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# Battery-Integrated Hybrid Renewable Energy Optimization to Reduce Intermittency in Weak Grids by Supplying Baseload-Like Generation Profile

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**Abstract**

Being non-dispatchable and intermittent, wind and solar energy is least favorable in the eyes of grid operator. One of the solution to RE's intermittency is Battery Energy Storage System (BESS) which can store energy and dispatch them as necessary. Major drawback of BESS is high upfront cost; hence the utilization of BESS should be optimized to achieve competitive Cost of Energy (COE) while providing stable electricity. This paper presents a study on best combination of intermittent renewable sources coupled with BESS and diesel generator to provide stable and baseload-like constant power daily. Taking case from Sumba Island in East Nusa Tenggara which represent small-to-medium sized island with abundance renewable energy source but minimum grid support system, the hybrid renewable is configured using HOMER software to analyze net present cost, cost of energy, BESS operational pattern and allocation. The research found out that combining BESS+PV+wind yield the lowest cost of energy and net present cost. Most of the time BESS recover its state of charge at noon where PV panels yield is biggest. Inclusion of diesel in the system reduce the net present cost & cost of energy owing to the smaller capacity of BESS needed to provide base-load like. Full renewable energy system is able to provide baseload-like yield to reduce intermittency with some limitations taking into accounts.

*Keywords: Battery, Weak Grids, Hybrid, Non-dispatchable Renewable Energy Integration*

## 1. Introduction

Indonesia as one of the largest energy producer & consumer in Southeast Asia has a crucial part in reducing carbon emission in the region. Indonesia produce 240.3 Terra Watt Hour (TWh) energy in 2014 and only 29.9 TWh sourced from renewable energy (IRENA & ACE, 2016). Since 2011, Indonesian government has set a roadmap to increase renewable energy portion in the energy to 23% by 2025 (Presiden Republik Indonesia, 2011). Latest report from Indonesian Agency for The Assessment and Application of Technology (BPPT) states that in 2025, new & renewable energy portion sits at 12.5% which is far less than previously aimed by the government (Agency for The Assessment and Application of Technology (BPPT), 2016). Renewable energy generation in Indonesia dominated by hydropower and biofuels, meanwhile as of 2016 there is only 0.3 MW operating wind farm and 12.94 MW of solar farm (PT PLN (Persero), 2017).

Solar energy is considered as intermittent renewable energy as the output of the solar panel fluctuate depending on solar radiation, cloud cover and other relevant factors (Ela, Diakov, Ibanez, & Heaney, 2013). Meanwhile wind energy is considered as a variable renewable because as a collection of wind turbines in a wind farm, the output of wind turbines doesn't drop significantly over a short period of time owing to the distributed turbines among large areas and kinetic inertia stored in its blades (Muyeen, 2012; Palchak et al., 2017). Utilizing intermittent and variable electricity generation facility in the grid increase the risk of operational failure and/or plant-level economic issues (Deutch, 2011). Power instability might occur when there is a sudden loss of load or generation which caused frequency oscillation that might trigger system blackout in weak grids. Owing to this fact that there is a challenge in developing wind and solar power for electricity production. Other electricity generations that can produce a stable electricity are needed to act as a base load in the grid system for the integration of wind & solar PV plants in weak grids.

The implementation of wind and solar renewable energy is naturally challenging in Indonesia. Geographically Indonesia builds from various island size, from large islands of Java, Sumatra & Kalimantan to smaller island in Nusa Tenggara & Maluku. The larger island is the home of Indonesia's largest electricity grid which consist of large coal and gas powerplant, whereas the smaller island usually consists of small systems that rely on distributed diesel generator. According to Ministerial Decree number 12 year 2017 and Ministerial Decree number 50 year 2017, states that the sale & purchase of electricity from renewable energy is only allowed if the grid can accept the renewable energy. which means that most likely weak grids won't be able to accept a large amount of variable renewable energy electricity (Ministry of Energy and Mineral Resources Indonesia, 2017). But based on measurement conducted by National Institute of Aeronautics & Space (LAPAN) and various government agencies, the smaller islands in eastern Indonesia possess high potential of wind and solar radiation. For example, in Oelbubuk, East Nusa Tenggara Province the wind can reach up to 6.1 m/s (30m measurement height) and in Sumba Island Nusa Tenggara Timur the wind can reach up to 8.2 m/s at 30m above sea level (Martosaputro & Murti, 2014; Setiawan & Wu, 2016). The case to build more electricity infrastructure in the areas is strengthen by the low electrification ratio. Electrification ratio in East Nusa Tenggara Province as reported by PT. PLN (Persero) is at 52.47% (PT PLN (Persero), 2017).

Battery Energy Storage System (BESS) application is considered as an alternative to integrate intermittent & variable renewable energy to the grid. BESS can be implemented as a spinning reserve, voltage support and ramping support. Ramping rate support reduce the fluctuation of renewable energy output to prevent frequency fluctuation and compliance with existing grid code (Görtz, 2015). BESS can used to prevent excess power flow from solar farm that can cause voltage rise on distribution feeder (Khadkikar, Varma, & Seethapathy, 2009). Utilizing BESS as spinning reserve allows the plant to store energy and release it as scheduled. Spinning reserve in intermittent renewable will increase penetration of renewable energy sources by reducing the amount of fossil-fuel spinning reserve needed to maintain grid integrity which is threaten by fluctuation output of intermittent & variable renewable (Dolara, Grimaccia, Magistrati, & Marchegiani, 2017).

Battery remain one of the most component in hybrid renewable energy system. In a hybrid wind & solar desalination plant, battery contribute 35% of the total cost which followed by wind generators at 31% (Koutroulis & Kolokotsa, 2010). Nookuea et al. combine wind, solar PV and BESS to provide reliable power for shrimp cultivation which implies that percentage of reliability is increased with the increase of life cycle cost (Nookuea, Campana, & Yan, 2016). Techno-economic analysis has been done by Khan et al. to supply a stable electricity up for telecommunication Base Transceiver Station (BTS) using combination of Wind, Solar, Diesel & Battery. the research conclude that PV-wind-diesel-battery hybrid can provide stable power up to 50 kW with the least Cost of Energy (COE) (Khan, Yadav, & Mathew, 2017).

In this study, various scenario of hybrid renewable energy system will be simulated to provide constant power to the system of east Sumba island in Indonesia. due to lack of automation and control on the existing generator, The Hybrid Renewable Energy System (HRES) should be able to provide constant power throughout the day and night similar to a base load generator. HOMER Software is used for sizing the equipment of the HRES to satisfy the baseload operational constraint. The economics of the electricity generated is calculated in terms of Levelized cost of electricity as one HRES with various generation sources and sizing based on HOMER simulation. Software version used is HOMER Pro version 3.8.7. HOMER has been used extensively to model micro grid and renewable energy integration around the globe (Ajlan, Tan, & Abdilahi, 2016; Halabi, Mekhilef, Olatomiwa, & Hazelton, 2017; Hiendro, Kurnianto, Rajagukguk, Simanjuntak, & Junaidi, 2013; Kalinci, Hepbasli, & Dincer, 2015; Khan et al., 2017; Shaahid, Al-Hadhrami, & Rahman, 2013).

# 2 Methodology

## *2.1 Case Study*

Sumba Island in East Nusa Tenggara province is selected as the case study for the implementation of HRES with BESS due to their abundance of renewable energy and critical electricity infrastructure condition. Sumba Island has been chosen as the Iconic Island of 100% Renewable Energy based on a study conducted by Hivos in 2010 together with Winrock International, a non-profit organization based on the abundance of renewable energy resource and low electrification ratio across the island. As of 2016 the electrification ratio in Sumba is at 42.5 % where 10 % is generated by renewable energy (Hivos, 2016).

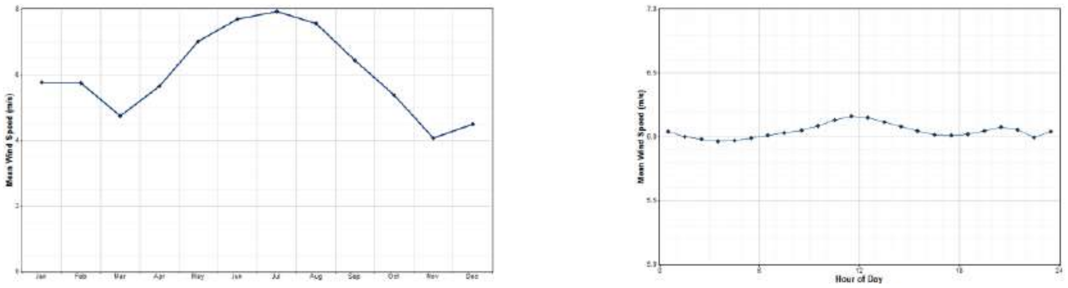
Sumba Island electrical grid consist of 2 small grids, East Sumba grid and West Sumba Grid. Both systems are not interconnected to one another. East Sumba grid consist of overall diesel power plant with installed capacity of 8.698 MW. Due to the age of these diesel generator generally the diesel generator can only work at 70 % of their nameplate capacity. In 2016 the average hourly peak load in East Sumba Grid is 5.67 MW and average hourly load is 4.19 MW. The amount of able generation capacity is matched with the load in a critical manner which means that if one of the power plant is under maintenance there will be rolling blackout across East Sumba grid as happened in September 2016 (Kompas, 2016). The control of the power plant is maintained using radio between 3 power plant centrals hence no grid automation is in place. The system is connected via a 20 kV medium voltage transmission line.

Based on studies conducted by Hivos and their partners, Sumba has 4 renewable energy resource that can be utilized. Hivos studied that Sumba has a good wind and solar resource which can be developed to a 10 MW Wind farm and 10 MW Solar Farm in Hambapraing, East Sumba. Micro-Hydro source is also being looked as one of the alternative with potency up to 10.2 MW in 300 Mini-grid locations. Sumba also claimed to have a potency for 8.5 MW hydro storage dams in Memboro river and Kadahang River (Sumba Iconic Island, 2016). For this simulation only wind & Solar PV renewable sources is used due to their location adjacent to existing grid.

## 2.2 Wind Speed

Wind speed data in East Sumba gathered from Modern Era Retrospective-Analysis for Research and Applications-2 (MERRA-2) released by National Aeronautic & Space Administration or NASA (Rienecker et al., 2011). MERRA-2 data has a resolution of a 0.5° in latitude (± 55 Km, close to equator) and 0.625° (± 69 Km, close to equator) in longitude. The hourly wind data is retrodicted since 1 January 1980 up to 1 July 2017. The closest data point located in -9.5° latitude and 120° Longitude which is 20 km from the site.

Based on MERRA, average wind speed in case area is 6.05 m/s at 100m height. The peak of the wind speed is in June, July & August with monthly mean up to 7.941 m/s as can be seen on **Error! Reference source not found.**a. There is no large diurnal pattern in East Sumba's Wind speed where in hourly average the wind speed is varies between 5.966 m/s between 03:00 to 04:00 and 6.164 m/s at 11:00 to 12:00 as can be seen on Fig. 1b.



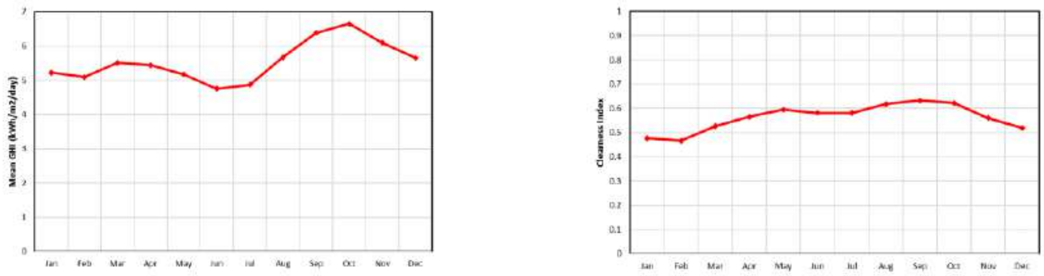

**(a)** **(b)**

**Fig. 1: Monthly average wind speed (a) and diurnal wind speed profile (b) in East Sumba based on MERRA-2 data**

## 2.3 Solar Irradiation

Solar global horizontal Irradiation (GHI) data in East Sumba gathered from NASA's Surface Meteorology and Solar Energy version 6 or SSE-6 (Stackhouse et al., 2016). SSE-6 data has a resolution of a 1° in latitude and longitude (± 111 Km, close to equator). The hourly wind data is modelled since July 1983 to June 2005. The closest data point located in -9.5° latitude and 120.5° Longitude which is 35 km from the site.

Based on SSE-6, annual average of daily radiation is 5.54 kWh/m$^2$/day with a average clearness index of 0.562. Based on data from local meteorological station, the sun is shining throughout the year 12-13 hour daily. The peak of the GHI is in September, October & November with monthly mean up to 6.65 kWh/m$^2$/day as can be seen on Fig. 2a. Clearness index in East Sumba ranging from 0.477 in February to 0.632 in September as can be seen on Fig. 2b. The higher index indicates there is large portion of the time the sky is cloudless.




**(a)** **(b)**

**Fig. 2: Monthly Average GHI (a) and clearness index (b) in East Sumba based on SSE-6 data**

## 2.4 Load Scenarios

Fig. 3 shows the hourly load average of East Sumba in 2016. Electricity peak load starts from 18:00 to midnight which peaked at 19:30 around 5000 kW. The non-peak load hover around 4000 kW for the rest of the day. The small load showed indicates that there is a blackout on some of the area and/or observational error of the grid operator due to manual data collection.

In this research, the author aware of the grid limitation on integrating HRES to East Sumba grid, hence the output of the HRES is limited to provide constant power for 24/7 utilizing BESS. With this operational pattern, the grid operator can always rely on HRES as a baseload for their system. Referring to load pattern of 2016 in East Sumba, the author creates 2 baseload scenarios and 1 load following scenario. Load scenario A represent a base load of 25% from non-peak load which is set around 1000 kW. Load scenario B further simulate a larger portion of renewable in the electricity mix with 50% of non-peak load supplied by baseload HRES. Load-following scenario C is the baseline where actual historic grid load is simulated assuming that the HRES maintain 25% portion in the electricity generation composition. Load scenario C is modelled as a comparison between baseload scenarios and the load following HRES integration. Scenario C is expected to have lower cost and spill compare to the base load scenarios.

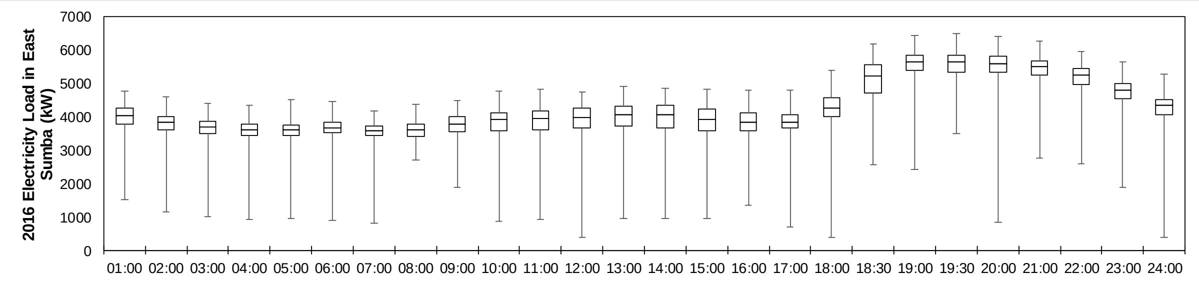



**Fig. 3: East Sumba Electricity Load in 2016**

## *2.5 Hybrid Renewable Energy System (HRES) Scenarios*

Hybrid Renewable Energy System with Battery Energy Storage System (HRES+BESS) scenario simulated is listed in Table 2a. Scenario 4 to 6 is simulated with a diesel to assess the impact of introducing diesel generator to HRES+BESS in terms of cost and excess. HRES specification data and assumption listed in Table 2b.

**Table 2: HRES combination scenarios (a) and HRES specification data & assumption (b)**

**(a)**

| Scenario | HRES Component | | | |
|---|---|---|---|---|
| | BESS | Solar PV | Wind | Diesel |
| 1 | • | • | | |
| 2 | • | | • | |
| 3 | • | • | • | |
| 4 | • | • | | • |
| 5 | • | | • | • |
| 6 | • | • | • | • |

**(b)**

| Description | Details |
|---|---|
| Type of Solar PV Module | Polycrystalline |
| PV System Lifetime | 25 years |
| Cost of PV Module | US$ 1.0/W |
| Module Efficiency | 0.1639 |
| Temperature Correction Factor | 0.41 %/°C |
| Inverter Efficiency | 0.95 |
| Cost of Inverter | US$ 0.04/W |
| Inverter Lifetime | 15 years |

| Description | Details |
|---|---|
| Type of Wind Turbine | 2500 kW - 121m rotor dia. |
| Cost of Wind Turbine | US$ 4.0/W |
| Life time of Wind Turbine | 25 years |
| Hub Height | 100 Meter |
| Type of Battery System | Lithium ion |
| Battery nominal capacity | 210 kWh/string |
| Cost of BESS | US$ 0.5/Wh |
| Type of Diesel Generator | 50 kW HSD |
| Cost of Diesel Generator | US$ 0.5/W |
| Diesel Generator Fuel Cost | US$ 0.74/Litre |

Boundary and limitations is applied to increase the accuracy of HRES optimizations. Configuration wise, The Wind turbine & Diesel generator are connected to the AC. PV panels and BESS are connected with DC bus. The installed diesel in scenario 4 to 6 is limited to 50 % of the aimed base load which is 500 kW (load scenario A) and 1000 kW (load scenario B). limitation of installed diesel is to prevent HOMER to rely mainly on diesel to generate electricity when the cost of energy (COE) is cheaper when running on diesel.

# 3 Results and Discussion

The scenarios in the result is shown as combination of both load scenario and HRES scenario. For example, simulation for load scenario A with HRES scenario 3 is displayed A3. The nomenclature goes thru load scenario A to C and HRES scenario 1 to 6. Designation HRES-1 to HRES-6 referring to scenarios involving all load simulation for each HRES component scenario 1 to 6.

## *3.1 HRES Component Optimization*

Optimizing all possible scenarios resulting to HRES components with the feasible solution with the lowest Net Present Cost (NPC) can be seen on Table 3. As seen on scenario 1,2 & 3, hybrid combination of both wind & solar PV reduces the amount of BESS needed to provide baseload. Having wind turbine in AC bus also reduce the capacity of inverter/rectifier needed to satisfy the required baseload. Massive amounts of battery & Wind turbines are allocated on HRES-2 & HRES-5 scenarios are caused by period when the wind is not blowing hence BESS is needed to store excess wind generated.

**Table 3: HOMER Optimized HRES Components**

| Load Scenario | A | | | | | | B | | | | | | C | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HRES Scenario** | **1** | **2** | **3** | **4** | **5** | **6** | **1** | **2** | **3** | **4** | **5** | **6** | **1** | **2** | **3** | **4** | **5** | **6** |
| BESS (kWh) | 23,100 | 38,850 | 14,910 | 11,130 | 18,270 | 13,230 | 48,510 | 204,750 | 31,290 | 20,790 | 34,650 | 27,720 | 26,880 | 34,230 | 16,800 | 12,810 | 32,550 | 30,450 |
| Solar PV (kW) | 10,592 | | 5,312 | 5,875 | | 4,601 | 20,509 | | 13,209 | 12,509 | | 10,993 | 10,469 | | 6,289 | 6,727 | | 12,702 |
| Wind (kW) | | 22,500 | 2,500 | | 17,500 | 2,500 | | 25,000 | 2,500 | | 20,000 | 2,500 | | 25,000 | 2,500 | | 25,000 | 2,500 |
| Inverter (kW) | 5,231 | 1,439 | 3,277 | 1,719 | 2,500 | 1,884 | 4,805 | 7,188 | 2,450 | 6,647 | 4,060 | 7,202 | 1,920 | 1,459 | 1,657 | 1,483 | 1,493 | 4,940 |
| Diesel (kW) | | | | 450 | 500 | 500 | | | | 900 | 1,000 | 950 | | | | 450 | 400 | 50 |

## 3.2 BESS Operational Pattern

Fig. 4 display the State of Charge (SOC) pattern of BESS for all non-diesel scenarios. For HRES scenario 1 & 3 where solar PV exist, the BESS is being used throughout the night extensively and charged during the day by the Solar PV. HRES-3 have a higher SOC level than HRES-1 owing to wind turbine that generate electricity but the pattern remains similar with HRES-1. HRES-2 shows a very different SOC profile with the rest of the scenarios. BESS's SOC in HRES-2 is constantly stays above 90%. This SOC pattern concludes that on average every hour of the day wind produces electricity and BESS provide smoothing facility to stabilize the total output of the system.

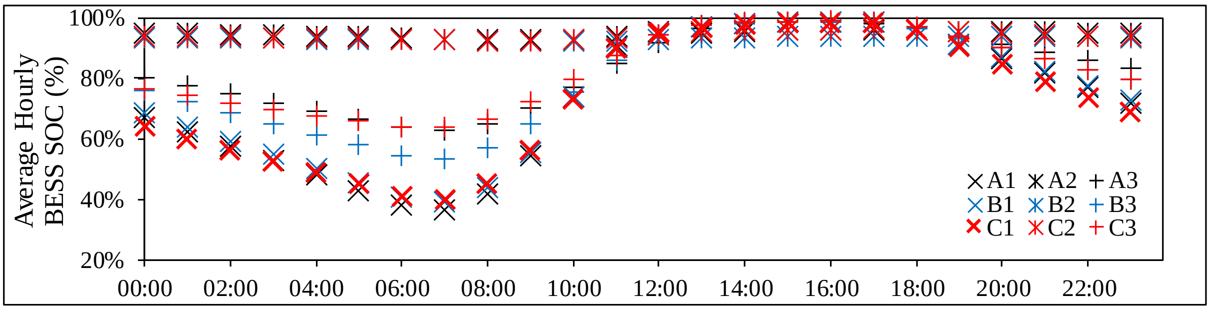
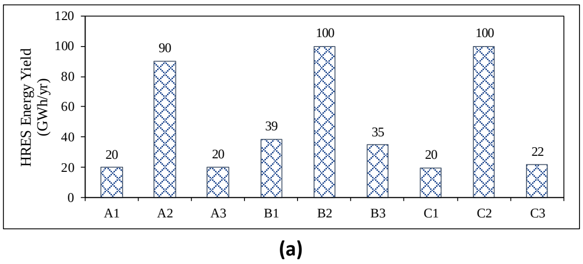



**Fig. 4: BESS's SOC diurnal profile**

## 3.3 HRES Yield & Spilled Energy

Key to optimizing HRES is harnessing BESS to store energy to service required load and minimize spill. Fig. 5a show the yield of HRES in non-diesel component. Other scenario's yield is dwarfed by the yield of the wind turbine in HRES-2 scenario. But as can be seen on Fig. 5b, more than 80% of the yield in HRES-2 is spilled. The spill is considerably less in load scenario B compare to load scenario A & C. the spill in the HRES is caused because after the BESS is fully charged, the total output of the wind and/or solar PV generation exceed the required load. HRES-1 has lower spill compared to HRES-3, but the size of the BESS installed in HRES-3 is far less compare to HRES-1 as can be seen on the bar charts in Fig. 5b.



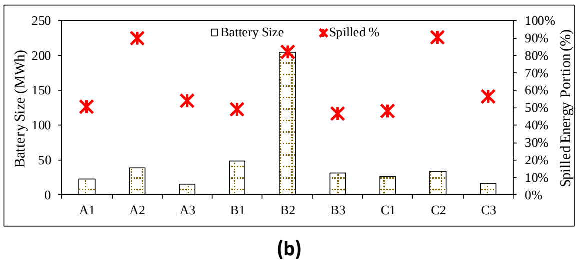




**Fig. 5: HRES energy yield (a) and HRES Spilled energy compared with its BESS capacity (b)**

## 3.4 Cost of Energy & Net Present Cost

Bar chart in Fig. 6 shows the Cost of Energy (COE) in US$/kWh of HRES for non-diesel scenarios. The crosses in Fig. 6 represent their respective Net Present Cost (NPC) to construct HRES. Highest COE & NPC is calculated for HRES-2 which render the scenarios to be infeasible economically to provide a relatively small baseload. COE-wise & NPC-wise, HRES-3 provide the most efficient costing compare with HRES-1 & HRES-2 on all load scenarios. COE to provide 1 MW baseload (Scenario A) and 2 MW baseload (Scenario B) is very similar and there is a linear up-trend on the NPC provide evidence that these baseload-like scenarios are scalable. As a comparison, the local Sumba average generation cost (grid's COE) as of 2016 is at US$ 0.142 hence none of the scenarios can compete with the existing average generation cost.

Comparing baseload operational pattern (A & B) and load following operational pattern (C), showed that it shows similar cost with load scenario A as the average 25 % of East Sumba load being followed is on average close to 1 MW. The notable shift of the load pattern is the capacity of inverter/rectifier installed on load scenario C is significantly less than scenario A & B, although lower inverter/rectifier is countered with higher PV/wind capacity in scenario C.

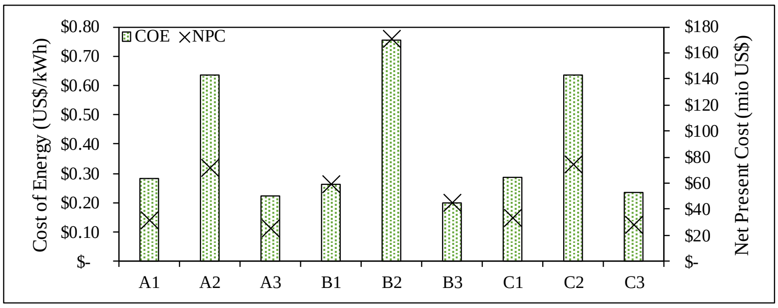
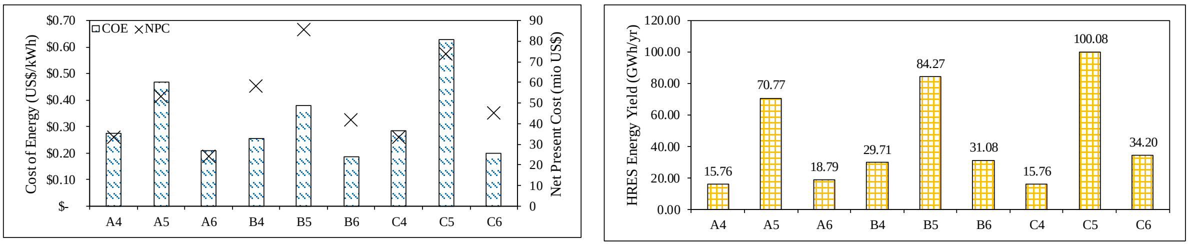



**Fig. 6 HRES COE & NPC for non-diesel scenarios**

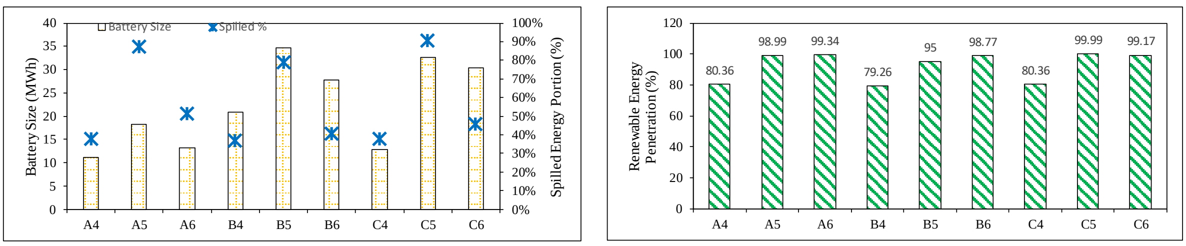
## 3.5 *Inclusion of Diesel in HRES*

On hypotheses, adding diesel to the HRE system could potentially reduce the amount of BESS needed and therefore reduce the COE of the system. In this study, simulation HRES-3 to HRES-6 on multiple load scenarios are conducted to prove the hypothesis. Fig. 7 shows the COE, NPC & yield for HRES+diesel scenarios which shows similar result with the non-diesel counterpart except for scenario C6 which require 12 MWp of Solar PV (compare to 6 MWp in C3) to service 25 % of actual load in East Sumba. Fig. 8b shows the renewable penetration of the HRES+diesel scenarios. HRES-4 constantly shows lowest renewable penetration indicating that the diesel will run when to support the battery when the SOC is low. Fig. 9 shows the SOC diurnal pattern of the HRES+diesel which is similar pattern to the non-diesel counterpart especially the part where PV+BESS scenario (HRES-4) is the one with the lowest SOC at the end of the night. The dependency of HRES-4 towards it's diesel generator is strengthen by the average diesel generator load diurnal pattern shown in Fig. 10. At night, there is almost certainty that diesel generator run at full power (450 kW) to support the discharge of BESS to the grid. HRES-5 & HRES-6 diesel generator load on average are working less than 30% most of the times especially during the day when Solar PV is producing electricity.




**(a)** **(b)**

**Fig. 7: HRES+Diesel scenarios COE & NPC (a) and Energy yield (b)**




**(a)** **(b)**

**Fig. 8: HRES+Diesel scenarios BESS size, spilled ratio (a) & renewable energy penetration (b)**

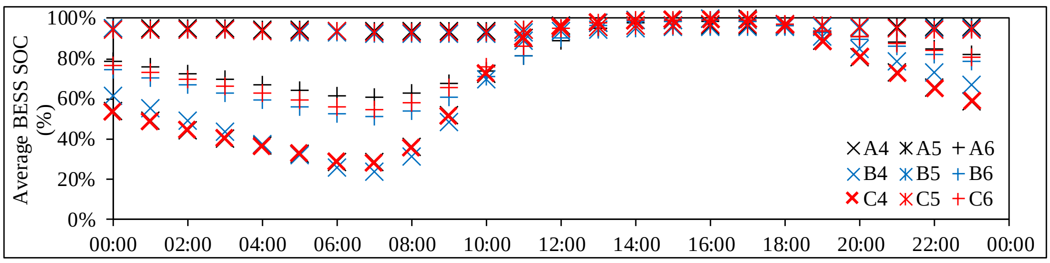



**Fig. 9: HRES+Diesel scenarios BESS SOC diurnal pattern**

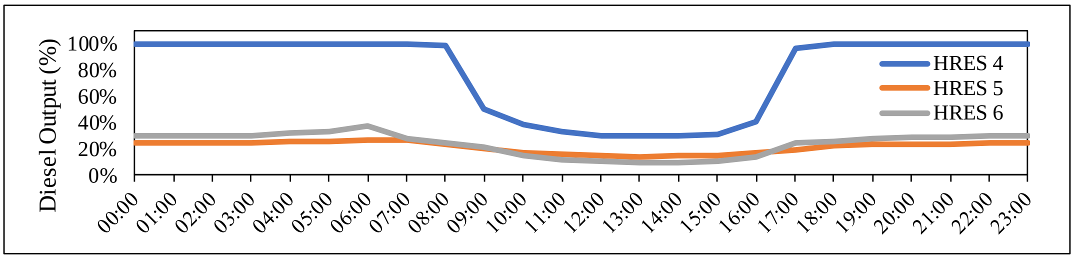



**Fig. 10: Diesel generator load percentage for HRES+Diesel scenarios**

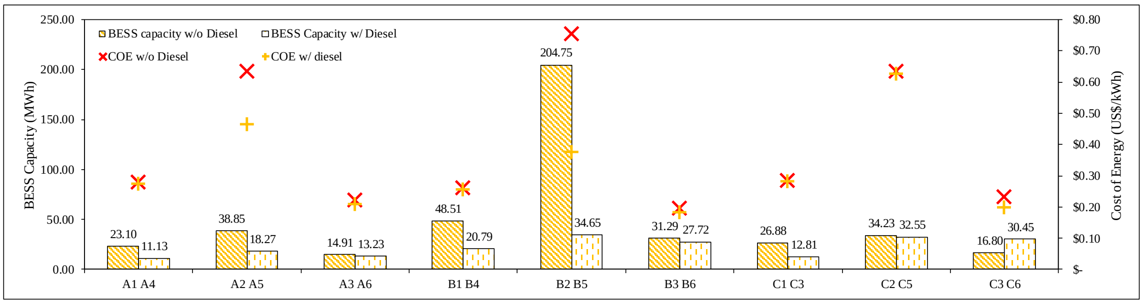



**Fig. 11: BESS capacity & COE Comparison between diesel and non-diesel HRES**

**Table 4: Annual pollutant emission from HRES+diesel scenarios**

| Pollutant | Scenarios | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A4 | A5 | A6 | B4 | B5 | B6 | C4 | C5 | C6 |
| Carbon Dioxide (Kg/yr) | 2,552,847.84 | 575,121.37 | 98,957.48 | 5,083,825.60 | 3,768,542.80 | 306,312.49 | 2,552,847.84 | 11,743.99 | 241,032.40 |
| Carbon Monoxide (Kg/yr) | 15,934.17 | 3,589.75 | 617.67 | 31,731.84 | 23,522.21 | 1,911.92 | 15,934.17 | 73.3 | 1,504.46 |
| Unburned Hydrocarbons (Kg/yr) | 702.12 | 158.18 | 27.22 | 1,398.22 | 1,036.47 | 84.25 | 702.12 | 3.23 | 66.29 |
| Particulate Matter (Kg/yr) | 95.57 | 21.53 | 3.7 | 190.31 | 141.08 | 11.47 | 95.57 | 0.44 | 9.02 |
| Sulfur Dioxide (Kg/yr) | 5,156.84 | 1,161.77 | 199.9 | 10,269.51 | 7,612.59 | 618.76 | 5,156.84 | 23.72 | 486.89 |
| Nitrogen Oxides (Kg/yr) | 14,977.54 | 3,374.23 | 580.58 | 29,826.76 | 22,110.01 | 1,797.13 | 14,977.54 | 68.9 | 1,414.14 |

Fig. 11 shows the comparison of BESS capacity & COE between HRES without diesel & HRES with diesel. In general, the capacity of BESS for each scenario is decreased with the introduction of diesel in the system except for scenario C6. However, throughout scenarios the COE is decreasing with the combination of diesel generator. The introduction of diesel generator resurfaces another problem needs to be considered which is emission. Table 4 list the emission per year of the HRES+diesel scenarios. Unfortunately, there is no standard economic valuation of emission in Indonesia which can affect the COE of HRES+diesel and shift the downward trend when comparing to non-diesel HRES.

## 4 Conclusions

This study is aimed to prove the capability of Hybrid Renewable Energy System (HRES) with Battery Energy Storage System (BESS) to provide a baseload-like output for weak grids with minimum system automation. The study concludes that having Solar PV, wind and BESS in one system can provide baseload-like power output with lowest Cost of Energy (COE) and Net Present Cost (NPC). Study also found that wind+BESS system is not practical and infeasible due to high percentage of spills and massive amount of battery to provide power when the wind is not blowing. PV+wind+BESS scenario reduces the amount of BESS needed to service the flat load when compared to PV+BESS only. Introducing diesel to HRES system does reduce the amount of BESS needed even further which in turn will reduce the NPC & COE. The drawbacks of this inclusion are the emission of pollutants from the system. Diesel used mostly during the night to support the dwindling State of Charge of the BESS.

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