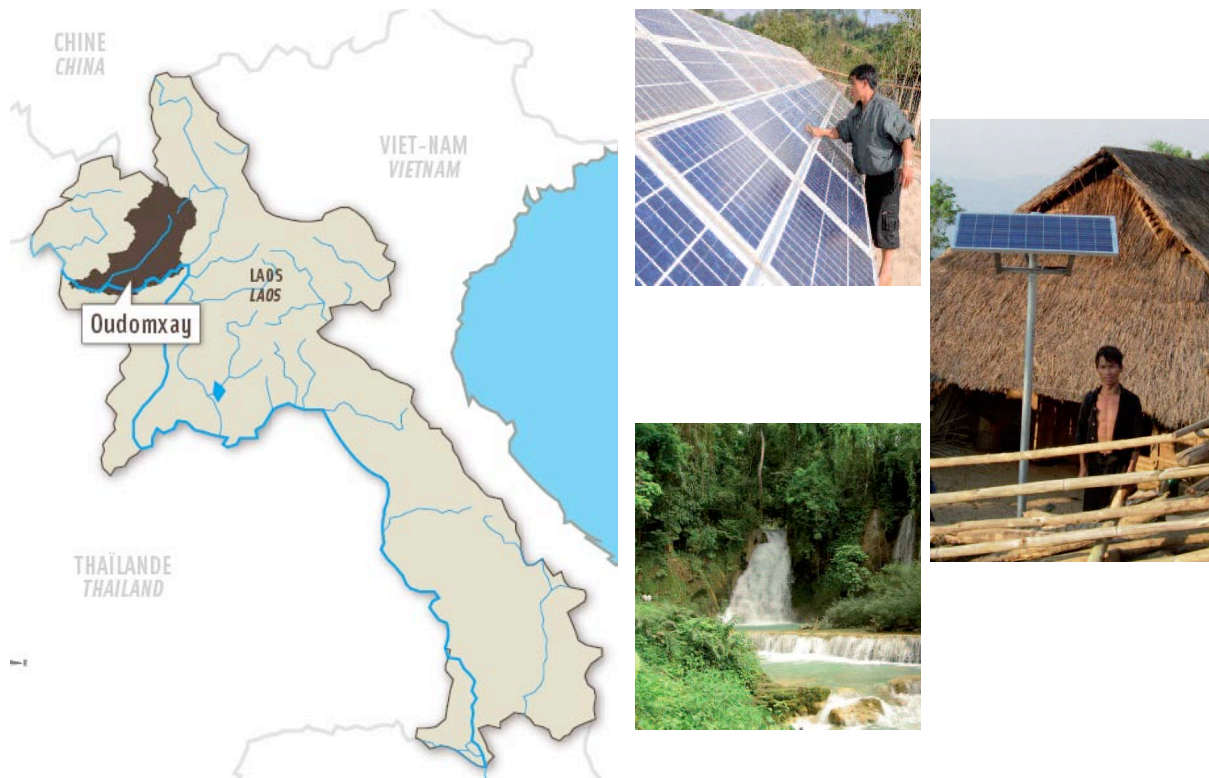


RESIREA

Renewable Energy Sustainable Programs for Intelligent Rural Electrification and Poverty Alleviation



Green electricity for 35 000 rural villagers in Oudomxay Province, Laos

European technical partners:



Local partner in Laos: Ministry of Energy and Mines



With the financing support of:



SYNTHESIS

The Programme “Green electricity for 35 000 rural villagers in Oudomxay province” will double the number of rural electrified villages in two districts of Oudomxay province.

Its purpose is the electrification of 30 rural villages with renewable energy sources.

The following table presents an overview of the Programme:

Districts cibles Target districts	Nombre de villages cibles Number of target villages	Technologie retenue Technologies adopted			Coût d'investissement Investment costs	Impacts Impacts			
		Solaire individuel Solar home Systems	Solaire centralisé Solar plants	Micro- hydraulique Micro hydro plants		Nombre de bénéficiaires Number of beneficiaries	Nombre d'infrastructures communautaires électrifiées Number of social infrastructures electrified	Nombre d'activités économiques développées Number of economic activities developed	Nombre de tonnes de CO ₂ évitées sur 20 ans Number of tonnes of CO ₂ avoided over 20 years
Xay Xay	9	2	2	5	870 000 €	10 000	15	34	1 300
Houn Sud Houn South	15	1	3	11	1 200 000 €	20 000	17	43	2 900
Houn Nord Houn North	6	3	3	0	480 000 €	5 000	12	19	800
Total	30	6	8	16	2 550 000 €	35 000	44	96	5 000

2 600 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 35 000 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 Laos.

In partnership with the Ministry of Energy and Mines and its Department of Electricity (DOE), 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 30 villages selected through the NORIA method, developed by the Fondation, based on in-depth analysis of the local contexts, and in partnership with Oudomxay authorities and the DOE, 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 3 levels of services, using low-consumptions appliances:

	Applications	Number	Daily use (hours)	Energy (kWh/month)	Global % of the households	Total nb of customers in the first year
Service 1	Lighting	1	2,5	1,1	60%	802
	Radio	1	2			
Service 2	Lighting	2	3	5,4	28%	410
	Night lamp	1	1			
	Radio	1	3			
Service 3	Small color TV	1	2	15,0	12%	190
	Lighting	3	4			
	Night lamp	1	4			
	Tape player	1	0,5			
	Medium color TV	1	3			
	DVD	1	2,5			
Fan	1	0,5				

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

Sector	Number	Type of activity
Education and health	32	Primary and secondary schools, health centers
Administration	12	Village office, associations
Public lighting	44	1 lamp spot for 40 houses

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

Sector	Number	Type of activity
Economic activities	96	workshops, shops and groceries, craft industries, water pumps

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 (3% per year);
- The consumption of economic activities increases (3% per year).

Years	1		10		20	
	Nb of customers	MWh/year	Nb of customers	MWh/year	Nb of customers	MWh/year
Number of connected households	1402	72	1852	114	2346	202
Social infrastructures	88	11	88	11	88	11
Economic activities	96	30	96	38	96	51
TOTAL	1586	113	2036	163	2530	264
Households connection rate	65%		70%		72%	

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.

A favourable solar potential, with an average irradiation of 4.5 kWh/m².day has led to the selection of solar technologies for 14 villages. For some of them, solar generators with mini-grid have been adopted, due to a high energy demand and grouped configuration of the dwellings. For the remaining 6 villages, Solar Home Systems have been adopted.

2 hydro potential sites have been identified. They can supply electricity to 16 villages.

Technology	Number of systems / plants	Number of villages	Total capacity installed
Micro-hydro plant	2	16	105 kW
Solar plant with mini-grid	8	8	61 kWp
Solar Home Systems	251	6	16 kWp

OPERATIONAL SCHEME

Taking into account the legal institutional framework in Laos 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 village actors, namely a Village Energy Committee and Village Technicians, to daily operate and maintain the electricity infrastructure and collect the fees.

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 diesel for back-up programmes and local taxes.

The figures presented below give an overview of the global Programme.

Clusters	Initial Investment cost	Average annual running costs (excluding replacement and expansion costs)	Average annual replacement costs	Average annual expansion costs
Xay	872 306€	11 359€	9 063€	1 703€
Houn South	1 195 596€	13 885€	9 380€	2 807€
Houn North	480 559€	10 229€	12 768€	473€
TOTAL	2 548 462 €	35 474€	31 211€	4 983€

The initial investment per customer is then **1 007€**.

ECONOMICAL ANALYSIS AND FINANCING PACKAGE

The economical analysis determines the cash-flows generated over 20 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 the relatively low ability to pay of the target population, the following tariff has been proposed:

0.30 €/kWh

Connection fees: from 20€ to 50€ depending on the level of service

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

Average monthly substitutable energy expenditure (€ per month)	2 €
Average monthly electricity bill (€ per month)	1,7 €
Invoice to expenditure ratio	0.85

Average annual revenues for the operator:

Cluster	XAY	HOUN SOUTH	HOUN NORTH	TOTAL
Mean annual revenue	20 499 €	43 049 €	10 848 €	74 396 €

The annual revenues will enable the local operator to cover its own total expenses and to aim for a profitability rate over 20 years (and the foreign initial investments with a low profitability level).

Note that regarding the particular context of tariffs in Laos and the low ability to pay of the population, the tariff rate mentioned does not cover equipment replacement at end of service life. As a result, the replacements and expansions costs will be taken in charge by subsidies and won't be at the charge of the operators.

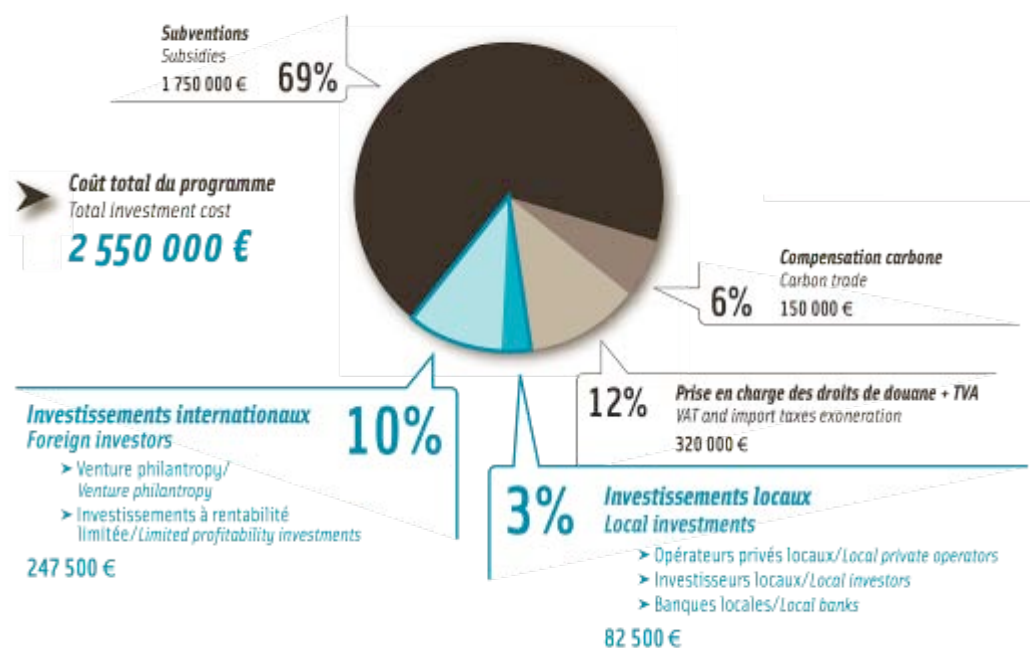
Global economic profitability for the local operators:

Necessary total subsidy rate	89%
Net Present Value over 20 years	71 154 €
Internal Rate of Return of the operators over 20 years	10%
Ration Revenues / Expenses for the operators	2

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 (3% and 10%, respectively).

	Xay		Houn South		Houn North	
	Allocation	Amount to be financed	Allocation	Amount to be financed	Allocation	Amount to be financed
Subsidy	73%	677 503 €	60,5%	812 664 €	80%	408 919 €
Taxes exoneration	15%	129 380 €	10,5%	124 225 €	14%	66 354 €
Carbon trade	4%	39 000 €	7,5%	87 000 €	5%	24 000 €
Local investment	2%	16 356 €	5,5%	64 677 €	0%	1 322 €
Foreign investment	6%	49 067 €	16%	194 030 €	1%	3 965 €
Total	100%	872 306 €	100%	1 195 596 €	100%	480 559 €



EXPECTED IMPACTS

Impact social Social impact

Éducation Education

29 écoles ou collèges/lycées électrifiés
29 primary and secondary schools electrified

Santé Health

3 centres de santé électrifiés
3 health centers electrified

Administratif Administration

12 bâtiments administratifs électrifiés (mairies, bureaux associatifs, etc.)
12 administrative buildings electrified (village offices, associations offices, etc.)

Éclairage public Public lighting

44 lampadaires
44 lamp spots

Impact économique Economical impact

Activités économiques Economic activities

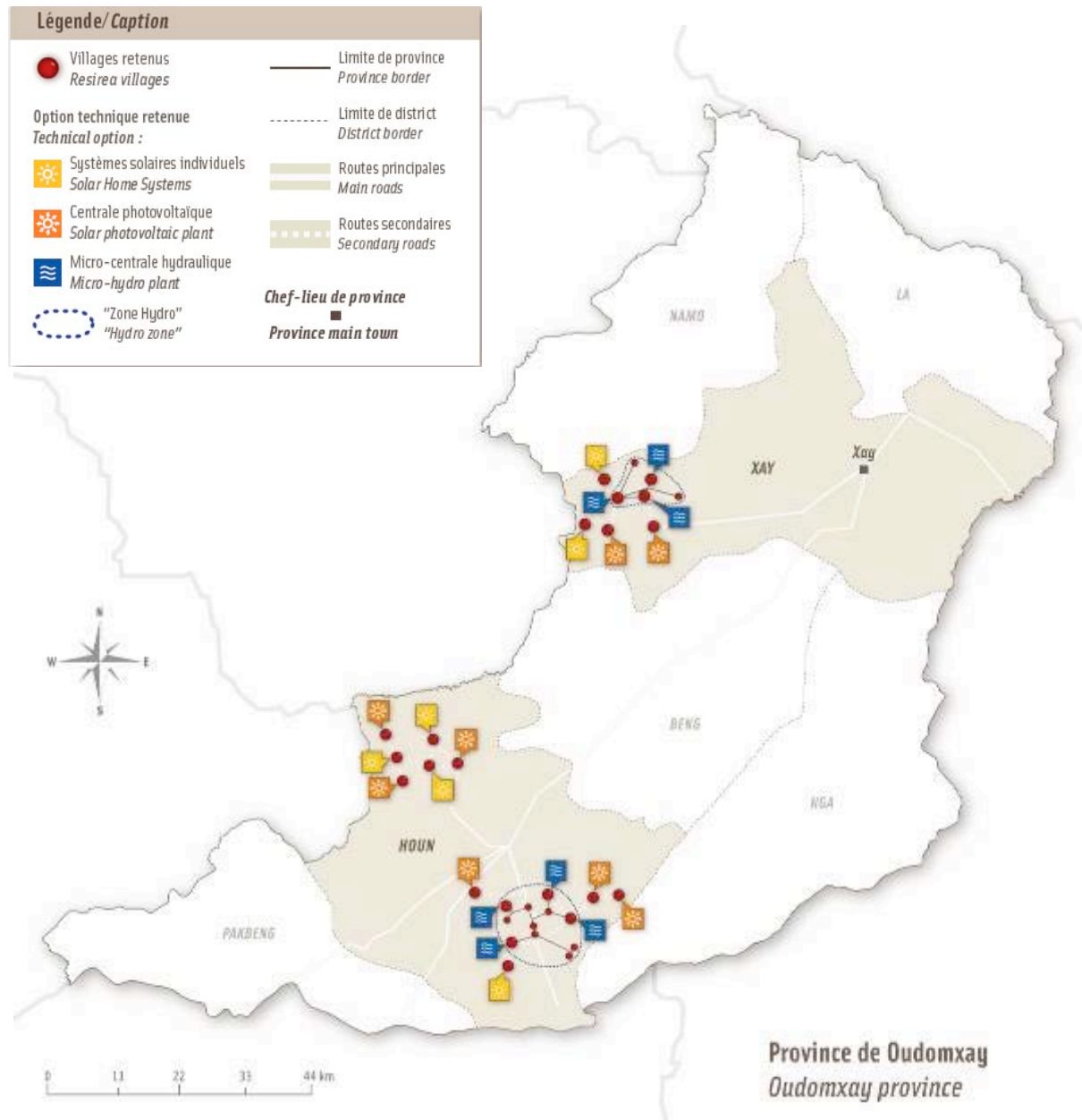
96 activités raccordées (ateliers, boutiques, pompes à eau, etc.)
96 connected activities (workshops, shops, craft industries, waterpumps, etc.)

Impact environnemental Environmental impact

Émissions de CO₂ évitées CO₂ emissions avoided

5 000 tonnes évitées sur 20 ans
5 000 tonnes avoided over 20 years

OVERVIEW OF THE THREE PRIORITY ZONES OF OUDOMXAY



HOUN NORD – HOUN NORTH ZONE

RESIREA Renewable Energy Sustainable programs for Intelligent Rural Electrification and poverty Alleviation



23 200 habitants/inhabitants > 62 villages

Accessibilité/Accessibility

- > 3 à 6 heures de 4x4 depuis le chef lieu de district de Houn, selon la saison
- > 3 to 6 hours 4-wheel drive from Houn district town, depending on the season

Dépenses énergétiques/Energy expenditures

- > 2 € par mois (\$3 per month)

Potentiel énergétique renouvelable/Renewable energy potential

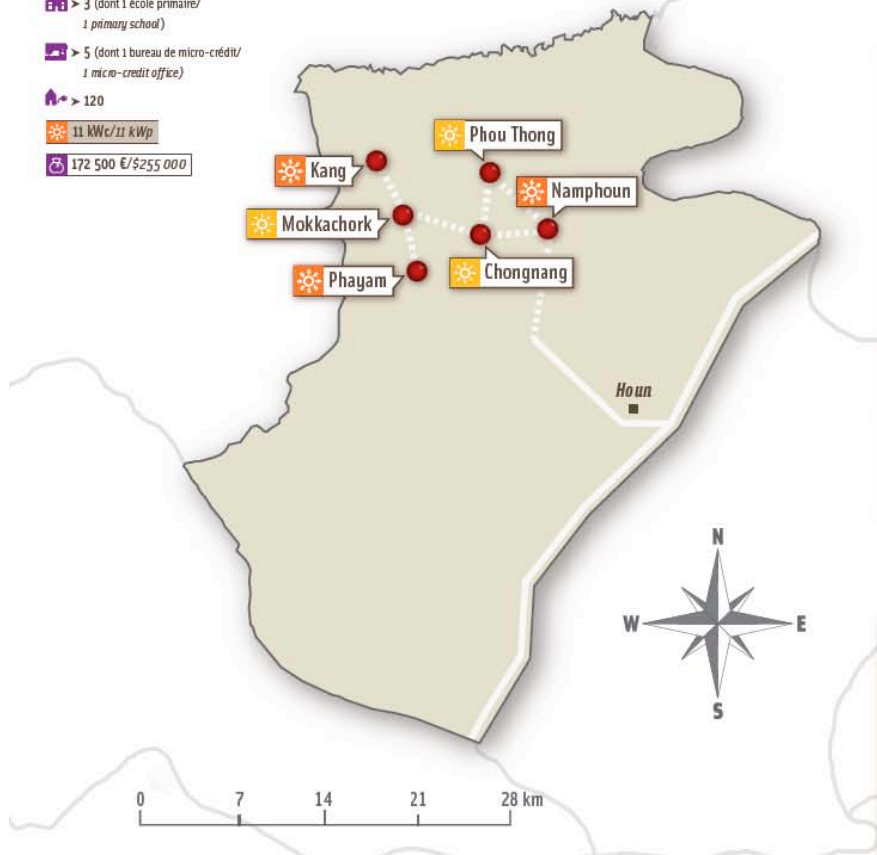
- > Solaire : 4 kWh/m².jour
- > Solar: 4 kWh/m².day
- > Biomasse : 235 t/an (raffles de maïs) et 80 t/an (balle de riz)
- > Biomass: 235 t/year (corn cobs) et 80 t/year (rice husk)

Taux d'électrification rurale/Village electrification rate

- > 1 %

CHONGNANG	MOKKACHORK	NAMPHOUN	PHAYAM	PHOU THONG
CO ₂ > 85	CO ₂ > 90	CO ₂ > 210	CO ₂ > 110	CO ₂ > 80
1 (1 école primaire/ 1 primary school)	2 (dont 1 écoles primaire/ 1 primary school)	3 (dont 1 école primaire/ 1 primary school)	2 (dont 1 école primaire/ 1 primary school)	1 (1 école primaire/ 1 primary school)
2	1	8 (dont 3 boutiques, 1 bureau de micro-crédit et 1 pompe à eau/ 3 shops, 1 micro-credit office and 1 water pump)	2	1
40	40	90	65	35
2 kWc/2 kWp	2 kWc/2 kWp	10 kWc/10 kWp	5 kWc/5 kWp	2 kWc/2 kWp
27 300 €/ \$40 000	29 000 €/ \$43 000	142 000 €/ \$210 000	83 000 €/ \$123 000	26 200 €/ \$39 000

KANG
CO ₂ > 225
3 (dont 1 école primaire/ 1 primary school)
5 (dont 1 bureau de micro-crédit/ 1 micro-credit office)
120
11 kWc/11 kWp
172 500 €/ \$255 000



Programme RESIREA/RESIREA programme HOUN NORD - HOUN NORTH ZONE

Nombre total d'abonnés visé à 20 ans
Number of customers in year 20
370

Nombre de bénéficiaires visé à 20 ans
Number of beneficiaries in year 20
5 000

Taux d'électrification rurale visé
Targeted village electrification rate
17 %

Tarif/Tariff rate
0,30 €/kWh (0.45 \$/kWh)

Investissement global/Total investment
480 000 €/ \$710 000

Légende/Caption

CO ₂ > Tonnes de CO2 évitées sur 10 ans/ Tonnes of CO2 avoided over 10 years	Option technique retenue/Technical option :
Infrastructures communautaires/Number of social infrastructures	Systèmes solaires individuels/ Solar Home Systems
Nombre d'activités génératrices de revenus/Number of income generating activities	Centrale photovoltaïque/ Solar photovoltaic plant
Nombre d'abonnés en année 10/ Number of customers in year 10	Villages retenus/Retained villages
26 kW > Puissance/capacity	Limite de district/District border
Investissement initial/initial investment	Limite de commune/ Commune border
	Routes principales/ Main roads
	Routes secondaires/ Secondary roads
	Chef-lieu de district/ District main town



HOUN SUD – HOUN SOUTH ZONE

RESIREA Renewable Energy Sustainable programs for Intelligent Rural Electrification and poverty Alleviation



38 700 habitants/inhabitants > 82 villages

Accessibilité/Accessibility

- > 3 heures à 4 heures et demi de 4x4 depuis le chef lieu de district de Houn, selon la saison
- > 3 to 4 and an half hour 4-wheel drive from Houn district town, depending on the season

Dépenses énergétiques/Energy expenditures

- > 1,8 € par mois (\$2.75 per month)

Potentiel énergétique renouvelable/Renewable energy potential

- > Solaire : 3,9 kWh/m².jour
- > Solar: 3,9 kWh/m².day
- > Hydraulique : Site hydraulique de Konglang, potentiel de 80 kW
- > Hydropower: Konglang hydro potential, 80 kW
- > Biomasse : 600 t/an (raffes de maïs) et 140 t/an (balle de riz)
- > Biomass: 600 t/year (corn cobs) et 140 t/year (rice husk)

Taux d'électrification rurale/Village rural electrification rate

- > 4 %

KATANGYA

- CO₂ > 345
- > 1 (1 école primaire/1 primary school)
- > 7 (dont 1 bureau de micro-crédit et 1 pompe à eau/1 micro-credit office and 1 water pump)
- > 170
- 11 kWc/11 kWp
- 174 500 €/\$260 000

KONLANG

Mokchaak - Namphaoyai - Mai - Namyueng
(Dou, Kewyaab, Konlang, Mae, Namyueng (2), OI, Xieng OI)

- CO₂ > 2 160
- > 13 (dont 10 écoles primaires et 1 centre de santé/10 primary schools and 1 health center)
- > 30 (dont 10 boutiques, 2 bureaux de micro-crédit et 4 pompes à eau/10 shops, 2 micro-credit offices and 4 water pumps)
- > 1 140
- 80 kW
- 845 000 €/\$1 260 000

MOKLAK

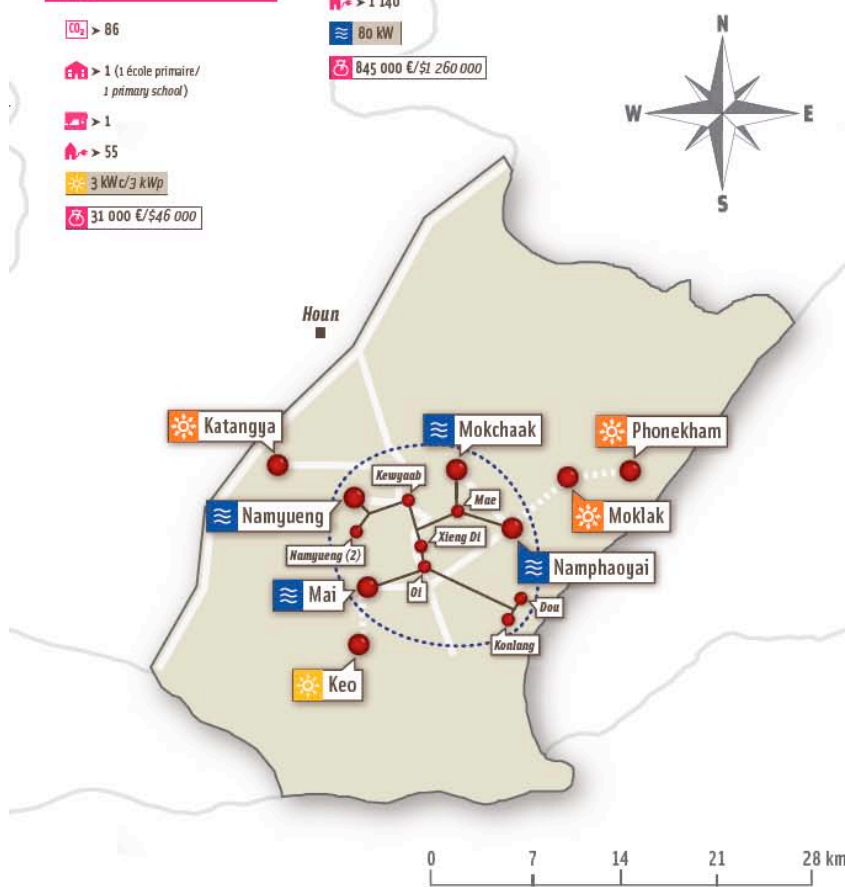
- CO₂ > 165
- > 1 (1 école primaire/1 primary school)
- > 3 (dont 1 pompe à eau/1 water pump)
- > 70
- 4 kWc/4 kWp
- 79 000 €/\$118 000

PHONEKHAM

- CO₂ > 145
- > 1 (1 école primaire/1 primary school)
- > 2 (dont 1 pompe à eau/1 water pump)
- > 65
- 4 kWc/4 kWp
- 70 500 €/\$106 000

KEO

- CO₂ > 86
- > 1 (1 école primaire/1 primary school)
- > 1
- > 55
- 3 kWc/3 kWp
- 31 000 €/\$46 000



Programme RESIREA/RESIREA programme HOUN SUD - HOUN SOUTH ZONE

Nombre total d'abonnés visé à 20 ans
Number of customers in year 20
1 500

Nombre de bénéficiaires visé à 20 ans
Number of beneficiaries in year 20
20 000

Taux d'électrification rurale visé
Targeted village electrification rate
17 %

Tarif/Tariff rate
0,30 € / kWh (0.45 \$ / kWh)

Investissement global/Total investment
1 200 000 € / \$1 790 000

Légende/Caption

- CO₂ > Tonnes de CO₂ évitées sur 10 ans / Tones of CO₂ avoided over 10 years
- Nom du village / Name of the village
- Nom des autres villages connectés / Name of the additional connected villages
- Option technique retenue / Technical option :
 - > Systèmes solaires individuels / Solar Home Systems
 - > Centrale photovoltaïque / Solar photovoltaic plant
 - > Micro-centrale hydraulique / MICRO-hydroplant
- > Zone hydro/hydro zone
- > Nombre d'infrastructures communales / 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
- 26 kW > Puissance / Capacity
- > Investissement initial / Initial investment
- > Villages retenus / Retained villages
- > Limite de district / District border
- > Limite de commune / Commune border
- > Routes principales / Main roads
- > Routes secondaires / Secondary roads
- > Chef-lieu de district / District main town

Partenaires du projet RESIREA / Partners of RESIREA project :



Avec le soutien financier de / With the financial support of :



XAY – XAY DISTRICT

RESIREA Renewable Energy Sustainable programs for Intelligent Rural Electrification and poverty Alleviation



67 296 habitants/inhabitants > 108 villages

Accessibilité/Accessibility

- > 4 à 8 h de 4x4 depuis le chef lieu de district de Xay, selon la saison
- > 4 to 8 hours 4-wheel drive from Xay district town, depending on the season

Dépenses énergétiques/Energy expenditures

- > 1,6 € par mois (\$2.4 per month)

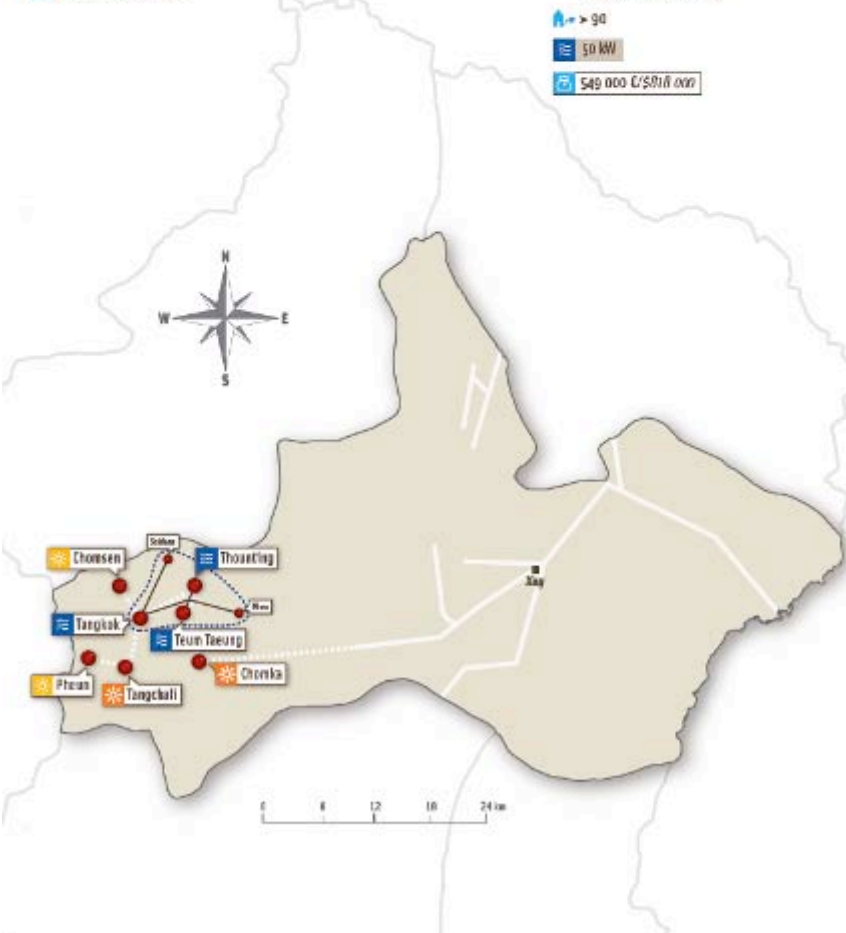
Potentiel énergétique renouvelable/Renewable energy potential

- > Solaire : 4 kWh/m².jour
- > Solar: 4 kWh/m².day
- > Hydraulique : Site hydraulique de Sakhan, potentiel de 50 kW
- > Hydropower: Sakhan hydro potential, 50 kW
- > Biomasse : 23 t/an (raffles de maïs) et 188 t/an (balle de riz)
- > Biomass: 23 t/year (corn cobs) et 188 t/year (rice husk)

Taux d'électrification rurale/Village rural electrification rate

- > 19 %

CHOMKA	CHOMSEN	TANGKOK	PHUEN	TANGCHALI
☎ > 180	☎ > 115	Tangkok – Thouting – Teum Tœung (Sakhan, Phœn)	☎ > 90	☎ > 180
🏠 > 2 (dont 1 école primaire/ 1 primary school)	🏠 > 1 (1 école primaire/ 1 primary school)	☎ > 735	🏠 > 1 (1 école primaire/ 1 primary school)	🏠 > 4 (dont 1 école primaire/ 1 primary school)
🏪 > 5 (dont 2 boutiques, 1 bureau de micro-crédit et 1 pompe à eau/ 2 shops, 1 micro-credit office and 1 water pump)	🏪 > 3 (dont 1 pompe à eau/ 1 water pump)	🏠 > 7 (dont 5 écoles primaires et 1 centre de santé/ 5 primary schools and 1 health center)	🏪 > 1	🏪 > 4 (dont 2 boutiques et 1 pompe à eau/ 2 shops and 1 water pump)
👤 > 115	👤 > 45	🏠 > 21 (dont 3 boutiques, 2 bureaux de micro-crédit et 3 pompes à eau/ 3 shops, 2 micro-credit offices and 3 water pumps)	👤 > 55	👤 > 90
☀️ 8 kWc/2 kWp	☀️ 4 kWc/2 kWp	☎ > 90	☀️ 3 kWc/2 kWp	☀️ 7 kWc/2 kWp
💰 131 000 €/5195 000	💰 41 000 €/567 000	💰 549 000 €/5816 000	💰 34 000 €/952 000	💰 115 000 €/177 000



Programme RESIREA/RESIREA programme XAY – XAY DISTRICT

Nombre total d'abonnés visé à 20 ans
Number of customers in year 20
730

Nombre de bénéficiaires visé à 20 ans
Number of beneficiaries in year 20
10 000

Taux d'électrification rurale visé
Targeted village electrification rate
30 %

Tarif/Tariff rate
0,30 €/kWh (0.45 \$/kWh)

Investissement global/Total investment
870 000 €/51 300 000

Légende/Caption

☎ = Nombre de CB (de 10 à 100 ans) /
Number of CB (between 10 and 100 years)

🏠 = Nombre de habitats avec connexion électrique /
Number of houses with electricity connection

🏪 = Nombre d'activités génératrices de revenus (boutiques et 1 bureau micro-entreprises) /
Number of income-generating activities (shops and 1 micro-enterprise office)

👤 = Nombre d'habitants en année 10 /
Number of customers in year 10

☀️ = Potentiel/Capacity

💰 = Investissement total/Total investment

☀️ = Spécifiques solaires: 10 modules/20 panneaux /
Solar: 10 modules/20 panels

☀️ = Central et solaire hybride/20 modules/20 panneaux /
Central and hybrid solar/20 modules/20 panels

🏠 = Micro-entreprise à genèse/autre-activités /
Micro-enterprise/other-activities

⋯ = Lien ligne/Power line

● = Villages rattachés à d'autres villages /
Villages attached to other villages

→ = Limite de district/District border

→ = Limite de commune/ Commune border

→ = Routes principales/Main roads

→ = Routes secondaires/ Secondary roads

☒ = Chef-lieu de district /
District Main town