Innovation Energie Développement (IED)

CAP-REDEO project

INDICATORS OF RURAL ELECTRIFICATION AND DEVELOPMENT

WORKSHOP REPORT

DELIVERABLE D2C

Intelligent Energy Europe

IED

Deliverable D2c

Contractual References :

IED	: 06/013/CAP REDEO
IEEA	: EIE/06/265/SI2.447980

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Table of contents

A) Annexes: PowerPoint presentations during the Multistakeholder WS
A1. Presentations by MIME
A2. Presentations by EDC,
A3. Presentations by EAC,
A4. Presentations by MEM,
A5. Presentations by EDL,

Background introduction

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 sectorial investment and planning *capacities and instruments* using Geographical Information Systems as the convening factor. The ultimate objective of the present action is that the developed tools outputs provide the required tangible elements for the formulation of appropriate policies and instruments to reach this goal. Hence, the project will:

- Raise awareness among high level decision makers of the important role energy can play in poverty eradication, through fostering of multisectorial working groups;
- Strengthen local energy expertise of the central planners – Ministry, power utility, regulator and of local Provincial authorities in planning methods;
- Demonstrate the energy services for poverty reduction linkages through providing basic infrastructure services and affordable modern income generation opportunities;
- Develop an alternative planning approach for electricity service delivery by emphasising the socio-economic impact of energy service extension, in stead of only relying technical-economic considerations.

In the short term, 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 areas from the perspective of maximising development impact of scarce resources.

In the medium term, the regional plans will help to develop electrification projects, from which the local population will benefit. A more integrated approach will contribute to bring additional investments in the sector in synergy with the recently established Rural Electrification Fund in Cambodia. There are several possibilities for replication and extension of the project outcomes in the other Provinces of Cambodia and Laos and to other countries in the region. 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 and will be hands on involved in implementing of the project. Specific training sessions at Provincial and National level will be organised. Regular meetings of the working groups as open workshops will ensure sharing of exchanges and ownership building.

# I. Energy Indicators for sustainable development

I.1. Links energy & development

Contents

1. Review the links between Energy & Development
2. Energy indicators for sust. dev.
3. Socio-economic impacts from REl. perspectives
4. Introduce new approach for REl. : multi-criteria, multi-sectoral dev. centre of attraction
5. Q&A, Practical exercises

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Sphere of energy planning activities

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4
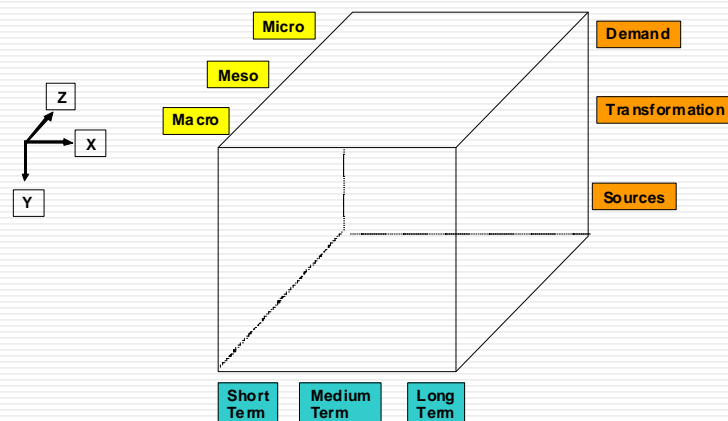
Energy & Dev.

☐ **Energy development** is the ongoing process to provide sustainable, accessible energy resources

- Societies have become increasingly vulnerable in their dependence on external energy sources
- Use of any given energy source in human societies encounters limits to quantitative expansion
- Energy development issues are part of the much debated sustainable dev problem
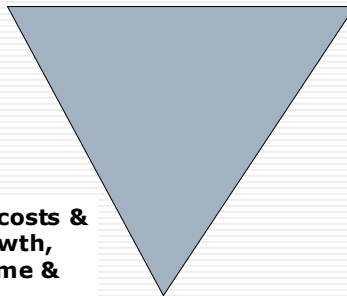

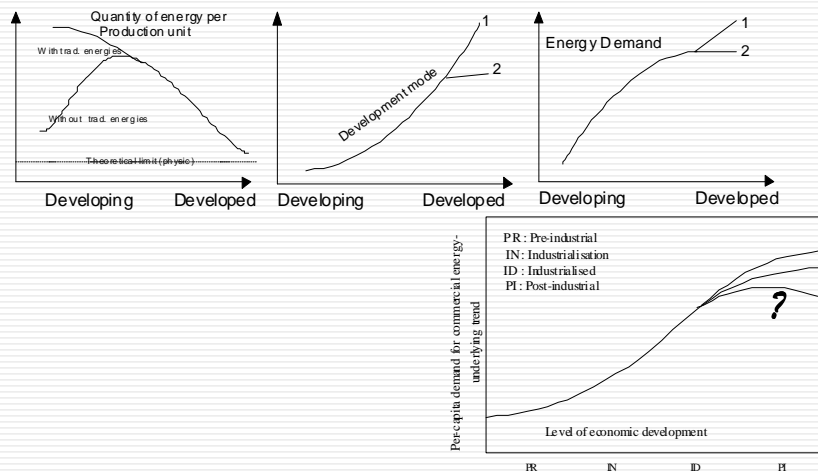# Linkage btwn energy & dev. can be discussed within 3 dimensions

Changes in energy consumption as determined by the dev. path

Social aspects and sustainable development

Impact of energy costs & availability on growth, employment, income & regional dev.

Facts & myths about the links

Quantity of energy per Production unit		Energy Demand
With trad. energies	1	1
Without trad. energies	2	2
Theoretical limit (physic)		
Developing Developed	Developing Developed	Developing Developed

Per-capita demand for commercial energy - underlying trend

PR : Pre-industrial
IN : Industrialisation
ID : Industrialised
PI : Post-industrial

?

Level of economic development

PR   IN   ID   PI

Factors determining changes in energy consumption

- ☐ Different growth rates (structural)
- ☐ Income-induced changes
- ☐ Growth-induced changes
- ☐ Energy price-induced changes
- ☐ Technology progress & substitution
- ☐ Regulations & restrictions

Development leads

☐ Energy consumption depends much on development paths

- ■ Economic structure
- ■ Energy intensity and elasticity
- ■ Urbanization
- ■ Life style

Energy as a constraint to dev.

☐ Non availability of energy resources
☐ Energy costs & prices
- ■ Reduce growth rate
- ■ Productivity
- ■ Employment,
☐ Social aspects
- ■ Well-being
- ■ Regional & social development (edu.)
- ■ Spatial population distribution

Energy Indicators for sustainable dev.

☐ The indicators are not merely data➜

- Provide a deeper understanding of the main issues
- Highlight important relations
- Tools for communication, dialogue
- Taken altogether, they gives clear picture of the whole system, interlinks and trade-off
- As a Measure of progress

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List of energy indicators for sustainable development

☐ Share of households (or population) without electricity or commercial energy

- Theme: Social – Equity
- Sub-theme: Accessibility
- Components:
  ☐ Households (or population) without electricity or commercial energy
  ☐ Total number of households (or pop.)

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List of energy indicators for sustainable development

☐ Share of households income spent on fuel & electricity

- ■ Theme: Social – Equity
- ■ Sub-theme: Affordability
- ■ Components:
  - ☐ Household income spent on fuel and electricity
  - ☐ Household income (total & poorest 20%)

List of energy indicators for sustainable development

☐ Household energy use for each income group and corresponding fuel mix

- ■ Theme: Social – Equity
- ■ Sub-theme: Disparities
- ■ Components:
  - ☐ Energy use per household for each income group
  - ☐ Household income for each income group
  - ☐ Corresponding fuel mix for each income gr.

List of energy indicators for sustainable development

☐ Accident fatalities per energy produced by fuel chain

- ■ Theme: Social – Health
- ■ Sub-theme: Safety
- ■ Components:
  - ☐ Annual fatalities by fuel chain
  - ☐ Annual energy produced

List of energy indicators for sustainable dev.

☐ Energy use per capita

- ■ Theme: Economic – Use & production
- ■ Sub-theme: Overall use
- ■ Components:
  - ☐ Energy use (primary, final, electricity use)
  - ☐ Total population

List of energy indicators for sustainable dev.

☐ Energy use per unit of GDP

- Theme: Economic – Use & production
- Sub-theme: Overall productivity
- Components:
  - ☐ Energy use (primary, final, electricity use)
  - ☐ GDP

List of energy indicators for sustainable dev.

☐ Efficiency of energy conversion & dist.

- Theme: Economic – Use & production
- Sub-theme: Supply efficiency
- Components:
  - ☐ Loss in transformation systems (including losses in electricity generation, trans, & dist.)

List of energy indicators for sustainable dev.

- ☐ Reserves to production ratio
- ☐ Resources to production ratio

  - ■ Theme: Economic – Use & production
  - ■ Sub-theme: Production
  - ■ Components:
    - ☐ Proven recoverable reserves
    - ☐ Total estimated resources
    - ☐ Total energy production

List of energy indicators for sustainable dev.

- ☐ Sectoral Energy Intensities (Ind., Agri., Services, Household, Trans.)

  - ■ Theme: Economic – Use & production
  - ■ Sub-theme: End use
  - ■ Components:
    - ☐ Energy use in each sector
    - ☐ Corresponding value added, or number of household, floor area, or passenger-km, tonne-km

List of energy indicators for sustainable dev.

☐ Fuel shares in energy & electricity; RE share in energy & electricity

- Theme: Economic – Use & production
- Sub-theme: Diversification (fuel mix)
- Components:
  - ☐ Primary energy supply & final consumption, electricity generation by fuel type, by RE
  - ☐ Total primary energy supply, total final consumption, total electricity generation.

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List of energy indicators for sustainable dev.

☐ End-use energy prices by fuel and sector

- Theme: Economic – Use & production
- Sub-theme: Prices
- Components:
  - ☐ Energy prices (with and without tax/subsidy)

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List of energy indicators for sustainable dev.

☐ Net energy import dependency

- ■ Theme: Economic – Security
- ■ Sub-theme: Imports
- ■ Components:
  - ☐ Energy import
  - ☐ Total primary energy supply

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I.2. Impact of rural electrification

Contents

1. Review the links between Energy & Development
2. Energy indicators for sust. dev.
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4. Introduce new approach for REl. : multi-criteria, multi-sectoral dev. centre of attraction
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Part 3

☐ Millennium development goals & REl.

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

R.El impacts?

1. **What are the issues, at stake?**
2. **What are the objectives?**
3. **Analysis of the impact: the principal factor**
   1. **Definition** of the associated conceptions
   2. Questions on « analyse »:
      - ☐ How ?: Analytical methods
      - ☐ When ?: timeframe
      - ☐ Where?: analytical zone (sample)
      - ☐ What ?: field and indicators of the impacts
4. **Conclusions:** which means ?

Strengthen R.El. impacts

- ☐ **Learning in the past**
  - ■ **Why there were weak impacts in the past?**
  - ■ **Incoherencies in the planning and in the implementations?**

- ☐ Historical analysis and desk study on REl impacts
- ☐ Elaborate recommendations for improvement:
  - ■ **In the RE planning:**
    - ☐ Multi-sector planning,
    - ☐ **Regional development planning: Electrification is one of the structural elements**
      - ■ Scenarios of energy demand forecasting,
      - ■ Selections criteria of the locations to be electrified,
  - ■ **In the implementation:**
    - ☐ Supporting measures for projects
   - ☐ Multi-sector coordination

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Strengthen R.El. impacts

- ☐ **Test new measures in the pilot projects (Monitoring)**
  - ■ Supporting measures
    - ☐ Access terms,
    - ☐ Tariff terms,
    - ☐ Development of production activities
  - ■ Coordinated implementation
    - ☐ Ensure inter-sector coordination
    - ☐ Availability of the funds
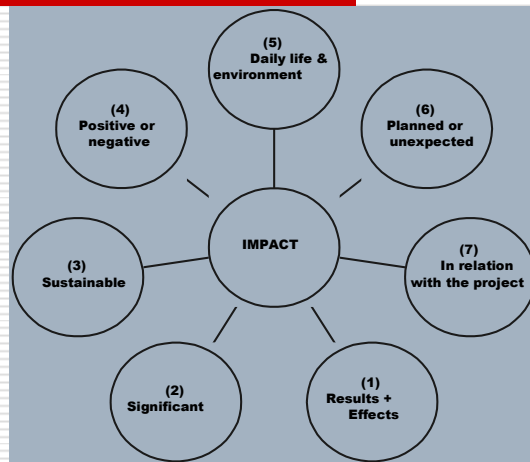 - ■ Monitoring and learning from the experience

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Impact analysis of R.El on poverty: a determinant aspect
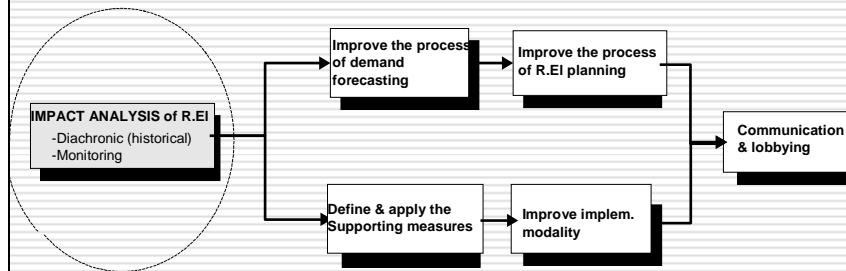
Definition concept to the impact analysis
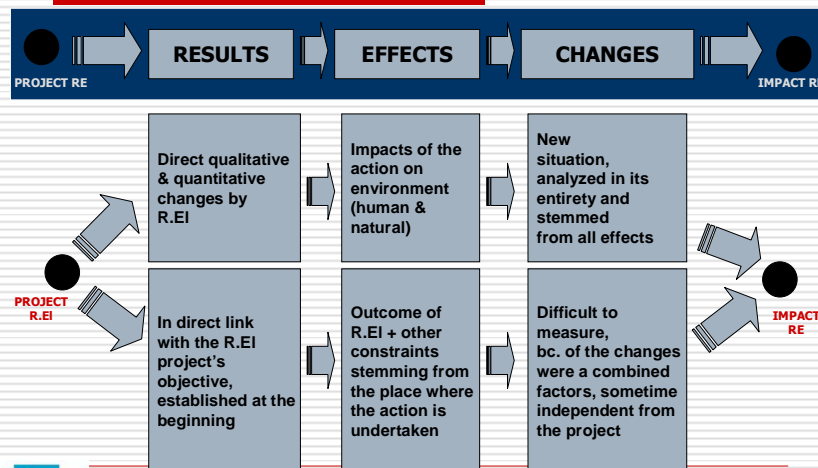
Possible changes from the impact

METHODES
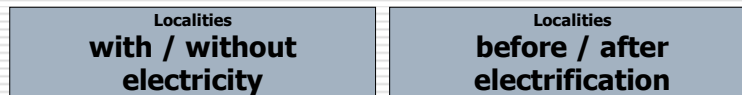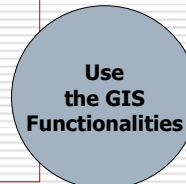
When & where to analyse: time & area
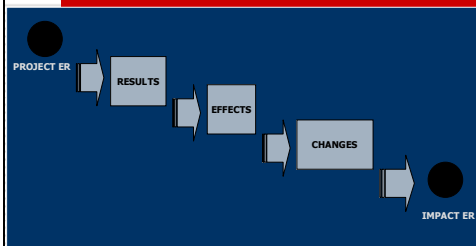
Area:
☐ Homogenous
- Target group (Target: localities electrified)
- Control group (Control: localities non-electrified)

Time:
- Historical analysis (diachronic)
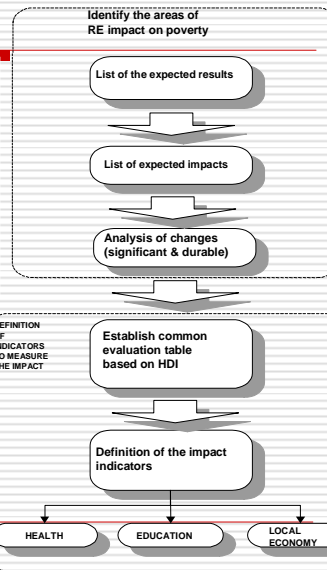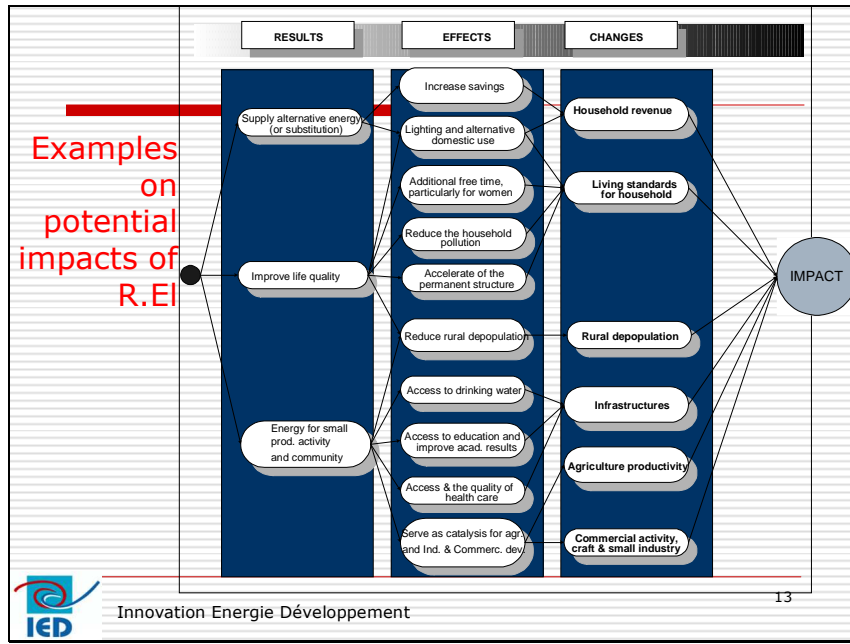- Monitoring of pilot projects (synchronic)

Area & indicators of impact

- **HDI : the Human Development Indicator is composed of three dimensions:**
  - **Long life in good health (life expectancy),**
  - **Access to the education and knowledge (measured by the adult literacy & education rate combined),**
  - **Living standards (measured by real GDP per capita)**

Examples on potential impacts of R.El

RESULTS	EFFECTS	CHANGES

- Supply alternative energy (or substitution)
- Improve life quality
- Energy for small prod. activity and community

- Increase savings
- Lighting and alternative domestic use
- Additional free time, particularly for women
- Reduce the household pollution
- Accelerate of the permanent structure
- Reduce rural depopulation
- Access to drinking water
- Access to education and improve acad. results
- Access & the quality of health care
- Serve as catalyst for agri. and Ind. & Commerc. dev.

- Household revenue
- Living standards for household
- Rural depopulation
- Infrastructures
- Agriculture productivity
- Commercial activity, craft & small industry

IMPACT

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Example on evaluation table based on HDI

HEALTH & SOCIAL WELFARE	EDUCATION	LOCAL ECONOMY
Quality of residential life •Access rate to electricity (penetration rate) •Diffusion of electric equipments •Reduce kerosene & fuel wood •….		**Household incomes** •Spending for household energy •Activity •Household Income •….
Access to drinking water •New source of access •Access rate to drinking water •….	**Access to education** •Number of schools •Rate of children go to school •Adult literacy rate •….	**Agriculture productivity** •Nb of agri cooperatives •Electrified Irrigation systems •Production equipment •….
Access to health care •Number of health centers •Frequentation rate •Diffusion of health care equipment •Vaccination rate •…	**Improve school results** •Success rate in examines •….	**Commercial activity, craft & rural industry** •Commerce, handicraft, industries •Diffusion of electric equipment •… **Rural depopulation**

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Conclusions on socio-economic impacts of R.El

☐ Historical data & statistics (electric, socio-eco.) for a period of time

☐ Pilot program to test new modalities

☐ Resources to ensure data collection and treatment (monitoring) for a period of time

☐ Means to ensure the lobbying at all levels (local, national & international) & improvement of the results along the new R.El projects

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II. GIS Energy database and structures

II.1. Cambodia GIS database

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)

National database, indicators and preliminary results for rural electrification in Cambodia

IED

1

Existing national GIS database

- ☐ MPWT database
  - ■ Geographic maps and village level population
  - ■ Created in 2003
- ☐ NIS (Ministry of Planning)
  - ■ Contains population census 1996 & pop. survey
  - ■ 13 886 villages, but not all have location coordinates
  - ■ Detailed fuel type & light sources by villages
- ☐ Seila database
  - ■ Comprehensive socio-economic database at commune & villages levels (105 attributes)
  - ■ as of the 2004 year

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Existing sectoral GIS database

☐ Medicam database
  ∎ Database on health care system in Cambodia in 2004
  ∎ Covers facility type, personnel, coverage
☐ EDC database
  ∎ On-going
  ∎ Covers EDC areas with power systems details
  ∎ Details for Kampong Cham
☐ EAC database
  ∎ REE facilities and areas
☐ Education database
  ∎ Schools, number of students, classes…
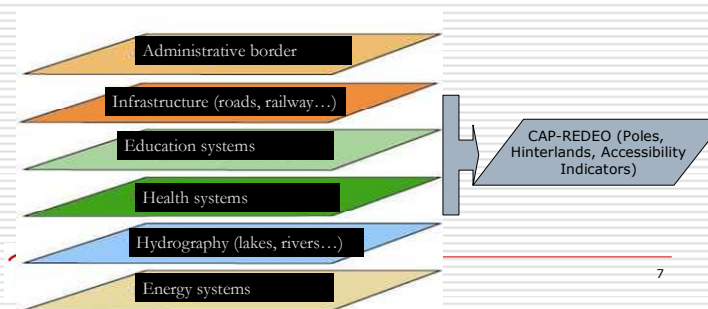
Innovation Energie Développement
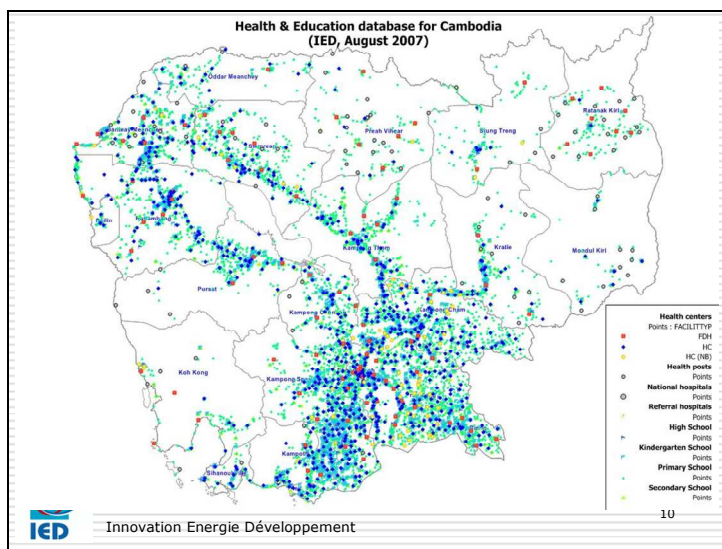
5

Creation of CAP-REDEO database

☐ We completed from different sources
  ∎ In consultation with concerned stakeholders (MIME, EDC, EAC)
  ∎ No data survey at national data
☐ Analyze and update available information
  ∎ Particularly on energy sector data
  ∎ Check geographic coordinate (X, Y) and projection system

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6

CAP-REDEO database

☐ Information are organized into Folders.
☐ Each folder have several thematic layers : each layer contains only one type of information. We will superimpose the layers into one project to produce a map.

Administrative border

Infrastructure (roads, railway…)

Education systems

Health systems

Hydrography (lakes, rivers…)

Energy systems

CAP-REDEO (Poles, Hinterlands, Accessibility Indicators)

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Administrative database of Cambodia
(IED, August 2007)

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Infrastructure database of Cambodia
(IED, August 2007)

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Health & Education database for Cambodia
(IED, August 2007)

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10

Energy sector database for Cambodia
(IED, August 2007)

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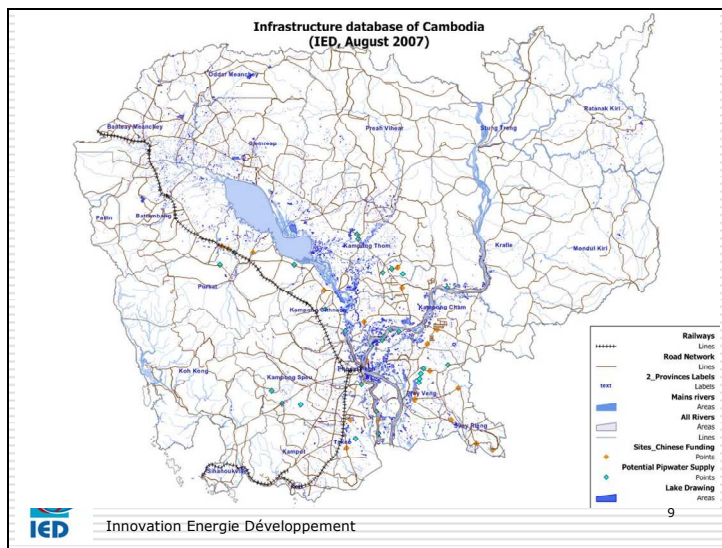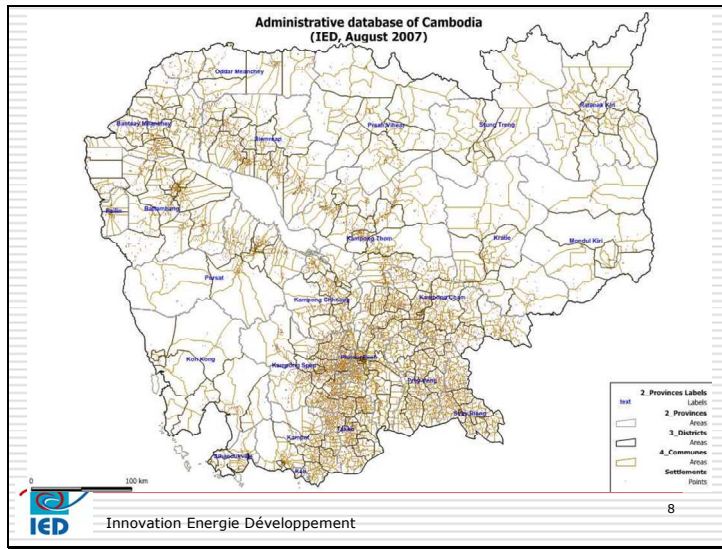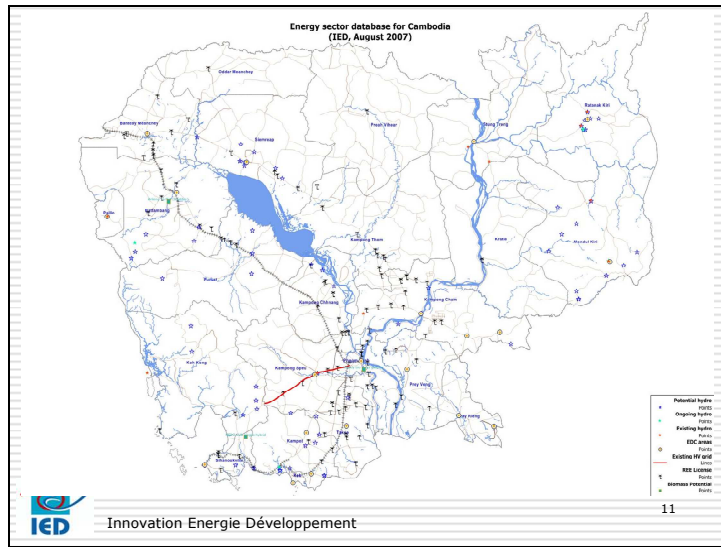
Thematic maps and indicators

☐ Administrative
  ■ Population & Number of households,
  ■ Road distance…
☐ Rural electrification
  ■ Electricity network
  ■ Power generation (diesel, biomass, hydro)
  ■ REE license, customers, installed capacity…
  ■ Village electrified, non electrified
☐ EDC and its control areas
  ■ Network, power plants, substations…
 ■ % of customers, MV & LV density, consumption..

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Name	FAMILY	TOTHH	population	HRS_MARK	KM_ROAD	HRS_ROAI
Chantrea Thmei	8	7	57	25	1,5	10
Spean Kdar	2	3	16	180	0	0
Sameakki Prayutth	5	5	23	30	0,8	8
Ou Pou	126	69	586	90	0	0
Danghet	31	17	85	41	0	0
Thma Ta Daok	12	8	116	180	0	0
Sa La	22	12	90	140	1	10

Thematic maps and indicators

☐ RE indicators at national, provincial, district & commune
  ■ Density,
  ■ % of HH has access to electricity
☐ Multi-sector
  ■ Health center, hospital
  ■ Drinking water systems
  ■ Bank service points, markets…
  ■ School type, number of students

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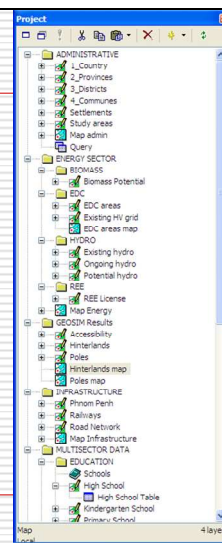
II.2. Lao GIS database

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)

National database, indicators and preliminary results for rural electrification in Lao PDR

IED

1

Existing national GIS database

☐ **National Geographical Department database**
- Administrative maps with some detailed data
- Hydrology
- Not updated since 2001?

☐ **Ministry of telecommunication, transport, post & construction**
- Main roads
- Not detailed as IED database

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4

Existing sectoral GIS database

- Ministry of Education database
  - Database on schools, number of students
  - Not GIS coordinates
- EDL database
  - Covers EDL areas with power systems details but not updated.
  - Details for Khammuon province?
- Ministry of Health database
  - Health centers, drug kits
  - No GIS coordinates, district level.
- Department of internal trade, business & market
  - List of markets
  - Not GIS coordinates

Creation of CAP-REDEO database

- We completed from different sources
  - In consultation with concerned stakeholders (MEM, EDL, …)
  - No data survey at national data
- Analyze and update available information
  - Particularly on energy sector data
  - Check geographic coordinate (X, Y) and projection system

CAP-REDEO database

- Information are organized into Folders.
- Each folder have several thematic layers : each layer contains only one type of information. We will superimpose the layers into one project to produce a map.

Administrative border

Infrastructure (roads, railway…)

Education systems

Health systems

Hydrography (lakes, rivers…)

Energy systems

CAP-REDEO (Poles, Hinterlands, Accessibility Indicators)

Administrative database

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Lao PDR
Population 6135000
Population density 26.7hab/km²
Electrified household 42.81%
Electricity cons. 147.3kwh/hab.

1_country label / Solar Home systems 2 / SHS OPS / SHS JICA / 1_Country / 2_Provinces / 3_D

Infrastructure database

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rs Internet / Main roads internet / Mekong River / Nbca 2000 / Reservoir4_221004 Drawing / Rivers /

Energy sector database

Innova

Hydropower plants
inst_cap MW
               <16.0
16.0...46.0
46.0...70.0
70.0...100.0
100.0...180.0
>180.0
Substations
   Points
SHS OPS
   SHS
22 kv lines
   Lines
35 kv lines
   Lines
115 kv lines
   Lines

other powerplants / Hydropower plants / SWS network / Substations / SHS OPS / 22 kv lines / 35 kv lines / 115 kv l

Thematic maps and indicators

- □ RE indicators at national, provincial, district & commune
  - Density,
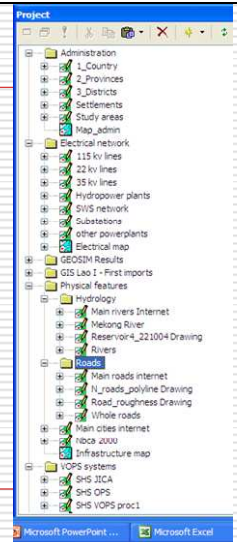 - % of HH has access to electricity
- □ Multi-sector
  - No database at national level
  - At Khammuon province we have multisector data : markets, schools, number of students, health centers

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Thematic map : Spatial distribution of % of electrified households by provinces

Number of Hh electrified
Number of household
2_%hh electrified
Areas : %hh_elect
- <15.00
- 15.00...28.00
- 28.00...32.00
- 32.00...38.00
- 38.00...51.00
- >51.00
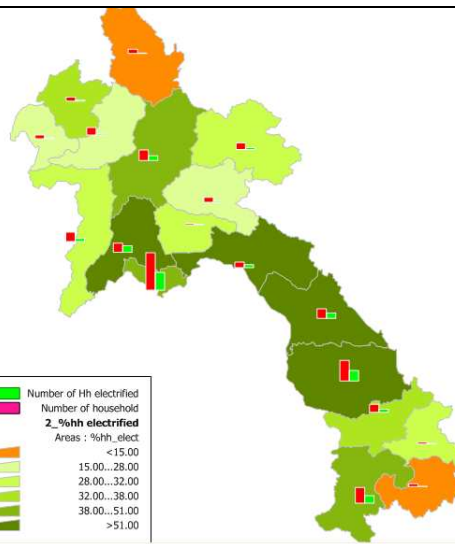
Innovation Ene

Thematic map : Spatial distribution of % of electrified households by districts

3_%hh electrified
Areas : %hh_elect
- <10.00
- 10.00...25.00
- 25.00...38.00
- 38.00...53.00
- 53.00...75.00
- >75.00

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Thematic map : Spatial distribution of % of electrified households by villages

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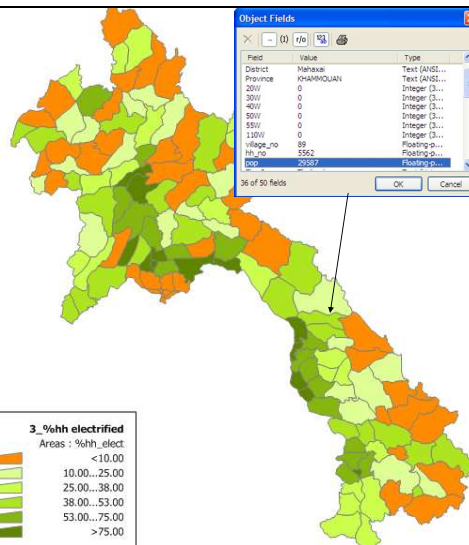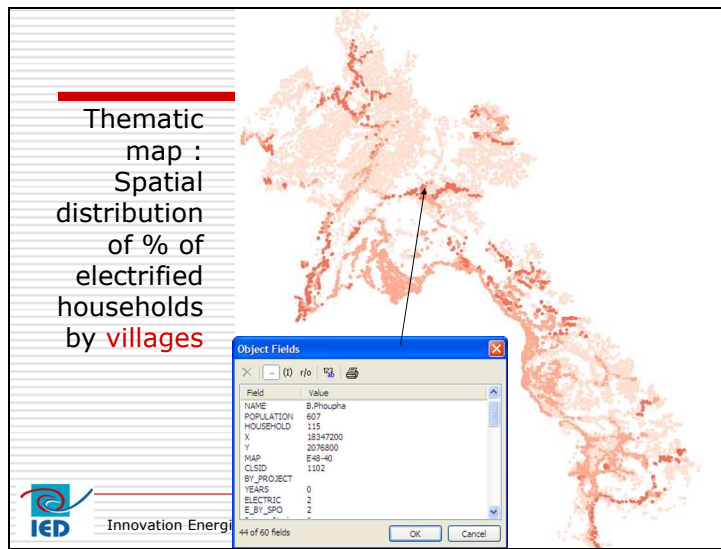
Use of these database

☐ They are first steps in development, RE planning & policy dialogue

☐ Coordinating & aid-decision tool for policy makers

☐ Serve base for **spatial analysis**
- Potential development, IPD
- Covered population
- Hinterland, accessibility

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III. Indicator for Potential Development (IPD) concepts and Development Poles (DP)

III.1. Analytical background

How to integrate multi-sector data in the R.El planning process?

☐ Multi-sector data were given few attention (lightweight) in the planning process ??

Proposition:

☐ **Firstly, by introducing upstream of the module «demand forecasting», a _classification_ of the localities in function of their potential development:**
- **Development center**
- **Other localities**

☐ **Secondly, «attach» other localities to the closest development center.**

Proposed approach on integrated R.El planning with social & economic impacts

- Data collection (multi-sector)
- Data collection (socio-eco)
- Data collection (technologies & costs)
- Calculate PDI of the localities
- Priority of the localities
  - Development centers (DC)
  - Other localities (OL)
- Demand forecasting By cluster (DC + OL)
- Elaboration of scenarios
- Eco-Fin analysis of scenarios
- Electrification plan - budget; - IRR
- Electrification plan - Impacts

Basic concept to construct clusters around dev. centers

- ☐ Attach the «other localities» to one locality identified as High potential development is based on:
  - ☐ Notion development center (poles) and its hinterland
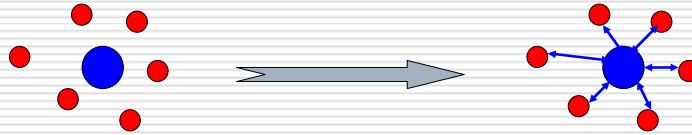
  - ☐ Optimization of power system (by demand)

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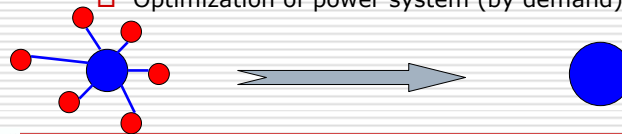
Schema on how to construct the clusters around the DC
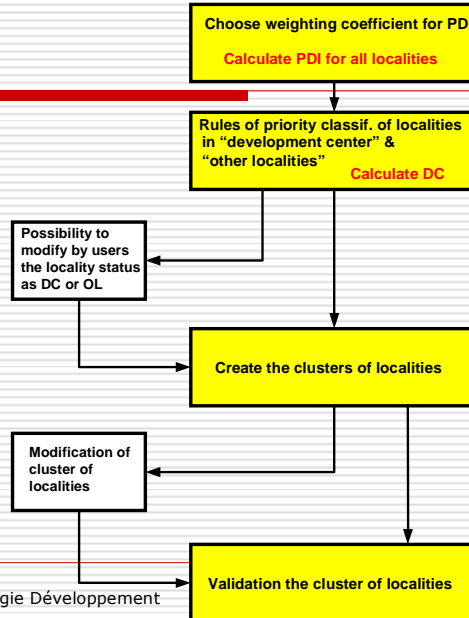
Choose weighting coefficient for PDI

Calculate PDI for all localities

Rules of priority classif. of localities in "development center" & "other localities"   **Calculate DC**

Possibility to modify by users the locality status as DC or OL

Create the clusters of localities

Modification of cluster of localities

Validation the cluster of localities

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Slide 24

Priority order of localities in «DC» et «OL»

Calculate Potential Development Indicator (PDI)

Example on weighting coefficients for PDI

Health care center	Maternity ward & hospital	1
	Health center	0,5
	No service	0

Schools	Secondary & +	1
	Primary	0,5
	No school	0

Local eco. activity	Daily market	1
	Non-regular market	0,5
	No market	0

Access roads	Year-round access	1
	Seasonal access	0,5
	No access	0

Calculate PDI for each locality

Slide 25

exercise

PDI =

$$\frac{1}{3}(PDI_{health})$$
$$+ \frac{1}{3}(PDI_{education})$$
$$+ \frac{1}{3}(PDI_{local\ economy})$$

$$PDI = \sum_{criteria}(weighting * value)$$

Priority order of localities in «DC» et «OL»

Calculate Potential Development Indicator (PDI)

Example on classification rules for localities

Minimum Population for DC	1000

All the admin centers are "DC"

Minimum number of "DC" in each region	20

Minimum number "DC" in each region	Function of index on poverty

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Example - health

Element	weight	criteria	weight	indicators	value	Ex.
Health	1/3	Health care center	1/2	*No service*	0	
				Basic structure (first aide)	0.2	
				Maternity ward	0.4	0.4
				Centre without surgery	0.4	
				Centre with surgery equip.	0.5	
				Hospital	1	
		Drinking water	1/2	*Water network*	1	
				Drinking fountain	0.5	0.5
				Well	0.2	
				Other	0	

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Example - education

Element	weight	criteria	weight	indicators	value	Ex.
Edu.	1/3	Adult literacy	1/2	*No training center and no system*	0	0
				existing structure	1	
		School rate	1/2	*Primary*	1/3	
				Secondary	1/3	1/3
				High school	1/3	
				No school	0	

Example – local economy

Element	weight	Criteria	weight	indicators	value	Ex.
Local eco.	1/3	Pop of the locality	2/9	*0-500*	0	
				500-1000	0.2	0.2
				1000-3000	0.5	
				More 3000	1	
		Pop of hinterland	1/9	*No hinterland*	0	
				1-2000	0.2	0.2
				2000-5000	0.3	
				5000-20000	0.5	
				More 20000	1	

(continue) Example – local economy

Element	weight	Criteria	weight	indicators	value	Ex.
Local eco.		Market	2/9	*Permanent market*	1	
				Weekly market	0.1	0.1
				Occasional market	0.05	0.05
				No market	0	
		Credit & saving points	2/9	*Branch of credit bank*	1	
				Village financing services	0.6	
				No service	0	0
		Close to the road	1/9	*0 km*	1	
				1-5 km	0.5	0.5
				More 5 km	0	

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Demo example

□ PDI $_{heath}$ = (0.4*1/2)+(0.5*1/2) = 0.45

□ PDI $_{edu}$ = (0*1/2)+(0.33*1/2) = 0.165

□ PDI $_{local\ economy}$ = (0.2*2/9)+(0.2*1/9)+ (0.15*2/9)+ (0*2/9)+(0.5*1/9) = 0.15

□ PDI $_{village}$ = 1/3*0.45 + 1/3*0.165 + 1/3*0.15 = 0.255

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Summary on PDI approach

☐ Notion on PDI to classify the localities on priority order in function of the impacts ➔ Applicable for whole country, one region, an area, one province…

☐ PDI is a composite index with the value = 0 - 1. Its conception is based in HDI

☐ **The Development Centers (DC) are those localities that have highest values.**

☐ DC are classified by order of priority, following their calculated values

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Some caveats

☐ The elements, criteria, indicators and the weighting systems to be elaborated depending on the country's contexts

☐ 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

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Alternative approach 1 – "gravity module"

□ **From our Assessments & experiences: the data are not always available for the whole entity**

□ **Alternative approach 1 ➜ Classification by the "GRAVITY MODULE"**
- Each DC has a attraction (magnet) on one locality in its surrounding zone

- This attraction is depending on
  □ In inverse proportion to the distance *d* between them
  □ In proportional to the "gravity" *λ* of the DC

- It is possible to determine the probability of the "gravity" by DC to a locality
- The surrounding areas identified by the approach territory are DC's HINTERLAND

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Gravity module

□ Model HUFF: probability of gravity of locality (j) by the DC (i)

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

□ Can be calculated for all points j ➜ iso-curve with equal probability

□ The DC the most important is the one that has the most population is covered

$$POP_{couv_i} = \sum_j P_{ij} \times POP_j = \sum_j \frac{\lambda_i}{d_{ij}^2 \displaystyle\sum_k \dfrac{\lambda_k}{d_{kj}^2}} POP_j$$

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Example on hinterland by "gravity module"
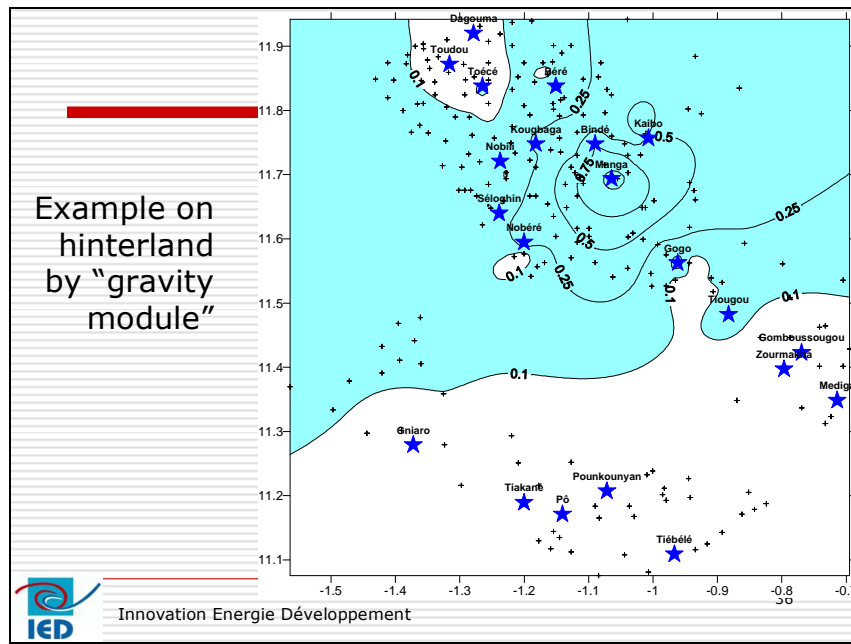
Alternative approach 2 – "Semi-automatic selection"

□ **Alternative approach 2 → Classification by the "SELECTION"**
  ■ From the available database → a number k of DC are pre-identified based on the minimum criteria
  ■ The list is then completed with the propositions by local players
  ■ A socio-economic study allow to validate or not these pre-identified

□ Flexible, with a possible of manual intervention

III.2. Adopted analytical grid for Cambodia and Lao PDR

Adopted analytical grid

- ☐ Based on our approach on IPD (Indicator of Potential Development)
- ☐ It must be simple and quantifiable values
- ☐ Depending much on GIS data availability
- ☐ In consultation with local stakeholders (Education, planning,…)

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III.2.1. Adopted analytical grid for Cambodia

Adopted indicator & values of Health system to elaborate IPD

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Criteria	indicators	value
Health point	Exist	0,1
Health center	Exist	0,3
FDH	Exist	0,7
National hospital	Exist	1
Pipe water (number of houses with access to piped water)	1-100	0,2
	100-500	0,4
	500-1000	0,6
	>1000	1
H20_HOUSE (number of houses with private pump well or ring well, usable year around)	1-100	0,2
	100-500	0,4
	500-1000	0,6
	>1000	1
H20_150M (number of houses with communal tap, pump well or ring well, usable year around)	1-100	0,1
	100-300	0,2
	300-500	0,6
	>500	1
H20_OTHER	1-200	0,2
	200-500	0,4
	500-1000	0,6
	>1000	1

Adopted indicator & values of Education system to elaborate IPD

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criteria	indicators	value
Kindergarten students	1-30	0,1
	30-100	0,5
	100-200	0,6
	>200	1
Primary school students	1-100	0,1
	100-500	0,5
	500-1000	0,6
	>1000	1
Secondary school students	1-100	0,1
	100-500	0,5
	500-1000	0,6
	>1000	1
High school student	1-100	0,1
	100-500	0,5
	500-1000	0,6
	>1000	1
Kindergarten	Exist	0,1
Primary school	Exist	0,3
Secondary school	Exist	0,7
High school	Exist	1

III.2.2. Adopted analytical grid for Lao PDR

Adopted indicator & values of Health system to elaborate IPD

HEALTH

Element	weight	sub-criteria	weight	indicators	value
Health	1/3	Health center type A	1/6	No	0
				Exist	0,8
		Health center type B	1/6	No	0
				Exist	0,5
		Hospital	1/6	No	0
				Exist	1
		Drug kits type A	1/6	No	0
				Exist	0,2
		Drug kits type B	1/6	No	0
				Exist	0,1
		number of villages covered by health center	1/6	1-4	0,3
				5-8	0,5
				9 - 12	0,75
				More 12	1

Adopted indicator & values of Education system to elaborate IPD

EDUCATION

Element	weight	criteria	weight	indicators	value
Education	1/3	Primary school's students	1/2	1-100	0,2
				100-400	0,5
				400-800	0,8
				>800	1
		Secondary school's students	1/2	1-100	0,2
				100-400	0,5
				400-800	0,8
				>800	1

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Adopted indicator & values of Local economy to elaborate IPD

Local Economy

Element	weight	criteria	weight	indicators	value
Local Economy	1/3	Population of the locality	4/10	1-500	0,2
				500-1500	0,5
				1500 - 4000	0,75
				>4000	1
		MARKET nearby	3/10	Permanent (big)	1
				haft permanent	0,7
				rural (small)	0,3
				ational check point	0,6
				local check point	0,3
				Future market	1
		Distance to road, km	3/10	0-1	1
				1-5	0,5
				>5	0,1

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III.3. IPD & Development poles

Identified Development Poles for Cambodia rural electrification

90 Development Poles identified for Cambodia rural electrification

Development poles are those who have highest IPD

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Hinterlands & population covered

☐ **Hinterland gives an estimate of the potential influence of a Development Pole on a given territory**
- It is a probabilistic method which tries to assess the potential preference of a population towards a Pole as a function of its perceived usefulness and ease of access, **compared to the usefulness and ease of access to other Poles**.

☐ We can use these probabilities to calculate the average population benefiting from the electrification of a Pole
- Priority must be given to Development Poles which have the largest « **population covered** », i.e. number of inhabitants of the Pole and its hinterland potentially benefiting from social and economic services offered by the Pole
- Poles will be ranked according to their population covered

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Hinterlands & accessibility for rural electrification in Cambodia

Hinterlands of a poles

Accessibility area

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List of development poles

Province	District	Commune	Name	pop	POPCOUV	RANK	IPD
Phnom Penh	Chamkar Mon	Boeng Trabaek	Phum1	877	672108	10	0,472
Kandal	Ta Khmau	Ta Khmau	Ta Khmau	7435	256972	20	0,523
Siem Reap	Siem Reab	Sala Kamraeuk	Voat Bour	4723	216094	30	0,486
Kandal	Kaoh Thum	Preaek Thmei	Preaek Ta Duong	2748	199059	40	0,483
Prey Veng	Kampong Trabaek	Prasat	Prasat	2608	195572	50	0,467
Prey Veng	Kampong Trabaek	Prasat	Chambak	1738	193680	60	0,472
Pursat	Bakan	Ou Ta Paong	Ou Ta Paong	1682	186580	70	0,534
Takeo	Bati	Souphi	Tram Khnar	2284	184347	80	0,534
Kampong Cham	Ponhea Kraek	Kandaol Chrum	Kandaol Chrum	846	179036	90	0,475
Siem Reap	Siem Reab	Sala Kamraeuk	Voat Svay	4316	176775	100	0,461
Takeo	Samraong	Lumchang	Prasiek	1237	176328	110	0,456
Takeo	Bati	Chambak	Seiha	1800	175925	120	0,461
Kandal	Ta Khmau	Ta Khmau	Preaek Samraong	6941	175488	130	0,478
Battambang	Battambang	Svay Pao	Preaek Moha Tep	5990	173937	140	0,509
Battambang	Battambang	Svay Pao	Kammeakkar	5516	171695	150	0,568
Kampong Thom	Stueng Saen	achar Leak	Achar Leak	1962	170853	160	0,487
Kampong Cham	Prey Chhor	Chrey Vien	Prey Totueng	3085	170200	170	0,605
Kandal	Kien Svay	Kokir	Tuol Tnaot	4809	169020	180	0,554
Kampot	Angkor Chey	Tani	Pral	2358	167564	190	0,593
Kampong Speu	Samraong Tong	Voa Sa	Chambak	1713	166475	200	0,464
Banteay Meanchey	Serei Saophoan	Kampong Svay	Kampong Svay	6776	166423	210	0,568
Kampong Speu	Basedth	Pou Angkrang	Trapeang Kak	1217	164991	220	0,461
Kampong Speu	Samraong Tong	Roleang Kreul	Angk Metrei	648	162929	230	0,475
Kampong Speu	Odongk	Khsem Khsan	Bat Doeng	1354	161230	240	0,491
Kandal	S'ang	Preaek Koy	Preaek Run	3401	159015	250	0,480
Kandal	Kien Svay	Kbal Kaoh	Preaek Thum	4480	157310	260	0,487
Kampong Cham	Kang Meas	Peam Chi Kang	Peam Chi Kang	1124	156849	270	0,593
Kandal	S'ang	Traeuy Sla	Preaek Pan	1896	156002	280	0,482
Kampong Cham	Tboung Khmum	Roka Po Pram	Trapeang Ruessei	4172	154737	290	0,509
Prey Veng	Kampong Leav	Kampong Leav	Phum Bei	2118	154680	300	0,510

Remaining issues

☐ Validate the list of Development Poles

- Validate "Analytical grid"

☐ Regular update & check

☐ We can develop a internet interface for easy access & policy decision

☐ How to integrate into planning process for rural electrification in Cambodia

☐ Customize specifications for Cambodia

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□ However, due to availability data for the whole country, only the population is used for elaboration of IPD, Covered population

□ Above analytical grid will be used for pilot RE planning in Khammuon province

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Step 1: Identify Development Poles for Lao rural electrification

Development poles are those who have highest IPD

Development Poles for Lao rural electrification

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Step 2: Hinterlands & population covered

- **Hinterland gives an estimate of the potential influence of a Development Pole on a given territory**
  - It is a probabilistic method which tries to assess the potential preference of a population towards a Pole as a function of its perceived usefulness and ease of access, **compared to the usefulness and ease of access to other Poles**.

- We can use these probabilities to calculate the average population benefiting from the electrification of a Pole
  - Priority must be given to Development Poles which have the largest « **population covered** », i.e. number of inhabitants of the Pole and its hinterland potentially benefiting from social and economic services offered by the Pole
  - Poles will be ranked according to their population covered

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Hinterlands & accessibility for rural electrification in Laos

Hinterlands of a poles

Accessibility area

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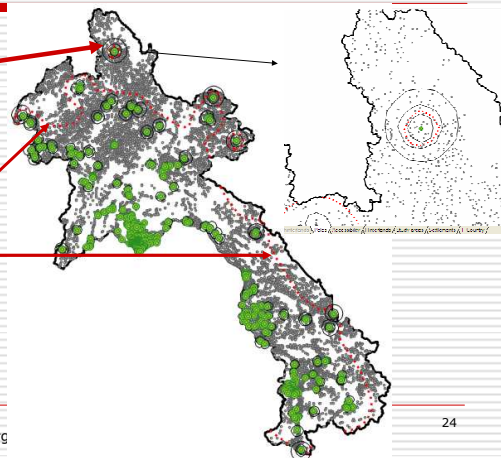
List of development poles

NAME	POP	HH	ELECTRIC	POPCOUV	ACCESSIBILITY	PREELEC	RANK	POLE	IPD
B.Viangmai	1332	223	1	103226	7708,438	FALSE	10	TRUE	1
B.Muangnga	1561	226	1	101630	6780,257	FALSE	20	TRUE	1
B.Phabat	1316	225	1	99147	7305,335	FALSE	30	TRUE	1
B.Thatlouang	1608	243	1	98857	7183,652	FALSE	40	TRUE	1
B.Non-Hin-He	1648	0	1	91046	3576,473	FALSE	50	TRUE	1
B.Nakham	1648	281	1	87283	3579,49	FALSE	60	TRUE	1
B.Donmalai	1515	262	1	85393	2741,479	FALSE	70	TRUE	1
B.Nam-Hon	1428	217	1	82125	2760,268	FALSE	80	TRUE	1
B.Napapha	1859	335	1	65062	2867,462	FALSE	90	TRUE	1
B.Ton-Hen	1319	183	1	59595	2816,276	FALSE	100	TRUE	1
B.Xanakham-Tai	1791	300	1	59244	5579,269	FALSE	110	TRUE	1
B.Champa	1357	178	0	59209	3052,491	FALSE	120	TRUE	1
B.Donxai	1324	233	1	59100	3058,802	FALSE	130	TRUE	1
B.Xanakham-Nua	1546	302	1	58791	5581,724	FALSE	140	TRUE	1
B.Phapoun	1396	222	1	58630	11965,78	FALSE	150	TRUE	1
B.Simuang	1679	260	1	58623	12595,68	FALSE	160	TRUE	1
B.Simoungkhoun	1431	197	1	58580	11756,23	FALSE	170	TRUE	1
B.Phak-Itou	1504	274	1	58534	2815,388	FALSE	180	TRUE	1
B.Keng	1330	218	1	58515	6146,936	FALSE	190	TRUE	1
B.Phouleng-Kang	1400	219	0	58450	2770,758	FALSE	200	TRUE	1
B.Boung	1561	243	1	58419	10465,09	FALSE	210	TRUE	1
B.Nalouam	1962	395	0	58268	2770,98	FALSE	220	TRUE	1
B.Natha	1679	260	1	58185	7483,127	FALSE	230	TRUE	1
B.Don-Mai	1320	223	1	58016	12089,74	FALSE	240	TRUE	1
B.Pakpang-Nua	1323	276	1	56407	2889,406	FALSE	250	TRUE	1
B.Kiouken	1555	314	0	54181	2756,178	FALSE	260	TRUE	1
B.Naphek-Gnai	1646	221	1	54173	2773,429	FALSE	270	TRUE	1
B.Nonsavang	1358	250	1	51192	2775,061	FALSE	280	TRUE	1
B.Phonmouang	1463	210	1	46498	2889,601	FALSE	290	TRUE	1
B.Laosouligna	1913	269	1	46121	2893,702	FALSE	300	TRUE	1
B.Kadan	1665	262	1	44079	2968,825	FALSE	310	TRUE	1
B.Nakasang	1649	293	2	43466	2737,265	FALSE	320	TRUE	1
B.Thensaban	1402	224	0	42678	2774,576	FALSE	330	TRUE	1
B.Mokmeuy	1326	209	0	42166	2981,804	FALSE	340	TRUE	1

Remaining issues

- ☐ Validate the list of Development Poles
  - ■ Validate "Analytical grid"
- ☐ Regular update & check
- ☐ We can develop a internet interface for easy access & policy decision
- ☐ How to integrate into planning process for rural electrification in Lao PDR
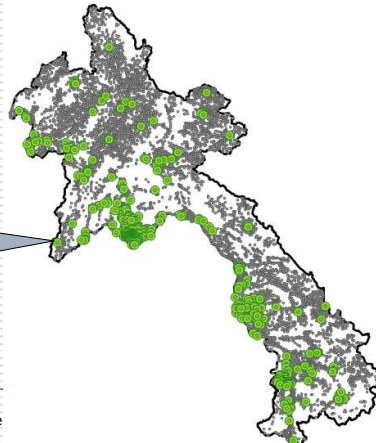- ☐ Customize specifications for Lao PDR

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