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PV supply chain readiness to support the 2060 Net Zero Emission Goal in Indonesia

Bertha M. Sopha[1], Wangi P. Sari[2]*, Dwi Novitasari[3], Rachmawan Budiarto [4], and Sarjiya[5]

Summary

The Government of Indonesia (GoI) is committed to achieving Net Zero Emissions (NZE) by 2060 as part of its commitment in tackling climate change. In its NZE roadmap, solar photovoltaics (PV) will be dominating Indonesia electricity supply plan with a projected capacity of 361 GW out of 587 GW. Indonesia has high potential for solar energy, but currently its utilization is under 1%. The PV supply chain is investigated to provide insights into accelerating solar power generation as outlined in the NZE roadmap. The results show that domestic industries can produce PV systems through assemblies of its main components. However, manufacturers of the parts and subcomponents required for the main components of the PV system, especially PV modules and inverters, are still non-existent in Indonesia.

Key Policy Recommendations

- Strategies need to be devised (short, medium, and long term) if Indonesia is to increase solar PV power plants to meet the NZE 2060 target (361 GW). These should be constantly evaluated and updated.
- The GoI should evaluate the supply chain readiness of PV and formulate strategies to support local manufacturing industries to accelerate PV domestic production and utilization.
- To produce competitive domestic solar production, the GoI should prepare and improve the three factors: investment, technology, and a skilled workforce.

ANDRES SIIMON / UNSPLASH

Introduction

The government of Indonesia (GoI) has set goals to increase its renewable energy in the national energy mix, as stated in the National Energy Policy 2017, to 23% and 31% by 2025 and 2050 respectively [1]. In 2021, at COP26, GoI further declared its target to reach Net Zero Emissions (NZE) by 2060. It is a huge leap and commitment by the country to support the reduction of greenhouse gas emissions globally.

In the NZE 2060 roadmap, solar photovoltaics (PV) become the cornerstone of the Indonesian electricity system [2–3]. Out of the 587 GW of the projected total capacity of New and Renewable Energy (NRE) capacity, 361 GW (> 60%) will be sourced from solar energy. In 2020, the solar PV utilization in Indonesia was 158.39 MW in both on-grid and off-grid systems [4]. Comparing to the PV utilization at 0.19 MW in 2010, the improvement was significant. PV power plant capacity has increased to 158.2 MW in 10 years. However, if the increase of PV utilization is kept at the same rate, the target of 361 GW will not be achieved by 2060.

PV technology is a promising alternative to be implemented in Indonesia for two reasons. First, the associated cost of PV investment has decreased significantly. The total installed cost of new utility-scale PV systems (global average) was estimated to be USD 1.8/watt (W) in 2015 and this could reduce by more than half to USD 0.8/W in 2025 [5]. Second, Indonesia has high potential for solar energy due to its stable irradiation level – at between, approximately, 3.6 and 6 KWh/m2 [6] throughout the year – and large land areas to install the PVs. However, despite its potential, solar power generation in the country is still less than 1% [7].

Furthermore, current domestic solar panel production capacity is only around 500 MW per year [8]. The utilization rate is also still very low, at around 150 MW out of the 200 GW potential [9]. Additionally, domestically made solar panel modules are 40% more expensive than imported ones [8]. The high price of solar panel modules is one of the problems that causes the low utilization of PV in Indonesia. The electricity generation costs from solar power plants (around USD 0.10 per kWh) is more expensive than that from coal-based power plants (around USD 0.045 per kWh) [10]. On the other hand, GoI has set the Domestic Component Level (TKDN[1]) at a minimum of 40% for the solar panel industry, which includes the manufacture of wafers, solar cells, and solar modules.

To achieve the NZE target, there is an urgency for an accelerated solar deployment in Indonesia. PV utilization in the country must be expanded rapidly by supporting PV production domestically. The increase in production entails improvements to the entire system and at each stage of the supply chain. **Therefore, this research discusses Indonesia's PV supply chain in which the outputs will include a set course of actions recommended for the GoI to support the realization and expansion of PV power plants.**

Methodology

We used a desk-based method to conduct this study. We focused on monocrystalline PV, as it is the most widely used and a mature technology and high efficiency. In this study, we first defined the PV supply chain from raw materials up to installation. After identification, each distribution level in the supply chain is grouped into a tier

[1] Tingkat Komponen Dalam Negeri (TKDN) in Indonesian: the percentage of domestic components in goods and/or services; the policy aims to encourage the use of all products produced by domestic industries.

based on a PV's Bill of Material (BOM, i.e., a list of raw materials, sub-assemblies, sub-components, parts and components require to manufacture the PV). Following this step, a supplier for each tier is identified and mapped. The availability of local suppliers was computed by calculating the percentage of components that can be sourced locally (at least one company in the country can supply the said components). Based on the supplier mapping for the PV, we discuss and evaluate supply chain readiness (at each level of production) for PV production in Indonesia.

Results and Discussion

PV SUPPLY CHAIN

The supply chain for PV consists of provision of raw materials and production at each tier that make up components for the PV system until the PV is installed on site and ready for use to generate electricity for the end customers. We have identified seven tiers of suppliers for the PV system, the role of each is illustrated in (**Figure 1**). There are six components (**Figure 2**) in tier 1 that together make up for PV system: the PV module and components for the balance of system (all components other than the PV module). The supply chain of the PV module involves 7 tiers, whilst inverters, charger controllers, and battery modules involve more tier suppliers than cables and mounting.

Each of the components in tier 1 are broken down further into the components required to make the PV system. For example, a subcomponent to produce the PV module (tier 1) includes a PV cell (tier 2) made of wafer and adhesive (tier 3). At the bottom of the tier (tier 7), quart sand is needed as the raw material. The complete list of components and Bill of Materials (BOM) for the PV system is available in our previous study [11].

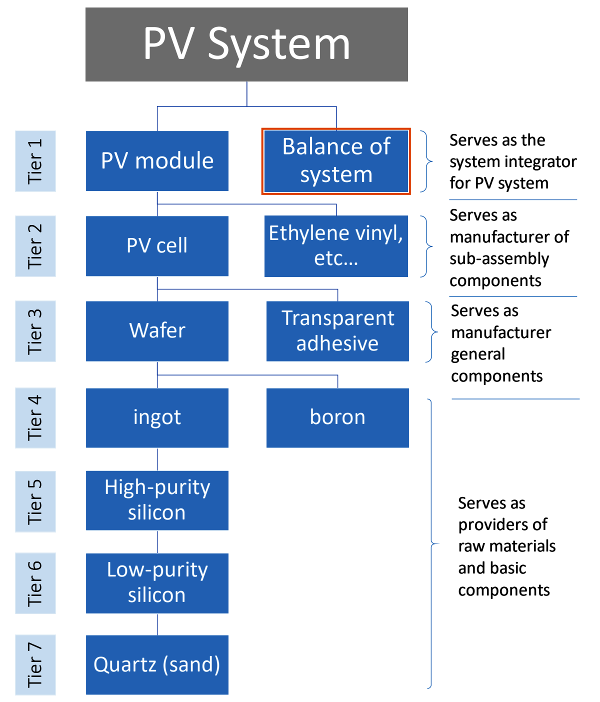

Figure 1: Illustration of components that make up PV system, grouped by tier.

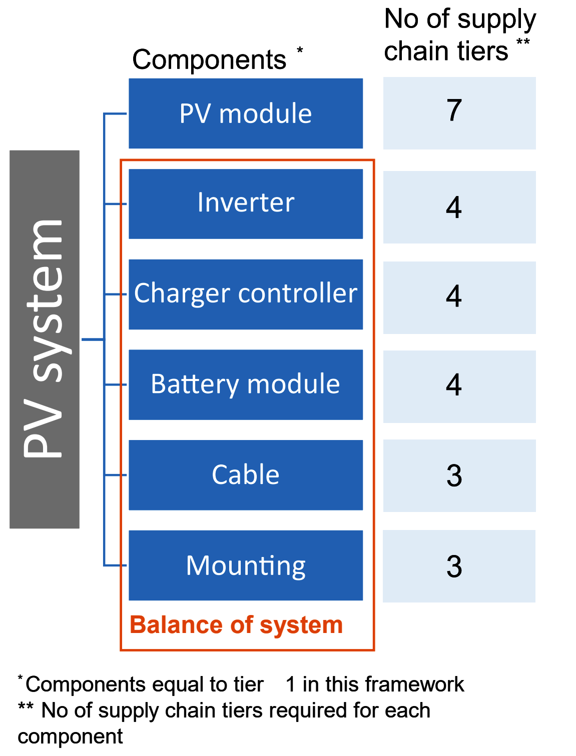

Figure 2: Tier 1 components that make up PV system

PV SUPPLIERS AT EACH TIER

The evaluation of suppliers for each tier is undertaken based on the list of components previously identified. We have identified 109 suppliers from local industries that can supply the components to make up the PV system. **Figure 3** illustrates the domestic capability to supply main PV components at each tier. Out of the main 6 components, cables and mounting can be produced locally and the basic components and raw materials for those are also available domestically. Raw material for the PV module, such as quartz sand, is also available (tiers 5–7); however, at tier 4 and higher, the supplier capability reduces significantly. At tier 2 of PV module (PV cell, ethylene vinyl, covers, frame, junction box, etc), local industry can only fulfil 22%, or 2 out of 9 components identified. Beside the PV module, parts to make inverters also have relatively low domestic availability. The PV module is the key component for PV system and an inverter is another major component which requires the most parts in the PV system.

The low capability of domestic industries to supply parts and components at middle tiers (tier 2–4) indicates that manufacturing technology for PV systems in Indonesia still lags behind and needs significant improvement, especially to produce the most important parts of PV systems.

The capability of suppliers at tier 1 is at 100%, meaning local industry can produce PV systems through assemblies of the main components. Since the local industries have low provision at middle tiers, the provision of the major components (tier 1) for PV systems must be made through imports. This will result in dependency on other countries to supply of those components. On the other hand, the Indonesian Ministry of Industry has measured the Domestic Component Level (TKDN) for solar panel industry at 40–47%, which has met the target of 40% by 2018 [12]. This target has been increased to reach 90% by 2025, so immediate efforts should be taken to increase the local provision of PV components.

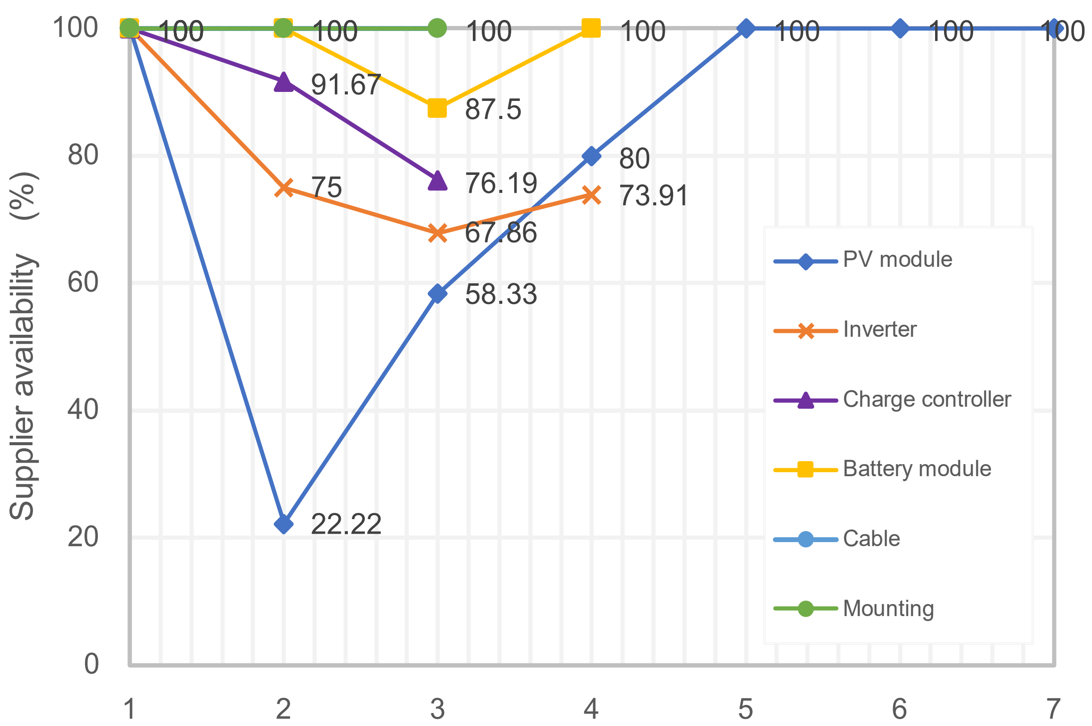

Figure 3: Domestic supplier capability to provide main PV components at each tier [7]

Conclusion and recommendation

This policy brief has analysed Indonesia's solar photovoltaic (PV) supply chain and identified the country's production capabilities and gaps.

1. Accelerating PV utilization for electricity generation in the country would help the government of Indonesia (GoI) to achieve its Net Zero Emissions (NZE) and Domestic Component Level (TKDN) targets. **A short, medium, and long term plan to increase the capacity of solar power plants is needed to achieve the GoI's 361 GW solar PV target by 2060** under the Directorate General of New, Renewable Energy and Energy Conservation (DGNREEC) under Ministry of Energy and Mineral Resources (MEMR).

2. Beside formulating strategies to increase PV power plants in the country, **the GoI should evaluate the supply chain readiness for PV implementation**. This includes mapping the local manufacturing capability of each tier in the PV supply chain and devising strategies to accelerate domestic production of PV system along its supply chain (not just at tier 1) – especially sub-components for PV modules, including PV cells, ethylene vinyl, covers, and junction boxes. With planning, Indonesia's domestic manufacturing ability and availability could be improved comprehensively.

3. **Three key factors are needed to domestically produce PV systems: investment, skilled workforce, and technology** (especially for the manufacturing of subcomponents of PV module), and a skilled workforce. These also need to be prepared for by the GoI if it is to seize the opportunity of PV power plants in the electricity system. For example, technology transfers could fill the gap in middle tier of the supply chain and distributed manufacturing sites could supply demand throughout the country.

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AUTHOR INFORMATION:

[1] **Bertha M. Sopha** (Department of Mechanical and Industrial Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia; Center for Energy Studies, Center for Development of Sustainable Region, Indonesia): Conception and design, acquisition of data and analysis

[2] **Wangi P. Sari** (Department of Mechanical and Industrial Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia; Center for Energy Studies, Center for Development of Sustainable Region, Indonesia): Writing – review & editing

[3] **Dwi Novitasari** (Department of Electrical and Information Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia; Center for Energy Studies, Center for Development of Sustainable Region, Indonesia): Writing & editing

[4] **Rachmawan Budiarto** (Department of Nuclear Engineering and Engineering Physics, Universitas Gadjah Mada, Yogyakarta, Indonesia; Center for Energy Studies, Center for Development of Sustainable Region, Indonesia): Review & editing]

[5] **Sarjiya** (Department of Electrical and Information Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia; Center for Energy Studies, Center for Development of Sustainable Region, Indonesia): Review & editing

*Corresponding Author: ***wangipandansari@ugm.ac.id***

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