Smart Grid & Micro Grid for Archipelagic Communities - Power Play of Policy-Industry-Capacity-Infrastructure

Hawaii Natural Energy Institute

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ASEAN Smart Grid Congress

Le Grandeur Palm Resort, Johor, Senai, Johor
3-4 December 2019

Hawaii Natural Energy Institute (HNEI)

School of Ocean and Earth Science and Technology
University of Hawaii at Manoa

- Founded as organized research unit in 1974, established in statute in 2007 - complements the state statute for the Energy Resources Coordinator and its delegate, the Hawaii State Energy Office
- 4 major funding sources; UHM, Barrel Tax, Extramural, Applied Research Laboratory– alternative energy via HNEI recognized as core competency for the UH ARL
- Diverse staff including engineers, scientists, lawyers; students and postdoctoral fellows seeking solutions to renewable generation & transportation fuels, grid integration, and innovation
- Combines research excellence with deep experience
  - ❖ Policy team –former Public Utilities Commissioner & State Energy Administrator
  - ❖ HNEI's GridSTART team has >120 years cumulative utility experience
  - ❖ Two of three (2 of 3) current PUC Commissioners came from HNEI

Strategic Focus

Support University's Hawaii Innovation Initiative

- Research, Development, Validation
- Analysis
- Policy Guidance
- Workforce Development

Programs & Alliances to Replicate and Expand

- Asia Pacific Regional Energy Systems Analysis (APRESA) supported by the Office of Naval Research - to develop resilient renewable energy systems in the Asia Pacific
- Islanded Grid Resource Center 2.0 in collaboration with Maine's Island Institute & the Renewable Energy Assistance Project of Alaska

HNEI REAP Renewable Energy Alaska Project ISLAND INSTITUTE

APRESA

HNEI is engaged with the governments and their consultants in Vietnam, Thailand, Japan and Korea on cooperative endeavors to incorporate large-scale energy efficiency, renewable energy, and advanced grid services and policies.

Examples include:

- *Policy and Analytical Support under October 2019 MOU with* Electricity & Renewable Energy Authority - had previously support RPS design
- *Renewable Energy Outreach, Education & Training*, for the Center of Regional and Urban Studies, Ho Chi Minh City
- *Grid Modeling and Integration Analysis & Planning* for EREA (Vietnam) and the Electric Generating Authority Thailand
- *Energy Venture & Innovation Support* with and for the Vietnam Ministry of Science and Technology (MoST)

The Global Smart Grid Market…

…is expected to grow around USD 70 billion at a compound annual growth rate of 15.56% through 2027.

North America is expected to hold the largest share in global **Smart Grid Market** through the forecast period i.e. 2018-2027. Increased and early adoption for smart grid is expected to support significant market growth.

SOURCE: Research Nester:
https://www.researchnester.com/sample-request-1361

Southeast Asia's Smart Grid Framework

- Navigant Research's assessment of future Southeast Asia grid revenue growth will more than double from roughly US$5.5 billion in 2018 to nearly US$13.0 billion in 2027 - this assumes a compound annual growth rate (CAGR) of 9.7%.
- Due to impacts of urbanization, population growth and consumption patterns, Vietnam and Indonesia are in the early stage of this growth, while Malaysia and Singapore are building their reputations as regional innovators.
- For Indonesia, Malaysia, Philippines, Singapore, Taiwan, Thailand, Vietnam, and the rest of Southeast Asia, we expect policies supporting this growth to include smart grid and related communications networks.

Smart Energy Transition Approach

1) Governance (binding obligations & oversight)
2) Energy Efficiency
3) Smart, Modern Grids
4) Renewable Resources & Energy Storage

RPS, Regulatory

EEPS, DR

AMI, IT, Big Data

Diversified RE

Hawaii Natural Energy Institute

FACT SHEET: Mission Innovation

The White House November 29, 2015

- **20 countries (*when announced)* – now 24 countries + European Commission**
- **Representing 80 percent of global clean energy R&D budgets**
- **Commit to double their respective R&D investments over five years.**


Australia


Austria


Brazil


Canada


Chile


China


Denmark


European Union


Finland


France


Germany


India


Indonesia


Italy


Japan


Mexico


Morocco


Netherlands


Norway


Republic of Korea


Saudi Arabia


Sweden


United Arab Emirates


United Kingdom


United States

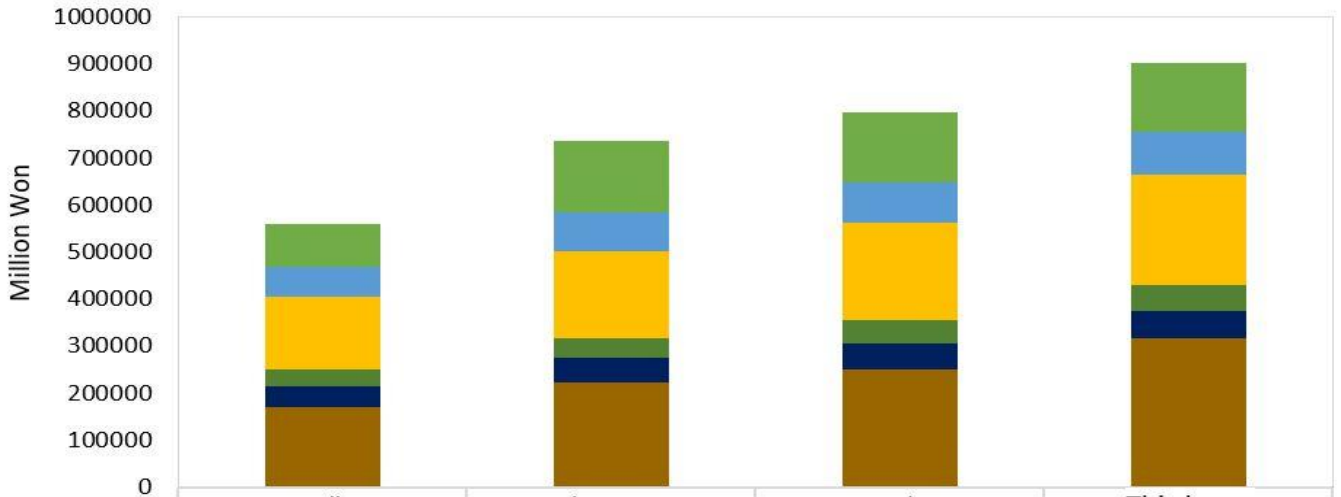
Republic of Korea

Ministry of Trade, Industry, and Energy (MOTIE)

Progress towards doubling public investment

Country-determined baseline year: FY 2016
Doubling target year: FY 2021

Baseline funding amount: USD $490 million
Doubling target amount: USD $980 million



	Baseline	First year	Second year	Third year
Energy efficiency	90097	150136	151289	146733
Carbon capture, use and storage	65966	83669	85122	90458
Renewables	152219	186025	207410	236484
Nuclear fission and fusion	37038	41733	48882	52935
Hydrogen and fuel cells	44333	51143	54319	58387
Other power and storage technologies	170882	223940	251944	317883
Other cross-cutting technologies/research	0	0	0	0
Unallocated	0	0	0	0
TOTAL	560535	736646	798966	902880

International Energy Joint R&D Projects under Mission Innovation in South Korea

- In September of 2018, South Korea launched a new international joint research competition, specifically dedicated to… boost collaboration between MI member countries and South Korea. Funding: up to $1 million/1 billion KRW per year (up to 3 years).
- Funding supports R&D cooperation among South Korean companies, universities and research institutes and their foreign partners.
- Projects promote international technology cooperation, stimulate national energy technology competitiveness and create new energy market by laying the foundation for overseas market entry.
- Funding amounts: up to $1 million per year (up to 3 years)

Hawaii - South Korea Alliance

- In August of 2015, State of Hawaii and the Korea Institute of Energy Technology Evaluation and Planning (KETEP) signed an MOU to cooperate in the development of green energy technology.
- In 2017, HNEI responded to a KETEP solicitation and received an award to conduct a feasibility study on Korean microgrid platforms in three potential Hawaii sites under KETEP's International Energy Collaborative Research and Development Program.
- On the most promising of the 3 sites, HNEI formed a six-party alliance in summer of 2018 to apply for KETEP Mission Innovation grant funding
- The international Alliance wins KETEP grant award in October for a 3-year project from November 2018 to June of 2021, work begins…

ENCORED LG Life's Good SEOUL NATIONAL UNIVERSITY GIST HNEI Hawai'i Natural Energy Institute University of Hawai'i at Mānoa NELHA

Potential NELHA Microgrid Use Cases

MG Domain	Business Key Features	UC nº	Name of the Use Case
Building / End Use Customers (in the Research Campus and Farm Compound)	• *Off-grid self-consumption capacity* • *Maximizing consumption of locally generated power* • *Reducing demand charges & costs via demand side management* • Maximizing low-cost self consumption distributed resources as a primary objective • *Long Term: Time of use and real-time pricing management*	1	Managing building energy flexibility
		2	Flexibility and DSM for efficiency and price control
		3	Increased percentage of self-consumption
		4	Optimized energy procurement
Microgrid (MG) and Grid Operation	• *Optimizing the NELHA MG network for greater coste-efficiency and resiliency.* • *Uninterruptable service with ESS + PV + backup generation + DSM for MG optimization and continuity of operation*	5	Microgrid PV Management
		6	Microgrid Emergency Response Mode

Hawaii-Korea Microgrid Project Overview

Deployment and Operation of "Smart" Microgrid Featuring Distributed Resources with Resilience in Off-grid Events

- Apply **big data / reinforcement learning** based prediction and optimization algorithms
- Development of **system scalability** through local EMS interworking
- Design & deploy **power trading model and service**

- **Coordinated control** for DG, diesel back-up generator, PV+ESS to maximize off-grid operation time
- Real-time **Simulator (RTDS)-based system** simulation and algorithm verification
- Includes microgrid optimal design methodology

AI-Based Cloud EMS

Off-Grid Operation

- **Microgrid system design** & on-site engineering for PV, ESS, Control system
- Install & operate **AI-based cloud/local EMS**
- Analysis of empirical results on economical value and system stability

Microgrid System Operation

Business Model

- **Integration of policies, statutes & regulations**
- Guidelines for microgrid business models
- Creation of a replicable, localized **new energy service model**

Supporting Hawaii's drive for 100% renewable energy through deployment of locally optimized microgrid operation technology

Featured Innovations

- Coordination control
- Frequency control
- Black start
- Automatic synchronizing

PMS

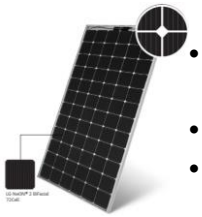
Microgrid EMS (local)

- Optimal Generation Planning (cost or CO_2 emissions)
- Monitoring distributed energy resources and analysis field data
- Peak monitoring and estimation
- Cost analysis

National Weather Service

- Big data collection/ preprocessing/ analysis
- Load and solar forecasting with reinforcement deep learning
- Optimal generation plan based on reinforcement deep learning

Cloud EMS



- 700~1,000kW
- N-Type
- Bifacial module (+ 5~30%)

Solar

- 500kW PCS
- 500kWh Battery
- 98.7% efficiency

ESS

Smart meter & Gateway

- Wireless connection
- Low power consumption
- Real-time data transmission

Thank you!

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