IRENA
International Renewable Energy Agency

Energy planning support

Summary report

2022 Regional Model Analysis & Planning Support Programme

Central Africa

August 2023

Table of contents

1 Introduction

Since 2013, Central African member states of the International Renewable Energy Agency (IRENA) have engaged with the agency on the topic of improving regional energy planning practices.

From 2018-2021, upon the request from the Commission of the Economic Community of Central African States (ECCAS), IRENA and the United Nations Industrial Development Organization (UNIDO) supported ECCAS Member States in the enhancement of regional capacities to establish a vibrant common market for renewable energy and energy efficiency product and services, and in drawing up a Regional Renewable Roadmap to define the actions to be carried out to promote renewable energy, which was validated at technical and ministerial levels. That roadmap includes recommendations to strengthen capacity for long-term energy planning processes and to prepare national and regional power sector or energy master plans that account for an increased share of variable renewables.

The following sections outline the two-phase capacity building programme on long-term energy planning and modelling provided by IRENA, in partnership with the Central Africa Power Pool (CAPP), to follow through on those recommendations. The training, model development, and results of the programme will serve as a critical starting point for the development of the region's first power sector masterplan.

1. 1 IRENA Regional Model Analysis & Planning Support Programme - Phase 1

Over the course of 2020-2021, in partnership with the CAPP, IRENA implemented the first phase of a Regional Africa Modelling Analysis & Planning Support Programme for CAPP member countries. A full summary report was produced to provide an overview of the programmes activities and outcomes. **The programme was fully funded by the generous contributions of the Walloon government, to support capacity building in Francophone countries in Central and West Africa.**

The six-month programme was developed in partnership with CAPP and approved by the CAPP planning sub-committee in February 2020, with the aim to strengthen the institutional capacity within its member countries' planning institutions to develop generation capacity expansion scenarios to inform the energy planning process. The programme was designed to end with the submission of a final report prepared and submitted by each country team. **The specific objectives of the programme were:**

- To **provide access to a least-cost optimization modelling tool** and planning methodologies, with introductory software training;
- To **provide multiple week-long trainings on IRENA's System Planning Test (SPLAT)-MESSAGE modelling framework**[1], and scenario modelling;
- **To facilitate better assessment of renewable energy** in the long-term energy mix;
- **To develop long-term scenarios and country analysis reports** beyond the SPLAT trainings, which give a quantitative basis for draft energy or power sector master plans;
- To provide the space and time for participants to **review and assess their country's institutional energy planning framework and capacity**, and **learn from the practices of other countries in the region.**

Over the course of 2021, about 50 technical planning experts from seven CAPP members[2] participated in the training programme, from the most relevant energy planning offices of ministries, electric utilities, and/or specialized government planning agencies. Based on the success of the first phase, feedback of external stakeholders, and the endorsement of the CAPP secretariat and its members, the capacity building training was continued with a second phase in 2022-2023.

[1] A brief overview of the modelling framework can be found in Appendix I.
[2] Countries participating in the first training phase included: Angola; Burundi; Cameroon; Central African Republic; Democratic Republic of Congo; Gabon; and Rwanda.

1. 2 IRENA Regional Model Analysis & Planning Support Programme - Phase 2

The second phase of the programme aimed to expand upon the training of CAPP members on long-term power sector modelling, with another six-month programme developed in partnership with the CAPP secretariat.[3] Building on the recommendations from external partners and CAPP member states, the trainings in the second phase focused on conducting more in-depth analysis of various SPLAT-MESSAGE model inputs and results, with a regional focus. For example, as recommended, trainees were presented with a chance to develop and analyse a wider variety of scenarios related to regional policy targets, and to investigate regional dynamics such as opportunities for cross-border trade in more detail.

In addition to furthering the training of CAPP member utilities on long-term power sector modelling, the second objective of the programme was to develop consolidated regional model results and a study which is to be released by IRENA, which may potentially serve as the basis for the eventual development of the first regional power sector masterplan.

Starting in September 2022, about 70 technical planning experts participated in the training programme, from the most relevant energy planning offices of ministries, electric utilities, and/or specialized government planning agencies. A nomination process was performed by management of the energy planning offices in each country, along with a review of nominees' background by IRENA staff, to ensure that appropriate participants were taking part. All eleven CAPP member countries sent representatives to participate in the training. **The full list of participants can be found in Appendix II of this report, and an overview of institutions represented can be seen below.**

- **Angola:** RNT (Rede Nacional de Transporte de Electricidade); IRSEA (Instituto Regulador dos Serviços de Electricidade e de Água)
- **Burundi:** Ministère de l'hydraulique, de l'Energie et des Mines; REGIDESO
- **Cameroon:** Ministry of Water Resources and Energy; SONATREL
- **Central African Republic:** Ministry of Energy
- **Chad:** Le Ministre du Petrole et de l'Energie; SNE
- **Republic of Congo:** Direction Générale de l'Energie; Energie Electrique du Congo (E2C)
- **Democratic Republic of Congo:** SNEL
- **Equatorial Guinea:** SEGESA
- **Gabon:** Ministre de l'Énergie et des Ressources Hydrauliques; SEEG

[3] This programme was also fully funded by the generous contributions of the Walloon government, to support capacity building in Francophone countries in Central and West Africa.

- **Rwanda:** Ministry of Infrastructure (MININFRA); REG (Rwanda Energy Group); EUCL
- **Sao Tome and Principe:** Direcção Geral dos Recursos Naturais e Energía; Empresa de Água e Eletricidade

Upon completion of the programme, certificates were issued to all those who participated in the traiing. The implementation of the programme was integrated with the ongoing development of the African Continental Power Systems Master Plan (CMP), which is led by the African Union Development Agency (AUDA) and which IRENA is supporting as a modelling partner.

Figure 1: Group photo during Training

2 Training activity

The structure of programme activities is included below, and consisted of over 65 hours of participation over the six-month training period. It is important to note that engagement and support was not limited to these discrete activities – between and after these activities IRENA continued to offer technical support as needed. **Access to the full agenda and set of lecture materials provided in the trainings can be found in the links below.**

1. **Preparatory course on the capacity expansion software MESSAGE**, implemented with the support of the Planning and Economic Studies Section of the International Atomic Energy Agency (IAEA)
    - » 20 – 23 September 2022: 4 days self-study and technical support (2 hours each)
2. **Training Course #1: Modelling concepts and issues related to regional planning**
    - » 17 – 20 October 2022: 4 full days (8 hours each) in one week
3. **Training Course #2: Regional model results and scenario development**
    - » 28 – 30 November 2022: 3 full days (8 hours each) in one week
4. **Final consultation session: Presentation of regional modelling results to countries and key stakeholders**
    - » 27 July 2023: 1 full day (8 hours)

Figure 2: Presentation session during Training.

2. 1 Logistics

Given the unique circumstances under which the programme took place due to the global pandemic, the training activities were conducted through a hybrid approach, with the following logistics:

- Hotel conference rooms booked for each national team (11 countries)
- ENG / FRE / POR / SPA language simultaneous translation
- Primary connection through hotel AV system
- Exercises performed by country teams in Zoom breakout rooms with virtual expert support
- Presentations / discussions held centrally
- All materials / attendance / recordings tracked through Sharepoint

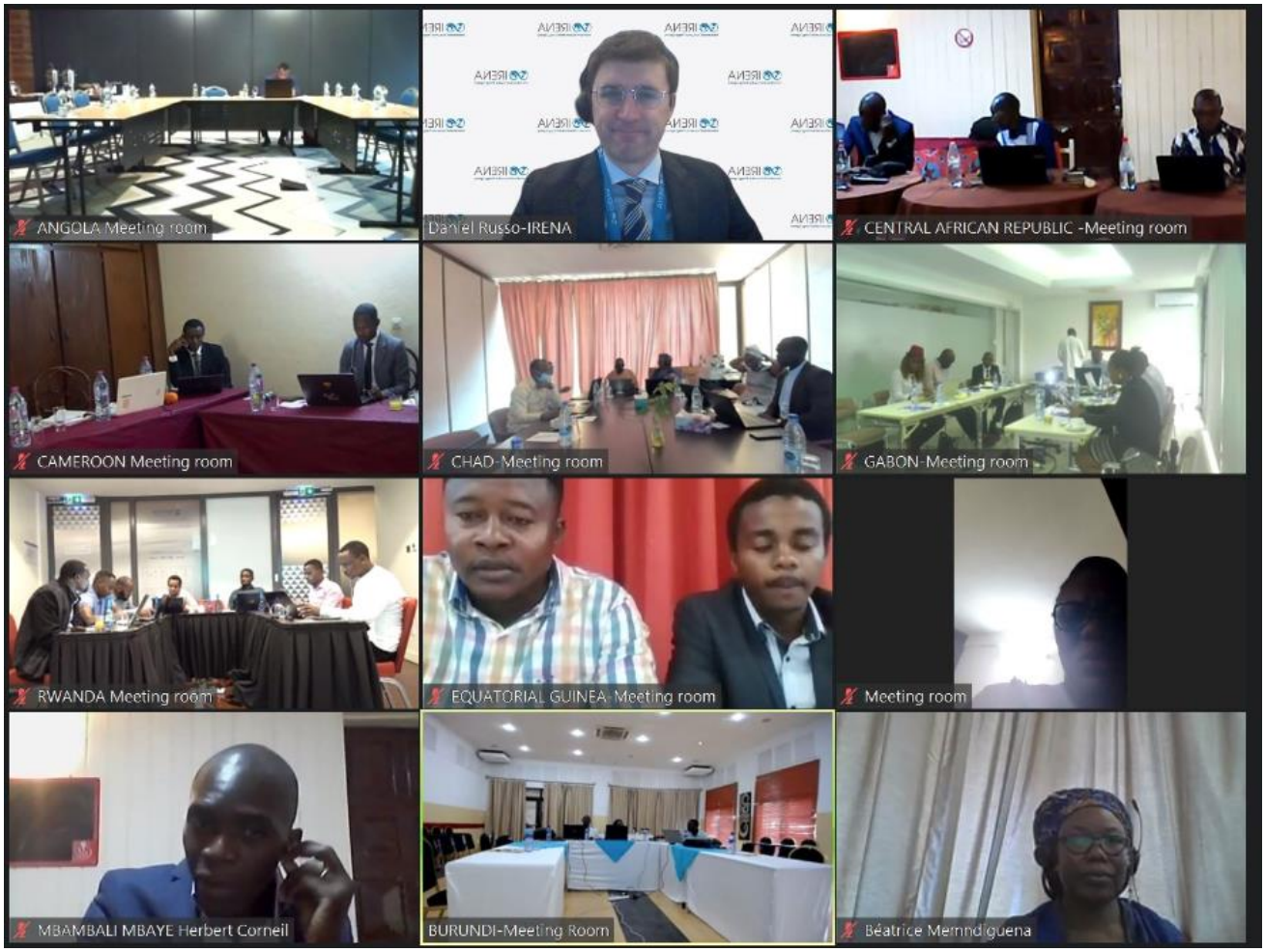

Figure 3: View of the typical training activity setup

3 Final consultation session

In the final consultation session, the latest regional model results were explored by IRENA, the CAPP Secretariat, country participants, and other stakeholders in the African Continental Power Systems Master Plan (CMP) programme. The results were achieved based on the work of participants in the previous training sessions, and contained scenarios developed according to the relevance of the CAPP region. **In the meeting, all participants endorsed the results as aligned with their expectations, and agreed they would be a critical starting point for the development of the region's first power sector masterplan.** This was the final consultation regarding modelling results before IRENA develops a consolidated regional study, which is also meant to support the region's official upcoming planning efforts.

3. 1 Key feedback, recommendations, and next steps

In the final meeting of the programme, all country teams and stakeholders provided their feedback on key issues, recommendations, and lessons related to their experience throughout the training and the development of long-term scenarios. The participants noted a range of concrete issues that emerged during their experience and made some recommendations about how those could be addressed going forward – select key points are included below :

- **Angola:**
  - Expressed general agreement on the results discussed;
  - They find the model highly useful as it consolidates diverse energy sources within their country and yields various results and insights;
  - Expressed the need for continuous assistance due to the ongoing learning curve associated with the model;
  - Regarding next steps, they noted that the insights from the training will be integrated into the next update of their electricity system plan.

- **Cameroon:**
  - Acknowledged the large amount of detailed work undertaken, and that their system's trajectory aligns well with the various scenarios outlined;
  - Expressed satisfaction with the results obtained - overall, the Cameroon results are reflected well and accurately at the national level, particularly in terms of renewable energy production;
  - The interconnections with neighboring countries, like Chad, are also acknowledged as contributing positively to the results;
  - Glad to see the results support the existing plan of Cameroon to potentially become a significant exporter of electricity and a transit country for the region's hydropower to the West African Power Pool;
  - The training has allowed for better understanding of energy planning, especially at the national level;
  - Emphasized the practical application of the learned tools, e.g. the tools are already being used in the function of Ministry of Water Resources and Energy in Cameroon;

- Shares concern about staying in continuous contact with the software to maintain skills - requests future programs for ongoing engagement and practice with the tools, as well as connectivity and updates at either national, regional or continental level.

- **Central African Republic:**
  - They believe that everything was taken into consideration in the results;
  - Despite some challenges in the past, found this initiative successful in bringing together various institutions to consolidate and analyse energy data, fostering collaboration and mutual understanding among the participants;
  - Found training significant for their energy planning efforts - they envision the integration of the training's outcomes into their internal processes, fostering comprehensive and informed decision-making;
  - Expressed their hope that insights will be widely distributed to higher levels;
  - Suggested regular training sessions to be beneficial, even though participant's commitments can sometimes hinder full participation.

- **Chad:**
  - Expressed gratitude for providing valuable tools for better energy planning and learning;
  - Highlighted the positive impact of the programme and their plan to continueally introduce new data to the tool;
  - Suggested organizing regular future meetings on the contents of this programme to facilitate interactions, project updates, and addressing challenges collaboratively – they anticipate encountering challenges during implementation and request ongoing support.

- **Rwanda:**
  - Note that their generation expansion planning, particularly related to solar capacity in and interconnections, aligns with the current results;
  - Affirmed that the results presented align well with their internal planning instruments and expressed appreciation for the accuracy of the presented findings.

- **CAPP Secretariat:**
  - The project in question holds immense importance, not only for Central Africa but for the entire continent of Africa
  - No objections regarding different scenarios, and alignment within the CMP framework; Agreed with what has been said and done
  - Reflected on the training's potential relevance to the subsequent processes - emphasized that many individuals from Member States are already equipped with these tools (such as MESSAGE) through training. These tools will enable them to analyze the results in their official masterplan, providing insightful feedback for a realistic regional master plan;
  - They anticipate support for countries without their master plans as the regional master plan is a compilation of individual country plans;
  - Highlight that continuous training is important, expressing readiness to conduct future training sessions with IRENA and other stakeholders to further benefit member countries of the CAPP.

- **IAEA**
  - Explained the complementary nature of shared tools between IAEA and IRENA and training programs to cover diverse needs;
  - Discussed ongoing projects in the region and regional program for all of Africa, within framework of which, continuity can be offered to support future work, leveraging the models built during this training.

`

- Emphasized readiness to assist with requests for support.

- **AUDA-NEPAD**
  - Pleased to see that the results align with the continental power system master plan, noting that this is the first time an original regional master plan has considered the possibility of exports to other power pools, which aligns with the aspiration for a single African electricity market;
  - Confirmed that the CAPP will be a central anchor for electricity trade on the African continent and net exporter as indicated in the presented results;
  - Emphasized the need to strengthen the CAPPs coordination capabilities on trade between the Member States, and noted that the progress is being made to set a strong basis for the work in developing the CAPP Master Plan;
  - Incorporating these results into the CAPP master plan is the next step;
  - Acknowledged opportunities to continue collaborations between IRENA and CAPP, recognising that this programmes work can make the development of a regional master plan more cost-effective.

- **Similar to the first phase of training, all of the participants called to institutionalise/stabilize/expand the planning and modelling processes performed in the programme – this shows the strong value and demand for this work**

Based on the activities and feedback outlined in this report, IRENA will continue to support the CAPP in their subsequent efforts to develop the region's first official masterplan, as part of the next phase of the CMP programme. After two phases of the Regional Model Analysis & Planning Support Programme, with over 220 hours of technical training provided between 2020-23, the CAPP region is also in an excellent position to take greater ownership of their planning processes, and to accelerate the pace of infrastructure development.

4 Appendices

4. 1 Appendix I: SPLAT-MESSAGE model

The SPLAT country models used in this programme were developed using a modelling software platform called the Model for the Study of Energy Supply Strategies and their Overall Environmental Impact (MESSAGE), a dynamic, bottom-up, multi-year energy system model applying linear and mixed integer optimisation techniques. This modelling platform was originally developed by the International Institute for Applied Systems Analysis (IIASA), but has recently been refined by the International Atomic Energy Agency (IAEA).

The modelling platform is a flexible framework within which the actual model is developed. The MESSAGE modelling platform consists of a set of demand projections, a database of transport infrastructure, energy supply technologies characterised by economic and technical parameters, and information on the existing capital stock and its remaining life.

Starting from the existing electricity infrastructure in the region, the model calculates an evolution of different technically feasible technology options that achieve a least cost objective over the planning period (i.e. total discounted minimum system costs, including capital, operation and maintenance (O&M), fuel and other user-defined costs), while meeting a number of system requirements (e.g. supply matching demand at a specific time, sufficient resources and capacity to provide the desired level of generation) and user-defined constraints (e.g. reserve margin, speed of technology deployment, emission limits, policy objectives).

The inputs to the model can be varied according to user preference, in order to explore different scenarios of system evolution under specific sets of assumptions. The model's 'solution' includes, among other things, investments in new technologies, production, fuel use and trade. The economic and environmental consequences associated with the least-cost energy systems identified can be easily calculated using the model.

More detail on the SPLAT-MESSAGE modelling framework and how it has been applied by IRENA can be found at this link.

4. 2 Appendix II: Participants

Country	Institution	Name	Role
Angola	RNT	ANTÓNIO ELIAS BALTAZAR MONIZ	
Angola	RNT	MANUEL ERICSON DA COSTA DOMINGOS	
Angola	RNT	Délcio Fonseca	
Angola	RNT	Dorivaldo Manuel	
Angola	IRSEA	Adérito Pedro Manico	Engineer
Angola	IRSEA	Alberto Evaristo Fernandes	Engineer
Angola	IRSEA	Antonio Manuel de Silva	Engineer
Burundi	MINHEM	Willy Ciza	Directeur des Energies Renouvelables et Efficacité Energétique
Burundi	REGIDESO	Aloys Ndayikundire	Chef de Service Planification et Gestion des Investissements
Burundi	REGIDESO	Osias Sakubu	Chef de Celluele Planification au Service Equipement Electricite
Burundi	REGIDESO	Emmanuel Ndayubaha	Conseiller en Planification au Service Planification et Gestion des Investissements
Burundi	REGIDESO	Claudine Ntakarutimana	Ingénieur d'Appui à la Cellule support technique et normalisation du Service Equipement Electricité
Burundi	REGIDESO	Hypax Clovis Habuwiteka	Staticien au Service Planification et Gestion des Investissements
Cameroon	MINEE	Joseph Ebako	Cadre, Direction des Energies Renouvelables et de la Maîtrise de l'Energie
Cameroon	MINEE	ESSOLA Pauline Carole épse ZOA MENGUENE	Chef de Service, Direction des Energies Renouvelables et de la Maîtrise de l'Energie
Cameroon	MINEE	Hippolyte Noutchou Noutchou	Cadre, Direction des Energies Renouvelables et de la Maîtrise de l'Energie
Cameroon	SONATREL	Terence Lukong	Sub-Director
Central African Republic	Ministry of Energy	Bruno Serge GBAGODO	Directeur des Etudes, des Statistiques et de la Planification
Central African Republic	Ministry of Energy	Nestor PAGOYO	Chef de Service de la Bioenergie et Geothermie
Central African Republic	Ministry of Energy	Herbert Corneille MBAMBALI MBAYE	Chef de Service des Micro et Mini-Hydroelectricite
Central African Republic	Ministry of Energy	Guy-Aime Mathias BIADI	Chef de Service de Gestion des Ressources Energetiques

Chad	Le Ministre du Petrole et de l'Energie	Beatrice Memndiguena	Directrice de l'Electricite et de la Planification Energetique
Chad	Le Ministre du Petrole et de l'Energie	Ali Brahim Ibni Oumar	Ingenieur a la Direction Technique de l'Energie
Chad	SNE	Gilbert Ngaryom	Chef de Département Essais & Mesures
Chad	SNE	Abdel-Mountalib Abdoulaye	Chef de Service Planification, Statistique et Contrôle
Chad	SNE	Djeba Koularambaye	Cadre à la Direction de Transport et Distribution
Chad	SNE	Zacharia Djaleu Habib	
Republic of the Congo	Direction Générale de l'Energie	Sylvain KIMBEMBE LOUKOMBO	Directeur de la Réglementation et du Contrôle
Republic of the Congo	Direction Générale de l'Energie	Boniface Hervé MABIKANA VOULA	Directeur des Statistiques, des Etudes Economiques et de l'Informatique
Republic of the Congo	Direction Générale de l'Energie	André N'KEYE	Directeur de l'Electricité et des Ressources Energétiques
Republic of the Congo	Energie Electrique du Congo (E2C)	Mathias Ahoura	
Republic of the Congo	Energie Electrique du Congo (E2C)	Simplice Herve Ngouembe	
Republic of the Congo	Energie Electrique du Congo (E2C)	Lipika Leonce Yoco-Yoco	
Republic of the Congo	Energie Electrique du Congo (E2C)	Lezin Fiacre Nzila	
Democratic Republic of the Congo	SNEL	David MUDIAMPIMPA BIENKO	Ingénieur Planificateur
Democratic Republic of the Congo	SNEL	Tonton BOKETSU LOKANGA	Ingénieur Planificateur
Equatorial Guinea	SEGESA	Francisco Asumu ONDO MIKUE	
Equatorial Guinea	SEGESA	Andrés Edjang MONSUY ANGUESOMO	
Equatorial Guinea	SEGESA	Nabil MIKO MIKO	
Equatorial Guinea	SEGESA	Andres Antonio Edu ondo	
Equatorial Guinea	SEGESA	Abercio EDJANG	
Equatorial Guinea	SEGESA	MARÍA MILAGROSA ÑENGONO BAYEME	
Equatorial Guinea	SEGESA	Abercio Edjang Nguema	
Equatorial Guinea	SEGESA	Crispín Bang Mitogo Nsang	
Equatorial Guinea	SEGESA	MANUEL NDONG MBA	
Equatorial Guinea	Ministry	Gaspar ASAMA BINDANG	

Gabon	Ministre de l'Énergie et des Ressources Hydrauliques	Alexis Léandre OKOUMA	Chef de Service Règlementation et Normalisation
Gabon	Ministre de l'Énergie et des Ressources Hydrauliques	Gigamesh Rosny OBAYE	Chargé d'étude a la Direction des Energie Nouvelles et Renouvelables
Gabon	SEEG	ELISEE NDAM née HERVO-AKENDENGUE Augusta	
Gabon	SEEG	ONDO NANG Franck	
Gabon	SEEG	BOULIKOU Lionel	
Gabon	SEEG	NGOUBI Alban Romaric	
Gabon	SEEG	MBADINGA Jean-Félix	
Gabon	SEEG	MBOUONGHO Rémus	
Gabon	SEEG	LINGOMA Gauthier	
Gabon	SEEG	BIGNOUMBA MBADINGA Diane	
Rwanda	Ministry of Infrastructure (MININFRA)	Devotha Nshimiyimana	Power Systems Planner Senior Engineer
Rwanda	Ministry of Infrastructure (MININFRA)	Diana Ngangure	Energy Policy Analyst
Rwanda	Energy Utility Corporation Limited (EUCL)	Ronald Ntare	Ag. Senior Engineer Planning
Rwanda	Energy Utility Corporation Limited (EUCL)	Regis Kanyamanza	Network Operations Planning Engineer
Rwanda	Renewable Energy Group (REG)	Fabrice Bucyedusenge	Corporate Planning Manager
Rwanda	Energy Development Corporation Limited (EDCL)	Jovine Nsekanabanga	Statistician
Rwanda	Energy Development Corporation Limited (EDCL)	Frederick Cyiza	Generation & Transmission Planning Engineer
Sao Tome and Principe	Direcção Geral dos Recursos Naturais e Energia	Belizardo da Conceicao Afonso Neto	Assistant Technique de Direction de l'Energie
Sao Tome and Principe	Direcção Geral dos Recursos Naturais e Energia	Gabriel Lima Maquengo	Directeur de l'Energie
Sao Tome and Principe	Direcção Geral dos Recursos Naturais e Energia	Diodotce Fernandes Martins das Merces Lima	Technique de Direction de l'Energie
Sao Tome and Principe	Direcção Geral dos Recursos Naturais e Energia	Angel Boa Esperança	Technique de Direction de l'Energie
Sao Tome and Principe	Empresa de Água e Eletricidade	Adelino Dias Sousa Pontes	Responsible du bureau des energies renouvelables e efficacite energetique