Overview:

Elements of Energy Forecasting

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Energy and Environmental Systems Engineer

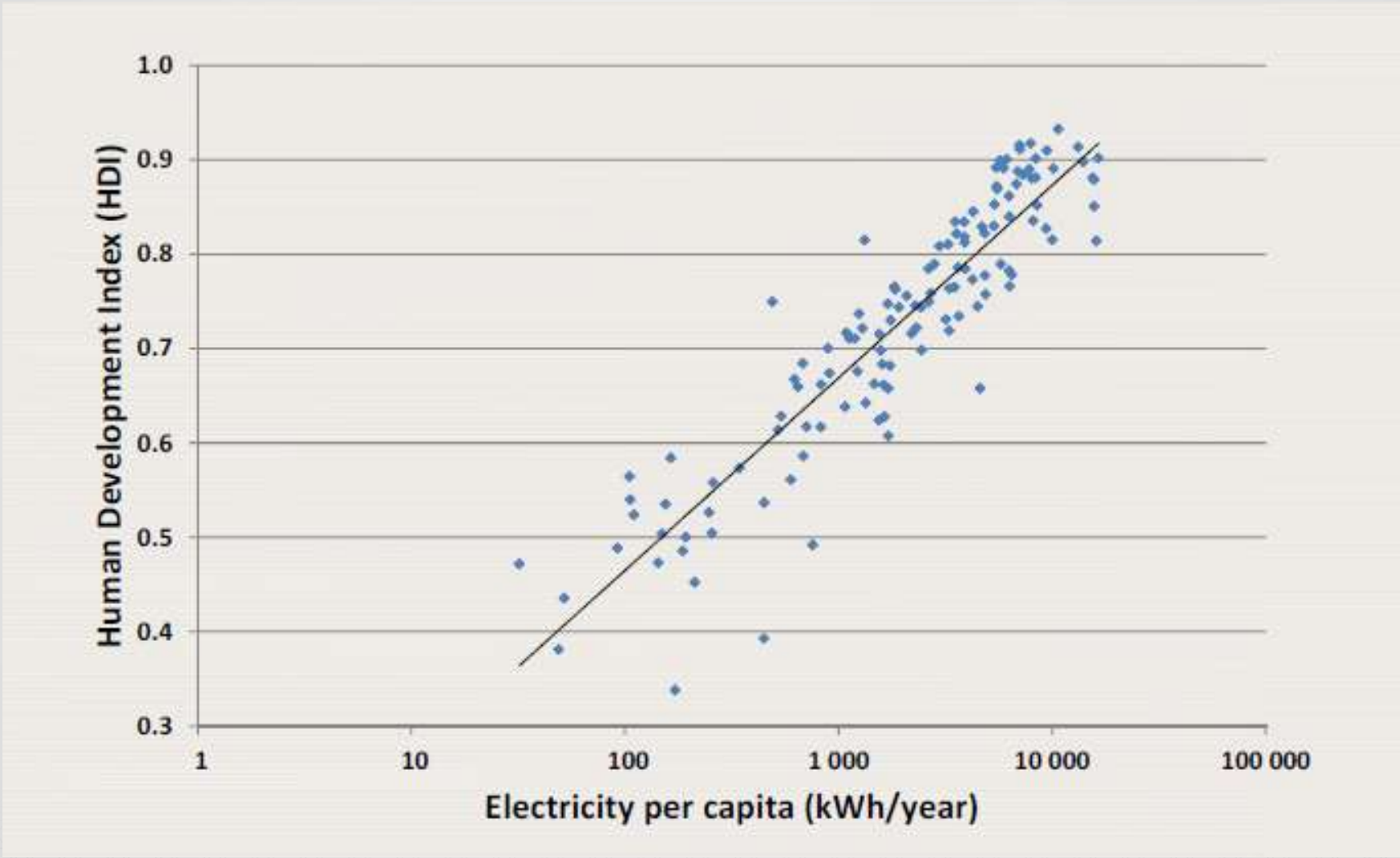
Introduction – Bruce Hamilton

- **1985-1995 Argonne National Laboratory**
  - Developed PC version of WASP
  - National Studies and International Training on Power System Planning
- **1995-2000 International Atomic Energy Agency**
  - Head of Energy Modeling , Databanks and Capacity Building Unit
  - Regional and National Technical Cooperation Projects
- **2000-2015 ADICA**
  - Energy and Power System Studies for ADB, JICA, World Bank, …
- **2015-Present Argonne National Laboratory**
  - Risk Informed Decision Making for Improved Energy Policy, Investment and Operations

Topics of Discussion

1. Importance of Energy
2. Role of Energy Planning
3. Energy Planning Process
4. Elements of Energy Forecasting and Analysis
5. Conclusions – Key Considerations and Potential Solutions

ENERGY IS A KEY INPUT FOR SOCIO-ECONOMIC DEVELOPMENT



ROLE OF ENERGY PLANNING

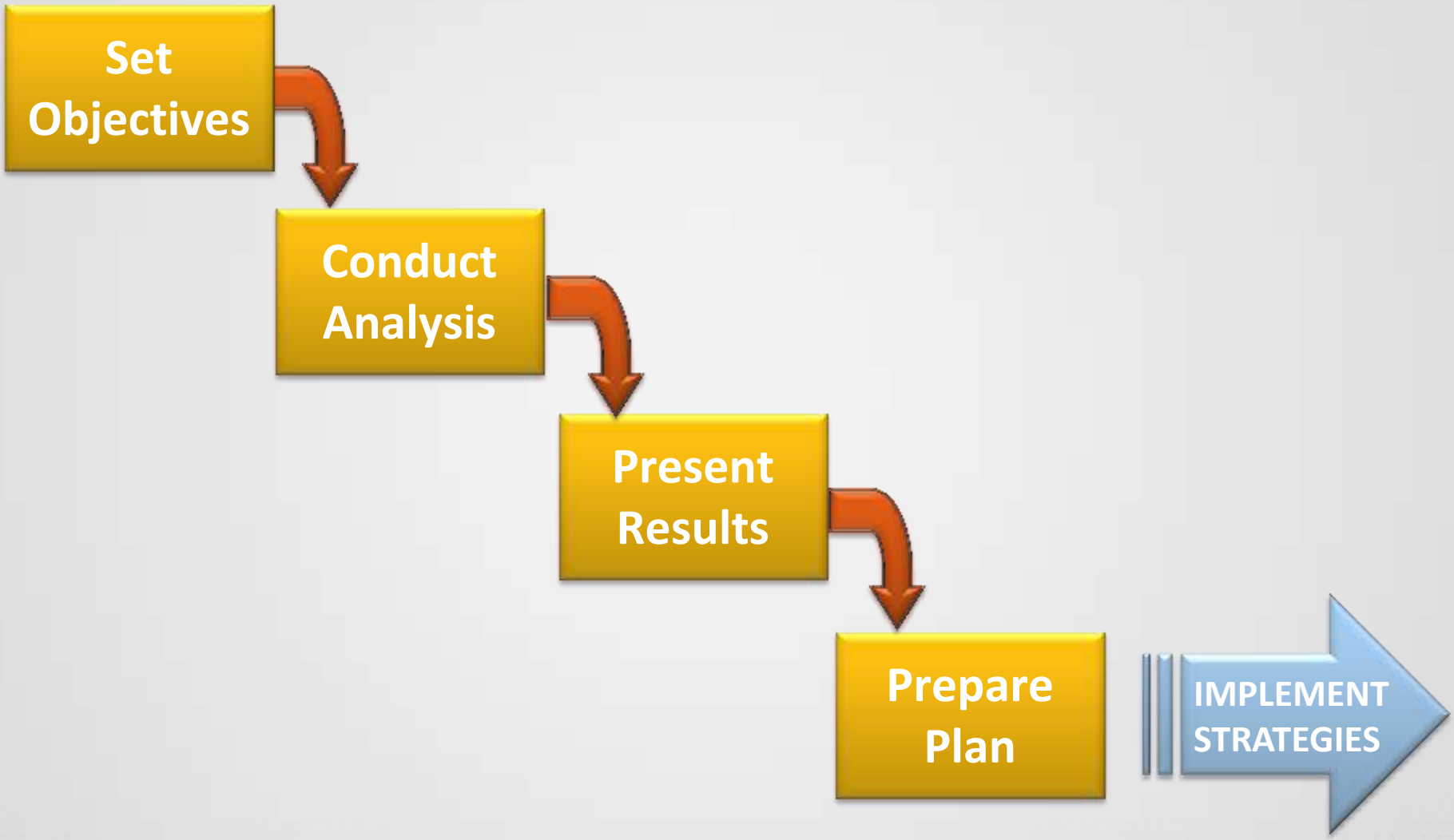
- **Government – Policy and Regulation Setting**
  - National (Taxes and incentives, emissions limits)
  - Regional (Transmission, reliability, energy markets)
  - State (Rates, taxes, Renewable & Demand Side Management goals)
  - Local (Codes, permitting, zoning requirements)

- **Utility – Investment and Operation Decision-Making**
  - Receive Input from Stakeholders (Government, Customers, Shareholders)
  - Define Corporate Mission
  - Receive information to support decision making
  - Make decisions on strategies for investment and operations

- **Energy Planning – Contributes to Informed Judgments**

  Energy planning involves analysis of the energy system with the intent of providing decision makers information that will enable them to make informed judgments on strategies needed to meet current and future energy objectives

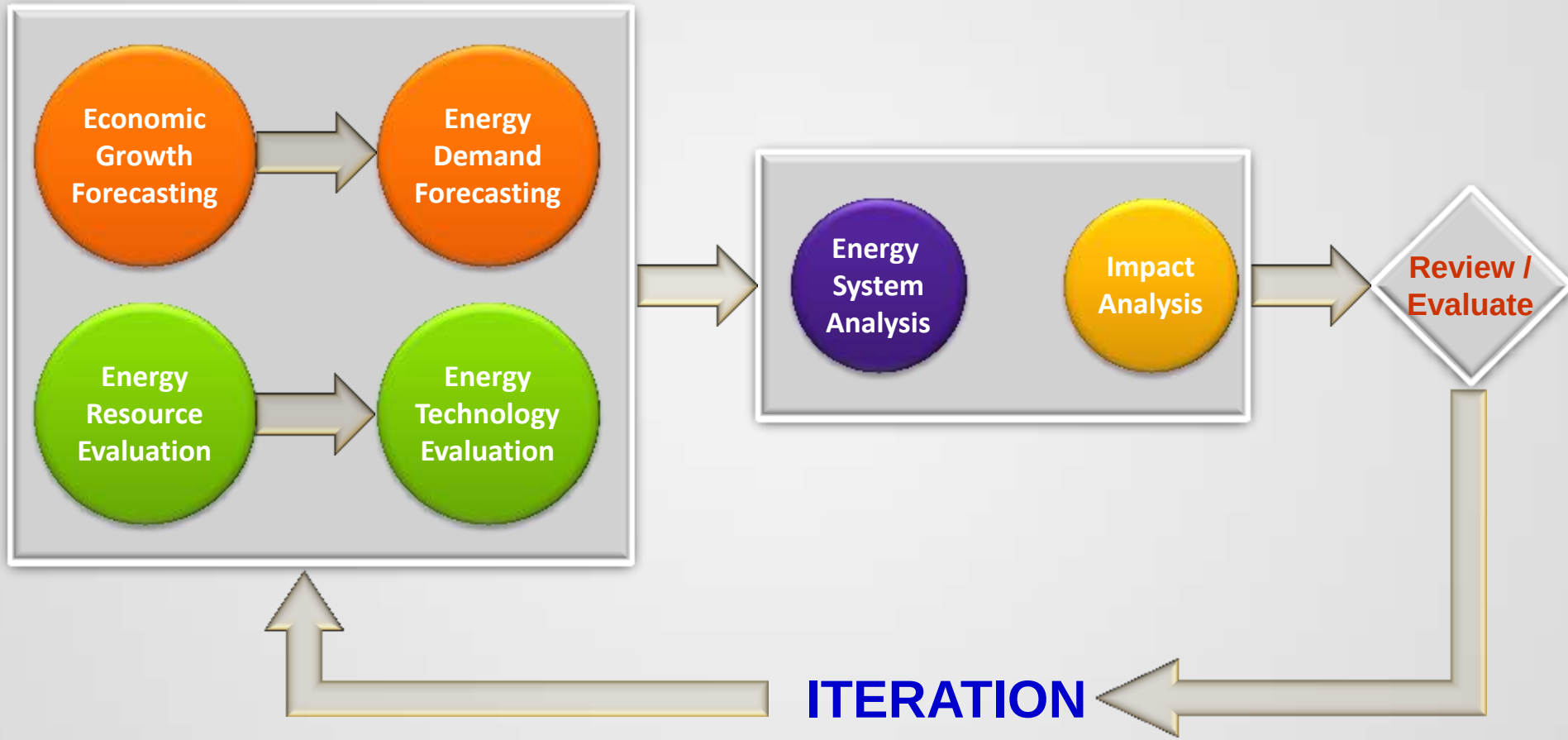
ENERGY PLANNING PROCESS



OBJECTIVES – SHOULD BE CLEARLY SPECIFIED AND MEASURABLE

1. **Available**
   - **Adequate supply** — *Meet 100% of projected demand*
   - **Reliable** — *Electric loss of load probability of 1%*
   - **Secure** — *75% from domestic sources*
   - **Sustainable** — *25% from renewable resources*
2. **Affordable**
   - **To consumers** — *Maximum of 15% increase in prices*
   - **For businesses** — *All energy companies profitable*
3. **Acceptable**
   - **Environmentally safe** — *0% increase in CO_2 emissions*
   - **Publicly acceptable** — *No licensing objections*

ELEMENTS OF ENERGY FORECASTING AND ANALYSIS



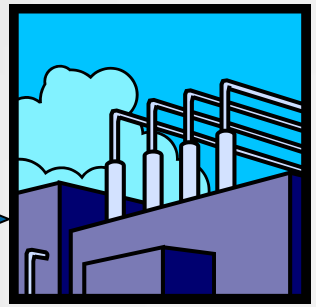
THE ENERGY CHAIN

Mine, Well
Import

Electrical Plant,
Refinery

Transmission lines,
Pipelines

Consumer



Extraction

Conversion

Transmission /
Distribution

Conversion

RESOURCES

PRIMARY

- coal
- oil
- natural gas

SECONDARY

- diesel
- kerosene
- electricity

FINAL

- diesel
- kerosene
- electricity
- natural gas

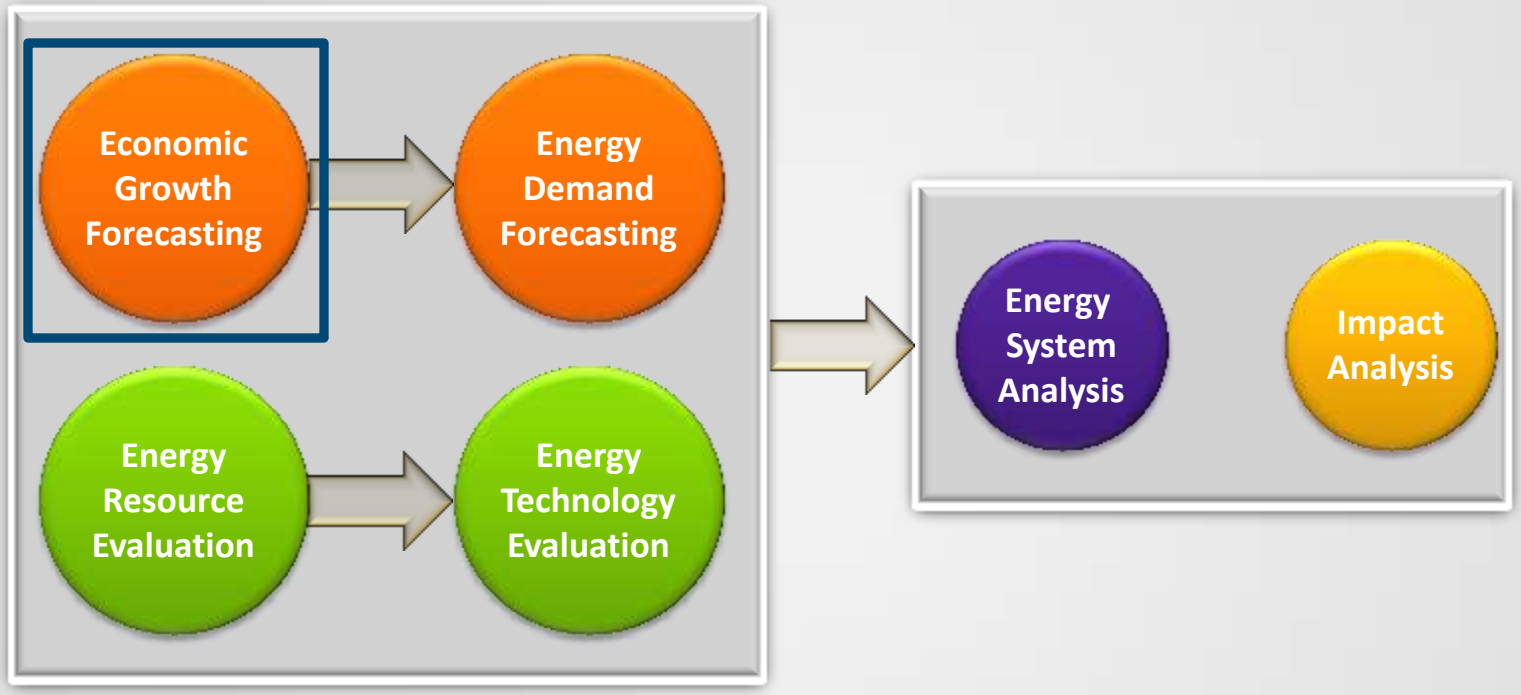
USEFUL

- heat
- light
- mechanical energy

Energy Resource and Technology Evaluation

Energy Demand Forecasting

ENERGY FORECASTING AND ANALYSIS

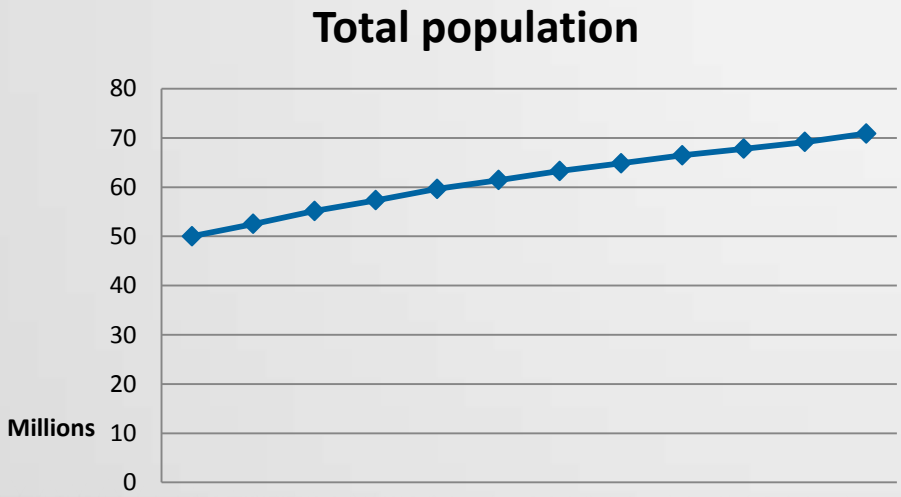


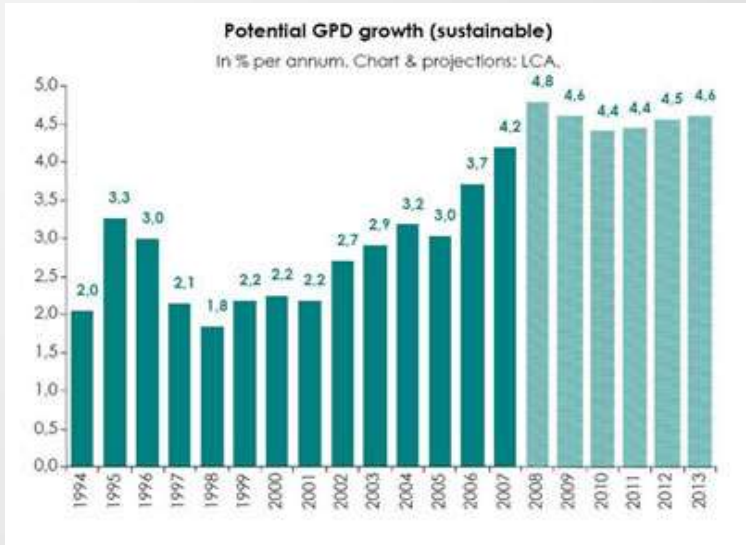
SOCIO-ECONOMIC ANALYSIS

Economic Growth Forecasting

Determine the Level and Pattern of Growth

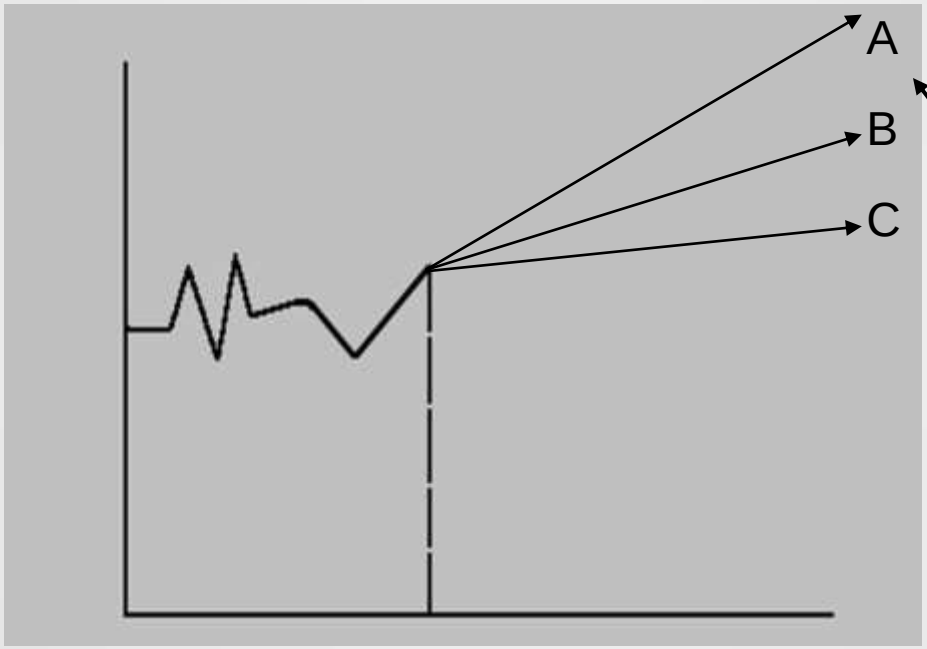
- Population growth
- Economic development
- Structural changes effecting energy





ECONOMIC GROWTH FORECASTING

GDP, Population, etc.

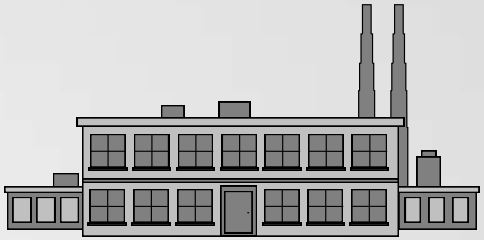


Scenarios can be used to address uncertainty

ENERGY DEMAND FORECASTING

Energy Demand Forecasting

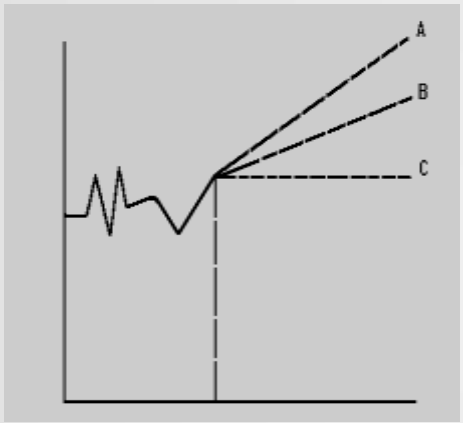
- Industry
- Residential
- Services
- Transport
- Agriculture
- etc.



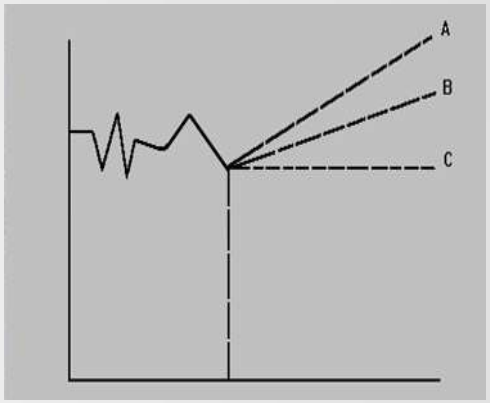
ENERGY DEMAND FORECASTING

Translates the economic and demographic growth scenarios into energy demand growth projections

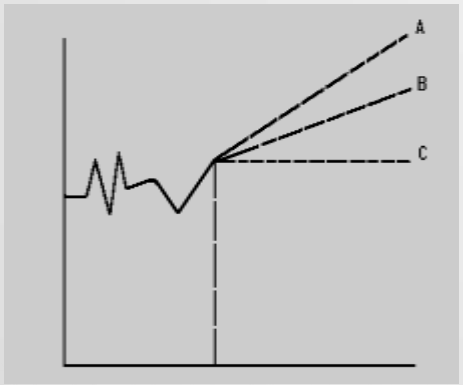
GDP Growth



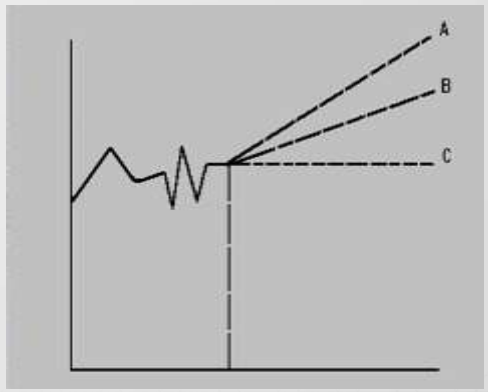
<u>Industrial Energy Demand</u>
Steel
Cement
Food Processing
etc.



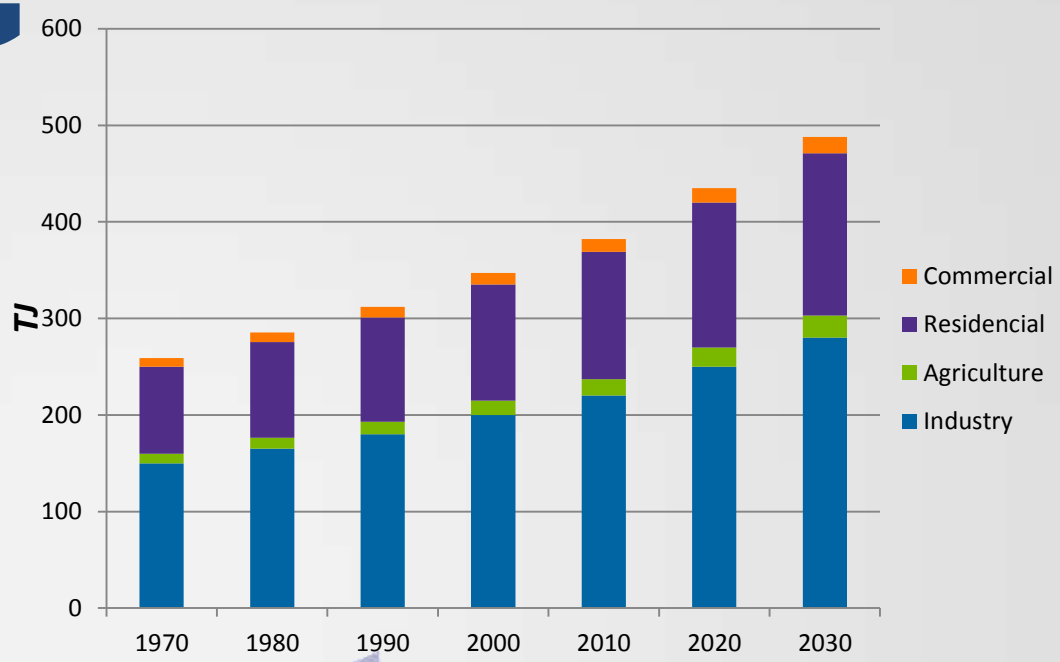
Population Growth

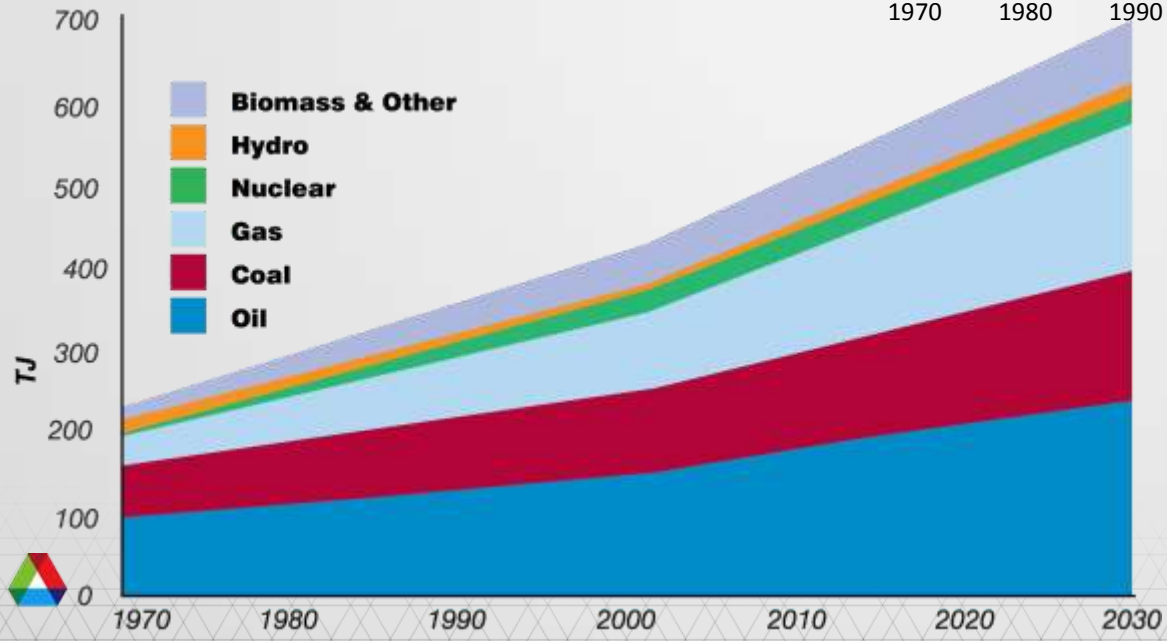


<u>Residential Energy Demand</u>
Heating
Cooling
Lighting
Refrigeration
etc.

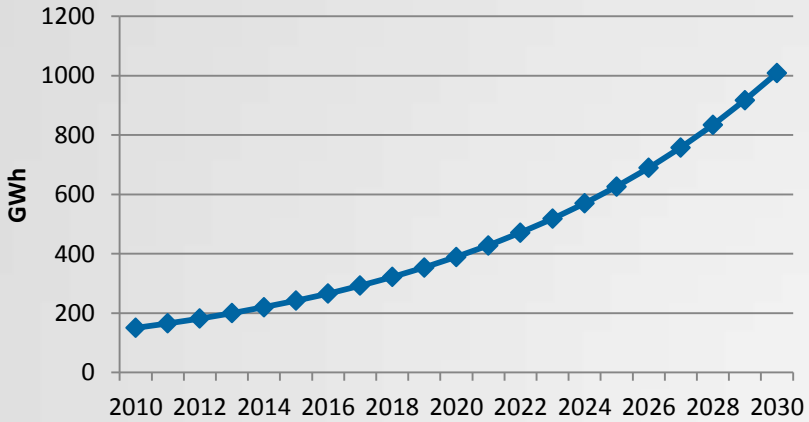


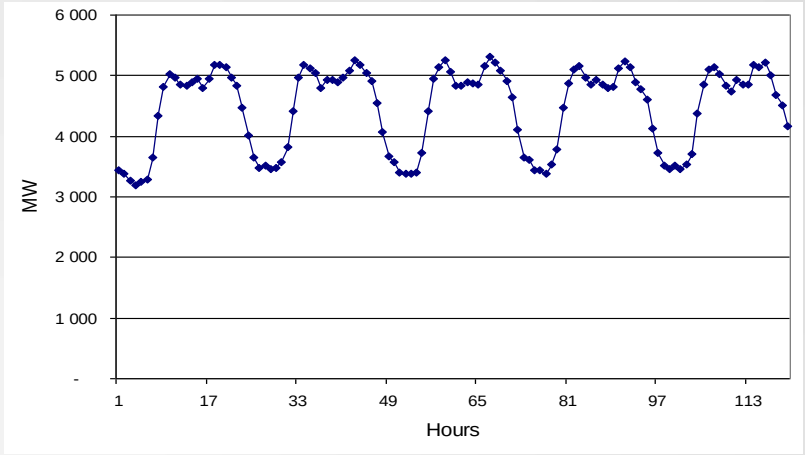
ENERGY DEMAND FORECASTING

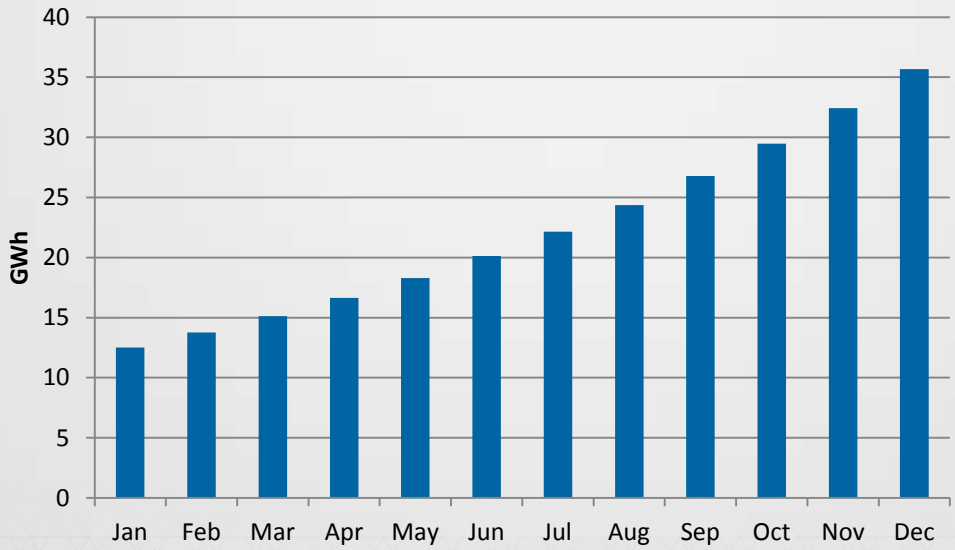




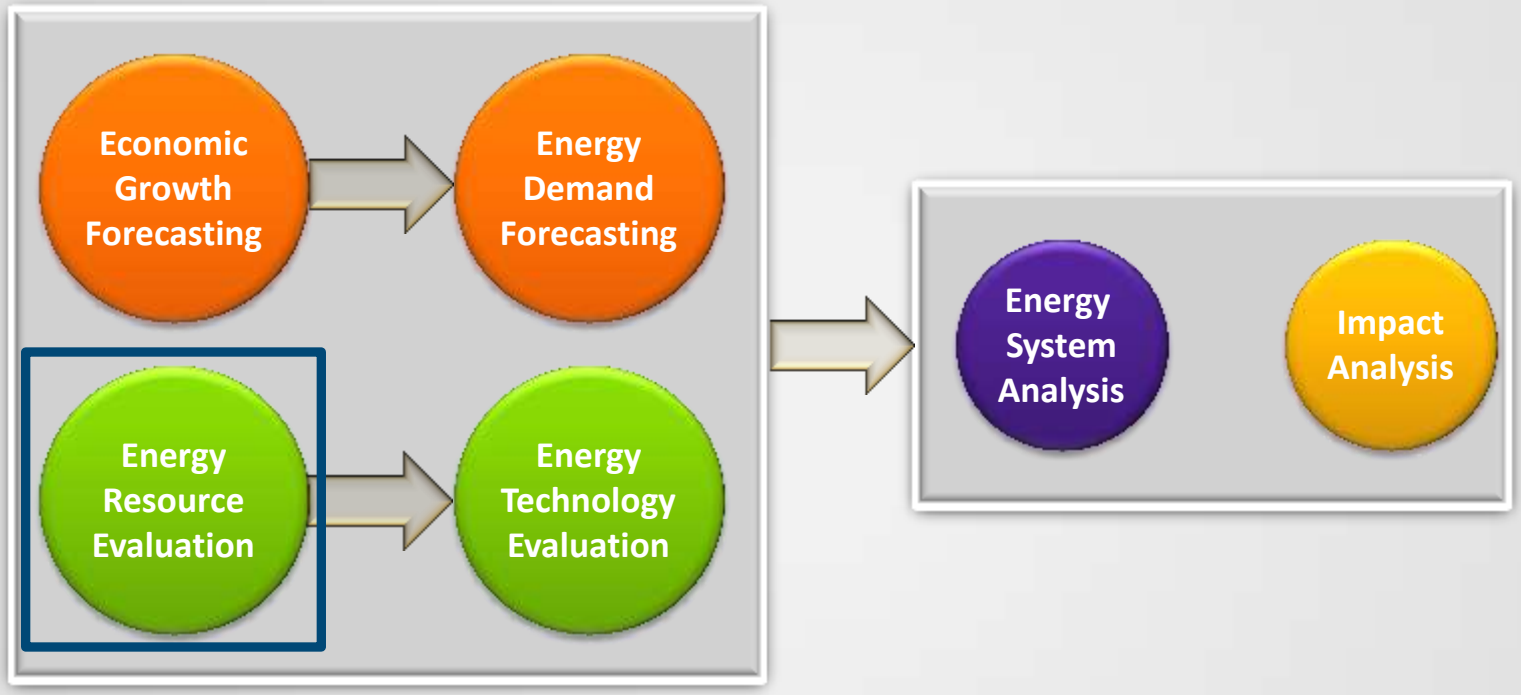
ELECTRICITY LOAD FORECASTING



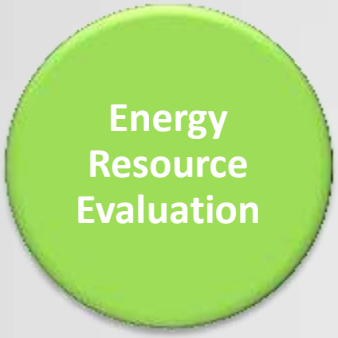




ENERGY FORECASTING AND ANALYSIS



ENERGY RESOURCE EVALUATION



Fossil Fuels:

- Coal
- Oil
- Natural Gas

Renewables:

- Solar
- Wind
- Biomass
- Hydro

How much is there in my country?

Which part of it is economically recoverable?

Can I import what I'm missing?

ENERGY TECHNOLOGY EVALUATION

Energy Technology Evaluation

- Assess Current System
- Foresee Planned Additions/Retirements
- Evaluated New Technology Options

Oil Production

Petroleum Refining

Pipelines

Biomass Cultivation

Ethanol Production

Consumers

COMPARE ALTERNATIVE ENERGY TECHNOLOGIES

Energy technologies must be characterized in a consistent manner, to allow for comparison of alternatives

Technical Performance

- **Efficiency**
- **Availability**
- **Reliability**

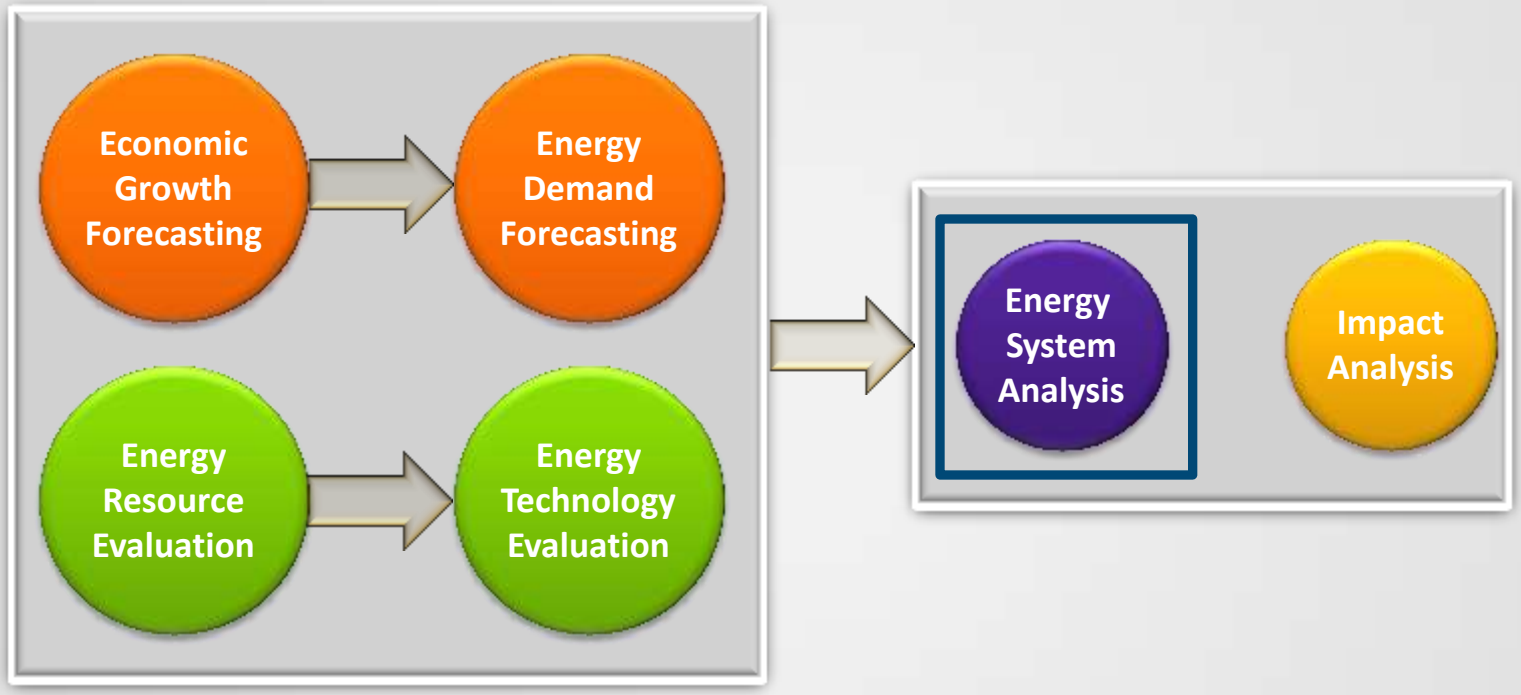
Economics

- **Capital Costs**
- **Fuel Costs**
- **Operating Costs**

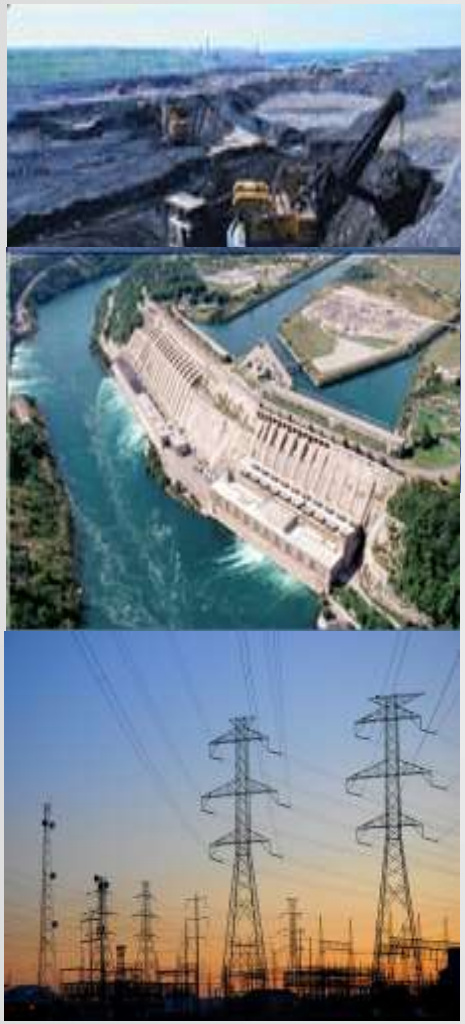
Environmental

- **Emissions, Residuals**
- **Water, Land Use**

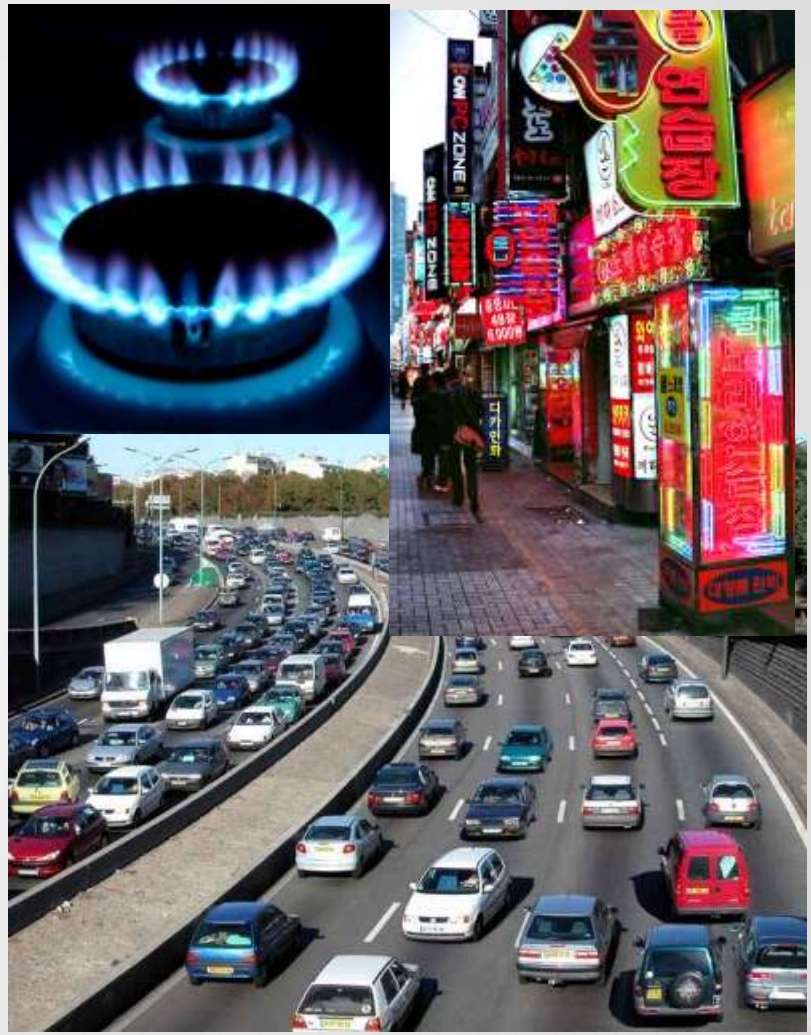
ENERGY FORECASTING AND ANALYSIS



ENERGY SYSTEM ANALYSIS



Energy System Analysis



ENERGY SYSTEM ANALYSIS

1. Formulate alternative strategies for sustainable energy sector development.

2. Determine the least-cost energy system development plan taking into account:
   - Energy demand
   - Resource availability
   - Techno-economic and environmental characteristics of supply options
   - System constraints (e.g., reliability, environmental)

IMPACT ANALYSIS

Impact Analysis

- Environment
- Financing needs
- Labour requirements
- Public health
- Public acceptance..

ENERGY FORECASTING AND ANALYSIS IS COMPLEX

Next lecture will present helpful tools and approaches

THANK YOU!

ANY QUESTIONS?