Analysis of discharge energy on deep and non-deep cycle accumulator on solar cell-based power source

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Abstract. Standard battery usually used for solar cell storage is an industrial type of battery that has a deep cycle battery. However, the disadvantage is that the price is too expensive for the public compared to no-deep cycle batteries in the market. With 300-Watt peak solar panels the average charge energy of 1.2 kWh non deep cycle is equal to 405.19 Watt-h and deep cycle is equal to 457.28 Watt-h. For boiling 2.5 litters of water with an induction cooker in steam setting the average discharge energy of non-deep cycle is 514.8 Watt-h and deep cycle is 503 Watt-h. The percentage of SoC charge energy non-deep cycle from 49 to 98 percent and deep cycle from 71 to 98 percent, discharge energy non-deep cycle from 98 to 32 percent and deep cycle from 98 to 71 percent My paper observer comparative discharge energy on deep and non-deep cycle accumulator on solar cell-based power source. We found the gap decrease SoC in non-deep cycle is equal to 66 percent is bigger than the non-deep cycle and it is equal to 27 percent. The percentage of SoC charge and discharge deep cycle accumulator is more stable.

1. Introduction

Indonesia has an average daily solar radiation level of 4.8 kilo watt-h per square meter [1]. The potential reaches 500 Gigawatt (GW) of solar power. But the utilization of the installed solar power plant capacity has only reached 24 Megawatts (MW). The utilization is very small compared to Thailand at 2.6 GW and the Philippines 868 MW.

The standard battery usually used for solar energy storage is the type of industrial battery that has a deep cycle. It is a type of battery designed to produce stable and long-term electrical energy or often called cycle and discharge. Ideally, this type of battery can be used up to 80% Depth of Discharge (DOD) of its nominal capacity. So that the energy capacity that can be used is greater, without having to damage and reduce the working life of the battery. But the drawback is the price. It is two times more expensive than ordinary batteries [2]. Automotive batteries and batteries in the market use space capacity of only 10-20% (DOD 10-50%) nominal battery capacity, but their prices are much cheaper and affordable by the general public when compared to standard solar cell batteries.

To support of the government program of "green energy", the authors investigate the comparison of energy accumulator discharge analysis on solar panel based on induction cookers. Research shows that the energy efficiency of induction cookers has the highest efficiency compared with other stoves that use gas fuel, kerosene or electric heaters, because the heat produced is almost entirely absorbed by pan. The use of gas in the community still causes many problems. In addition, the availability of natural gas is also decreasing. The use of LPG gas in the future will be more expensive along with the government's

policy to reduce subsidies in the natural gas sector. So, efforts are needed to utilize other energy and not depend on fossil energy [3]. In a national seminar on informatics UPN "Veteran" Yogyakarta on June 30, 2012, it was stated that   induction cooker is far more profitable when compared to electric stoves (hot plates) or gas stoves. For this reason, the author wants to examine the comparison of the ability of non-deep cycle battery discharge in the market and deep cycle battery to supply the energy of 300 – 1000 Watt induction cookers.

2. Methodology

In this research, we use data of monthly averaged insolation incident on a horizontal surface at indicated GMT times (kW/m2/day) data for Denpasar, Bali [4] as shown in Table 1.

Table 1. Monthly averaged insolation incident on a horizontal surface at indicated GMT times (kW/m2/day).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year average	4.93	5.04	5.43	5.39	5.19	4.84	4.79	5.33	5.95	6.19	5.67	5.28

Based on the table data above, the research is conducted as stated in Figure 1.
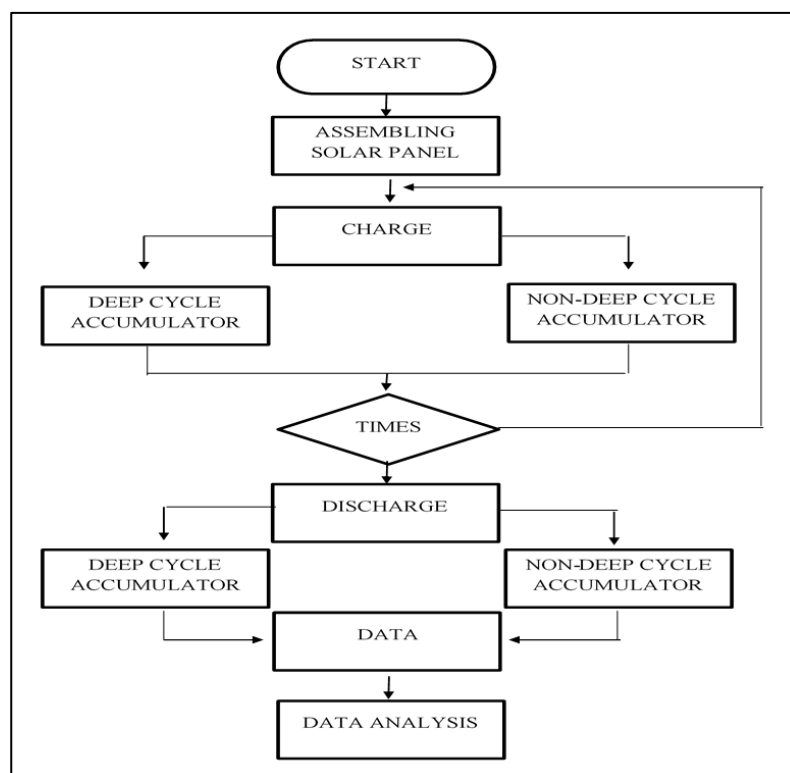
**Figure 1.** The research flow diagrams.

   Tools and Materials used in this research are as follows: solar panel mono crystalline 100 W, MPPT solar charge controller 20 A, digital clamp meter 20-200 A DC/AC, remote meter mt50, AC wattmeter digital 0-3680 W, digital battery tester Lancol micro-200 30-200 Ah, inverter DC pure sines 4000 W, non deep cycle accumulator Yuasa 100 Ah 12 V, deep cycle accumulator Luminous (12 V 100 Ah @ 10 hr), Cosmos CIC 996 induction cooker 300-1000 W, 20 m solar cell green power cable, water heater stainless pot 2 liter.

3. Results and discussion

3.1. Research location and focus

The study is conducted in Denpasar City, Bali on 300 Watt-peak solar panel and induction cooker 300 -1000 Watt to charge and discharge 12 V 100 Ah accumulator. The city of Denpasar is located at 8.67 south latitude and 115.21 eastern longitude. The research is focused on charge – discharge energy of non deep cycle and deep cycle accumulator with energy source from three units of 100-Watt peak solar panel with specification as shown in Table 2 and induction cooker 300-1000-watt consumption for boiling water 2.5 liter.

The solar cell system under study consists of three units of 100-Watt peak solar panels, one unit of 1.2 kWh non deep cycle accumulator, one unit of 1.2 kWh sealed lead-acid deep cycle accumulator, one unit of pure sines inverter 4000 watt, and one unit of induction cooker 300-1000 Watt. The scheme of these charge-discharge energy systems is shown in Figure 2. Both systems are charge and discharge energy accumulators.
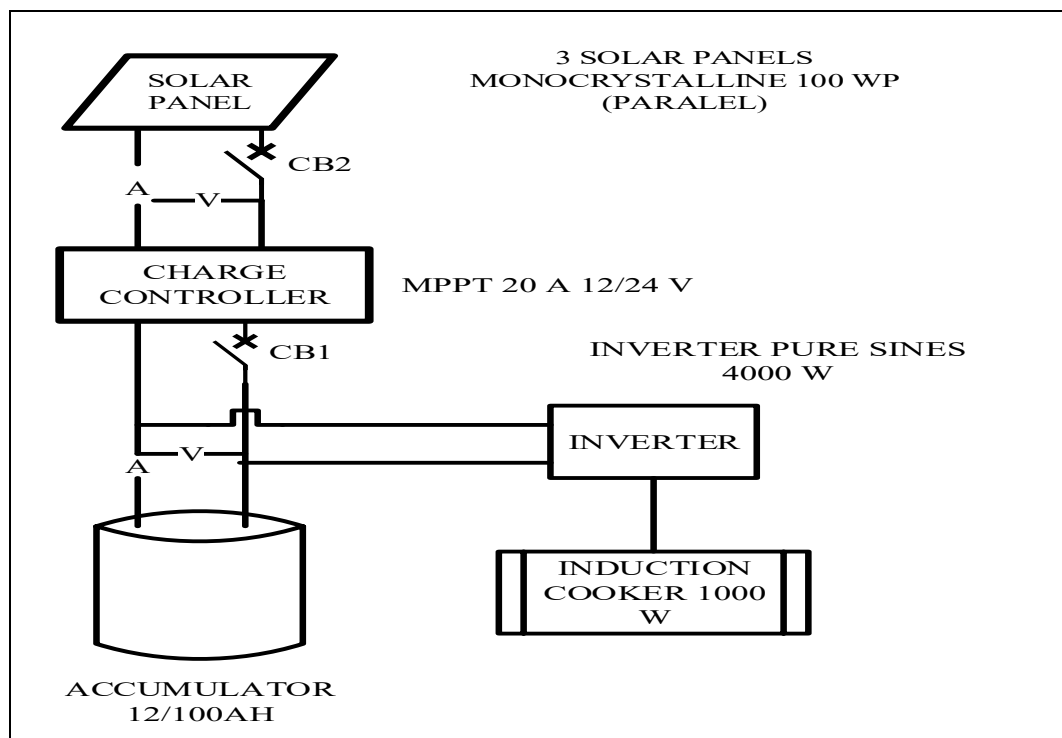

Figure 2. Charge and discharge energy accumulators by induction cooker base on solar panel.

Table 2. Specification of 100-Watt peak solar panel.

| Item	Value
Rated Maximum Power	100 W
Open Circuit Voltage (Voc)	21.6 V
Short Circuit Current (Isc)	6.11 A
Voltage at Maximum Power (Vmp)	18 V
Current at Maximum Power (Imp)	5.56 A
Size	1196 mm ×541 mm × 30 mm
Cell	36 pcs 125 × 125 monocrystalline silicon
Item	Value
Rated Maximum Power	100 W
Open Circuit Voltage (Voc)	21.6 V
Short Circuit Current (Isc)	6.11 A

3.2. Data analysis

3.2.1. Energy charge Data retrieval was carried out from May 29 - June 2, 2019 with solar cell resources to charge non deep cycle accumulator and discharges with the load of an induction cooker to boil 2.5 liters of water. The result is shown in Figures 3 below.
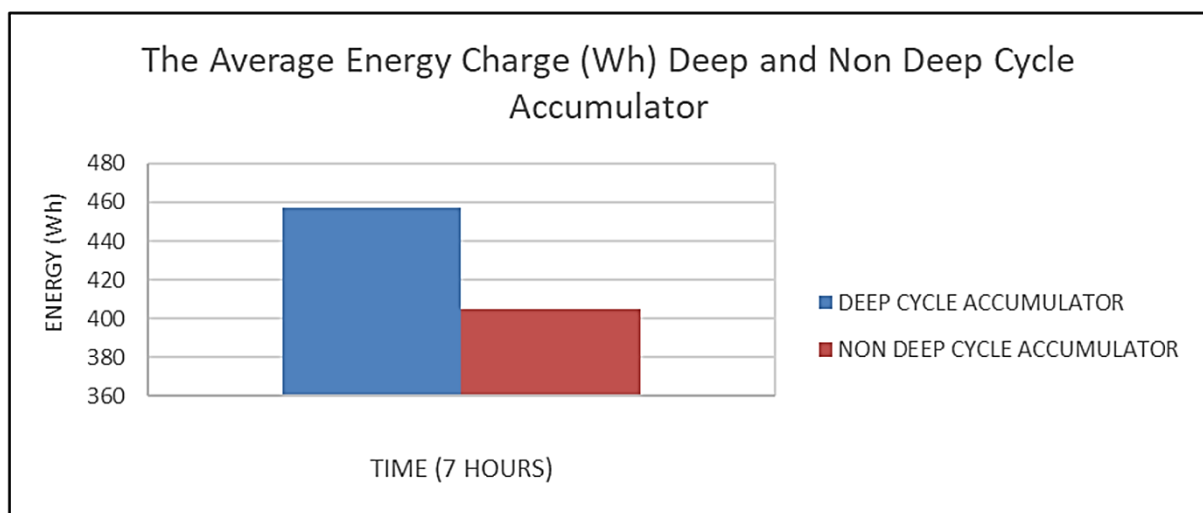
Figure 3. Graph of deep cycle and non-deep cycle charge accumulator energy.

The average deep cycle charge accumulator in 5 days is equal to 457.28 Wh from range 369.94 to 557.86 Wh, meanwhile the average non deep cycle charge accumulator in 5 days is equal to 405.19 Wh from range 348.23 to 451.24 Wh.

3.2.2. Energy discharge. Data retrieval was carried out from June 2 to June 7, 2019 with solar cell resources and discharges with the load of the induction cooker to boil 2.5 liters of water the results are shown in Figures 4 below:
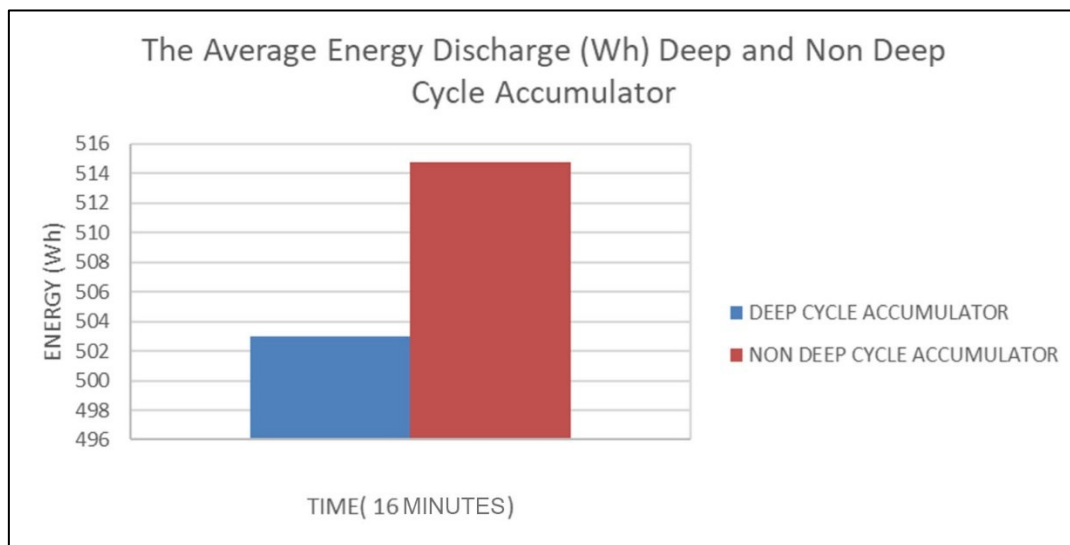
Figure 4. Graph of comparison deep cycle and non deep cycle discharge accumulator energy.

The average energy needed to boil 2.5 litters of water in a deep cycle accumulator is equal to 607.2 Wh from range 603 to 613 Wh. The average energy needed to boil 2.5 litters of water in a non-deep cycle accumulator is equal to 580.4 Wh from range from 524 to 634 Wh.

3.2.3. SoC charge by solar panel. Comparison of charge SoC (State of Charge) Accumulator non deep cycle and deep cycle by solar panels using battery measurement of 30AH-200AH Lancol Micro-200 tester as shown in Figure 5.
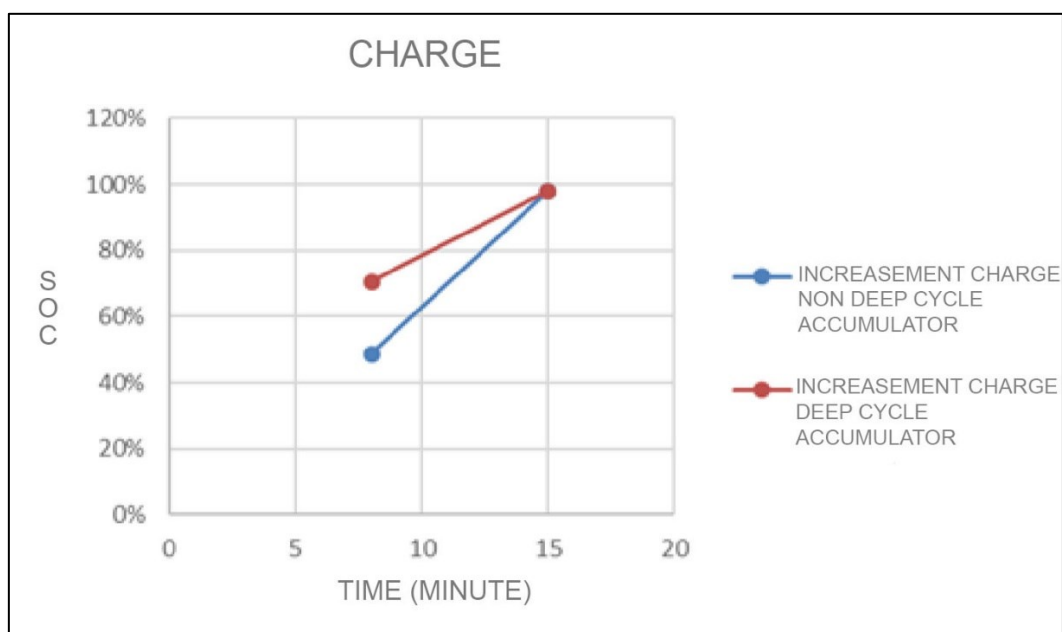
Figure 5. Graph of comparison deep cycle and non-deep cycle SoC charge accumulator.

The average increase SoC non deep cycle accumulator is equal to 49 percent, from range 49 to 98 percent, meanwhile the average increase SoC deep cycle accumulator is equal to 27 percent from range 71 to 98 percent.

3.2.4. SOC discharge by induction cooker Comparison of discharge SoC (State of Charge) Accumulator non deep cycle and deep cycle to boil water 2.5 Liter by induction cooker using battery measurement by tester 30 -200 Ah Lancol Micro-200 as shown in Figure 6.
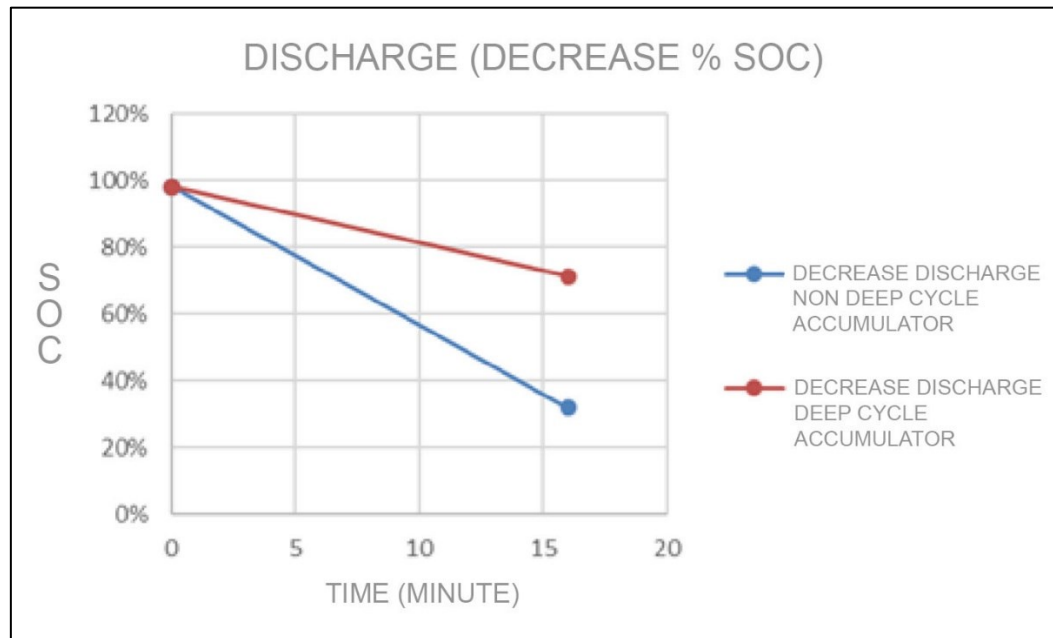
Figure 6. Graph of comparison deep cycle SoC discharge accumulator with non-deep cycle accumulator.

The average SoC decreases non deep cycle accumulator is equal to 66 percent from range 98 to 32 percent, meanwhile the average SoC decrease deep cycle accumulator is equal to 27 percent from range 98 to 71 percent.

4. Conclusions

The average energy generated by deep cycle accumulator charge in Denpasar, the capital province of Bali, the capital of Bali is equal to 457.28 Wh (range from 369.94 to 557.86 Wh) is higher than with an average non deep cycle accumulator is equal to 405.19 Wh (from range 348.23 to 451.24 Wh). The average charge SoC deep cycle accumulator is equal to 27 percent (range from 71 to 98 percent) is smaller than the non-deep cycle accumulator is equal to 49 percent (range from 49 to 98 percent).

The average discharge energy to boil 2.5 litters of water in the deep cycle accumulator is equal to 607.2 Wh (range from 603 to 613 Wh) within 16 minutes is greater than the average energy required by a non deep cycle accumulator which is 580.4 Wh (range from 524 to 634 Wh) within 16 minutes. The average of decrease SoC deep cycle accumulator is equal to 27 percent (range from 98 to 71 percent) is smaller than the non-deep cycle accumulator is equal to 66 percent from range 98 to 32 percent. So, the charge and discharge SoC deep cycle accumulator is more stable (smaller range) than the non-deep cycle accumulator. While the difference charge and discharge energy (Watt-h) between deep cycle and non-deep cycle accumulator is not too large.

5. References

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