

A MODEL FOR THE INTEGRAL PLANNING OF ELECTRIC POWER SYSTEMS AND NATURAL GAS TRANSPORTATION NETWORKS

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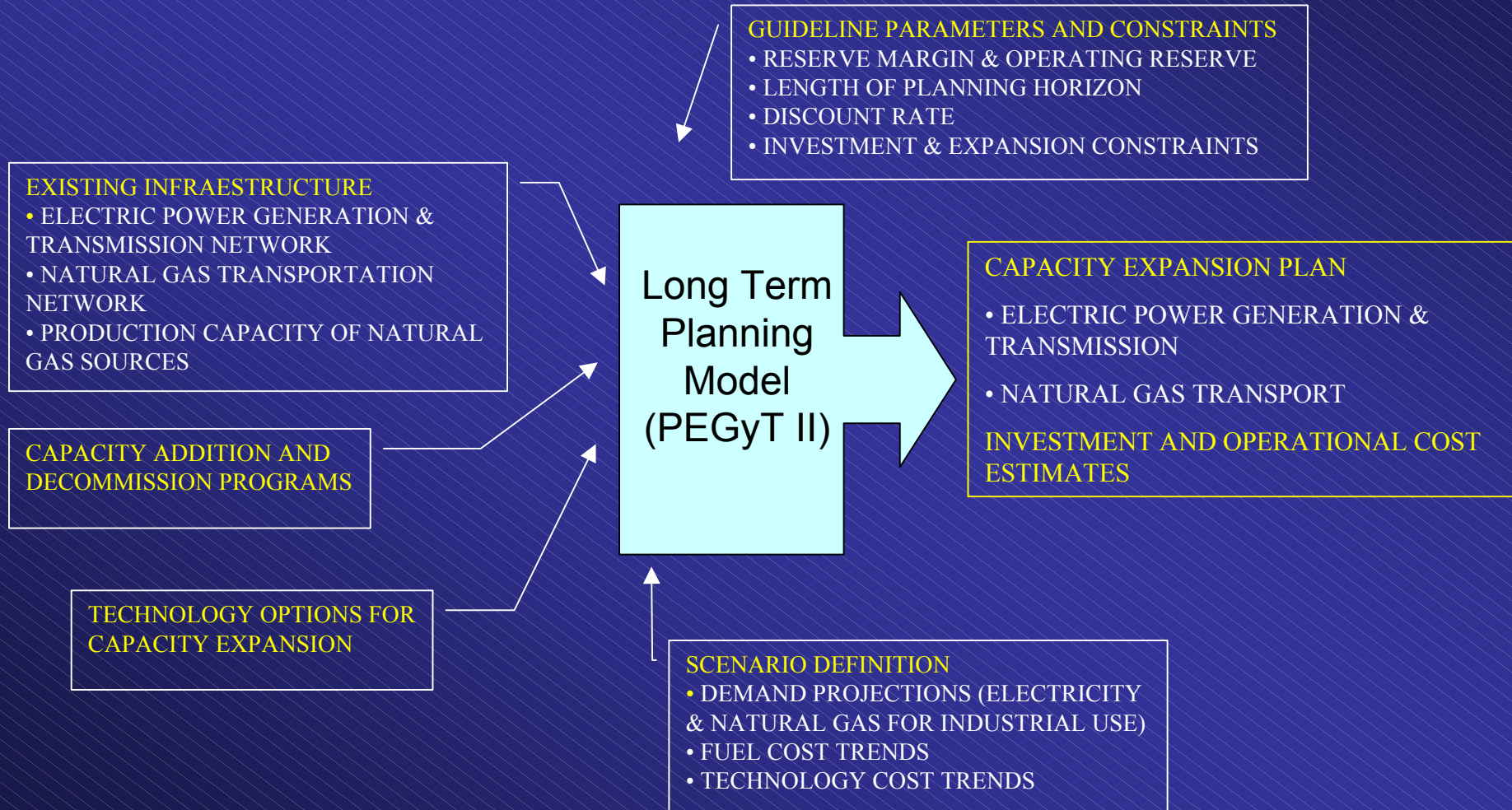
BACKGROUND

- THE NEED FOR THE INTEGRAL PLANNING OF ELECTRICITY TRANSMISSION AND NATURAL GAS TRANSPORTATION NETWORKS
 - ✓ INCREASED USE OF NATURAL GAS IN ELECTRICITY PRODUCTION
 - ✓ LARGE ECONOMIES OF SCALE IN BOTH TYPES OF NETWORKS
 - ✓ SITING DECISIONS OF GENERATION CAPACITY LEADING TO LOWER OVERALL INVESTMENT + OPERATION COSTS
- A PREVIOUS MODEL
 - ✓ PEGyT: A MODEL FOR THE LONG-TERM PLANNING OF ELECTRICITY GENERATION AND TRANSMISSION CAPACITIES
 - ✓ NO EXPLICIT CONSIDERATION OF NATURAL GAS TRANSPORTATION NETWORK

SCOPE OF THE MODEL

- A TOOL FOR THE LONG TERM PLANNING OF ELECTRICITY GENERATION CAPACITY
 - ✓ TECHNOLOGY SELECTION, AND DETERMINATION OF SIZE, LOCATION AND INSTALLATION DATES OF THE REQUIRED NEW GENERATION CAPACITY
 - ✓ MINIMIZING THE PRESENT VALUE SUM OF:
 - ELECTRICITY PRODUCTION COSTS
 - NEW GENERATION CAPACITY COSTS
 - NEW ELECTRICITY TRANSMISSION CAPACITY AND OPERATION COSTS
 - NEW NATURAL GAS TRANSPORTATION CAPACITY AND OPERATION COSTS

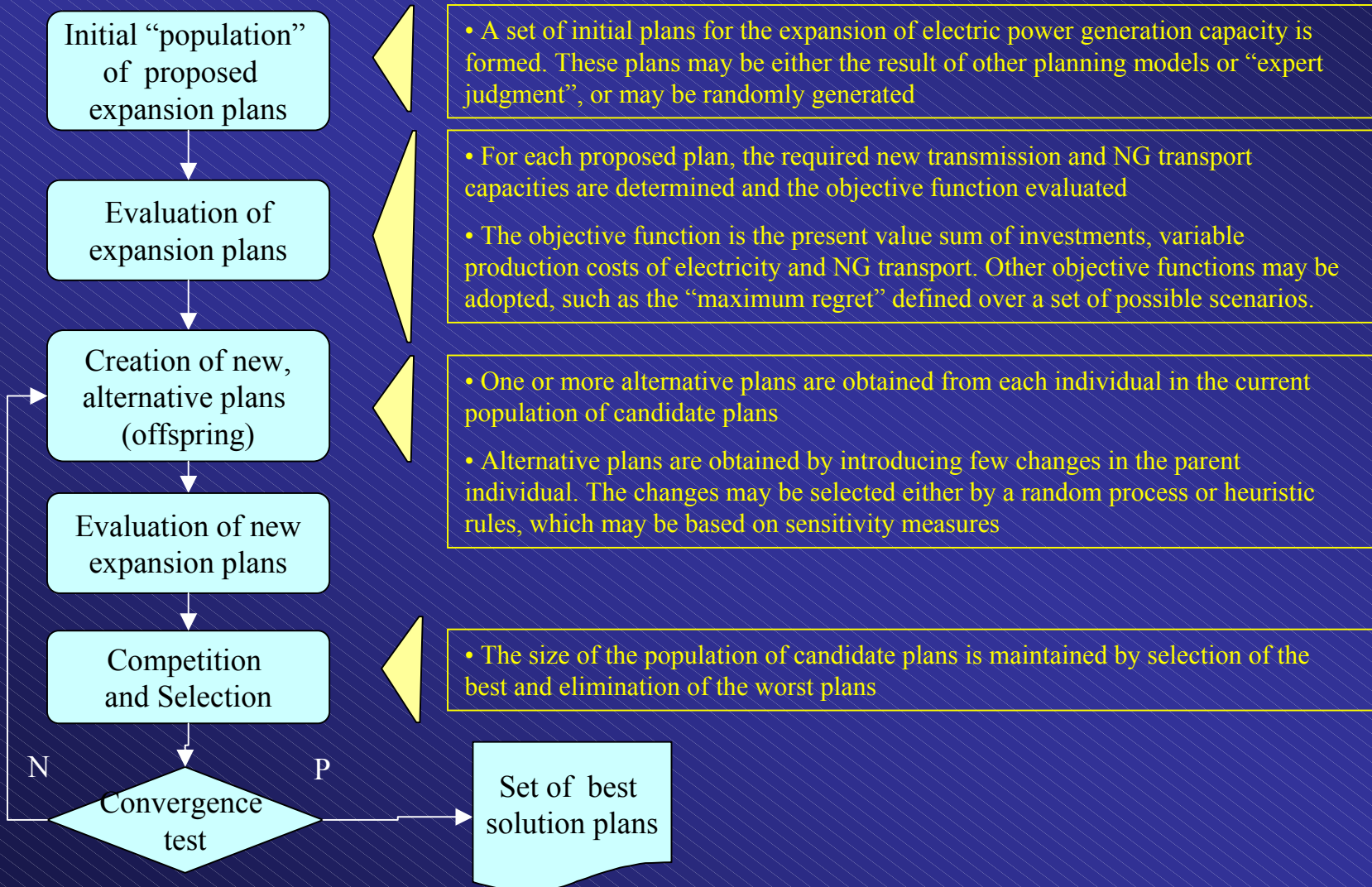
SCOPE OF THE MODEL



MODEL FEATURES

- LARGE SCALE, MIXED-INTEGER, NONLINEAR, MULTISTAGE OPTIMIZATION PROBLEM
- SOLUTION TECHNIQUES:
 - ✓ COMBINATION OF MODERN HEURISTICS (EVOLUTIONARY PROGRAMMING) AND MATHEMATICAL PROGRAMMING TECHNIQUES

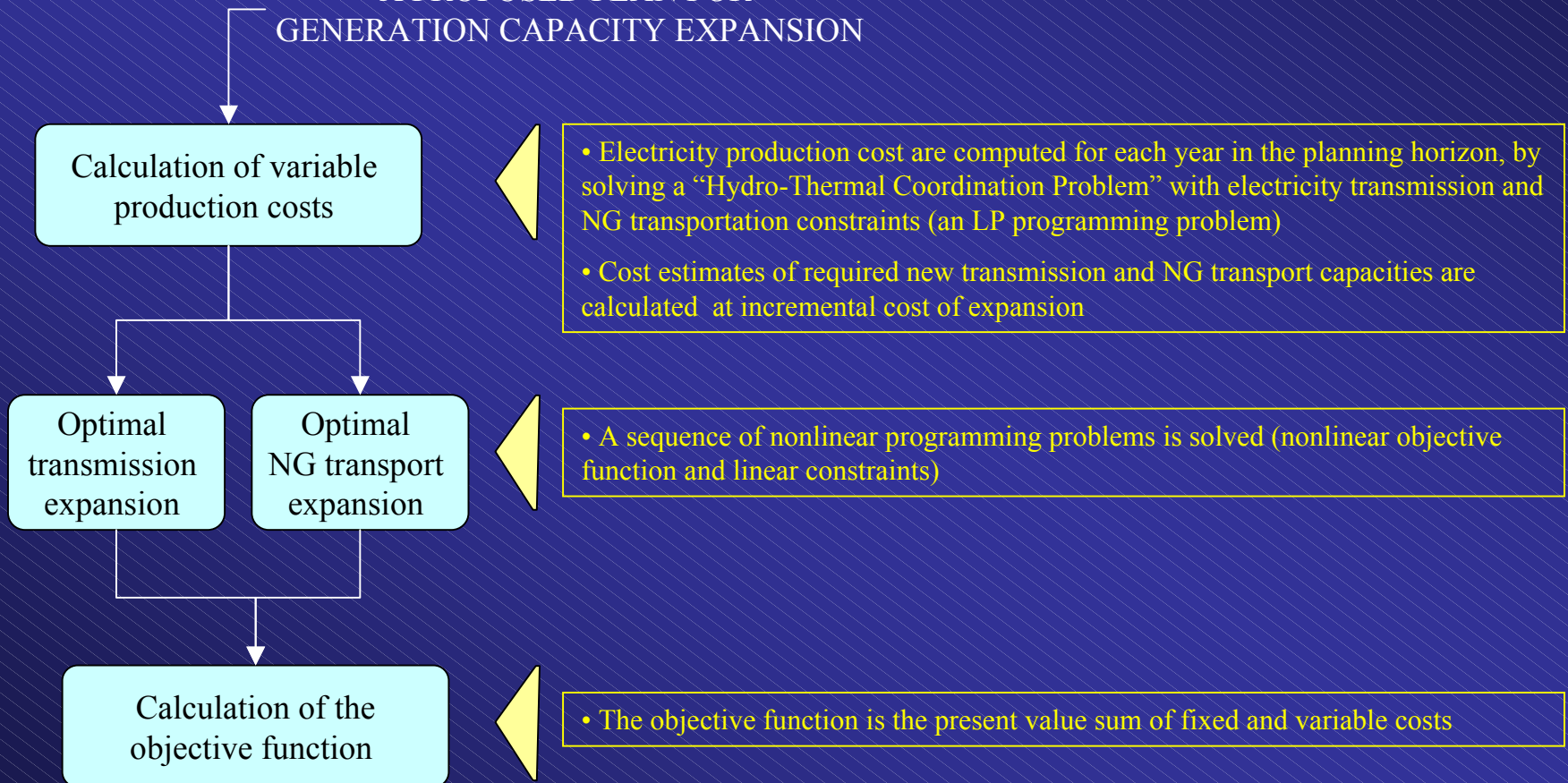
SOLUTION SCHEME: AN EVOLUTIONARY PROGRAMMING APPROACH



SOLUTION SCHEME

EVALUATION STEP: A MATHEMATICAL PROGRAMMING APPROACH

A PROPOSED PLAN FOR
GENERATION CAPACITY EXPANSION



APPLICATION EXPERIENCE

- THE NEW MODEL (PEGyT II) HAS BEEN APPLIED TO SEVERAL CASE STUDIES
 - ✓ THE MEXICAN NORTHWEST ELECTRIC POWER SYSTEM
 - ✓ THE MEXICAN INTERCONNECTED ELECTRIC POWER SYSTEM
- COMPARISON OF SOLUTIONS (NEW VS OLD MODEL) SHOW:
 - ✓ LESS CONCENTRATION OF NEW ELECTRIC GENERATION CAPACITY; SAME TRENDS (TECHNOLOGY, SIZE, LOCATION AND INSTALLATION DATES)
 - ✓ REDUCED REQUIREMENTS OF NEW INTERREGIONAL TRANSMISSION CAPACITY, SAME TRENDS
- SLOW CONVERGENCE
 - ✓ 80-100 HOURS (PENTIUM IV, 1.4GHZ)

AREAS FOR IMPROVEMENT

- REDUCING COMPUTATION TIME

 - POSSIBLE SOLUTION: PARALELL COMPUTATION

 - ✓ THE “EVALUATION” OF PROPOSED “INDIVIDUALS” (CANDIDATE GENERATION EXPANSION PLANS) IS COMPUTATIONALLY EXPENSIVE
 - ✓ EVALUATION OF INDIVIDUALS IS AMENABLE TO PARALELL COMPUTATION

APPLICATION EXAMPLE

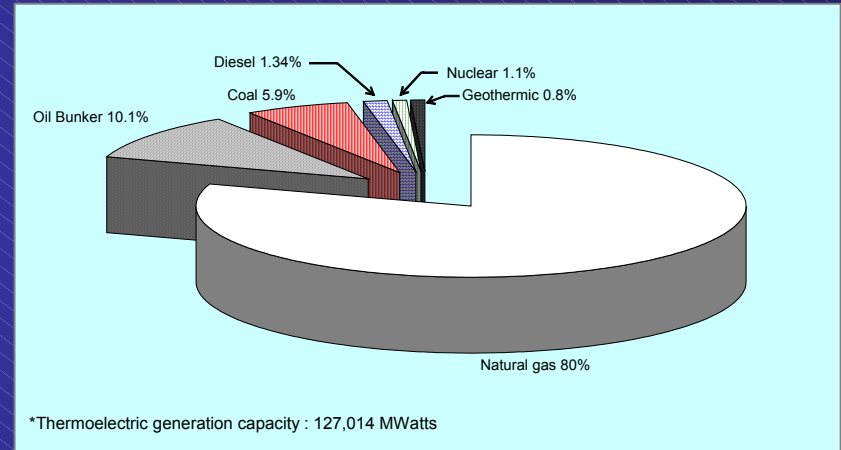
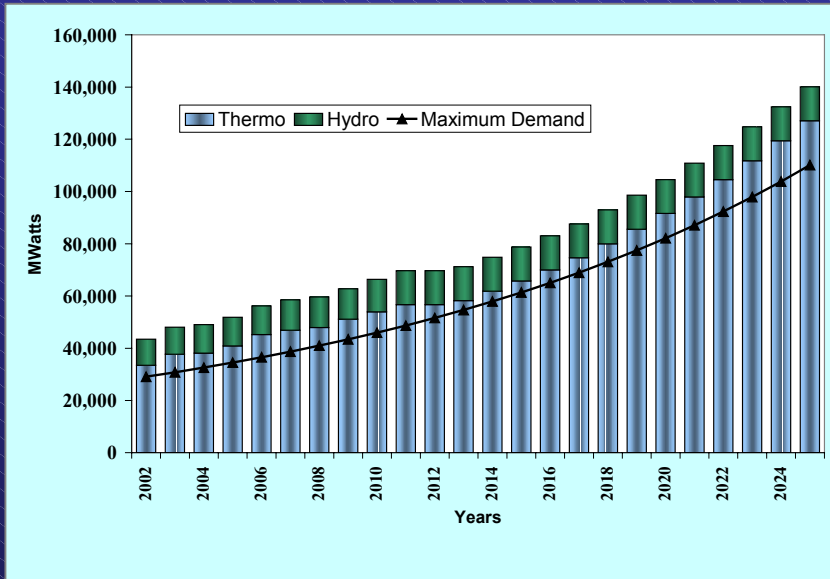
THE MEXICAN INTERCONNECTED ELECTRIC POWER SYSTEM

- PLANNING HORIZON: 2002-2025
- ALL DATA TAKEN FROM PUBLIC REFERENCES: NATIONAL AND INTERNATIONAL
- ELECTRIC NETWORK REPRESENTATION: 32 REGIONS, 40 INTERREGIONAL TIES
- TECHNOLOGICAL OPTIONS FOR CAPACITY EXPANSION:
 - ✓ 9 TYPES OF THERMOELECTRIC GENERATING UNITS
 - ✓ 14 HIDROELECTRIC POWER PROJECTS
 - ✓ ELECTRIC INTERREGIONAL TIES AT 230 KV AND 400 KV
- NATURAL GAS TRANSPORTATION NETWORK: 96 NODES AND 101 LINKS
- NATURAL GAS SOURCES: 6 NATIONAL, 4 BORDER INTERCONNECTIONS, 1 LNG FACILITY

APPLICATION EXAMPLE

THE MEXICAN INTERCONNECTED ELECTRIC POWER SYSTEM

(2002-2025)



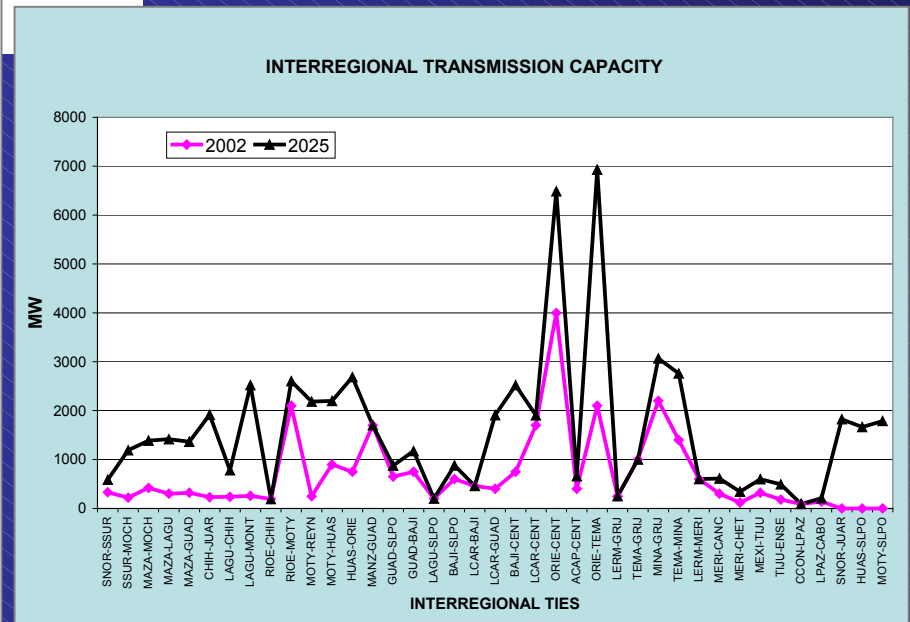
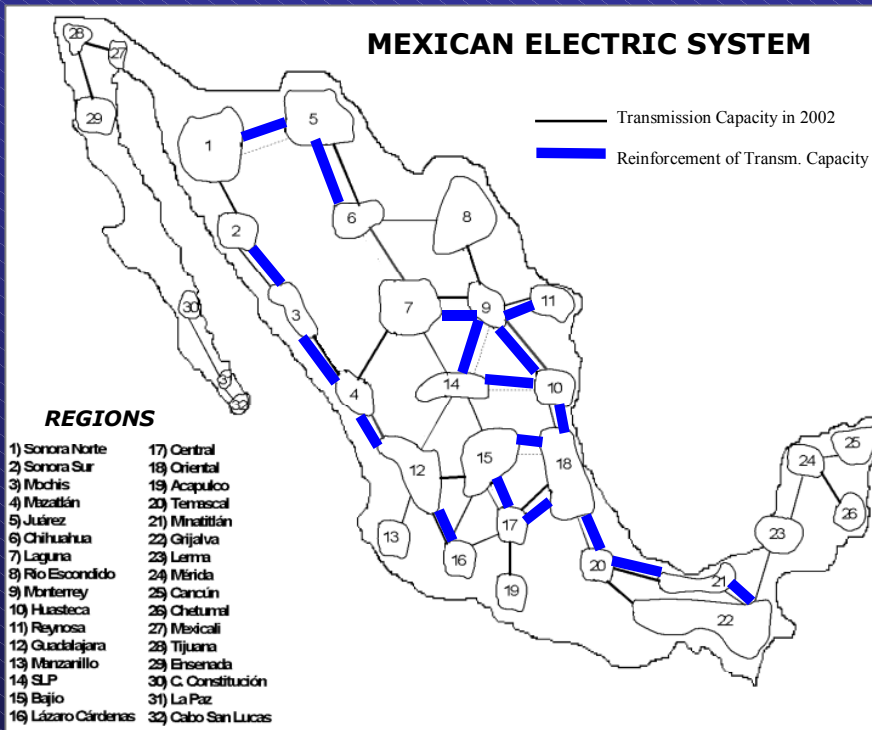
FUEL MIX FOR ELECTRIC POWER GENERATION IN 2005

PROJECTED DEMAND GROWTH AND ELECTRIC POWER GENERATION CAPACITY

APPLICATION EXAMPLE

THE MEXICAN INTERCONNECTED ELECTRIC POWER SYSTEM

(2002-2025)

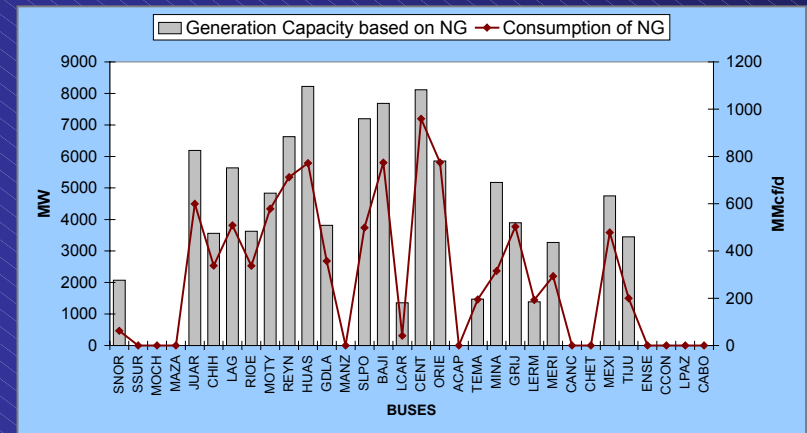
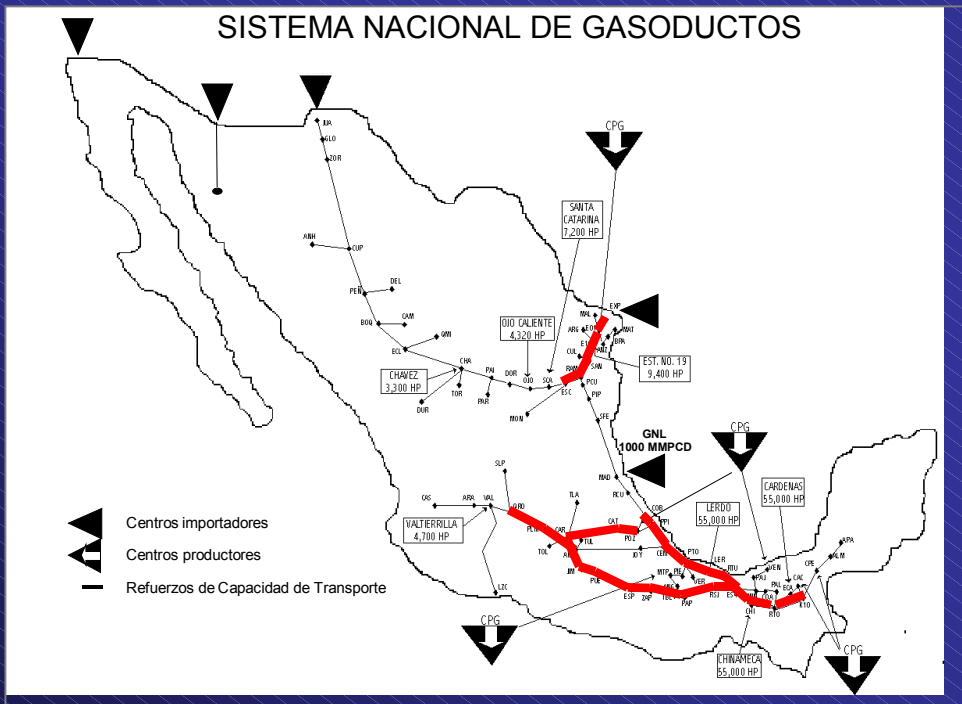


EXISTING (2002) AND ADDITIONAL TRANSMISSION CAPACITY (2025)

APPLICATION EXAMPLE

THE MEXICAN INTERCONNECTED ELECTRIC POWER SYSTEM

(2002-2025)



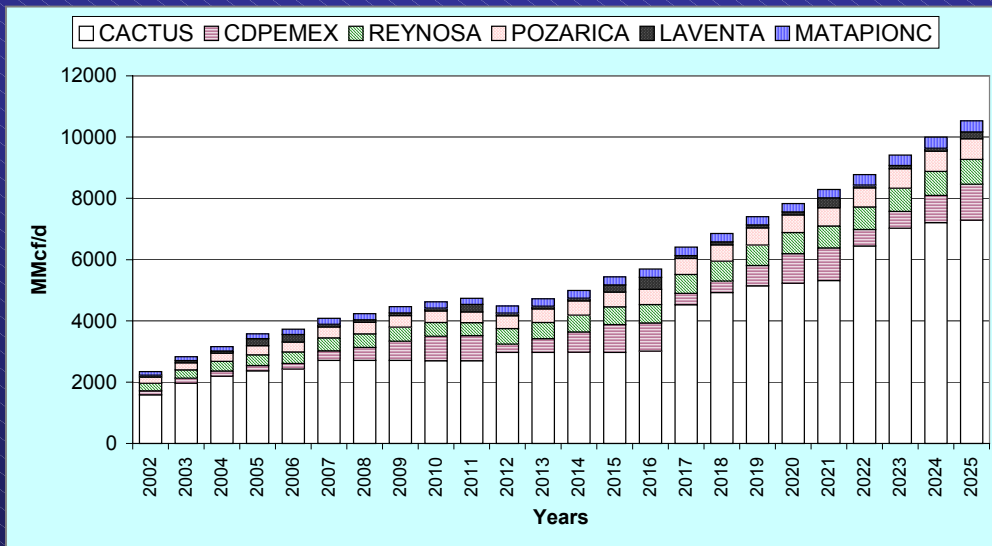
REGIONAL ALLOCATION OF NATURAL GAS BASED ELECTRIC POWER GENERATION CAPACITY

EXISTING AND ADDITIONAL NATURAL GAS TRANSPORTATION CAPACITY

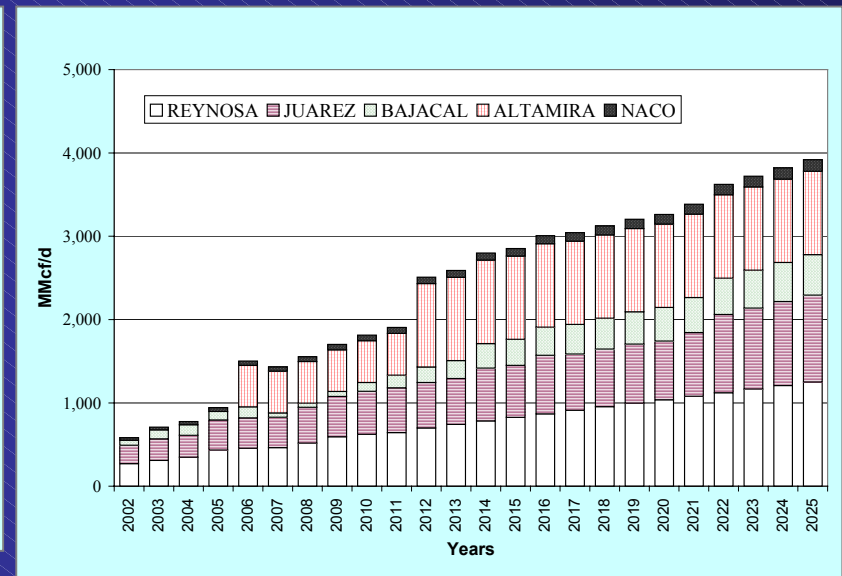
APPLICATION EXAMPLE

THE MEXICAN INTERCONNECTED ELECTRIC POWER SYSTEM

(2002-2025)



NATIONAL PRODUCTION OF NATURAL GAS



NATURAL GAS IMPORTS

THANK YOU