

# **“Energy Supply Options Study for Uruguay”**

## **A detailed Multi-Sector Integrated Energy Supply and Demand Analysis**

**Note: Lecture is based on Final Report prepared by ANL Staff (Guenter Conzelmann and Thomas Veselka).**

# Uruguay (Geographical location)



# ANL and Local Experts Used ENPEP to Analyze Natural Gas and Electricity Issues in Uruguay

- Overall energy sector development strategy in light of increasing regional integration
- Uruguay's energy supply system is undergoing change (MERCOSUR, natural gas imports, potential increase in electricity connections with other countries, energy sector reform, etc.)
- For a total of six scenarios, analyze fuel substitution trends due to gas imports and increased electricity interties, and project future market penetration of natural gas by sector
- ANL collaborated with a team of local energy experts from the Presidential Planning Office (OPP), Ministry of Energy (MoE), National Energy Office (DNE), Electric Utility (UTE), Oil Refinery (ANCAP), and Gas Company
- Project sponsored by The World Bank



# **“Energy Supply Options Study”**

## **Topics of discussion:**

- 1. Question to answer**
- 2. Study Objectives**
- 3. Energy network representation in BALANCE**
- 4. Scenarios (cases) considered**
- 5. Results**
- 6. Main conclusions in terms of fuel substitutions**

## 1.) Question to answer:

---

**What would be the impacts on the energy sector due to future changes in the supply system?**

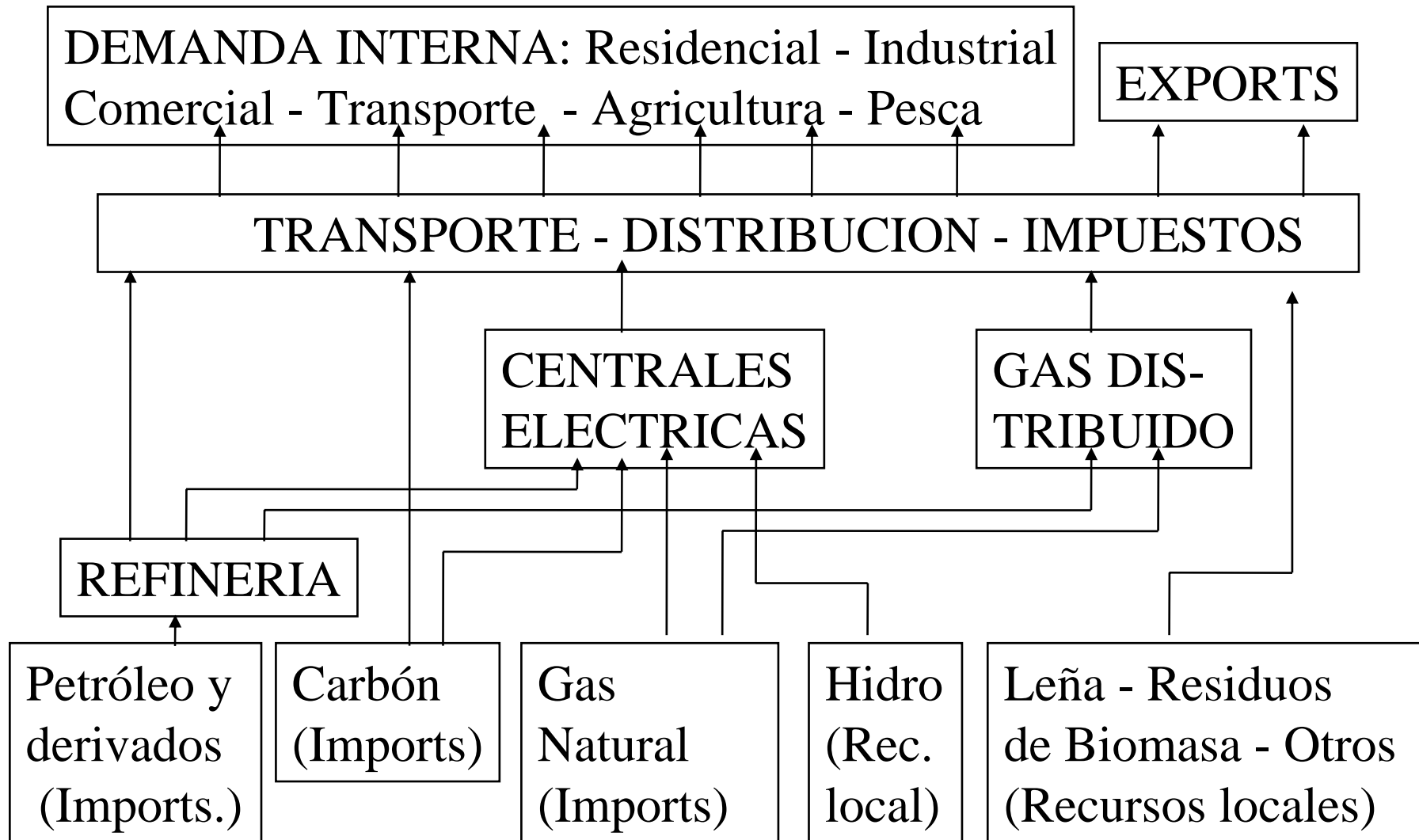
## **2.) Study Objectives**

- 1. Analyze Uruguay's past energy demand patterns**
- 2. Develop future demand projections for final and useful energy demand by sector and fuel and/or type of useful energy**
- 3. Conduct an integrated supply and demand analysis taking into consideration a variety of energy supply options**
- 4. Provide recommendations of a preliminary set of options that Uruguay should pursue to achieve an economic and reliable supply of energy**

## Study Objectives (cont.):

5. **Evaluate, from a technical and economic point of view, the effects on the energy system of:**
  - potential natural gas imports via a pipeline from Argentina
  - increase of the electricity exchanges with neighboring countries because a more important integration of the electricity markets
  - increase of the electricity transport capacity between Brazil and Uruguay
  
6. **Contribute to capacity building in the energy planning area using BALANCE**

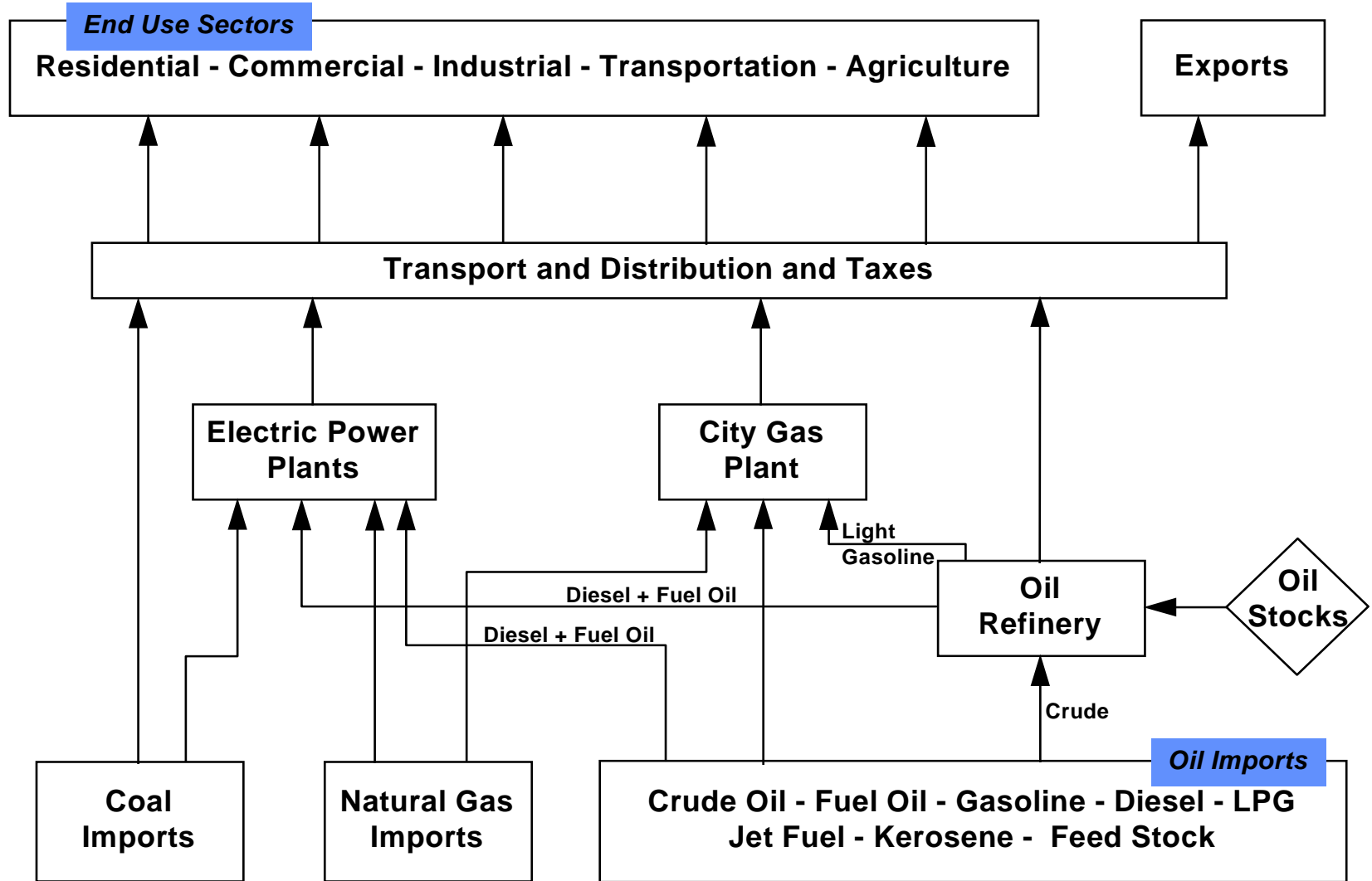
### 3.) Energy Network in Uruguay

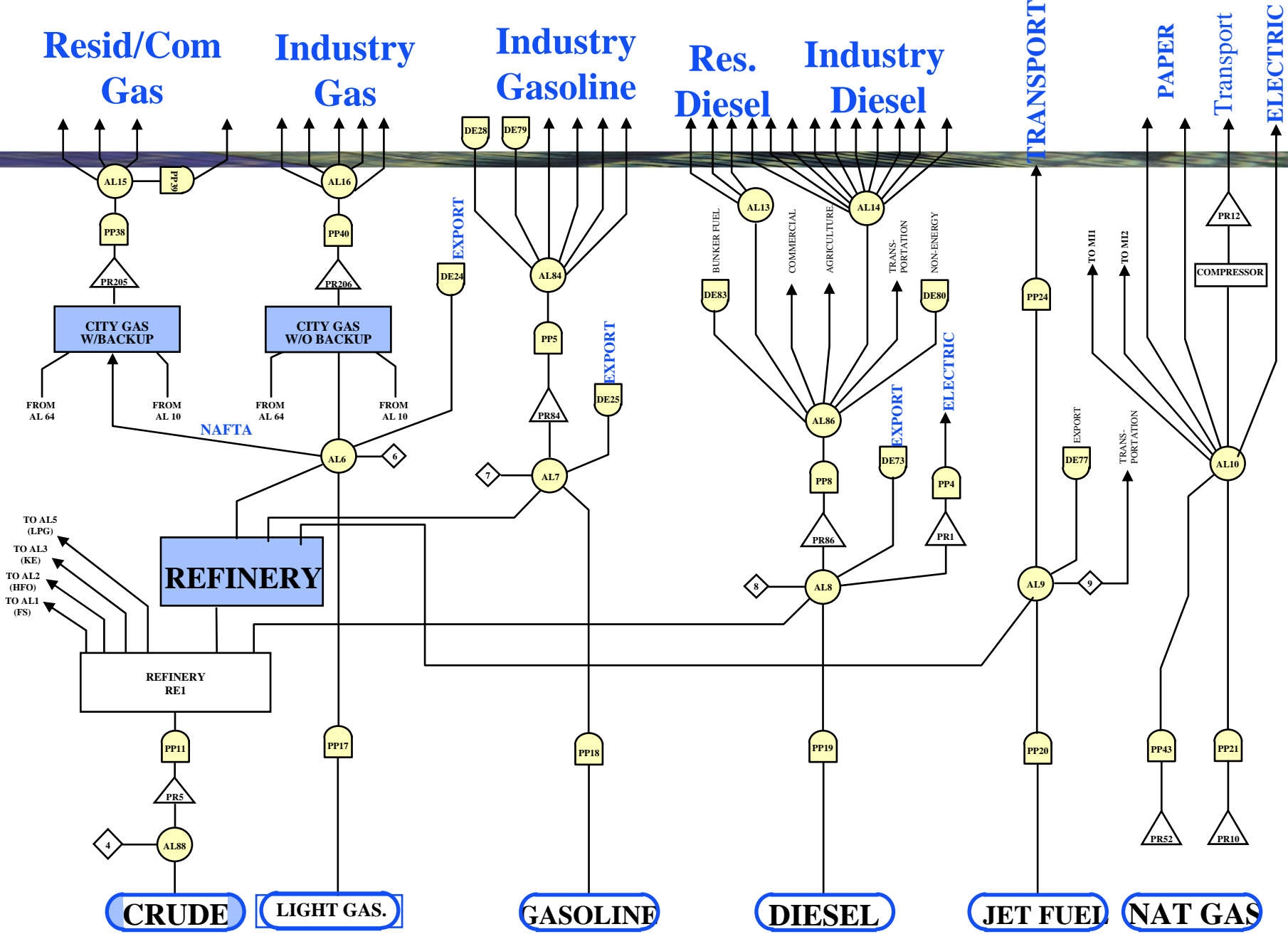


# A detailed BALANCE network was created to model the energy system in Uruguay

	<i>No. Used</i>
▪ Demand node	88
▪ Conversion node	247
▪ Multiple input	4
▪ Multiple output	6
▪ Decision/allocation node	199
▪ Pricing node	42
▪ Renewable resource node	9
▪ Depletable resource node	18
▪ Links	839

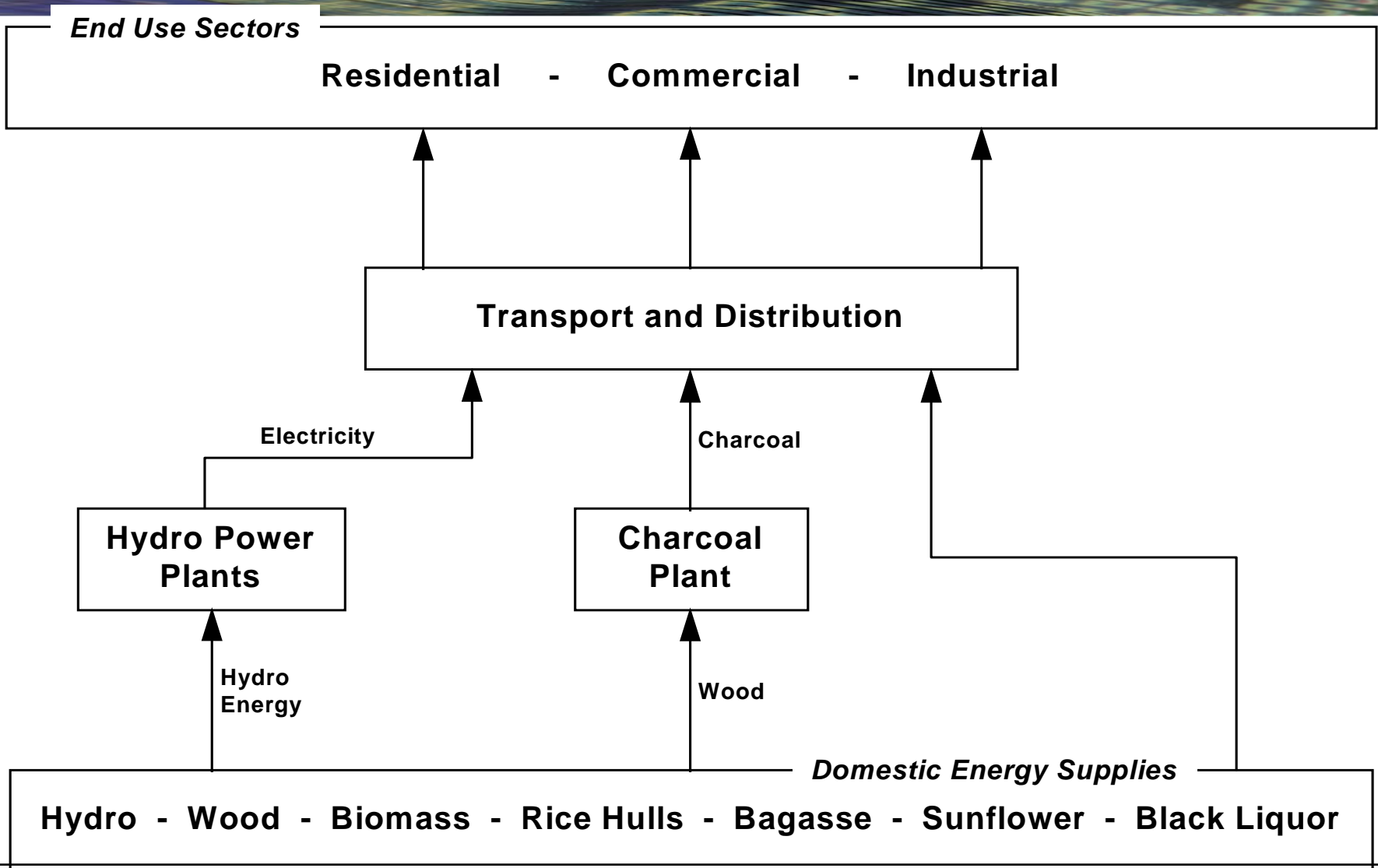
# Fossil Fuel Supply Representation

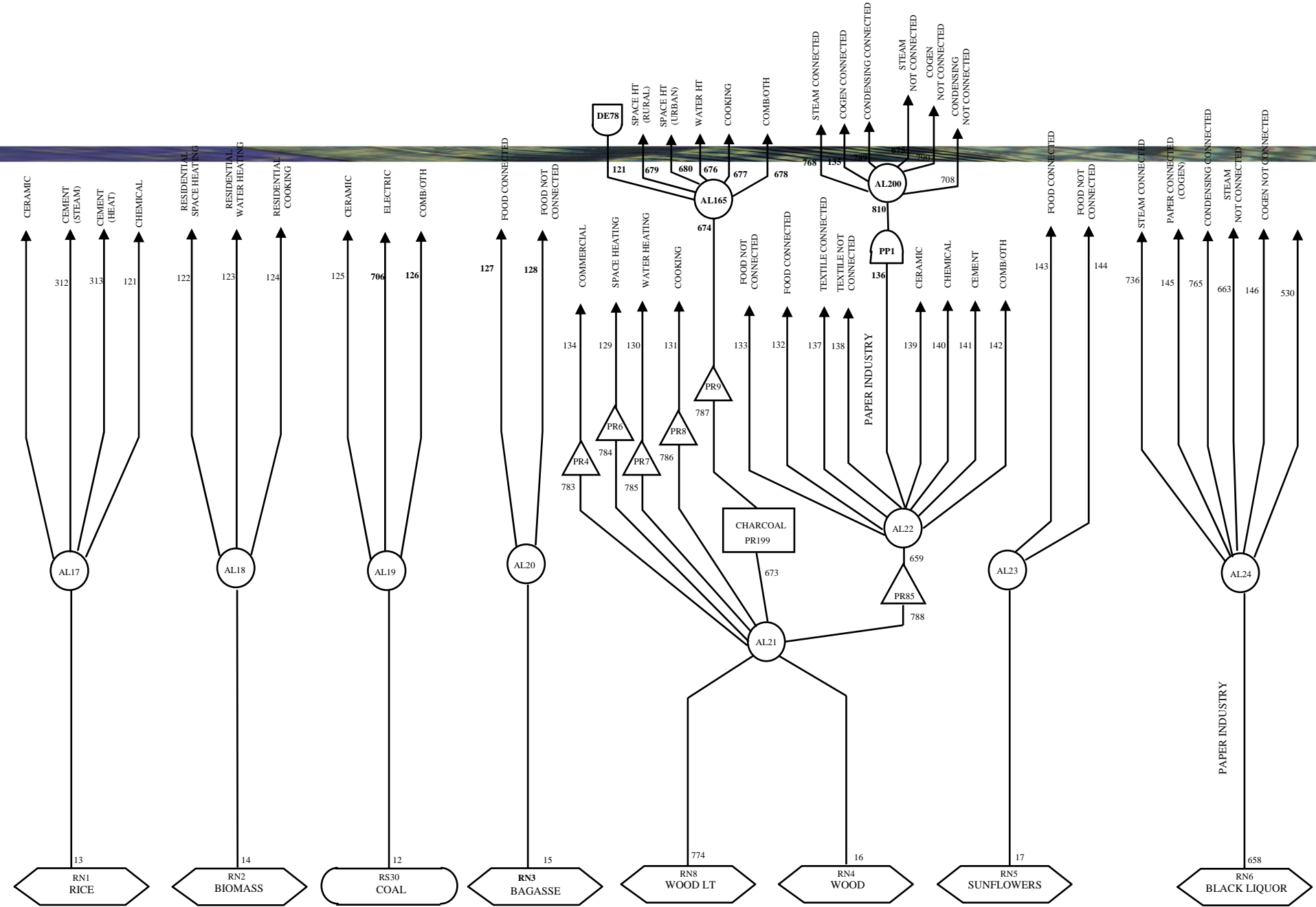






# Renewable Energy Resources

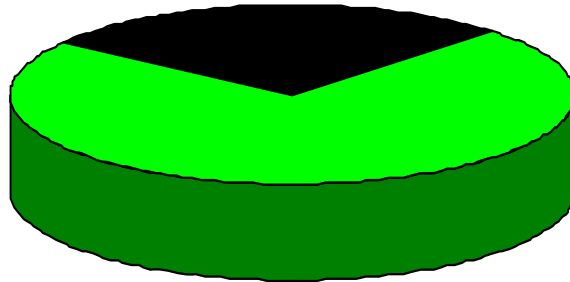




# Electric Sector

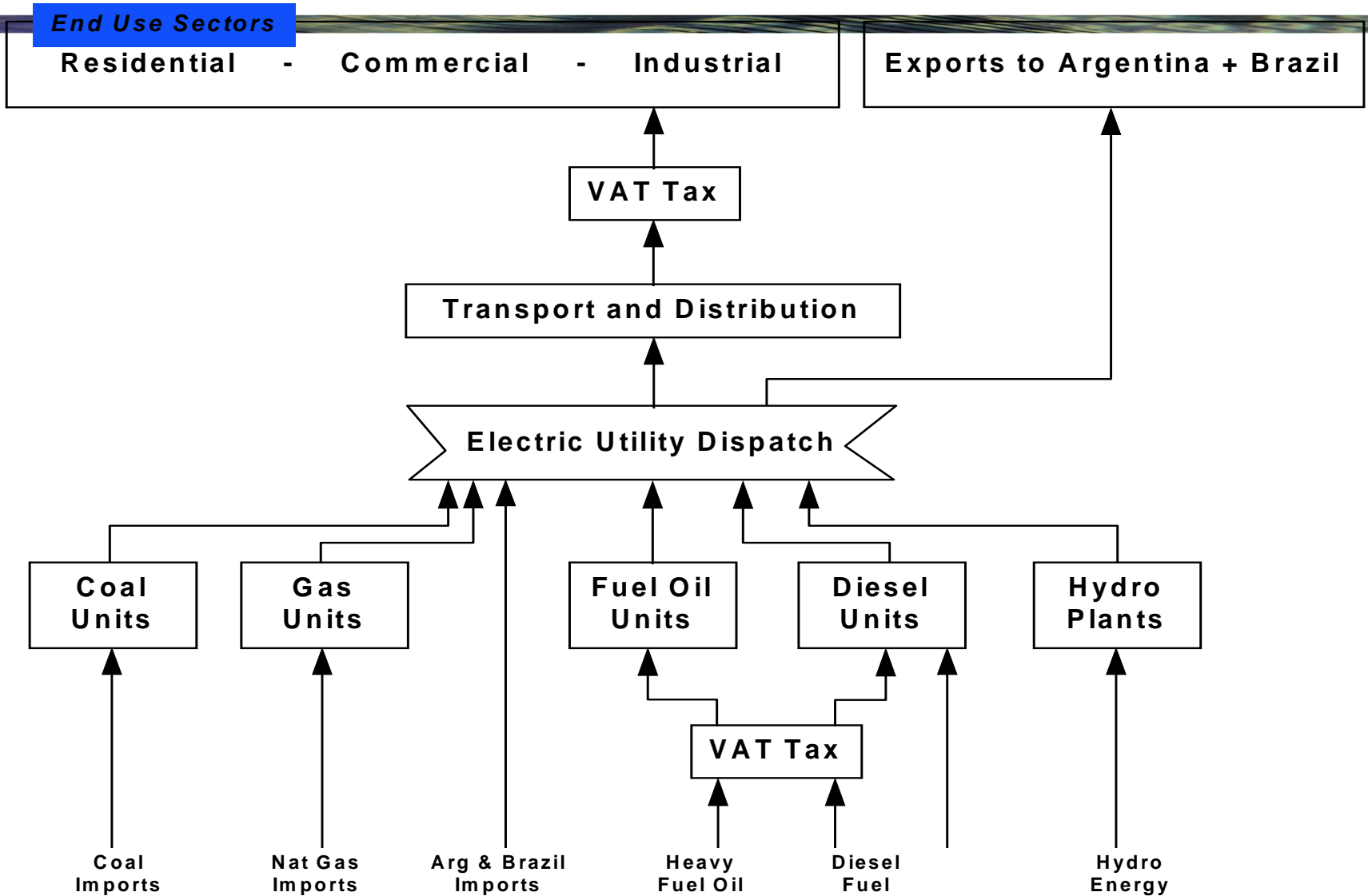
Year 1998  
2115 MW

Thermal  
Units  
27%



Hydro Units  
73%

# Electric Sector



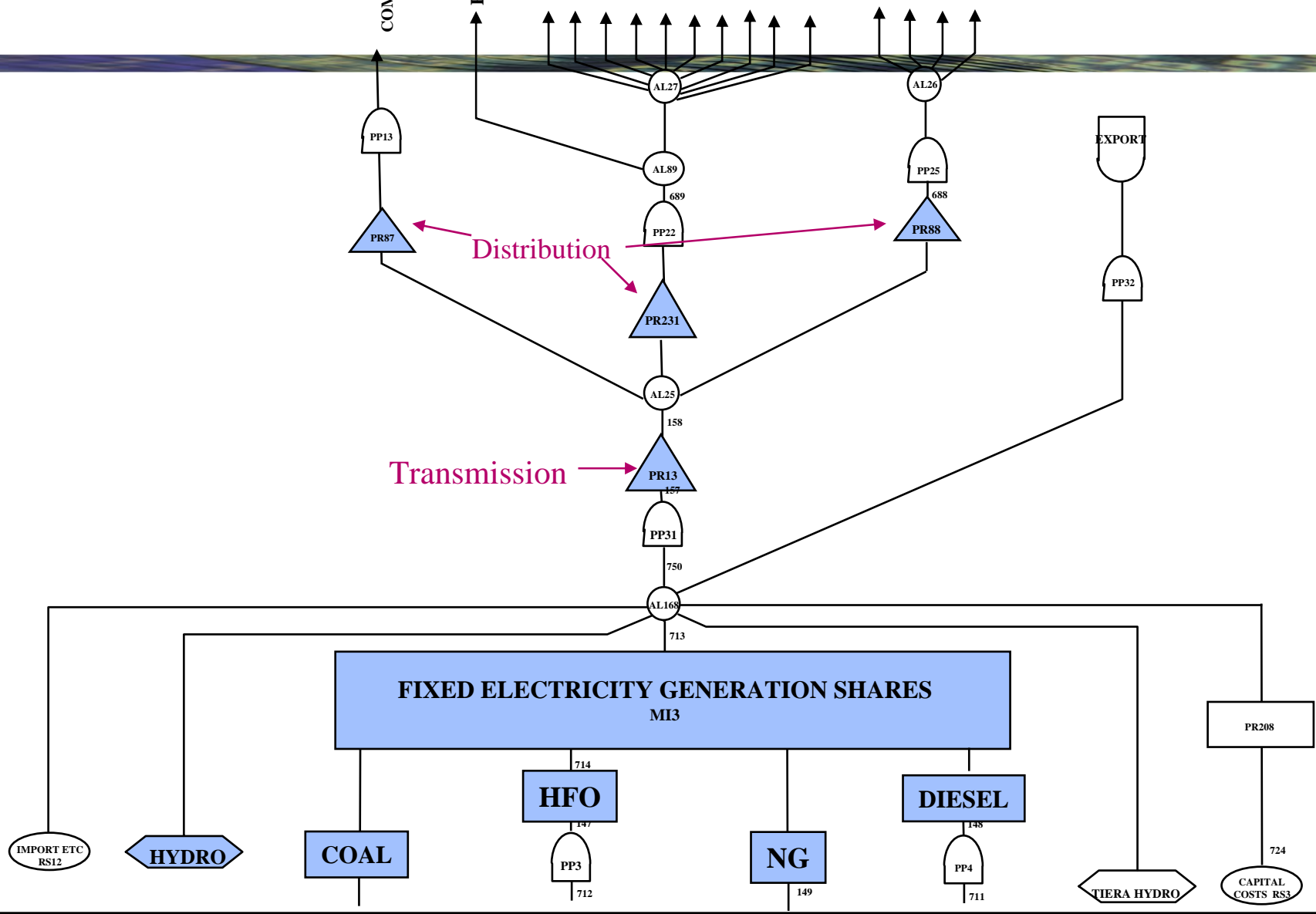
# ELECTRIC SECTOR

COMMERCIAL

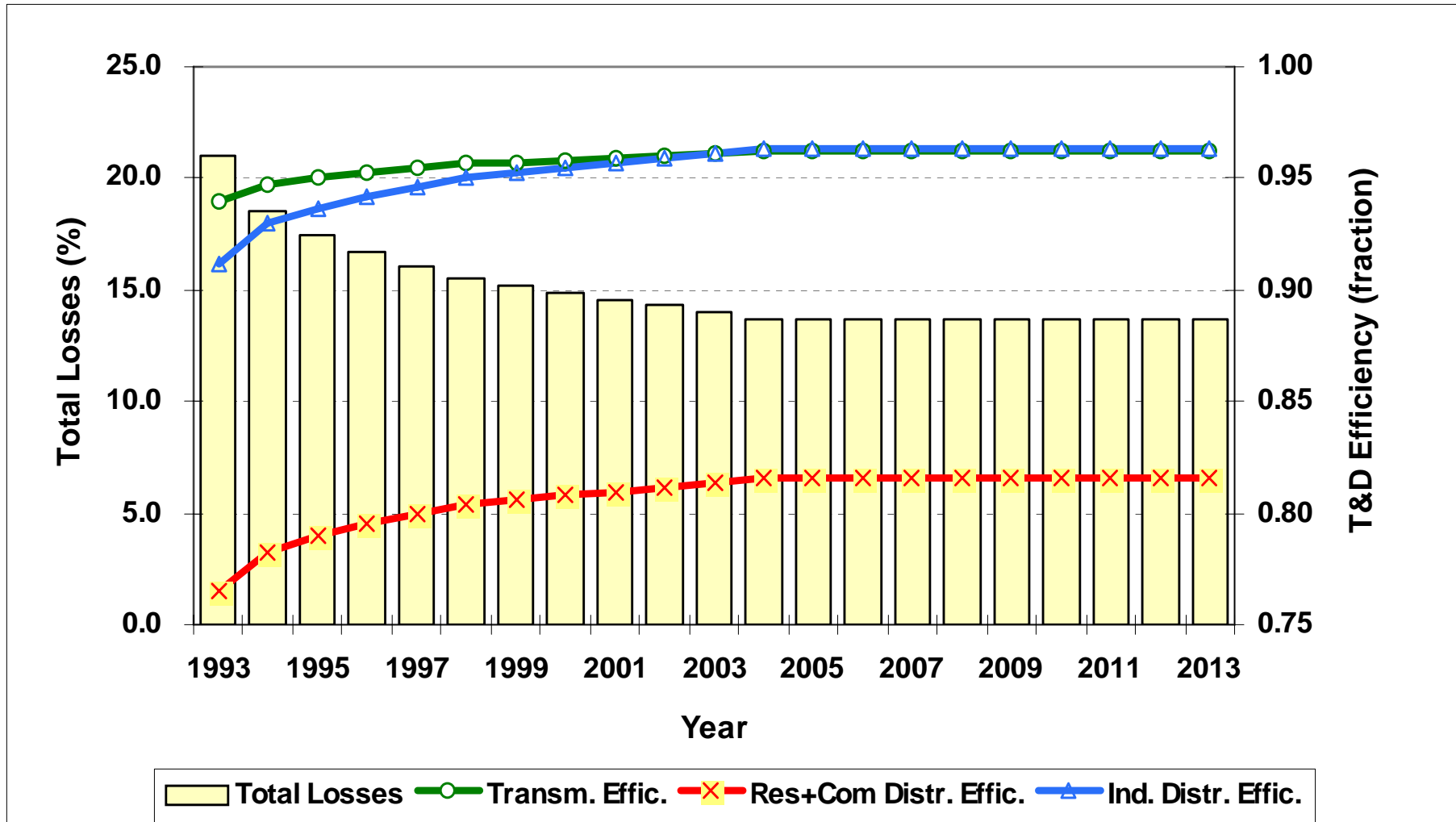
REFINERY

Industry

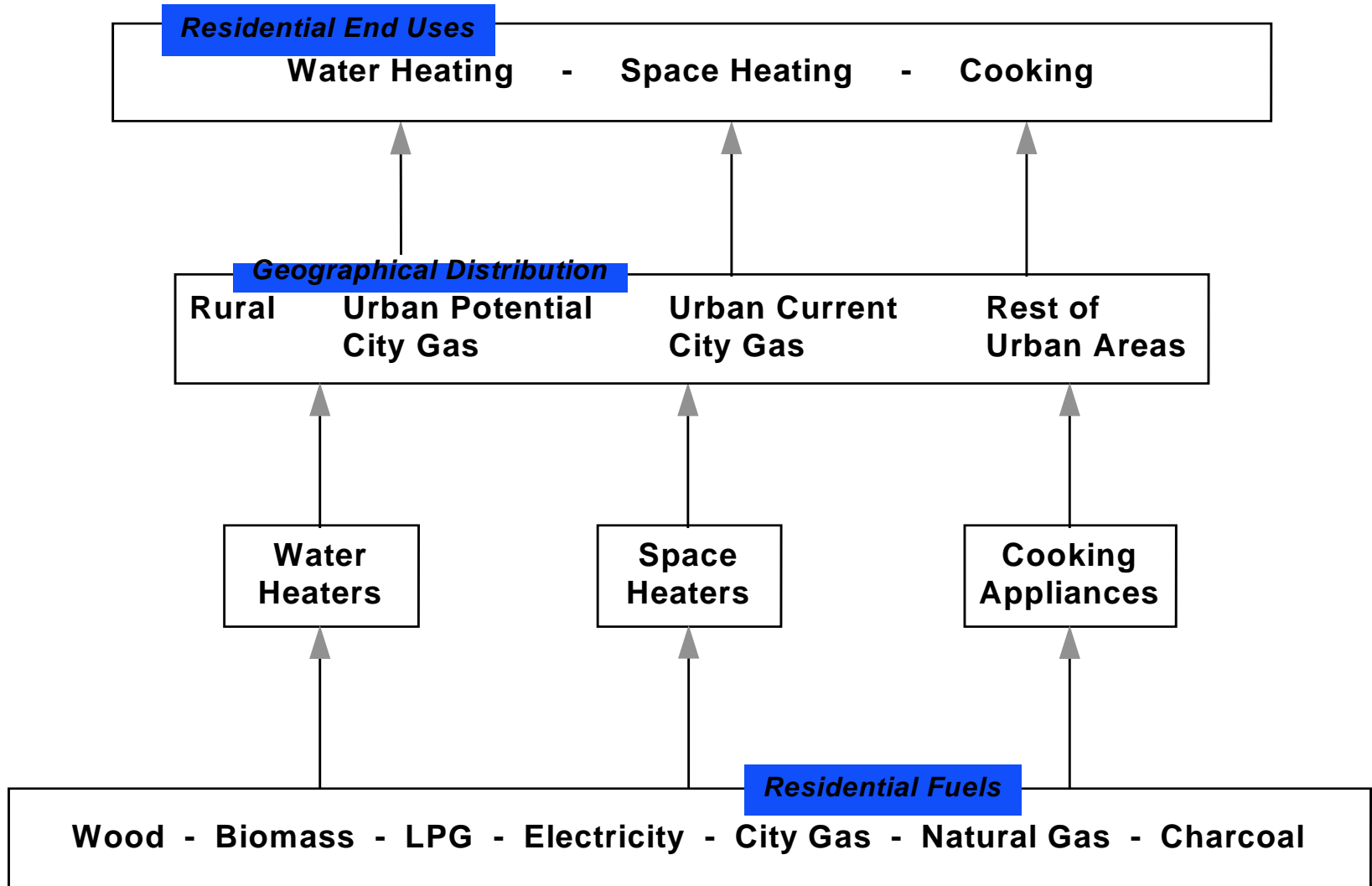
Residential



# More Efficient Utility T&D System

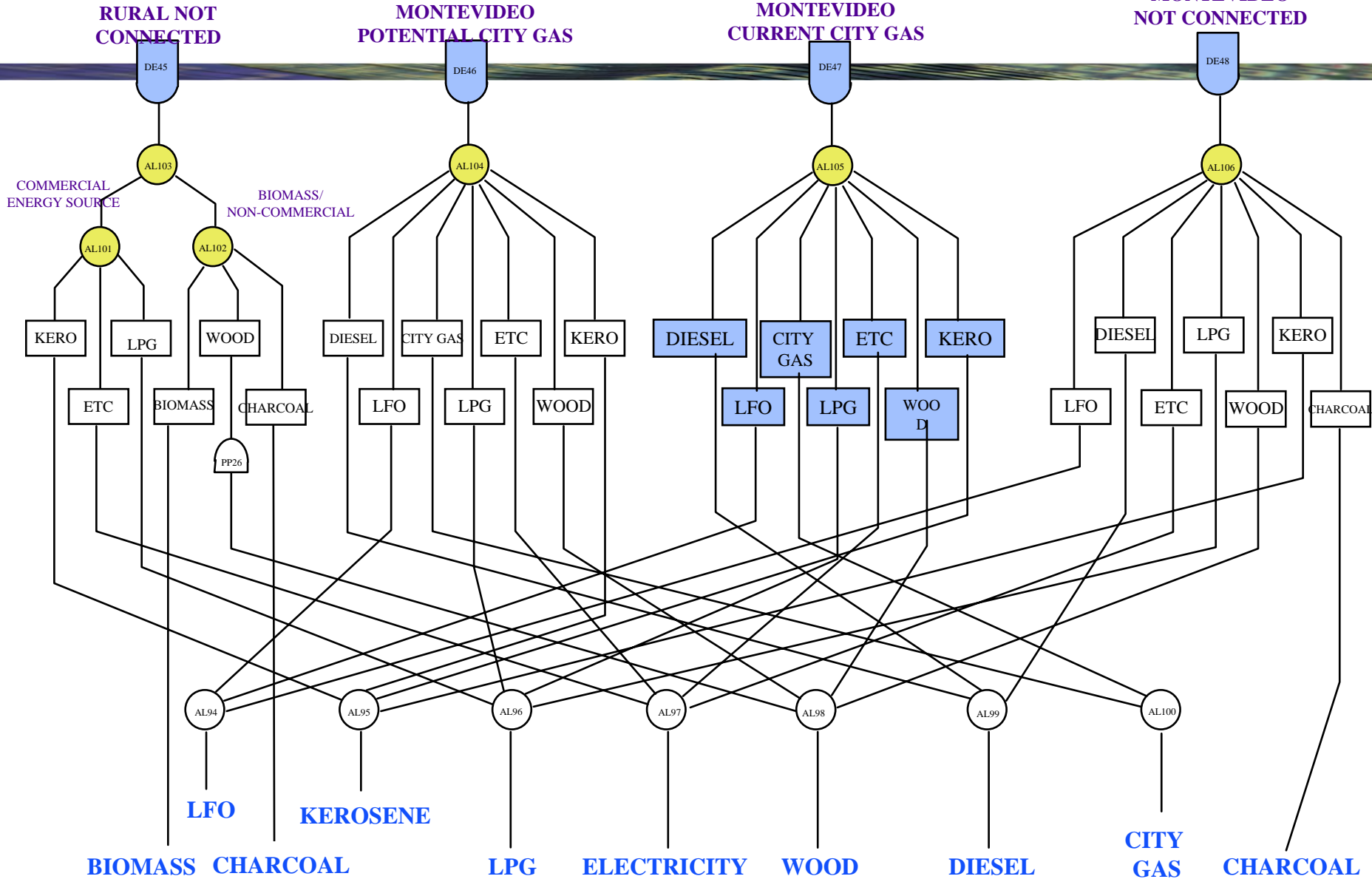


# Residential Demands

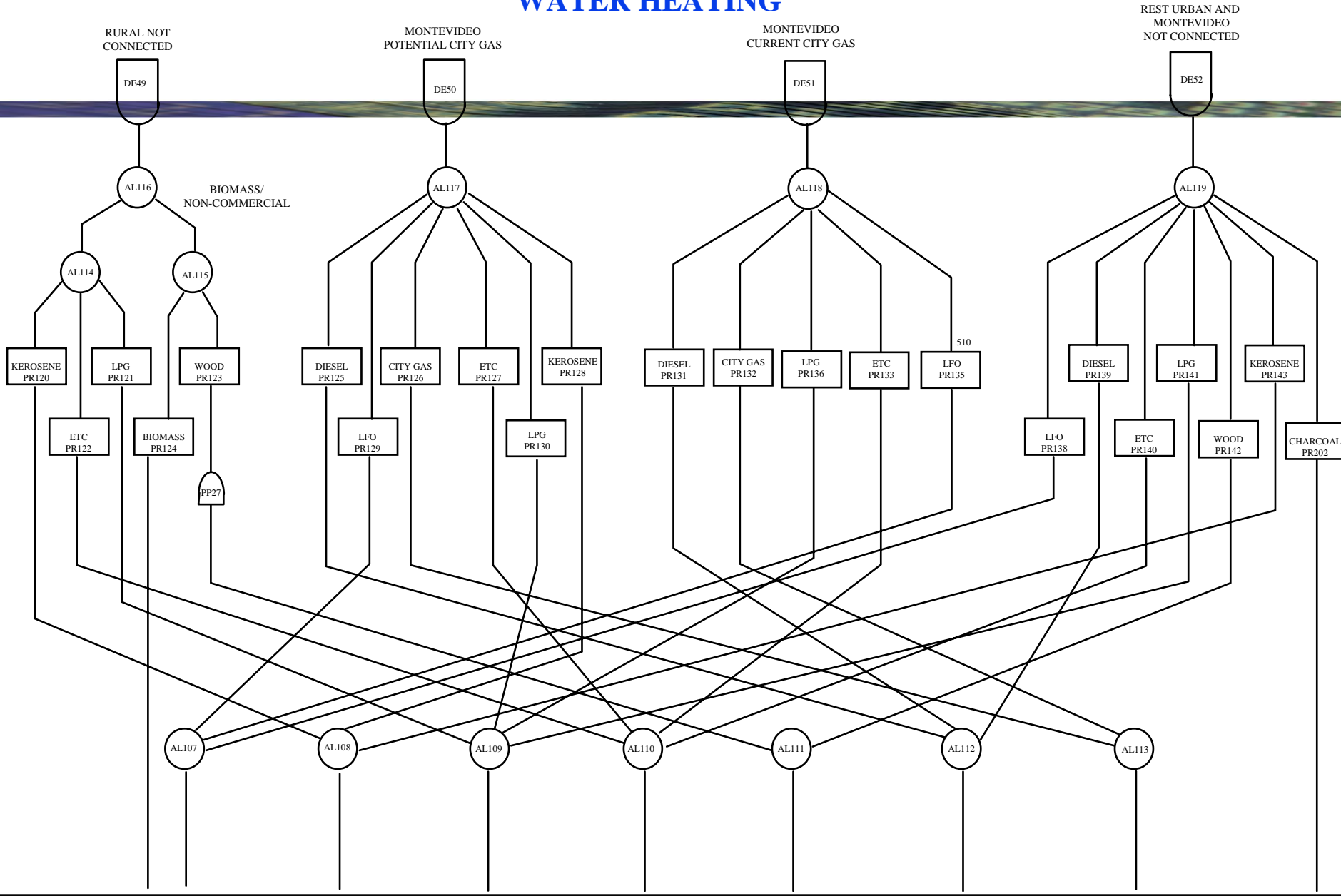


# RESIDENTIAL SPACE HEATING

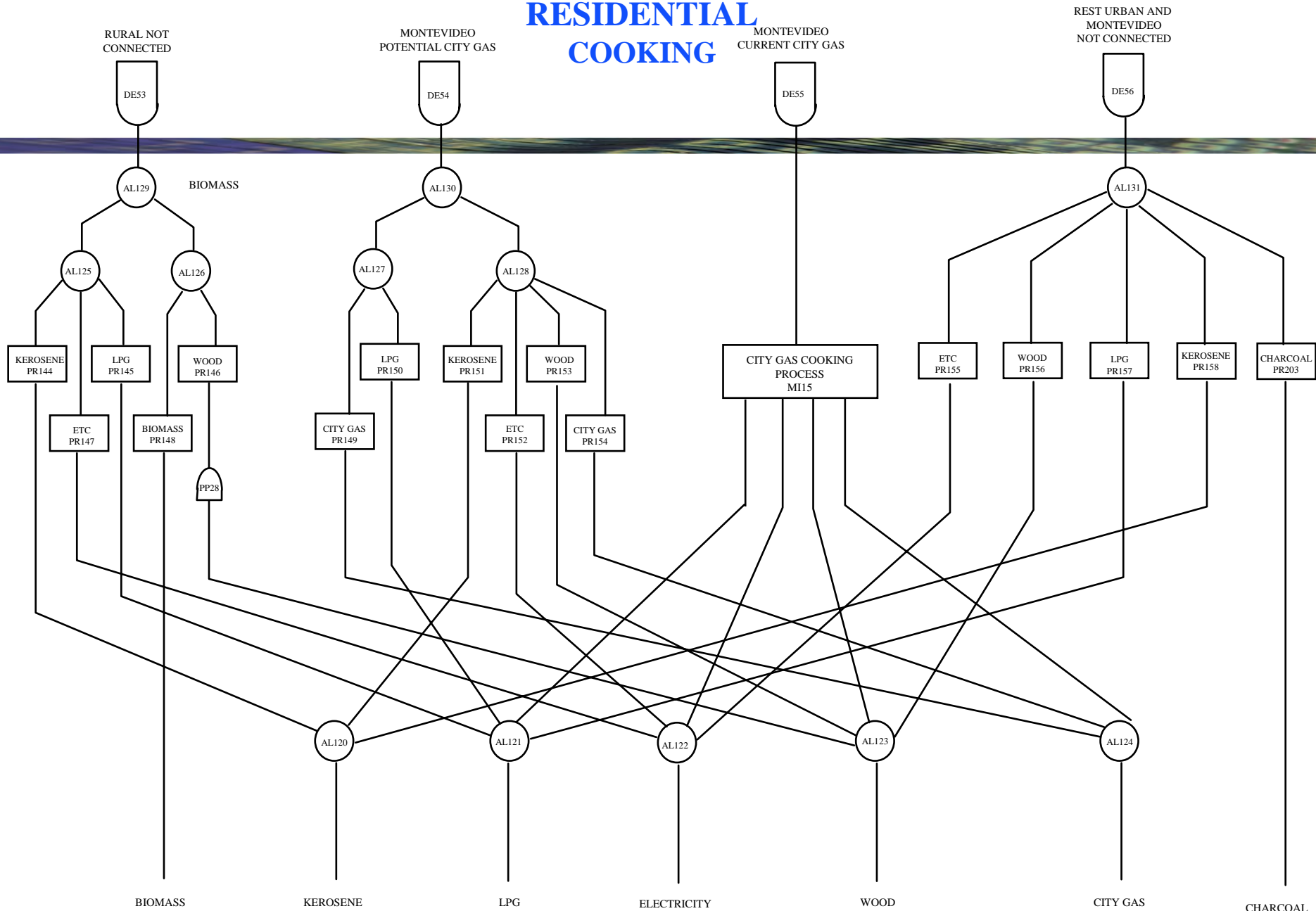
REST URBAN AND MONTEVIDEO NOT CONNECTED



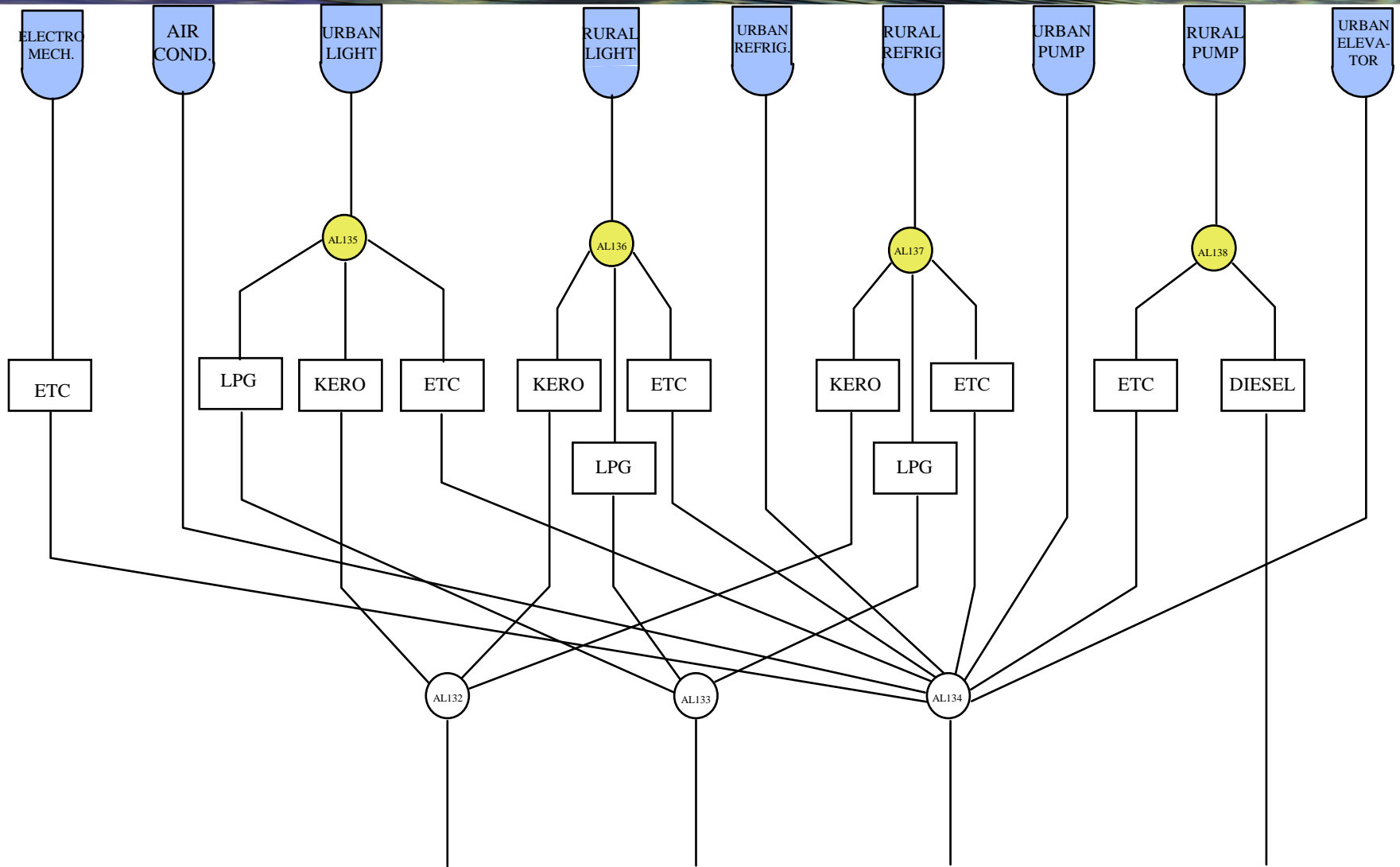
# RESIDENTIAL WATER HEATING



# RESIDENTIAL COOKING



# RESIDENTIAL OTHER



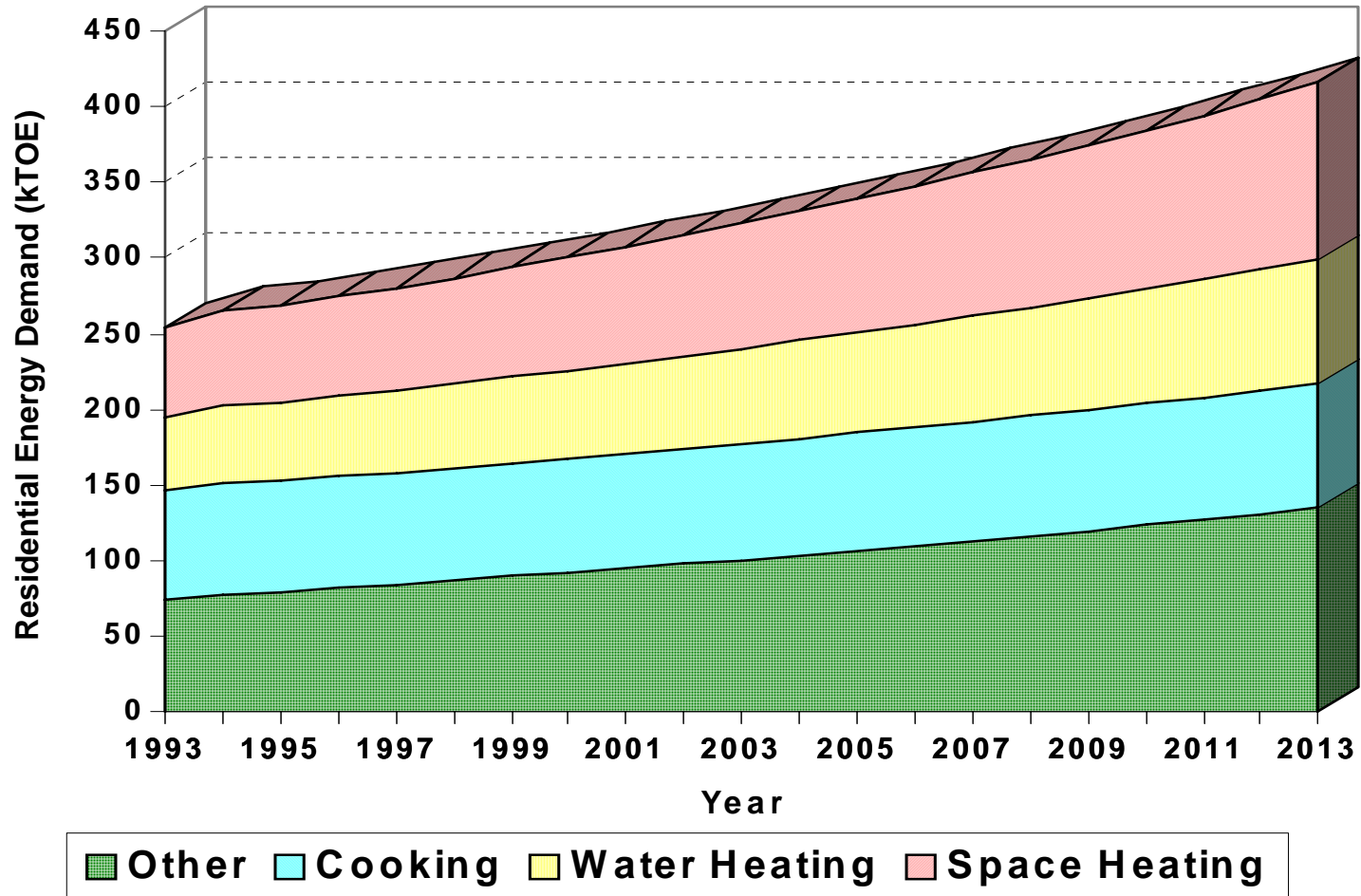
KEROSENE

LPG

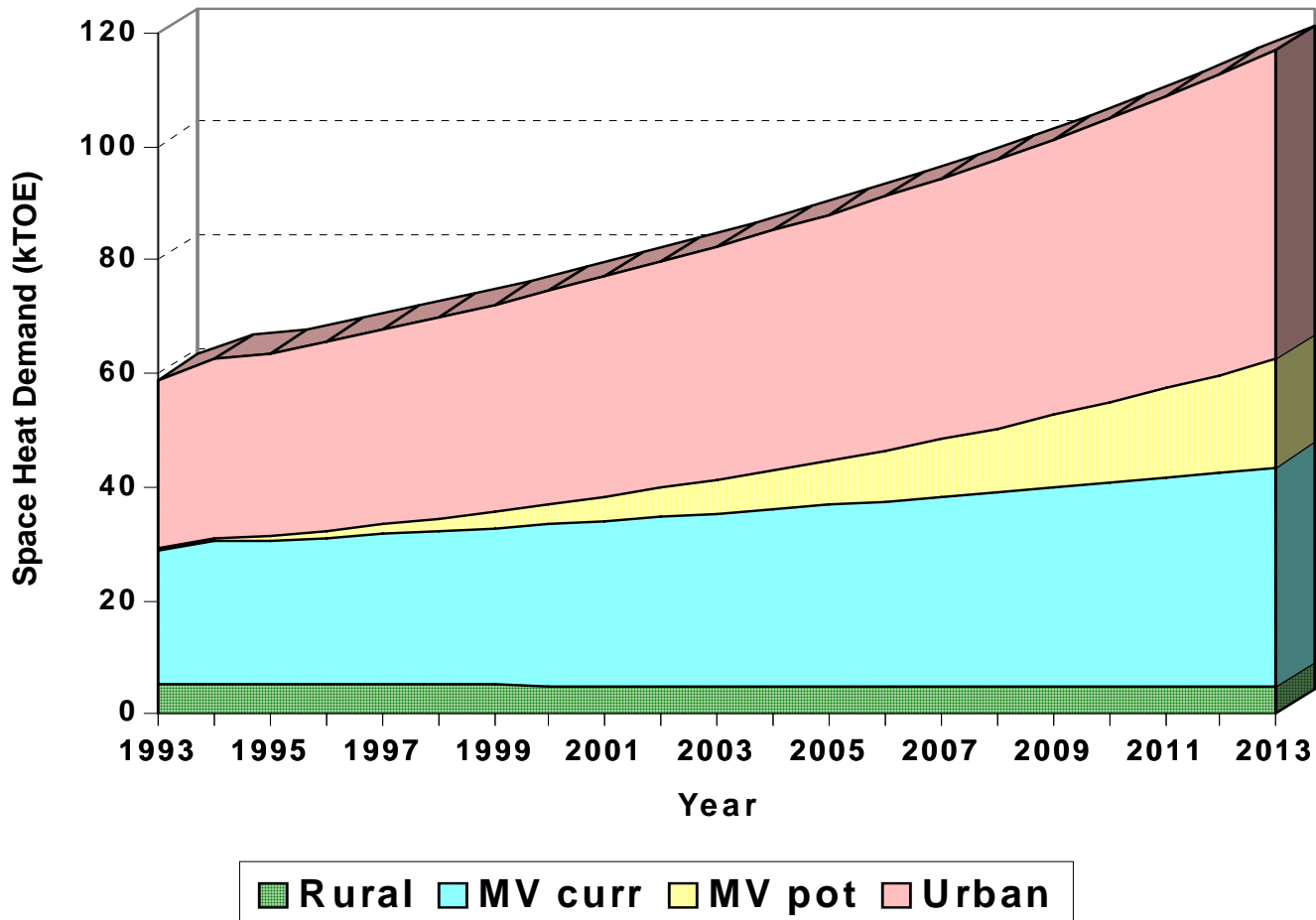
ELECTRICITY

DIESEL

# Residential Useful Energy Demand

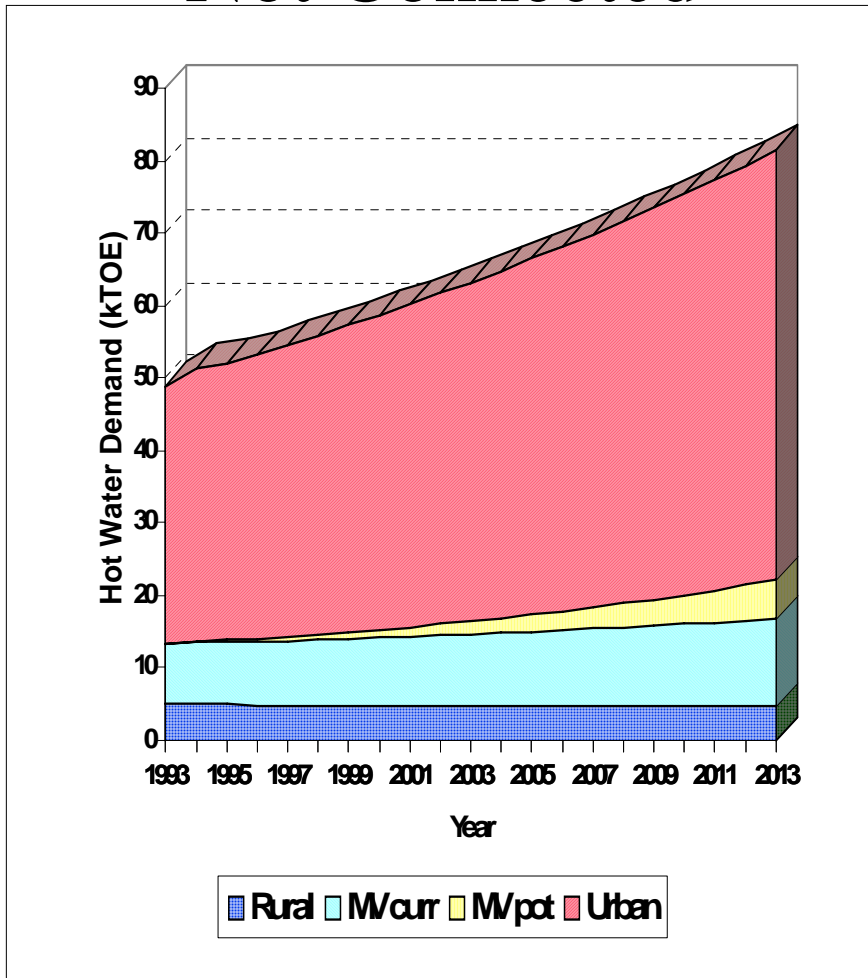


# Space Heating Demand (Useful Energy)

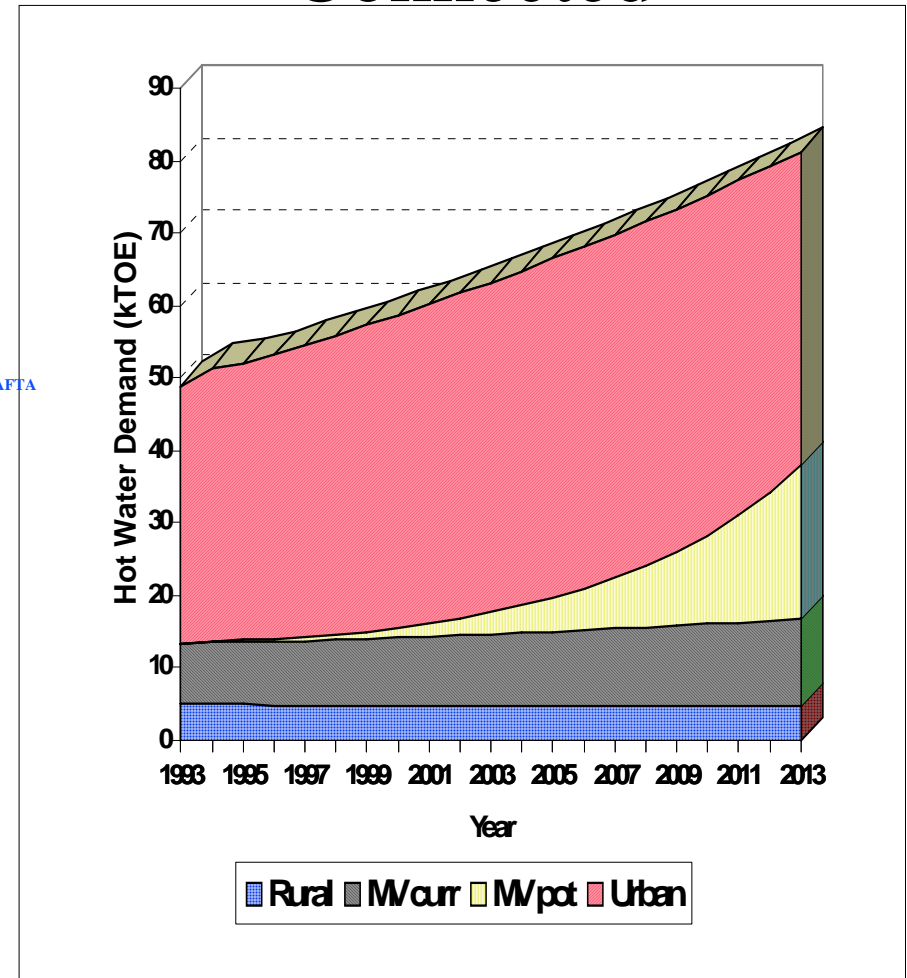


# Residential Water Heating Demand

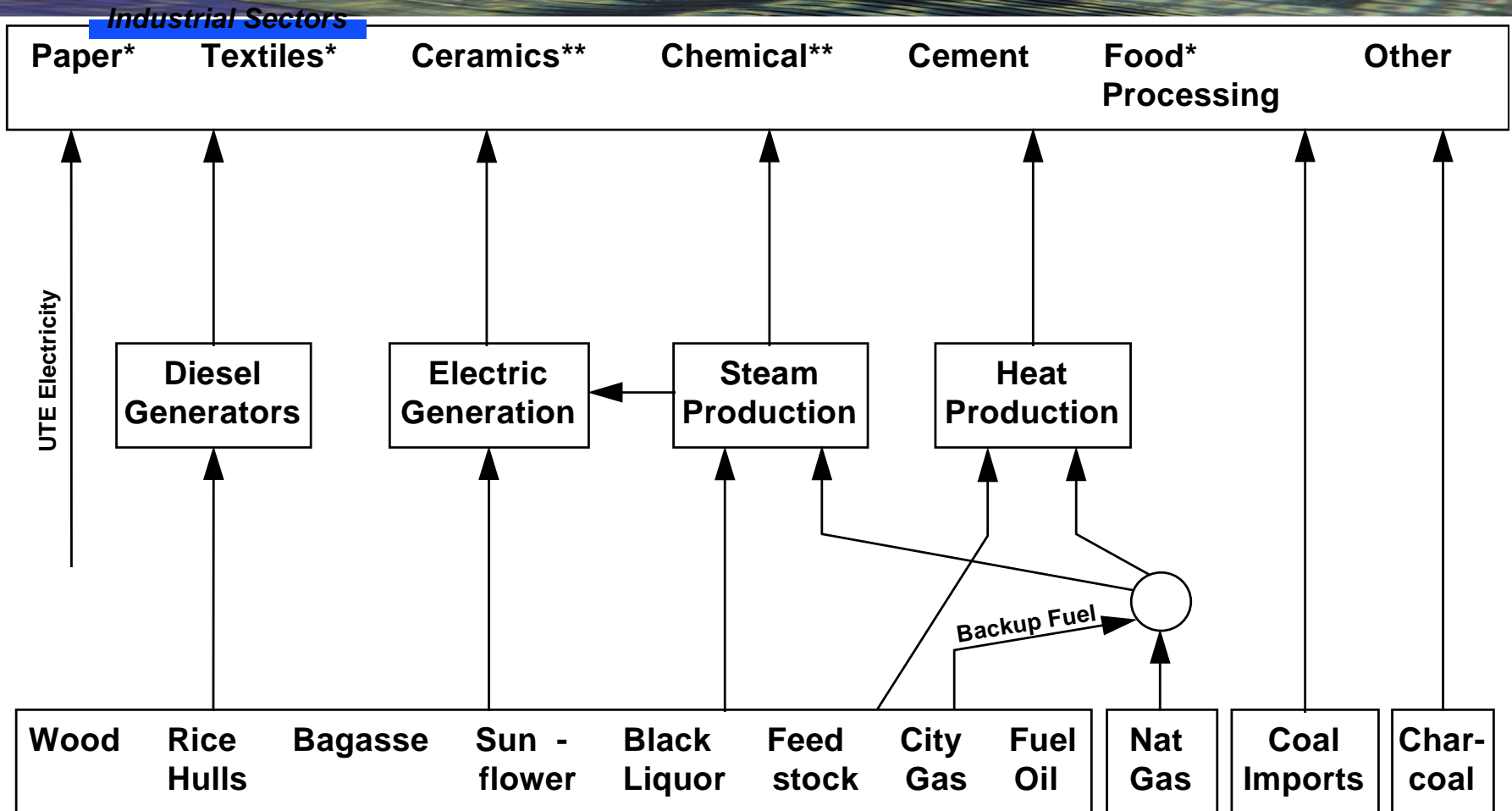
## Not Connected



## Connected



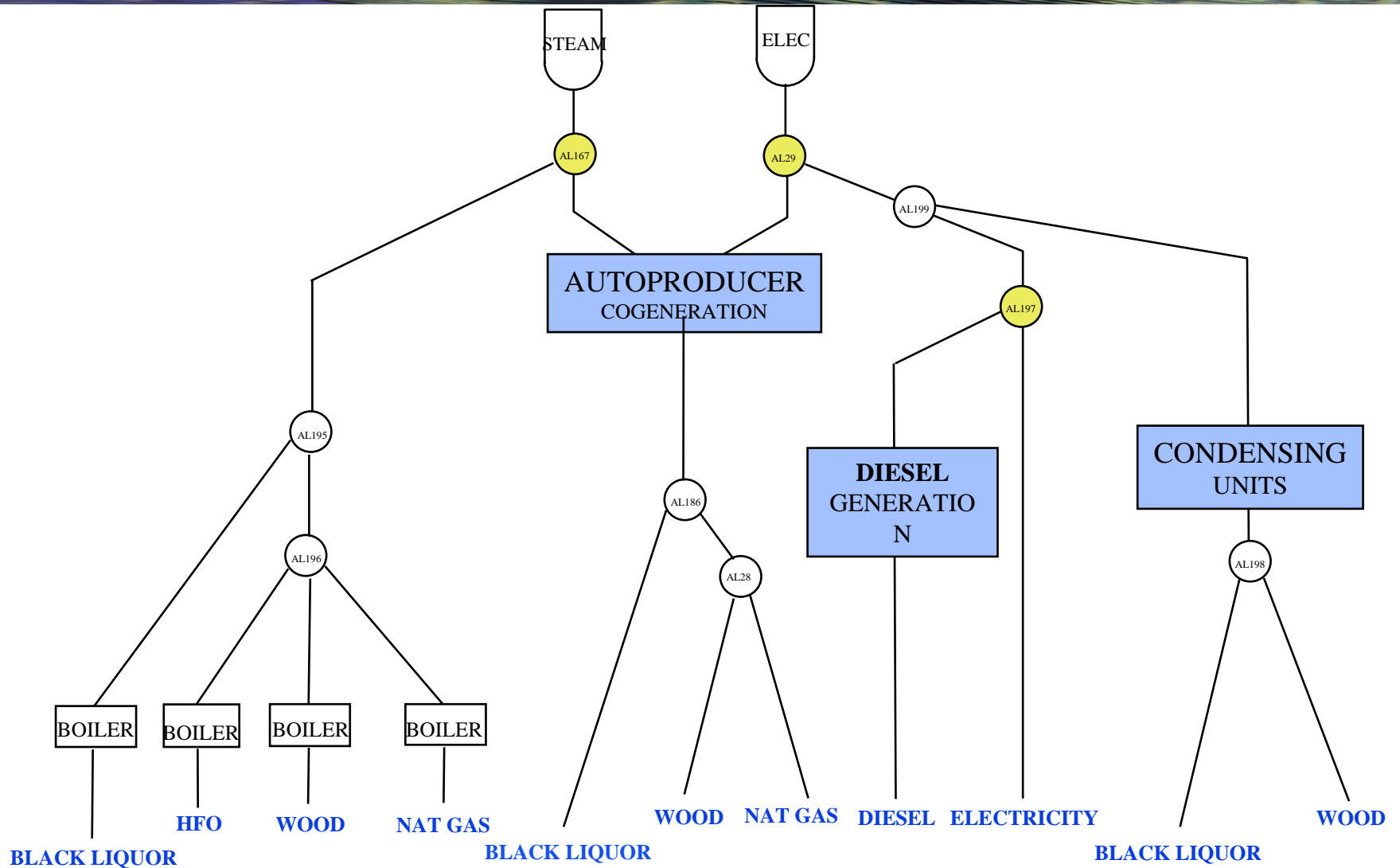
# Industrial Sector Representation



\* Separated into "Connected" and "Not Connected" to a future natural gas pipeline

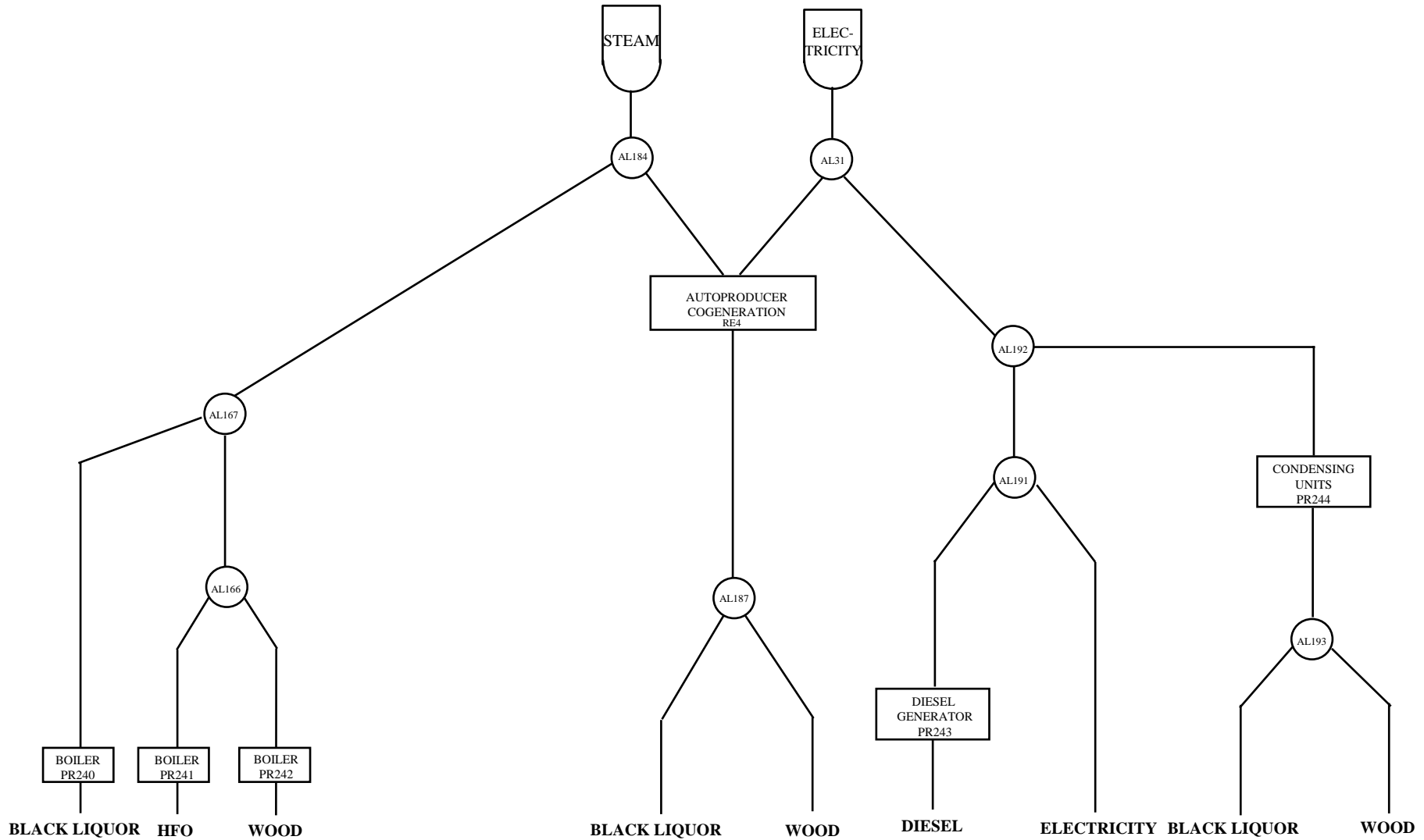
\*\* All plants in these industries are assumed to be connected to the natural gas pipeline

# PAPER INDUSTRY CONNECTED TO GAS PIPELINE

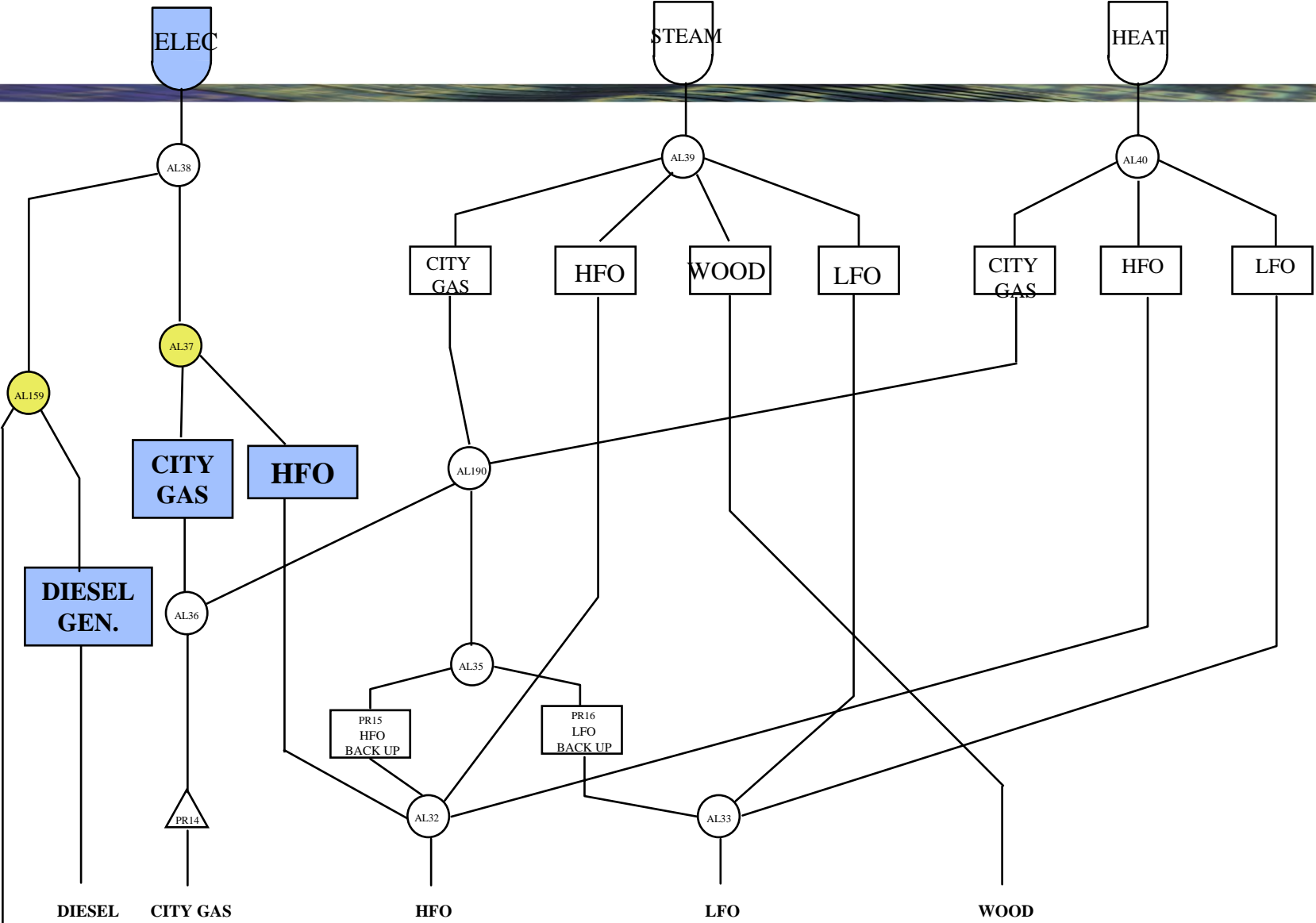


# PAPER INDUSTRY

## NOT CONNECTED TO GAS PIPELINE

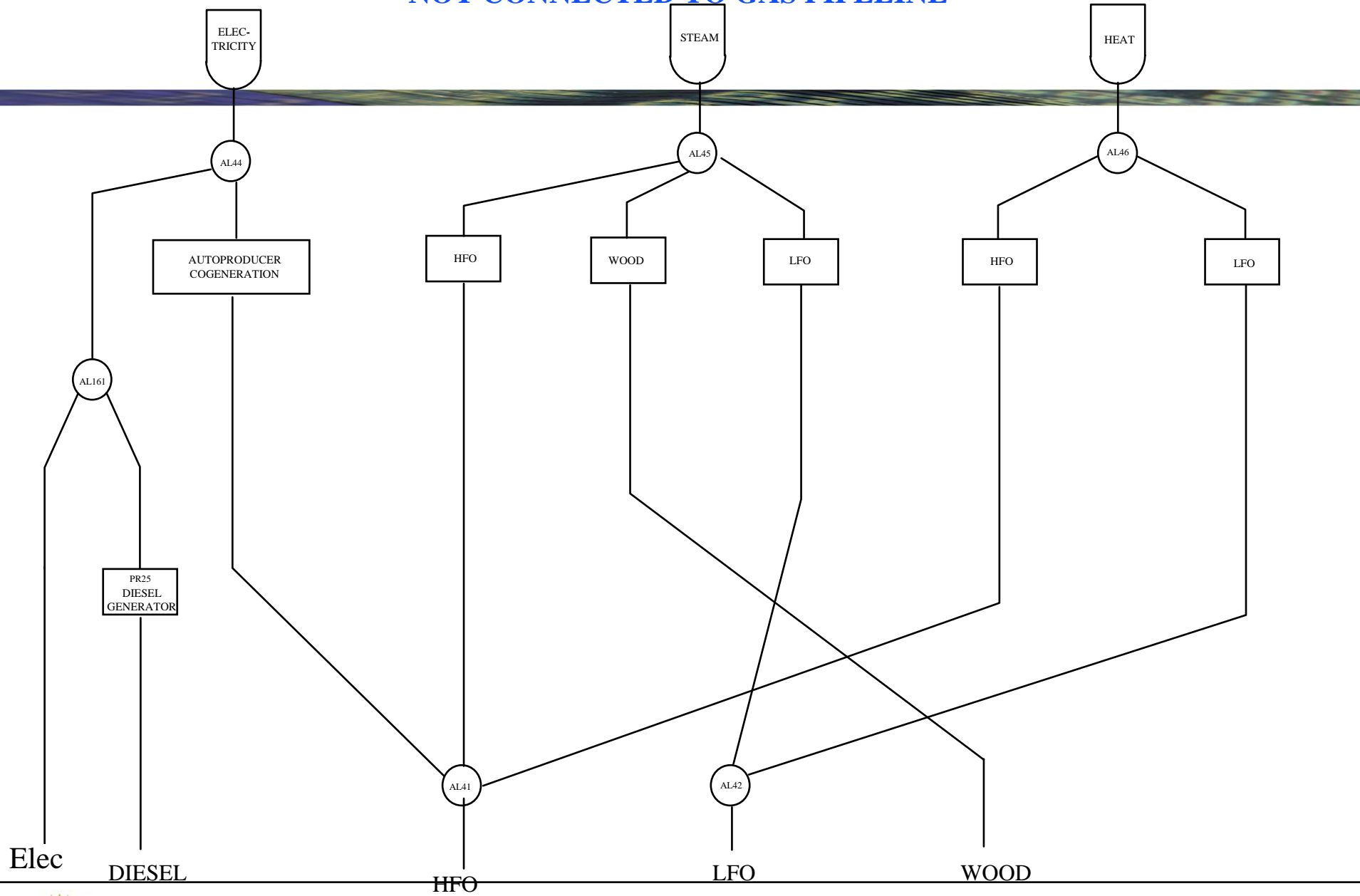


# TEXTILE INDUSTRY CONNECTED TO GAS PIPELINE

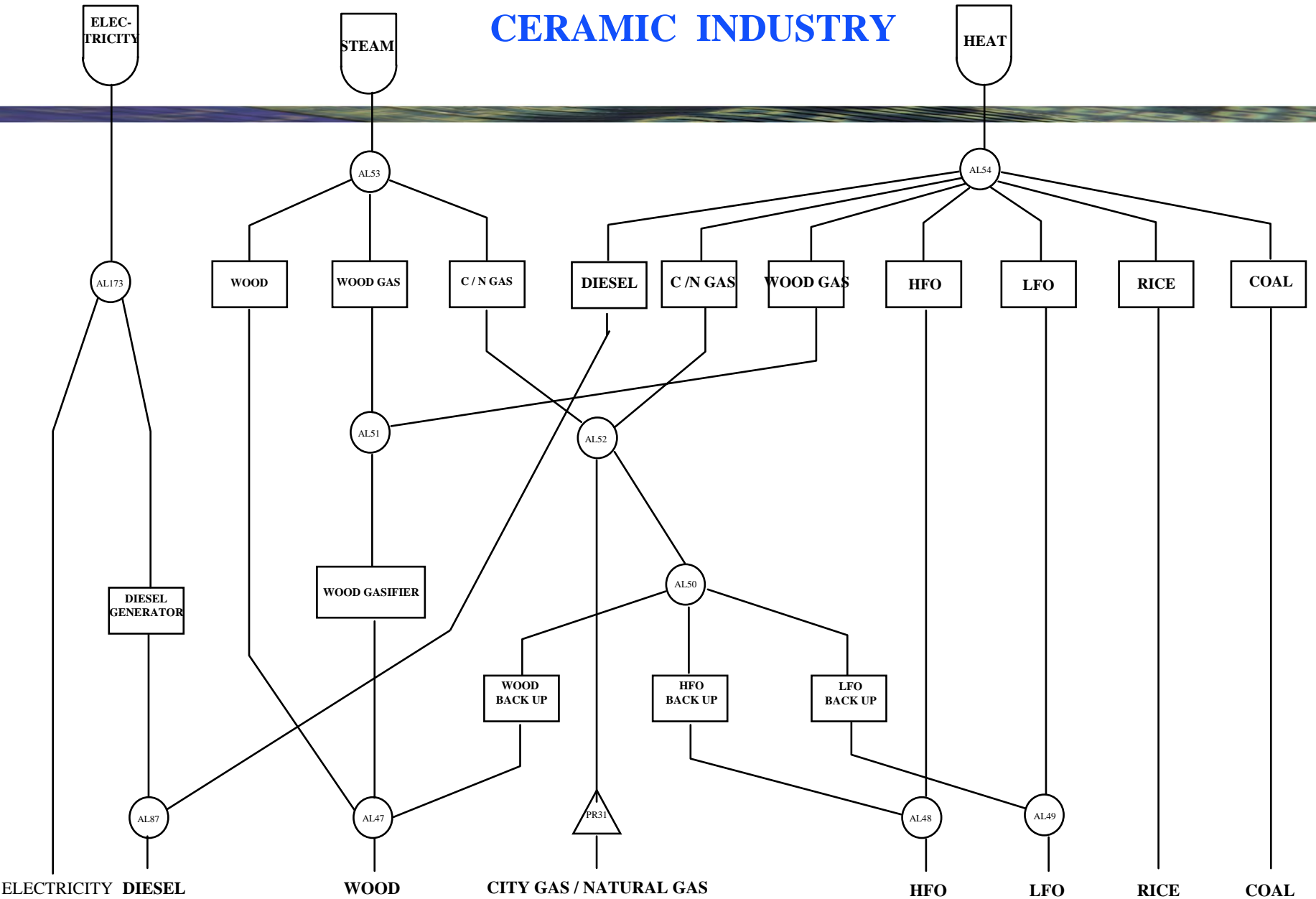


**ELECTRICITY**

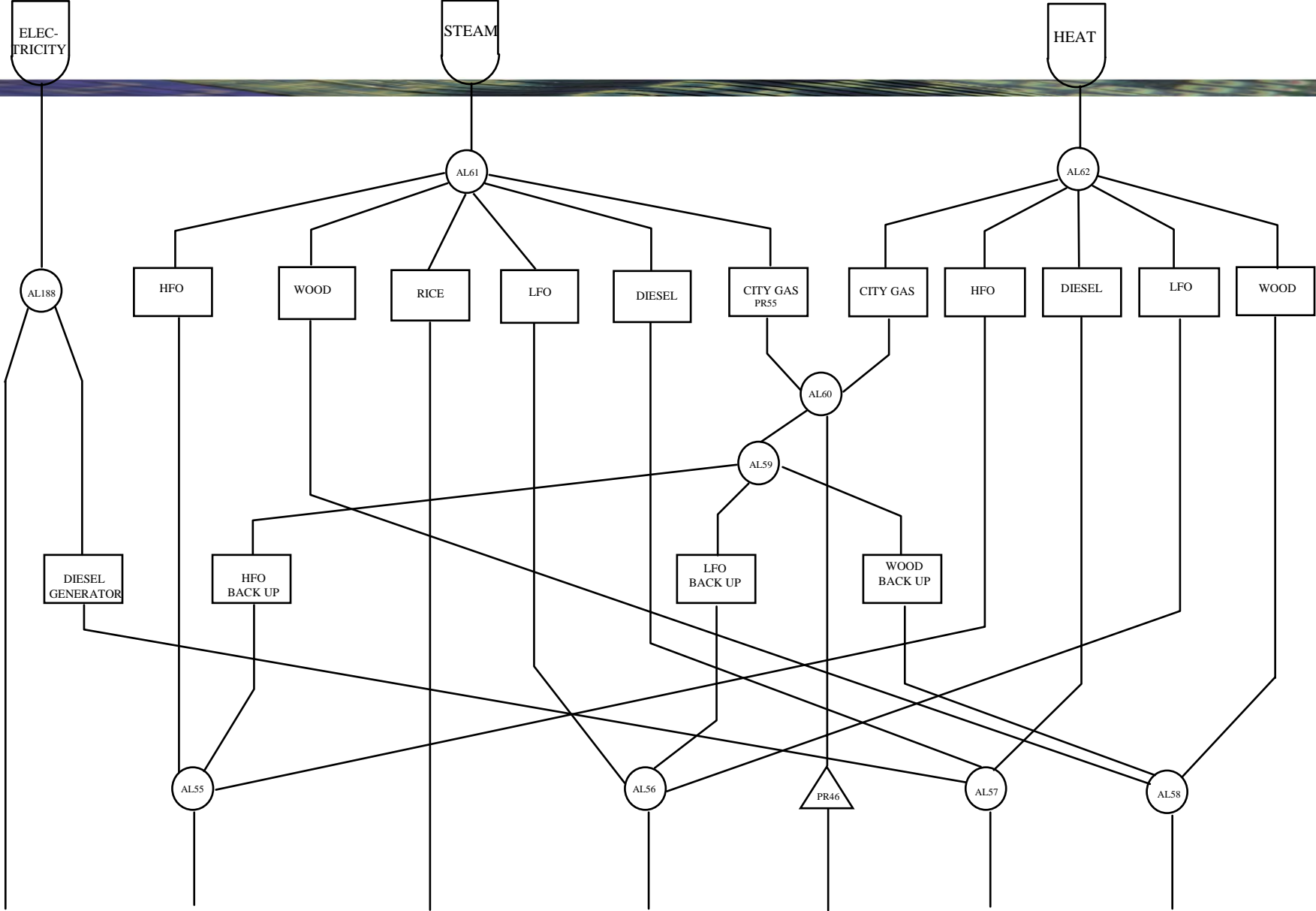
# TEXTILE INDUSTRY NOT CONNECTED TO GAS PIPELINE



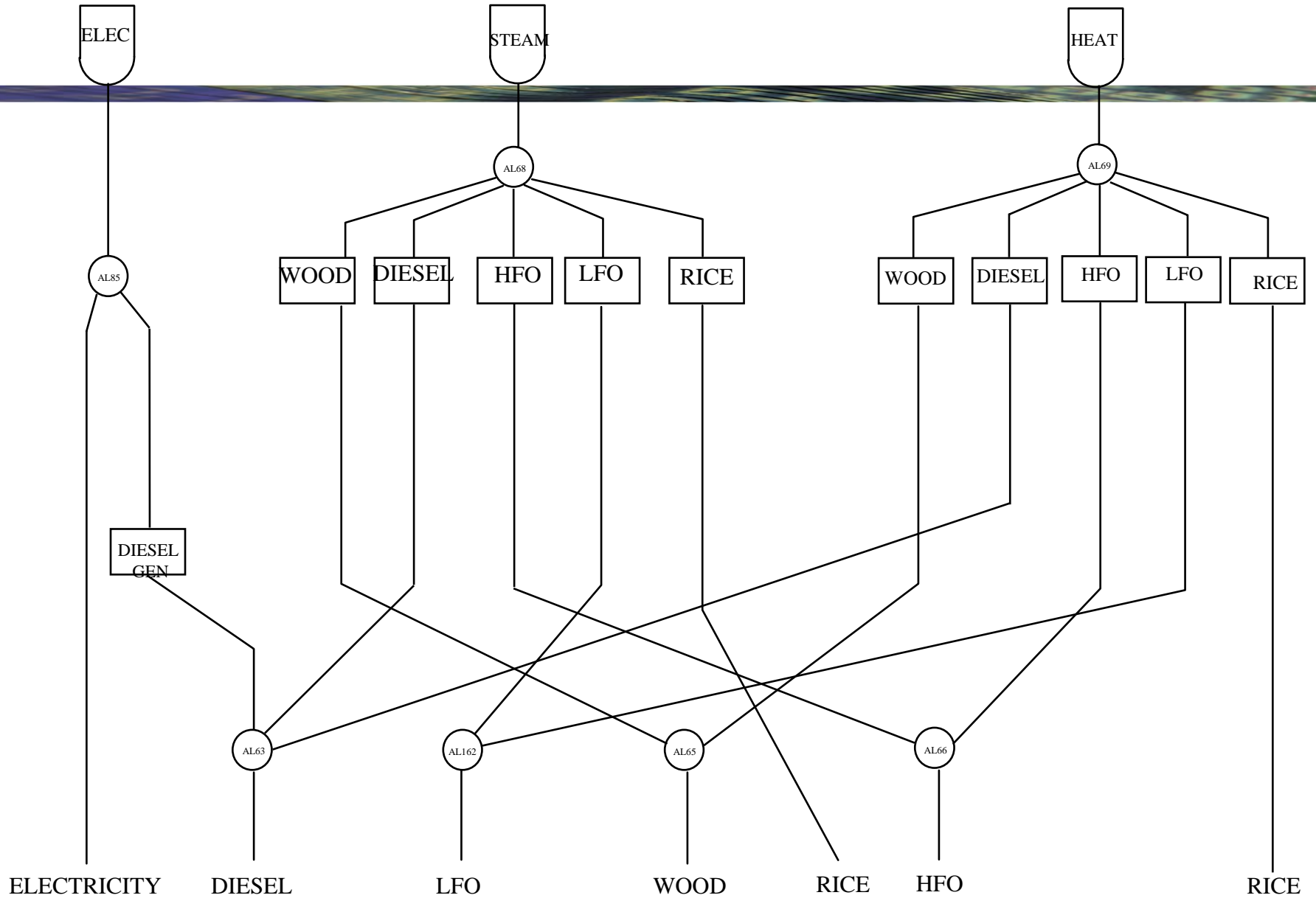
# CERAMIC INDUSTRY



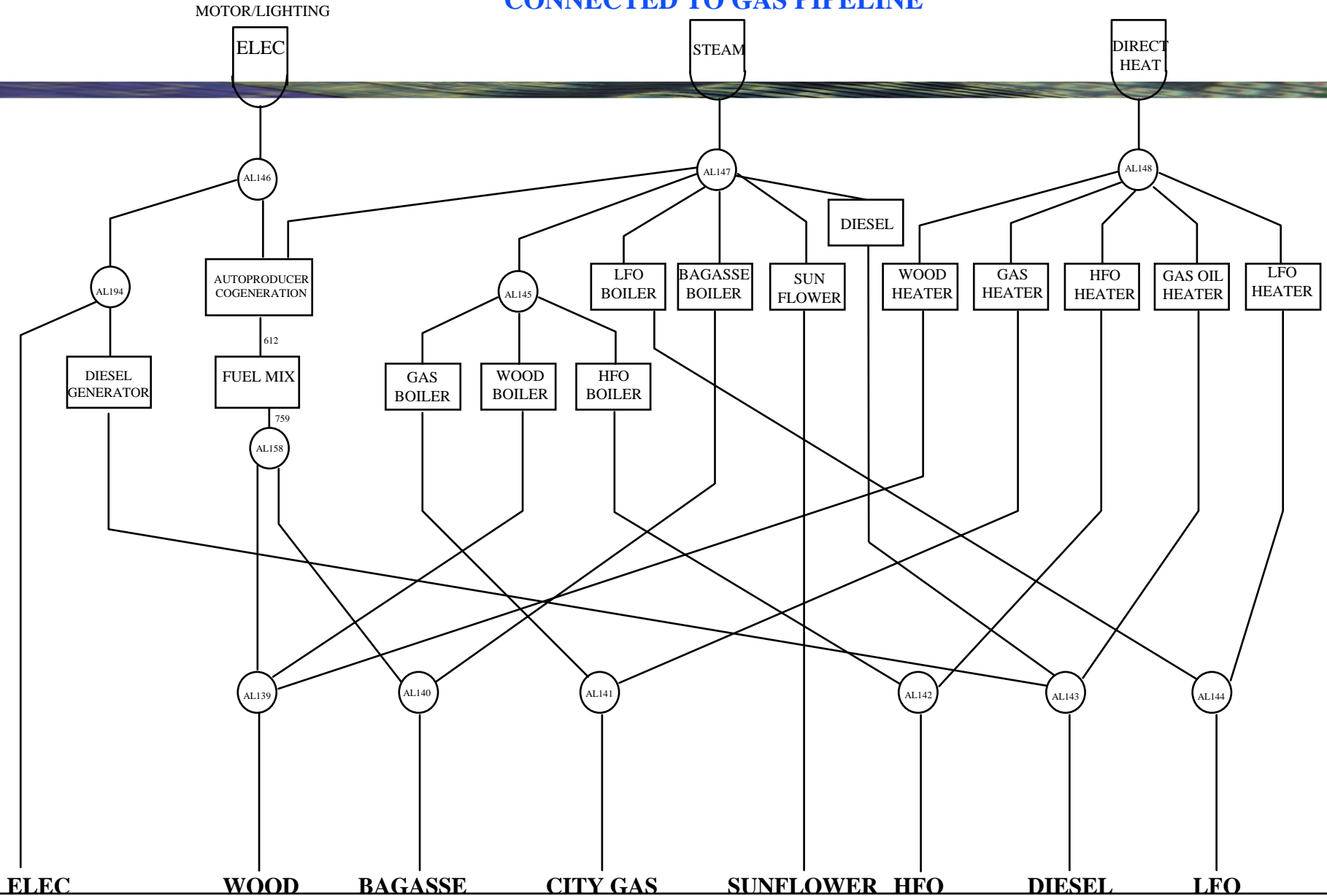
# CHEMICAL INDUSTRY



# CEMENT INDUSTRY

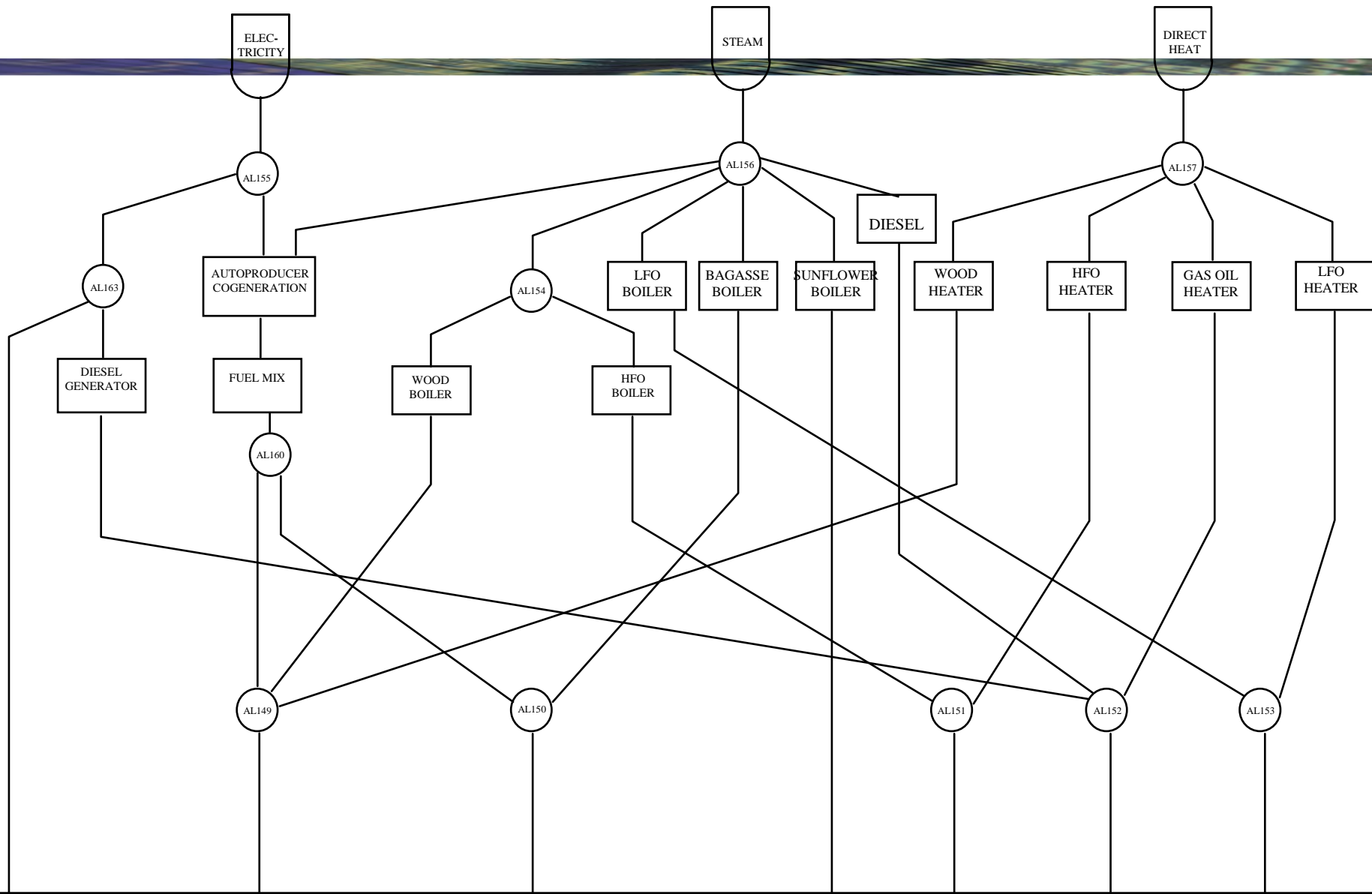


# FOOD PROCESSING CONNECTED TO GAS PIPELINE



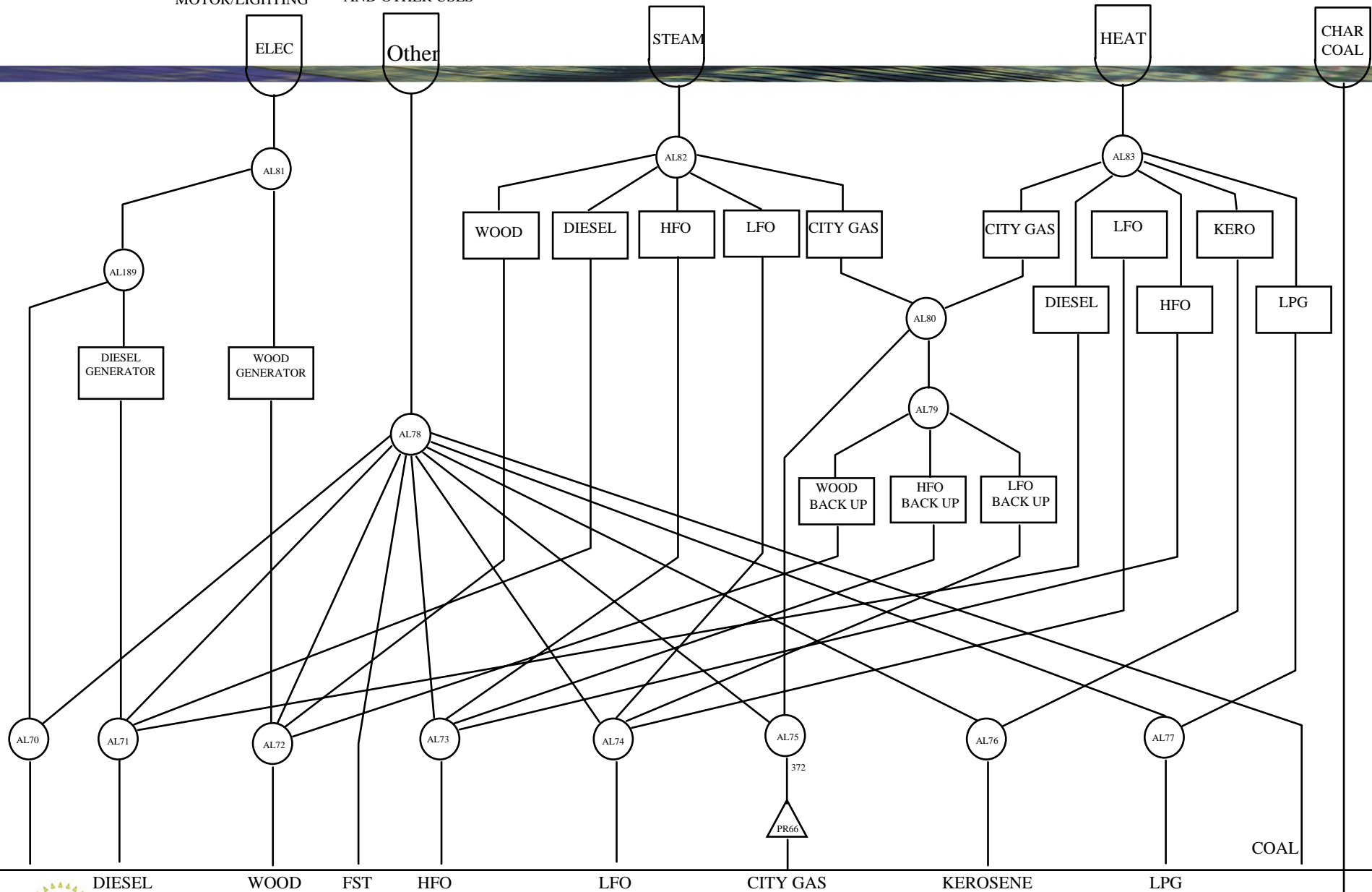
# FOOD PROCESSING NOT CONNECTED TO GAS PIPELINE

ELECTRICITY FOR  
MOTOR/LIGHTING

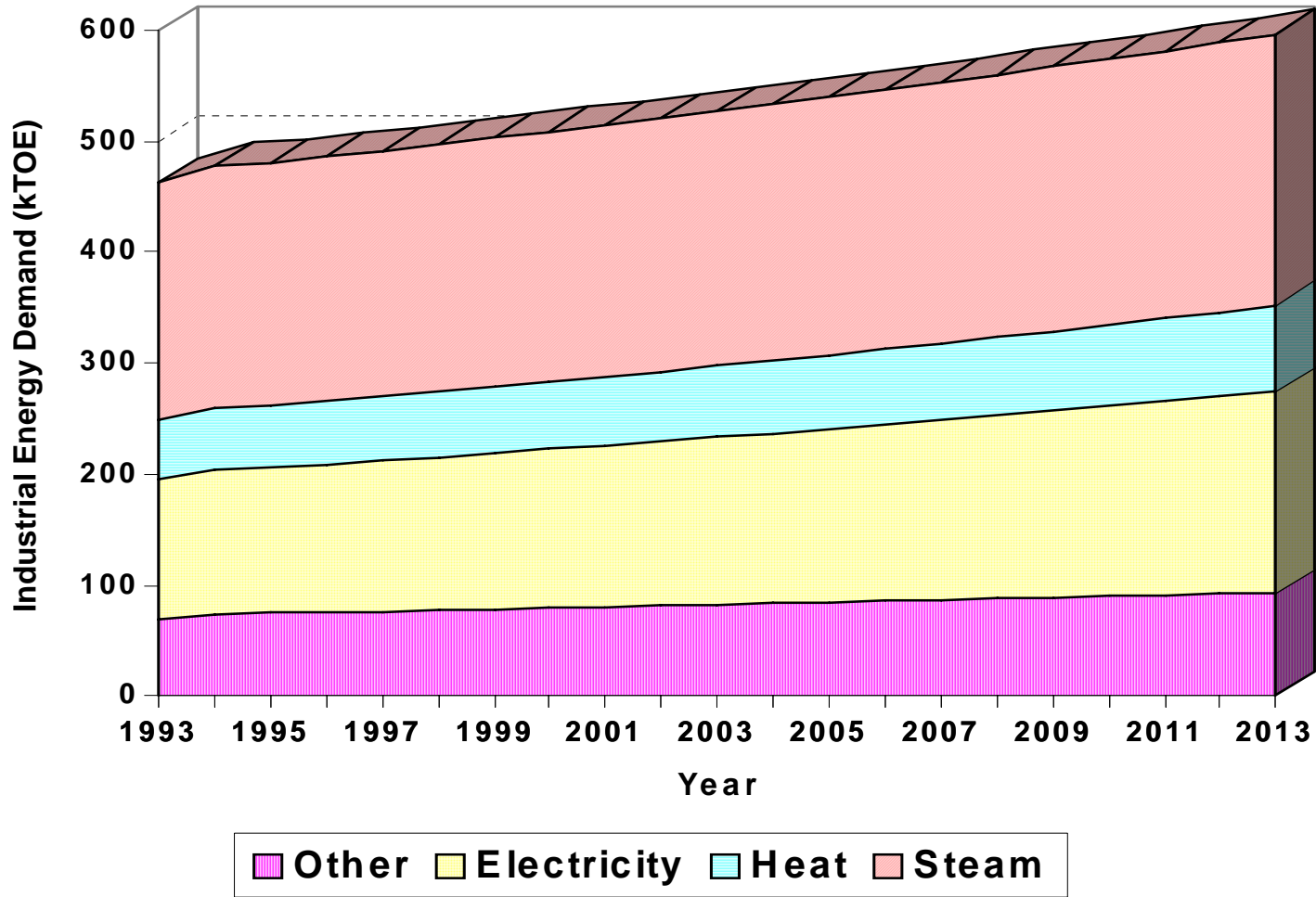


# COMBINED/OTHER INDUSTRY

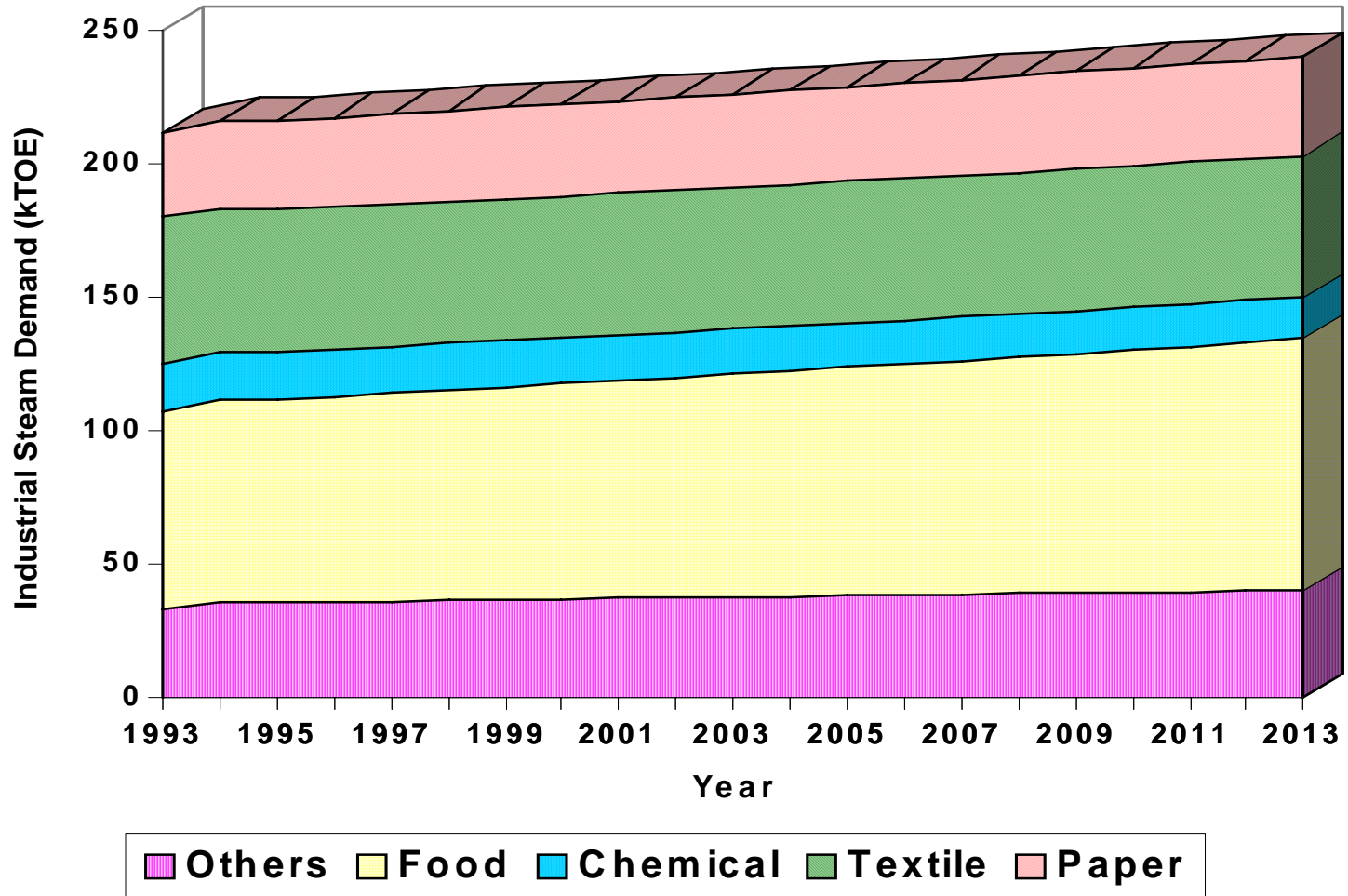
MOTOR/LIGHTING  
INTERNAL TRANSPORT  
AND OTHER USES



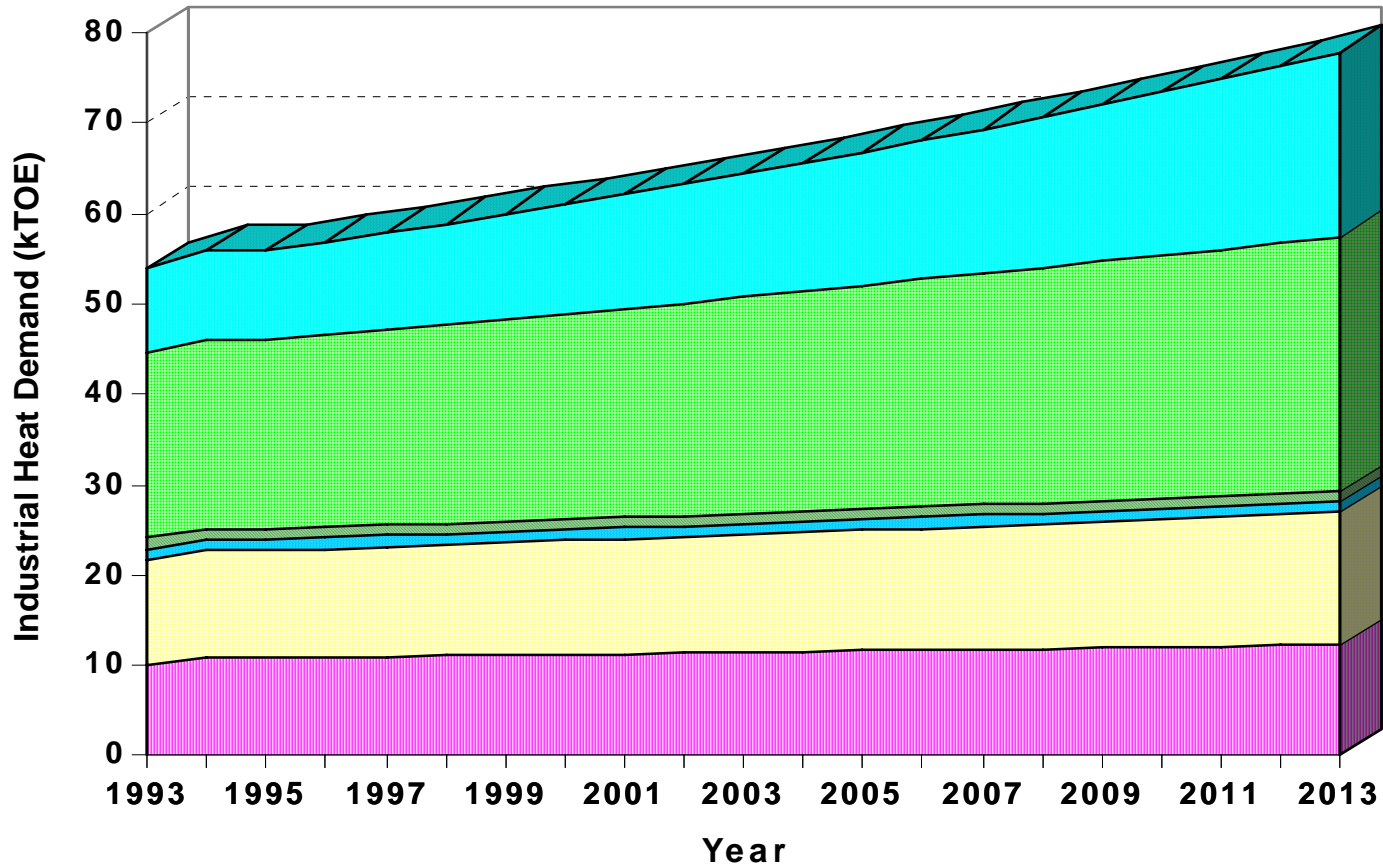
# Industrial Demand for Useful Energy



# Industrial Steam Demand

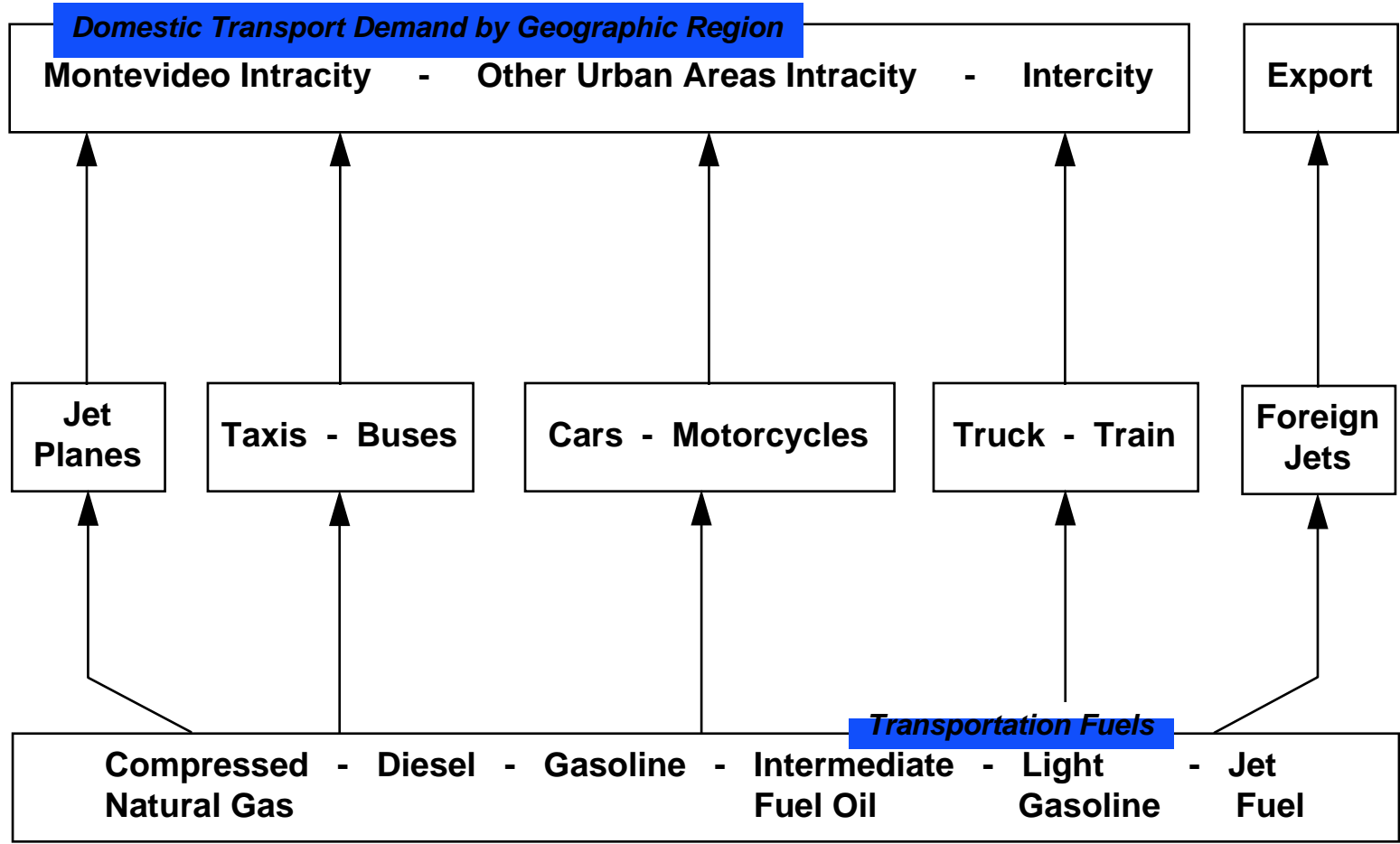


# Industrial Heat Demand

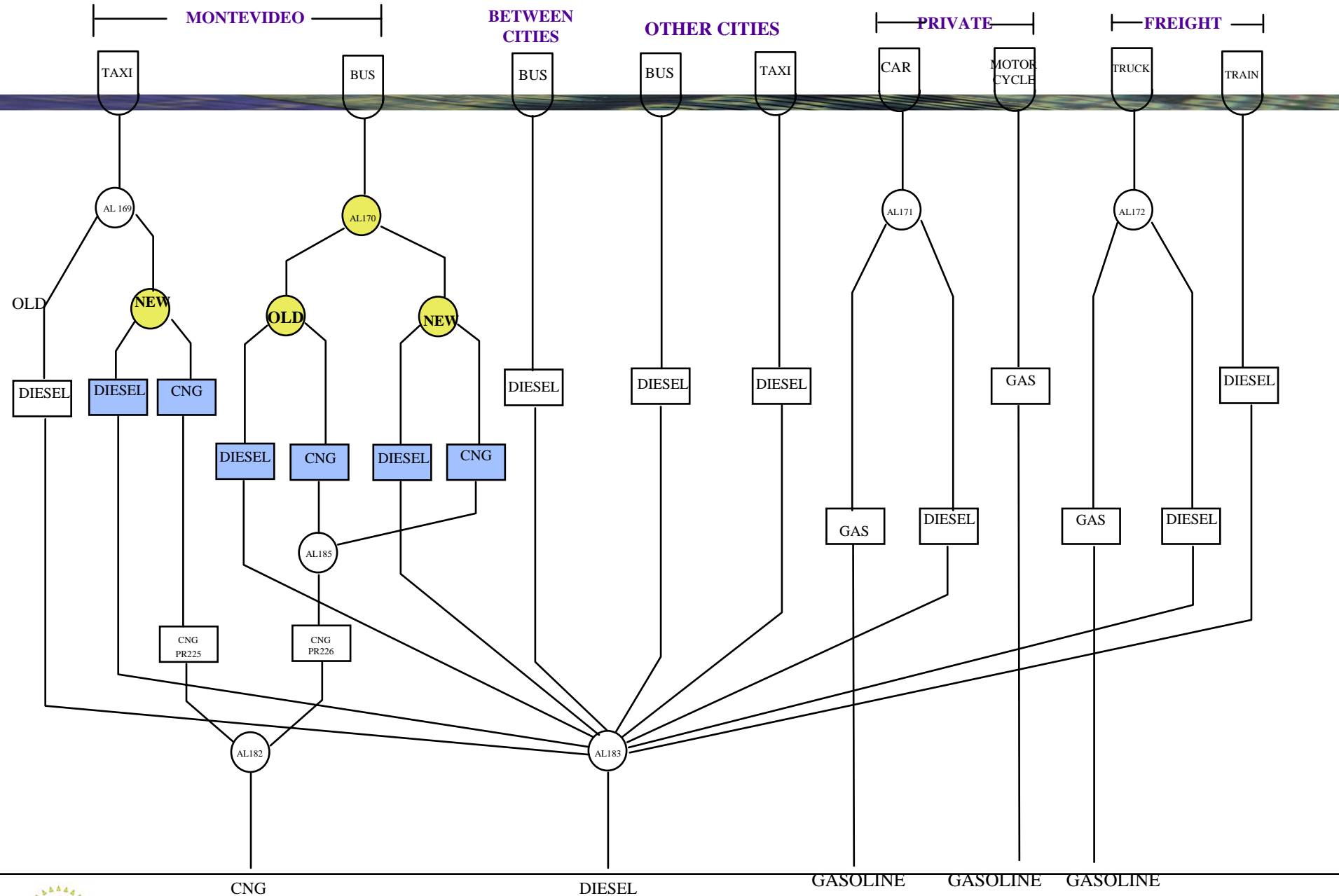


Others Food Chemical Textile Cement Ceramics

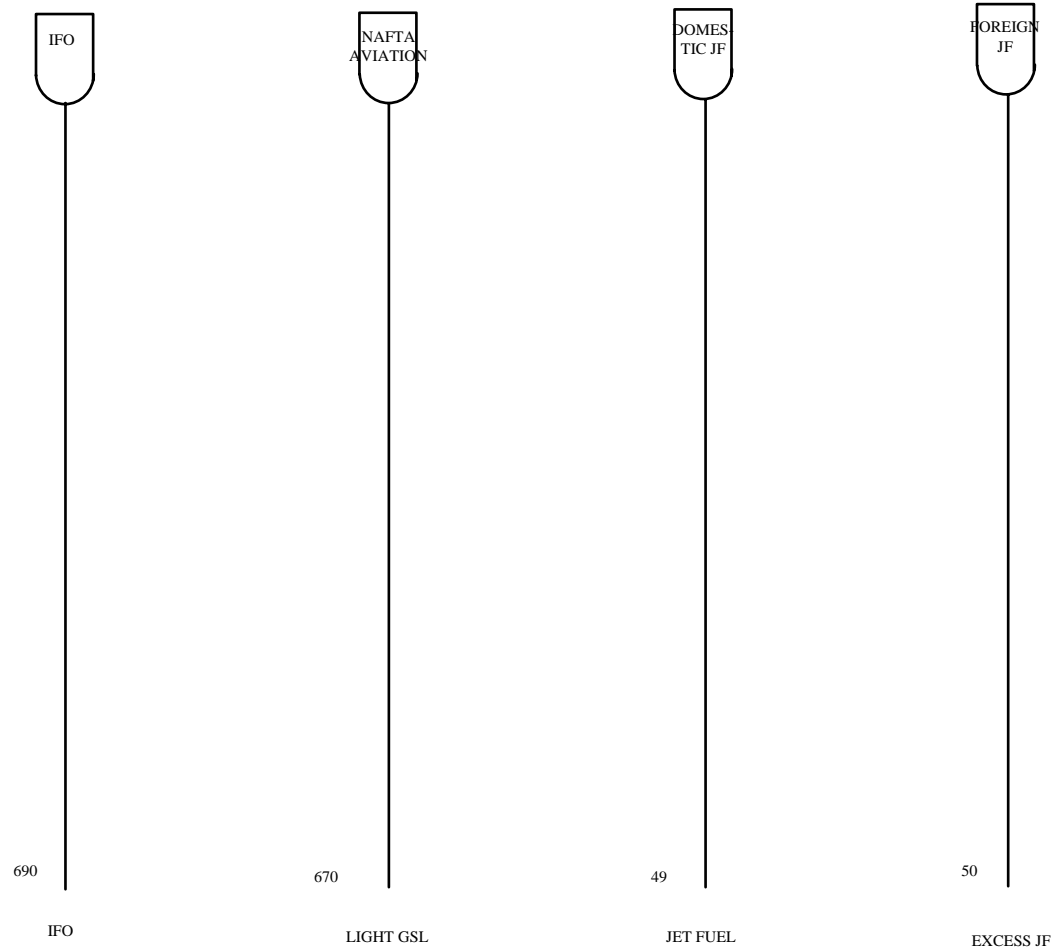
# Transport Sector Representation



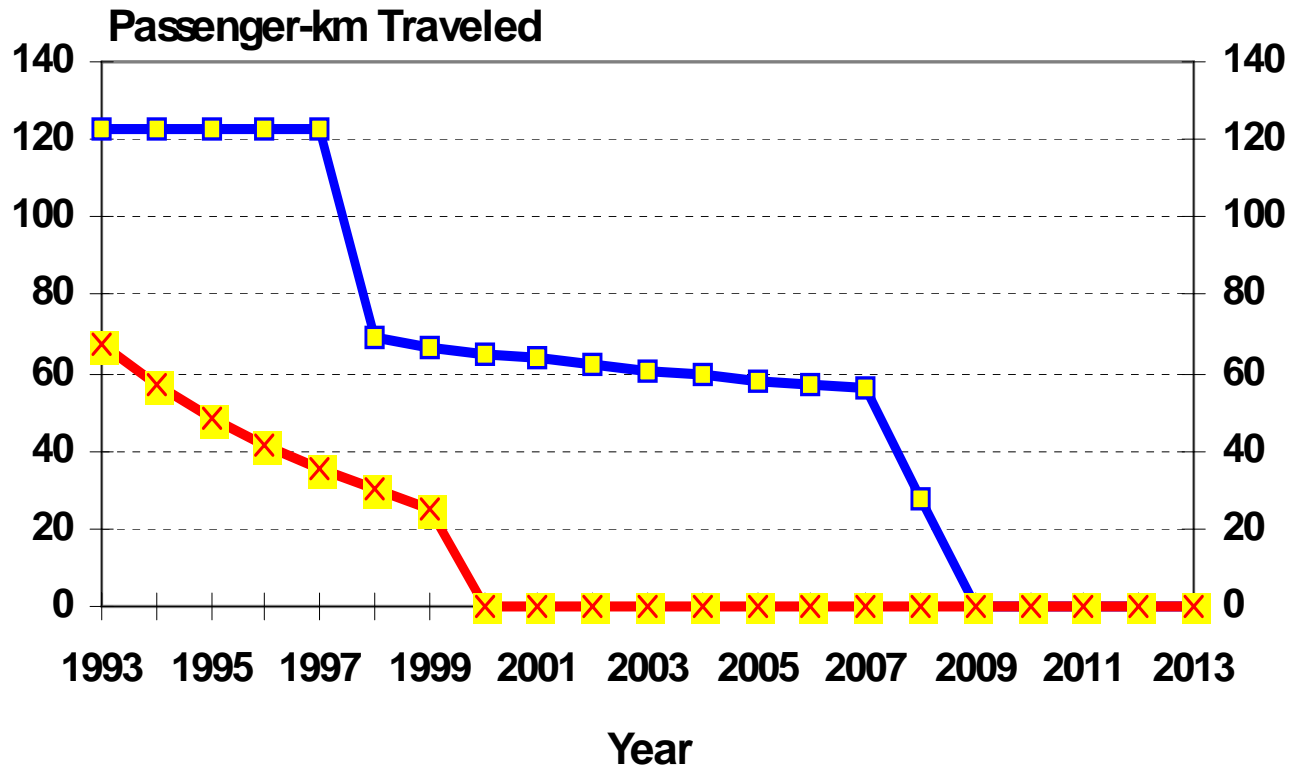
# TRANSPORTATION SECTOR



# TRANSPORTATION SECTOR (CONT'D)

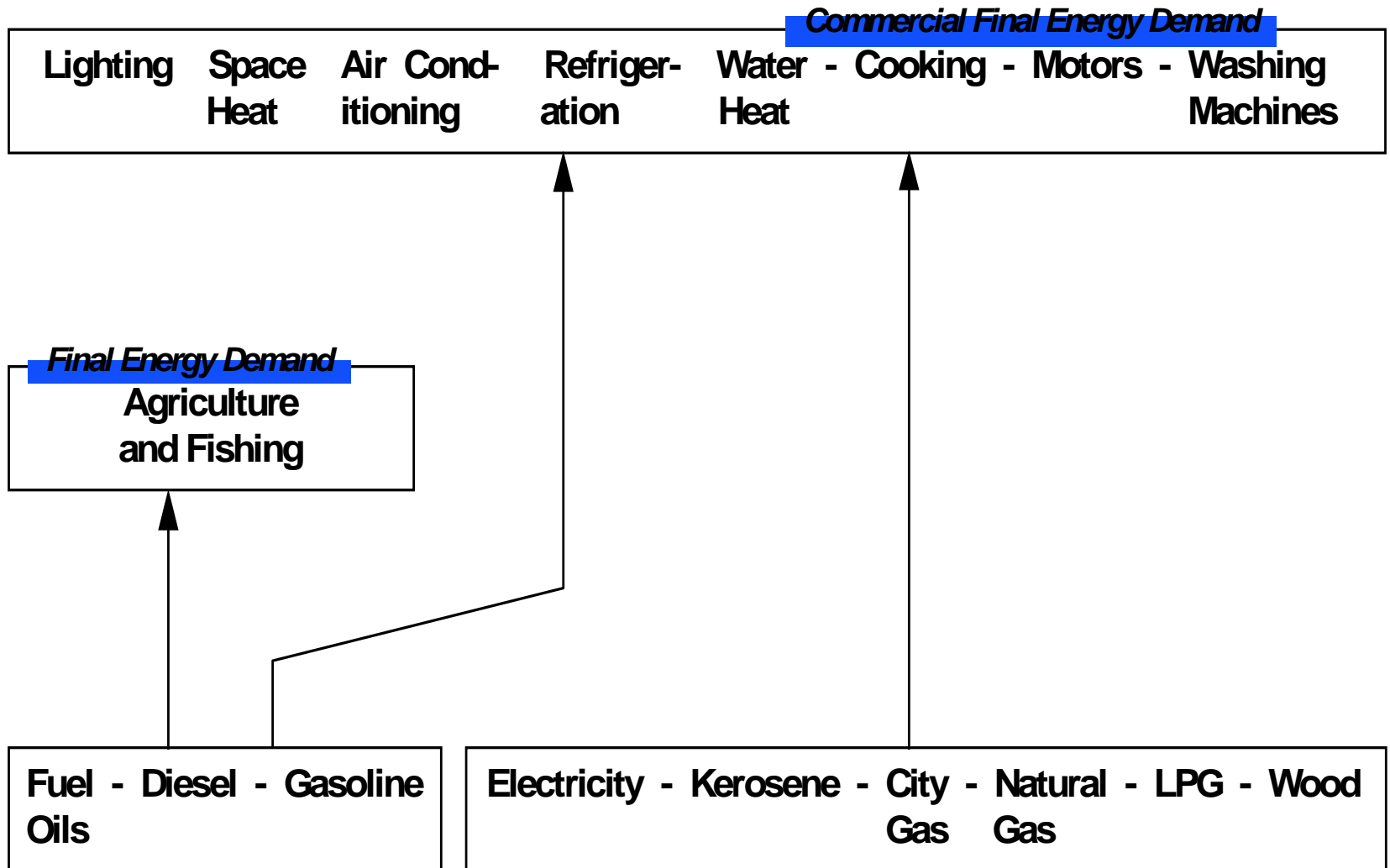


# Assumed Retirement Schedule

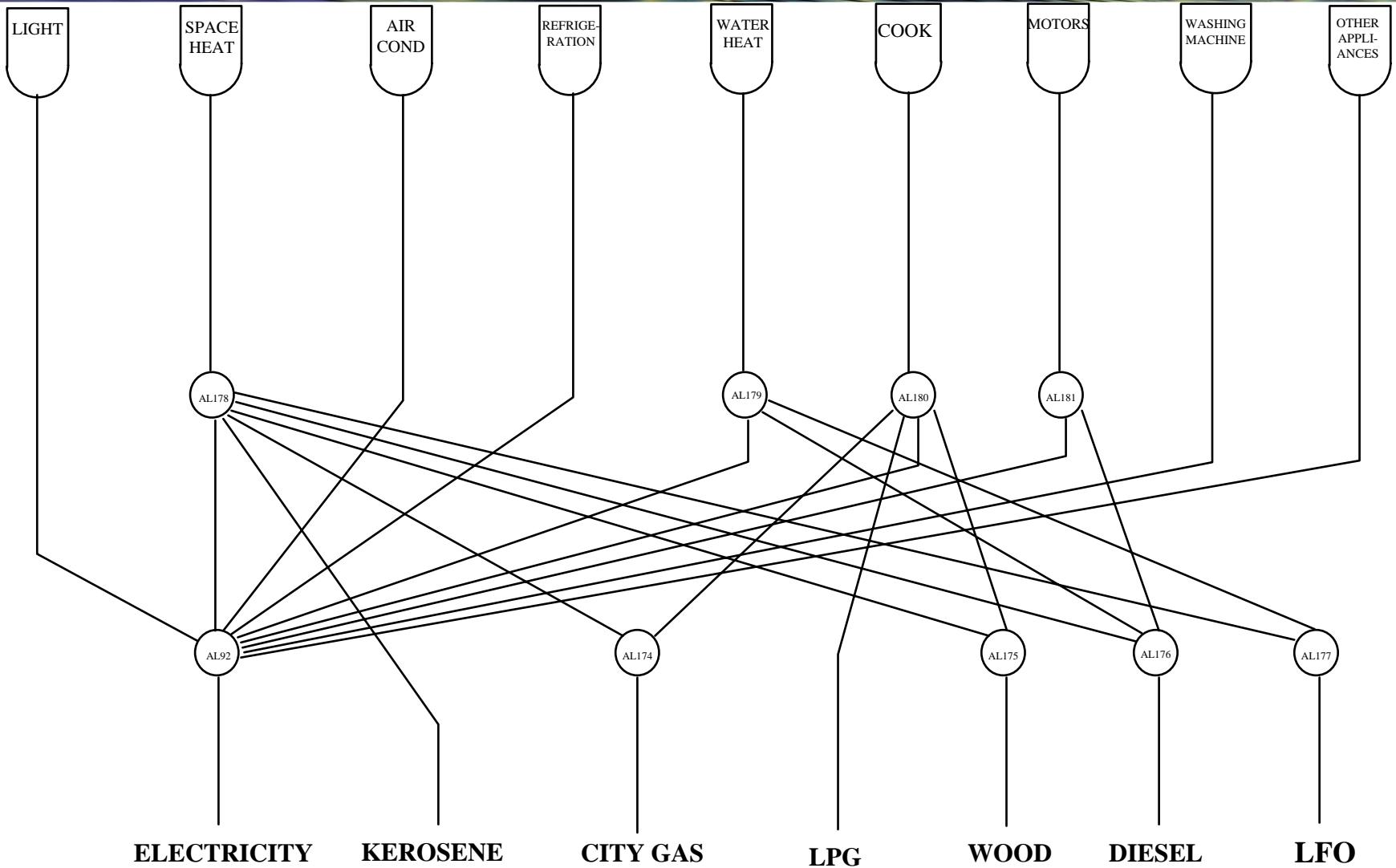


Travel Old Buses    Travel Old Taxis

# Agriculture & Commercial Sectors



# COMMERCIAL SECTOR



# 4.) Scenario Description

---

## **Scenario 1 - Reference case:**

- **Represents a continuation of the energy situation in the base year**
- **No Natural Gas**
- **Limited electricity exchanges between Argentina and Uruguay**
- **No important increase of the electricity capacity transportation between Brazil and Uruguay**

## Scenario 2:

- **Introduction of Natural Gas from Argentina**
- **Limited electricity exchanges between Argentina and Uruguay**
- **No important increase of the electricity capacity transportation between Brazil and Uruguay.**

## Scenario 3 :

- **Introduction of Natural Gas from Argentina**
- **Flexible electricity exchanges between Argentina and Uruguay (“open market.”)**
- **No important increase of the electricity capacity transportation between Brazil and Uruguay.**

## Scenario 4 :

- **No Natural Gas**
- **Flexible electricity exchanges between Argentina and Uruguay (“open”)**
- **Increase of the electricity capacity transportation between Brazil and Uruguay (HLT 300 MW)**

## Scenario 5 :

- **Introduction of Natural Gas from Argentina**
- **Flexible electricity exchanges between Argentina and Uruguay (“open”)**
- **Increase of the electricity capacity transportation between Brazil and Uruguay (HLT 300 MW).**

# Scenario 6:

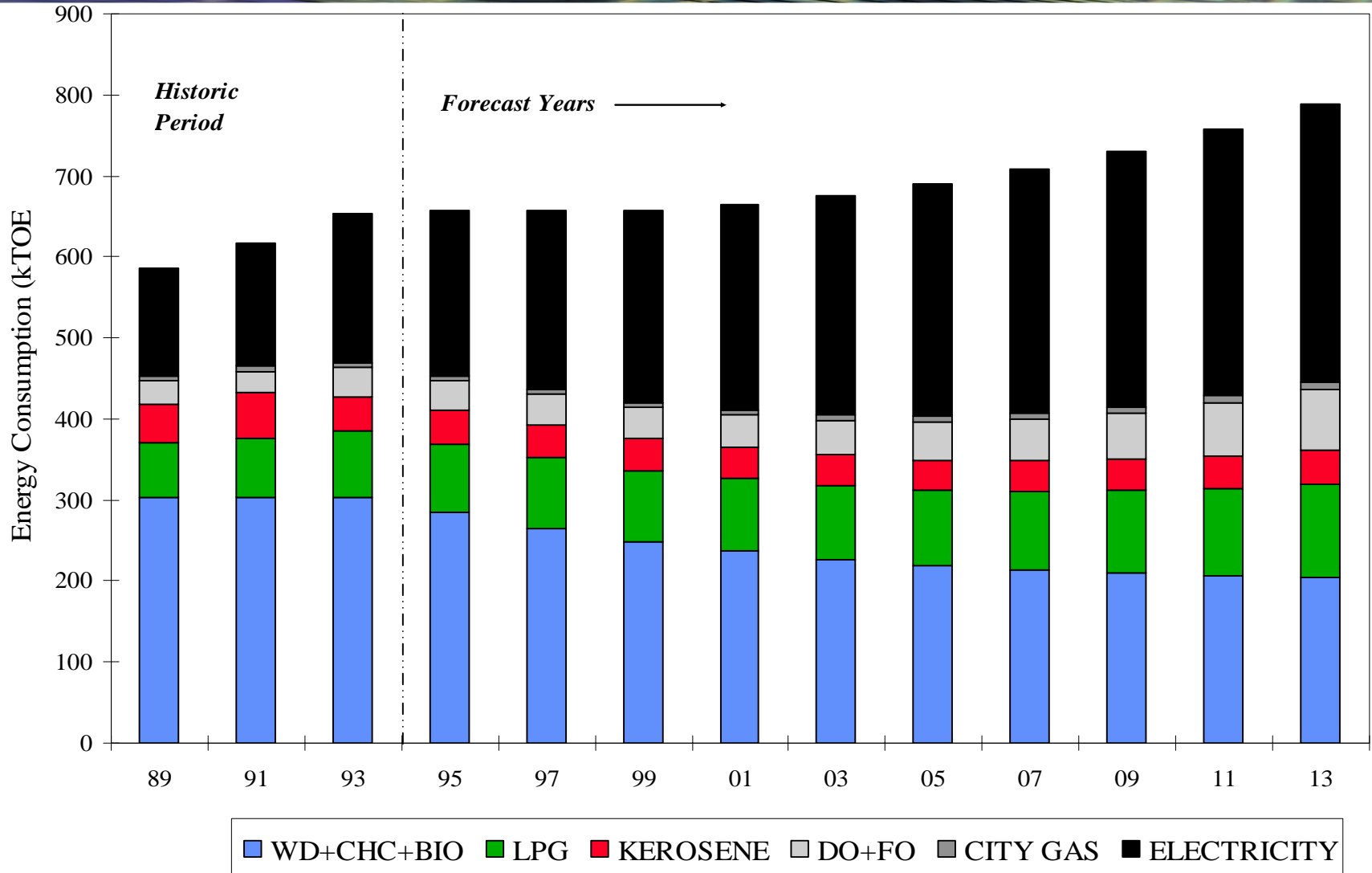
- **Reference Case 1995 :**
  - No Natural Gas
  - Limited electricity exchanges between Argentina and Uruguay
  - No important increase of the electricity capacity transportation between Brazil and Uruguay
  
- **Dry period between 1997 and 2001**

# 5.) Results

---

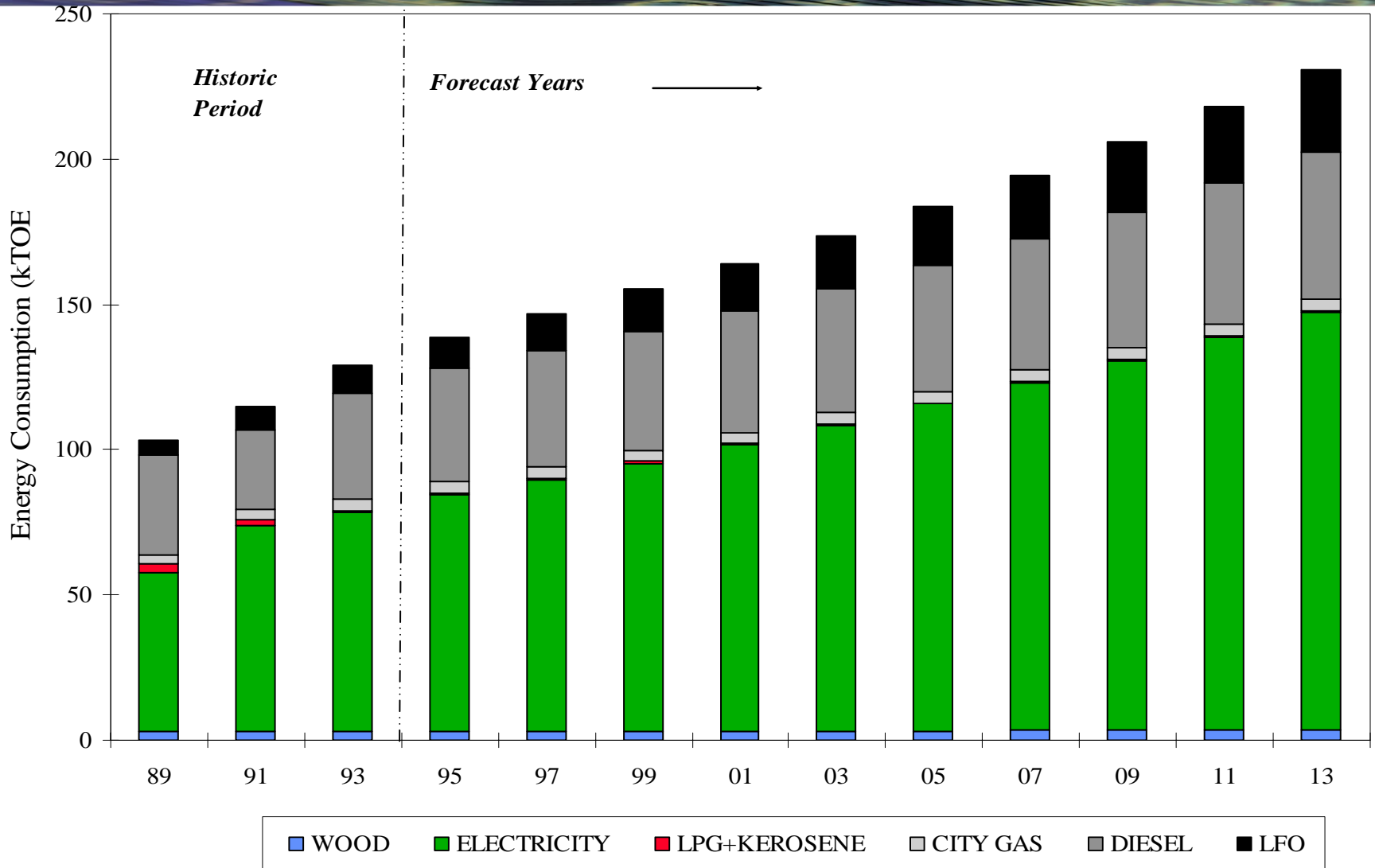
# Residential Final Energy Consumption

(Scenario 1: Reference Case)



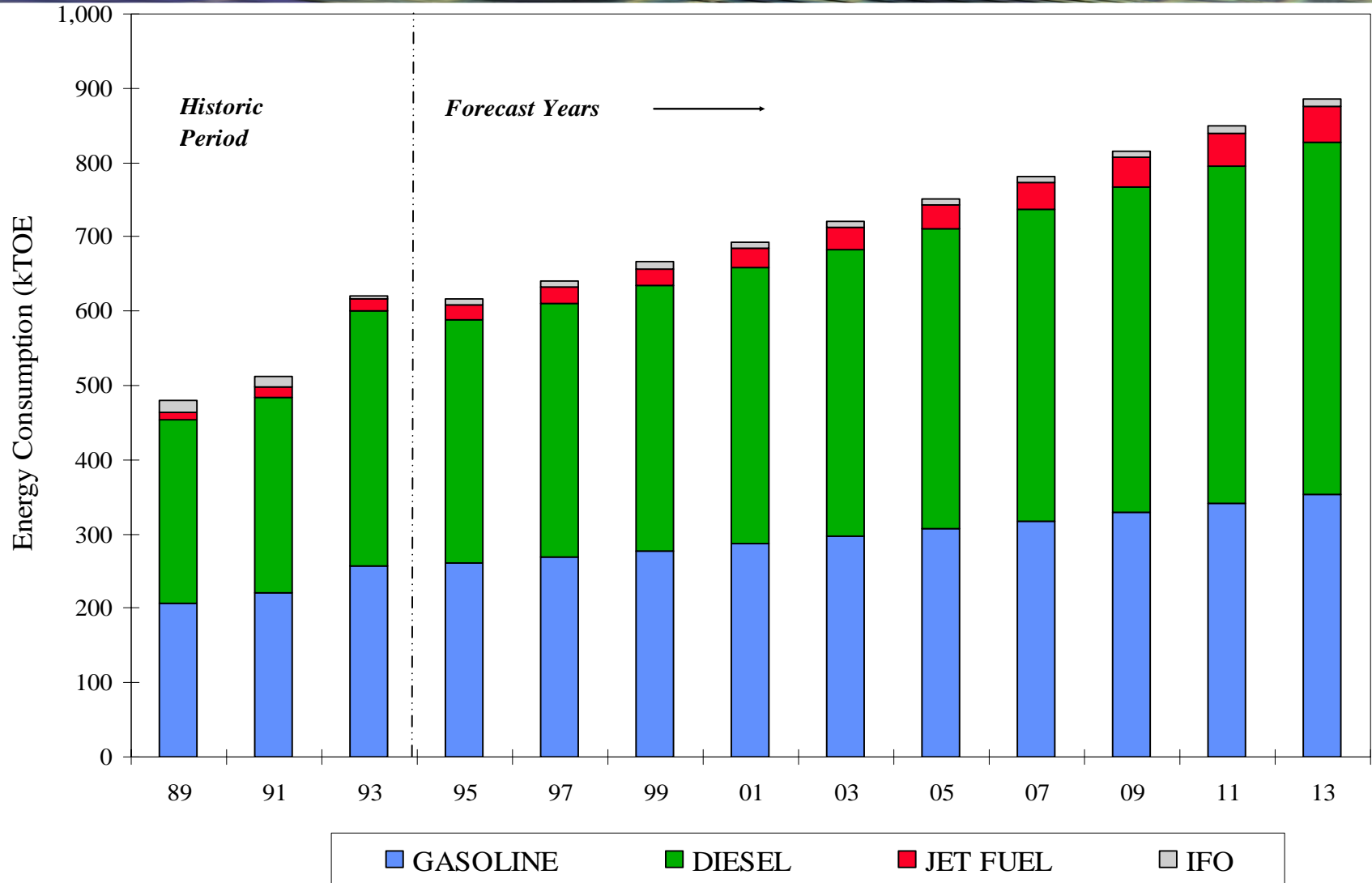
# Commercial Final Energy Consumption

(Scenario 1: Reference Case)



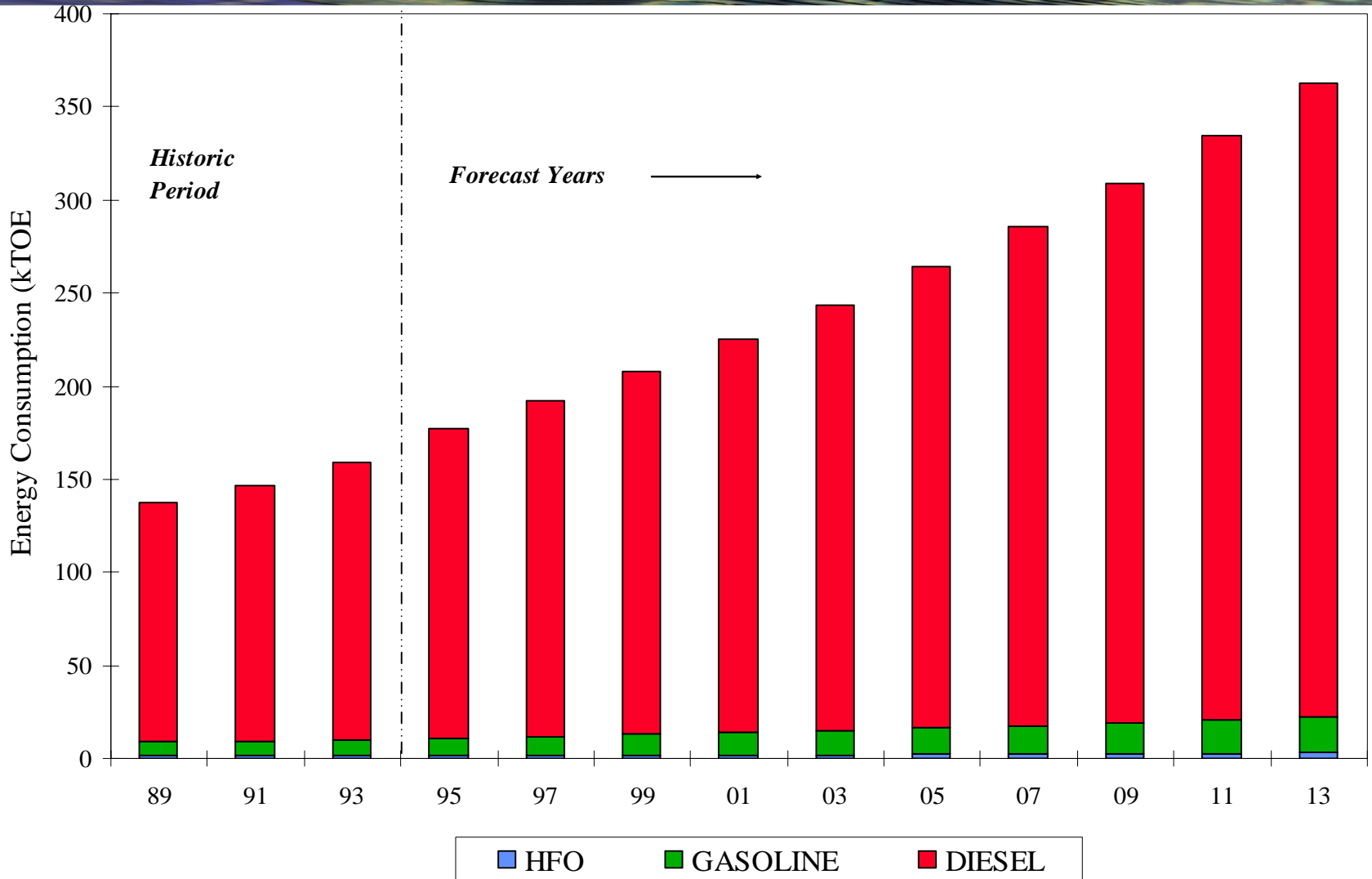
# Transport Final Energy Consumption

(Scenario 1: Reference Case)



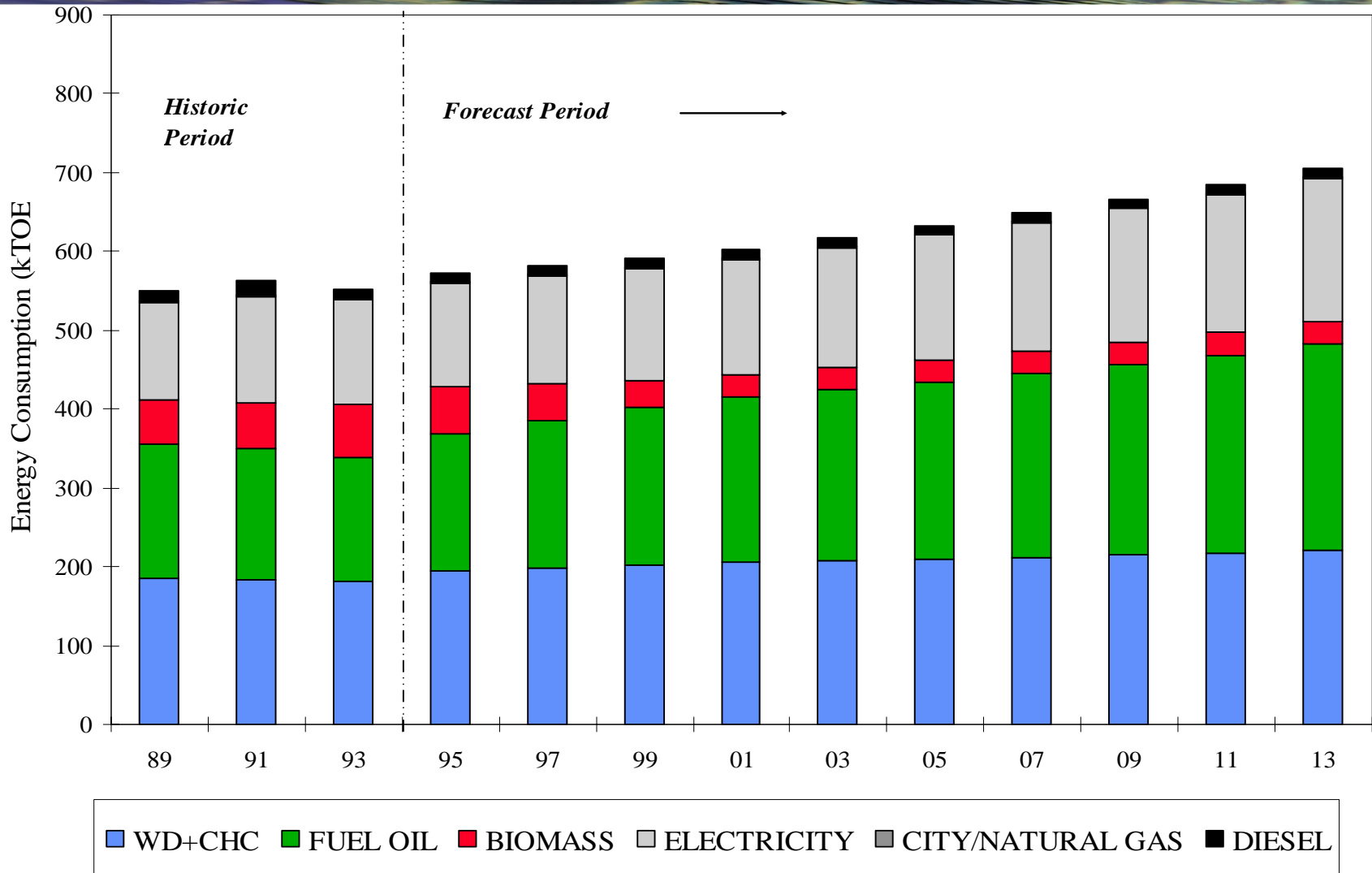
# Agriculture & Fishing Final Energy Consumption

(Scenario 1: Reference Case)



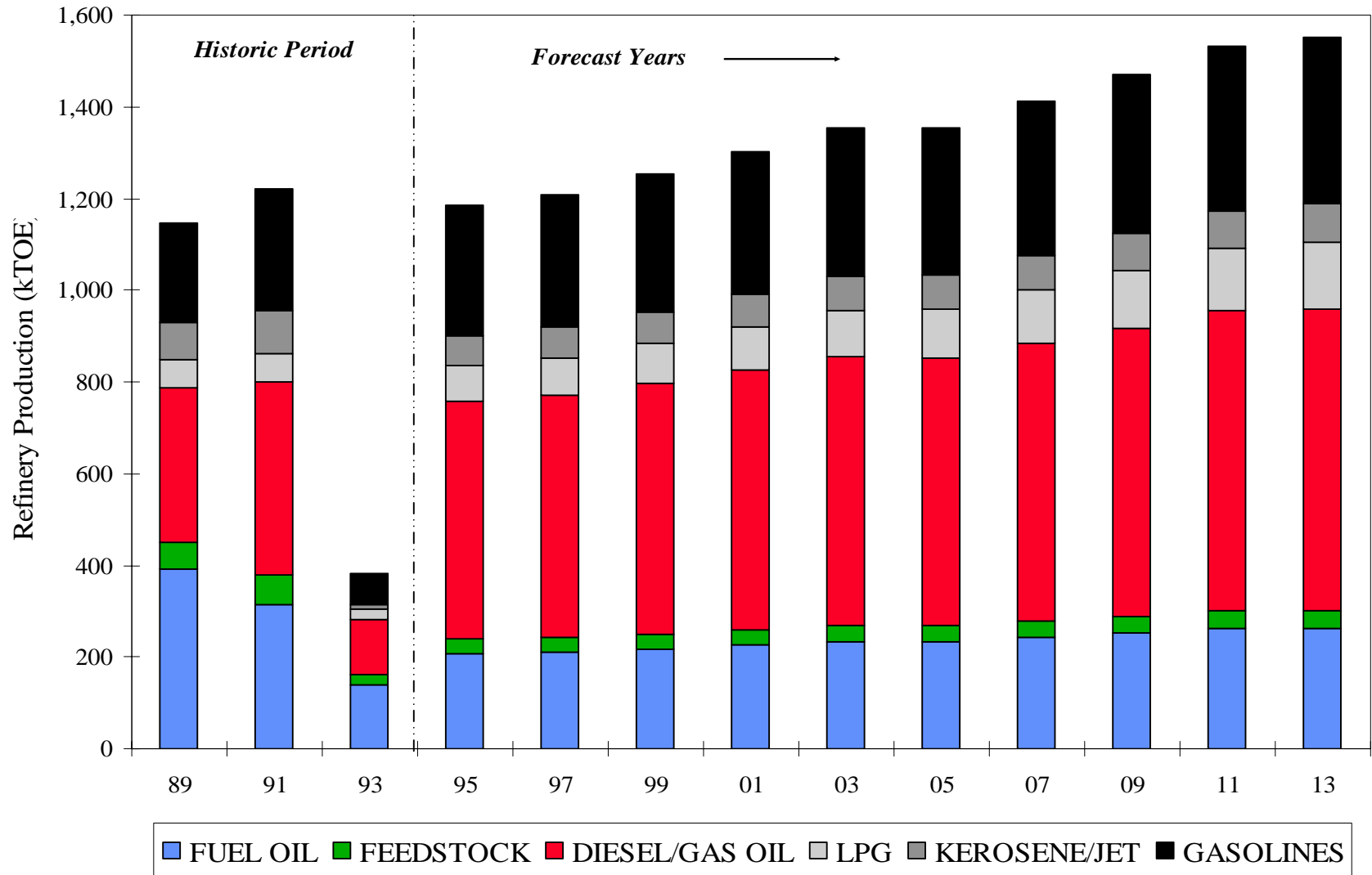
# Industrial Final Energy Consumption

(Scenario 1: Reference Case)



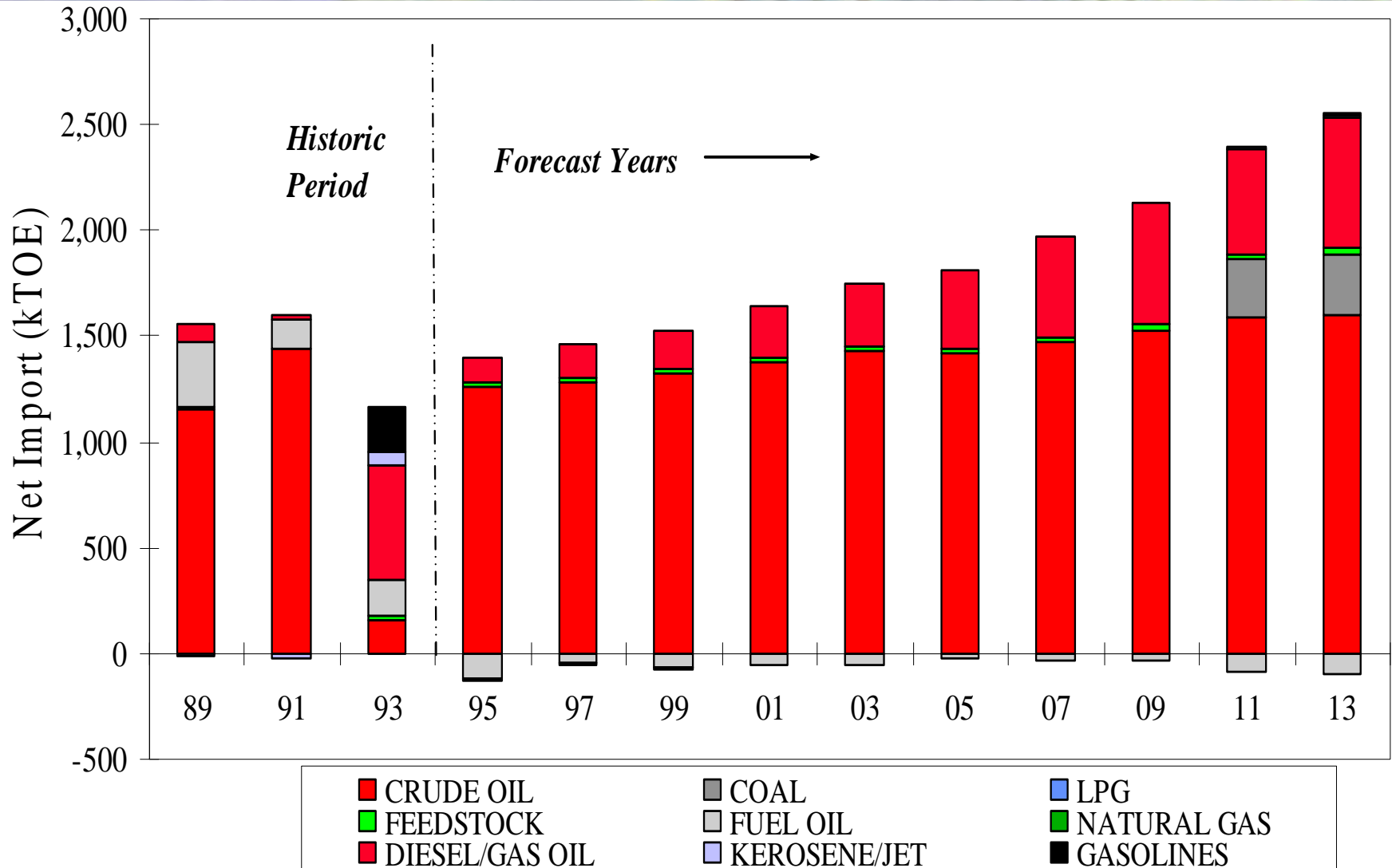
# Refinery Production

(Scenario 1: Reference Case)



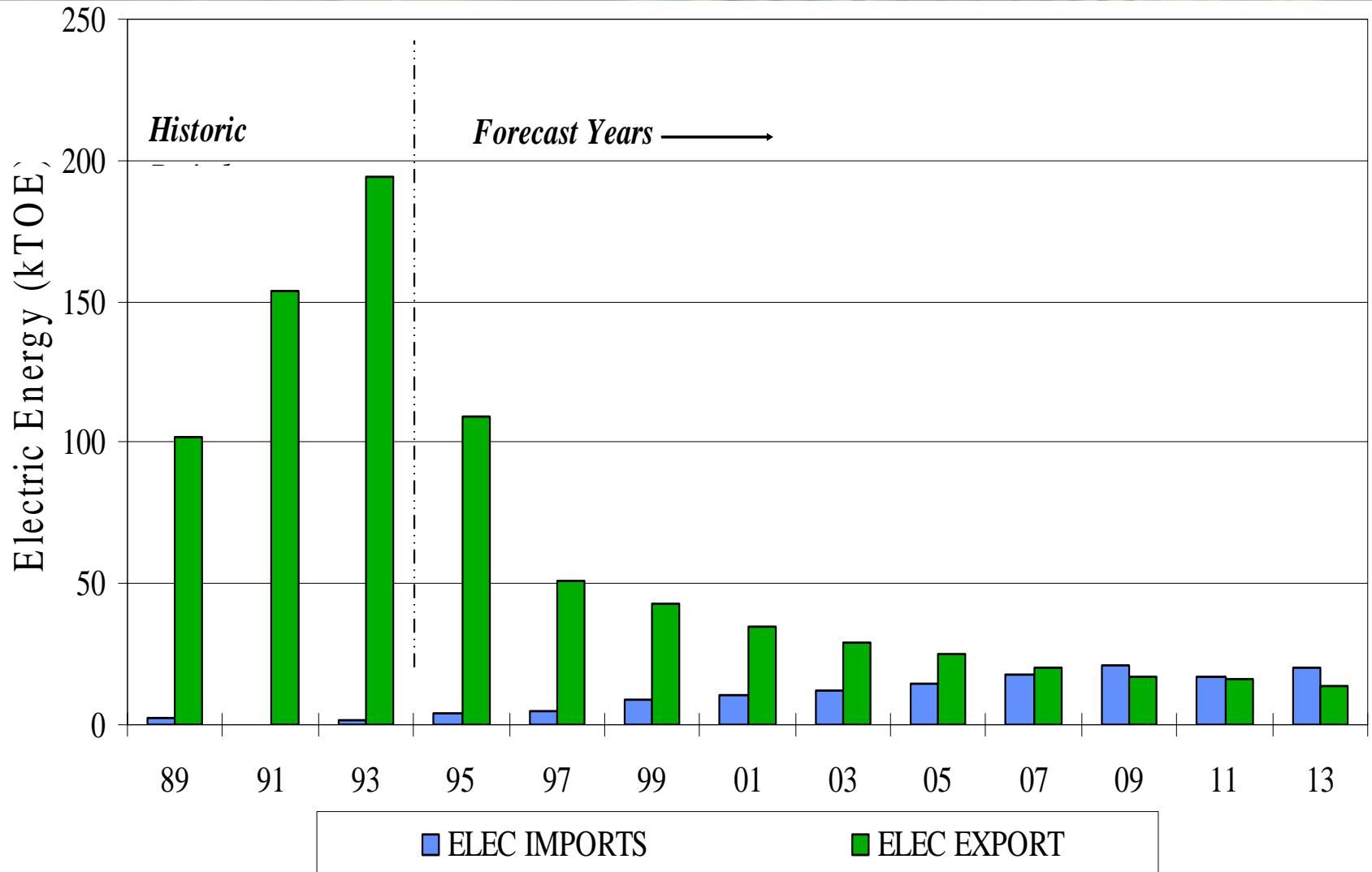
# Net Energy Import

(Scenario 1: Reference Case)

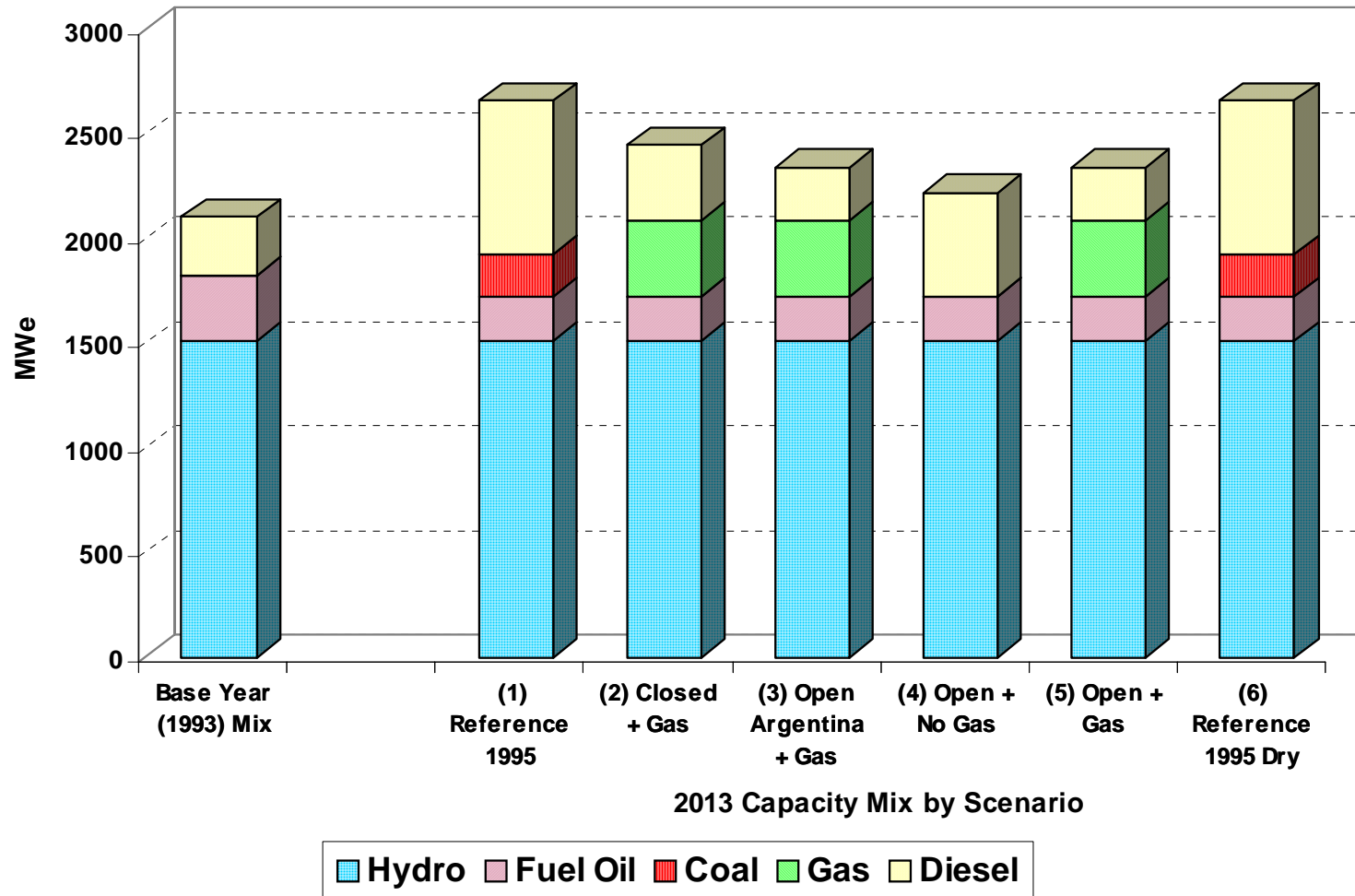


# Electric Imports & Exports

(Scenario 1: Reference Case)

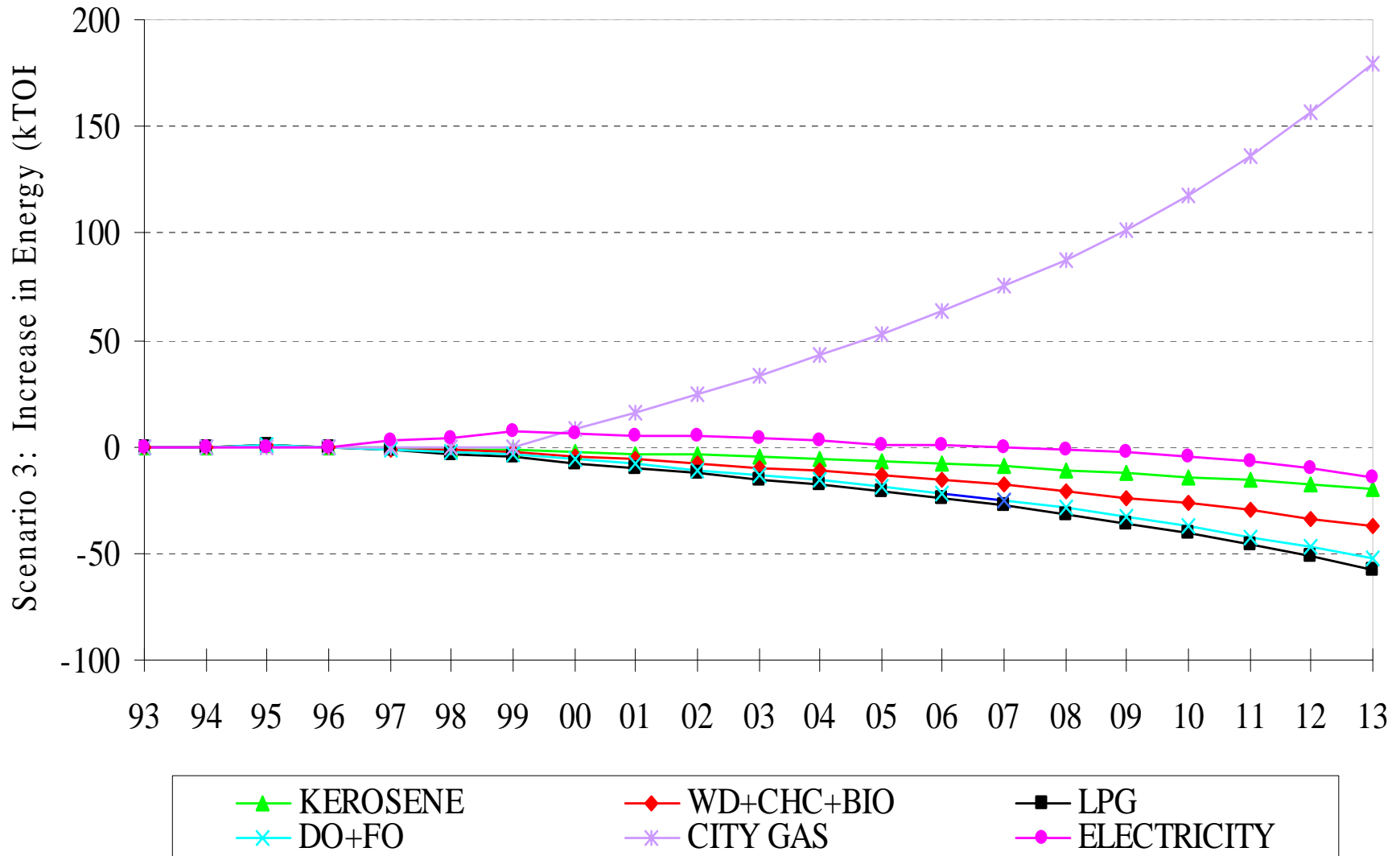


# Utility Capacity Expansion Plan



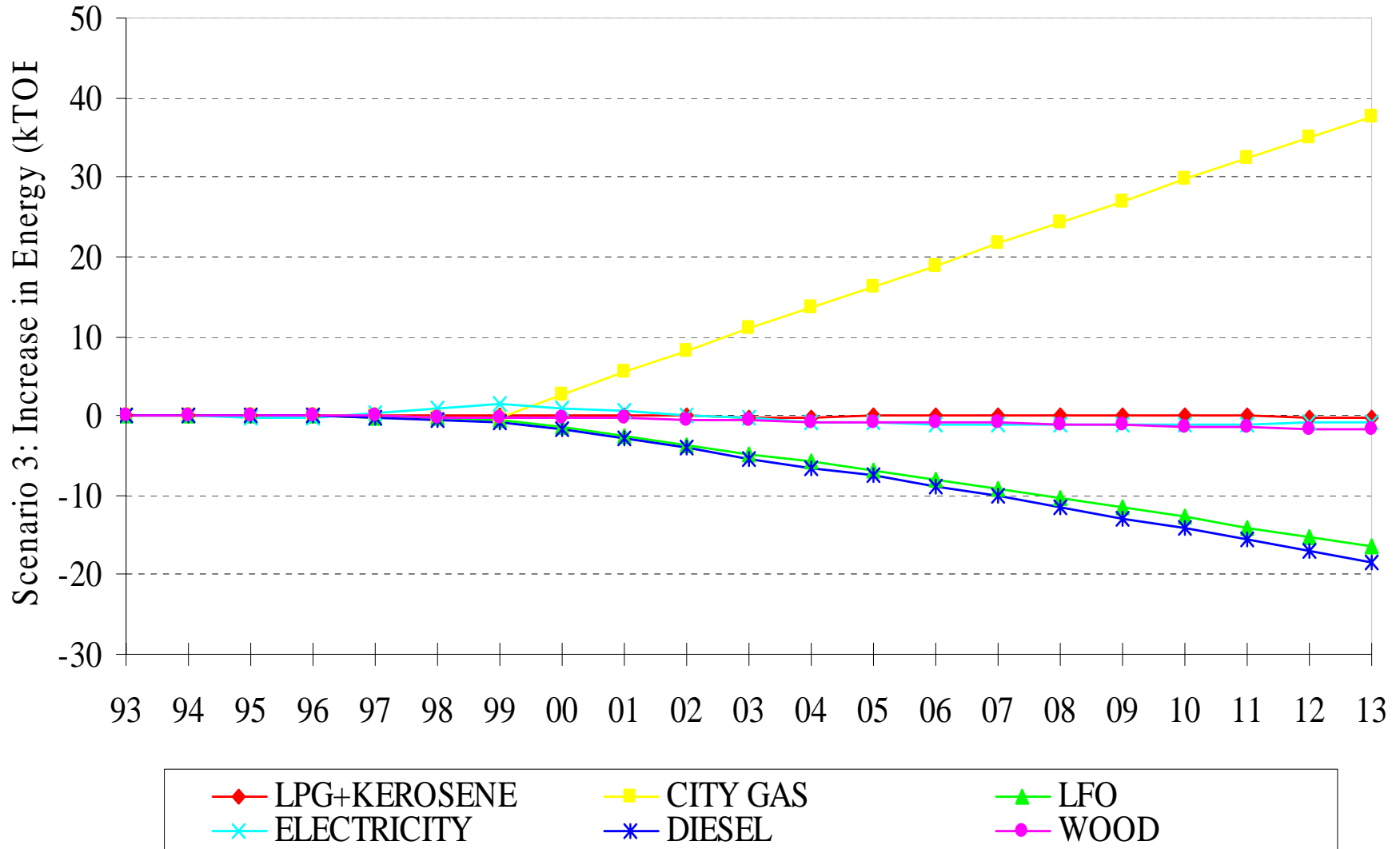
# Increase in Residential Energy Consumption

(Scenario 3: Open Arg + Gas)



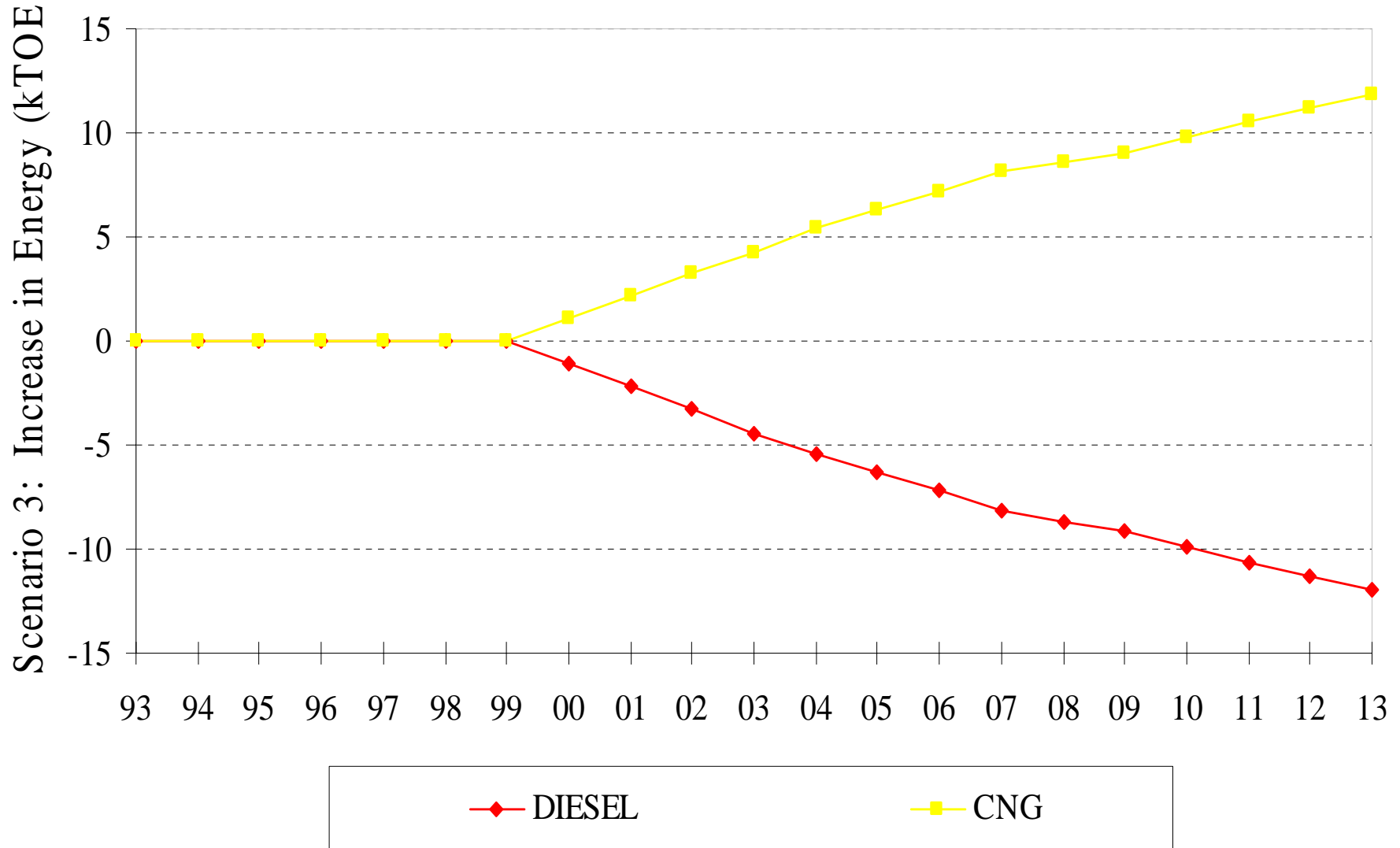
# Increase in Commercial Energy Consumption

(Scenario 3: Open Arg + Gas)



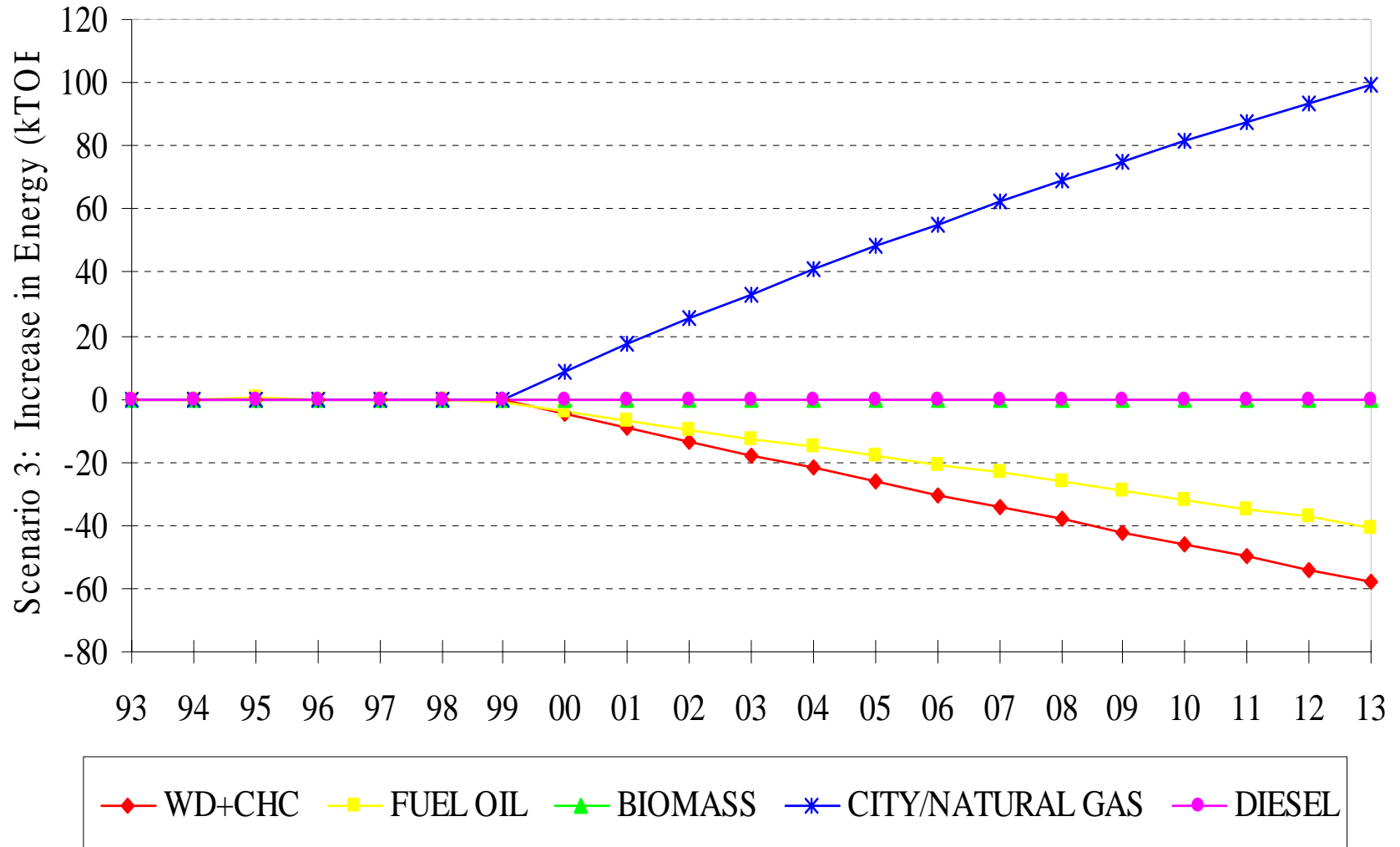
# Increase in Transportation Energy Consumption

(Scenario 3: Open Arg + Gas)



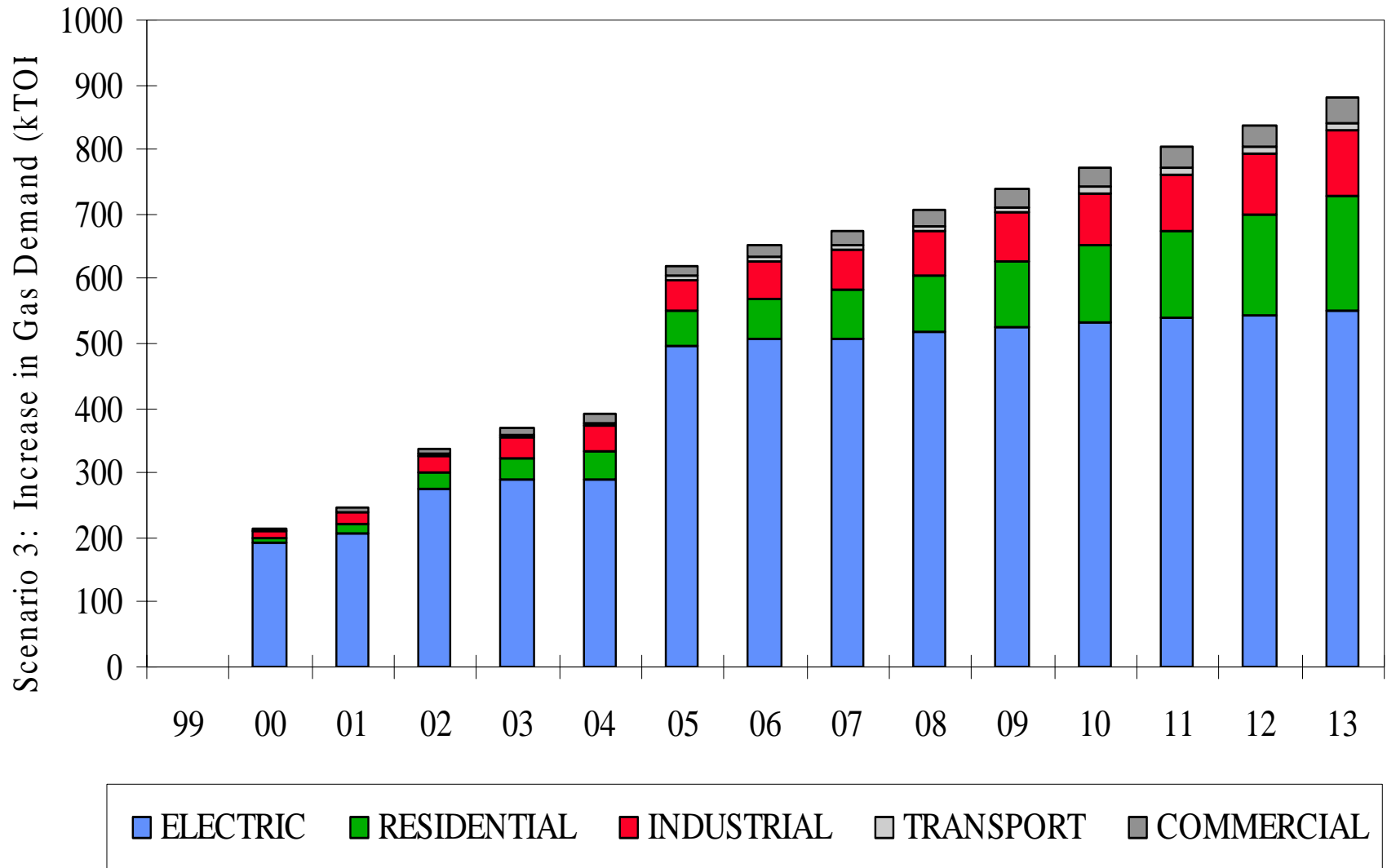
# Increase in Industrial Energy Consumption

(Scenario 3: Open Arg + Gas)



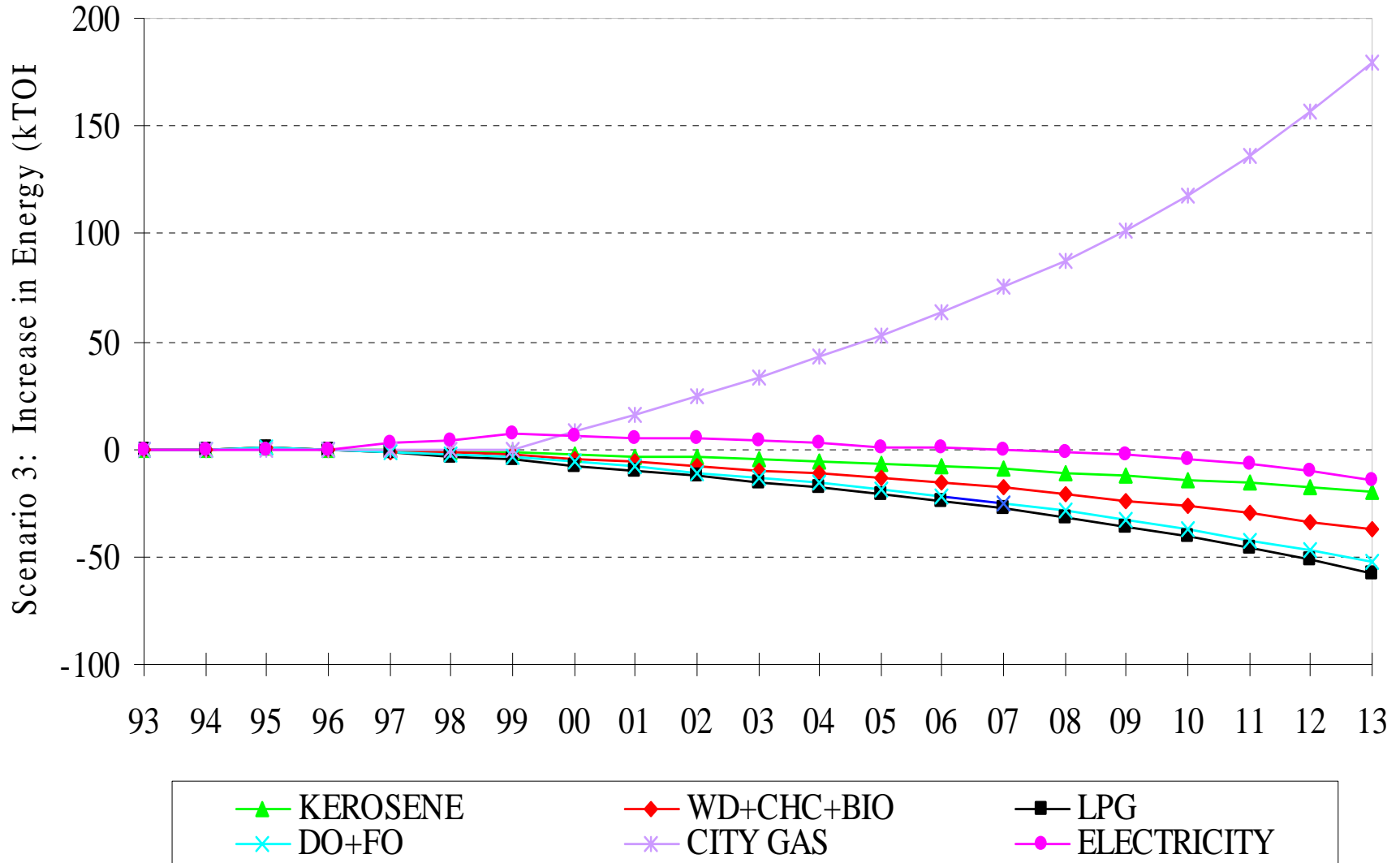
# Increase in Gas Consumption

(Scenario 3: Open Arg + Gas)



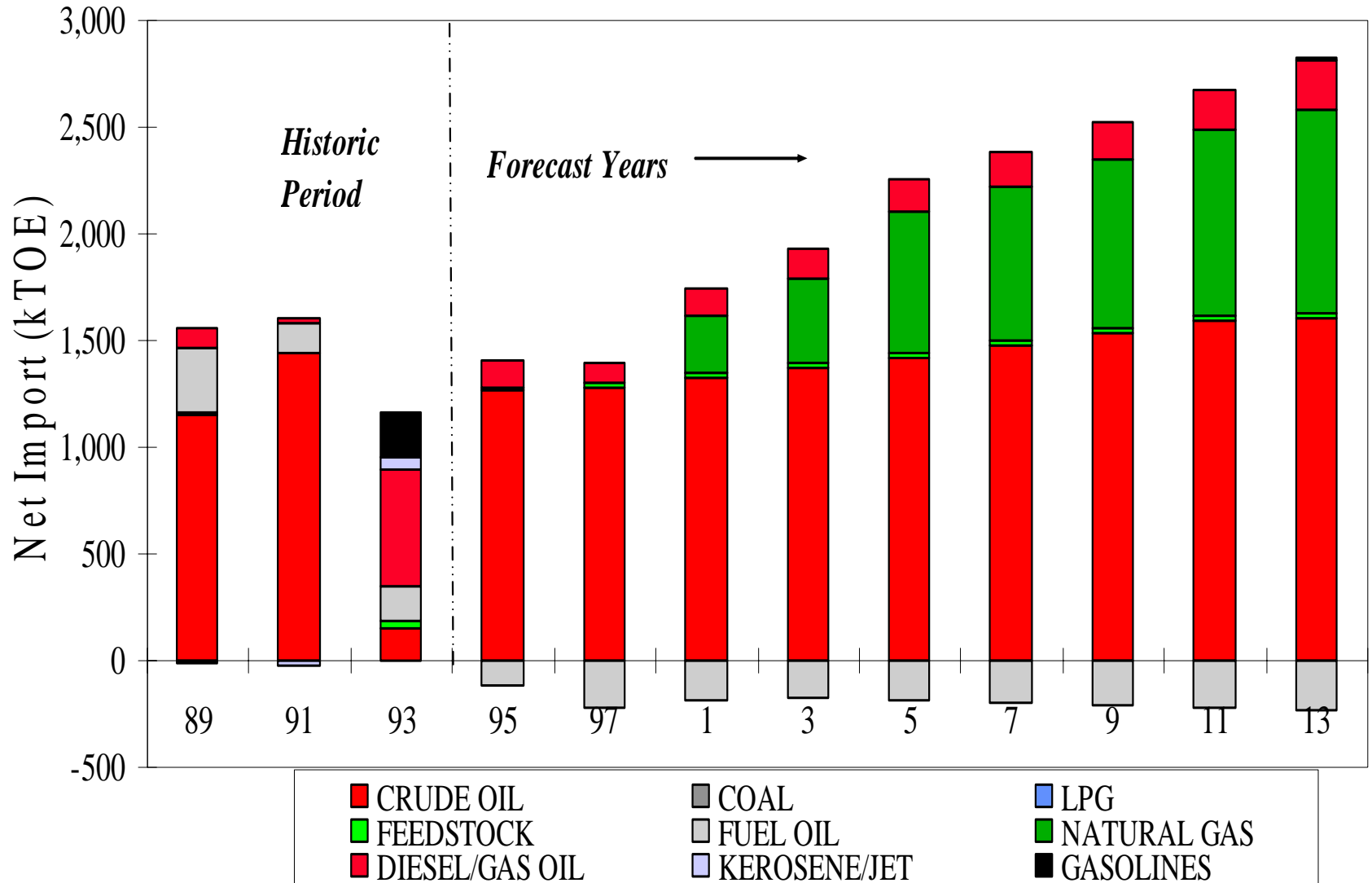
# Increase in Residential Energy Consumption

(Scenario 3: Open Arg + Gas)



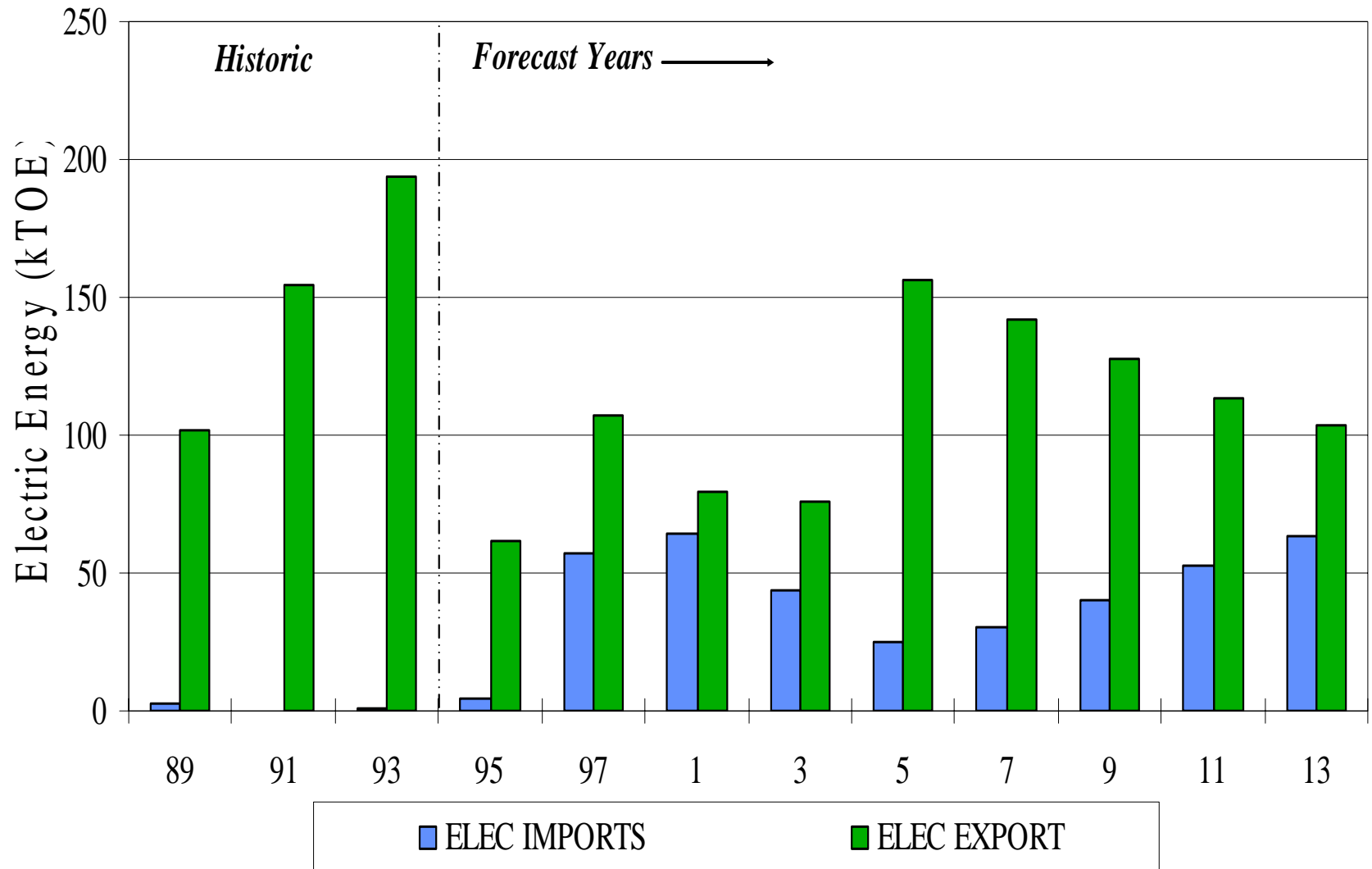
# Net Fossil Fuel Imports

(Scenario 3: Open Arg + Gas)

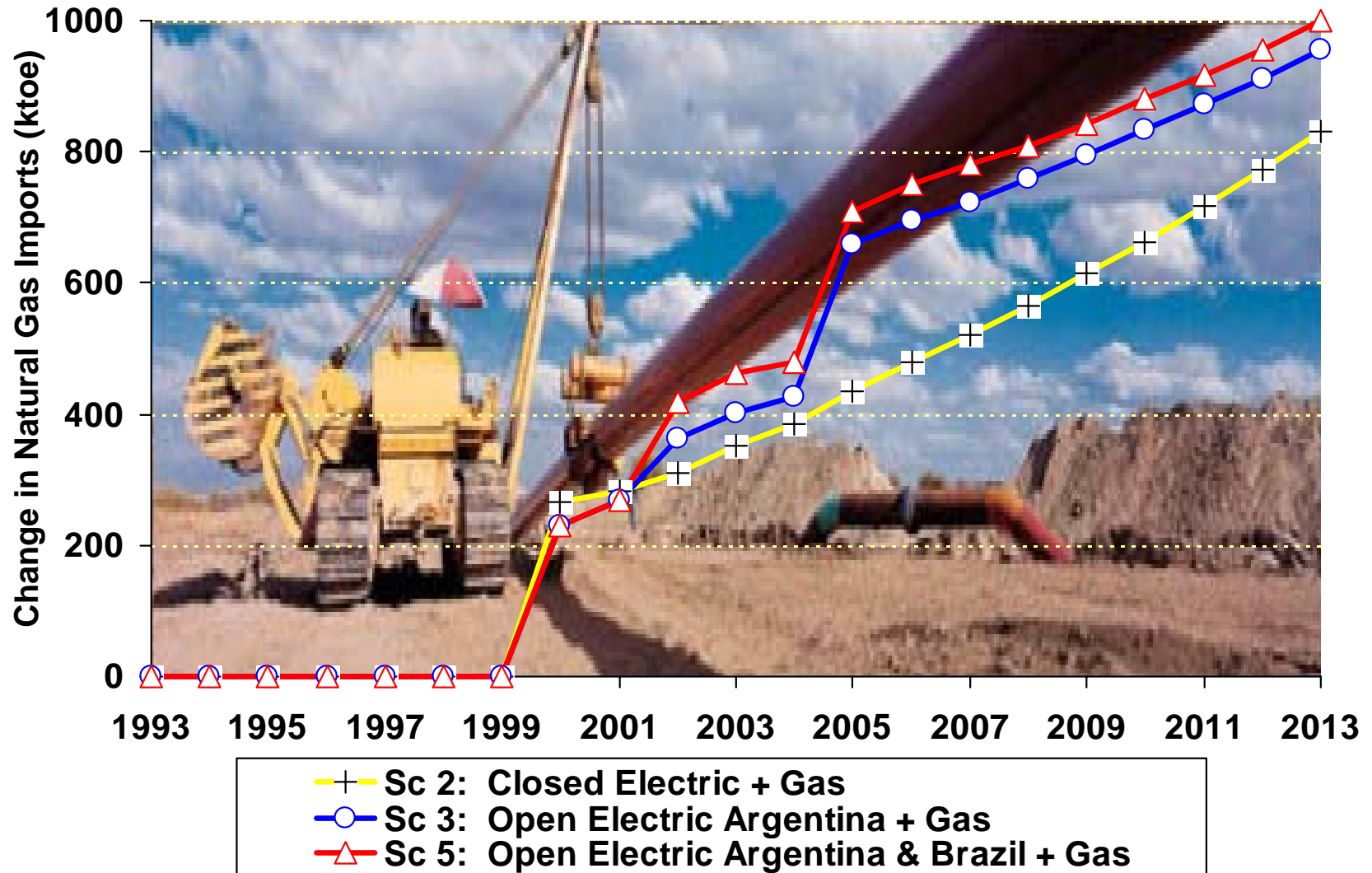


# Electricity Imports & Exports

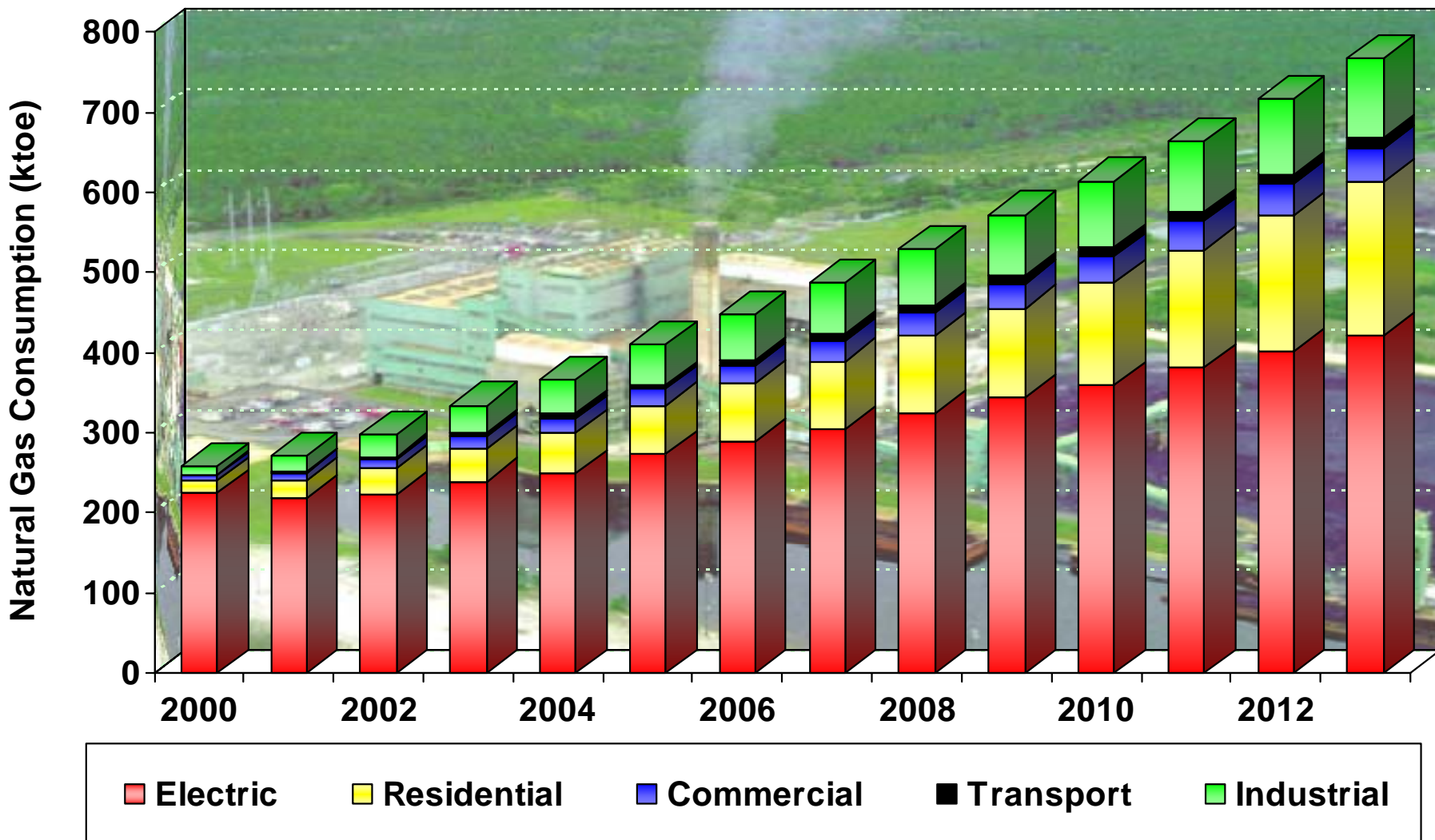
(Scenario 3: Open Arg + Gas)



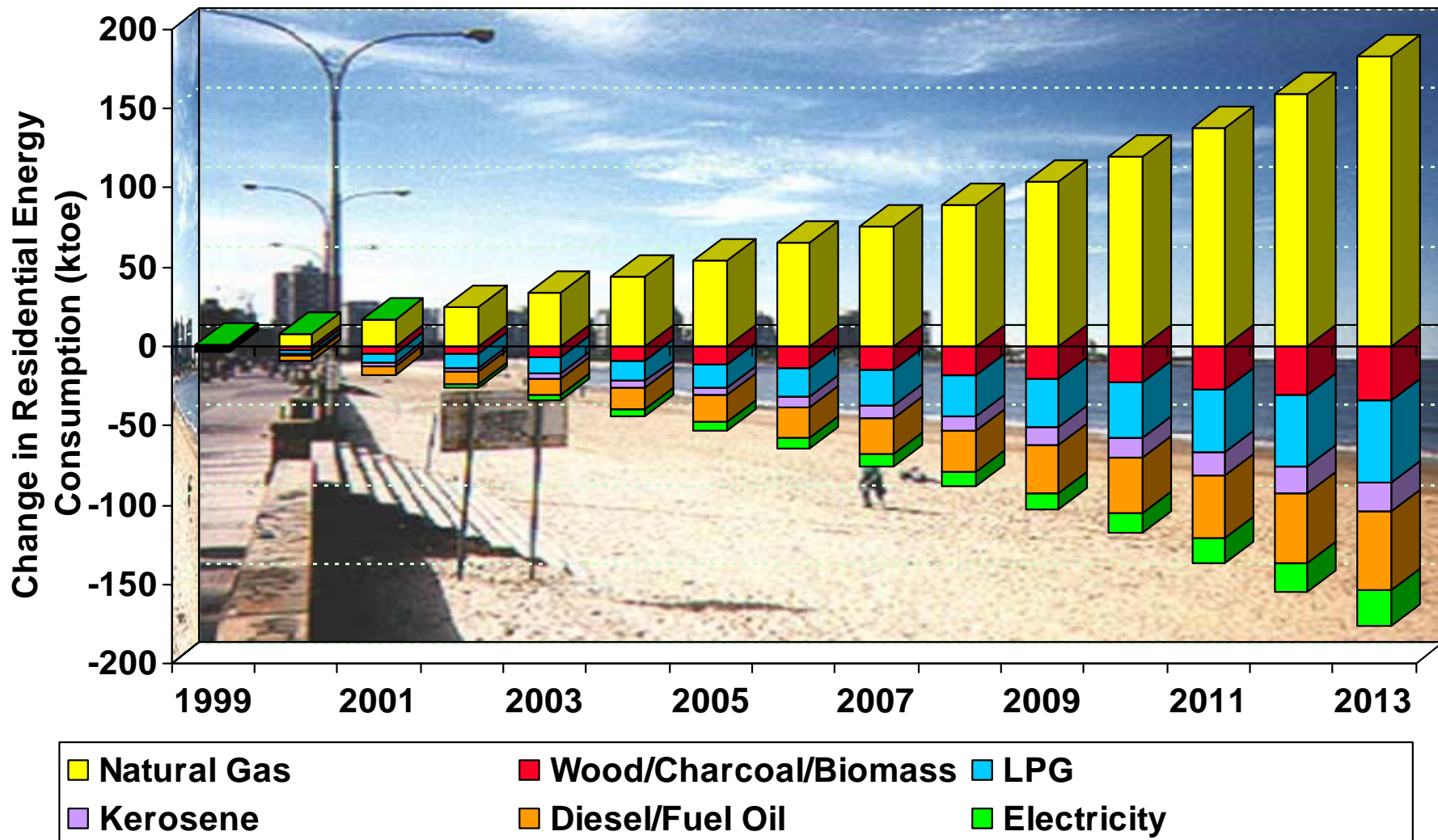
# Uruguay's Projected Natural Gas Imports Are Highest in an Open Regional Electricity Market



# Most of the Natural Gas will be Consumed by Uruguay's Electric Sector



# Uruguay's Natural Gas Imports Displace a Mix of Other Fuels in the Residential Sector



## **6) Main conclusions in terms of Fuel Substitutions**

- 1. Under natural gas scenarios, gas would provide between 25-28% of Uruguay's primary energy in 2013, and the crude oil participation would be reduced from 55% to 45-48%.**
- 2. The share of wood/biomass in the primary energy balance would drop from 16% to 10-11% under the natural gas scenarios.**
- 3. In the scenario with electric integration but no gas, the shares of crude oil and wood/biomass in the primary energy supply balance are expected to increase to 62% and 17% (from 55% and 16%).**
- 4. Imports of refined oil products (such as diesel, fuel oil, and LPG) are substantially reduced under all the alternatives, except scenario 6. For diesel 57 to 63% less, for fuel oil 52 to 92% less and LPG 80 to 100% of reduction.**

# Main conclusions in terms of Fuel Substitutions (cont.)

- 5. Under natural gas scenarios, the gas share in the final energy consumption will be around 11.5% in 2013. It will substitute mostly wood/charcoal, oil products, and to a much smaller degree electricity.**
- 6. Most of the gas would be used for power generation (55 to 63%) in 2013, while the residential sector would consume 20 to 25%, the industrial sector 11 to 13% and the commercial sector 4-5%.**