Renewable and Sustainable Energy Reviews 92 (2018) 638–641

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

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

Discussion on "Assessing feed-in tariffs on wind power installation and industry development in Taiwan" (Renewable and Sustainable Energy Reviews 2016; 58: 548–57)

ARTICLE INFO

Keywords:
System dynamics
Model
Variable
Test

ABSTRACT

This is a discussion on the paper titled "Assessing feed-in tariffs on wind power installation and industry development in Taiwan" published by Hsu et al. In the discussed paper, there were several missing variables in the historical test of the system dynamics (SD) model, and thus the test was not integrated and valid. Additionally, the simulated results of the missing variables were used as important indexes to observe the behavior of the SD model. Therefore, it was highly likely that the solution and related policy analysis based on the simulated results were incorrect. Accordingly, the present study illustrated the structure characteristics of the SD model with respect to the fore-mentioned problems, discussed the reason for missing variables and proposed a method to assess whether or not the historical test was integrated. Finally, after a careful analysis, this study offered suggestions to perfect the historical test proposed in the discussed paper.

1. Introduction and description of the issues

The SD method reflects the causal relationship among the system structures and factors, and it is helpful to understand different policies and measures. Since System Dynamics (SD) was created, the related theories and methods are under enduring improvement, and the application scope has expanded rapidly. SD plays an important role in solving complex problems of human society in many areas, such as project management [1], industrial operation [2], resource and environment [3–5], etc. By analysing the main factors of the realistic problems, the modelers use the corresponding functions to describe the realistic problems briefly and systematically. To a large extent, the equations and parameters in the SD model are estimated reasonably based on experience and hypothesis [6], so it is necessary that the model test is used to check the validity of the SD model. In the test methods of SD model, the historical test is widely applied, but there are some problems often existed in the application. After careful analysis, it is discovered that when the historical test is conducted, many modelers are not clear about the following key points: which variable should be selected as the observed object of the historical behavior (referred to as the examined variable); the reason for selecting the variable as the examined variable; whether the purpose of the historical test can be achieved when using the selected examined variables to conduct the historical test. Under this background, further study concerning the judgment method for the validity of SD simulation is essential for its practical application.

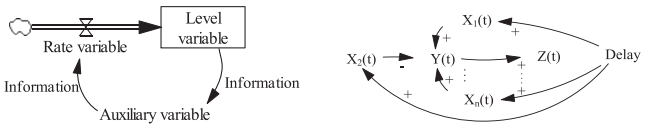
In recent years, the environmental and resource problems have been getting a lot of attention. One of the major subjects in the field is how to use the clean energy to generate electricity, and there are many literatures concerning this problem. The electricity market is relatively closed and monopolistic and largely influenced by the country's economy and the government policies in many countries [7]. However, after the deregulation of electricity markets, the competition becomes fiercer in this industry. Thus, it becomes harder for market subjects, such as power generators and electricity purchasers, to make business decisions [8]. They need to take much more competitive factors into consideration. Feed-in tariffs is an important factor in the electricity markets, and it has an effect on company's costs [9] and profits in terms of the economic benefits, and it will effectively influence the share of renewable energy and reduce carbon emissions in terms of the environmental benefits [10]. Launching policies related to feed-in tariffs is incentive to achieve benefits maximization of the economy, society and environment [11].

Reducing carbon emissions is one of the main ways to alleviate global climate change in many nations. Wind energy, which does not worsen global warming, is one of the world's cleanest energy resources, and many countries are vigorously promoting its development. There is rich wind power in Taiwan, and the government has established a variety of policies, measures, and programs to develop associated industries. By the end of 2012, Taiwan's cumulative installed on-land wind power capacity was approximately 560 MW. Before 2020, Taiwan is expected to increase its cumulative installed wind power capacity to 1200 MW, the target set by the government.

This is a discussion on the paper titled "Assessing feed-in tariffs on wind power installation and industry development in Taiwan" [12], which was published in *Renewable and Sustainable Energy Reviews*. The aforementioned paper (to be henceforth referred to as the "discussed paper") proposed a SD model to assess the policy effects of feed-in tariffs on the use of wind power in Taiwan and the growth of the country's wind power industry. In order to verify the behavioral validity of the SD model, a historical test [13] was conducted for the SD model in the discussed paper. The variables "Cumulative installed wind power capacity" and "Cumulative output value of the wind power industry" were selected as the examined variables, and the simulated results were compared with historical data from 2005 to 2012. The analysis indicated that the simulated values were very close to the historical data. From these aspects, Hsu et al. believed that the results of the simulation in the discussed paper were deemed as credible.

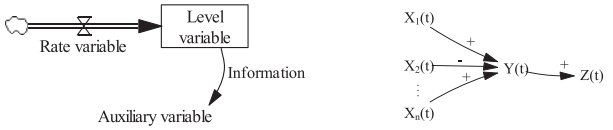
However, after a careful analysis, this paper determined that the historical test of the SD model in the discussed paper is not

https://doi.org/10.1016/j.rser.2018.04.119
Received 7 July 2016; Received in revised form 8 March 2018; Accepted 30 April 2018



(a) Closed-loop structure (b) Causal relationship of the feedback loop

Fig. 1. The closed-loop structure and related causal relationship of the feedback loop.



(a) Open-loop structure (b) Causal relationship of the directed-style

Fig. 2. The open-loop structure and related causal relationship of the directed-style.

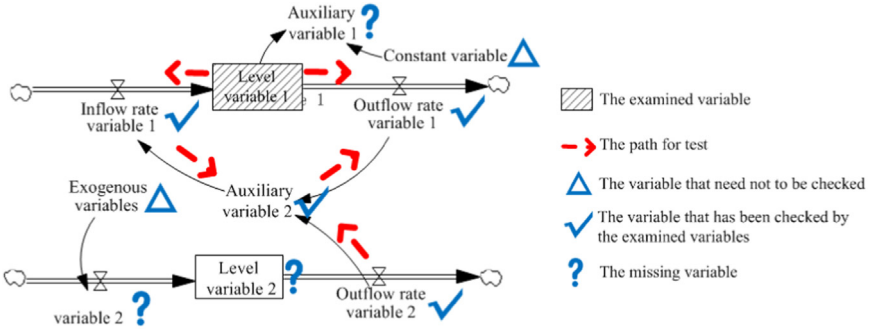
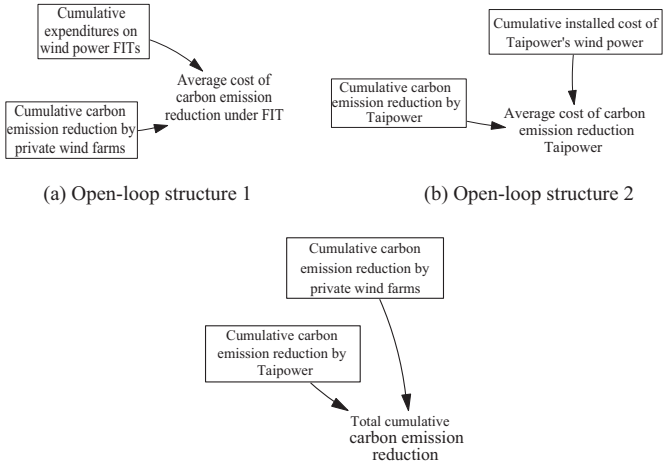


Fig. 3. The labelled graph of checking circumstances in which the examined variable is a level variable.



(a) Open-loop structure 1 (b) Open-loop structure 2

(c) Open-loop structure 3

Fig. 4. Partial open-loop structures in the SD model.

comprehensive, and that the variables selected as the examined variables are not appropriate and cannot guarantee that all variables could be checked in the SD model. Additionally, compared with the historical data, significant errors in the simulated results of the missing variables are most likely to exist and not be noticed. Therefore, the simulated results based on the SD model are highly likely to be incorrect. Based on the above uncertain factors, the simulated results of the missing variables are used as important indexes during scenario simulation to observe the behavior of the SD model in the discussed paper. In conclusion, the solutions and related policy recommendations provided by the discussed paper are not credible.

2. The reason for missing variables and the assessment method

In order to discover the reason for the missing variables in the historical test, it is important to first understand the structure of the SD model. Based on the feature of the feedback loop in basic units, the unit structure in the system can be divided into two categories, namely closed-loop structure and open-loop structure [14]. The former appears as a causal relationship of the feedback loop, and it can conduct a self-adjustment through information feedback (Fig. 1) [15]. The latter appears as a causal relationship of directed-style. It cannot conduct a self-adjustment through information feedback because the path of the