Energy 140 (2017) 708–715

Contents lists available at ScienceDirect

Energy

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

Has government intervention effectively encouraged the use of waste cooking oil as an energy source? Comparison of two Chinese biofuel companies

Huiming Zhang [a, b], Yu Zheng [c], Jie Cao [c, *], Yueming Qiu [d]

[a] Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters, Nanjing University of Information Science & Technology, Nanjing, 210044, China

[b] Charles H. Dyson School of Applied Economics and Management, Cornell University, Ithaca, NY 14853, USA

[c] China Institute of Manufacturing Development, Nanjing University of Information Science & Technology, Nanjing, 210044, China

[d] School of Public Policy, University of Maryland, College Park, 20742, USA

ARTICLE INFO

Article history:
Received 11 February 2017
Received in revised form
24 July 2017
Accepted 26 August 2017
Available online 28 August 2017

Keywords:
Waste cooking oil-to-energy
Government intervention
Policy instrument

ABSTRACT

There is a significant difference in the performance of waste cooking oil-to-energy companies in China. Most biofuel companies face a loss while a few others have high recovery rates and strong profitability. To shed light on this phenomenon and to aide in formulating policy, this paper constructs a framework from the two dimensions of X-Y and investigates the impact of government intervention on biofuel companies' performance by taking two companies located in the kitchen waste-to-resource pilot cities of Changzhou and Suzhou. Results indicate that: (1) the basic policy instruments of information disclosed and fee and penalty mechanisms in Changzhou are inferior to those of Suzhou. On the other hand, capital investment and cooperation between stakeholders are better in Changzhou. As for the value chain dimension, the policies are similar in both cities. This means that companies involved in the recycling of waste cooking oil and biofuel production equally neglect research and development, preferential loan and product sales by government. (2) In terms of effectiveness, recycling rates and company profits for Changzhou Yueda Kate New Energy Co. Ltd. are far below those of Suzhou Clean Environmental Technology Co. Ltd. Whether the biofuel companies are authorized by government or not, fee and penalty mechanisms and information disclosure are the key determinants affecting performance of biofuel companies. (3) There is still some room to improve the performance of Suzhou Clean Environmental Technology Co. Ltd. Policies can focus on the following: strengthening R & D, which improves the technological supply and diffusion capability of biofuel companies; building the demand-typed policy frame and adjusting policy structure; improving the market structure of biofuel companies.

1. Introduction

The disposal of waste cooking oil is, and has been for a long time, a major problem in China. Despite laws and the numerous reports in the news concerning food security and the regulating of waste cooking oil discharge, some restaurants still sell their waste cooking oil to illegal manufacturers who then refine it into poor quality oil with consequent serious health risks. Furthermore, the illegal disposal of waste cooling oil and the many food security incidents that have occurred in China seriously affect not only the credibility of government but also environmental pollution measures.

Using waste cooking oil to produce energy is one way to deal with the three major difficulties. A number of countries such as the US, Japan, the UK, Brazil and South Korea already do this. For example, Japan employs biodiesel refined from waste cooking oil to power its garbage trucks and supports biodiesel sales with consumption taxes. Similar to Japan, the US provides subsidies for the purchasing of waste cooking oil, as well as tax incentives for biofuel sales. In contrast to Japan and the US, Brazil allows up to 5% biofuel refined from waste cooking oil to be mixed with conventional biodiesel [1]. In South Korea, the proportion is slightly lower at 2% [2]. In Holland, waste cooking oil can be employed to produce aviation fuel.

China has concentrated more on converting waste cooking oil-

* Corresponding author.
E-mail addresses: kindcj@nuist.edu.cn (J. Cao), yqiu16@umd.edu (Y. Qiu).

http://dx.doi.org/10.1016/j.energy.2017.08.107
0360-5442/

to-energy, and has set out, among others, *Proposals on Reinforcing Renovation over Waste Cooking Oil and Kitchen Waste Management (2010)* and *Technical Standards on Kitchen Waste Disposal (2011)*. These deal with planning, regulation and technology. Since 2011, China has gone through four stages of the *Kitchen Waste Resource Utilization and Harmless Disposal Pilot Project* in 83 cities, including Beijing, Shanghai, Xi'an, Ningxia. Through a process of bidding, each city selected one kitchen waste disposal company and licensed that company to process wastes through to finished product. The end products mainly include biodiesel, bioethanol, biogas, glycerin and stearic acid. Waste cooking oil-to-energy policies still face some challenges though. The main problem is that a considerable number of biofuel companies, such as Beijing Hailiang Hongxin Science and Technology Co. Ltd. and Shanghai Yiran New Energy Co. Ltd., are facing losses or going broke. Sichuan Gushan Group, which was founded in 2001, was delisted because of losses. It is has already shut down and only 9 employees remain on the company payroll and the company is currently under investigation. In contrast to these companies, a small number of biofuel companies have abundant sources of raw material and are more profitable.

Why do companies in the pilot cities vary greatly in performance? Is government intervention effective in the waste cooking oil-to-energy industry? How should policies be improved? To solve these problems, this paper tries to explore the effectiveness of policies by investigating two typical biofuel companies located in the pilot cities. We hope to provide a reference for improving the performance of biofuel companies.

2. Literature review

Current research on the operation and management of waste cooking oil-to-energy companies mainly focuses on recycling rate [3], production costs [4,5], carbon dioxide emissions or environmental impact assessment [6–12], storage stability [13], the collection system route planning [14], input-output efficiency [15], the technical features of the industry [16,17]. The studies of waste cooking oil-to-energy policies can be grouped into two types:

(1) Supply chain incentive or planning policy options. A number of scholars have analyzed the waste cooking oil-to-energy industry and find that financial subsidies are an important measure in addressing this issue [18,19]. Looking at subsidies, Zhang et al. [20], based on a dynamic game model, compared the profit impact of tax preference, price subsidy on raw materials and product sales subsidies on each of the players in the supply chain. Followed by that, Zhang et al. [21] built an evolutionary game to model three parties including the government, biofuel enterprises and restaurants under the assumptions of incomplete information and bounded entity rationality, and investigated supply chain policy options. Escobar et al. [22] examined the economic performance of alternative systems of waste management proposed in the European Integral-b project. This project concerned the processing of cooking oil and solid organic waste generated by the hotel industry and discussed measures of producing diesel and anaerobic digestion. Results showed that both scenarios would produce net losses, which implied that stakeholders should finance the functions provided. Cho et al. [23] looked at the situation in South Korea, a country where dining out is very popular, and concluded that the promotion household collection of waste cooking oil was of great significance in kitchen waste-to-resource conversion. For this purpose, Cho et al. employed minimal value to conclude that the level of motivation was an important factor affecting respondents involved in the waste oil collection. Hussain et al. [24] looked at the situation in the UAE. They concluded that large scale production favored a decrease in the selling price of biodiesel and, along with subsidies, proposed an integrated residential collection mechanism. Gonzalez-Salazar et al. [25] researched waste oil to biofuel in Columbia and proposed price bonuses for effective waste management solutions, tariff exemption for developing equipment, tax reduction for imports, support for demos to develop and stimulate the conversion of biofuel residues and animal waste into energy.

As for the planning policies, Jiang and Zhang [26] built a mixed integer linear programming model for both economic and environmental optimization with the main purpose of determining both the location of distribution centers and factories and the allocation of the waste cooking oil among supply chain members. Clearly, unlike Zhang et al. [21], Jiang et al. were concerned about a firm's decisions. Looking at the kitchen waste-to-energy situation in Hongkong, Irene et al. [27] found that classifying trash was a worthwhile policy in converting waste-to- resource. According to Zhang and Jiang's findings [28], three key problems of the number, sizes and locations of bio-refinery, the sites and amount of WCO collected and the transportation plans of WCO and biodiesel should be addressed for the optimal design of waste cooking oil-to-biodiesel supply chain.

(2) Regulation policies for waste cooking oil-to-energy. Sheinbaum-Pardo et al. [29] found that illegal transactions in waste cooking oil were the main barriers to expanding production of waste cooking oil-to-biodiesel in Mexico and recommended that healthy edible oil standards as well as standard inspection measures be established. Taking Aveiro as an example, Rodrigues et al. [30] evaluated the feasibility of implementing the separate collection of bio-waste in restaurants and canteens in Portugal and pointed out the lack of dedicated infrastructure in municipal waste facilities was one of the obstacles restraining separate recycling.

Although much research has successfully explored waste cooking oil-to-energy policies, there is still a lack of biofuel case studies. Because different cities may vary in their recycling measures and the focus and strength of their policy instruments, this may influence the performance of biofuel companies. It follows that the selection of a typical enterprise and the investigation of government intervention in the waste cooking oil-to-energy industry may indicate the effectiveness of policy instruments.

3. Method

We have employed content analysis, initially proposed by the National Office of US Assessment and widely used by some studies [31,32]. This method determines which documents shall be included into content analysis, and constructs policy dimensions, lists coding catalog and examines results. Compared to the qualitative approach, content analysis is more applicable to policy investigations in depth because it achieves greater control of the research process and is able to reveal more quantitative characteristics in policy contents. Despite this, the classifying and coding of policy contents is both fussy and tedious. In terms of our research, there is no historical data for the policy documents, we just focus on classifying the policy context and examine the policy instruments qualitatively instead of listing coding catalog.

Policy instruments, which achieve policy objectives and have desirable effects, will be applied to explore government intervention in the waste cooking oil-to-energy sector. We classify the policy instruments into X-Y dimensions, where the X dimension indicates the basic policy instrument. As Rothwell and Zegveld [33] have indicated, basic policy instruments are of three main types: supply-typed, environmental-typed and demand-typed instruments. Both supply-typed and demand-typed policies have direct effects on the process of waste cooking oil-to-energy, the former one promoting the factors of supply with scientific and technological support and funding, and the latter one aiming to reduce the production uncertainty by developing mandatory biofuel sale legislation as well as