SUMMARY OF THE NATIONAL RENEWABLE ENERGY DEVELOPMENT PLAN

1. GENERAL CONTEXT, OBJECTIVES AND PROGRESS OF WORK

The various development goals set by the Government of Cameroon in documents such as the National Development Strategy (SND30) and Vision 2035 require significant transformation and improvement across the country's energy landscape. Given the role that renewable energy can play in meeting the nation's energy needs, a plan to guide investments in various renewable energy projects is essential. Long-term planning with intermittent targets has proven effective around the world in supporting the cost-effective development of energy infrastructure, including the integration of renewables into the generation mix.

This document provides a plan to assist the Department of Renewable Energy and Energy Management in formulating policies and implementing projects to achieve key renewable energy objectives. It employs historical network demand data, information on current rural electrification network and facilities, as well as demand growth rates specified in PDSE 2030 to model different scenarios to meet this demand using available energy resources.

This analysis also supports the proposal of a roadmap for the development of various renewable energy projects in the years to 2040 to achieve existing policy objectives for 2030 and 2035 in the most cost-effective way under different assumptions.

This work was carried out by a team comprising individuals from the public and private sectors, including the Ministry of Water and Energy (MINEE), Ministry of the Environment, Nature Protection and Sustainable Development (MINEPDED), National Electricity Transport Company (SONATREL), Rural Electrification Agency (AER) and Energy of Cameroon (ENEO). The delivery of this programme and the preparation of this report have served to underline the need for an improved data collection system, as well as a dedicated team to continue the modelling and analysis activity for Cameroon's energy system. The draft final document will be proposed for adoption before a panel of high-level sectoral actors, whose comments will be integrated to facilitate additional analyses and perspectives.

2. KEY RESULTS – LONG-TERM RENEWABLE DEVELOPMENT ROADMAP (2035)

The main features of the baseline "Policy Objectives" scenario explored in this analysis are the achievement of a 25% share of renewable energy in the electricity mix and the reduction of 32% of CO_2 emissions by 2035. Using reference demand assumptions, total electricity demand of 20 000 GWh in 2035 is met by production from large hydropower (40%) and gas (35%); with the remainder being met by other renewable energies (small hydropower, solar PV, wind and biomass). Under high demand assumptions, total electricity demand of 35 500 GWh in 2035 is met by production from gas power plants (45%) and large hydropower (30%); with the remainder being met by other renewable energies (small hydropower, solar PV, wind and biomass).

The installed capacity required to assure electricity production under reference demand assumptions increases from around 1 500 MW in 2020 to nearly 3 000 MW in 2030 and 4 000 MW in 2035; while in the high demand scenario, the total installed capacity reaches over 6 000 and 7 700 MW, respectively, in 2030 and 2035. These results show the sensitivity of total installed capacity to potential demand and the type of technology used to meet it.

In addition to scenarios under which renewable energy and CO_2 emission targets are met, the report also explores scenarios that illustrate other challenges Cameroon may face in meeting the demand projected under its economic developmental goals. These include: no new gas resources; low hydropower availability; high demand from intensive industrialisation; high fuel prices, and various combinations thereof. The table below displays the installed capacity required to meet electricity demand by 2035 under each of these scenarios.

The results show that in the case of limited gas supply, the model replaces gas plants with a combination of more diverse sources - especially solar PV, wind, battery storage and hydropower (run-of-river, in the case of average hydropower). Faced with low hydrology, no significant change in installed hydropower is noted, but a decrease in generation is observed; hence, generation from other sources increases to cover electricity demand. In the high demand, no new gas and low hydrology scenario, the model suggests that solar PV, wind and battery storage can be significantly expanded to cover the demand gap, complemented by high exploitation of sustainable biomass, small hydropower and even geothermal.

Table 1

YEAR 2035	DIESEL	HFO	GAS	LARGE HYDRO (DAM)	LARGE HYDRO (ROR)	WIND	SOLAR PV (UTILITY)	SMALL HYDRO	BIO-MASS	BATTERY STORAGE
Policy Objectives (RE/CO_2 target)	199	-	1190	1393	10	43	538	399	200	8
RE/CO_2 target + No Gas	199	-	330	1567	73	300	517	399	200	630
RE/CO_2 target + No Gas + Dry	199	-	330	1581	101	802	768	468	200	588
RE/CO_2 target + High Demand	199	-	3217	1588	137	139	1202	800	400	31
RE/CO_2 target + High Demand + No Gas	202	525	330	1640	988	2134	1777	800	400	1389
RE/CO_2 target + High Demand + No Gas + Dry	203	74	330	1692	477	3222	2656	800	400	1988

Figure 1 Comparison of production between different scenarios

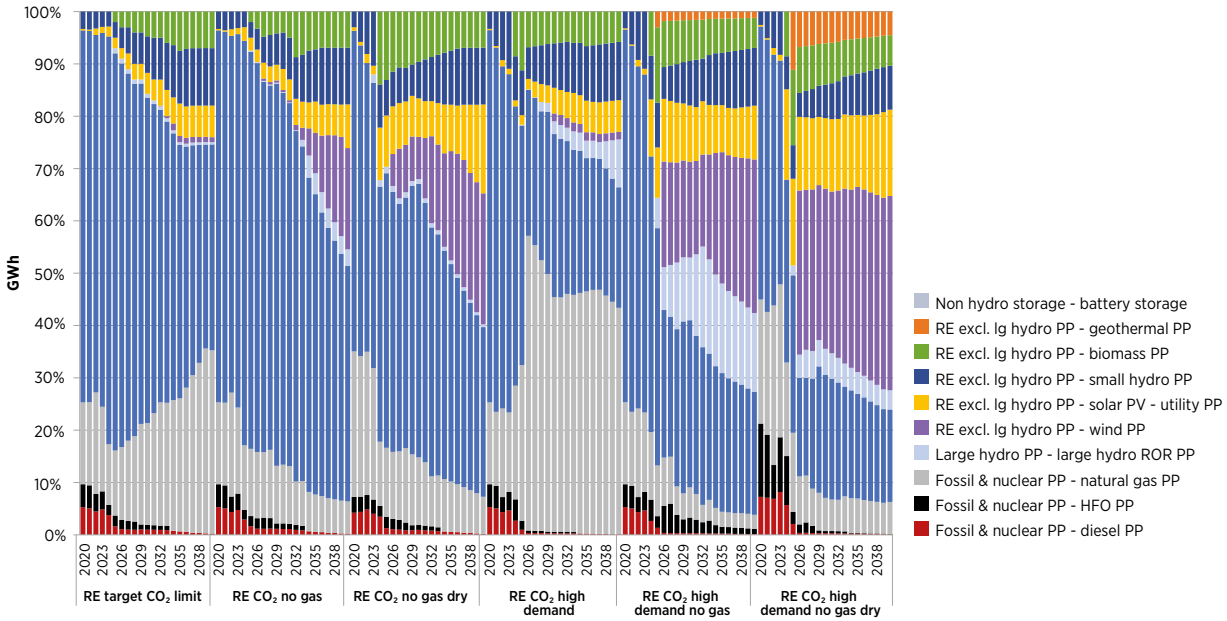


Figure 2 Comparison of electricity generation capacity between different scenarios

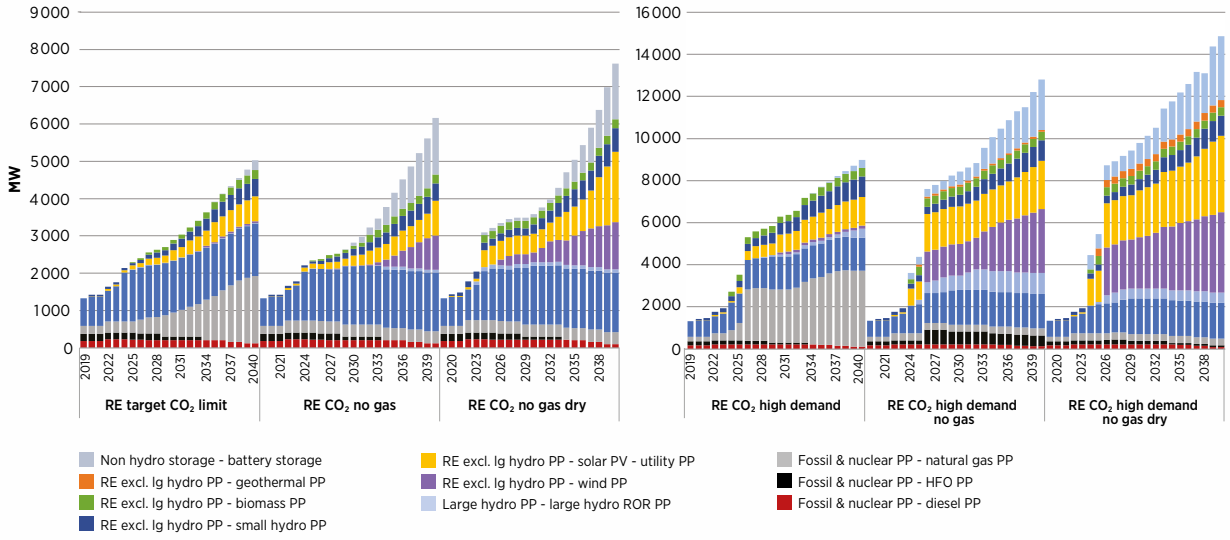


Figure 3 Comparison of new generation capacity for the different scenarios

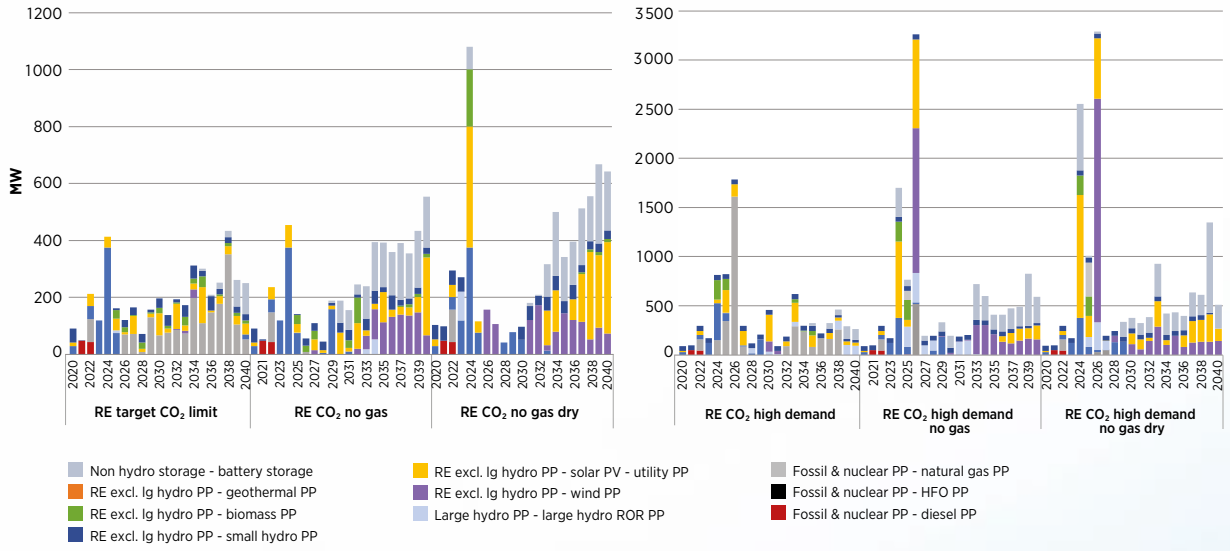


Figure 4 Comparison of required investment between different scenarios

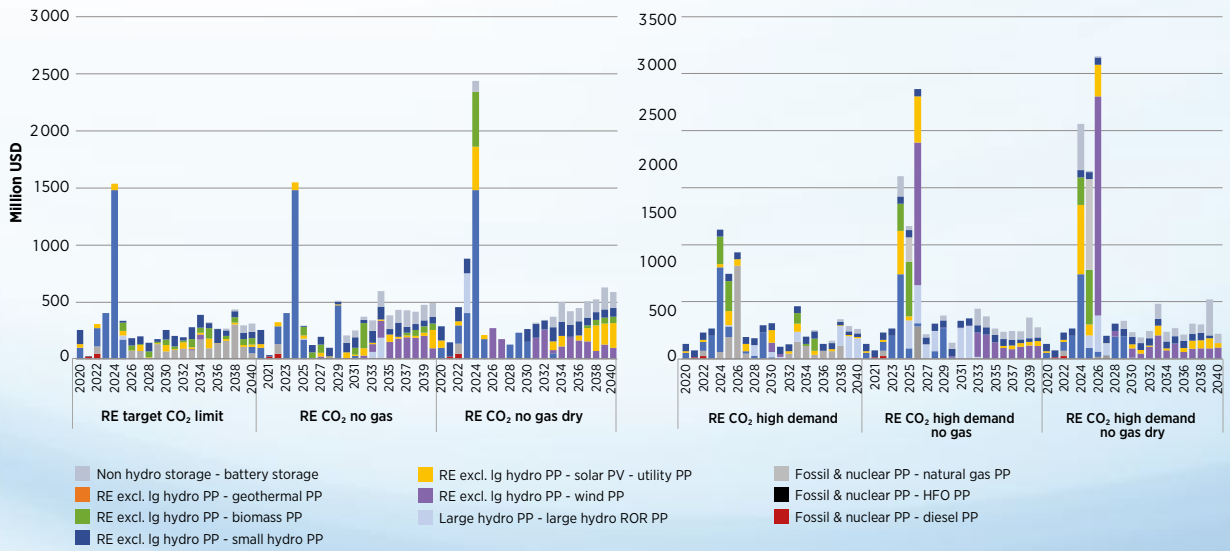
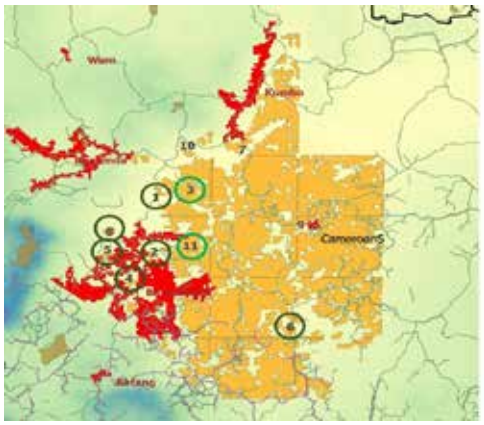
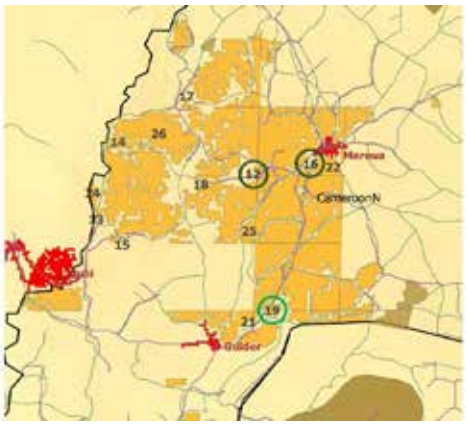


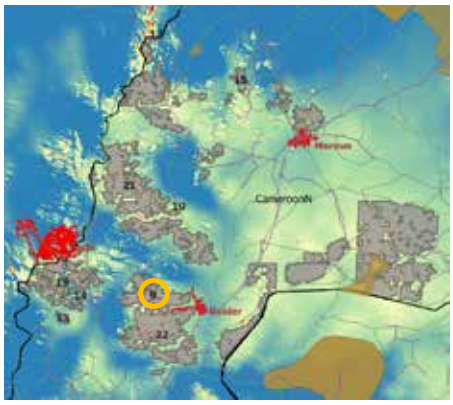
Figure 5 Location of proposed solar zones/projects (dark green = proposed in all scenarios; light green = prominent in specific scenarios)

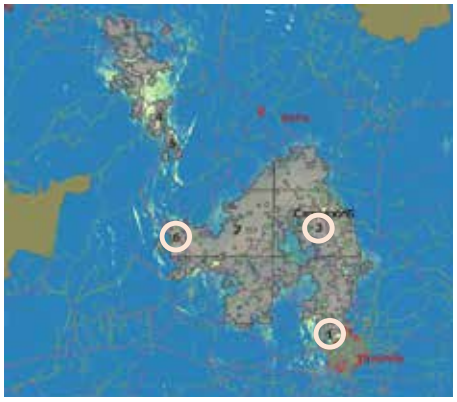




2035	Count	Min	Avg	Max
Solar PV Zone 001	6	27	27	27
Solar PV Zone 002	6	24	24	24
Solar PV Zone 003	2	0	248	804
Solar PV Zone 004	6	21	21	21
Solar PV Zone 005	6	30	30	30
Solar PV Zone 006	6	83	98	99
Solar PV Zone 007	1	0	14	81
Solar PV Zone 008	6	24	24	24
Solar PV Zone 009	1	0	10	57
Solar PV Zone 010	1	0	5	30
Solar PV Zone 011	3	0	354	750
Solar PV Zone 012	6	27	27	27
Solar PV Zone 013	1	0	5	30
Solar PV Zone 014	1	0	12	69
Solar PV Zone 015	1	0	4	24
Solar PV Zone 016	6	12	25	27
Solar PV Zone 017	1	0	4	24
Solar PV Zone 018	2	0	15	45
Solar PV Zone 019	5	0	35	42
Solar PV Zone 020	3	0	11	21
Solar PV Zone 022	4	0	86	171
Solar PV Zone 023	4	0	19	33
Solar PV Zone 024	0	0	0	0
Solar PV Zone 025	2	0	26	117

Figure 6 Location of proposed wind zones/projects (dark orange = selected in all scenarios; light orange = prominent in specific scenarios)





2035	Count	Min	Avg	Max
Wind Zone 001	4	0	25	38
Wind Zone 002	3	0	15	29
Wind Zone 003	2	0	433	1725
Wind Zone 004	2	0	56	167
Wind Zone 005	2	0	28	85
Wind Zone 006	4	0	136	279
Wind Zone 009	6	43	335	588
Wind Zone 010	2	0	12	35
Wind Zone 012	1	0	4	23
Wind Zone 013	1	0	6	35
Wind Zone 014	1	0	4	23
Wind Zone 015	3	0	59	99
Wind Zone 016	1	0	14	82
Wind Zone 017	0	0	0	0
Wind Zone 020	0	0	0	0
Wind Zone 021	2	0	43	139
Wind Zone 022	0	0	0	0

3. KEY RESULTS – SHORT-TERM RENEWABLE DEVELOPMENT ROADMAP (2025)

The results include a short-term roadmap to achieve these capacities, including construction of specific renewable energy projects such as solar, wind, small hydro and biomass power plants. The renewable capacities proposed for implementation in the short term to 2025 under each scenario are shown in the table below. In the Policy Objectives scenario (with reference demand and all technologies unconstrained in the model), there is a total of 131 MW of solar PV, 31 MW of biomass and 58 MW of small hydro built by 2025. However, if high demand is expected, with no new gas built, and the risk of low hydrology is realised, a total of 1 519 MW of solar PV, 400 MW of biomass, 300 MW of small hydro - and even 345 MW of geothermal and 695 MW of battery storage - is suggested by the model to be built by 2025.

It should be noted that wind power becomes important in several scenarios beyond 2025. In scenarios where high demand is expected, the model suggests a need to begin building wind power capacity as early as 2026; in a scenario with high demand, no new gas and low hydrology, the model suggests building over 2 GW between 2026 and 2030. In the basic Policy Objectives scenario (with reference demand and all technologies unconstrained), the first wind power plant appears in the grid by the year 2032.

Table 2

SCENARIO	SOLAR PV (UTILITY)	BIOMASS	GEOTHERMAL	SMALL HYDRO	BATTERY STORAGE
Policy objectives (RE/CO_2 target) 2020-2025	131	31	-	58	-
RE/CO_2 target + no gas 2020-2025	163	31	-	58	-
RE/CO_2 target + no gas +dry 2020-2025	531	200	-	200	79
RE/CO_2 target + high demand 2020-2025	323	310	-	300	-
RE/CO_2 target + high demand + no gas 2020-2025	903	400	93	300	359
RE/CO_2 target + high demand + no gas + dry 2020-2025	1 519	400	345	300	695

In terms of specific projects, the table below provides a sense of what renewables are suggested to be built by 2025 in the scenario with the least amount of overall capacity required (basic Policy Objectives scenario) and the scenario with the most amount of overall capacity required (the Policy Objectives scenario with high demand, no new gas and low hydrology). In addition to solar PV plants already in progress (P166 and Guider Maroua Rental), the model suggests that at least USD 64 million be invested in four solar PV projects totalling 65 MW by 2025 under the basic Policy Objectives scenario. In a scenario where more capacity is needed, the model suggests to go beyond these projects to build additional solar capacity in the Solar PV zones identified in this analysis, with a total investment of USD 1 356 million across 12 different solar PV zones in the north and south by 2025, totalling 1 410 MW of capacity.

Although there are no specific projects already identified for other renewable technologies, by 2025 the model suggests the possibility of investing in small hydropower (USD 145 million for 58 MW) and sustainable biomass (USD 74 million for 31 MW) under the basic Policy Objectives scenario. In the scenario with most capacity needs, the model suggests investing in additional small hydro and biomass by 2025 (USD 750 million for 300 MW and USD 1 442 million for 400 MW, respectively) but also possibly geothermal (USD 1 590 million for 345 MW) and battery storage (USD 834 million for 695 MW) to complement the additional solar PV.

Table 3

		POLICY OBJECTIVES (RE/CO_2 TARGET)		RE/CO_2 TARGET + HIGH DEMAND + NO GAS + DRY	
	2020-2025	**CAPACITY (MW)**	**INVESTMENT (MILLIONS USD)**	**CAPACITY (MW)**	**INVESTMENT (MILLION USD)**
Solar PV	Solar PV Zone 001	-	-	27	26
	Solar PV Zone 005	-	-	30	28
	Solar PV Zone 004	-	-	21	19
	Solar PV Zone 002	-	-	24	22
	Solar PV Zone 008	-	-	24	23
	Solar PV Zone 003	-	-	804	799
	Solar PV Zone 010	-	-	30	30
	Solar PV Zone 019	-	-	42	32
	Solar PV Zone 016	-	-	8	6
	Solar PV Zone 012	-	-	27	21
	Solar PV Zone 011	-	-	274	260
	Solar PV Zone 006	-	-	99	89
	P166	36	100	24	68
	GUIDER_ MAROUA_RENT	30	-	30	-
	MAROUA_SOLAR	15	15	15	15
	GUIDER_SOLAR	10	10	10	10
	GAROUA_AIRPORT	30	29	30	29
	Mbalmayo_JCM_Solar_Grid	10	10	-	-
Biomass	Generic Bagasse	31	74	200	482
	Generic Energy from Waste	-	-	200	960
Geothermal	Generic Geothermal	-	-	345	1590
Small hydro	Generic Hydro Small	58	145	300	750
Battery storage	Battery storage	-	-	695	834
Total		220	383	3 259	6 093

Note: All costs based on assumptions used in the modelling exercise – real costs may differ and all projects require proper exploratory studies.

Figure 7 Location of proposed solar zones/projects (dark green = proposed in all scenarios; light green = prominent in specific scenarios)

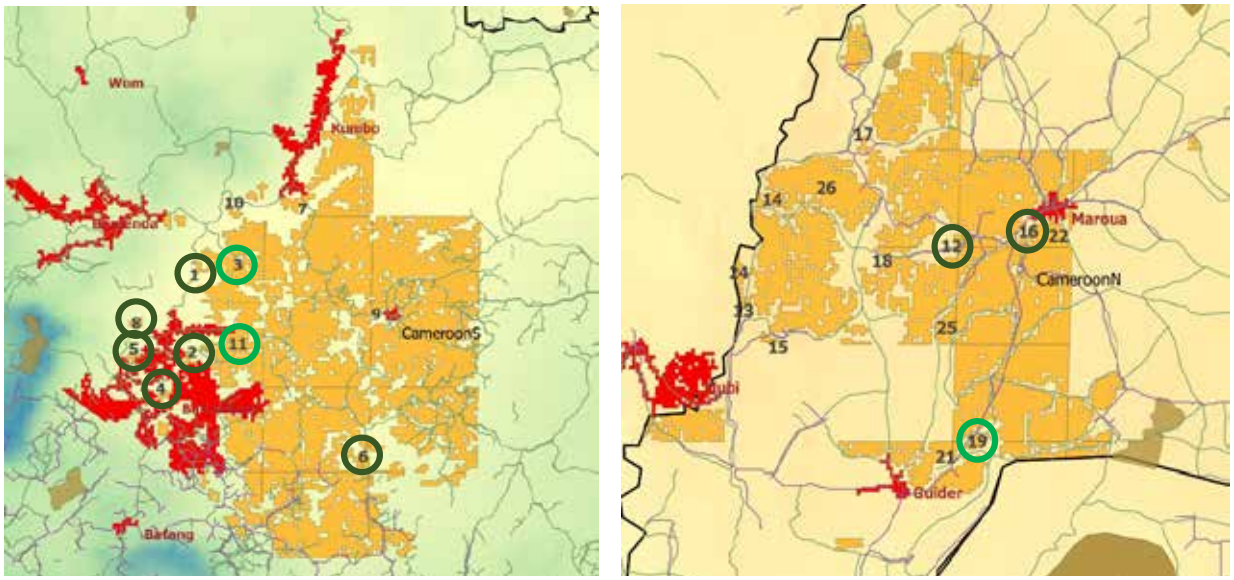


Figure 8 Proposed renewable energy projects to be implemented from 2022-2040 (Policy Objectives scenario)

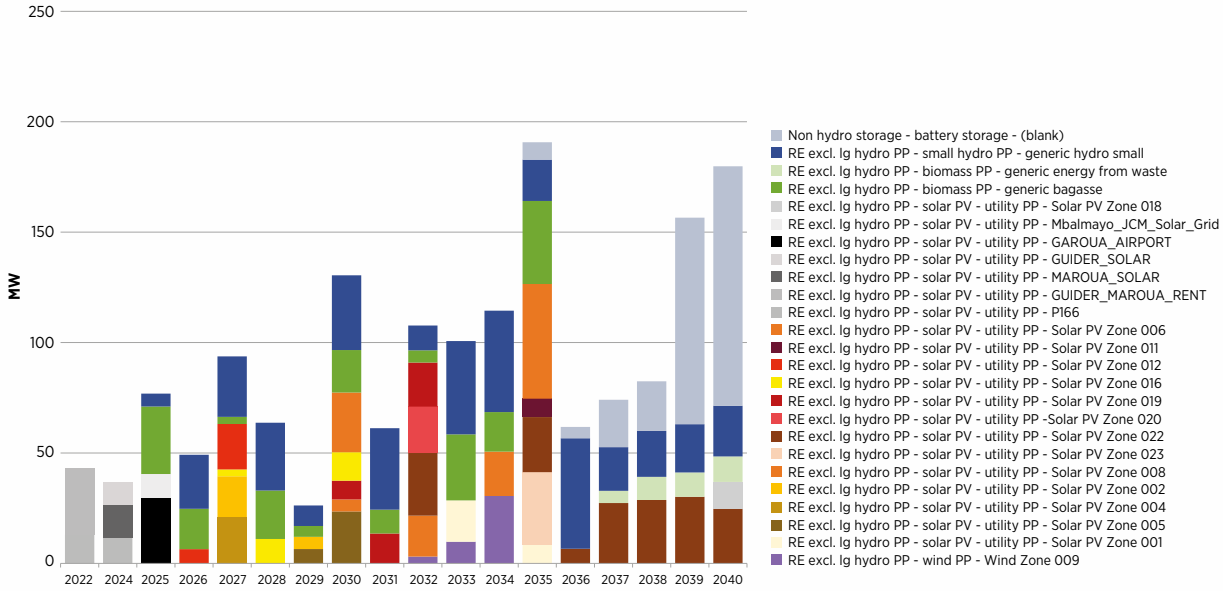
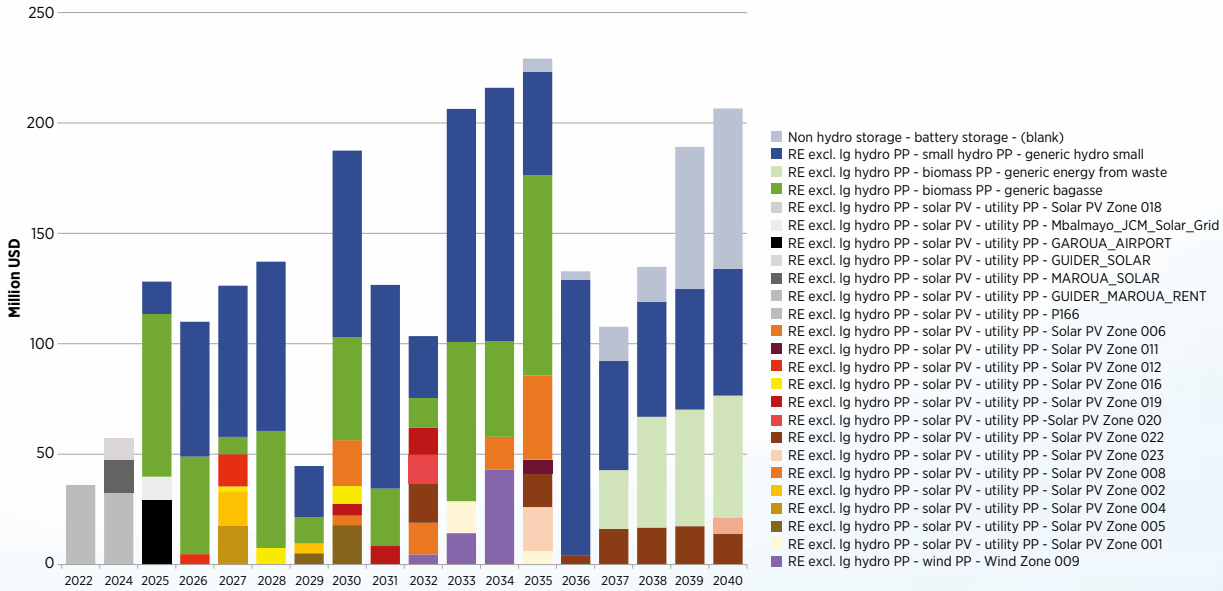


Figure 8 Projected Investments for the implementation of renewable energy projects in 2022-2040 (Policy Objectives scenario; million USD)



4. KEY MESSAGES FROM THE ANALYSIS

The major objective of the Plan is to provide a roadmap to achieve an optimal and successful renewable energy integration into the electricity mix, based on the various policies in place. The results presented were analysed to provide more insight into the following policy aspects.

4.1. Energy supply sufficiency

To date, most of the electricity consumed in Cameroon is supplied by large hydro, followed by fossil fuels. While hydro is limited by location, fluctuating hydrology and high investment costs, fossil fuels are today limited by their pollution factor and the rising cost of fuel. The results show that a large quantity of electricity can be generated from renewable resources such as wind and solar in zones with previously unrecognised potential. While electricity can be produced from solar farms in areas such as Bafang, Bamenda, Kumbo and Wum in the south of the country, there is also wind potential in Bamenda, Bafoussam, Bafia and other areas close to Yaoundé.

The demand for electricity is expected to rise from 7 246 GWh in 2021 to 14 531, 17 593, and 18 776 GWh by the year 2035, in the low, medium and high demand scenarios, respectively, based on the projections of the PDSE. The supply of electricity in all these scenarios illustrates the potential for renewables to become a major electricity supply option in meeting electricity demand and delivering associated targets.

4.2. Promotion of industrialisation

The economic development objectives of the country rely upon its ongoing industrialisation, they are undermined, however, by insufficient electricity supply. Therefore, electricity production is required not only to meet residential and commercial consumption, but more importantly, to satisfy the needs of the industrial sector. Renewable energy projects proposed by the model in various areas support this industrialisation, through the implementation of large-scale grid-connected projects. The presence of large-scale projects connected to the grid supplying cheap solar, biomass and wind energy would not only serve local industries - supporting their expansion - but also provide opportunities to attract foreign investment in various sectors. Meanwhile, small-scale projects like small hydro and mini solar plants would not only initiate the industrialisation of hitherto manual enterprises in rural areas, but also enable these structures to grow to enable secondary products. Achieving this level of industrialisation without renewable energy will lead to a significant increase in CO_2 emissions, which Cameroon is committed to reducing in its Nationally Determined Contribution (NDC).

4.3. Access to affordable electricity

One of the objectives of Vision 2035 is to provide universal access to electricity by the end of the planning horizon. According to the 2016 Energy Balance of Cameroon, electricity access in rural areas is about 32%, which provides some idea of the intensive work required to reach 100%. Whilst projects like the P166L - which has served to introduce electricity services to some rural populations- and grid extensions are ongoing, these will not be sufficient to achieve universal access, given the rapid rise in electricity demand in rural areas. This explains the why the results provided by the model support the development of various renewable energy projects close to consumption sites to satisfy demand.

4.4. The National Renewable Energy Development Plan and policy

The role of renewable energy in sustainable development is clearly demonstrated in this report. However, the successful implementation of these renewable energy projects requires both a strong commitment and a favourable policy environment. The Plan, and the associated modelling, identifies which renewable energy projects to develop, and the associated investments required, throughout the planning period. It also shows that a clear path from project development to commissioning is needed that establishes the stakeholder, timelines, procedures and fees involved. This would provide transparency to investors on the process of implementing renewable energy projects in Cameroon and enable the timely completion of projects.

5. ENERGY POLICY PROPOSITIONS

This report proposes a number of policy, regulatory and institutional changes that may enable the successful implementation of the Plan. These include: the use of appropriate tender and reverse auctions; the introduction of the renewable portfolio standard; a feed-in tariff scheme; a renewable and alternative energy agency; a law specific to renewable energy. An appropriate tender and reverse auction procedure would provide a platform for granting authorisation for the most efficient forms of renewable energy production at optimal cost. Introducing the renewable portfolio standard policy would lead to the rapid uptake of renewable energy as well as generate funds for further development. The feed-in tariff scheme will attract more investment in the sector and assist in realising this plan. Moreover, the creation of an agency in charge of implementing and coordinating renewable energy projects in Cameroon would go a long way toward realising successful implementation. Finally, a law dedicated to renewable energy is essential to achieving various targets fixed by Cameroon relating to emission reduction and the energy transition, supporting a sustainable energy system that is fit to support the development goals of Cameroon.