

Renewable Energy Research in Indonesia

Hamman Riza

Agency for the Assessment and Application of Technology

1. Introduction

Indonesia is the country with the largest energy consumption in Southeast Asia and fifth in Asia Pacific in primary energy consumption. High GDP growth, reaching an average of 6.04% per year for the 2017-2050 period, is expected to increase Indonesia's oil fuels demand in future. This will escalate Indonesia's role both in the world energy market and in efforts to decrease global greenhouse emissions.

Indonesia has been a net importer of oil since 2014. If the increase in this oil fuel dominated demand is not followed by any changes in the pattern of energy consumption, the energy sustainability and security of Indonesia will be disrupted.

The increasing need of energy and decreasing production of petroleum causing energy diversification efforts should be undertaken immediately. Management of renewable energy should be improved, but many obstacles cause of the development of utilization is still not optimal. One of the environmentally friendly energy that can become the solution is hydrogen gas, which is used as fuel for fuel cell.

BPPT (Agency for the Assessment and Application of Technology) is one of government institutions which is engaging in research, development, assessment and application of technology especially more closely to industry. It is under coordination with Ministry of Research, Technology and Higher Education of Indonesia. BPPT has been conducting research on fuel cells over the past decade. The research and development activity has produced various prototypes and the final application, among other fuel cell types polymer electrolyte membrane fuel cell (PEMFC) and solid oxide fuel cell (SOFC). PEMFC fuel cell prototype has been used as a back up power to the server in BPPT. Moreover, BPPT has also carried out research and development on SOFC which has being developed solid electrolyte based on Rare-Earth Element such as Gadolinium-Doped Ceria (GDC), Samaria-Doped Ceria (SDC) and Scandia Stabilized Zirconia (ScSZ).



Fig. 1. PEMFC as BACKUP SERVER at Puspiptek

2. R&D activities related to clean energy technology

In term of clean energy, beside research and development on hydrogen technology, BPPT also conducted research on Geothermal technology. Currently, BPPT developed condensing and binary cycle technology. 3 kw of Condensing technology has been installed in Kamojang West Java as a pilot project cooperation with Pertamina Geothermal Energy. Meanwhile, cooperation with GFZ Germany, BPPT has built a 500 kW binary cycle power plant in Lahendong South Sulawesi.

3. Specific Research activities in hydrogen, CCUS, and related technologies

Among all the renewable energies, hydrogen is a much sought-after clean energy source as it is no emission. Research on fuel cell and hydrogen technology in BPPT has been conducted for more than 15 years. Within this period, BPPT has already developed a fuel cell stack, catalyst, membrane and other fuel cell component. BPPT in collaboration with PT. Cascadiant Indonesia has developed fuel cell for backup power for Server in Puspipstek Serpong and for cooling system in Baron Techno Park. Recently, BPPT in collaboration with Toshiba Japan has already signed a MoU on Hydrogen Based Energy Supply System. The system called H2One is a demonstration for Off Grid Solution supplies the electricity drawn from solar photovoltaic and storage battery as well as electricity generated by pure hydrogen fuel cell system using the storage hydrogen. The project with fuel cell capacity of 10 kW will be installed in Baron Techno Park Yogyakarta as a demonstration.

The research development of electric vehicle in Indonesia becomes more popular, BPPT has installed a charging station. In the future, BPPT will combining FC and PV as an energy source for the charging station. Fuel Cell vehicle as pilot project for fuel cell application for transportation will be developed as well.

In addition, BPPT has been also developing solid oxide fuel cell (SOFC) based on local raw materials. By using locally produced both of cerium and gadolinium oxide, the cost effective solid electrolyte of gadolinium doped cerium with composition of $Ce_{0.9}Gd_{0.1}O_{1.95}$ for SOFC has been developed. It shows comparable results of electrolyte performance as gadolinium doped cerium (GDC) using commercial oxide from the market. Furthermore, in attempt to improve electrolyte performance and obtain optimum properties, other rare earth elements such as lanthanum (La), scandium (Sc), ytterbium (Yb) and neodymium (Nd) are used as co-dopant to GDC electrolyte. The prototypes of single cell SOFC have been fabricated for electrochemical performance testing. The results confirm that GDC with co-dopant is promising alternative electrolyte for intermediate temperature solid oxide fuel cells (IT-SOFC). For the next project, BPPT will develop micro SOFC components and system as alternative of secondary battery replacement for mobile devices.

4. International collaboration

4-1 International alliance/networking development

BPPT has concluded a number of comprehensive and specific MoUs with overseas institute.

- a. Currently, BPPT have signed MoU with Toshiba on Joint Research for Technology Assessment and Demonstration Hydrogen Autonomous Energy System (H2One)

Application for Off and Grid Connected Microgrid System. The activities include feasibility study, joint projects, researcher exchanges, and capacity building. Through these activities, our global relationship has been strengthened, which should be beneficial for both sides.

- b. BPPT has collaborated with Gunma University through SATREP Project for Development of a Model System for Fluidized Bed Catalytic Gasification of Biomass Wastes and Following Liquid Fuel Production in Indonesia
- c. Hydrogen production using Palm Oil Mill Effluent, collaboration with Feng Chia University Taiwan

4-2 International joint R&D activities

International joint research program for innovation in clean energy technologies in BPPT are;

1. Technology Assessment and Demonstration Hydrogen Autonomous Energy System (H2One) Application for Off and Grid Connected Microgrid System with Toshiba.
2. Development of a Model System for Fluidized Bed Catalytic Gasification of Biomass Wastes and Following Liquid Fuel Production in Indonesia with Gunma University (SATREP Program)
3. Hydrogen production using Palm Oil Mill Effluent, collaboration with Feng Chia University Taiwan



Fig 2. Biomass Gasification Pilot Plant in Puspiptek

5. Future perspectives

In Indonesia, fossil fuel plays a big role in increasing the economic growth. But the the problem is the reserve of this fuel supply is very limited, and its use has environmental impact.

Seeing these facts, the role of renewable energy in Indonesia becomes important. Renewable energy sources such as geothermal, hydropower, solar energy, biomass and other which have not been optimally used, are expected to assist in the development of Indonesia in the future.

Considering this situation, research and collaboration with international institution is highly

recommended to conduct the research about renewable energy development. As information that Indonesia is rich in biomass, which can be used as raw material for energy both for fuel and for power generation sources. In addition, Indonesia, which is located in the tropics, has solar and wind resources that can be utilized for power generation sources.



Dr. Ir. Hammam Riza, MSc. IPU

**Agency for the Assessment and Application of Technology,
Government of the Republic of Indonesia**

Jl. M.H. Thamrin 8, Lt. 2, Gd. II, Jakarta 10340, Indonesia
Email. hammam.riza@bppt.go.id

Summary of Qualifications

Extensive 32-years' experience in ICT, with emphasis in artificial intelligence, enterprise information system, cybersecurity, broadband and mobile communication with in-depth experience in research, development, engineering and operation of IT system and network.

- Currently, he holds position as Chairman of the Agency for the Assessment and Application of Technology – BPPT, Government of Indonesia.
- Formerly, he was Deputy Chairman BPPT for Natural Resource Development Technology
- He was the Deputy Chairman BPPT for Information Technology, Energy and Material, concurrently as executive Chief Information Officer (CIO)
- He was the Director of ICT Center and previously was Director of Science and Technology Information Network (IPTEKnet) BPPT, a government internet service provider and held various positions in major Internet start-up companies as professional executive consultant.
- He holds Doctor of Engineering degree in Electrical Engineering (cum laude), Master of Science in Computer Science and Bachelor in Electrical Engineering, majoring Electronics and Control System.
- He has broad experiences in the Information Communication Technology (ICT) with the following exposure to:
 - Artificial Intelligence and Language Processing
 - Digital Identification and Biometric System
 - Broadband Wireless Access and Next Generation Network

	<ul style="list-style-type: none"> - Enterprise Architecture and Executive Information System - Cyber security and Information Resiliency - IT Governance, IT Strategic Planning, IT Project Management and IT Service Management - Content Management System and e-Government - Language and Multimedia Technology
<p>Professional Experience</p>	<p>January 2019 - Now BPPT Chairman of the Agency for the Assessment and Application of Technology</p> <p>Feb 2018- Oct 2019 BPPT Deputy Chairman of Natural Resources Development Technology</p> <p>Oct 2014-Feb 2018 BPPT Deputy Chairman of Information Technology, Energy and Material</p> <p>June 2010-Oct 2014 BPPT Director of Center for Information and Communication Technology</p> <ul style="list-style-type: none"> • Indonesian National e-ID (e-KTP) system specification • Ubiquitous Government Service (Electronic Voting) Pemilukada • Air Traffic Management System (CNS/ATM) • Digital Broadcasting and Multimedia Digital Network • e-Development: e-Government and ICT Outlook • Safety, Security and Defense Information System <p>2009-Now BPPT Executive Chief Information Officer (CIO)</p> <ul style="list-style-type: none"> • System Integration for Government Enterprise Architecture • Cloud Computing Infrastructure (Data Center) • Government Information Policy and Service <p>2004-2010 BPPT Director IPTEKnet</p> <ul style="list-style-type: none"> • Government Internet Service Provider • Government Data Center Management • E-Government Content and Application • Sistem Integrasi dan Pengamanan Informasi TNI-AL (Enterprise Information System for Navy) • Presidential Accountability Infostructure (PAI) • Banda Aceh Municipality Information System (BAICC)

	<p>Lecturer</p> <ul style="list-style-type: none"> • Homepage, Magister Teknik Elektro, Universitas Pelita Harapan (UPH) 2009-2011 • Executive Development Program, LAPI-ITB • Magister Teknik Industri - Universitas Pelita Harapan (UPH) • Universitas Budi Luhur 2004-2008 <p>Professional Consulting Experiences</p> <ul style="list-style-type: none"> • Technical Committee, Standar Nasional Indonesia (RSNI) - Broadband Wireless Access (BWA), Kementerian Perindustrian (2007-2009) • Technical Committee, TIME, Departemen Komunikasi dan Informatika (2006) • Multipolar Corporation - Acting Vice President, IT Data Center (2003) and PT. Linknet/Lippostar - Acting Chief Operating Officer (2002) • LKBN Antara (Antara Online) – Senior IT Consultant (2001) • PT. Astaga Internet Konsultindo (Astaga.com) – Internet Consulting Chief Portal Officer (2000) • PT. Rahajasa Media Internet (RADNET) – Business Development Adviser (1995)
<p>Education</p>	<p>Doctor of Engineering (Cum Laude), New Mexico State University (research), Bandung Institute of Technology, 1999</p> <ul style="list-style-type: none"> • Master of Science (MSc), Department of Computer Science, University of Kentucky, 1991 • Master of Electrical Engineering, University of Illinois, Chicago, 1990 • Bachelor of Engineering, Bandung Institute of Technology, 1986 <p>Certification</p> <ul style="list-style-type: none"> • Primary Professional Engineers Insinyur Profesional Utama (IPU), Electrical Engineering Committee (Badan Kejuruan Elektro), Indonesian Engineers Association (Persatuan Insinyur Indonesia, PII) <p>Formal Training</p> <ul style="list-style-type: none"> • IT Infrastructure Library, IT Security (USA) • Content Management System: Vignette StoryServer, Broadvision Publishing Engine (USA) • Project Management and Business Planning (Japan)

<p>Professional Association</p>	<p>Head of Research and Development, Expert Committee of National Desk for Cyber Information Security and Resilience (DK2ICN), Coordinating Ministry of Politic, Law and Defense (POLHUKAM)</p> <ul style="list-style-type: none"> • Expert Member, Indonesia Telecommunication Society (MASTEL) • Secretary, Badan Kejuruan Elektro (BKE)- Persatuan Insinyur Indonesia -Indonesia Engineer Association (PII) • Supervisory Committee - Association of Indonesia Internet Service Provider APJII (2010-2012) • Head of Indonesia Internet Exchange IIX - APJII (2008-2010) • Country expert member of Asian Federation on Natural Language Processing (AFNLP) • Expert Members, Asian Language Resource (ALRC), • Expert Committee, Oriental COCOSDA (Speech Database) • Expert member of International Speech Communication Association (ISCA)
<p>Interest</p>	<p>Wireless and Broadband Telecommunication</p> <ul style="list-style-type: none"> • Electronic Identification and Biometrics System • Content Management System/Publishing system • Internet-based Information Technology/Services E-Commerce System: B2B/B2C • Enterprise Architecture, Executive Information System • Language Technology and Machine Translation System