Working Paper

User's Guide to CO2DB: The IIASA CO_2 Technology Data Bank Version 1.0

Sabine Messner and Manfred Strubegger

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Foreword

Policy options and measures for environmentally compatible development, particularly in energy, encompass a wide range of techno-economic and socio-behavioral adjustments and responses. They include technological measures to minimize energy-related GHGs emissions. Thus, there is a need for a comprehensive evaluation of innovative technologies with an account of their current status, implementation prospects, applicability in different geographical, economic and cultural settings, transfer to developing countries, cost structure, technical performance, market potential, time horizons of their availability and their forward and backward linkages to other enabling technologies. Such an assessment could be used to produce an inventory of the full range of technological and economic measures spanning efficiency improvements, conservation, enhanced use of low-carbon fuels, carbon free sources of energy and other options such as afforestation and enhancement of carbon sinks.

This evaluation and inventory of measures constitutes the main part of an on-going study within the area of energy and the environment at IIASA. This activity includes development of an integrated data base for a more comprehensive inventory of options available globally over longer time horizons together with descriptions of their comparative characteristics, important linkages to other technologies, development status and availability, etc. The software support system (CO2DB) for the data base is described in this paper by Sabine Messner and Manfred Strubegger. The paper can also serve as a manual for the data base users.

The data base includes detailed descriptions of the technical, economic, and environmental performance of technologies as well as data pertinent to their innovation, commercialization, and diffusion characteristics and prospects. Additional data files contain literature sources and assessments of data validity and concurrent uncertainty ranges. The technology data bank system (CO2DB) is a fully interactive software package designed to enter, update, and retrieve information on CO_2 reduction and removal technologies. The data base can facilitate the assessment of CO_2 reduction strategies by combining many individual technologies together, i.e., to analyze measures throughout the energy chain from primary energy extraction to measures to improve energy end-use efficiencies.

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Nebojša Nakićenović
Project Leader
Environmentally Compatible Energy Strategies

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Contents

List of Figures

List of Tables

User's Guide to CO2DB: The IIASA CO$_2$ Technology Data Bank Version 1.0

Sabine Messner and Manfred Strubegger

1 Introduction

1.1 Background

Energy technologies are the major emitters of anthropogenic CO$_2$, and knowledge about such technologies is a prerequisite for assessing the CO$_2$ problem. The IIASA CO$_2$ data bank is a software system for collecting data on technologies related to the CO$_2$ problem. It predefines the information to be entered in the data bank, structures it according to sector and type, and supports the evaluation of chains of energy conversion and utilization technologies.

The characteristics of technologies are the qualitative and quantitative technology descriptions, which are collected and structured by the data bank approach. Several reasons lead to the adoption of this approach:

- The data bank facilitates aggregation and evaluation of a consistent set of data on technologies relevant for CO$_2$ reduction and removal. It serves as a unified framework for data collection, structures the information, and defines the format.

- The software of the data bank system with its menu-driven user interface provides easy and fast access for entering and reviewing data. Specific items or types of technologies can be aggregated and viewed or printed using the query mechanism. Complete energy chains are easily evaluated by linking the technologies via the respective energy inputs and outputs.

- The consistent, unified framework for describing the technologies further simplifies the processing of the information. The evaluation of technological strategies with respect to properties defined in the data bank, such as efficiency or pollutant emissions, is a major goal of the development work.

- An important aspect in developing a data bank system is dissemination. The information collected can be easily distributed to cooperating institutions. Information exchange is taken into account via the input forms of the data bank system, formalized printouts from the data bank, or a data bank exchange.

The structure of the data bank is oriented along the lines of the information required to characterize technologies in the context of the CO$_2$ problem. This information is sorted according to the following:

- The technologies are described in their *technical* dimension. Since most of CO_2 emissions attributed to human activity are related to energy conversion or utilization, a technical description of such technologies includes quantity and quality of energy inputs and outputs. Also items such as material requirements and technical plant life are considered.

- Although over a time frame of several decades to a century present *economic* descriptors might not be too powerful, the common cost attributes (or estimates thereof) are collected for the technologies. Such data can be instrumental in ranking or evaluating the measures and, together with the technical information, the complete interlinked energy chains.

- *Environmental* issues are incorporated in terms of quantities of major pollutants emitted (e.g., to the atmosphere). For reduction measures the quantities extracted from the atmosphere are provided. CO_2 will be considered in this context.

- Other aspects concerning the potential *introduction* and *penetration* or *transfer* of *technologies* to specific regions include the description of the lifecycle of the technology (giving the dates of invention, innovation, etc.) and regional aspects such as limiting factors on and prerequisites for the introduction in a given region.

1.2   Program Overview

The CO_2 Technology Data Bank (CO2DB) is a fully interactive software package designed to allow the user to enter, update, view, and print information on CO_2 technologies. It comprises a main screen for selecting the type of table to be entered or actions such as import/export of data and print data to be taken, a selection menu displaying a list of technologies and the types of data available, and, for each technology, data entry tables giving technical, economic, ecological, and general information. Most actions in the system are invoked by function keys. An interactive help utility can be used to display the list of function keys available and to get information on the data required or actions to be taken.

The software of the CO_2 Technology Data Bank utilizes the commercially available data bank system db_VISTA[1]. db_VISTA is based on the network data bank model, which makes it a flexible programming tool with easy access to large volumes of data. It also supports functions of the relational data bank model and the QSL standard. The code is written in C language and runs on PCs and UNIX operating systems. Screen control is performed with Curses; the menus were designed with the menu generator FAST[2].

A technology can be defined by all items available in different data tables. However, it is not mandatory to enter all information; it might well be that, for instance, for the economic performance of or the materials needed for the construction of a technology, no data are available. Each table gives the user the opportunity to enter notes on caveats or additional information concerning the data in the table.

Each table (besides the table containing General Data) can be multiply defined for each technology. In this way, different technical and economic characteristics expected for different years in the future or for different regions can be introduced.

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[1] db_VISTA is a product of Raima Corporation.
[2] FAST and CURSES for MS-DOS are products of ASPEN SCIENTIFIC.

For data collection, input forms describe the information used to set up a technology description. Information on the technologies in the data bank can be printed in a standardized way.

Special features allow the user to select technologies conforming to predefined criteria for further processing, to calculate the overall efficiency, cost, and environmental effects of energy conversion chains, to store additional information on computer files using the. system editor, and to exchange technology data over different operating systems using the import/export facility.

1.3 Purpose of this Document

The major audience of this documentation is the person using the IIASA CO_2 Technology Data Bank (CO2DB). A separate publication, *Systems Documentation of CO2DB*, is directed toward the manager of the data bank system, i.e., the person installing and maintaining the software of CO2DB on a specific computer. The user's guide is divided into five sections:

1. The Introduction gives a general explanation of the scientific background of the software development, the data required, and a brief overview of the program.

2. The General Information Section describes the underlying data structures and explains how the software operates and communicates with the user. It also overviews general features available in CO2DB, such as the help facility.

3. The Technology Menus Section describes all technology data menus in terms of the information to be entered in these menus. It also covers the subwindows available from these menus.

4. The Special Menus Section provides the information required for the additional features of CO2DB, such as listing all technologies, performing queries on the data bank, calculating performance characteristics of energy chains, and printing tables of the technologies.

5. The section on Problem and Error Handling helps the user with commonly encountered problems.

2   General Information

2.1   Data Structure

The structure of the data bank system reflects the data requirements that are essential to the CO_2 problem. Each technology is described by seven groups of data (called tables according to the standards of the data bank). The tables reflect the following classification:

- General data,

- Technical data,

- Economic data,

- Environmental data,

- Labor and material requirements,

- Miscellaneous data,

- Literature source.

The following sections elaborate on the contents of the tables.

2.1.1   Table I: General Data

The General Data Table gives general, descriptive information on a technology:

- Technology identification; including long name, short identification, general notes, and an item on the quality of the data,

- Name of physical (paper) file and computer file containing additional information (graphs, process flowcharts, verbal descriptions, etc.),

- Definition of the status in the life-cycle and the timing of market penetration of this technology (stating the years of invention, innovation, first prototype, 1% and 50% market penetration, and a verbal description of the present life-cycle phase); the life-cycle concept and related data can be used to evaluate the timing and dynamics with which the technologies penetrate the market,

- Categorization of the technology with respect to four groups (sector, type, input, and output). The categorization serves as a basis for aggregating the technologies into groups for reporting and evaluation; the input and output definition is used to interlink the technologies in the evaluation of energy chains.

2.1.2 Table II: Technical Data

Table II consists of information concerning the physical energy flows in the process (quantities of energy inputs and outputs) and information on unit size, technical and average availability, construction time, and plant life.

The information on physical flows defines the efficiency of the technology and consequently the performance, e.g., in the context of reducing primary energy consumption without lowering the services provided by this energy. In the context of the evaluation of complete energy conversion chains from primary energy to energy services, the energy carriers in the technical description provide the point of linkage. The energy chains are structured along these energy carriers, as exemplified for the following energy chain:

1. The *energy service* light is provided by a light bulb, or another, more efficient type of lamp, which uses the final energy carrier electricity.

2. *Final electricity* is the product of the technologies electricity distribution and transmission, which link it to secondary electricity at the busbar of a power station.

3. The power station generates *secondary electricity* from a primary (e.g., natural gas or coal) or secondary (e.g., diesel oil or fuel oil) energy carrier or from a renewable source of energy (e.g., solar insulation in PV or STEC systems).

4. *Primary energy* is provided by mining or drilling technologies, imported from other regions or, for most renewable sources of energy, available in a given quality (e.g., insulation density) and quantity (for solar energy constrained by the amount of land available).

2.1.3 Table III: Economic Data

Economic data define the economic performance of the technology. They consist of investment, fixed and variable operating and maintenance costs, fuel and decommissioning costs, as well as the resulting total costs. The currency and the year have to be supplied.

Although the quality of an estimate of economic data for a time period up to a century is questionable, this information is useful in ranking the technologies and getting an indication of the economic impact of their application.

2.1.4 Table IV: Environmental Data

Environmental data concern the emission (or other way of disposal) of pollutants during operation of the unit. For reduction measures, this table contains the quantity of a pollutant removed from the atmosphere/soil/water. The environmental parameters are essential to evaluate the impacts of given CO_2-reduction strategies with respect to their effectiveness and potential side-effects.

2.1.5 · Table V: Labor and Material Requirements

Table V contains labor and material requirements for construction and operation of the unit. These data are required to formulate border conditions and limiting factors of strategies involving such technologies, if a technology requires large amounts of a specific material or is very labor intensive. No entries are given for technologies lying in the normal range of these values.

2.1.6 Table VI: Miscellaneous Data

Regional aspects of the applicability of the technology as well as the prerequisites for and limitations on the use are accumulated in the Miscellaneous Data Table. Additionally information on present research activities, producers, and number and capacity of existing units can be given.

Although they are generally not hard data but rather personal estimates of future border conditions (together with the characterization of the market penetration in Table I), the items defined in this table are a cornerstone of the evaluation of market potentials and the introduction of technological strategies. All considerations concerning technological diffusion and technology transfer, prerequisites for the introduction of a technology, and the timing of the introduction of a technology in a given region should be specified here. In a process of refinement, initially crude estimates or purely qualitative statements can evolve into the limiting factors applied for the final evaluation of technological strategies.

2.1.7 Table VII: Literature

This table provides the basic reference used to compile the information given on the technology defined. It includes the title, author(s), publisher, year of publication, and comments on the availability of the source.

2.2 Program Structure

The program structure of CO2DB accords to the data structure of the technology data tables. For each table defined in Section 2.1, a menu allows the user to enter all the information required. These menus can be accessed from the Main Selection Menu of CO2DB and are described in Section 3. Besides the table on general information, multiple definitions can be made for all technology tables. Specific tables can also be omitted in the definition of a technology.

From all technology menus and the Main, Selection Menu, three additional types of menus can be called:

- Function key 3 (F3) allows the user to call a selection screen which lists all technologies and the number of subtables defined for each table. From this screen, the Technology Selection Menu, technologies can be selected for processing (see Section 4.1), printing, or data export (see Section 4.1.2).

- Function key 4 (F4) invokes a similar selection menu which allows the definition of energy-conversion chains, which will, upon request, be evaluated in terms of efficiency, costs, and environmental impacts (see Section 4.2).

• Function key 2 (F2) allows the user to define, edit, save, and perform queries (see Section 4.3). Criteria for the queries can be defined for all items available in the tables. If the query is performed, the program will continue operation on the selected data until the query is turned off or a new query is executed.

Figure 1 shows these possible motions and the function keys used to invoke them.
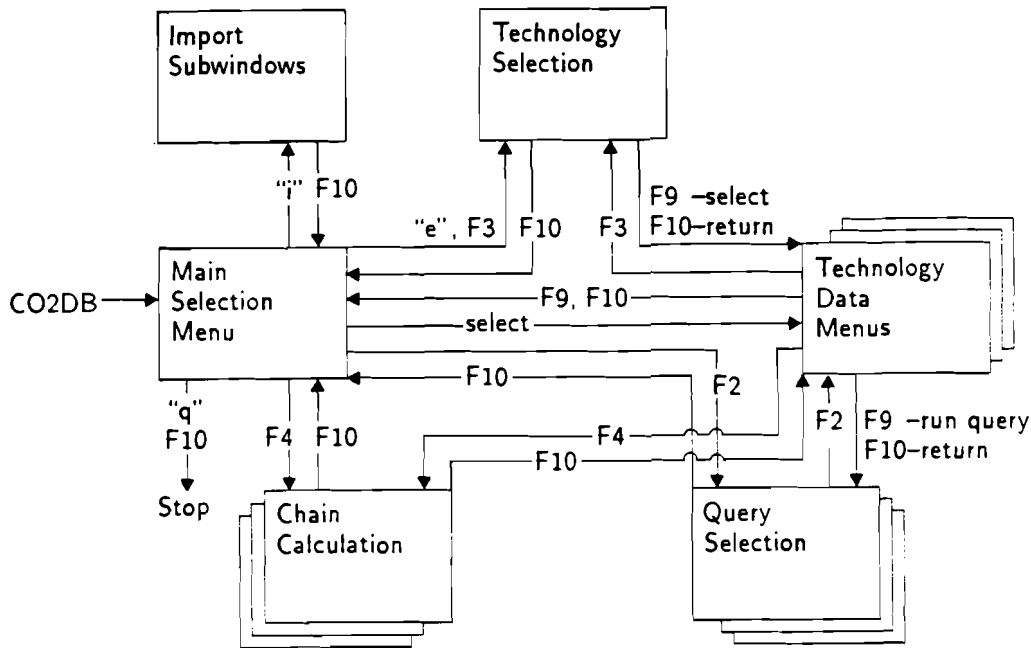
Figure 1: Motions between menus.

2.3 Menu Layout

All menus display the menu identification at the top of the screen and an information line on the most important keys at the bottom. Most error messages appear in this last line of the screen. These error messages require the user to hit ENTER to acknowledge the error and continue operation. Crucial error messages appear in the center of the screen and usually require an answer to continue.

All menus related to technology data display three lines of general information on the technology in the top section (below the menu identification). This information can be entered in the **General Data Menu**; all other technology menus only display this information.

2.4   Calling CO2DB

CO2DB is called from the level of the operating system by typing

CO2DB

The **Main Selection Menu** (see Section 3.1) appears first on the screen. At any point in the program a sequence of function keys 10 (F10) will let the user leave the program (without saving changes done in the technology data menus). The number of keys required depends on how far the user has progressed in the program. If there are changes to be saved, the user will be asked for confirmation; at this point it is also possible to save the changes and leave the program (using F8 to save the information and leave the technology data menus).

2.5   Communication with CO2DB

In general, communication with CO2DB is done with function keys and control keys. Such keys allow the user to initiate special actions, save data, move between the different menus, and change the mode of the program. CO2DB lists all keys available in a menu when sF1 is pressed.

The **Main Selection Menu** offers an additional communication option: single characters can be entered to select an item.

If an action initiated should be interrupted (e.g., discontinue printing although printing has been initiated in the **Technology Selection Menu**), the ESC key or key F10 can be used. It interrupts processing and leaves the user in the previous mode.

Overall program execution can always be stopped by pressing ^C. Data that were not saved will be lost in that case. Since it is not possible to work on more than one table of technology without saving or canceling the changed information, only changes made in one table get lost.

Generally program flow control in CO2DB is done by function keys. It uses four levels of function keys:

- Function keys 1 to 10 (denoted F1 to F10).

- Function keys 1 to 10 pressed together with shift (denoted sF1 to sF10).

- Function keys 1 to 10 pressed together with control (denoted ^F1 to ^F10).

- Function keys 1 to 10 pressed together with alt (denoted aF1 to aF10).

If these keys are not available on a specific terminal under the UNIX operating system, they can be replaced by a series of other keys (see *Systems Documentation of CO2DB*). The settings of most keys vary over the different types of menus and are described in the following sections. The last line of the screen always displays the most important keys available.

In addition to the function keys, the following control keys are available in CO2DB:

- ^C interrupts program (data are not saved).

- ^D deletes character the cursor is positioned on.

- ^L or (^R for Wyse terminals) refresh the screen.

- ^Q shows tables used for present technology.

- ^T in technology data tables displays subwindow for choosing next action (see Section 2.11).

- ^U undoes the last change in the last input field.

- ^V converts monetary data in current field to current units.

- ^W shows a window containing information on the program mode (see Section 2.8).

- ^Y or ^Z interrupts the program; processing can be continued by typing exit (on UNIX system V or under DOS) or fg (on Berkeley Unix).

2.6 Help Facility

CO2DB supplies help information in all menus. Four types of help are available (see also Section 3.9.3):

- The *field help* gives information on the data required for the field on which the cursor is currently positioned (function key 1 – F1).

- The *key help* gives information on all function keys available in the current menu (shifted function key 1 – sF1).

- The *screen help* gives general information on the screen currently shown and the data required for this screen (control function key 1 – ^F1).

- From the screen help and field help, additional information on how to move the help screen, change its size, and move within the help information is displayed if F1 is pressed again.

If the help information is longer than one page, cursor motion keys (key up, key down, page up, page down, home, end) can be used to move in the help information. Key F10 or ESC will cancel the help screen and go back to the previous menu.

2.7 Field Checks

For data entered in the input fields, the following types of checks are performed:

- Only numerical values are allowed in numerical fields.

- Some fields may not be left empty if the cursor is positioned on that field (no check is done if the cursor never enters the field).

- Only predefined strings can be given for specific fields. If wrong information is entered for such a field, a window will display the possible choices and the cursor keys and F9 can be used to select one of them.

- The range of possible values is given for some fields.

If a field check is performed for a specific field and the contents of the field is not valid, the contents will be erased, the field remains empty, and an error message might be displayed. If it is possible to decide the validity of a character at once, CO2DB will block entry of specific characters immediately.

2.8   Program Mode

CO2DB allows operation in three different modes:

Show mode: all technologies can be viewed, but it is not possible to change the information in the table,

Edit mode: all technologies can be viewed and changed: additional tables can be defined for existing technologies,

Enter mode: new technologies can be defined. In this mode, function key 9 (normal, shift, and control) will add a new record to the data bank during save. If the table was already saved using F8 this may result in duplicate table identifiers.

There are two ways to select the program mode:

- In the `Main Selection Menu`, the three program modes are offered for selection.

- In all technology menus, a subwindow can be called with `^W` that will allow the user to change the program mode (See section 3.9.2).

2.9   Table Identifiers

Each table of each technology has a unique identifier. CO2DB suggests for each table an identifier that consists of the number of the technology in the data bank, the type of table, and the number of this type of table for the current technology.

If, during data saving, CO2DB detects duplicate identifiers, an error message is displayed and the user has to correct the identifier of the current table (see Section 5.2). During data import, duplicate identifiers can either be resolved automatically by CO2DB or interactively by giving new identifiers for tables with conflicting identifiers (see Section 3.9.5).

2.10   Moving on the Screen

For moving on the screen, the following keys are available:

ENTER: go to the next input field.

Key down: go to the next input field.

Key up: go to the previous input field.

HOME: go to first input field/beginning of a list.

END: go to last input field/end of a list.

TAB: only for two column input and in the `Query Selection Menu`, go to the other column.

F5: go to a field by name (`F1` will show a list of field names from which the desired field can be selected, see also Section 3.9.3).

2.11 Moving between Technology Menus.

The tables of a data bank can be viewed as being in a three-dimensional space. The dimensions of this space are the single technologies (number of technologies is optional); different types of tables (maximum of 7 tables); and different tables of one type for one technology (maximum number of subtables: 17, for `General Data` only one table). It is possible to move forward and backward along these three dimensions.

sF6, ^F6: move forward and backward between the technologies, remains in the same table (data are not saved).

Page up, Page down: move forward and backward between one type of subtables of a technology, remains in the same type of table and technology (data are not saved).

sF10, ^F10: move forward and backward between the different tables of a technology, switch to next (previous) technology at last (first) table (data are not saved).

sF9, ^F9: move forward and backward between the different tables of a technology, switch to next (previous) technology at last (first) table (data are saved).

Figure 2 shows the possible motions and the function keys used.

CO2DB offers an additional way to perform most of the motions between technology windows. In all technology menus a subwindow can be opened on top of the screen by pressing ^T. This subwindow indicates different actions that can be chosen. A choice is made by pressing the letter which is typed in capital within the action identifier or by positioning the cursor on the action and pressing `F9`. If further selections are necessary, an additional window will appear to allow the user to make the next selection (again using the cursor and pressing `F9`). `F10` cancels an initiated selection. The following actions are available:

Technol.: switch technology (to first – `F6`; next – `sF6`; previous – `^F6`; last – `aF6`).

tAble: switch type of table of the same technology (to next – `sF10`; previous – `^F10`).

sUbtable: switch table among the same type of table of the same technology (to next – `Page down`; previous – `Page up`).

seleCt: goto `Technology Selection Menu` to select another technology (`F3`) or to `Query Selection Menu` to work on queries (`F2`).

Save: save current table (`F8`).

Quit: quit `Action Subwindow`.

SWITCH TECHNOLOGIES
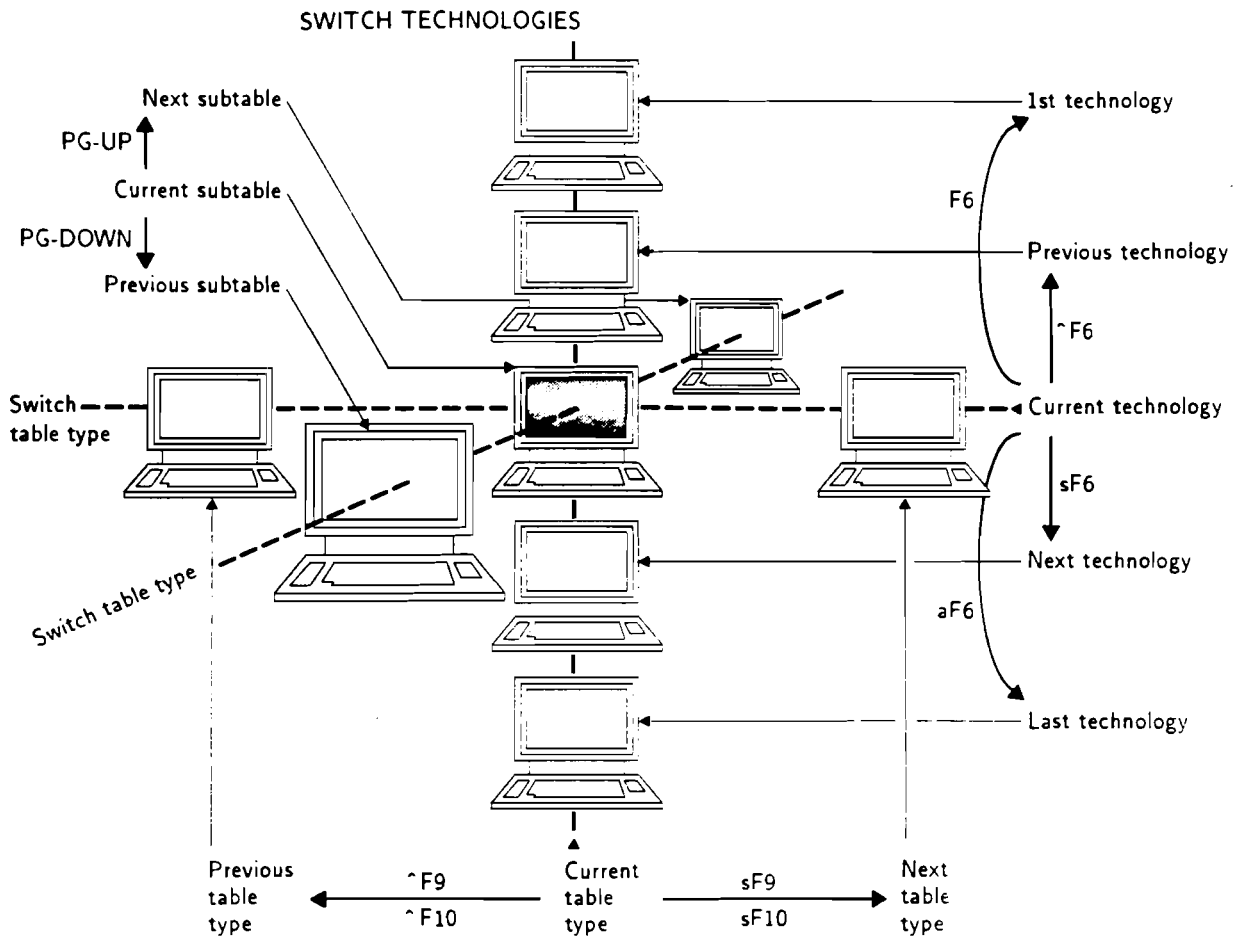
Figure 2: Motions between technology menus.

2.12   Changing the Contents of a Field

If the cursor is positioned on an input field where the information is to be changed, the following keys can be used:

Key left: move the cursor one position to the left (not for numerical fields).

Key right: move the cursor one position to the right (not for numerical fields).

^D: erase the character under the cursor (not for numerical fields).

Backspace: erase the character to the left of the cursor.

F7: erase the whole input field.

^U: undo last change.

Additional information typed at any position in an input field will be inserted at the cursor position.

3 Technology Menus

This section describes the main menu of CO2DB displayed when entering the program and the technology menus corresponding to the tables of the data bank. These menus allow the user to view, update, and enter all information available for a technology. Figure 1 shows how to move between the different types of tables, while Figure 2 shows the motions possible between the technology data tables.

3.1 Main Selection Menu

When entering CO2DB, the Main Selection Menu is displayed (see Figure 3).

```
┌─────────────────────────────────────────────────────────────────┐
│                                                                   │
│              IIASA - CO2 TECHNOLOGY DATA BANK                     │
│                                                                   │
│                   Main Selection Menu                             │
│                                                                   │
│          show _        enter _        edit _                      │
│                                                                   │
│                General Data            _                          │
│                Technical Data          _                          │
│                Economic Data           _                          │
│                Environmental Data      _                          │
│                Materials and Labour    _                          │
│                Producers/Applications  _                          │
│                Literature              _                          │
│                                                                   │
│                Import                  _                          │
│                Export/Print            _                          │
│                Quit                    _                          │
│                                                                   │
│  Copyright: IIASA 1991                          Version 1.0       │
├───────────────────────────────────────────────────────────────────┤
│  Shift-F1: Key Help, F10: quit                                   │
└───────────────────────────────────────────────────────────────────┘
```

Figure 3: Main Selection Menu.

This menu allows the user to choose from the three operation modes of CO2DB (show, enter, and edit, see Section 2.8); to select the different types of technology tables; and to import, export, or print data. For each option an input field allows the user to select the option. The user can chose one of the three last choices on the screen directly by typing the first character of the option and pressing ENTER: i followed by ENTER will initiate data import, e followed by ENTER will initiate data export or printing, i.e., it will enter the Technology Selection Menu; and q followed by ENTER will quit execution. All other items can be selected by typing a character (not e, q, or i) in the corresponding input field.

The program mode has to be selected together with a table type. In edit or show mode, this table of the current technology will be displayed (when CO2DB is loaded, the last technology is set as current technology). In enter mode a new technology will be opened after the last one.

Table 1 gives an overview of all keys available in the **Main Selection Menu**.

Table 1: Special keys in the Main Selection Menu.

Key	Description
F1	field help
sF1	key help
^F1	screen help
F2	enter query selection
F3	enter technology selection
sF3	print screen
^F3	dump screen
F4	enter chain calculation
F5	goto field
^F5	show field name
F7	clear field
sF7	clear all fields
F8	print table of contents
sF8	print TOC with comments
F10	quit
aF1	show units table
aF1aF1	show current units
^q	show tables used in query
^y,^z	goto system
^r,^l	refresh screen
^w	show program status
i	start import
e	start export/print/select
q	quit
HOME	goto first field
END	goto last field
ENTER	goto next field
UP	goto previous field
DOWN	goto next field

3.2 General Data

The **General Data Menu** (see Figure 4) is reached by selecting general data from the **Main Selection Menu**, by chosing this table in the **Technology Selection** Menu for one of the technologies available, or by moving from a neighboring table.

```
┌─────────────────────────────────────────────────────────────────┐
│ IIASA - CO2 TECHNOLOGY DATA BANK                    General Data │
│                                                                 │
│   Technology name: _____       │
│   ID: id75_____  Availability:  technical ____  commercial    │
│   No:  75_____  By: _____  Valuation: ___ │
│                                                                 │
│   Invention:  ____   Innovation:     ____   Prototype:      ___ │
│   Commercial: ____   1% market share: ____  50% market share: __ │
│   Life-cycle phase: _____       │
│                                                                 │
│   Notes:       _____       │
│                _____       │
│                _____       │
│                _____       │
│                _____       │
│                _____       │
│                _____       │
│                                                                 │
│   Keywords: Sector: _____  Type:  _____   │
│            Output: _____  Input: _____   │
│   Addit. info in: file _____  hard copy _____   │
└─────────────────────────────────────────────────────────────────┘
  Shift-F1: Key Help, ALT-M: Menu, F9: save, F10: cancel
```

Figure 4: General Data Menu.

The **General Data Menu** is the main table of the technology, which can only occur once per technology. The general information displayed on all technology tables can be entered here. The following items can be entered in this table:

Technology name: identification of the technology. This identification is used to identify the technology in selection menus, for printing and chain calculations.

ID: unique identifier of the technology. CO2DB provides a unique identifier composed of the string "id" concatenated with the number of the technology.

Availability, technical: year in which the technology is thought to be technologically available.

Availability, commercial: year in which the technology is thought to be commercially available and for that the economic data are given (if not stated differently).

No: number of the technology in the data bank. This is automatically given by CO2DB and cannot be changed by the user.

By: person who collected the data. Persons identified in the program settings can enter an @ followed by their initials; the name will be filled in by CO2DB (see *Systems Documentation of CO2DB*).

Valuation: personal assessment of quality and credibility of data.

Invention: year in which underlying invention took place.

Innovation: year in which related innovation took place.

Prototype: year in which first prototype was/will be constructed.

Commercial: year in which first commercial model was/will be constructed.

1% market share: year in which 1% market share was/will be reached.

50% market share: year in which 50% market share was/will be reached.

Life-cycle phase: description of present life-cycle phase of the technology.

Note: general comments on the technology.

Sector: sector the technology belongs to (e.g., electricity generation, transport sector). The sector must match one of the identifications from a predefined list (see *Systems Documentation of CO2DB*).

Type: category of CO_2 measures which the technology falls into (e.g., efficiency improvement, active CO_2 management). The category must match one of the identifications from a predefined list (see *Systems Documentation of CO2DB*).

Output: level of main energy output of the technology (e.g., secondary, useful). Level must match one of the identifications from a predefined list (see *Systems Documentation of CO2DB*).

Input: level of main energy input of the technology (e.g., primary, secondary). Level must match one of the identifications from a predefined list (see *Systems Documentation of CO2DB*).

Addit. info in: file: file with additional information (stored in a predefined subdirectory, see *Systems Documentation of CO2DB*). The file can be edited from all technology menus with sF5.

Addit. info in: hard copy: additional information (e.g., drawing of process flow, chemical formulas) is stored in a physical (paper) file which is identified here.

Table 2 gives an overview of all keys available in the technology selection menus.

3.3 Technical Data

The **Technical Data Menu** (see Figure 5) is reached by selecting technical data from the **Main Selection Menu**, by chosing this table in the **Technology Selection Menu** for one of the technologies available, or by moving from a neighboring table.

```
┌──────────────────────────────────────────────────────────────────┐
│ IIASA - CO2 TECHNOLOGY DATA BANK                   Technical Data  │
│                                                                    │
│  Technology name: _____        │
│  ID: id75_____   Availability:  technical ____  commercial  __   │
│  No:    75_____   By: _____  Valuation: _____  │
│                                                                    │
│  Table ID: _____   _____                                     │
│                                                                    │
│  Unit size: _____  [_____ __]  Constr. time: __ Pll: _____ [__] │
│  Technical availab.: _____  [___]  Average utilization: _____ [__]  │
│                                                                    │
│  Inputs:  Quantity:   Unit:        Outputs:  Quantity:   Unit:      │
│  _____  _____  [_____]    _____  _____  [_____]   │
│  _____  _____  [_____]    _____  _____  [_____]   │
│  _____  _____  [_____]    _____  _____  [_____]   │
│  _____  _____  [_____]    _____  _____  [_____]   │
│  _____  _____  [_____]    _____  _____  [_____]   │
│                                                                    │
│  Note:    _____        │
│                                                                    │
├──────────────────────────────────────────────────────────────────┤
│ Shift-F1: Key Help, ALT-M: Menu, F9: save, F10: cancel             │
└──────────────────────────────────────────────────────────────────┘
```

Figure 5: Technical Data Menu.

The **Technical Data Menu** gives information on the technical performance of the technology. The table can exist several times for each technology. The items (Technology name; ID; Availability, technical; Availability, commercial; No; By; and Valuation) are only displayed in this menu and can be changed in the **General Data Menu** of the technology. The following items can be entered in this table:

Table ID: unique identification of table. This is preset by CO2DB using the table type (tec), the number of the technology, and the number of the table of this type. It can be changed by the user, but has to be unique.

Unit size: unit size in which the technology can be constructed; three items (number, unit, and relation, e.g., 100 MW MO: 100 MW relative to main energy output). The unit has to be defined among the power units for energy-conversion technologies; the third item can be set to MO (main output), MI (main input), TO (total output), and TI (total input).

Construction time: duration of construction of one unit of technology, given in years; shorter times are not taken into account.

Pll: plant life, i.e., maximum time of technical operation of one unit (e.g., 2000 hours for light bulbs, 30 years for power plants).

Technical availab.: maximum availability for technical reasons (e.g., because of service time or failures) per year (e.g., 98 %).

Average utilization: average utilization of the technology per year (e.g., 6000 hours per year). If the plant life is given in terms of operation hours, the average utilization has to be set to 100 % to remain consistent in the chain calculations.

Inputs: identification of energy inputs used by the technology. Identifications are used to connect energy-conversion chains in chain calculations (e.g., "hard coal"). For energy-conversion technologies, the identifier has to be defined at the level of energy carriers chosen for this technology in the General Data Menu for the input.

Quantity: amount of the energy input going into the technology relative to the outputs quantified (if the energy flow is defined as efficiency, 1. is given here).

Unit: unit in which energy inputs are given (e.g., tce). If the energy flow is defined as efficiency, i.e., the unit of the energy inputs and energy outputs is the same, the units can be omitted. For energy chain calculations, the units have to be identified in the conversion table that can be displayed with aF1 (see also *Systems Documentation of CO2DB*).

Outputs: identification of energy outputs of the technology. Identifications are used to connect energy-conversion chains in chain calculations (e.g., "electr." for electricity). For energy-conversion technologies, the identifier has to be defined at the level of energy carriers chosen for this technology in the General Data Menu for the output.

Quantity: amount of the energy output produced by the technology relative to the inputs quantified (if the energy flow is defined as efficiency, the efficiency, e.g., 0.34, is given here).

Unit: unit in which energy outputs are given (e.g., kWh). If the energy flow is defined as efficiency, i.e., the unit of the energy inputs and energy outputs is the same, the units can be omitted. For energy chain calculations, the units have to be identified in the conversion table that can be displayed with aF1 (see also *Systems Documentation of CO2DB*).

Note: general comments on the technical information for the technology.

The data on plant life and average utilization are used for calculating the average cost of a technology, if chain calculations are performed. If no data are supplied, defaults are used (30 years for plant life and 100% for availability)

Table 2 gives an overview of all keys available in the technology selection menus.

3.4 Economic Data

The Economic Data Menu (see Figure 6) is reached by selecting economic data from the Main Selection Menu, by chosing this table in the Technology Selection Menu for one of the technologies available, or by moving from a neighboring table.

```
┌────────────────────────────────────────────────────────────────┐
│ IIASA - CO2 TECHNOLOGY DATA BANK                  Economic Data  │
│                                                                  │
│   Technology name: _____ │
│   ID: id75_____   Availability: technical ____ commercial      │
│   No:    75_____   By: _____ Valuation: __ │
│                                                                  │
│   Table ID: _____  _____  Costs per __                  │
│                                                                  │
│   Currency: _____  Year: ____                                │
│                                                                  │
│   Investment costs:      _____   [_____]                   │
│   Fixed O+M costs:       _____   [_____]                   │
│   Variable O+M costs:    _____   [_____]                   │
│   Fuel costs:            _____   [_____]                   │
│   Decomissioning costs:  _____   [_____]                   │
│                                                                  │
│   Total (excl. fuel):    _____   [_____]                   │
│   Total (incl. fuel):    _____   [_____]                   │
│                                                                  │
│   Note:      _____          │
│              _____          │
│                                                                  │
├────────────────────────────────────────────────────────────────┤
│ Shift-F1: Key Help, ALT-M: Menu, F9: save, F10: cancel           │
└────────────────────────────────────────────────────────────────┘
```

Figure 6: Economic Data Menu.

The Economic Data Menu gives information on the economic performance of the technology. The table can exist several times for each technology. The items (Technology name; ID; Availability, technical; Availability, commercial; No; By; and Valuation) are only displayed in this menu and can be changed in the General Data Menu of the technology. The following items can be entered in this table:

Table ID: unique identification of table. This item is preset by CO2DB using the table type (eco), the number of the technology, and the number of the table of this type. It can be changed by the user, but has to be unique.

Costs per: cost data can be given per MO (main output), MI (main input), TO (total output), and TI (total input) (mandatory input).

Currency: currency in which data are given (e.g., US$ or DM). For chain calculations, cost data of all technologies will be converted to a common unit. The currency has to be defined in the currency conversion table, which can be displayed by entering key aF1.

Year: year for which cost data are given; used for conversion to common year unit (e.g., US$85 must be converted to US$90). For chain calculations, cost data of all technologies will be converted to a common unit. The currency and year have to be defined in the currency conversion table, which can be displayed by pressing aF1 (see also *Systems Documentation of CO2DB*).

Investment costs: investment cost, usually per unit of installed capacity for the main output (in case of, e.g., CHP per unit of installed electric or total capacity) (value and unit, e.g., 1000 US$/kW). For energy-conversion technologies, the power unit used has to be defined in the conversion table and is displayed by entering aF1.

Fixed O+M costs: fixed operating and maintenance cost per year, usually per same unit as investment cost per year (value and unit, e.g., 10 US$/kW/yr). For energy-conversion technologies, the power unit used has to be defined in the - conversion table, displayed by pressing aF1.

Variable O+M costs: variable operating and maintenance cost per unit of output excluding fuel cost (value and unit, e.g., 1 US$/kWh). For energy-conversion technologies, the energy unit used has to be defined in the conversion table and is displayed by typing aF1.

Fuel costs: fuel costs usually per unit of energy input (value and unit, e.g., 1 US$/tce). For energy-conversion technologies, the energy unit used has to be defined in the conversion table displayed by entering aF1.

Decommissioning costs: decommissioning cost, usually per same unit as investment cost (value and unit, e.g., 100 US$/kW). For energy-conversion technologies, the power unit used has to be defined in the conversion table displayed by entering aF1.

Total (excl. fuel): total cost of system excluding fuel cost, usually per same output as variable O+M cost (value and unit, e.g., 1 US$/kWh). For energy-conversion technologies, the energy unit used has to be defined in the conversion table displayed with aF1. The total costs excluding fuel costs can be calculated by CO2DB from the other cost information by pressing the insert key (INS).

Total (incl. fuel): total cost of system including fuel cost, usually per same output as variable O+M cost (value and unit, e.g., 1 US$/kWh). For energy-conversion technologies, the energy unit used has to be defined in the conversion table displayed with aF1. The total costs including fuel costs can be calculated by CO2DB from the other cost information by pressing the insert key (INS).

Note: general comments on the economic information for the technology.

All cost data can be converted to the unit used for chain calculations by positioning the cursor on the field and pressing ^V. Caution: After all data have been changed, currency and year will have to be adapted manually!

Table 2 gives an overview of all keys available in the technology selection menus.

3.5 Environmental Data

The Environmental Data Menu (see Figure 7) is reached by selecting environmental data from the Main Selection Menu, by chosing this table in the Technology Selection Menu for one of the technologies available, or by moving from a neighboring table.

```
┌─────────────────────────────────────────────────────────────────────┐
│ IIASA - CO2 TECHNOLOGY DATA BANK                    Environmental Data │
│                                                                       │
│   Technology name: _____        │
│   ID: id75_____   Availability: technical ___ commercial ___        │
│   No:    75_____   By: _____ Valuation: _____   │
│                                                                       │
│   Table ID: _____  _____       Figures per _                  │
│                                                                       │
│   Pollutants:     Quantity:  Unit:                                     │
│   _____  _____  [_____]                                 │
│   _____  _____  [_____]                                 │
│   _____  _____  [_____]                                 │
│   _____  _____  [_____]                                 │
│   _____  _____  [_____]                                 │
│   _____  _____  [_____]                                 │
│   _____  _____  [_____]                                 │
│   _____  _____  [_____]                                 │
│                                                                       │
│   Note:     _____              │
│             _____              │
├─────────────────────────────────────────────────────────────────────┤
│ Shift-F1: Key Help, ALT-M: Menu, F9: save, F10: cancel                │
└─────────────────────────────────────────────────────────────────────┘
```

Figure 7: Environmental Data Menu.

The Environmental Data Menu gives information on the environmental performance of the technology. The table can exist several times for each technology. The items (Technology name; ID; Availability, technical; Availability, commercial; No; By; and Valuation) are only displayed in this menu and can be changed in the General Data Menu of the technology. The following items can be entered in this table:

Table ID: unique identification of table. This item is preset by CO2DB using the table type (env), the number of the technology, and the number of the table of this type. It can be changed by the user, but has to be unique.

Figures per: emission data can be given per MO (main output), MI (main input), TO (total output), and TI (total input) (mandatory input).

Pollutants: identification of pollutant/emittant to be accounted for (e.g., ash, SO_2, methane). In chain calculations, pollutants with the same identification in the technologies of the chain will be totaled.

Quantity: amount emitted (or taken from the atmosphere/reduced for negative figures).

Unit: unit in which the amount is given (e.g., grams per vehicle-km, grams per MJ output).

Note: general comments on the emission data for the technology.

Table 2 gives an overview of all keys available in the technology selection menus.

3.6   Materials and Labor Data

The **Materials and Labor Data Menu** (see Figure 8) is reached by selecting material
and labor data from the **Main Selection Menu**, by chosing this table in the
Technology Selection Menu for one of the technologies available, or by moving from a
neighboring table.

```
┌─────────────────────────────────────────────────────────────────────────┐
│ IIASA - CO2 TECHNOLOGY DATA BANK              Materials and Labour Data   │
│                                                                           │
│  Technology name: _____              │
│  ID: id75_____   Availability:  technical ‾__  commercial ____         │
│  No:    75_____   By: _____  Valuation: _____      │
│                                                                           │
│  Table ID: _____  _____        Figures per __                      │
│                                                                           │
│  Requirements during construction:   Requirements during operation:      │
│             Quantity:  Unit:                    Quantity:  Unit:          │
│  Labour:   _____   [_____]      _____   [_____]             │
│  Materials:                                                               │
│  _____ _____   [_____]      _____   [_____]             │
│  _____ _____   [_____]      _____   [_____]             │
│  _____ _____   [_____]      _____   [_____]             │
│  _____ _____   [_____]      _____   [_____]             │
│  _____ _____   [_____]      _____   [_____]             │
│  _____ _____   [_____]      _____   [_____]             │
│                                                                           │
│  Note:     _____               │
│            _____               │
├─────────────────────────────────────────────────────────────────────────┤
│ Shift-F1: Key Help, ALT-M: Menu, F9: save, F10: cancel                    │
└─────────────────────────────────────────────────────────────────────────┘
```

Figure 8: Materials and Labor Data Menu.

The **Materials and Labor Data Menu** gives information on the labor and material
requirements during construction and operation of the technology. The table can exist
several times for each technology. The items (Technology name; ID; Availability,
technical; Availability, commercial; No; By; and Valuation) are only displayed in this
menu and can be changed in the **General Data Menu** of the technology. The following
items can be entered in this table:

Table ID: unique identification of table. This item is preset by CO2DB using the table
type (**mat**), the number of the technology, and the number of the table of this
type. It can be changed by the user, but has to be unique.

Figures per: material/labor requirements can be given per MO (main output), MI
(main input), TO (total output), and TI (total input) (mandatory input).

Requirements during construction:

Labor Quantity: amount of labor required during construction.

Labor Unit: unit in which labor requirements during construction are given
(e.g., MM/MW).

Materials: identification of materials used during construction (e.g., use of glass
for PV-modules).

Materials Quantity: amount of material required during construction.

Materials Unit: unit in which material requirements during construction are given (e.g., kg/kW).

Requirements during operation:

Labor Quantity: amount of labor required during operation.

Labor Unit: unit in which labor requirements during operation are given (e.g., Mh/MWh).

Materials: identification of materials used during operation.

Materials Quantity: amount of material required during operation.

Materials Unit: unit in which material requirements during operation are given (e.g., g/kWh).

Note: general comments on the material and labor data for the technology.

Table 2 gives an overview of all keys available in the technology selection menus.

3.7   Miscellaneous Data

The Miscellaneous Data Menu (see Figure 9) is reached by selecting
producers/applications from the Main Selection Menu, by chosing this table in the
Technology Selection Menu for one of the technologies available, or by moving from a
neighboring table.

```
┌─────────────────────────────────────────────────────────────────────────┐
│ IIASA - CO2 TECHNOLOGY DATA BANK                       Miscellaneous Data │
│                                                                           │
│   Technology name: _____        │
│   ID: id75_____   Availability: technical ____ commercial             │
│   No:    75_____    By: _____  Valuation: _____        │
│                                                                           │
│   Table ID: _____  _____                                          │
│                                                                           │
│   Region:        _____           │
│   Producer:      _____           │
│   Research:      _____           │
│   Prerequ.:      _____           │
│                                                                           │
│   Limits:                                      Quantity:  Unit:           │
│             _____  _____  [_____]              │
│             _____  _____  [_____]              │
│             _____  _____  [_____]              │
│             _____  _____  [_____]              │
│             existing installations   #_____  _____  [_____]       │
│   Note:     _____                │
│                                                                           │
├─────────────────────────────────────────────────────────────────────────┤
│ Shift-F1: Key Help, ALT-M: Menu, F9: save, F10: cancel                    │
└─────────────────────────────────────────────────────────────────────────┘
```

Figure 9: Miscellaneous Data Menu.

The Miscellaneous Data Menu gives additional information on regional aspects of the
introduction of the technology. The table can exist several times for each technology.
The items (Technology name; ID; Availability, technical; Availability, commercial; No;
By; and Valuation) are only displayed in this menu and can be changed in the General
Data Menu of the technology. The following items can be entered in this table:

Table ID: unique identification of table. This item is preset by CO2DB using the table
    type (mis), the number of the technology, and the number of the table of this
    type. It can be changed by the user, but has to be unique.

Region: geographical area for which limits, existing installations, and so on are given;
    preferably classification according to IIASA regions (see Appendix A for a
    definition of the regions).

Producer: institutions, companies, or individuals producing prototypes, etc.

Researcher: institutions, companies, or individuals performing research in the area.

Prerequ.: prerequisites for the application, e.g., minimum wind velocities, additional
    research in a specific area.

Limits: definition of limits on market penetration, maximum annual new installation,
    maximum share of the market that can be covered, etc.

Quantity: numerical value for the limit.

Unit: unit in which the limit is given (e.g., maximum growth 1.5% per year, maximum of two GW new installations per year).

Existing installations: number of present installations (for country/region defined), e.g., three units of an integrated gasification combined cycle power plant are already installed in a region.

Quantity: total current capacity (for country/region defined).

Unit: unit current capacity (given in, for example, GW).

Note: general comments on the limits and regional data for the technology.

Table 2 gives an overview of all keys available in the technology selection menus.

3.8 Literature

The Literature Menu (see Figure 10) is reached by selecting literature from the Main Selection Menu, by chosing this table in the Technology Selection Menu for one of the technologies available, or by moving from a neighboring table.

```
┌──────────────────────────────────────────────────────────────────────┐
│ IIASA - CO2 TECHNOLOGY DATA BANK                           Literature  │
│                                                                        │
│  Technology name: _____           │
│  ID: id75_____  Availability:  technical ____ commercial  ____       │
│  No:    75_____  By: _____ Valuation: _____     │
│                                                                        │
│  Table ID:  _____ _____                                          │
│                                                                        │
│  Book title:  _____         │
│                                                                        │
│  Chap. title: _____         │
│                                                                        │
│  Author:      _____         │
│  Publisher:   _____         │
│                                                                        │
│  Type:        _____  Year: ____   IIASA-Nr.: _____           │
│  Access:      _____         │
│                                                                        │
│  Note:        _____         │
│               _____         │
│               _____         │
└──────────────────────────────────────────────────────────────────────┘
  Shift-F1: Key Help, ALT-M: Menu, F9: save, F10: cancel
```

Figure 10: Literature Menu.

The Literature Menu gives information on the data source used to compile the information. The table can exist several times for each technology. The items (Technology name; ID; Availability, technical; Availability, commercial; No; By; and Valuation) are only displayed in this menu and can be changed in the General Data Menu of the technology. The following items can be entered in this table:

Table ID: unique identification of table. This item is preset by CO2DB using the table type (lit), the number of the technology, and the number of the table of this type. It can be changed by the user, but has to be unique.

Book title: title of journal, book, and so on.

Chap. title: title of article, chapter in book, and so on.

Author: author of article, contacts for more information, and so on.

Publisher: company or institution where author is employed, publisher of book, name of journal, and so on.

Type: book, proceedings, journal article, personal communication, report.

Year: year of publication, volume of journal.

IIASA-No: IIASA accession number.

Access: Information on how to obtain a copy of the book or journal.

Note: general comments on the literature source.

Table 2 gives an overview of all keys available in the technology selection menus.

3.9   Subwindows

3.9.1   Special Key Display

The settings of special keys in the technology menus will be displayed in a subwindow when sF1 is hit. Table 2 shows the functions of these special keys.

Table 2: Special keys in the technology menus.

Key	Description
F1	field help
sF1	key help
^F1	screen help
F2	enter query selection
aF2	switch query off
F3	enter technology selection
sF3	print screen
^F3	dump screen
F4	enter chain calculation
sF4	delete technology/table
F5	goto field by name
sF5	edit info file
^F5	show field name
F6	goto first technology
sF6	goto next technology
^F6	goto previous technology
aF6	goto last technology
F7	clear field
sF7	clear all fields
F8	update current record
sF8	add record to db
F9	save and return to main menu
sF9	save and goto next menu
^F9	save and goto prev menu
aF9	save and exit
F10	quit and return to main menu
sF10	quit and goto next menu
^F10	quit and goto prev menu
aF10	exit
aF1	show units table
aF1aF1	show current units
^q	show tables used in query
^v	convert monetary data to current units (only in ECO tables, cost fields)
^y,^z	goto system
^u	undo last change
^r,^l	refresh screen
^w	show program status
^c	leave application
NEXT_PG	get next subtable
PREV_PG	get previous subtable
HOME	goto first field
END	goto last field
TAB	goto other column
INS	calculate total cost (only in ECO table, total cost fields)

3.9.2   Program Status

In all technology data menus and in the General Selection Menu and Technology Selection Menu, control key ^W opens a subwindow containing information on the

status of the current program. Figure 11 shows how this subwindow is opened on the **General Selection Menu**.


```
IIASA - CO2 TECHNOLOGY DATA BANK                         General Data

Technology name: _____
ID: id76_____ Availability: technical _____ commercial      _____
N_____ Valuation: _____
 |Mode:      enter  |
I|query      off    |Innovation:        _____  Prototype:        _____
C|drate      0.06   |1% market share: _____    50% market share: _____
L|resfile    ask    |
 |max_tn     75     |_____
N|curr_tn    76     |_____
 |new_sub_t  1      |_____
 |tabid      id76   |_____
 |date       14. 9.91|_____
 |time       19:10  |_____
 |USER       sabine |_____

Keywords: Sector: _____   Type:  _____
           Output: _____   Input: _____
Addit. info  in: file _____        hard copy _____

UP,DOWN to move; RIGHT,LEFT to switch; ENTER to finish
```

Figure 11: Program Status Subwindow.

This subwindow shows the following lines of information; the first four can be changed interactively using the cursor keys:

mode: CO2DB can be in show, edit, or enter mode (see also Section 3.1). In the program status subwindow, this mode can be changed by positioning the cursor on the corresponding line and using key right or key left to switch.

query: query selection can be off or on. If selection is on, cursor right will turn it off. The use of the CO2DB query selection mechanism is explained in Section 4.3.

d_rate: discount rate used for calculating total system costs. Key right or key left will increase or decrease the discount rate.

resfile: handling of results from chain calculations. Five options are available; switching is done using right and left cursor movements:

   appnd: append to existing result file;
   owrit: overwrite existing result file;
   new: generate new result file;
   move: rename existing result file;
   ask: ask for action to be taken at each calculation (default).

max_tn: number of technologies available in the data bank (cannot be changed).

curr_tn: number of technology currently selected (cannot be changed).

new_sub_t: identification, if current table is new (1), otherwise (0).

tabid: identifier (ID) of table selected (cannot be changed).

date: current date (cannot be changed).

time: current time (cannot be changed).

user: login identification of user (cannot be changed). Under DOS user will be substituted by freemem, a line displaying the free memory in the data segment in bytes.

The program status subwindow will be cleared if ENTER is hit.

3.9.3 Help Information

If one of the three types of help available within CO2DB (see Section 2.6) is called up, a subwindow will be opened showing the help information (see Figure 12 for an example of a field help). If extended help is needed, such as field names available for the goto function (F5 for goto, F1 for information on the fields available), the cursor can be used to select a field by pressing F9. The subwindow is erased and the original window restored by typing ESC or F10.

```
┌─────────────────────────────────────────────────────────────────────┐
│ IIASA - CO2 TECHNOLOGY DATA BANK                       Technical Data │
│                                                                       │
│   Technology name: _____  │
│ ┌───────────────────────────────────────────────────────────────────┐│
│ │ Name of Input 1                                      Length: 10    ││
│ │                                                                    ││
│ │ Identification of energy input.  Can be chosen by the user;        ││
│ │ If interlinked chains are to be evaluated, the identifiers         ││
│ │ chosen here have to provide the links between the technologies.    ││
│ │                                                                    ││
│ └───────────────────────────────────────────────────────────────────┘│
│    Inputs:    Quantity:   Unit:        Outputs:   Quantity:   Unit:    │
│                          [        ]                         [        ] │
│    _____    _____      [_____]    _____     _____    [_____] │
│    _____    _____      [_____]    _____     _____    [_____] │
│    _____    _____      [_____]    _____     _____    [_____] │
│    _____    _____      [_____]    _____     _____    [_____] │
│    _____    _____      [_____]    _____     _____    [_____] │
│                                                                       │
│    Note:          _____       │
│                   _____       │
├─────────────────────────────────────────────────────────────────────┤
│ Keys: F1: help, ESC: exit                                             │
└─────────────────────────────────────────────────────────────────────┘
```

Figure 12: Example of a field help subwindow.

In the field and screen help windows, entering F1 again will provide additional information on how to change the help screen and how to move within the help screen (see Table 3).

Table 3: Options available in help mode.

Key	Description
Key left	move help window up (or ^L)
Key right	move help window down (or ^H)
INS	increase help window size
DEL	decrease help window size
HOME	goto first line of help
END	goto last line of help
Page up	one page up
Page down	one page down
Key up	one line up (or ^K)
Key down	one line down (or ^J)

3.9.4   Units

In all technology data menus and in the Main Selection Menu, key aF1 will display four subwindows showing the current setting of the following items (see also Figure 13):

- Multiples which can be used for all units (e.g., M for Mega=10^6).

- Energy units and conversion factors of the main unit which is the unit in the first line, Wyr in Figure 13 (e.g., tce with 863).

- Power units and conversion factors of the main unit which is the unit in the first line, W in Figure 13.

- Monetary units and conversion factors of the main unit which is the unit in the first line, US$(90) in Figure 13.

```
┌Multiples┐┌Energy units────────┐┌Power units──────────┐┌Monetary units──────┐
│m   0.001││Wyr              1  ││W                 1  ││US$(90)            1 │
│k    1000││boe            184  ││boe/d      6.51e+04  ││US$(89)         1.04 │
│M   1e+06││toe        1.33e+03 ││boe/yr         178  ││US$(88)         1.08 │
│G   1e+09││tce            863  ││tce/yr         892  ││US$(87)         1.12 │
│T   1e+12││quad       3.31e+10 ││toe/yr     1.31e+03  ││US$(85)         1.18 │
│E   1e+15││BTU        3.31e-05 ││hp             750  ││US$(80)         1.53 │
│P   1e+18││cal        1.32e-07 │└─────────────────────┘│AS(90)        0.0937 │
└─────────┘│Wh         0.000114 │                        │SEK(90)       0.176 │
           │J          3.2e-08  │                        │US$(86)         1.15 │
           └────────────────────┘                        └─────────────────────┘

      Fixed O+M costs:        _____   [_____]
      Variable O+M costs:     _____   [_____]
      Fuel costs:             _____   [_____]
      Decomissioning costs:   _____   [_____]

      Total (excl. fuel):     _____   [_____]
      Total (incl. fuel):     _____   [_____]

      Note:                   _____

 ─────────────────────────────────────────────────────────────────────
  Keys: aF1: current units, any: quit
```

Figure 13: Units subwindows.

Entering aF1 again, an additional window will be displayed that allows the user to change the main unit used for chain calculations (see Section 4.2). The units are changed using the cursor keys to position the cursor to change the entry. Changes are saved by typing F9; the submenu can be left without saving by typing F10.

3.9.5 Import Data

Technology data that have been exported from this or another data bank (see Section 4.1.2) can be imported into the current data bank. CO2DB can import data from different directories on a computer, enhancing communication between members of a group cooperating on the development of a specific data bank. The directories for importing data can be set in the setup file (CO2_SET, see *Systems Documentation of CO2DB*). The directory where files are imported has to contain a setup file as well to determine where the additional files are to be copied from (see Section 3.1 for the definition of the additional file).

Typing an i in the Main Selection Menu or selecting the corresponding line will initiate import. Then the following steps have to be taken:

1. CO2DB displays a list of directories from which data can be imported (see *Systems Documentation of CO2DB*). One of these directories can be chosen by positioning the cursor on the corresponding line and pressing F9.

2. The next subwindow displays all export files available in this directory for import. At this point several options are available. If one is chosen, the action taken will be indicated by displaying the character listed in column ind in the following table next to the name of the file. The actions available are as follows:

Key	Description	ind
F9	import file	r
sF9	import and delete file	x
^F9	delete file	d
F10	stop importing	

3. If import was chosen, CO2DB asks if all or only selected technologies should be imported from that file. If only selected technologies are to be imported, CO2DB will ask for confirmation for each technology on the export file.

4. Next, CO2DB asks if it should change conflicting table identifiers (see Section 2.9) with or without asking for confirmation.

5. If conflicting table identifiers should be resolved interactively, CO2DB displays the conflicting identifiers together with the suggested new identifier; the user can choose an identifier by typing it or accept the suggested name by just hitting ENTER.

   If it is not possible to resolve conflicts by just using the current technology number (i.e., the current number was used in a technology already present in the data bank), CO2DB asks for a new identifier, and the user has to provide a unique id).

If an import file refers to an additional file that cannot be found on the disk, CO2DB will display the name of the file not available, and the user has to hit ENTER to continue. If CO2DB should create a file under a name already used, an error-message is issued and a new filename has to be given.

3.9.6   Additional Information File

By pressing sF5 in one of the technology data menus, an information file for the current technology is edited. The filename of this file is to be given in the General Technology Data, item Addit. info in: file.

The path to this file has to be set correctly in the setup file, and the editor used has to be defined in the environment variable ED or EDITOR (see *Systems Documentation of CO2DB*). Default setting is the UNIX editor vi, which under DOS is available with the MKS Toolkit.

4 Special Menus

4.1 Technology Selection Menu

The Technology Selection Menu can be called from all technology menus and from the Main Selection Menu using function key F3. Figure 14 shows an example of this menu.

```
┌──────────────────────────────────────────────────────────────────────┐
│                      TECHNOLOGY SELECTION MENU                         │
│ ┌Num Name                                       TEC ECO ENV MAT MIS LIT┐│
│   65 IGCC without CO2 recovery, basis for IGCC-rec   1   1   1   0   0   1│
│   66 IGCC with CO2 recovery by shift reaction        1   1   1   0   0   1│
│   67 Hydrocarb process, natural gas based            1   0   0   0   0   0│
│   68 Hydrocarb process, coal to hydrogen             1   1   0   0   0   1│
│   69 Hydrocarb process, coal to SNG                  1   1   0   0   0   1│
│   70 Hydrocarb, Natural gas to hydrogen              1   0   0   0   0   0│
│   71 Pulverized coal fired power plant               1   1   0   0   0   1│
│   72 Pulverized coal fired power plant with CO2 rec...1   1   0   0   0   1│
│   73 Natural gas fired combined cycle ppl            1   1   0   0   0   1│
│   74 Natural gas fired cc ppl with CO2 recovery      1   1   0   0   0   1│
│                                                                        │
│                                                                        │
│                                                                        │
│                                                                        │
│                                                                        │
│                                                                        │
│ Keys: F1: help, sF1: key-help, KEY/PG-UP/DOWN, F9: select, F10: quit   │
└──────────────────────────────────────────────────────────────────────┘
```

Figure 14: Technology Selection Menu.

For each technology one line of information is displayed:

Num: number of the technology.

Name: identification of the technology (Technology Name).

TEC: number of Technical Data Tables.

ECO: number of Economic Data Tables.

ENV: number of Environmental Data Tables.

MAT: number of Labor and Material Data Tables.

MIS: number of Miscellaneous Data Tables.

LIT: number of Literature Data Tables.

The Technology Selection Menu allows the user to select, print, and export technologies. Normal cursor motion keys (left, right, up, down, Page up, Page down, HOME, and END) can be used to move the cursor to select a technology and a column corresponding to a table type. Table 4 shows the keys available in the Technology Selection Menu.

Table 4: Special keys in the Technology Selection Menu.

Key	Description
ENTER	goto next line
UP	cursor up
DOWN	cursor down
TAB	cursor to next field
RIGHT	cursor to next field
BTAB	cursor to prev field
LEFT	cursor to prev field
END	cursor to last line
HOME	cursor to first line
NEXT_PG	next page
PREV_PG	previous page
t	tag/untag for print/export
u	untag all
sF4	delete technology
^F7	export to unity-tc
F8	print table
sF8	print/export technology
^F8	print/export all technologies
F9	select technology/table
F10	return
^r, ^l	refresh screen

4.1.1　Select a Technology

A technology can be selected for further processing (i.e., viewing, editing, or entering data in its tables) by positioning the cursor on the corresponding line, and a table type can be selected by positioning the cursor in the corresponding column of the technology; they will be selected by pressing F9. If more than one table exists of the type selected, a subwindow will present the existing tables, identified by the table identifier (Table ID in the corresponding menu), for choice.

4.1.2　Print and Export Technology Data

The print and export option of CO2DB allows the user to access four operation modes:

1. Print/export the table where the cursor is positioned (key F8, in the current version single tables cannot be imported).

2. Print/export the technology where the cursor is positioned (key sF8).

3. Print/export selected technologies: the technologies to be printed are tagged by typing t in the corresponding line; another t untags it; and u untags all. Key ^F8 can be used to print or export all tagged technologies.

4. Print/export all technologies: if no technologies are tagged, key ^F8 will print/export all technologies in the data bank.

After printing/exporting is initiated, CO2DB asks if the user wishes to print (make a hard copy) or export the selected technologies; the answer can be e for export, h for hard copy, or q to quit. Other entries will be ignored. Both the hard copy files and the export files have predefined names. If a file with the name to be used exists, CO2DB will ask for confirmation to continue and overwrite that file.

The file names generated as hard copy or export files have the structure listed in Table 5. The *Systems Documentation of CO2DB* describes the format of the import/export files.

Table 5: File names of export and hard copy files.

Files exported using print and export technology data

```
co2_ttt.n
     ttt ... exp for export files
             tab for hard copy (print) files
       n ... no of first technology on the file
```

Files exported using sF3

```
ttt_tn_sn.prt
     ttt ... identification of table
             (gen, tec, eco, env, mat, mis, lit)
      tn ... no of technology
      sn ... no of table
```

Hard copy files include special characters to generate boxes and can be printed on HP Laserjet or emulating laser printers. A setup string for the printer can be supplied in the setup file. Appendix B shows the format of such print files. Export files can be imported into other data banks. They also provide the option to communicate the contents of the data bank over different types of operating systems. Data bank files as such cannot be moved to another operating system or type of hardware[3].

---

[3]db_VISTA also has import/export functions that allow the user to exchange data via ASCII files, but for the specific task the mechanism suggested provides easier handling.

4.2   Chain Calculation

CO2DB offers the option to calculate the overall economic and environmental performance of a chain of energy conversion technologies. The chain of technologies has to be defined starting from the technology providing the final output of the chain to the technology in the conversion chain which consumes the energy input to the chain. The technologies of the chain are automatically linked using the names of the energy inputs and outputs of the technologies (defined in the Technical Data Menu, see Section 3.3).

The overall efficiency of the energy chain is calculated from the efficiencies of the single technologies (by mere multiplication, taking into account the energy unit conversion factors where necessary).

The overall economic performance is calculated by moving through the energy chain from the input to the output of the chain; each technology provides the energy input and therefore fuel costs for the previous technology (fuel costs given in the Economic Data Menu are only considered for the last technology in the chain, usually primary energy supply). The specific output cost for a technology are calculated according to:

$$c_{tot} = \left[\frac{(1+dr)^{pll} \times dr}{(1+dr)^{pll} - 1} \times c_{inv} + \frac{dr}{(1+dr)^{pll} - 1} \times c_{dec} + c_{fom} \right] \times \frac{1}{ut} + c_{vom} + \frac{c_{fuel}}{\eta},$$

where

c_{tot}	total cost per unit of energy output;
c_{inv}	investment cost per unit of capacity;
c_{fom}	fixed annual operating and maintenance cost per unit of capacity;
c_{vom}	variable operating and maintenance cost per unit of energy output;
c_{fuel}	specific fuel cost per unit of energy input;
c_{dec}	specific decommissioning cost per unit of capacity;
pll	plant life of the technology in years;
ut	average utilization of the technology as fraction of the year;
η	efficiency of the technology (as fraction);
dr	discount rate (as fraction).

This formula is based on the assumption that all costs are given in comparable units (e.g., \$/kW for investment, \$/kW/yr for fixed O+M, and \$/kWyr for variable O+M and fuel costs). The fuel cost is taken either from the Economic Data Table (for the last technology in the chain) or from the output cost of the next technology in the energy chain. The cost data are defined in the Economic Data Table, efficiency, plant life, and utilization of the technology in the Technical Data Table; and the discount rate can be displayed and changed in the Program Status Submenu (see Section 3.9.2).

Overall performance of the energy chain is calculated for all pollutants defined for the technologies in the energy chain, taking into account the efficiencies of the single conversion steps.

4.2.1 Chain Calculation Menu

The Chain Calculation Menu can be called from all technology menus and from the Main Selection Menu using function key F4. It allows definition of energy-conversion chains, for which the overall parameters can be calculated. The information displayed in this menu is the same as in the Technology Selection Menu (Section 4.1), but the available functions differ. Table 6 shows the keys available in the Chain Calculation Menu.

Table 6: Special keys available in the Chain Calculation Menu.

Key	Description
ESC	cancel
UP	move cursor up
DOWN	move cursor down
HOME	goto first line
END	goto last line
ENTER	goto next line
F1	screen help
sF1	key help
aF1	show units
aF1 aF1	show/change selected units
F5	edit result file
F7	clear selection of technology in current line
sF7	clear selection of all technologies
F8	show technology data of technology in current line
sF8	show selected technologies
F9	select technology in current line
sF9	calculate chain
F10	cancel
^L,^R	refresh screen

The technologies to be included in a chain are selected using the key F9 starting from the technology providing the output of the chain. Each technology selected will get the number of the technology in the chain in the column left of the technology number. The key sF8 can be used to display the names of all technologies selected. The key F8 shows the economic data of the technology where the cursor is positioned (see Table 7 for a list). The key sF9 performs the chain calculation for the present selection. The result is written to the result file and to the screen. For the result file, several options are available that either can be set in the Program Status Subwindow (see Section 3.9.2, entry resfile) or, if ask is set there, can be chosen after pressing sF9. Next, the default units for calculating energy, power, and monetary items are displayed and can be changed. If they are ok, typing the key F9 will continue the chain calculation and display the result on the screen. Figure 15 shows the result of such a chain calculation for a chain providing final electricity generated from hard coal. The key F10 cancels this result screen and returns the program to the Chain Calculation Menu.

Pressing the key F7 cancels the technology where the cursor is positioned from the chain (only allowed for the end of the energy chain), and entering the key sF7 cancels the

Table 7: Technology data displayed when F8 is pressed in the Chain Calculation Menu.

Item	Description
in	identifier of energy input
out	identifier of energy output
inv	specific investment cost
fix	fixed O+M cost
var	variable O+M cost
fue	fuel cost
dec	decommissioning cost
pll	plant life
plf	average utilization
eff	efficiency between input and output

```
Chain no: 1

    Electricity Distribution
    Electricity Transmission
    Conventional Hard Coal Power Plant
    Hard Coal Mining, North America

    Investments:        2550.62     CO2             3.96 kg/Wyr
    Fix O+M:             104.90     CH4            45.55 kg/kWyr
    Var O+M:               0.02     CO              0.61 kg/kWyr
    Decommissioning:       0.00     NMVOC           0.05 kg/kWyr
    Fuel Cost:             0.00     NOx            15.53 kg/kWyr
                                    SO2            11.52 kg/kWyr
    Total cost:            0.07
    Total efficiency:     29.99%

    Unit:           US$(90) per
                    kWh electr. (energy)
                    kW electr. (power)
```

Figure 15: Result of chain calculation.

whole selection. A new chain can be defined and calculated afterward. The key F10 quits the Chain Calculation Menu.

For calculating an energy conversion chain, CO2DB has to know all energy, power, and monetary units defined in the technologies used in the chain and the conversion factors. The units available and the conversion factors can be displayed using aF1; and pressing aF1 a second time, the units used for displaying the results can be changed. The units and conversion factors can be changed by the data bank manager, see *Systems Documentation of CO2DB*.

4.2.2 Data Required and Used for Chain Calculation

For technologies to be included in chain calculations, at least the energy output (name
and quantity; unit if required) and energy input (besides the last technology in the chain
which might have no input, like coal mining) have to be provided. If the last technology
in the chain has an energy input, the specific cost of this input has to be given to be
included in the chain calculation.

For all other data CO2DB assumes default values for chain calculations:

Item	Default Value
Efficiency	100 %
Plant life	30 years
Utilization	100 %
All costs	0
All emissions	0

If total costs excluding fuel costs are given in the Economic Data Table, these are used
instead of the costs calculated from the individual cost figures (investment and O+M
costs). For the first technology, the total costs including fuel cost have highest priority.

The current version of CO2DB considers only the flows related to the first energy
input/output in the list of energy forms. Additional inputs are treated as having zero
costs and no related emissions; additional outputs provide no additional services/energy
products.

This caveat can be handled by including the costs for additional inputs as variable O+M
costs and the related emissions in the emission table. To incorporate different chains for
producing the additional inputs several subtables can be created. Future versions of
CO2DB will allow the user to select precalculated chains to represent additional inputs
in chain calculations.

4.3 Queries

CO2DB allows the user to perform queries using the contents of all fields. The commands of the queries can be stored on query files, which can be retrieved and adapted for further work.

The **Query Selection Menu** can be accessed from all technology menus and from the **Main Selection Menu** using function key **F2**. A subwindow displaying all available query files is opened; the query to be used can be chosen with **F9**. If **F9** is pressed in the first (empty) line, the default query is chosen; a nonstandard file name may also be entered and chosen in this line. The **Query Selection Menu**, which is displayed next (see Figure 16), consists of four columns of input fields:

&| logical link between selections:

- **&** or **a** – logical and
- **|** or **o** – logical or
- **#** or **x** – exclusive or

Attribute: fields from the technology tables which can be used to select specific technologies. They are added, removed, or changed by entering the subwindow with **^F2**.

OP: operators to compare attributes with the value(s) in criterion:

- **=** or **eq** – equality check.
  Example: **=** "**hard coal**": the string has to be equal to **hard coal**.
- **<** or **lt** – numerical less than, only for numerical values.
- **>** or **gt** – numerical greater than, only for numerical values.
- **<=** or **le** – numerical less than or equal to, only for numerical values.
- **>=** or **ge** – numerical greater than or equal to, only for numerical values.
- **!=** or **ne** – not equal.
  Example: **!=** "**hard coal**": the string has to be different from **hard coal**.
- **?** or **re** – regular expression, only for character strings.
  Example 1: **re** "***coal**": the string has to end with **coal**, i.e., hard coal and brown coal would match.
  Example 2: **re** "**?oal**": the string has one arbitrary character in the beginning followed by **oal**, i.e., coal and Coal, but also goal would match.
- **in** – in list.
  Example: **in** ("**electr.**","**d_heat**"): the string has to be either **electr.** or **d_heat**.
- **be** – within a range of values (inclusive, see db_VISTA manual, page 44).
  Example: **be 100. and 1000.**: The value has to be between 100. and 1000.

Criterion: numerical value or string (strings must be enclosed in ""!) to compare the attributes.

```
                          QUERY SELECTION MENU

 &|  Attribute        OP  Criterion      demo.qsl              Overwrite
 |   Input name 1      =  "hard coal"
 &   output name 1     =  "electr."
 |   investment cost   >  1000.
 &   pollutant name    =  "CO2"




    Access:          _____

    Note:            _____
                     _____
                     _____

    Keys:  sF1 Help, KEY/PG-UP/DOWN, F9 to select, F10 to cancel
```

Figure 16:- Query Selection Menu.

Attributes have to be selected from the fields available in the technology data tables. Pressing the key ^F2 in the Query Selection Menu moves the cursor into the attributes field. Here attributes can be added or removed. Pressing the key F7 removes the attribute in the current line, and sF7 removes all defined attributes. A new attribute is added in the line where the cursor is positioned by using the following sequence:

1. Press F9: a list of available tables is displayed.

2. Press F9 again: the table type indicated by the cursor is selected, and the fields available for this table type are listed for selection.

3. Press F9 a third time: the field indicated by the cursor is selected. An x appears before the identification and in the corresponding attribute field.

4. The name to identify the field in further processing has to be typed in the attribute field. Typing ".<ENTER>" will result in using as many characters of the field identification as fit into the field (up to 15). For groups of fields (e.g., energy inputs) common denominators are available to search all corresponding fields (see Table 8). These denominators have to be entered manually.

After all attributes required are inserted in the attribute field, F10 will bring the cursor back to the other input fields.

Motion between these input fields is done using the cursor keys (within an input area), the TAB key, or shifted cursor right and left (from one input column to another, see Table 9).

If the query selection is ready, it can be performed by pressing the key F9. CO2DB asks if the query should be saved; possible answers are yes, no, or a new file name for the query file.

Table 8: Common denominators for groups of fields in query selection.

Denominator	Group of Fields
inputname	identification of energy inputs (technical data)
inputunit	unit of energy inputs (technical data)
outputname	identification of energy inputs (technical data)
outputunit	unit of energy inputs (technical data)
conmatname	identification of material during construction
conmatunit	unit of material during construction
opmatname	identification of material during operation
opmatunit	unit of material during operation
polname	identification of pollutant emitted
polunit	unit of pollutant emitted

From now on, CO2DB operates in query mode with the technologies selected by the query until this mode is switched off (using aF2 or in the Program Status Submenu) or a new query is performed.

Table 9 shows the keys available in the Query Selection Menu.

Table 9: Special keys in the Query Selection Menu.

Key	Description
ESC	cancel
UP	cursor up
DOWN	cursor down
LEFT	cursor left
RIGHT	cursor right
BACKSPACE	delete left char
sLEFT	prev field
sRIGHT	next field
BTAB	prev field
TAB	next field
DEL	delete char
INS	insert (toggle key)
HOME	first line
END	last line
ENTER	next field
sF1	key help
F2	reselect
sF2	save query
^F2	goto attribute field
F7	clear field
sF7	clear screen
F8	print table of contents
sF8	print TOC with comments
F9	perform query
F10	cancel
^a	goto beginning of field
^e	goto end of field
^c	cancel
^l,^r	refresh

5   Problem/Error Handling

5.1   Program Locking

If the data bank is in use, a lock file will prevent it from being called a second time. In this case a message will tell the user that the data bank is already in use. In special cases (system breakdown, errors in the CO2DB software) the lock file might still exist, although nobody is using it. In this case CO2DB asks if processing should be continued although a lock file exists.

Use of this flag when CO2DB is in use by another user under UNIX or has been suspended with ˆy might result in destruction of the whole data bank!

5.2   Duplicate Identifiers

All technology or table identifiers have to be unique over the whole data bank. If a table is to be stored and the table identifier does already exist in the data bank, CO2DB will display an error message. The identifier has to be changed, then the data can be stored.

An easy way to correct this error is to erase the contents of the ID field (using F7), then CO2DB will use a default identifier which is composed of the type of table, the number of the technology, and the number of this type of table for the current technology. See also Sections 2.9 and 3.9.5.

A common reason for this error is the practice of entering the technology menus in enter mode, saving the current information with F8, and, later on, trying to leave the table with F9, sF9, or ˆF9, which in enter mode adds a new record to the data bank (with the same identifier).

If technologies from other data banks have been imported, their IDs might not conform to their new numbers in the present data bank, resulting in conflicts with newly entered technologies. In this case nonstandard IDs have to be provided to solve the problem.

5.3   Error Messages

5.3.1   File co2db.dbd not found

The error message indicates that no data bank is present in the current directory, and that the user must change to the directory where the data bank is located.

5.3.2   Database co2db already in use

Someone is using the data bank in the current directory (possibly the same user with a suspended job). The message can also appear if CO2DB did not stop normally in the last execution and did not remove the locking file (co2db.lock). In this case CO2DB asks if operation should be continued or not.

5.3.3   Show option used – no changes possible

The default mode of CO2DB is the show mode, in that all available information can be displayed. If data should be changed in a displayed table, the mode can be changed

without leaving the table by typing ⁓W, positioning the cursor in the line displaying the mode, and changing the mode with cursor left/right keys (see also Section 2.8). F10 or ENTER erases the mode subwindow.

Appendix A: The IIASA Regions

- North America – US and Canada
- Western Europe – including Greece, Yugoslavia, and the former GDR
- Eastern Europe
- USSR
- Turkey
- Japan
- Oceania – Australia and New Zealand
- China
- India
- Four Tigers – Singapore, Taiwan, Hong Kong, South Korea
- Rest of Asia and the Pacific
- Rest of Asian Centrally Planned Economies
- North Africa
- Middle East
- South Africa
- Rest of Africa
- Brazil
- Rest of America and the Caribbean
- Developed Countries
- Less Developed Countries
- World

Appendix B: Sample Print File

Table I: General Data

1) Tech. name: IGCC with CO2 recovery by shift reaction		
2) Identification: igcc-rec	3) Technology No: 66	
4) Technical availablility:	5) Commercial availability:	
6) Data collected by: Sabine Messner		
7) Data quality:		
8) Invention:	Innovation:	Prototype:
1. Comm.:	1% share:	50% share:
9) Sector: electricity gen.	Type: fossil fuel conv.	
Output: secondary	Input: primary	
10) Description file:		
11) Hard copy no:		
12) Notes: integrated-gasifier combined-cycle power plant with recovery of CO2 by shift reaction and physical absorption		

Table II: Technical Data (energy forms)

ID: tec_72_1			
1) Unit size: [MO] 621	Unit: MW(e)		
2) Construction time: [yr]	3) Plant life: [ ]		
4) Techn. avail.: [ ]	5) Av./mnt. time: 68.5 [%]		
6) Energy inputs and outputs			
Name	in/out	Quantity	Unit
hard coal	Input	1	
electr.	Output	0.381	
7) Notes:			

Table IV: Environmental Data

ID:	env_67_1		
1) Pollutant	in/out	Quantity*	Unit
CO2	MI	0.3519	ton/kWyr
2) Notes: CO2 reduced by 88%			

Table VII: Literature

ID:	lit_72_1
1) Book: Technolgy and cost of recovering and storing CO2 from an integrated-gasifier, combined-cycle plant
2) Chapt.:
3) Author: C.A. Hendriks, K. Blok, W.C. Turkenburg
4) Publ.: Department of Science, Technology and Society, Utrecht
5) Type of publ.: Report
6) Year of publication: 1990
7) IIASA access:
8) Access:
9) Notes:

Table III: Economic Data (per MO)

ID: eco_72_1		
1) Currency: US $	2) Year: 1988	
Type of costs	Quantity	Unit
3) Investment:	1450	$/kW
4) Fixed O+M:	53	$/kW/yr
5) Variable O+M:		
6) Decomissioning:		
7) Fuel costs:	2	$/GJ
8) Total (excl. fuel):		
9) Total (incl. fuel):	4.4	c/kWh
10) Notes: Recovery cost: US$ 12.5 per mt		

Appendix C: Outlook for Version 2.0

The following additions for Version 2.0 of the CO2DB software are foreseen:

- Selection from precalculated or defined chains for additional inputs.

- Definition of costs and emissions for additional inputs.

- A "pocket calculator" for numerical input fields (add, subtract, multiply).

- A relation for multiple outputs to be used in chain calculations.

- Formalized links between subtables within a technology (defining, e.g., a specific year or a specific region).

- Automatic resequencing of table identifiers during import (not only in case of actual conflicts) to avoid ID conflicts during further input.

Index