Have to Re-examine Renewable Energy

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Abstract: In this paper, it was emphasized that the conversion process of renewable energy resource was non-renewable, and energy resources were re-classified as self-consumption-based energy resource which mainly consumed itself and carrier-consumption-based energy resource which mainly consumed carriers. This classification avails to improve energy conversion efficiency and utilization efficiency based on their respective disciplines and mechanisms.
Conventional energy system is established on the basis of self-consumption-based energy resource. And its theoretical, academic and technical contents have been unable to meet the needs of carrier-consumption-based energy resource for technological innovation. Therefore, in the era of vigorously promoting renewable energy resource, the energy theory and technology system corresponding with carrier-consumption-based energy resource must be established and new ways to use energy must be explored corresponding with carrier-consumption-based energy resource conversion mechanism.
We emphasized that it was necessary to set up the new theoretical and technical system of energy to adapt to renewable energy development, which was the key to solve energy problems.
Although the new theory deviates from the conventional view, it's crucial for establishment of new energy science and technology innovation system, and would play a significant role on sustainable development of human society and low carbon technology innovation.

Key words: *Renewable energy, Self-consumption-based, Carrier-consumption-based.*

Nomenclature

E_A *Available energy* ..... *j*
E_S *Self energy* .....*j*
η_c *Conversion efficiency*
η_{cc} *Carrier consumption efficiency*
e_{PE} *Index of unit energy environment* ..... $ppm \cdot j^{-1}$
P_{ep} *Pollution in equipment production process*.....*ppm*
P_{EP} *Pollution in energy production process*.....*ppm*
E_P *Energy production* .....*j*

1. Introduction—Energy resource and energy

Energy resource has always been a hot debate since the outbreak of oil crises. There are about twenty definitions of energy resource up to now. In The Encyclopedia of Science and Technology, energy resource is defined as the resources from which energy, such as heat, light, electricity and so on, can be obtained. In Encycopedia Britannica, energy resource is a union of all fuels, water, solar, wind, and can be converted into required energy by the appropriate means. Thus energy resource is not equal to energy. Energy resource can be considered as the resources which can be converted into energy. And these resources can't be utilized directly, but be utilized in the form of energy after corresponding conversion. So energy is the outcome of energy resource conversion and not equal to energy resource.

This paper clarified the difference between energy and energy resource through the systematic expatiation and proposed corresponding solution for the deficiency existing in the present energy research. And methods to improve the energy utilization efficiency were proposed through a clear classification of different types of energy utilization in order to clarify each

bottleneck of energy utilization efficiency. Therefore, the current low energy utilization efficiency could be improved fundamentally, and the new energy was promoted to become the leading energy resource.

2. Analysis of non-renewability for "renewable energy resource"

The history of human civilization is a history of human utilization of energy resource, and creation of any substance is inseparable from energy resource utilization. The development of human society has experienced three stages [1]: a stage that mainly utilize "renewable energy resource" such as solar, wind, geothermal, water and so forth; a stage that mainly utilize fossil fuels such as petroleum, natural gas, coal, and so on, which are not renewable; and a stage devoting major efforts towards development of renewable energy resource. At the first stage, human used natural energy sources intuitively to do simple work, provide heat and keep warm etc. At the second stage, the invention of steam engine promoted development of industrialization marked as fossil fuels (petroleum, natural gas and coal). Theory and technology system corresponding with energy resource generated gradually. But lack of theory and technology system corresponding with renewable energy resource constrained the development of energy resource. At the third stage, serious environmental problems and energy resource supply issues emerged constantly due to the large-scale utilization of fossil fuels at the second stage. Human is once again faced with the necessity to strongly emphasize the development of renewable energy resource.

In order to meet the demand of industrialized society, the emerging energy resources should be developed in a high efficiency, low consumption, high energy density, sustainable and little environmental impact direction. Therefore the renewable energy resources should be converted into stable energy such as electric power. With respect to high energy-density energy resources, such as oil and coal, most of renewable energy resources are low energy-density energy resources, such as wind, solar, tidal energy resources, they will consume more equipments (also carriers) in conversion process. The conversion efficiency, life, cost, and resources of carriers will determine the utilizing efficiency and the development of renewable energy resource. This is the reason why the renewable energy resource was substituted by fossil fuels at the second stage and couldn't be utilized on a large scale at the third stage [2].
To solve this problem, we proceeded with the substrate of renewable energy resource and explored ways to improve its efficiency through the technological analysis of renewable energy resource.

3. Energy system methodology

3.1. Classification of energy resource by dichotomy

Currently energy resource is classified into fossil energy, renewable energy, nuclear energy and hydropower, etc. in the form of energy resource, rather than in the form of energy resource utilization and conversion. From an objective point of view, some energy resources including fossil energy, nuclear energy and biomass energy are all available through their own consumption, while other energy resources, such as solar, wind, geothermal, ocean energy, etc. are available through carrier consumption. And these two forms of energy utilization and conversion have their own rules and theoretical basis.

When wind energy and solar energy included in renewable energy resource are converted from resource into energy, carriers are needed during the conversion process and the conversion efficiency depends on the adoptive carriers. Herein it can't simply be thought that energy resource is renewable so that the whole process of energy resource utilization is

renewable. Because the energy resource utilization efficiency doesn't depend on energy resource itself but depend on the adoptive carriers attributed to the low energy-density. Although this type of renewable energy resource are considered to be renewable but its renewability during the conversion process accompanied by carriers' consumption is untenable. So this type of renewable energy resource can't be entitled as "renewable energy resource". Here we focused on the different determinants in the energy resource utilization process and reclassified energy resource, which conduced to the development of new energy resource and acceptance of new energy resource as the mainstream in this society.

Here we focused on the different determinants in the energy resource utilization process, abandoned the existing classification of energy into renewable energy and non-renewable energy, reclassified the overall energy system, cleared the direction of the new energy development, which could conduced to effective solution of the new energy efficiency bottleneck issues, and acceptance of new energy as the mainstream in this society.

According to the determinant of energy efficiency, energy resource is re-classified as self-consumption-based energy resource which mainly consumes itself and carrier-consumption-based energy resource which mainly consumes carrier. According to the energy resource utilization ways, energy resource is re-classified as fuel type energy resource and non-fuel type energy resource. From the perspective of energy efficiency, the energy efficiencies of self-consumption-based energy resource and fuel type energy resource mainly depend on the substance itself, while the energy efficiencies of carrier-consumption-based energy resource and non-fuel type energy resource low energy-density are mainly determined by carrier ascribed to low energy-density. This classification is conducive to improve energy efficiency more effectively when studying laws and mechanisms, respectively, and to clear the relationship between different types of energy resources, finally clear the development direction of renewable energy resource.

At present, all of the energy resource theories are built on the basis of traditional energy resources. However, these theories have been established before the emergence of new energy resource. And new energy resource here mainly means carrier-consumption based energy resource and non-fuel-based energy resource proposed above.

In other words, these theories can't meet the demand of the existing energy resource technology innovation. And traditional production and living style, and traditional energy resource utilization ways can't pull birth of more rational, more scientific, more efficient, low-cost, new energy resource technologies. Therefore, in this era vigorously advocating the development of renewable energy resource, energy theories and technical systems corresponding with new energy resource should be build up, new energy resource utilization ways consistent with new energy resource conversion mechanism should be explored, and a revolutionary energy resource technology innovation should be developed, finally a new industrial revolution which is different from the previous industrial revolution marked as the steam engine should be activated.

3.2. Life circle analysis of energy technologies

We demonstrated the above view through life cycle analysis (LCA) of the energy utilization. LCA [3, 4] is an approach in which all energy and material inputs and outputs are accounted for in a technology system, and compilation and evaluation of the potential environmental impacts. The assessing object of LCA method is environmental impacts and material conversions caused by the product system or service system. LCA can identify and quantify

the energy consumption and waste discharge associated with the assessing object, and it also can assess the caused environmental burden correspondingly. Assessment of the environmental impacts caused by energy consumption and waste discharge can help provide an overview interaction between the product system and environment as complete as possible. It avails to find the timing and means to improve energy utilization efficiency and protect the environment, and provides products and technology criteria. Therefore, LCA can determine the non-renewability of energy utilization process and demonstrate bottlenecks of energy utilization efficiency through energy consumption, which not only proved the correctness of our classification, but also point out how to improve the energy utilization efficiency from the point of an overall view.

Therefore, human must re-examine the "renewable energy resource" problem. Carrier-consumption-based energy resource and non-fuel type energy resource are inexhaustible, clean and pollution- free as the existing substance in nature. They need to be converted into energy in the application process. And carriers must be used in the conversion process. Once these energy resources are converted into energy through carriers, the utilization process will consume carrier materials and give rise to pollution of the production process, coat, efficiency and waste proposal issues, which are critical issues of this energy resource utilization. In order to clarify the impact factors and developing direction of energy resource, the corresponding LCA-type formulas are established shown as below:

$$E_A = E_S \times \eta_C \times \eta_{CC} \tag{1}$$

$$e_{PE} = (P_{ep} + P_{EP}) \div E_P \tag{2}$$

The energy production and costs of energy production in the utilization process can be clarified according to above formulas. Solar and wind energy are chosen as an example. Since solar and wind energy can be greatly influenced by the natural environment and climatic conditions, with instability and uncertainty, in order to improve power quality, new energy storage devices must be set in new energy power generation system so that excess energy is stored when the external energy is sufficient, and lacked energy is complemented when the external energy is insufficient. For example wind generator can store the wind energy through inductive energy storage device and improve the quality of power supply. In addition to the traditional batteries and energy storage inductor, modern energy storage devices have been developed such as super-capacitors and flywheels, etc., but the exploitation of these materials and preparation process has huge energy consumption.

Amorphous silicon cells in solar photovoltaic industry provide an example [5, 6]. The photovoltaic industry chain consists of four parts: silicon material, silicon chips, solar cells, solar energy battery components. Preparation of silicon materials have gone through silicon ore mining, preparation of industrial silicon, the process of preparation of crystalline silicon and so on. Investigation of energy storage systems and examination of issues associated with waste disposal of expired batteries and development of energy storage devices for long-term use must be carried out in order to achieve stability in the independent power generation. At present, solar power plant construction requires an investment which is approximately 7-8 times that of coal [7], the power generation cost of solar electricity is about 8-9 times of coal, and requires much more land area than coal-fired electricity. By this token, the solar power generation technology presents not only high-cost problem but also the problem of consumption of resources, the process of pollution, waste disposal and other issues.

Take wind energy as an example [8], the world's wind power calculation is based on the standard of power generated by the largest wind of annual local detection, known as peak power. However, the maximal wind power of the year couldn't be maintained every day. In fact wind power unit effective power only reach to 20% of peak power, which makes wind energy cost of unit power very high; brings about large quantity of consumption of resources such as converting equipment, fan blades, transmission, generator; causes equipment maintenance and waste disposal problem latterly [9]. Without exception, the utilization efficiency of above energy in the utilization process mainly depends on the energy conversion means, which is the carrier consumption we mentioned above. In other words, this type energy converts through the carrier consumption. So we named this type energy carrier-consumption-based energy.

Here we propose the existing problems of new types of energy, don't oppose vigorously the development of new energy resources, and don't deny classifying energy into the renewable energy resource and non-renewable energy resource, but understand energy resource from another point of view. At the same time due to the shortage of fossil energy, we need to develop new energy resources vigorously. Raising these issues is only for pointing out that the new energy resource developing road is a materials innovation road, technological innovation road, process optimization road.

Through the re-classification of energy resource, developing directions of different types of energy resources can be clarified, e.g. the developing directions of self-consumption based energy resource and fuel type energy resource are the deployment of process and the implementation of energy saving measures; the developing directions of carrier-consumption-based energy resource and non-fuel type energy resource are choose of materials, study of technical principles. Here selection of materials for carrier-consumption-based energy resource mainly includes new materials for energy efficiency improvement and cost reduction etc.

3.3. New energy resource theory and technology system

There is another reason for the difficulty of existing new energy resource technologies to break through. It is that so far no scientific research institutions or scholars could propose a systematic concept and planning for energy science and energy systems, so the real energy discipline has not been established. The so-called discipline has two meanings: the disciplines and branches of knowledge; teaching, research and other functional units, which is relative definition on the teaching and research activities. Here "discipline" partially refers to the latter meaning, but are also relevant with the first meaning. While there are quite a bit researches on the branches of energy resource in the world and there are quite adequate research methods for all kinds of energy resources, the researches on energy system and energy discipline are relatively less, which causes the division between the disciplines, non-shared resources, over-specialization of talent education, narrow range of knowledge, narrow direction of research, overall low benefit and relatively decentralized scientific research especially individual research.

The re-classification on energy resource can't make changes on the nature of energy resource, but is very helpful for the improvement of energy efficiency, the establishment of energy discipline and talent education. For example, for the self-consumption-based energy, the establishment of discipline should be interdisciplinary-based on chemical engineering, energy chemistry, thermal engineering and so on; for carrier-consumption-based energy, the

establishment of discipline should be interdisciplinary-based on mechanical engineering, material science, energy biology, energy physics and so on.

Construction of a discipline possesses multiple functions, such as talent education, scientific research, social services, etc. Discipline set up under the right guidance of academic philosophy could develop the discipline of various functions of discipline much better. The establishment of energy discipline is in line with this standard. From the view point of energy classification, it can be analyzed that energy discipline is the intersection of parts of materials science, chemical technology, physics and mechanical engineering etc.

From now on, the systematic energy discipline hasn't been established, which causes a serious split within the disciplines. So, logical relationships between different types of disciplines, discipline characteristics and patterns of development can't be reflected accurately. This situation not only seriously affect the interaction between the cross discipline, integration, resulting in blind comparisons and vicious competition between different disciplines, impeding the normal development of energy disciplines, but also affect the energy talent education. Rational energy talent education is more conducive to the development of energy resource disciplines and the correct development path for energy can properly guide the efficient development and utilization of energy resource. Therefore, we must create the right energy system, adjust the energy disciplines reasonably, and establish the corresponding theoretical basis in order to study its regularity and mechanism. E.g. theoretical system for carrier-consumption-based energy resource may include energy ecology, energy transfer study, energy materials, energy bionics, energy chemical, biological energy, energy physics etc., and its technology system should include collection technology, conversion technology, energy storage technology, using technology and so on.

Discipline construction can promote the development of scientific research and industry and then stimulate the improvement of scientific research level and overall strength. With the social development and technological progress, the discipline construction has been the crucial factor to strengthen internal discipline, enhance the overall academic level of scientific research and promote talent education. In the beginning of establishing a new energy discipline system, the direction of development may not be stable. Therefore, it need to go through a period of adjustment, differentiation, and eventually evolved into a purposeful, organized common action. When this action is recognized by the society, a new discipline comes into being.

4. Conclusions

In this paper, starting from the energy resource, the non-renewability of energy utilization process was proposed on the basis of the exploration of the energy resource and it was pointed out that the existing energy utilization theory could not meet the existing demand for energy technology innovation. Therefore, new energy theory and technology system should be established corresponding with the new energy system and new energy utilization ways should be explored corresponding with the new energy conversion mechanism. So classification of energy resource by dichotomy was proposed and energy was re-classified as self-consumption-based energy and carrier-consumption-based energy. And this viewpoint was demonstrated by the LCA. In conclusion, after effectively addressing these problems, the corresponding energy systems should be established through discipline construction to promote scientific research and industrial development.

Today is accelerating development new energy resources. We must start from the origin of energy utilization and promote new energy resource into the mainstream of energy resources through exploring the origin of energy, principle inquiry, technological innovation, discipline construction and other means, so as to establish a new industrial revolution different from that marked as steam engine.

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