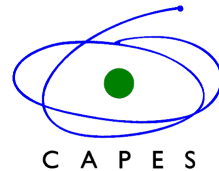




Thermal Generation Investment Analysis Using Decision Tools



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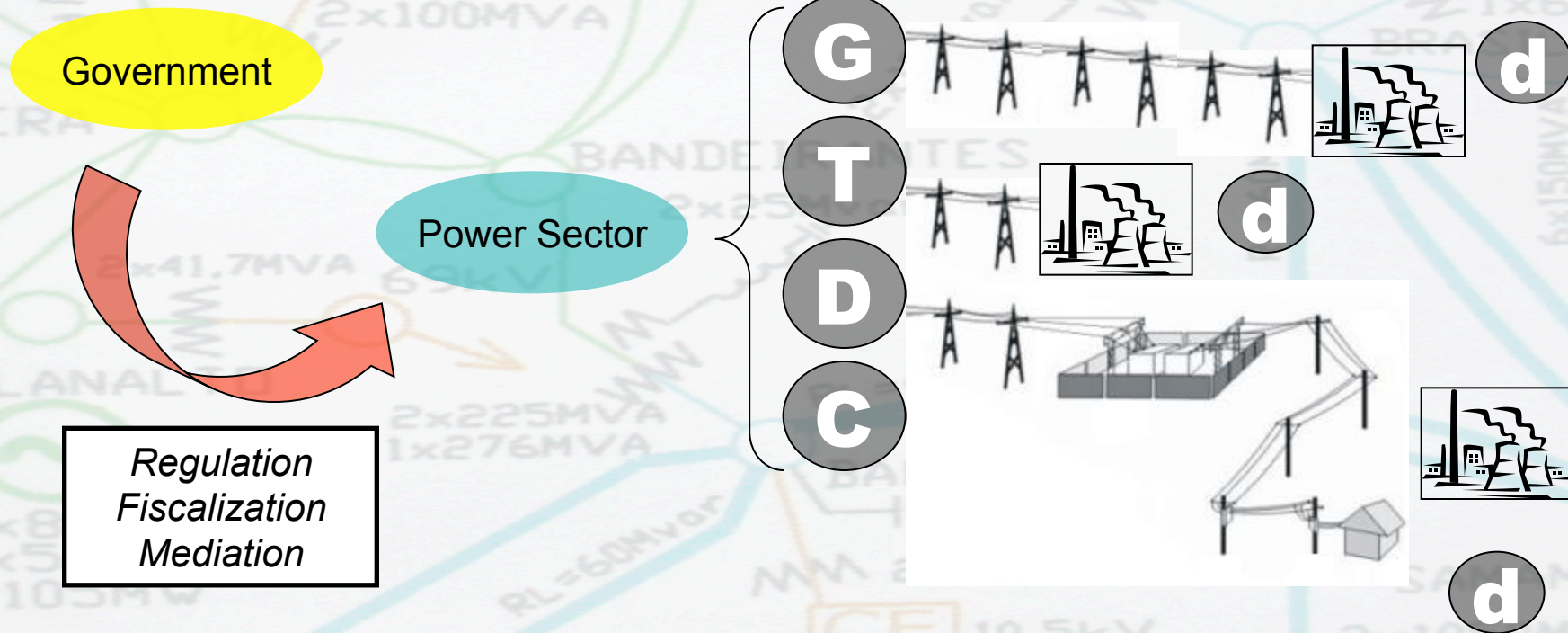


Introduction

- ❑ In a deregulated power market the participants can **produce their own energy** for **consumption** or/and also can **sell it on the market**
- ❑ Consumers have the opportunity to **select its energy provider**
- ❑ We analyze an investment problem where a decision maker has to **decide on the best** among four possible **alternatives of power supply**
- ❑ We consider **uncertainties** that have strong influence on the **net present values** and use **decision analysis tools** to help the decision maker

Deregulated Power Sector

- Among the possible options we evaluate an investment analysis of a **300 [MW] thermal generator** in the Brazilian South East region



Questions that Arise

- ❑ Should the company buy electricity from its local utility?
- ❑ Is it interesting to gamble on the spot market?
- ❑ Is it best to produce its own electricity?
- ❑ In this way:

The electricity prices and the electricity transmission tariffs become essential for the decision process

Strategic Table

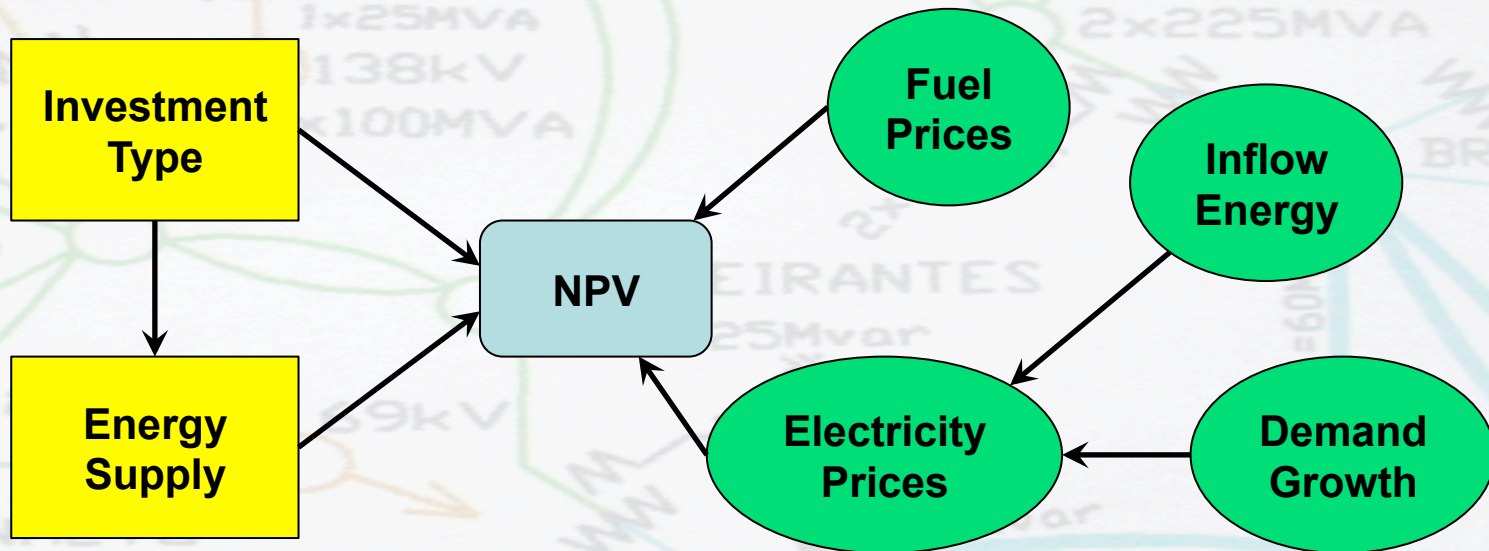
□ The first step of DA is to list all the viable options

Strategy Theme	Generator Technology	Energy Supply Font
Invest	None	Gas only
Not	Open Cycle	Local Utility Only
	Combined Cycle	Spot Market Only
		Spot Market & Gas

- Distribution system usage **A**
- Electricity consumed
- Investment (**\$473 Millions**)
- O&M (fix & random)
- Use of the distribution system **A**
- Electricity consumed
- Use of the distribution system **B**
- Interconnected system charges
- Electricity purchases
- Distribution system usage **B**
- Interconnected system charges
- Electricity purchases
- Investment (**\$234 Millions**)
- O&M (fix & random)

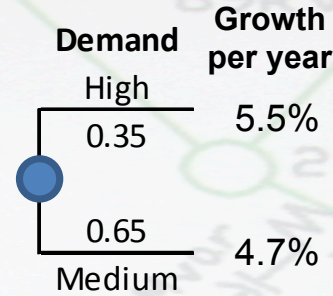
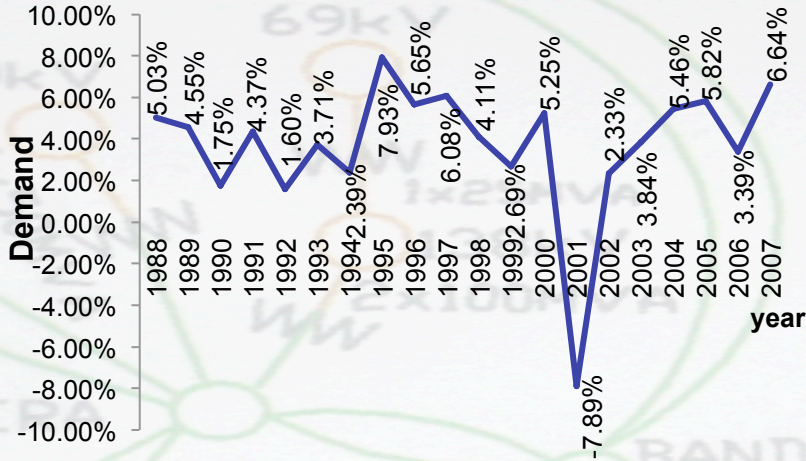
Influence Diagram

- Way to describe the existent dependencies among uncertainties and decisions

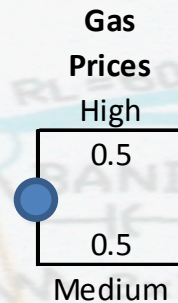
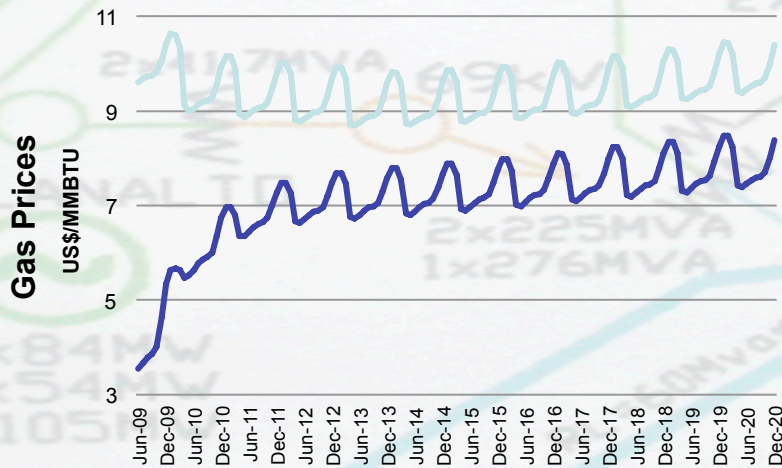


Used to visualize the probabilistic dependencies in a decision analysis and to specify the states of information for which independencies can be assumed to exist

Uncertainties



Initial System Electricity Demand
51,000 [MW]



Gas Prices [US\$/MMBTU]

	High	Medium
Henry Hub	9.57	7.15
Company	10.59	7.91

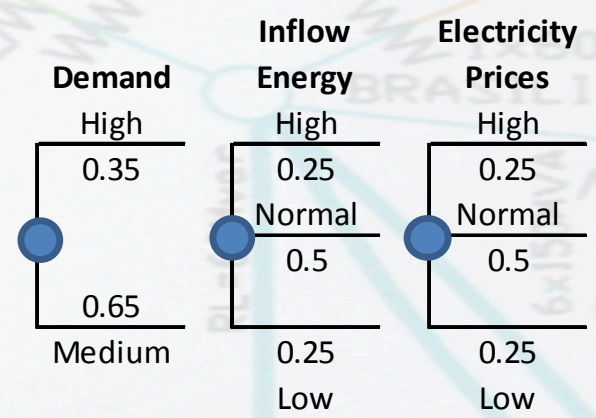
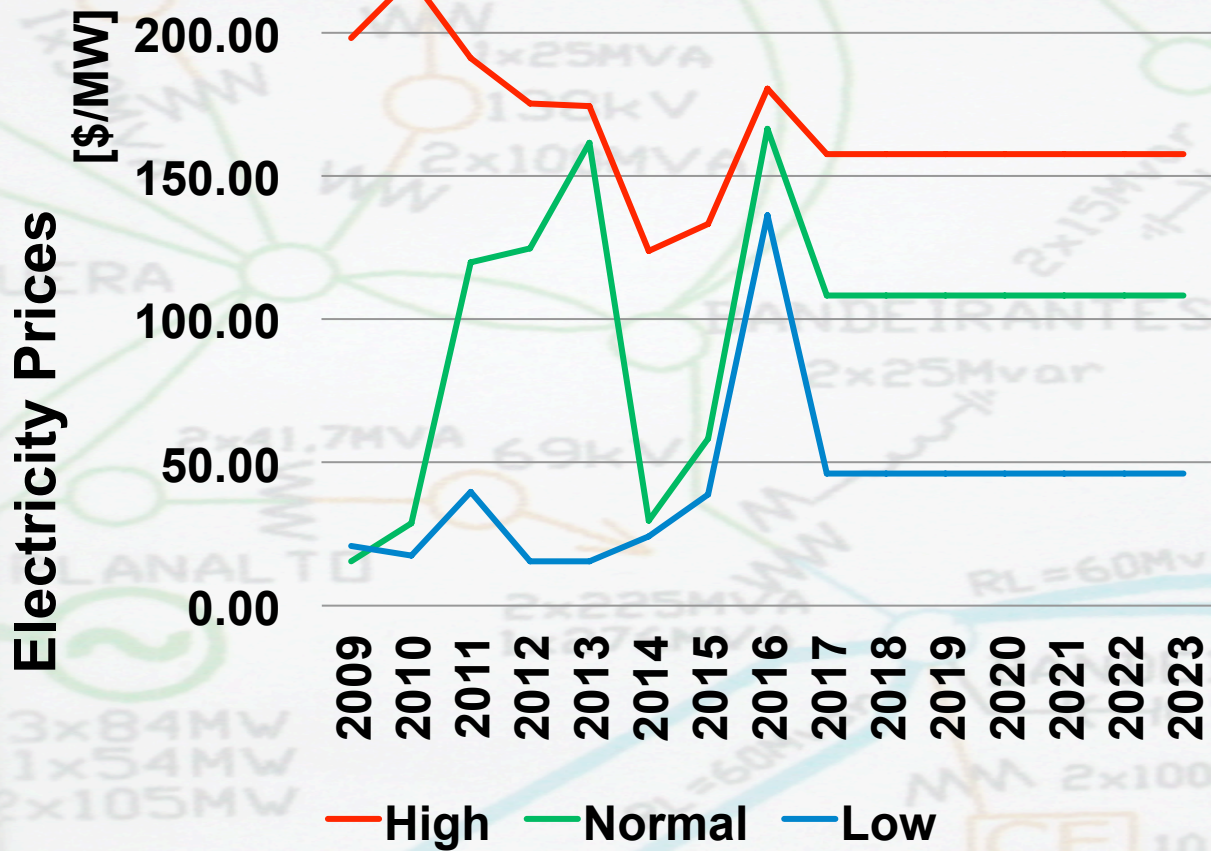
Modeling Uncertainty Relevance

- Demand growth and natural inflow energy at the reservoirs are **mutually irrelevant** but the **electricity prices depend on both**
- Monthly prices, energy inflow and demand growth data from 05/2003 to 01/2009 were used to compute the conditional probabilities

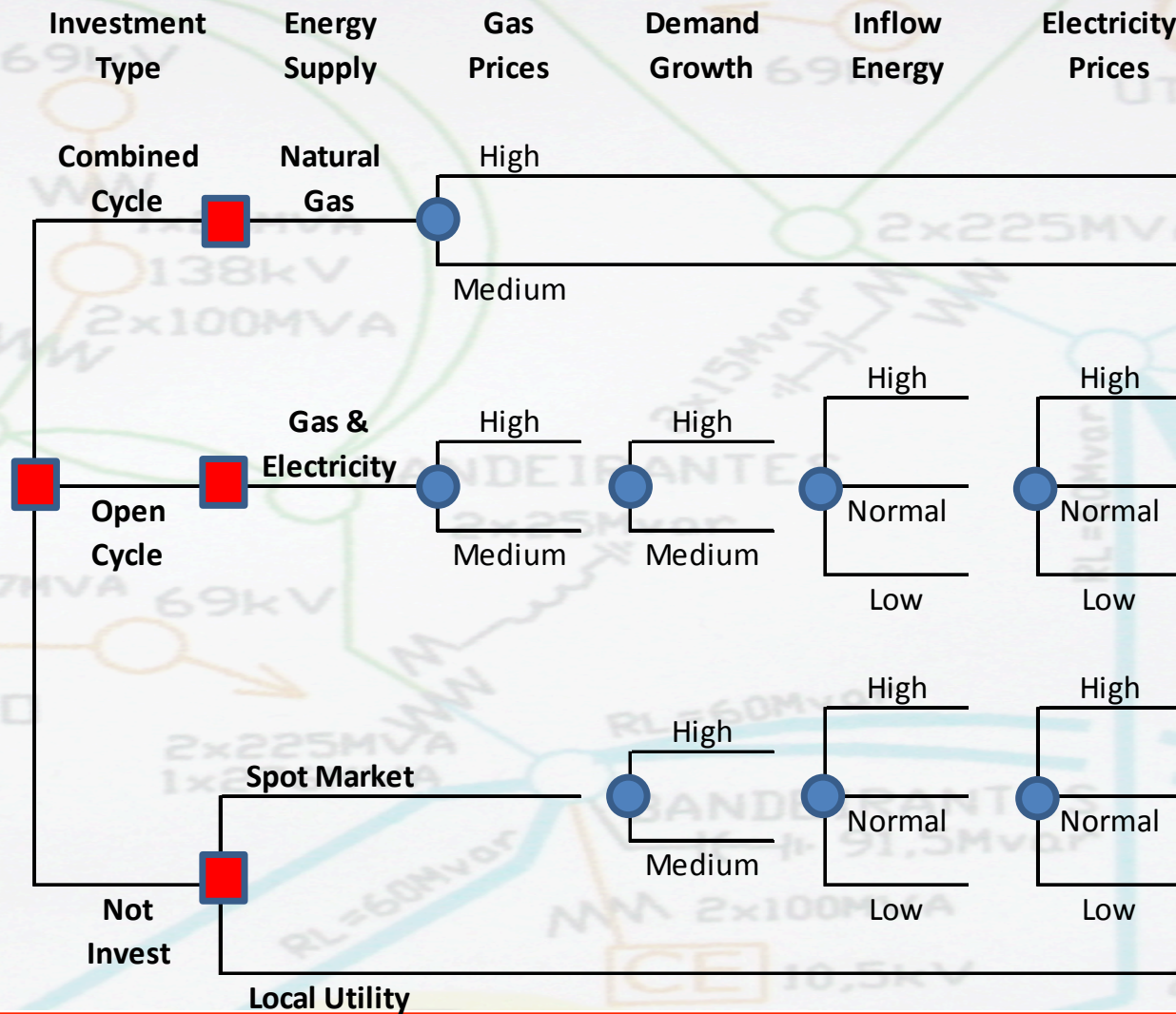
$$\{E \downarrow H \mid D \downarrow H \text{ and } I \downarrow H\} = \#months(E \downarrow H \mid D \downarrow H \text{ and } I \downarrow H) / \#months(D \downarrow H \text{ and } I \downarrow H)$$

		Electricity Prices		
Demand	Inflow	High	Med	Low
High	Wet	0,10	0,35	0,55
	Normal	0,15	0,55	0,30
	Dry	0,60	0,35	0,05
Med	Wet	0,05	0,30	0,65
	Normal	0,12	0,50	0,38
	Dry	0,40	0,40	0,20

Simulated Electricity Prices



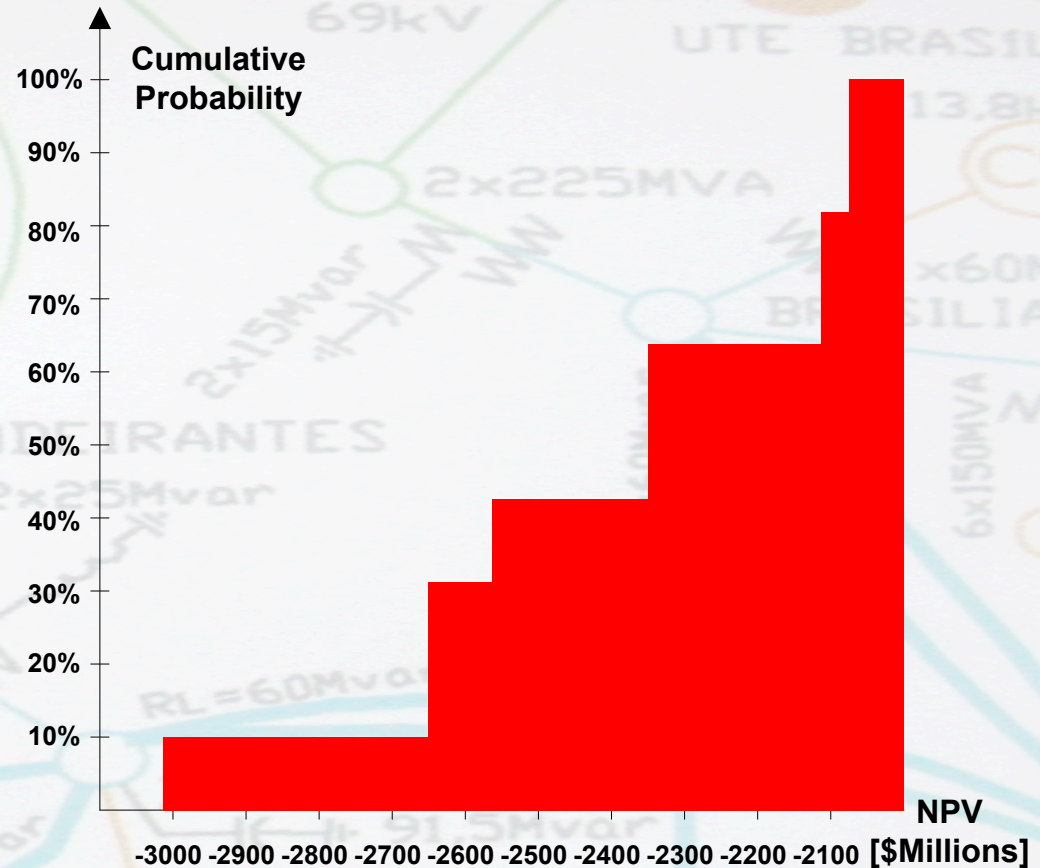
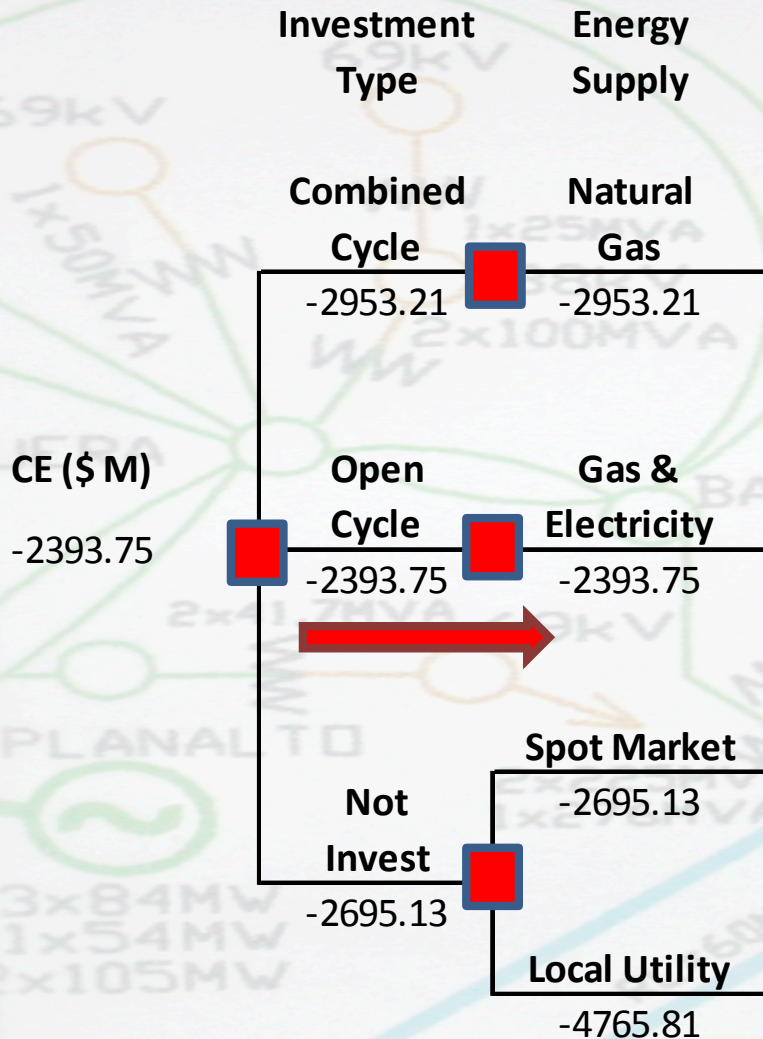
Decision Tree for the Problem



Results Obtained

	Gas	Electricity	Tariffs	NPV [\$ Millions]
Local Utility			Average	-4,765.81
		High		-4,118.32
Spot Market		Normal		-2,758.56
		Low		-1,845.17
	High			-3,122.80
Combined Cycle	Medium			-2,783.62
	High	High		-3,015.72
Open Cycle		Normal		-2,638.61
		Low		-2,096.88
		High		-2,542.12
	Medium	Normal		-2,329.91
		Low		-2,057.03

Results Obtained (cont)



Summary & Conclusions

- ❑ Real investment decisions are **complex** processes due to the **large amount of information** together with the **high level of risk** involved
- ❑ We presented some of the consequences of the use of logical and consistent techniques of **DA to help the decision maker** to choose among possible alternatives of electricity supply
- ❑ **More uncertainties** can be modeled: distribution tariffs, reliability of the generators, other fuel costs
- ❑ Add **other alternatives** to the problem which implies on changes in the decision tree



Thank you!
