Renewable Energy 58 (2013) 21–27

Contents lists available at SciVerse ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene

A novel analysis model of China's new energy talents

Lin Liu [a], Guodong Li [b], Han Luo [b,*]

[a] School of Economics and Management, North China Electric Power University, Beijing 102206, China
[b] School of Control and Computer Engineering, North China Electric Power University, Beijing 102206, China

ARTICLE INFO

Article history:
Received 9 November 2012
Accepted 4 March 2013
Available online 30 March 2013

Keywords:
New energy talents
Clustering model
Primary key
Binary relation
Primary attribute

ABSTRACT

Sustainable development of the new energy industry requires continuous input from professional talents. The new energy industry will continue to grow in importance, and the characteristics of the necessary cross-discipline talents that will promote its development are becoming more and more defined. This article puts forward an analysis model starting with the addition of talents carriers subdivided by specialties, and takes this subdivision as a starting point with the purpose of maximizing talents selection throughout the entire nation. First of all, we define each talent as a specific vector. Then a clustering algorithm is used to perform an analysis and the new energy talents database is created. Finally, we use an algorithm based on graph theory and discrete mathematics to calculate the essential value of the talents vector. This value provides a measurement of the importance of the talents. The current talents structure is analyzed in order to clarify understanding of the present situation so as to enable informed planning of targeted training needs and structural adjustments, thus meeting the sustainable development requirements for the new energy industry in China.

1. Introduction

In the 21st century secure energy sources and environmental protection have become a globally highlighted issue. Many governments pay high attention to the development of renewable energy sources as a highly important measure to help ease the worrying problem of a sustainable, reliable energy supply and reduce the serious climatic effects of greenhouse gas emissions. Therefore, development goals and incentive policies have been put forward in order to guide and encourage the development of renewable energy. China has adopted renewable energy as the most significant measure for the improvement of the energy supply structure, ensuring stability of energy supply, the decrease of environmental pollution and the realization of sustainable development, especially in the period of the Tenth Five Year Plan (2006–2010). During this time, when the new energy industry [1–3] was booming, the Renewable Energy Law was implemented and the Long-term Development Program for Renewable Energy was created. The new and renewable energy options consist of wind energy, solar energy, biomass energy, geothermal energy, tidal energy, etc. Hydro energy is classified as conventional energy because of the universal application. At present in China, wind energy, solar energy and biomass energy are dominant in terms of the scale of the industrialization, while the scale of the industrialization of other forms of energy is still relatively small, still being at the research stage.

Sustainable development of the new energy industry requires continuous input from professional talents. On one hand, the new energy industry is considered to be one of industry's high-tech fields. The characteristics of the necessary cross-discipline talents that will promote its development are becoming more and more defined, leading to higher systematic requirements and greater difficulties in training new talents. On the other hand, as the growing state of the new energy industry in China continues to become more and more important, the demand for the needed talents is experiencing a period of great-leap-forward growth. Because of these factors it is a most important task for the nation and the associated enterprises to carry out scientific human resource planning, determine the current available stock, capability and structure of existing talents, and then establish an effective training system based on the demands and the goal of sustainable development of the new energy industry. One important aspect of new energy talents planning is to analyze the existing talents stock, capability and structure as it exists at present and predict these conditions for a certain period of time in the future, thereby clarifying existing problems and helping to plan for optimized adjustment.

* Corresponding author.
E-mail addresses: liulin0627@126.com (L. Liu), lgd@ncepu.edu.cn (G. Li), lbyzmy@163.com (H. Luo).

0960-1481/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.renene.2013.03.006

At present in China, the larger scale of the fore mentioned wind energy, solar energy and biomass energy demands relatively more talents of research, exploitation and application, which is significant in the research from the perspective of analysis of the man power's structure. This paper presents the cluster analysis method of new energy talents mainly to verify the data of the wind, solar, biomass energy talents that are investigated.

2. New energy talents structure

In general, the talents structure is analyzed through the varying aspects of talents classification; educational background, specialist training, professional title, skill, age, etc. As a new technological industry, the new energy industry exhibits two obvious characteristics. One is that multiple disciplines and multiple specialties coexist and the talents carriers are numerous; the other is that Chinese specialization curriculums offered by universities and the scale of training has lagged behind the needs of industrial development. It is also the case that employees are able to transfer their skills from other professions in various ways, a situation that may exist for a certain period of time, providing another source channel for new energy talents by obtaining talents from other substitutable specialties that possess relevant training and practice.

Therefore, it is the definition of skill carriers and the subdivision of specialties that should be taken into consideration in addition to the traditional talents classification, educational background, specialty (professional title, skill) and age when defining potential new energy talents.

2.1. The definition of carrier types

The definition of carriers of new energy talents is determined by analysis of the environment of talents development and training. The talents carriers are divided into universities, scientific research institutions, industrial entities and the administrative departments of the government through determination of their position in the industrial chain (R&D, production, popularization, and management). On this basis, the various concrete units are subdivided in accordance with different properties, attempting to cover all the links of the industrial chain and all the carriers of different skill sets.

For example, universities are divided into those institutions directly under the control of the State Ministry of Education, followed by local universities and civilian-run universities according to their different characteristics. After this, the talents are distributed through the new energy faculties and research institutions.

2.2. The subdivision of new energy specialties

On the basis of carrier division, the new energy specializations (wind energy, solar energy, and biomass energy) are further subdivided by defining the research directions, practice processes, development situation, etc., from the transverse dimension of the analytical graph. Due to the fact that at present most talents are entering the new energy industry by transferring from other substitutable specialties, and this trend is likely to continue for some time into the future, taking the subdivision of research directions as the main index for the analysis of talents structure is in accordance with these characteristics and thus necessary.

As an example, the wind energy major offered by universities and institutions could be subdivided into the various areas of design and manufacture of wind turbine units, wind turbine aerodynamic simulation modules, wind turbine and wind farm electrical engineering, wind turbine and wind farm automation, and wind farm construction and operation (planning, design, operation systems and maintenance).

3. The clustering model of new energy talents

In general, the information in the talents information database is divided mainly by the sub-organizations, specialties, etc. However, taking into account that the new energy industry is a new technological industry requiring input from multiple disciplines and skill carriers, it cannot be analyzed in accordance with conventional practices. Survey of the data has shown that the starting point for proper analysis could be the difficult to define affiliations of research subdivisions in the new energy structure model, so as to cluster all the talents, and only then perform an analysis using conventional methods.

3.1. The clustering model

Within the model of the new energy talents structure, there is information describing the various research directions of the model. We assume that there are n directions, so a talents vector can be built which is notated in Eq. (1), and the introduction of the vector is in Table 1 g_i is the ith talents vector, and $r_{ij}(1 \le j \le n)$ is the research direction.

$$g_i = (r_{i1}, r_{i2}, \ldots, r_{\mathrm{in}}) \tag{1}$$

The value of $r_{ij}(1 \le j \le n)$ is 0 if the talents know nothing about the research direction, otherwise it is a decimal value which is less than or equal to 1 and greater than 0, the decimal value describing the research degree.

We focus on the similarities between the talents vectors. The vectors that have close similarities can probably be dealt with as belonging to the same class.

Function $similarity(g_i,g_j)$

Here, we not only take the distance between the vectors but also the inner association into consideration. We use the function of their combination. The similarity function is defined as:

$$similarity\left(g_i, g_j\right) = \alpha * fd\left(distance\left(g_i, g_j\right)\right) + \beta * fc\left(g_i, g_j\right) \tag{2}$$

where, $fd(distance(g_i,g_j)) \in [0,1]$ is a function of Euclidean Distance, $fc(g_i,g_j)$ is the function of the components between g_i and g_j, and α,β is the constant value.

Function $fd(distance(g_i,g_j))$

$$\begin{cases} 1 & ;i=j \\ \dfrac{1}{1+e^{\frac{-1}{\sum_{j=1,j\neq i}^{n}\mathrm{Euclidean\,Distance}\left(g_i,g_j\right)}}} * \dfrac{1}{1+e^{\frac{-1}{\mathrm{Euclidean\,Distance}\left(g_i,g_j\right)}}} & ;i\neq j \end{cases} \tag{3}$$

Function $fc(g_i,g_j)$

Assume the vector $g_i=(r_{i1},r_{i2},\ldots,r_{in})$, $g_j=(r_{j1},r_{j2},\ldots,r_{jn})$.

Table 1
Meaning of the vector.

	r_{i1}	r_{i2}	…	r_{in}
g_i	re 1	re 2	…	re n