Supplementary Materials

S1. Domestic electricity demand

Table S1 shows the growth of domestic electricity demand and the number of households each year being customers. This study focused on the demand in 2020, which was 72.76 TWh.

Table S1. Growth of domestic electricity demand from 2010 to 2020 [1].

Year	Average kWh/household	Total households (10^3)	Total household consumption (TWh)	Percentage of increase (%)
2010	1521.00	26.59	40.44	-
2011	1529.00	28.07	42.91	6.13
2012	1561.00	30.21	47.16	9.90
2013	1540.64	32.51	50.09	6.21
2014	1577.00	34.47	54.36	8.52
2015	1567.00	35.69	55.93	2.89
2016	1581.00	38.16	60.33	7.87
2017	1510.00	39.98	60.37	0.06
2018	1481.00	41.88	62.02	2.73
2019	1490.00	43.83	65.30	5.29
2020	**1608.70**	**45.38**	**72.76**	**11.42**
Annual increase percentage (average)				6.10

S2 Electricity Generation from Wind Turbines

Power generated from wind turbines depends on the turbine type, size, and wind speeds. For simplification, this study used a wind turbine model (Enercon E-115) with specifications as shown in Table S2.

Table S2. Enercon-115 specifications.

Rated power	3	MW
Hub height	92	m
Maximum power coefficient	47	%
Rated wind speed	12	m/s
Rotor diameter	115.7	m
Swept area	10515.5	m^2
Cut-in wind speed	2	m/s
Rated wind speed	12	m/s

Cut-out wind speed	28	m/s

The output power from the turbine is determined by the formula below:

$$P_t = \frac{1}{2} * \rho * A * v^3 * C_p \quad \text{(S1)}$$

Where P_t is the generated power (Watt), ρ is the density of air (1.225 kg/m^3), A is the swept area of rotor blades (m^2), v is the wind speed (m/s) at hub height and C_p is the power coefficient. The power coefficient of turbines can reach 0.59 [2].

In order to calculate the generated power, the wind speed needs to be corrected due to the vertical difference in wind speeds [3]. The wind speed is measured at the height of 10 m, while the hub height is 92 m. The wind speeds need to be modified by a power law exponent α, taken as 1/7 [3,4]. The formulation of wind speed at hub height is given by

$$v_{hub} = v_{10} * (\frac{h_{hub}}{10})^{\alpha} \quad \text{(S2)}$$

v_{hub} is the wind speed at hub height (m/s), v_{10} is the wind speed at 10 m (m/s) and h_{hub} is the hub height (m).

S3 Diagram of scenarios used in this study

Table S3 presents the 35 scenarios used in this study and their relation to the electricity production by each RES, the value of each KPI within each scenario and the electricity production coverage to the electricity demand. Scenarios 1-6 are the baseline. Scenario 1 used only the existing capacity while scenario 2-6 used four of five existing capacities with the remaining RES was set to maximum capacity. Scenario 2 relied on geothermal and spent the highest CAPEX and OPEX among the baseline scenarios to successfully meet the electricity demand. Meanwhile, scenario 5 was less polluting and the most CAPEX- and OPEX-efficient scenario, but with high curtailment. Scenarios 2, 5 and 6 can already meet the demand and even result in curtailments. This study adjusted those three scenarios to become adjusted 2, 5 and 6 (as seen in scenarios 33 – 35) to mitigate curtailments. Then, each KPI as the consequences were recalculated.

Table S3. Overview of all scenarios.

	Scenarios					Electricity Production (TWh)					KPIs					Energy efficiency (%)	Demand (TWh)	Deficit/Curtailment (TWh)
	Geo	Hydro	MSW	Solar	Wind	Geo	Hydro	MSW	Solar	Wind	CAPEX (B$)	OPEX 25 yr (B$)	ROI %	CO_2 emission* (Mton)	CO_2 reduction (%)			
1	0	0	0	0	0	10.14	25.12	1.61	0.02	0.02	11.01	3.80	245.75	1359.69	95.51	51	72.76	-35.86
2	1	0	0	0	0	59.11	25.12	1.61	0.02	0.02	35.99	19.87	23.98	3220.49	89.36	118	72.76	13.11
3	0	1	0	0	0	10.14	43.71	1.61	0.02	0.02	14.98	3.80	172.66	1805.89	94.03	76	72.76	-17.27
4	0	0	1	0	0	10.14	25.12	4.34	0.02	0.02	11.80	4.59	223.35	1987.01	93.43	54	72.76	-33.13
5	0	0	0	1	0	10.14	25.12	1.61	168.04	0.02	40.25	18.54	135.85	9425.02	68.86	282	72.76	132.17
6	0	0	0	0	1	10.14	25.12	1.61	0.02	685.25	87.47	3.82	2047.60	9582.48	68.34	992	72.76	649.38
7	0	0	0	1	1	10.14	25.12	1.61	168.04	685.25	116.71	18.56	1431.49	17647.80	41.69	1223	72.76	817.40
8	0	0	1	0	1	10.14	25.12	4.34	0.02	685.25	88.26	4.61	2014.86	10209.80	66.27	996	72.76	652.10
9	0	1	0	0	1	10.14	43.71	1.61	0.02	685.25	91.44	3.82	1971.03	10028.68	66.86	1018	72.76	667.97
10	1	0	0	0	1	59.11	25.12	1.61	0.02	685.25	112.45	19.89	1413.02	11443.28	62.19	1060	72.76	698.34
11	0	0	1	1	0	10.14	25.12	4.34	168.04	0.02	41.05	19.33	135.64	10052.33	66.79	285	72.76	134.90
12	0	1	0	1	0	10.14	43.71	1.61	168.04	0.02	44.22	18.54	140.53	9871.21	67.38	307	72.76	150.76
13	1	0	0	1	0	59.11	25.12	1.61	168.04	0.02	65.23	34.61	80.73	11285.81	62.71	349	72.76	181.14
14	0	1	1	0	0	10.14	43.71	4.34	0.02	0.02	15.77	4.59	160.34	2434.52	91.96	80	72.76	-14.54
15	1	0	1	0	0	59.11	25.12	4.34	0.02	0.02	36.78	20.66	26.85	3848.99	87.28	122	72.76	15.84
16	1	1	0	0	0	59.11	43.71	1.61	0.02	0.02	39.95	19.87	36.30	3666.31	87.89	144	72.76	31.69
17	0	0	1	1	1	10.14	25.12	4.34	168.04	685.25	117.51	19.35	1416.42	18276.56	39.61	1227	72.76	820.14
18	0	1	0	1	1	10.14	43.71	1.61	168.04	685.25	120.68	18.56	1396.67	18093.88	40.21	1249	72.76	835.99
19	1	0	0	1	1	59.11	25.12	1.61	168.04	685.25	141.69	34.63	1098.65	19508.35	35.54	1291	72.76	866.36
20	0	1	1	0	1	10.14	43.71	4.34	0.02	685.25	92.23	4.61	1940.90	10657.31	64.79	1022	72.76	670.70
21	1	0	1	0	1	59.11	25.12	4.34	0.02	685.25	113.24	20.68	1397.83	12071.78	60.11	1064	72.76	701.07
22	1	1	0	0	1	59.11	43.71	1.61	0.02	685.25	116.41	19.89	1377.99	11889.10	60.72	1085	72.76	716.92
23	0	1	1	1	0	10.14	43.71	4.34	168.04	0.02	45.01	19.33	140.23	10499.84	65.31	311	72.76	153.49

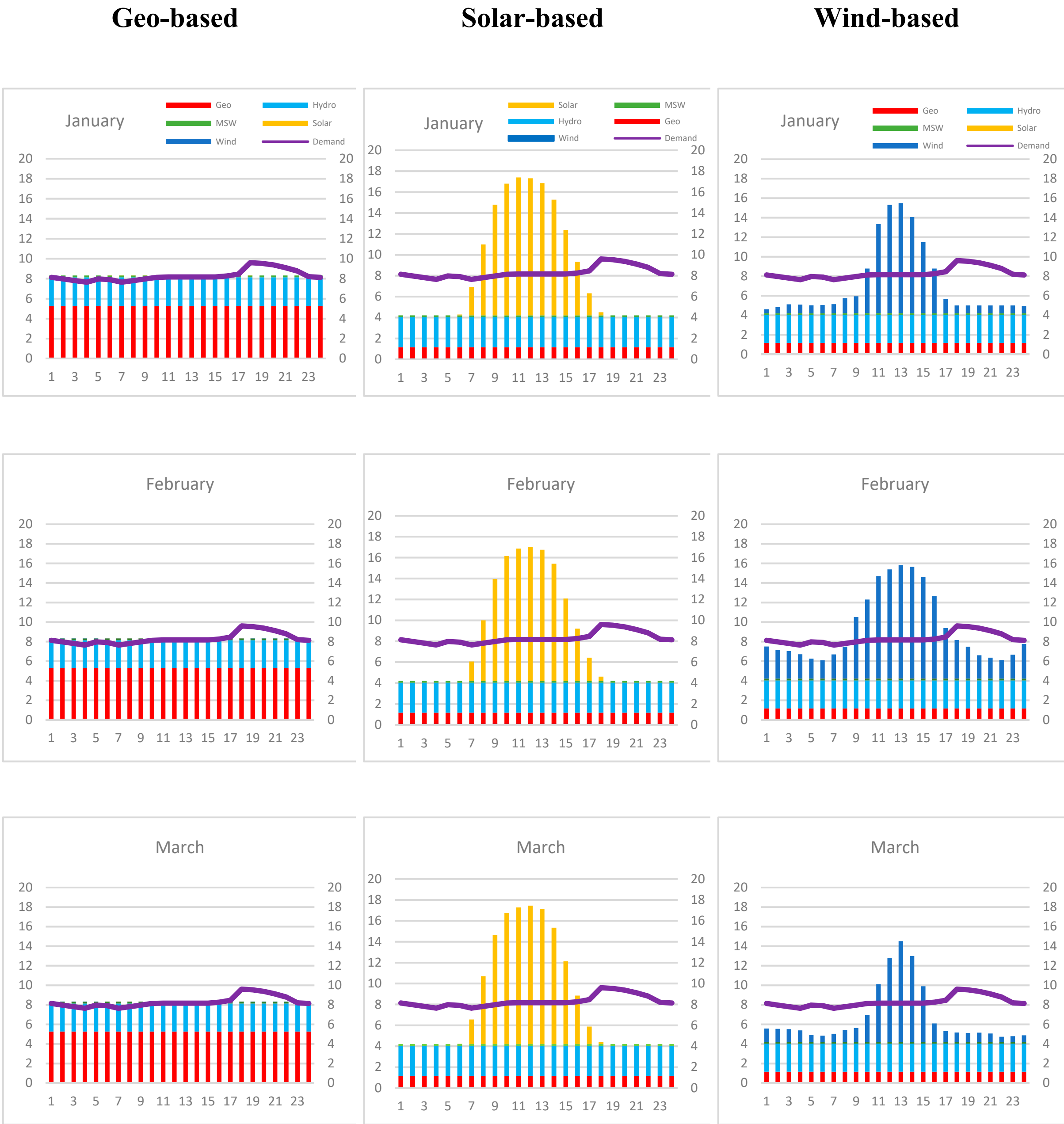
24	1	0	1	1	0	59.11	25.12	4.34	168.04	0.02	66.02	35.40	81.47	11914.31	60.63	353	72.76	183.87
25	1	1	1	0	0	59.11	43.71	4.34	0.02	0.02	40.75	20.66	38.68	4295.06	85.81	147	72.76	34.43
26	1	1	0	1	0	59.11	43.71	1.61	168.04	0.02	69.20	34.61	85.66	11731.63	61.24	374	72.76	199.72
27	0	1	1	1	1	10.14	43.71	4.34	168.04	685.25	121.47	19.35	1382.41	18722.59	38.14	1253	72.76	838.72
28	1	0	1	1	1	59.11	25.12	4.34	168.04	685.25	142.48	35.42	1090.01	20137.10	33.46	1294	72.76	869.10
29	1	1	0	1	1	59.11	43.71	1.61	168.04	685.25	145.66	34.63	1363.64	19954.42	34.07	1316	72.76	884.95
30	1	1	1	0	1	59.11	43.71	4.34	0.02	685.25	117.21	20.68	86.30	12517.85	58.64	1089	72.76	719.66
31	1	1	1	1	0	59.11	43.71	4.34	168.04	0.02	69.99	35.40	1070.80	12360.38	59.16	378	72.76	202.45
32	1	1	1	1	1	59.11	43.71	4.34	168.04	685.25	146.45	35.42	24.47	20583.17	31.99	1320	72.76	887.69
Adjusted 2	5.26	2.87	0.18	0.00	0.00	46.11	25.12	1.61	0.02	0.02	29.35	15.60	29.37	2726.31	90.99	100.00	72.76	0
Adjusted 5	1.16	2.87	0.18	14.89	0.00	10.14	25.12	1.61	35.96	0.02	24.15	10.42	48.34	3085.10	89.81	100.00	72.76	0
Adjusted 6	1.16	2.87	0.18	0.00	12.27	10.14	25.12	1.61	0.02	35.91	50.07	3.81	138.99	1790.37	94.08	100.00	72.76	0

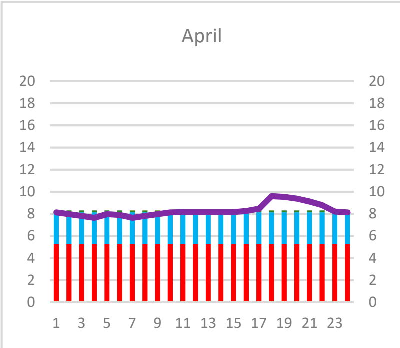
Legend:

- Design of scenarios (Green)
- Electricity production (Yellow)
- KPIs (Grey)
- The geo-based energy mix (Red) uses the current capacity of solar and wind energy, the maximum potential of hydropower and MSW, and an adjustment of the geothermal potential.
- The solar-based energy mix (Orange) uses the current capacity of geothermal and wind energy, the maximum potential of hydropower and MSW, and an adjustment of the solar potential.
- The wind-based energy mix (Blue) uses the current capacity of solar and geothermal energy, the maximum potential of hydropower and MSW, and an adjustment of the wind potential.
- 0 means only using the existing capacity of each RES in 2020
- 1 means using all available potential of each RES in 2020

S4 Electricity generation and storage requirements on Java and Bali islands in 2020

Figure S1 presents the typical electricity generation from three primary energy mixes. The average hourly electricity generation was calculated monthly to depict detailed features of high and low electricity generation periods.

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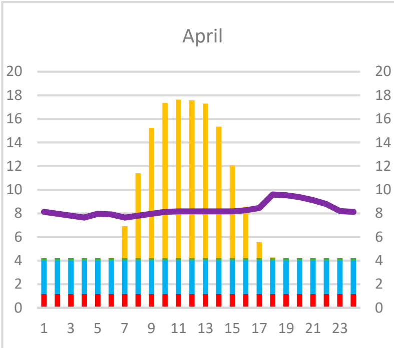
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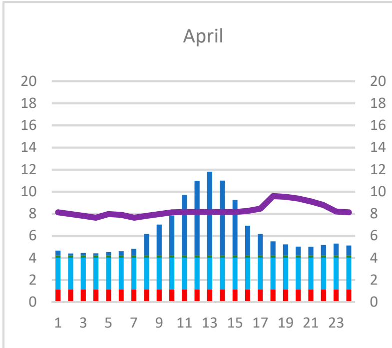
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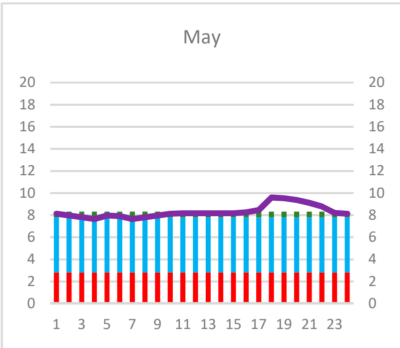
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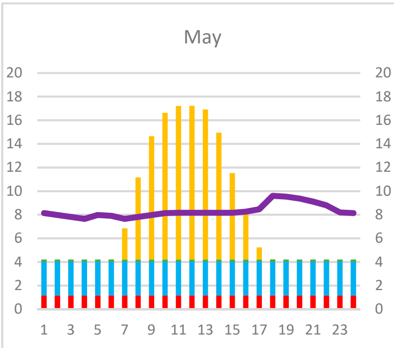
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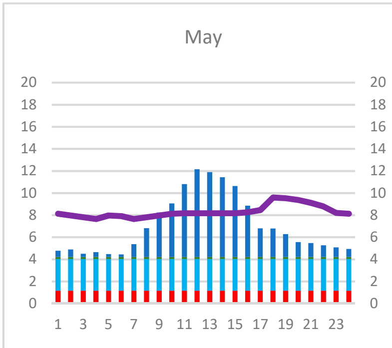
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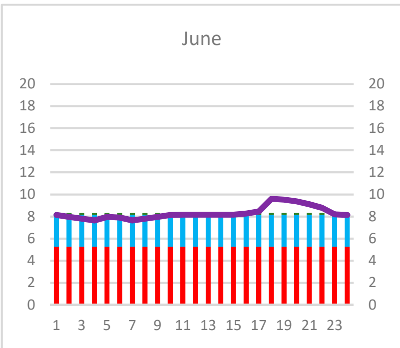
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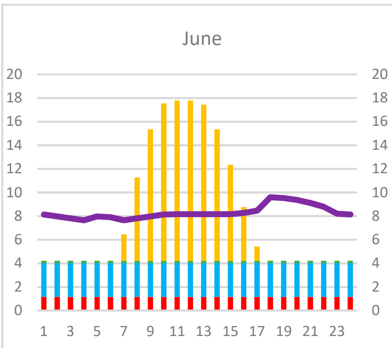
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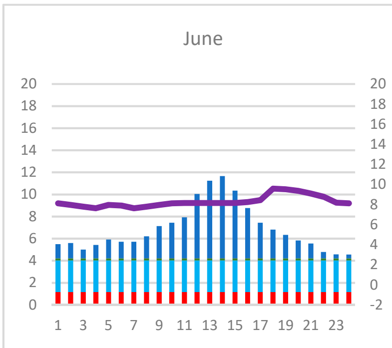
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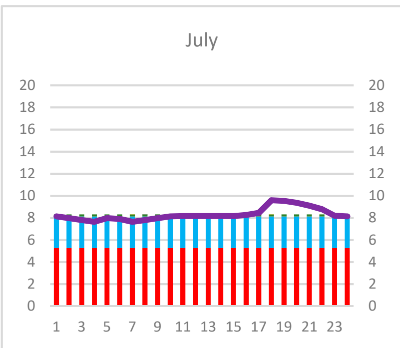
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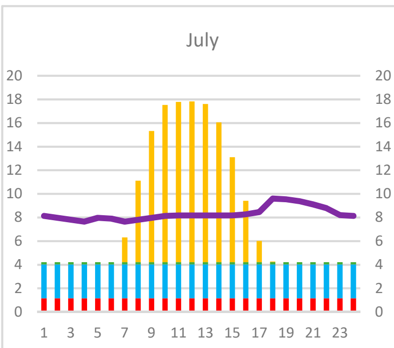
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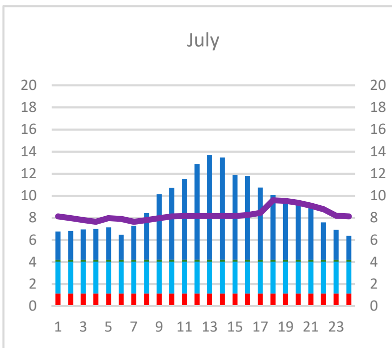
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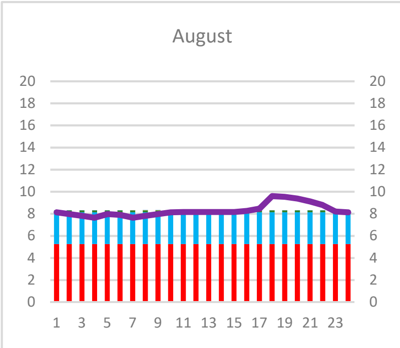
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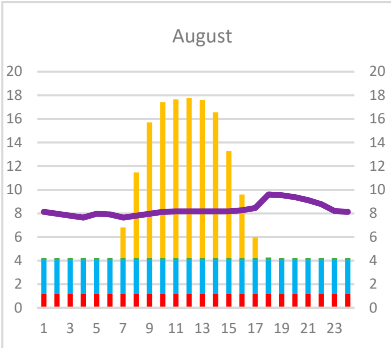
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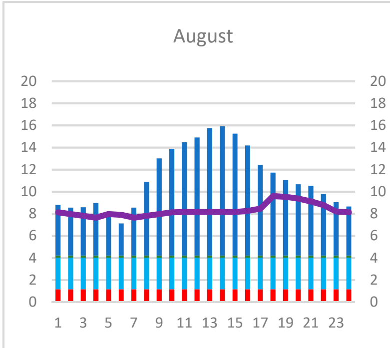
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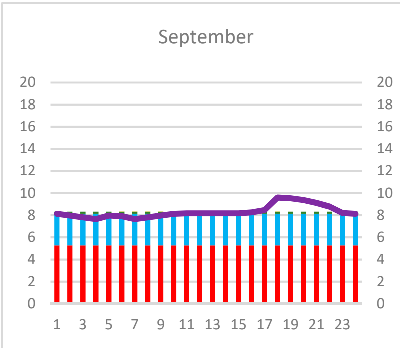
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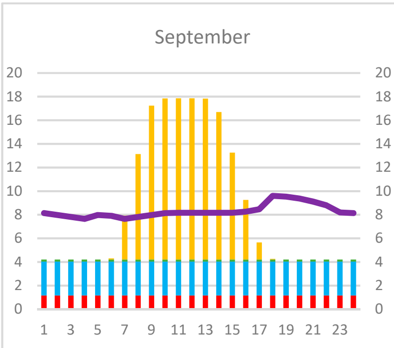
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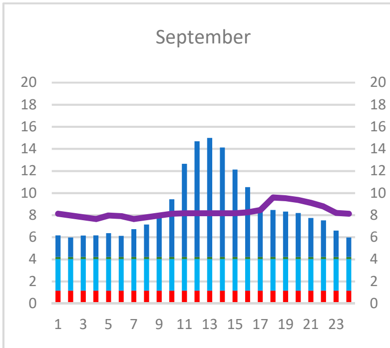
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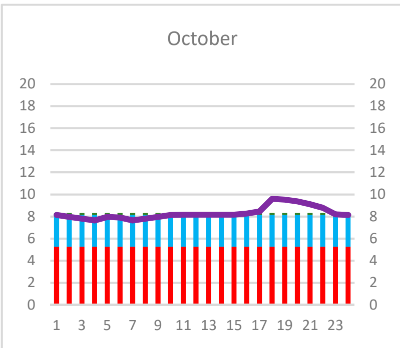
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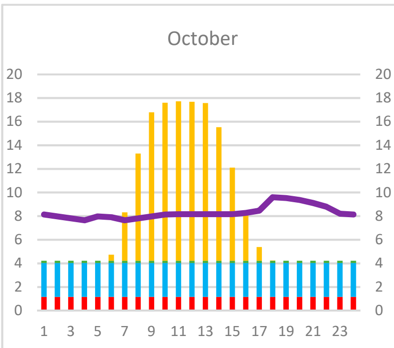
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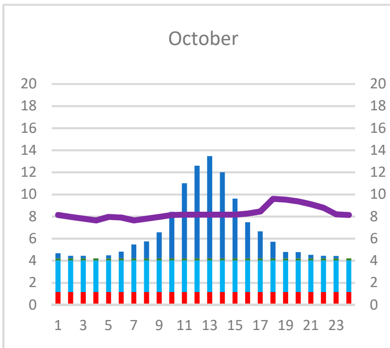
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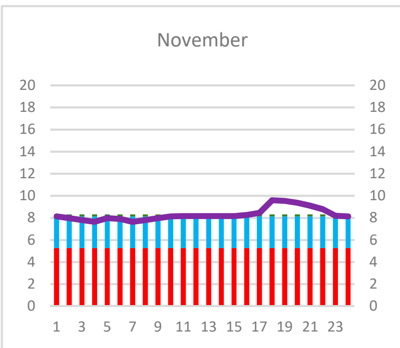
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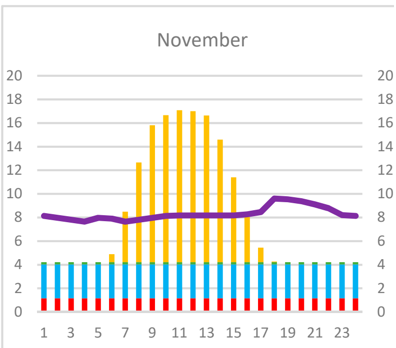
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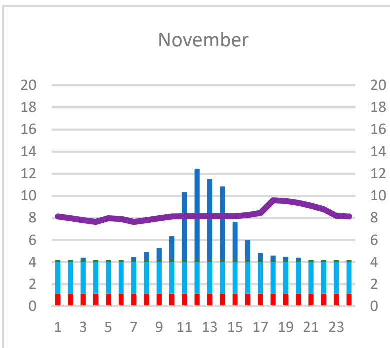
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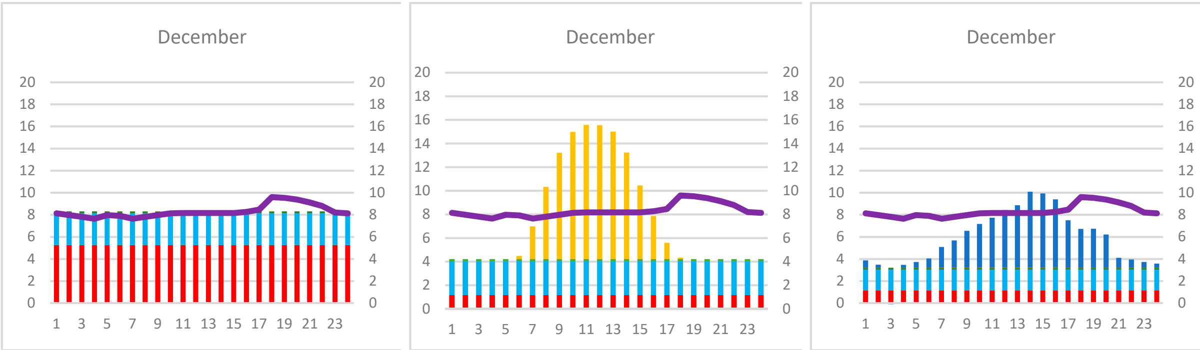
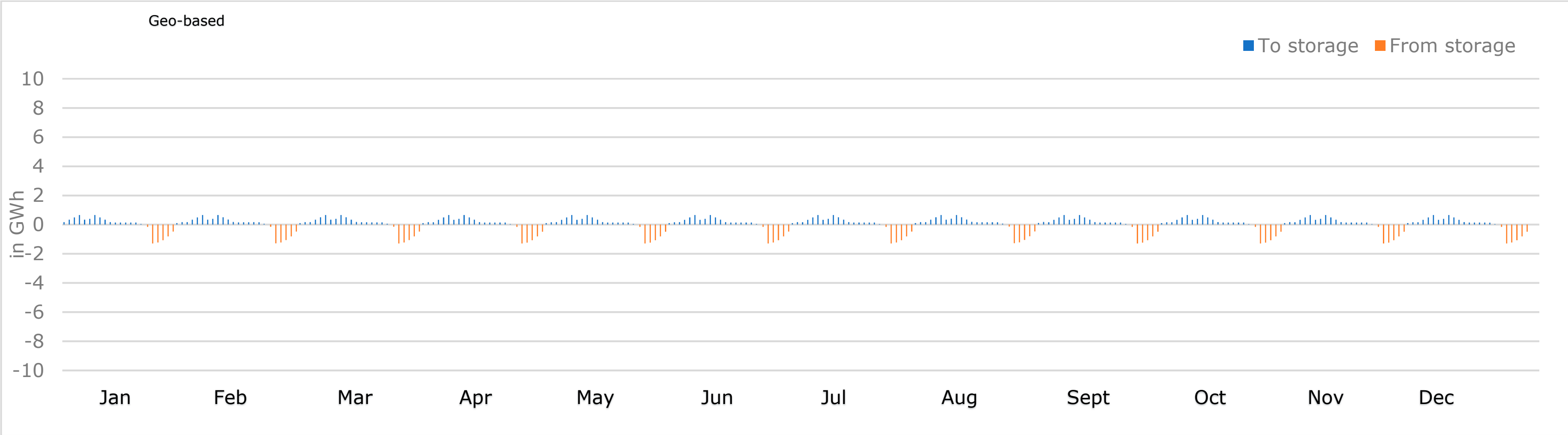
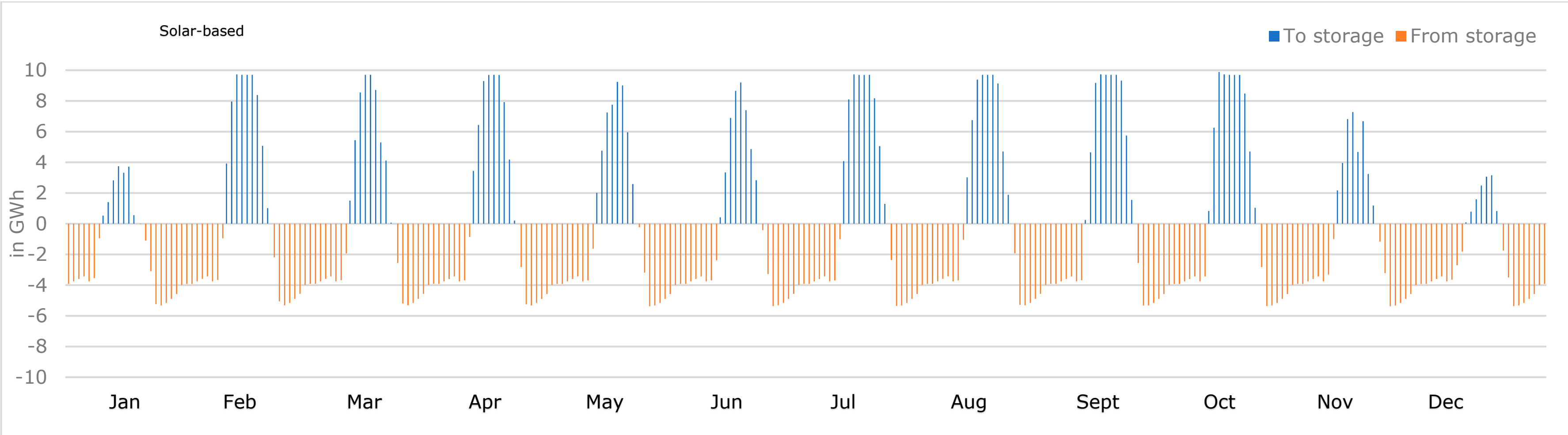


Figure S1. Typical electricity generation on Java and Bali islands for each month in 2020 from three adjusted energy mixes (in GWh).

All excess energy generated will be assigned to energy storage for later use. Figure S2 shows the excess energy that is stored in and extracted from the energy storage for the three scenarios.


Geo-based
To storage
From storage
10
8
6
4
2
0
-2
-4
-6
-8
-10
in GWh
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec


Solar-based
To storage
From storage
10
8
6
4
2
0
-2
-4
-6
-8
-10
in GWh
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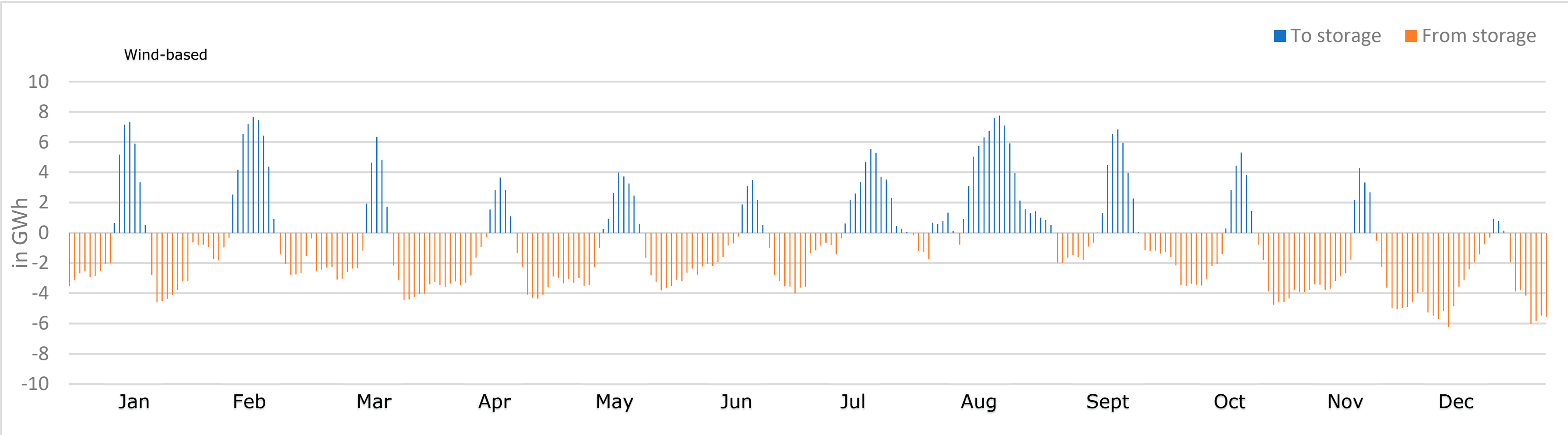

Figure S2. Energy to and from energy storage in GWh for the three energy mixes.

S5 Annual capacity development for each source

Table S4 shows different schemes of capacity development on geo-, solar- and wind-based scenarios to keep up the electricity generation with the electricity demand. Geothermal, hydropower, and MSW potential can meet demand until 2024, 2030, and 2039, respectively, in the geo-based energy mix. From then until 2050, solar and wind energy should lead capacity development. In the solar-based mix, solar energy suffices until 2034, hydropower until 2030, and MSW until 2038. Wind and hydropower should be pivotal until 2043, after which other RES or fossil fuels may complement solar. For the wind-based mix, wind and hydropower potential are effective until 2032 and 2030. Solar, wind, and MSW should dominate until 2046, followed by other RES or fossil fuels.

Table S4. Capacity development for three significant scenarios each year.

Geo-based

Years	Solar Capacity (GW)	Wind Capacity (GW)	Potential of solar and wind (GW)		Status	Geothermal (GW)	Potential of Geothermal (GW)	Status	Hydropower (GW)	Potential of hydropower (GW)	Status	MSW (GW)	Potential of MSW (GW)	Status	Total Required Capacity (GW)	Capacity development/year
2020	0.003	0.001	33.12	24.01	Matched	5.26	6.75	Matched	2.87	4.99	Matched	0.18	0.50	Matched	8.32	0.43
2021	0.003	0.001	33.12	24.01	Matched	5.54	6.75	Matched	3.02	4.99	Matched	0.19	0.50	Matched	8.75	0.48
2022	0.003	0.001	33.12	24.01	Matched	5.84	6.75	Matched	3.18	4.99	Matched	0.20	0.50	Matched	9.23	0.51
2023	0.004	0.001	33.12	24.01	Matched	6.16	6.75	Matched	3.36	4.99	Matched	0.22	0.50	Matched	9.74	0.55
2024	0.004	0.001	33.12	24.01	Matched	6.51	6.75	Matched	3.55	4.99	Matched	0.23	0.50	Matched	10.29	0.59
2025	0.004	0.001	33.12	24.01	Matched	6.88	6.75	Unmatched	3.75	4.99	Matched	0.24	0.50	Matched	10.88	0.62
2026	0.004	0.001	33.12	24.01	Matched	7.28	6.75	Unmatched	3.96	4.99	Matched	0.25	0.50	Matched	11.50	0.66
2027	0.004	0.001	33.12	24.01	Matched	7.69	6.75	Unmatched	4.19	4.99	Matched	0.27	0.50	Matched	12.16	0.70
2028	0.005	0.001	33.12	24.01	Matched	8.13	6.75	Unmatched	4.43	4.99	Matched	0.28	0.50	Matched	12.86	0.73
2029	0.005	0.001	33.12	24.01	Matched	8.60	6.75	Unmatched	4.68	4.99	Matched	0.30	0.50	Matched	13.59	0.78
2030	0.005	0.001	33.12	24.01	Matched	9.09	6.75	Unmatched	4.95	4.99	Matched	0.32	0.50	Matched	14.37	0.81
2031	0.005	0.001	33.12	24.01	Matched	9.60	6.75	Unmatched	5.23	4.99	Unmatched	0.34	0.50	Matched	15.17	0.85
2032	0.006	0.001	33.12	24.01	Matched	10.14	6.75	Unmatched	5.52	4.99	Unmatched	0.35	0.50	Matched	16.02	0.90
2033	0.006	0.001	33.12	24.01	Matched	10.71	6.75	Unmatched	5.83	4.99	Unmatched	0.37	0.50	Matched	16.92	0.95
2034	0.006	0.002	33.12	24.01	Matched	11.31	6.75	Unmatched	6.16	4.99	Unmatched	0.39	0.50	Matched	17.87	1.00
2035	0.007	0.002	33.12	24.01	Matched	11.94	6.75	Unmatched	6.51	4.99	Unmatched	0.42	0.50	Matched	18.88	1.06
2036	0.007	0.002	33.12	24.01	Matched	12.61	6.75	Unmatched	6.87	4.99	Unmatched	0.44	0.50	Matched	19.94	1.12
2037	0.008	0.002	33.12	24.01	Matched	13.32	6.75	Unmatched	7.26	4.99	Unmatched	0.47	0.50	Matched	21.06	1.18
2038	0.008	0.002	33.12	24.01	Matched	14.07	6.75	Unmatched	7.67	4.99	Unmatched	0.49	0.50	Matched	22.24	1.25
2039	0.008	0.002	33.12	24.01	Matched	14.86	6.75	Unmatched	8.10	4.99	Unmatched	0.52	0.50	Unmatched	23.49	1.32
2040	0.009	0.002	33.12	24.01	Matched	15.69	6.75	Unmatched	8.55	4.99	Unmatched	0.55	0.50	Unmatched	24.81	1.39
2041	0.009	0.002	33.12	24.01	Matched	16.58	6.75	Unmatched	9.03	4.99	Unmatched	0.58	0.50	Unmatched	26.20	1.47
2042	0.010	0.002	33.12	24.01	Matched	17.51	6.75	Unmatched	9.54	4.99	Unmatched	0.61	0.50	Unmatched	27.67	1.55
2043	0.011	0.003	33.12	24.01	Matched	18.49	6.75	Unmatched	10.07	4.99	Unmatched	0.65	0.50	Unmatched	29.22	1.64
2044	0.011	0.003	33.12	24.01	Matched	19.53	6.75	Unmatched	10.64	4.99	Unmatched	0.68	0.50	Unmatched	30.86	1.73
2045	0.012	0.003	33.12	24.01	Matched	20.62	6.75	Unmatched	11.24	4.99	Unmatched	0.72	0.50	Unmatched	32.60	1.83
2046	0.012	0.003	33.12	24.01	Matched	21.78	6.75	Unmatched	11.87	4.99	Unmatched	0.76	0.50	Unmatched	34.43	1.93
2047	0.013	0.003	33.12	24.01	Matched	23.01	6.75	Unmatched	12.53	4.99	Unmatched	0.80	0.50	Unmatched	36.36	2.04
2048	0.014	0.003	33.12	24.01	Matched	24.30	6.75	Unmatched	13.24	4.99	Unmatched	0.85	0.50	Unmatched	38.40	2.16
2049	0.015	0.004	33.12	24.01	Matched	25.66	6.75	Unmatched	13.98	4.99	Unmatched	0.90	0.50	Unmatched	40.56	2.28
2050	0.015	0.004	33.12	24.01	Matched	27.10	6.75	Unmatched	14.77	4.99	Unmatched	0.95	0.50	Unmatched	**42.83**	unknown

Solar-based

Years	Solar Capacity (GW)	Wind Capacity (GW)	Potential of solar and wind (GW)	Status	Geothermal (GW)	Potential of Geothermal (GW)	Status	Hydropower (GW)	Potential of hydropower (GW)	Status	MSW (GW)	Potential of MSW (GW)	Status	Total Required Capacity (GW)	Capacity development/year

2020	14.890	0.001	33.12	24.01	Matched	1.16	6.75	Matched	2.87	4.99	Matched	0.18	0.50	Matched	19.10	1.00
2021	15.666	0.001	33.12	24.01	Matched	1.22	6.75	Matched	3.02	4.99	Matched	0.19	0.50	Matched	20.10	1.10
2022	16.523	0.001	33.12	24.01	Matched	1.28	6.75	Matched	3.18	4.99	Matched	0.20	0.50	Matched	21.19	1.18
2023	17.440	0.001	33.12	24.01	Matched	1.36	6.75	Matched	3.36	4.99	Matched	0.22	0.50	Matched	22.37	1.26
2024	18.422	0.001	33.12	24.01	Matched	1.43	6.75	Matched	3.55	4.99	Matched	0.23	0.50	Matched	23.63	1.34
2025	19.470	0.001	33.12	24.01	Matched	1.51	6.75	Matched	3.75	4.99	Matched	0.24	0.50	Matched	24.98	1.43
2026	20.584	0.001	33.12	24.01	Matched	1.60	6.75	Matched	3.96	4.99	Matched	0.25	0.50	Matched	26.40	1.51
2027	21.763	0.001	33.12	24.01	Matched	1.69	6.75	Matched	4.19	4.99	Matched	0.27	0.50	Matched	27.92	1.60
2028	23.010	0.001	33.12	24.01	Matched	1.79	6.75	Matched	4.43	4.99	Matched	0.28	0.50	Matched	29.52	1.69
2029	24.324	0.001	33.12	24.01	Matched	1.89	6.75	Matched	4.68	4.99	Matched	0.30	0.50	Matched	31.20	1.78
2030	25.713	0.001	33.12	24.01	Matched	2.00	6.75	Matched	4.95	4.99	Matched	0.32	0.50	Matched	32.98	1.85
2031	27.155	0.001	33.12	24.01	Matched	2.11	6.75	Matched	5.23	4.99	Unmatched	0.34	0.50	Matched	34.83	1.96
2032	28.680	0.001	33.12	24.01	Matched	2.23	6.75	Matched	5.52	4.99	Unmatched	0.35	0.50	Matched	36.79	2.07
2033	30.290	0.001	33.12	24.01	Matched	2.36	6.75	Matched	5.83	4.99	Unmatched	0.37	0.50	Matched	38.86	2.18
2034	31.991	0.002	33.12	24.01	Matched	2.49	6.75	Matched	6.16	4.99	Unmatched	0.39	0.50	Matched	41.04	2.30
2035	33.788	0.002	33.12	24.01	Unmatched	2.63	6.75	Matched	6.51	4.99	Unmatched	0.42	0.50	Matched	43.34	2.43
2036	35.685	0.002	33.12	24.01	Unmatched	2.78	6.75	Matched	6.87	4.99	Unmatched	0.44	0.50	Matched	45.77	2.57
2037	37.688	0.002	33.12	24.01	Unmatched	2.93	6.75	Matched	7.26	4.99	Unmatched	0.47	0.50	Matched	48.35	2.71
2038	39.805	0.002	33.12	24.01	Unmatched	3.10	6.75	Matched	7.67	4.99	Unmatched	0.49	0.50	Matched	51.06	2.87
2039	42.040	0.002	33.12	24.01	Unmatched	3.27	6.75	Matched	8.10	4.99	Unmatched	0.52	0.50	Unmatched	53.93	3.03
2040	44.400	0.002	33.12	24.01	Unmatched	3.45	6.75	Matched	8.55	4.99	Unmatched	0.55	0.50	Unmatched	56.95	3.20
2041	46.893	0.002	33.12	24.01	Unmatched	3.65	6.75	Matched	9.03	4.99	Unmatched	0.58	0.50	Unmatched	60.15	3.38
2042	49.526	0.002	33.12	24.01	Unmatched	3.85	6.75	Matched	9.54	4.99	Unmatched	0.61	0.50	Unmatched	63.53	3.57
2043	52.307	0.003	33.12	24.01	Unmatched	4.07	6.75	Matched	10.07	4.99	Unmatched	0.65	0.50	Unmatched	67.10	3.77
2044	55.244	0.003	33.12	24.01	Unmatched	4.30	6.75	Matched	10.64	4.99	Unmatched	0.68	0.50	Unmatched	70.86	3.98
2045	58.346	0.003	33.12	24.01	Unmatched	4.54	6.75	Matched	11.24	4.99	Unmatched	0.72	0.50	Unmatched	74.84	4.20
2046	61.622	0.003	33.12	24.01	Unmatched	4.79	6.75	Matched	11.87	4.99	Unmatched	0.76	0.50	Unmatched	79.05	4.44
2047	65.083	0.003	33.12	24.01	Unmatched	5.06	6.75	Matched	12.53	4.99	Unmatched	0.80	0.50	Unmatched	83.48	4.69
2048	68.737	0.003	33.12	24.01	Unmatched	5.35	6.75	Matched	13.24	4.99	Unmatched	0.85	0.50	Unmatched	88.17	4.95
2049	72.596	0.004	33.12	24.01	Unmatched	5.65	6.75	Matched	13.98	4.99	Unmatched	0.90	0.50	Unmatched	93.12	5.23
2050	76.673	0.004	33.12	24.01	Unmatched	5.96	6.75	Matched	14.77	4.99	Unmatched	0.95	0.50	Unmatched	**98.35**	Unknown

Wind-based

Years	Solar Capacity (GW)	Wind Capacity (GW)	Potential of solar and wind (GW)		Status	Geothermal (GW)	Potential of Geothermal (GW)	Status	Hydropower (GW)	Potential of hydropower (GW)	Status	MSW (GW)	Potential of MSW (GW)	Status	Total Required Capacity (GW)	Capacity development/year
2020	0.003	12.27	33.12	24.01	Matched	1.16	6.75	Matched	2.87	4.99	Matched	0.18	0.50	Matched	16.48	0.85
2021	0.003	12.905	33.12	24.01	Matched	1.22	6.75	Matched	3.02	4.99	Matched	0.18	0.50	Matched	17.33	0.94
2022	0.003	13.611	33.12	24.01	Matched	1.28	6.75	Matched	3.18	4.99	Matched	0.18	0.50	Matched	18.27	1.00
2023	0.004	14.367	33.12	24.01	Matched	1.36	6.75	Matched	3.36	4.99	Matched	0.18	0.50	Matched	19.27	1.07
2024	0.004	15.175	33.12	24.01	Matched	1.43	6.75	Matched	3.55	4.99	Matched	0.18	0.50	Matched	20.34	1.15
2025	0.004	16.039	33.12	24.01	Matched	1.51	6.75	Matched	3.75	4.99	Matched	0.18	0.50	Matched	21.49	1.22
2026	0.004	16.956	33.12	24.01	Matched	1.60	6.75	Matched	3.96	4.99	Matched	0.18	0.50	Matched	22.71	1.29
2027	0.004	17.928	33.12	24.01	Matched	1.69	6.75	Matched	4.19	4.99	Matched	0.18	0.50	Matched	24.00	1.36
2028	0.005	18.955	33.12	24.01	Matched	1.79	6.75	Matched	4.43	4.99	Matched	0.18	0.50	Matched	25.36	1.44
2029	0.005	20.038	33.12	24.01	Matched	1.89	6.75	Matched	4.68	4.99	Matched	0.18	0.50	Matched	26.80	1.52
2030	0.005	21.182	33.12	24.01	Matched	2.00	6.75	Matched	4.95	4.99	Matched	0.18	0.50	Matched	28.32	1.58
2031	0.005	22.370	33.12	24.01	Matched	2.11	6.75	Matched	5.23	4.99	Unmatched	0.18	0.50	Matched	29.90	1.67
2032	0.006	23.626	33.12	24.01	Matched	2.23	6.75	Matched	5.52	4.99	Unmatched	0.18	0.50	Matched	31.57	1.76
2033	0.006	24.953	33.12	24.01	Unmatched	2.36	6.75	Matched	5.83	4.99	Unmatched	0.18	0.50	Matched	33.33	1.86
2034	0.006	26.354	33.12	24.01	Unmatched	2.49	6.75	Matched	6.16	4.99	Unmatched	0.18	0.50	Matched	35.19	1.97
2035	0.007	27.833	33.12	24.01	Unmatched	2.63	6.75	Matched	6.51	4.99	Unmatched	0.18	0.50	Matched	37.16	2.08
2036	0.007	29.396	33.12	24.01	Unmatched	2.78	6.75	Matched	6.87	4.99	Unmatched	0.18	0.50	Matched	39.24	2.19
2037	0.008	31.047	33.12	24.01	Unmatched	2.93	6.75	Matched	7.26	4.99	Unmatched	0.18	0.50	Matched	41.43	2.32
2038	0.008	32.790	33.12	24.01	Unmatched	3.10	6.75	Matched	7.67	4.99	Unmatched	0.18	0.50	Matched	43.74	2.45
2039	0.008	34.631	33.12	24.01	Unmatched	3.27	6.75	Matched	8.10	4.99	Unmatched	0.18	0.50	Matched	46.19	2.58
2040	0.009	36.576	33.12	24.01	Unmatched	3.45	6.75	Matched	8.55	4.99	Unmatched	0.18	0.50	Matched	48.77	2.73
2041	0.009	38.630	33.12	24.01	Unmatched	3.65	6.75	Matched	9.03	4.99	Unmatched	0.18	0.50	Matched	51.50	2.88
2042	0.010	40.799	33.12	24.01	Unmatched	3.85	6.75	Matched	9.54	4.99	Unmatched	0.18	0.50	Matched	54.38	3.04
2043	0.011	43.090	33.12	24.01	Unmatched	4.07	6.75	Matched	10.07	4.99	Unmatched	0.18	0.50	Matched	57.43	3.21
2044	0.011	45.509	33.12	24.01	Unmatched	4.30	6.75	Matched	10.64	4.99	Unmatched	0.18	0.50	Matched	60.64	3.39
2045	0.012	48.064	33.12	24.01	Unmatched	4.54	6.75	Matched	11.24	4.99	Unmatched	0.18	0.50	Matched	64.03	3.59
2046	0.012	50.763	33.12	24.01	Unmatched	4.79	6.75	Matched	11.87	4.99	Unmatched	0.18	0.50	Matched	67.62	3.79
2047	0.013	53.614	33.12	24.01	Unmatched	5.06	6.75	Matched	12.53	4.99	Unmatched	0.18	0.50	Matched	71.41	4.00
2048	0.014	56.624	33.12	24.01	Unmatched	5.35	6.75	Matched	13.24	4.99	Unmatched	0.18	0.50	Matched	75.41	4.22
2049	0.015	59.803	33.12	24.01	Unmatched	5.65	6.75	Matched	13.98	4.99	Unmatched	0.18	0.50	Matched	79.63	4.46
2050	0.015	63.161	33.12	24.01	Unmatched	5.96	6.75	Matched	14.77	4.99	Unmatched	0.18	0.50	Matched	**84.09**	unknown

*Orange: solar potential.

*Grey: wind potential.

*Green: status, highlighting that the potential of RES can still be developed to meet the demand.

*Red: the last year of a specific RES can be developed.
*The capacity of each RES after red cell is still growing to show the required capacity to balance the growing demand even though the current potential is insufficient

S6 Annual capacity development
Figure S3 highlighted that only geo-based scenario can meet the electricity demand without any additional extension.

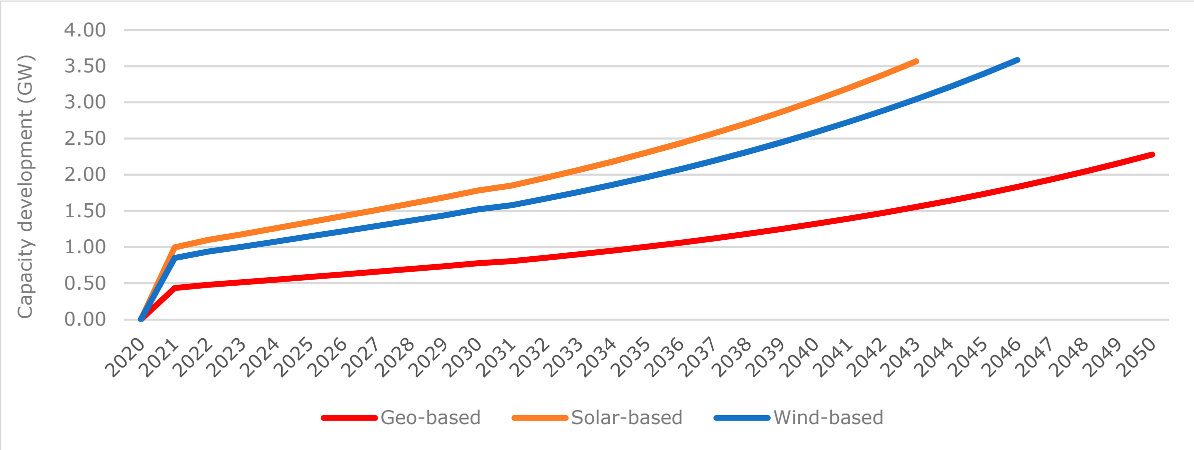

Figure S3. Capacity development per year for the three significant scenarios with average increase/year: geo-based 1.15 GW, solar-based 2.64 GW, wind-based 2.25 GW.

S7 Sensitivity analysis of the wind-based energy mix
Table S5 depicts that the wind-based scenario has a high resistance towards extreme climate. It fails to supply reliable electricity only when the wind speed is lower by 10%. However, there is an alternative to deal with this issue: adding some capacities from solar panels or geothermal energy. It is because the potential of solar and geothermal energy is excessive in Java and Bali.

Table S5. Result of scenario analysis.

	CAPEX	OPEX	ROI %	CO_2 emission (billion tons)	CO_2 reduction (%)	Generation ratio (%)	Reliability	Demand (TWh)	Curtailment (TWh)
Before sensitivity analysis/original scenario (adjusted 6)									
Wind-based	50.07	3.81	138.99	17.90	94.08	100	Reliable	72.76	0
After sensitivity analysis									
Extreme climate *	50.07	3.81	120.08 (-13.61%)	17.47 (-2.40%)	94.23 (+0.14)	95 (-5)	Reliable	72.76	-3.56
37 **	47.48 (+5.18)	4.47 (+17.33)	124.47 (-10.45%)	19.19 (+7.19%)	93.66 (-0.43)	100	Reliable	72.76	0
38***	48.01 (+4.13)	4.42 (+15.98%)	125.79 (-9.50%)	18.84 (+5.25%)	93.77 (-0.31)	100	Reliable	72.76	0
39****	47.74 (+4.65%)	4.73 (+24.30%)	125.12 (-9.98%)	19.00 (+6.13%)	93.72 (-0.36)	100	Reliable	72.76	0

* Extreme climate: 10% higher solar irradiation and 10% lower wind speed.
** 37: wind energy capacity is lowered by 10% and replaced by solar energy.
*** 38: wind energy capacity is lowered by 10% and replaced by geothermal energy.
**** 39: wind energy capacity is lowered byS 10% and replaced by solar (5%) and geothermal energy (5%).

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