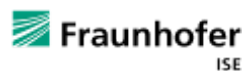


Renewable Energy Sustainable Programs for Intelligent Rural Electrification and Poverty Alleviation



Green electricity for 100 000 rural villagers in Kampong Thom, Cambodia

European technical partners:



Local partner in Cambodia: Ministry of Industry, Mines and Energy



With the financing support of:



SYNTHESIS

The Programme “Green electricity for 100 000 rural villagers in Kampong Thom province” will increase the rural electrification rate five-fold in three districts of Kampong Thom province. Its purpose is the electrification of 27 rural villages with renewable energy sources.

The following table presents an overview of the Programme:

Districts cibles <i>Target districts</i>	Nombre de villages cibles <i>Number of target villages</i>	Technologie retenue <i>Technologie adapted</i>		Coût d'investissement <i>Investment cost</i>	Impacts <i>Impacts</i>			
		Solaire centralisé <i>Solar plants</i>	Centrale biomasse <i>Biomass gasification system</i>		Nombre de bénéficiaires <i>Number of beneficiaries</i>	Nombre d'infrastructures communautaires électrifiées <i>Number of social infrastructures electrified</i>	Nombre d'activités économiques développées <i>Number of economic activities developed</i>	Nombre de tonnes de CO2 évitées sur 10 ans <i>Number of tonnes of CO2 avoided over 10 years</i>
Prasat Sambour	10	4	6	2 200 000 \$	47 000	49	193	3 000
Sandan	8	0	9	1 300 000 \$	20 000	27	67	2 600
Prasat Balangk	9	2	6	1 500 000 \$	33 000	17	76	2 400
Total	27	6	21	5 000 000 \$	100 000	93	336	8 000

4 500 customers will benefit from a sustainable electricity access, based on clean energies and at a lower cost than their traditional energy expenses (petrol lamps, candles, batteries, etc.).

Approximately 100 000 people will indirectly benefit from the Programme.

CONTEXT

The Programme fits in the national strategy to increase electrification of remote and rural areas and to promote the use of local renewable energy potentials in Cambodia.

In partnership with the Ministry of industry, Energy and Mines (MIME), this Programme has been elaborated since 2007 in the frame of a European project called RESIREA, which associated the following partners:

- The Fondation Energies pour le Monde, in France;
- The Fraunhofer Institute for Solar Energy, in Germany;
- The Center for Agronomical Research of Wallonie, in Belgium.

The 27 villages selected through the NORIA method, developed by the Fondation, based on in-depth analysis of the local contexts, and in partnership with Kampong Thom authorities and the MIME, are favourable for sustainable off-grid renewable-energy based electrification.

MARKET ANALYSIS

The collected data in each priority village allowed to determine the current electricity demand and to anticipate its evolution.

The domestic, social and economic demands have been taken into account in order to enhance the impacts of electricity on rural development.

Energy demand analysis:

The different categories of electricity demands have been taken into consideration:

- The domestic energy demand has been segmented into 4 levels of services, using low-consumptions appliances:

	Applications	Number	Daily use (hours)	Power consumption (kWh/month)	Global % of the households	Total nber of customers in the 1 st year
Service level 1	Lighting	1	2	1,1	22%	600
	Radio	1	3			
Service level 2	Lighting	2	2	4,6	41%	1237
	Radio	1	3			
	Small color TV	1	2			
Service level 3	Lighting	2	3	10,0	30%	994
	Radio & Tape player	1	3			
	Medium color TV	1	3			
	DVD	1	2,5			
Service level 4	Lighting	3	4	16,3	7%	228
	Night lamp	1	1			
	Large color TV	1	4			
	DVD	1	3,5			
	Fan	1	0,5			

- The social energy demand, with different categories of users:

Sector	Number	Type of activity
Education and health	58	Primary and secondary schools, health centers
Administration	35	Village office, associations
Public lighting	250	1 lamp spot for 20 houses

- The economic energy demand, with different types of activities:

Sector	Number	Type of activity
Economic activities	336	Workshops, shops and groceries, craft industries, ...

Evolution of the energy demand:

The energy demand increases with time because:

- The individual electricity consumption of households increases (2% per year);
- The number of connected households increases (2% per year);
- The consumption of economic activities increases (2% per year).

Years	1		6		10	
	Nb of customers	MWh/year	Nb of customers	MWh/year	Nb of customers	MWh/year
Number of connected households	3059	244	3481	304	3744	352
Social infrastructures	343	27	343	27	343	27
Economic activities	336	192	336	211	336	229
TOTAL	3738	463	4160	542	4423	608

Around 60% of the households from the three target areas would be connected.

TECHNICAL OPTIONS ADOPTED

The analysis of the locally available energy resources and of the context of each priority village (geographical configuration of the villages, energy demand) enables to select the most suitable technical options for each locality.

Two solutions have been adopted: - solar photovoltaic and biomass gasification. In both options, the production equipment is connected to a local distribution grid and supplies one or more target villages.

Technology	Number of systems / plants	Number of villages	Total capacity installed
Solar plant with mini-grid	4	6	118 kWp
Gasification system	10	21	410 kW

OPERATIONAL SCHEME

Taking into account the legal institutional framework in Cambodia and the dialogue with local partners during RESIREA studies, it is proposed that one private company in each cluster of villages (Priority Zone) operates the electricity infrastructures installed in the area, in order to benefit from scale-effects and reduce operational costs.

This operator will be supported by local staff in each village to daily operate and maintain the electricity infrastructure and collect the fees. The Electricity Authority of Cambodia (EAC), responsible for regulating the electricity sector and imposing national standards, will monitor the operator for fulfilment of its obligations.

ESTIMATION OF INVESTMENT AND RUNNING COSTS

The initial investment cost is composed of additional studies required before the installation of the equipments, the costs of equipments and their installation.

Annual operating costs include: equipment renewal, staff costs, maintenance, management costs, purchase of biomass to supply the gasifiers and diesel for back-up programmes, local taxes and licence fees payable to EAC.

The figures presented in the next page give an overview of the global Programme.

Clusters	Initial Investment cost	Average annual operation costs (including replacement and expansion)
Prasat Sambour	2 243 005 USD	84 430 USD
Sandan	1 322 139 USD	56 350 USD
Prasat Balangk	1 493 462 USD	57 038 USD
TOTAL	5 058 606 USD	197 818 USD

The initial investment per customer is then **1 129 USD**.

ECONOMICAL ANALYSIS AND FINANCING PACKAGE

The economical analysis determines the cash-flows generated over 10 years.

Analysis of the revenues:

The revenues of the operator have been assessed basing on a tariff-schedule proposal. Due to the legal framework and matching the ability to pay of the target population, the following tariff has been proposed:

0.80 USD/kWh

Connection fees: from 15 USD to 50 USD depending on the level of service

The cost of the electricity is lower than the current substitutable expenses:

Average monthly substitutable energy expenditure (USD per month)	6,8 USD
Average monthly electricity bill (USD per month)	6,4 USD
Invoice to expenditure ratio	0,9

Average annual revenues for the operator:

Cluster	PRASAT SAMBOUR	SANDAN	PRASAT BALANGK	TOTAL
Mean annual revenue	161 024 USD	137 234 USD	128 434 USD	426 692 USD

The annual revenues will enable the local operator to cover its own total expenses and to aim for a profitability rate over 10 years (and the foreign initial investments with a low profitability level).

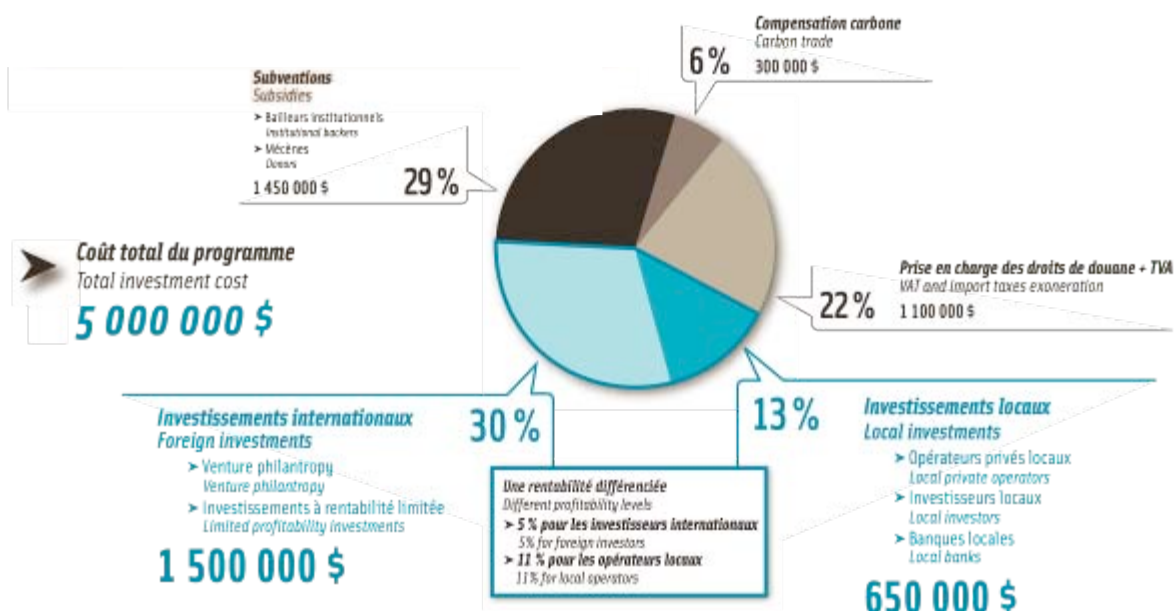
Global economic profitability for the local operators:

Necessary total subsidy rate	56%
Net Present Value over 10 years	443 054 USD
Internal Rate of Return of the operator over 10 years	11%
Ration Revenues / Expenses for the operator	2.15

Financing package per cluster and for the whole Programme:

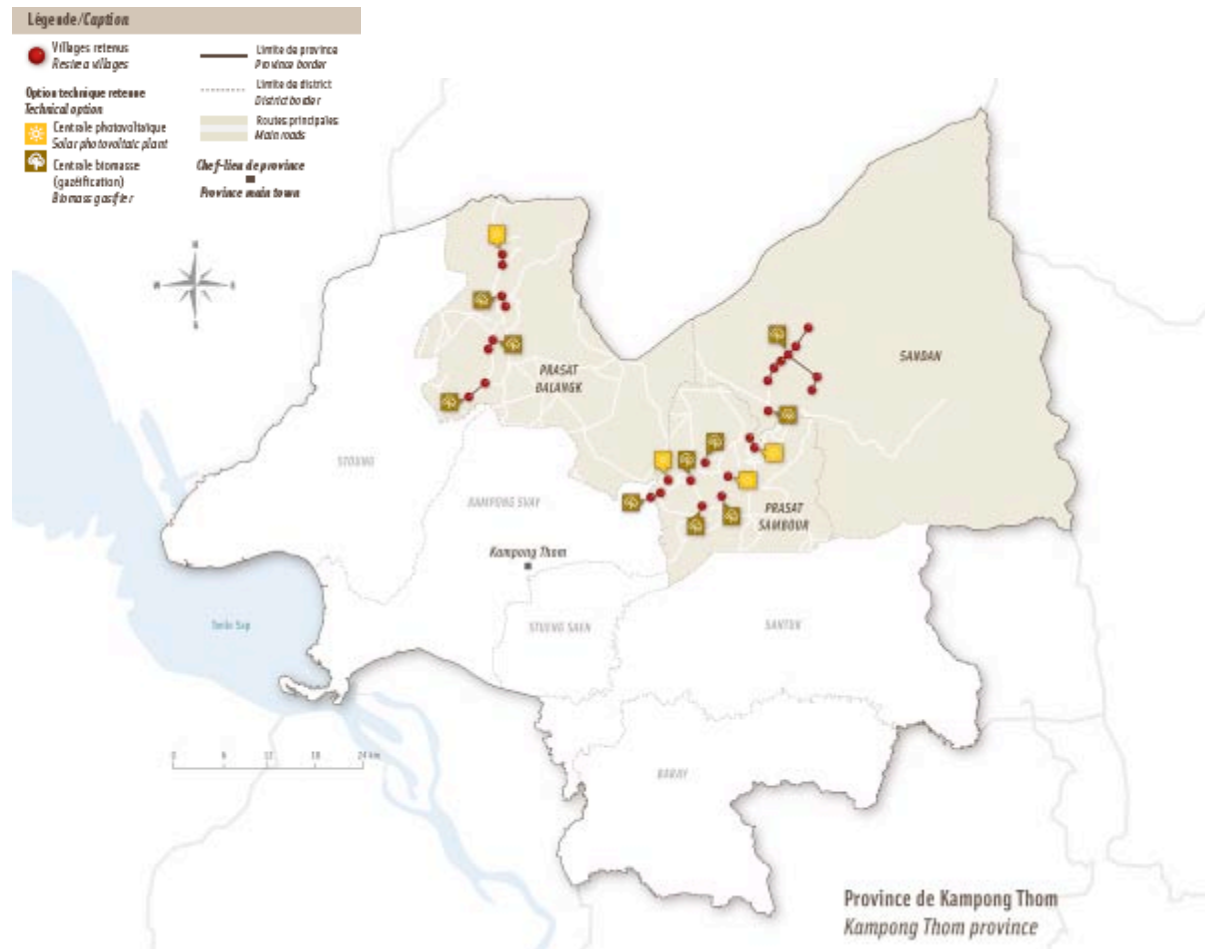
Funding for the programme covers the initial investment costs. Only foreign investment and local operator investment aim a profitability rate (5% and 11%, respectively).

	Prasat Sambour		Sandan		Prasat Balangk	
	Allocation	Amount to be financed	Allocation	Amount to be financed	Allocation	Amount to be financed
Subsidy	36%	807 479 USD	22%	285 477 USD	23%	337 376 USD
Taxes exoneration	24%	544 717 USD	17%	222 772 USD	23%	338 514 USD
Carbon trade	5%	120 000 USD	8%	104 000 USD	6%	96 000 USD
Local investment	10%	231 243 USD	16%	212 967 USD	14%	216 472 USD
Foreign investment	24%	539 566 USD	38%	496 923 USD	34%	505 101 USD
Total	100%	2 243 005 USD	100%	1 322 139 USD	100%	1 493 462 USD

**EXPECTED IMPACTS**

Impact social Social impact	Éducation Education	28 écoles ou collèges/lycées électrifiés 28 primary and secondary schools electrified
	Santé Health	30 centres de santé et pharmacies électrifiés 30 health centers and pharmacies electrified
	Administration Administration	35 bâtiments administratifs électrifiés (mairies, bureaux associatifs, etc.) 35 administrative buildings electrified (commune offices, associations offices, etc.)
	Éclairage public Public lighting	250 lampadaires 250 lamp spots
Impact économique Economical impact	Activités économiques Economic activities	336 activités raccordées (restaurants, ateliers, boutiques, artisans, etc.) 336 connected activities (restaurants, workshops, shops, craft industries, etc.)
Impact environnemental Environmental impact	Émissions de CO2 évitées CO2 emissions avoided	8 000 tonnes évitées sur 10 ans 8 000 tonnes avoided over 10 years

OVERVIEW OF THE THREE PRIORITY ZONES OF KAMPONG THOM



PRASAT SAMBOUR – DISTRICT



39 524 habitants/inhabitants > 66 villages

Accessibilité/Accessibility

- > 1 heure en voiture depuis le chef-lieu de province
- > 1 hour in car from Kampong Thom City

Dépenses énergétiques/Energy expenditures

- > 4,5 \$ (3 €) par mois/per month

Potential énergétique renouvelable/Renewable energy potential

- > Solaire : 4,7 kWh/m².jour
- > Solar: 4,7 kWh/m².day
- > Biomasse : 1 100 t/an (bois de cajou) et 200 t/an (balle de riz)
- > Biomass: 1 100 t/year (cashew wood) et 200 t/year (rice husk)

Taux d'électrification rurale/Village rural electrification rate

- > 2 %

Légende/Caption

> No. de bénéficiaires potentiels visé à 10 ans / Number of beneficiaries targeted after 10 years

> Tonnes de CO2 évitées sur 10 ans / Tonnes of CO2 avoided over 10 years

Nom du village/Name of the village

> No. de infrastructures communales / Number of social infrastructures

> No. de activités génératrices de revenus / Number of income generating activities

> No. de diplômés en année 10 / Number of graduates in year 10

> Technologie retenue / Technical option adopted

12 kW > Puissance/Capacity

> Investissement initial / Initial investment

SAMBOUR

> 16 000

> 1 260

Sambour

> 6 (dont 1 école primaire et 1 collège / 1 primary school and 1 secondary school)

> 34 (dont 24 boutiques / 24 shops)

> 220

21 kW

140 000 \$ / 95 000 €

Trapeang Chruk

> 5 (dont 1 école primaire / 1 primary school)

> 11 (dont 7 boutiques et 1 chargeur de batteries / 7 shops and 1 battery charging station)

> 110

10 kW

90 000 \$ / 60 000 €

Ou Kru Kae

> 6 (dont 1 école primaire / 1 primary school)

> 14 (dont 9 boutiques / 9 shops)

> 150

16 kWc / 16 kWp

325 000 \$ / 220 000 €

Atsu – Cheay Sampov

> 10 (dont 2 écoles primaires, 1 collège et 1 centre de santé / 2 primary schools, 1 secondary school and 1 health center)

> 26 (dont 19 boutiques et 1 chargeur de batteries / 19 shops and 1 battery charging station)

> 310

29 kW

230 000 \$ / 160 000 €

TANG KRASAU

> 13 000

> 895

Tang Krasau

> 7 (dont 1 école primaire / 1 primary school)

> 27 (dont 17 boutiques et 3 chargeurs de batteries / 17 shops and 3 battery charging stations)

> 280

26 kW

180 000 \$ / 125 000 €

Tuek Andoung

> 4 (dont 1 école primaire et 1 centre de santé / 1 primary school and 1 health center)

> 17 (dont 11 boutiques et 2 chargeurs de batteries / 11 shops and 2 battery charging stations)

> 190

18 kW

145 000 \$ / 100 000 €

CHHUK, KOUL

> 17 500

> 845

Chhuk Stueng

> 3 (dont 1 centre de santé / 1 health center)

> 28 (dont 9 boutiques et 1 chargeur de batteries / 9 shops and 1 battery charging station)

> 140

19 kWc / 19 kWp

340 000 \$ / 230 000 €

Ta Aok – Kampong Chuea

> 8 (dont 1 école primaire et 2 collèges / 1 primary school and 2 secondary schools)

> 36 (dont 20 boutiques et 1 chargeur de batteries / 20 shops and 1 battery charging station)

> 350

43 kWc / 43 kWp

750 000 \$ / 510 000 €

PRASAT BALANGK – DISTRICT



46 693 habitants/inhabitants > 64 villages

Accessibilité/Accessibility

> Moins de 2 heures en voiture depuis le chef-lieu de province
> Less than 2 hours in car from Kampong Thom City

Dépenses énergétiques/Energy expenditures

> 6,5 \$ (4,4 €) par mois/per month

Potentiel énergétique renouvelable/Renewable energy potential

> Solaire : 4,6 kWh/m².jour
> Solar: 4,6 kWh/m².day
> Biomasse : 1 900 t/an (bois de cajou) et 370 t/an (balle de riz)
> Biomass: 1 900 t/year (cashew wood) et 370 t/year (rice husk)

Taux d'électrification rurale/Village rural electrification rate

> 2 %

Légende/Caption

- > Nombre de bénéficiaires potentiels visés à 10 ans/ Number of beneficiaries targeted after 10 years
- > Tonnes de CO2 évitées sur 10 ans/Tonnes of CO2 avoided over 10 years

Nom du village/Name of the village

- > Nombre d'infrastructures communautaires/Number of social infrastructures
- > Nombre d'activités génératrices de revenus/Number of income generating activities
- > Nombre d'abonnés en année 10/Number of customers in year 10
- > Technologie retenue/Technology option adopted
- 12 kW > Puissance/Capacity
- > Investissement initial/Initial investment

SAMEAKKI

> 5 000
 > 450

Thmei – Trach

> 2 (1 école primaire et 1 collège/1 primary school and 1 secondary school)

> 19 (dont 14 boutiques et 2 chargeurs de batteries/ 14 shops and 2 battery charging station)

> 235

21 kW

190 000 \$/125 000 €

SA KREAM

> 11 000
 > 600

Sa kream Cheung – Sa kream Tboung

> 6 (dont 1 école primaire, 1 collège et 1 centre de santé/1 primary school, 1 secondary school and 1 health center)

> 19 (dont 12 boutiques et 2 chargeurs de batteries/ 12 shops and 2 battery charging station)

> 330

37 kW

245 000 \$/163 000 €

KRAYA

> 8 800
 > 800

Kraya Cheung – Kraya Tboung

> 4 (dont 1 école primaire et 1 collège/1 primary school and 1 secondary school)

> 19 (dont 11 boutiques et 3 chargeurs de batteries/ 11 shops and 3 battery charging stations)

> 475

54 kW

370 000 \$/247 000 €

DOUNG

> 8 200
 > 550

Doung – Dang Ta Aek

> 5 (dont 1 école primaire et 1 collège/1 primary school and 1 secondary school)

> 19 (dont 16 boutiques et 1 chargeur de batteries/ 16 shops and 1 battery charging station)

> 310

39 kW/39 kWp

695 000 \$/465 000 €

SANDAN – DISTRICT



42 196 habitants/inhabitants > 80 villages

Accessibilité/Accessibility

> 2 heures 30 en voiture depuis le chef-lieu de province
 > 2 hours 30 in car from Kampong Thom City

Dépenses énergétiques/Energy expenditures

> 7,3 \$ (4,9 €) par mois/per month

Potentiel énergétique renouvelable/Renewable energy potential

> Solaire : 4,6 kWh/m².jour
 > Solar: 4,6 kWh/m².day
 > Biomasse : 518 t/an (bois de cajou) et 250 t/an (balle de riz)
 > Biomass: 518 t/year (cashew wood) et 250 t/year (rice husk)

Taux d'électrification rurale/Village rural electrification rate

> 6 %

Légende/Caption

- > Nombre de bénéficiaires potentiels visé à 10 ans / Number of beneficiaries targeted after 10 years
- > Tonnes de CO2 évitées sur 10 ans / Tonnes of CO2 avoided over 10 years

Nom du village/Name of the village

- > Nombre d'infrastructures communautaires / Number of social infrastructures
- > Nombre d'activités génératrices de revenus / Number of income generating activities
- > Nombre d'abonnés en année 10 / Number of customers in year 10
- > Technologie retenue / Technology adopted
- 12 kW > Puissance / Capacity
- > Investissement initial / Initial investment

MEAN CHEY

- > 9 000
- > 400

Roneam

- > 9 (dont 1 école primaire, 1 collège et 1 centre de santé / 1 primary school, 1 secondary school and 1 health center)
- > 18 (dont 10 boutiques et 2 chargeurs de batteries / 10 shops and 2 battery charging station)
- > 170

22 kW

150,000 \$ / 100 000 €

CHHEU TEAL

- > 11 000
- > 2 200

Beung Pra – Veal Pring Kraom – Chheu Teal – Boeng Rolum – Samret – Kampong Ta Ben – Kai Rang – Andong Pring

- > 18 (dont 5 écoles primaires, 1 collège et 1 centre de santé / 5 primary schools, 1 secondary school and 1 health center)
- > 49 (dont 33 boutiques et 5 chargeurs de batteries / 33 shops and 5 battery charging station)
- > 1 180

170 kW

1 150 000 \$ / 800 000 €