Indicators and criteria for assessing achievement of renewable energy utilization in communities

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Abstract

This research has objectives to develop indicators and criteria for assessing achievement in using renewable energy for communities. The researchers used Delphi technique for interviewing to collect opinions from experts who had strong experience in renewable energy utilization in the Northern region of Thailand. The 8 indicators for achieving assessment on community renewable energy utilization consisted of perception, attitude/motivation, learning, community potential, leaders, community and household participation, problem solving, and internal and external networks. The criteria for achievement assessment consisted of 4 levels of scores that range from 0 – 100 points. The 4 levels are Excellent, Good, Fair, and Poor, according to potential of the community. For success in supporting the use of renewable energy in communities, participation and cooperation from people in the community and external organizations are essential. These sectors need to get involved and play important roles to push forward and maintain sustainable production and utilization of renewable energy in communities.

Keywords:

Achievement indicators, assessment criteria, renewable energy, community energy

1. Introduction

Energy is an essential fundamental factor for development of a country regarding both economy and society. Any operations, irrespective of being in fields of industry, transportation, or agriculture, require energy in all procedures. Increase of population leads to higher energy consumption. Currently, Thailand has a population of 65 million people [1], with 30 million people or 8 million households living in rural areas [2]. The energy consumption of a household also increased. According to the analysis on energy use of 52,000 households inside and outside municipalities of all provinces throughout the country, it was found that the mean income of a household was 27,545 baht a month, or 330,540 baht a year. On average, each household has a total expense on energy use of 2,135 baht, from its overall expense of 21,157 baht per month [3]. In 2015, the total amount of energy import was 71,925 thousand tons of oil equivalent (TOE), and the final energy use was 77,881 thousand TOE, which increased last year 2.7%. The cost of total energy use in the year was as high as 998,428 million baht. According to the situation of ever-increasing energy import, the Thai government has a policy to pay attention to development of domestic energy sources for security in terms of energy. In order to sustainably support people's energy demand, the government also aims to strengthen communities and promotes a behavior of efficient energy use in households [4]. Since 2006, the Ministry of Energy has initiated the project of community energy planning in order to encourage participation of the public sector in energy and environment management. The Ministry also emphasized efficient budget planning in communities, provided opportunities to communities to take

part in energy administration and management, and promoted their attitude toward sustainable energy use. This project was participated by 1,095 out of the total of 7,608 Local Administrative Organizations around the country from 2005-2013. [5]. However, according to the assessment on outcomes from the project of community energy planning as conducted in each region, among the 18 communities from the Northern region that participated in the project, only 5 or 27.77% of them succeeded in following the energy plan, transferring the knowledge body, and developing or applying energy technology in other forms. Most problems of unsuccessful communities happened due to a lack of leaders to drive and move the project forward, inadequate knowledge and enthusiasm of the community people, insufficient supporting budget, a lack of appropriate technology that matches the potential of community, a lack of good administration, and inadequate participation of all parties from the government and communities [6].

Due to these reasons above, achievement in promoting renewable energy use in communities requires readiness assessment of communities from the beginning by considering various aspects of factors such as personnel, resources, budget, and administration [7]. Therefore, the researchers are interested in developing indicators and criteria for assessing achievement in renewable energy use. The main aim of this research is to provide communities or related organizations appropriate directions and guidelines to be applied for developing energy use in communities so that they can rely on themselves sustainably.

2. Methodology

In developing indicators and criteria for assessing achievement of renewable energy utilization, 3 operational steps were conducted as follows:

Step 1 Study documents, journal articles, concepts, and related theories, and then inquire representatives of renewable energy users from 267 households in 4 provinces of the Northern region of Thailand, namely Phayao, Lamphun, Chiang Mai, and Phitsanulok provinces in order to draft a framework of achievement indicator assessment of renewable energy utilization in communities.

Step 2 Develop achievement indicators of renewable energy utilization by applying a Delphi technique for 3 rounds. The target group includes 20 experts who are representatives of community leaders, group leaders who have experience in renewable energy use, energy scholars, and people who take part in driving community energy. The tool was a questionnaire for inquiring opinions. The used statistics consisted of percentage (%), median (Mdn.), standard deviation (SD) and interquartile range (IQR).

Step 3 Build some criteria for assessing achievement of renewable energy usage. Test efficiency of the criteria with 5 experts, including energy scholars and renewable energy group leaders. Finally, conclude the research results.

3. Results and discussion

3.1 Results

In this research, some indicators and criteria for assessing achievement of renewable energy utilization were developed. The results can be concluded as follows.

3.1.1 From inquiring opinions of participants from 267 sample households in 4 Northern provinces who had used renewable energy continuously for at least 2 years, it was found that the framework for assessing achievement indicators consisted of 10 major indicators namely: 1) perception, 2) learning, 3) needs and motivation, 4) leaders, 5) attitude, 6) community potential, 7)

family/households, 8) internal and external networks, 9) communities participation, and 10) problem solving.

3.1.2 From inquiring opinions of 20 experts with a Delphi technique for 3 rounds in order to develop achievement indicators for renewable energy utilization in communities, it was found that the researchers unanimously agree with the 10 major indicators and 33 minor indicators (the minor indicators are not listed here). The top 3 important indicators are Perception (13.97%), Learning (13.24%), and Community potential (10.29%), respectively, as shown in Table 1.

Table 1 Opinions of experts on the indicators for assessing achievement of renewable energy use (multiple response).

Indicators	Count (n=20)	Pct of Responses	Pct of Cases
1. Perception	19	13.97	95.00
2. Learning	18	13.24	90.00
3. Needs and motivation	13	9.56	65.00
4. Leaders	12	8.82	60.00
5. Attitude	11	8.09	55.00
6. Community potential	14	10.29	70.00
7. Family/Household	13	9.56	65.00
8. Internal and external networks	11	8.09	55.00
9. Communities Participation	13	9.56	65.00
10. Problem solving	12	8.82	60.00
Total	136	100.00	680.00

3.1.3 Twenty experts have investigated appropriateness and feasibility of the 10 indicators by considering the median (Mdn.) value of at least 3.5 and the interquartile range (IQR) of 0 to 1.5. All the 10 indicators passed unanimous consensus from the experts, as shown in Table 2.

Table 2 Appropriateness and feasibility of the achievement indicators for assessing renewable energy use.

Indicators	Appropriateness				Feasibility			
	Mdn.	S.D.	IQR.	Consensus	Mdn.	S.D.	IQR.	Consensus
1. Perception	4	0.65	1	Pass	5	0.61	1	Pass
2. Learning	4	0.63	1	Pass	4	0.64	1	Pass
3. Needs and motivation	4	0.56	1	Pass	4	0.63	1	Pass
4. Leaders	4	0.72	0	Pass	4	0.62	1	Pass
5. Attitude	4	0.54	1	Pass	5	0.67	1	Pass
6. Community potential	4	0.53	1	Pass	4	0.48	1	Pass
7. Family/Household	4	0.57	0.75	Pass	4	0.48	0.75	Pass
8. Internal and external networks	4	0.68	1	Pass	5	0.67	1	Pass
9. Community participation	4	0.71	1.5	Pass	5	0.59	1.5	Pass
10. Problem solving	4	0.63	0	Pass	4	0.66	0	Pass

3.1.4 The main indicators in Table 2 were grouped and developed to derive 8 major indicators and 20 minor indicators. The criteria for assessing achievement in renewable energy use of communities was then determined. These criteria passed the validity check by some experts, as shown in Table 3.

Table 3 Major and minor indicators for assessing achievement of renewable energy use in community.

Major indicators	Minor indicators
1. Perception (15 points)	1. People in the community perceive the situation of energy and realize the importance of renewable energy.
	2. The energy plan of the community is recognized.
	3. Knowledge appropriate to context, resources, and lifestyle of the community is integrated and applied to energy use.
2. Attitude/Motivation (10 points)	4. The community people want to use renewable energy.
	5. The community people have conscious to use energy worthily.
3. Community potential (10 points)	6. People in the community are ready to produce and use renewable energy.
	7. The community has energy/resources and technology for energy production.
4. Learning (15 points)	8. The community people are enthusiastic and able to learn technology for taking care and maintaining the energy production system.
	9. People in households and communities exchange knowledge and learn together.
	10. Knowledge is transferred among members in the community or to the next generation of community people.
5. Leaders (15 points)	11. The community has a leader or a group of leaders that can stimulate community people to recognize the importance in procuring renewable energy.
	12. The community has gurus or volunteers to support mutual learning in the community.
	13. The community has knowledgeable leaders who are able to transfer knowledge to community people.
6. Community and household participation (15 points)	14. Community people unite and discuss renewable energy.
	15. Community people take part in the decision making process for choosing, renewable energy and technologies that are appropriate for the local area.
	16. People in the community conduct activities about energy together and manage energy with the collaboration of most people.
7. Problem solving (10 points)	17. Community people try to find solutions to solve problems concerning energy and the environment.
	18. People in the community utilize resources for optimum benefits and apply resources efficiently by means of reducing, reusing, recycling, and repairing.
8. Internal and external networks (10 points)	19. There are external organizations that support budget, technology, or equipment for strengthening the community's renewable energy use.
	2 0 . There are networks or a learning center in the community that promotes knowledge transfer, occupation, and the income of community people.

In assessing the achievement indicators of renewable energy use in communities according to Table 3, these following criteria are applied.

Score	**Level**	**Meaning**
80 points up	Excellent	The community has high potential to use renewable energy, and deserves supports in terms of budget, technology, etc. for continuous development.
70 - 79 points	Good	The community has a potential to use renewable Energy, and deserves supports in terms of budget, technology, etc. as required by the community.
60 - 69 points	Fair	The community has some potential to use renewable energy, and should be strengthened and supported for the missing indicators in order to develop renewable energy use in the community.
Less than 60 points	Poor	The community is still in lack of potential to use renewable energy, and needs support for the missing indicators in order to initiate renewable energy use in the community.

3.2 Discussion

From assessing the results of the previous community energy planning project, it was found that there were some successful and unsuccessful communities. This difference may be due to varied effectiveness of supportive factors for renewable energy use when applied to communities that have different characteristics of energy management. Therefore, a community or an external organization that aims to use renewable energy in a community should follow these guidelines of operation.

1. Enhance knowledge and realization in energy: Communities should have knowledge about the energy situation, energy source, energy processing, and energy use. In addition, the community people should be implanted with the mindset of energy conservation, energy saving, and the importance of renewable energy use in communities. They should also be educated to adjust their energy use behavior towards efficiency. They should learn to use energy for maximum benefits according to true demand of the community [8-10].

2. Budget and technology supports: At present, budget and technology given to communities are not sufficient for continuous operation. Budgets are not thoroughly distributed to all communities. Some communities lack equipment and correct understanding of renewable energy. In addition, some technologies do not match the requirements of certain communities [6-7]. Therefore, communities should receive a budget for developing their people to acquire knowledge and technical skills on the use of technology for renewable energy production. Appropriateness of budget and technology should be judged from demand and potential of the community. Budget given to a community must be sufficient for it to rely on itself and start using renewable energy. Knowledge on how to use the budget should also be given to the community for sustainable self-reliant energy production. Practical trainings should be organized by emphasizing capacity building activities for leaders, heads, and energy volunteers. Activities of transferring knowledge from community gurus to general people should be included in the training. Technology used in communities should be simple and easy to operate such as braziers (clayed stoves), efficient stoves, chaff stoves, biogas digesters, etc. Litter, agricultural remains, manure and food waste should be used as raw materials for energy production so that communities or households can maintain and repair themselves.

3. Administration and participation: In order to drive energy production in a community, participatory administration is required. Heads should encourage the community people to move together. Solutions for this purpose include planning about production and utilization of renewable energy in communities together to promote a feeling of mutual ownership. The plan must be followed, and outcomes should be investigated and assessed for sustainability of energy production. Outcome assessment should be conducted by the community itself or supportive organizations. Obstacles and problems should be studied in order to find ways to improve the energy production system for higher efficiency. Local Administrative Organizations and academic organizations around the area should take action to enhance and support budget, knowledge, and technologies of renewable energy. These approaches will encourage community people to produce and utilize energy efficiently according to potential of resources in the area. The community will gain higher income and spend less on energy from outside. Besides, community energy management should ensure sustainable energy use. [8-11].

4. Conclusions

In order to promote and support the use of renewable energy in a community, potential of the community should be assessed based on 8 indicators including perception, attitude/motivation, learning, community potential, leaders, community and household participation, problem solving, and internal and external networks. By assessing these indicators, the right direction for developing community energy successfully will be discovered. The community and external organizations must prepare their readiness in terms of knowledge about energy, participatory planning and administration, budget allocation, and appropriate technology, etc.

Potential and capable leaders are very important in driving the community and households to be able to produce and use renewable energy. The leaders must be able to transfer knowledge to the community people so that they understand the situation, and should build a good attitude toward renewable energy. Moreover, leaders should encourage people to take part in administering and solving the problems. Leaders should also coordinate with academic organizations in order to promote integrated knowledge to their community. Supports from others organizations, such as budgets from Local Administrative Organizations, knowledge from academic institutions, and occupation promotion for community people from community development organizations or community enterprise development organizations are important for achieving tangible and sustainable renewable energy use in the community.

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