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Development the Use of Renewable Energies in Iran: A Systems Thinking Approach

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ABSTRACT

The aim of this project is to implement system thinking and system approach in energy supply system of Iran and Development Study of renewable energy, and replacing it as a clean and optimal energy. New energy systems in future must be based on fundamental structural changes where carbon-free energy sources, Such as renewable energy has a big role in one hand because of their technology simplicity against technology of nuclear power. In this article we introduce the Renewable energy and systematic looking and casual loop and explanation the loops to expand the use of renewable energies, and key performance variables have a big role in making policy in this field and Levers such as making culture and grounds, GDP, savings, investment ratio in the development of this type of energy efficient technologies are described.

1.INTRODUCTION

Problems of human societies and organizations are increasingly becoming more complex and solving them requires better thinking. There are many cases in which administrators and officials' attempts for solving a problem have simply relieved it, and shortly after, the problem was back again or has led to bigger and worse problems. Systems approach claims to provide a more systematic attitude to deal with the complexities of today's world. Systems thinking aims to improve our understanding of the relationship between the performance of a system and its internal structure and operational policies so that we can design effective leverage policies using this understanding. However, there are various topics in this area which among them are systems approach1, system dynamics2 and systems analysis3. Although the topics are different from each other, they are used interchangeably in many cases.

The tremendous development of science and technology in today's world has apparently led to comfort and welfare of human life. But this development has also caused new problems for humans which include environmental pollution, large-scale changes in the Earth's climate, etc. We are particularly aware that oil and its derivatives are vital and national valuable assets for the country which cause irreparable losses if used non-optimally. Therefore, pundits and experts are looking for resources that will gradually replace fossil fuels. Experts believe that the use of clean energy such as solar, wind, geothermal, hydrogen energy and etc. instead of fossil fuels will prevent environmental pollution and its various risks. This project is an attempt to study the impact of using renewable energy and discuss its economic and environmental benefits as well as its accessibility. It is hoped that a change would be created in providing the energy.

Many of the procedures towards creating the change fail due to the fact that change agents are not offered help. Fear of change and its consequences is not a problem which needs a solution. It's a natural phenomenon and rather an appropriate response to change. These challenges will be overcome by providing an appropriate level of certainty and psychological security, and social capacity (Senge1, 2007).

History of systems theory can be examined from two perspectives. The first one prefers to study the development of systems theory through investigating developments and events which took place in American universities (and especially university MIT) from 1940 to 1970. The second approach studies the evolution of attitudes towards the worldviews and science method in the world. The following is a summary of the above two approaches.

A) Evolutions in MIT: After World War II, three mutations occurred at MIT that each lasted for 10 years. Enormous thought and scientific developments were the results of these mutations. As a result, new cognitions were introduced to the world. They include various concepts starting from cybernetics to the most acute issue of time i.e. economic growth restriction. In this era, concepts such as feedback3 which were used for machines till that time, were also used for the organism. Consequently, the emergence of two new sciences, i.e. Automation and Informatics was facilitated.

In 1948, the book "Cybernetics" was published by Weiner4. Wiener was a professor of mathematics at MIT who participated in a project on the construction and application of Automated Targeting Systems for antiaircraft weapons with the cooperation of a young engineer named Julian Biglow. They found similarities between behavioral abnormalities in these devices and some disorders in human bodies.

B) Changes in the scientific method:

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According to the second approach, thinking techniques are divided into three groups:

1. The initial holism:

This technique was the dominant way of thinking till the Renaissance. This period is known as the period of dominion of philosophies and authorities (who knew a little of any topic). A major drawback of holism was that it had no growth.

2. Reductionism:

Reductionist thinking has existed since ancient civilizations, and it is thought to originate from the ancient Greek philosophers' thought. Reductionist thinking first divides every phenomenon into smaller parts and tends to reach the behavior of the main phenomenon through studying the behavior of each part. In other words, it considers the behavior of the main phenomenon as the sum of behaviors of its parts. Rene Descartes, French philosopher who is a proponent of this theory, established some principles for it. Descartes states that one must follow the following principles in dealing with every phenomenon:

Never to accept anything as true unless one clearly knew it to be true

To divide every possible problem into small parts, and to solve the problems by attacking these parts

To start from analyzing the simplest element, then gradually and in an orderly manner, study the more complex elements so that finally understand the characteristics of the main phenomenon or realize the reason for the specific behavior of that behavior.

After the Renaissance, the above method became the dominant and pervasive method and it was called analysis. In this era, scholars would select a small part and focus on it. This method became so dominant that today we equal "analysis of a problem" with "trying to solve a problem". If we are asked for an alternative method for the analysis method, we fail to have an answer. Observation and testing are two important principles in this period. By definition, when there is a cause and effect relationship between two things, this means that the cause is the necessary and sufficient condition for the effect. Effect does not occur without the cause. If the cause is present, there will also be the effect. During this period, efforts were made to understand the natural phenomena without using the concept of "space". Mechanistic thinking was applied gradually in the humanities and management. But the nature of this science was not consistent with the mechanistic thinking.

1.1.Significance of the study

Planning for the future based on current needs or gaps in current services is not a favorable national wealth for successful participation in the future world. It is necessary to use scenarios-based planning for the development propulsions and future evolutions based on megatrends and discontinuous processes by relying on new approaches, and to take actions for analyzing the current and future challenging issues, and planning for the future successful presence in accordance with the capabilities and features of the society. Surely these actions require a fundamental change in the structure of the energy system. Many of the procedures towards creating the change fail due to the fact that change agents are not offered help and instead they are left alone. Fear of change and its consequences is not a problem that needs a solution. It's a natural phenomenon and even an appropriate response to change. These challenges will be overcame by providing an appropriate level of certainty and psychological security, and social capacity.

There are logical reasons for shifting to renewable energy sources. These reasons are intertwined with the environment, economy and social issues and cannot be ignored. They include:

1. An escape from the abyss of rising oil prices and its adverse effects on economic and social conditions and security of countries
2. Preventing the reuse of oil as a weapon and leverage
3. Global concern for the depletion of oil reserves and its effects on social life
4. An escape from adverse environmental impacts, burning of fossil fuels, global temperature rise and climate change

Countries such as America, Germany, Japan, Britain, Norway and the Netherlands have had success in replacing renewable sources of energy. This success, especially in the production of energy from sun, wind and water has been more obvious.

2. LITERATURE REVIEW

The principles and mechanisms of system dynamics were first introduced in the 1940s and 1950s, and studies were conducted on them. System dynamics is a method to understand certain kinds of complex problems of the system. Indeed, this field is derived from the industry and the issues arising from it. Its primary task has been related to some management issues such as instability in production and employment, little growth or incompatibility of organizations' activities and loss of market share. The main idea of using the dynamic systems model was introduced by Naill3 (1973) in the United States on the energy in the gas industry. He investigated variables such as exploration, production, demand and investment and offered options on the amount of unproved reserves, tax rates, technological issues and legislations. This model is one of the earliest and best energy dynamic simulation models (DSMs). In addition, the demand for this model is exogenous and the mutual relationship between the economy and energy has not been considered. In this model, modelling of the production cycle has not been done in details and the need for investment has not been studied.

Sterman2 (1988) developed a dynamic system model in the context of reciprocity between energy and economy. Then Sterman et.al investigated the oil industry and considered variables that included exploration, production, consumption, technology, prices, income and investment, demand and replacement. They investigated options such as price controls and regulations, taxes, costs, effects of replacement, policies of OPEC and other suppliers, the cost of imports and constraints, resources and strategic reserves in their dynamic model of oil. This model has solved the problems of time in Naill's model. Bodger and May3 (1992) have examined the model of energy from wood, oil, gas, nuclear and sun in New Zealand. In their model, they studied variables of energy sources, the energy refining industry, and production and consumption sectors. This dynamic model have provided the possibility of replacing various kinds of energy to help policymakers in the field of energy. Similar models were introduced by Chowdhury and Shau 1 (1992) in oil exploration and extraction in India. Finally, Chi et al 2 (2009) presented a dynamic system model for the UK gas industry. In this model, variables of exploration, production and consumption, consumption prediction and replacement were considered and they were investigated on factors including tax policies, demand, technology, independent level of gas export. This model has been based on the model of Sterman et al.

3. METHODOLOGY

The method used to solve the problem in this field is the dynamic systems method or the dynamic system. System thinking is a way of viewing the universe and its phenomena. This thinking attitude presents an effective methodology for socio-cultural systems in an environment of confusion and complexity. System thinking is not about simply looking at parts and details of a system. But the interactions between the parts and the interaction between the parts and the environment are also investigated. The world is changing. The speed of change in our time is more than any other time in human history. Changing is a dynamic process which does not happen at once. Recognizing the appropriate direction of change is not an easy task due to the complexity of change. Organizations and human societies, in response to environmental changes, may support the changes which are not fruitful, and even in case of success, it leads to the weakening and destruction of the community.

Achievements in creating changes require an understanding of the causes of changes in the past, and recognizing the structures and relationships for making future developments. Most of the changes that we strive to understand are the willing or unwilling consequences of the mankind itself. Fundamental changes in today's communities and organizations require new social intelligence. To this end, developing systems thinking is vital to human survival.

4. Instrument

4.1. Dynamic System Tools

4.1.1.feedback:

Feedback is one of the mechanisms which is somehow available in most systems and it is also one of the central concepts in systems dynamics. However, our mental model face problems in incorporating critical feedbacks that create the dynamics of our systems (Sterman, 2011). Living organisms change their behavior upon receiving the warning signs. Relationship between a living organism and its environment is a two-way interaction based on the principle of feedback. A living organism effects on its environment.

Based on another definition of feedback, it is a process in which a signal passes through a chain of causal relationships till it effects on itself again. In regard to the type of second effect, there are two types of feedback:

Positive feedback: Increase (decrease) in one variable finally causes a further increase (decrease) in that variable.

Negative feedback: Increase (decrease) in one variable finally causes a decrease (increase) in that variable. Dynamic systems are powerful tools that simulate a system using computing techniques and facilitate the investigation of problems and the description of the behavior of complex systems. This tool has many applications in the field of energy and numerous models based on this methodology have been developed. These models have been used in energy policy makings and they will be used in the future (Javadpur, 1388).

4.1.2.Causal-Loop Diagram

This diagram is an important tool to demonstrate the feedback structure of systems. Having a long history in scientific works and increasing promotion in the business world, these diagrams are the best choice in the following cases:

1. Quick access to a hypothesis about the causes of the dynamics
2. Perception and understanding of individuals or groups' mental models
3. Linking important feedbacks which are effective in creating problems based on your beliefs

The diagram consists of a number of variables which are connected by arrows which represent causal influences between variables. Correlation between variables, reflects the past behavior of the system. Correlations do not demonstrate the system structure. Correlations between variables which previously had been reliable might be broken: if circumstances change; if the feedback loop that had previously been silent becomes dominant; and if some new policies are tested. Causality models and charts should only contain relations which show the causal structure of system (Soheili, 2001; Chiung1, 2012; Zhibin2, 2013).

Each link in the causal loop diagram should reflect the causal relationship between variables. Do not enter correlation between variables in the diagram. A system dynamics model should mimic the structure of real system in a way that the

behavior of the model is similar to that of the real system. Similar behavior means both repetition of historical experiences and the response to the new conditions and policies.

4.2. Causal loops modelling

1. Identifying the main variables
2. Drawing diagrams of the system behaviors over time.
3. Developing cause and effect diagrams
4. Analyzing the behavior of loops over time
5. Identifying general patterns governing the system
6. Identifying key leverage points
7. Developing intervention strategies in the system.

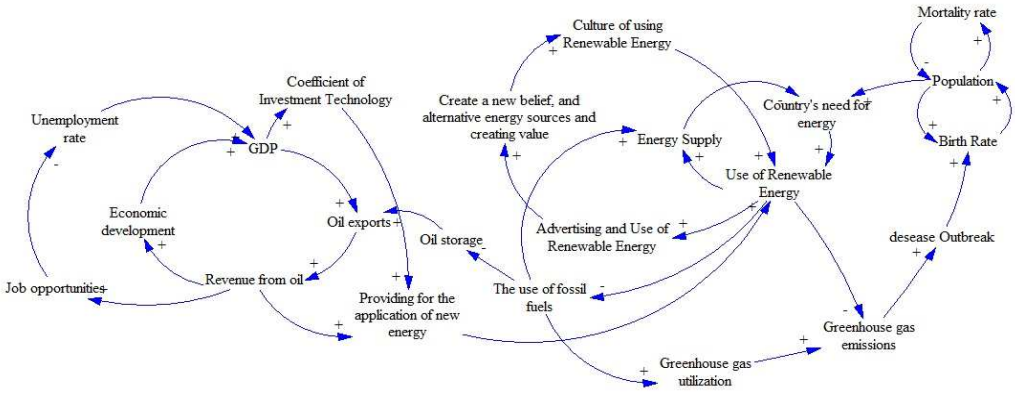

Fig. 1. Causal-loop model of the development of renewable energies in Iran

5. Causal Loop Diagram (CLD) analysis

In the above diagram, as it is observed, there are many loops, each of which can have a significant impact on the overall system. As stated earlier, there are 2 types of loops: negative (balancing) loops and positive (reinforcing) loops.

5-1- analysis of loop (1)

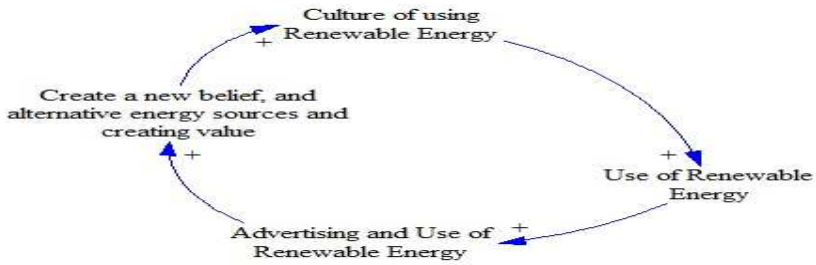

Figure 2. Loop 2 of causal-loop diagram in figure 1

This loop is a reinforcing loop. In this loop, it has been suggested that if the advertising and use of renewable energy logos are increased, and people clearly feel these logos, then it's easier to believe that the replaced energy is similar to renewable energy. Therefore suitable circumstances will be provided for the creating the culture of the use of renewable energies. Finally, the development of using renewable energies will be easier. However, this process of the creating the culture refers to Edgar Schein's organizational culture model.

4.2 Analysis of loop (2)

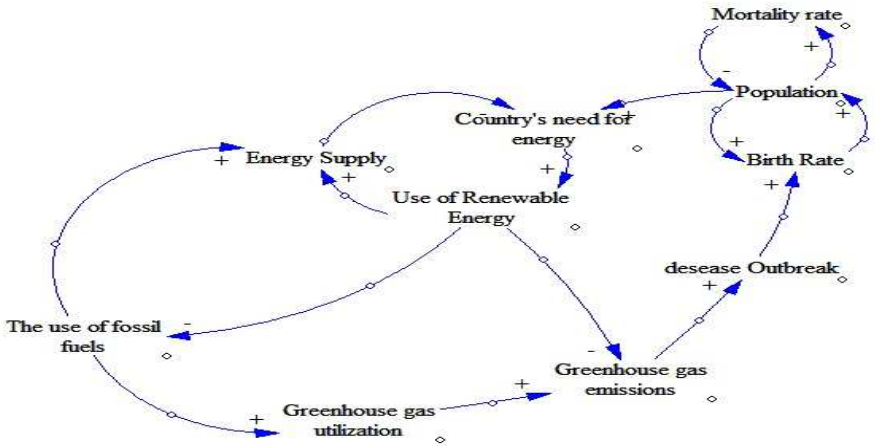

Figure 3 . Loop (2) of causal-loop diagram in Figure 1

As it is seen, in loop 2, there are five loops, two of which are balancing loops and three of them are reinforcing and positive. Two loops of the population show that as the fertility rate increases, the population rate increases. Also, as the population rate increases, the fertility rate increases. And on the other hand, the population decreased with increased mortality rates. As the population increases, mortality rates increases. This is an example of the balancing loop. As a result, population growth has led to country's more need to energy. And finally, we should use either fossil fuels or renewable energy. In case of using renewable energy, use of fossil fuels reduces and consequently, greenhouse gas emissions will be reduced. This factor will have considerable impact on population rate.

4.3.Analysis of loop (3)

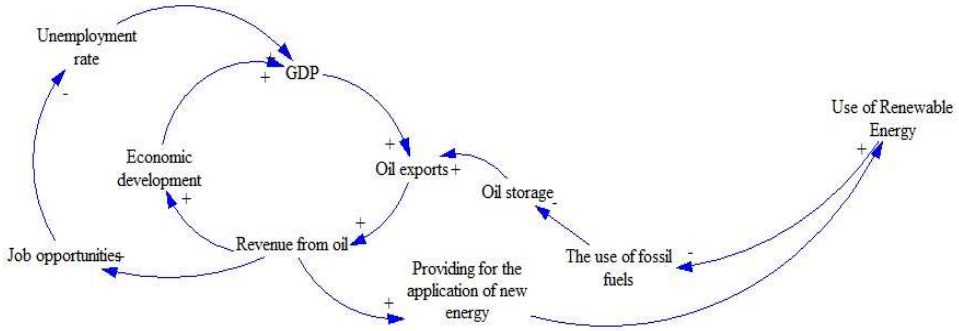

Figure 3 . Loop (3) of causal-loop diagram in Figure 1

In the Figure, there are two reinforcing loops. In the first loop, it is shown that by the use of renewable energies, the use of fossil fuels reduces. As a result, there will be storage in the domain of oil and gas and this storage will be followed by increased exports of oil products. And consequently, this will increase export earnings. This increase in the income, directly or indirectly, helps to providing new energy equipment and thus the use of renewable energies expands. However, the other loop indicates that as exports increase, the revenue increases and consequently, this will lead to the economic achievements and developments in the country. This alone is an effective factor in the increase in gross domestic production which will help to oil and non-oil exports.

6. Conclusion

In systems worldview, meaningfulness is among the characteristics of any system. The final goal and the ultimate cause which was previously considered as a metaphysics issue, plays an important role in the systems approach. Understanding and recognition of the behavior of feedback systems is one of the goals of dynamic systems. Structures of the real problems are often complex. Power supply system is among the most complex feedback systems. Recognizing the behavior and finding leverage variables of this system for the preparation of a comprehensive policy and renewable energy development is among the goals of the system.

What was discussed in this paper is that the development of use of new energy sources to replace fossil fuels is essential. New energy systems in the future must be based on fundamental structural changes in which zero emission energy sources such as solar, wind, and geothermal energy, and neutral organic matters such as biomass energy are used. The achievements of this research are divided into two parts. First, we should look for new energies and try to develop

them. Second, along with the use of new technologies to optimize and save energies, we must put renewable energy development on the agenda and create culture and prepare equipment of this type of energy.

Regardless of large-scale renewable energy projects, the unique opportunity of using this type of energy in rural areas should not be neglected. The cost of transferring energy to these areas is very high and costs a lot to the energy network of the country at peak energy demand. Such areas have high potentials such as energy production from urban and rural waste, and animal waste (biomass) and the use of wind, solar, and water energy which can contribute to the development of more energy in the country.

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