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MINISTRY OF WATER, ENERGY AND HYDROCARBONS

SREP PROGRAM

Investment Plan for renewable energy in Madagascar

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LIST OF ACRONYMS

ADER	Agence de Développement de l'Electrification Rurale (Rural Electrification Development Agency)
AFD	Agence Française de Développement (French Development Agency)
ARELEC	Autorité de Régulation de l'Electricité (Ex ORE) (Electricity Regulatory Authority (Ex ORE))
AfDB	African Development Bank
WB	World Bank
CAPEX	Capital Expenditure
CI	Centre Isolé de la JIRAMA (JIRAMA Isolated Center)
DDP	Direction de la Dette Publique (Public Debt Division)
DFIs	Development Finance Institutions
REN	Renewable energy
EPA	Etablissement public à Caractère Administratif (Public institution of an administrative nature)
ADF	African Development Fund
FNED	Fonds National de l'Energie Durable (ex FNE) (National Sustainable Energy Fund (ex FNE))
GIZ	Gesellschaft für Internationale Zusammenarbeit
GNT	Gestionnaire National de Transport (National Transmission Operator)
TSO	Transmission System Operator
DSO	Distribution System Operator
GO	Gas Oil
HFO	Heavy Fuel Oil
IPP	Independent Power Producer
JIRAMA	JIRO Sy RANO Malagasy, water and electricity company in Madagascar
km	Kilometre
kV	KiloVolt
kW	KiloWatt
MEEH	Ministère de l'Eau, de l'Energie et des Hydrocarbures (Ministry of Water, Energy and Hydrocarbons)
MFB	Ministry of Finance and Budget
MOP	Maîtrise d'Ouvrage Publique (Public Project Management)
MWh	MegaWatt hour
m / s	Metre per second
NPE	Nouvelle Politique de l'Energie (2015) (New Energy Policy (2015))
UNIDO	United Nations Industrial Development Plan
OPEX	Operational Expenditure
ORE	Office de Régulation de l'Electricité (newly ARELEC) (Electricity Regulatory Office (Ex ARELEC))
PCG	Partial Credit Guarantee
IP	Investment Plan
PIC	Pôles Intégrés de Croissance (Integrated Growth Hubs)
PRG	Partial Risk Guarantee
RI	Réseau Interconnecté (Interconnected Network)
IFC	International Finance Corporation
SREP	Scaling Up Renewable Energy Program
EU	European Union

1. SUMMARY OF THE PROPOSAL

1.1. PROGRAM OBJECTIVES AND PRIORITIES

This investment plan, drawn up under the guidance of the Ministry for Energy, must contribute to the Government's energy priorities according to the NPEs (2015-2030), the objectives of which are as follows:

i. 71% of households will use modern cooking facilities, compared to about 4% currently;
ii. 70% of households will have access to electricity or a modern source of lighting, compared to 15% currently;
iii. 80% of the energy mix targeted for 2030 will be renewable, compared to 1% at present;
iv. 60% of households, businesses, and industries will adopt effective measures of electricity use, compared to the currently almost non-existent penetration rate.

It is clearly stated that the investment plan will endeavor to:
• Strengthen an environment conducive to the development of renewable energy;
• Reinforce implementation capabilities;
• Catalyze the increased investment in renewable energy;
• Improve the long-term economic viability of the renewable energy sector; and
• Increase access to energy.

In response to challenges posed by climate change, the aim of the SREP (Scaling Up Renewable Energy Program in Low Income Countries Program) is to demonstrate the economic, social and environmental viability of electricity generation based on renewable energy while at the same time increasing access to electricity.

The SREP program should assist low-income countries to kick off the transformation toward increasing their electricity generation by exploiting their national renewable energy potential. To initiate this change on a larger scale, it has to identify barriers to public and private investment in renewable energy and suggest ways to remedy them. The SREP challenge is therefore multi-faceted and must lead to economic, social and environmental benefits by contributing to the reduction of air pollution, greenhouse gas emissions and global warming while improving energy safety. Madagascar is one of the 14 African countries chosen for the SREP Program.

The main aim of this Investment Plan is to identify renewable energy projects to be given priority for SREP funding in order to initiate the energy transition and development of the sector in Madagascar. This plan must meet the SREP criteria set out above, as well as the objectives of the NPE (New Energy Policy), which the Madagascan government has set.

The forthcoming PDMC study (Cost Effective Expansion Plan) will focus on developing the 3 major interconnected networks; consequently, in the absence of the PDMC results, particular attention will be paid to independent centers and rural electrification in this Plan.

1.2. FUNDING PLAN PROPOSAL FOR MADAGASCAR

The national energy context was studied in detail to develop this funding plan. Madagascar's high renewable energy potential includes: 7,800 MW of hydroelectricity potential, a very large average sunshine of 2,000 kWh/m²/year countrywide and winds above 7 m/s in the north and south of the country.

The Madagascan electrical system has 3 HV interconnected grids (RI): Antananarivo-Antsirabe (RIA), Toamasina (RIT) and Fianarantsoa (RIF) operated by JIRAMA.
It has 115 operating centers, 100 of which are powered exclusively by diesel-driven therm-electric generating sets (GO or HFO).

Currently it is not economically viable to interconnect all the isolated centers, which is why rural electrification by mini-networks and an increase in the share of renewable energy in JIRAMA isolated centers have emerged as the two strategic avenues for developing renewable energy in the country.

Approximately 250 specific sub-projects were identified and studied. These sub-projects are mainly intended for rural electrification and hybridization of Jirama isolated centers. Subsequent to a multi-criteria analysis and discussions with MEEH, ORE, JIRAMA and ADER, 68 sub-projects were selected as candidates for SREP funding.

The program is divided into two projects (strategic avenues): the development of rural electrification by renewal energy plants and mini-networks as well as the hybridization of JIRAMA's priority isolated centers. Each project is linked to identified sub-projects. Nine sub-projects of small hydroelectric plants and mini-networks were chosen for the former, representing a potential installed capacity of 15 MW and 59 hybridization sub-projects of Jirama centers by photovoltaic solar or wind turbine power were chosen for the latter, totalling a potential installed power of 38 MW.

These two strategic avenues, with a total capacity of 53 MW, meet the six sector objectives detailed in the diagram below. The funds allocated to the SREP program will contribute to each of these avenues.

Each avenue includes project preparation activities: feasibility studies, design studies, transaction advice, and client project management assistance. Project preparation requires support from a capacity development program.

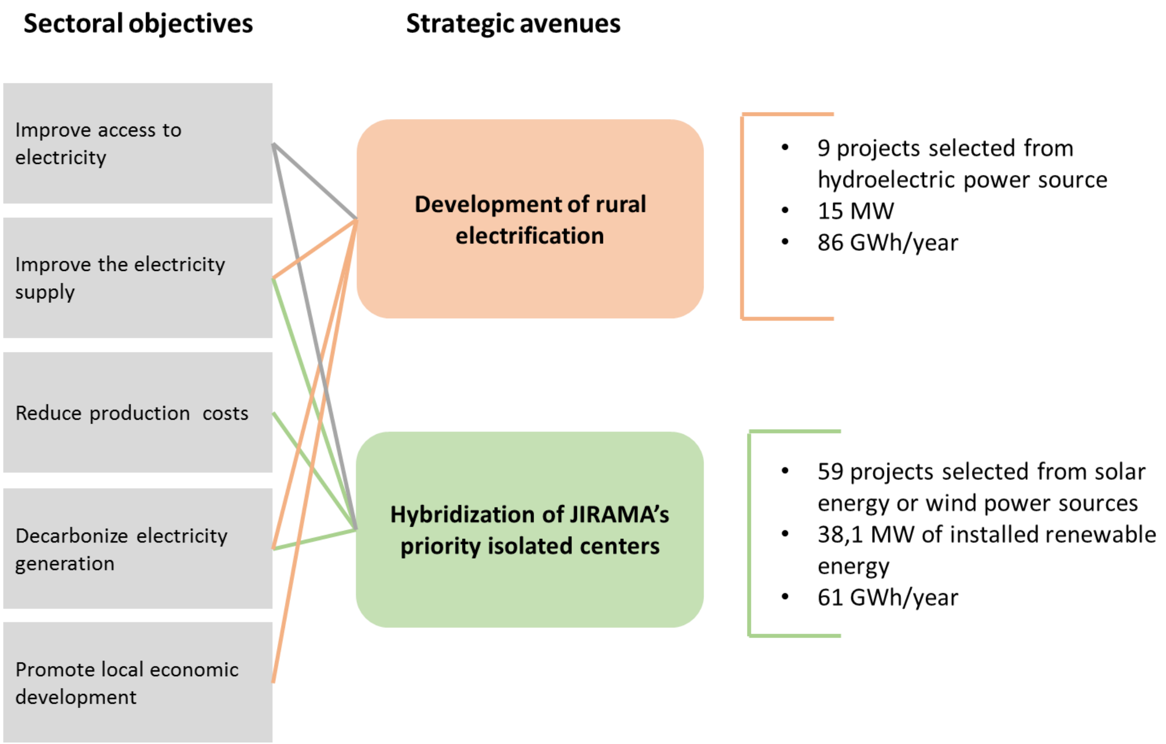

Fig. 1. SREP program strategic avenues and sector objectives

The purpose of the SREP program is to catalyse funding from donors responsible for SREP implementation (World Bank Group and African Development Bank), other active donors in Madagascar (EU, UNIDO, GIZ and AFD) and the private sector.

Tabl. 1 - SREP program financing plan (Project 1): Rural electrification by renewable energy plants and mini-grids (in millions of dollars)

Unit: $M	SREP	WB	AfDB	Other donors[1]	Private sector	State Contribution	Supplementary grant contribution sought	Total
Rural electrification by renewable energy plants and mini-networks								
Feasibility studies		3[2]		1.4				**4.9**
Project implementation technical assistance.	0.5[3]							
Investments	11.5[4]		5 to 10[5]	7.1[6]	7.5[7]		**8.8**	**39.9 to 44.9**
Total	**12**	**3**	**5 to 10**	**8.5**	**7.5**		**8.8**	**44.8 to 49.8**
SREP Leverage	**3.7 to 4.1**							

The Rural electrification by renewable energy plants and mini-grids project will be implemented by the World Bank

[1] EU, AFD, UNIDO

[2] Parallel financing (loan) granted under the PAGOSE project ("Electric Sector Operations and Governance of Improvement Project")

[3] SREP funding by grant

[4] SREP funding consisting of $1.5 million grant and $10 million loan

[5] Loan granted by AfDB

[6] Funding provided by the other donors is mainly in the form of grants

[7] Mainly equity instruments

Tabl. 2 - SREP program financing plan (Project 2): Hybridization of JIRAMA isolated centers (in millions of $)

Unit: $M	SREP	WB	AfDB	Other donors[8]	Private sector	State Contribution	Total
Hybridization of Jirama's priority isolated centers							
Technical assistance and project management	2[9]					(10)	**2**
Investments	6[11]		Loan 5 to 10	(12)	25.7[13]		**30.7 to 35.7**
Total[14]	**8**		**5 to 10**		**25.7**		**38.7 to 43.7**
SREP Leverage	**4.8 to 5.5**						

The Hybridization of JIRAMA isolated centers project will be implemented by The African Development Bank (AfDB).

The leverage effect of SREP funding is defined as the ratio between the overall funding and the funding provided by the SREP (including the warranty). According to the funding plan, this leverage effect is 1:4.1 for the rural electrification project and 1:5.5 for the hybridization component (including the warranty).

The available funding volumes are less than the funding requirements of the entire pipeline of sub-projects. The funding announced by the donors for rural electrification, depending on the type of structure chosen, will enable the development of sub-projects with a renewable energy combined installed capacity of 2.5 to 5.6 MW. With respect to hybridization, sub-projects with a renewable energy combined capacity of up to 14.1 MW may be achieved. In this way, during the preparation phases of the SREP program strategic avenues, only priority sub-projects will be selected according to the amount of funding available.

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[8] EU, AFD, UNIDO

[9] SREP funding by grant

[10] In the case of transferring hybridization projects from isolated centers to private operators, the State contribution could take the form of contributing to make energy purchase contracts secure by Jirama.

[11] SREP guarantee contribution

[12] The AFD intends to set up a SUNREF credit line in support of the private sector.

[13] Loans granted by DFIs, loans granted by local commercial banks, and equity instruments

[14] Totals are given with warranty

According to the funding plan presented above, the expected results of the program are as follows:

Tabl. 3 - SREP program anticipated results

Additional installed renewable energy capacity (MW) under SREP: photovoltaic solar, hydroelectric, and wind	19.7 MW
Annual renewable energy source electricity generation (GWh) from sub-projects supported by SREP	Approx. 55 GWh
Number of homes receiving access to electricity through a project resulting from SREP	Approx. 18,500 homes
Additional financing mobilized	Overall funding of $93.5 million, including a $20 million SREP contribution (1:4.7 leverage effect)
Reduced production costs of Jirama isolated centers due to hybridization	20%

2. NATIONAL CONTEXT AND POTENTIAL FOR RENEWABLE ENERGY

2.1. ENERGY SECTOR BACKGROUND

Madagascar has considerable renewable energy resources (hydraulic, solar, wind, and biomass), while overall energy consumption remains very low. This energy consumption is still dominated by fuelwood and its derivatives. Furthermore, the country imports petroleum products, still widely used for electricity generation (the amount of hydrocarbons purchased by JIRAMA (integrated public operator) in 2014 amounts to US$150 million (about 483,000 billion Ariaries), i.e. an increase of more than 100% compared to the 2009 level), and the high cost of energy – particularly electricity[15] – has an adverse effect on the country's social and economic development and contributes to maintaining a high level of poverty.

The electricity access rate was around 15% in 2015[16]. The infrastructure of the electrical energy sector is also inadequate and a large part of existing generation and distribution facilities are dilapidated; the energy supply no longer covers the current high growth demand.

The government's 1999 electricity sector reform created several institutions (including the ORE sector regulator and ADER rural electrification agency), a fund (FNE) and development programs such as the PIC (Integrated Growth Centers) project. The Government's objectives, with its New Energy Policy (NPE) launched in 2015, for the energy sector aim to speed up the population's access to modern energy (and in particular electrical energy) through a policy focused on the participation of beneficiary communities and the private sector as well as developing sources of renewable energy.

2.2. TECHNICAL DESCRIPTION OF THE ENERGY SECTOR AND THE POTENTIAL OF RENEWABLE ENERGIES

The Madagascan electrical system has 3 HV interconnected grids (RI): Antananarivo-Antsirabe (RIA), Toamasina (RIT) and Fianarantsoa (RIF) operated by JIRAMA.
It has 115 operating centers, 100 of which are powered exclusively by diesel-driven therm-electric generating sets (GO or HFO): nearly 90% of these centers are therefore supplied by conventional energy.

The installed power on the isolated grids and centers in Madagascar at the end of June 2017 was 684 MW for an available power of 417 MW (Source: JIRAMA, June 2017) to which 7,865 kW (approx. 8MW) of installed power for rural electrification has to be added. The total installed capacity therefore represents about 692 MW. The energy mix is shared between hydroelectric

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[15] The average cost of producing electricity produced and purchased by Jirama is between 1,100 and 1,200 Ar/kWh between 2011 and 2015. In comparison, the average selling price of electricity for all Jirama customers is around 380 Ar/kWh. On 04/05/2018, 1 Euro was worth 3855 MGA (Ariary) and 1 USD equated to 3220 MGA.

Source: Jirama activity reports.

[16] Source: New Energy Policy, 2015

power stations that provide 54% of the country's energy and thermal power stations providing the rest (46%). JIRAMA's photovoltaic share is currently negligible at 0.0001% of the country's power generation. The diagrams below show the developments in power from the installed facilities and the mix over the last 6 years.

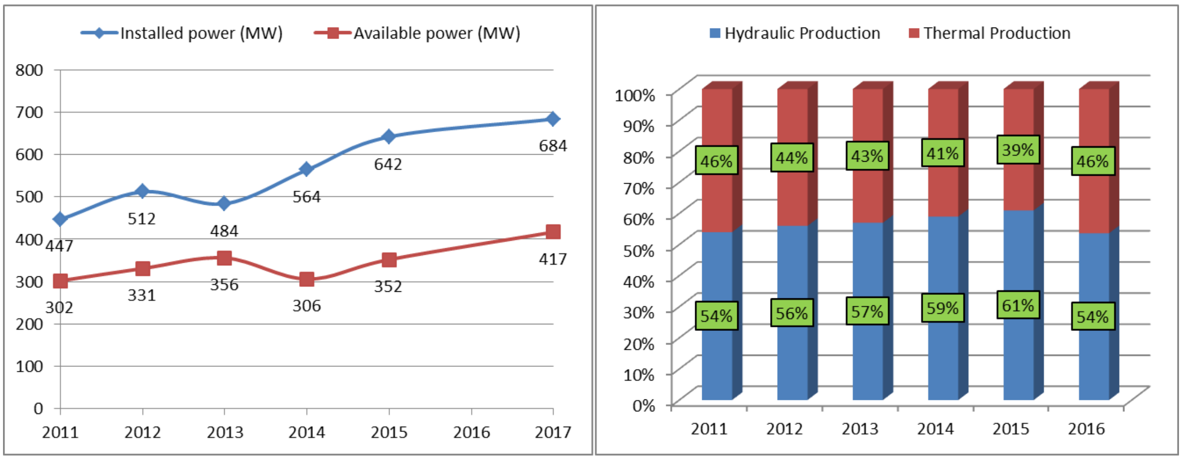

Fig. 2. Evolution of total power (left) and energy mix (right) from generation plants in Madagascar (source: JIRAMA)

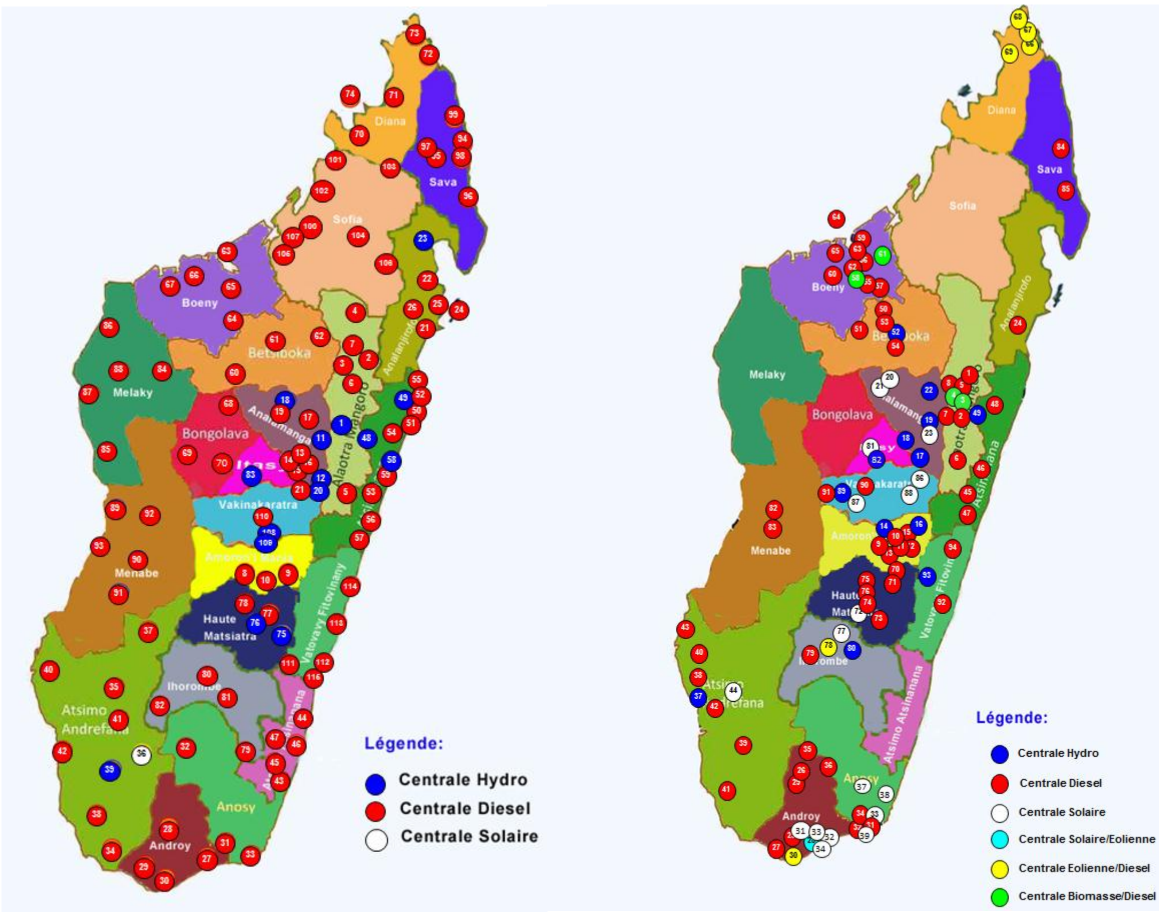

Fig. 3.* *Location of JIRAMA generation plants (left) and for Rural Electrification (right). Source: ORE website

The country's hydraulic potential is around 7,800 MW, but less than 2% are in use.
In terms of solar power, almost every region of the country has more than 2,800 hours of annual sunshine. Madagascar, with an average of 2.000 kWh/m²/year, belongs to the family of countries rich in solar energy potential.

With regard to wind potential, in general, the North (around Antsiranana) and the South (around Taolagnaro) have wind speeds upward 7 m/s and therefore conducive to electricity generation.

Madagascar is therefore a country that is rich in renewable and competitive energy resources compared to conventional energies.

The maps showing solar and wind energy potential are appended to this report.

3. CONTEXT OF THE RENEWABLE ENERGY SECTOR

3.1. STRATEGY FOR THE SECTOR

The Government's objectives for the energy sector aim to speed up the population's access to modern energy (and in particular electrical energy) through a policy focused on the participation of beneficiary communities and the private sector as well as developing sources of renewable energy.

The Government presented the sectoral objectives, in its New Energy Policy (NPE) in 2015, including technical, institutional, legislative and regulatory objectives to be implemented by 2030. This document is part of the State of Madagascar's international commitments to combat climate change and reduce the environmental and social impacts of infrastructure projects[17]. The main objectives determined to achieve the sector's Vision by 2030 are as follows:

- **Electricity and lighting**. Seventy percent of households will have access to electricity or a modern source of lighting, compared to 15% currently. This objective will be achieved by means of extending and interconnecting the networks (with a power generation mix consisting of 75% hydroelectricity, 15% thermal, 5% wind, and 5% solar); mini-grids (with a mix consisting of 50% hydroelectricity, 20% biogas from rice balls, 25% diesel, and 5% photovoltaic solar energy); 5% from the Domestic Solar System (SSD); and 5% solar lamps. In total, 80% of the energy mix targeted for 2030 will be based on renewable energy. Sixty percent of households, businesses, and industries will adopt effective measures of electricity use, compared to the currently almost non-existent penetration rate.
- **Cooking**. Seventy-one percent of households will use modern burners, compared to about 4% now (70% improved firewood or coal, and approximately 1.5% liquefied petroleum gas LPG and ethanol). One hundred percent of sustainable-source wood is converted into charcoal by high-yielding carbonization grindstones.
- **Commercial and industrial thermal uses**. Sixty percent of businesses and industries will adopt effective measures of hydrocarbon and biomass use, compared to the currently almost non-existent penetration rate.

In order to achieve these objectives, the Madagascar Energy Policy Letter will specify the means to be implemented. These include renewable energy and energy efficiency, rural electrification, legislative and regulatory framework, subsidy and pricing system, partnerships, investment and finance, and inter-institutional coordination.

- **Renewable energy.** This in particular involves preparing comprehensive national mapping of hydroelectric resources along with an investment plan. Similar studies should be conducted to identify the best biomass resource, solar and wind turbine sites, while taking environmental factors into account.
- **Rural electrification**. A more coordinated approach to funding will increase the 6.1% of the rural population with access to electricity in 2016 (INSTAT data) eightfold or more by 2030, by an institutional strengthening of ADER, improved regional energy planning, promoting the private sector and implementing projects.

[17] The NPE is one of the tools for implementing the National Development Plan (PND) guidelines which have contributed to drafting the Republic of Madagascar's National Pre-determined Planned Contribution (CPDN).

The CPDN also reiterates the NPE objectives with regard to the energy sector.

- **Legislative and regulatory framework**. The aim here is to implement a legislative and regulatory framework to promote renewable energies covering both large-scale production and decentralised production and self-production: the renewal of all expired licences and authorisations (including those of Jirama), development of a legal and contractual framework for mini-networks, strengthening of ORE prerogatives and independence, review of the authorization upper limits applicable to the various types of energy so as to facilitate the process of implementing new electricity generation facilities, opportunity for the FNE to raise funds from DFIs and borrow from financial markets, to strengthen environmental protection standards, etc.
- **Subsidy and pricing**. A framework for subsidies should be set up. Calls for tenders for rural electrification projects shall, as assessment criteria, include both the unit price of energy and the fixed premium or power charge proposed so as to target subsidies in relation to purchasing power.
- **Partnerships, investments and funding**. Funding needs (around US $12 billion for electrification, US $310 million for the entire wood-energy program and US $1.2 billion for energy efficiency over the period 2015-2030) will require good inter-ministerial coordination as well as efficiency and responsiveness of the various entities responsible in partnership with the DFIs and the private sector. The development and operationalization of PPP funds will also finance the preliminary studies, granting of guarantees and recovery of financial viability discrepancies.
- **Inter-institutional coordination**. The NPE implementation will involve strengthening the governance of the sector. Given this framework, the Ministry of Energy will ensure inter-agency coordination on themes involving several ministries, including land allocation processes and the issue of water rights.

3.2. INSTITUTIONAL CAPACITY AND STRUCTURE

The electrical energy sector in Madagascar is controlled by a sectoral ministry (Ministry of Water, Energy and Hydrocarbons), regulated by an independent public institution (ORE, now ARERELEC), and includes an integrated public operator (JIRAMA) and an agency to promote rural electrification (ADER). These institutions have been operational for more than 10 years and are confirmed in the new sectoral legal framework described in Law # 2017-020 on the Electricity Code in Madagascar. The sectoral institutional framework allows the main functions required to implement the national sectoral policy to be assigned to an institution, possibly with the support from third-party institutions.

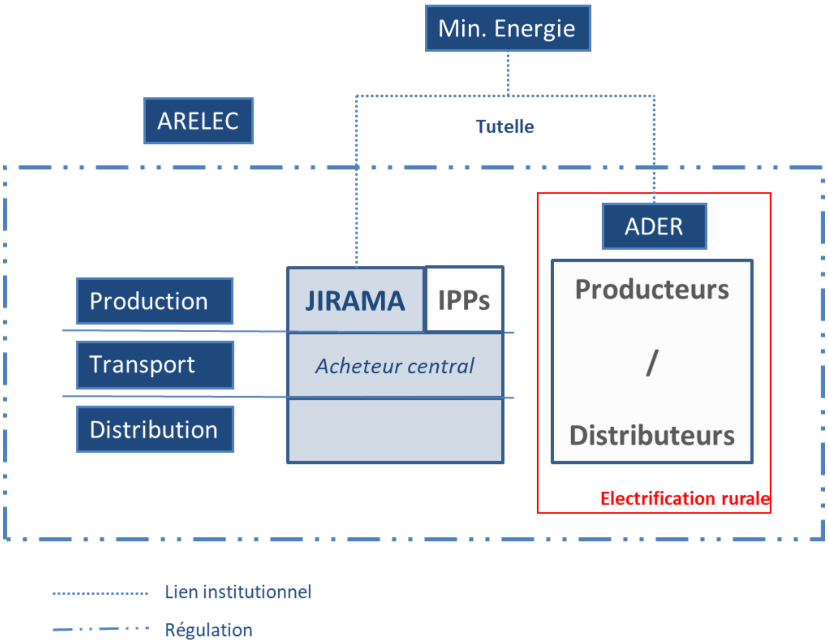

Fig. 4.* *Institutional framework of the electricity sector

The Ministry of Water, Energy and Hydrocarbons is the electricity sector supervisory ministry. It has authority over the production, transmission and distribution of electricity in Madagascar. It develops the general policy on electrical energy, launches calls for tender in the transmission and distribution sub-sectors (calls for tender in terms of production are launched by the Transmission Grid Operator), and sets standards as well as technical specifications for electrical installations.

The regulatory body, formerly the **Office for the Regulation of Electricity** (ORE), was established by Law # 98-032 of January 20, 1999. It was a public institution of an administrative nature, under the technical supervision of the Ministry of Electrical Power. Law # 2017-020 provides a real step forward in terms of the regulatory body which becomes an independent authority known as the **Electricity Regulating Authority** (ARELEC). Its independence is strengthened particularly due to its collegial management, conditions for appointing and/or recruiting its staff, fulfilling its mandate and its financial independence.

The **JIRO sy RANO Malagasy** (JIRAMA) is a State Corporation founded by Order # 75-024 of October 17, 1975 operating in the water and electricity sectors, which among other things, aims to carry out or have carried out nationwide all operations relating to the production, transmission and distribution of energy as well as the supply of drinking or industrial water. The current status of the JIRAMA, which is a transmission grid operator and therefore a central buyer, whose rights and obligations are still not specified, as well as its fragile financial situation, pose a risk to securing possible transactions with potential independent producers of electricity.

The Rural Electrification Development Agency (ADER) was founded by Decree 2002-1550, amended by Decrees 2003-510 and 2011-262 and more recently by Law No. 2017-020. ADER is a specialized public institution subject to general accounting rules for its financial operations attached to the Ministry of Electrical Energy. Its main remit is to increase access to electricity, particularly in rural and suburban areas. ADER has recently launched calls for projects to implement rural electrification projects from renewable sources, including hydroelectric resources. These calls for projects have been launched under the Regional Master Plans for Rural Electrification developed by ADER since 2010.

The **National Electricity Fund** (FNE) became **the National Sustainable Energy Fund** (FNED), which was founded in 2002 to contribute to funding rural and suburban electricity infrastructure development projects, based on renewable energy and energy efficiency, and on which financial aids and tools for operator-holders of Declarations, Authorization Contracts or Concessions are taken. The FNE, in operation since 2004, was managed by the Executive Secretariat of the ADER which assists it and allocates grants to private rural electrification projects. The FNE reform 2017-021 has now created an independent fund dedicated to sustainable energy (renewable energy and energy efficiency), whose management is entrusted to a credit institution.

3.3. ROLE OF THE PRIVATE SECTOR

Many national private players, particularly SMEs, and international players are involved in the electricity sector in Madagascar, mainly in the production, self-production and distribution of electricity in rural areas.

The main operators contributing to the Jirama transmission grid are in production: Company HFF (Henri Fraise Fils et Cie), Hydelec Madagascar SA, Symbion Power, Aggreko, AFL Power, ENELEC, etc. For rural electrification, 28 private companies currently operate in the sector, such as CASIELEC, JIRAFFI, SM3E, etc.

Private players are therefore already involved in the rural electrification sector, which is one of the SREP’s focuses. Consequently there are operators with practical knowledge of these technologies.

Whether for rural electrification or hybridization of Jirama's isolated centers, the conclusions of the study (see paragraph 7.2.1 and 7.2.2) tend to favour the structuring options involving private players (licenses or authorizations depending on the installed powers). The fabric of private companies may therefore be required to take part in project funding and not be limited to construction techniques and infrastructure operations. Subsequent to call for tender by the Consultant with private players in the electrical power sector in Madagascar, obstacles to funding of projects by local private players were identified:

- Although an inter-ministerial decree specifies the method of calculation and allocation of subsidies for rural electrification projects, the operators involved have reported a lack of visibility on the level of subsidy to be granted by the ADER under the FNED (e.g. FNE). Better project planning and a strengthened FNED would mitigate these risks.
- Private operators also face difficulties in accessing external funding, particularly from local commercial banks. Such banks are in fact only able to offer loans in the local currency, for relatively short durations (less than 10 years), often well below the economic life of electrical facilities. Boosting the attractiveness of sub-projects for international banks, by grouping them into large-size lots and by mobilizing guarantees, would remove this obstacle.
- Furthermore, local operators’ financial surfaces are too weak to mobilize the funding required to implement often highly capital-intensive sub-projects. Such operators often rely on the financial capacity of their parent companies to fund sub-projects that remain relatively small (from a few tens of kW to a few hundred kW).
- The national currency, Ariary, is also a major obstacle to investment, particularly in the electrical power sector. Foreign exchange risk, arising when project costs and income are paid or received in one or more currencies other than those of the funding, may not be borne by private investors. The mitigation measures that may be considered are: PPA signing (if applicable) in a strong currency, introduction of indexing adjustment formulas on tariffs in case of an excessive currency variation, or the use of loans from local commercial banks.

- The lack of technical capacity of national private operators responding to public calls for tender involving external funding also impedes the development of renewable energy production sub-projects by the national private sector. The creation of domestic and international private company joint ventures helps to overcome this lack of skills. Similarly, recruitment of qualified local staff may be complex due to lack of skills.

- There is also a high risk associated with the sale of the generation potential (including unpaid invoices, or non-applied indexation and price revision formulas). The sectoral legal framework provided for in the Electricity Code project appears to be particularly protective of private operators on this point. Provision of guarantees (Partial Warranty for Risks or Payment Warranty see paragraph 7.2.2) helps mitigate this risk.

The SREP program aims to remove some of these obstacles.

3.4. LEGAL FRAMEWORK OF THE ELECTRICITY AND RENEWABLE ENERGY SECTOR

3.4.1. Declaration, authorization and concession schemes

Law # 2017-020 provides for the Declaration, Authorization and Concession schemes for implementing independent electricity generation sub-projects. The schemes considered according to the sub-sector are as follows:

Tabl. 4 - Scheme applicable by sub-sector under Law # 2017-020 on the Electricity Code

<table>
<tr><th colspan="2">Installations</th><th>Declaration</th><th>Authorization</th><th>License</th></tr>
<tr><td rowspan="8">Production</td><td>Thermal</td><td></td><td>P ≤ 500 kW</td><td>P > 500 kW</td></tr>
<tr><td>Hydroelectricity</td><td>P ≤ 500 kW</td><td>500 kW <P ≤ 5MW</td><td rowspan="7">P > 5 MW</td></tr>
<tr><td>Wind power</td><td>P ≤ 250 kW</td><td>250 kW < P ≤ 5 MW</td></tr>
<tr><td>Solar thermal energy</td><td></td><td>P ≤ 5 MW</td></tr>
<tr><td>Solar photovoltaic</td><td>P ≤ 150 kW</td><td>150 kW ≤ P ≤ 5 MW</td></tr>
<tr><td>Biomass</td><td></td><td>P ≤ 5 MW</td></tr>
<tr><td>Geothermal and marine-based energy</td><td></td><td>P ≤ 10 MW</td></tr>
<tr><td>Waste</td><td></td><td>P ≤ 5 MW</td></tr>
<tr><td colspan="2">Distribution</td><td></td><td>P ≤ 5 MW</td><td>P > 5 MW</td></tr>
<tr><td colspan="2">Transmission</td><td colspan="2"></td><td>All transmission facilities</td></tr>
</table>

The table above shows inconsistencies in the power thresholds of the geothermal electrical installations as well as those of marine origin (energies not developed in the framework of the Investment Plan): installations of this type with power between 5 and 10 MWc fall within the scope of both the Authorization and Concession schemes.

3.4.2. Provisions for regulating activities and tariffs

ARERELEC is at the heart of the electricity sector legal framework in law # 2017-020:

- Call for tender projects relating to the purchase of electricity or the granting of Concession or Authorization shall, prior to their launch, be submitted to ARRELEC for review and endorsement.
- ARRELEC shall give its approval, prior to signature, for electrical power purchasing contracts forwarded to it by the Central Buyer.
- ARRELEC may, if the network permits, allow certain producers to provide power directly to certain users on the basis of a threshold to be set by the ministry upon ARRELEC's proposal.

ARRELEC calculates and sets the following regulated tariffs:

- Interconnected systems:
    - Power and energy sales from the Central Buyer to Distributors and Distribution Licensees;
    - Power and energy sales from Distributors and Distribution Licensees to end users;
    - Charges for Transmission and Distribution on interconnected grids;

  - Sales of power and energy surpluses from Self-producers to Distributors and Distribution Licensees;
  - Sales of power and energy surpluses from Self-producers to Suppliers (Licensed) and end customers.

- Outside the interconnected grids as well as mini-grids:
  - Power and energy sales from Distributors and Distribution Licensees or Suppliers to end users;
  - Power and energy sales from Producers and Production Licensees to Distributors and Distribution Licensees ;
  - Distribution fees;
  - Sales of power and energy surpluses from Self-producers to Distributors and Distribution Licensees;
  - Sales of power and energy surpluses from Self-producers to Suppliers (Licensed) and end customers.

Other tariffs, and in particular those for electrical power sold to JIRAMA by the Distributors and Production Licensees, are not set by ARRELEC and are not subject to price regulations (Article 82 of Law #2017-020).

3.4.3. Renewable energy provisions

Law # 2017-020 on the Electricity Code provides that the State shall promote and develop renewable energy, in particular through specific incentives and funding measures to be set down by decree. Tax and customs benefits are also announced, but they are not defined and the code thus refers to finance laws to clarify this scheme in the General Tax Code and Customs Code.

Requests for renewable energy projects are dealt with on a priority basis by national transmission operator (GNT), transmission system operator (TSO), distribution system operators (DSO) or mini-grids. These grids give the lowest possible injection priority to renewable energy production facilities. The procedures for implementing this injection priority are not specified.

3.4.4. Rural electrification provisions

The new Electricity Code provides for two provisions concerning rural electrification: the transformation of ADER status (from EPA to that of the Specialized Public Establishment subject to general accounting rules) and the switch from FNE to FNED. The ADER budget will be taken from the FNED budget.

According to the FNED Law, all applications for funding must be submitted to ADER for review prior to being processed by the Credit Institution managing the FNED.

According to the Ministerial Order # 36150/2010 laying down the detailed rules and procedures for calculating and allocating subsidies levied on the Electricity Fund to finance the Rural Electricity Projects, the maximum amount of subsidy awarded to the Distribution Licensees and/or Distributors is 70%. The procedures applicable to the FNED have not yet been defined.

3.5. FORECAST OR ONGOING INVESTMENTS FROM OTHER DEVELOPMENT PARTNERS

Many multi-lateral technical and financial partners (TFPs) such as the World Bank Group (WB) institutions, African Development Bank (AfDB), European Union (EU), or United Nations Industrial Development Organization (UNIDO), but also bilateral partners, are involved in the electricity sector, and more particularly renewable energy AFD, KfW, etc. The main objective of these interventions is to strengthen JIRAMA's operational performance, to support sectoral planning and take part in preparing and financing renewable energy projects, mainly hydroelectricity.

The main programs and projects funded by the Madagascar TFPs are shown in the following table.

Tabl. 5 - Main programs and projects funded by the Madagascar TFPs

Program/Project	Objectives	Amounts	Donors	Start date	End date
Scaling Solar	The Scaling Solar program aims to promote the private sector's contribution to solar energy development. A 25 MWc photovoltaic plant project in Madagascar is being developed with support from the IFC. The short list of sponsors was unveiled by the MEEH in February 2018		World Bank Group	2016	-
Energy Sector Management Assistance Program (ESMAP)	Production of a small hydroelectric project atlas in Madagascar	USD 1,380,000	World Bank and 17 bilateral donors	May-13	Mar-17
Electricity sector operations and governance improvement project	The objective of the project is to improve JIRAMA's operational performance, as well as the reliability of electricity supply in the project area and, in the case of an eligible energy crisis or emergency, provide an immediate and effective response.	USD 65,000,000	World Bank (IDA)	Mar-16	-
Southern African Development Community (SADC) Project Preparation and Development Facility (PPDF)		EUR 11,750,000	EU	Nov-13	Nov-18
Pico-hydro electricity for rural development (PHEDER)	Implementation of regional master plans for rural electrification in the Analamanga and Amoron'i mania regions	EUR 2,352,758	EU	Nov-11	Oct-16
Village hydroelectric networks, energy and environmental protection program (Rhyvière II)	Setting up four grids from hydroelectric power to improve access to electricity for 8,000 rural households	EUR 7,250,000	FFEM, EU (energy facility), power grid delegates	Dec-14	Dec-18

Program/Project	Objectives	Amounts	Donors	Start date	End date
Program to support energy sector reforms (PARSE)	PARSE aims to improve the JIRAMA's governance and financial management framework on the one hand, and on the other hand, to improve the efficiency of electricity generation as well as reduce load shedding.	USD 19,000,000	African Development Bank (AfDB)	Feb-17	-
Sahanivotry Small Hydro Power	Funding of the Sahanivotry hydroelectric project developed in PPP	EUR 12,072,760	African Development Bank and others	Oct-07	-
Improving access to energy for productive purposes through the development of small hydroelectric power stations (PCHs) in rural areas in Madagascar	The project aims to transform and boost the small hydroelectric power station (PCH) sector for productive purposes in rural areas in Madagascar and to generate sustainable income in the operations areas. In addition, the project aims to mobilize private sector investment in conjunction with public funds, demonstrate that there is a market, develop appropriate financial instruments, lay down technical specifications, build capacities while strengthening the political and regulatory environment.	USD 14,305,000	Government of Madagascar + Global Environment Fund (UNIDO) + Private Sector + Financial Sector	Jan-16	-

4. CONTRIBUTION TO THE NATIONAL ENERGY ROADMAP

4.1. PROBABLE IMPACT AND BENEFITS OF SREP INVESTMENT

The SREP program is part of the Madagascan sectoral policy for the period 2015-2030 (defined in the New Energy Policy). This policy transposes the State of Madagascar's international commitments to combat climate change and reduce the environmental and social impacts of infrastructure projects.

It sets access targets (70% of households will have access to electricity or a source of modern lighting) and energy mix targets (80% of the mix will be from renewable hydroelectric power) for the electricity sector. The Madagascar Energy Policy Letter will specify the means to be implemented to achieve these objectives. These include renewable energy, rural electrification, legislative and regulatory framework, subsidy and pricing system, partnerships, investment and finance, and inter-institutional coordination. The SREP investment plan is a direct part of this proactive approach.

Rural electrification projects develop access to electricity for people and connect approximately 250,000 new users to the grid. The rural electrification projects identified are supplied by fully renewable resources. Hybridization of the Jirama isolated centers may increase the share of renewable energy in the mix, but also reduce the use of fossil resources, which is also one of the sectoral policy objectives. In all, the SREP program will commission 53.2 MW of renewable energy capacity.

The SREP program creates a favourable context in which to achieve the sectoral policy objectives. The program's institutional activities will strengthen the capabilities of sector players and continue efforts to adapt the regulatory framework to developing renewable energy. The implementation of the projects identified will strengthen inter-ministerial coordination and inter-actors while capitalizing on experience gained. Finally, the SREP has a knock-on effect with financial institutions. Setting up an incentive framework and defining a strategic investment program will help to mobilize additional resources and promote cooperation between donors and State authorities. For instance, in the field of solar energy, SREP works in synergy with the Scaling Solar program funded by the World Bank Group. This program promotes the development of high-power solar power plants connected to the grid (25 MWc project in progress). SREP is involved in the development of small capacity distributed solar energies (from 50 kWc to a few MWc): hybridization of isolated centers and rural electrification.

4.2. SREP INVESTMENT AS A STARTING POINT FOR A RENEWABLE ENERGY GROWTH PROCESS IN MADAGASCAR

The New Energy Policy sets ambitious targets on the penetration of renewable energy by 2030 in the energy mix: 75% hydroelectricity, 5% wind power, and 5% solar energy. The projected growing demand determine a target output of 7,900 GWh in 2030, which is nearly five times greater than the 1,651 GWh produced in 2016.

The generation objectives of the NPE may be broken down by 2030 as follows: 5,900 GWh of hydro production, and 400 GWh of wind and solar energy, respectively. Currently, only hydroelectric power is developed and produces 885 GWh per year (2016 data). All the projects identified under the SREP program will provide 59 GWh per year from solar energy, 1 GWh from wind power and 85 GWh of hydroelectricity. The SREP program which represents only 2% of production targets by 2030 is merely a first step in achieving the NPE.

SREP sub-projects were partly selected according to their implementation timeline. The majority of selected sub-projects can be developed in 2 years. The SREP program could, with its medium-term results, serve as a pilot project for the longer-term development of renewable energy.

SREP creates a proactive approach around the development of renewable energy that is intended to be continued by the players in the sector. Investment subsidies for rural electrification should be granted on a case-by-case basis, depending on the profitability of the project, and on a sliding scale. Once the economic fabric of rural electrification is in place, the decreased subsidy will force operators to be more efficient and make large scale savings.

Strategic and sectoral studies may be carried out under the program. Project preparation studies will provide the technical basis for developing other projects. The work to strengthen the regulatory framework for developing renewable energy undertaken by MEEH, ORE and ADER can be taken a step further and implemented in the framework of the SREP program.

5. PRIORITIZING RENEWABLE ENERGY SUB-PROJECTS

5.1. CANDIDATE RENEWABLE ENERGY SUB-PROJECTS

The Consultant selected and prioritized the most promising renewable energy sub-projects during the technical assistance study to develop the investment plan. The methodology and results obtained are summarized in this section.

- *JIRAMA isolated centers for renewal energy hybridization:*

For these centers already equipped with a thermal power plant, a solar/thermal and wind/thermal hybrid power plant standard model has been developed. The dimensioning of the renewable energy power to be installed at an isolated center equipped with a thermal generating set was given 70% of the peak power (provided by JIRAMA) in 2020. This date was chosen because the sub-projects currently being studied are to be developed for commissioning around that time. The value of 70% was chosen since the objective is to achieve energy self-sufficiency at peak sunshine hours during the day (according to the Jirama load curves, the mid-day power averages between 50 and 70% of the peak evening power). It should be noted that the chosen potential sub-projects have only been subject to a standard definition and should undergo feasibility and in-depth studies to optimize their design.

- *Hydroelectric power stations (power less than 10 MW):*

Here the Consultant relied on the ESMAP study which recently helped determine small-scale hydroelectricity potential in Madagascar. This study resulted in a selection of 17 sub-projects for power plants ranging from a few hundred kW to 15 MW. Since this list has already been optimized and prioritized, the Consultant automatically considered all 17 sub-projects as candidates. Depending on the power and location of these hydroelectric plants, they may be intended to:

  - Supply a JIRAMA isolated center,
  - Be connected to an RI to enable the power to be evacuated, while having a rural area electrification component.

These sub-projects are sized with a guaranteed installed power at 95% of the time in an average hydrological year. This means an auxiliary thermal generating set in case of failure can be avoided thus limiting investments.

- *Renewable energy plants planned in the ADER schedule:*

The ADER leading up to 2020 identifies a significant number of sub-projects in the 13 regions involved in the plan. These sub-projects are numerous and have a highly variable basic unit size. Some of them (mainly solar hybrid projects) do not have associated production costs. As there is insufficient data to qualify them (production, cost of production, renewable energy power versus thermal power, etc.) we did not take them into account in order to focus on sub-projects at a more advanced level of study, which will probably be developed as a priority.

Sub-projects are compared according to their advantages in terms of electrification and production cost so as to focus in each geographical area on the most high-performance sub-projects. Within this framework, we have identified that the chosen biomass sub-projects have very high production costs compared to other types of renewable energy. Therefore, these sub-projects will not be considered in this study as they would be excluded at the multi-criteria analysis stage. The retained sub-projects are therefore mainly mini-hydro plants but also wind/thermal hybridization plants.

The prepared list of sub-projects has thus helped choose those for which it is advantageous to prioritize the allocation of SREP funding. This was done through a multi-criterion analysis to take into account all of the important aspects when developing a government energy policy. This selection is detailed in the next section.

Tabl. 6 - Summary of the preselection results

Family of sub-projects	Type of REN projects retained	Number	REN power (MW)	Investment (€M)
JIRAMA isolated center hybridization	Solar energy (78), Wind power (3)	81	54.2	114.9
ESMAP hydroelectric power stations (for RI connection or isolated centers)	Hydro	4	9.6	55.9
ADER master plan	Hydroelectric power (22), Wind power (6)	28	35.3	226.2
TOTAL	**Solar energy (78), Wind power (9) and Hydroelectric power (26)**	**113**	**99.1**	**397**

5.2. PRELIMINARY ECONOMIC ANALYSIS OF RENEWABLE ENERGY SUB-PROJECTS

The detailed data for each specific sub-project are given in the Annex (forecasted demand, investments, cost of production, etc.). These sub-projects can be classified into three families: the preliminary economic analysis methodology for each type of sub-project is detailed below.

5.2.1. Costs of JIRAMA hybrid power plant sub-projects

For potential hybridization sub-projects of Jirama isolated centers powered by thermal power plants, in the absence of pre-feasibility studies, the costs for their hybridization with a photovoltaic or wind power plant have been assessed by the Consultant. They are given below (Source ADEME, 2016):

Tabl. 7 - Capital investment and operating costs

Type	REN plant power	CAPEX (€/kW)	OPEX (€/kW)
Solar photovoltaic	Greater than 1 MW	1,600	48
	Less than 1 MW	2,000	60
Wind power	Greater than 250 kW	2,000	60
	Less than 250 kW	3,500	90

NB: The CAPEXs of the related thermal power plants have not been taken into account because they are already available in the Jirama isolated centers.

To ensure greater independence in relation to thermal power generation and to ensure a significant reduction in fuel consumption, batteries have to be used. The installed battery capacity, for an installed power greater than 250 kW, shall be equal to the power supplied by the power plant at full load for one hour. Example: for a 1 MW installed photovoltaic plant, battery capacity will be 1,000 kWh.

The installed battery capacity, for an installed power of less than 250 kW where the evening peak will generally be more marked, shall be higher to keep the benefits of using of lethal solar energy. It will therefore be equal to the power supplied by the power plant at full load for 4 hours. Example: for a 100 kW PV plant, battery capacity will be 400 kWh.

The CAPEX of Lithium-ion batteries is €300/kWh of installed batteries.

Production cost:

To estimate the generation cost of each potential sub-project, the annual average power generation was estimated based on the value of the overall irradiation at each identified location and the projected installed power.

To achieve the weighted average of thermal power generation costs (Ct) and solar energy (Cs), the following formula is used:

$$\text{Coût de production centrale hybride} = \frac{(\mathrm{Prod_{tot2020}} - \mathrm{Prod_s}) \times \mathrm{C_t} + \mathrm{Prod_s} \times \mathrm{C_s}}{Prod_{tot2020}}$$

Note: The estimated total production of the center in 2020 ($Prod_{tot2020}$) and thermal power generation cost for each center are derived from Jirama data.

5.2.2. ADER sub-project costs

The ADER schedule leading up to 2020 identifies a significant number of sub-projects (hydroelectric, wind/thermal or solar/thermal hybrid) with the related investments as well as the estimated production costs. These basic data were analysed and updated by the Consultant.

The ADER sub-projects systematically requiring the creation of a mini-grid, matching investment and impact on production costs are taken into account in the calculation. Based on our experience in similar regions, the cost of the lines was taken at €65,000 per km. To estimate the total cost, their length was assessed based on the estimated number of fokontany (villages) to be electrified by sub-projects (this number is provided in the ADER rural electrification indicative master plan).

5.2.3. Costs of hydroelectric sub-projects identified as part of the ESMAP study

The best mini-hydroelectric sub-projects (less than 10 MW) identified in this study were used directly. Economic data and projected production are directly derived from this study (the costs prior to 2017 have simply been updated).

Detailed results for each identified sub-project are given in the Annex.

5.3. MULTI-CRITERIA ANALYSIS AND SELECTION OF RENEWABLE ENERGY SUB-PROJECTS

A multi-criteria analysis was conducted to prioritize potential renewable energy sub-projects among the 118 previously identified sub-projects. This decision support tool helps simplify a problem that involves meeting several criteria.

Nine selection criteria (listed below) were selected to assess sub-projects on the same basis. Each sub-project identified is then assessed according to the nine criteria with a rating from 1 (unsatisfactory) to 5 (very satisfactory). The chosen judgment criteria are as follows:

- **Reducing production costs**
  - According to the positive impact on operating costs compared to a situation with a reference Project (these reference sub-projects match an equivalent thermal production). This criterion tends to favor locations where the cost of kWh production is particularly high, for example certain Jirama facilities have very high production costs due to their isolation, so they will be prioritized.
- **Production cost**
  - According to the estimated cost of kWh production calculated for the project. It is important to note that the calculated production costs match cost-effective production. They therefore represent the investments required to carry out the project, and are therefore not directly comparable, since in the case of a new area to be electrified, the investment cost for the development of a mini-grid is taken into account, whereas the Jirama isolated centers already have these grids. These production costs are quite different from the selling tariffs that will be applied to users, and therefore cannot be used to calculate financial profitability.
- **Electrification of a new area**
  - According to the estimated impact of a project on rural electrification (a rural project requiring the creation of a complete mini-grid is given priority)
- **Adapting to local demand and guaranteed power**
  - According to project suitability with local forecasedt demand
- **Implementation feasibility**
  - According to the ease of construction, operation and maintenance. It depends, among other things, on the isolation, security of the site, local availability of qualified personnel, but not the financial aspects which are taken into account in another specific criterion.
- **Development timeline**
  - According to project implementation duration (from the study phase through to commissioning)
- **Environmental impact**
  - According to the renewable energy technology and socio-environmental features of the project location region
- **Impact on the region's social development**

- According to the renewable energy technology, project size and development potential of the region upon project implementation

- **Funding and structuring feasibility**
  - According to funding and installation complexity

Weighting is then applied to highlight the criteria that are consistent with the target strategy. As part of this study, the Consultant attempted to identify the strategic avenues to be explored to meet the MEEH's needs and expectations as well as the criteria for SREP funding.

In this context, and although each criterion used is important, the following three criteria were chosen as a focus:

- **Reducing production costs**: This criterion seems particularly important in the context of Madagascar and for the MEEH. Production costs of the JIRAMA isolated centers are often very high and weigh on JIRAMA's financial status. Hybridization by renewable energy would improve energy independence from fossil fuels.

- **Electrification of a new area**: Madagascar, with its very low national electrification rate of 15%, faces the challenge of improving the electricity availability rate. This is the aim set by the government in the NPE (New Energy Policy) by targeting an ambitious electrification rate of 70% by 2030. This criterion is therefore strategic.

- **Development timeline**: To start the transition to renewable energy and quickly catalyze investments to meet the commitments set out in the NPE (electrification rates of 70% and 80% of the original renewable mix) leading up to 2030, rapid-development sub-projects must be implemented. The SREP must thus provide support for the funding of such pilot sub-projects to encourage other investors to follow suit.

Each of these three criteria has been affected by double weighting in relation to the other six (the total of the weighting factors must always equal 1). The weighting retained by the Consultant is as follows :

Tabl. 8 - Criteria and weighting system retained by the Consultant

Criteria	Weighting
Reducing production costs	**0.18**
Production cost	0.08
Electrification of a new area	**0.17**
Adapting to local demand and guaranteed power	0.08
Ease of implementation	0.08
Development timeline	**0.17**
Environmental impact	0.08
Social impact and help to develop the region	0.08
Funding and structuring feasibility	0.08

The scores obtained for a given project, on each criterion, are multiplied by the weighting factor in the table. The average of these scores is then given to obtain an overall score for the project between 0 and 5.

The target objective for all sub-projects is USD 200 million (approximately EUR 170 million).

According to the multi-criteria analysis and associated sensitivity analysis, the 69 best-ranked sub-projects were finally selected for a total investment of EUR 178 million. The main information pertaining to the selected sub-projects is summarized in the following table (details are attached to the Annex).

Tabl. 9 - Summary of final selection results

Family of sub-projects	Type of renewable energy projects retained	Number	Renewable energy power (MW)	Investment (€M / $M)
JIRAMA isolated center hybridization	Solar energy (57), Wind power (2)	59	38.1	80.9 / 95
ADER Master Plan (including 1 ESMAP Hydroelectric Plant) *	Hydro	9*	15	93.6 / 110
TOTAL	**Solar energy (57), Wind power (2) and Hydroelectric power (9)**	**68**	**53.1**	**174.5 / 205**

*An additional hydroelectric sub-project had been selected in Ampitabepoaky but already had a License Agreement with HFF (Henri Fraise Fils et Cie).

6. PROGRAM DESCRIPTION

The program is divided into two strategic Avenues (called Projects) meeting six sector objectives detailed in the diagram below. Each Project is linked to identified sub-projects. The funds allocated to the SREP program will contribute to each of these avenues.

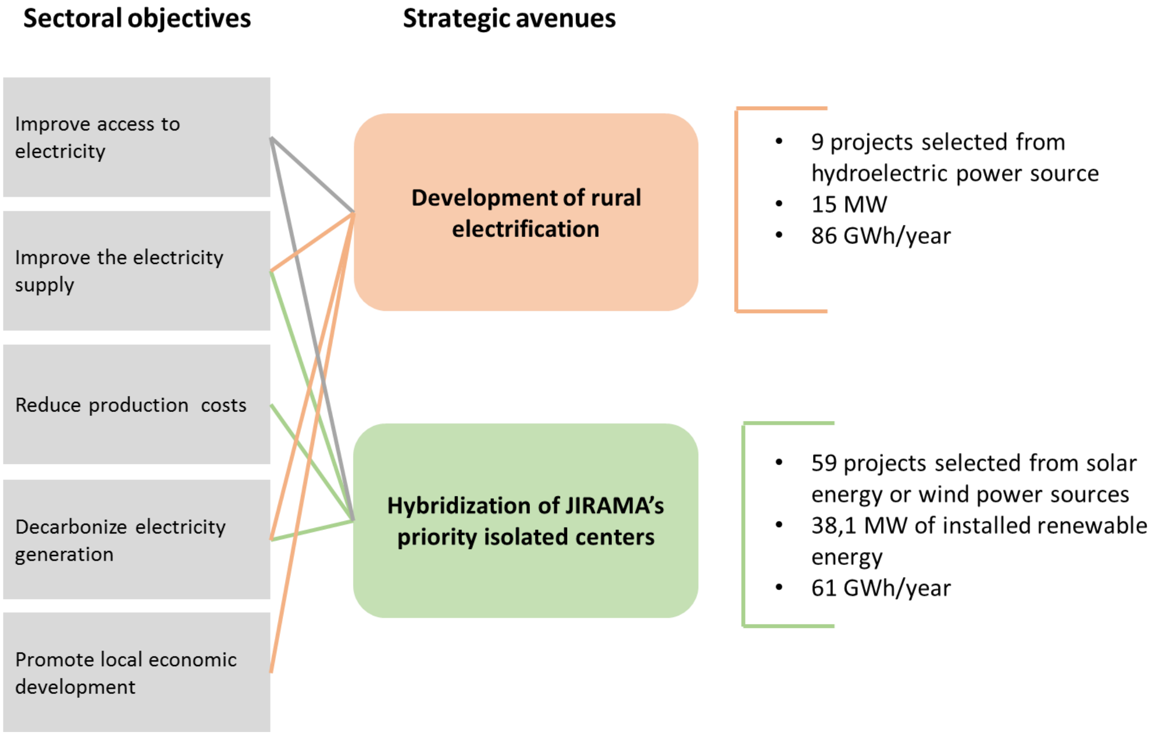

Fig. 5. SREP program strategic avenues and sector objectives

The first project consists of rural electrification sub-projects selected under this investment plan.

The second project focuses on sub-projects for the hybridization of selected Jirama isolated centers.

Each project includes project preparation activities: feasibility studies, design studies, transaction advice, and project management assistance. Project preparation may be supplemented by a capacity-building program.

6.1. OVERVIEW OF THE PROGRAM'S TWO STRATEGIC PROJECTS

In order to identify priority investment sub-projects, it is important to determine SREP-Madagascar's strategic projects. These strategic choices are the result of collaborative work with all stakeholders.

The Madagascan government has established ambitious objectives under its New Energy Policy, in particular increasing the electrification rate to 70% compared to 16% at present. In terms of energy mix, a target of at least 75% renewable energy has been set. This would be mainly based on hydroelectricity, but also on wind power, photovoltaic energy and biomass. In order to be consistent with this national strategy, the selection of sub-projects is based on the following development avenues.

6.1.1. Project 1: Rural electrification by renewable energy plants and mini-grids

Rural electrification of areas not yet supplied by JIRAMA is a fundamental point in increasing the rate of electrification in rural areas with a particularly low rate (estimated by ADER at 6%). Most of these populations have access to wood fuel, with significant environmental consequences in terms of deforestation, air pollution and CO_2 emissions. In order to achieve the ambitious NPE objectives with 70% of the population being covered by 2030, the development of rural power plants and mini-grids is unavoidable. Given the size of the country and spread of the demand on energy, it is not economically viable to connect the whole country to a single interconnected grid.

In order to select priority sub-projects, we relied on the ADER schedule for 2020, which is a census of priority areas and conducive to the development of rural electrification sub-projects. All these sub-projects were analyzed and compared through a multi-criteria analysis. The most advantageous sub-projects were selected and are shown in the following table. Estimated investments take into account the creation of more or less extensive mini-grids depending on the power to be discharged.

The advantage of hydroelectric power stations has emerged from other competing options for rural electrification. Biomass plants were not economically viable, and the hybridization of thermal power plants by wind or low-power solar energy in isolated areas seemed complex to implement and less economically attractive.

It should be noted, however, that as data on possible photovoltaic plant sub-projects in rural areas were not obtained, they could not be selected. The integration of photovoltaic sub-projects may nevertheless be highly appealing in rural areas that do not have one of the hydroelectric structures such as those selected. These sub-projects can therefore be studied on a case-by-case basis and be added to this rural electrification component. The following table shows the sub-projects specifically selected for their interest value:

Tabl. 10 - Sub-projects for rural electrification for SREP funding

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
AMBOHIDAVA	ALAOTRA MANGORO	Hydro	470	2 676	6,90
ANDRIAMAMOVOKA 4	ALAOTRA MANGORO	Hydro	241	1 372	3,33
Site près de TSARAMANDROSO	SOFIA	Hydro	236	1 344	4,61
DANGORO = Antanjona (ESMAP)	VATOVAVY FITOVINANY	Hydro	5 100	29 039	48,18
BEHAZOMATY	BONGOLAVA	Hydro	100	569	0,93
MAROBAKOLY	SOFIA	Hydro	420	2 391	3,60
SISAONY	ANALAMANGA	Hydro	5 500	31 317	19,98
ITENDA	VAKINANKARATR A	Hydro	1 794	10 215	14,07
ANTSAVILY	ITASY	Hydro	1 181	6 725	8,42
TOTAL			**15 042**	**85 648**	**110**

6.1.2. Project 2: Hybridization of priority Jirama centers

The majority of the 115 JIRAMA isolated centers are almost exclusively supplied by thermal plants and often have very high production costs, significantly affecting JIRAMA's financial situation. We have therefore studied a hybridization of these centers using renewable energy plants (mainly photovoltaic or wind turbines) in order to reduce production costs and improve JIRAMA's trade balance. In the long term, lower production costs and improved quality of service (higher peak power, less frequent power cuts, etc.) are the best lever to increase the number of subscribers, and thus the rate of service in existing isolated centers (the rural electrification rate is particularly low around these areas, at about 6% in 2016 according to ADER).

Following a multi-criteria analysis and referral to proposals from MEEH, ADER and JIRAMA, the following priority hybridization sub-projects emerged.

These centers include 9 sub-projects (*identified by an asterisk in the table*) that were already the subject of a call for tenders from JIRAMA in November 2017. This call for tenders involved a total of 12 sub-projects for solar hybridization of isolated centers. Each of these 12 sub-projects is a separate batch of the tender. The structuring mode chosen for this call for tenders is an IPP type installation. Similarly, 17 other sub-projects (*identified by two asterisks*) in the table were already the subject of a call for tenders from JIRAMA in December 2017.

Tabl. 11 - Sub-projects for hybridization of JIRAMA isolated centers for SREP funding

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
MAHABO *	MENABE	Solar	300	473	0.71
IKONGO	VATOVAVY FITOVINANY	Solar	50	79	0.19
KANDREHO	BETSIBOKA	Solar	35	55	0.13
MANDRITSARA *	SOFIA	Solar	700	1,103	1.65
BELOHA	ANDROY	Solar	55	87	0.21
BENENITRA * *	ATSIMO ANDREFANA	Solar	100	158	0.38
ANAHIDRANO	SOFIA	Solar	35	55	0.13
BESALAMPY * *	MELAKY	Solar	200	315	0.75
AMPANIHY * *	ATSIMO ANDREFANA	Solar	200	315	0.75
BETROKA * *	ANOSY	Solar	300	473	0.71
MOROMBE	ATSIMO ANDREFANA	Solar	190	299	0.71
ANKAZOABO-ATSIMO	ATSIMO ANDREFANA	Solar	115	181	0.43
BEFOTAKA	ATSIMO ATSINANANA	Solar	20	32	0.08
SOALALA	BOENY	Solar	75	118	0.28
ANKAZOBE	ANALAMANGA	Solar	170	268	0.64
BEKILY	ANDROY	Solar	195	307	0.73
MORAFENOBE * *	MELAKY	Solar	100	158	0.38
RANOHIRA *	IHOROMBE	Solar	200	315	0.75

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
AMBOVOMBE	ANDROY	Wind power	355	1,000	0.96
IAKORA	IHOROMBE	Solar	30	47	0.11
ANJOZOROBE * *	ANALAMANGA	Solar	200	315	0.75
MANANARA-AVARATRA *	ANALANJIROFO	Solar	1100	1,733	2.59
AMBATOFINANDRAHANA	AMORON'I MANIA	Solar	120	189	0.45
AMBATOMAINTY * *	MELAKY	Solar	100	158	0.38
BEFANDRIANA-AVARATRA	SOFIA	Solar	310	488	0.73
BETIOKY-ATSIMO	ATSIMO ANDREFANA	Solar	165	260	0.62
MANJA	MENABE	Solar	115	181	0.43
AMBOASARY-ATSIMO * *	ANOSY	Solar	300	473	0.71
MIANDRIVAZO * *	MENABE	Solar	300	473	0.71
SAKARAHA * *	ATSIMO ANDREFANA	Solar	500	788	1.18
FENOARIVO CENTER	BONGOLAVA	Solar	80	126	0.30
MAROLAMBO	ATSINANANA	Solar	70	110	0.26
IVOHIBE	IHOROMBE	Solar	50	79	0.19
MANANDRIANA	AMORON'I MANIA	Solar	65	102	0.24
VONDROZO	ATSIMO ATSINANANA	Solar	65	102	0.24
ANTSALOVA * *	MELAKY	Solar	100	158	0.38
BORIZINY (PORT-BERGE) * *	SOFIA	Solar	600	945	1.41
IHOSY * *	IHOROMBE	Solar	1100	1,733	2.59
TANAMBE	ALAOTRA MANGORO	Solar	425	669	1.00
MAINTIRANO *	MELAKY	Solar	600	945	1.41
MAMPIKONY * *	SOFIA	Solar	700	1,103	1.65
TSARATANANA * *	BETSIBOKA	Solar	200	315	0.75
ANTSOHIHY *	SOFIA	Solar	1600	2,520	3.76
MAHAJANGA	BOENY	Solar	10980	17,294	25.80
BEZAHA	ATSIMO ANDREFANA	Solar	120	189	0.45
MORONDAVA *	MENABE	Solar	2600	4,095	6.11
MIDONGY-ATSIMO	ATSIMO ATSINANANA	Solar	45	71	0.17
VAVATENINA	ANALANJIROFO	Solar	295	465	0.69
ANALALAVA	SOFIA	Solar	110	173	0.41

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
ANIVORANO-AVARATRA * *	DIANA	Solar	300	473	0.71
AMBATONDRAZAKA *	ALAOTRA MANGORO	Solar	2000	3,150	4.70
FARAFANGANA	ATSIMO ATSINANANA	Solar	780	1,229	1.83
MAROVOAY	BOENY	Solar	540	851	1.27
TOLIARY	ATSIMO ANDREFANA	Solar	6150	9,686	14.45
BEALANANA * * *	SOFIA	Solar	240	378	0.90
BELON'I TSIRIBIHINA * *	MENABE	Solar	300	473	0.71
MANANJARY *	VATOVAVY FITOVINANY	Solar	1000	1,575	2.35
AMBATO-BOINA	BOENY	Solar	260	410	0.61
TSIHOMBE	ANDROY	Wind power	90	180	0.50
TOTAL			**38,100**	**60,487**	**95.0**

* JIRAMA project, whose call for tenders was already launched in November 2017

* * JIRAMA project, whose call for tenders was already launched in December 2017

* * * A EU-funded 1,600 kW hydroelectric project under the PHEDER project is in the process of being implemented near Bealalana to electrify rural municipalities, the solar hybridization project may be advantageous in a second phase if the plant does not fully cover the local demand.

6.2. PROJECT PREPARATION STUDIES, TECHNICAL ASSISTANCE AND CAPACITY BUILDING

Project preparation studies will be carried out to implement each project. Technical assistance and consultancy service assignments will be mobilized to support project development.

A capacity building program for players in the sector will simultaneously enable the training of public institutions on how to implement the renewable energy development policy.

6.2.1.1. PROJECT PREPARATION STUDIES AND TECHNICAL ASSISTANCE

The funding plan for each project may include a grant share to carry out sub-project preparation studies and to fund technical assistance services for their implementation.

a) Feasibility studies

Whether the sub-project is structured in Public Client Project Management (MOP) or Independent Power Producer (IPP), a feasibility study is required for the preparation of sub-projects. It helps:

- Chose the site location
- Size the project, define technical options, and specify the quality standards required for equipment
- Study the connection conditions
- Determine the structuring mode, funding scheme, tariff schedule and legal set up
- Define the tender process and contribute to drafting tender documents (including sample contracts and technical specifications)

In order to facilitate the start-up of sub-projects, SREP funding could be used to subsidize feasibility studies for the first sub-projects implemented.

In addition, environmental and social studies will have to be carried out for each sub-project to comply with national regulations and financial institution requirements.

b) Project management assistance

In the context of developing Public Project Management projects, the contracting authority may be supported by a project management assistant. This Assistant provides support during the feasibility study phase (supervision of the technical design office and advice for the Project Owner), contract award and the early years of the plant operation.

c) Transaction advice

In the context of developing a private project management project (license in particular), it is recommended that the Granting Authority (State or ADER) use a transaction consultant. This advice may cover institutional, legal and financial aspects and may be shared between several firms. The consultant is involved in structuring the project, economic and financial modelling, tariff study, legal and contractual set-up, drafting sample contracts, supporting the development of tender documents, supporting bid assessment and supporting the negotiation phase.

d) Project preparation costs

In general, the costs of preparing sub-projects vary from 3 to 8% of the investment amount. Estimates for each of the strategic avenues are given below:

Tabl. 12 - Estimate of project preparation costs for each of the strategic avenues

Project	Amount of investments	Budget for project preparation studies and mobilization of technical assistance
Rural electrification by renewable energy plants and mini-grids	$110 million	$5 million
Hybridization of JIRAMA's priority isolated centers	$95 million	$4 million

6.2.1.2. STAKEHOLDER CAPACITY DEVELOPMENT PROGRAM

Capacity development for stakeholders in the sector is dealt with in a cross-functional way in the investment plan. Its purpose is to contribute to an institutional and regulatory environment conducive to developing renewable energy, and to train stakeholders in implementing this policy.

Capacity development needs for public players have been identified:

- Training public players (Government, Jirama, ADER and ARELEC) in how to develop renewable energy projects including a module dealing with general aspects, a module on economic and financial aspects as well as a module on technical aspects:
    - Module 1: general aspects
    - Presentation of the principles for structuring MOP and PPP projects and related funding schemes;
    - Presentation of possible legal and contractual arrangements;
    - Presentation of standard tools for selecting operators (PPP models, licensee contract, connection agreement, grid access and operation, etc.). It is recommended that ARRELEC also have in-depth training on electricity purchase contracts given its new responsibilities (see paragraph 3.4.2).
    - Module 2: economic and financial aspects
    - Financial analysis of options for structuring MOP or PPP projects: VFM (*value for money*) principle and budgetary sustainability;
    - Economic analysis of renewable energy projects: calculation of greenhouse gas (GHG) emissions avoided, economic profitability of projects;
    - Financial analysis and modelling of renewable energy projects: different types of financial models (feasibility/structuring model, transaction model, and regulatory model), updating of regulatory-type models.
    - Module 3: technical aspects
    - Training in how to prepare a project: selecting sites, sizing, choosing equipment, feasibility study follow-up, understanding the grid input mechanisms, support for preparing the technical specifications of the various contracts (license contract, connection agreement in the case of an IPP set-up or the Engineering Procurement and Construction (EPC) contract in the case of MOP structuring)
    - Training in how to monitor the construction phase and technical acceptance of plants
    - Training in the management of license contracts and operational monitoring of renewable energy plants.
- JIRAMA training on the operating challenges of hybrid systems: if the hybridization of isolated centers is delegated to private operators, it is important that JIRAMA also has sound knowledge of these systems as an integrated operator (central buyer, carrier and distributor): connection conditions, energy purchase, operation and maintenance of a hybrid system and management of the distribution grid.
- ADER training on the technical challenges when developing mini-grids and other off-grid solutions powered by renewable energies: knowledge and dissemination of

renewable energy technologies with or without storage, maintenance of such equipment, and development planning,

- Mobilization of technical assistance from ARRELEC to train its operators and support it in the new Electricity Code transition process: internal reorganization, support for drafting application texts, anticipation of future developments to adapt to the new energy mix, including the introduction of lethal energy. Specific training may be organized to train ARELEC personnel how to check compliance of electrical installations.

- Jirama and ADER technical assistance to set up an environmental and social management system for renewable energy projects. Training of supervisors to monitor the environmental and social performance of renewable energy project developers.

- Awareness-raising and training on the steering and development challenges of a grid integrating a growing penetration of intermittent energy: this training for MEEH, ADER, JIRAMA and ARRELEC would provide general knowledge of technologies to modernize the grids (instrumentation, remote management, development of the dispatching system, implementation of a Supervision Control And Data Acquisition system (SCADA)).

Although the training plan is intended for public players, capacity building for private players is also a lever in developing the renewable energy sector. The skills of technical operators (suppliers, fitters and engineering companies) must evolve with technological advances. Operators must also have sound knowledge of standards and certification processes. Local financial institutions (commercial banks, micro-credit institutions and investment funds) must be made aware of renewable energy funding mechanisms.

Beyond training, supplementary sectoral studies may be carried out. In order to achieve the objectives of the New Energy Policy, the Madagascan authorities use planning tools. Several studies have been carried out or are in progress. The World Bank's Energy Sector Management Assistance Program (ESMAP) has led to the development of a master plan for the development of small-scale hydroelectricity[18]. The Lowest Cost Master Plan (PDMC), which is being developed, will identify production projects (hydroelectric, renewable and thermal energy), and will determine the transmission system developments needed to integrate these means of production and to create an investment plan. A strategy to gain access to electrification in Madagascar (National Strategy for Electrification, SNE) is being prepared and focuses on the development of a rural electrification strategy (by extending existing grids and off-grid solutions), with a national electrification plan and a short-term (3 years) and medium-term (10 years) priority investment program.

The electrical system will have to evolve to meet the increasing penetration of renewable energy. Currently, discussions are under way on the modernization of the transmission system and its dispatching.

GIZ supports MEEH and ADER in preparing implementation decrees for Law 2017-021 on creating the FNED. Additional support can be mobilized to support the Government in drafting the other implementing legislation of Law 2017-020 on the Electricity Code.

[18] Hydro Planning Report – Renewable Energy Mapping: Small hydro Madagascar – January 2015 – SHER/mhylab/Artelia

Tabl. 13 - Cost estimate of the cross-functional "capacity development" program

		Institutions	Duration (weeks)	Number of participants	Budget*
Training and support for sector players					
Training of public players in the development of renewable energy generation projects	Module 1: general aspects	MEEH, ADER, JIRAMA, ARELEC	1	30	USD 65,000
	Module 2: economic and financial aspects	MEEH, ADER, JIRAMA, ARELEC	1	20	USD 55,000
	Module 3: technical aspects	MEEH, ADER, JIRAMA	1	15	USD 50,000
Training on the operating challenges of hybrid systems		JIRAMA	1	15	USD 50,000
Training on the technical challenges of developing off-grid renewable energy for rural electrification		ADER	1	15	USD 50,000
Support for ARRELEC in the new Electricity Code transition process	Module 1: training on the new regulation challenges	ARELEC	2	15	USD 100,000
	Module 2: training in checking compliance of electrical installations	ARELEC	1	15	USD 50,000
Jirama and ADER technical assistance to set up an environmental and social management system for renewable energy projects.		JIRAMA and ADER	1	15	USD 50,000
Awareness and training on the challenges of steering and developing a grid incorporating an increasing penetration of intermittent energy		MEEH, ADER, JIRAMA, ARELEC	1	25	USD 60,000
				Sub-total	**USD 530,000***

**** Training budgets are based on on-site training in Madagascar and include the remuneration of instructors, their travel, preparation of teaching materials and room rental costs, but do not include any logistics costs of participants.***

6.3. ENVIRONMENTAL AND SOCIAL RISKS

An analysis of the environmental and social risks related to the chosen projects is given in the table below.

The potential environmental and social risks for each type of project (rural electrification by Jirama hydroelectric power station/thermal power plant hybridization by photovoltaic or wind power generation) are described, and then the relevant mitigation measures proposed. The analysis is conducted for each project (risks related to the project landtake, risks related to the construction phase, and risks related to the operation phase).

At this stage, it appears that the main socio-environmental risks would be those related to the release of the necessary area for each development (land, social, cultural, etc.). This challenge is generally critical for all development sub-projects in Madagascar.

The importance of each risk will depend on each project and location. Nevertheless, the environmental and social review concluded that the sub-projects identified are generally environmentally and socially acceptable. The chosen sub-projects are of relatively limited sizes, and therefore should not cause major environmental risks.

The environmental and social assessment to be carried out for each project, when implementing the program, will thus consist of assessing the actual importance of environmental and social risks identified in the following table, specifically for each project (in the form of an Environmental Impact Study or Environmental Commitment Program, depending on the notification from the National Environment Office). The development of a Framework for Environmental and Social Management of the Program in general could also be a tool required to properly integrate environmental and social dimensions into its implementation.

Tabl. 14 - Environmental and social risks & related mitigation measures

Activity	Potential E&S risks	Mitigation
Hydroelectric power station (rural electrification)		
Project footprint		
Location & Landtake need	Risk of expropriation or eviction from homes in the area of landtake that may lead to impoverishment of the populations involved. Interference with subsistence / economic activities: agriculture, fisheries, forest product collection, mining activities, etc. Encroachment on or destruction of a tribal, cultural, ethnic, historical or religious area. Encroachment on a conservation area (protected area, etc.).	Optimization of facility design to minimize the landtake required and avoid critical or cultural sites (protected area, etc.). Implementation of a Compensation Plan (identifying the people affected, preparing a compensation program, monitoring the implementation, etc.). Setting up a framework for consultation with conservation players.
Construction phase		
Dam layout	Flooding of the upper reach: loss of vegetation, risk of destruction of critical ecology, loss of wildlife habitat, and loss of terrestrial fauna. Increase in upstream water level: water courses less suitable as spawning sites, possible effect on the existence and distribution of habitats conducive to other stages of development, Degradation of water quality: increased turbidity and silting by suspended particulate matter, effects of the degradation of water quality on aquatic resources. Drop in the water level of the dam's lower reach: risk of water use conflicts, unbalanced distribution of water, disturbance of aquatic wildlife, and loss of subsistence fishing opportunities.	Optimization of dam design (minimization of dam height). Prior completion of hydro-ecological study and reference piscifauna study, as well as detailed study of water use downstream of the dam. Implementation of an information strategy for local communities from the project preparatory phase onward.
Headrace digging	Production of large volumes of excavated materials and/or rock scaling. Loss of archaeological, heritage or cultural resources.	Optimization of tunnel design (layout, length, etc.). Implementation of the Excavation Management Plan (method of managing excavated materials, reuse, recovery, storage, ..., avoidance of induced impacts such as land conflicts or nuisances, etc.).
Construction of the power plant	Loss of vegetation. Risk of destruction of critical ecology. Loss of fauna habitat. Loss of terrestrial fauna. Risk of soil erosion by leaching unprotected surfaces, resulting in suspended solids intensive runoff. Loss of archaeological, heritage and cultural resources.	Implementing the Land Clearance Management Plan (land clearing limitation, regulatory aspects, land clearing follow-up provisions). Implementing the Anti-Erosion Plan (anti-erosive action, implementation and monitoring provisions).

Activity	Potential E&S risks	Mitigation
Installing ancillary utilities (access route and transport line)	Loss of vegetation. Risk of destruction of a critical ecosystem. Loss of fauna habitat. Loss of terrestrial fauna. Disturbance of streams and water ways due to construction, traffic, siltation and modification of flow patterns. Opening of closed environments promoting the movement of people to critical areas or protected natural environments. Risk of soil erosion by leaching unprotected surfaces, resulting in suspended solids intensive runoff. Degradation of the landscape due man-made structures. Loss of archaeological, heritage and cultural resources.	Optimization of the design and layout of the access track and transport line to reduce land clearing as much as possible. Implementing the Land Clearance Management Plan (land clearing limitation, regulatory aspects, land clearing follow-up provisions). Implementing the Anti-Erosion Plan (anti-erosive action, implementation and monitoring provisions).
Operating phase		
Dam operation	Bank erosion & solid additions: Tank sedimentation, storage capacity reduction, water quality degradation. Giving preference to vector habitats: Increase in water-borne diseases. Impacts induced by the development of the dam: Development of activities generating environmental impacts: irrigated crop, industries, growth of municipalities, etc.	Implementation of a program for routine and regular maintenance of the facilities (upkeep of the banks, etc.). Setting up a collaboration with local authorities to raise awareness of populations located upstream.
Power plant operation	Disturbance of the environment (human & wildlife) by noise generated by the operation of the plant.	Implementation of an information strategy for local communities from the project preparatory phase onward. Implementation of a program for routine and regular maintenance of the plant.
Transport line and post offices available	Impact of electric and magnetic fields. Risk of accident for populations and wildlife (including birdlife). Risk regarding air navigation safety	Optimization of the transport line route design to minimize the impact on birdlife as much as possible (avoiding the migration corridor, avoiding protected areas, etc.). Carrying out a reference ornithological study of the transport line route (qualitative and quantitative inventory of ornithological fauna).

Activity	Potential E&S risks	Mitigation
Photovoltaic generation (Jirama thermal plant hybridization)		
Project footprint		
Location & Landtake need	Risk of expropriation or eviction from homes in the area of landtake that may lead to impoverishment of the populations involved. Interference with subsistence / economic activities: agriculture, fisheries, forest product collection, mining activities, etc. Encroachment on or destruction of a tribal, cultural, ethnic, historical or religious area. Encroachment on a conservation area (protected area, etc.). Landscape change, landscape quality degradation.	Optimization of facility design to minimize the landtake required and avoid critical or cultural sites (protected area, etc.). Implementation of a Compensation Plan (identifying the people affected, preparing a compensation program, monitoring the implementation, etc.). Setting up a framework for consultation with conservation players. Technical consideration that protects the landscape (shrub belt, etc.).
Construction phase		
Power plant construction work	Loss of vegetation and fragmentation of natural habitat through land clearing. Disturbance of natural run-off water flow due to land clearing and levelling. Soil destructuring which may lead to the risk of erosion. Problem of managing excavated materials resulting from land levelling. Atmospheric emissions and noise pollution generated by the worksite activities. Risk of accident along the routes used for the supply of materials. Breakdown of migration paths or fauna access (e.g. through access tracks). Risk of introducing invasive species that can impact wildlife, flora, ecosystems, crops (by the arrival of labor from outside the area). Interaction of external labor with local communities, which may increase the risk of occurrence of community diseases, including HIV/AIDS. Actual or perceived disruption of normal community life, by the physical presence of labor for the construction. Risk of damage to cultural heritage or site amenity values. Risk to safety, human health and well-being related to construction activities.	Implementation of the Environmental Protection Plan of the site (limitation of land clearing and stripping, protection of woody vegetation, external and internal drainage, vegetation of slopes and bare ground, etc.). Implementation of the Management Plan for Earthworks (reuse of excavated materials for backfill, criteria for choosing the place to deposit non-reused excavation material, stabilization of the excavation material deposits, etc.). Implementation of the Project vehicles and Traffic Management Plan (quality, upkeep and maintenance, loading, traffic schedules, forward speed rules, itinerary). Implementation of the HSE Plan on the worksite (HSE risks, applicable procedures, contingency plan, etc.). Implementation of the Social Aspects Monitoring Plan (recruitment, working conditions, compliance with the local community lifestyle, cultural aspects, etc.).

Activity	Potential E&S risks	Mitigation
Operating phase		
Solar panels in use Power plant operation Equipment maintenance	Disturbance to bird behaviour Local residents bothered by light reflected from panels. Water consumption related to plant operation. Alteration of water quality in the area by discharge from the plant. Disturbance of local wildlife by site lights at night. Generation of hazardous products through maintenance and repair activities of plant equipment and resources (particularly solar panels and end-of-life batteries). Contamination of soil and surface or groundwater by an accidental spillage of hazardous substances.	Technical consideration that minimizes the impact on birds and wildlife in general, during project design (optimization of solar panel surfaces, adoption of photovoltaic modules with anti-glare, use of low light intensity lighting, etc.). Technical consideration that minimizes the inconveniences for local residents, when designing the project (visual screen by tree vegetation, etc.). Implementation of the Water Management Plan (optimization/rationalization and monitoring of water use, effluent management). Implementation of the Waste Management Plan (identification, collection, storage, disposal/treatment).
Wind power generation (Jirama thermal power station hybridization)		
Project footprint		
Location & Landtake need	Risk of expropriation or eviction from homes in the area of landtake that may lead to impoverishment of the populations involved. Interference with subsistence / economic activities: agriculture, fisheries, forest product collection, mining activities, etc. Encroachment on or destruction of a tribal, cultural, ethnic, historical or religious area. Encroachment on a conservation area (protected area, etc.). Landscape change, landscape quality degradation.	Optimization of facility design to minimize the landtake required and avoid critical or cultural sites (protected area, etc.). Implementation of a Compensation Plan (identifying the people affected, preparing a compensation program, monitoring the implementation, etc.). Setting up a framework for consultation with conservation players. Technical consideration that protects the landscape (wind turbine colour, height, number, etc.).

Activity	Potential E&S risks	Mitigation
Construction phase		
Wind farm layout work	Loss of vegetation and fragmentation of natural habitat through land clearing. Disturbance of natural run-off water flow due to land clearing and levelling. Soil destructuring which may lead to the risk of erosion. Problem of managing excavated materials resulting from land levelling. Atmospheric emissions and noise pollution generated by the worksite activities. Risk of accident along the routes used for the supply of materials. Breakdown of migration paths or fauna access (e.g. through access tracks). Risk of introducing invasive species that can impact wildlife, flora, ecosystems, crops (by the arrival of labor from outside the area). Interaction of external labor with local communities, which may increase the risk of occurrence of community diseases, including HIV/AIDS. Actual or perceived disruption of normal community life, by the physical presence of labor for the construction. Risk of damage to cultural heritage or site amenity values. Risk to safety, human health and well-being related to construction activities.	Implementation of the Environmental Protection Plan of the site (limitation of land clearing and stripping, protection of woody vegetation, external and internal drainage, vegetation of slopes and bare ground, etc.). Implementation of the Management Plan for Earthworks (reuse of excavated materials for backfill, criteria for choosing the place to deposit non-reused excavation material, stabilization of the excavation material deposits, etc.). Implementation of the Project vehicles and Traffic Management Plan (quality, upkeep and maintenance, loading, traffic schedules, forward speed rules, itinerary). Implementation of the HSE Plan on the worksite (HSE risks, applicable procedures, contingency plan, etc.). Implementation of the Social Aspects Monitoring Plan (recruitment, working conditions, compliance with the local community lifestyle, cultural aspects, etc.).
Operating phase		
Use of wind turbines	Disturbance for birds and fauna habitats.	Optimization of project design to keep the impact on birdlife to a minimum (avoiding the migration corridor, avoiding protected areas, etc.). Carrying out a reference ornithological study of the layout site (qualitative and quantitative inventory of ornithological fauna).
Operation of the wind turbines	Mechanical and aerodynamic noise. Electro-magnetic interference.	Technical consideration that minimizes noise (number of turbines, type of blades, etc.). Optimal choice of the site layout (avoiding densely populated areas and airports, etc.).

7. FUNDING PLAN AND INSTRUMENTS

7.1. OVERVIEW OF THE FUNDING PLAN

Funding needs, for the two strategic avenues identified, represent a total investment amount of $205 million, $110 million for rural electrification and $95 million for the hybridization of isolated centers.

The purpose of the SREP program is to catalyse funding from donors responsible for SREP implementation (World Bank Group and African Development Bank), other active donors and DFIs in Madagascar (EU, UNIDO, GIZ and AFD) and the private sector.

Tabl. 15 - SREP program financing plan (Project 1)

Unit: $M	SREP	WB	AfDB	Other donors[19]	Private sector	State Contribution	Supplementary grant contribution sought	Total
Rural electrification by renewable energy plants and mini-networks								
Feasibility studies		3[20]		1.4				**4.9**
Project implementation technical assistance.	0.5[21]							
Investments	11.5[22]		5 to 10[23]	7.1[24]	7.5[25]		**8.8**	**39.9 to 44.9**
Total	**12**	**3**	**5 to 10**	**8.5**	**7.5**		**8.8**	**44.8 to 49.8**
SREP Leverage	**3.7 to 4.1**							

[19] EU, AFD, UNIDO

[20] Parallel financing (loan) granted under the PAGOSE project ("Electric Sector Operations and Governance of Improvement Project")

[21] SREP funding by grant

[22] SREP funding consisting of $1.5 million grant and $10 million loan

[23] Loan granted by AfDB

[24] Funding provided by the other donors is mainly in the form of grants

[25] Mainly equity instruments

Tabl. 16 - SREP program financing plan (Project 2)

Unit: $M	**SREP**	**WB**	**AfDB**	**Other donors[26]**	**Private sector**	**State Contribution**	**Total**
Hybridization of Jirama's priority isolated centers							
Technical assistance and project management	2[27]					(28)	**2**
Investments	6[29]		Loan 5 to 10	(30)	25.7[31]		**30.7 to 35.7**
Total[32]	**8**		**5 to 10**		**25.7**		**38.7 to 43.7**
SREP Leverage	**4.8 to 5.5**						

The **World Bank** will be responsible for implementing the “Rural Electrification by renewable energy and mini-grids" project and

The **African Development Bank** will be responsible for implementing the "Hybridization of priority Jirama isolated centers" project.

Investment tools for the private sector (AfDB private sector arm, credit line, private sector contribution) are only valid in the case of a private-public partnership project, i.e. the work permit to a private operator. The contribution of the private sector was assessed through financial modelling, which is described in the following paragraphs.

All the investments made by the lessors are in foreign currency, private financing may be in foreign currency or local currency.

The government's contribution can be made in various ways: grant, tax exemption, sovereign guarantee etc.

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[26] EU, AFD, UNIDO

[27] SREP funding by grant

[28] In the case of transferring hybridization projects from isolated centers to private operators, the State contribution could take the form of contributing to make energy purchase contracts secure by Jirama.

[29] SREP guarantee contribution

[30] The AFD intends to set up a SUNREF credit line in support of the private sector.

[31] Loans granted by DFIs, loans granted by local commercial banks, and equity instruments

[32] Totals are given with warranty

The available funding volumes are less than the funding requirements of the entire pipeline of sub-projects. The funding announced by the donors for rural electrification (see the following paragraphs), depending on the type of structure chosen, will enable the development of sub-projects with a renewable energy combined installed capacity of 2.5 to 5.6 MW. With respect to hybridization, if the available funding meets the private financing called on, sub-projects with a renewable energy combined capacity of up to 14.1 MW may be achieved. In this way, during the preparation phases of the SREP program strategic avenues, only priority sub-projects will be selected according to the amount of funding available.

7.2. COSTS AND SOURCES OF FUNDING

The SREP funds have a dual objective:

- To initiate proactive development of renewable energy by ensuring the financial feasibility of the initial projects;
- To sustain this momentum by creating an appealing environment for the private sector.

The following paragraphs reveal the thought processes at work on the structuring and funding schemes to meet these objectives.

Structural options are defined in accordance with the existing regulatory framework, taking into account current practices and feedback from pilot projects developed in Madagascar.

Funding schemes are developed based on available financing with the objective being to maximize the installed renewable energy capacity while maintaining acceptable electricity selling rates.

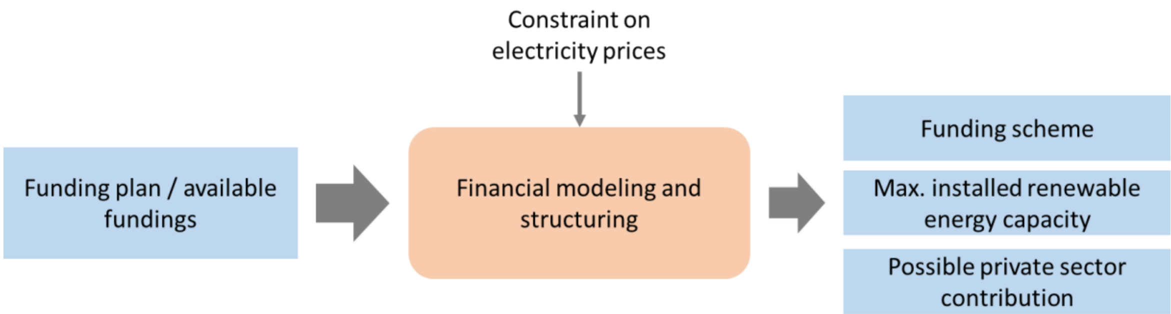

Fig. 6. Methodology for studying funding schemes

The sources of funding studied are as follows:

- Public financing: State contribution in the form of grant or equity share, grant or licensing loans from donors to the State, insurance or warranty tools[33];
- Private funding: loans from DFIs, loans from local commercial banks, equity contributions from private investors.

The share of public and private funding is to be adjusted according to the profitability of the project and the resources available, with the cost of public funding being less than private sector funding. In order to mobilize private funding, a project must be profitable and offer attractive guarantees.

7.2.1. Project 1: Funding scheme for rural electrification by renewable energy plants and mini-grids

7.2.1.1. CONTRACT SCHEME

In the case of rural electrification, the scope of activity does not only include construction and operation of a production infrastructure, but also the distribution and marketing of electricity. Two schemes can be considered to structure these activities:

- **Public project management**: in this option, the public authority is responsible for funding, building and operating the infrastructure (generation plant and distribution grid). These infrastructures can be transferred to Jirama, which is then in charge of their operation and the marketing of electricity to end customers. This scheme involves integrating the rural electrification mini-grid on the Jirama perimeter.
- **License to a private operator**: part of the funding, construction, operation and maintenance of the infrastructure as well as the marketing of electricity are delegated to the private operator. The licensee shall be remunerated by the tariff paid by the users [34]

[33] Warranties and insurance are intended to cover commercial risk, foreign exchange risk and political risks. Madagascar is a member of the Africa Trade Insurance (ATI) which offers investor or credit insurance products.

[34] Local financial players (commercial banks and investors) can contribute to project funding, thereby reducing exchange rate risk and strengthening sector dynamics. The interest rates charged by local banks are nevertheless higher and maturities lower than those available from international institutions.

a) Public project management

The first option would consist of an extension of the perimeter granted to Jirama. However ADER is normally responsible for developing rural electrification. It is therefore recommended that the responsibilities of Jirama and ADER be clearly defined in the implementation of rural electrification sub-projects. This type of set-up is tricky given the Jirama's financial difficulties as well as its lack of experience and technical capacity for this type of project. An EPC (Engineering Procurement and Construction) contract is recommended to build the infrastructure. This contract allows for the recruitment of a single operator for the design, fitting out and construction of the infrastructure. Project management assistance can also be mobilized.

b) License to a private operator

The second option involves the approach chosen by ADER to develop rural electrification projects. A call for tenders was launched in April 2017 for the license to decentralize electrification in three municipalities[35].

According to Law No. 2017-020, the scheme applicable to renewable energy production activities (solar, wind and hydroelectricity) is as follows: the license for power levels greater than 5 MW and the authorization for lower power levels (see paragraph 3.4.1). The license contract is signed by the private operator with the granting authority (Ministry or ADER depending on the sharing of skills to be defined by the decree acting on the delegation of authority to the ADER). MEEH and ADER have a sample license contract which was set up with support from the World Bank. The relationship between the operator and the end customers is governed by individual subscription contracts.

The license for rural electrification projects allows the transfer of responsibility for technical hazards to private operators. The licensee also assumes the commercial risk of payment from users. This risk is particularly high in rural areas because users are often without bank accounts and have low incomes. Revenue generated by users does not cover infrastructure investment costs (renewable energy plants and grids). An investment subsidy may be provided to ensure the profitability of the project. It reduces the tariff level and makes electricity more accessible to users. This is the approach currently used by ADER: between 40 and 80%[36] of the investment costs are subsidized by the lessors or the FNE. On the other hand, awareness-raising work helps to strengthen appropriation of the project by the beneficiary communities. When funding is granted in foreign currency, the exchange risk for the private operator is high because the project's revenues are in local currency. This risk can be mitigated by mobilizing exchange risk instruments or by providing a part of the funding in local currency.

[35] Ambatosia, Beandrarezona, Ambodiampana

[36] Information obtained during exchanges with operators, donors and ADER

7.2.1.2. FUNDING SCHEME

The funding scheme depends on the structure chosen. The following graphs and tables show the results of the funding scheme analysis. The assumptions and details of the analysis are given in paragraphs 0 and b) below.

Indicative donor contributions for projects involving rural electrification by renewable energy and mini-grids are reiterated below:

Tabl. 17 - Indicative donor contributions for rural electrification

SREP	AfDB	Other donors[37]
Grant $1.5 million **Loan $10 million[38]**	Loan $5 to $10 million[39]	$7.1 million[40]

The sovereign loan and international commercial debt are generally in foreign currency.

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[37] EU, AFD, UNIDO

[38] License loan: 40-year maturity with 10 years differed, up to 75% grant

[39] Loan to the private sector, applies only in the case of a license

[40] Funding provided by the other donors is mainly in the form of grants

A funding scheme is prepared, based on the indicative funding of each of the donors, and taking project cost constraints into account.

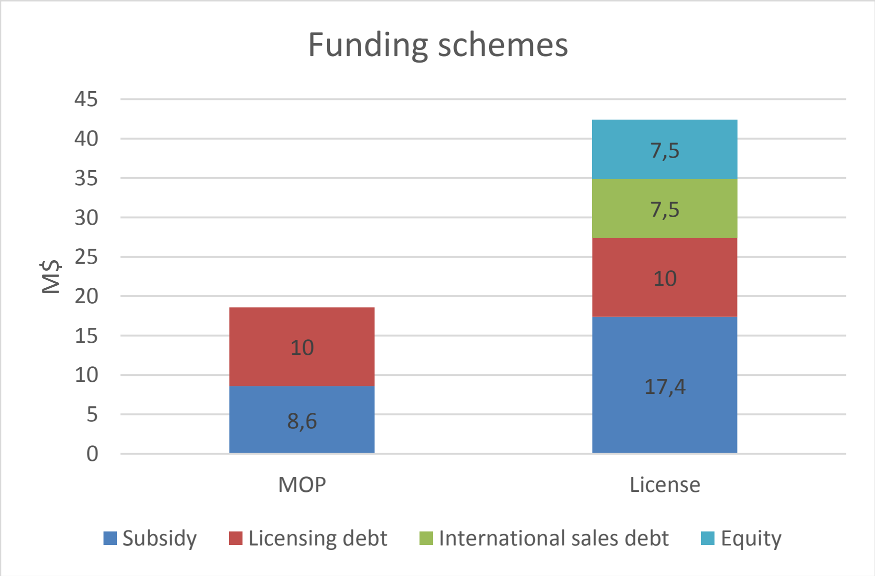
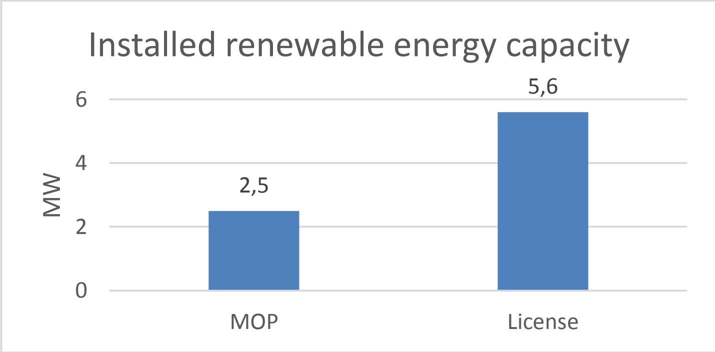


Fig. 7. Funding schemes for rural electrification based on the chosen structuring

The scheme for funding the public project management option is defined by assuming that, apart from the SREP sovereign loan, all donor contributions are made in the form of a grant.

The scheme for funding the license to a private operator option is prepared by assuming that a share of own funds is provided by the private sector, up to 30% of non-subsidy investments. In this case, in order for the project to be cost-effective and the tariff maintained at an acceptable level, the investment subsidy must be increased to $17.4 million. Funding for supplementary grants is therefore sought.

On the basis of the funding schemes described above, the overall envelope of feasible electrical installations is estimated:



	MOP	License
Linear system of installed distribution lines	80 km	190 km
Energy produced	14 GWh	32 GWh

Fig. 8. Dimensioning of the electrical system according to the chosen structuring

The cost of distributed electricity[41] is derived from the estimate of the feasible electrical system and the funding scheme:

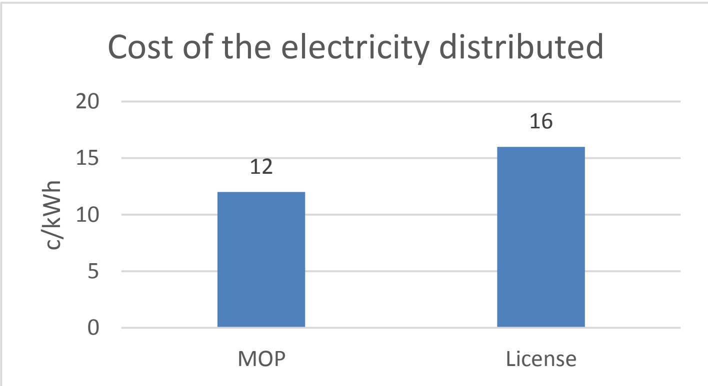


Fig. 9. Cost of distributed electricity according to the chosen structuring

In conclusion, structuring in public project management only mobilizes reduced-cost funding (grants and licensing loans) to ensure the profitability of the project and reduce the tariff level. In the case of the license, the use of private sector funding increases the financing envelope and develops a larger renewable energy capacity. However, a larger proportion of subsidy is needed to ensure the cost-effectiveness of the project.
The following paragraphs detail the analysis of funding schemes and provide assumptions.

a) Case of a project developed using public project management

[41] This cost is calculated excluding taxes and excluding marketing costs.

In the case of a project developed using public project management, only the funding tools for the State (sovereign grants and loans) apply.

Tabl. 18 - Indicative donor contributions for rural electrification – case of the MOP

$M	SREP	Other donors[42]	State Contribution
Rural electrification by renewable energy plants and mini-grids			
Investments	Grant 1.5 Loan 10[43]	7.1[44]	Possible contribution

Assuming that all "other donor" funding is provided as a grant, the following funding plan is obtained: $8.6 million grant and $10 million loan All of these funds are provided in foreign currency.

The investment costs (CAPEX) and operating costs (OPEX) of the 9 rural electrification sub-projects have been calculated (see paragraph 5.2). By averaging the latter, the following unit costs are obtained:

Tabl. 19 - CAPEX and OPEX per energy and power unit

Investment cost (CAPEX) per MW installed	$7.5 million/MW
Operating cost per MWh produced	$ 11.23 /MWh/year
Energy produced by MW installed per year	5,694 MWh/MW/year

The costs of deploying distribution grids account for 34% of CAPEXs.

The electrical system can be sized based on the available investment amounts and the above ratios. A total investment of $18.6 million enables 2.5 MW of renewable energy to be developed, deploying 80 km of distribution grid and generating an energy of 14 GWh.

The following table gives the assumptions made for modelling. The ratio “share of energy produced actually invoiced" is the quotient of the energy sold multiplied by the renewable energy plant generation potential. Users connect up gradually and their consumption increases as electrical equipment is acquired. Since the infrastructure is generally sized for medium term consumption, the entire plant's generation potential cannot be sold in the early years. This difficulty was confirmed by the operators during the tendering assignment. This ratio therefore reflects operators’ turnover deficit in the early years.

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[42] EU, AFD, UNIDO

[43] License loan: 40-year maturity with 10 years differed, up to 75% grant

[44] Funding provided by the other donors is mainly in the form of grants

Tabl. 20 - Financial modeling assumptions

Project duration	10 years
Rate of interest on the license debt	1%
Share of the energy produced actually invoiced	70%

A simplified financial modelling is carried out using the assumptions given above. The updated cost of distributed energy is 12c/kWh. This cost includes only energy production and distribution costs as well as financing costs. Management and counting costs should be included as well as the various fees and taxes, in order to estimate the actual selling price of electricity. The rates charged to private customers by Jirama are between 13 to 20c/kWh depending on consumption, power required and area. In the field of rural electrification, the tariffs applied by private operators are around 500 Ariary/kWh, i.e. 16c/kWh. Thus, the tariff obtained in connection with a public project management set-up is acceptable. However, this set-up does not allow additional private funds to be raised and the power that can be developed remains limited.

b) Case of a project granted to a private operator.

In the case of a license, the financial scheme is structured around a private company (created or not for the project alone) which finances the infrastructure, manages it and collects subscription payments from users. This company combines equity capital (shareholder capital) and a bank debt. Funds for the private sector can be mobilized and the indicative donor contributions that can be taken into account are as follows.

Tabl. 21 - Indicative donor contributions for rural electrification – case of license

$M	SREP	AfDB	Other donors[45]
Rural electrification by renewable energy plants and mini-grids			
Investments	Grant 1.5 Loan 10[46]	Loan 7.5	7.1[47]

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[45] EU, AFD, UNIDO

[46] License loan: 40-year maturity with 10 years differed, up to 75% grant

[47] Funding provided by the other donors is mainly in the form of grants

In order to complement the financing plan, private sector funds can be mobilized. Assuming a 70%/30% split between debt and equity, the system is as follows:

Tabl. 22 - Funding scheme for rural electrification – case of license

Funding instrument	Amount	Share
Sovereign loan	$10 million	70%
International commercial debt	$7.5 million	
Equity	$7.5 million	30%

The sovereign loan and international commercial debt are provided in foreign currency. Equity can be provided in the local currency.

Financial modeling assumptions are given in the following table:

Tabl. 23 - Financial modeling assumptions

Project duration	10 years
License loan rate	1%
Private sector MDB loan rate	7.5%
Equity target TRI	15%
Corporate tax rate	33%
Share of the generated energy invoiced	70%

The cost of distributed electricity, using the funding plan given above, is over 26c/kWh. However, in order to be able to electrify the least privileged areas and ensure the recovery of invoices from final consumers, the tariffs must be acceptable. An investment subsidy is then required.

To achieve a target rate of 16c/kWh, the subsidy must cover at least 30% of the investment amount, i.e. $17.4 million. This subsidy is higher than the donor contributions and supplementary grant funding is sought.

By adding a grant of $17.4 million to the funding scheme shown above, the investment amount comes to $42.4 million. This represents to an installed renewable energy power of 5.6 MW and 190 km of distribution grid. The energy produced is estimated at 32 GWh per year.

Thus, the development of rural electrification by license to a private operator makes it possible to mobilize more financing through the use of private funding. However, a subsidy covering at least 30% of the investment amount must be made in order to offset the costs of private funding and bring the tariff back to an acceptable level. As part of the funding is provided in foreign currency and all revenues are in local currency, the exchange risk is high.

7.2.2. Project 2: funding scheme for hybridization of the JIRAMA priority isolated centers

7.2.2.1. CONTRACT SCHEME

Two structuring methods may be considered for electricity generation projects. The first is public project management (MOP) development for which the energy installation is developed, operated and owned by the State or Jirama. The public authority then uses an EPC (Engineering, Procurement and Construction) contract, also called "turnkey". This contract can be supplemented with technical assistance during the first few years of operation or a global EPC + O&M contract provided for. This method of structuring generally benefits from licensing loans, or even subsidies from financial institutions for development granted to the State and surrendered to the national electricity company and thus benefits from advantageous financial conditions.

The second structuring method is the IPP (Independent, Power, Producer) set-up for which a producer (or “project company") – a predominantly private capital company - designs, builds, operates and maintains an electrical production facility and sells the energy generated to the central buyer, Jirama. The private partner is then an infrastructure licensee during the operating period and then transfers it to the public part.

The approach recently adopted by Jirama hybridize isolated centers is the license to a private operator. In November 2017, national tenders for the license of 12 isolated centers were launched. At the beginning of 2018, 20 centers again went up for international tender to be granted to a private operator. These examples as well as Jirama's meagre experience in the management of renewable energy power stations lead to a licensing structure.

Thus, during the stakeholder tendering assignment, the parties agreed on the choice of a licensing model to a private operator, to develop the "hybridization of isolated centers” avenue, as part of the SREP investment plan.

The perimeter licensed to the private operator may be defined according to two diagrams. Either, the Renewable Energy plant is licensed and Jirama continues to operate the associated thermal unit. Or, the thermal unit and renewable energy plant are licensed to the private operator. The first scheme is not recommended because the two means of production, owned by different players, compete rather than creating a synergy. In addition, this set-up complicates the operation technically. In the second diagram, in order to ensure the proper operation of the thermal unit under hybridization with an intermittent power plant, the rehabilitation or renovation of this unit may not be included in the private operator’s scope. As part of some of the calls for tender launched by Jirama, the licensee provides a new thermal unit and the Jirama unit is decommissioned.

According to Law # 2017-020, the applicable scheme is either the license (renewable energy power greater than 5 MW) or authorization (renewable energy power less than 5 MW). Focusing on the basic contractual system requires careful arrangement of the license contract, binding the granting authority and the private operator, energy purchase contract (PPA), binding Jirama and the private operator, and the interconnection/network access agreement between the same parties. In fact, certain parts such as the acceptance and commissioning conditions of the power plants, operating conditions, etc., may be covered by several contracts (license, PPA and interconnection). In 2017, with support from the World Bank, MEEH developed a sample license contract as well as a sample energy purchase contract.

The license of hybrid isolated centers enables the technical risks to transferred to a private operator. The private operator in this scheme takes a significant commercial risk on selling generation potential to the central buyer (Jirama). In order to limit this risk, mechanisms may be set up (letter of credit, escrow account, guarantees, etc.; see paragraph 7.2.2.3). The private operator also assumes the risk of fluctuations in fuel prices. This risk can be mitigated by indexing the rate on fuel prices (approach used in Jirama calls for tender). The public authority may also bear this risk by taking responsibility for the supply of fuel. Finally, if the funding is provided in foreign currency and the energy purchase contract is signed in local currency, the exchange risk for the private operator is high. One solution may be to transfer this risk to the central buyer by signing the contract for the purchase of energy in foreign currency (approach used in Jirma calls for tender). This risk may also be mitigated by mobilizing exchange-risk instruments or by providing a part the funding in local currency.

7.2.2.2. FUNDING SCHEME

As license structuring has been the subject of a stakeholder consensus, the funding scheme is developed using this assumption. The following tables show the results of the analysis of the funding schemes.

Indicative donor contributions for the isolated centers hybridization avenue are reiterated below:

Tabl. 24 - Indicative donor contribution for hybridization of isolated centers

SREP	AfDB	Other donors[48]
$6 million warranty	Loan $5 to $10 million	Credit line

Credit lines provide support for the local banking sector. The AfDB loan can be supplemented by other contributions from the DFIs (e.g. the IFC is a stakeholder in the SREP). Thus, in order to optimize the impact of the guarantee provided by the SREP, the financing scheme is developed under the assumption of additional funding: private investors (in compliance with the debt/equity ratio of 70%/30%), loans from international institutions, and loans from local banks. It is shown in the diagram below.

[48] AFD

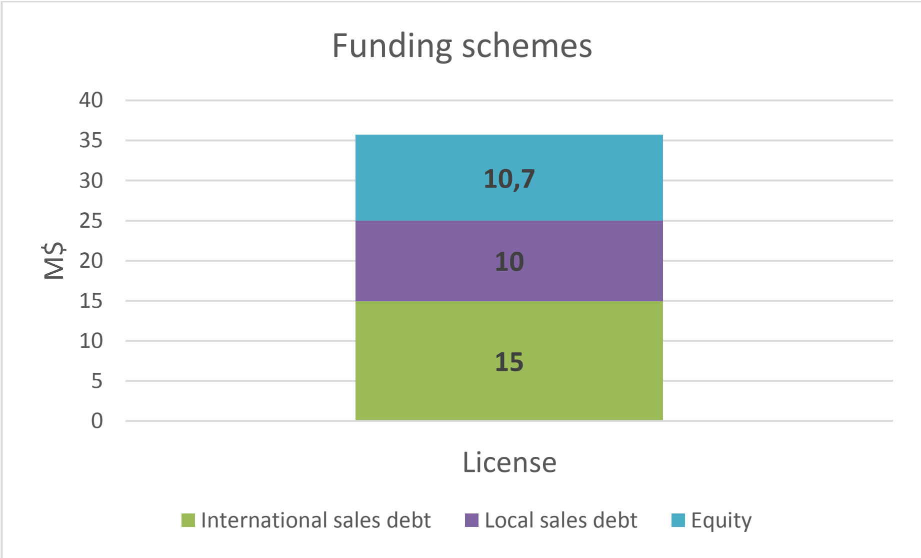


Fig. 10. Funding schemes for hybridization of isolated centers

Funding from DFIs is, in general, provided in foreign currency. A part of the equity investments and funding from local banks may be made in local currency.

The investment costs (CAPEX) and operating costs (OPEX) of the hybridization sub-projects have been calculated (see paragraph 5.2). By averaging the latter, the following unit costs are obtained:

Tabl. 25 - CAPEX and OPEX per energy and power unit – hybridization of isolated centers

Investment cost (CAPEX) per MW of installed renewable energy	$2.5 million/MW/year
Operating cost per MWh (renewable and thermal energy) generated	$255 /MWh/year
Energy generated (renewable + thermal) by MW of installed renewable energy	5,365 MWh/MW/year

On the basis of the funding schemes described above, the overall envelope of feasible electrical installations is estimated:

Tabl. 26 - Electrical system sizing for hybridization of isolated centers

Installed renewable energy power	14.1 MW
Energy generated (renewable + thermal)	76 GWh
Share of renewable energy in the generation of energy.	30%

The following table gives the assumptions made for financial modelling:

Tabl. 27 - Financial modeling assumptions

Project duration	20 years
Rate of interest on the license debt	1%
Rate of interest on the international commercial debt	7.5%
Rate of interest on the local commercial debt	19%
Equity target TRI	15%
Corporate tax rate	33%

The cost of the energy generated is calculated from the design of the electrical system and funding scheme: 30.6c/kWh. This cost represents a saving of almost 20% compared to the non-hybridized thermal system. Thus, hybridization is of economic interest without resorting to licensing funding or subsidies.

Given the financial situation of Jirama, the central buyer, the commercial risk of buying energy is highly critical. To mitigate this risk, it is recommended that SREP provide a guarantee of $6 million. The impact of the guarantee depends on the type of guarantee sought. The exact terms of the guarantee [2]implemented (type, leverage, pricing, etc.) will be determined when preparing projects. Assuming a leverage of 1:4, as part of the funding plan presented above:

- If a payment guarantee of $6 million is requested, it will cover 12 months of central buyer payment.
- If a partial risk guarantee of $6 million is requested, it will guarantee 96% of the debt.

When part of the funding is provided in foreign currency and the energy purchase contract is signed in local currency, the exchange risk for the private operator is high. Mitigation measures were identified in the previous paragraph.

The following section provides a detailed analysis of the warranty tools.

7.2.2.3. WARRANTY TOOLS

Hybridization of isolated centers allows for the systematic reduction of production costs compared to the reference case of an entirely thermal system. This reduction is 19.6% on average. This represents a major saving for Jirama, the central buyer. Thus, hybridization is of economic interest without resorting to licensing funding or subsidies.

However, these projects represent significant commercial risks in the event of failure to pay electricity by the central buyer.

Given the financial situation of Jirama, the central buyer, the first risk is highly critical. Guarantee mechanisms can be set up to cover this risk. In the context of specific investment projects of public interest which have an impact on development, the term “guarantees in support of projects” is used as opposed to “guarantees in support of reforms”. These guarantees are granted by the development financial institutions (MIGA, IBRD, IDA, ADB, AfDB, etc.) and specialized institutions. In the case of projects structured in private public partnership, there are several types of guarantees:

- Loan guarantees cover failure to pay the debt service and are divided into two categories depending on whether the indebted entity is public or private:
  - Partial credit guarantee (PCG): covers a failure to pay the debt service, usually by a public sector borrower, regardless of the cause of failure.
  - Partial risk guarantee (PRG): covers commercial creditors of a private project against a failure to pay the debt service resulting from decisions or inaction by the public authorities.
- Payment guarantees cover non-compliance with State (non-loan) payment obligations to private entities. Payment obligations include the purchase of services by the public entity (e.g. electricity purchase contract) and compensation for private entities (traffic guarantees, tariff compensation, etc.).

Tabl. 28 - Type of guarantee and entity covered

Type of guarantee	Who is covered?	What kind of transaction is covered?	What risks are covered?
Partial credit guarantee	Public sector borrower (State or State Corporation)	Credit: failure to pay the debt service	Irrespective of the cause of failure
Partial risk guarantee	Trade creditors	Credit: failure to pay the debt service	Political risks: currency inconvertibility, expropriation, regulatory change, armed conflicts, breach of contract, etc.
Payment guarantee	Project company	Payments due by the public entity	Irrespective of the cause of non-compliance with the obligation to pay

In most cases (e.g. IBRD, IDA, and FAD guarantees), where the guarantee is issued in favour of a private entity (commercial bank or project company), the guarantee is backed by a sovereign counter-guarantee of the host country in favour of the institution issuing the guarantee. When the guarantee is called on by the beneficiary, the host country shall be obliged to reimburse the institution issuing the guarantee.

The guarantees are subject to instruction by the issuing institutions and commissions are charged. They are generally paid by the borrower or the project company. For IBRD or IDA for example, the opening and instruction commissions are between 15 and 50 basic points and the annual recurring charges between 25 and 100 basic points.

As part of the concession set-up of a hybridization project, the risk of payment by Jirama, the central buyer, can therefore be insured by a partial risk guarantee covering the project's commercial creditors or by a payment guarantee covering the project company. Possible contractual arrangements are as follows:

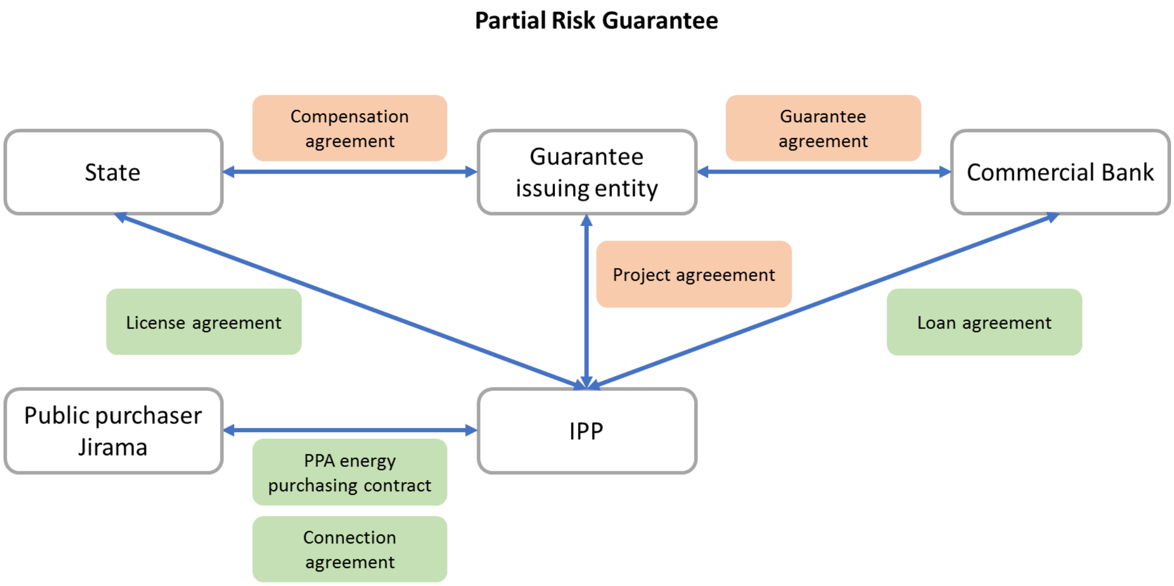


Fig. 11. Contractual scheme of partial risk guarantee

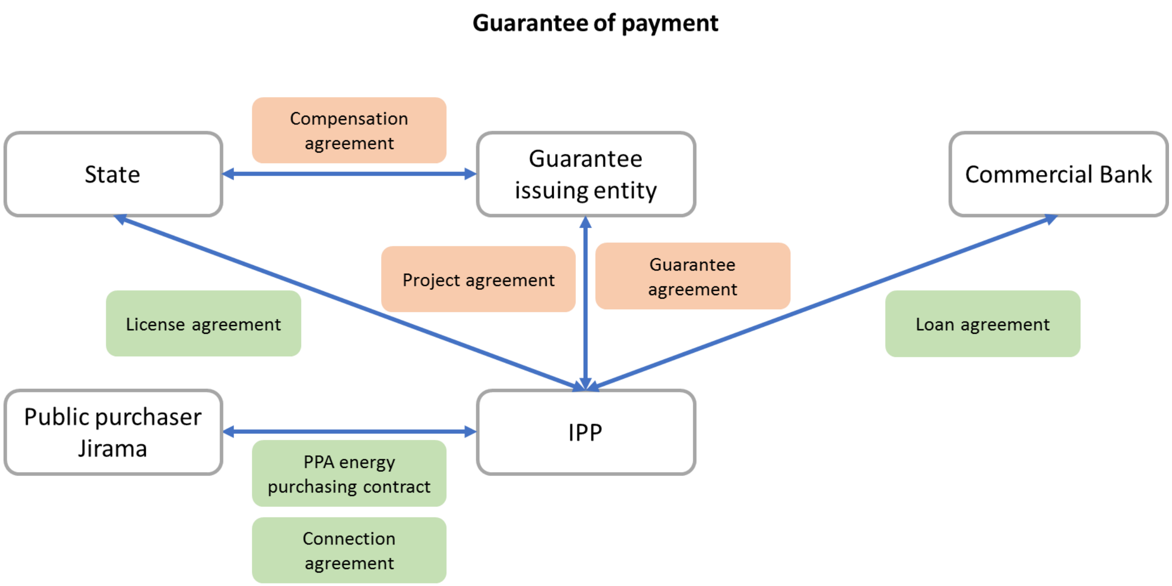


Fig. 12. Contractual scheme of a payment guarantee

SREP is requested to provide a guarantee of $6 million. This guarantee would create an attractive environment for private developers for hybridization projects in isolated centers and would have significant leverage.

Beyond SREP funding, development financial institutions can contribute to hybridization projects to limit the risks identified above. Financial tools to cover foreign exchange risk, additional guarantees or coverage may be mobilized.

7.3. FUNDING BENEFICIARIES

In the SREP funding scheme there are two types of funding:

- Public funding granted by donors: sovereign grants and loans. The beneficiary of these funds is the State which may then surrender them to other institutions (Jirama, FNED etc.).
- Private funding provided by private donors, commercial banks and private investors: loans and equity contributions. This funding only applies in the case of project development in private project management (license). The beneficiaries of these funds are project companies and private operators.

7.3.1. Rural electrification funding vehicle

At the donor tendering meeting held on 21/03, it was proposed that donors should contribute their respective contributions to the National Sustainable Energy Fund (FNED), which was being set up for rural electrification projects.

In this way, two funding channels may be considered for the SREP contribution to the rural electrification avenue:

- SREP funds are paid to the State for direct funding of projects
- The SREP funds are paid to the State which then pass them onto the FNED

The purpose of the FNED is to "contribute to the funding of rural and suburban infrastructure development projects"[49]. Furthermore, "loans and grants from financial institutions and international organizations granted to the State" form part of the FNED's identified resources. The FNED foundation decrees to implement the law are being developed with support from GIZ. It is planned that the management of the fund will be entrusted to a credit institution.

In order for the SREP to contribute to the FNED, the timetables for the availability of SREP funding and the creation of the fund will have to have to coincide. In addition, the organization and operation of the FNED will have to comply with the donor guidelines.

7.3.2. Beneficiaries of the proposed guarantee tool for the hybridisation of isolated centers

The guarantee sought under SREP may be of two types: a partial risk guarantee to cover political and country risks and a payment guarantee enabling the private project manager to cover the risk of non-payment by the central buyer.

According to the contractual schemes given in the paragraph7.2.2.3, the beneficiaries of the guarantees are:

- **Commercial banks**, for partial risk guarantees, which would have the effect of securing the conditions under which the borrowing of private developers would have subscribed and thus lowering the relevant interest rates.
- **Project companies**, for payment guarantees, set up by private developers, enabling private developers to cover any failure to pay by Jirama, the central buyer.

[49] See the first Article of Law No. 2017-021 reforming the National Electricity Fund (FNE)

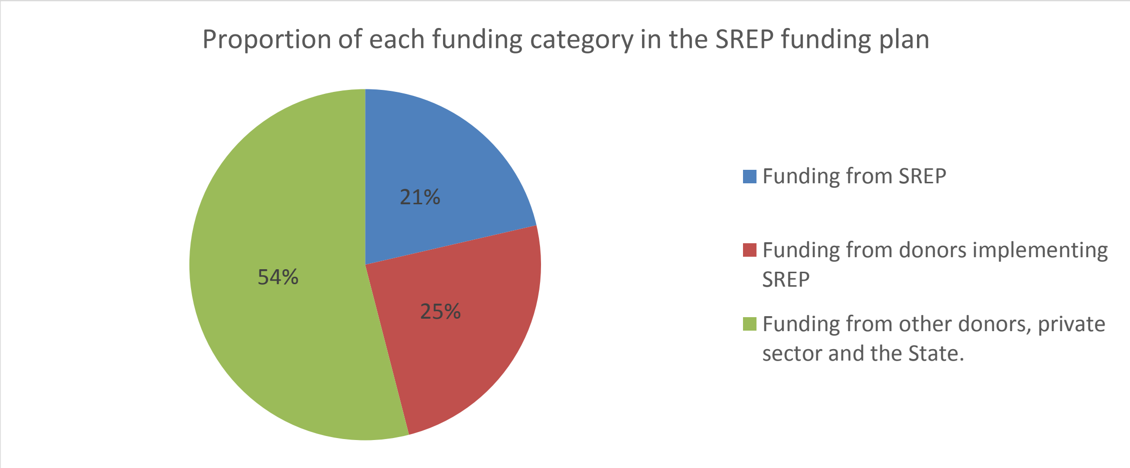
7.4. LEVERAGE EFFECT OF ADDITIONAL CO-FUNDING

Funding, for the leverage calculation, falls into one of three categories:

1. Funding provided by SREP (guarantee included)
2. Funding provided by donors providing SREP implementation (WB and AfDB)
3. Funding provided by other donors, the private sector and the State.

The following diagram shows the share of each type of funding in the funding plan given in paragraph 7.1 prepared following the stakeholder consultation:

Fig. 13. Illustration of SREP leverage



The leverage effect of SREP funding is defined as the ratio between the overall funding and the funding provided by SREP [(1)+(2)+(3)] / (1). Depending on the funding plan, this leverage is 1:4.7.

The SREP leverage program is defined as the relationship of all funding on the total sum of funding provided by SREP and by the donors of the SREP implementation: [(1)+(2)+(3)] / [(1)+(2)]. Depending on the funding plan, this leverage is 1: 2.2.

Thus the SREP program catalyzes investments in the renewable energy sector. SREP creates a forum for discussion among the sector donors in Madagascar around a tangible investment plan. Furthermore, the SREP program support is aimed at creating a favourable framework for contributing to the private sector. Thus, the decision to develop private project management projects (license), accompanied by incentive tools (grants, licensing loans and guarantees) would, depending on the funding scheme (see paragraph 7.2), help mobilize a contribution from the private sector representing more than 40% of investments.

7.5. INSTITUTIONAL DIAGRAM OF PROJECT IMPLEMENTATION

A good division of roles and responsibilities between the different public players enables the effective implementation of the investment plan. A coordination, monitoring and evaluation unit for the program may be set up. The institutional scheme adopted must also comply with the regulations in force. The following table provides a proposal for an institutional scheme for avenues 2 and 3 in the case of private project management.

Tabl. 29 - Institutional diagram of investment plan implementation

	For hybridization (with a license)	**For rural electrification (with a license)**
Feasibility and financial sustainability studies: ⇨ **Governed by the law PPP**	The Ministry of Energy, with technical support from Jirama, is recruiting the service providers and piloting the feasibility and sustainability studies phase. The studies are sent to the PPP Unit of the Ministry of Finance for approval, except for smaller sub-projects.	The Ministry of Energy, with technical support from ADER (or ADER by delegation of power), is recruiting the service providers and piloting the feasibility and sustainability studies phase. The studies are sent to the PPP Unit of the Ministry of Finance for approval, except for smaller sub-projects.
Tendering for private operator recruitment: ⇨ **Governed by sectoral law and as a substitute by Law PPP.**	MEEH energy with technical support from Jirama is responsible for recruiting the private operator.	MEEH with technical support from ADER (or ADER by delegation of authority) is responsible for recruiting the private operator.
Contracting authority awarding the license	The license is awarded by the Ministry of Energy**.**	The license is awarded by the Ministry of Energy or ADER by delegation of authority (according to decree to be published)
Follow-up and monitoring of license agreements	ARELEC and Ministry of Energy	ARELEC and ADER

8. RISK ASSESSMENT

8.1. RISK ANALYSIS

When the license for an electricity generation (and distribution) project is granted to a private operator, the risks are divided between the public authority and that operator. In order to analyze these risks a risk matrix has been set up.

In this matrix, the main risks have been identified by type of risk (technical risks, E&S risks, commercial risks, country risks and other risks). An allocation of these risks between the public player and the private operator as well as relevant mechanisms to control them, where appropriate, i.e. to reduce their likelihood and the economic impact, were then recommended.

Rural electrification and hybridization projects for isolated centers will be analysed under the license to a private operator (see paragraph 7.2.1 and 7.2.2). A colour code distinguishes the special characteristics of each of the strategic avenues (green for rural and electrification and orange for the hybridization of thermal/renewable energy generation):

Tabl. 30 - Risk matrix for sub-projects granted to a private operator

Type of risk	Risk	Who bears the risk	Mitigation measure
Technical risk	Exceeding the cost; Exceeding the time limit; Design and construction defect; Operating and maintenance defect.	Private	Limiting the risks of incremental costs by conducting preliminary studies (soil studies, generation potential, etc.)
	Rural electrification: in the case of an isolated rural site, difficult access increases the maintenance risk.	Private/public	Guidance on maintenance conditions for access routes in the license contract.
	Infrastructure under-use: grid unavailability or insufficient energy removal.	Private	Infrastructure sizing consistent with demand and grid absorption capacity; Remuneration of the installed capacity; Hybridization: Purchase guarantee by the main purchaser of a minimum quantity produced even if not delivered (Take or Pay)
	Resource availability (wind / sunshine / hydrometry)	Private	Accuracy in the assessment of generation potential during feasibility studies.
	Theft or deterioration of rural electrification equipment	Private	Raising awareness and appropriation by the community.
	Poor condition of the hybridized thermal unit, insufficient production flexibility.	Private	Including the rehabilitation or replacement of the thermal unit in the license contract to the IPP.
Environmental and social risk	Making land safe	Public	Anticipating the acquisition of land by the State; Giving preference to a public utility declaration procedure; Settlement of disputes; Purging customary rights upstream of the work.
	Impact of work and operations on the environment; dismantling of the facility.	Private	Compliance with the Environmental and Social Management Plan by the private operator and State control.

Type of risk	Risk	Who bears the risk	Mitigation measure
	Social impact of the project Rural electrification: the benefits to the community are direct and the risk of non-acceptance of the project is reduced	Public or private (depends on the player supporting the compensation measures)	Estimated compensation under an action plan and a relocation plan, compensation upstream of the project; Implementation of compensatory measures: Community infrastructure, improvement of public services, agricultural arrangements, etc. Consulting the populations affected and involving them in the project; Recruiting local labor for work.
Commercial risk	Delay of payments due by the central buyer.	Private	State guarantee on payments; The State itself may benefit from a Partial Risk Guarantee.
	Non-payment or low consumption of end users	Private (collection of payments by the private operator);	Subsidy of installed capacity for investment; Tariff study and adjustment of the tariff to the ability of users to pay; Raising awareness to and appropriation of the project by the community.
	Fuel prices for the thermal part	Private	The fuel is delivered by the State (or Jirama) to the IPP. The selling price of electricity by the IPP does not therefore include the purchase of diesel oil.[50] Or: Indexing the selling price of electricity (thermal) on the price of fuel.
Country risk	Political risk resulting in a breach of contract	Public and private	Termination clause in the PPA and the license contract State covered by a partial guarantee (PRG or Political Risk Insurance)
	Exchange Risk	Private if the investment currency is different from the private operator's payment foreign currency	Hybridization: Preference given to signing the PPA in a strong foreign currency; Or use loans from local commercial banks; Introduce a tariff indexing formula on foreign currency variations.
	Non-compliance with State commitments (in particular the purchase guarantee)	Public	Partial warranty (PRG/PRI)
Other risks	Insufficient funding, unsuccessful PPP set-up.	Public and private	Good structuring of the project, mixing public and private funding.

[50] In this case, in order to encourage the IPP to use solar energy generation as a priority, imposing a minimum percentage of solar energy generation may be considered. Alternatively, the State (or Jirama) may commit to providing a quantity of fuel equivalent to a target performance level from the solar power plant. If this level is not achieved, the private sector purchases the amount of fuel missing.

8.2. ABSORPTION CAPACITY OF SREP RESOURCES

In the Energy Policy Letter, the investment required to achieve electricity access targets is estimated at $12 billion. As part of this policy, the SREP program represents only a small share of these investments (1.6%).

If all of the projects identified under the SREP program ($200 million investment) are implemented over five years, this would result in an average disbursement of $40 million per year and 69 sub-projects to be carried out. The government should get organized to implement such a level of disbursement (delegation to ADER, support from Jirama, mobilization of technical assistance, etc.). The task is all the more complex because there are many, small sub-projects. This underlines the importance of grouping these sub-projects into a reduced number of large lots. It is therefore recommended that, for each development avenue (rural electrification and hybridization of isolated centers), sub-projects are grouped together into lots according to the following criteria:

- Combined power of about 2 to 5 MW (depending on sub-project unit size)
- Deployment of one type of technology per lot
- Geographical consistency of the allotment

In addition, it is recommended to proceed in phases. The funding plan set up will help carry out between 35 and 40% of the identified sub-projects. This can be a good first step in the development of sub-projects.

9. MONITORING AND EVALUATION

In order to check and assess the effectiveness of the SREP Madagascar program and each of the sub-projects developed within this framework, it is important to establish a simple monitoring and evaluation system (M&E) to take a step back from the objectives and analyze the results achieved.

To this end, the SREP Madagascar investment plan results Framework provides a basis for monitoring the results and impacts of activities funded under SREP. It will also contribute to improving the framework for the overall energy sector in Madagascar.

The table below shows the Framework of the prepared results. It may be enriched as required by MEEH, in particular by setting annual targets to achieve longer-term targets such as those of the NPE by 2030.

Tabl. 31 - Framework of the Madagascar SREP PI expected results

Result	Key Indicators	Reference conditions	Targets
SREP Madagascar transformation impacts			
Support for low-carbon emission energy development	Renewable energy level in energy mix	54% of renewable energy (2016)	80% of renewable energy (2030)
Increased access to energy for populations	National electrification rate	15% (2016)	70% (2030)
Improved energy safety	Increased public and private investment in the energy sector	USD 12 billion investment requirement over the period 2015 - 2030	
Results of the Madagascar SREP[51]			
Increased amount of energy generated from renewable energy	Annual electricity generation (GWh) from sub-projects supported by SREP	0 (2018)	Approx. 55 GWh (2022)
Increased in the population's energy coverage rate	Number of people receiving access to electricity through a project resulting from SREP	0 (2018)	Approx. 93,000 people (2022)
Attraction of new investments for renewable energy sub-projects	Leverage: funding from other sources in addition to SREP	USD 20 million[52]	USD 93.5 million[53] (2020)
Improved air quality and impact on global warming	Emission of GHG avoided (tonnes of CO_2 per year) due to SREP sub-projects	0	Approximately 37,000 Tonnes of CO_2 avoided per year (from 2022)

[51] Results of projects related to the funding plan

[52] SREP grant contribution, license loan and guarantee.

[53] Total amount of funding

ANNEXE 1 Project Concept Briefs

PROJECT 1 - RURAL ELECTRIFICATION BY RENEWABLE ENERGY PLANTS AND MINI-GRIDS

PROBLEM STATEMENT

In Madagascar 85% of the population has no access to electrical power for primary needs such as lighting, heating and cooking. The vast majority of Madagascan people therefore live in rural areas and use wood energy exclusively as a primary resource. In terms of the environment, this leads to massive and worrying deforestation as well as considerable pollution. From the point of view of social and economic development, it is recognized that increasing access to electricity is an important lever for improving access to basic social services, reducing inequalities, contributing to economic development and reducing poverty.

Currently, about 90% of the population is not connected to the interconnected grid or to an independent stand-alone center managed by JIRAMA. In addition, only 6% of rural residents have access to electricity through a mini-grid within the scope of ADER. From a technical-economic point of view, it is impossible to electrically interconnect a country as vast as Madagascar in one go: in fact, population densities are low in rural areas, with fokontanys far away from each other. It is therefore essential to improve the situation as soon as possible to create independent mini-grids, along with renewable production equipment. The country's renewable energy potential is massive, in particular, with many potential sites that are very conducive to building hydroelectric power stations (the overall potential of the island is estimated at 7,800 MW). This renewable and clean resource ensures energy independence from fossil fuels while being economically competitive.

PROJECT CONTRIBUTION TO INITIATING TRANSFORMATION

To achieve the ambitious target of a 70% rate of access to electrification by 2030 as set by the Government of Madagascar in the NPE, developing rural electrification is a particularly major challenge. By contributing to this project, the SREP program should facilitate the implementation of the chosen sub-projects to help increase access to electricity in rural areas using a clean and sustainable energy source. According to the multi-criterion analysis carried out under this investment plan, rural electrification projects, which are the most advantageous in terms of the SREP and MEEH criteria, were selected. The top 9 sub-projects identified are mini-hydro sub-projects related to the creation of mini-grids. They represent an investment of approximately $110 million for an installed power of 15.2 MW, which is twice the capacity currently installed for rural electrification (about 8 MW). These sub-projects will help to reach currently non-electrified areas and populations that are not included in the Madagascar Lowest Cost Master Plan (PDMC). The funding announced by the donors, depending on the type of structure chosen, will enable the development of a part of the chosen sub-projects for a renewable energy total installed capacity of 2.5 to 5.6 MW. In this way, during the preparation phases of the SREP program project, only priority sub-projects will be selected according to the amount of funding available.

The mini-networks associated with each of these sub-projects will be larger than most of the existing ones and should thus contribute to supplying 5,000 to 11,000 new households in rural areas. The jobs potentially created and attractiveness generated by the arrival of electricity will make it possible to make these centers rural development hubs.

IMPLEMENTATION READINESS

In order to encourage private operators' interest in these sub-projects with variable unit size and to simplify tendering processes, the top 9 sub-projects chosen were grouped into homogeneous lots in terms of combined power (3 lots of about 5 MW). The following tables detail the suggested allotment. As can be seen, the largest sub-projects Dangoro and Sisaony will be subject to an individualised call for tenders.

It should be noted, however, that as data on possible photovoltaic (or wind power) plant sub-projects in rural areas were not obtained, they could not be selected. The integration of photovoltaic sub-projects may nevertheless be highly appealing in rural areas that do not have one of the hydroelectric structures such as those selected. These sub-projects can therefore be studied on a case-by-case basis and be added to this rural electrification component.

The total investment in the portfolio of identified sub-projects is $110 million, thus exceeding the amount of available funding (up to $44.9 million with input from the private sector). Only priority sub-projects will be chosen during the SREP investment projects' operational preparation, according to the amount of funding available. The lots may therefore be tailored according to the selection of priority sub-projects.

Tabl. 1 - Lot 1: Rural electrification by hydroelectric power stations and mini-grids

SUB-PROJECT NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment share for mini-grids ($M)	Total investment ($M)
AMBOHIDAVA	ALAOTRA MANGORO	Hydro	470	2,676	3.6	6.9
ANDRIAMAMOVOKA 4	ALAOTRA MANGORO	Hydro	241	1,372	1.1	3.3
Site near TSARAMANDROSO	SOFIA	Hydro	236	1,344	2.3	4.6
BEHAZOMATY	BONGOLAVA	Hydro	100	569	0.4	0.9
MAROBAKOLY	SOFIA	Hydro	420	2,391	1.1	3.6
ITENDA	VAKINANKARATRA	Hydro	1,794	10,215	4.4	14.1
ANTSAVILY	ITASY	Hydro	1,181	6,725	2.3	8.4
TOTAL			**4,442**	**25,292**	**15.2**	**41.8**

Tabl. 2 - Work package 2: Rural electrification by hydroelectric power stations and mini-grids

SUB-PROJECT NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment share for mini-grids ($M)	Total investment ($M)
SISAONY	ANALAMANGA	Hydro	5,500	31,317	3.6	20

Tabl. 3 - Work package 3: Rural electrification by hydroelectric power stations and mini-grids

SUB-PROJECT NAME	Region	Planned Renew. Energy type	Installed power (kW)	Generation potential (MWh/year)	Investment share for mini-grids ($M)	Total investment ($M)
DANGORO = Antanjona (ESMAP)	VATOVAVY FITOVINANY	Hydro	5,100	29,039	18.3	48.2

Investments dedicated to the creation of mini-grids in the vicinity of the hydroelectric works considered were evaluated on the basis of the number of Fokontanys to be supplied by ADER. For Sisaony, in particular, it appears that the projected investment in mini-grids would not allow the total energy produced by the power plant to be discharged. These figures, as well as those of installed power and generation potential are given for information purposes as the sub-projects are at the identification stage. The technical and economic data for each project should therefore be confirmed and refined during feasibility studies.

RATIONALE FOR SREP FUNDING

SREP funding removes the following barriers:

- Lack of technical ability and resources of public players: it is recommended to develop these projects in the form of licenses to private operators so as to transfer technical and commercial risks to the private partner, but also to limit the impact of the program on the state budget.
- High investment costs: Investment costs of the chosen rural electrification projects are high in relation to the income generated. An investment subsidy is recommended to ensure the cost-effectiveness of projects at an acceptable level.
- The population has little ability to pay: in order to be able to electrify the least privileged areas and ensure the recovery of invoices from final consumers, the tariffs must be acceptable. Several rural electrification projects currently under way offer a rate of 500 ariary/kWh, representing 16c/kWh. The proposed funding scheme allows for a cost of distributed electricity of the same order of magnitude. However, this cost is calculated excluding taxes and excluding commercial costs and additional efforts will have to be made (e.g. exemption) to reduce the rate.
- Facilitating the private sector contribution: the financing scheme considered in private project management would leverage private sector equity contributions up to 17% of the total investment.

ENVIRONMENTAL AND SOCIAL IMPACT

An analysis of the environmental and social risks was conducted on the chosen projects.

For these 9 sub-projects involving rural electrification by a hydroelectric power station and mini-grids, potential environmental and social risks were described and the appropriate mitigation measures proposed.

At this stage, it appears that the main socio-environmental risks would be those related to the release of the necessary area for each development (land, social, cultural, etc.). This challenge is generally critical for all development sub-projects in Madagascar.

The importance of each risk will depend on each sub-project and location. Nevertheless, the environmental and social review concluded that the sub-projects identified are generally environmentally and socially acceptable. The chosen sub-projects are of relatively limited sizes, and therefore should not cause major environmental risks.

The environmental and social assessment to be carried out for each project, when implementing the program, will thus consist of assessing the actual importance of environmental and social risks identified, specifically for each project (in the form of an Environmental Impact Study or Environmental Commitment Program, depending on the notification from the National Environment Office). The development of a Framework for Environmental and Social Management of the Program in general could also be a tool required to properly integrate environmental and social dimensions into its implementation.

RESULTS INDICATORS

The objective of rural electrification is to improve access to electricity for rural populations, promote local economic development and de-carbonize electricity generation. The project performance indicators are as follows:

Tabl. 4 - SREP performance indicators for project 1

SREP Indicators	Description	Expected result
Increased installed capacity to generate renewable energy.	Technologies that increase the installed generation (MW) of renewable energy sources.	2.5 MW (in MOP) or 5.6 MW (licensed to a private operator)
Increased access to electricity through renewable energy	Technologies that directly increase the number of households with access to modern energy services.	About 5,000 households[54] (in MOP) or Approximately 11,000 households (licensed to a private operator)
Low-carbon impact power generation developed	Technologies with the lowest carbon emissions during operation.	Very positive (No carbon emissions during use)
Increased accessibility and competitiveness of renewable energy	Technologies that increase the accessibility of renewable energy technologies and the competitiveness of the renewable energy market.	Pilot projects using a sustainable approach based on private sector contribution[55]
Increased industrial use of energy	Technologies that contribute to increasing income levels and end-user productivity.	Positive
Impact on economic, social and environmental development	Technologies that have a positive impact on economic, social and environmental development.	Very positive
Level of economic and financial profitability	Technologies with a higher level of economic and financial viability (lower LCOE).	According to the funding scheme presented, rural electrification projects maintain the cost of energy distributed at an acceptable level (less than 16c/kWh).
Leverage effect	Technologies that trigger additional projects, lead to investments by other donors or the private sector and catalyze energy sector reforms.	Funding provided by SREP for rural electrification avenues has a leverage effect of 1:4.1[55]
Category	Technologies that directly promote category main-streaming, increase opportunities for women and reduce the burden of domestic tasks for women	Positive (making household tasks easier with access to electricity)

[54] Assumption of 5 people per household

[55] Case of development using private project management

FINANCING PLAN

The financing plan for the SREP investment plan, reflecting indicative contributions from donors, is as follows:

Tabl. 5 - Indicative donor contribution for rural electrification

$M	SREP	WB	AfDB	Other donors[56]	Total
Technical assistance and project management	$0.5 million grant	Loan 3		$1.4 million	**$4.9 million**
Investments	Grant $1.5 million Loan $10 million[57]		Loan $5 to $10 million[58]	$7.1 million[59]	**$23.6 to 28.6 million**

The sovereign loan and international commercial debt are provided in foreign currency. Equity can be provided in the local currency. When funding is granted in foreign currency, the exchange risk for the private operator is high because the project's revenues are in local currency. This risk can be mitigated by mobilizing exchange risk instruments or by providing a part of the funding in local currency.

The available funding volumes are less than the funding requirements of the entire pipeline of sub-projects. The funding schemes shown below allow between 15 and 40% of the chosen rural electrification sub-projects to be achieved. Phasing is required and, during the preparation phases of the SREP program project, only priority sub-projects will be selected according to the amount of funding available.

[56] EU, AFD, UNIDO

[57] License loan: 40-year maturity with 10 years differed, up to 75% grant

[58] Loan to the private sector, applies only in the case of a license

[59] Funding provided by the other donors is mainly in the form of grants

Funding schemes are developed based on available financing with the objective being to maximize the installed renewable energy capacity while maintaining acceptable electricity selling rates. In the case of rural electrification, the funding scheme depends on the structuring of the chosen project.

Tabl. 6 - Funding schemes – rural electrification

Characteristics		Donor Contributions			Financing sought		
Dimensioning of the electrical installation	**Cost of the distributed electricity**[60]	**SREP**	**AfDB**	**Other donors**	**Supplementary grant contribution**[61]	**Private sector equity contribution**	**Total**
	Option 1: Public project management						
2,5 MW of installed renewable energy power 80 km of distribution lines laid out 14 GWh of energy produced per year	12 c/kWh	Grant $1.5 million Loan $10 million		$7.1 million			**$18.6 million**
Option 2: License to a private operator							
5,6 MW of installed renewable energy power 190 km of distribution lines laid out 32 GWh of energy produced per year	16 c/kWh	Grant $1.5 million Loan $10 million	Loan $5 to $10 million	$7.1 million	$8.8 million	$7.5 million	**$39.9 to $44.9 million**

[60] The cost of electricity is calculated based on simplified financial modeling, the assumptions of which are given in the body of the report in paragraph 0

[61] State contribution or supplementary funding from donors

The following graph illustrates the additional contributions to be made by type of funding in the case of a license to a private operator.

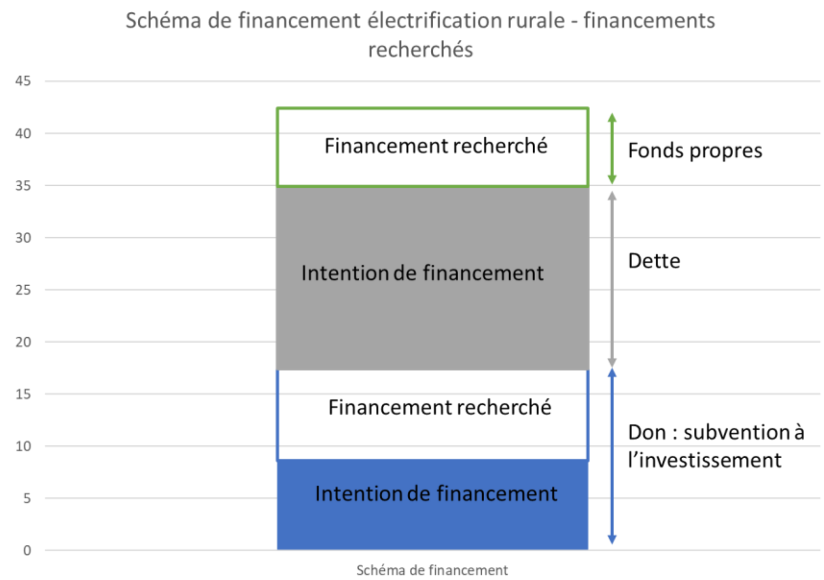


Fig. 14. Funding sought – rural electrification – case of a license to a private operator

In conclusion, structuring in public project management only mobilizes reduced-cost funding (grants and licensing loans) to ensure the profitability of the project and reduce the tariff level. No additional funding is required to make the project viable.

In the case of the license, the use of private sector funding increases the financing envelope and develops a larger renewable energy capacity. However, an additional subsidy is needed to ensure the cost-effectiveness of the project. Additional funding is sought.

Two funding channels may be considered for the SREP contribution to the rural electrification avenue:

- SREP funds are paid to the State for direct funding of projects
- The SREP funds are paid to the State which then pass them onto the FNED

The purpose of the FNED is to “contribute to the funding of rural and suburban infrastructure development projects”[62]. Furthermore, “loans and grants from financial institutions and international organizations granted to the State” form part of the FNED's identified resources. The FNED foundation decrees to implement the law are being developed with support from GIZ. It is planned that the management of the fund will be entrusted to a credit institution.

In order for the SREP to contribute to the FNED, the timetables for the availability of SREP funding and the creation of the fund will have to have to coincide. In addition, the organization and operation of the FNED will have to comply with the donor guidelines.

[62] See the first Article of Law No. 2017-021 reforming the National Electricity Fund (FNE)

PROJECT PREPARATION TIMETABLE

Tabl. 7 - Forecast timetable of the rural electrification Project

Date	Activities
June 2018	Approval of the investment plan
July 2019	Preparation / Studies / Drafting calls for tender
June 2019	Approval of funding
November 2019	Launching calls for tender and selecting private partners
2020	Start of construction work for hydroelectric power stations / mini-grids
2022	Commissioning of power plants

REQUESTS FOR FUNDING IN PREPARATION FOR THE INVESTMENT

In the case of license structuring, a feasibility study is required for the preparation of sub-projects. It helps:

- Choose the location of the renewable energy plant;
- Evaluate the generation potential;
- Analyze local electricity demand;
- Size the project, define technical options, and specify the quality standards required for equipment (distribution grid and power plant);
- Carry out the environmental and social impact assessment of projects as well as the related mitigation measures that could be implemented;
- Establish the financial and economic feasibility of projects;
- Determine the structuring method, funding scheme, tariff structure and legal set-up;
- Define the consultation process and take part in drafting call for tender documents (including sample contracts and technical specifications).

A Project Preparation Grant contribution will not be requested for rural electrification.

PROJECT 2 - HYBRIDIZATION OF PRIORITY JIRAMA ISOLATED CENTERS

PROBLEM STATEMENT

Madagascar has considerable renewable energy resources (hydraulic, solar, wind, and biomass), while overall energy consumption remains very low. This energy consumption is still dominated by fuelwood and its derivatives. Furthermore, the country imports petroleum products, still widely used for electricity generation (the amount of hydrocarbons purchased by JIRAMA (integrated public operator) in 2014 amounts to US$150 million, i.e. an increase of more than 100% compared to the 2009 level), and the high cost of energy – particularly electricity[63] – has an adverse effect on the country's social and economic development and contributes to maintaining a high level of poverty. The Madagascan electrical system has 3 HV interconnected grids (RI): Antananarivo-Antsirabe (RIA), Toamasina (RIT) and Fianarantsoa (RIF) operated by JIRAMA. It has 115 operating centers, 100 of which are powered exclusively by diesel-driven therm-electric generating sets (GO or HFO). Furthermore, with a very high average sunshine of 2,000 kWh/year across the country and winds above 7 m/s in the north and south of the country, solar and wind energy resources are considerably under exploited. Therefore, the use of these resources appears to be particularly high priority in those isolated centers whose fuel consumption weighs particularly heavily on Jirama's finances.

PROJECT CONTRIBUTION TO INITIATING TRANSFORMATION

In order to respond in an appropriate way to energy sector problems in Madagascar, a multi-criterion analysis has been conducted under this Investment Plan. The criteria and their weighting have taken into account the strategic objectives of the Ministry of Water, Energy and Hydrocarbons and the essential criteria of the SREP program. This analysis highlighted the importance of hybridization of thermal power plants in Jirama isolated centers by photovoltaic or wind power generation depending on the potential of the area involved. Fifty nine potential sub-projects with a hybridization priority were identified from among the 115 JIRAME isolated centers. They represent a total investment of approximately $95 million for an installed capacity of 38.1 MW. The funding announced by the donors will enable the development of a part of the chosen sub-projects for a combined installed renewable energy capacity of up to 14.1 MW. In this way, during the preparation phases of the SREP program strategic avenues, only priority sub-projects will be selected according to the amount of funding available. These sub-projects will lead to a significant reduction in production costs in the isolated centers whose operations weigh most heavily on JIRAMA's finances. They will ensure greater independence from fossil fuels by take advantage of the region's energy potential; the impact on air pollution will be reduced accordingly. Finally, these projects will provide an opportunity to increase the electricity coverage of populations around these centers with the aim of connecting approximately 7,500 additional homes.

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[63] The average cost of producing electricity produced and purchased by Jirama is between 1,100 and 1,200 Ar/kWh between 2011 and 2015. In comparison, the average selling price of electricity for all Jirama customers is around 380 Ar/kWh.

Source: Jirama activity reports.

IMPLEMENTATION READINESS

In order to encourage private individuals' interest in these sub-projects with variable unit size and to simplify tendering processes, the sub-projects were grouped into homogeneous lots in terms of combined power and total investment. The sub-projects were separated into 5 lots of about 5 MW of combined power. Lot 4 consists of a set of small-scale sub-projects in the southern half of the country, while lot 6 comprises similar sub-projects in the northern half of the country. Lots 5 and 7 represent larger-scale photovoltaic plants (6 MW and 11 MW). Lot 8 consists of the 2 potential wind power hybridization sub-projects: these test sub-projects, located to the extreme south of the country (a very favorable wind energy zone in Madagascar), will be used to assess the advantages of developing this technology for Madagascar.

The total investment in the portfolio of identified sub-projects is $95 million, thus exceeding the amount of available funding (up to $35.7 million with input from the private sector). Only priority sub-projects will be chosen during the SREP investment projects' operational preparation, according to the amount of funding available. The lots may therefore be tailored according to the selection of priority sub-projects.

The following tables provide details of the allotment.

Tabl. 1 - Lot 4: Sub-projects for the hybridization of priority JIRAMA centers

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
BELOHA	ANDROY	Solar	55	87	0.21
MOROMBE	ATSIMO ANDREFANA	Solar	190	299	0.71
BEFOTAKA	ATSIMO ATSINANANA	Solar	20	32	0.08
ANKAZOABO-ATSIMO	ATSIMO ANDREFANA	Solar	115	181	0.43
BEKILY	ANDROY	Solar	195	307	0.73
IAKORA	IHOROMBE	Solar	30	47	0.11
BETIOKY-ATSIMO	ATSIMO ANDREFANA	Solar	165	260	0.62
VONDROZO	ATSIMO ATSINANANA	Solar	65	102	0.24
IVOHIBE	IHOROMBE	Solar	50	79	0.19
BEZAHA	ATSIMO ANDREFANA	Solar	120	189	0.45
MIDONGY-ATSIMO	ATSIMO ATSINANANA	Solar	45	71	0.17
FARAFANGANA	ATSIMO ATSINANANA	Solar	780	1,229	1.83
TOTAL			**1,830**	**2,882**	**5.78**

Tabl. 2 - Work package 5: Sub-projects for the hybridization of priority JIRAMA centers

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
TOLIARY	**ATSIMO ANDREFANA**	**Solar**	**6,150**	**9,686**	**14.45**

Tabl. 3 - Work package 6: Sub-projects for the hybridization of priority JIRAMA centers

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
IKONGO	VATOVAVY FITOVINANY	Solar	50	79	0.19
KANDREHO	BETSIBOKA	Solar	35	55	0.13
ANAHIDRANO	SOFIA	Solar	35	55	0.13
SOALALA	BOENY	Solar	75	118	0.38
ANKAZOBE	ANALAMANGA	Solar	170	268	0.28
AMBATOFINANDRAHANA	AMORON'I MANIA	Solar	120	189	0.64
BEFANDRIANA-AVARATRA	SOFIA	Solar	310	488	0.73
MANJA	MENABE	Solar	115	181	0.45
FENOARIVO CENTER	BONGOLAVA	Solar	80	126	0.43
MAROLAMBO	ATSINANANA	Solar	70	110	0.30
MANANDRIANA	AMORON'I MANIA	Solar	65	102	0.26
TANAMBE	ALAOTRA MANGORO	Solar	425	669	0.24
VAVATENINA	ANALANJIROFO	Solar	295	465	0.43
ANALALAVA	SOFIA	Solar	110	173	0.28
MAROVOAY	BOENY	Solar	540	851	0.28
BEALANANA	SOFIA	Solar	240	378	1.00
AMBATO-BOINA	BOENY	Solar	260	410	0.90
TOTAL			**2,995**	**4,717**	**8.68**

Tabl. 4 - Work package 7: Sub-projects for the hybridization of priority JIRAMA centers

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
MAHAJANGA	**BOENY**	**Solar**	**10,980**	**17,294**	**25.8**

Tabl. 5 - Work package 8: Sub-projects for the hybridization of priority JIRAMA centers

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
AMBOVOMBE	ANDROY	Wind power	355	1,000	0.96
TSIHOMBE	ANDROY	Wind power	90	180	0.50
TOTAL			**445**	**1,180**	**1.46**

The projected installed capacity and the expected output were assessed to provide a basis for comparison. These figures are given for information purposes as the sub-projects are at the identification stage. The technical and economic data for each sub-project should therefore be confirmed and refined during feasibility studies. For example, thermal unit investments may have to be included if existing units in JIRAMA isolated centers are to be decommissioned soon or are unavailable.

Finally, the following 2 tables show the JIRAMA sub-projects selected for SREP funding and which have already been the subject of a JIRAMA call for tenders in November and December 2017.

Tabl. 6 - Sub-projects for the hybridization of priority JIRAMA centers whose call for tenders have already been launched by JIRAMA in November 2017

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
MAHABO	MENABE	Solar	300	473	0.71
MANDRITSARA	SOFIA	Solar	700	1,103	1.65
RANOHIRA	IHOROMBE	Solar	200	315	0.75
MANANARA-AVARATRA	ANALANJIROFO	Solar	1100	1,733	2.59
MAINTIRANO	MELAKY	Solar	600	945	1.41
ANTSOHIHY	SOFIA	Solar	1600	2,520	3.76
MORONDAVA	MENABE	Solar	2600	4,095	6.11
AMBATONDRAZAKA	ALAOTRA MANGORO	Solar	2000	3,150	4.70
MANANJARY	VATOVAVY FITOVINANY	Solar	1000	1,575	2.35
TOTAL			**10,100**	**15,908**	**24.0**

Tabl. 7 - Sub-projects for the hybridization of priority JIRAMA centers whose call for tenders have already been launched by JIRAMA in December 2017

JIRAMA CENTERS / SUB-PROJECTS NAME	Region	Planned REN type	Installed power (kW)	Generation potential (MWh/year)	Investment ($M)
BENENITRA	ATSIMO ANDREFANA	Solar	100	158	0.38
BESALAMPY	MELAKY	Solar	200	315	0.75
AMPANIHY	ATSIMO ANDREFANA	Solar	200	315	0.75
BETROKA	ANOSY	Solar	300	473	0.71
MORAFENOBE	MELAKY	Solar	100	158	0.38
ANJOZOROBE	ANALAMANGA	Solar	200	315	0.75
AMBATOMAINTY	MELAKY	Solar	100	158	0.38
AMBOASARY-ATSIMO	ANOSY	Solar	300	473	0.71
MIANDRIVAZO	MENABE	Solar	300	473	0.71
SAKARAHA	ATSIMO ANDREFANA	Solar	500	788	1.18
ANTSALOVA	MELAKY	Solar	100	158	0.38
BORIZINY (PORT-BERGE)	SOFIA	Solar	600	945	1.41
IHOSY	IHOROMBE	Solar	1100	1,733	2.59
MAMPIKONY	SOFIA	Solar	700	1,103	1.65
TSARATANANA	BETSIBOKA	Solar	200	315	0.75
ANIVORANO-AVARATRA	DIANA	Solar	300	473	0.71
BELON'I TSIRIBIHINA	MENABE	Solar	300	473	0.71
TOTAL			**5,600**	**8,820**	**14.9**

RATIONALE FOR SREP FUNDING

SREP funding removes the following obstacles:

- Facilitating contribution from the private sector: Given Jirama's financial situation, there is a high criticality level of risk of the central buyer failing to pay for electricity. In order to reduce the commercial risk to private investors, it is recommended that SREP provide a guarantee. It may be one of two types: a partial risk guarantee covering the project's commercial creditors or a payment guarantee covering the project company.

- Reducing the impact of the isolated centers on the JIRAMA budget: The majority of the 115 JIRAMA isolated centers are almost exclusively supplied by thermal plants and often have very high production costs, significantly affecting JIRAMA’s financial situation. Operating the isolated centers chosen for the study represents an annual cost of $60 million for Jirama. Hybridization would reduce the average production cost of the isolated centers by 20%.

- Reducing greenhouse gas emissions: Hybridization of the Jirama isolated centers reduces the thermal power proportion by 30% in the centers involved in favor of renewable energy.

- Lack of technical ability of public players in the sector: Given Jirama’s limited experience in the management of the renewable energy plants, a private operator license arrangement is recommended. This arrangement enables a large number of risks to be taken on board by the private sector, including technical risks during the construction and operation phases. In order to ensure the proper operation of the thermal unit under hybridization with an intermittent power plant, the rehabilitation or renovation of this unit may not be included in the private operator’s scope.

ENVIRONMENTAL AND SOCIAL IMPACT

The potential environmental and social risks for Jirama hydroelectric power station/thermal power plant hybridization projects by photovoltaic or wind power generation are described, and then the relevant mitigation measures proposed. At this stage, it appears that the main socio-environmental risks would be those related to the release of the necessary area for each development (land, social, cultural, etc.). This challenge is generally crucial for all development projects in Madagascar. The importance of each risk will depend on each project and location. Nevertheless, the environmental and social review concluded that the sub-projects identified are generally environmentally and socially acceptable. The chosen sub-projects are of relatively limited sizes, and therefore should not cause major environmental risks.
The environmental and social assessment to be carried out for each project, when implementing the program, will thus consist of assessing the actual importance of environmental and social risks identified, specifically for each project (in the form of an Environmental Impact Study or Environmental Commitment Program, depending on the notification from the National Environment Office). The development of a Framework for Environmental and Social Management of the Program in general could also be a tool required to properly integrate environmental and social dimensions into its implementation.

RESULTS INDICATORS

The main objectives of the hybridization avenue are to improve the electricity supply service, reduce electricity production costs and decarbonize electricity generation. Taking into account maximum projected investments, the performance indicators are as follows:

Tabl. 8 - SREP performance indicators for project 2

SREP Indicators	Description	Expected result
Increased installed capacity to generate renewable energy.	Technologies that increase the installed generation (MW) of renewable energy sources.	14.1 MW
Increased access to electricity through renewable energy	Technologies that directly increase the number of households with access to modern energy services.	Approx. 7,500 homes[64]
Low-carbon impact power generation developed	Technologies with the lowest carbon emissions during operation.	Positive (Decrease in carbon emissions through photovoltaic hybridization) 30% of the energy produced from renewable sources
Increased accessibility and competitiveness of renewable energy	Technologies that increase the accessibility of renewable energy technologies and the competitiveness of the renewable energy market.	Pilot projects with a sustainable approach. The SREP guarantee strengthens the attractiveness of the private sector projects.
Increased industrial use of energy	Technologies that contribute to increasing income levels and end-user productivity.	Positive
Impact on economic, social and environmental development	Technologies that have a positive impact on economic, social and environmental development.	Very positive
Level of economic and financial profitability	Technologies with a higher level of economic and financial viability (lower LCOE).	Reduction of isolated center production compared to the reference case without hybridization of 20%
Leverage effect	Technologies that trigger additional projects, lead to investments by other donors or the private sector and catalyze energy sector reforms.	According to the planned funding scheme, SREP funding has a leverage effect of almost 1:5.5.
Category	Technologies that directly promote category main-streaming, increase opportunities for women and reduce the burden of domestic tasks for women	Positive (making household tasks easier with access to electricity)

FINANCING PLAN

Indicative donor contribution for the isolated hybridization centers obtained during the March 2018 stakeholder consultation mission are given again below:

[64] Assumption of 5 people per household

Tabl. 9 - Donor funding incentives for hybridization of isolated centers

	SREP	AfDB	Other donors[65]
Technical assistance and project management	$2 million grant		
Investments	$6 million warranty	Loan $5 to $10 million	Credit line

The available funding volumes are less than the funding requirements of the entire pipeline of sub-projects. The funding schemes given below enable between 35 and 40% of the sub-projects identified for isolated center hybridization to be achieved. Phasing is required. During the preparation phases of the SREP program projects, only priority sub-projects will be selected according to the amount of funding available.

The funding scheme is developed based on available financing with the objective being to maximize the installed renewable energy capacity while ensuring the profitability of the project. License structuring, for the hybridization of isolated centers, has been the subject of a stakeholder consensus, the funding scheme is developed using this assumption.

Tabl. 10 - Funding schemes – hybridization of isolated centers

Characteristics		Donor contributions			Financing sought			
Dimensioning of the electrical installation	Cost of the electricity produced[66]	SREP	AfDB	Other donors	DFIs	Debt added from local private banks	Private sector equity contribution	**Total (excl. warranty)**
14 MW of installed renewable energy power **76 GWh of energy produced per year (renewable energy + thermal)** **Share of renewable energy in the generation of energy: 30%**	30.6 c/kWh	$6 million warranty	Loan $5 to $10 million	Credit line	$5 million	$10 million	$10.7 million	**$30.7 to 35.7 million**

[65] AFD

[66] The cost of electricity is calculated based on simplified financial modeling, the assumptions of which are given in the body of the report in paragraph 7.2.2.2

The cost of the energy produced represents a saving of almost 20% compared to the non-hybridized thermal system. Thus, hybridization is of economic interest without resorting to licensing funding or subsidies.

Funding from DFIs is, in general, provided in foreign currency. A part of the equity investments and funding from local banks may be made in local currency. If the energy purchase contract is signed in local currency, the exchange risk for the private operator is to be taken into account.

The following graph illustrates the additional contributions to be made by type of funding:

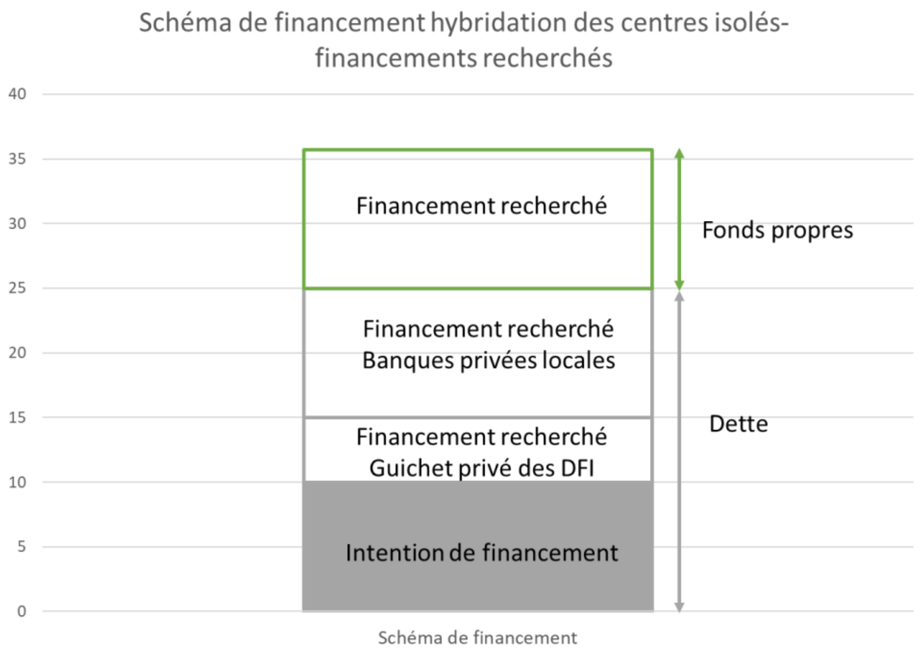


Fig. 15. Funded sought – hybridization of isolated centers

A large share of private funding has to be mobilized. Commercial risks need to be mitigated to make the project attractive to the private sector.

Given the financial situation of Jirama, the central buyer, the commercial risk of buying energy is highly critical. To mitigate this risk, it is recommended that SREP provide a guarantee of $6 million. The impact of the guarantee depends on the type of guarantee sought. The exact terms of the guarantee implemented (type, leverage, pricing, etc.) will be determined when preparing projects. Assuming a leverage of 1:4, as part of the funding plan presented above:

- If a payment guarantee of $6 million is requested, it will cover 12 months of central buyer payment.
- If a partial risk guarantee of $6 million is requested, it will guarantee 96% of the debt.

PROJECT PREPARATION TIMETABLE

Tabl. 11 - Forecast timetable for the hybridization avenue of the JIRAMA isolated centers

Date	Activities
June 2018	Approval of the investment plan
July 2018	Preparation / Studies / Drafting calls for tender
June 2019	Approval of funding
November 2019	Launching calls for tender and selecting private partners
2020	Start of construction work for hydroelectric power stations / mini-grids
2022	Commissioning of power plants

REQUESTS FOR FUNDING IN PREPARATION FOR THE INVESTMENT

In the case of license structuring for a private operator, a feasibility study is required for the preparation of sub-projects. It helps:

- Set up the diagnosis of the thermal unit;
- Define the potential for rehabilitation or replacement of the thermal unit;
- Choose a location for the renewable energy plant;
- Evaluate the renewable energy generation potential;
- Size the project, define technical options, and specify the quality standards required for equipment;
- Study the connection conditions;
- Carry out the environmental and social impact assessment of sub-projects as well as the related mitigation measures that could be implemented;
- Establish the financial and economic feasibility of sub-projects;
- Determine the structuring method, funding scheme, tariff structure and legal set-up;

A $1.4 million Project Preparation Grant is sought for the hybridization avenue of isolated centers.

ANNEXE 2 List of potential renewable energy sub-projects identified and evaluated

JIRAMA CENTERS / SUB-PROJECTS NAME	TYPE	Region	Existing Power plant type	Peak demand 2020 (kW)	Production 2020 (MWh)	Cost of Production 2017 (cts€/kWh)	Selected REN type	Installed power of REN (kW)	Energy capacity (MWh/an)	Remaining Thermal production (MWh/an)	Investment (M€)	Investment part for mini-grid (M€)	OPEX (M€/an)	REN Cost of production (cts €/kWh)	Cost of production (cts €/kWh)	Reference project Investment (M€)	Reference project OPEX (M€)	Reference project cost of production (cts €/kWh)
AMBANJA	Jirama center hybridization	DIANA	Thermal	2 053	7 729	30	Solar	2800	4 410	3 319	5,60		0,168	15,8	21,7	0,04	0,05	31,6
AMBATO-BOINA	Jirama center hybridization	BOENY	Thermal	375	1 075	32	Solar	260	410	665	0,52		0,016	15,8	25,7	0,05	0,05	34,9
AMBATOFINANDRAHANA	Jirama center hybridization	AMORON'I MANIA	Thermal	175	337	35	Solar	120	189	148	0,38		0,012	25,3	29,5	0,02	0,01	39,6
AMBATOMAINTY	Jirama center hybridization	MELAKY	Thermal	105	240	41	Solar	100	158	82	0,32		0,010	25,3	30,5	0,01	0,01	44,1
AMBATONDRAZAKA	Jirama center hybridization	ALAOTRA MANGORO	Thermal	2 147	8 220	27	Solar	2000	3 150	5 070	4,00		0,120	15,8	22,4	0,17	0,24	28,3
AMBILOBE	Jirama center hybridization	DIANA	Thermal	1 744	5 940	30	Solar	1700	2 678	3 263	3,40		0,102	15,8	23,5	0,25	0,27	32,4
AMBOASARY-ATSIMO	Jirama center hybridization	ANOSY	Thermal	299	713	31	Solar	300	473	240	0,60		0,018	15,8	20,8	0,01	0,02	33,1
Ambodimanga [RIA]	Hydro ESMAP	ALAOTRA MANGORO				11	[Ambodimanga - RIA]	2000	15 300		19,5			7,0	7,0	2,00	1,66	12,1
AMBOHIBOTO	ADER	ITASY		200	600		Hydro	1830	10 420		6,8	0,8		6,94	6,94	2,29	4,69	47,07
AMBOHIDAVA	ADER	ALAOTRA MANGORO		760	2 280		Hydro	470	2 676		5,9	3,1		22,04	22,04	0,59	1,20	47,07
AMBOLOFOTY	ADER	ATSIMO ANDREFANA		80	240		Wind	100	120		0,6	0,3		48,77	57,50	0,13	0,05	54,82
AMBOSITRA	Jirama center hybridization	AMORON'I MANIA	Thermal	1 421	5 127	33	Solar	1 300	2 048	3 079	2,60		0,078	15,8	25,8	0,16	0,21	34,9
AMBOVOMBE	Jirama center hybridization	ANDROY	Thermal	505	1 403	33	Wind	355	1 000	403	0,82		0,024	10,1	16,7	0,07	0,07	36,2
AMPANIHY	Jirama center hybridization	ATSIMO ANDREFANA	Thermal	171	499	36	Solar	200	315	184	0,64		0,019	25,3	29,4	0,02	0,02	39,0
AMPARAFARAVOLA	Jirama center hybridization	ALAOTRA MANGORO	Thermal	495	1 307	29	Solar	345	543	764	0,69		0,021	15,8	23,5	0,07	0,06	32,4
AMPIHAMIBE MAHAZOSOA	ADER	ANDROY		80	240		Wind	100	120		0,6	0,3		48,77	57,50	0,13	0,05	54,82
AMPITABEPOAKY	ADER	BONGOLAVA		640	1 920		Hydro	765	4 356		6,8	2,6		15,91	15,91	0,96	1,96	47,07
ANAHIDRANO	Jirama center hybridization	SOFIA	Thermal	50	67	50	Solar	35	55	12	0,11		0,003	25,3	29,7	0,02	0,01	56,9
ANALALAVA	Jirama center hybridization	SOFIA	Thermal	160	383	37	Solar	110	173	210	0,35		0,011	25,3	31,9	0,02	0,02	40,8
ANDILAMENA	Jirama center hybridization	ALAOTRA MANGORO	Thermal	335	1 031	30	Solar	235	370	661	0,75		0,023	25,3	28,1	0,03	0,03	32,2
ANDRIAMAMOVOKA 4	ADER	ALAOTRA MANGORO		240	720		Hydro	241	1 372		2,8	1,0		21,20	21,20	0,30	0,62	47,07
Andriamanjavona / Namorona 2 [RIF]	Hydro ESMAP	VATOVAVY FITOVINANY				6	[Namorona 2 - RIF] Hy	4300	34 100		17,6			5,7	5,7	4,30	2,02	7,1
ANGONDOGONDO	ADER	IHOROMBE		160	480		Hydro	165	940		2,6	0,7		29,03	29,03	0,21	0,42	47,07
ANIVORANO-AVARATRA	Jirama center hybridization	DIANA	Thermal	276	662	36	Solar	300	473	189	0,60		0,018	15,8	21,6	0,04	0,03	39,7
ANJOZOROBE	Jirama center hybridization	ANALAMANGA	Thermal	167	360	37	Solar	200	315	45	0,64		0,019	25,3	26,7	0,02	0,02	40,7
ANKAZOABO-ATSIMO	Jirama center hybridization	ATSIMO ANDREFANA	Thermal	166	404	65	Solar	115	181	223	0,37		0,011	25,3	46,9	0,01	0,03	67,5
ANKAZOBE	Jirama center hybridization	ANALAMANGA	Hydro + Thermal	240	660	33	Solar	170	268	392	0,54		0,016	25,3	29,9	0,03	0,03	35,9
ANOSIBE AN'ALA	Jirama center hybridization	ALAOTRA MANGORO	Thermal	174	414	37	Solar	120	189	225	0,38		0,012	25,3	31,6	0,02	0,02	40,4
ANTAFOFO	ADER	ITASY		640	1 920		Hydro	3223	18 352		13,2	2,6		7,50	7,50	4,03	8,26	47,07
ANTANAMBAO-MANAMPOTSY	Jirama center hybridization	ATSINANANA	Thermal	95	154	47	Solar	65	102	52	0,21		0,006	25,3	32,6	0,01	0,01	51,9
ANTSALOVA	Jirama center hybridization	MELAKY	Thermal	88	179	38	Solar	100	158	22	0,32		0,010	25,3	26,8	0,01	0,01	42,3
ANTSAVILY	ADER	ITASY		480	1 440		Hydro	1181	6 725		7,2	2,0		11,06	11,06	1,48	3,03	47,07
ANTSOHIHY	Jirama center hybridization	SOFIA	Thermal	1 445	6 059	31	Solar	1600	2 520	3 539	3,20		0,096	15,8	24,8	0,15	0,21	33,3
BEALANANA	Jirama center hybridization	SOFIA	Thermal	345	870	32	Solar	240	378	492	0,77		0,023	25,3	28,9	0,03	0,03	34,8
BEFANDRIANA-AVARATRA	Jirama center hybridization	SOFIA	Thermal	445	1 001	32	Solar	310	488	513	0,62		0,019	15,8	24,2	0,04	0,04	35,3
BEFOTAKA	Jirama center hybridization	ATSIMO ATSINANANA	Thermal	25	36	52	Solar	20	32	4	0,06		0,002	25,3	28,3	0,01	0,01	58,2
BEHAZOMATY	ADER	BONGOLAVA		80	240		Hydro	100	569		0,8	0,3		14,12	14,12	0,13	0,26	47,07
BEKILY	Jirama center hybridization	ANDROY	Thermal	279	678	35	Solar	195	307	371	0,62		0,019	25,3	30,6	0,03	0,03	38,2
BELOHA	Jirama center hybridization	ANDROY	Thermal	79	226	48	Solar	55	87	139	0,18		0,005	25,3	39,3	0,01	0,01	51,0
BELON'I TSIRIBIHINA	Jirama center hybridization	MENABE	Thermal	402	1 184	32	Solar	300	473	711	0,60		0,018	15,8	25,7	0,04	0,05	34,9
BENENITRA	Jirama center hybridization	ATSIMO ANDREFANA	Thermal	59	103	50	Solar	100	158	- 54	0,32		0,010	25,3	12,4	0,01	0,01	54,2
BEROROHA	Jirama center hybridization	ATSIMO ANDREFANA	Thermal + Solar	53	196	43	Solar	35	55	141	0,11		0,003	25,3	38,3	0,01	0,01	45,8
BESALAMPY	Jirama center hybridization	MELAKY	Thermal	141	353	65	Solar	200	315	38	0,64		0,019	25,3	29,5	0,02	0,03	68,2
BETIOKY-ATSIMO	Jirama center hybridization	ATSIMO ANDREFANA	Thermal	232	529	46	Solar	165	260	269	0,53		0,016	25,3	35,9	0,02	0,03	49,2
BETROKA	Jirama center hybridization	ANOSY	Thermal	427	1 116	40	Solar	300	473	644	0,60		0,018	15,8	29,6	0,04	0,05	42,6
BEZAHA	Jirama center hybridization	ATSIMO ANDREFANA	Thermal	170	481	31	Solar	120	189	292	0,38		0,012	25,3	28,8	0,02	0,02	33,8
BORIZINY(PORT-BERGE)	Jirama center hybridization	SOFIA	Thermal	627	1 963	30	Solar	600	945	1 018	1,20		0,036	15,8	23,3	0,07	0,08	32,9
DANGORO = Antanjona (ESMAP)	ADER (ESMAP)	VATOVAVY FITOVINANY		3 840	11 520		Hydro	5100	29 039		41,0	15,6		14,45	14,45	6,38	13,07	47,07
EFAHO	ADER	ANOSY		1 160	3 480		Hydro	1238	7 049		10,9	4,7		15,66	15,66	1,55	3,17	47,07
EJEDA NORD	ADER	ATSIMO ANDREFANA		80	240		Wind	100	120		0,6	0,3		48,77	57,50	0,13	0,05	54,82
FANJAHIRA	ADER	ANOSY		680	2 040		Hydro	756	4 305		6,4	2,8		15,01	15,01	0,95	1,94	47,07
Fanovana [RIA]	Hydro ESMAP	ALAOTRA MANGORO				11	[Fanovana - RIA] Hydr	3000	23 600		11,3			4,9	4,9	3,00	2,55	12,0
FARAFANGANA	Jirama center hybridization	ATSIMO ATSINANANA	Thermal	1 111	3 404	31	Solar	780	1 229	2175	1,56		0,047	15,8	25,5	0,13	0,14	34,0
FENOARIVO CENTRE	Jirama center hybridization	BONGOLAVA	Thermal	115	207	50	Solar	80	126	81	0,26		0,008	25,3	34,8	0,01	0,02	53,9
FOTSIMELOKA	ADER	VATOVAVY FITOVINANY		2 720	8 160		Hydro	3040	17 310		26,9	11,1		15,87	15,87	3,80	7,79	47,07
HABOHABO SUD	ADER	ANDROY		80	240		Wind	100	120		0,6	0,3		48,77	57,50	0,13	0,05	54,82
IAKORA	Jirama center hybridization	IHOROMBE	Thermal	40	65	58	Solar	30	47	17	0,10		0,003	25,3	33,9	0,01	0,01	63,2
IHOSY	Jirama center hybridization	IHOROMBE	Thermal	1 012	3 821	27	Solar	1100	1 733	2 088	2,20		0,066	15,8	22,1	0,12	0,14	29,5
IKALAMAVONY	Hydro ESMAP	HAUTE MATSIATRA	Thermal	174	228	45	[Vohinaomby] Hydro E	300	2 400	-	7,50			12,7	12,7	0,02	0,02	51,9
IKONGO	Jirama center hybridization	VATOVAVY FITOVINANY	Thermal	71	93	45	Solar	50	79	14	0,16		0,005	25,3	28,2	0,01	0,01	52,1
ITENDA	ADER	VAKINANKARATRA		920	2 760		Hydro	1794	10 215		12,0	3,7		12,10	12,10	2,24	4,60	47,07
IVOHIBE	Jirama center hybridization	IHOROMBE	Thermal	74	142	44	Solar	50	79	63	0,16		0,005	25,3	33,5	0,01	0,01	48,2
KANDREHO	Jirama center hybridization	BETSIBOKA	Thermal	52	70	70	Solar	35	55	15	0,11		0,003	25,3	34,9	0,01	0,01	77,1
LOKOHO	ADER	SAVA		1 360	4 080		Hydro	1600	9 110		16,3	5,5		18,46	18,46	2,00	4,10	47,07
MAHABO	Jirama center hybridization	MENABE	Thermal	256	882	34	Solar	300	473	409	0,60		0,018	15,8	24,0	0,03	0,04	35,8
MAHAJANGA	Jirama center hybridization	BOENY	Thermal	15 688	79 847	27	Solar	10980	17 294	62 554	21,96		0,659	15,8	24,6	1,82	2,50	28,9
MAHANORO	Jirama center hybridization	ATSINANANA	Thermal	554	1 742	33	Solar	390	614	1 128	0,78		0,023	15,8	26,7	0,10	0,11	35,5

JIRAMA CENTERS / SUB-PROJECTS NAME	TYPE	Region	Existing Power plant type	Peak demand 2020 (kW)	Production 2020 (MWh)	Cost of Production 2017 (cts€/kWh)	Selected REN type	Installed power of REN (kW)	Energy capacity (MWh/an)	Remaining Thermal production (MWh/an)	Investment (M€)	Investment part for mini-grid (M€)	OPEX (M€/an)	REN Cost of production (cts €/kWh)	Cost of production (cts €/kWh)	Reference project Investment (M€)	Reference project OPEX (M€)	Reference project cost of production (cts €/kWh)
MAHAVELONA(FOULPOINTE)	Jirama center hybridization	ATSINANANA	Thermal	656	2 606	29	Solar	460	725	1 881	0,92		0,028	15,8	25,5	0,06	0,09	31,3
MAHERIARA	ADER	ALAOTRA MANGORO		320	960		Hydro	350	1 993		4,0	1,3		20,51	20,51	0,44	0,90	47,07
MAINTIRANO	Jirama center hybridization	MELAKY	Thermal	564	2 183	29	Solar	600	945	1 238	1,20		0,036	15,8	23,0	0,06	0,08	30,5
MAMPIKONY	Jirama center hybridization	SOFIA	Thermal	572	1 855	29	Solar	700	1 103	753	1,40		0,042	15,8	21,3	0,07	0,07	32,2
MANAKAMBAHINY	Jirama center hybridization	ALAOTRA MANGORO	Thermal	151	358	36	Solar	105	165	192	0,34		0,010	25,3	31,2	0,02	0,02	39,6
MANAKARA	Jirama center hybridization	VATOVAVY FITOVINANY	Thermal	1 533	5 894	30	Solar	1300	2 048	3 846	2,60		0,078	15,8	25,0	0,19	0,23	32,3
MANANDONA	ADER	VAKINANKARATRA		760	2 280		Hydro	690	3 929		7,1	3,1		18,49	18,49	0,86	1,77	47,07
MANANDRIANA	Jirama center hybridization	AMORON'I MANIA	Thermal	91	144	36	Solar	65	102	42	0,21		0,006	25,3	28,3	0,01	0,01	41,1
MANANETY	ADER	VAKINANKARATRA		400	1 200		Hydro	450	2 562		4,3	1,6		17,15	17,15	0,56	1,15	47,07
MANANJARY	Jirama center hybridization	VATOVAVY FITOVINANY	Thermal	993	3 894	29	Solar	1000	1 575	2 319	2,00		0,060	15,8	7,7	0,13	0,15	30,9
MANANARA-AVARATRA	Jirama center hybridization	ANALANJIROFO	Thermal	864	2 837	36	Solar	1100	1 733	1 105	2,20		0,066	15,8	5,7	0,07	0,10	37,9
MANDRITSARA	Jirama center hybridization	SOFIA	Thermal	680	2 016	33	Solar	700	1 103	913	1,40		0,042	15,8	23,5	0,08	0,08	35,8
MANJA	Jirama center hybridization	MENABE	Thermal	162	534	38	Solar	115	181	353	0,37		0,011	25,3	34,0	0,02	0,02	40,8
MANJAKONY	ADER	ANALAMANGA		960	2 880		Hydro	5000	28 470		18,1	3,9		6,62	6,62	6,25	12,81	47,07
MANOROKA	ADER	ATSIMO ANDREFANA		80	240		Wind	100	120		0,6	0,3		48,77	57,50	0,13	0,05	54,82
MAROBAKOLY	ADER	SOFIA		240	720		Hydro	420	2 391		3,1	1,0		13,21	13,21	0,53	1,08	47,07
MAROLAMBO	Jirama center hybridization	ATSINANANA	Thermal	100	158	56	Solar	70	110	47	0,22		0,007	25,3	34,5	0,01	0,01	61,0
MAROVOAY	Jirama center hybridization	BOENY	Thermal	771	2 878	29	Solar	540	851	2 027	1,08		0,032	15,8	25,1	0,10	0,11	31,4
MIANDRIVAZO	Jirama center hybridization	MENABE	Thermal	342	1 186	29	Solar	300	473	713	0,60		0,018	15,8	23,9	0,03	0,04	31,5
MIDONGY-ATSIMO	Jirama center hybridization	ATSIMO ATSINANANA	Thermal	66	74	37	Solar	45	71	4	0,14		0,004	25,3	25,8	0,01	0,01	44,7
MITSINJO	Jirama center hybridization	BOENY	Thermal	141	444	43	Solar	100	158	287	0,32		0,010	25,3	36,6	0,02	0,03	45,4
MORAFENOBE	Jirama center hybridization	MELAKY	Thermal	108	246	37	Solar	100	158	89	0,32		0,010	25,3	29,6	0,01	0,01	40,8
MOROMBE	Jirama center hybridization	ATSIMO ANDREFANA	Thermal	270	943	38	Solar	190	299	644	0,61		0,018	25,3	33,7	0,03	0,04	39,9
MORONDAVA	Jirama center hybridization	MENABE	Thermal	2 740	10 005	29	Solar	2600	4 095	5 910	5,20		0,156	15,8	23,6	0,30	0,34	31,5
NOSY-VARIKA	Jirama center hybridization	VATOVAVY FITOVINANY	Thermal	89	194	36	Solar	60	95	100	0,19		0,006	25,3	30,7	0,01	0,01	39,7
RANOHIRA	Jirama center hybridization	IHOROMBE	Thermal	205	531	46	Solar	200	315	216	0,64		0,019	25,3	33,5	0,02	0,03	48,5
SAINTE MARIE	Jirama center hybridization	ANALANJIROFO	Thermal	1 374	5 217	30	Solar	1500	2 363	2 854	3,00		0,090	15,8	23,6	0,20	0,23	32,4
SAKARAHA	Jirama center hybridization	ATSIMO ANDREFANA	Thermal	531	1 814	31	Solar	500	788	1 026	1,00		0,030	15,8	24,4	0,05	0,06	33,2
SARAHANDRANO	ADER	SAVA		440	1 320		Hydro	560	3 189		5,8	1,8		18,94	18,94	0,70	1,43	47,07
SISAONY	ADER	ANALAMANGA		760	2 280		Hydro	5500	31 317		17,0	3,1		5,70	5,70	6,88	14,09	47,07
Site près de TSARAMANDROSO	ADER	SOFIA		480	1 440		Hydro	236	1 344		3,9	2,0		29,42	29,42	0,30	0,60	47,07
SOALALA	Jirama center hybridization	BOENY	Thermal	105	198	50	Solar	75	118	80	0,24		0,007	25,3	35,4	0,01	0,01	54,7
TANAMBE	Jirama center hybridization	ALAOTRA MANGORO	Thermal	607	1 208	29	Solar	425	669	538	0,85		0,026	15,8	21,6	0,05	0,04	32,3
TAOLANARO	Jirama center hybridization	ANOSY	Thermal	3 622	14 732	13	Wind	2535	8 200	6 532	5,83		0,175	8,8	10,8	0,42	0,24	15,6
TERABOVO	ADER	ANDROY		80	240		Wind	100	120		0,6	0,3		48,77	57,50	0,13	0,05	54,82
TOLIARY	Jirama center hybridization	ATSIMO ANDREFANA	Thermal	8 787	41 976	29	Solar	6150	9 686	32 289	12,30		0,369	15,8	26,3	1,04	1,52	31,3
TSARATANANA	Jirama center hybridization	BETSIBOKA	Thermal	201	424	34	Solar	200	315	109	0,64		0,019	25,3	27,5	0,02	0,02	37,8
TSIHOMBE	Jirama center hybridization	ANDROY	Thermal	131	443	33	Wind	90	180	263	0,42		0,013	29,2	31,3	0,01	0,02	35,2
TSIROANOMANDIDY	Jirama center hybridization	BONGOLAVA	Thermal	1 079	3 799	31	Solar	755	1 189	2 610	1,51		0,045	15,8	26,4	0,12	0,14	34,0
VANGAINDRANO	Jirama center hybridization	ATSIMO ATSINANANA	Thermal	455	1 209	35	Solar	320	504	705	0,64		0,019	15,8	27,1	0,05	0,06	38,0
VATOMANDRY	Jirama center hybridization	ATSINANANA	Thermal	653	1 804	41	Solar	455	717	1 088	0,91		0,027	15,8	31,2	0,06	0,09	44,1
VAVATENINA	Jirama center hybridization	ANALANJIROFO	Thermal	421	1 137	36	Solar	295	465	672	0,59		0,018	15,8	27,8	0,04	0,05	38,8
VOHIBINANY(BRICKAVILLE)	Jirama center hybridization	ATSINANANA	Thermal	409	1 280	35	Solar	285	449	832	0,57		0,017	15,8	28,4	0,04	0,05	37,7
VOHIMARINA	Jirama center hybridization	SAVA	Thermal	978	3 751	28	Solar	1 100	1 733	2 019	2,20		0,066	15,8	22,6	0,13	0,15	30,7
VOHIPENO	Jirama center hybridization	VATOVAVY FITOVINANY	Thermal	207	742	33	Solar	145	228	514	0,46		0,014	25,3	30,8	0,03	0,04	35,6
VONDROZO	Jirama center hybridization	ATSIMO ATSINANANA	Thermal	89	127	40	Solar	65	102	25	0,21		0,006	25,3	28,1	0,01	0,01	45,9
TOTAL								99 119			397,0							

: JIRAMA project, whose call for tenders was already launched in November 2017

: JIRAMA project, whose call for tenders was already launched in December 2017

ANNEXE 3 List of chosen renewable energy sub-projects

JIRAMA CENTERS / SUB-PROJECTS NAME	TYPE	Region	Selected REN type	Installed power of REN (kW)	Energy capacity (MWh/an)	Investment (M€)	Investissement (M$)	Cost of production (c$/kWh)	Rank (with Artelia-Nodalis weighting factor)	Rank (Economic weighting factor)	Rank (Environmental and social weighting factor)
MAHABO	Hybridation Jirama	MENABE	Solar	300	473	0,60	0,71	27,0	1	1	1
IKONGO	Hybridation Jirama	VATOVAVY FITOVINANY	Solar	50	79	0,16	0,19	30,1	2	23	2
KANDREHO	Hybridation Jirama	BETSIBOKA	Solar	35	55	0,11	0,13	38,2	3	25	3
MANDRITSARA	Hybridation Jirama	SOFIA	Solar	700	1 103	1,40	1,65	26,4	4	2	8
BELOHA	Hybridation Jirama	ANDROY	Solar	55	87	0,18	0,21	44,8	5	31	9
BENENITRA	Hybridation Jirama	ATSIMO ANDREFANA	Solar	100	158	0,32	0,38	9,1	6	65	13
ANAHIDRANO	Hybridation Jirama	SOFIA	Solar	35	55	0,11	0,13	31,9	7	15	38
BESALAMPY	Hybridation Jirama	MELAKY	Solar	200	315	0,64	0,75	39,2	8	56	12
AMPANIHY	Hybridation Jirama	ATSIMO ANDREFANA	Solar	200	315	0,64	0,75	32,2	9	44	15
BETROKA	Hybridation Jirama	ANOSY	Solar	300	473	0,60	0,71	33,9	10	6	4
MOROMBE	Hybridation Jirama	ATSIMO ANDREFANA	Solar	190	299	0,61	0,71	38,4	11	7	5
ANKAZOABO-ATSIMO	Hybridation Jirama	ATSIMO ANDREFANA	Solar	115	181	0,37	0,43	53,5	12	55	11
BEFOTAKA	Hybridation Jirama	ATSIMO ATSINANANA	Solar	20	32	0,06	0,08	30,1	13	40	34
SOALALA	Hybridation Jirama	BOENY	Solar	75	118	0,24	0,28	39,5	14	57	24
ANKAZOBE	Hybridation Jirama	ANALAMANGA	Solar	170	268	0,54	0,64	33,7	15	4	28
BEKILY	Hybridation Jirama	ANDROY	Solar	195	307	0,62	0,73	34,3	16	24	10
MORAFENOBE	Hybridation Jirama	MELAKY	Solar	100	158	0,32	0,38	32,5	17	64	21
RANOHIRA	Hybridation Jirama	IHOROMBE	Solar	200	315	0,64	0,75	37,3	18	16	29
AMBOVOMBE	Hybridation Jirama	ANDROY	Wind	355	1 000	0,82	0,96	18,6	19	5	6
IAKORA	Hybridation Jirama	IHOROMBE	Solar	30	47	0,10	0,11	37,3	20	73	31
ANJOZOROBE	Hybridation Jirama	ANALAMANGA	Solar	200	315	0,64	0,75	28,3	21	43	59
MANANARA-AVARATRA	Hybridation Jirama	ANALANJIROFO	Solar	1100	1 733	2,20	2,59	26,3	22	21	44
AMBATOFINANDRAHANA	Hybridation Jirama	AMORON'I MANIA	Solar	120	189	0,38	0,45	32,7	23	42	25
AMBATOMAINTY	Hybridation Jirama	MELAKY	Solar	100	158	0,32	0,38	33,5	24	63	20
BEFANDRIANA-AVARATRA	Hybridation Jirama	SOFIA	Solar	310	488	0,62	0,73	27,3	25	20	35
BETIOKY-ATSIMO	Hybridation Jirama	ATSIMO ANDREFANA	Solar	165	260	0,53	0,62	40,4	26	46	14
MANJA	Hybridation Jirama	MENABE	Solar	115	181	0,37	0,43	38,7	27	45	16
AMBOASARY-ATSIMO	Hybridation Jirama	ANOSY	Solar	300	473	0,60	0,71	22,9	28	39	32
MIANDRIVAZO	Hybridation Jirama	MENABE	Solar	300	473	0,60	0,71	27,2	29	13	36
SAKARAHA	Hybridation Jirama	ATSIMO ANDREFANA	Solar	500	788	1,00	1,18	27,7	30	14	37
AMBOHIDAVA	ADER	ALAOTRA MANGORO	Hydro	470	2 676	5,9	6,90	25,9	31	60	7
FENOARIVO CENTRE	Hybridation Jirama	BONGOLAVA	Solar	80	126	0,26	0,30	38,7	32	62	79
MAROLAMBO	Hybridation Jirama	ATSINANANA	Solar	70	110	0,22	0,26	38,0	33	86	47
IVOHIBE	Hybridation Jirama	IHOROMBE	Solar	50	79	0,16	0,19	37,4	34	54	40
MANANDRIANA	Hybridation Jirama	AMORON'I MANIA	Solar	65	102	0,21	0,24	30,7	35	37	57
VONDROZO	Hybridation Jirama	ATSIMO ATSINANANA	Solar	65	102	0,21	0,24	30,1	36	38	58
ANTSALOVA	Hybridation Jirama	MELAKY	Solar	100	158	0,32	0,38	28,4	37	72	48
BORIZINY(PORT-BERGE)	Hybridation Jirama	SOFIA	Solar	600	945	1,20	1,41	26,3	38	22	60
IHOSY	Hybridation Jirama	IHOROMBE	Solar	1100	1 733	2,20	2,59	25,0	39	3	45
TANAMBE	Hybridation Jirama	ALAOTRA MANGORO	Solar	425	669	0,85	1,00	24,2	40	19	33
ANDRIAMAMOVOKA 4	ADER	ALAOTRA MANGORO	Hydro	241	1 372	2,8	3,33	24,9	41	59	18
Site près de TSARAMANDROSO	ADER	SOFIA	Hydro	236	1 344	3,9	4,61	34,6	42	85	19
MAINTIRANO	Hybridation Jirama	MELAKY	Solar	600	945	1,20	1,41	26,1	43	18	26
MAMPIKONY	Hybridation Jirama	SOFIA	Solar	700	1 103	1,40	1,65	23,7	44	10	71
TSARATANANA	Hybridation Jirama	BETSIBOKA	Solar	200	315	0,64	0,75	29,6	46	52	84
ANTSOHIHY	Hybridation Jirama	SOFIA	Solar	1600	2 520	3,20	3,76	28,2	47	11	72
MAHAJANGA	Hybridation Jirama	BOENY	Solar	10980	17 294	21,96	25,80	28,5	48	9	70
BEZAHA	Hybridation Jirama	ATSIMO ANDREFANA	Solar	120	189	0,38	0,45	32,4	49	30	41
MORONDAVA	Hybridation Jirama	MENABE	Solar	2600	4 095	5,20	6,11	26,9	50	12	73
MIDONGY-ATSIMO	Hybridation Jirama	ATSIMO ATSINANANA	Solar	45	71	0,14	0,17	26,9	51	83	76
DANGORO = Antanjona (ESMAP)	ADER (ESMAP)	VATOVAVY FITOVINANY	Hydro	5100	29 039	41,0	48,18	17,0	53	76	17
BEHAZOMATY	ADER	BONGOLAVA	Hydro	100	569	0,8	0,93	16,6	54	69	27
VAVATENINA	Hybridation Jirama	ANALANJIROFO	Solar	295	465	0,59	0,69	31,7	55	82	63
ANALALAVA	Hybridation Jirama	SOFIA	Solar	110	173	0,35	0,41	35,9	56	71	75
ANIVORANO-AVARATRA	Hybridation Jirama	DIANA	Solar	300	473	0,60	0,71	23,7	58	36	80
AMBATONDRAZAKA	Hybridation Jirama	ALAOTRA MANGORO	Solar	2000	3 150	4,00	4,70	25,5	59	26	81
FARAFANGANA	Hybridation Jirama	ATSIMO ATSINANANA	Solar	780	1 229	1,56	1,83	29,2	60	29	87
MAROVOAY	Hybridation Jirama	BOENY	Solar	540	851	1,08	1,27	28,8	61	27	85
TOLIARY	Hybridation Jirama	ATSIMO ANDREFANA	Solar	6150	9 686	12,30	14,45	30,3	62	28	86
BEALANANA	Hybridation Jirama	SOFIA	Solar	240	378	0,77	0,90	32,4	64	50	49
BELON'I TSIRIBIHINA	Hybridation Jirama	MENABE	Solar	300	473	0,60	0,71	29,3	65	51	50
MANANJARY	Hybridation Jirama	VATOVAVY FITOVINANY	Solar	1000	1 575	2,00	2,35	26,6	66	35	68
AMBATO-BOINA	Hybridation Jirama	BOENY	Solar	260	410	0,52	0,61	29,4	67	53	51
TSIHOMBE	Hybridation Jirama	ANDROY	Wind	90	180	0,42	0,50	35,1	68	41	22
MAROBAKOLY	ADER	SOFIA	Hydro	420	2 391	3,1	3,60	15,5	74	68	43
SISAONY	ADER	ANALAMANGA	Hydro	5500	31 317	17,0	19,98	6,7	81	66	82
ITENDA	ADER	VAKINANKARATRA	Hydro	1794	10 215	12,0	14,07	14,2	84	88	52
ANTSAVILY	ADER	ITASY	Hydro	1181	6 725	7,2	8,42	13,0	85	67	83
TOTAL				**53 142**	**146 136**	**174,5**	**205,06**				

: JIRAMA project, whose call for tenders was already launched in November 2017

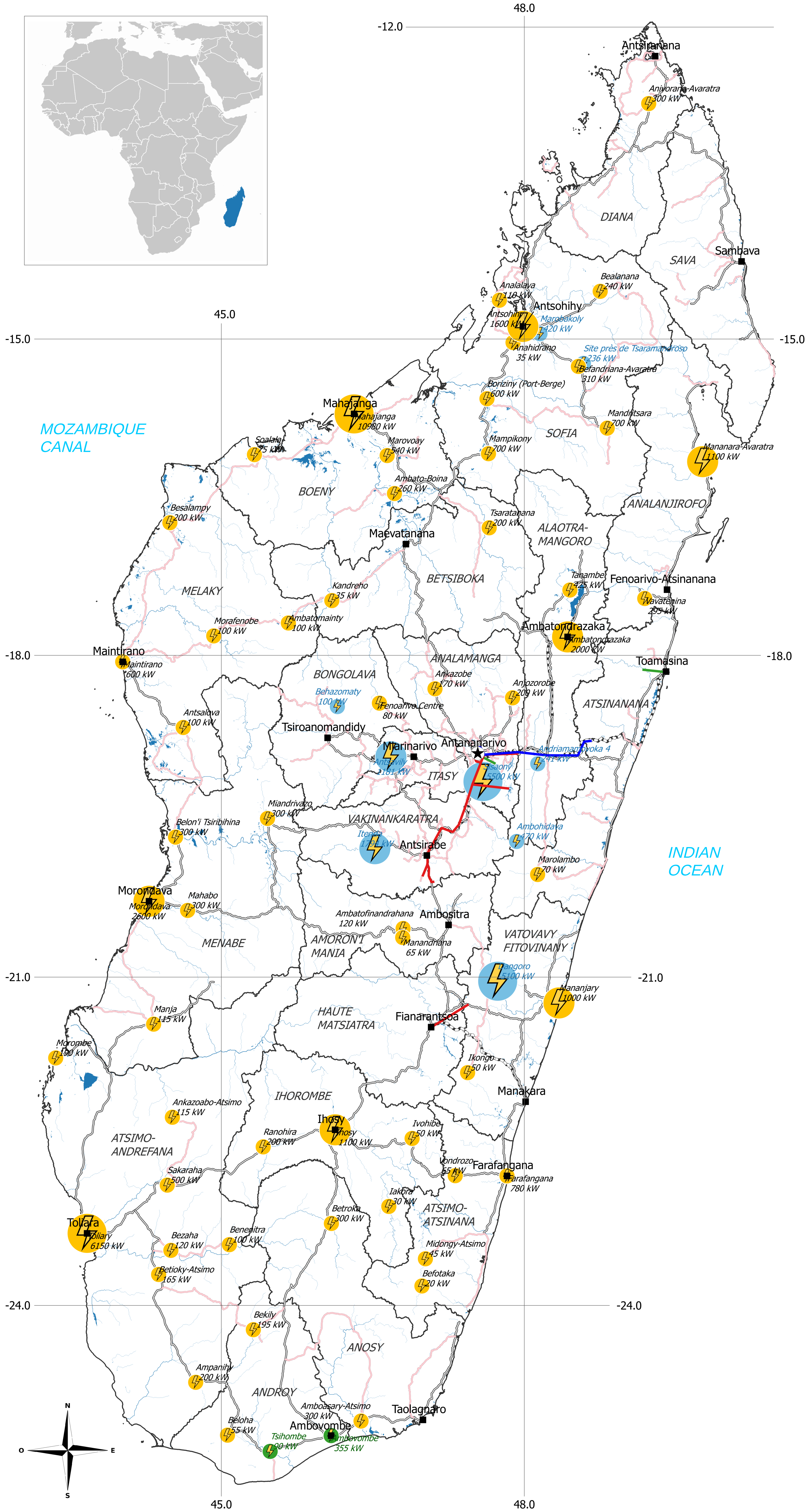
: JIRAMA project, whose call for tenders was already launched in December 2017

ANNEXE 4 Map of Madagascar with location of sub-projects selected in the SREP context

MADAGASCAR

Investment plan for renewable energies in Madagascar (SREP)

ELECTRICAL GRID AND POWER PLANT



Map legend

- Main rivers
- Lakes
- Boundaries of the administrative regions

Major cities

- Capital
- Capitals of the regions

Road network

- National roads
- Local interest roads
- Railroad

Sub-projects selected in the SREP context

Hybrid solar thermal power plants

- > 5 MW
- 1 to 5 MW
- < 1 MW

Hybrid wind thermal power plants

- > 5 MW
- 1 to 5 MW
- < 1 MW

Hydroelectric power plants

- > 5 MW
- 1 to 5 MW
- < 1 MW

Transmission Line

- 138 kV
- 63 kV
- 35 kV

0 50 100 150 200 250 km

Système de coordonnées géographiques : WGS 84
Datum : WGS 84

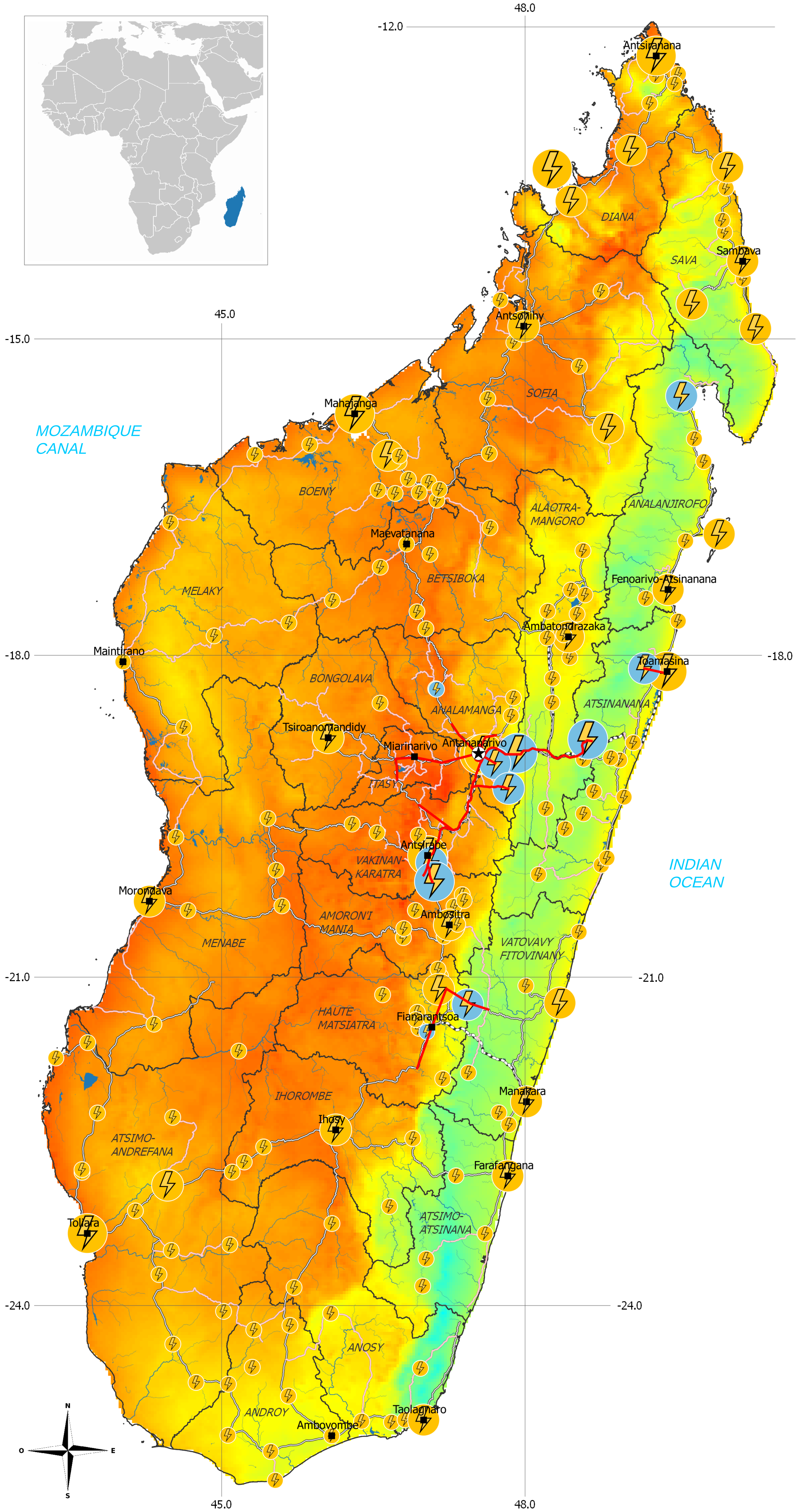
Sources des données :
- Limites administratives : Institut Géographique et Hydrographique de Madagascar (FTM)
- Réseau hydrographique : Calculé sur base du SRTM 3 arc-secondes, NASA
- Réseau routier et Chemins de fer : Schéma National d'Aménagement du Territoire (SNAT)
- Réseaux interconnectés (RI) et Sites hydroélectriques : Compilation de données de Jiro sy Rano Malagasy (JIRAMA) et Office de Régulation de l'Electricité (ORE)
- Projets sélectionnés pour un financement SREP : Plan directeur indicatif de l'électrification rurale de l'ADER, Février 2015

ARTELIA Nodalis CONSEIL REPOBLIKAN'I MADAGASIKARA

ANNEXE 5 Map of Madagascar's electrical grid with solar energy potential

MADAGASCAR

Investment plan for renewable energies in Madagascar (SREP)



ELECTRICAL GRID AND POWER PLANT

This map shows the electrical grid consisting of 3 HV interconnected grids: Antananarivo-Antsirabe (RIA), Toamasina (RIT) and Fianarantsoa (RIF) with power plants (thermal and hydro). The solar potential is presented by the global horizontal irradiance.

Map legend

- Main rivers
- Lakes
- Boundaries of the administrative regions

Major cities

- Capital
- Capitals of the regions

Road network

- National roads
- Local interest roads
- Railroad

Global horizontal Irradiation [2005 annual average] [kWh/m²]

- 902 kWh / m2
- 1121 kWh / m2
- 1340 kWh / m2
- 1559 kWh / m2
- 1778 kWh / m2
- 1998 kWh / m2
- 2217 kWh / m2
- 2436 kWh / m2
- 2655 kWh / m2

Existing electrical grid

Main existing hydrolectric power plants [11]

- > 10 MW
- 1 to 10 MW
- < 1 MW

Main existing thermal power plants [171]

- > 10 MW
- 1 to 10 MW
- < 1 MW
- Existing transmission lines

0 50 100 150 200 250 km

Système de coordonnées géographiques : WGS 84
Datum : WGS 84

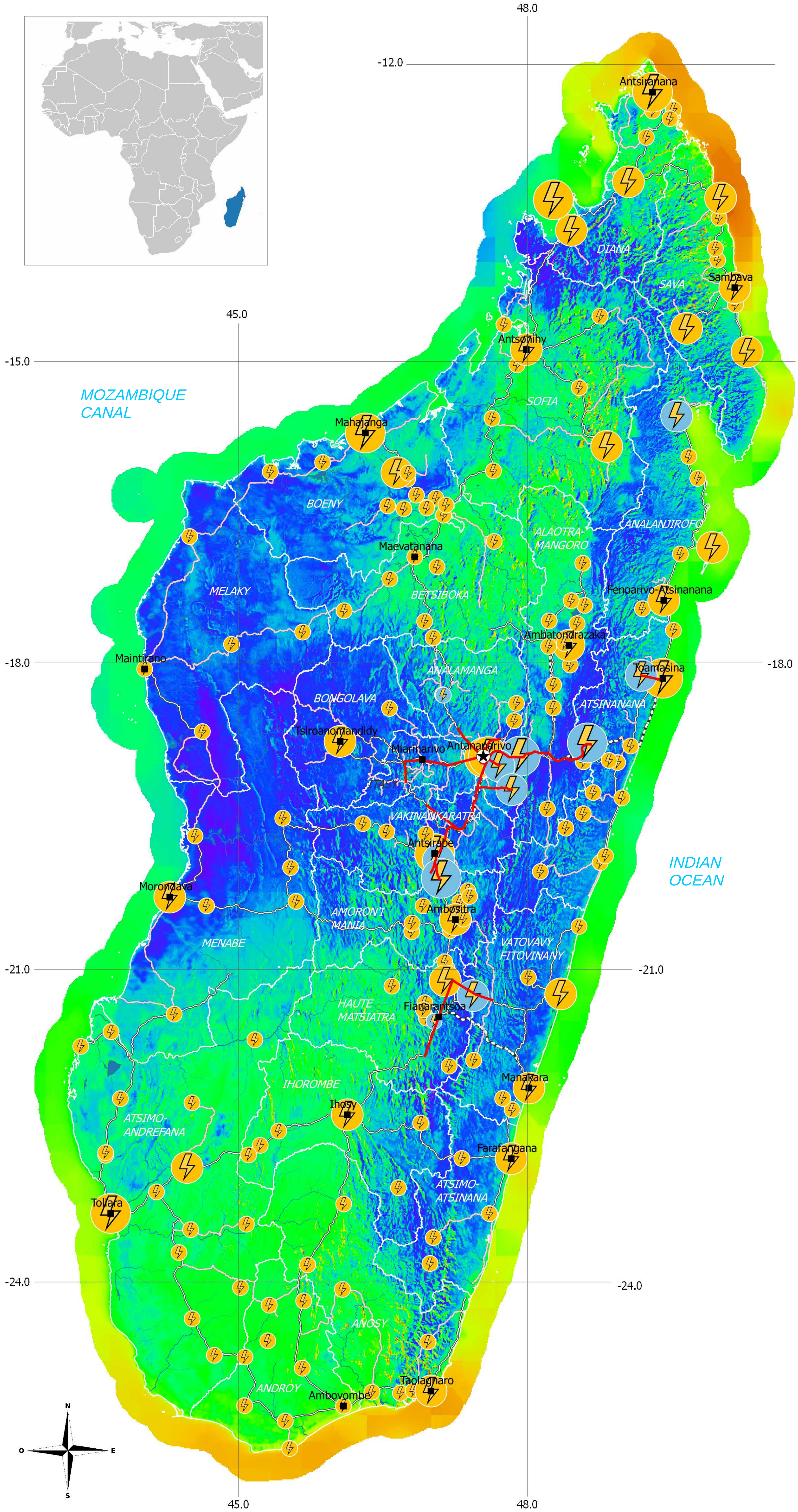
Sources des données :
- Limites administratives : Institut Géographique et Hydrographique de Madagascar (FTM)
- Réseau hydrographique : Calculé sur base du SRTM 3 arc-secondes, NASA
- Réseau routier et Chemins de fer : Schéma National d'Aménagement du Territoire (SNAT)
- Réseaux interconnectés (RI) et Sites hydroélectriques : Compilation de données de Jiro sy Rano Malagasy (JIRAMA) et Office de Régulation de l'Electricité (ORE)
- Centrales thermiques : JIRAMA, 2012
- Irradiation: IRENA Global Atlas (HelioClim3 - GHI, MINES ParisTech), 2013

ARTELIA Nodalis CONSEIL REPOBLIKAN'I MADAGASIKARA

ANNEXE 6 Map of Madagascar's electrical grid with wind power potential

MADAGASCAR

Investment plan for renewable energies in Madagascar (SREP)



ELECTRICAL GRID AND POWER PLANT

This map shows the electrical grid consisting of 3 HV interconnected grids: Antananarivo-Antsirabe (RIA), Toamasina (RIT) and Fianarantsoa (RIF) with power plants (thermal and hydro). The wind potential is presented by the wind power density.

Map legend

- Main rivers
- Lakes
- Boundaries of the administrative regions

Major cities

- Capital
- Capitals of the regions

Road network

- National roads
- Local interest roads
- Railroad

Power density of the wind at 50m [W/m²]

bellow 25 W/m2
75 W/m2
125 W/m2
200 W/m2
350 W/m2
500 W/m2
725 W/m2
1000 W/m2
1325 W/m2
above 1325 W/m2

Existing electrical grid

Main existing hydrolectric power plants [11]

- > 10 MW
- 1 to 10 MW
- < 1 MW

Main existing thermal power plants [171]

- > 10 MW
- 1 to 10 MW
- < 1 MW

Existing transmission lines

0 50 100 150 200 250 km

Système de coordonnées géographiques : WGS 84
Datum : WGS 84

Sources des données :
- Limites administratives : Institut Géographique et Hydrographique de Madagascar (FTM)
- Réseau hydrographique : Calculé sur base du SRTM 3 arc-secondes, NASA
- Réseau routier et Chemins de fer : Schéma National d'Aménagement du Territoire (SNAT)
- Réseaux interconnectés (RI) et Sites hydroélectriques : Compilation de données de Jiro sy Rano Malagasy (JIRAMA) et Office de Régulation de l'Electricité (ORE)
- Centrales thermiques : JIRAMA, 2012
- Densité de puissance du vent : Global Wind Atlas by DTU Wind Energy, 2015

ARTELIA Nodalis CONSEIL REPOBLIKAN'I MADAGASIKARA Fitiavana - Tanindrazana - Fandrosoana

ANNEXE 7 MDB Request for payment of implementation services

<table>
<tr><th colspan="4">SCALING UP RENEWABLE ENERGY PROGRAM IN LOW-INCOME COUNTRIES
MDB Request for Payment of Implementation Services</th></tr>
<tr><td>1. Country/Region:</td><td>Madagascar</td><td>2. CIF Project ID#:</td><td>(Trustee will assign ID)</td></tr>
<tr><td>2. Project Title:</td><td colspan="3">Rural electrification by renewable energy plants and mini-grids</td></tr>
<tr><td>3. Request for project funding:</td><td>At time of country program submission (tentative):

Grant: US$ 2 million
Non-grant: US$ 10 million</td><td colspan="2">At time of project approval:

Grant: -
Non-grant: -</td></tr>
<tr><td rowspan="2">4. Estimated costs for MDB project implementation services:</td><td rowspan="2">Initial estimate - at the time of Country program submission: $428,000

Final estimate - at time of project approval:</td><td colspan="2">MDB: World Bank</td></tr>
<tr><td colspan="2">Date: June 2018</td></tr>
<tr><td>5. Request for payment of MDB Implementation Services Costs:</td><td>✓ First tranche: US$ 128,000

Second tranche: US$300,000</td><td colspan="2"></td></tr>
<tr><td>6. Project/program financing category:</td><td colspan="2">a - Investment financing - additional to ongoing MDB project

b- Investment financing - blended with proposed MDB project

c - Investment financing - stand-alone

d - Capacity building - stand alone</td><td>☐

☑

☐

☐</td></tr>
<tr><td>7. Expected project duration (no. of years):</td><td colspan="3">5 years</td></tr>
<tr><td>8. Explanation of final estimate of MDB costs for implementation services:</td><td colspan="3">Not applicable</td></tr>
<tr><td colspan="4">9. Justification for proposed stand-alone financing in cases of above 6 c or d: n/a</td></tr>
</table>

<table>
<tr><th colspan="5">SCALING UP RENEWABLE ENERGY PROGRAM IN LOW-INCOME COUNTRIES
MDB Request for Payment of Implementation Services</th></tr>
<tr><td>1. Country/Region:</td><td>Madagascar</td><td>2. CIF Project ID#:</td><td colspan="2">(Trustee will assign ID)</td></tr>
<tr><td>2. Project Title:</td><td colspan="4">Hybridization of JIRAMA isolated centers</td></tr>
<tr><td>3. Request for project funding:</td><td colspan="2">At time of country program submission (tentative):
Grant: $2 million
Non-grant: $6 million</td><td colspan="2">At time of project approval:

Grant:
Non-grant:</td></tr>
<tr><td rowspan="2">4. Estimated costs for MDB project implementation services:</td><td colspan="2" rowspan="2">Initial estimate - at the time of Country program submission: $428,000

Final estimate - at time of project approval: TBD</td><td colspan="2">MDB: African Development Bank</td></tr>
<tr><td colspan="2">Date: June 2018</td></tr>
<tr><td>5. Request for payment of MDB Implementation Services Costs:</td><td colspan="2">✓ First tranche: US$ 128,000

Second tranche: U$300,000</td><td colspan="2"></td></tr>
<tr><td>6. Project/program financing category:</td><td colspan="3">a - Investment financing - additional to ongoing MDB project

d - Capacity building - stand alone</td><td>☐
☑
☐
☐</td></tr>
<tr><td>7. Expected project duration (no. of years):</td><td colspan="4">5 years</td></tr>
<tr><td>8. Explanation of final estimate of MDB costs for implementation services:</td><td colspan="4">Not applicable</td></tr>
<tr><td colspan="5">9. Justification for proposed stand-alone financing in cases of above 6 c or d: n/a</td></tr>
</table>

ANNEXE 8 Project preparation grant request

<table>
<tr><th colspan="4">SREP INVESTMENT PROGRAM

Project Preparation Grant Request</th></tr>
<tr><td>1. Country/Region:</td><td>Madagascar/Africa</td><td>2. CIF Project ID#:</td><td>(Trustee will assign ID)</td></tr>
<tr><td>3. Project Title:</td><td colspan="3">Hybridization of Isolated Diesel Generation Centers with Solar</td></tr>
<tr><td>4. Tentative SREP Funding Request (in US$ million total) for Project at the time of Investment Plan submission (concept stage):</td><td colspan="2">Grant:
• US$ 2 million</td><td>Loan:
• US$ 6 million</td></tr>
<tr><td>5. Preparation Grant Request (in US$):</td><td colspan="2">US$ 1.4 million</td><td>MDB: African Development Bank</td></tr>
<tr><td>6. National Project Focal Point:</td><td colspan="3">Tsiky Harivelo Robison

Head of Resources Development Service
Direction of Renewable Energy Development
Ministry of Water, Energy and Hydrocarbons</td></tr>
<tr><td>7. National Implementing Agency (project/program):</td><td colspan="3">Ministry of Water, Energy and Hydrocarbons</td></tr>
<tr><td>8. MDB SREP Focal Point and Project/Program Task Team Leader (TTL):</td><td colspan="2">Focal point:
Leandro Azevedo
CIF Coordinator
l.azevedo@afdb.org</td><td>TM: Cherif SEYE
Sustainable Energy & Finance Advisor
c.seye@afdb.org</td></tr>
<tr><td colspan="4">Description of activities covered by the preparation grant:
The grant will cover activities related to the preparation of a program for hybridization of the JIRAMA isolated diesel generation centers with solar PV technologies to tender out and select private partners for investing and operating them under Independent Power Producer arrangements.</td></tr>
<tr><td colspan="4">9. Outputs: Policy Framework</td></tr>
<tr><td colspan="2">Deliverable</td><td colspan="2">Timeline</td></tr>
<tr><td colspan="2">• Feasibility studies for 59 centres
• Grouping of projects and preparation of bidding documents for each group of projects
• Advisory for evaluation of bids and negotiation with bidders
• Preparation of IPP documentation
• Contracting with selected IPPs</td><td colspan="2">2 years</td></tr>
<tr><td colspan="4">10. Budget (indicative):</td></tr>
<tr><td colspan="2">Expenditures[b]</td><td colspan="2">Amount (in USD million) – estimates</td></tr>
<tr><td colspan="2">Consultants/technical assistance</td><td colspan="2">1.5</td></tr>
<tr><td colspan="2">Equipment</td><td colspan="2">0.0</td></tr>
<tr><td colspan="2">Workshops/seminars/trainings</td><td colspan="2">0.075</td></tr>
</table>

Travel/transportation	0.2
Others (admin costs/operational costs)	0.075
Contingencies (max. 10%)	0.15
Total cost (including other contributions)	**2.0**
Other contributions: SEFA	0.6
11. **Timeframe** (tentative): 2 years	
12. **Other partners involved in project design and implementation**: Sustainable Energy Fund for Africa (SEFA)	
13. **If applicable, explanation for why the grant is MDB executed:** Not applicable.	
14. **Implementation Arrangements** (including procurement of goods and services)**:** The recipient will be responsible for the implementation of the grant in accordance with AfDB's rules and procedures namely in terms of: (i) procurement, (ii) disbursement, (iii) financial management, and (iv) audit.	

ANNEXE 9 Independent reviewer recommendations

REPOBLIKAN'I MADAGASIKARA
Fitiavana - Tanindrazana - Fandrosoana

MINISTRY OF WATER, ENERGY AND HYDROCARBONS

SREP MADAGASCAR

INVESTMENT PLAN OF RENEWABLE ENERGY

Independent Reviewer Recommendations

N°	Recommendation	Response
i	**Estimate the real capacities of the various local participants and to identify their needs in training, in accompaniment and technical support, on promotion and in communication & visibility :** in this context, by knowing at first all the components, the activities, the tasks, the objectives, the expected, indicator results and the projected schedule of realization of the project SREP, and to proceed in: - Estimate the capacities of the various participants according to their respective needs in the implementation of the PI - Estimate their respective needs in strengthening of their capacity and in training and in tools and modules of management, follow-up and evaluation, measures and checks and in coordination and planning.	These capacities will be assessed during project preparation
ii	**Organize a planning workshop for the SREP project.** This workshop of an average duration of 3 days would bring together about twenty representatives of MEEH, JIRAMA, ADER, ARELEC, Ministry of Finance and Budget, Ministry of decentralized cooperation and local development, Ministry of Economy and Planning, development partners and donors in Madagascar and the private sector. This workshop would make it possible, according to the participative approach, to plan the IP according to its objectives. A summary report and / or table first would include: specific objectives, activities, tasks, indicators, assumptions, task managers and timeframes, etc. This document will also include the needs for capacity building in human and logistical resources as well as the details of technical assistance and training will be appropriate by the various stakeholders.	Indeed, the workshop is one of the ways to collect the different view of the project stakeholders. This recommendation will be considered during the preparation phase.

iii	**Optimize the 3 components: SREP Program / Capacities of technical and financial execution / Duration**: The results of this workshop will also make it possible to evaluate the capacities to put for the execution of the program which foresees the realization of 68 sub-projects during a five-year term and the management of an annual average funding of $ 40M during this period. This program seems too ambitious compared to the current capacities of the country from the point of view of its technical implementation and its financial management.	These components can be part of sub-project evaluation indicators. The aim is to develop renewable energies on a large scale.
iv	**Endow the SREP project with ongoing technical assistance for the first two to three years of its implementation.** The technical assistant must have extensive experience in managing renewable energy projects, developing policies and strategies and action programs in this area, awarding contracts and acting as a catalyst between the various stakeholders. Short-term experts will be needed for ad hoc assignments, training, procurement, studies and others.	Certainly, to have good results, the support of the experts is very essential. This component will be proposed in the technical assistance of the projects.
v	**Provide the private sector the same priorities as other stakeholders** in terms of training on developing business plans, procurement, access to finance and project management. Transform the content of the electricity code into an application decree and / or reference- framework **,** particularly in terms of the procedures for granting concessions, authorizations, details on subsidies, incentives and tax benefits to be granted to customers, renewable energy projects and equipment and the related eligibility criteria**.**	The Ministry of Energy works closely with the private sector to develop the energy sector. The private sector has been consulted and will be considered during the implementation of the projects. In fact, the capacity building of private sector is also a lever for developing the renewable energy sector. The legislative frameworks of the code of electricity are under development. Reference frameworks that require reinforcement will be inserted as in the application texts of Law 98-032 that is in force now.
vii	**Set up a unit for coordination, planning, monitoring and evaluation of the program within the MEEH**	A coordination unit and a SREP committee already exist at the MEEH but we must just integrate all the stakeholders

1. **Title of the plan of investment**

   SREP-MADAGASCAR: Investment Plan Scaling Up of Renewable Energy

2. **Program under the SCF**

   Scaling Up Renewable Energy in Low Income Countries (SREP)

3. **Name of the reviewer**

   Naceur Hammami

4. **Date of submission:**

   Thursday 17th of May, 2018

5. **Part 1 : general Criteria**

In a global way, the Investment Plan (IP) SREP-Madagascar proposed joins in the Malagasy sectorial policy for the 2015-2030 period defined in the New Energy Policy adopted in 2015 (NEP). It complies with the principles and the objectives of the SREP and its implementation would contribute to the development of the Malagasy energy sector in coherence with the national politics and strategies promulgated by this country regarding energy sector in general and renewable energies sources in particular.

The conditions and the ways which must be set up to reach the goals fixed by this new “Policy Letter" are widely defined and concern essentially the renewable energies, the rural electrification, the legal and regulatory framework, the system of subsidy, the partnerships, the investments and the financing as well as the inter-institutional coordination and the technical support including the capacity building. The investment plan SREP joins completely in this dynamics.

For the electricity sector, the objectives aim at a 70 % electricity access rate of the households to the electricity or at the quite different sources of modern lighting and energy mix. 80 % of this mix will be of renewable energy origin in particular the hydropower, the photovoltaic solar energy and the wind energy. Also the IP bases essentially on these most plentiful three renewable forms of energy in Madagascar.

To reach these goals, the Malagasy Government undertook targeted and strategic measures by proceeding by the revision of the legal framework which adopted in 2017 whose purpose is to overcome the shortcomings encountered and the limits of the former law n°98-032 and to replace it by the new law n° 2017-20. This is considered as a component of the strategy of implementation of the NEP. It had handled all the aspects related to the attributions of institutions and governance of the sector, the thresholds of the authorizations and concessions contracts, the simplification of the corresponding procedures and the necessary capacities bound to the use of the sources of EnR2 by aiming at mainly (i) to make more attractive and more reassuring the electricity sector for the investors and promoters, the donors, the development partners and financial institutions, (ii) to provide consumers with a better quality of electrical service, at an affordable cost and respecting the principle of continuity and the non-discrimination, and (iii) to contribute to improving the governance of the electricity sector in terms of transparency and accountability.

The "electricity code" plans that the Government assures the promotion and the development of the renewable energies in particular by incentives and the specific financing and also the fiscal and customs advantages. All these measures are not defined yet and must be specified through application decrees of the laws of the finances in the general code of taxes and customs. The countries which knew a considerable development of renewable energies and energy efficiency sector endowed their national programs by incentive measures and with encouragement. As an example, the exemption from duties of customs and the VAT of the imported renewable energies equipments, the exemption from the VAT of equipment produced locally, the subsidy of the projects and the corresponding studies within the framework of projects using the equipments of the renewable energies, etc.

The originality of the IP -MADAGASCAR is that it was developed on the basis of a detailed study of the national energy context and of solid technical evaluations with a consensus of all the main stakeholders in the sector. The SREP program so consists of two strategic projects those are identified and align perfectly with the NEP. Their strategic characteristics enable them to achieve the main objectives such as the improving access to electricity and the corresponding service the cost cutting of kWh production and the improvement of the quality life of the population in particular that of the woman and finally affordable production in an of green and clean energy thereby creating a favorable economic and social environment.

In this context, approximately 250 specific sub-projects had been identified and studied for the rural electrification and the hybridization of the decentralized centers of the national company of electricity Jirama. The analysis made by the key stakeholders in particular the ministry in charge of the energy, the agency of regulation, the national company of electricity and the agency of rural electrification allowed the selection of 68 sub-projects to be the object of a financing proposal SREP within the framework of this IP. Eventually, lowering the cost of kWh production and improving the quality of service will be the best lever to increase the number of subscribers and thus the rate of electricity supply in remote centers

These two strategic projects require a total installed capacity of 53 MW of renewable energies that can annually produce more than 145 GWh and avoid the emission of about 130, 000 tons of CO^2 a year. The estimated total investment is about $205 M.

The institutional framework of the electric power sector of Madagascar as described in the Electricity Code has been developed with a single objective of coordination, complementarily, collaboration and perfect synergy between the different actors and operators to ensure the implementation of the NEP in particular through the various mentioned schemes of concession and authorization. The main speakers:

- **The Ministry of Water, Energy and Hydrocarbons (MWEH).** It develops the general policy of electricity sector, launches the calls for tenders in the sub-sectors of transport and distribution and sets standards and technical specifications applicable to the electrical installations.
- **The Electricity Regulatory Authority (ARELEC).** Its role is to issue the opinion on tendering projects and the various stages of procurement related to the purchase of electricity or the granting of concessions or authorizations, sets regulated tariffs on and off interconnected networks as well as on mini-grids.. Also,, sales of power and energy from dealers and distribution licensees or suppliers to end-users etc..
- **The JIRO RANO Malagasy (JIRAMA).** Its role is to carry out or have carried out all over the territory all operations relating to the production, transport and distribution of energy and the supply of drinking water and industrial water
- **The Rural Electrification Development Agency (ADER).** Its main purpose is to increase the access rate to electricity, especially in rural and peri-urban areas.
- **National fund of the sustainable energy (FNED).** It's an independent fund created by law 2017-021 and dedicated to the sustainable energy whose management is entrusted to a credit institution. The mission is to contribute to the financing of the development projects of electric infrastructures in rural and peri-urban areas, based on the renewable energies on which financial aids and tools are taken for operators holding declarations, authorization or concessions contracts.
- **Private operators:** Several private national actors in particular SMEs and international actors exist in Madagascar in electricity sector mainly in the production, the auto-production and the electricity supply in rural areas. 28 private actors are already involved in the field of rural electrification which is a focus SREP. There are therefore operators with practical experience of these technologies.

Whether for rural electrification or the hybridization of remote Jirama centers, the IP has provided for the involvement of private actors in terms of concessions or authorizations or declarations according to the powers installed. Thus private companies may be involved in financing projects and not limited to technical activities of construction and operation of infrastructure.

At the financial level: As in many countries, private operators find it difficult to access external financing and also from local commercial banks. Such banks are not in fact able to propose that loans in local currency, over relatively short periods often well below the economic life of electrical installations. Promoting the attractiveness of subprojects for international banks, grouping them in large batches and mobilizing guarantees, would be a solution to overcome this obstacle;

At the level of the legal framework: There is a significant risk related to the sale of the producible, in particular at the level of the unpaid bills or the formulas of indexing and revisions of the not applied prices. The sectoral legal framework provided for by the Electricity Code seems particularly insecure with regard to private operators. The possible contribution of guarantees such as the partial guarantee of risks or the guarantee of payment would make it possible to mitigate this risk. An alternative shall be studied under the SREP.

At the level of the technical implementation of the projects, As provided by the Law n ° 2017-20 the regimes of the declaration, the authorization and the concession for the implementation of subprojects of independent production of Electricity had envisaged according to the sub-sector considered: production, transport and distribution and according to the type of renewable energy source: solar photovoltaic and thermal, wind, geothermal and biomass and finally according to the installed capacity.
The lack of technical capacity of local private operators responding to public calls for tender involving external financing also hinders the development of RE production sub-projects. Consortia of national and international private companies make up for this lack of skills. Similarly, the recruitment of qualified local staff can be complex due to lack of skills.

At the level of experience in the field of implementation of renewable energy projects and partnership with donors, development partners and financial institutions, since 2011, Madagascar has benefited from about $ 100 Million and over € 33.4 Million for the development of the renewable energy sector. Numerous Technical and Financial multilateral Partners (TFPs) such as the institutions of the WB group, the ADB, the EU, UNIDO, but also bilateral have been involved in the electricity sector and more particularly in the electricity sector through renewable energy sources. These interventions concerned 9 projects mainly aimed at strengthening JIRAMA's operational performance, providing support for sectoral planning and participating in the preparation and financing of renewable energy projects, mainly hydroelectricity. The private sector has also been involved in the implementation of these projects**.**

The SREP program could create a favorable context for the achievement of sectoral policy objectives. The institutional activities of the program will strengthen the capacities of the sector's stakeholders and continue efforts to adapt the regulatory framework to the development of renewable energies. The implementation of identified projects will strengthen interdepartmental and inter-agency coordination while capitalizing on the experiences gained. Finally, the SREP aims a ripple effect with financial institutions. The establishment of an incentive framework and the definition of a strategic investment program will mobilize additional resources and promote cooperation between donors and state authorities. For example, in the field of solar energy, SREP works in synergy with the Scaling Solar program funded by the World Bank Group. This program promotes the development of large-scale solar power plants connected to the grid (25 MWp project in progress). SREP is involved in the development of small-scale distributed solar energy (from 50 kWp to a few MWp): hybridization of decentralized centers and rural electrification.

Contribution of the SREP project in the New Energy Policy objectives

The New Energy Policy by 2030 sets ambitious targets for the penetration of renewable energies into the energy mix: 75% hydropower, 5% wind, and 5% solar. The demand growth forecast defines a target output of 7900 GWh in 2030, which is compared to the 1651 GWh produced in 2016. With an increase of almost 5 times during this period

The projects identified under the SREP program will contribute with 73 GWh of hydroelectricity, 43 GWh per year of solar, 40 GWh / year of wind. The SREP program can only be a first step in achieving these goals. On this basis, the contribution of SREP alone, not to mention the training effect, would contribute 6% to NEP objectives by 2025 and 2% by 2030.

The transformative impact is the spirit of this SREP project. It comes on time to contribute to the first phase of the implementation of the NEP of the country on the one hand and the application of the new electricity code recently created in 2017 in the other hand. The SREP project will act as a catalyst in terms of (i) support and technical assistance to public and private institutions, (ii) the exploitation of lessons learned and their dissemination on a large scale as well as those relating to gender, and (iii) the promotion of increased investments in renewable energies sources in total investment and the mobilization of other public and private finance that will lead to replication through demonstration effects, institutional learning and increased investor confidence.

6. Part 2:Compliance with the criteria of investment and the business model of the concerned program

- ✓ **Stimulate the increase of the contribution of the investments in the field of renewable energies with regard to the total investment of the energy sector.**

The investment plan includes several positive indicators on the stimulation of new investments in renewable energies and more specifically to contribute to the financing of the SREP program. These indicators have been well notified:

- **In the new law 2017-02 relating to the electricity code** which provides for the creation of the National Fund for Sustainable Energy (FNED) whose mission is to contribute to the financing of projects for the development of electrical infrastructure in rural and peri-urban areas , based on renewable energies and the promotion of energy efficiency, and on which financial aids and tools are collected for operators holding Declarations, Authorization contracts or Concessions. The SREP will have a role of technical assistance to help the State to conceive this fund essentially on the modes of its sourcing, its management and the procedures and criteria of eligibility to reach it.

- **Sources of financing:** the total budget of the SREP program, estimated at $ 205 million, shows that approximately 38% or $ 77.5 million were identified during the consultation of donors, particularly SREP and the ADB and the private sector. The 62% remain unidentified. The mobilization of this important complement of funding through Technical and Financial Partners (TFPs), the private sector and development partners requires efforts to be deployed by the Government of Madagascar with the necessary support of SREP. These contributions can only be really identified after the results of the techno-economic feasibility studies for the definitively selected sub-projects.

- **Private operators:** Many national and international private operators operate in Madagascar in the electricity sector, mainly in the production, self-generation and distribution of electricity and rural electrification. 28 private companies are currently operating in this sector. SREP will have a role to play in building the capacity of the private sector and supporting it in accessing funding domestically and internationally. It lacks visibility on the viability of projects and the renewable energy market in Madagascar at the level of local financial institutions. A communication and promotion action is needed and to which SREP could play a role and contribute to it.

- **The SREP funding scheme** mentions, in addition to the SREP contribution, the involvement of the World Bank, the AfDB, the private sector, the State and other donors. The feasibility studies of the 68 projects and their economic viability will certainly attract new investments in addition to those that have been achieved since 2011 through many multilateral technical and financial partners (TFPs) such as BM, AfDB, EU and UNIDO where $ 100 million and over € 33.4 million for the development of the renewable energy sector have been mobilized**.**

- SREP proposes to play a role in leveraging investments from TFPs in particular and the rest of potential co-financiers, including the private sector, on the other hand. Sustainability data are needed to attract these co-financiers.

- SREP foresees the duplication of the program presented through the demonstration effects, the reinforcement of the institutional capacities and the improvement of the trust of the investors thus the reinforced participation of the private actors through the development of the projects of concessions and authorization.

- Given the financial situation of the central buyer Jirama, the commercial risk for the purchase of energy is of high criticality. To mitigate this risk, it is proposed that SREP also provide a guarantee of a certain amount to be calculated. The impact of the guarantee depends on the type of guarantee requested. The precise terms of the guarantee (type, leverage, pricing, etc.) will be determined during project preparation.

- ✓ **Enabling Environment.** The SREP represents the country's long-term commitment to promote renewable energies as part of its new energy policy and its energy access goals and its willingness to implement this policy through the creation of a law tracing all the necessary institutional, regulatory and financial provisions. In fact, SREPs will be an important tool to support the implementation of this NEP and support the strengthening of Madagascar's policy and regulatory environment, and institutions with a view to facilitating investment in the field of renewable energies**.**

- ✓ **Increase energy access :** The two strategic projects proposed by the SREP investment plan are aimed at a first objective, namely the significant improvement of access to energy through the use of renewable energies, especially micro-hydro, solar and wind energy and hybrid-isolated systems (mini-grids.) The 68 selected sub-projects will produce 147 GWh per year to satisfy the equivalent of more than 350,000 new households with electricity services**.**

- ✓ **Implementation capacity:** The implementation of the SREP-Madagascar program was based on the role of the various stakeholders as described in the new electricity code and in accordance with the objectives of the NEP. The implementation of the two SREPs projects will be carried out mainly by MEEH, ARELEC, JIRAMA, ADER, FNED and the private sector as well as TFPs.

- ✓ **The IP provides for an accompaniment and capacity building component for different stakeholders according to their specific roles and missions**. However, the private sector also requires training in project development, business plan development, management, monitoring and evaluation, and developing relationships with local financial institutions and access to international financing.

- ✓ **Improve the long-term economic viability of the renewable energy sector**: The economic viability of the two proposed projects has been addressed. Moreover, at this level, the selection of the 68 subprojects has been done according to several criteria, including economic viability and where the kWh produced is competitive with fossil fuels and even with competing renewable energies. It is understood that this stage allowed the identification and the pre-selection of the sub-projects pending the actual feasibility studies that will be carried out during the final selection.

- ✓ **Transformative Impact** : The total capacity of the two projects is 53 MW representing about 10% of the country's total installed capacity. The investment plan provides for a transformational change at the national level once the results of two SREPs projects have been achieved. More important is that this change be launched even before the completion of the SREP project in a meaningful and sustainable way. However, in addition to the public actors already mentioned above, two actors are decisive for this objective and will have to be involved in a significant way: private actors and the local and international financial sector to broaden the large-scale development of renewable sectors. The SREP is expected to give the necessary importance to this issue.

7. Part III. Recommendations

The SREP Madagascar project perfectly meets the common objectives of the State and SREP. Ownership of the SREP project by the State is obvious, the institutional, regulatory environment for the implementation of the IP is favorable with a new proactive energy policy, a new electricity code appropriate to this policy is already approved and a promising presence in recent years of donors, development partners and private operators. All these factors can make the SREP-Madagascar project a model or good practice to promote internationally. However, it is highly recommended to:

i) **Estimate the real capacities of the various local participants and to identify their needs in training, in accompaniment and technical support, on promotion and in communication & visibility :** in this context, by knowing at first all the components, the activities, the tasks, the objectives, the expected, indicator results and the projected schedule of realization of the project SREP, and to proceed in:

- Estimate the capacities of the various participants according to their respective needs in the implementation of the PI

- Estimate their respective needs in strengthening of their capacity and in training and in tools and modules of management, follow-up and evaluation, measures and checks and in coordination and planning.

ii) **Organize a planning workshop for the SREP project.** This workshop of an average duration of 3 days would bring together about twenty representatives of MEEH, JIRAMA, ADER, ARELEC, Ministry of Finance and Budget, Ministry of decentralized cooperation and local development, Ministry of Economy and Planning, development partners and donors in Madagascar and the private sector. This workshop would make it possible, according to the participative approach, to plan the IP according to its objectives. A summary report and / or table first would include: specific objectives, activities, tasks, indicators, assumptions, task managers and timeframes, etc. This document will also include the needs for capacity building in human and logistical resources as well as the details of technical assistance and training will be appropriate by the various stakeholders.

iii) **Optimize the 3 components: SREP Program / Capacities of technical and financial execution / Duration**: The results of this workshop will also make it possible to evaluate the capacities to put for the execution of the program which foresees the realization of 68 sub-projects during a five-year term and the management of an annual average funding of $ 40M during this period. This program seems too ambitious compared to the current capacities of the country from the point of view of its technical implementation and its financial management.

iv) **Endow the SREP project with ongoing technical assistance for the first two to three years of its implementation.** The technical assistant must have extensive experience in managing renewable energy projects, developing policies and strategies and action programs in this area, awarding contracts and acting as a catalyst between the various stakeholders. Short-term experts will be needed for ad hoc assignments, training, procurement, studies and others.

v) **Provide the private sector the same priorities as other stakeholders** in terms of training on developing business plans, procurement, access to finance and project management. Transform the content of the electricity code into an application decree and / or reference-framework **,** particularly in terms of the procedures for granting concessions, authorizations, details on subsidies, incentives and tax benefits to be granted to customers. renewable energy projects and equipment and the related eligibility criteria**.**

vi) **Set up a unit for coordination, planning, monitoring and evaluation of the program within the MEEH**

vii) In conclusion

1. The proposed SREP-Madagascar Investment Plan is interesting at several levels

a) Despite its pilot nature, this program provides for the installation of approximately 53 MW, a fairly significant contribution to the installed national electricity capacity.

b) The projects proposed have an innovative character at the technical level (PV connected to the grid, hybrid PV-Diesel systems) and institutional approach (PPI, PPP, etc.) at the not only national scale but also at the regional level.

c) It provides an opportunity for multi-donor involvement and interventions with several types of mechanisms in collaboration with the public and private sectors.

d) The experience to be acquired by Madagascar in the development of large renewable energy projects and consequently the creation of a real market in this field.

2. The proposed projects are ambitious and complex (management of concession contracts, permits ...) and require consistent technical assistance and detailed studies as well as training at all levels. The NEP and the new electricity code require support for their implementation and the success of the SREP program.