

Integrated Resource Planning

Integrated Resource Planning, *Overview*

- ◆ **Goals**
- ◆ **Limits**
- ◆ **Resource Planning under various industry structures**
- ◆ **Methodology**
 - The demand side
 - The supply side
 - Portfolio analysis

Integrated Resource Planning

Resource Planning, *Process Goals*

- ◆ **Minimize system cost, or plan to reliability criteria**
- ◆ **Bring structure to decision making process**
- ◆ **Expose logical inconsistencies**
- ◆ **Test sensitivities**

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Resource Planning, *Results Goals*

◆ Power System

- Least cost
- Reliability
- Minimize Financial Risk
- Supply/Fuel diversity
- Increase Flexibility

◆ Social Benefits

- Environmentalism
- Energy Security or Independence

◆ Development & Social Benefits

- Technology/expertise transfer
- Rural electrification
- Local employment
- Use of local resources

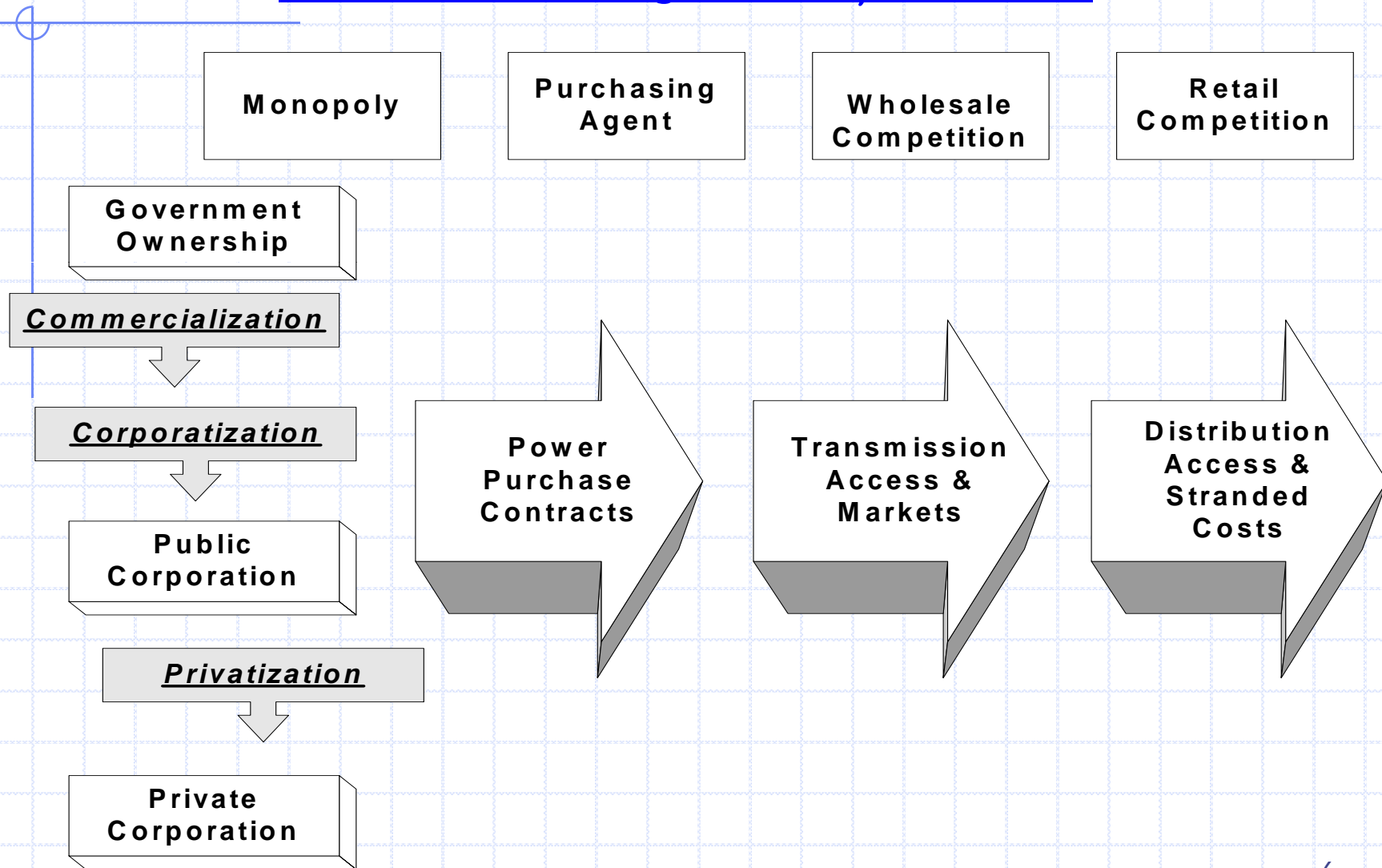
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Resource Planning, *Limits*

- ◆ **Not a substitute for management strategy or public policy**
- ◆ **Cannot adequately capture noneconomic criteria**
 - Energy security
 - Energy independence
 - Diversity of supply portfolio**
 - Market transformation

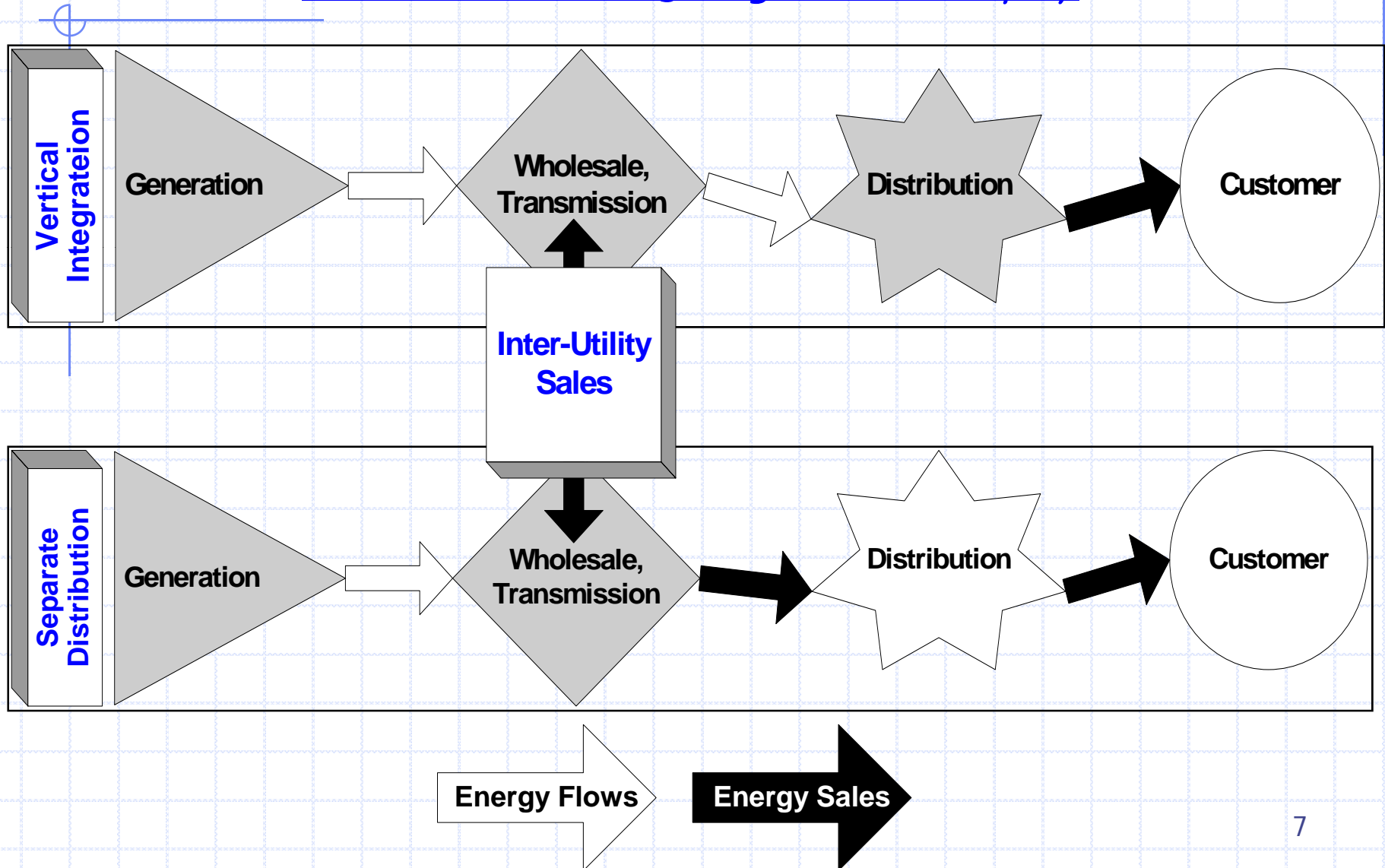
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Resource Planning, *Industry Structure*



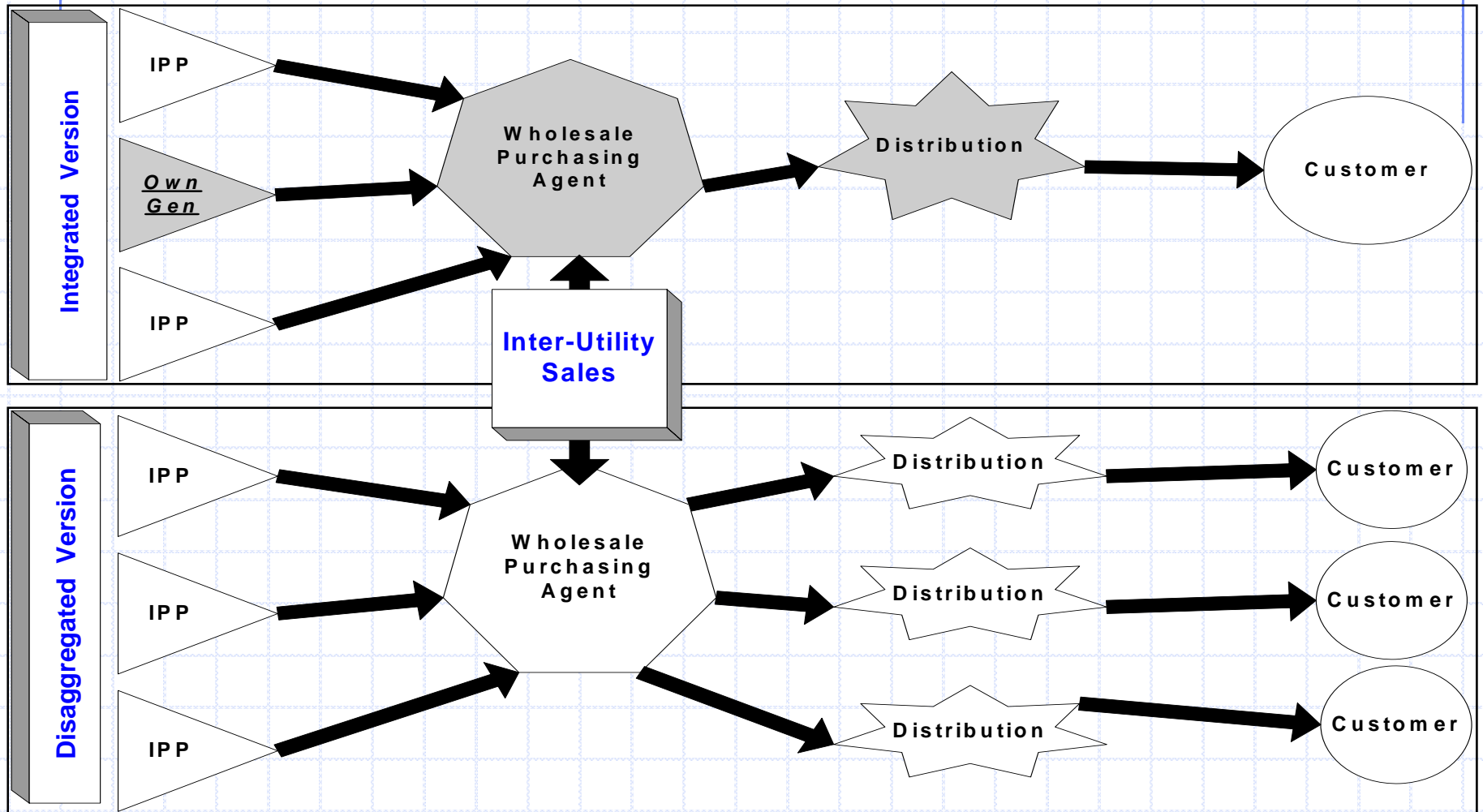
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Resource Planning, Regulated Monopoly



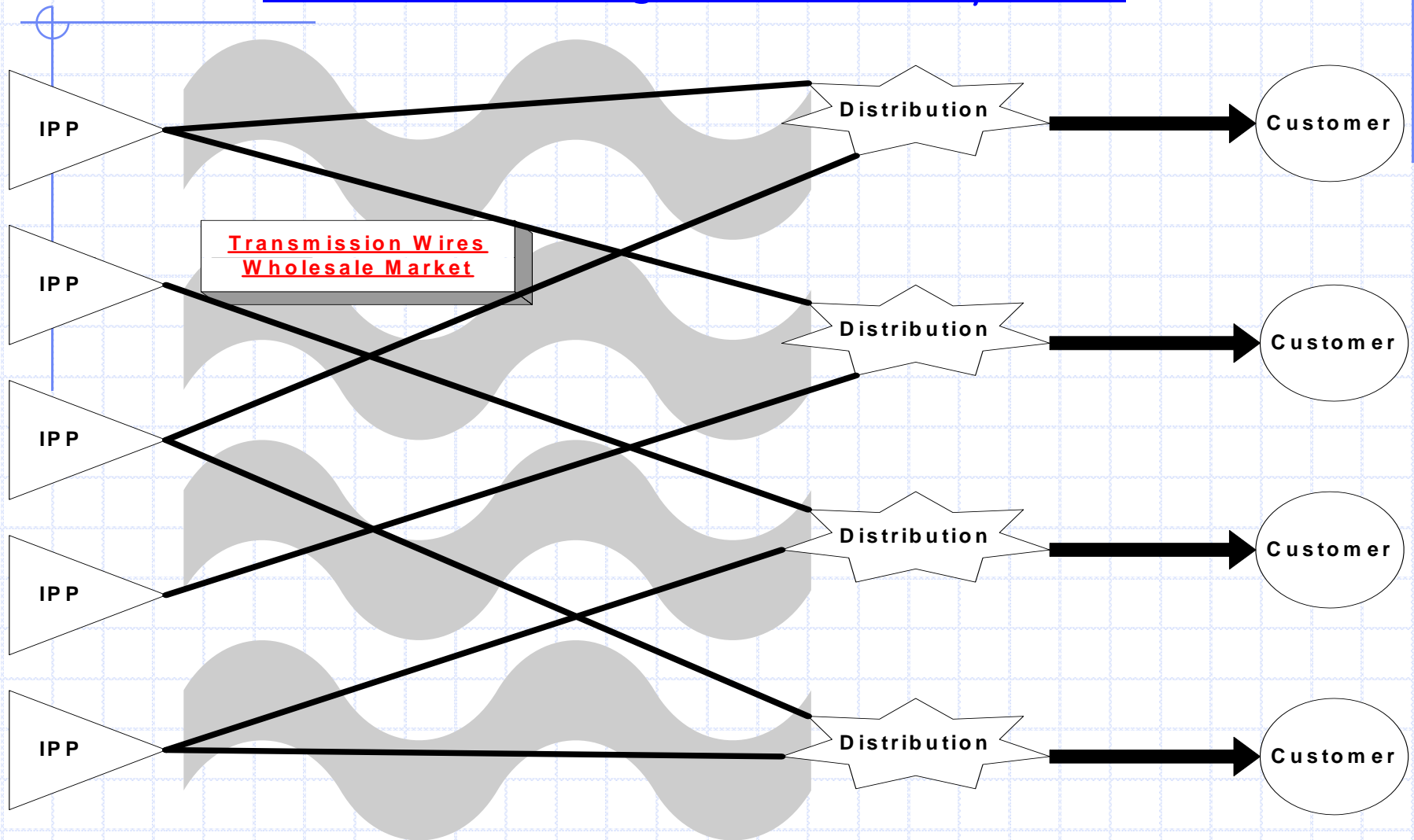
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Resource Planning, Purchasing Agent



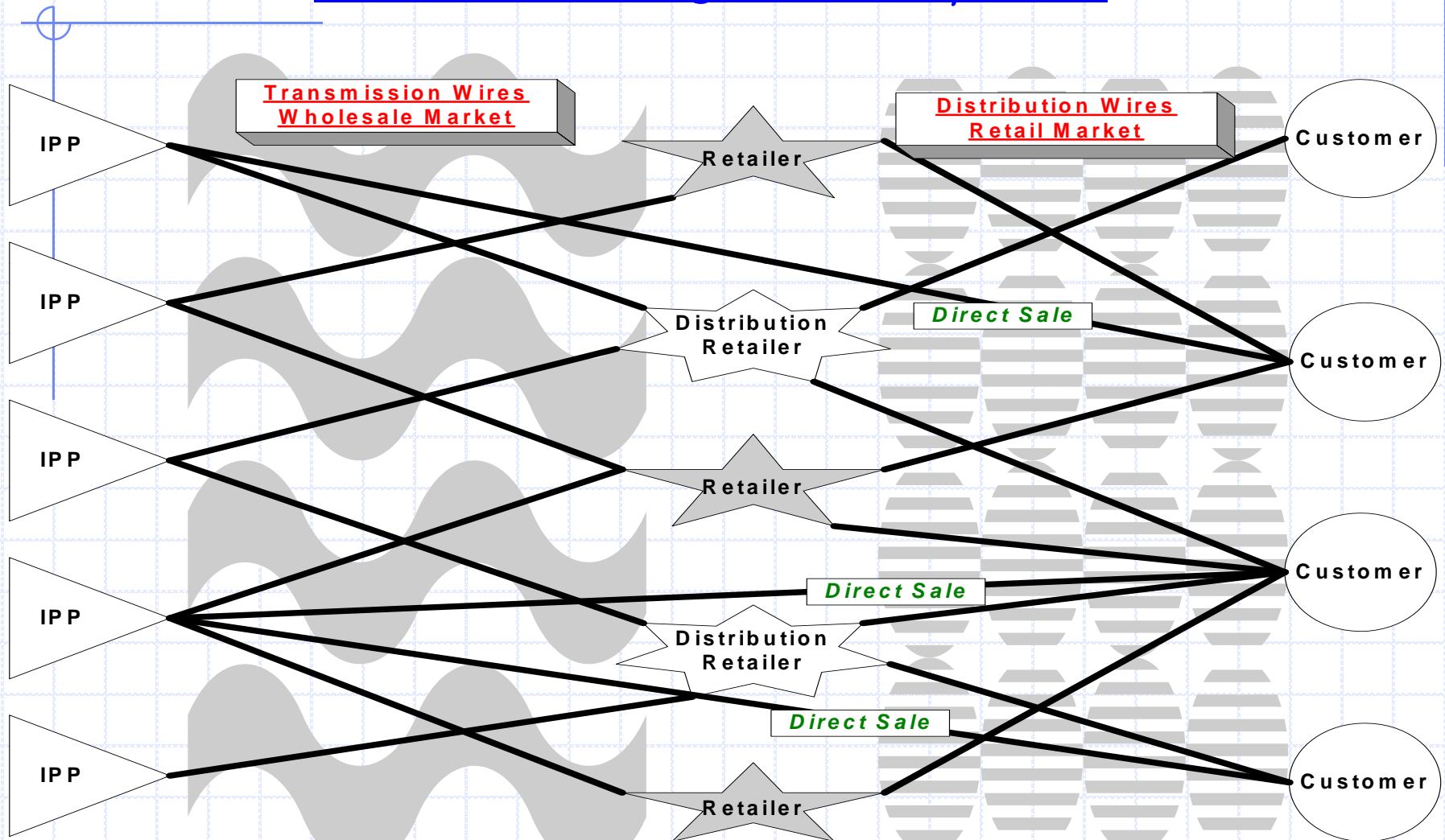
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Resource Planning, Wholesale Competition



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Resource Planning, Retail Competition



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Resource Planning, *Regulated Monopoly*

- ◆ **Most common structure for IRP**
- ◆ **Collaborative process between the utility, industry regulators, government and other stakeholders**
- ◆ **Likely to contribute to improving public acceptance**

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Resource Planning, *Purchasing Agent*

- ◆ **More difficult because costs and benefits occur with different entities**
- ◆ **Success depends on close collaboration between entities**
- ◆ **Regulator faces a more complex situation since distinctly different entities must be monitored**
- ◆ **Elements of IRP likely to become more decentralized and business oriented**

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Resource Planning, *Competition*

- ◆ **More focus on energy commodity price forecasting, risk assessment, risk management**
- ◆ **Results from the planning process are often proprietary**
- ◆ **Separate and understand the business-driven functions and public policy driven functions of integrated planning**
- ◆ **May still be used to specify main guidelines for energy policy and consider longer term aspects of supply, diversification, fuel substitution, conservation and environmental issues**

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Resource Planning Methodology, *The Demand Side*

Load Forecasting Techniques

- Judgmental
- Time Series Analysis
- Trend or Ratio Analysis
- Econometric Analysis
- End-Use Forecasting

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Resource Planning Methodology, *The Demand Side*

Forecast Methodology Options

Judgmental

- Best when clear consensus or authority exists
- Best when trends are regular and predictable
- Lacks detail and documentation supporting assumptions

Time-Series Analysis

- Mathematical extrapolation of historical patterns
- Poor at capturing turning points
- Used mainly for short-term analysis

Ratio or Trend Analysis

- Low cost and data requirements
- Useful for reality checks
- May be too simplistic for complex applications

Econometric

- Equations used to specify important determinants of demand
- Significant theoretical and practical background research
- May require substantial data
- Requires software and analytical expertise

End-Use/Engineering

- Can produce detailed outputs
- Substantial data requirements and cost
- Does not include behavioral

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Resource Planning Methodology, *The Demand Side*

Econometric

- Equations used to specify important determinants of demand
- Significant theoretical and practical background research
- May require substantial data
- Requires software and analytical expertise

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Resource Planning Methodology, *The Demand Side*

Demand Function for Electric Energy

$$Q = f(Y, P_e, P_o, AS, W, T, X)$$

where:

Q = Quantity of Energy consumed

Y = Income

P_e = Price of Electric Energy

P_o = Price of substitute energy sources

AS = Appliance stocks

W = Weather

T = Trends or Tastes

X = Miscellaneous

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Resource Planning Methodology, *The Demand Side*

Difficulties with Estimating Parameters

- Structural Changes in Economy or Power Sector
- Short Time Series of Available Data

Solutions

- Simplified Specification of Demand Equation
- Parameters Substituted from Energy Economics Literature

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Resource Planning Methodology, *The Demand Side*

Elasticity Model

➤ Elasticity = (% Change in Quantity ÷ % Change in Price or Income)

➤ $\% \Delta Q = (\% \Delta P * E_p) + (\% \Delta Y * E_y)$

where: Q = Quantity consumed

P = Price of electricity

E = Elasticity (price or income)

Y = Income (GDP)

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Resource Planning Methodology, *The Demand Side*

Logarithmic Partial Adjustment Model

- Accounts for Time Lags
- Estimates Constant Elasticities

Model Specification

$$\ln Q_t = (E_y * \ln Y_t) + (E_p * \ln P_{et}) + (a * \ln Q_{t-1})$$

where:

- ln = natural logarithm
- t = time period t
- t-1 = previous time period
- a = adjustment parameter

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Resource Planning Methodology, *The Demand Side*

Elasticities

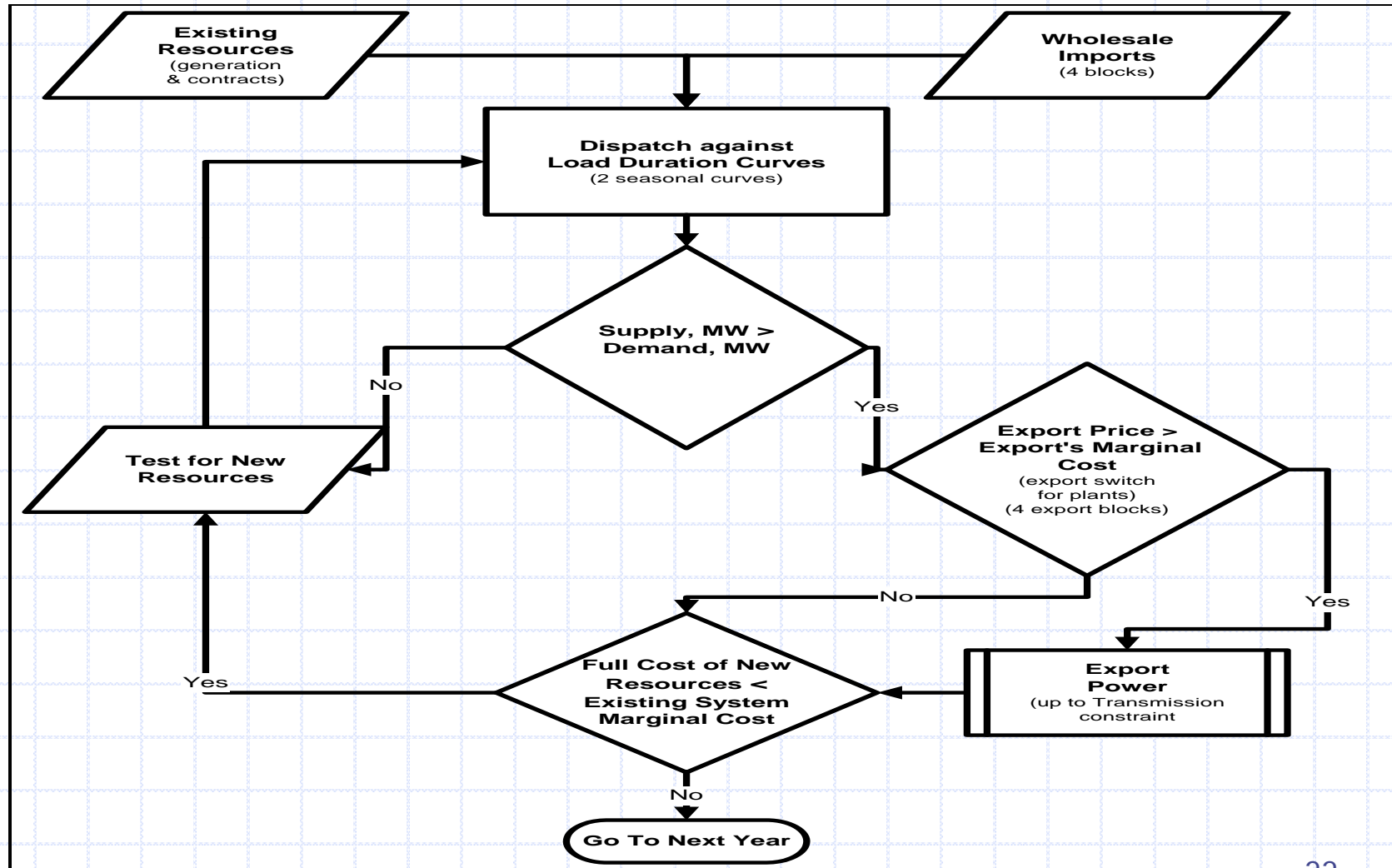
Based on literature search of energy economics literature

Adjustments made to agree for comparable situations and future outlook

	Price Elasticity		Income Elasticity		Adjustment Coefficient
	Short Run	Long Run	Short Run	Long Run	
Residential	-0.20	-0.50	0.24	0.60	0.40
Industrial	-0.16	-0.40	0.36	0.90	0.57
Agricultural	-0.16	-0.40	0.36	0.90	0.57
Other	-0.20	-0.50	0.24	0.60	0.40

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Resource Planning Methodology, *The Supply Side*



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Resource Planning, *Supply Side Inputs*

◆ Existing Resources

- **Capacity**
- **Heat Rate**
- **Maintenance Outage Rate**
- **Forced Outage Rate**
- **Fuel Cost (variable or contract)**
- **Variable Operation and Maintenance**
- **Fixed Operation and Maintenance**
- **Must Run Status**
- **Operating Life**

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Resource Planning, *Supply Side Inputs*

◆ New Resources

- **Capacity**
- **Heat Rate**
- **Maintenance Outage Rate**
- **Forced Outage Rate**
- **Fuel Cost (variable or contract)**
- **Variable Operation and Maintenance**
- **Fixed Operation and Maintenance**
- **Must Run Status**
- **Operating Life**

- **Weighted Cost of Capital (calculated)**
- **Interest during construction and during operation**
- **Construction timing and schedule**

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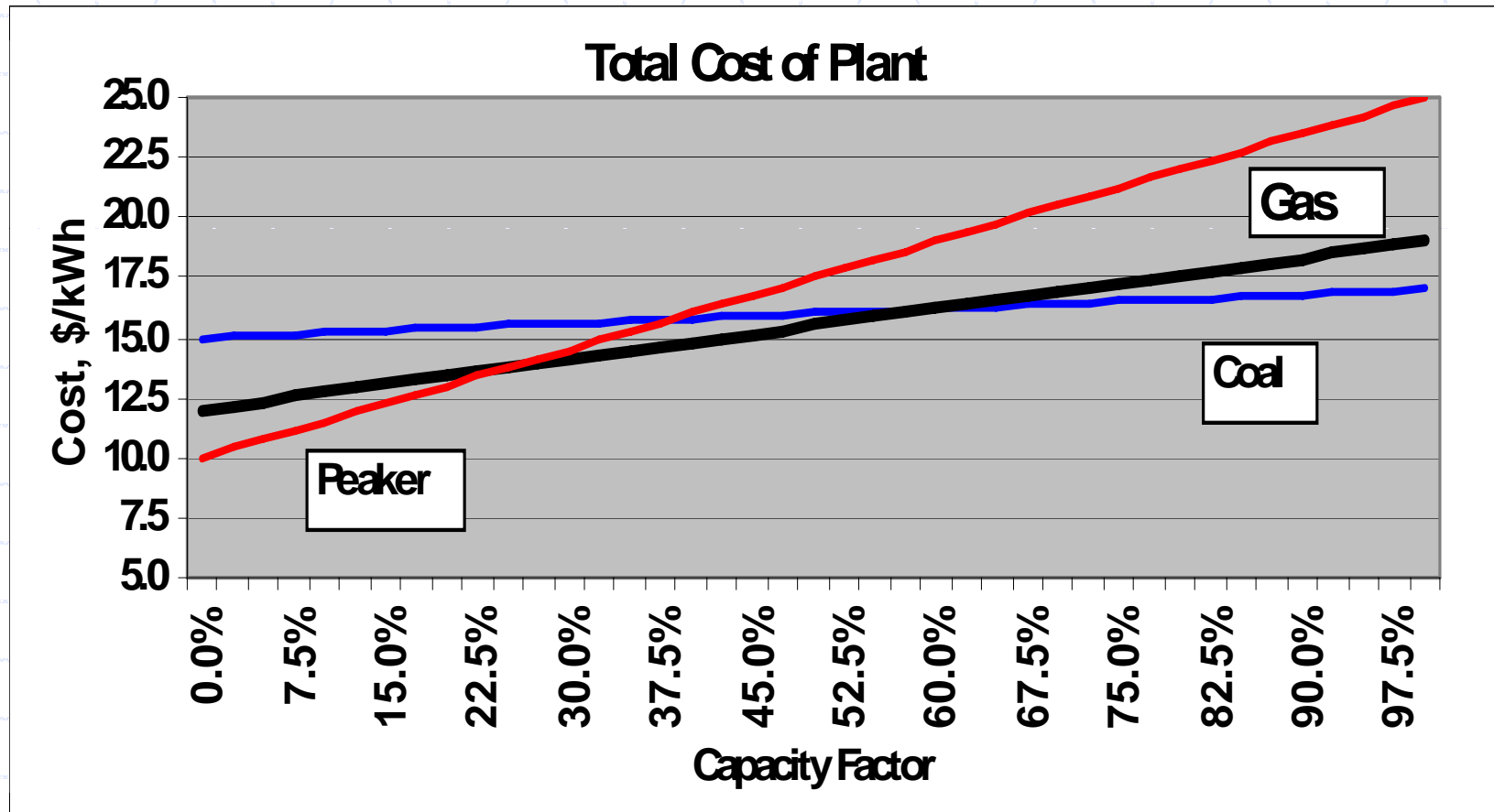
Resource Planning, *Supply Side Inputs*

◆ **Contracts**

- **Capacity**
- **Variable cost**
- **Fixed Cost**
- **Contract Term**

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Resource Planning, Supply Side Summary

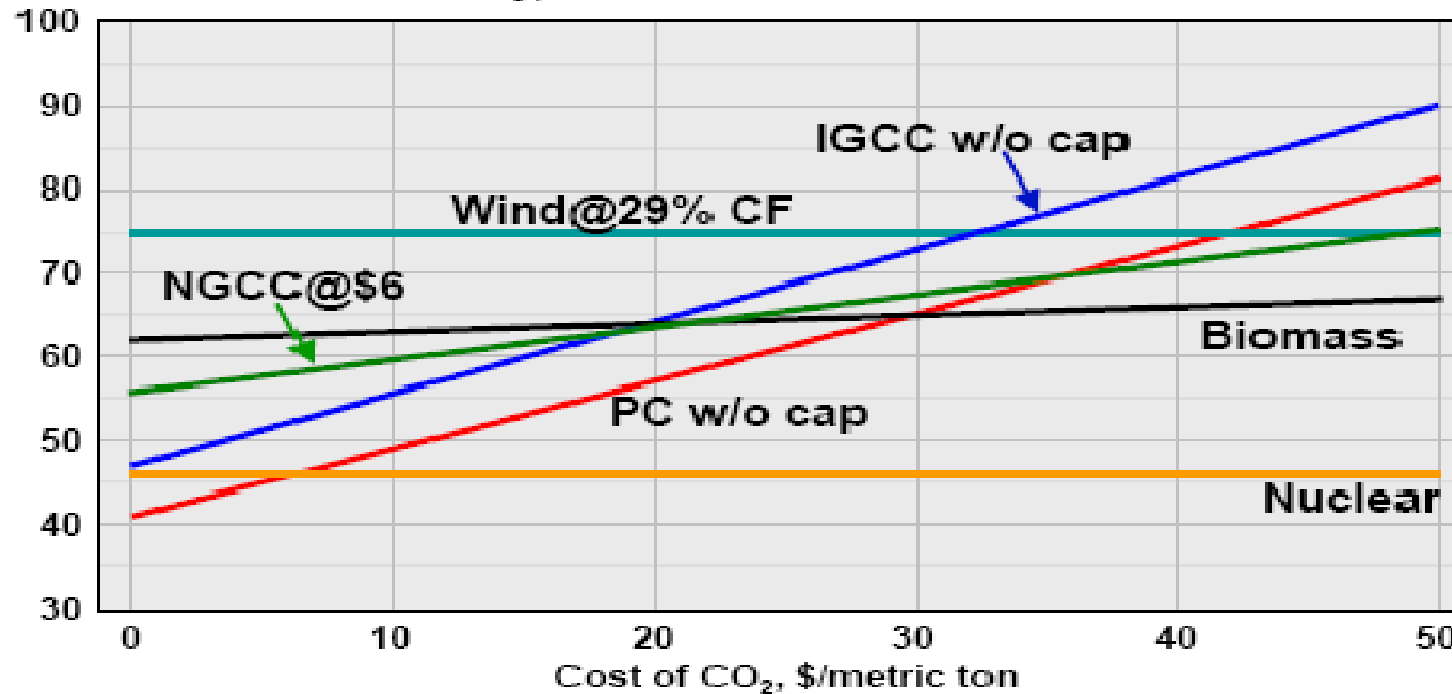


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Resource Planning, Supply Side Summary

Comparative Costs in 2010

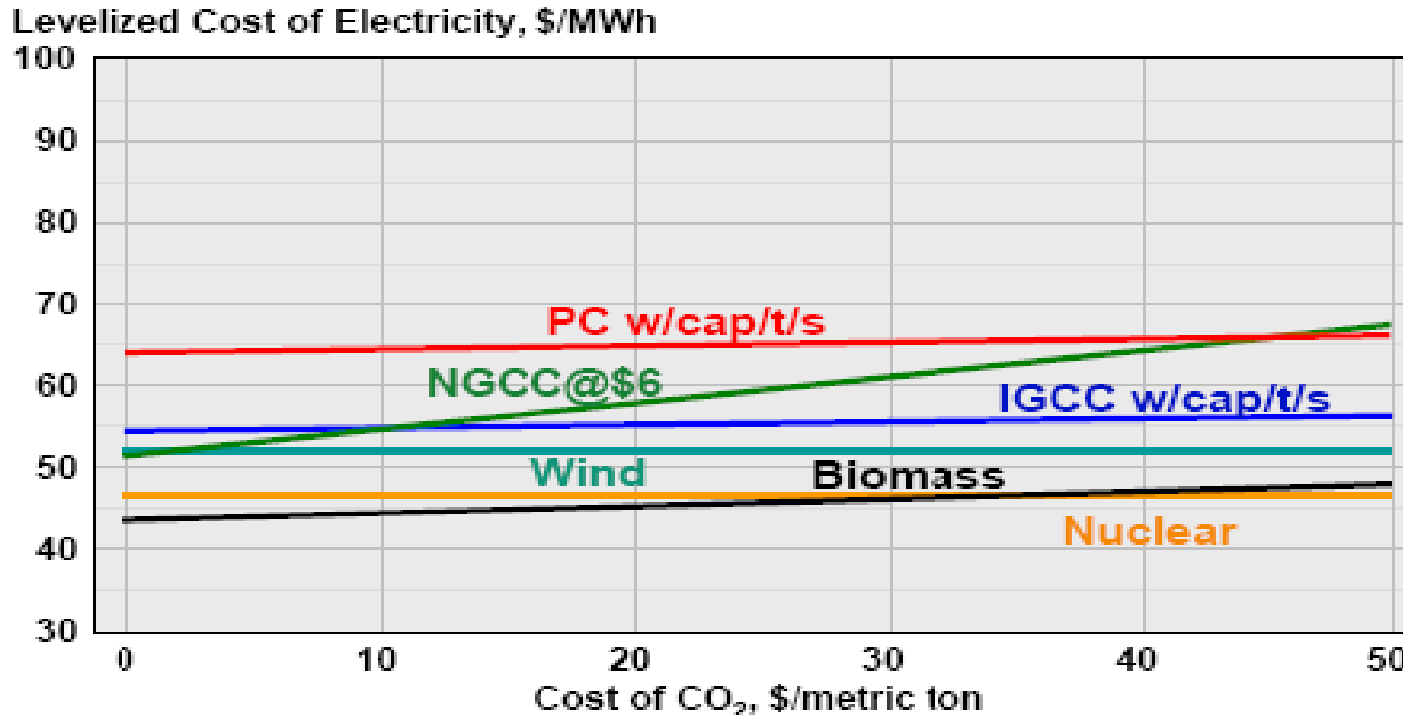
Levelized Cost of Electricity, \$/MWh



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Resource Planning, Supply Side Summary

Comparative Costs in 2020

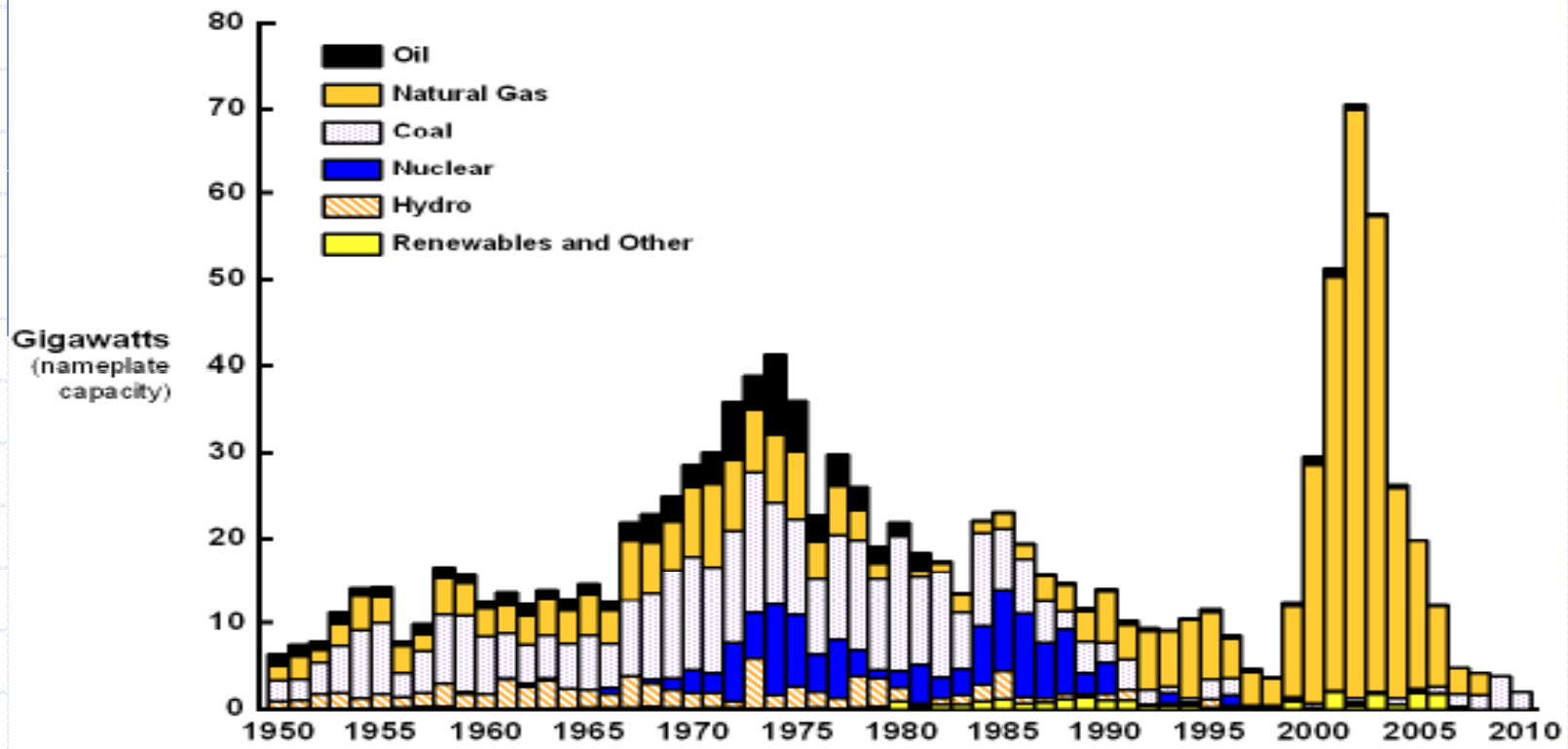


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Resource Planning, *The Supply Side, Real World Results*

Figure 1

US Capacity Additions, 1950–2010



Source: Cambridge Energy Research Associates, 50512-9_0525

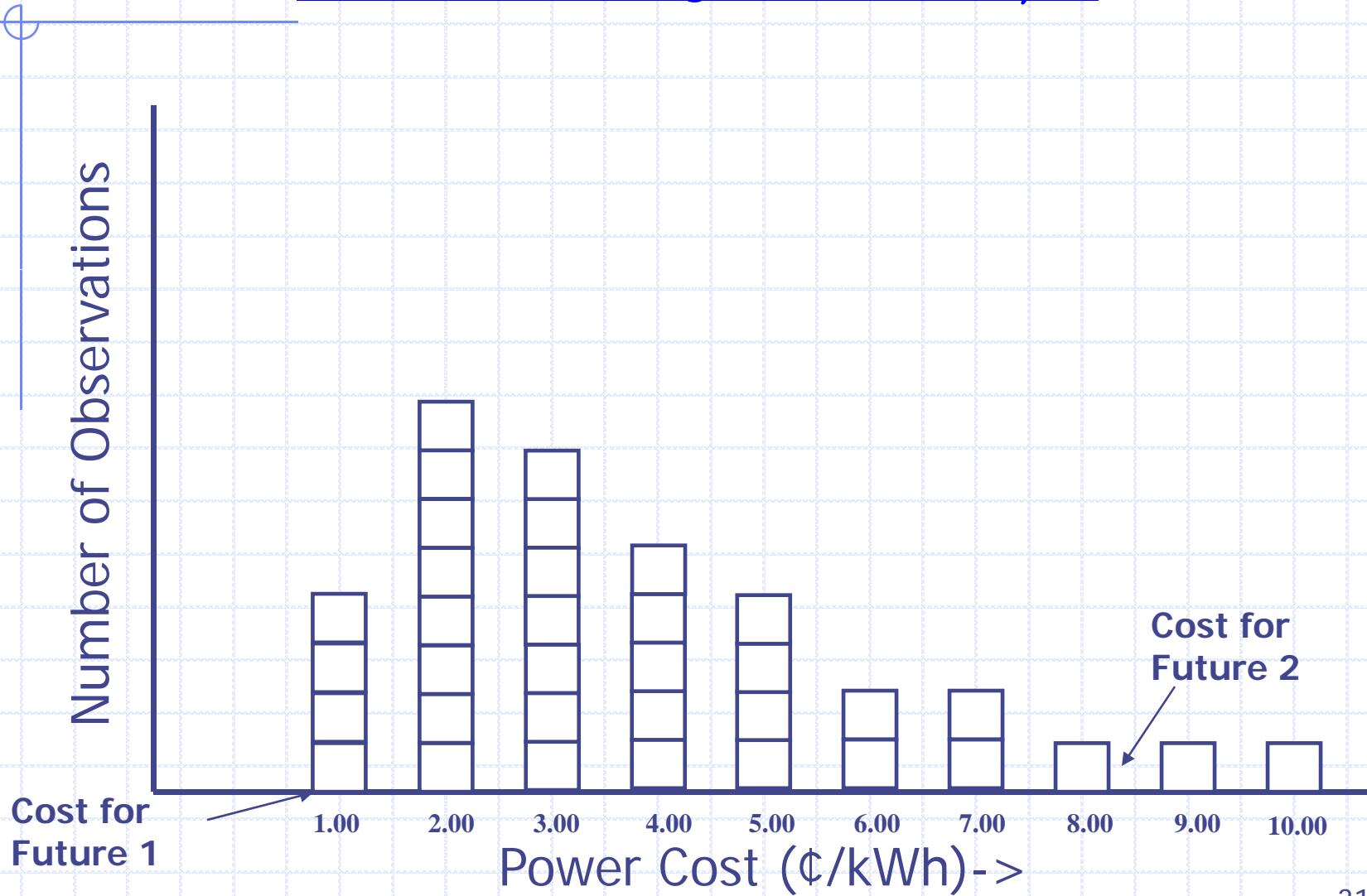
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Resource Planning, Portfolio Analysis

	Umbrella Manufacturer	Resort Owner	Combined Portfolio
Rainy Season	50%	-25%	12.5%
Sunny Season	-25%	50%	12.5%
Average Return	12.5%	12.5%	12.5%
Std Dev	0.53	0.53	0.00

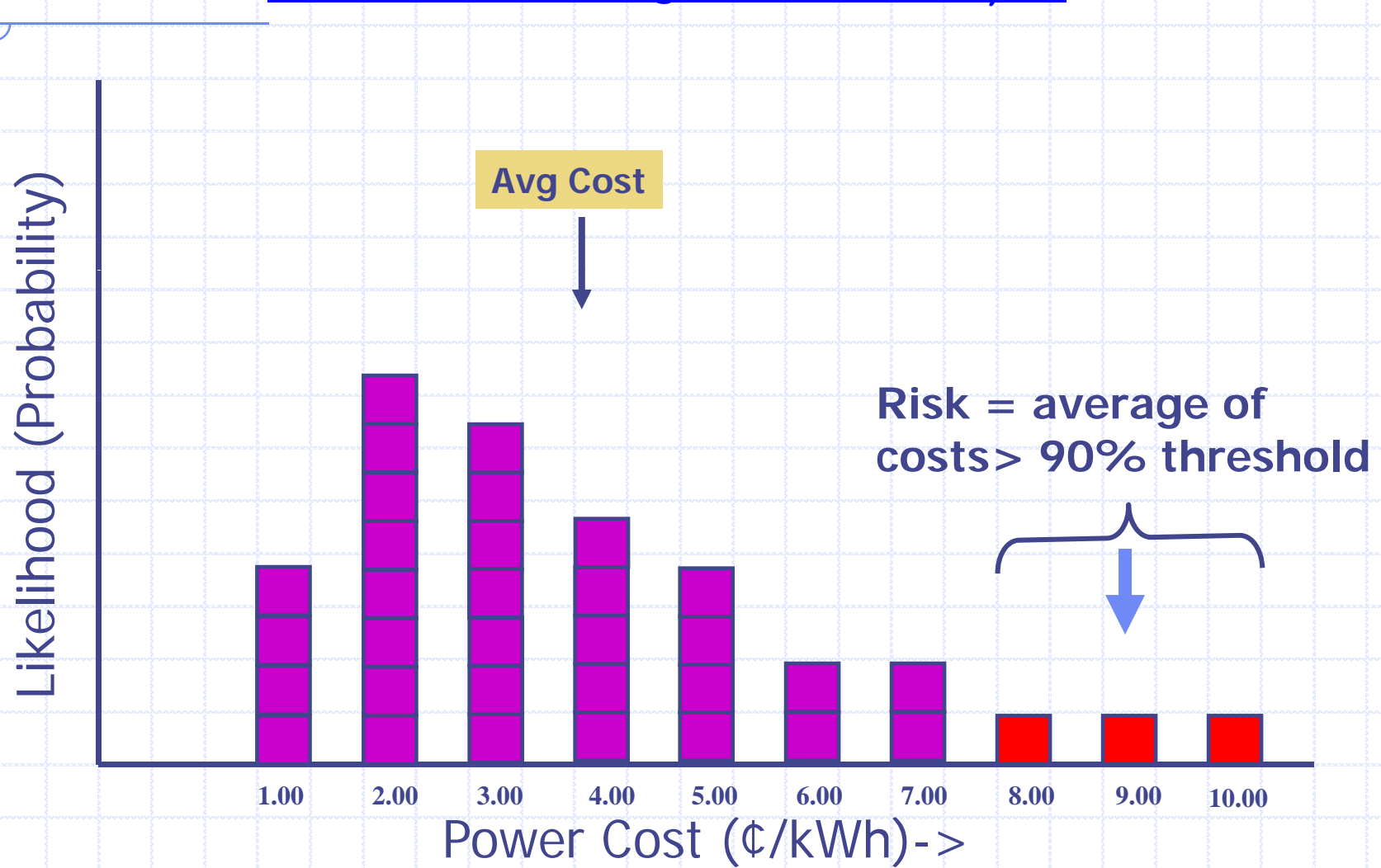
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Resource Planning, Portfolio Analysis



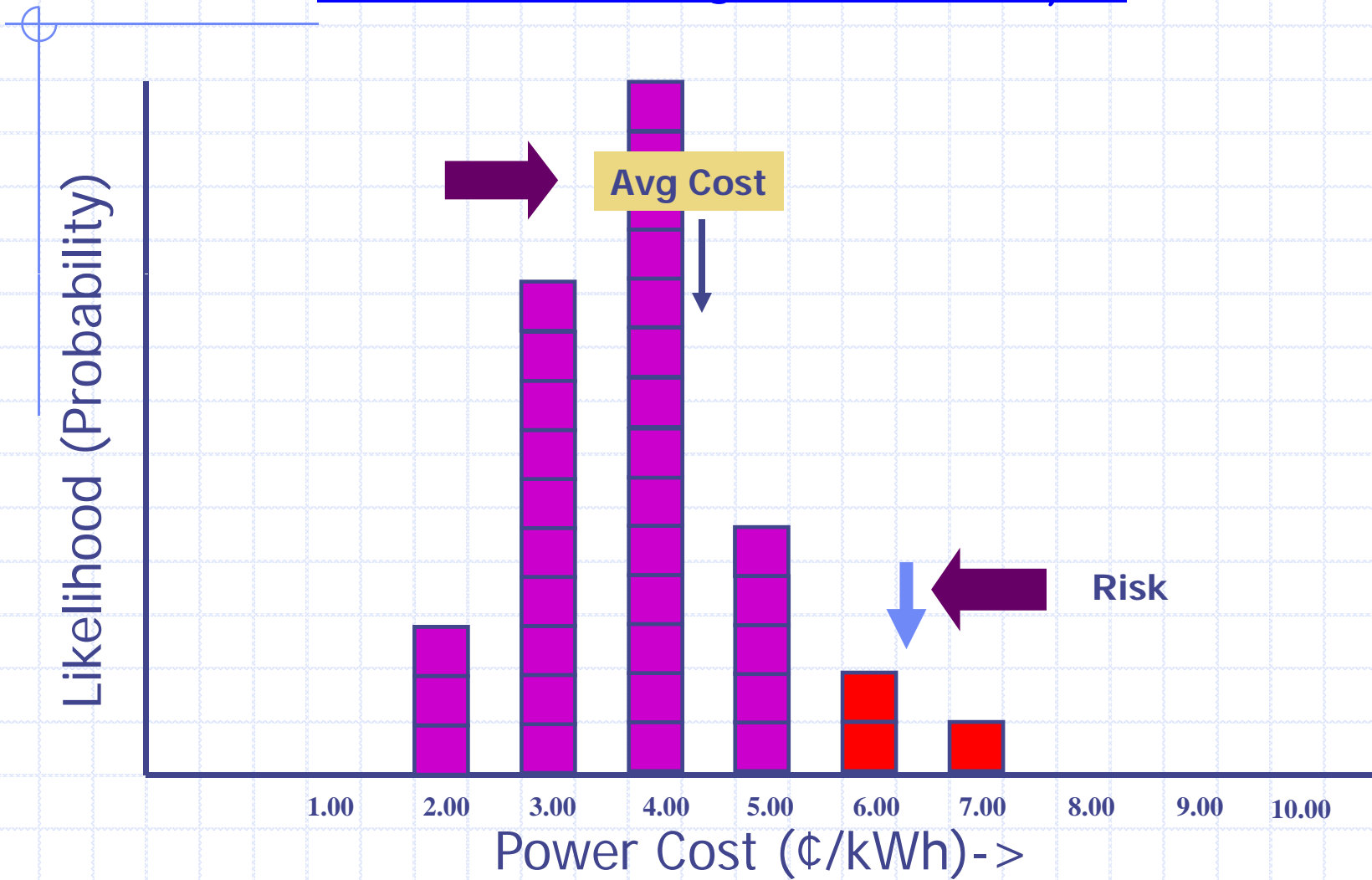
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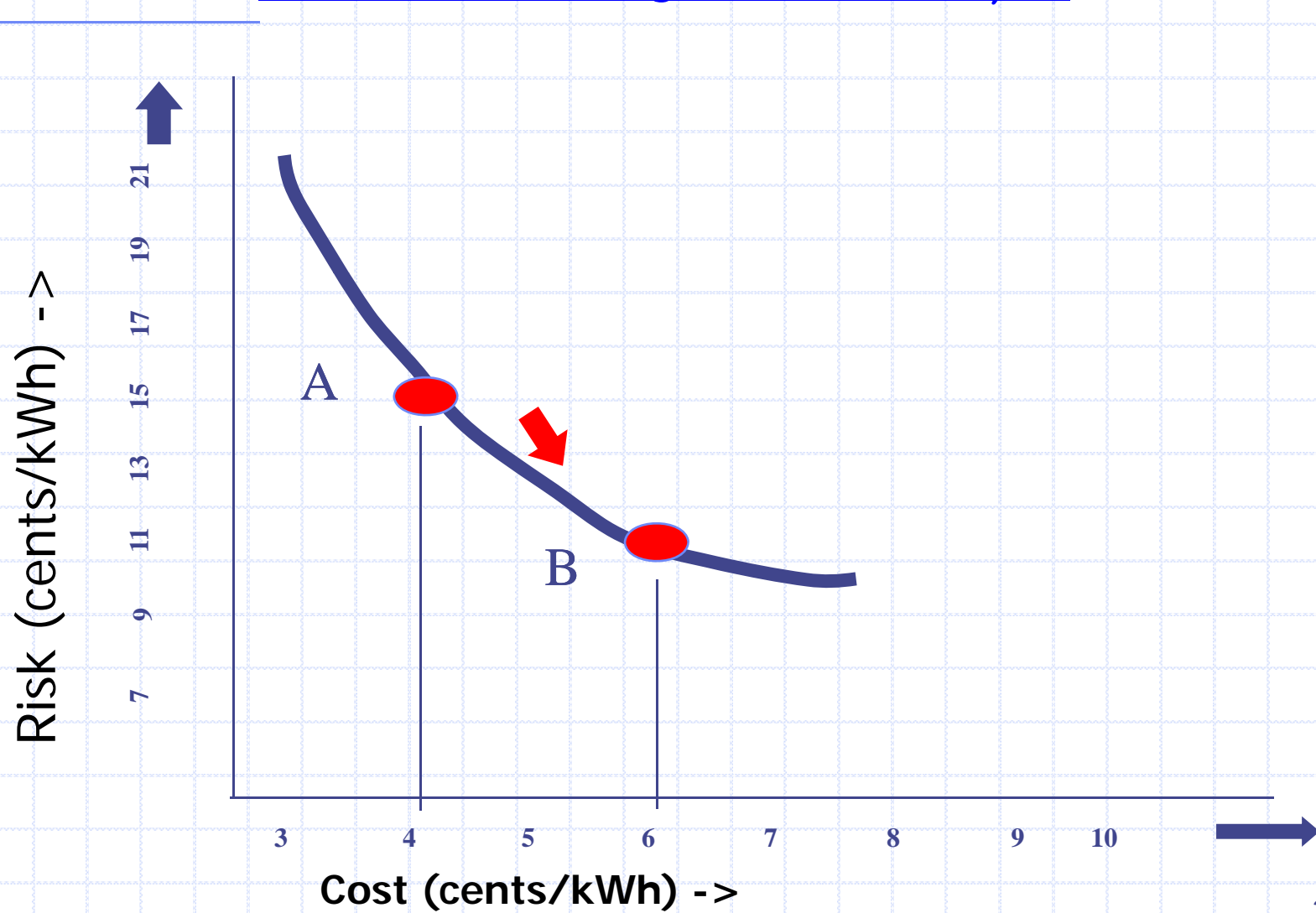
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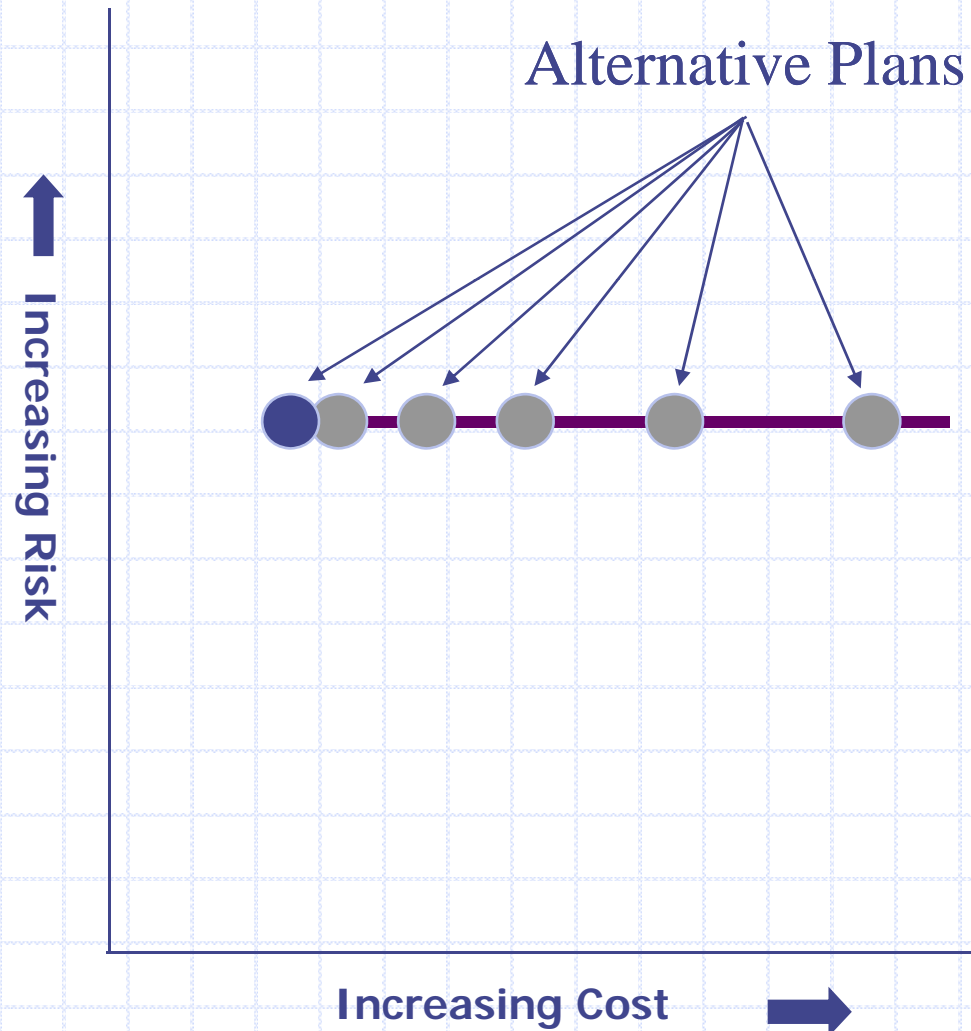
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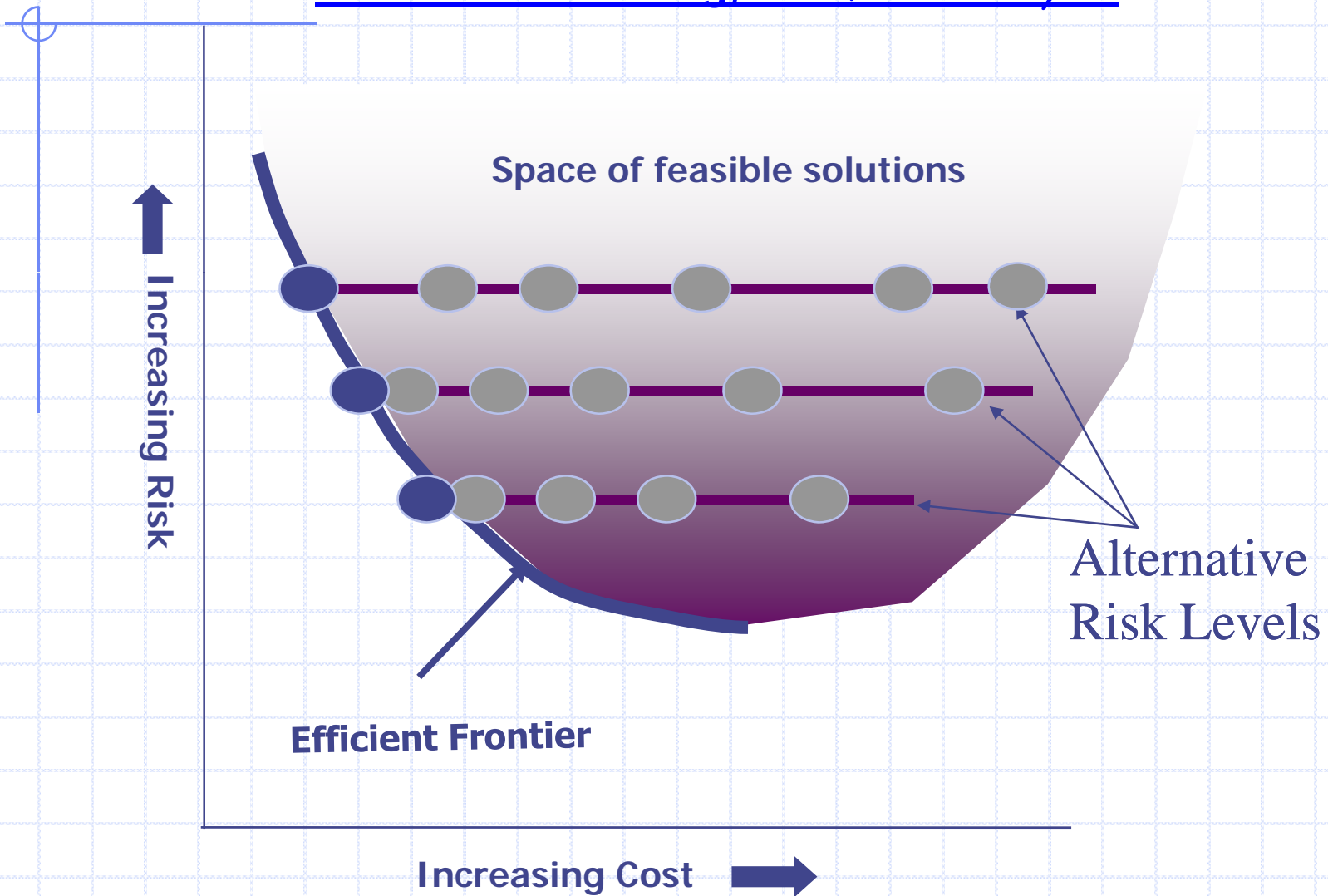
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Resource Planning, *Portfolio Analysis*



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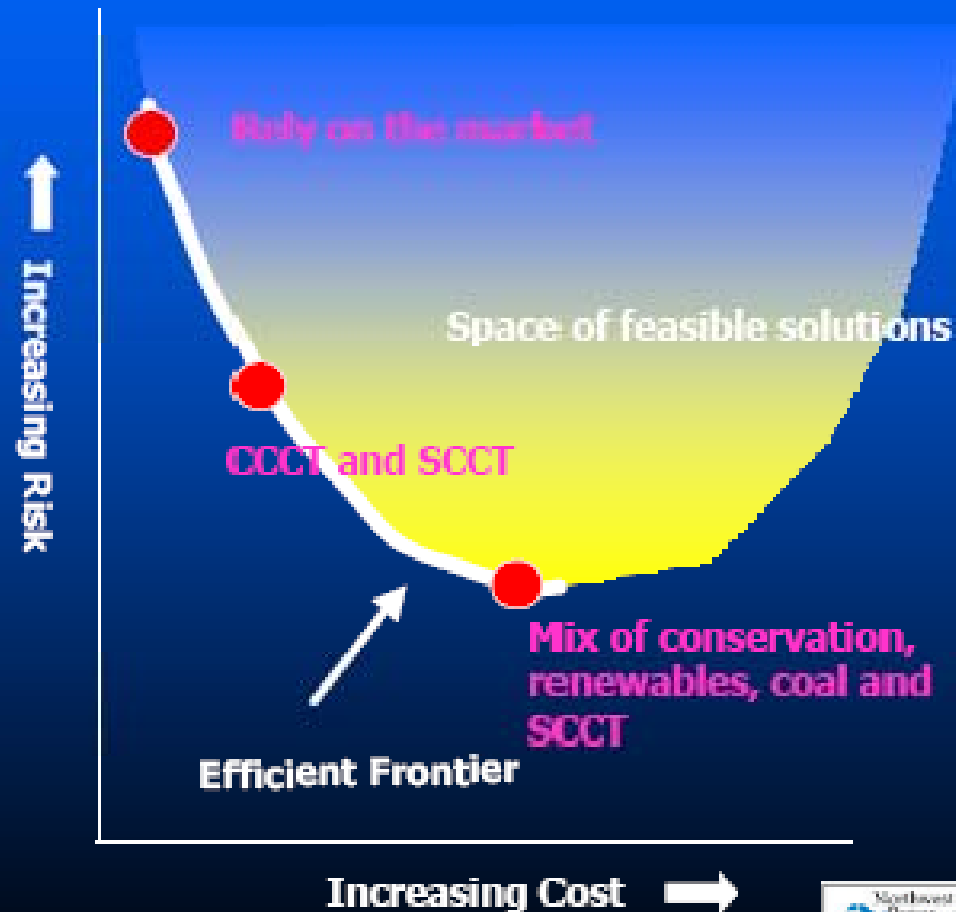
Resource Planning, Portfolio Analysis



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Resource Planning, Portfolio Analysis

■ Fixed cost, low fuel risk resources tend to minimize risk, at increased cost



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Cost-Risk Trade-off

