Energy Sector Models and Tools for Climate Policy Analysis

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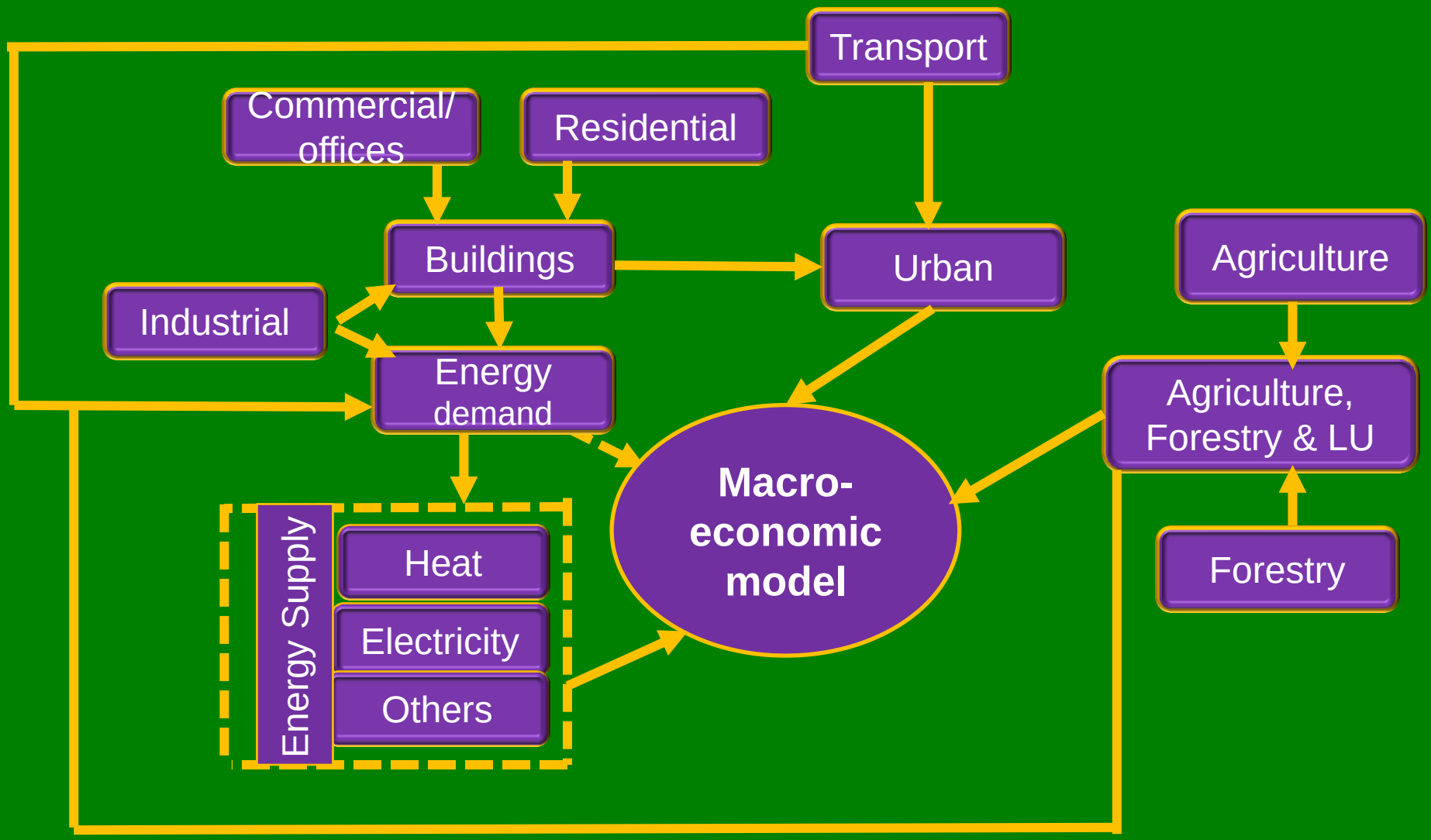
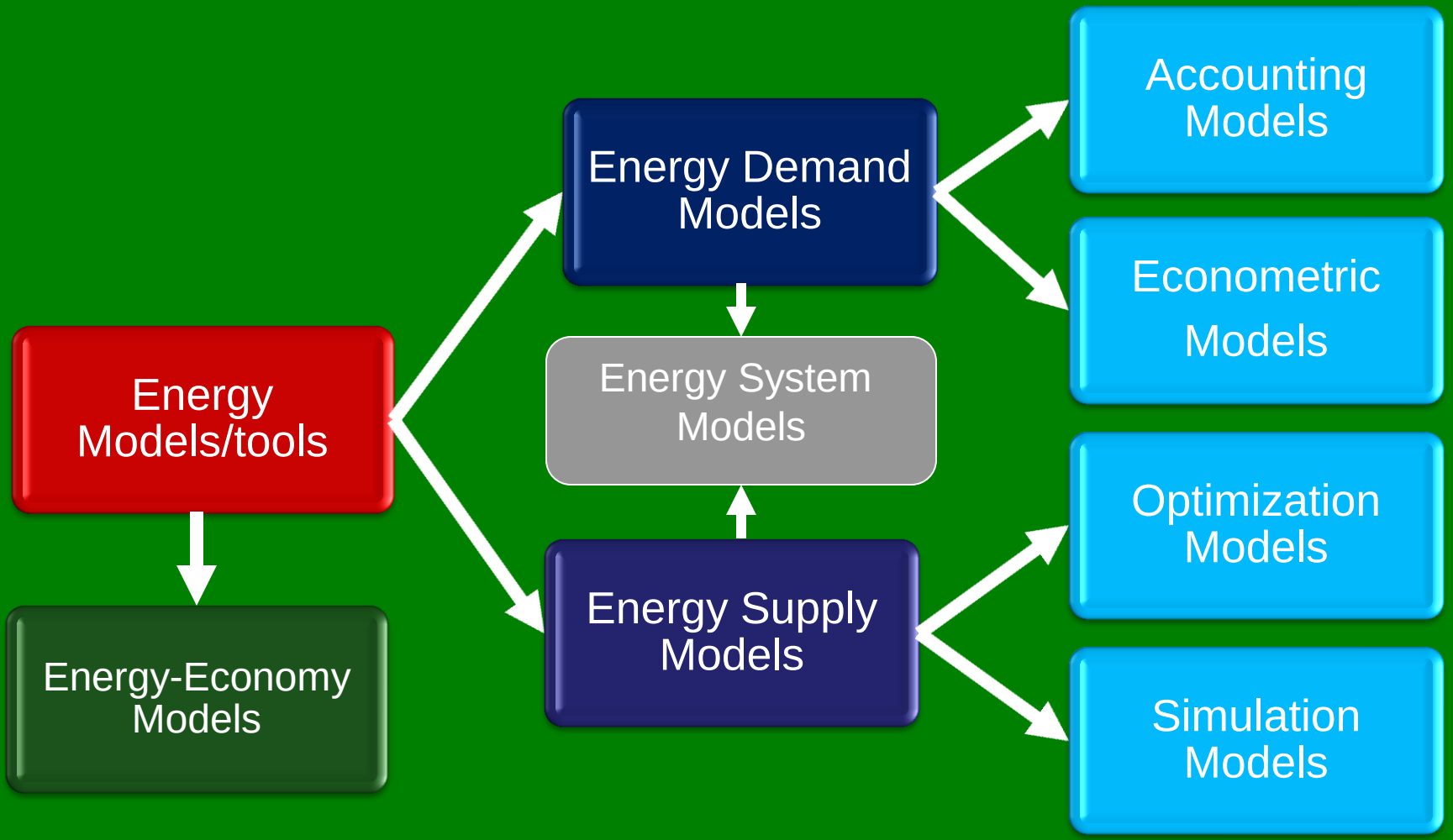
Modeling Framework for Climate Change Mitigation Analysis



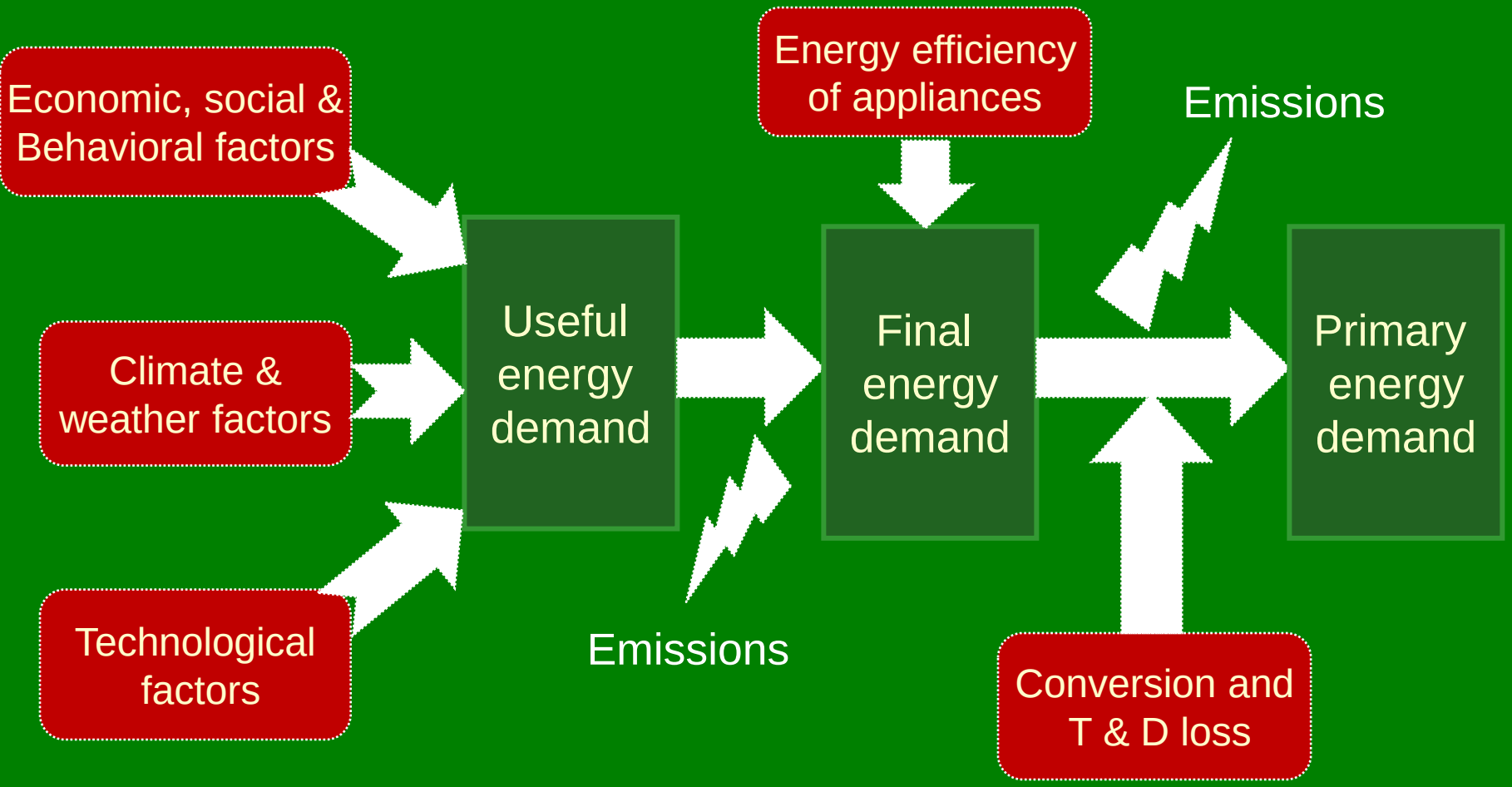
Key Drivers for Reference Scenario Design

- Macroeconomic variables, particularly anticipated economic (GDP) growth as most of other variables depend on this variable
- Demographic variable (population growth)
- Energy resource potential (supply side)
- Socioeconomic and behavior parameters (demand side)
- Technology and cost trends
- To make scenarios comparable across countries – assumptions on common variables should be the same (e.g., future energy prices, future costs of energy technologies, assumptions on technological innovation)

Model Classification/Typology



Approach -- Energy Demand



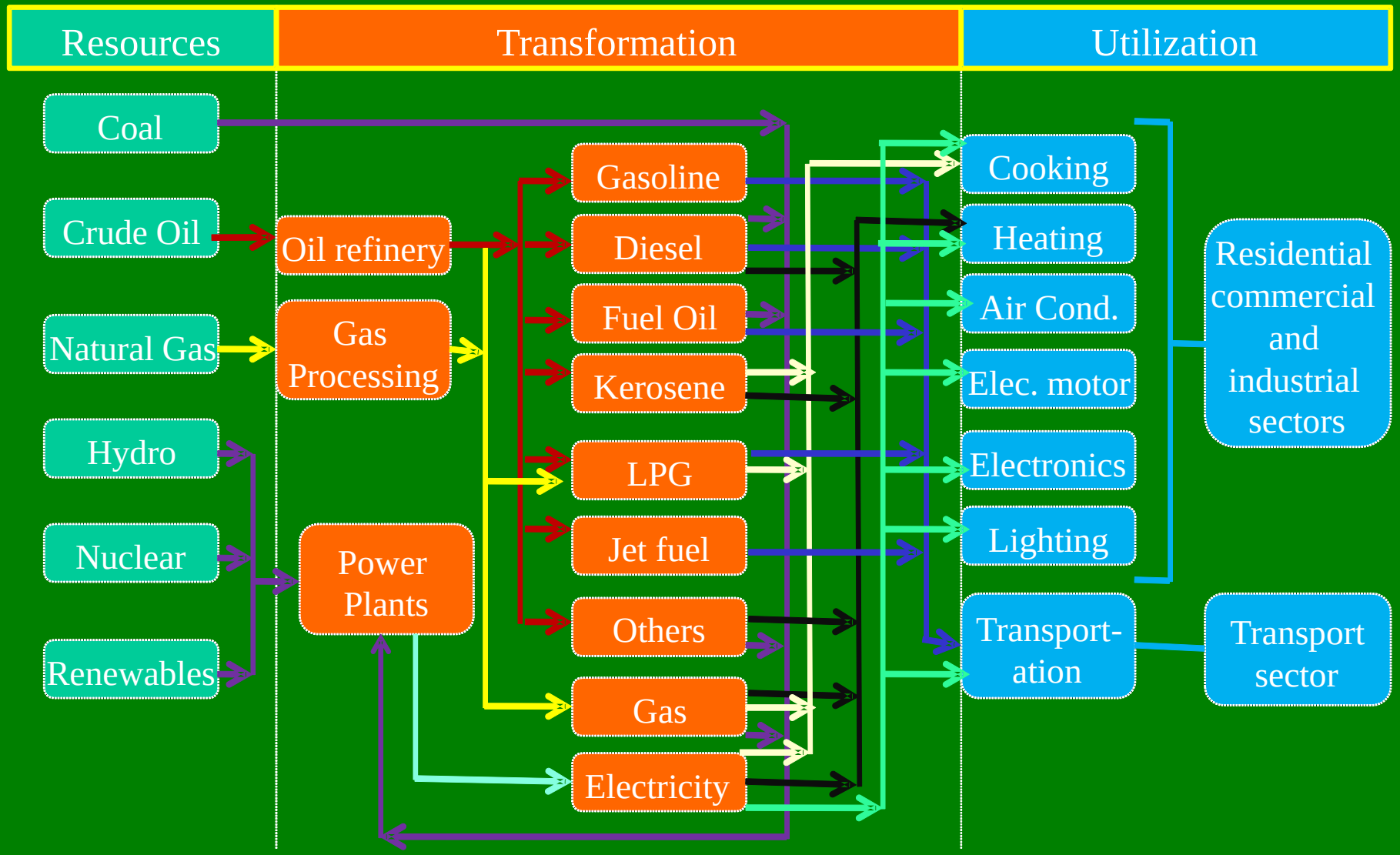
World Bank Energy Demand Model: EFFECT

- EFFECT (Energy Forecasting Framework and Emissions Consensus Tool) is a energy accounting model, developed and maintained at ESMAP, World Bank.

- Using end-use accounting approach it forecasts energy demand in various economic sectors (road transport, agriculture, power, industry, household and non-residential buildings).

- EFFECT has been used in almost all countries where the World Bank carried out low carbon and green growth studies (India, Georgia, Macedonia, Nigeria, Poland and Vietnam).

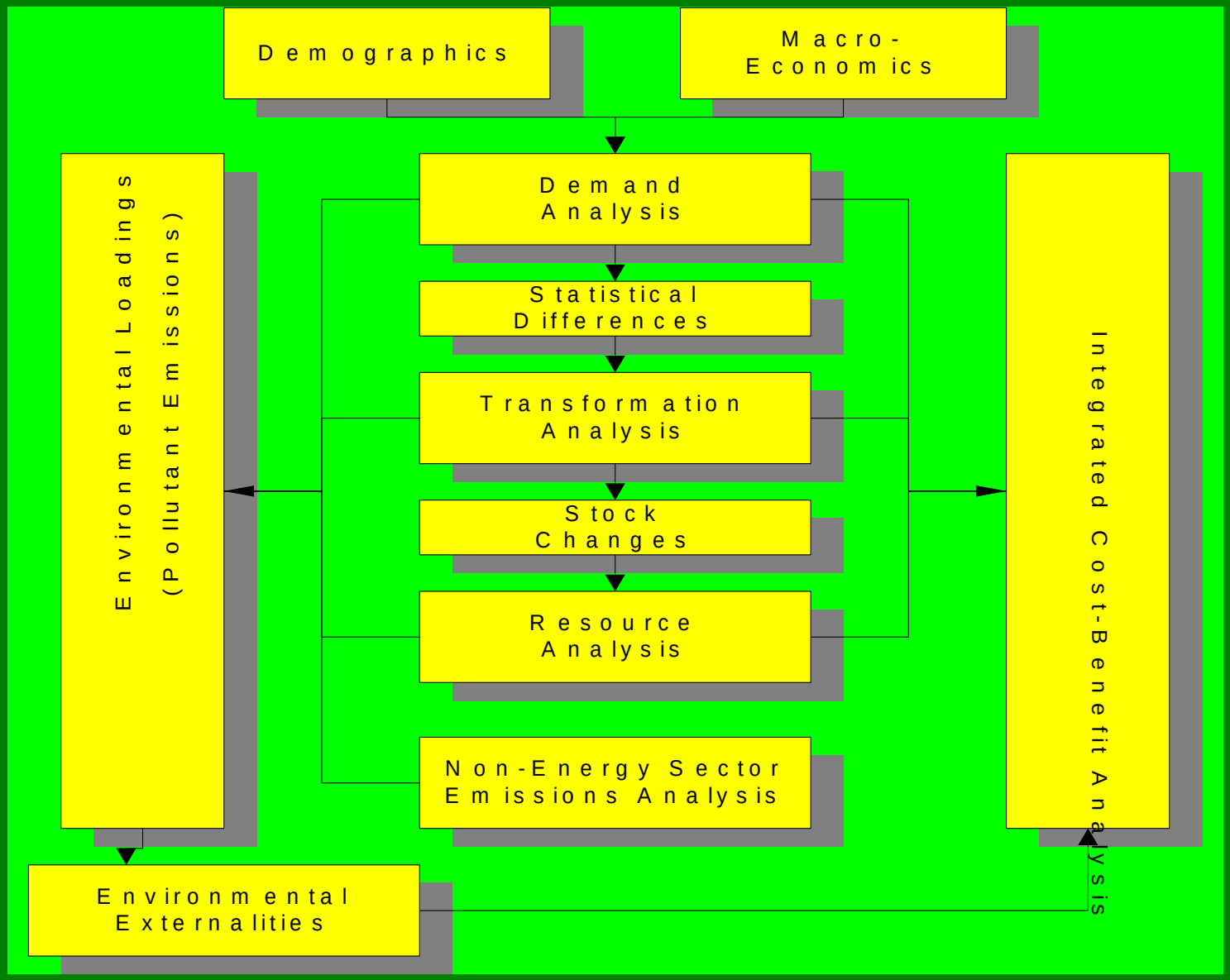
Approach -- Energy Supply/System



MARKAL/TIMES

- MARKAL is a “bottom-up” model with detailed representation of energy resources and production technologies
- It follows the principal of reference energy system and finds a least cost set of technologies to satisfy end-use energy service demands and user-specified constraints
- MARKAL (more recently TIMES) is found extensively used for both academic and consulting studies

Energy System Model – LEAP



Data Requirement

Energy demand models

- Economic and demographic data (historical and forecasts)
  - (GDP, sectoral value added, population, energy prices, costs of energy consuming devices and processes, elasticity parameters)
- Technological data (Current, and forecasts if available)
  - (e.g., Space heating need per square feet, electricity demand per ton of steel production in arc furnace, unit energy requirement of a refrigerator, mileage of a car, occupancy of a bus)

Energy supply models

- Energy resource data
  - (e.g., Oil and gas reserves, hydropower potential, wind profile, solar irradiation)
- Economic data (Current and forecasts)
  - (e.g., Capital and O&M costs of power generating technologies, energy prices)
- Technological data (Current, and forecasts if available)
  - (e.g., thermal efficiency of power plants, contents emission causing elements if fuel)

Data Challenges

Economic data

- GDP forecasts are often available but not the sectoral outputs and value added
- Current costs of energy consuming devices and processes are always difficult to get and forecasts on them are not available (assumptions based on historical trends could be an option)
- Elasticity parameters vary across countries, sectors but normally are not available especially for developing countries

Technological data

- Some technical data are difficult to obtain due to lack of surveys (e.g., inventory of energy consuming devices and appliances; annual utilization of vehicles, mix of light bulbs in households, specific energy consumption in industrial processes, annual utilization of private vehicles, occupancy of public vehicles)

Energy resource data

- Resource data for renewable energy (wind profile and solar irradiation) are always difficult to get

Some Misconceptions

- More data intensive model is better than less data intensive one – wrong
  - A smart modeler always tradeoffs data need vs. cost vs. quality of results to meet the objectives (e.g., if electronic devices uses only 5% electricity consumption in the household sector, a modeler is not expected to dig into details of TV, VCR)

- A complex the model is more robust – Not necessarily
  - If the marginal benefit in terms of quality of results by making the model too complex is small, why should it be made complex with additional costs and data need

- A model needs to reflect every physical realities – Not possible

- Data are available at no cost