Embrace The Future

Indonesia Grid Readiness for Variable Renewable Energy (VRE)

Inline with ASEAN Power Grid Development

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ISO 37001 ANTI-BRIBERY MANAGEMENT
ISO
37001

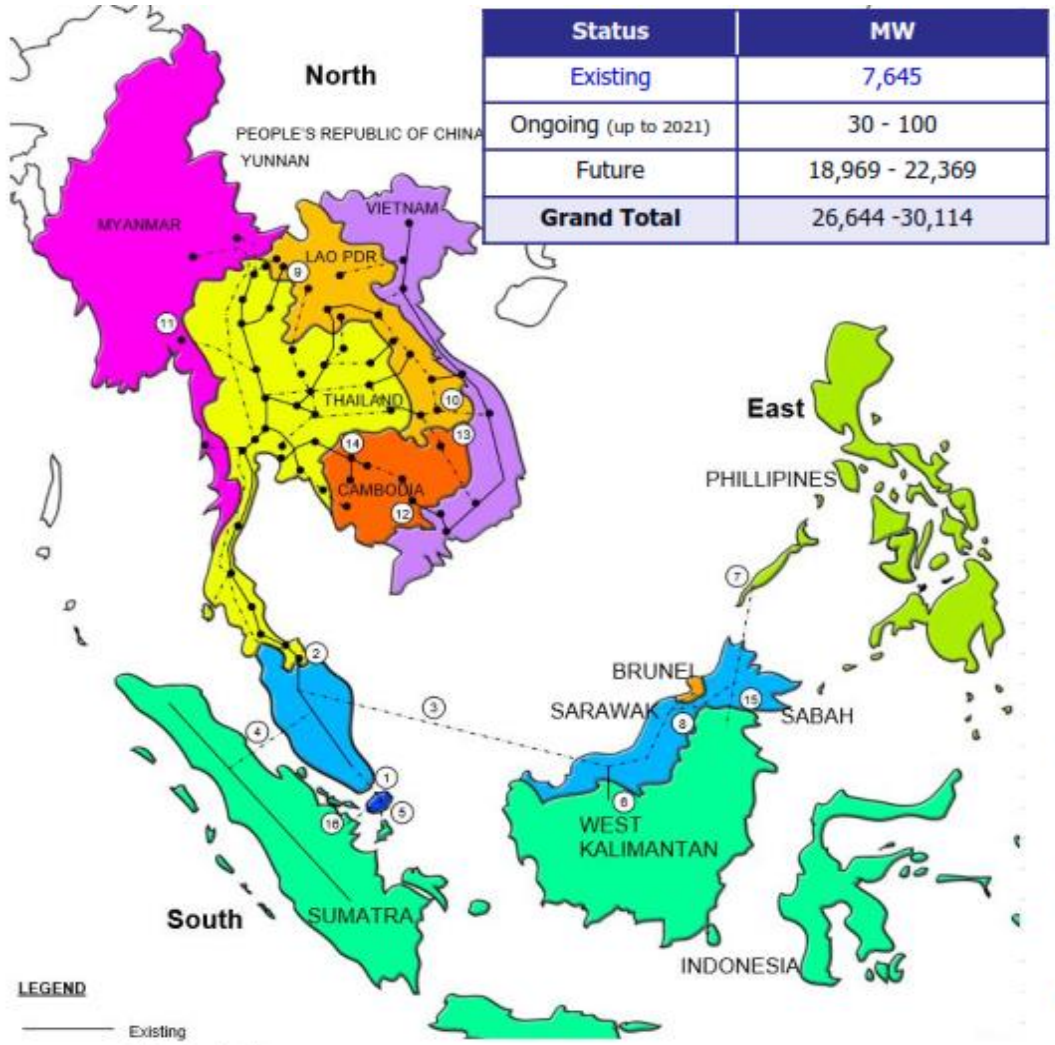
Sistem Manajemen
Anti Penyuapan (SMAP)

www.pln.co.id

ASEAN Power Grid Development

Status April 2020

Status	MW
Existing	7,645
Ongoing (up to 2021)	30 - 100
Future	18,969 - 22,369
Grand Total	26,644 -30,114



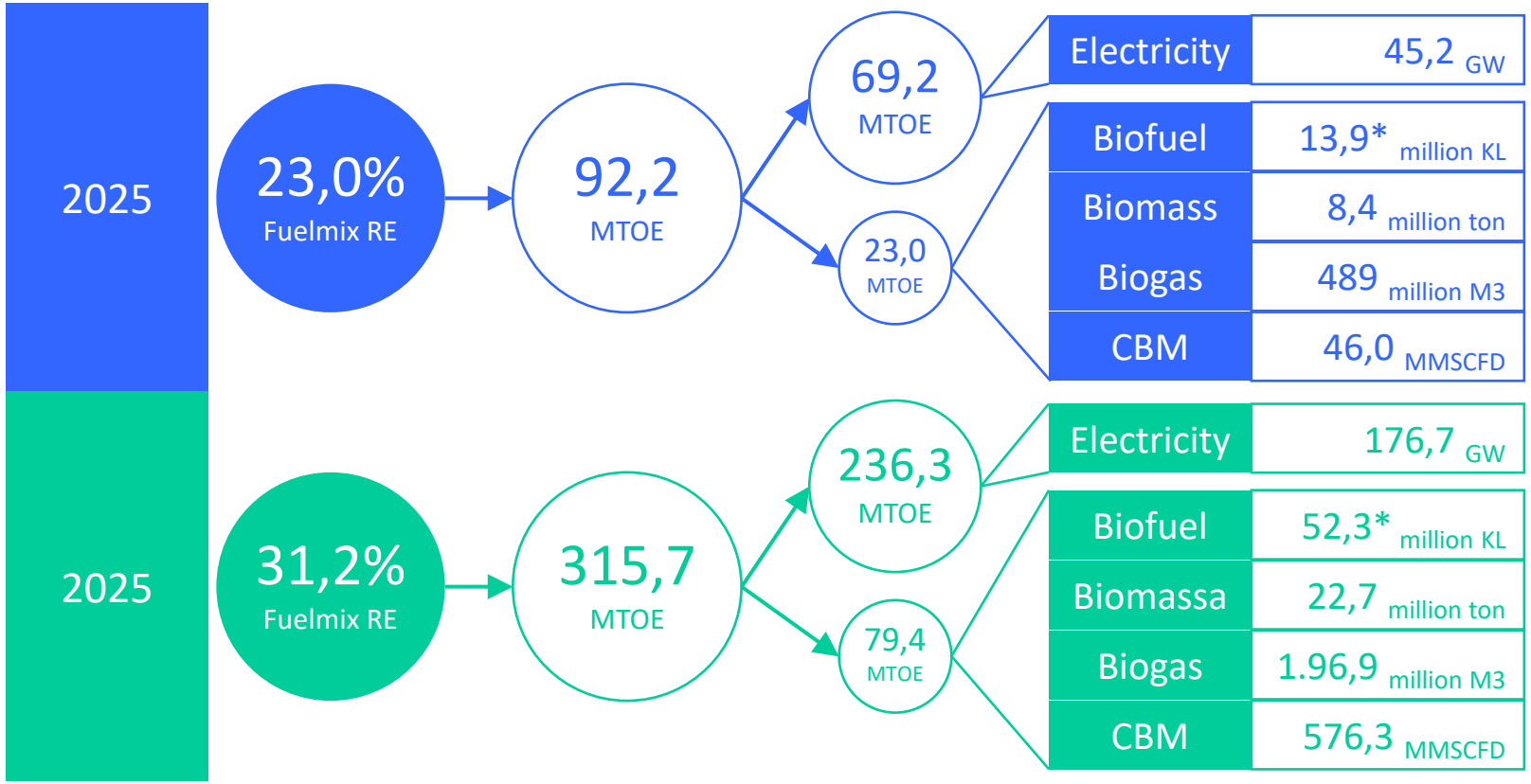
TBC stands for to be confirmed

The Existing Project as of April 2020

The Priority Projects, which refer to the APAEC 2016-2020, are underlined and indicated in Red.

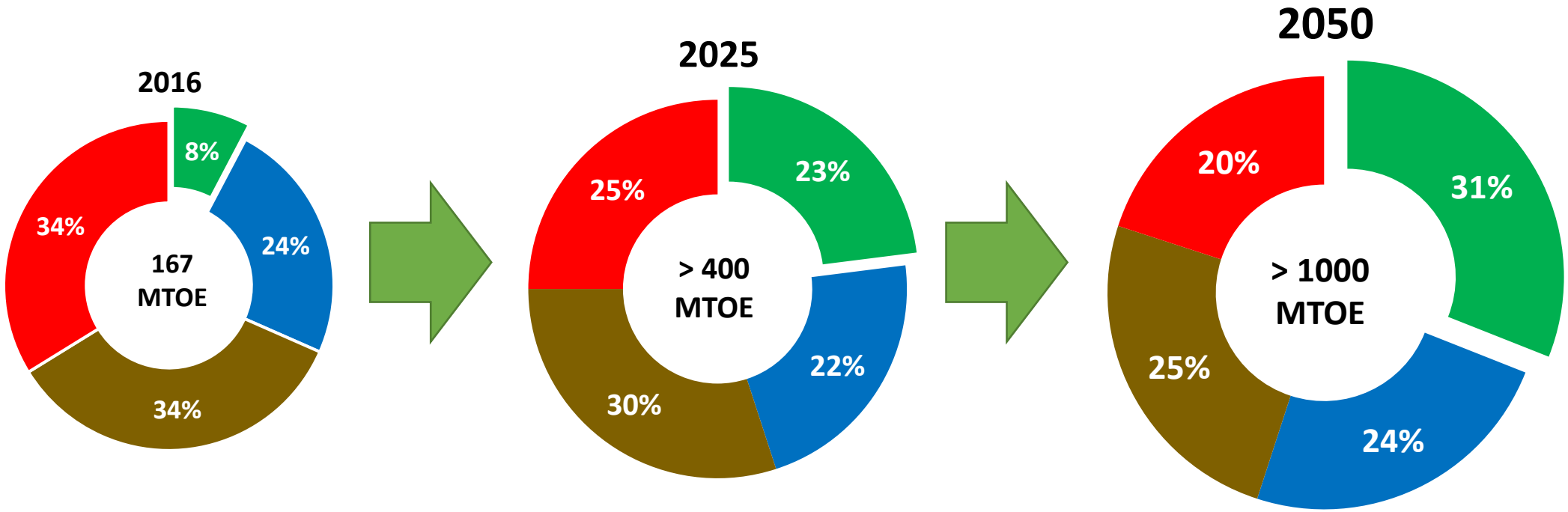
1)	**P.Malaysia – Singapore**	
	• Plentong – Woodlands	Existing
	• P.Malaysia – Singapore (2nd link Plentong – Woodlands)	post 2020
2)	**Thailand – P.Malaysia**	
	• Sadao - Chuping	Existing
	• Khlong Ngae – Gurun	Existing
	• Su Ngai Kolok – Rantau Panjang	TBC
	• Khlong Ngae – Gurun (2nd Phase, 300MW)	TBC
3)	**Sarawak – P. Malaysia**	**TBC**
4)	**P.Malaysia – Sumatra**	**TBC**
5)	**Batam – Singapore**	**TBC**
6)	**Sarawak – West Kalimantan**	**Existing**
7)	**Philippines – Sabah**	**TBC**
8)	**Sarawak – Sabah - Brunei**	**2022**
	• Sarawak – Brunei	2021
	• Sarawak – Sabah	2022
9)	**Thailand – Lao PDR**	
	• Nakhon Phanom - Thakhek - Theun Hinboun	Existing
	• Ubon Ratchathani 2 - Houay Ho	Existing
	• Roi Et 2 – Suvannakhet - Nam Theun 2	Existing
	• Udon Thani 3 - Na Bong - Nam Ngum 2	Existing
	• Nakhon Phanom 2 – Thakhek – Then Hinboun (Exp.)	Existing
	• Mae Moh 3 – Nan2 – Hong Sa (3Units)	Existing
	• Udon Thani 3 – Nabong (converted to 500KV)	Existing
	• Ubon Ratchathani 3 – Pakse – Xe Pian Xe Namnoi	Existing
	• Khon Kaen 4 – Loei 2 – Xayaburi	Existing
	• Thailand – Lao PDR (New)	TBC
10)	**Lao PDR – Vietnam**	**2016 - 2020**
	• Xekaman 3 – Thanh My	Existing
	• Xekaman 1 – Pleiku 2	Existing
	• Nam Mo - Ban Ve	TBC
	• Luang Prabang - Nho Quan	TBC
11)	**Thailand – Myanmar**	**TBC**
12)	**Vietnam – Cambodia (New)**	
	• Chau Doc – Takeo – Phnom Penh	Existing
	• Tay Ninh – Stung Treng	TBC
13)	**Lao PDR – Cambodia**	
	• Ban Hat - Kampong Sralao	Existing
	• Ban Hat - Stung Treng	Existing
14)	**Thailand – Cambodia (New)**	**post 2020**
	• Watthana Nakhon – Aranyaprathet – Banteay Meanchey	Existing
	• Thailand – Cambodia	post 2020
15)	**East Sabah – North Kalimantan**	**TBC**
16)	**Singapore – Sumatra**	**TBC**

Indonesia Renewable Energy Target in 2025 & 2030 RUEN



source : RUEN/ Rencana Umum Energi Nasional
* Exclude the biofuel for big power plant of 1,1 million kL 2025 and 1,9 million kL 2050

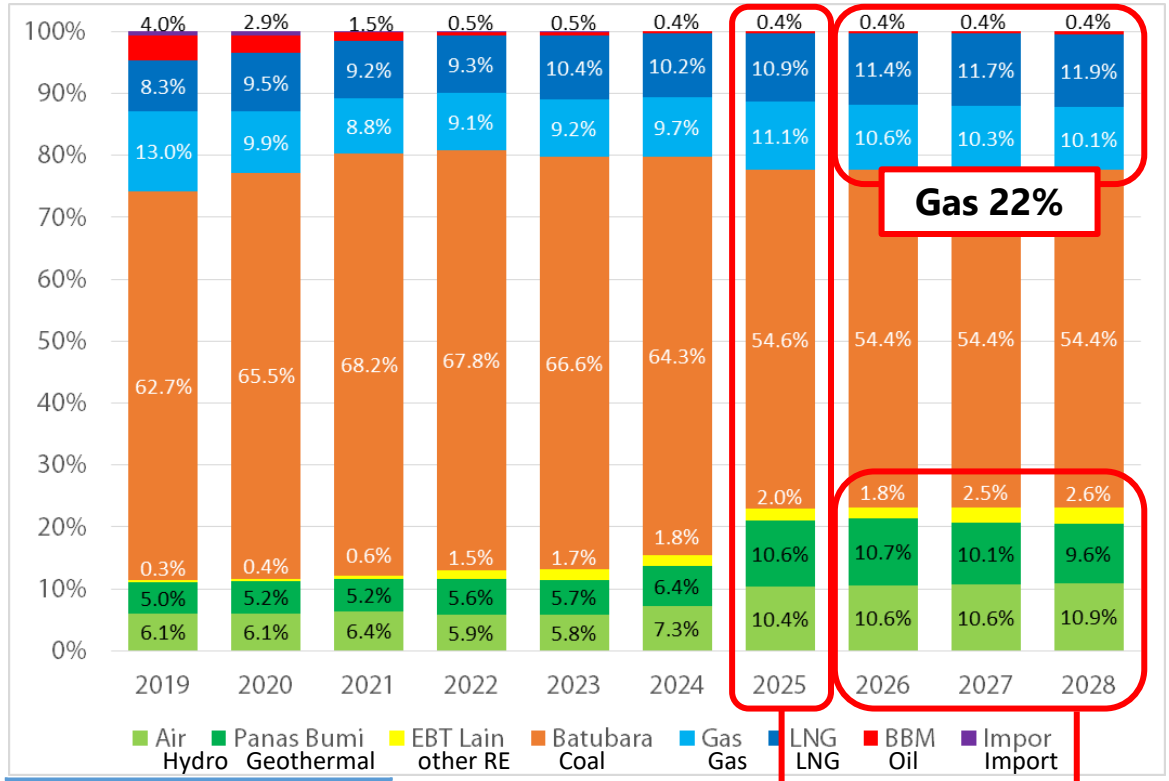
Indonesia RE Fuel Mix Target at 23% in 2025
RUEN

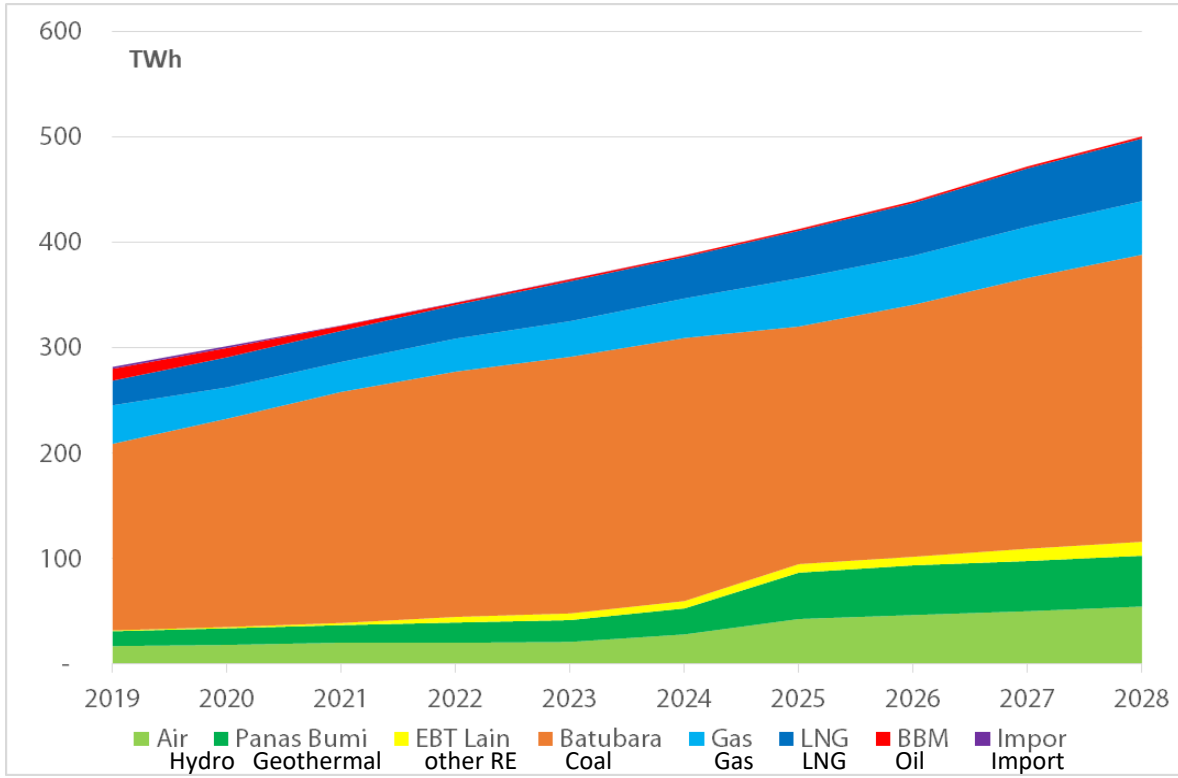


	2016	2025	2050
Total installed capacity	59 GW	135 GW	430 GW
Energy Consumption	0,64 TOE/Capita	1.4 TOE/Capita	3.2 TOE/Capita
Electricity Consumption	956 KWh/Capita	2500 KWh/Capita	7000 KWh/Capita

source: PERPRES No. 22 Tahun 2017 (Rencana Umum Energi Nasional)

Indonesia Fuel Mix Projection 2019 – 2028 RUPTL





Jenis	RUPTL 2019-2028
RE	23,0%
Gas	22,0%
Coal	54,6%
Oil	0,4%
Total	100%

Fuel mix target in 2025

- In order to ensure the RE fuel mix at 23,2% in 2026-2028, its necessary to add about 3.200 MW more rooftop PV (equal to 1,6 million rooftop PV @2kW)
- This target could only achieve success through the public participation and government support on the development of RE, especially rooftop PV, which their price is expected to decrease in the next coming years

Source : RUPTL 2019-2028

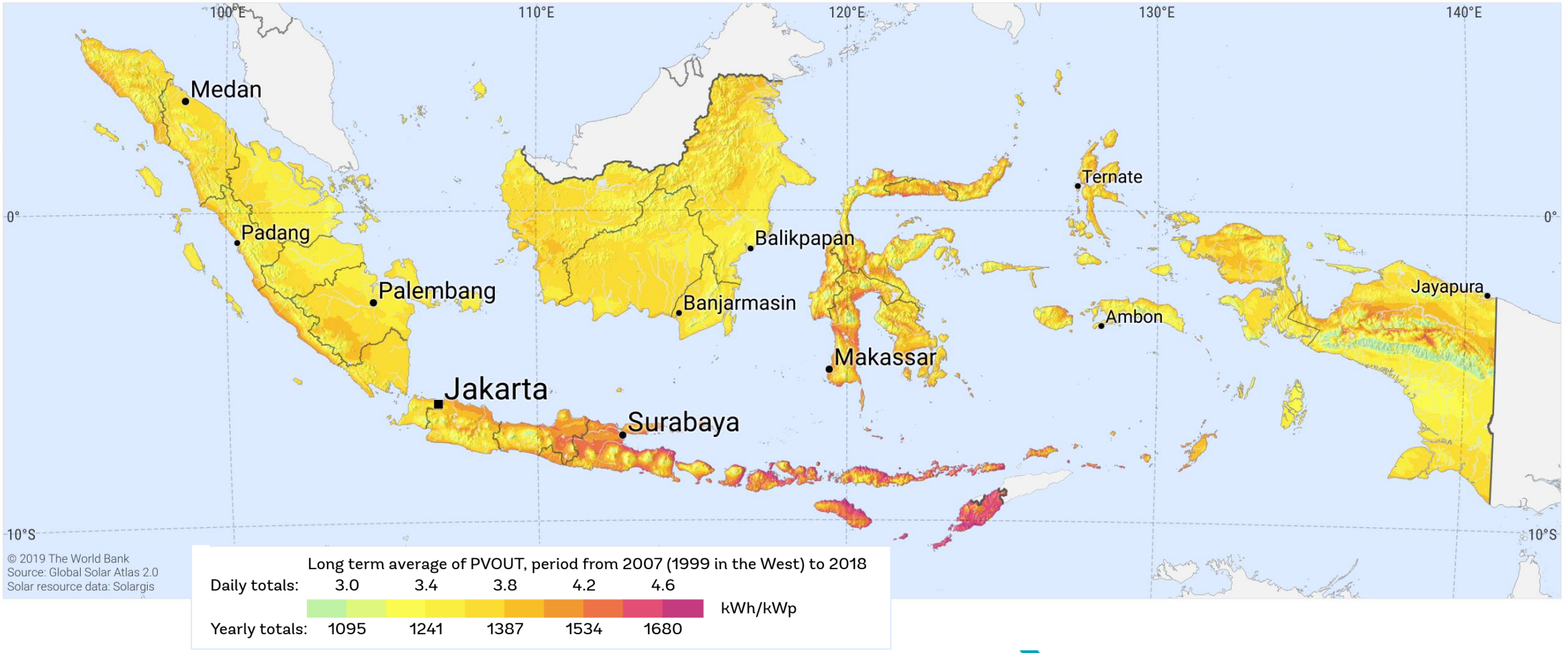
Renewable Energy Power Plant Program 2028 RUPTL

(MW)

No	RE Power Plant	Capacity	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
1	Geothermal	MW	190	151	147	455	245	415	2,759	45	145	55	4,607
2	Hydro	MW	154	326	755	-	182	1,484	3,047	129	466	1,467	8,009
3	Micro Hydro	MW	140	238	479	200	168	232	27	20	20	10	1,534
4	PV	MWp	63	78	219	129	160	4	250	-	2	2	908
5	Wind	MW	-	-	30	360	260	50	150	-	-	5	855
6	Biomass/ Wastes	MW	12	139	60	357	50	103	19	5	15	35	794
7	Maritime	MW	-	-	7	-	-	-	-	-	-	-	7
8	Bio-Fuel	thousand Kilo Liter	520	487	291	167	151	146	154	159	166	175	2,415
Jumlah		**MW**	**560**	**933**	**1,697**	**1,501**	**1,065**	**2,287**	**6,251**	**199**	**648**	**1,574**	**16,714**

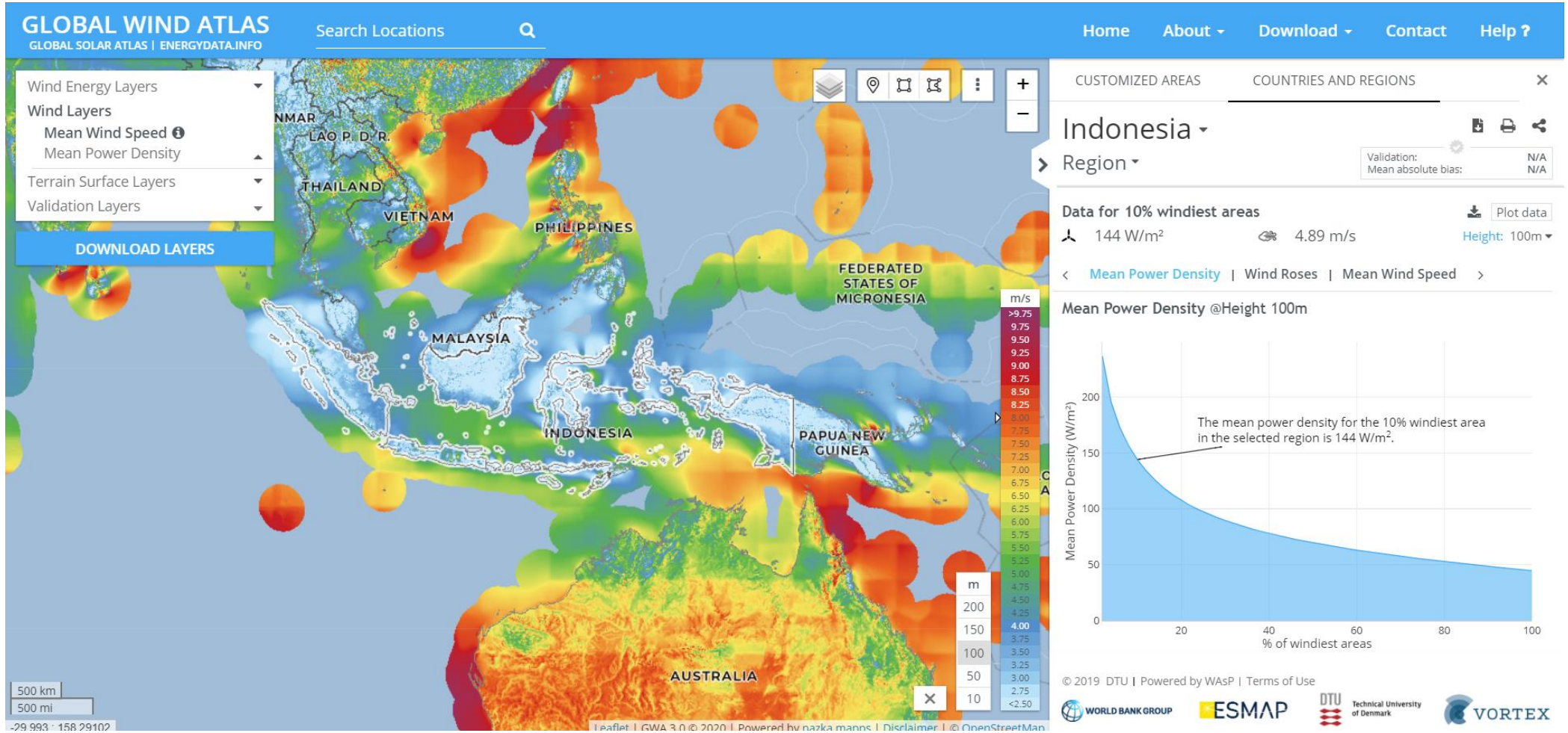
Source : RUPTL 2019-2028

Solar PV Potential Maps



Source : Global Solar Atlas (https://globalsolaratlas.info/download/indonesia)

Wind Power Potential Maps



Source : Global Wind Atlas (globalwindatlas.info/area/Indonesia)

Wind Power Potential by Provinces
RUEN

No	Provinsi	Potensi (MW)
1	Nusa Tenggara Timur	10.188
2	Jawa Timur	7.907
3	Jawa Barat	7.036
4	Jawa Tengah	5.213
5	Sulawesi Selatan	4.193
6	Maluku	3.188
7	Nusa Tenggara Barat	2.605
8	Bangka Belitung	1.787
9	Banten	1.753
10	Bengkulu	1.513
11	Sulawesi Tenggara	1.414
12	Papua	1.411

No	Provinsi	Potensi (MW)
13	Sulawesi Utara	1.214
14	Lampung	1.137
15	DI. Yogyakarta	1.079
16	Bali	1.019
17	Kalimantan Selatan	1.006
18	Kepulauan Riau	922
19	Sulawesi Tengah	908
20	Aceh	894
21	Kalimantan Tengah	681
22	Kalimantan Barat	554
23	Sulawesi Barat	514
24	Maluku Utara	504

No	Provinsi	Potensi (MW)
25	Papua Barat	437
26	Sumatera Barat	428
27	Sumatera Utara	356
28	Sumatera Selatan	301
29	Kalimantan Timur	212
30	Gorontalo	137
31	Kalimantan Utara	73
32	Jambi	37
33	Riau	22
34	DKI Jakarta	4

Total (MW)	**60.647**

Source : Peraturan Presiden RI Nomor 22 Tahun 2017 Tentang Rencana Umum Energi Nasional

Solar Power Potential by Provinces RUEN

No	Provinsi	Potensi (MW)
1	Kalimantan Barat	20.113
2	Sumatera Selatan	17.233
3	Kalimantan Timur	13.479
4	Sumatera Utara	11.851
5	Jawa Timur	10.335
6	Nusa Tenggara Barat	9.931
7	Jawa Barat	9.099
8	Jambi	8.847
9	Jawa Tengah	8.753
10	Kalimantan Tengah	8.459
11	Aceh	7.881
12	Kepulauan Riau	7.763
13	Sulawesi Selatan	7.588
14	Nusa Tenggara Timur	7.272
15	Papua Barat	6.307
16	Sulawesi Tengah	6.187
17	Kalimangtan Selatan	6.031

No	Provinsi	Potensi (MW)
18	Sumatera Barat	5.898
19	Kalimantan Utara	4.643
20	Sulawesi Tenggara	3.817
21	Bengkulu	3.475
22	Maluku Utara	3.036
23	Bangka Belitung	2.810
24	Banten	2.461
25	Lampung	2.238
26	Sulawesi Utara	2.113
27	Papua	2.035
28	Maluku	2.020
29	Sulawesi Barat	1.677
30	Bali	1.254
31	Gorontalo	1.218
32	DI. Yogyakarta	996
33	Riau	753
34	DKI Jakarta	225
Total		207.898

Source : Peraturan Presiden RI Nomor 22 Tahun 2017 Tentang Rencana Umum Energi Nasional Hal 77

Java Bali VRE Development Plan 2019-2028
RUPTL

Tahun	Banten		DKI Jakarta		Jawa Barat		Jawa Tengah		DIY		Jawa Timur		Bali		Jawa-Bali		Jumlah	
	PLTS	PLTB	PLTS	PLTB	PLTS	PLTB	PLTS	PLTB	PLTS	PLTB	PLTS	PLTB	PLTS	PLTB	PLTS	PLTB	Tahunan	Kumulatif
2019															-	-	-	
2020					5								50		55	-	55	55
2021					145						50				195	-	195	250
2022	10	100				150	60	50				50			70	350	420	670
2023	10	100			150	50									160	150	310	980
2024												50			-	50	50	1,030
2025	50	50				100	50				100		50		250	150	400	1,430
2026															-	-	-	1,430
2027															-	-	-	1,430
2028															-	-	-	1,430
Jumlah	**70**	**250**	**-**	**-**	**300**	**300**	**110**	**50**	**-**	**-**	**150**	**100**	**100**	**-**	**730**	**700**	**1,430**	
	320		**0**		**600**		**160**		**0**		**250**		**100**		**1430**			

Source : RUPTL 2019-2028

JMB Power System Readiness
VRE Integration Anticipation

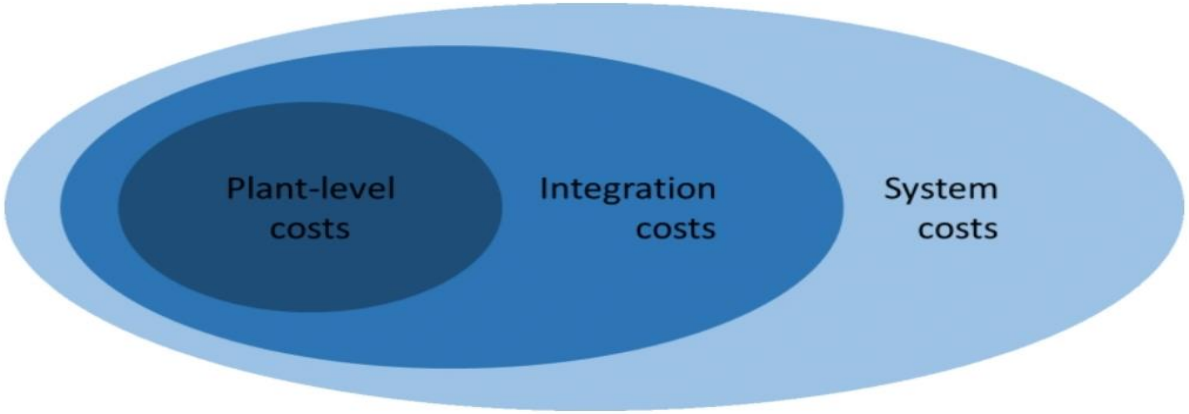
Target set by KOMITE ENERGI NASIONAL (KEN)

Sasaran – Sasaran yang diamanatkan dalam KEN

Tahun 2015–2050

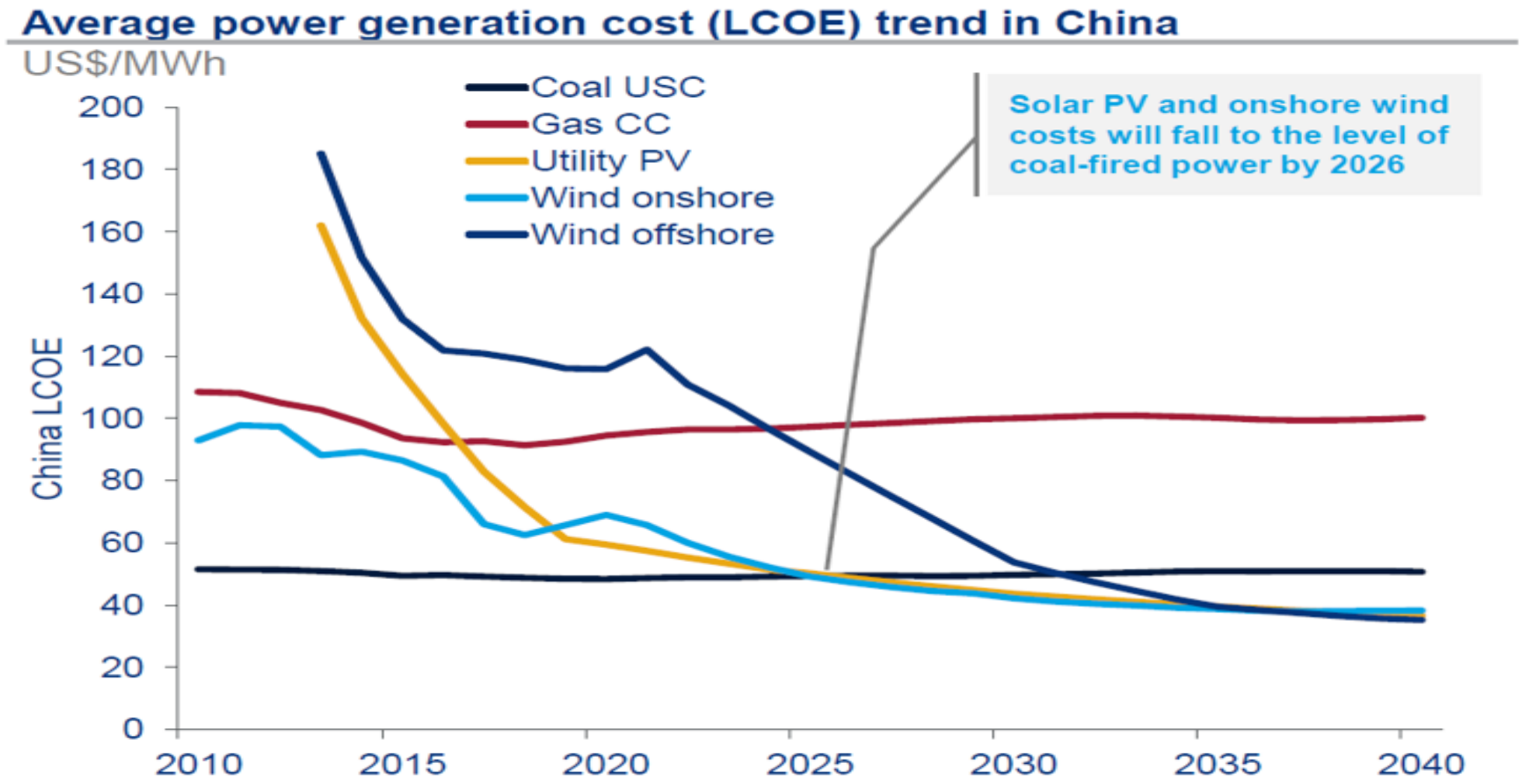
No.	Sasaran KEN	Satuan	2015	2020	2025	2050
1	Penyediaan energi primer	MTOE			> 400	> 1.000
2	Target bauran energi:					
	a. EBT	%			> 23	> 31
	b. Minyak bumi	%			< 25	< 20
	c. Batubara	%			> 30	> 25
	d. Gas bumi	%			> 22	> 24
3	Penyediaan pembangkit tenaga listrik	GW			> 115	> 430
4	Rasio elektrifikasi	%	85	100		
5	Pemanfaatan energi primer per kapita	TOE			1,4	3,2
6	Pemanfaatan listrik per kapita	KWh			2.500	7.000
7	Elastisitas energi				< 1	
8	Penurunan intensitas energi final	%	1% per tahun			
9	Rasio penggunaan gas rumah tangga	%	85			

RE Implementation Cost

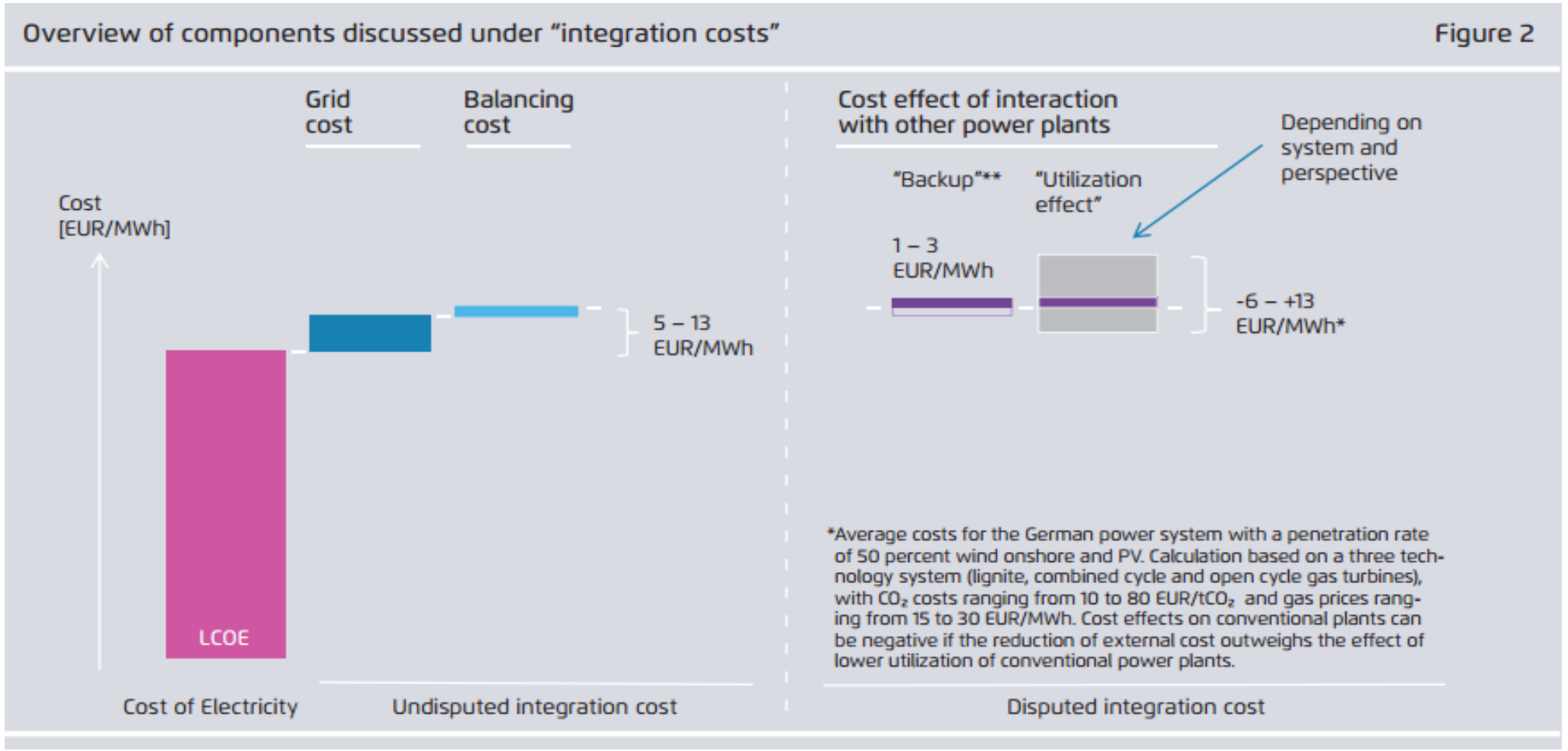


1. **Plant Level Cost : Levelised Cost of Electricity (LCOE)**
2. **Integration Cost :**
   a. Grid Impact Cost : Additional infrastructure cost
   b. Balancing Impact Cost : VRE energy forecast accuration mitigation Cost
   c. Adequacy/Backup Cost : Availability, Intermittency dan Inertia Cost
3. **System Cost**

Energy Production Cost Comparison (Plant Level Cost)



Overview of the RE Integration Cost Components



Source: Agora Energiewende (2015)

VRE Development Initial Consideration

1. Solar & Wind Potential Location
   - Determine the type, characteristic and potential capacity of the VRE on related location
   - Conduct primary/direct measurement by developer
   - Determine the estimated production, power, efficiency and VRE LCOE
   - Agregracy of VRE intermittent probability as well as per location
2. System Ramp up/down flexibility ability, fast response availability, system stiffness reliability level requirement
3. System Impact Study (technically and cost)
4. Term & Requirement and VRE power plant technology

System Operation Flexibility Challenges

1. Transmission Constraints
2. Primary Energy Constraints
   - Lack of gas availability, TOP gas contract, gas pipe flexibility and FSRU capacity
   - De-rating due to Season variation
   - Lack of Coal primary energy quality
3. IPP TOP Contract
4. Coal Power Plant High Technical Minimum Load and Composition
5. Power Plant Governor Free activation and AGC Contribution Limitation
6. In-effectiveness of the Grid Code Compliance

System Operation Flexibility Enhancement Plan

1. Transmission System priority enhancement plan
2. Primary Energy flexibility enhancement plan :
   - FSRU construction in West Java
   - JTB pipe gas new contract
   - Pump Storage construction
   - Battery Energy Storage System (BESS) construction
3. Power Plant Governor Free activation and AGC contribution Roadmap
4. Weather Monitoring System, Real time load forecasting dan economic dispatch unit integration
5. Upgrading control center program
6. Management Committee of Grid Code (KMAJ) Jawa Bali routine coordination and RE sub committee establishment

Predicted Quota of VRE for Java Bali Grid

Phase	Year	System Peak Load (MW)	RE Quota (MW)	Constraint	Δ cost	Pre-Requirement / Grid Improvement Needed
1	2020-2021	26,737	200	AGC	≈	Governor Free and AGC
2	2022 – 2023	29,160	1000	AGC, TML, Must run Unit	+	+ AGC, *Weather Monitoring System, Real time Forecasting*, Fast Response reserve dan Flexible Generation
3	2024 – 2025	31,668	2000	Peaker Installed capacity , TML	+	+ Pump Storage, Storage System BESS, FSRU/CNG Terminal, + Anciliary Service, additional Fast Response Unit, BESS, RSH unit Coal PP/ Curtailment VRE

Concluding Remark :

Embrace the future, modern power system control for enabling VRE integration to the Grid

1. In line with PLN Transformation program to be a green, lean, innovative and customer focus company, Indonesia Grid will be prepared for incorporating VRE integration by reinforcement of existing grid infrastructure, including upgrading the existing control centre into an advance control centre.
2. Indonesia Grid will move away from current condition of :
    - Dispatchable generation
    - Known transmission topology
    - Forecast for load

    into future power system where we will have :
    - Forecast for generation (Variable Renewable Energy)
    - Flexible transmission topology
    - Dispatchable load (Demand Response and/or Distributed Energy Resources)
3. Objective of Indonesia power system operation as stipulated by Grid Code can be achieved : reliable, quality, economic and green, and smooth integration of VRE to the grid, inline with the program of ASEAN Power Grid.

PLN

THANK YOU