Study on the freezer system with solar energy source

*Onon Bayasgalan[1], Amarbayar Adiyabat[2]

1. Graduate student , 2. Assoc.Prof

Many countries started to use renewable energy resource as an alternative energy source for electricity production because of environmental issues such as global warming and greenhouse gas concentration as a result of burning fossil fuels. Out of 5 main renewable energy resources, solar energy utilization is constantly increasing because of its mature technology and equally distributed resource throughout the world. Therefore, solar energy is used in many fields and in this study, photovoltaic system performance for meat freezer in rural areas of Mongolia is investigated. The main facilities are movable freezing container, grid connected 3kW photovoltaic modules, inverter, diesel generator and data logger to measure the parameters of this system. Starting from November 2015, we collected a year round site measurement which includes solar irradiation, outside and inside temperature of the container, electricity production and consumption. We use HOMER software to calculate the energy production by photovoltaic system and energy consumption of freezer system. Then, we compared this calculation with the real value and calculated the solar energy share of total electricity consumption. Also, we modeled an E-nose to monitor the freshness of meat preserved in the freezer. The result suggests that it is suitable to use photovoltaic system for meat storage in rural areas where grid electricity interrupts often.

Keywords: solar energy, photovoltaic system, freezing system

Derivation of time series of the sky-cloud ratio from omnidirectional camera images for predicting sky conditions

*Teppei Sonoda[1], Kazunori Ogohara[1], Yuji Hatanaka[1], Wataru Sunayama[1]

1. University of Shiga Prefecture

Prediction of photovoltaic output is necessary to efficiently control photovoltaic systems. In order to make a prediction about the output, it is necessary to predict the variations of the sky conditions. Therefore, the purpose of this study is to prepare a system that can always continue to take sky images using an omnidirectional camera, and to develop algorithms for calculating the time series of the sky ratio. First, we take sky images once every minute by the camera and store them as JPEG images. Next, we train a classifier using R and B of some images. Finally, we calculate the sky ratio of images, which we did not use for the training, using the classifier. F-measure in the cases of cloudy day is >0.9 and that in the cases of clear day is approximately 0.9 at daytime. Although F-measure tends to decrease drastically in the images with dark sky at dawn and evening, we are able to extract variations in sky ratio over the observation period, especially accurately in cloudy and mostly sunny days.

Keywords: Photovoltaic generation, All-sky images

Climatological attribution of wind power ramp events in East Japan and their probabilistic forecast based on multi-model ensembles

*Masamichi Ohba[1], Daisuke Nohara[1], Shinji Kadokura[1]

1. Central Research Institute of Electric Power Industry

This study presents an application of self-organizing maps (SOM) for the climatological/meteorological study of wind power ramp events. SOM constitutes an automatic data-mining clustering technique, which allows for summarizing of a high-dimensional data space in terms of a set of reference vectors. SOM is applied to analyze and establish the relationship between atmospheric synoptic patterns over Japan and an object e.g., wind power generation. In this study, synoptic patterns derived from the JRA-55 reanalysis over the Tohoku region in Japan are classified by using SOM into a two-dimensional lattice of patterns. Wind-power ramp events (defined as a 30% change in power in less than 6 h) mainly take place during the winter months in East Japan. Our SOM analysis for weather patterns in boreal winter extracts seven typical patterns that are linked to frequent occurrences of wind ramp events.
Medium-range probabilistic wind power prediction is derived by this SOM lattices based on the weather patterns of the multi-center grand ensemble forecasts for a particular day. Because this analog approach effectively handles the stochastic uncertainties indicated by the large number of ensemble members, a probabilistic wind power generation is easily and quickly obtained from the huge number of ensemble forecasts. The use of multi-center grand ensemble forecasts provides results better than those from one forecast model. The predictability skill of the forecasts for the wind power generation and ramp events show the relatively good skill score under the downscaling technique. It is expected that the results of this study provides better guidance to the user community and contribute to future development of system operation model for the transmission grid operator. The advantage of this method is it can include the interpretative analysis of the impact of meteorological/climatological factors on the variation of the renewable energy.

Keywords: Wind power, Ramp events, Self-organizing maps, Weather patterns, Synoptic climatology, Renewable energy

Evaluation of shallow groundwater quality for use in open-loop type groundwater-based heat pump system

*Seiichiro Ioka[1], Isao Machida[2], Hirofumi Muraoka[1], Yota Suzuki[3]

1. North Japan Reserach Institute for Sustainable Energy, Hirosaki University, 2. AIST, 3. Graduate School of Science and Technology, Hirosaki University

In cold snowy regions, kerosene is used as fuel to melt snow in the winter, but geothermal heat is more suitable in terms of suppressing greenhouse gas emissions. Regarding shallow geothermal heat utilization heat pump systems, there are closed-loop and open-loop systems. In a closed-loop system, a high initial cost is required for installation of the underground heat exchanger, but in the case of the open-loop system using the shallow groundwater, the initial cost can be suppressed as compared with the case of the conventional method. Therefore, we think it is important to promote open-loop systems using shallow groundwater. However, in floodplains and deltas excluding alluvial fans used as farmlands and residential lots, shallow groundwater may contain a large amount of iron and free carbonic acid, which may affect the use of heat pumps. In particular, it is not clear whether the free carbonate concentration is constant in shallow groundwater or variable, greatly or otherwise. Therefore, in this study, we aimed to clarify the fluctuation characteristics of several water quality parameters, especially free carbonate concentration, in shallow groundwater. For almost one year, groundwater was monthly collected from three depths of about 3 m, 8 m, and 18 m in the downstream area of the Tsugaru plain of the Aseishi River in Aomori Prefecture. At the time of collection, pH, electrical conductivity, and water temperature were measured in the field. Concentrations of Na^{+}, NH_4^{+}, K^{+}, Mg^{2+}, Ca^{2+}, F^{-}, Cl^{-}, Br^{-}, NO_3^{-} SO_4^{2-}, Fe, Mn, Sr, Ba, Si, and alkalinity were analyzed. Using the measurement results from such, the free carbonate concentration was determined using the aqueous geochemical calculation computer program PHREEQC. The free carbonate concentration fluctuated, with a range of approximately 50 to 100 mg/L of groundwater at a depth of 3 m, about 40 to 80 mg/L at a depth of 8 m, and approximately 10 to 30 mg/L at a depth of 18 m. This is possibly due to the fact that the influence of events occurring on the ground surface decreases with an increase in depth.

Keywords: open-loop type groundwater-based heat pump system, shallow groundwater, water quality

