



Development of the Energy Balance Statistics and Energy Systems Model for the Union of Comoros



Copyright © 2018
United Nations Economic Commission for Africa
www.uneca.org

All rights reserved.
The text and data in this publication may be reproduced as long
as the source is cited. Reproduction for commercial purposes is
forbidden.

Disclaimer
This report is the result of the analysis of a study commissioned by
the United Nations Economic Commission for Africa, Sub-Regional
Office for Eastern Africa (UNECA SRO-EA). However, the report
does not purport to represent the views or the official policy of the
institution or of any SRO-EA member country.

Contents

Executive summary	7
Acknowledgements	9
1. Introduction	10
Country background.....	10
Overall aims and specific objectives of this study	11
Description of the energy system.....	11
2. Study methods	17
Data gathering process and stakeholder involvement	17
LEAP: a tool for energy system modelling	17
The energy balance format.....	19
Scenario selection and analysis	20
3. Data inputs and assumptions	21
Cross-cutting assumptions.....	21
Data pertaining to final energy demands	21
Data entry in LEAP	21
Data processing for energy statistics	21
4. Historical energy statistics	23
Grande Comore energy statistics	25
Anjouan energy statistics	27
Mohéli energy statistics	29
5. Building energy scenarios	31
5.1 Reference scenario (REF)	32
5.2 National Energy Independence (ENE1)	35
5.3 Accelerated Electricity Access (ENE).....	37
5.4 Biomass Energy Transition (BIO)	38
5.5 Combined scenarios (COM)	40
6. Conclusions and recommendations	44
7. References	46
Appendix 1	48
Appendix 2	51
Appendix 3	52

List of Acronyms

DEA	Direction de l'Eau et de l'Assainissement
DEM	Direction de l'Energie et des Mines
DER	Direction des Energies Renouvelables
DG	Direction Générale
DGEME	Direction Générale de l'Energie, des Mines et des l'Eau
EDA	Electricité d'Anjouan
EPS	Service d'Etudes, Planification et Statistiques
GDP	Gross domestic product
HFO	Heavy fuel oil
IEA	International Energy Agency
LCOE	Levelized cost of energy
LDC	Least Developed Country
LEAP	Long-range Energy Alternatives Planning
MAMWE	Gestion de l'Eau et de l'Electricité aux Comores
OECD	Organisation for Economic Cooperation and Development
SA	Service de l'Assainissement
SAEMR	Service Accès, Efficacité et Maitrise des ressources
SCA2D	Strategy for Accelerated Growth and Sustainable Development
SCH	Société Comorienne des Hydrocarbures
SE	Service de l'Energie
SEI	Stockholm Environment Institute
SERVP	Service Etudes, Recherche et Valorisation du Potentiel
SM	Service des Mines
SRE	Service des Ressources en Eau
TPES	Total Primary Energy Supply
UNECA	United Nations Economic Commission for Africa

List of Tables

Table 1: Renewable Energy potential in Comoros.....	14
Table 2: National energy balance for Comoros in 2017, all islands combined (in terajoules)	23
Table 3: Energy balance summary by region for Comoros in 2017, all fuels combined (in terajoules).....	24
Table 4: 2017 energy balance for Grande Comore (in terajoules)	26
Table 5: 2017 energy balance for Anjouan (in terajoules)	28
Table 6: 2017 energy balance for Mohéli (in terajoules)	30
Table 7: National Energy Independence scenario assumptions	36
Table 8: Installed and additional capacity to achieve 55% renewable energy options (in MW).....	36
Table 9: LPG requirements for household and commercial sectors in the reference and BIO scenario	41
Table 10: Plant capacity for the combined scenarios	43

List of figures

Figure 1: Real annual growth rate in Comoros	10
Figure 2: National energy mix in 2017	12
Figure 3: Petroleum product imports distribution in 2017	13
Figure 4: Government agencies with energy-related mandates, and an assessment of overlap/interlinkage among their respective roles.....	15
Figure 5: Proposed Institutional arrangement in DGEME. Acronyms defined at the beginning of this report	16
Figure 7: The main LEAP interface	18
Figure 6: List of stakeholders consulted for historical data, and the type of data sought from each	18
Figure 8: An example of an energy balance table, showing different flows (in rows) and energy commodities (in columns)	19
Figure 9: Simplified high level energy balance computation expression.....	20
Figure 10: LEAP tool work space.....	22
Figure 11: Sankey diagram energy flow of Comoros	24
Figure 12: Share of total final energy demand by sector in Grande Comore	25
Figure 13: Share of total final energy demand by fuel in Grande Comore.....	26
Figure 14: Energy flow Sankey diagram of Grande Comore.....	27
Figure 15: Share of total energy demand by sector in Anjouan	27
Figure 16: Share of energy demand by fuel in Anjouan.....	28
Figure 17: Energy flow Sankey diagram of Anjouan	29
Figure 18: Share of total energy demand by sector in Mohéli	29
Figure 19: Share of total final energy demand by fuel in Mohéli	30
Figure 20: Energy flow Sankey diagram of Mohéli.....	31
Figure 21: Energy demand by sector in medium-term projection	33
Figure 22: Fuel contribution to final energy demand by sector.....	33
Figure 23: National petroleum products required to meet final energy demand	34
Figure 24: Fuel requirement for electricity generation.....	35
Figure 25: Electricity generation by plant	35
Figure 26: Renewable energy proportions in the Energy Independence scenario	37
Figure 27: Accelerated Electricity Access scenario compared to Baseline scenario	39
Figure 28: Energy demand and generation in Accelerated Electricity Access scenario	39
Figure 29: Share of households adopting alternative cooking fuels	40
Figure 30: Transition from wood to LPG	41
Figure 31: Energy demand in all scenarios.....	42
Figure 32: Percent share for fuel for final energy demand	42
Figure 33: Electricity supply in all scenarios	43

Executive summary

This report is developed as part of an advisory service request made to UNECA by the Government of the Union of Comoros. The request was for the development of national energy balance statistics to bridge gaps in the energy information system, as well as for the development of a national energy systems model to support energy sector planning, the analysis of the National Energy Strategy and the delivery of capacity development in energy planning. This report focuses on the development of Comoros' first energy balance statistics (for 2017) and on a nationally and regionally disaggregated energy systems model. It also analyses model scenarios on the basis of targets specified in the Energy Strategy 2033.

The energy sector of Comoros is characterized by a reliance on firewood and petroleum products as the two main sources of final energy consumption in the country (which totals 6,487 terajoules (TJ) per year). The energy mix is 57% biomass, 2% electricity and 41% oil products. The role of renewable energy in generation is gradually increasing, but is still negligible compared to conventional energy sources. Considering the different sectors, household energy consumption accounts for 63% of total final energy consumption; the other main sources are the transport sector (32%) and the industrial and commercial sector (5%). Most of the biomass consumed is used for households and restaurants (93%) and ylang-ylang (essential oil) distilling (7%). The petroleum products consumed are all imported and are used for transport, electricity generation and household use. Comoros relies mainly on thermal generation of electricity from fossil fuels (219.11 million kilowatt hours (kWh)), while using some hydro (8.65 million kWh) and minimal solar energy. The high cost of electricity is mainly attributed to the dilapidated state of the distribution grid, which gives rise to over 40% losses in energy transmission. The management challenges of the state-owned utility (MAMWE) and high costs of imported fuel also increase the delivered cost of energy.

To develop the energy balance statistics, the International Energy Agency guidelines were used; energy data was thus gathered at the decentralized level of each island (Grande Comore, Anjouan and Mohéli) and combined for the national energy balance statistics. These statistics indicate that the country's total primary requirements stood at over 7.5 petajoules (PJ) in 2017, over half of which arose in Grande Comore. Nationally, this indicates an average annual requirement of 9.1 gigajoules (GJ) per capita. Among final energy demands, the average annual electricity consumption per person in Comoros was 66.1 kilowatt hours (kWh) per capita. Comparatively, the average electricity consumption across all Least Developed Countries was just over 200 kWh/capita in 2014. The energy intensity of the Comoros economy was USD 0.19 per megajoule (MJ) in 2017, similar to economic intensities observed in other Least Developed Countries. Energy requirements are dominated by wood and other biomass, satisfying nearly half of primary energy needs in 2017. This is followed by diesel consumption, which is also used for power generation. Gasoline and kerosene are important fuels for transportation, and households also rely on kerosene for cooking needs. All petroleum products are imported.

The Energy Strategy 2033 of the Union of Comoros specifies targets to be achieved. On the basis of the national and regional energy systems model developed in the Long-range Energy Alternatives Planning (LEAP) tool, five scenarios from the strategy are analysed to demonstrate a pathway for their achievement. The first is a Reference Scenario based on historic growth trends. The second is the National Energy Independence Scenario, which requires the share of renewable energy to increase to 10% by 2018 and 55% by 2033. To achieve the required dispatch mix, the national installed capacity of renewables on each of the islands was 9.4 MW, based on baseline electricity demand projection.

The third is the Accelerated Electricity Access Scenario, seeking to increase electrification to 60% by 2018 and 100% by 2033. To meet this goal, electricity demand would increase by 55% in 2033 to 135 GWh, requiring Comoros to generate an additional 23 MW power capacity to satisfy the demand. The fourth is the Biomass Energy Transition Scenario, seeking to reduce the contribution of wood fuels in the country's overall energy consumption to 65% by 2018 and 25% by 2033. In implementing this policy, Comoros would be able to save 20% of total final energy demand from the baseline and reduce total wood requirement for final energy delivery by 64%. The rise in LPG demand in this ambitious scenario requires concerted action and active private sector involvement.

A Combined Scenario analysis is also conducted for all these policy measures. On the supply side, the National Energy Independence scenario results in the decrease of electricity generation by 25% (from 145 GWh to 109 GWh) in 2033. This is attributed to grid stabilisation and reduced grid losses. The Biomass

Energy Transition (BIO) scenario has minimum effect on electricity supply. The Accelerated Electricity Access Scenario steeply increases electricity demand, increasing the generation requirement to 226 GWh – 56% higher than the Reference Scenario. But a combined implementation of the Accelerated Electricity Access and National Energy Independence scenarios keeps down the increase to 17%. This is attributed to the savings from an enhanced grid network and a more efficient renewable energy technologies mix.

In conclusion, the energy balance statistics for Comoros (2017) showed that 51% (or 3,820 TJ) of the total energy consumed is imported, while 49% (or 3,742 TJ) is generated within Comoros. Most of this generated energy is the firewood used in the residential sector for cooking. The total primary supply of energy on each of the three islands was 4,392 TJ for Grande Comore, 2,759 TJ for Anjouan and 411 TJ for Mohéli in 2017. However, an average of 13% of this energy is lost during transformation, transmission and distribution. Comoros has a great opportunity to reduce these losses through grid stabilisation.

The projections indicate that Comoros' energy demand up to the year 2033 will grow from 6,597 TJ in 2017 to 11,189 TJ in 2033 in the baseline (reference) scenario. This would be met by 9,383 TJ in total energy supply, made up of 72% oil products, 22% biomass and 6% renewable.

The following key recommendations are made to strengthen the country's energy planning capacity and relevant energy statistics:

1. Based on the 2017 Energy Balance Statistics developed at island and national levels, subsequent updates and reporting of energy balance statistics should be pursued by organizing national data in accordance with the baseline balance statistics established and the IEA guidelines.
2. Strengthen the Energy Planning Unit within the Directorate General of Energy, Mining and Water as a hub for collecting and organizing energy sector data and to implement the national energy systems model to respond to energy sector policy and planning requirements.
3. Support institutionalization of the annual production of the national Energy Balance Statistics report by the Directorate General of Energy, Mines and Water Resources.
4. Maintain a national biomass inventory to support evaluation of sustainable biomass use and improve on biomass energy planning.
5. Conduct additional data gathering to fill the gaps in the developed national and regional energy systems models to improve the accuracy of the model for policy and planning uses.

Finally, it is essential that Comoros continually build capacity in all energy sub-sectors and relevant government agencies if the country is to achieve the National Energy Strategy and Agenda 2030 Sustainable Development Goals, particularly goal #7 on energy.

预览已结束，完整报告链接和二维码如下：

https://www.yunbaogao.cn/report/index/report?reportId=5_751

