APPENDICES

APPENDIX A
STAIR: A FLEXIBLE SPREADSHEET MODEL FOR LONG TERM ENERGY SCENARIOS

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Long term scenarios are an essential tool to quantify and better understand the influence of various determinants on energy use. The scenarios need to distinguish between energy sources -- Coal, Oil, Natural Gas, and Biomass -- as well as between main sectors of activity -- Residential, Transport, Industry, Services, and Agriculture. The evolution of each sector depends on different factors and follows different patterns. Moreover, determinants and patterns can differ widely between countries and regions, particularly in the developing world. Given these regional and national differences in economic and human activity, it is unrealistic to rely on rigid models to estimate energy demand on the basis of a pre-determined set of economic and demographic variables.

Based on earlier work performed in conjunction with the EPA Report to Congress on Climate Stabilization (Sathaye et.al., 1988), we have developed a series of linked spreadsheets which are intended to be a flexible and customized tool for analysis of long term energy supply and demand by main sectors of activity. The spreadsheets consider the principal energy end-uses and the factors which determine their future evolution in order to estimate energy use for each sector. The spreadsheets are customized for quantifying scenarios of long-term energy use in the developing countries. With slight modifications, particularly for the residential sector, they can be used for industrialized countries as well.

The set of spreadsheets is a modular system which permits analysis at various levels of detail and disaggregation. As shown in Figure A1, the main spreadsheet *STAIR*[*] provides the workplace for basic assumptions and sectoral results, as well as for the conversion of final energy demand into primary supply requirements. For each sector -- Residential, Transport, Industry, Services, and Agriculture -- we provide a choice of sectoral modules which vary in their data requirements and the level of analytical detail. Final results, which include projections of energy demand by fuel type, are displayed in identical format in each sectoral spreadsheet. These are then transferred to the main spreadsheet for the calculation of national energy demand and supply.

We consider two scenarios for 2025. The first scenario is a base case where no emphasis is placed on reducing emissions of greenhouse gases. The second scenario considers reduction in the use of high carbon fuels. The attempt is to use each form of energy more efficiently, and to move away from using coal to oil to natural gas to renewable biomass and finally to other renewable fuels.

The choice of the level of detail is left to the user. Depending on the availability of data, the user can choose to work at levels of detail different for each sector. For example, unavailability of data may require the analyst to work at level 1 in the residential sector but it may allow him to work at level 2 in the industrial sector. Final results expressed in the form of fuel demand can be merged from each of these in the main STAIR spreadsheet. The user can also expand the sectoral spreadsheets to calculate specific indicators, e.g. desegregating ownership levels by income groups.

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[*]"S.T.A.I.R." identifies the five sectors considered in the model.

We have used six abbreviations to describe the activity in relevant cells of the spreadsheet. These are explained below:

Abbreviations	Explanation
85	Year 1985
25	Year 2025
Cal	Calculated using a spreadsheet formula.
Inp	Data to be input by the user.
Est	Estimated by the user outside the spreadsheet.
Copy	Value copied from another cell of the spreadsheet.
SSO	Data from Assumptions in STAIR worksheets.

Below is a brief description of each of the spreadsheets and some suggestions on how to customize them.

The STAIR Spreadsheet System

Main Spreadsheet

STAIR: This main spreadsheet contains the basic assumptions about population, urbanization, household size, and economic activity (GDP) and its components. These assumptions are used in sectoral spreadsheets for estimating energy use in 2025. Results of fuel use in 2025 for the two scenarios are assembled in this spreadsheet.

Sectoral fuel use, including electricity demand, is aggregated to provide a total delivered energy demand by fuel type. Electricity demand is then converted into fuels required for generation. Fuel supply requirements are estimated after accounting for fuel losses in processing. These are added to the fuels for electricity generation in order to determine the total fuel supply.

Procedure for Assembly: Each sectoral spreadsheet has sectoral energy demand by fuel type under the title "RESULTS", which is listed under the Range Name "results". While in the STAIR spreadsheet with the cursor at the top left hand corner of a sectoral title in the RESULTS section, you may access the results for that particular sector by a FILE/COMBINE/VALUES command. The file to be accessed will be the appropriate file, where data has been entered and calculations done, from among the nine sectoral files shown in the Figure. The range name to be accessed is "results". Access values and not the formulas.

STAIR_COST: This spreadsheet is similar to the one above, but additionally estimates the capital requirements for supplying electricity. This is done on the basis of assumed capacity factors and capital cost for each type of fuel supply. The total capital cost may then be compared with the overall GDP. We do not account for construction times in this preliminary version. We assume that capital expenditure takes place in a single year in 1985 and 2025.

Residential Spreadsheet: Select one of the following.

RES1: This is used to estimate the fuel demand for the residential sector. The spreadsheet distinguishes between rural and urban fuel demand and assumes different intensity

of fuel, biomass and electricity use. Fuel use is then exogenously desegregated among the various fossil fuels. Basic assumptions are extracted from the STAIR spreadsheet.

RES2: This spreadsheet estimates fuel demand in the residential sector by distinguishing between principal end-uses in urban and rural areas separately. End-uses considered are cooking, hot water, space heating, and other energy needs. In the former three end-uses we distinguish between LPG-Kerosene, coal, biomass and electricity use. Other energy needs are separated into those for lighting, air-conditioning, refrigeration, washers and others.

This level of analysis will also enable the user to examine the costs of improving efficiency of lighting, cooking and other end-uses. These costs may then be compared with marginal cost of supply. (Cost modules are not included in the spreadsheets yet.)

Industrial Spreadsheet: Select one of the following.

IND1: This spreadsheet distinguishes between the intensity of fuel, biomass and electricity use. Fuel use is further divided into coal, oil and gas use. Intensity is measured with respect to value added in the industrial sector. Basic assumptions on economic growth and industrial value added are extracted from the STAIR spreadsheet.

IND1-2: This spreadsheet uses the same distinction of energy demand as above. Value added in the industrial sector is separated into that from manufacturing and mining, construction and utilities. Manufacturing is further divided into energy intensive and otherwise.

IND2: At this level, we rely on physical output in steel, aluminum and other energy intensive industries to distinguish energy use in different types of these industries. The formulas assume that output will increase in proportion to energy intensive value added. We have given examples of how steel and aluminum industries may be analyzed. Other industries, such as chemicals or pulp and paper, can be added in a similar manner at the user's discretion.

This level of analysis will also enable users to examine the costs of improving efficiency of certain types of energy intensive industries. These then may be compared with marginal cost of supply.

Transportation Spreadsheet: Select one of the following.

TRANS1:This spreadsheet distinguishes between the intensity of fuel, biomass and electricity use. Fuel use is further divided into coal, oil and gas use. Intensity is measured with respect to value added in the transport sector. Basic demographic and economic assumptions are extracted from the STAIR spreadsheet.

TRANS2: This sheet distinguishes between road, rail and air transport. Within road transport, we distinguish between cars, motorcycles, and trucks and buses. We use physical indicators of number of vehicles, distance traveled and vehicle efficiency to determine the amount of fuel use.

This level of analysis will also enable users to examine the costs of improving efficiency

of vehicles. These costs may then be compared with marginal cost of supply. (Cost modules are not included in the spreadsheets yet.)

Services Spreadsheet:

SERV1: This spreadsheet distinguishes between the intensity of fuel, biomass and electricity use. Fuel use is further divided into coal, oil and gas use. Intensity is measured with respect to value added in the services sector. Basic assumptions on economic activity are extracted from the STAIR spreadsheet.

Agriculture Spreadsheet:

AGRI1: This spreadsheet distinguishes between the intensity of fuel, biomass and electricity use. Fuel use is further divided into coal, oil and gas use. Intensity is measured with respect to value added in the agricultural sector. Basic assumptions on economic activity are extracted from the STAIR spreadsheet.

REFERENCE

Sathaye, J., A. Ketoff, L.Schipper, and S. Lele. 1989. An End-Use Approach to Development of Long-Term Energy Demand Scenarios for Developing Countries, Lawrence Berkeley Laboratory Report (LBL-25611), Berkeley, CA.
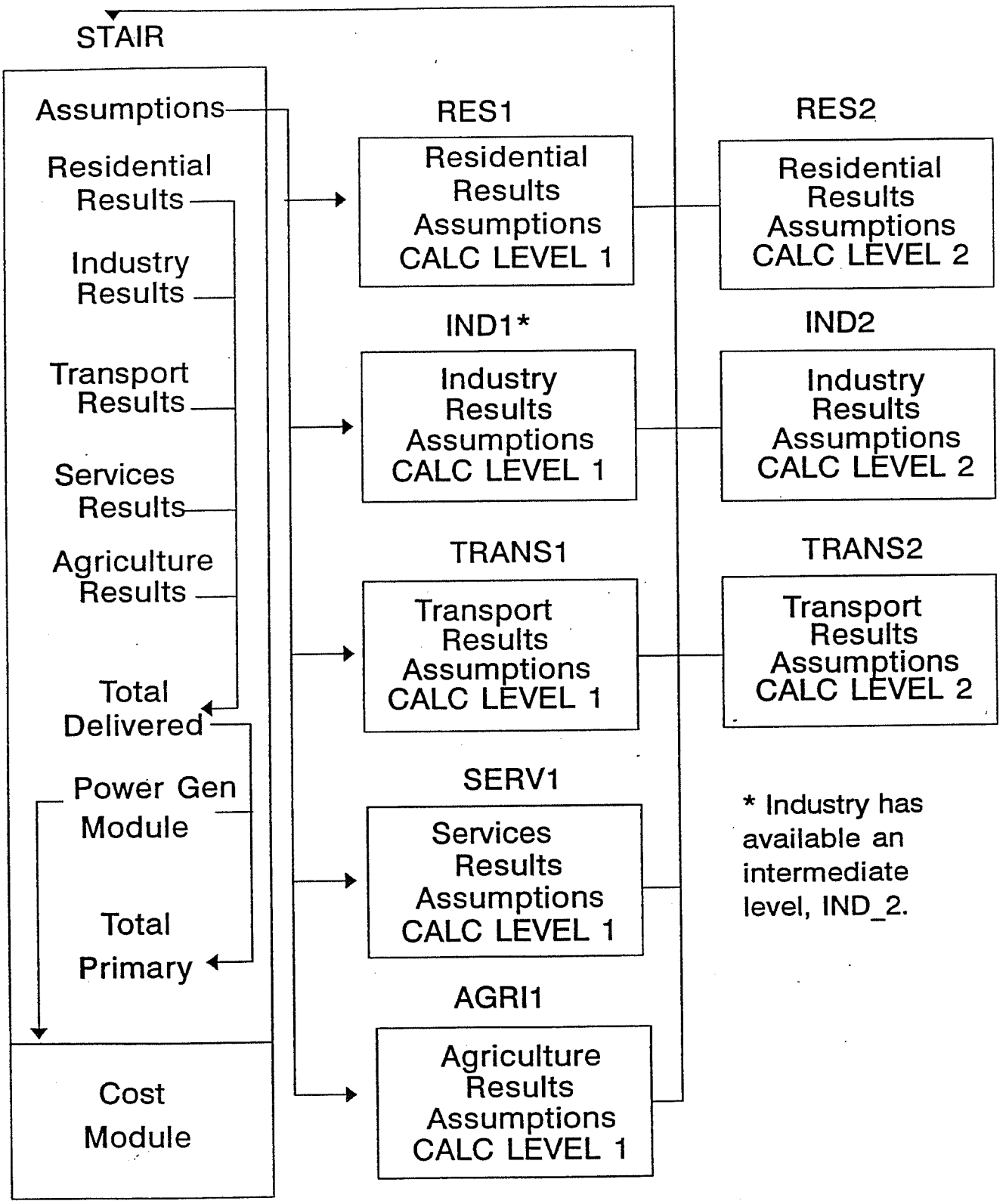
Figure A1: STAIR Model Structure