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Abstract

Distribution Planning is a very complex task in which the planners must ensure that the system will meet the demand regarding substation and feeder capacity. The basic goal of a distribution utility could be expressed as: Supply of electricity, Good economy and Good safety.

The implementation took two years of development. The solution is called GISPLAN, and can perform several types of analysis on existing and planned network: Fault Analysis, Load Flow, Technical Losses Calculations, Load Increase, Outage Management Studies, Reliability Studies, Cost Benefit Ratios Determination, Optimal Capacitor Placement, and others.

GISPLAN is a powerful tool to help planners creating scenarios studies and performing simulations to evaluate the impact of modifications in the network, current or future. All simulations can be easily visualized. The most important benefits were: reduced time to plan, better solutions, good performance of calculations, easy drawings and easy and fast input of data.
Main Figures

Concession Area : 194,548 km²
47% of California

Municipalities served: 393.
Population: 10 millions.
Number of Customers: 3,3 millions.
Per Capita Consumption: 1900 kWh/year
Urban Area: 98% of population served.
Rural Area: 85% of population served.
Losses: 6,0%.
SCOPE

138/34,5/13,8 kV

595 - 13,8 kV feeders

291 - 34,5 kV feeders

507 - 13,8 kV feeders
THE PLANNING DISTRIBUTION PROBLEM

GDP X ELECTRIC ENERGY
DEMAND GROWTH

JK  Milagre  Cnizado  Real
PLANNING PROCESSES

- Load Forecast
- Long Range Planning
  - Technical evaluation
  - Economic Evaluation
- Short Range Term
Value Chain

Complexity and Uncertainties

High
Planning

Low
Project and Contraction
Construction
Operation
Maintenance

Risk
Planning Programmes:

• Strategic Planning (long term)
• Tactic Planning (medium term)
• Operational Planning (short term)
LONG RANGE PLANNING
SUBSTATION LOCATION
Strategic Plan (Long Range)
20 years.

Substations:
Transportation Models
- Load Forecasting (grids)
- Location
- Size
- Time
Medium Range and Short Range
Migration Project

Migrageo
Migration Program for Vision System to ArcGis System.

21 applications to be converted;
1,200,000 code lines (GML, C, PASCAL, JSP)

36 Projects
Estimated WorkForce: 120,000 IT mxh

Time Period: 4 to 5 years.
GIS Copel  Old System
Old Architecture

DOCUMENTATION

Network DB.

Updating process

Updating Process

PLANNING

Network Vision.

Planning Visions

Strong Relationship
New Architecture

Network DB

Updating

PLANNING

Network Vision

Planning Visions

Updating

Network DB PLANNING
New Architecture

Study areas creation process:
Feeder / Substation

Scenario 0
Scenario 1
Scenario 2
Scenario 10

Validation

Storage

PC Planner

Scenario Creation

Network Database
New Architecture

- Possibility to create different scenarios related to the same data-base.
- Easy to update.
- Less Work.
- More freedom to the planner.
Integrated System

- Automation
- Load Forecasting
- Customers
- Other systems
- Documentation
- Mapping and Raster Images
- Construction
- Outages
FUNCTIONALITIES

SEARCH: elements search, network, diagrams, drawings geographic information...

SIMULATIONS: load flow, current and voltage calculations, load curves, equipment adjusts.

ECONOMICS: Technical Losses, Non-delivered Energy and Voltage Deviation costs.

NETWORK OPTIMIZATION: equipment location, investment adviser, reliability planning.

NETWORK MANAGEMENT: integration, indexes, violations list.
GISPLAN – Network Layout Drawings

Single Line Diagrams

Easy to use and input data
GISPLAN – Network Layout Drawings

Substations
Transformers
Switches
Capacitors
Regulators
Lines
Cables
GISPLAN - VISUALIZATION

Important elements amplified

Easy to find HV customers.
GISPLAN - VISUALIZATION

Background Maps
Geographical maps
Rural Areas
GISPLAN - SIMULATIONS

FEEDERS LOAD CURVE:
3 typical curves for each feeder: workday, saturday and sunday
The curves are generated automatically from metering feeders (automation).

Curve Automatic Process of Selection and Choice – errors filtering
GISPLAN- SIMULATION

TRANSFORMERS LOAD CURVE:
Based on customer curves
Customer curve based on consumption and metering
Adjusted by the feeder curve.

High Voltage Customers:
Load Curve from meters
GISPLAN- SIMULATION

Single phase and three phase calculations
Balanced and unbalanced
Voltage Drop
Power Flow Analysis
Violations Information
GISPLAN - ECONOMIC CONCEPTS

OPTIMIZATION

Costs

Global Cost

Investment

Other Costs

SQ1

Service Quality

C1

INV1
GISPLAN – Economics
NDE Calculation – Non-Delivered Energy

Outages Data
Voltage Deviation Calculation

\[
c_{DT} = 0.0044 \cdot (QT - 4)^{1.45} \times \sum_{i=1}^{3} \sum_{j=1}^{24} (D_{ij} \times N_{h_i}) \quad [\text{US$}]
\]
GISPLAN - OPTMIZATION
REGULATOR AND CAPACITORS AUTOMATIC LOCATION
GISPLAN – NETWORK MANAGEMENT

Automatic Generation of Indexes

% of Feeders that meets Loading Planning Criteria

<table>
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<tr>
<th>Year</th>
<th>%</th>
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GISPLAN - OPTMIZATION

ADVISER HELP PLANNER TO BEST NETWORK INVESTMENT:
-Reconductoring, new feeders, extension from single to three phase supply.
CONCLUSIONS

• SYSTEMS BECAME MORE COMPLEX, SO OPTIMUM PLANNING IS IMMINENT FOR EFFICIENCY IMPROVEMENT.

• RESEARCH AND DEVELOPMENT PROJECTS ARE THE BASE OF SYSTEM INNOVATION

• INTEGRATION IS FUNDAMENTAL.

• COPEL OPTION WAS FOR TAYLOR MADE SYSTEM.

• OPTIMIZATION GUARANTEE LOW TARIFFS.
REFERENCES


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