

Small-Scale Hydropower Generation

1. Motives and Objectives of Research

It is said that fossil fuels, such as coal and oil, will deplete within about 50 years¹. This is a serious problem for Japan that depends largely on thermal power generation². On March 11, 2011, the Great East Japan Earthquake caused an accident of the Fukushima No.1 Plant. As a result, the credibility for safety of nuclear power generation has been lost. Therefore, Japan has come to depend increasingly on thermal power generation. To resolve this energy problem, it is essential to promote the use of renewable energy.

Especially, small-scale hydropower generation is quite excellent among others in terms of S+3E (Energy Security, Environment, Economic Efficiency, and Safety)³. Let's compare it with solar-power generation. In terms of Energy Security, small-scale hydropower generation, which can generate power in day and night using a flow of water, is better than a solar power, which cannot work at night without sunlight. Also, in terms of environment, small-scale hydropower generation just using a flow of an existing river is better than a large-scale power generation plant that requires deforestation for dam construction.

	エネルギーの安定供給	環境保全 (1kWhあたりのCO ₂ 排出量)		経済性 (1kWhあたりのコスト)			安全性など
		原料の採掘や建設、輸送時など	発電時	2014年 モデルプラント	2014年時点 での燃料費	2030年 モデルプラント	
原子力	● 燃料の埋蔵地域が世界に広く分布 ● 備蓄性に優れる ● 燃料をリサイクルできる	19	発電時にCO ₂ を排出しない	10.1円～ (8.8円～)	1.5円	10.3円～ (8.8円～)	● 徹底した安全確保、厳重な放射線管理、廃棄物の適切な処理、処分が必要
太陽光 (住宅用)		38		29.4円 (27.3円)	0円	12.5円～16.4円 (12.3円～16.2円)	● 広い土地が必要
風力 (陸上)	● 資源が枯渇するおそれがない ● 自然条件に左右される	26		21.6円 (15.6円)	0円	13.6円～21.5円 (9.8円～15.6円)	
水力 (一般)		11		11.0円 (10.8円)	0円	11.0円 (10.8円)	
石炭火力	● 燃料の埋蔵地域に偏りがなく、世界に広く分布	79	943 864	12.3円 (12.2円)	5.5円	12.9円 (12.9円)	● 世界的な資源価格の変動により、発電コストが大きく左右される
天然ガス (LNG) 火力	● 燃料の埋蔵地域の偏りが小さい	123	599 476	13.7円 (13.7円)	10.8円	13.4円 (13.4円)	
石油火力	● 燃料の埋蔵地域が中東に偏っている	43	738 695	30.6円～43.4円 (30.6円～43.3円)	21.7円	28.9円～41.7円 (28.9円～41.6円)	

In our country, there are as many as 19,686 places where a small-scale hydropower plant can be

¹ 「世界のエネルギー事情 関西電力」

https://www.kepco.co.jp/energy_supply/energy/nowenergy/world_energy.html

(2019年2月18日確認)

² 「日本が抱えているエネルギー問題 経済産業省・資源エネルギー庁」

<http://www.enecho.meti.go.jp/about/special/johoteikyo/energyissue.html>

(2019年2月18日確認)

³ 「これからのエネルギー 関西電力」

https://www.kepco.co.jp/sp/energy_supply/energy/nowenergy/future_energy.html

(2019年2月20日確認)

installed, but only 522 places, only 3% of all, have been used for such generation⁴.

Our group has studied how to spread the use of small-scale hydropower generation by using uninstalled locations.

2. Fieldwork

First, to find out the reasons why small-scale hydropower generation is not popular, we interviewed Mr. Tetsuya Matsuura, President of DK-Power, Ltd. which has been handling such generation as business.

He pointed out three main causes

1) Difficulty in acquisition of water rights

Water rights means ones to possession and management of rivers and waterways. Before installing hydropower generation equipment, the owner's permission is needed. But it is not known who the owner is because Japan has been an agricultural country from a long time ago. So it is difficult to look for the owner. Also, in many cases, negotiations to get the permission don't go well.

2) Initial costs and maintenance expenses

It costs as much as about 30 million yen to install a generator. Additionally, maintenance including cleaning is needed because mud and fallen leaves accumulate inside a generator. Though initial costs can be recovered in about 20 years, it is difficult to install privately.

3) People's low environmental awareness

When the company tries to install such a system as part of business, many cases are not realized by being hampered by people's conservative view derived from low environmental awareness. President Matsuura frequently said, "After all, people's way of thinking is important."

Next, we visited Terauchi water distribution station in Toyonaka City to observe machines for small-scale hydropower generation, where we could see electricity being actually generated. According to the station, not all electricity is sold, but some is supplied for the station, and the remaining is sold to get profit.

3. Detail of Research

As above mentioned, there are three reasons why small-scale hydropower generation is not prevalent. We focused on the third reason "people's low awareness of environment." We thought if it is improved, the negotiation to acquire water rights could go well. So we promoted our research on this point.

According to the survey⁵ on "low environmental awareness" conducted by the National Institute for Environmental Studies in 3,000 men and women aged 18 and older, the majority are aware of environmental issues, but few take action to solve them. This means they know about environmental issues but not actually put into practice.

⁴ 「小水力発電の現状について」

http://www.mlit.go.jp/river/shinngikai_blog/shigenkentou/dai01/pdf/s07.pdf

(2019年2月18日確認)

⁵ 「環境意識に関する世論調査報告書 2016 国立環境研究所」

<https://www.nies.go.jp/whatsnew/2016/jqjm10000008nl7t-att/jqjm10000008noea.pdf>

(2019年2月19日確認)

The current elementary education covers a broad range of curricula, such as social studies, science, physical education, socio-environmental studies, moral education, and so on, but the contents vary from subject to subject, with no connection among them. Experience learning is also included as part of environmental education, but it is temporary with no continuity⁶.

Therefore, we thought that education improvement would be effective to change students' awareness and activity. If the environmental education is integrated and students can learn systematically and continue experience learning, then they could nurture a high awareness of trying to improve the environment.

To probe this hypotheses, we planned an actual class plan. (Fig. 1) The target is 5th and 6th grade school students. The flow of the lessons is first to give a quiz with threefold choice to draw students' attention, and then environmental and energy problems are explained. Finally, a situation game is played to consider what energy problems would happen, through which students could nurture the ability to apply their knowledge to take action.

(Fig. 1)

Class Plan (45 minutes)				
Title	Learning and practice	Learning objectives	Time	
Introduction	<ul style="list-style-type: none"> • Separation into groups • Five quizzes with threefold choice • Current situations surrounding energy problems in Japan and the world, and knowledge of power generation methods 	<Quiz> <ol style="list-style-type: none"> 1. Which energy cannot be used repeatedly? (1) Water (2) Sunlight (3) Natural gas 2. Which is the correct proportion of renewal energy to total power generation? (1) 15.6% (2) 30.6% (3) 60.6% 3. If we continue to use oil energy like this, how long can we use it? (1) 31 years (2) 51 years (3) 71 years 4. Where can a small hydropower plant be installed? (1) Pool (2) River (3) Pond 5. Small-scale hydropower can generate 1,000 kW. How many air conditioners are equal to it? (1) 10 units (2) 100 units (3) 1,000 units 	<ul style="list-style-type: none"> • Drawing attention of students • Telling students that environmental problems are not somebody else's problem 	5 minutes
Explanation	<ul style="list-style-type: none"> • Now CO₂ reduction becomes a serious challenge in the Paris Agreement. • A high-potential small-scale hydropower generation is catching people's attention as renewable energy. • Small-scale hydropower generation is more excellent in terms of S+3E. • Japan depends too much on fossil fuels and import from foreign countries for natural resources. 	<ul style="list-style-type: none"> • Disseminating basic knowledge 	15 minutes	
Game	<ul style="list-style-type: none"> • Competing among groups • Considering suitable energy combinations according to various situations 	<Situations> <ol style="list-style-type: none"> 1. Crude oil prices steeply rise and oil imports decline. 2. A nuclear power plant accident happens and the plant completely stops. 3. A certain country occupies the East China Sea, making the imports of oil, coal and natural gas difficult. 4. Japanese yen depreciates while the prices of oil, coal and natural gas rise. 	<ul style="list-style-type: none"> • Deepening understanding by exchanging opinions among students • Confirming the importance of renewable energy 	20 minutes
Summary	<ul style="list-style-type: none"> • Reconfirmation of the importance of renewable energy • Making students understand how effective small-scale hydropower generation is among renewable energies 	<ul style="list-style-type: none"> • Reconfirming what students learn about 	5 minutes	

We will do questionnaires about the contents of lessons before and after the class. (Fig. 2) We look at the difference in the answers before and after the class to confirm whether students' awareness of environment has heightened or not.

⁶ 「学校教育における環境教育」 著/工藤由貴子

(Fig. 2)

第一問

- (1)日本が行っている発電のうち、化石燃料(石油、石炭、天然ガスなど)を使用した発電方法は全体の約何%?
① 25% ② 55% ③ 85%
- (2)世界の化石燃料は、いずれ枯渇するといわれています。その中でも石炭はあと何年で枯渇するといわれている?
① 50000年 ② 5000年 ③ 50年
- (3)次のうち再生可能エネルギー(太陽光、風力など)を使った発電方法は?
① 原子力発電 ② バイオマス発電 ③ 火力発電
- (4)再生可能エネルギーを使った発電方法には、小水力発電があります。小水力発電を行うことが出来ない場所は次のうちどこ?
① 川 ② 水たまり ③ 浄水場
- (5)1時間に1kw発電すると、エアコン何台を稼働することができる?
① 1台 ② 10台 ③ 10000台

第二問

- (1)あなたは、地球温暖化対策や環境に優しいこととして、何か取り組んでいることはありますか?
① ある ② ない
- (2)①と答えた人→具体的に何をしていますか?
()
- (3)小水力発電に興味はありますか?
① ある ② ない
- (4)あなたは地球環境問題を解決したいですか?
① はい ② いいえ

これでアンケートは終わります。ご協力ありがとうございました。

4. Results and Challenges of Research

We thought that elementary school's environmental education is important to spread the small-scale hydropower generation. So we examined what lacks in the current education and made a class plan to try to give lessons to students. But the plan has not been put into practice. A future challenge is to carry out this class plan.

5. Reference materials

- 1) 「世界のエネルギー事情 関西電力」
https://www.kepcoco.jp/energy_supply/energy/nowenergy/world_energy.html
- 2) 「日本が抱えているエネルギー問題 経済産業省・資源エネルギー庁」
<http://www.enecho.meti.go.jp/about/special/johoteikyo/energyissue.html>
- 3) 「これからのエネルギー 関西電力」
https://www.kepcoco.jp/sp/energy_supply/energy/nowenergy/future_energy.html
- 4) 「小水力発電の現状について」
http://www.mlit.go.jp/river/shinngikai_blog/shigenkentou/dai01/pdf/s07.pdf
- 5) 「環境意識に関する世論調査報告書 2016 国立環境研究所」
<https://www.nies.go.jp/whatsnew/2016/jqjm10000008nl7t-att/jqjm10000008noea.pdf>
- 6) 「学校教育における環境教育」著/工藤由貴子