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Innovative Microgrid Solution for Renewable Energy Integration within the REIDS Initiative

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Abstract

In order to provide sustainable clean energy for the growing demand of electrical power in off-grid districts in Asia Pacific and South-East Asia through renewable energy sources (RESs) integration, ENGIE and Schneider Electric have made a partnership to join the Renewable Energy Integration Demonstration-Singapore (REIDS) initiative, the world largest microgrid demonstrator in the tropical area, to demonstrate state-of-the-art multi-fluid microgrid solution. Currently being constructed on Semakau Island, South of Singapore, the demonstration platform will enable ENGIE and Schneider Electric to integrate and test their solution that will provide a package of services including electricity, mobility, and clean cooking. Key innovations of the project include: The scalability and ability to start from both greenfield system (electrification of remote districts) and brownfield system (with existing equipment); A multi-fluid optimization module to enhance synergies between different technologies (renewable production, consumption, flexible loads, storage, H_2 chain, and biogas chain) to provide cheap and reliable electricity with low environmental impact; A power control module allowing up to 100% intermittent RESs penetration in the power thanks to the cutting edge technology of virtual synchronous generator; The integration of an H_2 chain for energy storage and mobility purposes; The integration of biogas technology for waste treatment and clean cooking. Promising results have already been observed in both companies' research centers on different technology bricks. These different bricks are currently being integrated into this microgrid for the first time to be verified for the feasibility and stability of the complete solution. Different use cases for both technical and commercial purposes have been designed and will be tested in the microgrid. Different tests and reports on this multi-fluid microgrid on Semakau Island will enable us to optimize the solution to be suitable for the tropical conditions of South-East Asia, thus promoting the integration of renewable energy for all.

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Keywords: Microgrid solution; renewable energy; multi-fluid optimization; power control; H_2 chain; biogas technology.

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1. Introduction

"Sustainable Energy for All to Meet Fundamental Electricity Needs" was defined as a priority goal by the United Nations. However, in Asian countries, energy-poor people are still numerous. For instance, In Philippines, 4.4 millions of households don't have access to electricity [1]. In APAC regions, microgrid market is forecasted to grow at a compound annual growth rate of 31.3% from 2013 to 2023 (from ($764M to $5.6B), where rural communities and urban communities, mostly off-grid, will lead the market demand [2].

Currently, those off-grid areas are mostly electrified with diesel generators. However, the import of diesel is quite expansive, not to mention that it is not environmentally friendly. For example, in some islands in Indonesia or Philippines, the cost of electricity can reach more than 330$/MWh [3]. Those high costs are mostly due to the logistic costs to import diesel for the power generation in these areas. As a result, these communities are highly depending on oil prices variations. In the event of extremely bad weather conditions, the import of diesel from the outside is cut off, which can result in several days without any energy access for the people in such a community, thus stopping the whole economic activities in this area. Many programs have been launched in order to prevent such incidents from happening in the future. It is an opportunity to develop those off-grid regions with more sustainable and less polluting sources of energy – CO_2 emissions from electricity generation account for 45% of energy-related emissions. in a cost effective and competitive way – using renewable energy sources.

This paper aims to introduce a multi-fluid microgrid solution co-developed by ENGIE and Schneider Electric for off-grid regions, and to share the vision of use a multifluid microgrid to provide different kinds of services.

2. Development of Next Generation Microgrid within REIDS

Solutions in the current market to supply electricity in remote locations already exist. However, most solutions are based on diesel generators, thus very polluting and OPEX expensive. The energy supply is then totally depending on the import of fuel and its price variations. It can be seen from [4] that during the past 10 years, the crude oil price varies in a very wide range. This figure proves that the solutions based on diesel generators do not have sufficient stability in terms of operational cost, and it could be very hard to perform a validated feasibility study because of such instability. Moreover, south East Asia government target soci economic development such as eco touristic activities which one of the pillar is to increase the clean electricity facilities and employment creation around agroforestry necessary for biomass electricity production. Hybrid solutions with small amount of solar photovoltaic (PV) arrays and energy storage systems are currently being deployed but remain limited.

ENGIE and Schneider Electric's ambition is to develop the next generation of microgrid, with a greater penetration rate of renewable energy sources (RESs) and energy storage systems (ESSs), to provide a package of services including electric supply as well as water treatment, mobility and clean cooking. The two companies formed in 2015 a consortium, and join the REIDS program in Singapore.

The REIDS initiative is an ambitious international R&D program led by Nanyang Technological University (NTU) and supported by the Economic Development Board (EDB) of Singapore and National Environment Agency (NEA) of Singapore [5]. REIDS aims at developing a microgrid demonstration platform, which will be the largest microgrid demonstrator in the tropics. This platform is located in Semakau Landfill (SL), South of Singapore; companies from all over the world will develop several cutting-edge microgrid solutions for isolated islands. It will test and demonstrate the integration of solar, wind, tidal, diesel, storage and power-to-gas technologies, and ensure these energy sources operate well together. Fig. 1 illustrates how the Semakau site will look like potentially (actual site may differ).

Fig. 1. Illustration of REIDS project on Semakau, Singapore.