

As mentioned in the problem of audits, the non-expert executive boards are an important problem to deal with. The board and the managers are selected without any condition to have a certificate, experience, training that implies the management skills regarding cooperatives for the person to be elected. Since, the cooperatives can’t employ professional managers or expert personnel; the executive boards and managers’ inability to benefit from the knowledge and experience of the superior organizations as in previously mentioned problems, the success of small scale cooperatives’ depends on the amateur administration.

With the modern management mentality in mind, specialization and division of labour in the cooperatives are emphasized by the report since they have the basic business management functions such as financing, accounting, marketing, manufacturing, research & development. However, the feasibility of this project is considered applicable only if they have professional personnel working for every function, which is difficult possibility for the cooperatives. It is advised that the executive board of the cooperatives should focus on the short, medium and long term objectives and targets of the cooperative, on relations with the members and they should leave the work to professionals in the issues which are related with the business management side of the cooperatives helped by regulations.
and supplementary mechanisms with the aim of rendering the corporate governance mentality dominant (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

8.2.2.7 Problems Stemming From the Legislation and the Implementation

The problems regarding this topic is argued by many of the researches and analyses made in Turkey regarding the cooperatives and point out that the problem is scattered legal regulations, insufficient and complex structure of the legislation regulating the field, and the legislation’s inability to integrate the cooperatives’ principles and basic values. Different types of cooperatives operate under three different ministries causing differences in implementation and audit of the master contracts prepared making it harder to create a joint implementation. In addition, with the lack of specialized courts and specific problems of the jurisdiction the process takes a long time, since there are 3.000 cases regarding the cooperatives are submitted to the Court of Appeals annually. 60% of these cases are about the disputes among the cooperatives and the members. These problems result in the impeding of the activities of cooperatives, slowing down the operations (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

In order to solve these problems, the report mentions that the amendments on law needed for the master contract changes with the cooperatives, can only be made with the decision of General Assembly, since the changes follows the amendments. The problem against this solution is considered to be reaching to an agreement with the multi managed structure of cooperatives. The practical needs for these changes are met with judicial decisions with inadequate regulations making the lawsuit times longer, either. The report concludes that considering proposals such as abandoning the multi managed structure in the implementation of the legislation on cooperatives and establishing specialized courts or boards of dispute resolution for the judicial process will make the law flexible and applicable to allow some changes (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

8.2.3 Analysis of “Turkish Cooperatives Strategy and Action Plan 2012-2016”

The "Turkish Cooperatives Action Plan" follows The Project Design Manual created by International Labour Organization’s Cooperative Facility for Africa, their International Training Centre for Enterprise, Microfinance and Local Development Programme and the Sustainable Development and Governance Cluster, with the subtitle of “A Step-by Step Tool to Support the Development of Cooperatives and Other Forms of Self-Help Organization”. This manual was also given example in the International Year of Cooperatives Website under the Resources Page (United Nations, 2012). The Design Manual uses Project Cycle Management method used by many other cooperation agencies such as the European Commission External Cooperation Programmes and German Technical Cooperation to effectively conceive and plan the cooperatives implementation on demand driven proposals. The Manual also considers the cooperatives need to apply more entrepreneurial approach in order to detect opportunities and how to benefit from them. In order to show the application process a case study of the fictitious Hanassi Dairy Cooperative, created by real life experiences, located in a poor rural district of a developing country is used (International Labour Organization, 2010).

However, the "Turkish Cooperatives Action Plan" has a centralized view and want to limit the number of cooperatives. This approach can be seen as a logical considering their high numbers and mostly ineffective status, however the “good examples” of cooperatives in the report, given under “The Cooperatives in the World” part, are a part of the current market structure, whom have have high number of members and high income with no rural connection. Importance is given to the superior organization and business side of solutions, while research and rural development problems are hoped to be solved by increased business methods and financing opportunities. In addition, the social problems’ solutions are relied on the worldwide research solutions, disregarding the local problems and research of the cooperatives.

On the other hand, during the interviews, the executives of cooperatives themselves argued the main problem was capital and proper control, hence the business part of the cooperatives. The two cooperatives, one in Şanlıurfa; The Union of Husbandry Cooperatives for Şanlıurfa and the Toslak, Yeniköy, Hacıkerimler Villages Agricultural Development Cooperative in Alanya are very different examples of how region, the market and connections can affect the cooperatives and how
generalizations for the solutions, especially when talking about rural areas that are so different, is not the way to argue about cooperatives in Turkey.

8.2.3.1 Case Study: Urfa Husbandry Cooperatives Union

Located in the same city of the Ceylanpınar Biogas facility (Figure 6), The Union of Husbandry Cooperatives for Şanlıurfa, is famous especially for its sheep and goat husbandry, which comes up to 10% of all sheep and goats in Turkey (Invest in Urfa, 2011). However, these numbers were nearly double in the 1980 and 1990s, after that period, a neoliberal approach in economy and certain market changes have created a different view for rural farming. The profits from husbandry has become unable meet the cost of needed inputs for animal breeding, feeding and milking. Most of the husbandries who has 20-30 sheep in the area has taken credits in order to survive however, in the end they were forced to sell their farming lands which have been in their family for more than 1000 years (İzol, 2013).

Considering the situation, the head of the Union, Cihan İzol, argues that, this problem is not just because of the market structure but instead it is wrong governmental projects. He agrees that current market structure is not suitable for the local breeds of the animals, which goes for very low prices, on the other hand he argues this is because of the governmental projects of breeding. The new animals that are chosen to breed comes from Trabzon, which is in the northeast part of Turkey, and the animals from there are much suitable for mild weather. However in the summer, Urfa can be at hot as 55°C degrees under the sun, which affects the animals, and resulting in sickness where nearly 50% of all animas are lost. In the end, the animals that was brought in order to develop husbandry in Urfa, ends up putting the farmers and the endemic sheep breeds in trouble (İzol, 2013).

This problem gets no attention from the local administrative officials, whom according to İzol, are there to promote their own political campaigns. He argues that a high executive in the Ministry of Agriculture has come to Urfa and promoted certain farms and cooperatives, in order to gain closeness to the government and get elected for the parliament, but after he was elected these projects were never applied. However, these unfinished projects are supported by distributing the EU and World Bank funds, in a different fashion than before. Compared to last years, the big farmers and big cooperatives are getting more money than the small ones, and end up opening petrol stations and hotels under the cooperatives names with the funds specific for agriculture. In addition, the direct help that has been given to the small farmers is either coal for heat or clothes, which is not suitable for the farmers, who wants their debts for feed to go away (İzol, 2013).

İzol argues these projects, will end the rural agriculture business, which at the end will hurt the small business. On the other hand, he argues this is just what the governmental economics projects want, opening up big shopping malls rather than helping historical small businesses and creating richer rich against the powerless middle class farmers. In the end, this will force the rural populations to migrate to bigger cities, losing the young population and finishing the rural areas, which fits perfectly in the arguments of the Rural Development Theory. In order to do something against this trend İzol, who belongs to the famous İzol family of Urfa, becomes the head of the Union, however he argues in order to do this job, one has to take a heavy load of work, since it follows 120 cooperatives, who has more than 8000 members. On the other hand, these cooperatives are mostly inactive because of their financial problems, some of them are even under levies. This puts the cooperatives under a different situation. Rather than focusing on education and seminars and democratic representation; economically and socially inactive cooperatives tries to survive which ends up unsuccessful at the end (İzol, 2013).

Some cooperatives, under the Union’s leadership is focusing on a plan to collect their animals under one roof. This plan, which is called, Urfa Feeding Centre, has been going on for more than 10 years but with the current economic conditions of the members of the cooperatives, the capital is harder to find. The Centre is being built on a 850 hectare land, and currently has 145,000 animals registered, which will be fed and taken care of by veterinarians. This project will take care of producing the market products, according to the needs of the members with slaughter, milking and packaging areas. In the following years, the manure, which will be collected in a collective area, can be processed for biogas and produce the electricity and the heat that the Centre needs. The financing of this project
comes from 1000 members and will cost nearly 4.5 million TL (~2 million €), however the government supports seems to go to the aforementioned places, rather than this programme (İzol, 2013).

Hence, the government does not support a programme that is built by the cooperatives in order to survive against the big companies and global market. This puts the Cooperative Report by the Customs and Trade Ministry in another perspective. On the other hand, many prominent researchers in this area argues; Turkey; when it comes to building and planning the projects on paper is one of the leading countries in the world, however, when it comes to action, the governmental projects either fail or support certain organizations (Çikın, 2006) (Yıldırım, 2013). The Union and individual cooperatives have applied to the ministries and certain administrations more than they want to admit but there were no responses.

In order to solve these problems, İzol argues that, the administration of the cooperatives and unions has to get a small percentage from the profit of all its members, rather than raising the membership fees, considering the investors do not want to invest in small businesses but rather to the big ones. In addition, he argues the cooperatives should be divided into their main production, rather than their aim, in decentralized, rural areas with a society and members that knows each other better. Even though he is the member of the governmental party and his brother is a parliament member, İzol argues current government has lost the connection to its people in this area and their plans do not include the real people. He argues in a survival situation like this, the problems such as education and seminars can be put into the second place (İzol, 2013).

8.2.3.2 Case Study: A Biogas Production Plant Project From a Cooperative

Another project for a biogas production plant was considered to be built by the Toslak, Yeniköy, Hacıkerimler Villages Agricultural Development Cooperative in Alanya county of Turkey, which is in the southern part of Turkey (Figure). This region is known for tourism and its agricultural crop production, especially by a widespread use of greenhouses, reaching 200,000 tonnes of products, just from Alanya county’s greenhouses (Özen, 2013).

One of the many cooperatives in the area, Toslak, Yeniköy, Hacıkerimler Villages Agricultural Development Cooperative has been formed in 2005, after the new election of the village administrators (muhtar). The muhtars of these three villages, have contacted each other, to do a project together to develop the area and a cooperative was born. Until 2007, there has been two governmental major projects involving giving 500 m2 of agricultural land to 50 families in the region and milk processing centres for the husbandry (Özen, 2013). On the other hand, in between 2007 and 2010, the
cooperative has not been active because of the political problems of the three muhtars, leading to the bust of the milking project and creating economic problems for its members. In 2010, Mustafa Özen, the current cooperative leader has come into the position, by being elected by the members after he has been asked to put his candidacy, because of his experience. After helping the cooperative members by applying for a credit for fixing their economic conditions, one of his contacts, has asked him, if he would think to sell the products of cooperative members directly to one of the biggest retailers in Turkey, with the condition of producing “good products”. “Good products” are agricultural products that has not been treated with chemicals, during its production, and this new trend has been very helpful to the cooperative leading to an agreement and the growth of this programme from 5 person operation to a 12 person transport operation with commission for the cooperative and a total of 3 billion TL (~ 1.5 billion €) of income every year for its members for more than 3 years (Özen, 2013).

Özen, has used his previous experiences that comes from an EU project manager for a small organization for creating projects, seminars and education for the cooperative’s nearly 300-400 members, about the “good products” process and modern greenhousing techniques. The members had the chance to occasionally go out from their villages and visit other greenhouse production sites, agriculture fairs and even a factory in Berlin. These projects other than creating a high number of knowledgeable members, have created also a good media attraction for the site and the cooperative leading to many connections. One of the connections was with Solea Energy and aforementioned Mr. Kayhan Kalelioğlu. (Özen, 2013). The project in total was planned to cover a 10 km area, with 1200 hectare of greenhouse production. This production produces 40,000 tons of residue every year, which the cooperative was planned to use nearly 20,000 tonnes of it, producing 2 toe of energy every year. After everything was set, the project was sent to the Eastern Mediterranean Development Agency, that works with European Association Of Development Agencies, has given a 50% development grant. This has made the project to have a pay-back time of a little more than one year (Özen, 2013).

These projects and the current situation has been brought to the member’s attention and although there was a low participation, it was accepted that he members were supporting this as a feasible plan. However, during the location search for the project, the neighbours of one of the planned spaces, have carried out their own research and found out that these plants have a distinct odour and have a collection areas, where all the residues are put (Özen, 2013). They were afraid this will affect them, so they started lobbying against this project, with the support of the old muhtars who were afraid of these things too. On the other hand, they were unresponsive when they have been told that the biogas plants that they were researching uses animal manure and the planned biogas plant will use crop residues, which do not have this odour. Özen and other members visit another similar plant nearby to show the difference, however , in the end, the lobbying continues and the muhtars political power shows itself and the project get a negative revote at the end both from the members and the administrative branch of the muhtars (Özen, 2013).

Özen argues, even tough their economic capital problem is solved and they have been creating education and seminar activates nearly every other week, the social conditions have not changed that much. The education and seminars serve as a way to certificate the member’s talents; however, the mindset and political will of the members are still connected to the governmental benefits rather than local development benefits. On the other hand, as a cooperative Toslak, Yeniköy, Hackerkimler Villages Agricultural Development Cooperative may be the exception that proves the rule; the cooperative has a research about their land, for encouraging new investments and informing its members with SMS in any case of change. Özen is also in the executive branch of the Antalya Cooperative Union and has good connections with the other cooperatives in the area (Özen, 2013). He also argues, since the income from the greenhouses are well compared to starting salary of current jobs, the youth is staying in the villages to take care of the greenhouses. Therefore, if the youths are properly educated, they will be the distinctive members of the cooperatives, but Özen argues generally, since they have a certain job opportunity they don’t continue their education after high school. On the other hand, this might not be a problem, if the treasury officials from the government creates a better auditing system, the problem of financing might be solved. Özen mentions that most of the capital of the cooperatives goes to unrelated issues, such as personal accounts, in that sense even a hired professional executive might be unreliable (Özen, 2013).
All in all, the Toslak, Yeniköy, Hacıkerimler Villages Agricultural Development Cooperative seem positive example in the middle of the inactive cooperatives and plans to have a different future than the Urfa Husbandry Collective Union. The members of the cooperative that I have talked, whom did not want to give their names, argues that Mehmet Özen is a good leader and they are happy about their current situation. They tell me, he will not give up about the biogas plant and since there is a new law on the way, making the Ottoman old administrative branch muhtars extinct, the administrative powers fall to the municipality and the municipality of Alanya, whom they argue, can make Özen’s and theirs project come alive.

8.2.4 Analysis of the Two Cooperatives and the Role of Turkish Cooperatives for a New Administrative Partnership:

The two cooperatives shows us the different conditions of different cooperatives in different regions. The member cooperatives of The Husbandry Cooperative Union in Urfa is struggling to survive, in an area where the market conditions and governmental projects have chosen bigger suppliers against the small producers of the rural areas. On the other hand, Toslak, Yeniköy, Hacıkerimler Villages Agricultural Development Cooperative is flourishing with an active market for their products and a successful transport business for their members. The head of The Husbandry Collective Union in Urfa Cihan İzol argues that, Toslak, Yeniköy, Hacıkerimler Villages Agricultural Development Cooperative has been very lucky to find their market and earn their economical independence, so that they can actually fulfil the cooperative principles (İzol, 2013).

They both argue though, the problem is not with the cooperatives but rather their auditing system from the Ministries. They say the officials come only once a year and that is not enough for cooperatives who are used by retired officials. These officials uses the cooperatives as the diving board for their political career that leads to the parliament and after they are elected, their leadership ends with the cooperative administration falling apart (İzol, 2013) (Özen, 2013). They argue if these problems are fixed, the image of the cooperatives will be fixed too, however, İzol argues lowering dependency on other production branches for agriculture products depending on the specific needs for the cooperatives, such as transport, packaging and energy production, which can be easily done by the cooperatives, is the only way to survive and confront the global markets and corporations who hold all these branches under their production centres (İzol, 2013). Özen argues these kind of projects must be supported and continue to be supported depending on their success rates (Özen, 2013).

This chapter undertook the responsibility to answer the administrative part of our third aim; Does the renewable energy alternative provide an alternative development for the current rural conditions?”. Although the biogas production in itself does not offer a solution, through their field work and experience Kalelioğlu and Tolay suggests that the cooperatives are the efficient ways of collecting residues since they are formed by the rural farmers and survive in the area (Kalelioğlu, 2012) (Tolay, 2013). This proposition also fits in with the Resilient Energy System Theory’s idea of a community owned renewable energy technology that can supply the needed energy services with existing technologies (O’Brienn & Hope, 2010). In addition, further investigation on cooperatives points out that through their principles, they are very suitable for the new administrative partnership system that rural development needs. The cooperatives answer to the need of a new partnership model that builds itself on mutual benefits between different activities that are strategic and desirable, cooperating the agricultural and non-agricultural actors will be the new administrational status of the rural development models. Through the democratic membership system and their dependency on their rural areas and their development, the cooperative grow within and with the rural populations, giving them an open ground to decide on the desirable and strategic market changes. Turkish cooperatives seem to have a lot of problems in their hands, most of them can’t answer to the 7 principles of cooperatives, on the other hand, this problem is solved when the cooperatives have a chance to survive, if they have an open market for their goals, however this seems to be a hard objective, considering the governmental market structure benefits some cooperatives and big markets, rather than small and local ones.
9. Conclusion

This paper aimed to find a solution for the dependency problem of Turkish energy consumption. The numbers showed that, Turkey is 90% dependant on coal consumption, 94% dependant on oil consumption and 98% dependant on natural gas consumption for energy production. This has put Turkey in a position, where 80% of the energy consumed is dependant to other countries (Ministry of Energy and Natural Resources, 2012). Considering the economic pressure and the political condition of the region that Turkey is in, the energy sector is unresilient to the changes that might happen in the short or long run. In order to create a resilient energy system; diversification of energy production through renewable energy sources using indigenous resources are the key goal (O’Brienn & Hope, 2010) (Balat, 2010).

This paper had three aims to fulfil its goal. The first aim was to find the renewable energy alternative source for Turkey, where the second aim argues that this alternate renewable energy source must fit in the structures of Resilient Energy Systems Theory in order to create the much needed sound energy sector. On the other hand, since it is going to using the indigenous resources, the alternate renewable energy source must help the rural areas and its development in the process, which creates the background for the third aim.

In order to fulfil the first aim and find the renewable energy alternative for Turkey, many studies were investigated however, the study by Barış and Küçükali was chosen in order to answer this question. Its broad selection criteria, which points out the conflicting areas and uses a multi criteria method to evaluate the renewable energy sources under economic, environmental and social aspects. This study choose biomass as “the most appropriate renewable energy source” for Turkey, considering its high social benefits resulting from public acceptance and job creation and high capacity factor that comes from efficient production through all year (Barış & Küçükali, 2012). The paper later focuses on biogas production, from many different biomass energy production possibilities, realizing its use of high renewable indigenous sources for substrates, high energy production possibilities and socio-economic advantages. The theoretical biogas production of Turkey can replace 31% of the natural gas consumption lowering the high dependency on this product, and will be able to cover 10% of the total energy consumption, more than all of the current renewable energy systems combined (Deutsches Biomasse Forschungs Zentrum, 2011). Following this choice biogas was applied to the theoretical aspects of this paper.

When applied to the Resilient Energy Systems Theory biogas fits perfectly to the systems through the farmers, an available actor who can be the producer and the user of the energy technology, by harvesting the Indigenous Intermittent Renewable Resources, either by raising the animal for its manure or plant the crops that will be used by energy crop or a residue (O’Brienn & Hope, 2010). These sources then will be used in a localized renewable technology, using anaerobic fermentation and co-generation plants for energy (Kaya & Öztürk, 2012). In addition, the small settlements of the farmers will be provide the diffused system of ownership aspect of the theory. In this way biogas fulfils the answer for our second aim; “Can the renewable energy alternative be considered as a resilient energy source?”. Our third aim and second theory was about Rural Development theory and aiming to find an answer to the question; “Does the renewable energy alternative provide an alternative for the current rural development conditions?”. Although the Rural Development theory is controversial and differs for every area, the main goal is to solve the problems of unemployment and inequality of GDPs in the rural areas compared to the urban areas that resulted from the market structure of 1990s (Ploeg, et al., 2000) (Ambrosio-Albalà & Bastiaensen, 2010). The first aim of fulfilling this goal is explained as economic diversification and biogas production creates a diverse economy from the beginning, by uniting the energy and agricultural sector. In addition, the new employment possibilities such as construction, engineering, mechanics and their side jobs will create an opportunity for the young population in the region. This new diverse income will also help the different sectors in the rural area, such as the service industry. The theory also calls for a new administrative system of partnerships and cooperation for the new rural development, however the biogas production plants itself does not give us a new system for administration.
In order to complete the background and the principles of the Rural Development Theory, Kayhan Kalelioğlu and Tolay argues that a 15 km circle of waste management system in the rural area can be considered an answer for the Resilient Energy System’s search for a community owned renewable energy technology, that can supply the needed energy services with existing technologies and cooperatives can be the new partnership system that can harvest the indigenous sources (Tolay, 2013) (Kalelioğlu, 2012) (O’Brienn & Hope, 2010). In addition the seven principles that promotes a democratic participation of the members, who can join the cooperative regardless of gender, social, racial, political or religious belief, the cooperatives also provide education, training and information to its members in order to participate equally and unite for their society in order to work for the sustainable development of their communities (International Co-operative Alliance, 2013). However, in the Turkish case, the cooperatives that aims for rural development are high in number; nearly 2% of all cooperatives in the world, and according to the Turkish government this creates problems for the cooperatives. The governmental report; Turkish Cooperatives Strategy and Action Plan 2012-2016, argues that, to solve the problems that contradicts with the principles of cooperatives, such as inability to educate, creating a democratic environment and fixing the image of the cooperatives that creates further problems for capital gain; a new centralized structure must be formed that manages the cooperatives (Ministry of Customs and Trade: Directorate General of Cooperatives, 2012).

Although this is all and well, the two cooperatives that was interviewed; The Union of Husbandry Cooperatives for Şanlıurfa and the Toslak, Yeniköy, Hacıkerimler Villages Agricultural Development Cooperative in Alanya points out that the rather than the centralized management, a better auditing system that promotes the successful works of the cooperatives must be formed in order to create a better cooperative image. The head of the cooperatives Cihan İzol and Mustafa Özen also argues the cooperatives also should not be a political diving board for the retired governmental officials to get into the parliament then abandoning the cooperatives. However, the solution depends on the members who are still in the mindset of accepting governmental benefits rather than improving their rural area in most of the places, which comes from their incapacity to earn their economic freedom resulting from the market and governmental structures of the 1990s, that promoted big producers and cooperatives rather than the local and small ones (İzol, 2013) (Özen, 2013). In conclusion, the cooperatives provide a new administrative partnership system for rural development theory, however in the Turkish case in order for this ideology to be spread the successful examples like the Toslak, Yeniköy, Hacıkerimler Villages Agricultural Development Cooperative in Alanya, who had plans to build its own biogas plant, must be promoted and provide a concrete example of a farmer’s democratic cooperative that can build its own resilient energy production system.

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There is currently unutilized and unused potential of considerable biogas production from agriculture and animal husbandry. This potential will help the ecological conditions of Turkey since it will also provide and economically acceptable investment for small farmers, providing less polluted rivers and groundwater while reducing the greenhouse gas emissions and creating a less dependant, modernized agricultural and animal husbandry sector, whom will help the energy and rural development of their regions. What should be researched further is the complete potential of these residues. After completing this, a system of “contracted purchasing”, where the resources that farmer has left to the farmer and he decides sell to a buyer, for a contracted term under certain quality, amount and conditions for certain purchase agreements and grants before the production (Duff, 2009). This project can be developed between the energy companies, in which the companies can be a partner for the energy produced by buying the substrates from the cooperative, leaving them a small commission and increasing the income of the members. A similar project is used by the İzmir Municipality in order to buy milk for the schools and flowers for the urban decoration projects, which in total reaches to 35 million € income for the cooperatives (Yapar, 2013). The planned contracts and the project should be applied into a test area, where the decision are made from the executives in cooperatives, administrative and universities in the local area for the use of the farmer’s resources, the place for the biogas production centre and how the products will be used. Sadly, the current government has national targets focused on fossil fuels and lack the ability to apply the environmental laws that will penalize fossil fuel users and promote the investments that will lower the dependency and increase the resiliency of their country. However, one should keep in mind that energizing a growing economy by 80% dependency on the sources that can be fallible and produce unforeseen conditions. As Carl Sagan
mentions: “Avoidable human misery is more often caused not so much by stupidity as by ignorance, particularly our ignorance about ourselves.” (Sagan, 1995). We must listen one of the greatest mind in history, search for our energy within.

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