Capacity & institutional strengthening for rural electrification and development - Decentralised Energy Option (CAP-REDEO)

Supported by the European Commission through the Intelligent Energy Europe Agency (IEEA) and French Ministry of Foreign Affairs (MAE)

The project factsheet

- ***Project title: "Capacity & institutional strengthening for rural electrification and development - Decentralised Energy Option"- CAP-REDEO***
- ***Supported by: Intelligent Energy Europe Agency (IEEA) and French Ministry of Foreign Affairs (MAE)***
- ***Covers period: December 2006 – December 2009***

Objectives

1. Improve the impacts of rural electrification on poverty alleviation by establishing effective multi-sectoral investment and planning capacities and instruments using GIS as the convening factor.
2. Formulate appropriate policies and instruments to reach this goal by establishing rural electrification master plans for two provinces:
   - ❖ Khammuon (Laos PDR)
   - ❖ Kongpong Cham (Cambodia)

Activities

- Establishment of a national level multisector working group which will work on rural electrification planning issues, articulating multi-sector development, formulate planning objectives and comment on scenario results, provide inputs for developing a national level convening tool;
- Development of a concrete Provincial level rural electrification development programme using the GEOSIM tool and suggest implementation modalities;
- Establishment of Provincial level working groups to validate the Provincial-level rural electrification plans;
- Training courses on data base GIS, Load forecasting; financial and economic analysis; Energy and development links, impacts and indicators; participatory planning…

Coordinator

IED (Innovation Energie Development) – French engineering and consulting firm, Project' Leader. www.ied-sa.fr

European partner

ETC Energy – ETC Energy unit of the ETC Foundation, the Netherlands non-profit organisation. www.etc-energy.org

Subcontractors and national stakeholders

- Cambodian Development and Engineering Company (CDEC), Cambodia;
- SV company, Laos PDR
- Ministry of Industry and Mines (MIME, Cambodia),
- Electricité du Cambodge (EDC),
- Electricity Authority of Cambodia (EAC);
- Rural Electrification Funds (REF, Cambodia),
- Ministry of Energy and Mines (MEM, Lao PDR),
- Electricité du Laos (EDL)

For more information, please visit our website: www.cap-redeo.com

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Intelligent Energy Europe

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RÉPUBLIQUE FRANÇAISE
MINISTÈRE DES AFFAIRES ÉTRANGÈRES

Newsletter No. 1

The first meeting week in Vientiane, Laos PDR, 3rd - 5th April 2007

Geographical Information System in Laos

□ KHAMPHONE SYVONGXAY

THE government will have access to more information to allow the expansion of the electricity grid in rural areas, by using a computerised Geographical Information System.

Yesterday in Vientiane the government agreed to funding for the project from 'Intelligent Energy Europe' and the French Ministry of Foreign Affairs.

It approved the Capacity and Institutional Strengthening for Rural Electrification and Development project to test and implement a pilot project for decentralised energy options in Khammuan province.

Khammuan province has facilities for the generation of electricity through hydropower and solar power, as well as capable human resources.

The project will provide important information for rural electrification planning in the future, said the Director General of the Department of Electricity, Mr Houmphone Bulyaphone.

The project will be tested and implemented in Laos and Cambodia, and will run for two years from 2007-2008.

The objective of the project is to improve the impact of rural electrification on sustainable development and poverty alleviation, using the Geographical Information System.

Both countries will develop their technical capacity and be provided with the hands-on tools to direct investments and decide between off-grid and on-grid options, renewable or fossil fuel off-grid production, as well as priority projects to maximise development.

Training sessions will be organised for a hands-on approach to learning, along with regular meetings with working groups to ensure sharing of knowledge and ownership building.

The GIS-based tool GEOSIM for rural electrification will be developed as a result of the two ASEAN member countries having very low rates of rural electrification.

GEOSIM is a computerised rural electrification planning tool developed by Innovation Energie Developpement of France.

An electricity service plays a key role in rural development, giving access to affordable, reliable and safe electricity which can improve food, education and health services, as well as improving opportunities for income generation.

PHOTO ESSAY — Vientiane Times

out 50 representatives from the Ministry of Energy and Mines attending the Rural Electrification Multi-Criteria Planning using GEOSIM Tool workshop at Lane Xang Hotel in Vientiane yesterday. *--Photo Khamphone*

The Vientiane Times coverage of the CAP-REDEO event, issue 5th April 2007.

Capacity & institutional strengthening for rural electrification and development - Decentralised Energy Option (CAP-REDEO)

Supported by the European Commission through the Intelligent Energy Europe Agency (IEEA) and French Ministry of Foreign Affairs (MAE)

Welcome to the first newsletter of the CAP-REDEO project. This special newsletter focuses on the first meeting week, which was organized in Vientiane, Laos PDR from 3rd to 5th April 2007. The workshop was organized jointly by IED, project coordinator and the Ministry of Energy and Mines (MEM) of Laos PDR, with the assistance from other stakeholders. Three main activities were taken place during this meeting's week (see the meeting's brochure in the annex for more details):

a) Project's consortium kick-off meeting;
b) Workshop "Rural electrification – Multi-criteria planning using GEOSIM tool"; and
c) Training courses on "energy & development links, impacts & indicators" and "database management and GIS".

1. Project's consortium kick-off meeting, 3rd April 2007

The first project consortium meeting was organized on 3 April 2007. About 24 delegations from IED, ETC, MIME, EAC, EDC, MEM, EDL, CDEC, SV Company, participated and made contributions to the kick-off meeting. The objective and topics for discussion of this kick-off is to:

- Kick-off meeting with all stakeholders from Laos & Cambodia to establish *common understanding* of the project conditions, objectives, deliverables, implementation and responsibilities between partners.
- *Project conditions* are : contract, contexts, partners, stakeholders and associates
- *Methodologies*: brief introduction to the method, inputs and outputs, work organisation
- List of *deliverables* and expected date for delivery, format, and contents.
- *Implementation* plan includes time schedule (planning), interactions between tasks,
- *Responsibility* must be clearly identified and agreed on.

After welcome and introduction of the partners and subcontractors, delegations adopted the proposed agenda, and discussed the project objectives. IED presented overview of the work program and "Quick Presentation of GEOSIM software" – a specific tool for rural electrification with GIS database (see annex).

Figure 1: kick-off meeting ambience;

General organization was clarified. Collaboration agreements have been signed with EDC, EDL, MIME, MEM and letters exchanged with REF and EAC.
Delegations also discussed detailed Work Packages. Deliverables and responsibilities were agreed upon.

2. Workshop on "Rural electrification – Multi-criteria planning using GEOSIM tool", 4th April 2007

The workshop was organized on 4th April. The workshop was attended by representatives of Ministry of Energy and Mines of Lao PDR, representative of EU delegation in Vientiane, representatives from national and international stakeholders. In total, **45 delegates** attended the workshop including representative from France, the Netherlands, Cambodia, and Lao PDR.

Figure 2 : Delegations at the workshop

The workshop was opened by Mr. Houmphone Bulyaphol, General Director of Department of Energy (DOE, MEM), who welcomed delegated to Vientiane. He informed the delegations that the governments of Laos have formulated their rural electrification policy as a part of wider rural transformation and poverty alleviation perspective which set very high target on rural electrification. He believes that rural electricity services play a key role in rural development to meet long term development goals by the Lao government. In this context, he finally wished delegates a successful workshop.

A welcoming speech from EU representative in Vientiane, Mr. Mel Jones was addressed to delegates. He stressed the important contribution of the EU and particularly from this project in poverty alleviation millennium goals set by the Lao Government.

The welcoming speech was followed by a presentation from IED - Project coordinator, Ms. Anjali Shanker, who presented CAP REDEO project, its partners, project's objectives and milestones. This was followed by a presentation by Mr. René Magermans from ETC energy, who provided information on ETC and access to energy:

- ETC & Energy programs
- ETC-EASE approaches and practices
- EASE in CAP REDEO

The agenda of the workshop was designed around the main topic for discussion, "GEOSIM - Rural Electrification Planning using Geographical Information Systems". All presentations from Lao delegation and Cambodian delegation were focused on the particular points of the rural electrification planning status, approaches and methodologies in their respective countries.

IED delegation illustrated the GEOSIM approach who takes into account the socio-economic aspects in electrification planning through a series of short country case studies, where the GEOSIM tool has been applied for different approaches in rural electrification planning: *off-grid master plan (**Ethiopia**), internet database tool for sharing information (**Burkina Faso**), regional mini-hydro power development*

*(**Cameroon**), and grid extension component (**Niger**).*

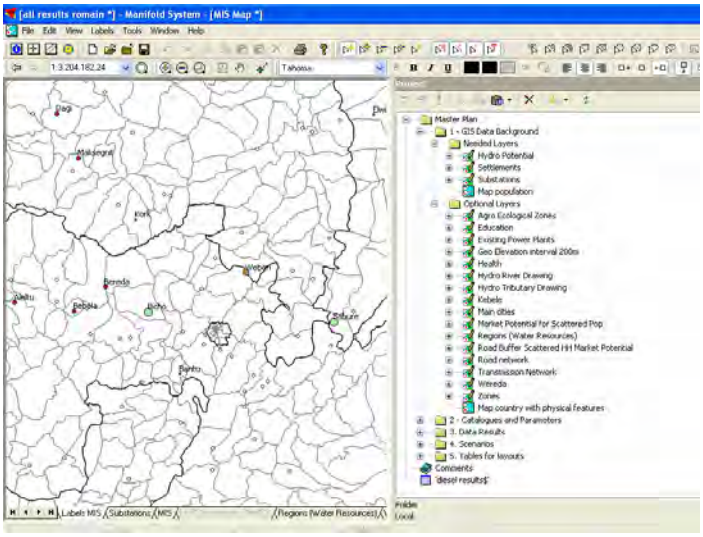


Figure 3 : Example of GEOSIM software under Manifold interface.

Why a GIS-based tool GEOSIM for rural electrification in Cambodia and Lao PDR?

Rural electricity services play a key role in rural development because the access to affordable, reliable and safe electricity can greatly improve food, education and health services, as well as improving opportunities for income generation.

Cambodia and Laos PDR are two members of ASEAN with very low rate of rural electrification. Currently, their respective electrification rates are around 17% and 35%. The governments of Cambodia and Laos have formulated their rural electrification policy as a part of wider rural transformation and poverty alleviation perspective. The target for rural electrification is to reach 70% of Cambodia rural population and 90% of Lao rural population within 20-30 years. To meet these challenges, the policy makers and planners need to analyse the options and perspectives: its supply sources, its main actors and its rural energy market, to show that with the mobilisation of all means and resources, these targets are achievable.

To establish the optimal energy planning scenarios for medium and long terms in a changing environment, the authorities and developers need adapted and powerful tools to take all technico-economical conditions, socio-environment aspects, geographical allocation of supply sources and demand into consideration. Geographical Information System (GIS) based tools are the most adapted for this purpose.

GEOSIM, GIS-based tool developed by IED, covers all aspects of rural electrification planning: load forecasting, technico-economic comparison of various generation options (grid extension, off-grid, renewable), and also development impacts related issues: identification of areas of high development potential, integration of development impact indicators beyond economic and financial indicators. GEOSIM has user-friendly interface and web-base capacity to represent data, indicators and results in geographical dimensions for policy makers and planners to make right and optimal decisions.

Multi-sector and multi-criteria planning approach

The Lao PDR and Cambodia governments have set theirs Millennium development goals (MDG) in a priority order as follows:

1. Eradicating poverty & hunger

2. Achieving (primary) education
3. Promoting gender equality
4. Reducing mortality
5. Improving health
6. Combating disease
7. Ensuring environmental sustainability

To measure the rural electrification impacts on these MDG, the frequent questions have been asked are: What are the issues? What are the objectives? Analysis of the impact: the principal factors?

Classical approach in rural electrification planning is usually based on several steps without integrate multi-sector data or these data were given few attention (*lightweight*) in the planning process. IED has developed a new approach based on a proposition:

- Firstly, by introducing upstream of the module «demand forecasting», a classification of the localities in function of their potential development: Development Poles (or centers) and Other localities
- Secondly, «attach» other localities to the closest development poles.

GEOSIM tries to "internalise" the link between Development Goals and Access to electricity in the R.E. planning process. A more detailed description of the approach is given in the annex of this newsletter.

Overall workshop conclusions

At the last session, the workshop participants have opportunities to exchange information and discussions on practices of rural electrification planning, on GEOSIM methodology. Each delegation has been invited to contribute to the conclusions of the workshop which are summarized herewith:

- There is a general consensus by the participants that the multi-criteria approach proposed in GEOSIM tool is well adapted for the contexts in Lao and Cambodia. However, there are several particularities which the delegates highlighted and that will be taken into account during the implementation (development and application):
    - a strong PV development in Laos (PESCO)
    - a presence of small REE (rural electrification enterprises) in Cambodia.

Lao PDR	Cambodia
6 PESCOs (state companies)➔10-15 in next few year	600-800 REEs (most are licensed, but some do not)
0,1-0,3$/kWh	0,5$-1,2$/kWh
Widely use PV kits	Widely use battery
Mostly SHS, some village hydro & genset	Only diesel but potential for PV, mini-hydro

Figure 4 : a comparative rural electrification contexts between Laos PDR & Cambodia.

- The concerns have been expressed by the delegates that as we work with GIS, the availability and the update of the database are primordial importance. These data are usually not readily available in developing countries. However, the delegations agreed that they will provide all existing data in their possession and assist subcontractors in data collection

from other ministries and organizations

- Delegates recommended that the transfer of technology (software) and knowledge through training and collaboration must be started as soon as possible in order to let the focal points to learn these new approaches and techniques.
- The delegations have expressed their supports and endorsements for the presentations. The delegations thanked to the organizers and the MEM host for a good organization of the workshop, and to IEEA and MAE for their financial supports.

3. Training courses on "Energy & development links, impacts & indicators" and "database management and GIS", 4th – 5th April 2007

The workshop was followed by two training modules on the module B: "Energy and development links, impacts & indicators" and the module A: "database management and GIS".

Total of **15 participants** from MEM, EDL, NUOL, EDC, MIME, EAC & REF have participated on these training modules where the attention has been paid to equilibrium between theoretical and practical exercises.

Figure 5 : Training participants in Vientiane, 5 April 2007.

During the first training module B, the detailed approach on multi-criteria approach in rural electrification planning was presented, focusing on elaboration of the ***"Indicator for Potential Development – IPD"***. The conception of the indicator IPD was based on the UNDP conception of "Human Development Indicator". IPD consists of three main components: Education system, Health system and Local Economy system, which in their turns are consists of different criteria and indicators (see the annex for more details).

$$IPD = 1/3\,(IPD_{health}) + 1/3\,(IPD_{education}) + 1/3\,(IPD_{local\ economy})$$

The participants have learned these new approach, how to elaborate the analytical grid and criteria with practical exercises. However, there are some caveats that need to point out:

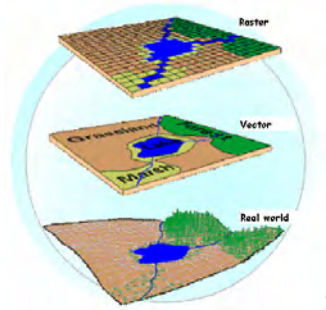
- *Depending on the country's contexts, the proposed criteria, indicators and the weighting systems have to be adapted.*

- *Their elaboration must be taken into consideration the availability of the data in the country*
- *They must be a subject to a multi-sector consent and coordination with other stakeholders.*

The training module A introduced the basic notion of the GIS (Geographical Information System) database, a specific software MANIFOLD on which the GEOSIM software was developed.

During one day, the participants have learned how to structure a GIS Database, GIS database management, specific CAP REDEO data requirement and an Introduction to Manifold software. The trainees have opportunities to do practical exercises on computers with collected real data for Cambodia and Lao PDR: Education data, Health data, Local Economy data.

What is a GIS ?



This term is used because GIS tend to deal primarily with `geographic' or `spatial' features. These objects can be referenced or related to a specific location in space. The objects may be physical, cultural or economic in nature. Features on a map for instance are pictorial representations of spatial objects in the real world. Symbols, colours and line styles are used to represent the different spatial features on the two-dimensional map.

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4. Annexes

Annex 1 – Brochure of the first meeting week in Vientiane 3-5 April 2007

Annex 2 – General Introduction on the GEOSIM© tool and approach

Tuesday 3 April 2007: Kick-off Meeting of CAP REDEO (reserved for consortium members only)

Wednesday 4 April 2007 morning: Workshop (open on invitation)

Session 1: Opening speeches

- European delegation in Vientiane
- Host country – MEM representative
- French Embassy representative

Session 2: GEOSIM - Rural Electrification Planning using Geographical Information Systems (GIS)

Session 3: Discussions and recommendations

Wednesday 4 April 2007 afternoon: Training workshop on energy & development links, impacts & indicators

Thursday 5 April 2007: Training workshop on database management and GIS

The CAP REDEO project: supported by "Intelligent Energy Europe" (IEEA), and French Ministry of Foreign Affaires (MAE)

Capacity and Institutional strengthening for rural electrification and development – decentralised energy options (CAP REDEO) is a program supported by the European Commission in the framework of its program COOPENER, and by the French Ministry of Foreign Affaires.

The global objective of the project in Laos and Cambodia is to improve the impact of rural electrification on sustainable development and poverty alleviation by establishing effective cross-sectoral investment and planning capacities using Geographical Information Systems as the convening factor. Both countries will develop technical capacity and be endowed with hands on tools to direct investments and decide between off grid and on grid options, renewable or fossil fuel based off grid production – and priority projects from the perspective of maximising development impact of scarce resources.

This can only be achieved through a hands-on "learning by doing" approach wherein a focus group will be formed at the National level, and at the Provincial levels. Specific training sessions will be organised. Regular meetings of the working groups will ensure sharing of knowledge and ownership building.

The European coordination is ensured by the Consulting company Innovation Energie Développement (IED, France), and ETC Foundation (ETC, Netherlands) is partner.

The project is essentially articulated through the following:

- ✓ Establishment of a national level multisector working group which will work on rural electrification planning issues, articulate multi-sector development, formulate planning objectives and comment on scenario results, provide inputs for developing a national level convening tool;
- ✓ Development of a concrete Provincial level rural electrification development programme using the GEOSIM tool and suggest implementation modalities
- ✓ Establishment of a Provincial level working group to validate the Provincial level plan;
- ✓ Trained focus groups amongst the associates on:
  - data base structuring, use of Geographical Information Systems; establishment, use and maintenance of a multisector national level data base for rural electrification and development planning
  - techno economic aspects of grid, off grid and renewable energy projects; Load forecasting; financial and economic analysis;
  - energy and development links, impacts and indicators; participatory planning and validation of investment plans;
  - the GIS based planning tool GEOSIM.

CAP REDEO is being implemented in Laos PDR and in Cambodia. In each concerned country, the project CAP REDEO is implemented through close cooperation with local institutions (ministries, utilities, and regulators), private stakeholders, and partnership with local companies.

From 3 to 5 April 2007 Vientiane, Lao PDR

Meeting week:

- Kick off,
- Workshop,
- Trainings

CAP REDEO Capacity and Institutional strengthening for rural electrification and development – decentralised energy options

Coordinator:

Partner:

With the support from

Ministère des Affaires étrangères

&

Intelligent Energy Europe

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Workshop on "Rural electrification Multi-criteria planning using GEOSIM tool"
Vientiane, Laos PDR, April 4, 2007

Coordinator: IED

Partner: ETC ENERGY

Why a GIS-based tool GEOSIM for rural electrification in Cambodia and Lao PDR?

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Detailed Workshop agenda

Wednesday 4 April 2007

8h00-8h30 **Registration**

Session 1: Opening and introduction to CAP REDEO

8h30-9h00 **Opening remarks and welcomes**
Mel Jones, European Commission representative
Houmphone Bulyaphone, General Director, DOE/MEM
Representative of French Embassy

9h00-9h15 **Introduction to CAP REDEO, partners, objectives and milestones**
Anjali Shanker, Director, Innovation Energie Développement (IED)

9h15-9h30 **ETC and "access to energy" programs: approach and practices**
René Magermans, Expert, ETC foundations (ETC)

9h30-10h00 **Coffee break**

Wednesday 4 April 2007 (continue)

Session 2: GEOSIM - Geographical Information Systems tool for Rural Electrification Planning

10h00-10h15 **Rural electrification situation in Laos PDR: planning approaches and practices**
Mr. Houmphone B., General Director, Department of Electricity (DOE / MEM)

10h15-10h30 **Rural electrification situation in Cambodia: planning approaches and practices**
HE Tun Lean, General Director, General Department of Energy (MIME)

10h30-11h00 **GEOSIM – GIS based Rural Electrification Planning tool: approaches**
Denis Rambaud-Measson, Managing Director IED

11h00-12h00 **GEOSIM – GIS based Rural Electrification planning tool: Applications and case studies**
- National level – Ethiopia
- Internet application – Burkina Faso
- Regional development with focus on mini hydro – Cameroon
- Regional development with focus on grid extension - Niger

Cyril Perret, Expert IED

Session 3: Discussion and conclusions

12h00-12h20 **Roundtable discussions and open remarks**

12h20-12h30 **Conclusions by IED**

12h00-14h00 **Lunch**

Intelligent Energy Europe

Capacity & Institutional strengthening for rural electrification & development – decentralized energy option (CAP REDEO)

Supported by the Intelligent Energy Europe Agency (IEEA) and French Ministry of Foreign Affairs (MAE)

General Introduction on the GEOSIM© tool and approach, and applications to date

IED

ETC ENERGY

Contents

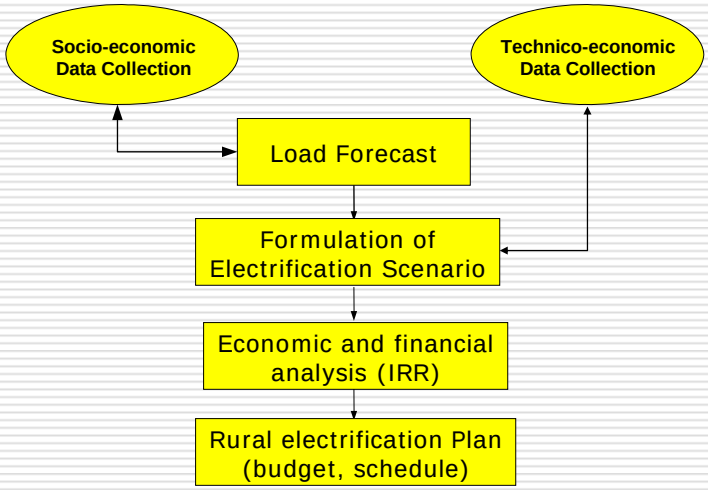
1

Why a new approach for Rural Electrification Planning?

- Historical situation
  - Rural electrification: a “loss making activity” for the national Utilities
  - Existing planning tools: technico-economic optimisation for grid extension
- New context:
  - Access to modern energy access: a pre-requisite for poverty alleviation (WSSD, 2002) and to achieve the MDG
  - End of monopoly situation: multiplication of Rural Electrification operators required coordination of investment

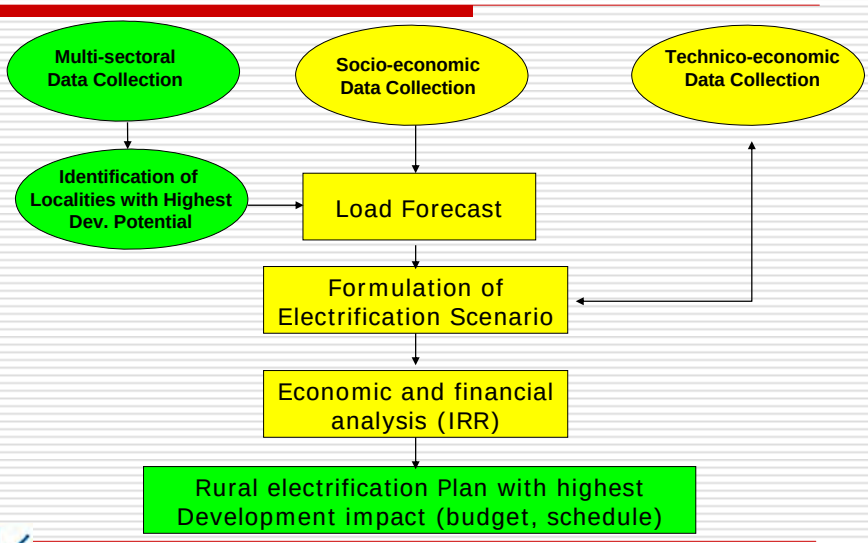
1

Conventional R.E planning



1

New R.E planning



2

GEOSIM©

- **GEOSIM©** is a rural electrification planning tool developed by IED, based on the new paradigm for rural electrification: ***Maximising the potential Direct and Indirect Impact of rural electrification***.
  - Using GIS software
  - Customised in accordance with each Country policy: already been applied in a number of countries (Burkina Faso, Mali, Niger, Cameroon, Ethiopia).

2

GEOSIM©

❹ Integration of isolated supply for social services	Sizing and cost of off-grid standard schemes: Multifunctional platform (motive power) and Solar PV for social services
❸ Least cost Electrification Plan	Load forecast and least cost plan for RE from grid extension and mini grid (isolated or cluster of localities) ; supply from diesel, hydro, biomass
❷ Maximising Development Impact	Selection of localities with Highest Development Potential (Development Centres)
❶ Data collection	Data collection for the GIS database

2

Step 1: Data acquisition

- Compulsory data:
  - Localities (geographic coordinates, population, socio-economic characteristics, electrical status)
  - Existing power grid (HV, MV, power plants,…)
  - Characteristic of hydro sites and biomass potential
- Other layers of information:
  - Administrative boarders (Regions, province…)
  - Social Infrastructures (Education, health, …)
  - Economic activities (agro-industries, market place,…)
  - Other (roads, protect areas, river,…)

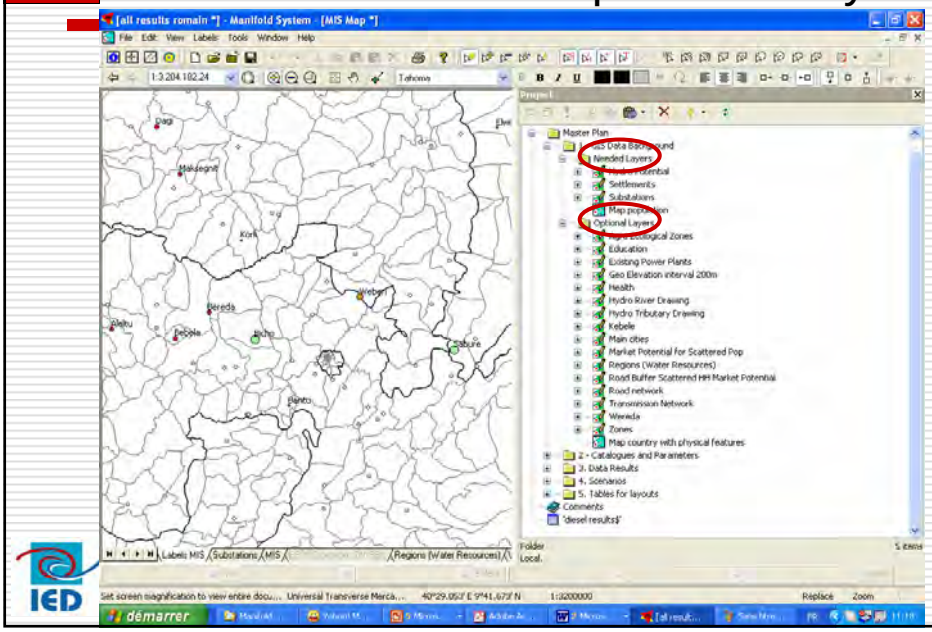
2

Step 1: Data acquisition

- Data collection requires partnership with institutions from other sectors:
  - health, education, rural development,…
- Update should be continuously made: need for continuous collaboration, which will be achieved only if there is a common interest:
  - Exchange of data should be both way
  - Possibility to establish permanent data exchange

2

Step 1: GIS layers



2

Step 2: Development Centres

- In theory, based on an Indicator which reflects the Potential for Development (PDI) of the locality:

$$PDI = 1/3\ (PDI_{health}) + 1/3\ (PDI_{education}) + 1/3\ (PDI_{economy})$$

COMPONANTE	WEIGHT	Example of CRITERIA	WEIGHT [0,1]
HEALTH	1/3	Health infrastructure	1/2
		Drinking water	1/2
EDUCATION	1/3	Adults Alphabetisation	2/3
		% access to school	1/3
LOCALE ECONOMY	1/3	Population in the locality	1/4
		Market	1/4
		Saving & credit facility	1/4
		Distance to the paved road	1/4

EXAMPLE OF SUB-CRITERIA	VALUE [0,1]
No health facility	0
Dispensary	0,2
Health post	0,5
Maternity	0,8
Hospital	1

2

Step 2: Development Centres

- In practice: based on PDI indicators, survey and discussion with local stakeholders

Selected localities (Development Centres)

SPATIAL ANALYSIS MODULE

- **Population cover by each Centres**
- **Hinterlands Cartography**
- **Identification of Localities Isolated from the Centres**

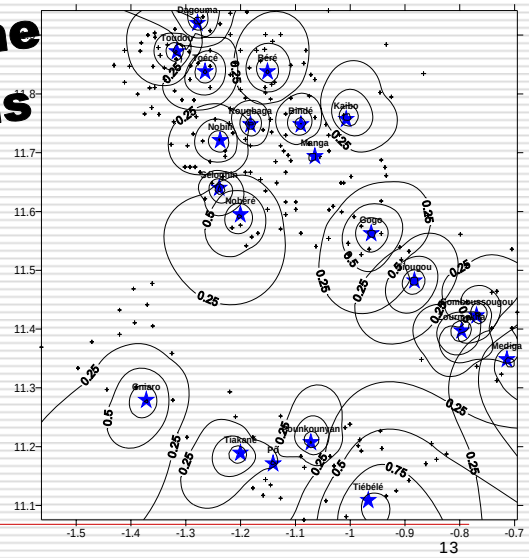
2

Step 2: Development Centres

Illustration of the Spatial Analysis

- **Gravity model: each locality (i) has a probability to attract a locality (j) (HUFF model):**

$$P_{ij} = \frac{\frac{\lambda_i}{d_{ij}^2}}{\sum_k \frac{\lambda_k}{d_{kj}^2}}$$



2

Step 3: Least cost Electrification Plan

- Load forecast scenario
  - 24 hours service
  - 8-12 hours service
- Supply options (grid & mini grid)
  - Grid extension
  - Diesel genset
  - Micro-Hydro
  - *Biomass*

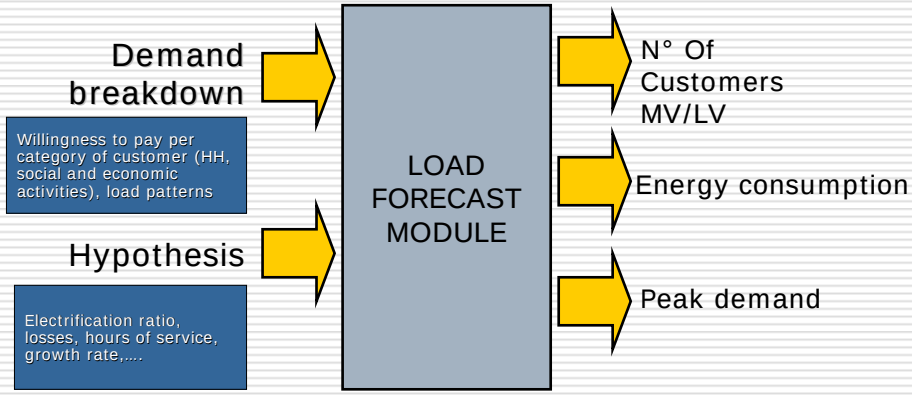
} **isolated localities and cluster of settlements**

- Least cost plan based on €/kWh to supply the Development Centres

2

Step 3: Load forecast module

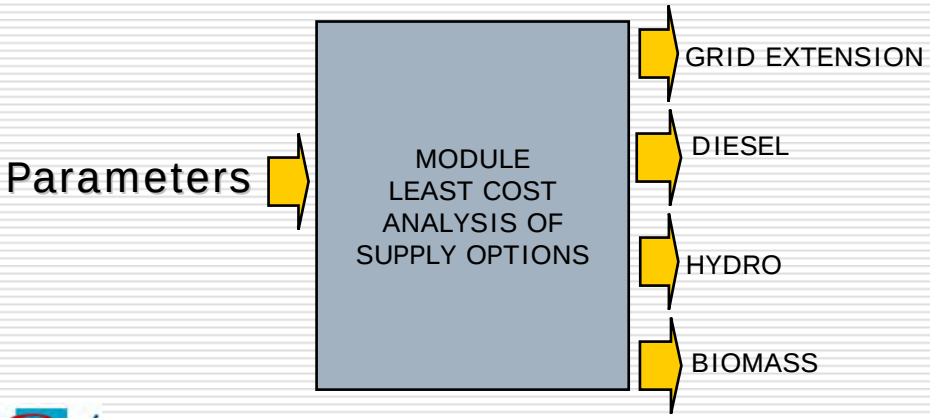
- Objective: to provide key parameters of the load for the whole planning period



2

Step 3: Supply option module

- Least Cost analysis to supply power to Development Centres (isolated or Clusters)



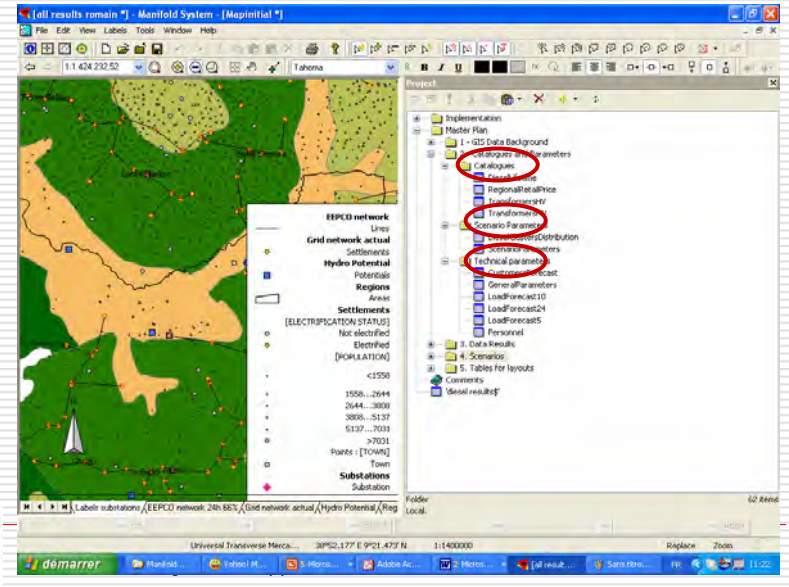
2

Step 3: Key Parameters

- GEOSIM© uses more than 70 parameters (technical, economic and financial) which can easily be adapted by the user.
  - Scenario Parameters
  - Investment Parameters
  - Operation and Maintenance Parameters
  - Socio-economic Parameters
  - Economic and Financial Parameters

2

Step 3: Key Parameters



2

Step 3: Key Parameters

DESCRIPTION	VALUE
Base year (for while cost are valid)	2006
Population year census	1994
Base Population year	2006
Population Annual Growth (%)	2,35
Minimum of Settlement population to be electrified	500
Number of people per HouseHold	4,7
Discount rate for Economic analysis (%)	10
Discount rate for Financial analysis (%)	6
Exchange rate in base year : BIRR per US$	8,827
Foreign Inflation rate (%)	2
Local Inflation rate (%)	4
Diesel price ex Djibouti in base year (US$/bbl)	57,7
Diesel fuel price differential inflation (%)	1
Power purchase price from EEPCO in base year	1
Number of hours of demand per day (5, 10 or 24)	24
Diesel genset and Hydro losses (%)	10
Number of Diesel Gensets to supply the load curve	1
SHP annual availability (%)	75
Annual Diesel fixed O&M cost ratio (%)	4
Annual SHP O&M cost ratio (%)	2
Transformer OM cost in % of investment	2
MV O&M annual cost in % of investment	2
System LV O&M annual cost in % of investment	2
Number of households per LV line km	70
System LV line km cost in base year (BIRR)	79440
MV line km cost in base year (BIRR)	110340
Power house Cost (BIRR)	150000
Willingness to pay in base year (BIRR/kWh)	4,3
Specific fuel consumption for diesel power generatio	0,33
Number of hours in a year	8760

DESCRIPTION	VALUE
Lifetime of LV line	30
Lifetime of MV line	30
Lifetime of SHP	30
Lifetime of transformer	30
Lifetime of power house	30
Maximum lifetime for all machines (year)	8
Low capacity meter price	132,35
High capacity meter price	424,35
Maintenance discount ratio (%)	20
Constant (0) / Current (1) price mode (only 0 or 1)	0
Peak hours per week day (/24)	4
Genset Safety margin (%)	10
Internal settlements MV/LV length line ratio (%)	25
Average Annual personnel salary (BIRR)	6000
Operating cost ratio (%)	50
HV system grid extension cost (%)	20
MV distance coefficient (%)	20
Fuel Transportation cost to Addis Ababa (%)	17
Fuel Delivery cost (BIRR/l)	0,85
Rural electrification occurs in Start Year Phase 1	2006
Stop Year Phase 1	2010
Num Settlements Phase 1	300
Start Year Phase 2	2011
Stop Year Phase 2	2015
Grid connection occurs in year	2025
Num Settlements Phase 2	300
Buffer Grid Limit (km)	100
Buffer Grid Step (km)	20
Hydro Cluster Limit (km)	50
Diesel Cluster Limit (kW)	1000
Diesel Projects Selection	200

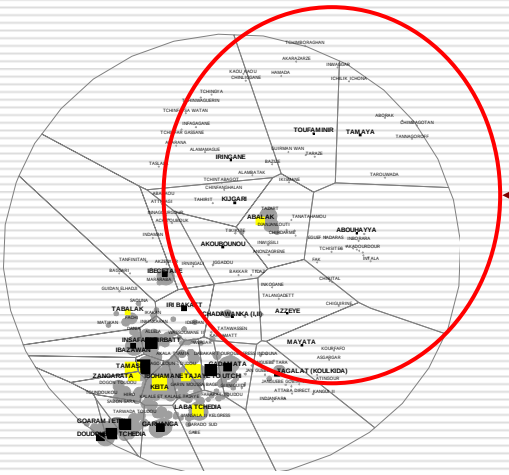
2

Step 4: isolated social services

- Identification of settlements located far away from the Development Centres selected for Electrification
- Investment Plan to provide basic power service to social activities from Multifunctional platform (motive power) and Solar PV located in these isolated settlements:
  - Health Infrastructure
  - Education Infrastructure(primary, secondary schools,...)
  - ...

2

Step 4: Isolated social services



Isolated Settlements

3

GEOSIM© Outputs.

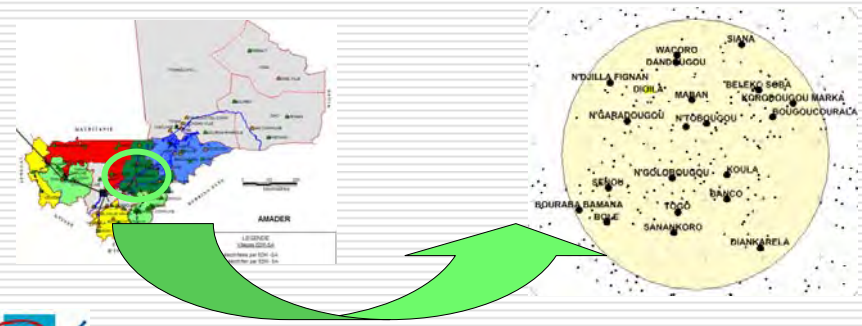
- Investment plans
  - List of projects
  - Classified by supply options (grid extension, hydro, biomass, diesel, isolated)
- Possibility to calculate customised indicators:
  - % of electrified HH
  - Population living in electrified settlement
  - Population within less than “X” km from rural maternity
  - …

3 Example of GEOSIM© application

- In Ethiopia:
  - For the whole country: Off-grid rural electrification master plan (WB)
  - For a pilot area + training of Regional energy bureaus (PDF)
- In Cameroon, Burkina Faso, Mali and Niger:
  - For a pilot area in each country (EC)
  - In Burkina, with an Internet / GIS application with free access: GEONET©

3 Example: Mali

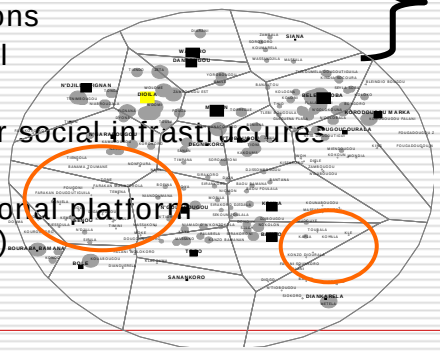
- Study area:
  - 195.000 inhabitants
  - 200 settlements
  - 21 Development Poles (1 already electrified)



3 Example: Mali

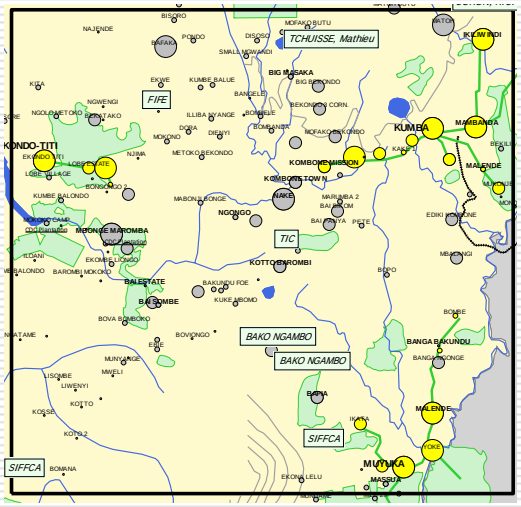
- Key results:
  - Total Investment: 3,4 M€
  - 16 isolated diesel
  - 3 grid extensions
  - 1 cluster diesel
  - 55 Solar PV for social infrastructures
  - 52 Multifunctional platforms (Motive power)

Beneficiaries
49 000
54 000
34 000



3 Example: Cameroon

- Study area:
  - 352.000 inhabitants
  - 138 settlements
  - 12 Development Centers (7 already electrified)



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Example: Cameroon

- Key results:
  - Total Investment: 8,2 M€

Beneficiaries	
2 isolated diesel 4 grid extensions	40 000
1 cluster hydro	31 000
34 Solar PV for social infrastructures	53 000
33 Multifunctional platform (Motive power)	19 000

3

Cameroon: Small hydro cluster

- Total Invest.: 5,9 M€
- SHP capacity: 2 MW
- N° of settlements: 24
- Population: 31000

- PPA will be required to sell extra power to National Utility