

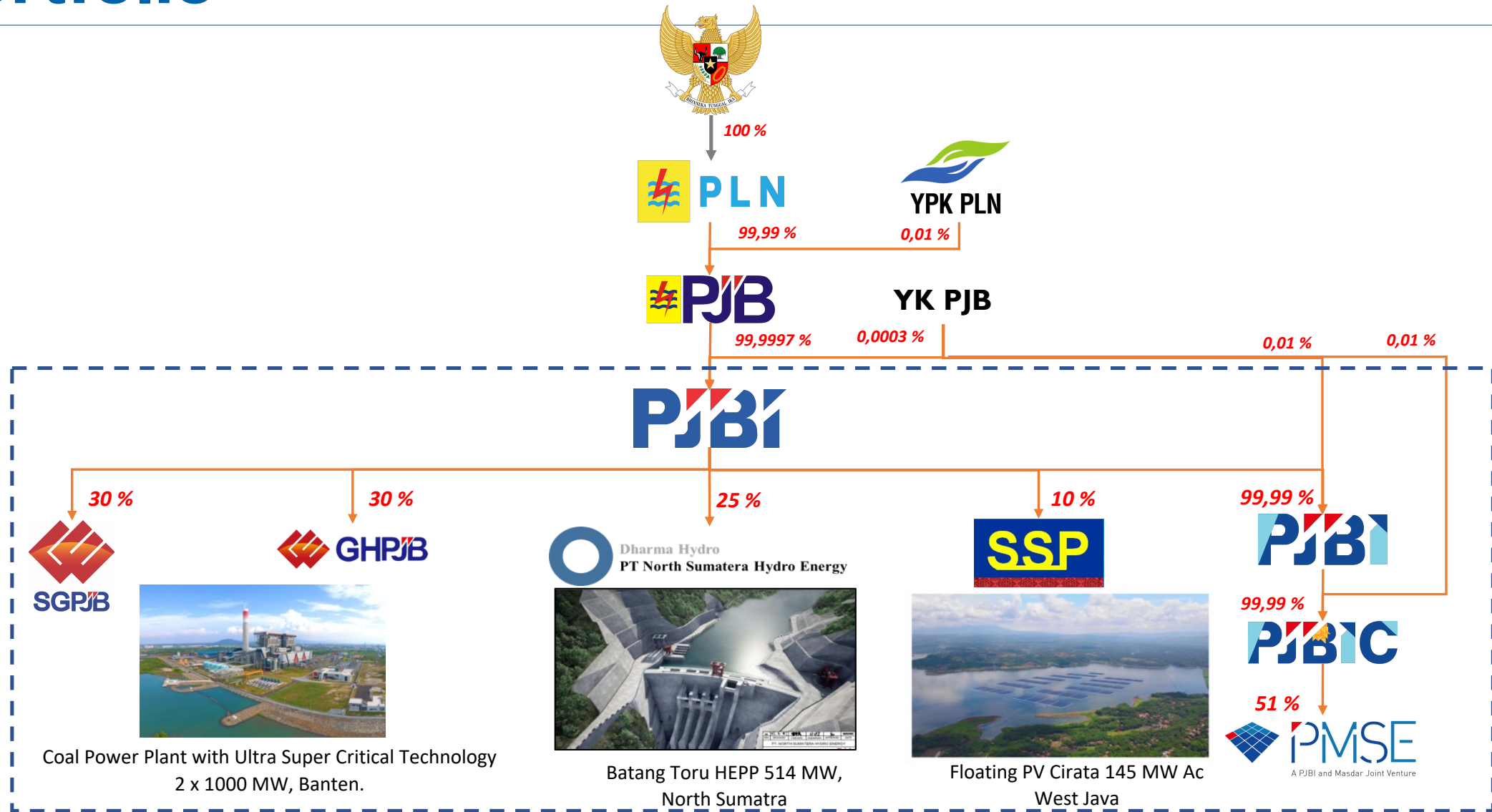


Opportunity and Challenge of Development of Floating Solar PV in Indonesia

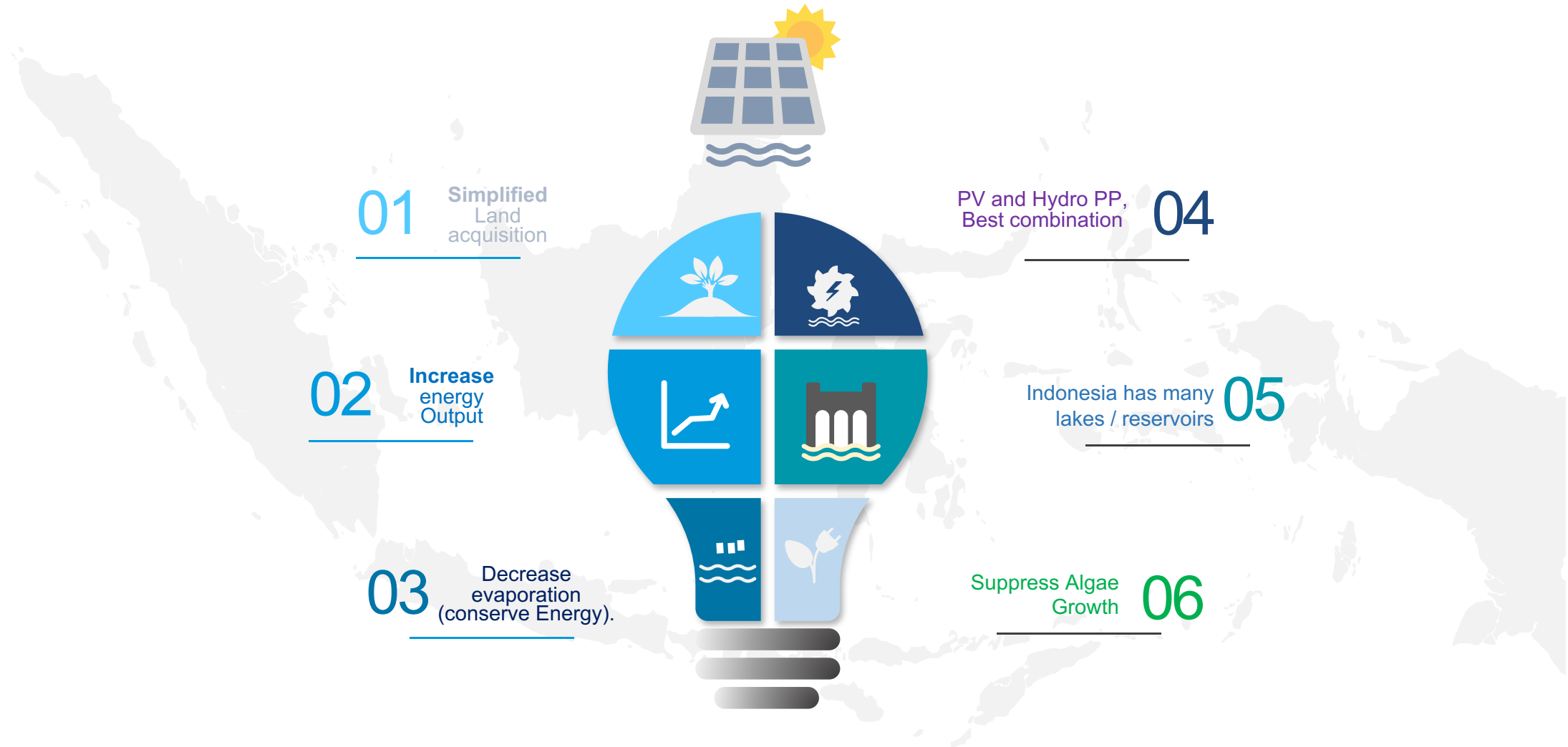
Jakarta, 16 April 2021



Portfolio



Why Floating PV



Source: @2019, When Sun Meets Water, World Bank Group, ESMAP, SERIES

Opportunity- Potential Reservoir for Floating PV in the World

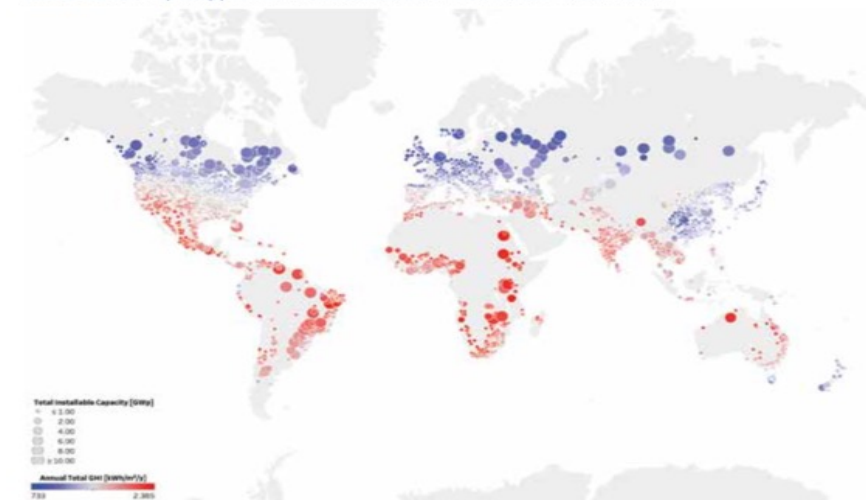
TABLE 3.1. Floating photovoltaic potential, capacity and energy generation by continent
(man-made reservoirs and dams only)

Continent	Total surface area available [km ²]	No. of water bodies assessed	Total FPV capacity potential [GWp] (% of water surface used for PV installation)			Total annual FPV energy output potential [GWh/y] (% of water surface used for PV installation)		
			1%	5%	10%	1%	5%	10%
Africa	101,130	724	101	506	1,011	167,165	835,824	1,671,648
Asia*	115,621	2,041	116	578	1,156	128,691	643,456	1,286,911
Europe	20,424	1,082	20	102	204	19,574	97,868	195,736
N. America	126,017	2,248	126	630	1,260	140,815	704,076	1,408,153
Oceania	4,991	254	5	25	50	6,713	33,565	67,131
S. America	36,271	299	36	181	363	58,151	290,753	581,507
Total	404,454	6,648	404	2,022	4,044	521,109	2,605,542	5,211,086

Source: SERIS calculations based on the Global Solar Atlas, © World Bank Group (2019) and the GRanD database, © Global Water System Project (2011).

Notes: *Middle East is included in Asia. FPV = floating photovoltaic; GWh/y = gigawatt-hour per year; GWp = gigawatt-peak; km² = square kilometer; PV = photovoltaic.

FIGURE 3.2. FPV capacity potential worldwide based on total surface area available



Source: SERIS based on the Global Solar Atlas, © World Bank Group (2019) and the GRanD database, © Global Water System Project (2011). Note: GWp = gigawatt-peak; kWh/m²/y = kilowatt-hour per square meter per year; kWp/m² = kilowatt-peak per square meter; PV = photovoltaic.

1

- There are more than 400,000 square kilometers (km²) of man-made reservoirs in the world
- Usage of 1% from surface area available, will give more than 400 GWp installed capacity with energy yield of 500 thousands GWh/ annual
- China is the largest PV Floating developer in the World, followed by Japan, Korea dan England. And recently Vietnam, Malaysia and Singapore also developed Floating PV

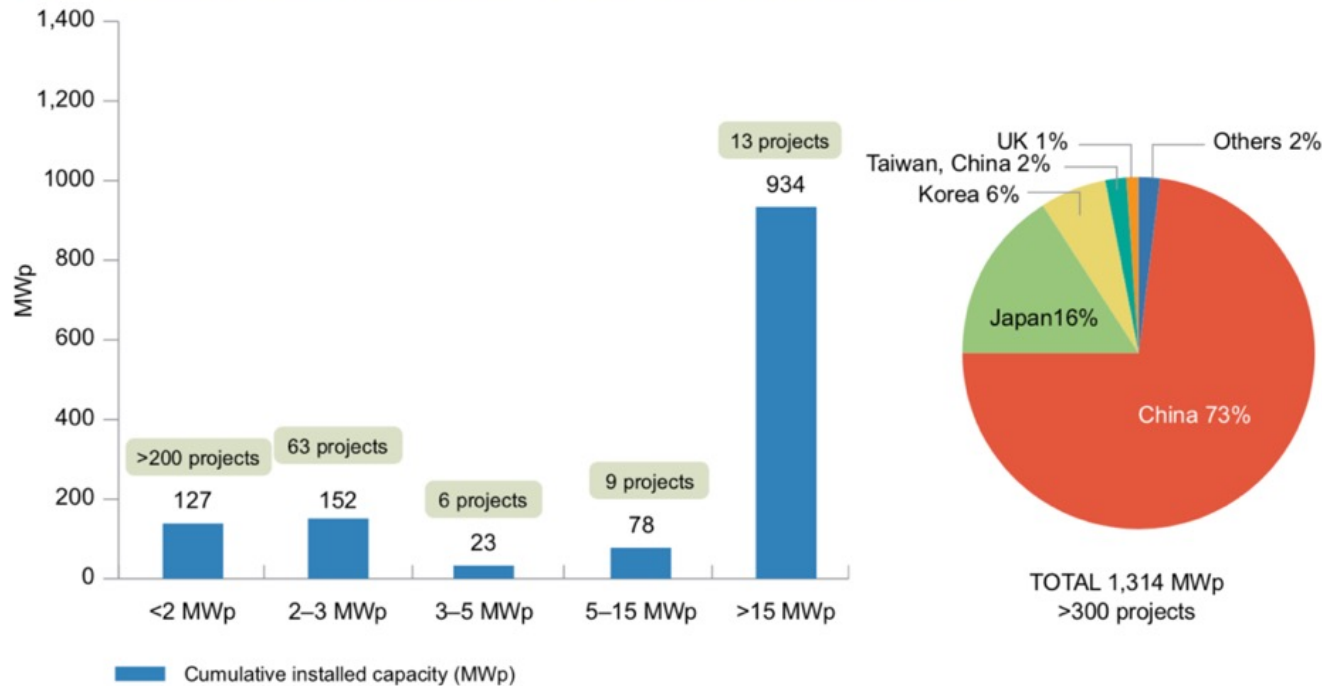
2

- Indonesia has more than 192 Dam and reservoir, with catchment area **86,247 Hectares**, and high potential to optimize the utilization as Floating PV Power plant more than **4,300 MWP** (5% utilization of catchment area) (*internal research*)

Source: @2019, When Sun Meets Water, World Bank Group, ESMAP, SERIES

Distribution of Floating PV Plants According Their size

FIGURE 3.3. Distribution of FPV plants according to their size, as of December 2018



Source: Authors' compilation based on various external sources (public media releases and direct insights from industry representatives).

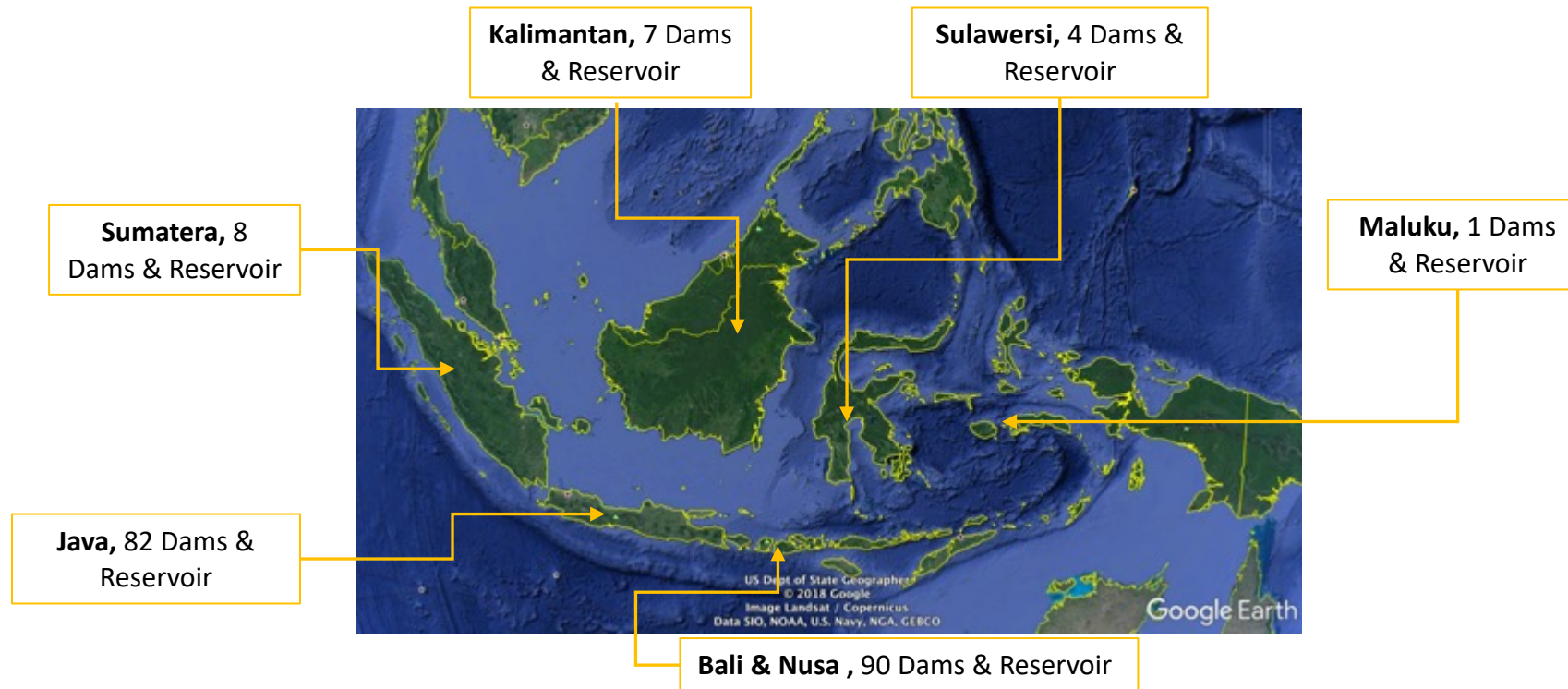
Note: MWp = megawatt-peak. List of projects attempts to be exhaustive, but omissions might have occurred.

- Floating PV become new trend in the world, which total installed capacity around 1,314 MWp, and increasing over years.
- While FPV Project Size above 15 MWp just only 13 projects in the world, which total installed capacity 934 MWp.
- China is the largest PV Floating developer in the World (73%)

Opportunity- Potential Reservoir for Floating PV in Indonesia

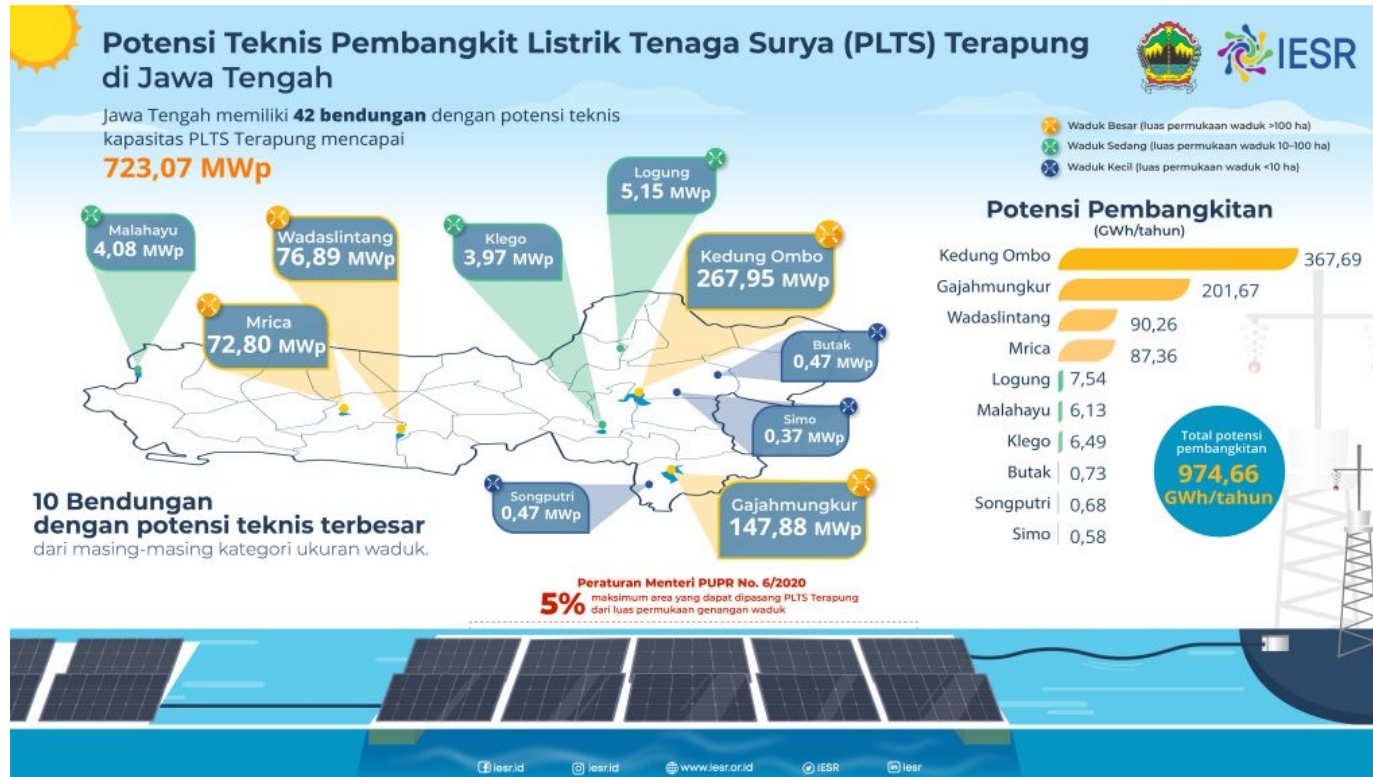
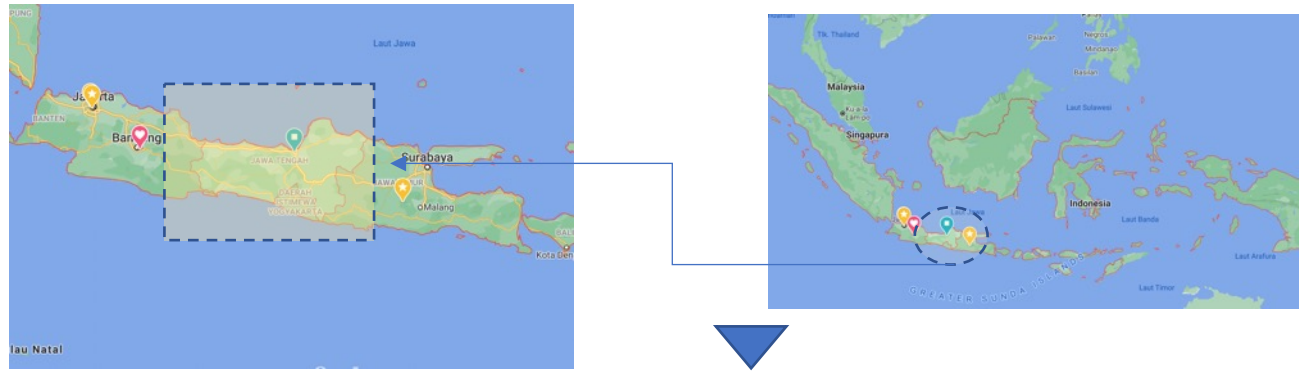
Floating PV is become new trend in the word due to certain advantages: optimizing utilization of reservoir, avoid land-use, providing complementary with hydropower (hybrid operation), reducing evaporation and boost up energy yield up to 10% due to lower ambient temperature.

Indonesia has more than 192 Dam and reservoir, with catchment area **86,247 Hectares**, and high potential to optimize the utilization as Floating PV Power plant more than **4,300 MWP** (5% utilization of catchment area) (*internal research*)



Data from: Ministry of Public Works

Technical Potential Floating PV in Central Java (IESR Study)



1. There are 10 potential reservoir that can be used for Floating PV, most of them is also for Hydro Power Plant
2. More Than 700 MW of Floating PV can be implemented in 10 reservoir in Central Java (by using Ministry of Public Works regulation No 6/2020, which maximum capacity is 5% from water bodies area)

Challenge in Development of Floating PV in Indonesia

01 New Technology
(Pioneer)

02 CAPEX
Relatif higher compared
to Ground Mounted

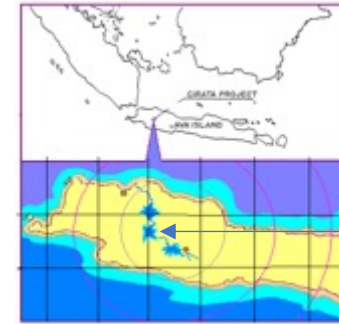
05 Regulation and Dam
Safety
Dam Safety Analysis is a must in
development of Floating PV

03 Permits and Environment
All Permits, and Environment
and Social Impact Analysis
should be done

04 Maintenance & Operation
Relativey complex compared
to Ground Mounted

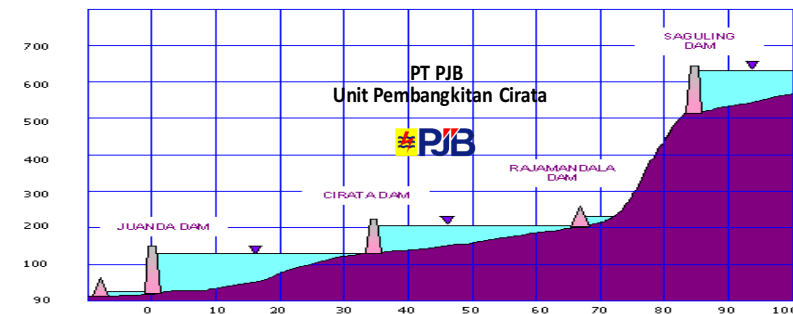
Overview of Floating PV Cirata 145 MW Ac

No	Item	Description
1	Parties	<ol style="list-style-type: none"> PT PEMBANGKITAN JAWA-BALI ("PJB"), a limited liability company duly organised and existing under the laws of Indonesia MASDAR, UAE
2	Participation Interest And The JVC	<ol style="list-style-type: none"> PT PJB 51% MASDAR 49%
3	Install Capacity	145 MW _{AC}
4	Estimation Project Cost	140 Million USD
5	Location	Cirata Hydropower Reservoir, owned by PT Pembangkitan Jawa Bali, with land requirement of approximately 240 hectares with location in coordinates: Latitude: -6.702659 °; Longitude: 107.334567°
6	Energy Yield	250 GWh/ Year
7	Area Usage	The Project will be occupied approx. 240 Ha of the Area of Reservoir (occupied 3,8% of total area)
8	Transmission Line	Energy of Floating Solar PV will be transmitted through 150 KV, Grid for about 3,8 KMS across Centayan Mountain to Cirata High Voltage Substation
9	Scheme & COD	PPA 25 years, BOOT, COD Estimation November 2022
10	Levelized Tariff	5,8179 US\$/kWh
11	Financing Date	Expected on 13 May 2021 (Based on PPA)



Cirata Hydro Power Plant, Owned by PT PJB, a Subsidiary of PT PLN (Persero)

Ds. Cadassari, Kec. Tegalwaru, Plered, Purwakarta, West Java

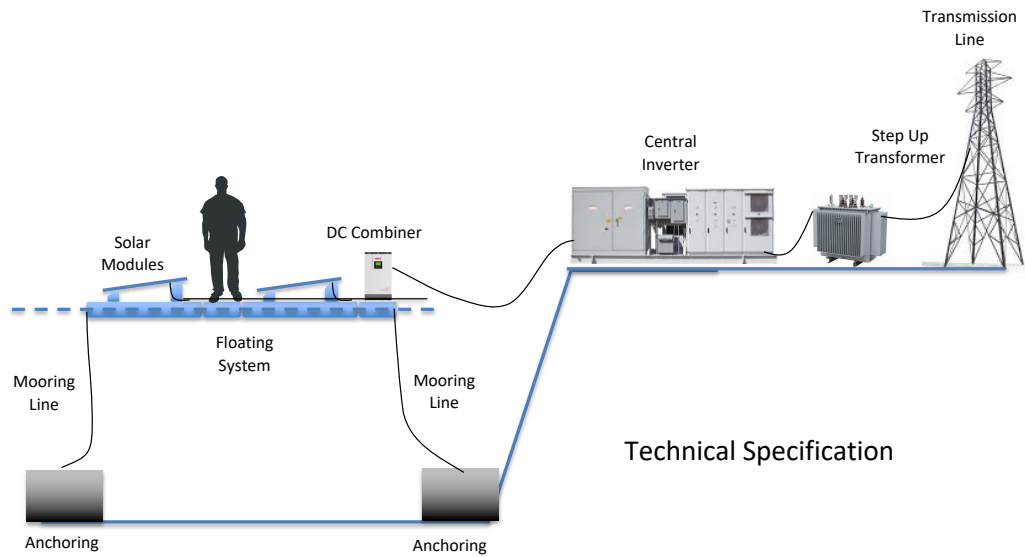


Cascade of Citarum River



Illustrative Picture

Illustrations of Floating PV Cirata



Illustrative Picture of Floating PV Cirata



Construction Phase



Operation and Maintenance Phase



150 KV Transmission Line

A wide-angle, low-perspective shot of a floating solar farm. The image shows a central aisle of grey metal structures with black cables running down the center of a large body of water. On either side of this aisle, there are long, parallel rows of dark blue solar panels. The water is a deep blue, and the sky is bright with scattered white clouds. In the background, there are green trees and a small hill under a clear blue sky. The overall scene is clean, organized, and futuristic.

Thank You