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DEVELOPMENT OF THE REDEO TOOL

Center for Energy and Processes (CEP)

1. Hardware and software requirements
2. Technical structure and choices
3. Installation instructions
4. Guidelines
5. Further improvements

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1. Hardware and Software requirements

SOFTWARE REQUIREMENTS

- **REDEO tool is based a GIS platform :**

MANIFOLD

- **REDEO runs on Win XP – (does not support NT, 9x or Me).**
- **REDEO requires Microsoft .NET Framework 1.1.**
- **REDEO uses Microsoft Internet Explorer 5.01 (but you may use whatever browser you like)**

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1. Hardware and Software requirements

MANIFOLD 6.00

- Very powerful Geographic Information System (GIS).
- Available in several product versions: Professional Edition, Enterprise Edition, Universal Edition …
  REDEO requires the **Standard Edition**
- Manifold may be enhanced with optional extensions : Business Tools, Surface Tools, Geocoding Modules...
- More information on www.manifold.net

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1. Hardware and Software requirements

HARTDWARE REQUIREMENTS

- Hardware requirements vary considerably depending on **the size** and **level of detail** of the study case area.

Minimal configuration (Slow computation & size limits)	Our Choice
CPU : 500Mhz	CPU : 2.4 Ghz
RAM : 512 MB	RAM : 1 GB
Disk : 50 GB	Disk : 100 GB
GPU : Any NVidia	GPU : Any NVidia

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2. Technical structure and choices

TECHNICAL CHOICES

- REDEO runs under Manifold environement.
- Compatibility with Microsoft standards such as ActiveX, OLE DB, ODBC, Microsoft Internet Information Server, COM, Microsoft XML, ASP …
- Use of standard Microsoft dialogs for common user tasks.
- Manifold uses standard Microsoft languages built in for scripting : Visual Basic, Visual Script, Microsoft Jscript (Javascript), …

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2. Technical structure and choices

TECHNICAL CHOICES

1. Modules developed in an external environment using Manifold libraries ?

or

2. Modules developed inside the Manifold environment and operating as an add-on ?

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2. Technical structure and choices

- **Choice 1 :**
  - *Advantages :*
    - \+ Advanced programming tools,
    - \+ Dedicated development environment (Debugger, tracer, …),
    - \+ User interface.
  - *Defaults :*
    - \- Tool spited in several parts,
    - \- Management of the interactions between Manifold and the modules,
    - \- Modification in the registry base.

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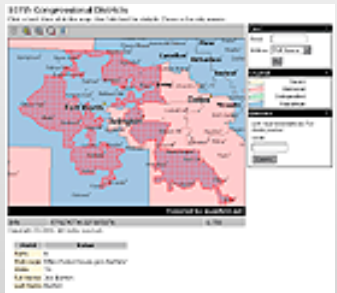
2. Technical structure and choices

- **Choice 2 :**
  - *Advantages :*
    - \+ Better integrated solution
    - \+ Ease of implementation
    - \+ Flexibility (future developments)
  - *Defaults :*
    - \- Code writing support,
    - \- Minimal development tool and environment.

FINAL CHOICE FOR REDEO : 2nd choice

2. Technical structure and choices

TECHNICAL STRUCTURE



Manifold manage GIS data :

Input data

Output data

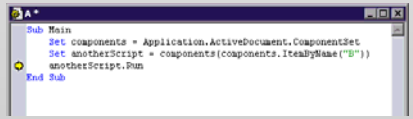
Screen Display

and

REDEO Tools Menu

Script engine manages REDEO behaviour

Interfaces use VBScript engine



Computing done in VB.NET

Dynamic Linked Libraries

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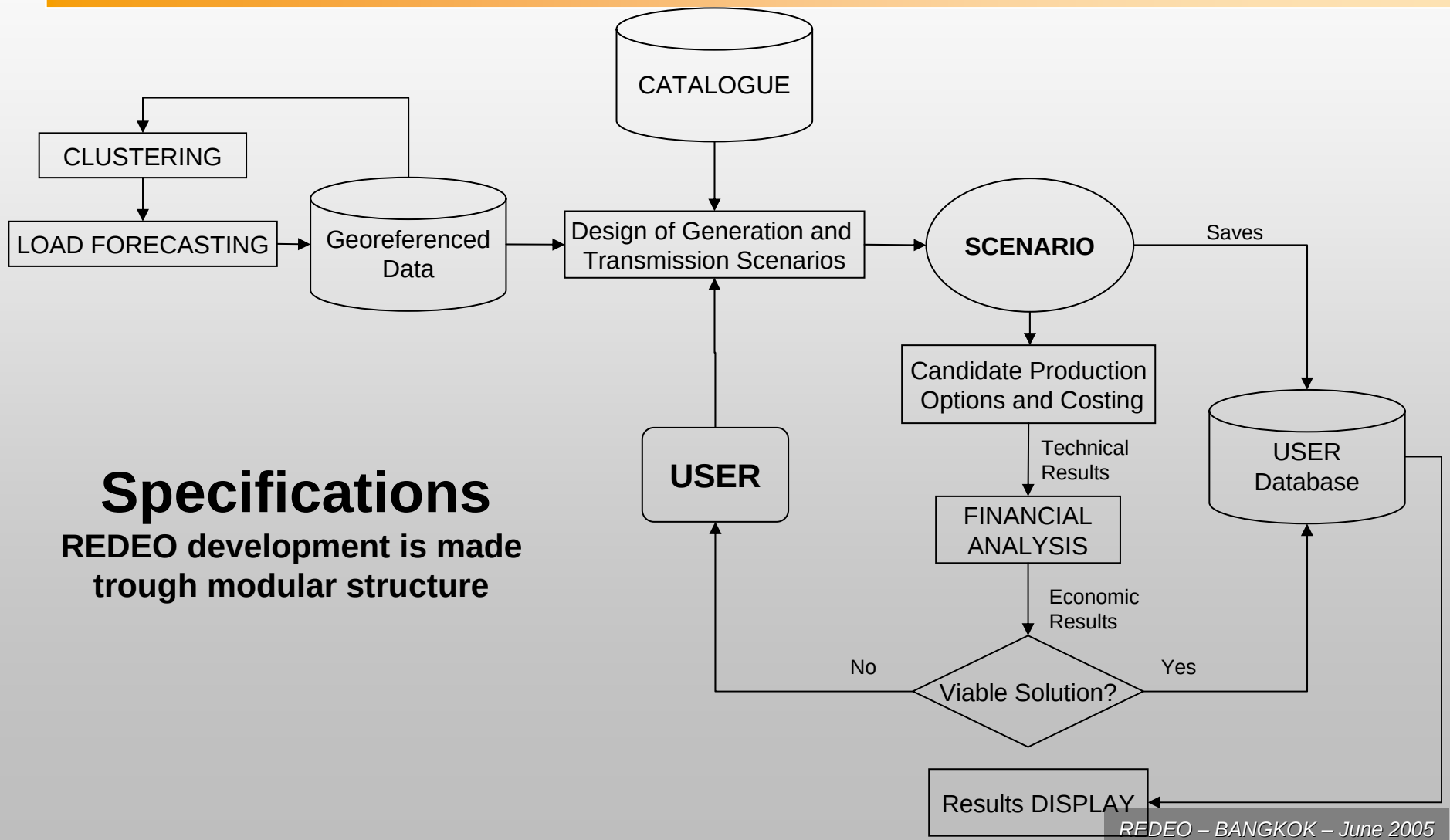
2. Technical structure and choices

- **Script inputs :**
  Geographical data,Technical data, Economical data, User keyboard inputs …

- **Script calculations :**
  Geographical calculations (manifold built-in functions), Technical and economical calculations (loops, SQL Queries, optimisation, …), Calls to other scripts

- **Script outputs :**
  Maps, Tables, …

2. Technical structure and choices



Specifications

REDEO development is made trough modular structure

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3. Installation Instruction

- **The Manifold software has to be installed on the computer** *(typically in C:\Program Files\Manifold System)*
- **In its actual version, Redeo requires only to install**
  - *Specific Redeo files in the C:\Program Files\Manifold System\Config folder*
  - *The geographical database in your working directory : only one file xxx.map (usually size < 1 Mo)*
- **A double click on xxx.map launches the redeo tool**

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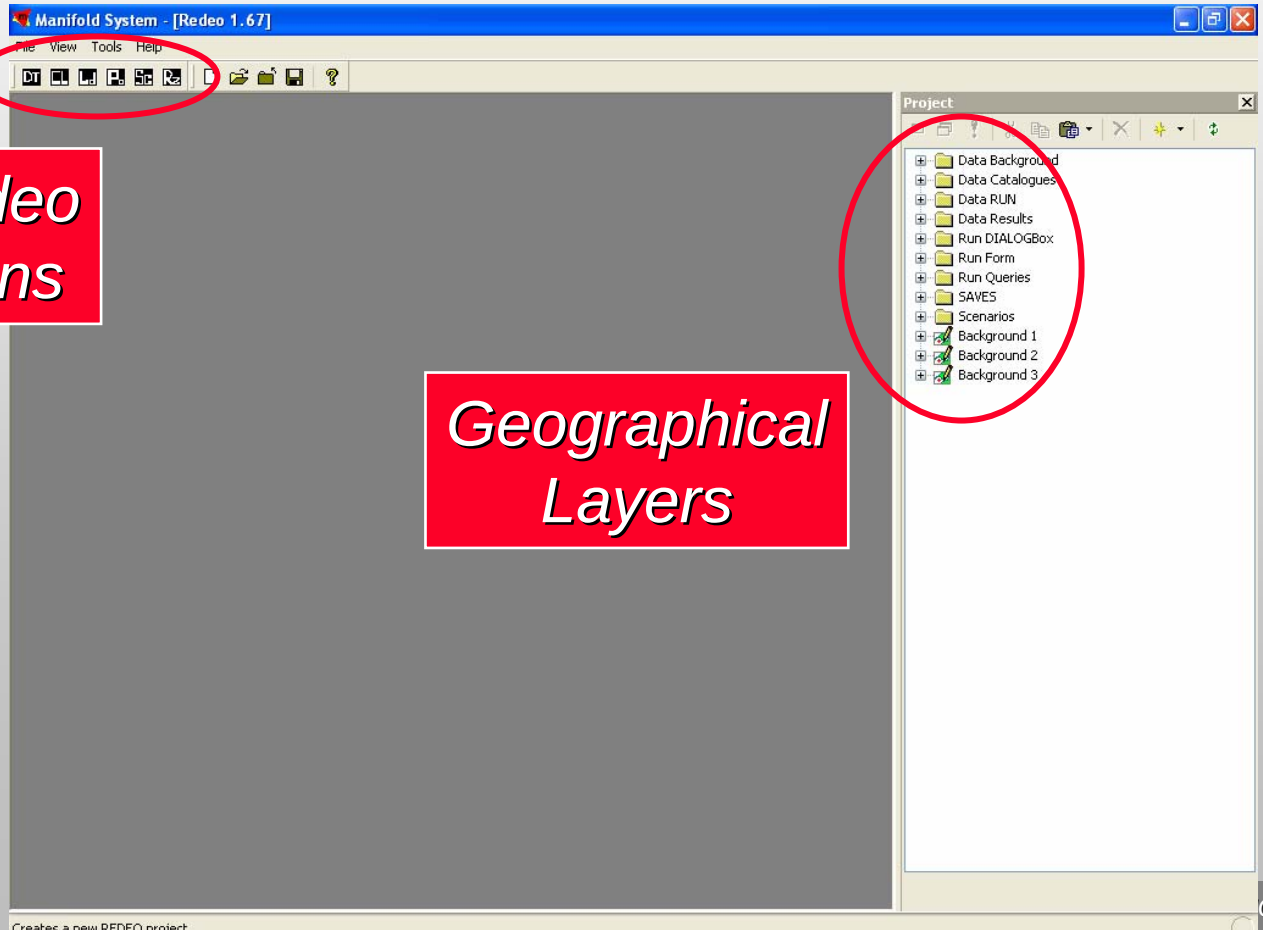
4. Guidelines

- ✓ **Startup screen :**



5 Redeo buttons

Geographical Layers

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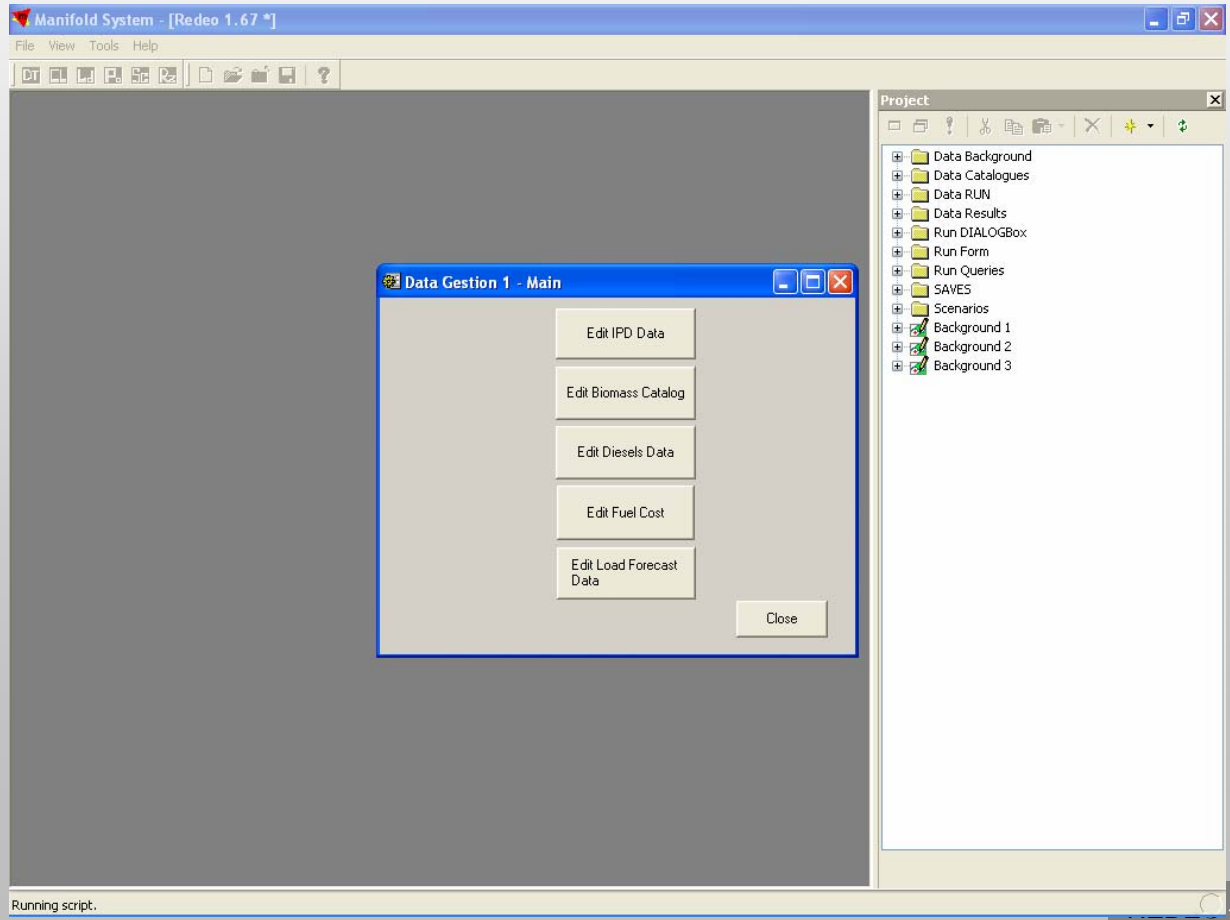
4. Guidelines

✓ Button 1 : Data Management



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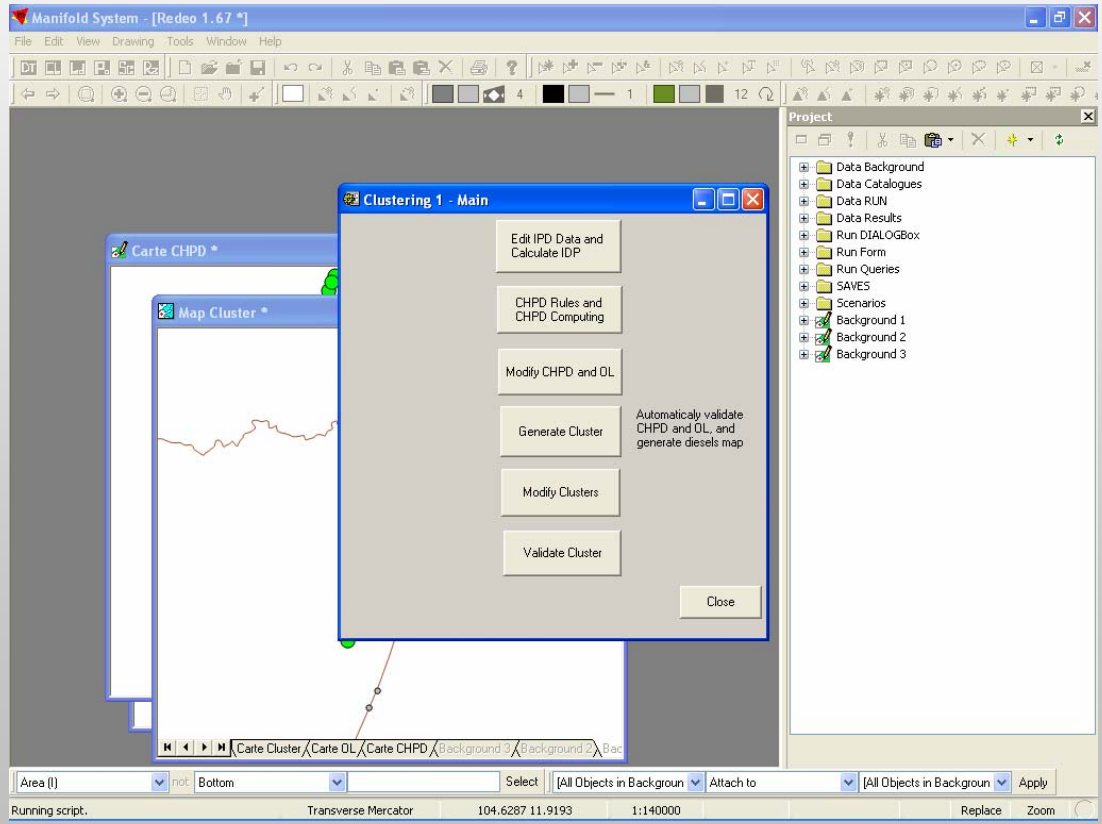
4. Guidelines

✓ Button 2 : Clustering



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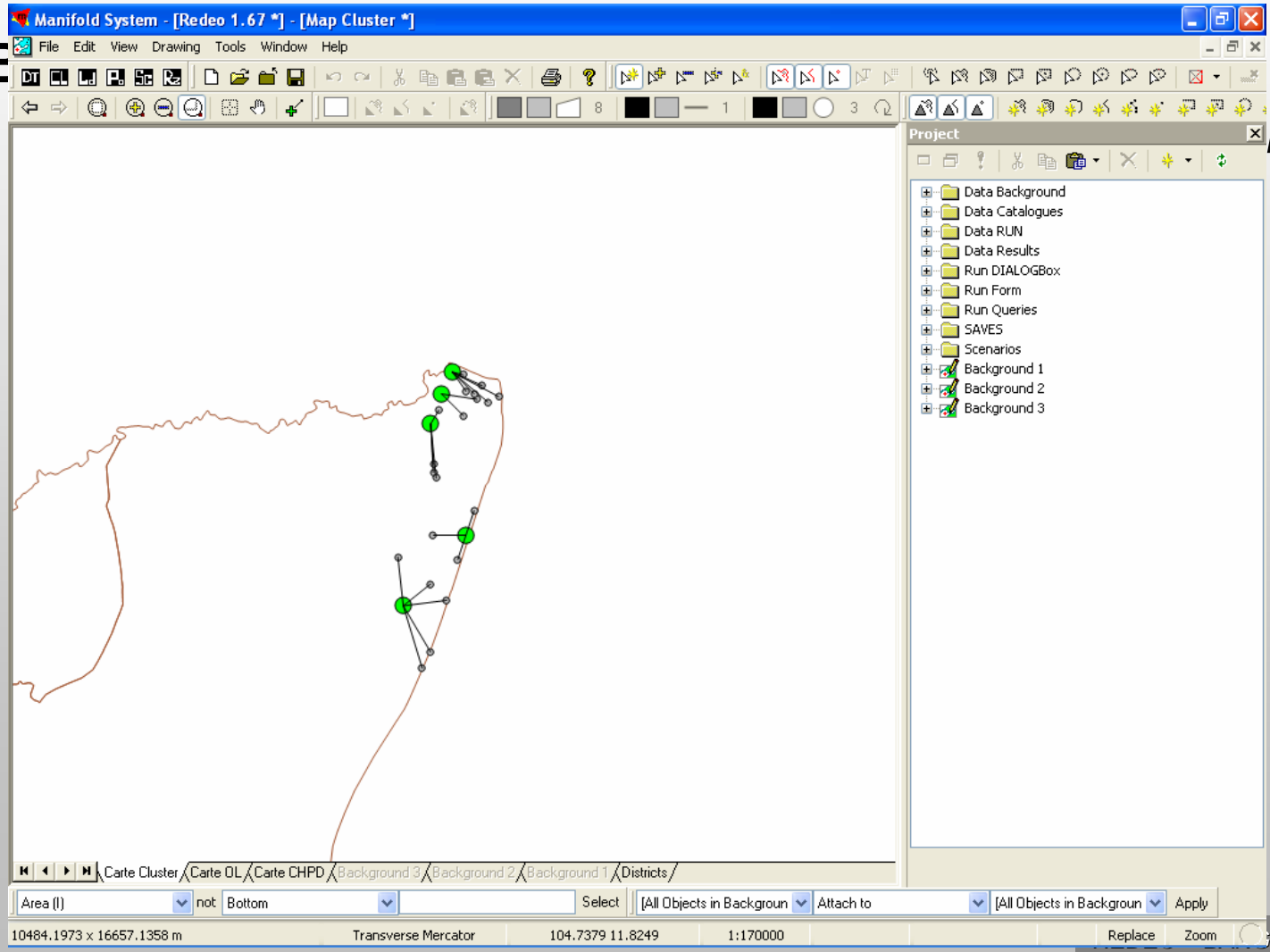
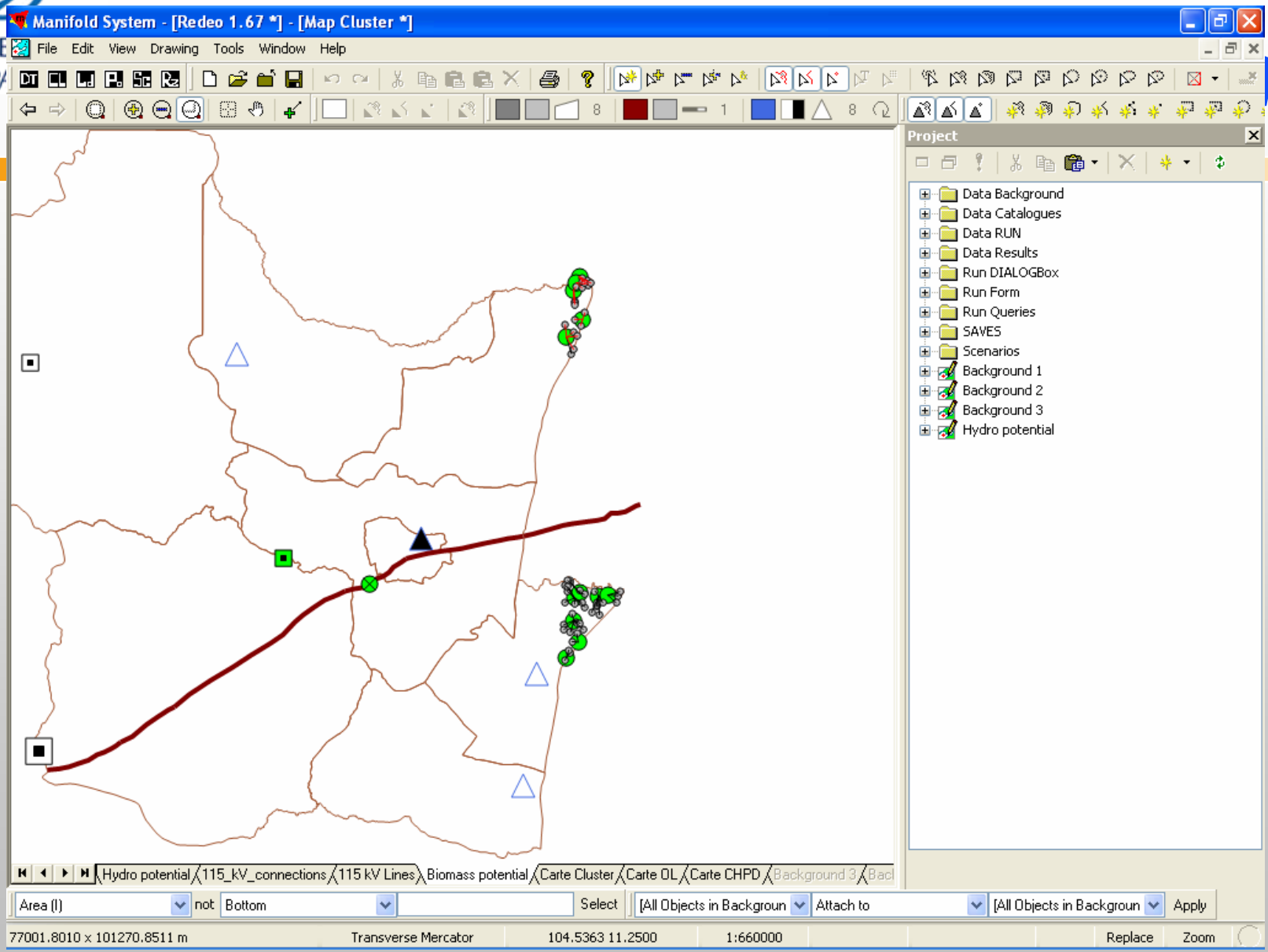
4. Guidelines

- ✓ E
  - ×
  - ×



lities


Manifold System - [Redeo 1.67 *] - [Map Cluster *]
File Edit View Drawing Tools Window Help
Project
Data Background
Data Catalogues
Data RUN
Data Results
Run DIALOGBox
Run Form
Run Queries
SAVES
Scenarios
Background 1
Background 2
Background 3
Hydro potential
Hydro potential 115_kV_connections 115 kV Lines Biomass potential Carte Cluster Carte OL Carte CHPD Background 3
Area (I) not Bottom Select [All Objects in Backgroun Attach to [All Objects in Backgroun Apply
77001.8010 x 101270.8511 m Transverse Mercator 104.5363 11.2500 1:660000 Replace Zoom

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4. Guidelines

- Button 4 : Scenarios
- A locality can be electrified
  - By a MV connection to the existing HV grid
  - By a MV grid from a hydro plant
  - By a MV grid from a biomass plant
  - By an autonomous diesel plant
  - By a MV grid connected to an isolated diesel plant
- The Redeo tool generates the global electrification scheme according to these 5 options

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4. Guidelines

- **Button 5 : Results analysis**
  - *Technical synthesis*
  - *Economical analysis*
  - *Environmental impacts*
  - *Development indicators*
  - *…*

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5. Potential for further improvement

- **Redeo is a “prototype” :**
  - *New software*
  - *New concept*
- **New software : bugs to be expected**
- **Methodology still to be improved**

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5. Potential for further improvement

- **Methodology :**
  - *Improvements in the implemented modules*
    - RE systems modelling (seasonality, …)
    - Cost calculations (diesel)
    - …
  - *Improvements in the algorithms :*
    - Grid extension
    - …

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5. Potential for further improvement

- **Methodology :**
  - *New technical options :*
    - Wind power
    - Hybrid systems
    - Microgrids
    - …
- **Feedback from the end users :**
  - *Does Redeo exactly match the needs ?*
  - *Data availability ?*
  - *…*

RURAL ELECTRIFICATION DECENTRALIZED ENERGY OPTIONS (REDEO)

Assessment of Software Programs and Areas of Application for Cambodia, Laos and Vietnam

S. Kumar, N. Mithulananthan and Ram M. Shrestha

Final workshop
30th June - 1st July, 2005

Objective and Organization of this presentation

- ✓ Project methodology
- ✓ Presentation on software tools
  - ❖ Brief description of the tools
  - ❖ Advantages and disadvantages
  - ❖ Discussion of these tools for CLV energy planners

Project Methodology

- Literature review on existing software tools
- The three countries selected for testing, developing and implementing the approach are Cambodia, Laos and Vietnam (CLV) → Data gathering for case study.
- Preparing REDEO tool using GIS
- Testing the software tool for rural electrification planning in developing countries → Application to Cambodia, Laos and Vietnam.
- Final workshop → Feedback and application from CLV and selected ASEAN member countries.

Presentation on software tools

Assessment of Software Programs and Areas of Application for Cambodia, Laos and Vietnam

- The main objective of this task is to provide a set of identified computerized decision aid tools for rural electrification planning in developing countries, especially, Cambodia, Laos and Vietnam.
- Study various existing software tools to Cambodia, Laos and Vietnam, and identify the benefits and limitations from the point of view of individual country.

1. RETScreen
2. Homer
3. Vipor
4. Powerworld Simulator
5. Solargis
6. LEAP

1. RETScreen

- RETScreen is an integrated renewable energy project analysis software consisting of easy to use Microsoft Excel spreadsheets.
- RETScreen is useful for both decision-support and capacity-building purposes.
- RETScreen is developed by the CANMET Energy Diversification Research Laboratory (CEDRL), Canada.
- Wind, small hydro, solar photovoltaics (PVs), combined heating and power, biomass heating, solar air heating, solar water heating, passive solar heating, ground-source heat pumps, and refrigeration are the modules that have been developed in RETScreen.
- The software is available free at http://www.retscreen.net/ang/t.php.

1. RETScreen (Cont.)

- The software can be used to evaluate:
  - The annual energy production,
  - The costs and financial viability of the renewable energy technologies (RETs).
  - The greenhouse gas emission reductions for various types of energy efficient and RETs (optional).

1. RETScreen (Cont.)

Advantages

- ✓ Reduces costs, time, risks and errors associated with preparing project pre-feasibility studies.
- ✓ Provides a low cost preliminary design method for project developers and industry.
- ✓ Provides GHG analysis to help the user estimate the greenhouse gas emission reduction (mitigation) potential of the proposed project.
- ✓ RETScreen economic analysis can consider a variety of discount rate, taxes benefit, etc. and financial analysis indicators (e.g. Simple payback, NPV, IRR etc.). A cash flow graph is also included.

Disadvantages

- ✓ RETScreen looks at one technology at a time.
- ✓ Only annual energy production is considered, rather than a more detailed time series analysis, which would consider energy production and load variations on a much shorter time scale (e.g. 1 hour).
- ✓ Only in Wind Energy model, the Sensitivity and Risk Analysis tool has developed.

1. RETScreen (Cont.)

❖ The potential of RETScreen's application for Cambodia, Laos and Vietnam

Items	Cambodia	Laos	Vietnam
1. Input data (1)			
Biomass	NA	NA	NA
Small hydro	NA	NA	NA
Solar	NA	NA	NA
Thermal	NA	NA	NA
Wind	NA	NA	NA
The product data (RETs)	NA	NA	NA
2. Availability of tool	Free	Free	Free
3. Usability (training, help etc.) (2)	Available	Available	Available
4. Output			
The annual energy production (Mwh/year)	Useful	Useful	Useful
The life-cycle costs of the RETs (USD/Mwh)	Useful	Useful	Useful
The greenhouse gas emission	Useful	Useful	Useful

❖ **Notes:**

- ✓ **(1)** – *In case where data is not available then one can use the product, cost, and weather database (example: solar data can be obtained by http://eosweb.larc.nasa.gov/sse/RETScreen/) that are included in the RETscreen software tool.*
- ✓ *(2) – Currently, case study material is not available to access the Combined Heat & Power model.*

2. Homer

- HOMER is a tool that simplifies the task of evaluating design options for both off-grid and grid-connected power systems for remote, stand-alone, and distributed generation (DG) applications.
- HOMER's optimization and sensitivity analysis algorithms allows to evaluate the economic and technical feasibility of a large number of technology options and accounts for variation in technology costs and energy resource availability.
- The software is available free at http://analysis.nrel.gov/homer/.

2. Homer (Cont.)

- HOMER models both conventional and renewable energy technologies:

- ✓ Power Source:
  - Solar photovoltaic (PV)
  - Wind turbine
  - Run-of-river hydro power
  - Generator: diesel, gasoline, biogas, alternative and custom fuels, co-fired
  - Electric utility grid
  - Micro turbine
  - Fuel cell
- ✓ Storage
  - Battery bank
  - Hydrogen
- ✓ Loads
  - Daily profiles with seasonal variation
  - Deferrable (water pumping, refrigeration)
  - Thermal (space heating, crop drying)
  - Efficiency measures

2. Homer (Cont.)

- Advantages
  - ✓ Homer searches for the optimal system considering the selected RETs at a time.
  - ✓ Analyze grid or off grid rural electrification system. Homer reports both of optimal and near optimal solutions.
  - ✓ Analysis done on an hourly basis.
  - ✓ Sensitivity analyses to determine the effect of the inputs.
  - ✓ Results are based life cycle analysis.
  - ✓ More detailed than RETScreen software.
  - ✓ Can model AC or DC loads.

- Disadvantages
  - ✓ Can not model both of AC and DC loads. (Load modeling AC or DC at a time)
  - ✓ Calculates Net present cost only.
  - ✓ GHG analysis is not available, but Carbon emission (tonne/year) can be obtained

2. Homer (Cont.)

- **The potential of HOMER's application for Cambodia, Laos and Vietnam**

Items	Cambodia	Laos	Vietnam
1. Input data (1)			
Load	NA	NA	Available
Solar (hourly or monthly)	NA	NA	NA
Wind (hourly or monthly)	NA	NA	NA
The cost and performance data (Energy options)	NA	NA	NA
2. Availability of tool	Free	Free	Free
3. Usability (training, help, case studies etc.)	Available	Available	Available
4. Output (2): Optimization for designing power systems			
Hourly simulation of power systems	Useful	Useful	Useful
The life-cycle costs of power systems	Useful	Useful	Useful
Sensitive analysis	Useful	Useful	Useful

Notes: (1) – *One can use the product, cost, weather database that are included in the RETscreen software tool or other database should be developed.*
– *HOMER defines three kinds of load data: Primary Load, Deferrable Load and Thermal Load.*
– *HOMER does not contain a library of component cost and performance data. But it can be obtained at the Lawrence Berkeley National Laboratory's Distributed Energy Resources Group at http://der.lbl.gov/tech_data.html*
(2) – *Output data could be obtained including PV, wind, batteries, inverters and fuel –fired gen-sets and various combinations of these technologies.*

3. Vipor

- This software has been developed by the National Renewable Energy Laboratory (NREL).
- Vipor model provides the optimal combination of rural electrification systems by using the lowest cost combination of centralized and isolated power generation.
- The distribution grid is optimally designed with consideration of selection of the optimum locations for the centralized power plant, the placement of multiple transformers, and the network of medium and low voltage lines. The voltage drop constraint is implemented using a maximum low voltage line length.
- The software is available free at http://analysis.nrel.gov/vipor/.

3. Vipor (Cont.)

- Advantages
  - ✓ Vipor is able to optimize the mix of centralized and isolated generation.
  - ✓ It selects between grid extension and hybrid system for centralized power.
  - ✓ It selects the optimal placement of the centralized power systems.
  - ✓ Vipor determines the optimal placement of transformers.
  - ✓ Vipor determines the optimal Medium voltage and Low voltage distribution network.
  - ✓ Vipor uses Graphical user interface (GUI).

- Disadvantages
  - ✓ Vipor does not consider limits of RETs option, and the optimal network might not be the best.
  - ✓ Vipor supports only 10 RETs candidates in a network at a time of analysis.
  - ✓ Vipor does not consider power losses in distribution system.

3. Vipor (Cont.)

❖ The potential of VIPOR's application for Cambodia, Laos and Vietnam

Items	Cambodia	Laos	Vietnam
1. Input data [(1)]			
Loads	NA	NA	Available
Sources	NA	NA	NA
Terrain	GIS map	GIS map	GIS map
Distribution costs	NA	NA	NA
2. Availability of tool	Free	Free	Free
3. Usability (training, help, case studies etc.)	Available	Available	Available
4. Output [(2)]: Optimization for designing village electrification systems			
Centralized vs. isolated power systems (like solar home systems)	Useful	Useful	Useful
Breakdown of costs	Useful	Useful	Useful
Revenues	Useful	Useful	Useful

Notes: ***(1) – VIPOR defines the various kinds of load data: houses, stores, a church, temple, pagoda and a community center.***

– One can use the generation cost curve of the wind turbines, PV panel, a single backup generator, and battery storage those could be obtained by HOMER tools. For other technologies' generation cost curves, one has to develop the analysis by other means (e.g. in the cases of biomass, micro hydro, multiple diesels).

– One has to convert the existing GIS data into VIPOR for analysis

(2) – Output data could be obtained including a map of the optimal configuration of village electrification systems.

4. Powerworld Simulator

- Load flow problems can be solved by Powerworld Simulator which is one of the commercially available power flow software. Various graphical options in the software make it more appealing compare to other programs used for power flow studies.
- It is developed by Powerworld Corporation, USA.
- A free demonstration Powerworld Simulator software with some limitation on number of nodes is available free at “http://www.powerworld.com/downloads.html”.

4. Powerworld Simulator (Cont.)

- Advantages
  - ✓ A full featured power system simulation package includes AC/DC Optimal power flow analysis, pricing, etc.
  - ✓ It is user-friendly and highly interactive,
  - ✓ The simulator has extensive graphics and animation capabilities.
  - ✓ A detailed online help file has been integrated.
- Disadvantages
  - ✓ Free demonstration Powerworld Simulator software with some limitation on number of nodes

5. Solargis

- The Solargis project (JOULE 2 Program) integrates renewable energy technologies for decentralized electricity production in Europe and developing coutries.
- The Solargis project is coordinated by the Centre d'Énergétique (CENERG) – ARMINES (France).
- This tool's objective is to orientate studies of integration of RE electricity production at a regional scale by using a GIS. It determines which technology of production is the most appropriate for a given place. A comparison of technologies is based on a LEC (Leveled Electricity Costs) study.

5. Solargis (Cont.)

- Advantages
  - ✓ Tool for sizing and optimizing Renewable energy systems for electricity generation (using PV arrays, wind turbines, ...) in various configurations (stand alone, grid connected, with or without storage, hybrid systems, ...)
  - ✓ Regional level analysis by application of a Geographical Information Systems software for analysis
  - ✓ Permits for technical and economical analysis (detecting High Potential Areas, and levelized electricity cost analysis)

- Disadvantages
  - ✓ Model integrated in GIS environment (GIS ArcView 3.0 from ESRI (ESRI was founded as Environmental Systems Research Institute in 1969))
  - ✓ Not a free model

5. Solargis (Cont.)

The potential of SOLARGIS's application for Cambodia, Laos and Vietnam

Items	Cambodia	Laos	Vietnam
1. Input data			
Wind resources map	NA	NA	NA
Solar resource map	NA	NA	NA
Population density	Available	Available	Available
Existing network map	NA	NA	Available
Load scenarios	NA	NA	Available
Technologies catalog	NA	NA	NA
Social and economics	Available	Available	Available
Energy demand	NA	NA	NA
2. Availability of tool	NA	NA	NA
3. Usability (training, help, case studies etc.)	NA	NA	NA
4. Output:			
Cost for decentralized options: PV, wind, diesel, hybrid… based electricity production	Useful	Useful	Useful
Cost for the grid connection option	Useful	Useful	Useful

6. LEAP

- The Stockholm Environment Institute-Boston has developed the Long-range Energy Alternatives Planning (LEAP). This is an advanced software tool for energy and environmental scenario analysis.
- With its flexible data structures, LEAP allows the analysis of technological specification and end-use detail as the user chooses.
- The software tool is suitable for performing energy assessments in developing or industrialized countries, for multi-country regions, or for local energy planning purposes
- LEAP includes a wide array of features designed to make creating scenarios, managing and documenting data and assumptions and viewing results reports.
- It is designed to work closely with Microsoft Office products making it easy to import, export and link to data and models created elsewhere.

6. LEAP (Cont.)

- Advantages
  - ✓ User friendly
  - ✓ Transparent & flexible data requirements
  - ✓ Documentations are available for study
  - ✓ Available to total energy system, and detailed electric system analysis
  - ✓ Analyzing all environmental burdens
  - ✓ Generates comparisons of alternative scenario results in physical, environment, and cost/benefits based decision support analysis
  - ✓ Medium to long-term, annual time steps
  - ✓ Local, regional, national and global levels for analysis

- Disadvantages
  - ✓ Does not automatically identify least-cost system
  - ✓ Does not automatically yield price-consistent solutions (e.g. demand forecast may be inconsistent with projected supply configuration
  - ✓ Without fuel competitiveness between renewable energy and fossil fuels
  - ✓ All power plants are assumed to be available at peak load time

6. LEAP (Cont.)

The potential of LEAP's application for Cambodia, Laos and Vietnam

Items	Cambodia	Laos	Vietnam
1. Input data			
Social and economics	Available	Available	Available
Energy demand	NA	NA	NA
Energy transformation	NA	NA	NA
Emission factor by fuels	NA	NA	NA
2. Availability of tool	Free	Free	Free
3. Usability (training, help, case studies etc.)	Available	Available	Available
4. Output:			
Energy demand	Useful	Useful	Useful
Energy conversion	Useful	Useful	Useful
Energy resources	Useful	Useful	Useful
Cost of the energy systems	Useful	Useful	Useful
Emissions	Useful	Useful	Useful

Summary

Name	Developer	Scope
LEAP	SEI-Boston, USA	Integrated Energy/Environment Analysis
RETSCREEN	Natural Resource Canada	Energy production, life-cycle costs and GHG emission reductions for various energy efficient and renewable energy technologies
HOMER	National Renewable Energy Laboratory, USA	Design of off- and on-grid electrification options
VIPOR	National Renewable Energy Laboratory, USA	Design of isolated electrification options (and includes in a centralized distribution network)
POWERWORLD SIMULATOR	Powerworld Corporation, USA	The software can be used to give an analyst a comprehensive look at issues surrounding electrical power flows in a transmission grid
SOLARGIS	The Centre d'Énergétique (CENERG) – ARMINES (France)	Integration of renewable energy technologies and for decentralized electricity production in Euro and developing courtiers.

Summary

Name	Platform	Methodology
LEAP	Windows	Physical Accounting, Simulation
RETSCREEN	Windows	Physical Accounting
HOMER	Windows	Optimization
VIPOR	Windows	Optimization
POWERWORLD SIMULATOR	Windows	Simulation, Optimization
SOLARGIS	Windows	Mapping and Technical and economical evaluations

Summary

Name	Cost/Licensing	Web Site/Contact
LEAP	Free to qualified users from developing countries	forums.seib.org/leap leap@tellus.org
RETSCREEN	Free	www.retscreen.net rets@nrcan.gc.ca
HOMER	Free	www.nrel.gov/homer peter_lilienthal@nrel.gov
VIPOR	Free	http://analysis.nrel.gov/vipor tom_lambert@nrel.gov
POWERWORLD SIMULATOR	Free demonstration Powerworld Simulator software with some limitation on number of nodes	http://www.powerworld.com info@powerworld.com
SOLARGIS	Not free	http://www-cenerg.cma.fr

REDEO : Rural Electrification Decentralized Energy Options

Presentation of the prototype tool

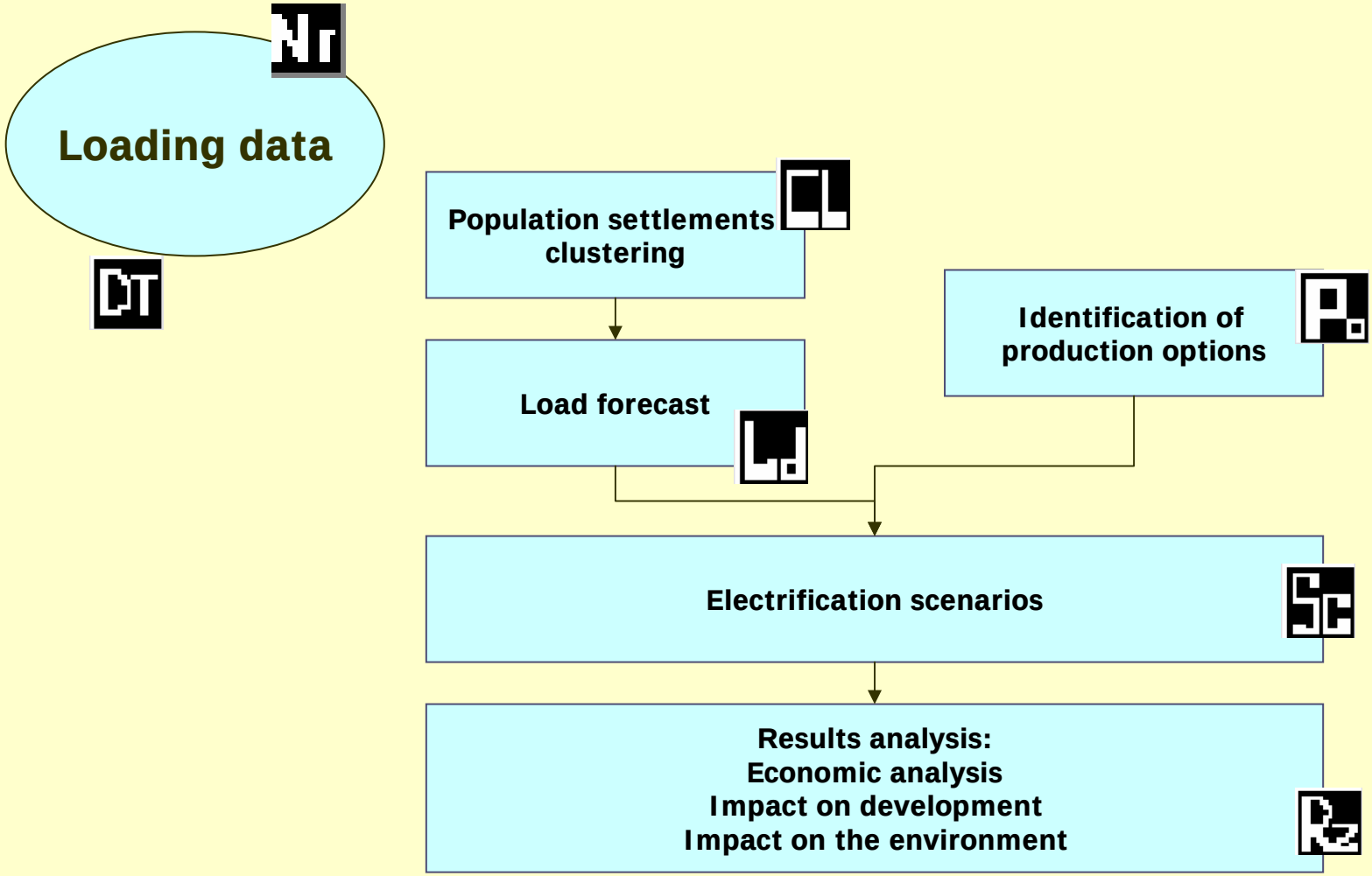
Bangkok – June 2006

Supported by the EAEF – European Commission – ASEAN Energy Facility

Introduction

1. The REDEO tool is an add on to the GIS Manifold
2. Proceeds with a classical planning methodology
3. Interactive: variables and parameters can easily be changed
4. Allows for geographical representation of results: help in decision aid
5. The result of this project is the production of a prototype version
6. Your comments and input regarding the interface and results representation (still weak) are welcome in view of the preparation of the implementation phase of REDEO

The structure of the approach and toolbar

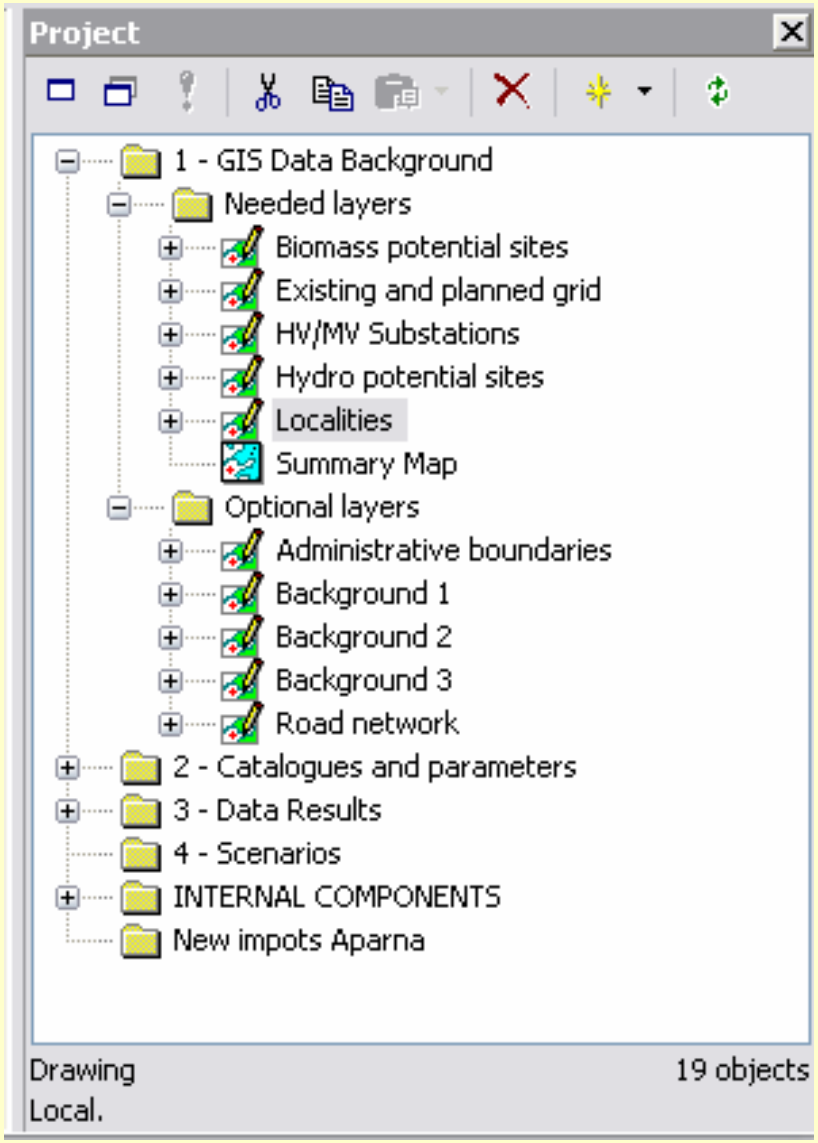


Overview of the objectives of the 6 steps (1)

1. **New REDEO Project and Data input**
   - Consists in inputting all the background data needed to analyse a given area
2. **Settlement clustering module**
   - Aggregates localities into synergetic development poles
   - Simplifies the load forecast and planning
   - Organises localities into « Centres » CHPD and « Peripheries » OL
   - Excludes certain localities which will be left with stand alone / PV options
3. **Load forecasting module**
   - Over 25 years by 5 steps
   - Disagregated by type of consumer, energy and peak

Overview of the objectives of the 6 steps (2)

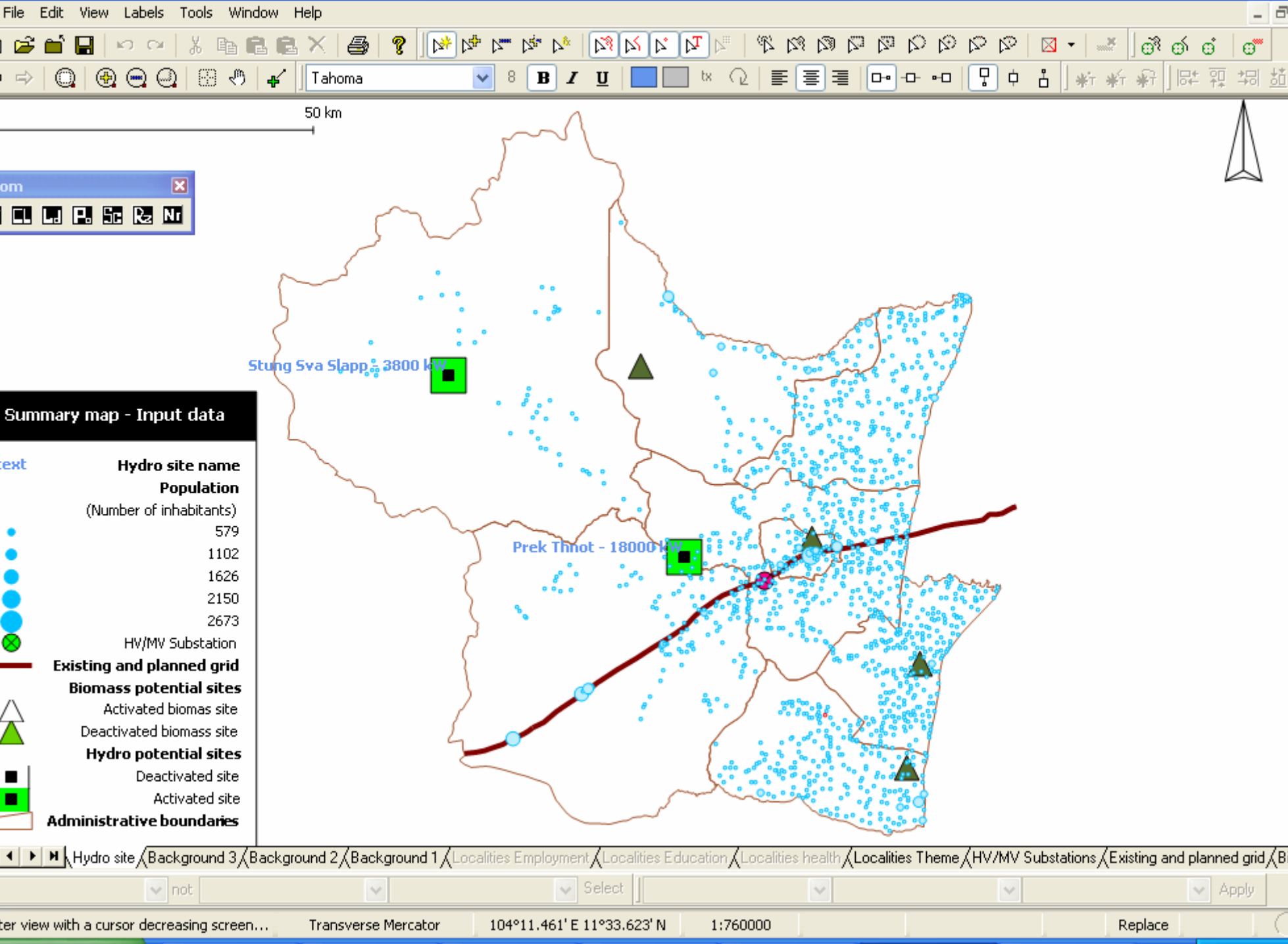
4. **Identification of production options**
   - Inputting, costing all alternative production options
   - Biomass, hydro, grid extension, diesel
5. **Electrification scenarios**
   - Deploys the grid to connect a production option to certain load centres
6. **Impact on development and the environment**
   - A series of criteria for analysis

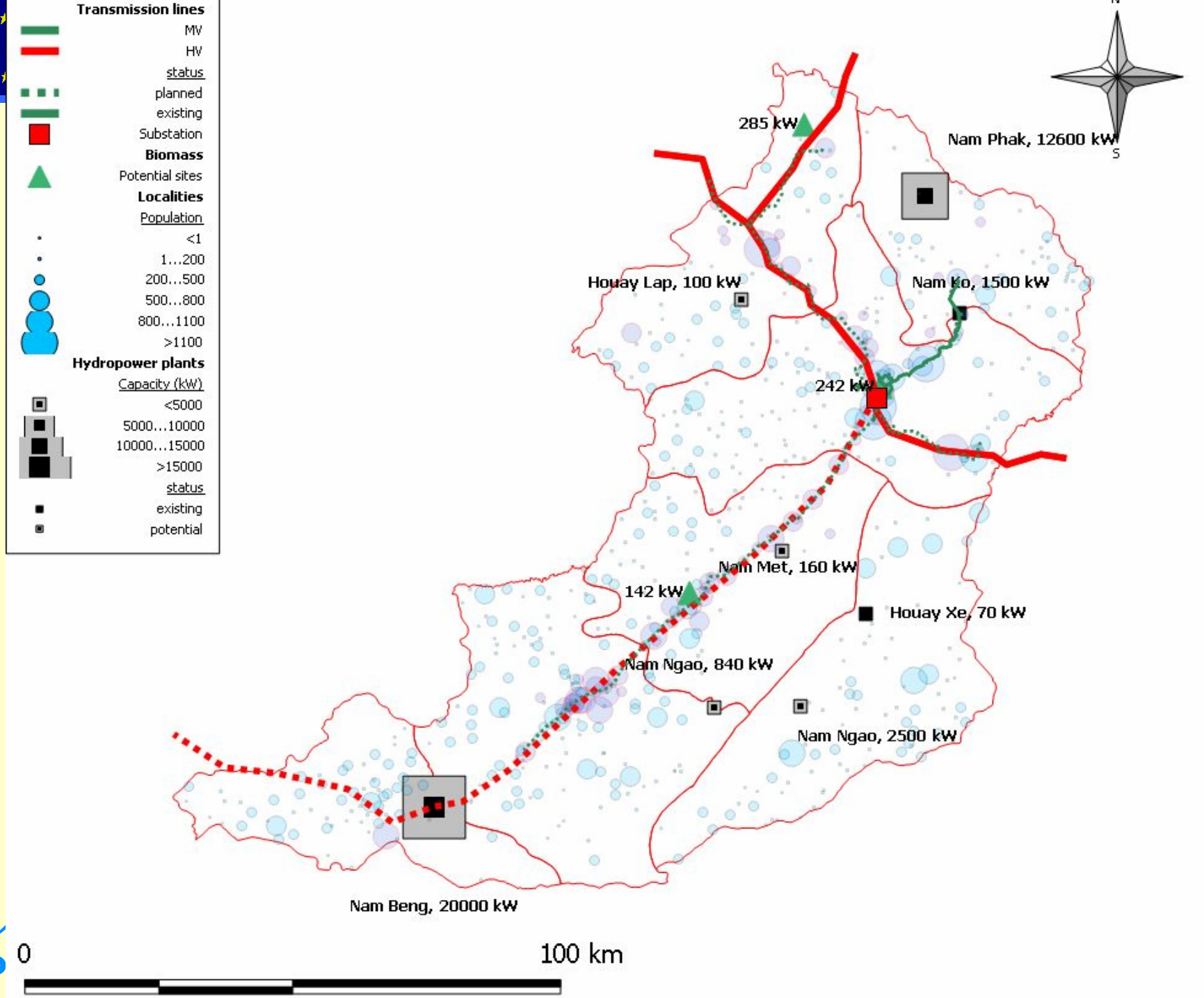


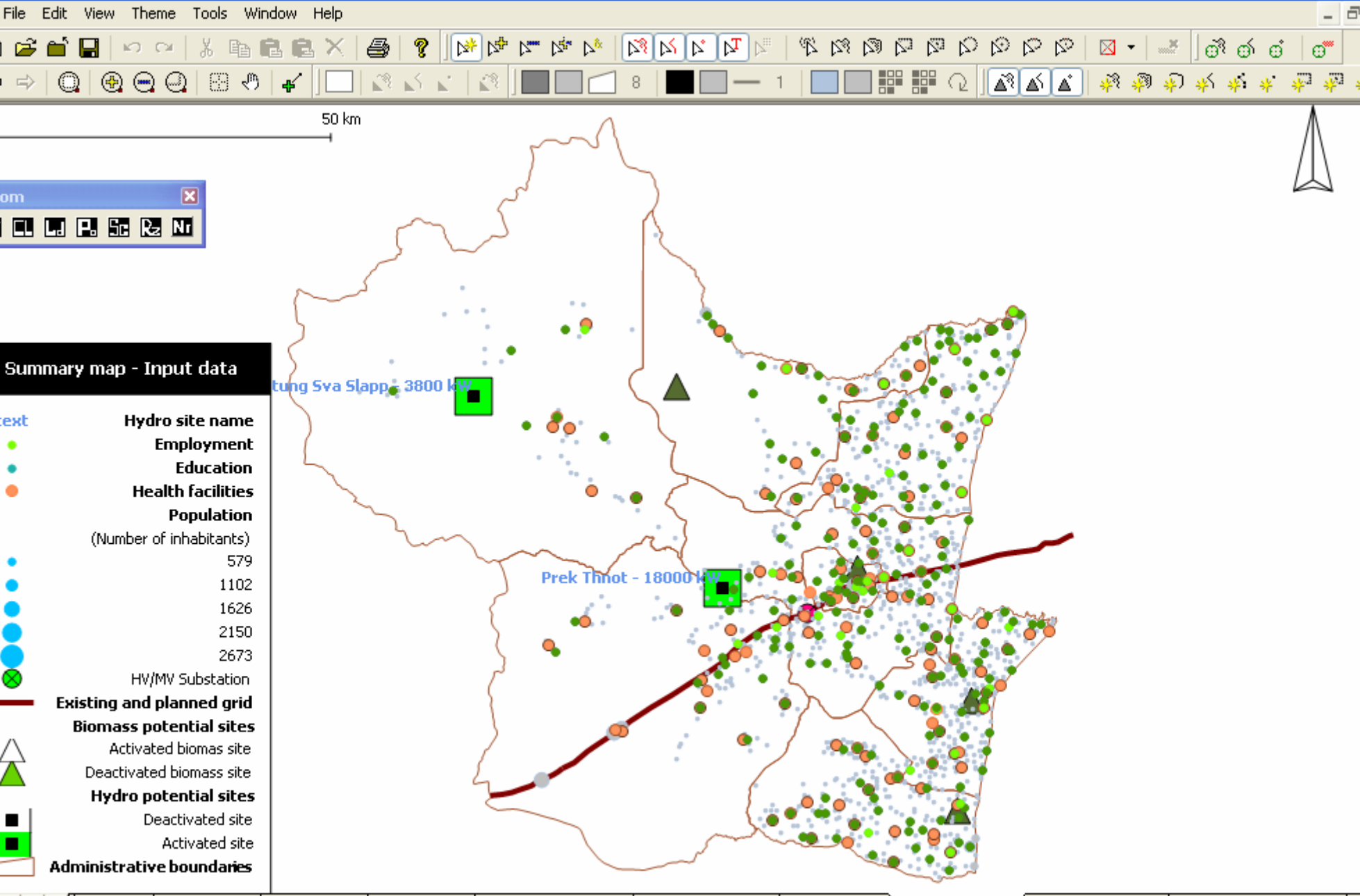
GIS Background folder

Requires:

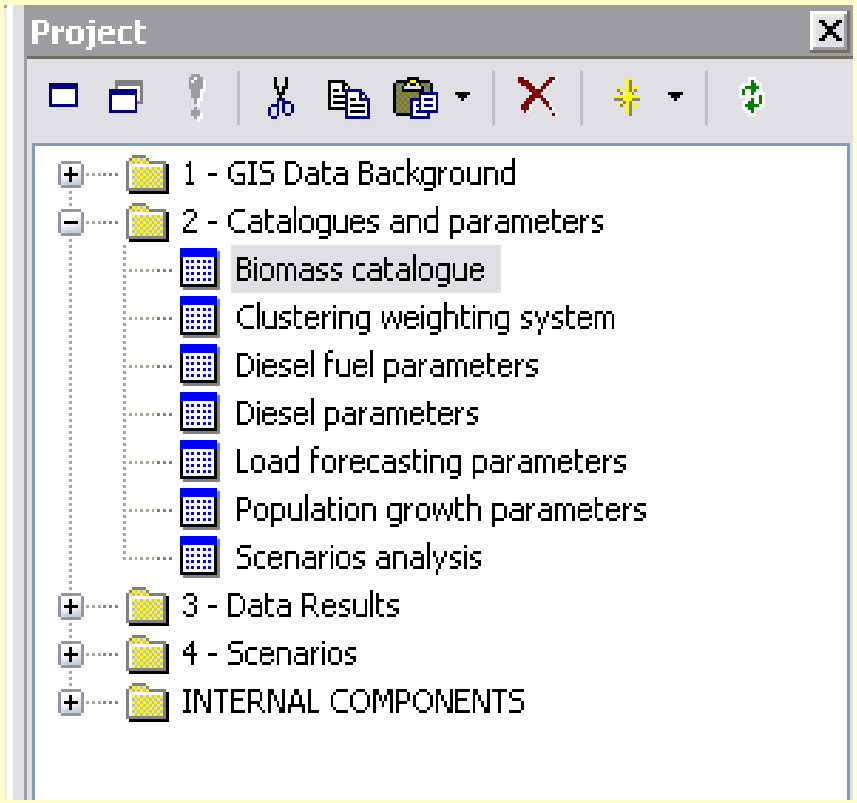
- Localities table [p10]
- information on existing network source [p11]
- information on biomass potential [p 12]
- information on hydro site potential [p 12]


File Edit View Labels Tools Window Help
Tahoma
50 km
Stung Sva Slapp - 3800 kW
Prek Thnot - 18000 kW
Summary map - Input data
Hydro site name
Population
(Number of inhabitants)
579
1102
1626
2150
2673
HV/MV Substation
Existing and planned grid
Biomass potential sites
Activated biomas site
Deactivated biomass site
Hydro potential sites
Deactivated site
Activated site
Administrative boundaries
Hydro site
Background 3
Background 2
Background 1
Localities Employment
Localities Education
Localities health
Localities Theme
HV/MV Substations
Existing and planned grid
Transverse Mercator
104°11.461' E 11°33.623' N
1:760000
Replace


Transmission lines
MV
HV
status
planned
existing
Substation
Biomass
Potential sites
Localities
Population
<1
1...200
200...500
500...800
800...1100
>1100
Hydropower plants
Capacity (kW)
<5000
5000...10000
10000...15000
>15000
status
existing
potential
285 kW
Nam Phak, 12600 kW
Houay Lap, 100 kW
Nam Ko, 1500 kW
242 kW
Nam Met, 160 kW
142 kW
Houay Xe, 70 kW
Nam Ngao, 840 kW
Nam Ngao, 2500 kW
Nam Beng, 20000 kW
0
100 km


File Edit View Theme Tools Window Help
50 km
Summary map - Input data
tung Sva Slapa - 3800 kW
Prek Thnot - 18000 kW
Hydro site name
Employment
Education
Health facilities
Population
(Number of inhabitants)
579
1102
1626
2150
2673
HV/MV Substation
Existing and planned grid
Biomass potential sites
Activated biomas site
Deactivated biomass site
Hydro potential sites
Deactivated site
Activated site
Administrative boundaries
Hydro site
Background 3
Background 2
Background 1
Localities Employment
Localities Education
Localities health
Localities Theme
HV/MV Substations
Existing and planned grid
not
Duplicates
Select
[All Objects in Administrati
Attach to
[All Objects in Administrati
Apply
Transverse Mercator
104°32.544' E 11°59.737' N
1:760000
Replace

Data Catalogues



Provides the information and parameters needed for:

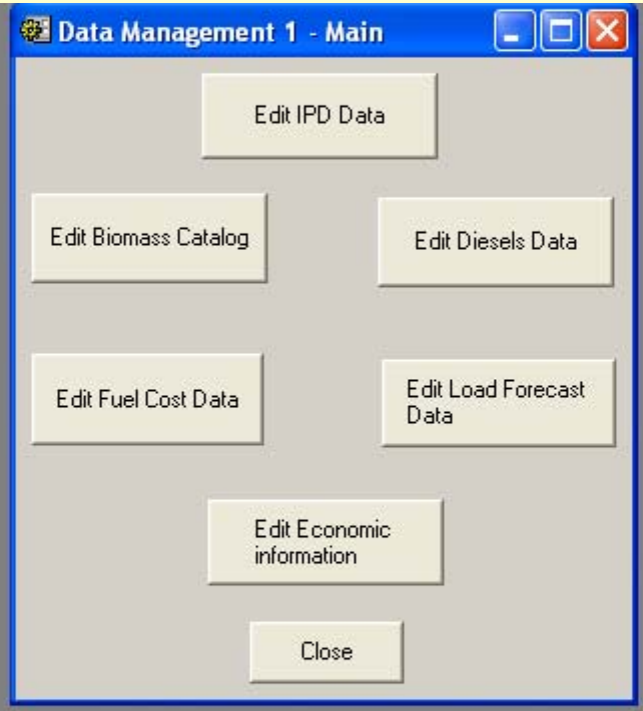
- clustering
- load forecast
- Cost of diesel power supply for a cluster
- Cost of supply with grid extension
- Cost and characteristics of biomass options

View Tools Help

Custom

DT CL LJ PL SC RZ NT

Through the data input interface

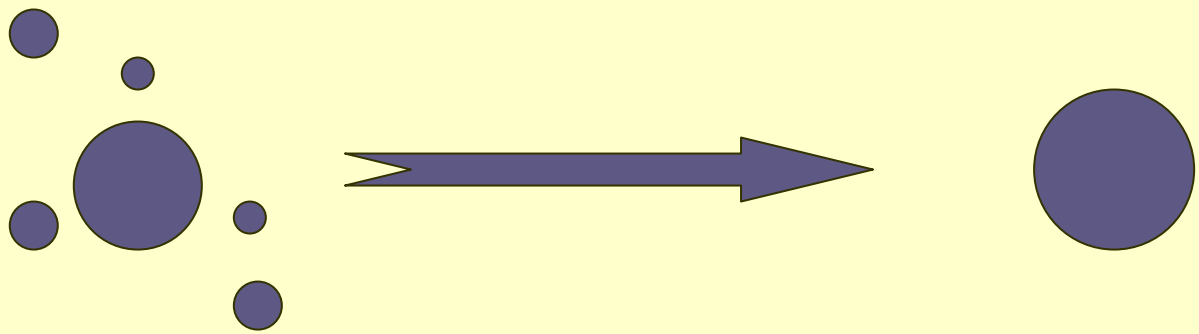


Running of each module

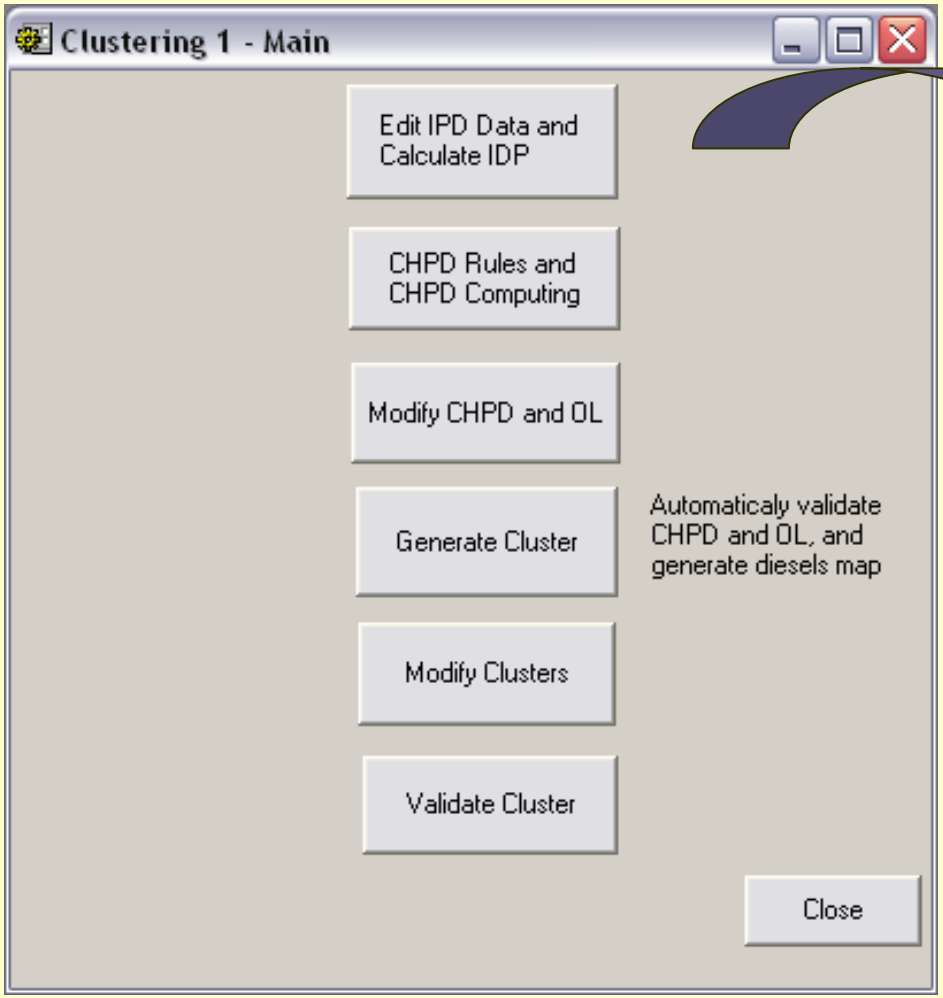
ning script.

clustering

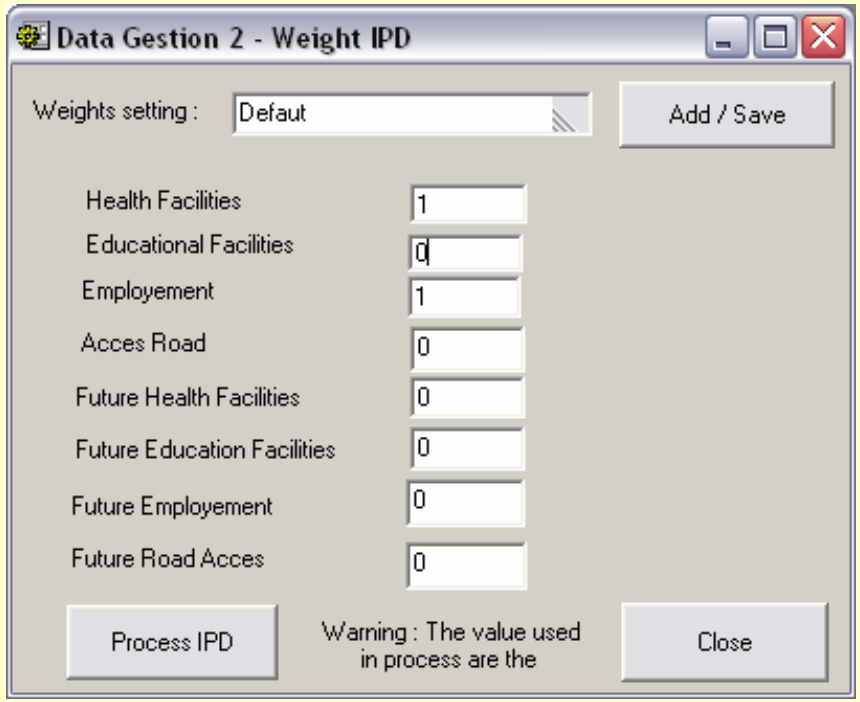
- Concept:
  - To aggregate small villages into load points



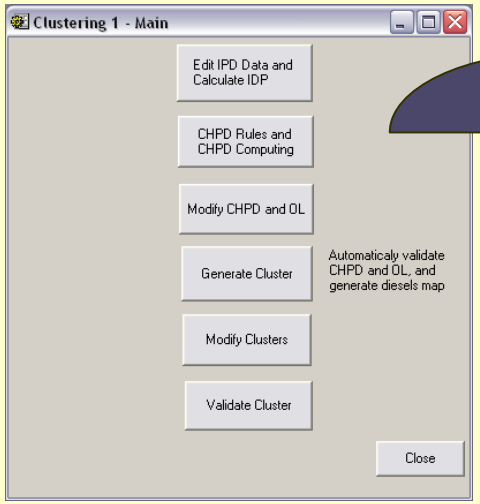
[P. 28]

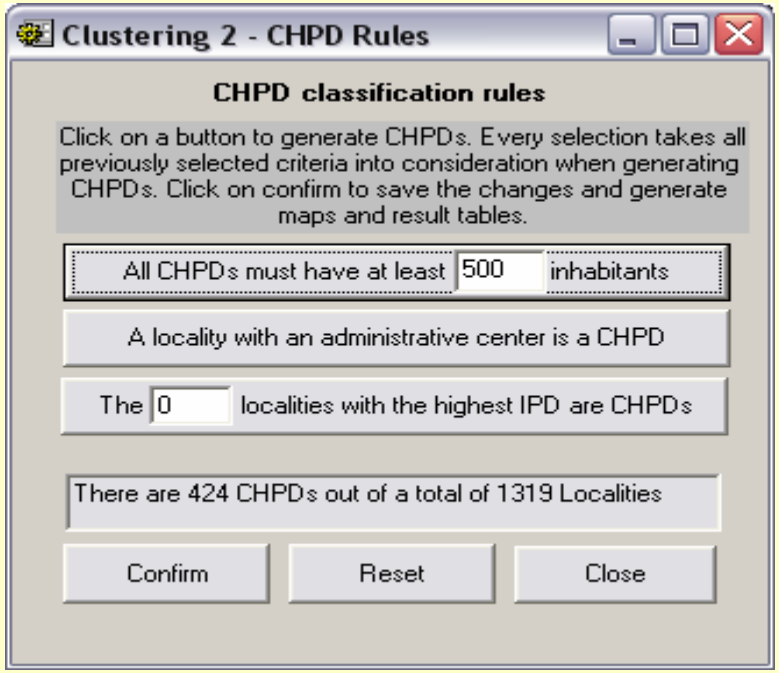


Scoring system for selecting localities with high development potential

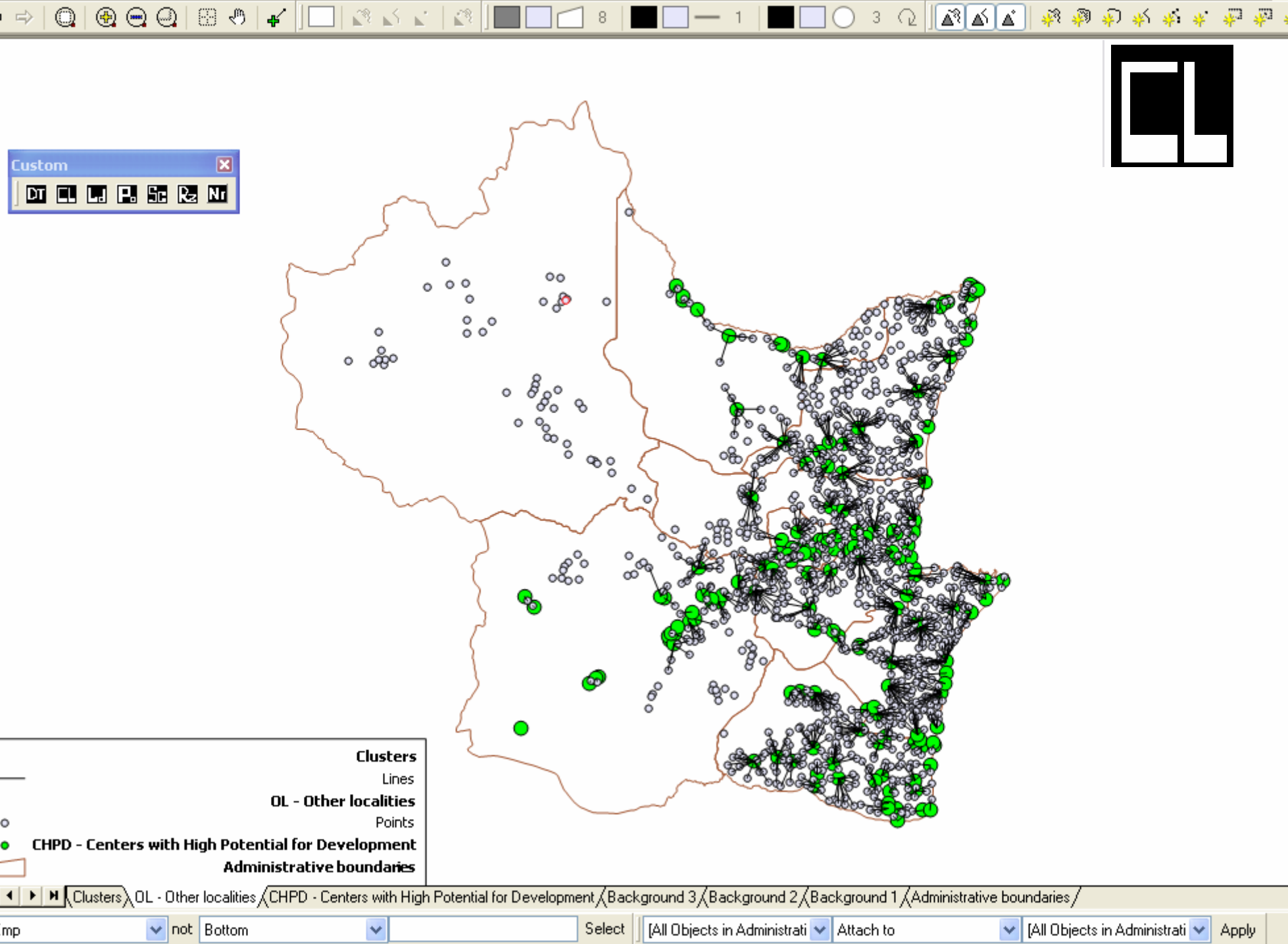


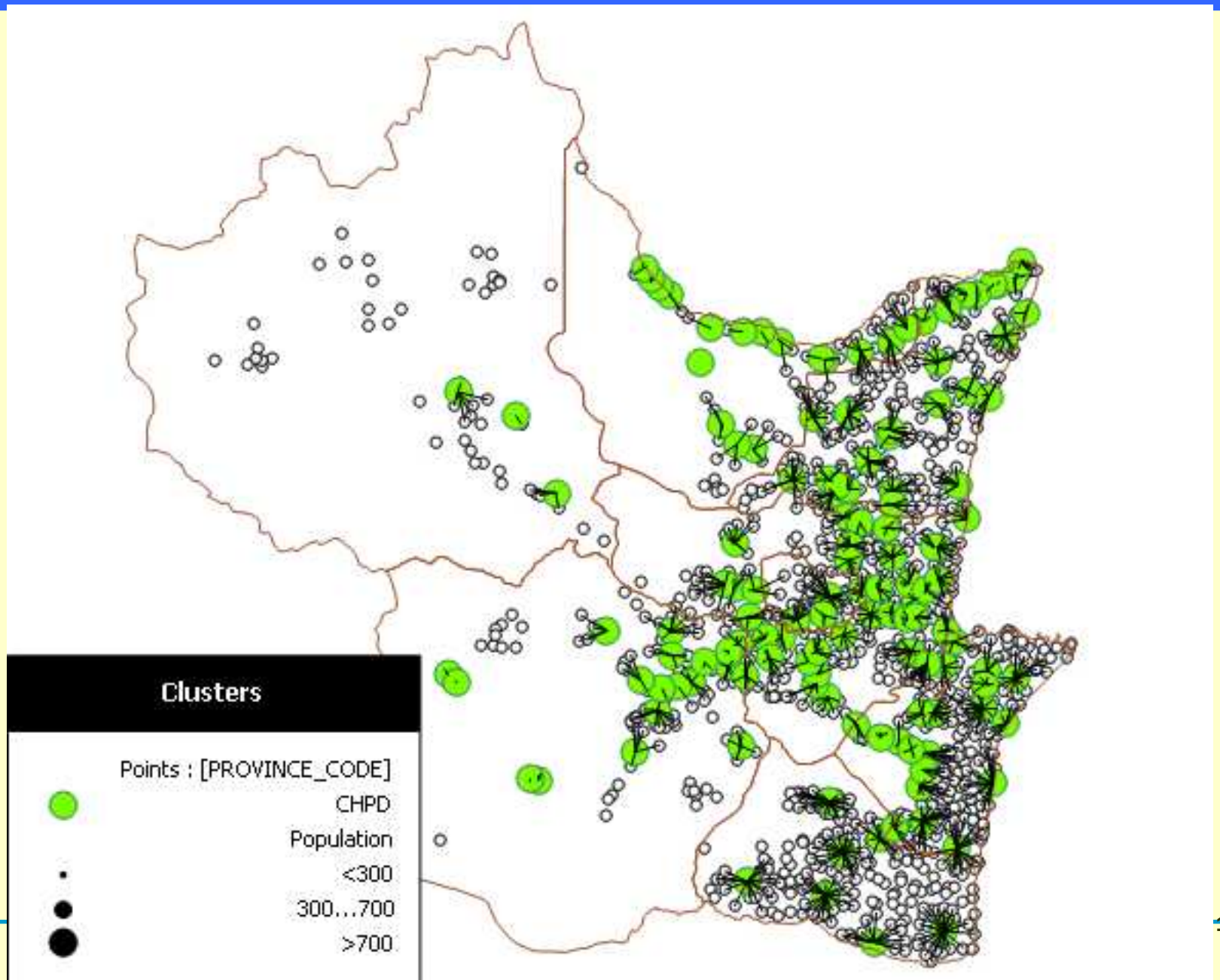
[P. 28]

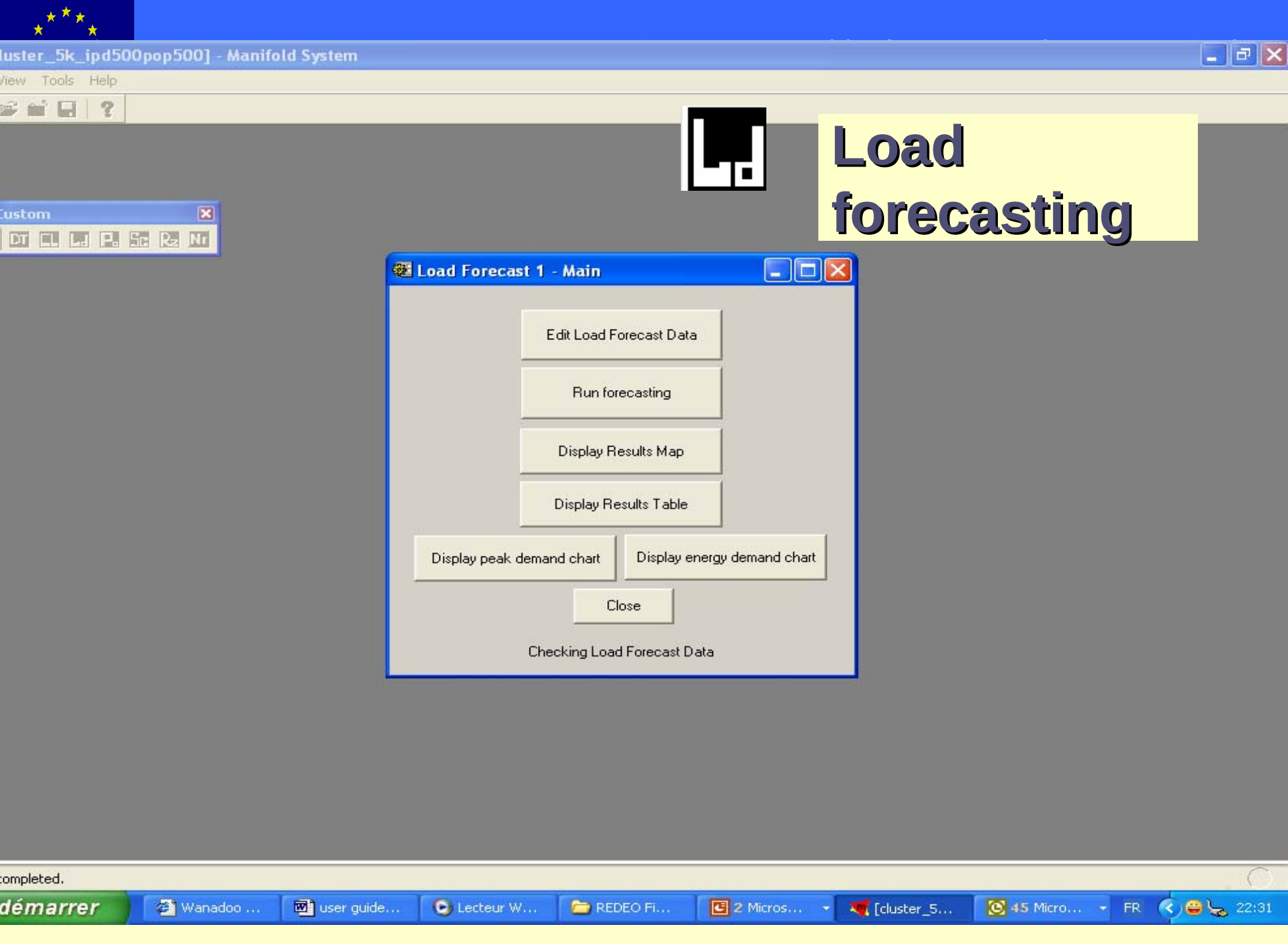


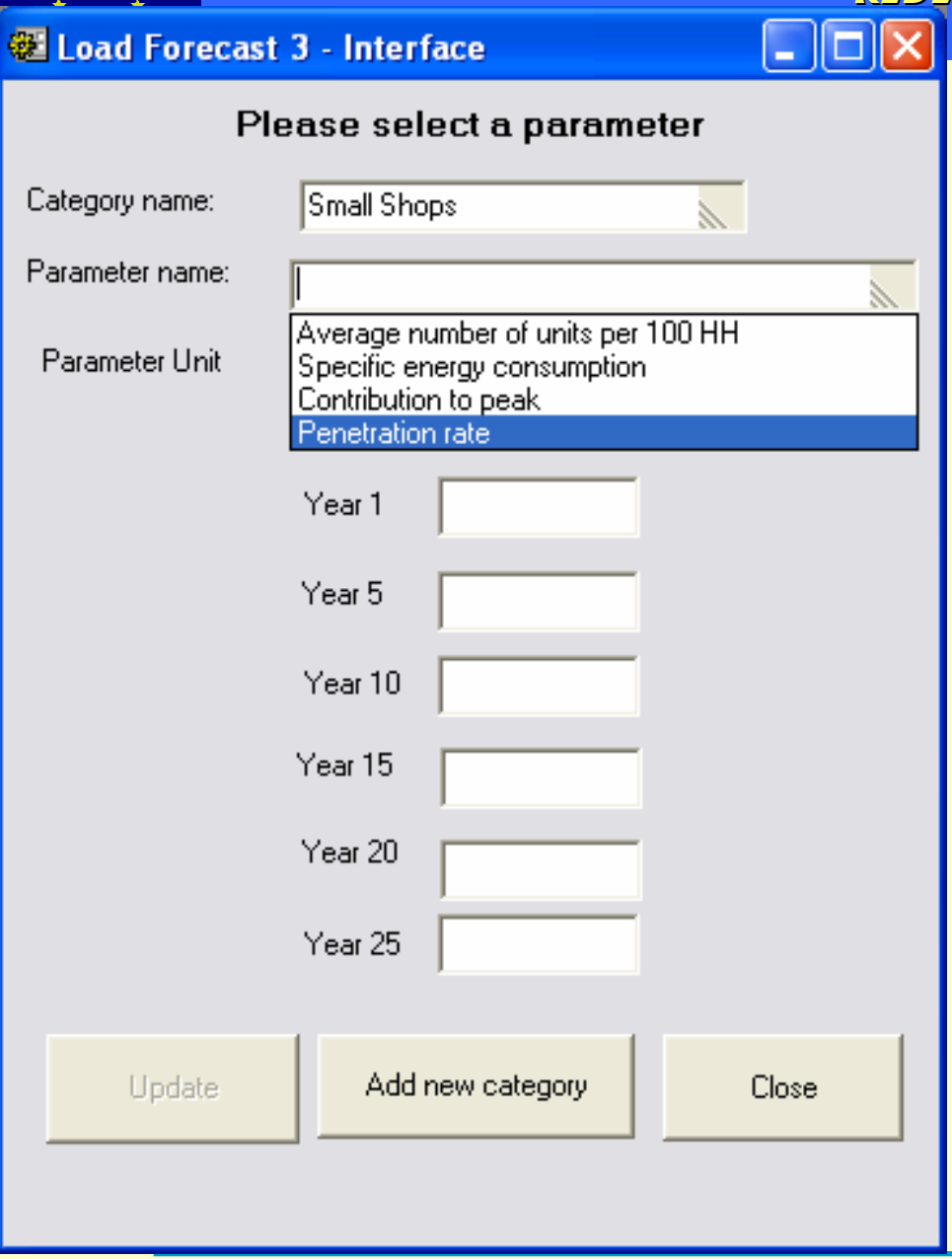


- The user can input additional criteria: min population, number of localities which will become CHPDs, administrative centers automatically integrated
- The user can then manually on the map change a CHPD / OL
- The cluster is generated based on the maximum distance CHPD to OL inputted by the user
- The user can then join / remove an OL manually

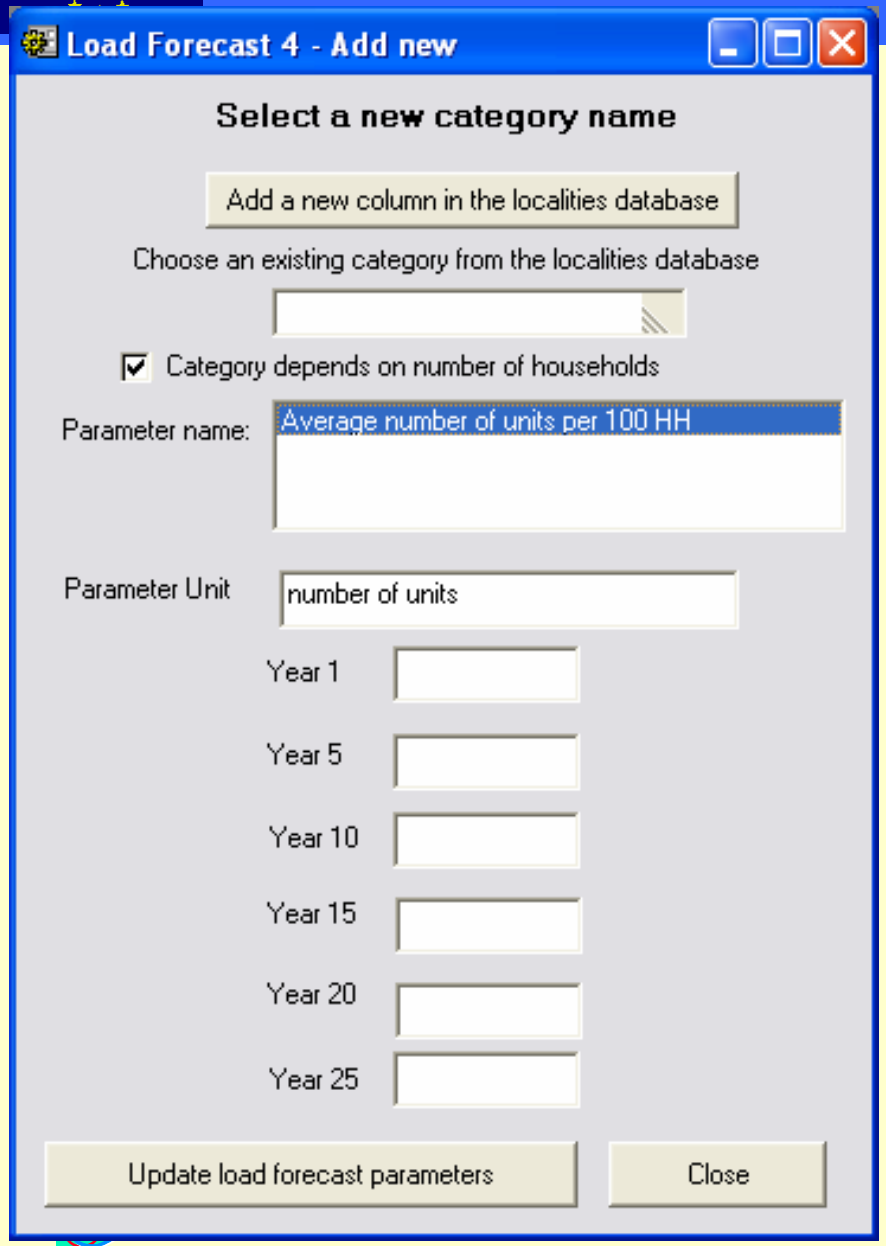

Custom
Clusters
Lines
OL - Other localities
Points
CHPD - Centers with High Potential for Development
Administrative boundaries
Clusters
OL - Other localities
CHPD - Centers with High Potential for Development
Background 3
Background 2
Background 1
Administrative boundaries
not
Bottom
Select
Attach to
Apply

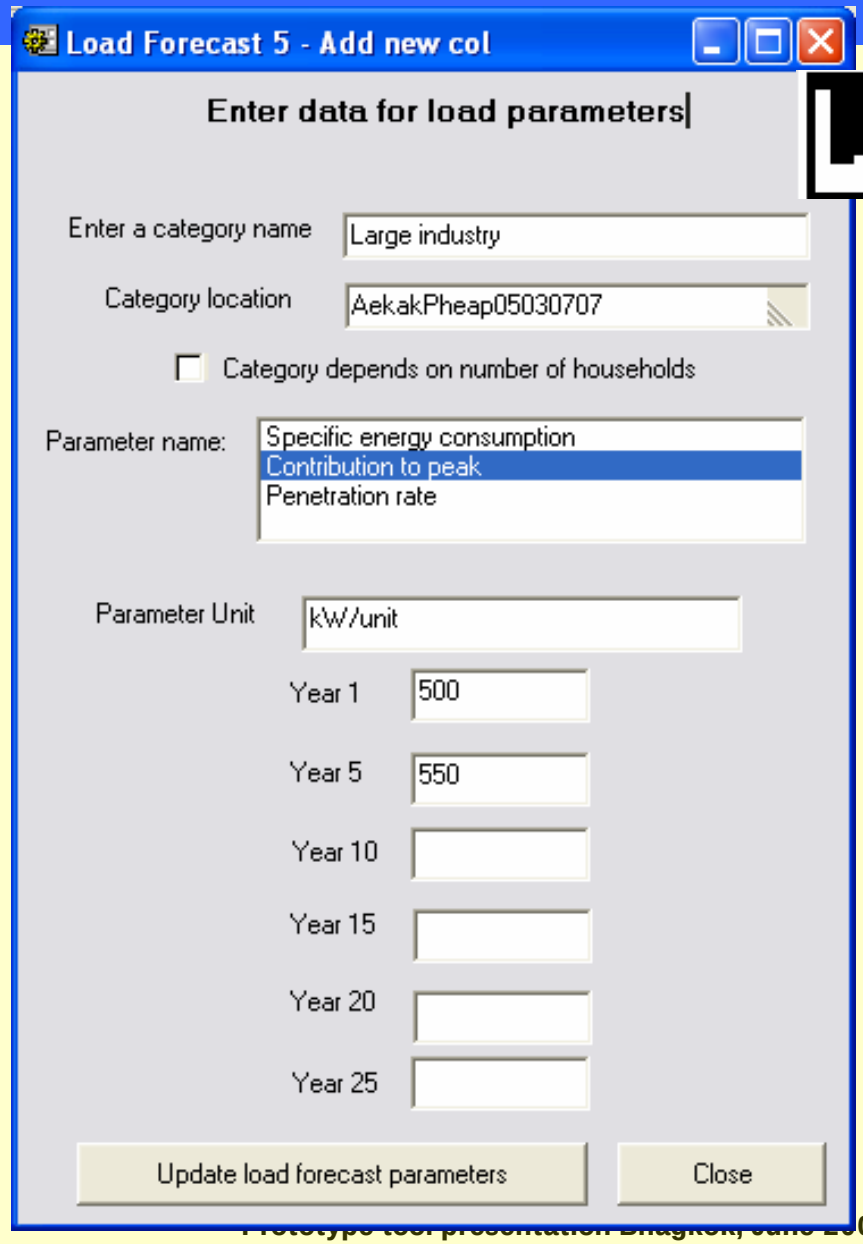

Clusters
Points : [PROVINCE_CODE]
CHPD
Population
<300
300...700
>700


luster_5k_ipd500pop500] - Manifold System
iew Tools Help
Custom
Load Forecast 1 - Main
Edit Load Forecast Data
Run forecasting
Display Results Map
Display Results Table
Display peak demand chart
Display energy demand chart
Close
Checking Load Forecast Data
Load forecasting
completed.
démarrer
Wanadoo ...
user guide...
Lecteur W...
REDEO Fi...
2 Micros...
[cluster_5...
45 Micro...
FR
22:31



- These 4 parameters have to be filled in for each 5 year step
- for each consumer category


Load Forecast 4 - Add new
Select a new category name
Add a new column in the localities database
Choose an existing category from the localities database
Category depends on number of households
Parameter name:
Average number of units per 100 HH
Parameter Unit
number of units
Year 1
Year 5
Year 10
Year 15
Year 20
Year 25
Update load forecast parameters
Close


Load Forecast 5 - Add new col
Enter data for load parameters
Enter a category name
Large industry
Category location
AekakPheap05030707
Category depends on number of households
Parameter name:
Specific energy consumption
Contribution to peak
Penetration rate
Parameter Unit
kW/unit
Year 1
500
Year 5
550
Year 10
Year 15
Year 20
Year 25
Update load forecast parameters
Close

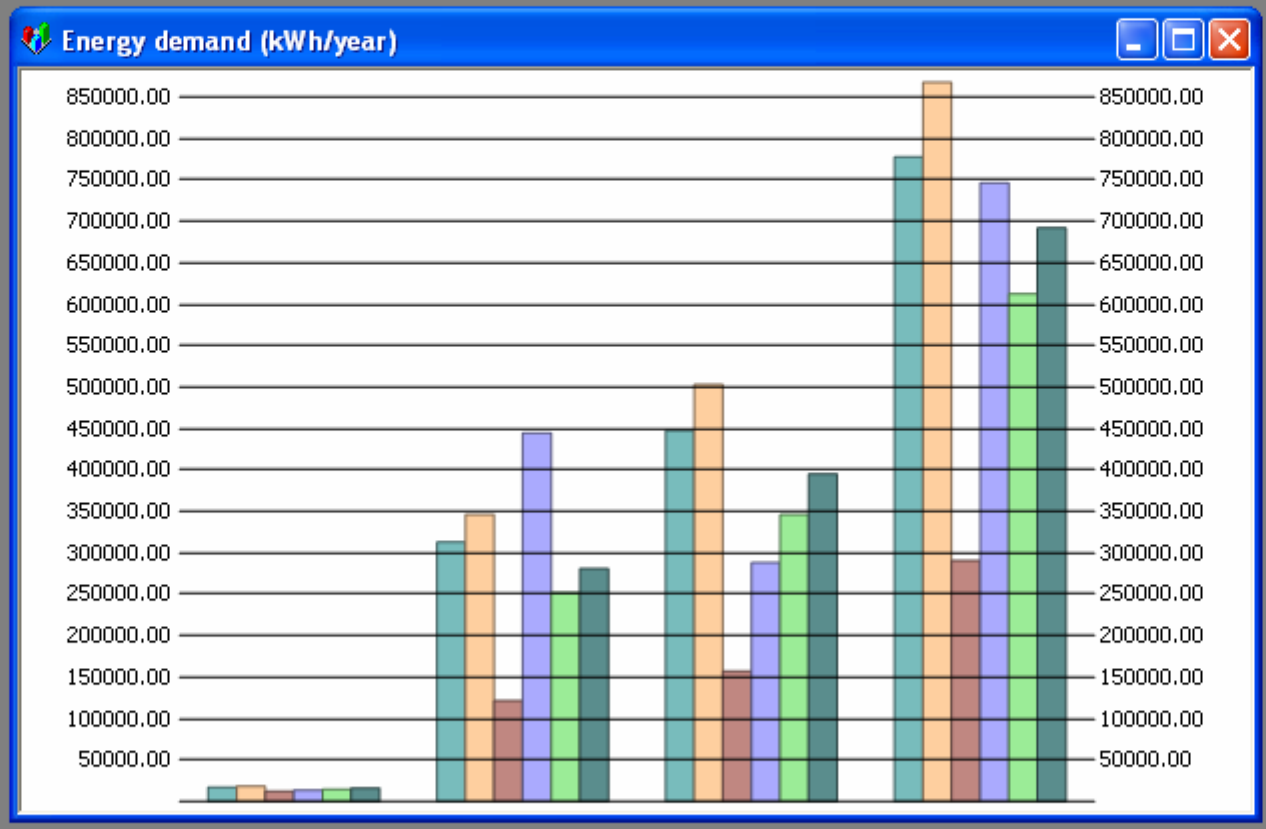
[cluster_5k_lpd500pop500 *] - Manifold System

Edit View Chart Tools Window Help

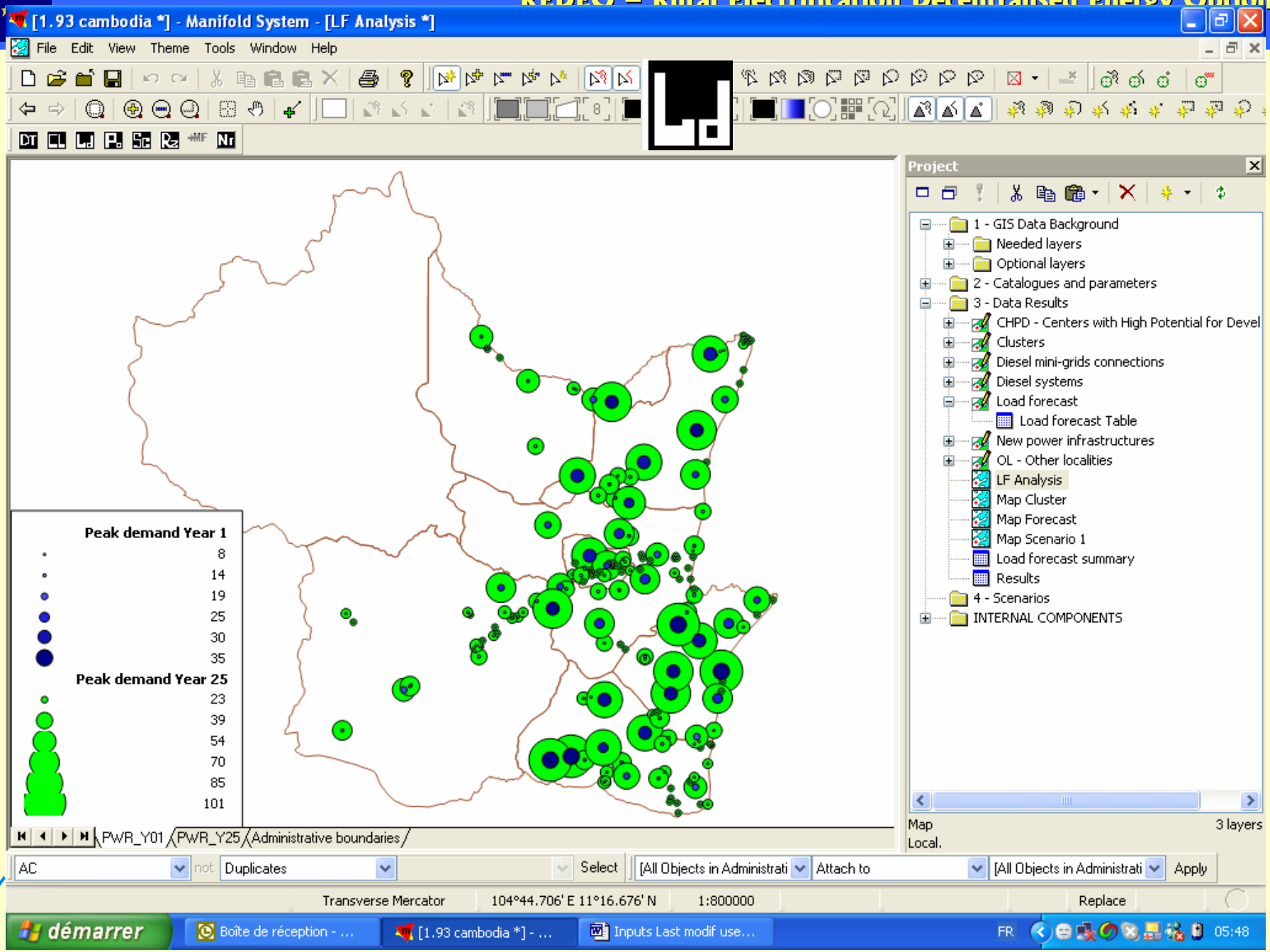
Custom

DT CL PL SC RG NT

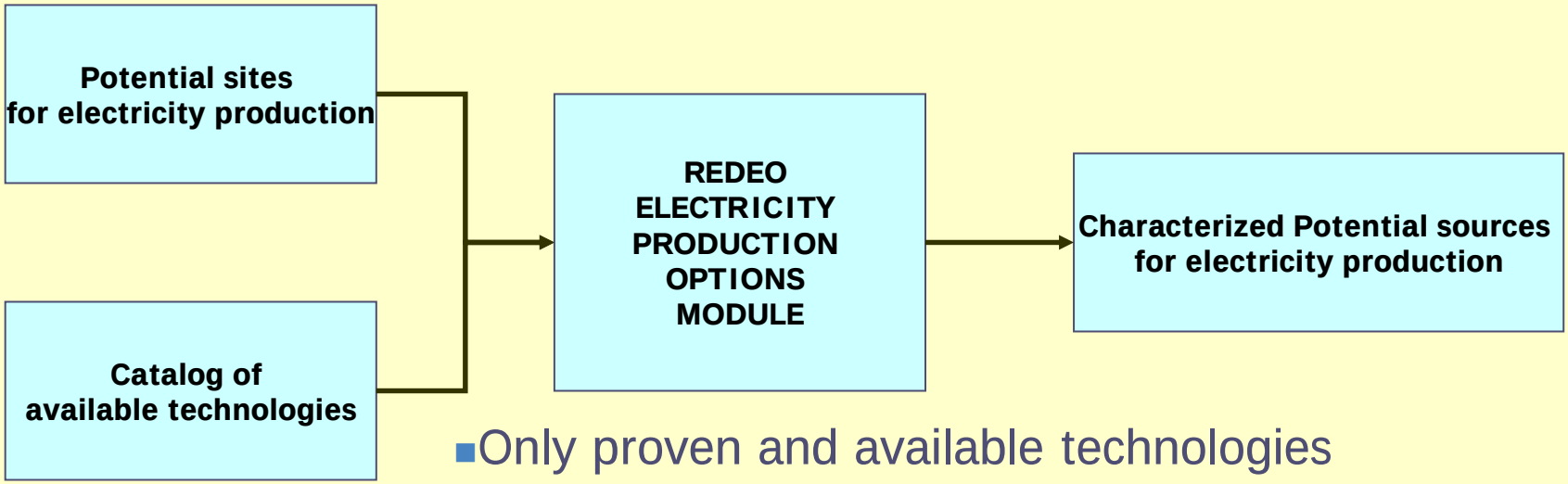
Energy demand (kWh/year)



Replace

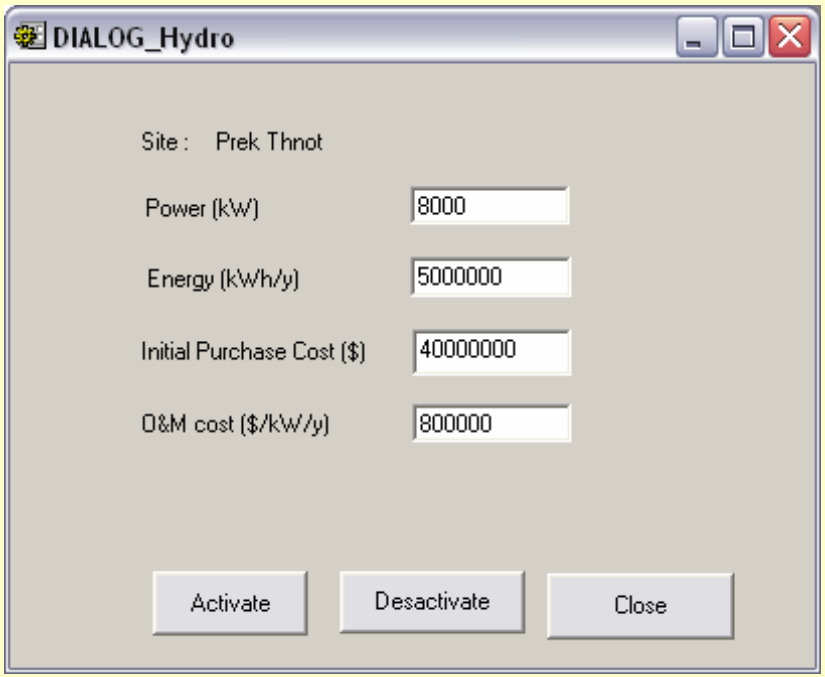

[1.93 cambodia *] - Manifold System - [LF Analysis *]
File Edit View Theme Tools Window Help
Project
1 - GIS Data Background
Needed layers
Optional layers
2 - Catalogues and parameters
3 - Data Results
CHPD - Centers with High Potential for Devel
Clusters
Diesel mini-grids connections
Diesel systems
Load forecast
Load forecast Table
New power infrastructures
OL - Other localities
LF Analysis
Map Cluster
Map Forecast
Map Scenario 1
Load forecast summary
Results
4 - Scenarios
INTERNAL COMPONENTS
Peak demand Year 1
8
14
19
25
30
35
Peak demand Year 25
23
39
54
70
85
101
PWR_Y01
PWR_Y25
Administrative boundaries
Map
3 layers
Local.
AC
not
Duplicates
Select
[All Objects in Administrati
Attach to
[All Objects in Administrati
Apply
Transverse Mercator
104°44.706' E 11°16.676' N
1:800000
Replace
démarrer
Boîte de réception - ...
[1.93 cambodia *] - ...
Inputs Last modif use...
FR
05:48

Production options [p.38]



- Only proven and available technologies
- List of technologies
  - Small hydro-electricity production
  - Biomass electricity production
  - Diesel gensets
  - Connection to existing MV-grid

Small hydro

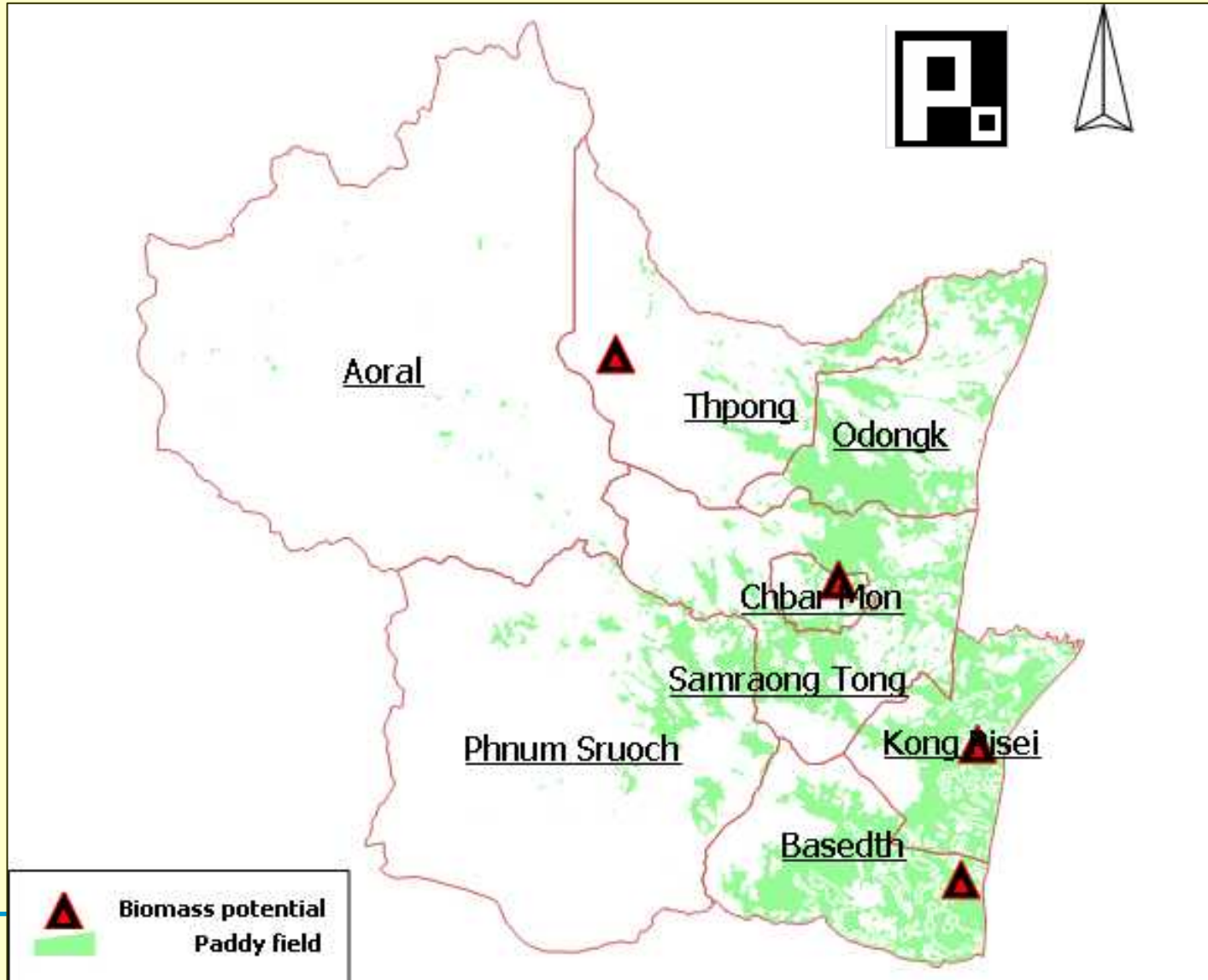


- Data ***inputted*** at the level of the map
- Or input data
- With no link to the catalogue as the information is very site specific

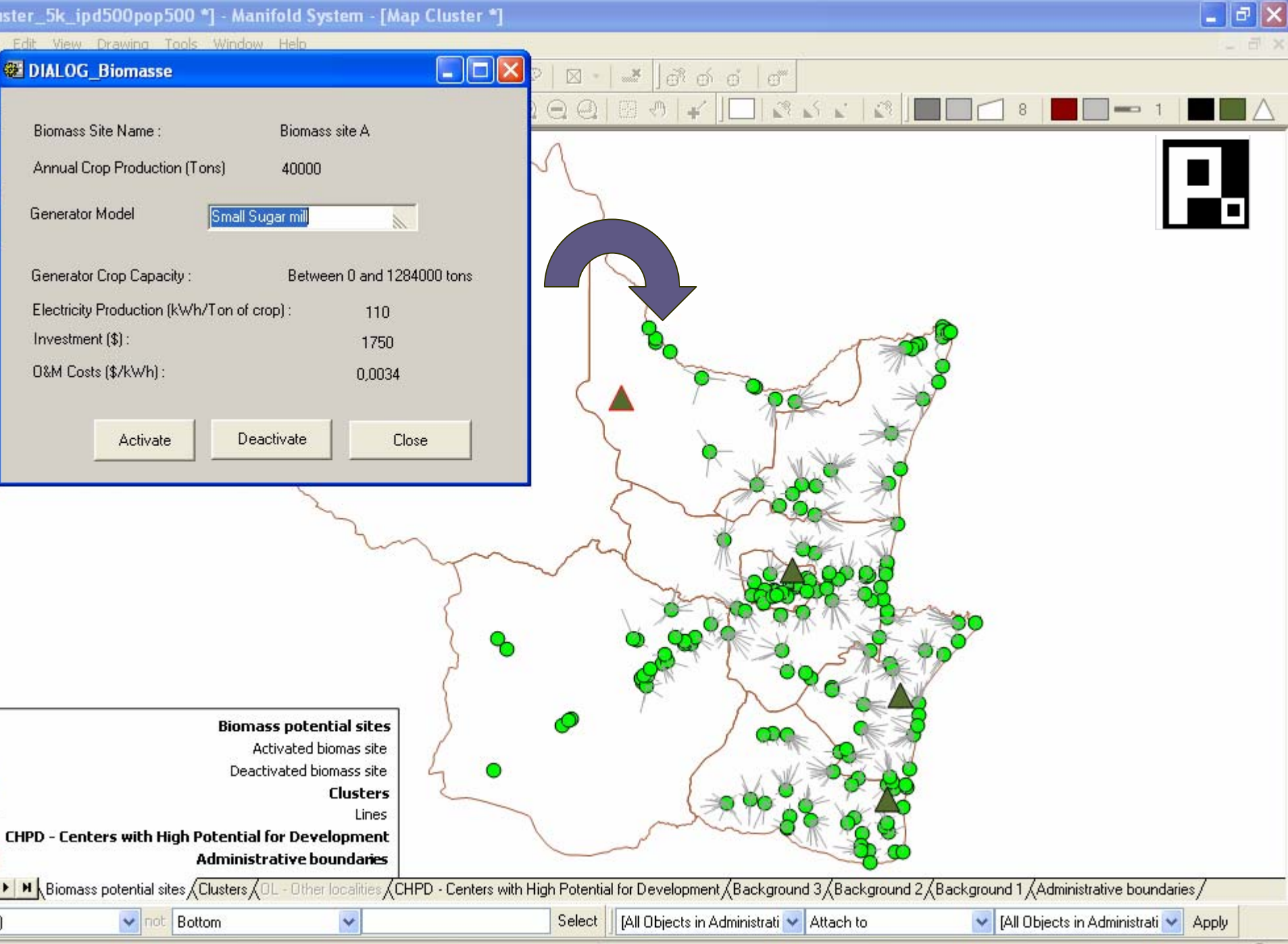
Version with seasonal variation and diesel back up available soon

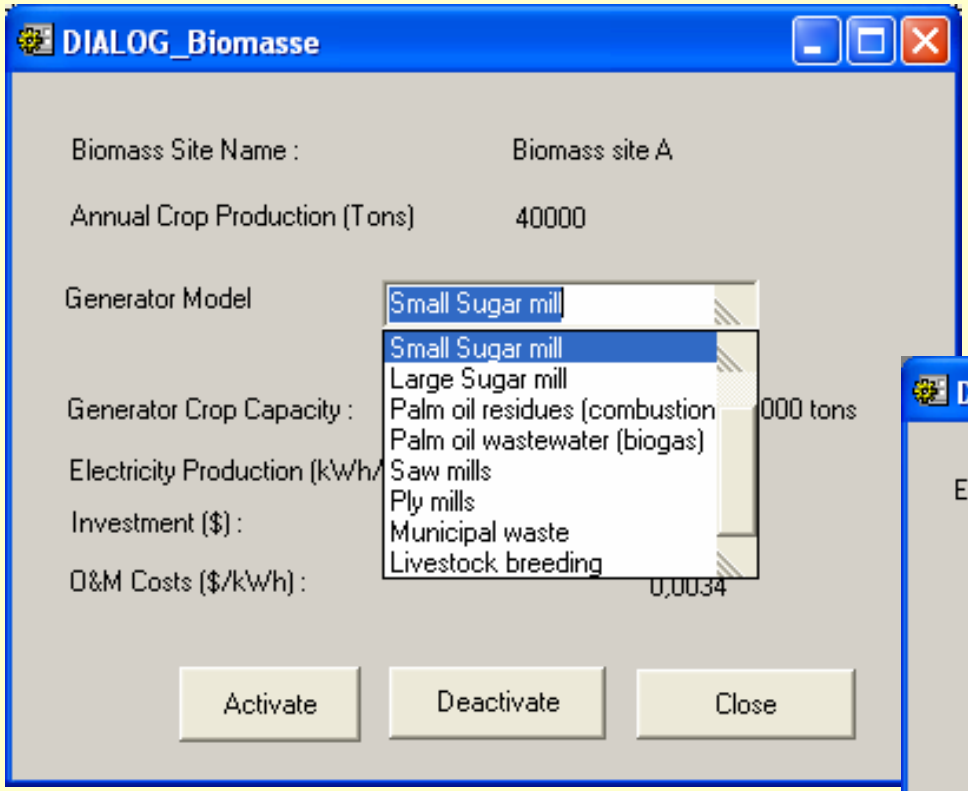
Biomass electricity production – potential sites

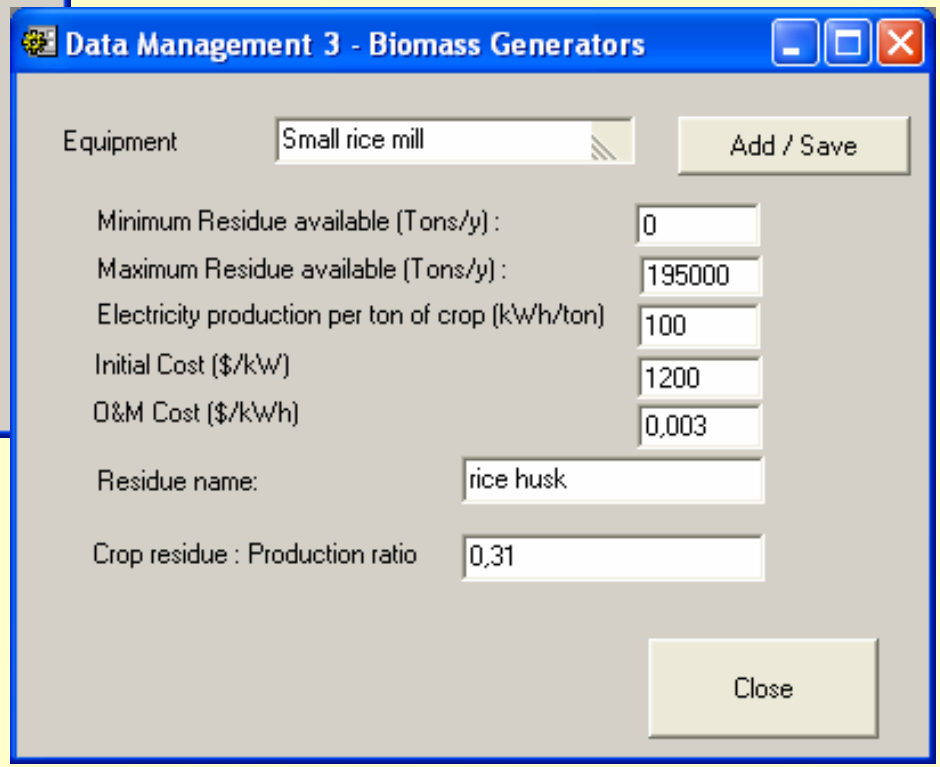
- Potential locations
  - Land-use patterns
  - Agro-industries
- **Potential capacity**
  - Statistics
  - Technologies



IED

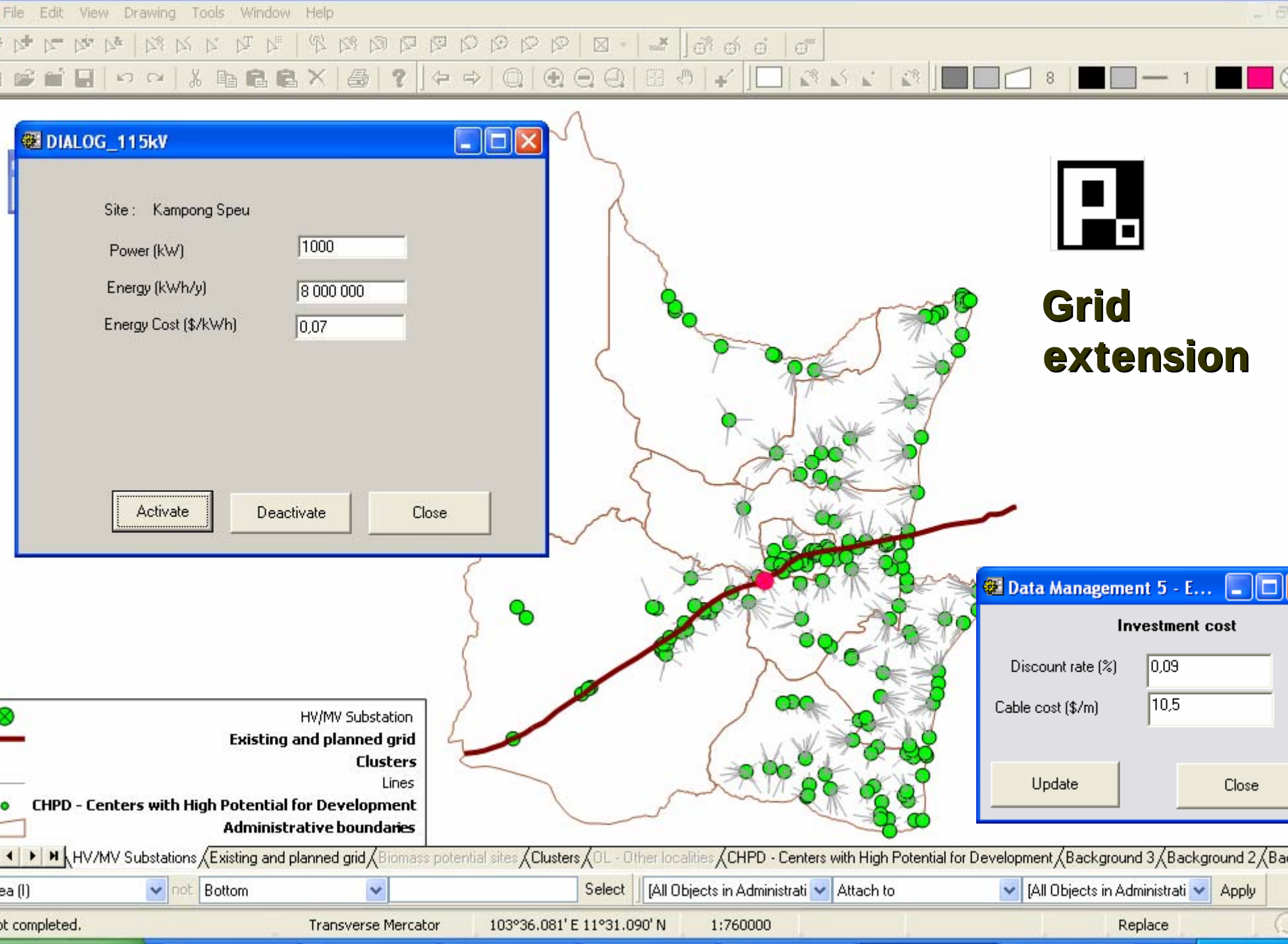

ster_5k_ipd500pop500 *] - Manifold System - [Map Cluster *]
Edit View Drawing Tools Window Help
DIALOG_Biomasse
Biomass Site Name :
Biomass site A
Annual Crop Production (Tons)
40000
Generator Model
Small Sugar mill
Generator Crop Capacity :
Between 0 and 1284000 tons
Electricity Production (kWh/Ton of crop) :
110
Investment ($) :
1750
O&M Costs ($/kWh) :
0,0034
Activate
Deactivate
Close
Biomass potential sites
Activated biomas site
Deactivated biomass site
Clusters
Lines
CHPD - Centers with High Potential for Development
Administrative boundaries
Biomass potential sites
Clusters
OL - Other localities
CHPD - Centers with High Potential for Development
Background 3
Background 2
Background 1
Administrative boundaries
not
Bottom
Select
[All Objects in Administrati
Attach to
[All Objects in Administrati
Apply



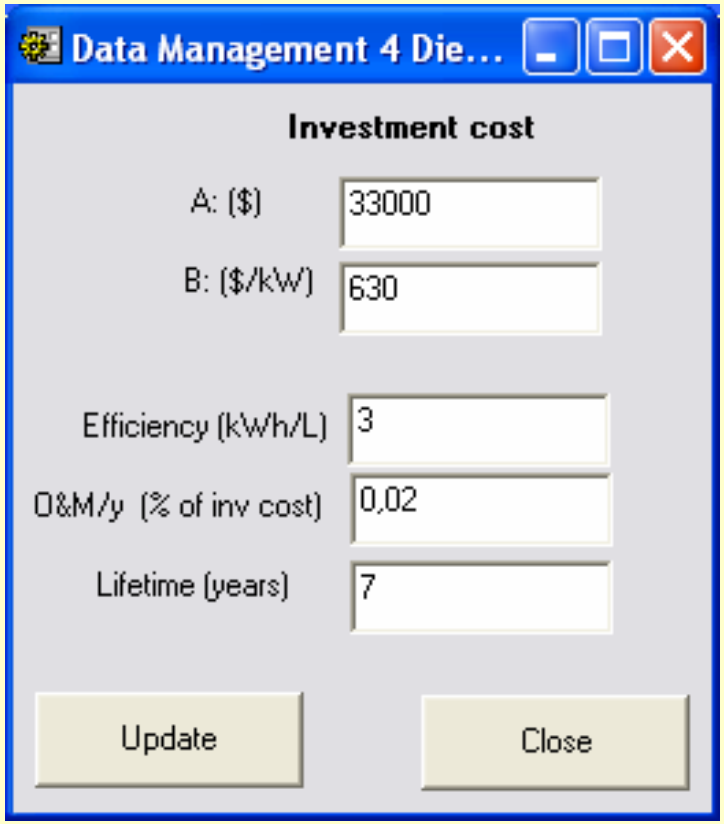


Select technology associated

Add a technology

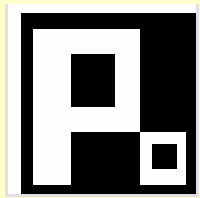

File Edit View Drawing Tools Window Help
DIALOG_115kV
Site : Kampong Speu
Power (kW)
1000
Energy (kWh/y)
8 000 000
Energy Cost ($/kWh)
0,07
Activate
Deactivate
Close
Grid extension
Data Management 5 - E...
Investment cost
Discount rate (%)
0,09
Cable cost ($/m)
10,5
Update
Close
HV/MV Substation
Existing and planned grid
Clusters
Lines
CHPD - Centers with High Potential for Development
Administrative boundaries
HV/MV Substations
Existing and planned grid
Biomass potential sites
Clusters
OL - Other localities
CHPD - Centers with High Potential for Development
Background 3
Background 2
Bottom
Select
Attach to
Apply
Transverse Mercator
103°36.081' E 11°31.090' N
1:760000
Replace

Diesel option



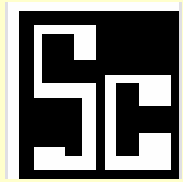
capacity	investment cost	price/kW installed
50 kW	64500 $	1290 $/kW
100 kW	96000 $	960 $/kW
200 kW	159000 $	795 $/kW
500 kW	348000 $	696 $/kW
1000 kW	663000 $	663 $/kW

Fuel cost per litre every year.



- Evolve the tool:
  - With other technologies ?
  - Grid connection of renewables ?
  - Hybrids re. Seasona effects.

Electrification scenarios [p. 42]



- Helping the user to define a scenario
  - I.e. a way to electrify the province
- Options can be considered in various orders
  - Only biomass and hydro
- And everything can be changed by hand

Approach

1. Cost of supplying each cluster with a diesel genset is computed:
   - Average life cycle kWh cost

2. For Hydro and Biomass, the resource is deployed as long as :
   - There is sufficient capacity and energy available
   - The average life cycle kWh cost is cheaper than that of diesel

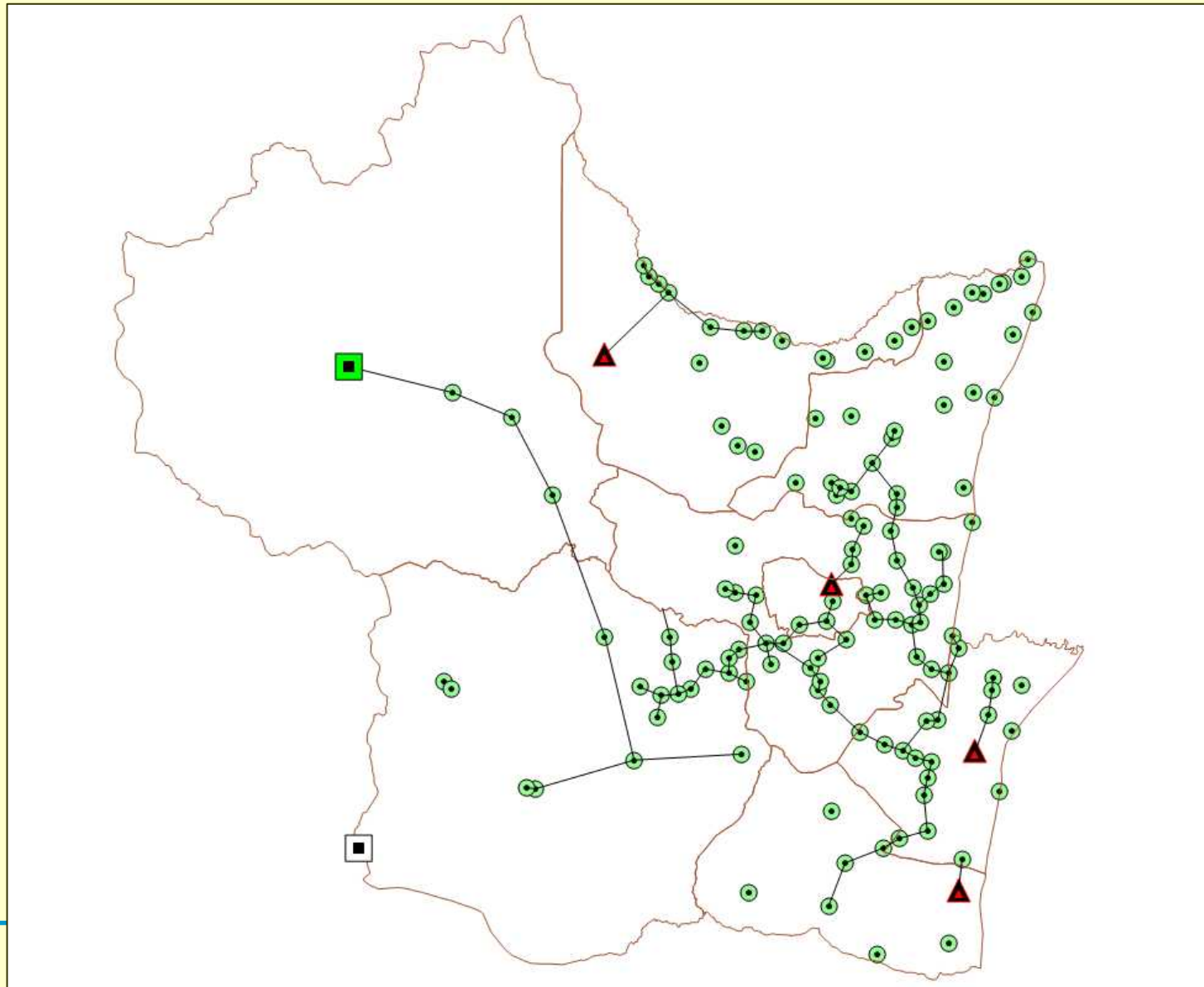
A version with seasonality and hybrids will be shortly available

Approach

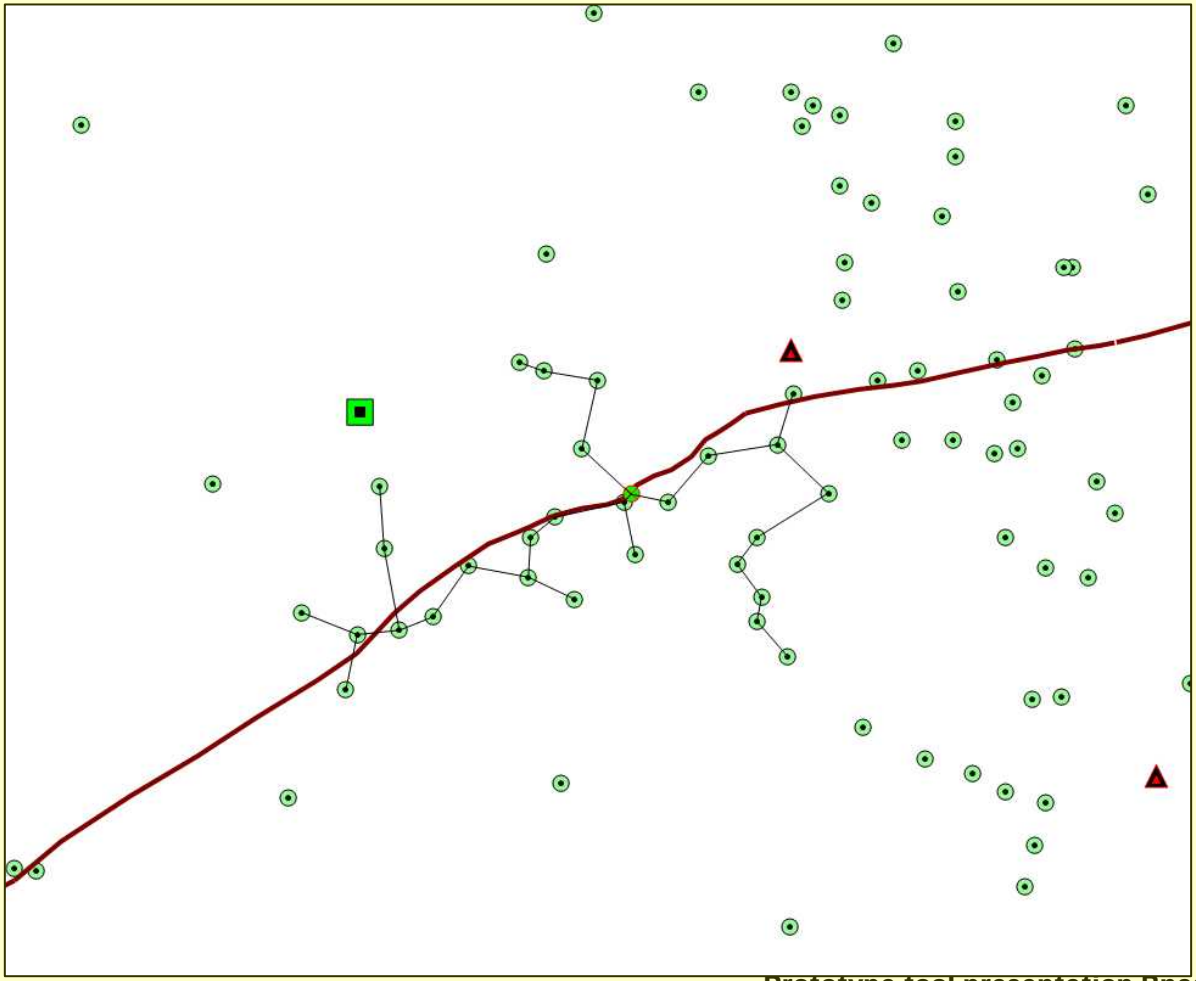
3. For grid extension, the grid is deployed as long as:
   - There is sufficient capacity and energy available
   - The average life cycle kWh cost is cheaper than that of diesel for the considered cluster

4. Balance clusters are then electrified either through isolated diesel gensets per cluster or by associating 2 clusters integrating the cost of the line connection.

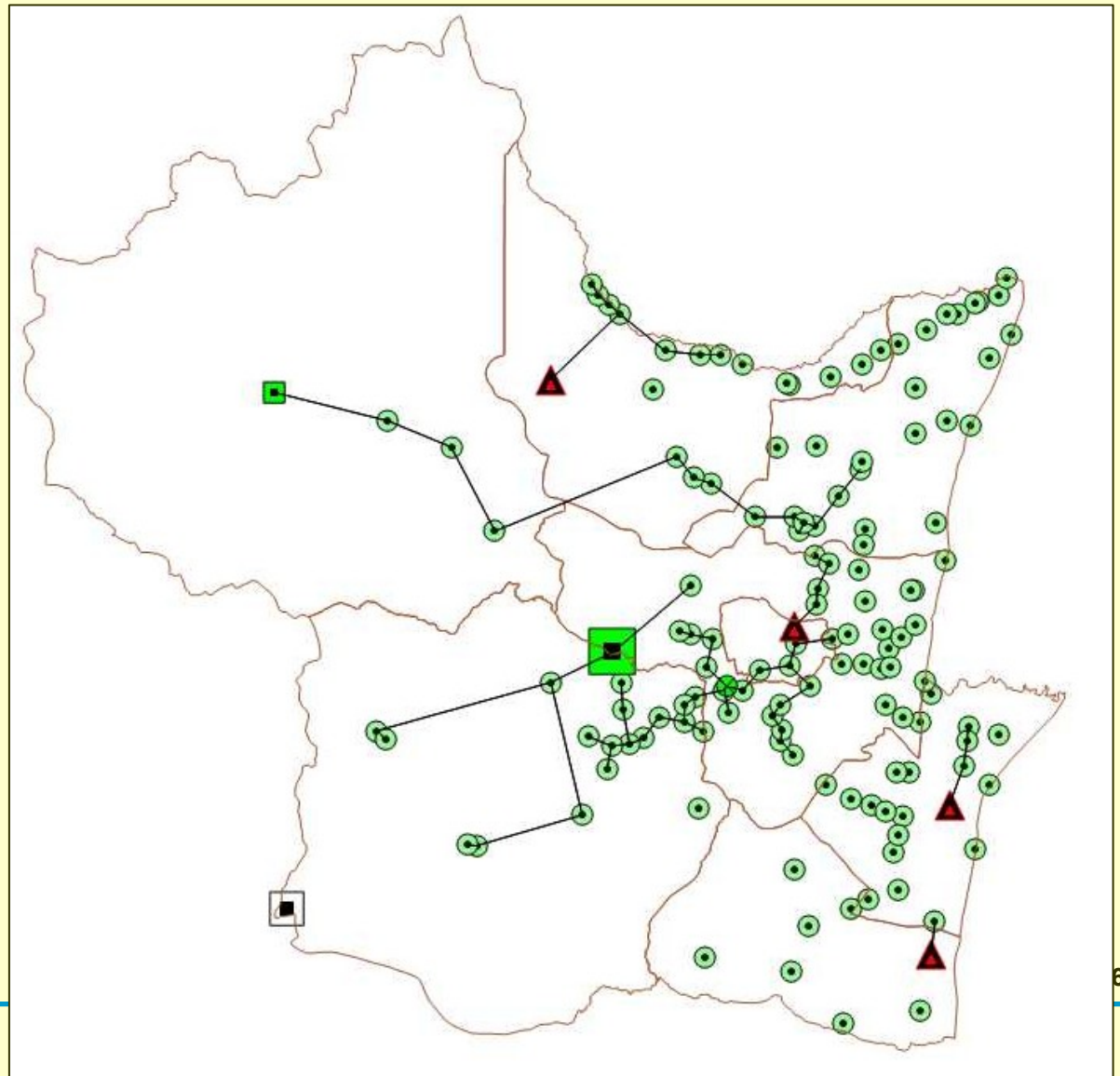
Only biomass and hydro



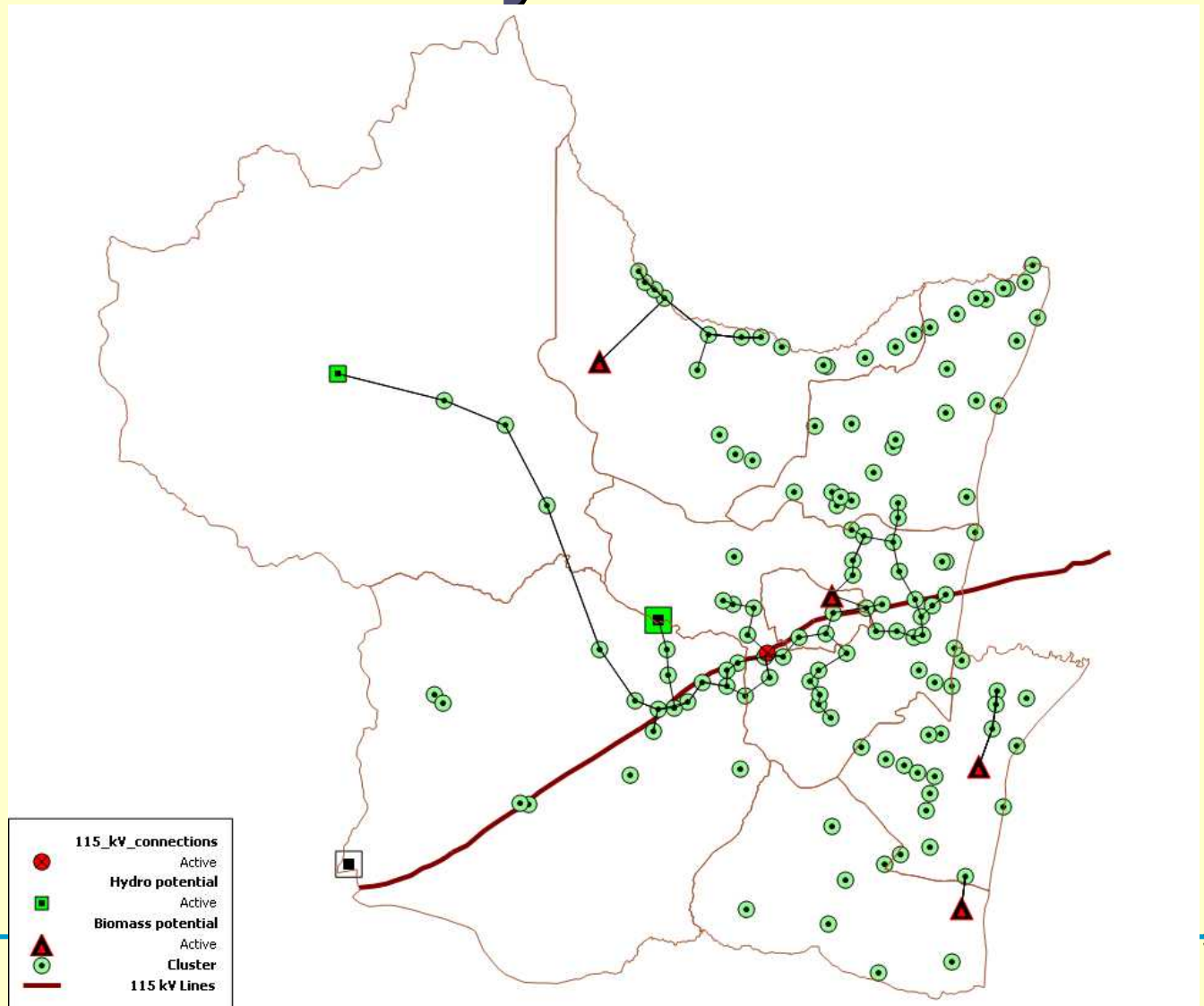
Potential connection to the grid



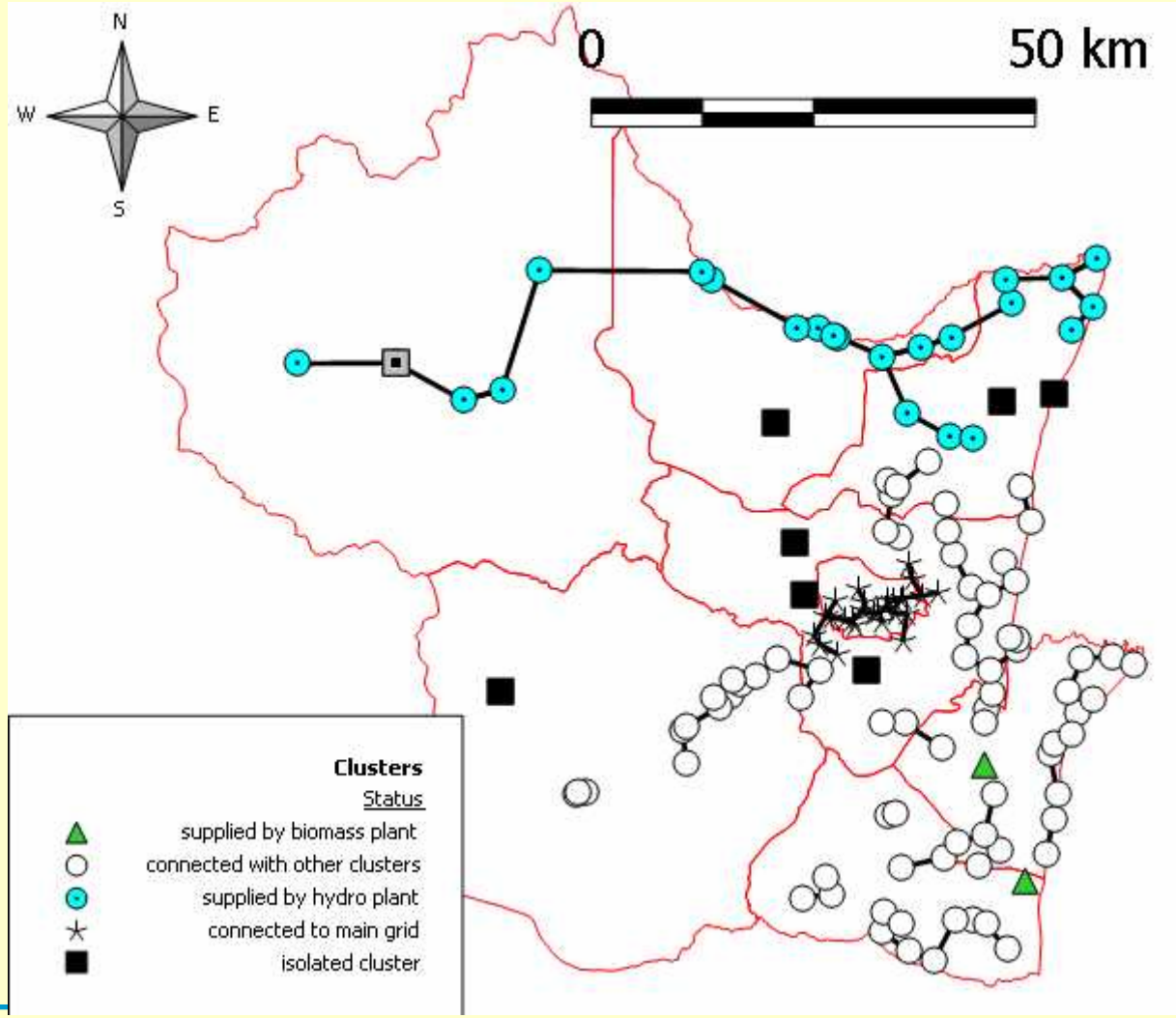
Grid extension first then biomass and hydro

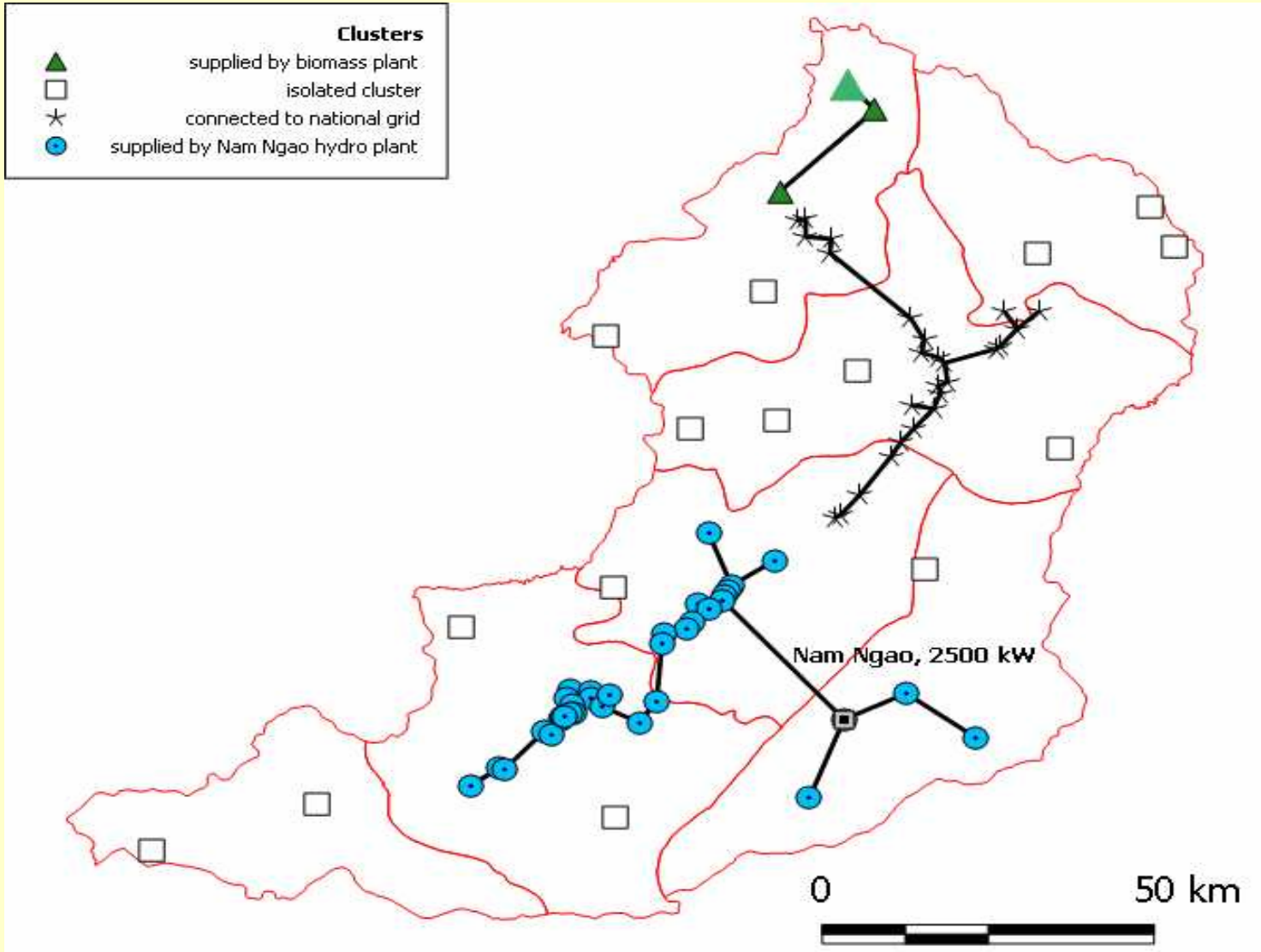


Grid extension after hydro

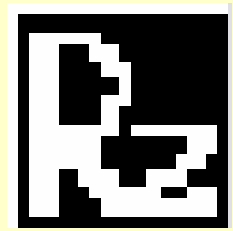


Example of final scenario – with diesel minigrids




Clusters
supplied by biomass plant
isolated cluster
connected to national grid
supplied by Nam Ngao hydro plant
Nam Ngao, 2500 kW
0
50 km

n°	technology	pop. covered	investment cost	kWh life-cycle cost	annual O&M costs (y0)
1	hydro	89 673	6 200 000	4,137	124 000
2	grid extension	71 845	557 500	7,19	11 150
3	biomass	9 228	700 000	6,754	20 119
4	biomass	5 905	700 000	6,8	21 670
5	isolated cluster	5 615	188 106	8,33	80 901
6	isolated cluster	6 879	206 376	8,34	89 989
7	isolated cluster	3 872	123 090	8,59	46 339
8	isolated cluster	2 789	97 764	8,82	32 338
9	isolated cluster	4 100	148 290	8,51	60 183
10	isolated cluster	6 087	226 158	8,47	101 367
11	isolated cluster	5 607	165 930	8,4	68 027
12	mini-grid	21 071	540 782	8,19	217 014
13	mini-grid	12 856	430 196	8,43	151 202
14	mini-grid	13 080	361 424	8,16	156 236
15	mini-grid	41 402	1 448 216	8,31	514 228
16	mini-grid	43 671	1 658 206	8,35	619 025
17	mini-grid	45 298	1 352 390	8,26	508 242
18	mini-grid	73 413	2 565 780	8,28	1 030 098
19	mini-grid	8 697	300 142	8,46	108 032
20	mini-grid	30 476	930 932	8,23	370 136
21	mini-grid	43 362	1 351 592	8,24	540 473
	TOTAL	544 926	20 252 874		4 870 770



Results for each project

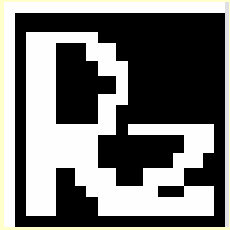
Average tariff

INTERNAL RATE OF RETURN

Human development indices provided

Indicator	Unit	year 0	year 10	year 20
Households electrification rate	%	27%	46%	55%
Localities electrification rate	%	71%		
Percentage of health centers being electrified	%	100%		
% of population having access to « electrified » health center	%	100%		
Mean distance to a non-electrified health center	Km	17,10		
Mean distance to an electrified health center	Km	17,10		
Percentage of schools being electrified	%	71%		
% of population having access to « electrified » primary school	%	40%		
Mean distance to a non-electrified primary school	Km	1,16		
Mean distance to an electrified primary school	Km	2,57		

Financial analysis for a given project or a combination of projects



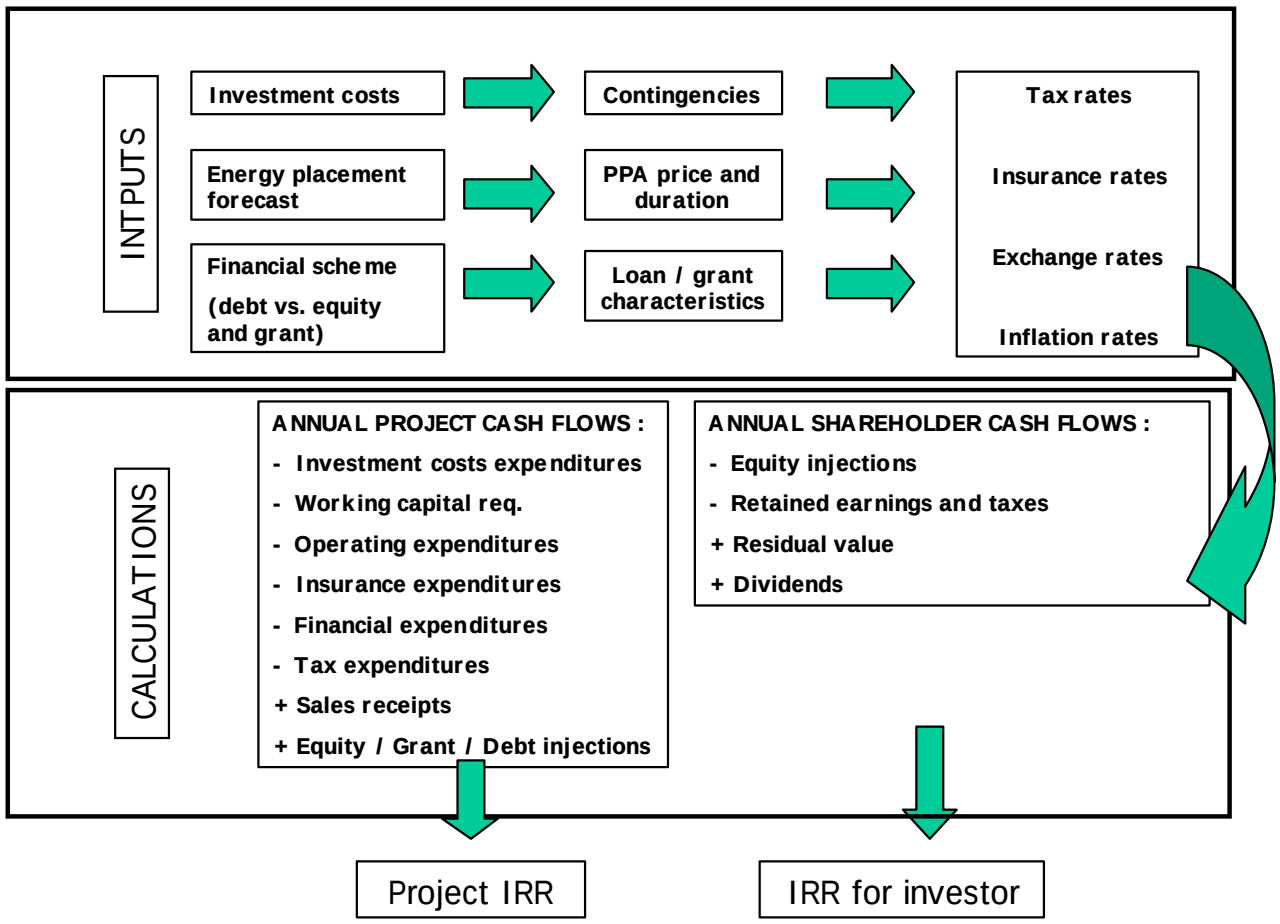
- Input fiscal information – taxation, duties, ...
- Input financing scheme
  - two credit facilities (duration, grace, interest rate)
  - percentage of equity

↓

Financial kWh cost

Return on equity for the investor

Financial analysis module



UPCOMING

1. FINANCIAL ANALYSIS MODULE
2. LAUNCHING OF THE PROVINCIAL LEVEL STUDIES, TRAINING FOR LAOS AND CAMBODIA
3. AWAITING RESPONSE FROM EAEF FOR SUPPORTING INDONESIA AND THE PHILIPPINES

Thank you for your attention and your collaboration

Anjali SHANKER
Director – IED

www://ied-sa.fr

Rural Electrification in Brazil and Bangladesh: Lessons for CLV countries

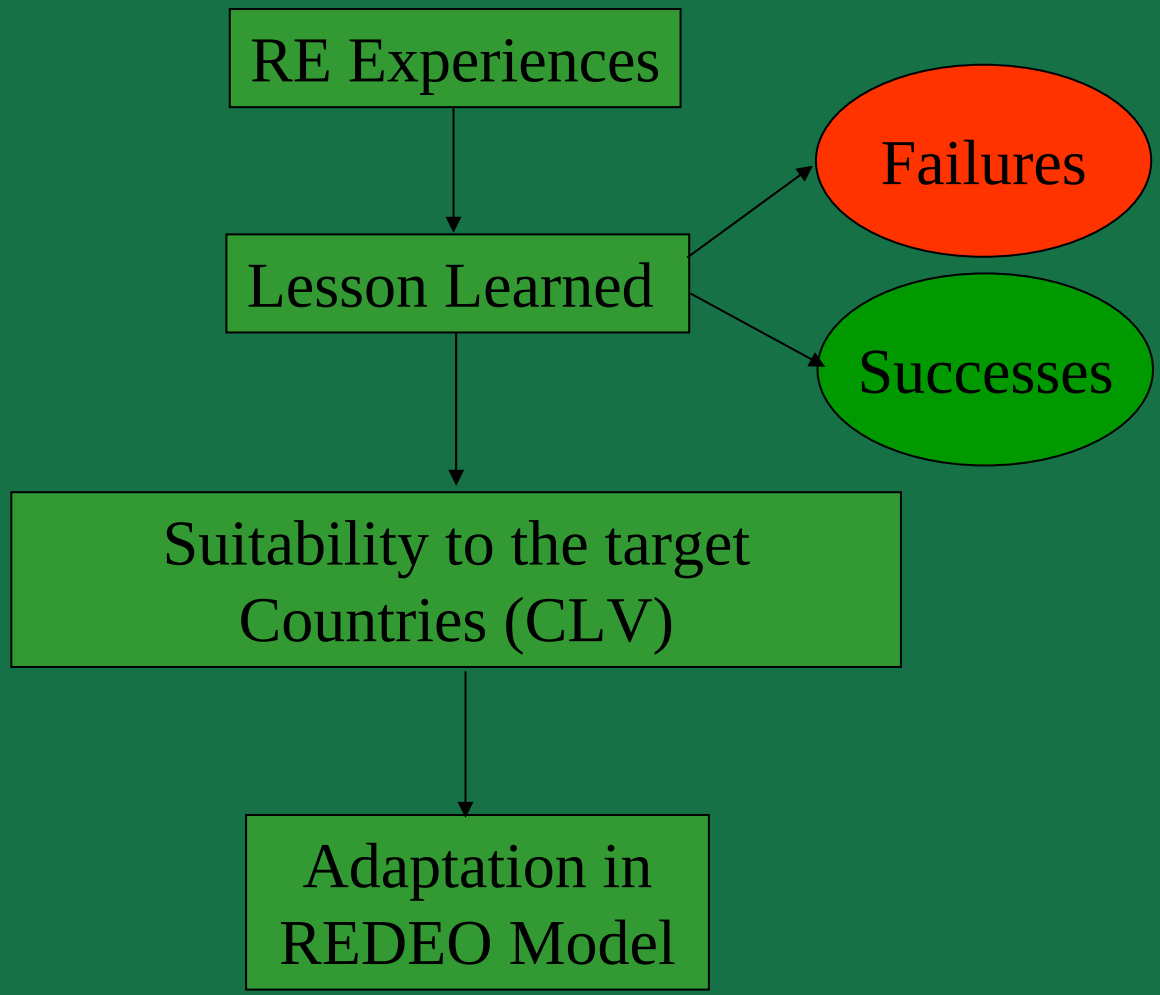
Dr. N. Mithulananthan, S. Kumar, Ram M. Shrestha

June 30, 2005 – July 1, 2005

Outline

- Objective
- Country Background
- Power System and Electrification Status
- Stakeholders
- Rural Electrification Approach
- Tax Incentives on Renewable Energy Technologies
- Rural Electrification Best Practices
- Conclusion

Objective


RE Experiences
Lesson Learned
Failures
Successes
Suitability to the target Countries (CLV)
Adaptation in REDEO Model

Background - Brazil

- **Background**

- **5th** largest country, **15th** largest economy and **10th** largest power system in the world with installed capacity of **86.5 GW** (2003)

- In term of population, it is **14** times larger than Cambodia, **31** times larger than Lao PDR and just two time larger than Vietnam.

- The population density in Brazil, Cambodia, Lao PDR and Vietnam is **21, 74, 24 and 245** inhabitant per sq. km.

Background - Bangladesh

- **Background**

- **8th** most populated country in the world, however the land area is smaller than the CLV countries.
- In terms of population, it is **10** times larger than Cambodia, **24** times larger than Lao PDR and little less than two time larger than Vietnam.
- The population density in Bangladesh, Cambodia, Lao PDR and Vietnam is **959, 74, 24 and 245** inhabitant per sq. km.

Comparison with CLV countries

Data for year 2003	Brazil	Bangladesh	Cambodia	Lao PDR	Vietnam
Population, million (world rank)	176.6 (5)	138.1 (8)	13.4 (61)	5.7 (99)	81.3 (14)
Surface Area, 1000 Sq. km.	8515	144	181	236.8	331.7
Population density, inhabitant/sq. km.	21	959	74	24	245
GDP, billion US$ (world rank)	492.3 (15)	51.9 (54)	4.2 (125)	2.1 (140)	39.2 (58)

Power System and Electrification Status - Brazil

- **Power System and Electrification Status**

- Power Sector is deregulated, presently **64** distribution companies operating to distribute electricity to end users

- Total installed capacity is **86.5 GW** and hydropower contribute to **90.6%** of total installed capacity (2003).

- The country has set target of reaching **100%** electrification by **2015**.

- Around **93%** of the total population has access to electricity; **99%** of urban population has access to electricity while for rural population the rate is **69%.**

- Also there is regional disparity in access to electricity. The isolated North and Northeast regions have less electricity coverage.

- The isolated region are largely being served by Diesel Generators and are slowly moving towards renewable**.**

Power System and Electrification Status - Bangladesh

- **Power System and Electrification Status**
- Power Sector is reformed, and the distribution in the rural areas is the responsibility of the **67** independent consumer-owned cooperatives known as "*Palli Bidyut Samities (PBSs)"*, functioning under the umbrella of an apex organization the Rural Electric Board (REB).
- The total installed capacity is **4680 MW** (2003).
- Natural gas is the major fuel for electricity generation and contribute to **84.5%** of the total installed capacity.
- The country has set target of reaching **100%** electrification by **2020**.
- Rural population constitutes **76%** of total population.
- Around **32%** of the total population has access to electricity;
- Only **15%** of rural population has access to electricity,

Comparison with CLV Countries

Data for year 2003	Brazil	Bangladesh	Cambodia	Lao PDR	Vietnam
Installed capacity (MW)	86,500	4,680	187	683	10,010
Generation characteristics	90.6% hydro	84.5% natural gas	84% diesel	97% hydro	44% hydro, 31% gas
Electrification Coverage (% of household)	93	32	15	40	83.5%

Stakeholders in Rural Electrification - Brazil

- **Public Sector:**
  - **Ministry of Mines and Energy (MME) –** Government agency in charge of energy policies.
  - **National Electric Power Regulatory Agency (ANEEL) –** Regulator and supervisor of the generation, transmission and distribution and lease of electric energy; issue concessionary contracts.
  - **National Council for Energy Policy (CNPE) –** To ensure structure and stable supply of electric utilities
  - **Concessionaires and Permissionaires -**
  - **Cooperatives**
- **Non Profit Entities:**
  - **Reference Center –** There are reference centers for Small Hydro, Solar and Wind, Biomass that promotes the development of renewable energy by information dissemination, fostering dialogue between those involved and supporting studies and projects.

Stakeholders in Rural Electrification - Brazil

- **Non Profit Entities:**
  - **RENOVE (National Network of Civil Society Organizations for Renewable Energy) –** Network of NGOs that supports commercializing of RE technologies through capacity building for energy policy makers, technical assistance, small demonstration project etc.
  - **NGOs –** Different NGOs support renewable energy program, specially solar home systems.
- **Private Sector:**
  - **ABEER (Brazilian Association of Renewable Energy Companies) –** it is the association of PV companies doing business in Brazil.
  - **APMPE (Brazilian Association of Small and Medium Size Electric Power Producers) –** it is an association of companies that are involved primarily in small hydropower sector.

Stakeholders in Rural Electrification - Bangladesh

- **Government Organizations:**
  - **Bangladesh Power Development Board (BPDB) –**Carries out distribution in most of the areas except Dhaka and its adjoining areas and some rural areas. Also involved in dissemination of centralized solar PV system.
  - **Local Government Engineering Department (LGED) –** Vital player in rural infrastructure development including solar energy, it also execute Renewable Energy Information Network (REIN) to disseminate information regarding RE through its comprehensive web database
- **Semi-Government Organizations:**
  - **Rural Electrification Board (REB) –** Responsible for rural electricity supply and implementation rural electrification specifically through national grid extension.
  - Execute rural electrification through ***Pali Bidyut Samities*** (PBS) based on the model of Rural Electric Co-operatives in USA.
  - PBS operates and manages a rural distribution system within its area of jurisdiction and is an autonomous organization registered with REB.
  - The consumers participate in policy making of PBS through elected representative to PBS governing body.

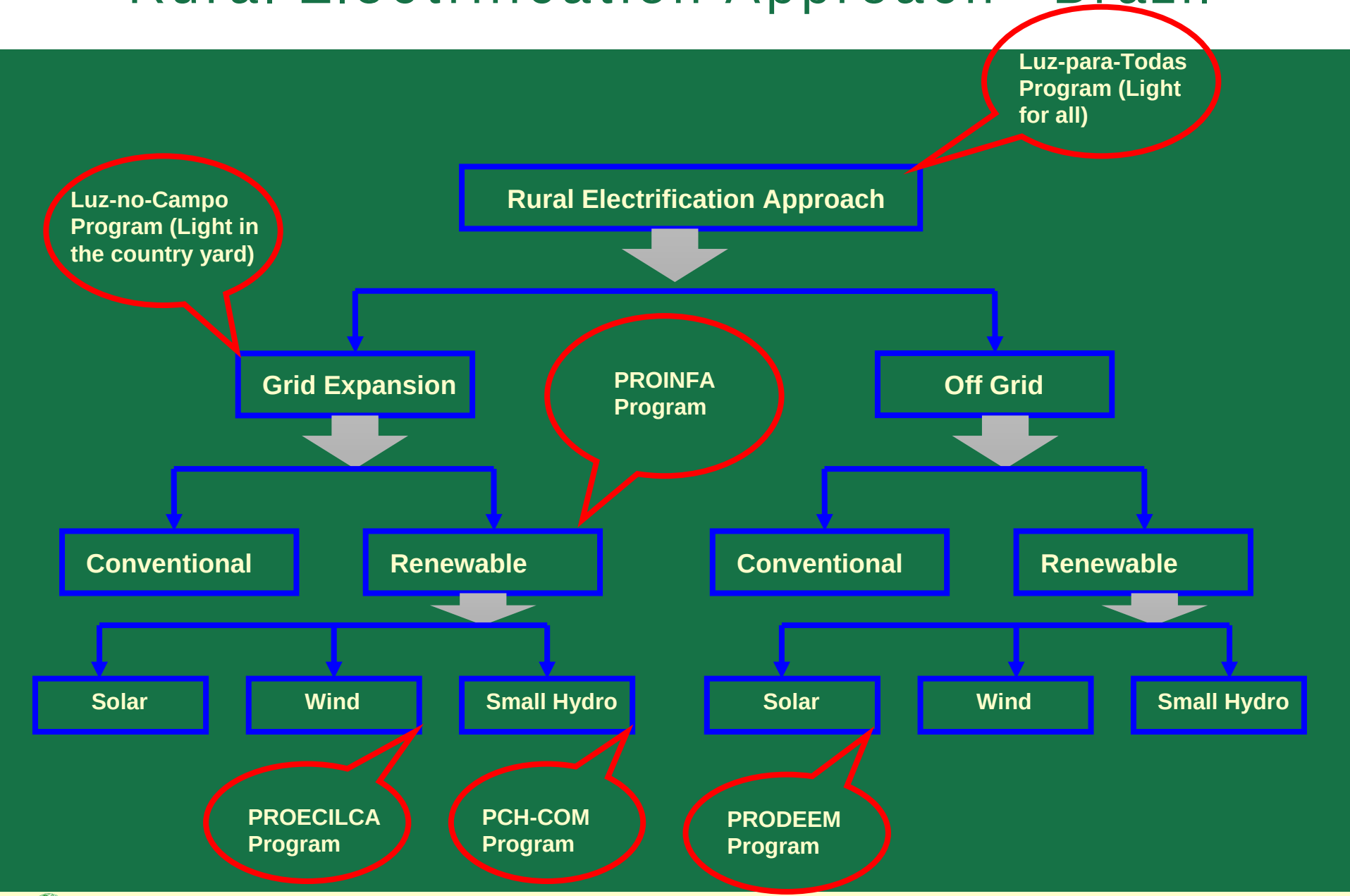
Stakeholders in Rural Electrification - Bangladesh

- **Rural Electrification Board Contd..-**
  - PBS uses area coverage concept that generally comprises 5-10 thanas (1,500 – 2,000 sq. km area, 15,000 – 30,000 consumers, 800 – 1,500 km distribution lines).
  - For each PBS load forecast is made for next 20 years.
  - Cost of distribution system is given on a **33** year term loan to PBS.
  - To maximize consumer welfare PBSs operate on the financial principle of “No-loss and No-profit” basis.
  - Implement phase wise program to ensure mobilization of fund and steady growth of electrification program. (Present 5th phase underway).
  - REB model is one of the success story in Bangladesh rural electrification and have been instrumental in attaining high levels of operational efficiency. (low system loss **15**%, nearly **100**% billing collection).
  - REB monitors and track PBS performance through performance target agreement negotiated annually between each PBS and the REB.
  - REB reward PBS that perform well relative to target and penalizes employees of PBS with poor performance.

Stakeholders in Rural Electrification - Bangladesh

- **Non-Government Organizations:**
  - **Grameen Shakti –** It disseminate SHS with soft financing systems. Either 15% down payment and remaining 85% to be repaid within 36 months or 25% down payment with 75% to be repaid within 24 months or 4% discount on cash purchase. It has installed 23,231 SHS (1.25 MW) till April 2004.
  - **Bangladesh Rural Advancement Committee (BRAC) –** It is the largest development organization with objective of "Alleviation of Poverty and Empowerment of the Poor". BRAC launched integrated and multipurpose solar energy program in 1997. It has installed over 9497 SHS (263.5 kW)
  - **Other small NGOs like SHUBASHATI, Center of Mass Education in Science (CMES), Bangladesh Center for Advanced Studies (BCAS), ANANDO**
- **Private Entrepreneurs/Companies**
- **Research and Development Organizations – mainly universities.**

Rural Electrification Approach - Brazil



Rural Electrification Programs - Brazil

1. **Luz-no-Cambo (Light in the country side) –**
   - Mainly **Grid Extension** program with target to electrify 1 million household between 1999 – 2002.
   - Credit available to assist concessionaries and permissionaires.
   - Fund is made available through RGR (*Reserva Global de Reversao*) – RGR is a fund raised with compulsory tax contribution from all concessionaires.
   - 50% RGR resources should be used in North, North-east and Mid-west and new consumer will pay only tariffs.
2. **Luz-para-Todos (Light for All) –**
   - Program launched to electrify remaining 12 million population in Brazil by 2008.
   - It considers all the technology options including distributed generation for rural electrification.
   - Under the program, the consumer do not have to pay for network expansion cost, which used to be a great hurdle.
   - Financed through CDE (Energy Development Account) – CDE is fund created to support renewable sources of energy. The fund comes from annual payment for use of public assets, fines etc.

Rural Electrification Programs - Brazil

3. PRODEEM (Energy Development of States and Municipalities)

- Largest PV based **off-grid rural electrification program** in developing country.
- Sponsored by government.
- Considers all sources of energy but under the program only solar PV were bought and installed for power generation, lighting and water pumping.
- Phase wise implementation (currently sixth phase is complete), 8,700 solar systems with total of 5.2 MWp was purchased.
- Centralized project with top-down approach to identify sites and to install equipment, where material is procured centrally and then distributed according to demand.
- The program focuses on community establishments like school, health facilities and other installations.
- No cost recovery scheme, so it result in unsustainable service and a lack of funds for maintenance.

Rural Electrification Programs - Brazil

4. PCH-COM (Small hydropower development and commercialization program)

- To encourage grid-connected small-scale hydropower generation by guaranteeing purchase of power.
- The goal is to select up to 1200 MW over three year period 2001-2003 in blocks of 400 MW per year.

5. PROEOLICA (Emergency Wind Power Development Program)

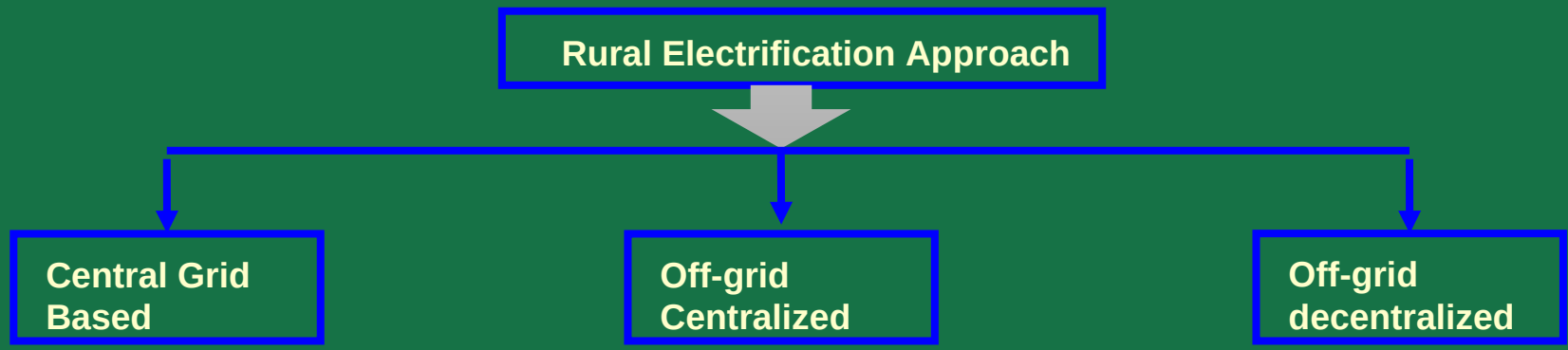
- The goal of program is to install up to 1,050 MW of wind energy by December 2003 and integrate that power into national grid.
- Guaranteed wind energy purchased by state-run Eletrobras over next 15 years.
- Project that go online soonest are provided further incentives.

Rural Electrification Programs - Brazil

6. PROINFA

- Main objective is to diversify Brazilian energy supply mix by increasing share of renewable energy technologies.
- In first phase 1,100 MW of wind, 1,100 MW of small hydro and 1,100 biomass will start operation.
- Electricity from different sources of energy are purchased at different prices.
- In second phase, the contribution of these renewable energy resources is to increase, supplying 10% of the nation's annual electricity consumption within 20 years.
- Support to nationally produced components. In first phase, the supplier is considered eligible for bidding only if the share of nationally produced components is more than 60% (90% in second phase).

Rural Electrification Approach - Bangladesh



1. Central Grid Based Rural Electrification

- REB is a central authority responsible for rural electrification through 67 *Palli Bidyut Samities" (PBS)*.
- PBS are the community owned entities that looks after the distribution in their respective areas and hence are considered be the successful model for rural electrification due to local participation.
- REB buys electricity from BPDB and then sells to the rural consumers.
- The distribution loss is around **15%,** and around 100% billing collection.
- Apart from conventional sources, BPDB has a small centralized solar PV systems of 54 kWp and a Wind farm of 1 MW.

Rural Electrification Approach - Bangladesh

2. Off-Grid Centralized Rural Electrification

- The Micro Hydro Power (Village power) is under development in Bangladesh by Intermediate Technology Development Group.
- The rural cooperatives can be run successful with proper system and management practice.
- Important feature of this approach is that a rural community requires project facilitation from experts in technology and project management.

3. Off-Grid Decentralized Rural Electrification

- **Solar Program -** The off-grid decentralized rural electrification is increasing due to emergence of household Solar Photo-Voltaic (SPV) industry with NGO and bilateral donor support and the REBs adoption of renewable energy policy and implementation strategy for off-grid electricity supply.
- Grameen Shakti, has been a leader in building a household SPV industry providing financing to rural consumers for such systems through its rural banking network.

Rural Electrification Approach - Bangladesh

3. Off-Grid Decentralized Rural Electrification (contd..)

- REBs renewable energy policy has selected household SPV systems as it's preferred option for rural areas that will not be reached by the rural grid for at least five-years.
- REB will provide household SPV system on a monthly fee basis with PBSs retaining the ownership of SPV.
- The monthly use fee would be set by REB based on a measure of consumers ability to pay for a system. PBS would also be responsible for maintaining the household SPV.
- World Bank is currently developing a Rural Electrification and Renewable Energy Development Project to support development of rural household SPV systems (50,000 SHS in period 2003 – 2008).
- **Wind Program –** Wind Power (Hybrid System) is installed by Grameet Shakti with total capacity of 10 KWp.
- Similary 10 kWp Wind Solar Hybrid system in installed at St. martins Island by LGED.

Rural Electrification Approach - Bangladesh

3. Off-Grid Decentralized Rural Electrification (contd…)

- **Micro Hydro –** A 10 kW Micro hydro power unit is installed by LGED.
- **Biomass Program -** Biogas pilot plant project has been implemented by Bangladesh Council of Scientific and Industrial Research (BCSIR) (around 17200 nos.), LGED (1166 nos.) and Bangladesh Rural Advancement Committee (BRAC) (1200 nos.)

Subsidy / Incentives for RET

- **Brazil –**
  - Solar panel (except charger, battery and inverter) and Wind energy equipment are taxed at the lowest rate, as they are exempted from Industrial Product Tax (IPX, average 15%) and Merchandize and Source Circulation (ICMS, average 17%) tax.
  - Biomass generation equipment are only exempted from IPI tax.
  - Small hydropower, solar PV, Wind and Biomass plants receives benefits of 50% reduction on wheeling fees.
- **Bangladesh –**
  - Import duty and Value Added Tax (VAT) has been lifted from solar photovoltaic and wind turbines since 1998.
  - Under the Biogas Pilot Plant project, the Government of Bangladesh (GOB) gives 5000 Taka subsidy for a family-size biogas plant which can be used for cooking and lighting purposes.
  - Solar PV program of different government bodies (BPDB, LGED, REB) are basically subsidy driven.

Lesson Learned from Brazil & Bangladesh Rural Electrification

1. Setting the target
2. Identify the technology options
3. Policy change and new/appropriate policies
4. Tax
5. Financing
6. Pro-poor measures
7. Technology based tariff
8. Incentive for locally manufactured technology
9. Connection charges
10. Delivery mechanism
11. Local Participation

Lesson Learned Contd..

- **Setting the target –** Clearly defined target (in terms of number to consumer to be benefited, capacity and technology to be installed and the time line and of course with the provisional budget) has to be set. Brazil plans universal access to electricity by 2015 and has set the target to be met concessionaires operating in their areas**.** Target to achieve 10% share of renewable in 20 years through PROINFA program**.**
- **Cambodia –** Target 25% coverage by 2010 and 70% 2030.
  - Target need to be set for each of the 24 isolated systems presently serving the country.
  - target under World Bank program; 45,000 new connection, 12,000 SHS, 850 kW village hydro, 5% of share from solar and hydro
- **Lao PDR –** Target 90% coverage by 2020.
  - SPRE project Phase 1 target – 52,000 households with 10,000 from off grid and SPRE project Phase 2 target – 71,500 households with 20,000 from off grid
- **Vietnam –** Target 90% coverage by 2005 by grid extension and 95% by 2010.
  - Set target to electrify 400 communes with off grid renewable energy technologies in remote rural areas that will not be in the reach of national grid

Lessons Learned Contd..

- **Identify the Technology Options –** The technology options (grid expansion or off grid type with specific source) to be used should be clearly identified.
- There should be appropriate resource mix. E.g. is the case of PROINFA which plans to install grid connected 1,100 MW each of solar, wind and small hydro**.**
- Luz-no-Campo program consider grid option; *Luz-para-Todos* program considers off grid as well; PROECILA program focus on grid connected Wind; PCH-COM program focus on small hydro, PROINFA program focus on grid connected renewable; and PRODEEM considers off grid renewable with special focus on Solar PV**.**
- **Cambodia –** few indigenous resources and depends heavily on diesel, but solar home system can have good scope.
- **Lao PDR –** Lacks technology diversity in off grid solution. Presently only solar home system is being delivered as off-grid component even in places where hydropower is abundant. So, special demonstration project is required.
- **Vietnam –** Despite high potential for wind and solar energy, these options are still in the primitive stage. Special program needs to be launched to develop market of RET and to electrify 400 communes beyond the reach of national grid.

Lesson Learned Contd..

- **Policy change and adoption of new/appropriate policies. –** Policies that favors renewable energy development, creation of rural electrification funds, incentives for low income population, free connection charges, subsidy to RET and subsidy to rural population has to be established in CLV countries.

- **Taxes –** one of the common barrier for the promotion of renewable energy for rural electrification is the taxes. Exemption in taxes can lead to wide spread use, as is the case in Brazil and Bangladesh where solar and wind generators are subsidized at the lowest ever**.**

- Similar tax exemption has to be considered for CLV countries and since CLV countries are rich in biomass resources (and are locally available), tax exemption can be extended to biomass generation and other cogeneration facilities.

- **Financing –** Large resource is required for financing rural electrification projects and this requires creation of fund and to ensure its sustainability, by imposing tax on consumers. E.g. includes RGR and CCC and CDE, that are used to support rural electrification in Brazil**.**

Lesson Learned Contd..

- **Financing –**
- Cambodia is in process of implementing Rural Electrification Fund however clear policy is required for operation of fund and other mechanism is required to ensure the sustainability of fund.

- In Lao PDR the Rural Electrification Fund is still under review while in Vietnam no provision of specific rural electrification fund was found. To scale up rural electrification and to allow poor to have access to electrification, fund are very vital.

- **Pro-Poor Measures –** Necessary to protect the interest of poor. Un-electrified household are the one that have no access to electricity or are not able to afford it. Brazilian government took two distinct measures.
    - Establishment of regional electricity tariff such that consumer in isolated regions with low electrification coverage will pay the lowest tariff.

    - Policy measure to give preference of electrification fund for the low income household. (Eg. The law direct half of fund from RGR to be directed to region with lowest electrification levels and other half is allocated to rural electrification and low-income users).

- Low income households are given discount on their electricity tariffs.

Lesson Learned Contd..

- **Pro-Poor Measures –**
- In CLV countries, household sector is being cross subsidized with low consumption household (generally less than 50 kWh/month) paying the lowest tariff.
- In Vietnam, electricity price varies from province to province and Government will specify the tariff ceiling and Chairman of Provincial People Committee will define price for specific areas.
- In Cambodia rural areas are being served by 600 private Rural Electricity Enterprise (REE), which are unregulated and price is very high (US$ 0.3 – US$ 0.9 per kWh).
- **Technology Based Tariff for Promotion of RET –** As RET is expensive technology based tariff can make RET cost competitive with conventional sources.
- Recognizing this fact, the Brazilian government has put forward the technology based tariff in its PROINFA program. Under the program the highest tariff is given to electricity generated from Wind energy.

Lesson Learned Contd..

- **Technology Based Tariff for Promotion of RET –**
- Similarly in Bangladesh, the price of electricity generated from renweable energy sources will not be regulated by Government, once the Renewable Energy Policy will be put into place.
- Technology based tariff is not in practice in CLV countries and can be better option to promote renewable energy technologies with increased private sector participation.
- **Incentive/Support for Locally Manufactured Technology** – Support for locally manufactured technology is vital to reduce the cost of equipment, develop local manufacturing base, create jobs, meet the local technology requirements and contribute to the national economy.
- In Brazil, under PROINFA program, the bidder can take part only if 60% (from 2007 on wards this is to increase to 90%) of total cost of renewable energy technology (wind, small hydro and biomass) and services are sourced in Brazil.
- RET market in CLV countries are in primitive stage but has a very good potential and hence such policy measures can be taken in future.

Lesson Learned Contd..

- **Connection Charges –** Initial connection charges are greatest barrier to rural households.
- In Brazil new consumer do not have to pay connection charges.
- It can be a very good lesson to CLV countries to scale up rural electrification process
- **Delivery Mechanism** – Innovative service delivery mechanism is required to have the rural community access to electricity via decentralized technologies.
- By providing credit to entrepreneur that built energy technologies and distribute to villagers (*Luz do Sul program in Brazil).*
- By *p*roviding credit to member villagers for purchase of RET, channeled through existing cooperatives (APAEB – Association of Small Agriculturalists of Bahia State, Brazil).

Lesson Learned Contd..

- **Delivery Mechanism** –
- Similarly *Grameen Shakti* in Bangladesh provides credit for purchase of Solar Home System under different modes. (15% down payment and rest on installment over 36 months, 25% down payment and remaining on installment over 24 months).
- Cambodia need to adopt suitable delivery mechanism to improve the current situation.
- In Vietnam Solar PV is being deployed by Vietnam Women's Union (VWU) in partnering with Solar Electric Light Company (SELCO) and Vietnam Bank for Agriculture and Rural Development (VBARD). VWU markets SELCO system and administers consumer loans provided by VBARD and has been successful.
- In Lao PDR, among various delivery mechanism, the lease-purchase scheme that is being implemented by EdL appears to be appropriate.

Lesson Learned Contd..

- **Local Participation –**
- Local participation in planning and operation of rural electrification and renewable energy development is very essential for success and sustainability.
- The Bangladesh model of rural electrification through REB via establishment of *Palli Bidyout Samities (PBS, cooperatives operated on principle of no profit no loss)*, has been a success story. Within each PBS, the distribution network is designed on the basis of “area coverage rural electrification”.
- The supply of each cooperative covers in general 1,000 to 1,500 sq. km. with 15,000 to 30,000 consumers and includes some 800 to 1,500 km of distribution lies.
- PBS is operated by the local people with strict monitoring from REB via standard performance targets.
- They have achieved almost 100% billing collection and figure of distribution loss is minimum, around 15%. This is an marvelous achievements as compared to the other developing south Asian countries.

Lesson Learned Contd..

- **Local Participation Contd..–**
- In Cambodia, **600** Rural Electricity Enterprise (REE) serves the rural population. These REEs are established by entrepreneur are profit oriented that used diesel for electricity generation. The price of electricity is therefore one of the highest. Cambodia has to learn from Bangladesh rural electrification model.

- In Vietnam, power distribution sector is characterized by small distributed entities (rural communes, around 8,800), serving limited number of customers (average 1,300 households). The large number of communes and small distribution area has lead to the poor and unreliable distribution infrastructure. Vietnam can implement model similar to PBS of Bangladesh by merging communes with greater coverage and better infrastructure.

- **Incentives for use of renewable technology –** In Brazil and in Bangladesh, various tax exemption has been granted for the import of Solar and Wind energy generators to increase its penetration**.** In Brazil, various incentives are provided for entrepreneur generating electricity from renewable sources, like 50% reduction in wheeling charge etc.

- Similar measure can be taken for the CLV countries to promote renewable energy technologies through increased private sector participation.

Conclusion

- RE option should consider all the three options, economics play vital role –
  - Grid extension
  - Off-grid centralized
  - Off-grid decentralized
- Customers or end users should be treated as an important stakeholders in RE planning process as in Bangladesh.
- Based on the “desperate situation” certain areas can be prioritized, i.e. based on financial contribution of the area or the local government.
- Country wide specific program may exist for promotion of some generation options, this should be identified and incorporated in the planning process.
-
- The massive rural electrification effort taken by Brazil through various policy initiatives and backed by rural electrification fund can be a good lesson for Cambodia and Loa PDR which are still in initial phase of their rural electrification process.

Conclusion

- Similarly, the Brazilian achievements and experience in implementing rural electrification programs even after privatization of distribution sector can be interesting for the Vietnam which is in process of deregulation of electricity sector.
- The Brazilian experience in implementing off-grid rural electrification with top down approach and Bangladesh experience in implementing decentralized off-grid rural electrification can be a good lesson for Vietnam to electrify their rural communes out of reach of gird and to achieve the universal electrification.
- Similarly the local participation in distribution sector in Bangladesh can be a good model for implementation in the CLV countries.
- The tax incentives, subsidies, and other measures to promote renewable energy in Brazil and Bangladesh can be a good lesson to CLV countries.

Thank you

Rural Electrification Decentralised Energy Options (REDEO)

AIT, June 30 – July 1, 2005

Need of Rural Electrification in Cambodia

Content

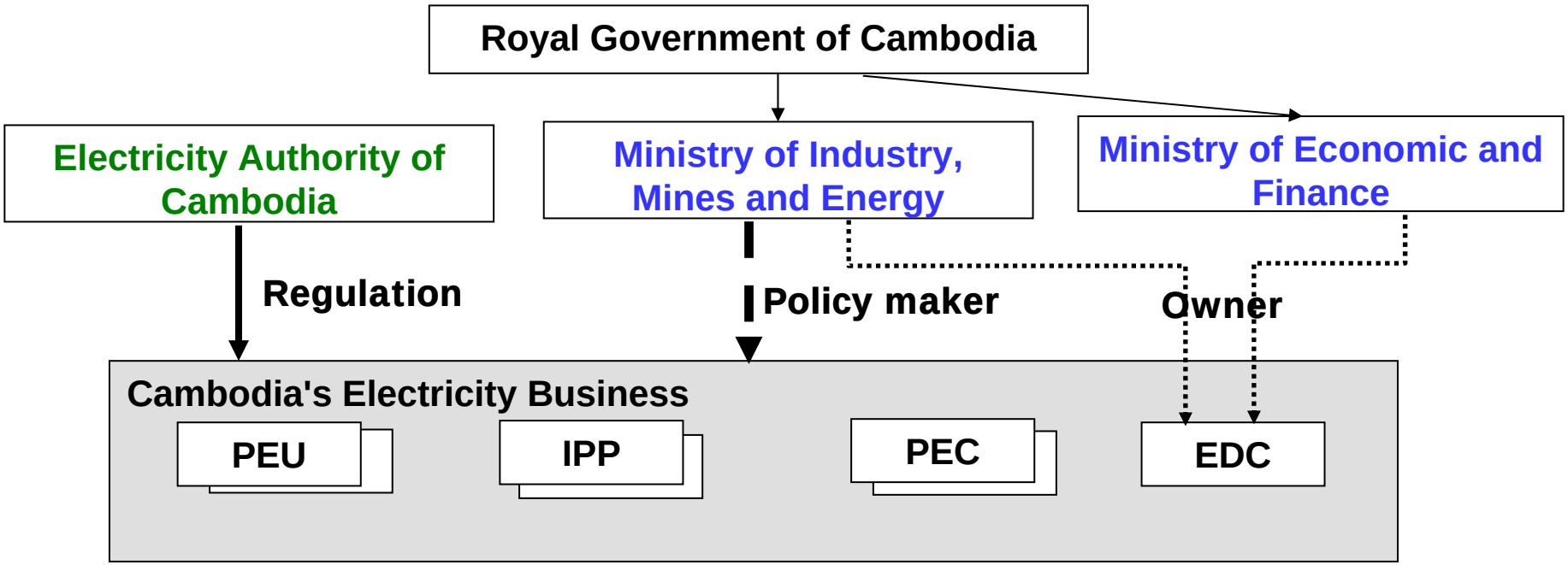
- *Background*
- *Rural Electrification in Cambodia*
- *Master Plan For Renewable Energy*
- *Financial support: Establishment of Rural Electrification Fund*
- *Conclusion: Benefit to population*

Background

- **Territory: 181,035 sq. km**
- **Population: 13 million (85% in rural areas)**
- **GDP: US$280 per capita**
- **Electrification rate : 17% (urban~54% and rural~13%)**
- **Energy consumption: 55 kWh per capita**
- **Electric energy price : US$0.09-0.25 per kWh**
- **In rural area / using battery and diesel generator : US$0.4-0.8 per kWh**
- **Generation in 2004 : 200MW and 1,000GWh**
- **Projection in 2015 : 750 MW and 3,000GWh**
- **Main generation source: Fuel Oil (DO and HFO)**
- **High potential of hydro source : more than 8,000MW**

Map of Cambodia

Current Structure of Electricity Sector



Ownership of EDC

Policy; Planning; Development; Technical standard

Tariff, license, Review the Planned Investments, finances and performance; Enforce the regulations, rules and standards

Background (cont.)

- March 1996: Corporatisation of Electricité du Cambodge (EDC) as a limited liability state company to supply electricity to Phnom Penh and six provincial towns. In 2004 MIME transfers 7 more provincial towns to EDC. EDC manages about 80% of generation and distribution in the country and also is responsible for all transmission operation.
- Feb., 2001 : Promulgation of Electricity Law, setting a framework to regulate the electricity sector.
- Sep., 2001 : Establishment of Electricity Authority of Cambodia (EAC), as a regulatory body, which is responsible for licensing, tariff setting and enforcing the performance of the electricity supply industry.
- MIME : continues to be responsible for government policy, strategic planning and technical standards for the electricity sector.
- Other suppliers of electricity : Private Electricity Operators/Companies, including IPPs, Provincial Electricity Companies and Rural Electricity Enterprises, manage the remaining generation and distribution systems.

Power Sector Development Policy

- To provide an adequate supply of energy throughout Cambodia at reasonable and affordable price,
- To ensure a reliable and secured electricity supply at reasonable prices, which facilitates the investments in Cambodia and developments of the national economy,
- To encourage exploration and environmentally and socially acceptable development of energy resources needed for supply to all sectors of Cambodia economy,
- To encourage the efficient use of energy and to minimize the detrimental environmental effects resulted from energy supply and consumption.

Energy Sector Strategy

With referring to the draft CPSS 1999-2016 (WB) & the draft revised 2004-2020, its focus on 3 mains components:

1- Generation Master Plan

2- Transmission Master Plan

3- Rural Electrification

Rural Electrification

Why Rural Electrification ?

Rural Electrification development requests high capital investment with many difficulties in the operation and also the profit obtaining is too low. But the most of population lives in rural areas, 85%, so Rural Electrification is a tool for national socioeconomic development which the global benefit are:

- Reduce in the flight of rural people to the urban areas.
- Reduce the gap between Urban and Rural areas
- Promotes agricultural development
- Increase agro-industrial and commercial activities / increase employment
- RE improve the living conditions

Current Situation of Energy Use in Rural Area

Base on the survey of 2000 showed:

- **Kerosene 92%**
- **L.a.Batteries 55%**
- **Dry Cell Batteries 24%**
- **Candles 11%**
- **REE 04%**
- **Small Genset 03%**
- **EDC Grid 02%**

Difficulties in RE

- Low income levels of rural population
- Low profit
- Financial constraints faced by the REE's
- Lacking of investment
- High loss, Low load factor, High cost & poor quality of supply.

Barriers

In principle:

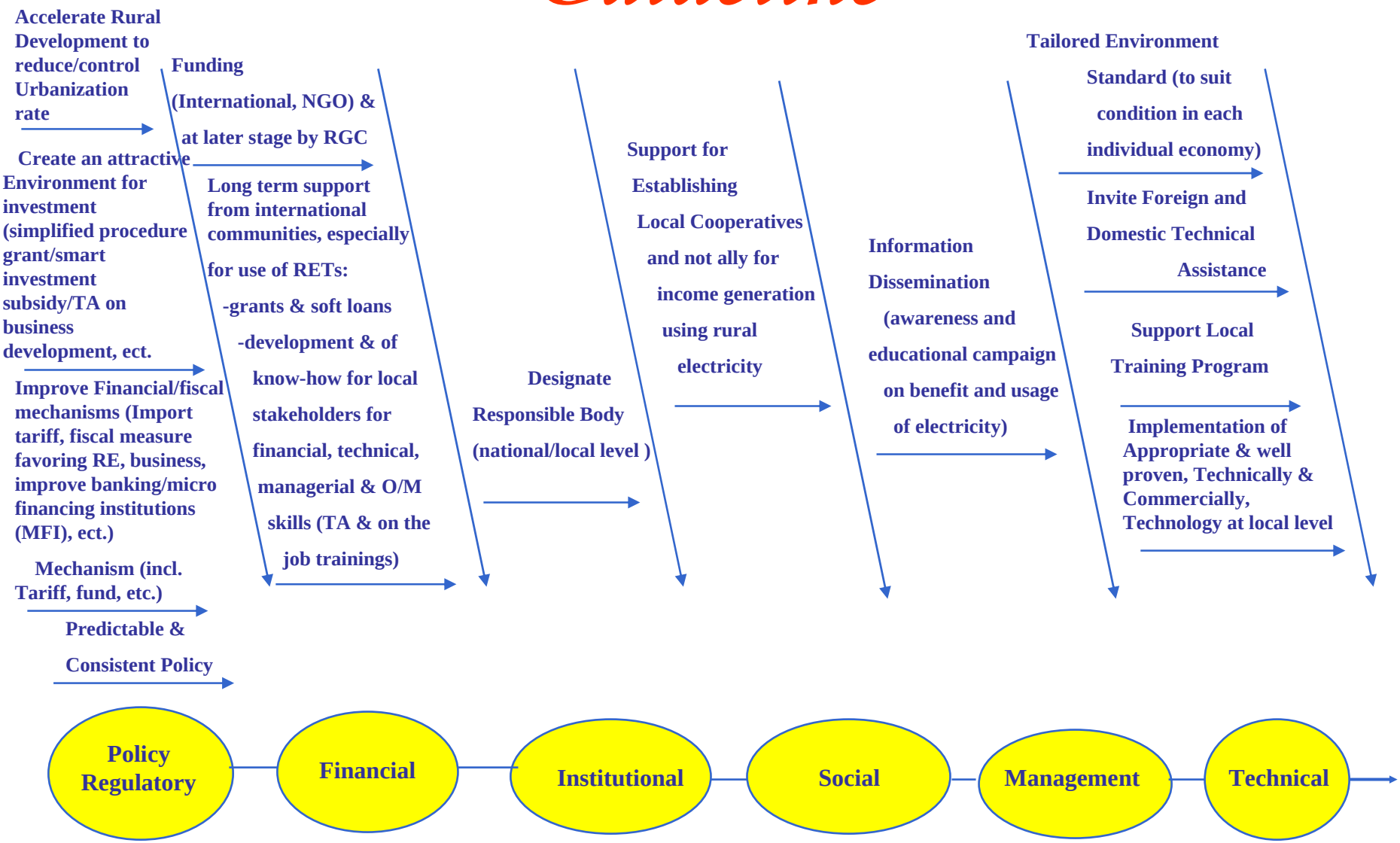
1. **Policy barrier**
2. **Financial barrier**
3. **Institutional barrier**
4. **Social barrier**
5. **Managerial barrier, and**
6. **Technical barrier**

RE – Strategy Components

- Target to achieve 70% of RE by the year 2030 with grid quality.
- Main components of the Rural Electrification Strategy:

1. **Grid expansion from the existing**
2. **Diesel stand-alone, Mini-Utility Systems**
3. **Cross-border Power Supply from neighboring countries (Thailand, Vietnam and Lao)**
4. **Renewable Energy (Solar, Wind, mini-micro hydro, Biomass, Biogas, biofuel etc…)**

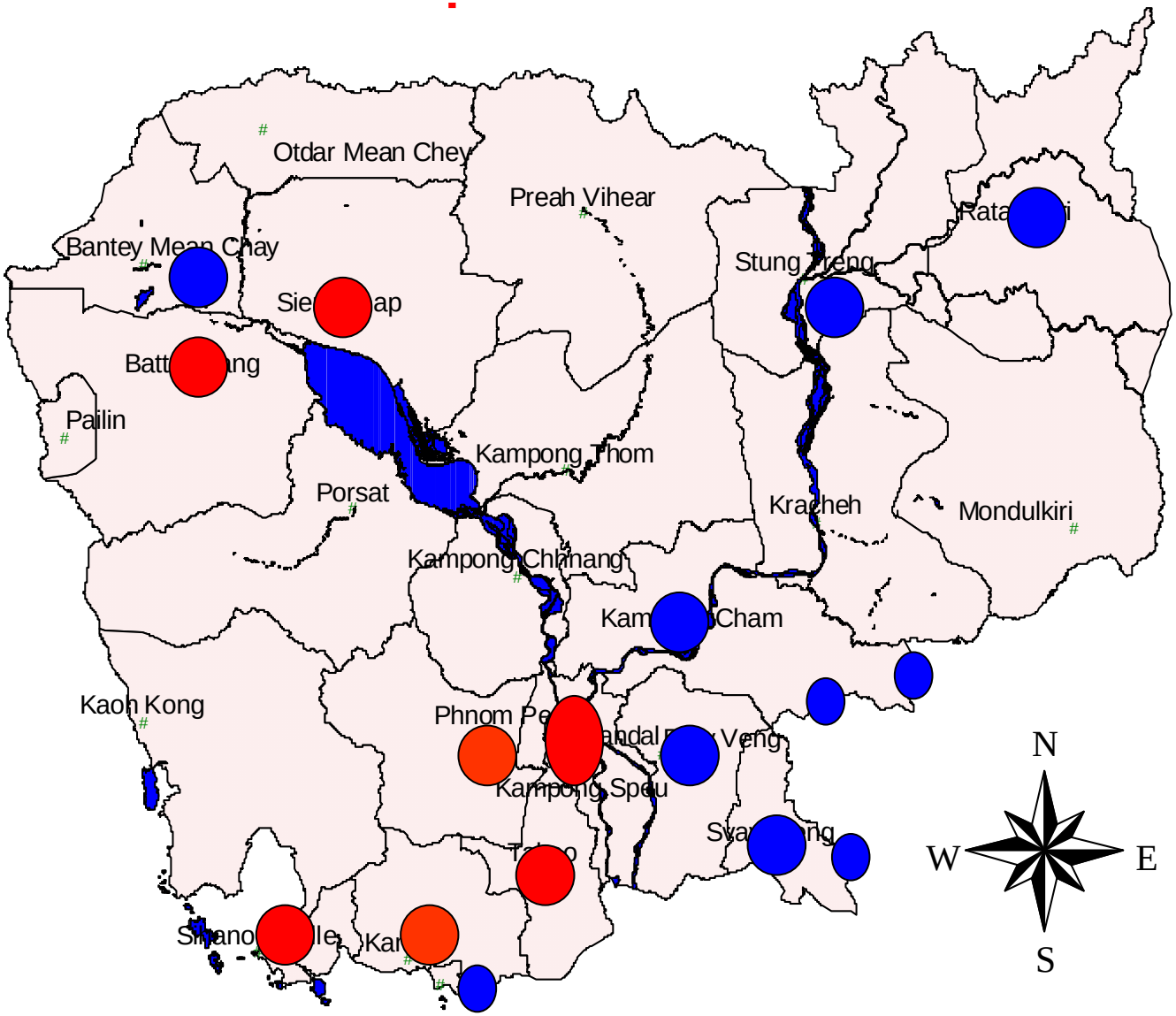
Schematic Rural Electrification (RE) Guideline



Grid Extension

- Extension from EDC grid to supply bulk power via medium voltage within 40-50km from EDC load centers to REE's or PEC's
  - Phnom Penh extend to surrounding areas
  - Kampong Speu to along Road N. 4: East and West
  - Sihanouk Ville to Prey Nop and to Stung Have
  - Kampot to Chhouk and to Kep
  - Battambang to Maung and to Phnom Sampove
  - Takeo to Samrong and to Kampong Chrey
  - Siem Reap to Pourk, to Pradak and Rolous – Damdek
- Partnership between EDC and private sector
- Supply at least 50,000 households customers
- Subsidize from REF
- Capacity building

EDC's Operation Areas After 2004



Grid connection Plan

1-Phnom Penh

2- Kampong Speu

3-Sihanoukville

4-Kampot

5-Takeo

6-Battambang

7- Siemreap

Off-Grid Rural Electrification

Off grid electrification with renewable energy under MIME's program and responsibility.

Mini grids supplied by small diesel generators, hydro generation or a combination of both

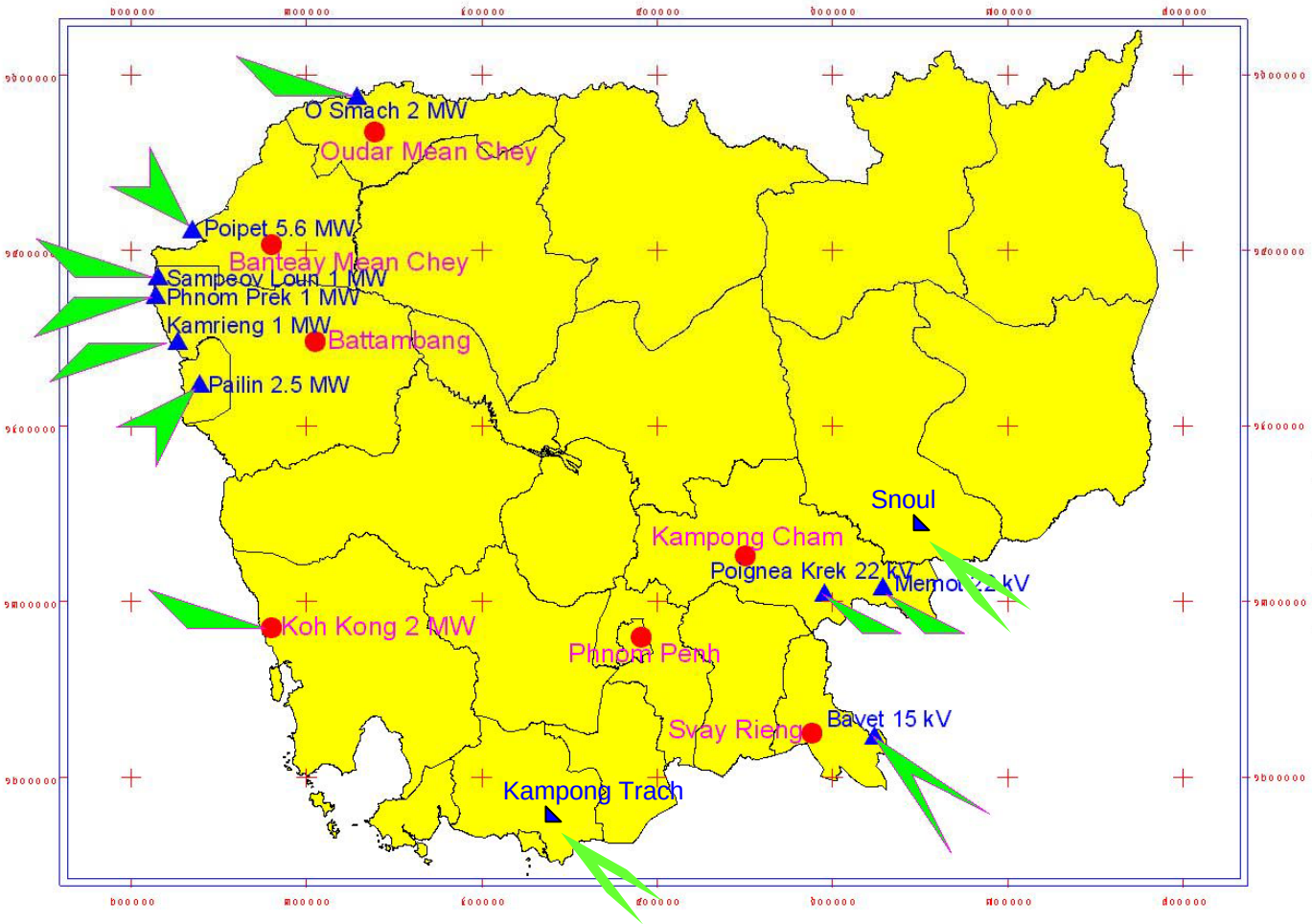
Batteries are mostly used in conjunction with diesel generation

Active solar energy program in Cambodia being driven by the Solar Energy Application Office, Technical Energy Department, MIME, with co-operation with the Institute of Technology Cambodia and the Asian Institute of Technology.

Cross-Border Supply

- Supply to rural communes from existing grids in the border
- Reduction tariff from 0.50 $/kWh to 0.14$/kWh in Thailand border and to 0.16 $/kWh in Vietnam
- Seven existing border supplies with Thailand and there are several in planning
- Five existing border supplies with Vietnam and several are on going projects and several projects in planning

MV Interconnection from Neighboring Countries



N
W E
S

Legend

- District Town
- Provincial Town
- Area Surface

+ Pailin, 18/05/01, 2.5 MW, BanPhakKad, PongNam Dis., Chanthaburi Province (5 Years).
+ Sampeo Loun, 27/04/01, 1 MW, BankhaoDin, Khlong Hat Dis., Sa Keo Province (5 Years).
+ Kam Rieng, 1 MW, Ban Laem, ThepNiMith Subdistrick, Pong NamRon Dis., Chanthaburi province (5 Years).
+ Phnom Prek, 2 MW, 27/04, BanSubTaLee, SoiDao Dis., Chanthaburi province (5 Years).
+ Poipet, 5.6 MW, 22 kV, BangKlong Luk, Aranyaprathase Dis., Sra Kaew Province (5 Years).
+ O Smach Oddor Meanchay, 2 MW, Kap Choeng Dis., Surin Province (5 Years).
+ Kok Kong, 2 MW, BanHoad Lek, Klong Yai Dis., Trat Province (10 Years)

Grid-Connected Small Hydropower

- Cheaper compare to diesel generator
- Could be executed by private sector
- Power Purchase Agreement with EDC
- World Bank assisted Technical Assistance for Preparation of a Private Power Policy

Micro Hydro Village Electrification

- Development micro hydro 20 – 200 kW for Village isolate grid
- Can be received subsidize from REF

Master Plan on Renewable Energy

Purpose – To identify and evaluate the Renewable Energy Potential for the whole Kingdom of Cambodia

- GOAL - To improve the current level of electrification and reduction poverty as well as enhancing education and medical treatment is the rural areas.
- PURPOSES- Study of policies to promote electrification in those areas not yet serviced
  - Introduction and development of Renewable Energy Technologies
  - Study of institution and organization for sustainable operation and maintenance supported by the appropriate business model, including the financial procurement plan.
- TAGET – To achieve 100% of Rural Villages by the year 2020.

Renewable Energy

Renewable Energy Resources

i) **Solar energy** the average sunshine duration of 6-9 hours per day given in average of 5 KWh/m2/day, thus, considerable potential of solar energy.

ii) **Wind Energy** The southern of the great lake Tonle Sap, the mountainous districts in the southwest and the coastal regions such as Sihanoukville have the annual average wind speed of 5m/s or greater; thus the introduction of wind power generation system in these areas is promising.

iii) **Hydro** The potentiality (8,000 MW, but current contribution to electricity production less than 20MW).

iv) **Biomass** The Energy Master Plan report prepared by NEDO identified significant biomass energy resources from a variety of agricultural residues such as rice husk.

v) **Biogas** The effectiveness of small scale biogas has been demonstrated in Cambodia by a number of different projects. The use of animal wastes to generate high quality gas for cooking has significant economic, health, social and environmental benefits for poor rural households.

National Policy and Strategy on Renewable Energy (1/4)

1. Cambodia National Policy on RE (1/2)

The basis of the proposed policy is:

- Endeavor to provide access to reliable, safe and environmentally clean electricity services to rural areas, at an affordable cost to the national community;
- Act as a market enabler and encourage private sector participation in providing rural renewable electricity services;
- Provide effective legal and regulatory framework for enabling access to reliable, safe and clean electricity services to rural areas, at an affordable cost to the national community;

National Policy and Strategy on Renewable Energy (2/4)

1. Cambodia National Policy on RE (2/2)

- Encourage the most efficient systems for generation, transmission and distribution of electricity from clean and renewable energy sources, to enable a rational electricity tariff policy through promotion of differentiated tariffs based on cost recovery principles;
- Promote renewable electricity systems for rural applications, as part of a national portfolio of grid and off-grid technologies, provided they are the least-cost option for the national communities; and
- Ensure adequate resources and appropriate institutional mechanisms to empower the poor, particularly those in rural areas.

National Policy and Strategy on Renewable Energy (3/4)

2. Cambodia Strategy on RE (1/2)

- Widely expand the access for electricity services to the rural population through development of appropriate programs and action plans to promote the Renewable Energy Technologies (RET);
- Expand the supply base for renewable energy services by motivating and promoting the participation of private entrepreneurs so as to provide efficient and cost-effective services, which will benefit the whole community;
- Facilitate systematic market and institutional development in renewable electricity sector by creating a comprehensive legal and regulatory framework to enable effective participation of government, private and community based entities in providing electricity services to the rural consumers;

National Policy and Strategy on Renewable Energy (4/4)

2. Cambodia Strategy on RE (2/2)

- Ensure a wide and equitable access of electricity services to all sections of the rural population by developing appropriate tariff policies and instituting a rational tariff regime;
- Promote environmentally sustainable small power technologies including RET in on-grid and/or off-grid mode in order to create wide access for rural consumers to affordable electricity services; and
- Contribute to empowerment of the rural poor by creating economic opportunities and uplifting standards of living through electricity services, and through involving them in planning, operation, maintenance and management (OM&M) of programs providing those services.

OTHERS...

- Promote and encourage Rural Electrification Entrepreneurs (REE) to participate by various supports, i.e. ideas, “subsidies”, training for awareness and understanding of renewable energy. The next step would be to reduce, even to spot using Diesel Generation sets and to replace these by Renewable Energy Technologies (RET).
- Create Community Business Associations or Organizations (CBA) in order to develop activities in villages and communes, particularly in remote areas, where private sector is not yet aware of or cannot yet reach.
- Necessity to create NGO, agents, associations, different centres in order to accelerate the development and to reach the targets set by the RGC in terms of RE:
  - 2020 all villages will be electrified by electricity from different forms
  - 2030 70% of rural households with grid quality electricity.

Concept of Sustainable Rural Electrification and Its Target

Aims at:

- Non-electrified remote areas, which are far from national grid
- Developing the country
- Promoting local resources, such as Solar, Wind, Hidro, Biogas, Biomass, or Geothermal
- People participation.

Key Success Factors of Sustainable Rural Electrification

Are:

1. To provide sufficient Transfer of Practical Techniques to local staff,
2. To secure Sustainable Revenue at site for Implementation Activities, and
3. Public Participation and Consultation for Planning, Construction, Maintenance and Management.

Financial support: Establishment of Rural Electrification Fund

- RE is more expensive . The consumer affordability problem makes it difficult for potential investors to get rural electrification projects organized and financed. Without subsidies, RE-rates and the quality of supply will remain low.
- The Government of Cambodia is proposing to establish a REF to facilitate the policy on RE and the subsidies on RE Projects.
- The REF-subsidy enables project sponsors to attract *equity capital* and *commercial bank loans* to finance the balance cost of upfront investment and working capital. The REF framework allows a maximum of players to engage in RE and simultaneously assists the development of the national capital market

Proposed Grant for Rural Electrification

- Financing Grants

Type	*Grant proposed, US$ per household connected*	*Estimated total cost/unit in US$*
New household connected (diesel)	**45 $**	**150 $**
Mini hydro from 0.5 MW up to 5 MW	**400$/kW installed**	**1744$/kW installed**
Micro hydro From 50 kW up to 500 kW	**400$/kW installed**	**2700$/kW installed**
Solar Home System	**100$/set**	**400$/set of 40 Wp**

Estimation of Project cost

- **Financial Resources**

  From government budget through MIME.

  The main funding sources will be the government loans from WB/IDA,

  Other sources: grants from donors, private equity, etc.

  SUMMARY OF PROJECT COST

Type	***Local (US$ M)***	***Foreign (US$ M)***	***Total (US$ M)***
REE off-Grid Extension (45 000 HH)	1.82	4.11	5.93
Mini hydro (6.0 MW)	2.81	6.37	9.18
SHS (12 000) (GEF US$ M 1.2)	0.79	3.19	3.98
Village hydro (850 kW) (GEF US$M 0.30)	0.53	1.25	1.78
Sub-total REF Component	5.95	14.92	20.87

Conclusion: Benefit to population

- People will receive power supply with quality improvement and lower price
- Improve their welfare and increase productivities
- Enhance growth in rural enterprises by availability of electricity
- Enhance social service such as health education
- Industry and commercial can reduce their production cost
- Benefit to other organization such the stat utility and REE can reduce current price and improve the service, MIME and EAC received TA for promoting the different models of private sector.
- Promoting the development of renewable energy

REDEO : Rural Electrification Decentralized Energy Options

Demonstration of the REDEO prototype

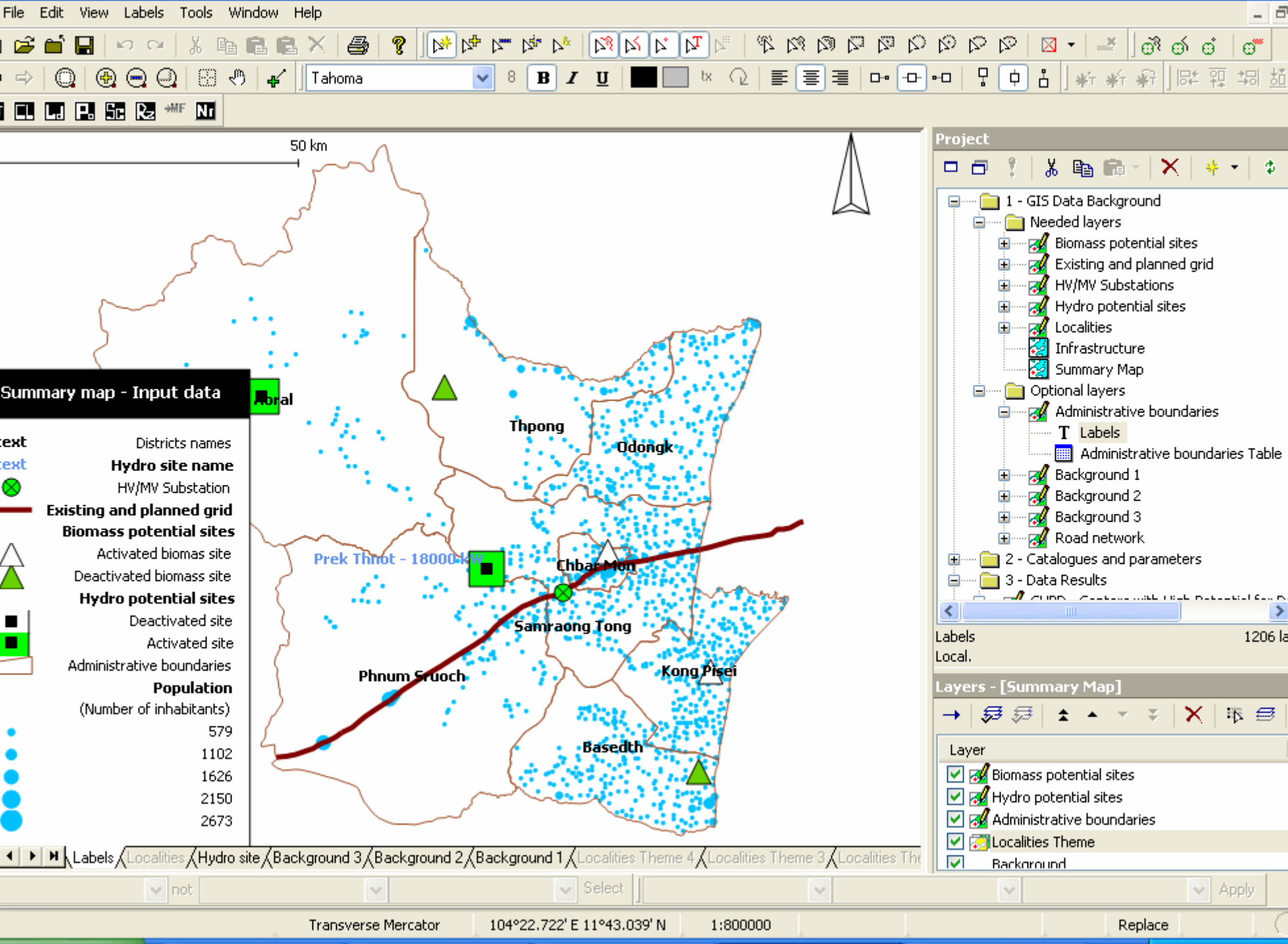
Final workshop – June/July 2005

Mr. Pierrick YALAMAS - IED

Supported by the EAEF – European Commission – ASEAN Energy Facility

Introduction

1. Demonstration of REDEO's use based on Kampong Speu province
2. Programming work has been an interactive process:
    1. Continue improving based on suggestions and obtained results
    2. This is now a prototype version
    3. Which has to be finalized
    4. Based on your comments
    5. Models could be more detailed in a follow-up of the REDEO project (seasonality, …)
3. The prototype has to be finalized
    1. Processing of some steps are long:
        1. Results are given here
        2. It will be improved
    2. Economic and financial analysis and results analysis is being completed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Hydro potential sites
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3 - Data Results
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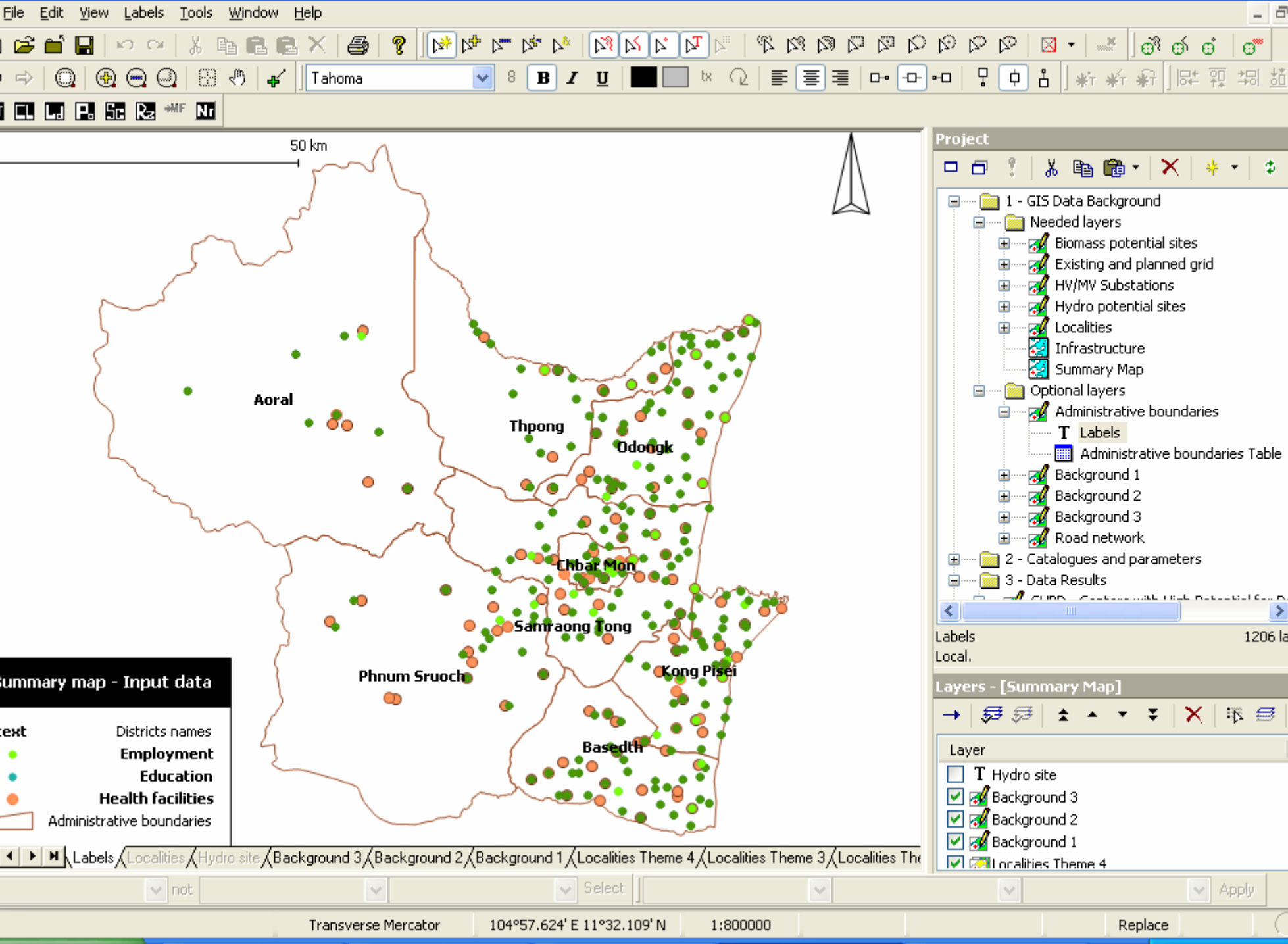
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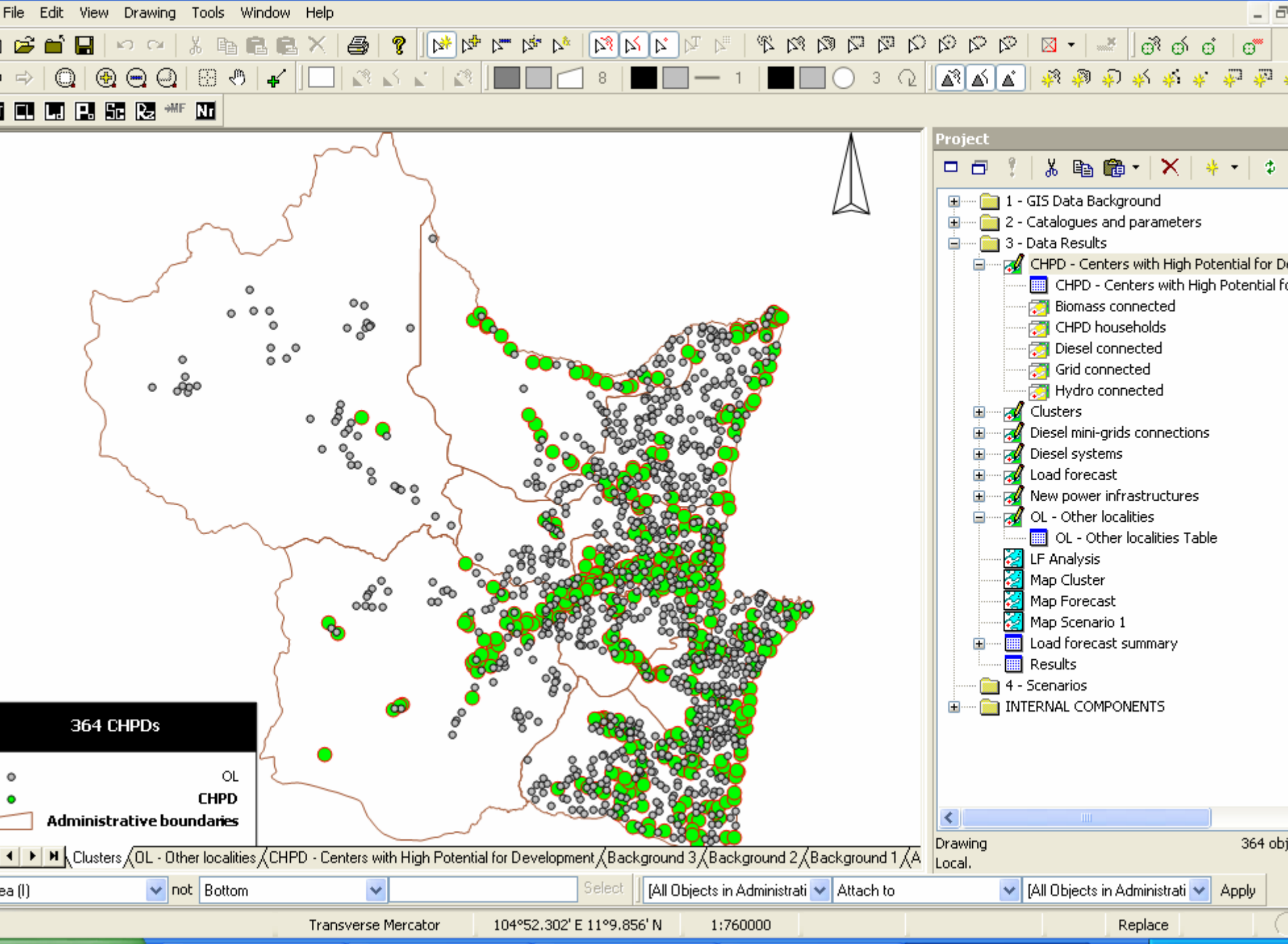
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Map Cluster
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Results
4 - Scenarios
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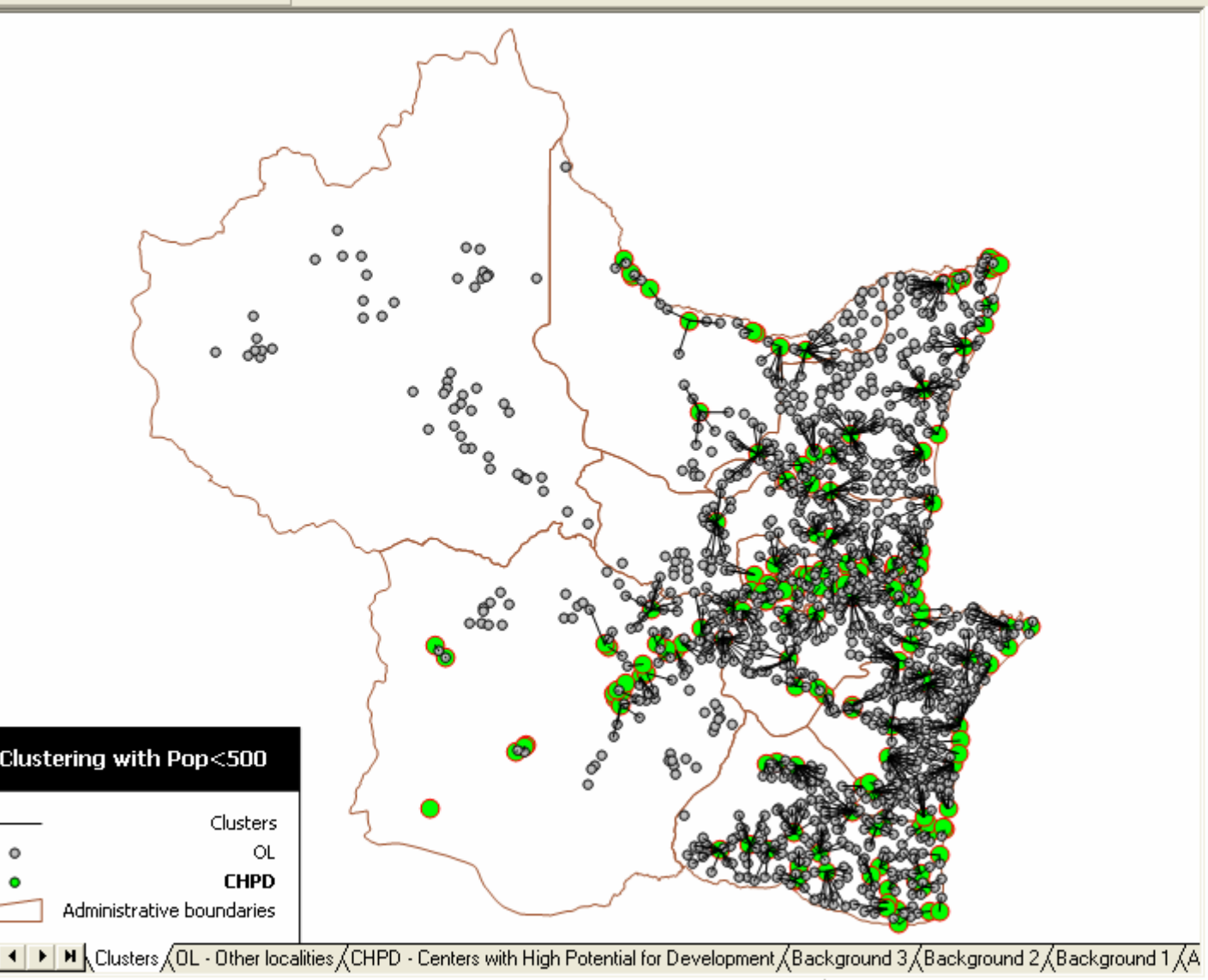

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Project

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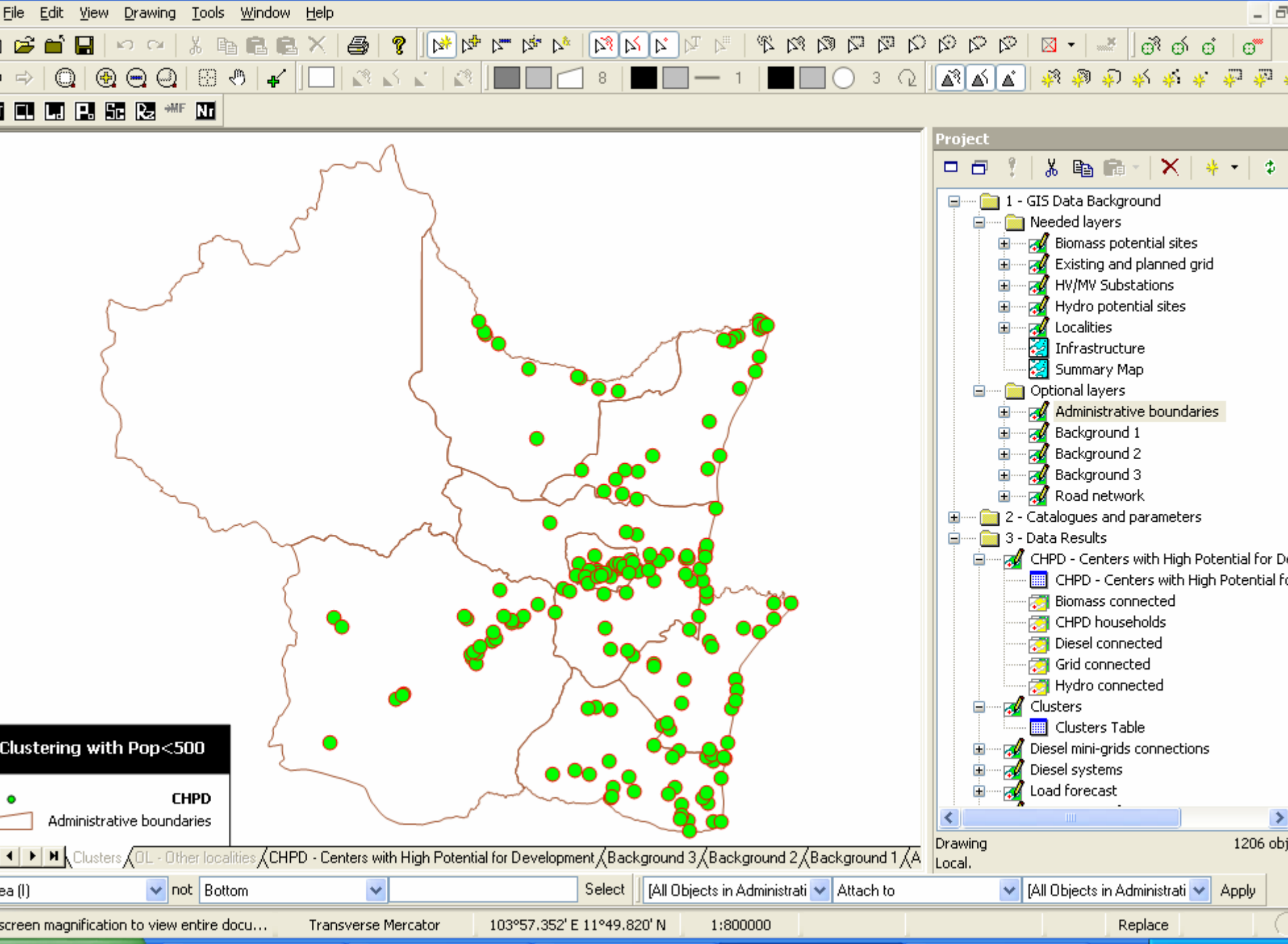
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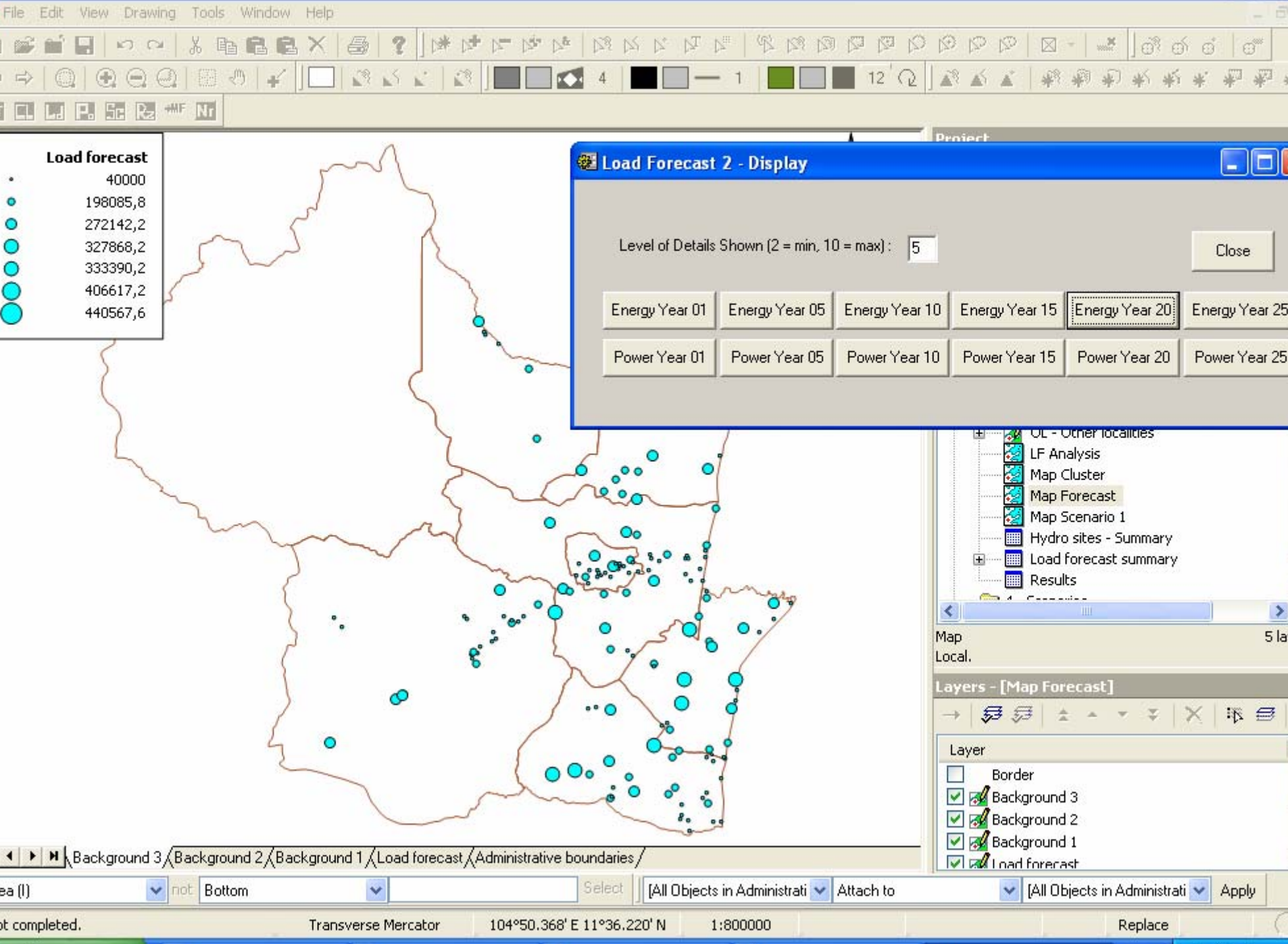
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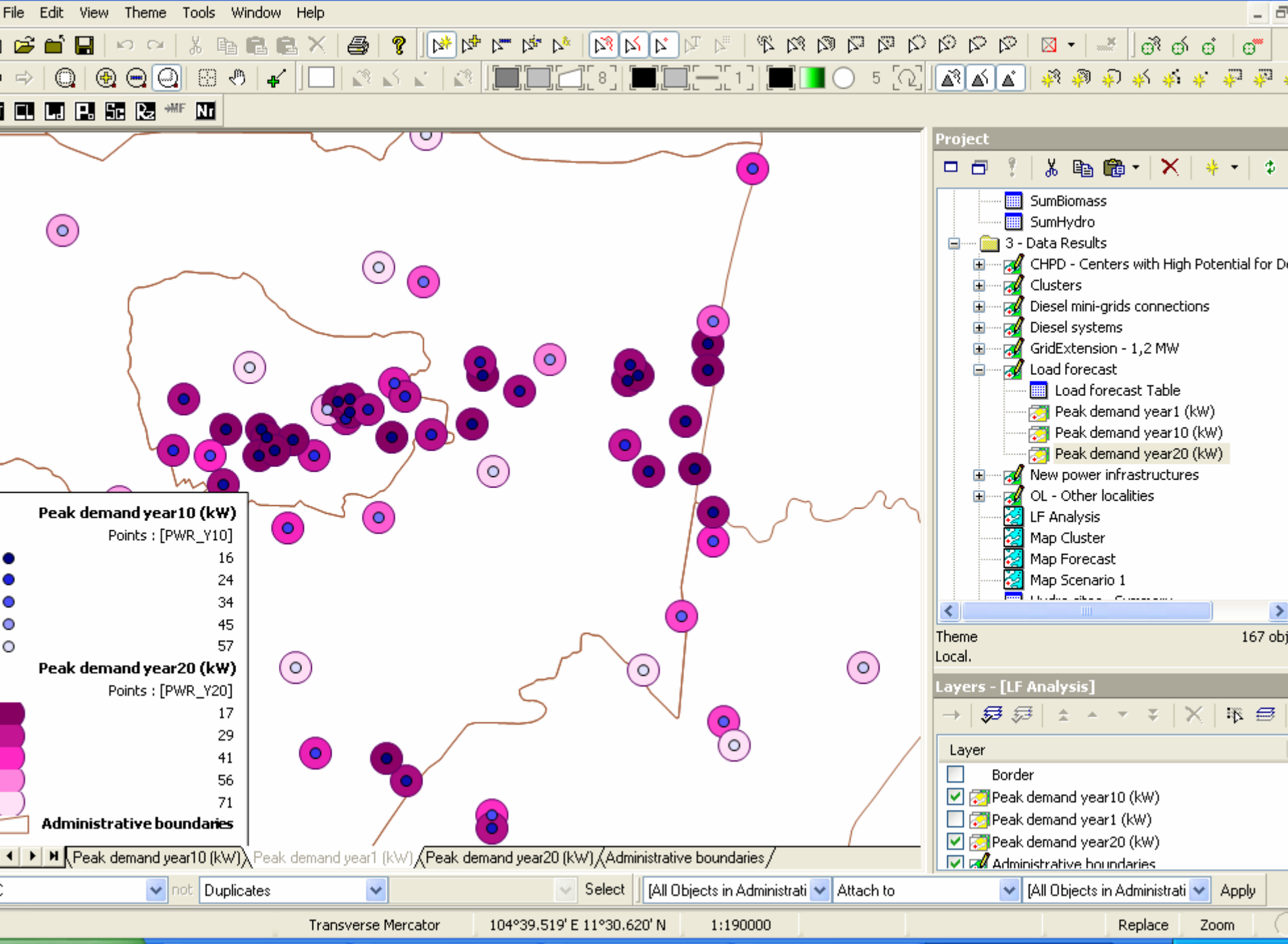
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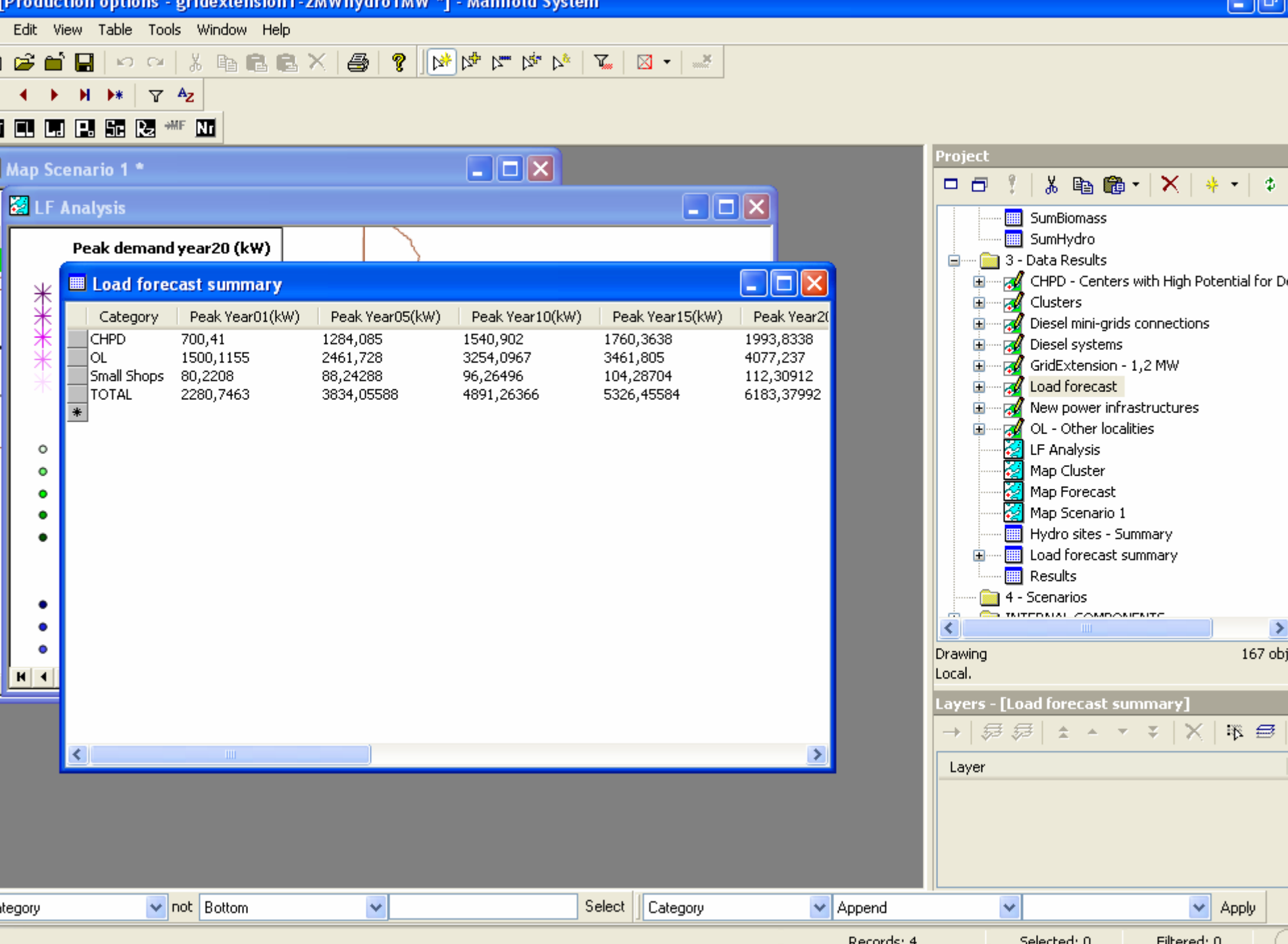
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Small Shops | 80,2208 | 88,24288 | 96,26496 | 104,28704 | 112,30912
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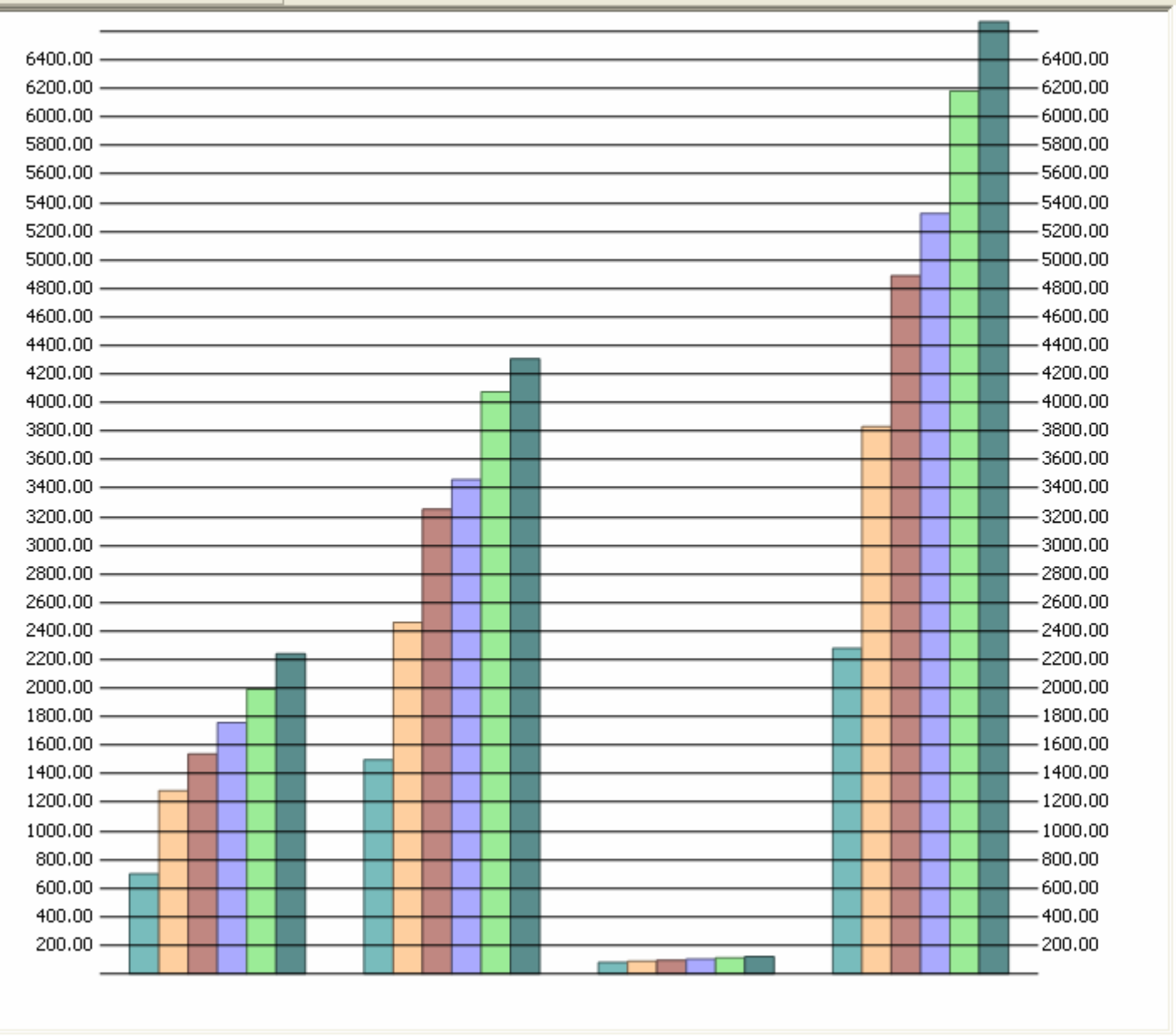

Project

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- 2 - Catalogues and parameters
- 3 - Data Results
- 4 - Scenarios
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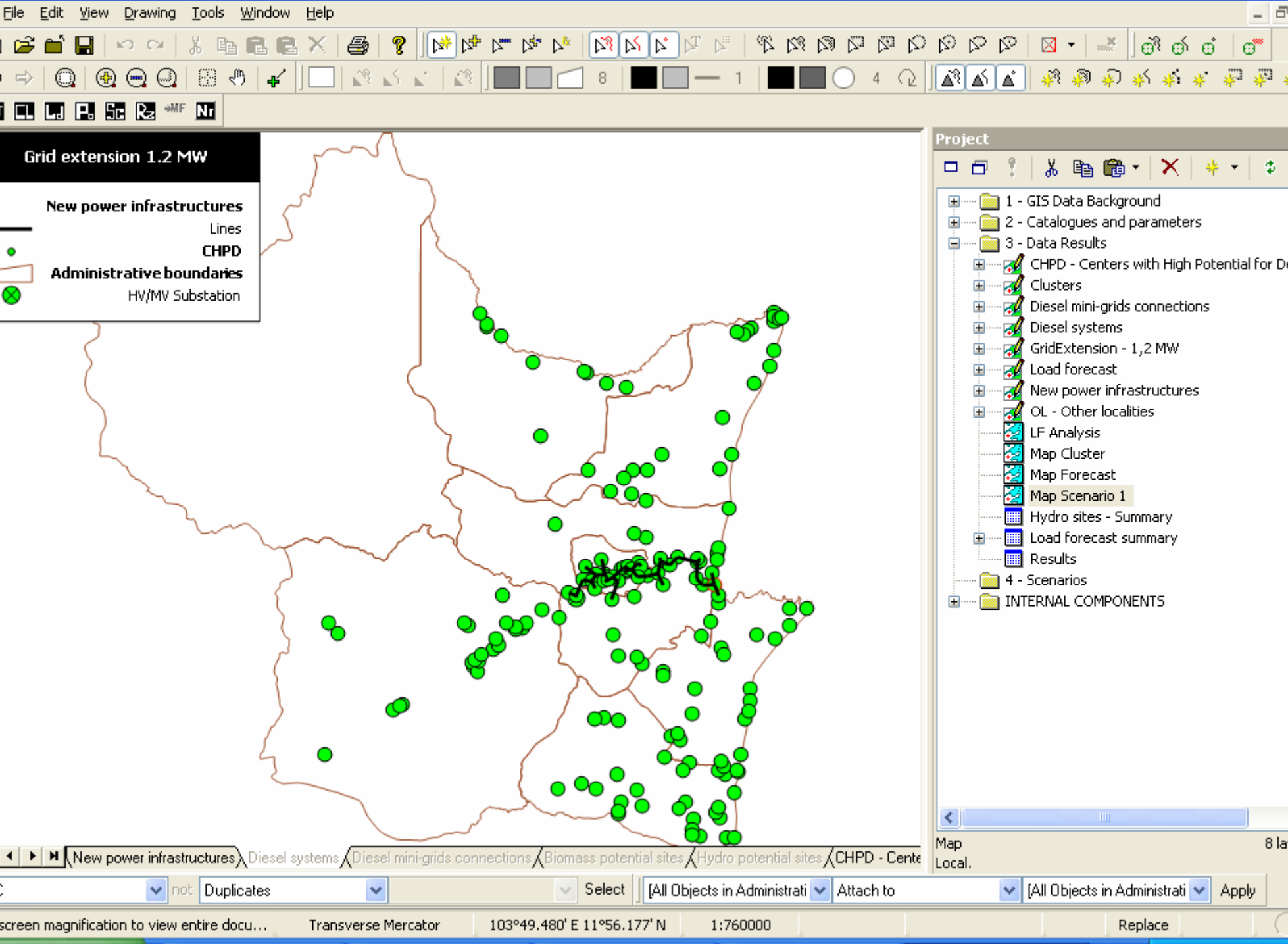
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Grid extension 1.2 MW
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1 - GIS Data Background
2 - Catalogues and parameters
3 - Data Results
CHPD - Centers with High Potential for D
Clusters
Diesel mini-grids connections
Diesel systems
GridExtension - 1,2 MW
Load forecast
New power infrastructures
OL - Other localities
LF Analysis
Map Cluster
Map Forecast
Map Scenario 1
Hydro sites - Summary
Load forecast summary
Results
4 - Scenarios
INTERNAL COMPONENTS
New power infrastructures
Diesel systems
Diesel mini-grids connections
Biomass potential sites
Hydro potential sites
CHPD - Cente
Map
Local.
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Transverse Mercator
103°49.480' E 11°56.177' N
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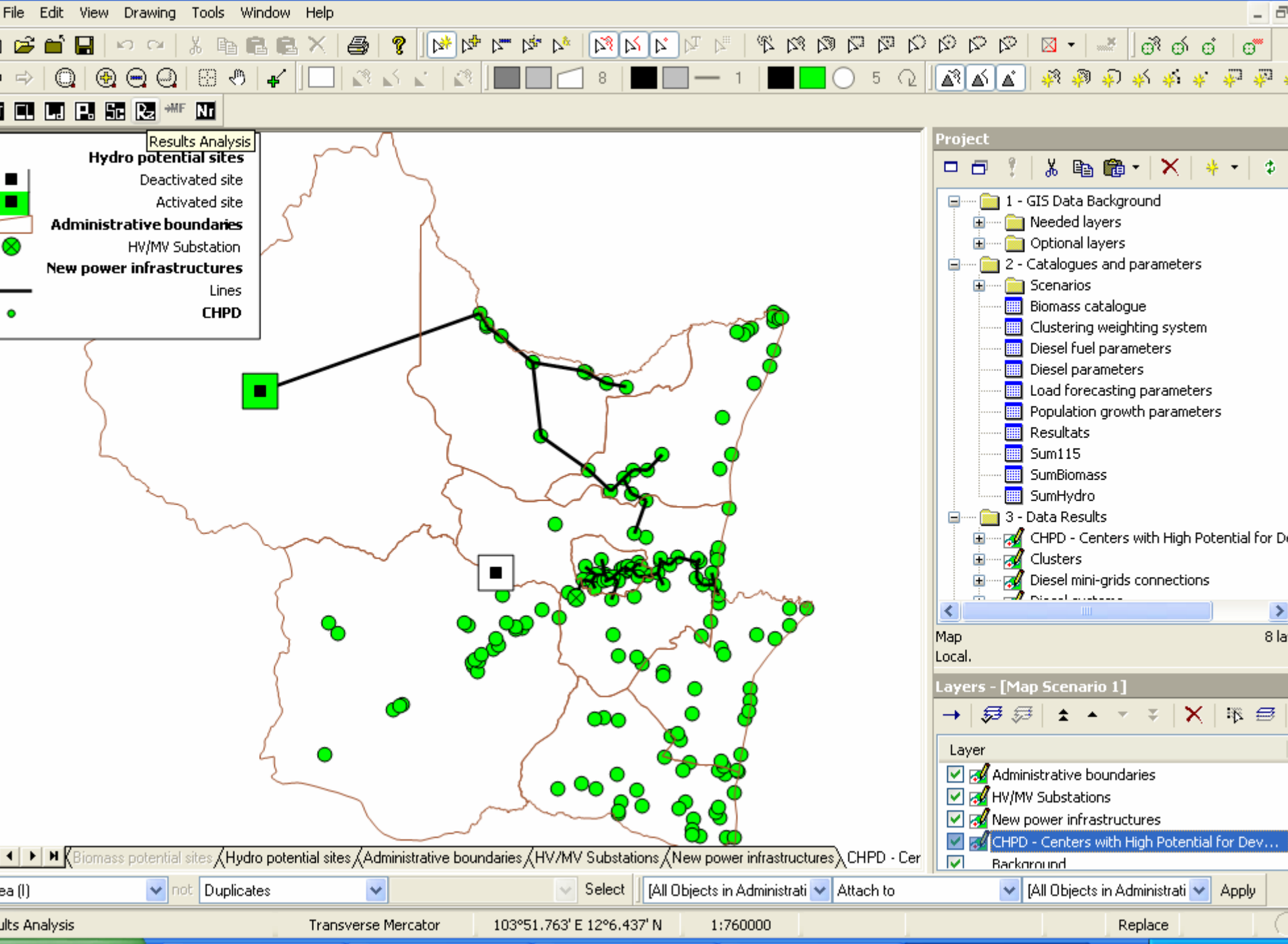
File Edit View Drawing Tools Window Help
Results Analysis
Hydro potential sites
Deactivated site
Activated site
Administrative boundaries
HV/MV Substation
New power infrastructures
Lines
CHPD
Project
1 - GIS Data Background
Needed layers
Optional layers
2 - Catalogues and parameters
Scenarios
Biomass catalogue
Clustering weighting system
Diesel fuel parameters
Diesel parameters
Load forecasting parameters
Population growth parameters
Resultats
Sum115
SumBiomass
SumHydro
3 - Data Results
CHPD - Centers with High Potential for De
Clusters
Diesel mini-grids connections
Map
Local.
Layers - [Map Scenario 1]
Layer
Administrative boundaries
HV/MV Substations
New power infrastructures
CHPD - Centers with High Potential for Dev...
Background
Biomass potential sites
Hydro potential sites
Administrative boundaries
HV/MV Substations
New power infrastructures
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103°51.763' E 12°6.437' N
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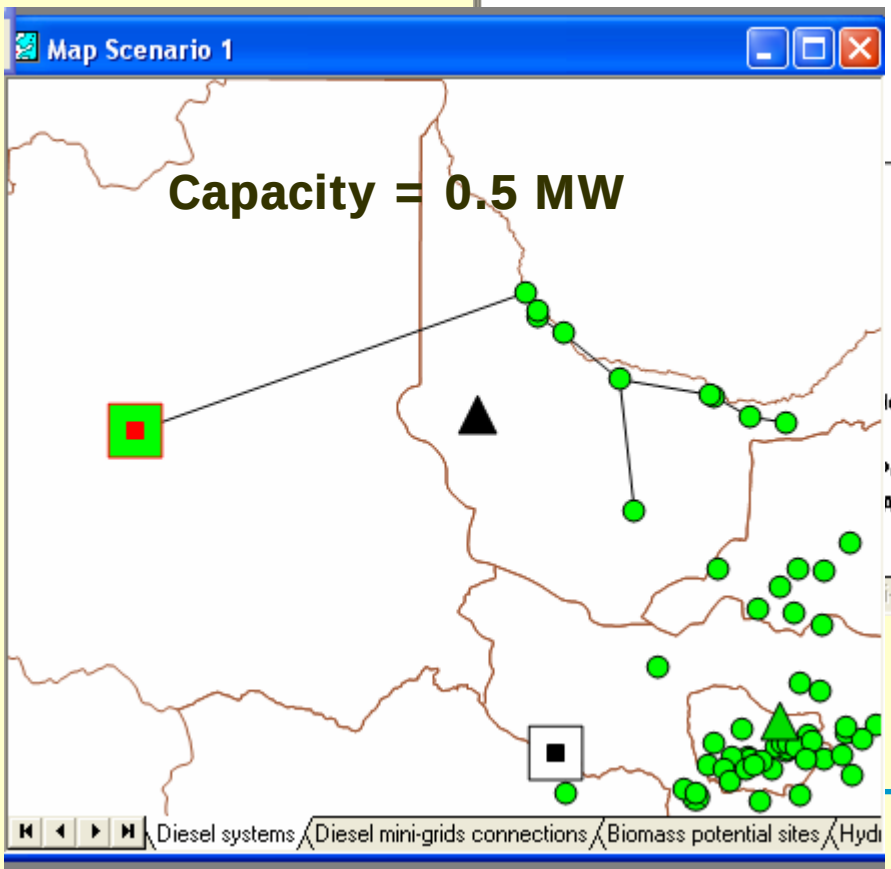
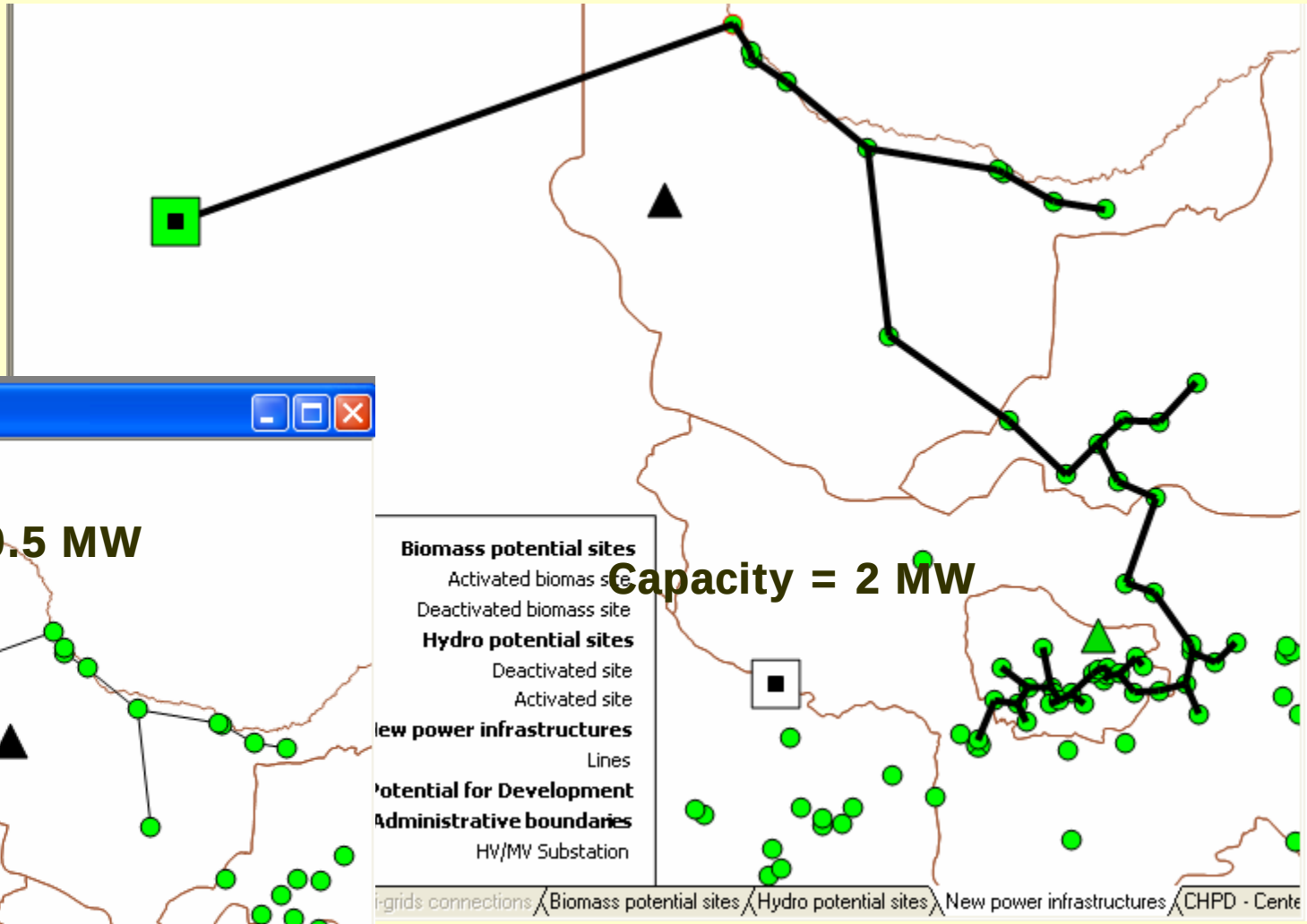

Map Scenario 1
Capacity = 0.5 MW
Diesel systems
Diesel mini-grids connections
Biomass potential sites
Hydr


Capacity = 2 MW
Biomass potential sites
Activated biomas site
Deactivated biomass site
Hydro potential sites
Deactivated site
Activated site
lew power infrastructures
Lines
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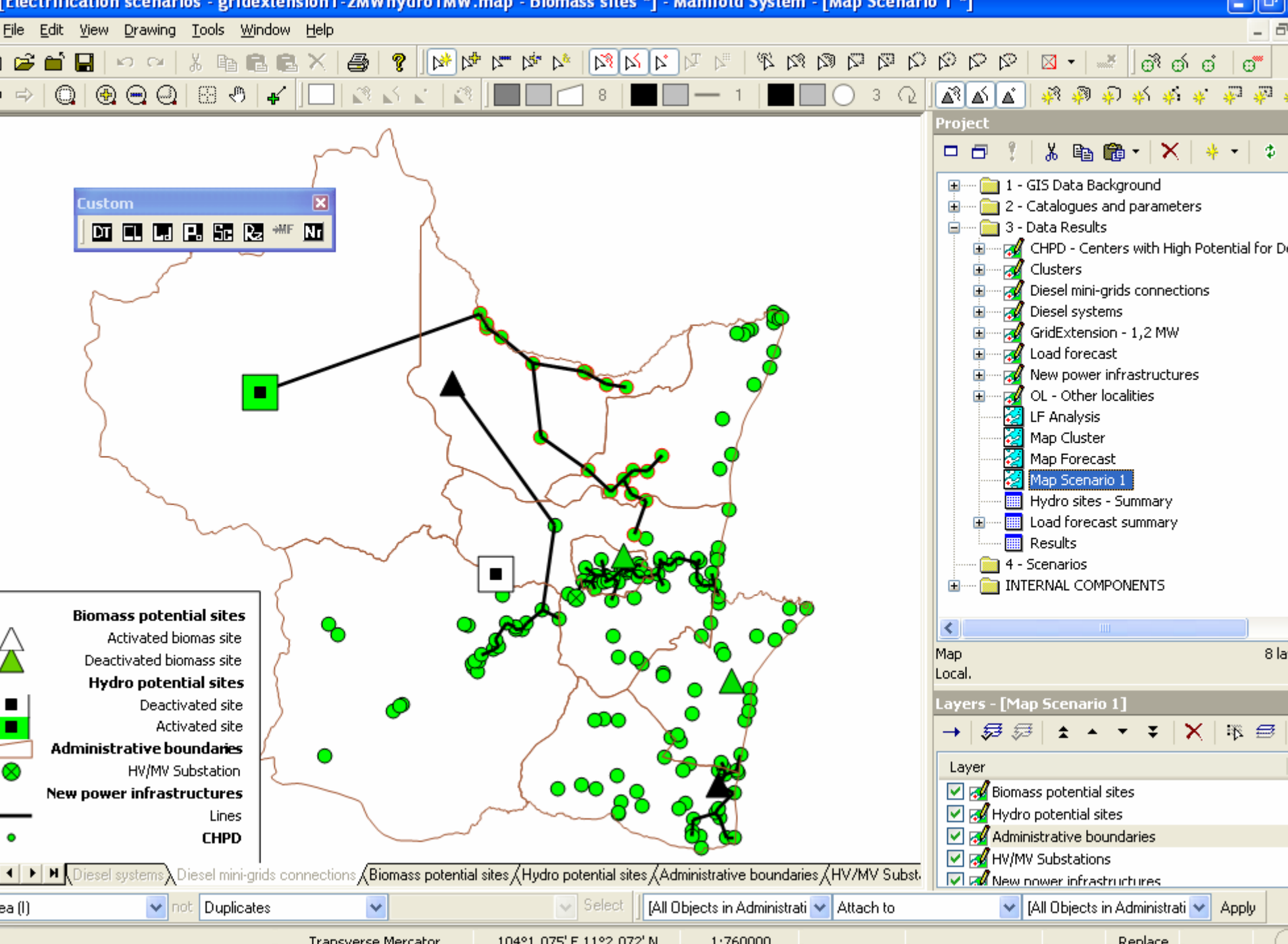
Administrative boundaries
HV/MV Substation
-grids connections
Biomass potential sites
Hydro potential sites
New power infrastructures
CHPD - Cente


[Electrification scenarios - gridextension1-2MWhydro1MW.map - Biomass sites *] - Manifold System - [Map Scenario 1 *]
File Edit View Drawing Tools Window Help
Custom
Project
1 - GIS Data Background
2 - Catalogues and parameters
3 - Data Results
CHPD - Centers with High Potential for D
Clusters
Diesel mini-grids connections
Diesel systems
GridExtension - 1,2 MW
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Map Scenario 1
Hydro sites - Summary
Load forecast summary
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4 - Scenarios
INTERNAL COMPONENTS
Map
Local.
Layers - [Map Scenario 1]
Layer
Biomass potential sites
Hydro potential sites
Administrative boundaries
HV/MV Substations
New power infrastructures
Biomass potential sites
Activated biomas site
Deactivated biomass site
Hydro potential sites
Deactivated site
Activated site
Administrative boundaries
HV/MV Substation
New power infrastructures
Lines
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Biomass potential sites
Hydro potential sites
Administrative boundaries
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104°1 075' E 11°2 072' N
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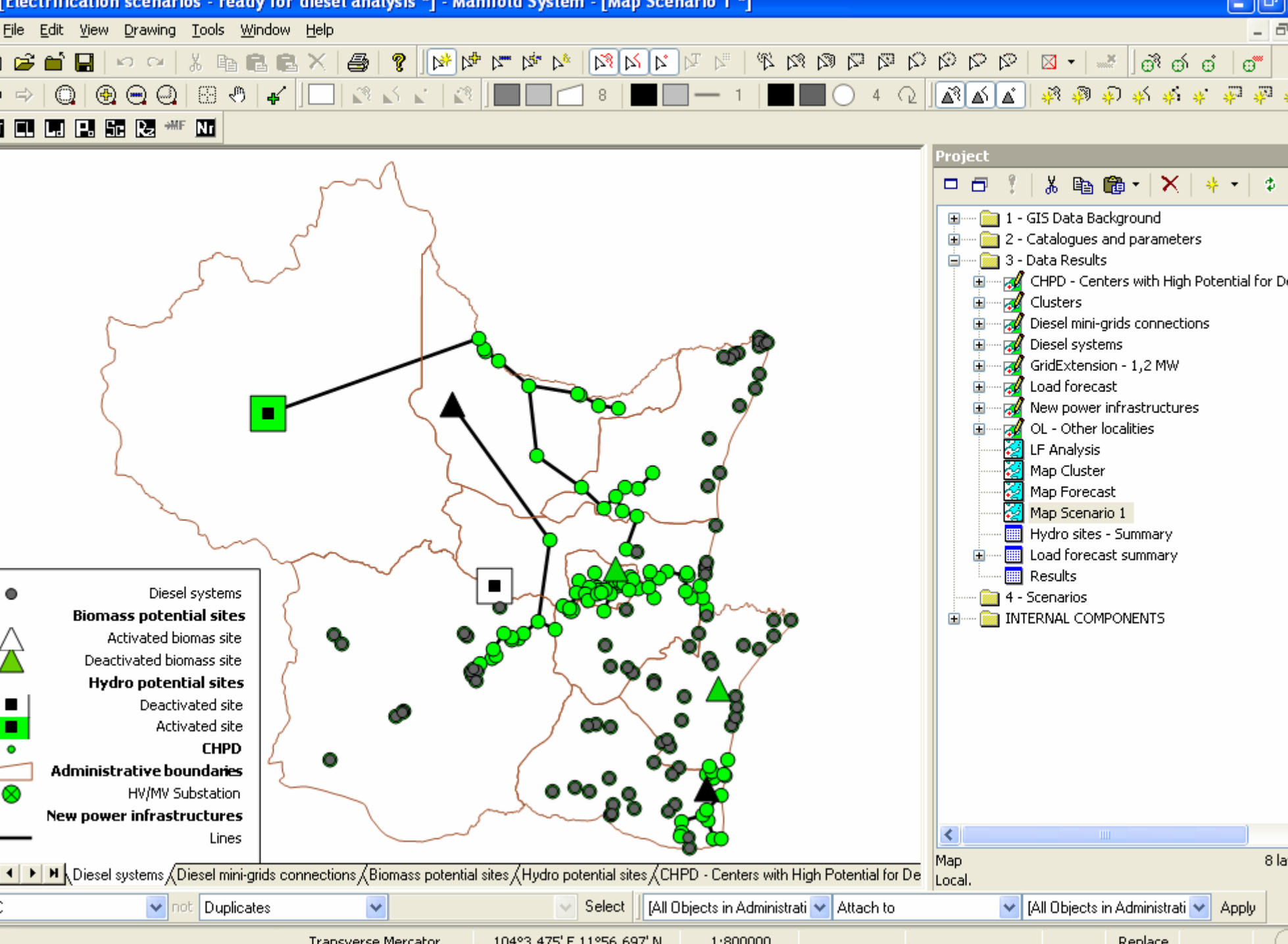
[Electrification scenarios - ready for diesel analysis *] - Manifold System - [Map Scenario 1 *]
File Edit View Drawing Tools Window Help
Project
1 - GIS Data Background
2 - Catalogues and parameters
3 - Data Results
CHPD - Centers with High Potential for De
Clusters
Diesel mini-grids connections
Diesel systems
GridExtension - 1,2 MW
Load forecast
New power infrastructures
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LF Analysis
Map Cluster
Map Forecast
Map Scenario 1
Hydro sites - Summary
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Results
4 - Scenarios
INTERNAL COMPONENTS
Diesel systems
Biomass potential sites
Activated biomas site
Deactivated biomass site
Hydro potential sites
Deactivated site
Activated site
CHPD
Administrative boundaries
HV/MV Substation
New power infrastructures
Lines
Diesel systems
Diesel mini-grids connections
Biomass potential sites
Hydro potential sites
CHPD - Centers with High Potential for De
Map
Local.
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Apply
Transverse Mercator
104°3 475' E 11°56 697' N
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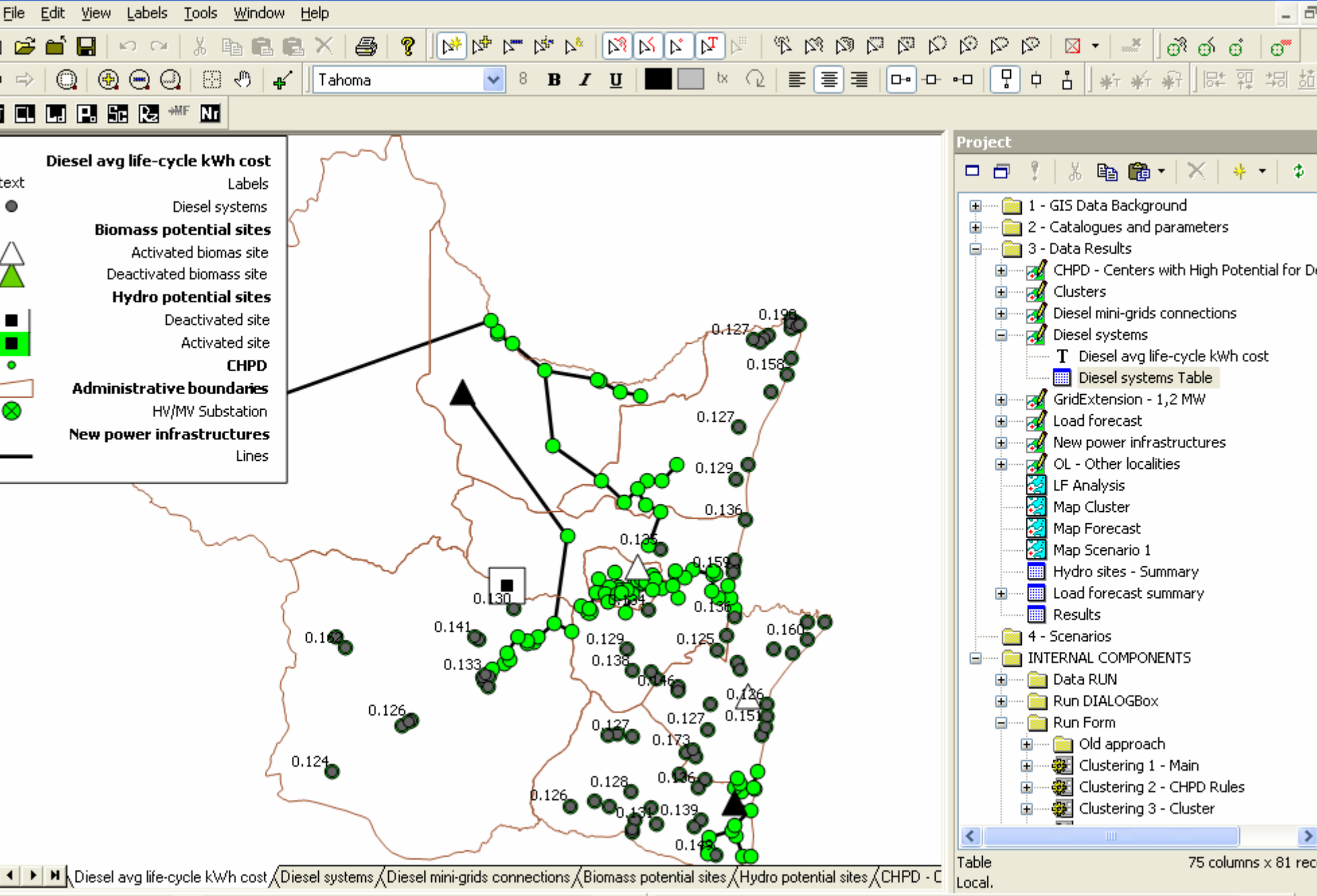
File Edit View Labels Tools Window Help
Tahoma
Diesel avg life-cycle kWh cost
Labels
Diesel systems
Biomass potential sites
Activated biomas site
Deactivated biomass site
Hydro potential sites
Deactivated site
Activated site
CHPD
Administrative boundaries
HV/MV Substation
New power infrastructures
Lines
0.127
0.158
0.127
0.129
0.136
0.130
0.141
0.133
0.129
0.125
0.138
0.160
0.126
0.151
0.127
0.173
0.126
0.124
0.128
0.126
0.139
Project
1 - GIS Data Background
2 - Catalogues and parameters
3 - Data Results
CHPD - Centers with High Potential for D
Clusters
Diesel mini-grids connections
Diesel systems
Diesel avg life-cycle kWh cost
Diesel systems Table
GridExtension - 1,2 MW
Load forecast
New power infrastructures
OL - Other localities
LF Analysis
Map Cluster
Map Forecast
Map Scenario 1
Hydro sites - Summary
Load forecast summary
Results
4 - Scenarios
INTERNAL COMPONENTS
Data RUN
Run DIALOGBox
Run Form
Old approach
Clustering 1 - Main
Clustering 2 - CHPD Rules
Clustering 3 - Cluster
Diesel avg life-cycle kWh cost
Diesel systems
Diesel mini-grids connections
Biomass potential sites
Hydro potential sites
Table
75 columns x 81 rec
Local.
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Select
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Transverse Mercator
103°52.536' E 12°6.985' N
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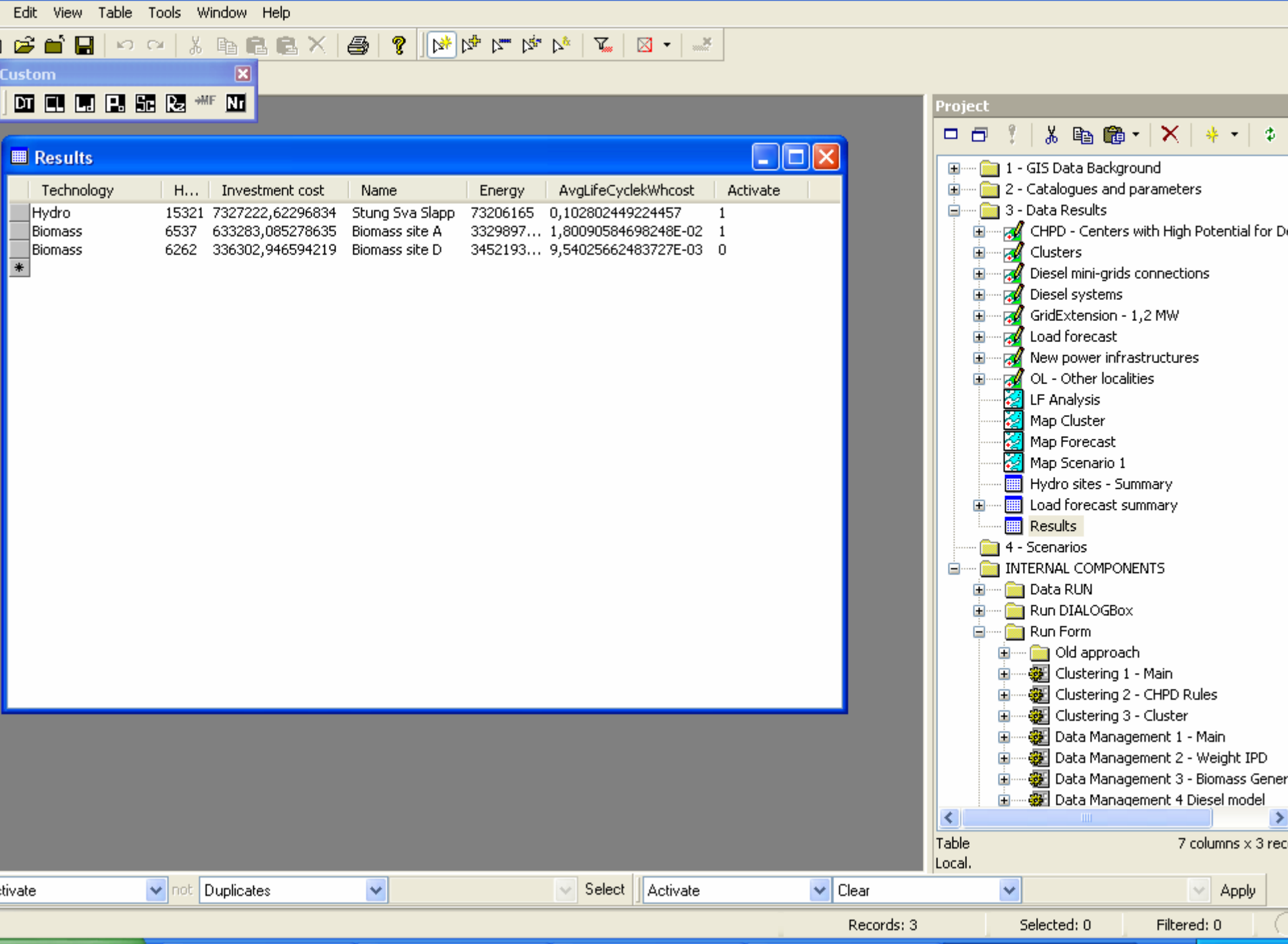
Replace


Edit View Table Tools Window Help
Custom
Results
Technology H... Investment cost Name Energy AvgLifeCyclekWhcost Activate
Hydro 15321 7327222,62296834 Stung Sva Slapp 73206165 0,102802449224457 1
Biomass 6537 633283,085278635 Biomass site A 3329897... 1,80090584698248E-02 1
Biomass 6262 336302,946594219 Biomass site D 3452193... 9,54025662483727E-03 0
Project
1 - GIS Data Background
2 - Catalogues and parameters
3 - Data Results
CHPD - Centers with High Potential for D
Clusters
Diesel mini-grids connections
Diesel systems
GridExtension - 1,2 MW
Load forecast
New power infrastructures
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LF Analysis
Map Cluster
Map Forecast
Map Scenario 1
Hydro sites - Summary
Load forecast summary
Results
4 - Scenarios
INTERNAL COMPONENTS
Data RUN
Run DIALOGBox
Run Form
Old approach
Clustering 1 - Main
Clustering 2 - CHPD Rules
Clustering 3 - Cluster
Data Management 1 - Main
Data Management 2 - Weight IPD
Data Management 3 - Biomass Gener
Data Management 4 Diesel model
Table
Local.
7 columns x 3 rec
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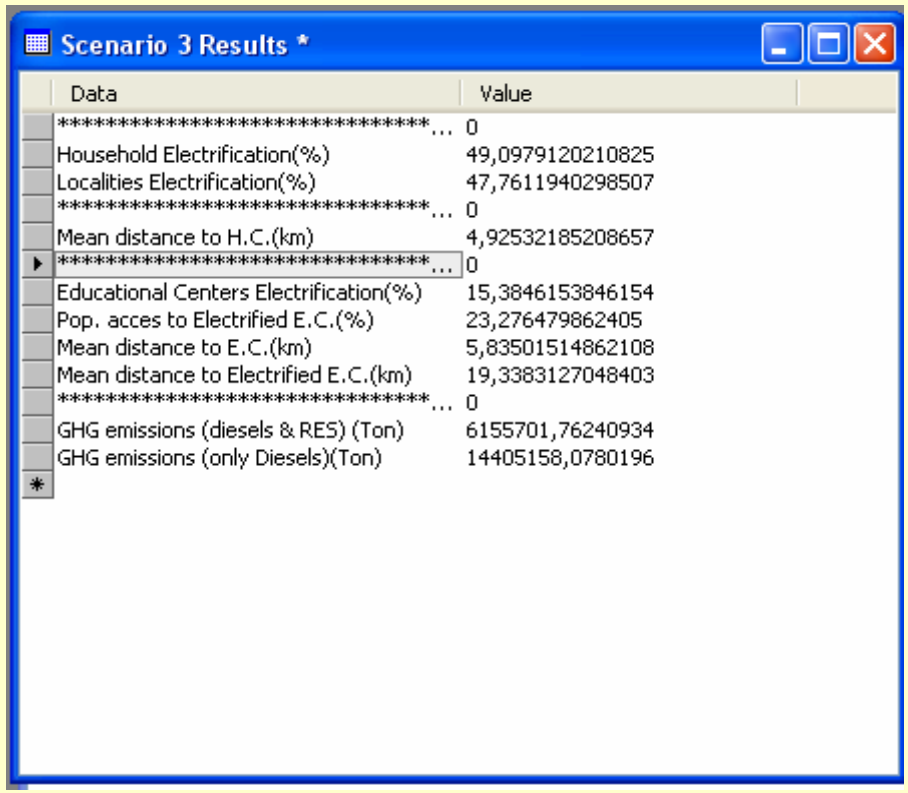
Clear
Apply
Records: 3
Selected: 0
Filtered: 0

Sample of indicators on development and the environment for a given set of projets



Scenario 3 Results *

Data	Value
**********	0
Household Electrification(%)	49,0979120210825
Localities Electrification(%)	47,7611940298507
**********	0
Mean distance to H.C.(km)	4,92532185208657
**********	0
Educational Centers Electrification(%)	15,3846153846154
Pop. acces to Electrified E.C.(%)	23,276479862405
Mean distance to E.C.(km)	5,83501514862108
Mean distance to Electrified E.C.(km)	19,3383127048403
**********	0
GHG emissions (diesels & RES) (Ton)	6155701,76240934
GHG emissions (only Diesels)(Ton)	14405158,0780196

Thank you for your attention and your collaboration