UETT Energy Model

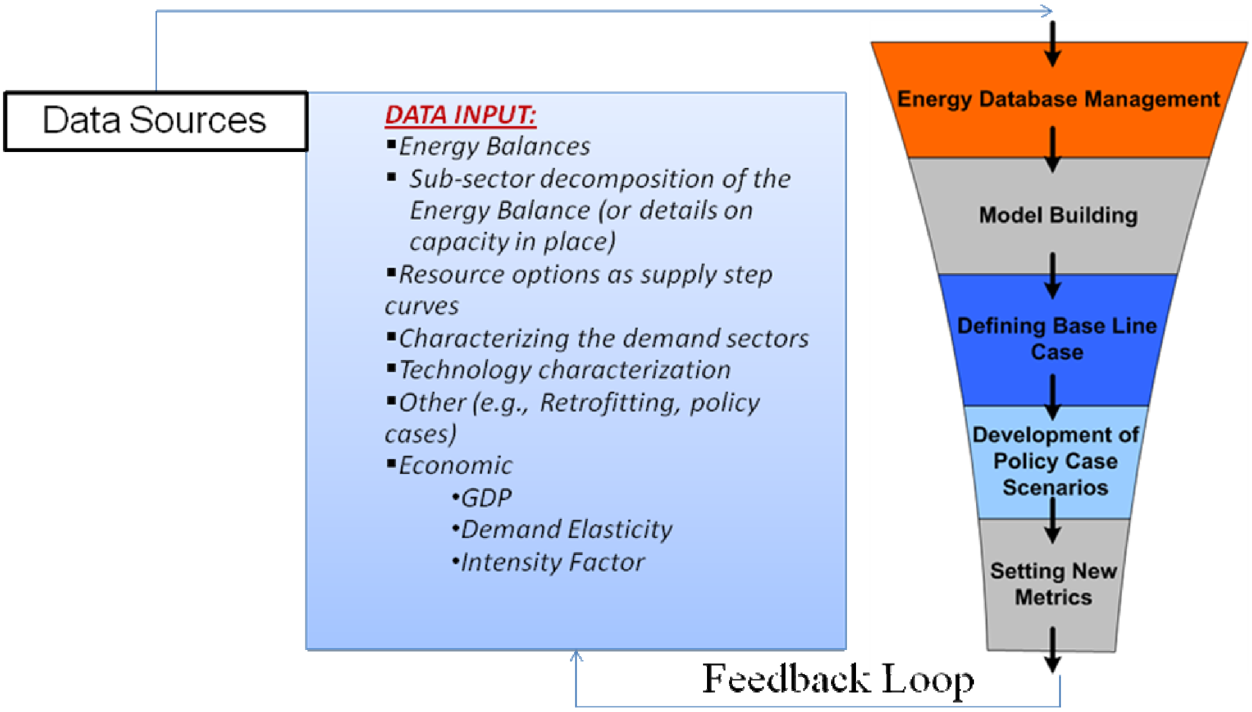
Data Sources Tables

I. Overview

This section identifies all the data sources upon which the model has drawn. The tables are organized by category/activity split and nature of the data sought. For each entry the Data Sources identifies the particular section, and perhaps page/table therein, used. The Notes and Comments should very briefly describe the Data Source, and highlight any issues or shortcomings with the Source in terms of providing complete and consistent coverage for the associate data needed.

II. Modeling Approaches

It is important to distinguish that MARKAL/TIMES, unlike many other models, uses the concept of energy service demand, not final energy demand. This enables the model to evaluate fuel mix and device choices reflecting industry and consumer choices for meeting future service level. These energy service demands can be specified in whatever units are convenient (e.g., vehicle-miles traveled for transportation, lumens for lighting, BTUs for space cooling, etc.). In these cases, the end-use devices must be defined in terms that convert final energy carriers into these energy service units.



There are two general approaches used to develop the sub-sector-level breakout for each of the demand sectors: top-down decomposition and bottom-up aggregation. Both approaches involve a number of development steps. For most sectors, a top-down decomposition approach is necessary because the existing stock of end-use devices and the amount of fuel each consumes is not known. In this approach, decomposition shares are applied to the sector energy consumption totals to determine subsector totals for each fuel type, which are then further broken down into the individual end-use services, perhaps with some intermediate splits as well. These shares are a straightforward mechanism employed to disaggregate the sector level fuel use to each sub-sector demand, though often need to be determined by surveying or expert judgment. Data on sub-sector final energy consumption can be estimated from basic data such as number of households and final energy consumption per household/activity. For these sectors, Bottom-up approach may be also employed after collecting the device level data characterization. For this purpose, the energy survey is mandatory tool.

For Transportation and Landscape/Water pumping shares may be estimated using a bottom-up approach, based on technology stock and use/performance information to aggregate up to the sector energy consumption values. In this case the device details are aggregated and crosschecked against the sector energy balance.

For each demand sector, the number of sub-sectors is based on the need to adequately model the energy system at the appropriate level of detail, when supported by data. An example of possible sub-sector detail might be commercial building types (which can be classified according to purpose (e.g., academic, administration, school, canteen, and other commercial services) or size (e.g., large, small), or residential location (e.g., colony or hostel) or household income class (e.g., low, medium, high). These additional breakdowns are important to consider and represent when the energy use patterns and/or policies to be examined warrant separation into these finer groupings. The goal is not simply to add detail, but rather to develop the level of detail that is supported by the available data and appropriate for the intended uses of the model. The appropriate demand services are (e.g., cooling/heating, lighting, refrigeration, cooking), which may be developed by means of surveying.

For each of the demand services, information on the demand timing is required to properly distinguish the time-of-use of the demand for commodities such as electricity. The demand timing splits determine the amount of each demand service that must be satisfied in each season and time-of-day time-slice. In order to properly represent these patterns, data on daily and seasonal electricity consumption (and seasonally for gas) by end-use category is needed or needs to be derived / estimated. In particular, utility load curves by sector and by sub-sector would be ideal. Data on the effects of climate on daily and seasonal demands can be useful (that is, degree day information for the calibration and typical year).

For certain sub-sectors where the demand is uniform throughout the year, which is often the case for commercial facilities, it is assumed that the demand follows the overall fractional split for season and time-of-day. However, if a demand typically does not follow those splits (e.g., residential lighting is mostly at night, residential and commercial space cooling mainly in the summer), then demand service timing splits need to be specified. An approach should be set-up that allows for the calibration of demand fraction shares to accurately represent the daily and seasonal load curves in the model.

III. Resource Supply

Resource supply information is needed to determine the initial year production/cost information, and to describe the anticipated future production/cost.

Nature of the Data	Data Sources	Notes and Comments
Petroleum Products		
Current and Future Import Levels and Prices		
WAPDA Electricity		
Current and Future Import Levels and Prices		
Natural Gas		
Current and Future Import Levels and Prices		
Biomass		
Indigenous Supply by Type		
Other		

IV. Electricity (Generator) Sector

The electricity sector information is needed to determine the initial year capacity in place, and the associated production/cost information for the existing power plant, identify anticipated refurbishments and known new builds (e.g., PV), as well as describe the future technology options.

Nature of the Data	Data Sources	Notes and Comments
Power sector characterization		
Existing Thermal Plant Characterization		
Transmission and Distribution		
Demand / Load Profiles (by end-use customer class and time-of-day)		
Future Technology Characteristics		
Renewable Resource Potential (solar & wind), by class/season(time-of-day)		

Parameters Required for Characterization of Electricity Sector Technologies

Characteristic	Unit	Comment
Name		
Fuel(s) used		
Capacity	MW	Electric rating only
Remaining life	Years	TIMES can also use the start year for the plant
Efficiency (by fuel)	OUT/IN	
Fixed O&M Cost	RsM/MW	
Variable O&M Cost	RsM/MJ	
Availability factor	Annual or seasonal	Wind and solar plants have seasonal availability factors.
Fuel Input Share(s)	Fraction	Needed for multi-fuel plants.
Output to Power Ratio	Fraction	Needed when non-electric outputs are also produced, such as heat (co-generation plant), fuels or water.
Emission control option	RsM/MJ	
Retrofit option	RsM/MW	

V. Academic/Admin Blocks

The academic, administration and services blocks information is needed to determine the appropriate level of disaggregation of the block into categories and their associated energy service demands, the initial year amount for final energy consumed for each the categories/service demands, the capacity and performance/cost characteristics for existing devices meeting each service demand, the timing of the load for each of the category/demand services, and to describe the future technology options, as well as derive the future demand for energy services.

Nature of the Data	Data Source	Notes and Comments
Academic/Admin Blocks		
Determination of the appropriate breakdown of the block according to customer classes and/or building type		
Energy services appropriate for each category/sub-block		

Nature of the Data	Data Source	Notes and Comments
Base year levels and fuel splits within sub-blocks / services		
Timing of demand for energy services		
Existing Technology Characterization		
Characterization of future technology options		
Projections for future growth of the block		

VI. Residential Sector

The residential sector information is needed to determine the appropriate level of disaggregation of the sector into categories and their associated energy service demands, the initial year amount for final energy consumed for each the categories/service demands, the capacity and performance/cost characteristics for existing devices meeting each service demand, the timing of the load for each of the categories/demand services, and to describe the future technology options, as well as derive the future demand for energy services.

Nature of the Data	Data Source	Notes and Comments
Resident sector		
Determination of the appropriate breakdown of the sector according to customer classes and/or building type, as well as colony and hostels		
Energy services appropriate for each category / subsector		
Base year levels and fuel splits within sub-sectors / services		
Energy services by fuel and subsector		
Timing of demand for energy services		
Existing Technology Characterization		
Characterization of future technology options		

End-use technologies to meet the demands for energy services need to be fully characterized. The following Table lists the main parameters that are needed. These are considered in greater detail in each of the sector-specific sections.

Parameters Required for Characterization of Residential Sector Technologies

Characteristic	Unit	Comment
Technology Name		
Input Energy carrier		
Capacity	MJ/a	
Remaining life (existing)	Years	TIMES can also use the start year for existing devices
Lifetime (new)	Years	New devices
Efficiency	OUT/IN	
Investment cost	Rs/MJa	New devices only
Fixed O&M Cost	Rs/MJ	

Variable O&M Cost	Rs/MJa	
Utilization factor	Annual	
Input share	Fraction	For duel-fuelled technologies
Output share	Fraction	For technologies providing more than one energy service e.g., heat pump providing heating and cooling, car doing short/long-distance driving

VII. Transportation Sector

The transportation sector information is needed to determine the appropriate level of disaggregation of the sector according to mode, the initial year amount for final energy consumed for each the modes, the capacity and performance/cost characteristics for existing devices meeting each service demand, the timing of the load for each of the modes, and to describe the future technology options, as well as derive the future demand for energy services.

Nature of the Data	Data Source	Notes and Comments
Transportation sector		
Determination of the appropriate breakdown of the sector according to transportation mode (class)		
Profile (stock) and characterization of the existing vehicle fleet for each mode, including activity per vehicle/mode type, fuel consumed and efficiency (l/km), and other existing vehicle characteristics (e.g., operation costs		
Characterization of future technology options		
Future year projections by class		

Parameters Required for Characterization of Transport Sector Technologies

Characteristic	Unit	Comment
Vehicle type		
Existing stock	Number	
Annual distance travelled	Km/yr	
Input energy carrier		
Average occupancy	Passenger/vehicle	
Remaining life (existing)	Years	TIMES can also use the start year for existing vehicles
Lifetime (new)	Years	New vehicles
Efficiency	passenger-km/MJ	
Investment cost	RsM/vehicle	New vehicles only
Fixed O&M Cost	Rs/vehicle/a	
Variable O&M Cost	Rs/vehicle/km	
Capacity factor	1	
Input share	Fraction	For dual fuel vehicles
Output	passenger-km	Calculated (not data)

VIII. Landscape and Water Pumping

The structure for this sector requires the following types of data:

- Technology stock data – tractors / irrigation pumps;
- Stock activity levels / fuel consumption; and
- Characterization of existing end-use technologies.

IX. Projections of Future Energy Service Demands

The demand projection approach may vary by sector / category, but they are all essential determine by associating the growth for each sector to economic, demographic and other drivers.

Nature of the Data	Data Source	Notes and Comments
Demand Sector Characterization		
Economic, demographic and other potential drivers; including an indication of students intake rates and anticipated changes in "customer classes" (income)		
Official projections for sub-sectors, where available		
Other "projections" and reports (e.g., Student's thesis etc.)		
Sectors-specific growth rates, and their relationship to each sector		