ENPEP MODEL ENHANCEMENTS AT ANL

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Abstract

Argonne National Laboratory (ANL) has been involved in energy and electricity planning analyses for almost 20 years. Their activities include the development of analytical tools and methodologies along with their application to a wide variety of national energy planning studies. The methodologies cover all aspects of energy planning. In response to a request by the US Department of Energy (USDOE) to integrate existing tools into a package that could be distributed to developing countries for their own use, the ENergy and Power Evaluation Program (ENPEP) was developed. The USDOE wanted an all purpose tool that would allow the user to do a complete energy analysis, from demand forecast through primary energy resources allocation to electricity generation system expansion plan and environmental analysis. Since its original development, the ENPEP modules have been improved and enhanced to incorporate advancements in computer hardware and software technology, as well as to correct bugs that were identified in the programs. In cooperation with other organizations (e.g. The World Bank - IBRD - and the International Atomic Energy Agency - IAEA -), the ENPEP package has been used at national, regional and inter-regional training courses, as well as in the conduct of national energy/electricity planning studies. This paper reviews the development of the ENPEP package and the proposed enhancements to the package.

INTRODUCTION

The development of the ENPEP system began in 1985 at ANL. Prior to that time, most energy planning activities were carried out on large mainframe computers. These computers often belonged to the financial division of an organization and had little time available to run energy planning tools. The arrival of desk top PCs provided an opportunity to transfer the existing tools to a platform that the energy planners could control at a cost that was reasonable. ENPEP was planned as a modular tool that could be integrated. Each module can be used as a stand alone package or as in conjunction with other modules of the ENPEP system, depending on data availability and the scope of analyses to be conducted in each case. The different modules of the ENPEP package and alternative paths to use the system are illustrated in Figure 1.

Considering the limitations of the early PCs, e.g. memory and disk space, the program developers worked diligently to respect the constraints of the available technology. Because of these limitations special emphasis was given to the design of a flexible system that could be easily adapted to different working environments.
Upon completion, the ENPEP package was transferred by the USDOE to the IAEA for release to interested Member States and international organizations. Before initiating overall distribution of the program, the IAEA, in cooperation with some Member States and with support provided by the USDOE and ANL, conducted several field tests to validate the program and its application to national conditions. The first field test was executed in 1987 in cooperation with Indonesia followed by a second field test with Malaysia in 1988.

At the end of 1988, The World Bank initiated a regional project on energy planning for Europe and the Arab States, funded by the United Nations Development Programme (UNDP). Under this project several countries carried out energy planning analyses using different planning tools, including various modules of the ENPEP package and other planning tools supported by the IAEA (e.g. MAED, VALORAGUA). In support of these studies, training courses were required for users of the ENPEP modules. Table 1 shows that 42 persons participated in the World Bank/UNDP sponsored ENPEP training courses at ANL in 1988 and 1989.

The IAEA also recognized the need to provide formal training on the ENPEP package. As such, they organized the first Interregional Training Course on Integrated Energy and Electricity Planning for Nuclear Power Planning with emphasis on the ENPEP package in 1991. This was followed by a second IAEA sponsored ENPEP training course in 1992. A regional ENPEP course was held in Hungary in 1994. See Table 1 for the number of participants and countries represented in each course.

Fig. 1 Overview of the ENPEP System and the Various Chains for using the Modules
Since the development of the ENPEP package, it has been distributed to more than 35 countries and 5 international organizations which are using it for integrated energy and electricity planning. Independent modules of the system (e.g. MAED, ELECTRIC/WASP, LDC and ICARUS) have been released to additional countries who are using one or more of the modules for planning of their electricity system.

Enhancements to the ENPEP Package

Since the ENPEP package was first developed, several enhancements have been introduced in cooperation and with support from the IAEA. Additional funding from the United States government has also been provided for these enhancements.

These enhancements have been necessary to adapt the program to changing commercial software and to introduce improvements as required by the users. This has led to updated ENPEP versions that respond better to the needs of the planner while making use of limited commercial software packages.

Most Recent Enhancements

The latest version of the ENPEP package was distributed at the end of the 1994 regional training course in Paks, Hungary. Since then several enhancements have been made, including:

- increased the dimensions of the BALANCE module to accommodate networks with up to 1000 links and 100 demand growth projections. This was in response to requests of BALANCE users who were confronted with complex energy networks. The original system allowed only 500 links and 20 demand growth projections.

- incorporated the newest version of the WASP program (WASP-III PLUS) as the ELECTRIC module of ENPEP. WASP-III Plus was developed by the IAEA for use in mainframe computers. The adaption of the model included conversion of the code to the PC environment and the introduction of additional ENPEP screens to allow the user to input new data items.

- updated the IMPACTS module to accommodate BALANCE networks with up to 1000 links. This was required because of the increased number of links in the BALANCE module.

- revised the ENPEP User's Manual to reflect program enhancements.

Near-Term Improvements

Based on requests from several users of the program, the following enhancements are being introduced:
• End of 1995:

Finalize the current version of the program (Version 3.0) including:

1) correct problems encountered during the conduct of the inter-regional training course on energy demand forecasting for nuclear power planning (MAED) held at ANL in Spring 1995.

2) insure full transfer capability of data between ENPEP modules, particularly after having introduced WASP-III Plus as the ELECTRIC module.

3) resolve pending problems encountered in the ELECTRIC and BALANCE modules.

• February 1996:

Enhance the representation of the electric sector in the BALANCE module with the goal of making it consistent with the electric sector representation in the ELECTRIC module (WASP).

Long-Term Enhancements

As microcomputer software becomes more powerful and advanced, user-friendly environments (i.e. Windows) are considered state-of-the-art for PC applications. It has been realized that there is a need to develop a Windows version of ENPEP. Attempts in this direction have been initiated by the Russian Research Centre “Kurchatov Institute” which developed a prototype for the MACRO and DEMAND modules.

The ENPEP development team has set up the following guidelines for developing the Windows version of the program:

• the GUIDE Module functionality will constitute the basis of a Windows version of the BALANCE module in order to take advantage of the experience obtained during the development of the GUIDE module.

• the ELECTRIC module will take advantage of the developments made under the Interagency project on Data Bases and Methodologies for Comparative Assessment of Different Energy Sources for Electricity Generation (DECADES) in order to make use of the databases already developed.

• the IMPACTS module will be re-designed to take advantage of enhanced commercial software for handling databases and spreadsheets.

• the PLANTDATA, LDC, MAED and ICARUS modules will not be a part of the initial windows version of ENPEP.
• a Beta version of ENPEP-Windows is proposed to be available in 1997.

TRAINING COURSES

As discussed earlier, several training courses on ENPEP have been organized by the World Bank/UNDP and the IAEA. Table 1 summarizes the ENPEP training courses conducted to date and displays the number of experts and countries that have participated in each session of the course.

Table 1 ENPEP Training Courses

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Participants</th>
<th>Number of Countries</th>
<th>Sponsoring Agency</th>
<th>Course Venue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>20</td>
<td>9</td>
<td>World Bank/UNDP</td>
<td>ANL, USA</td>
</tr>
<tr>
<td>1989</td>
<td>22</td>
<td>11</td>
<td>World Bank/UNDP</td>
<td>ANL, USA</td>
</tr>
<tr>
<td>1991</td>
<td>33</td>
<td>11</td>
<td>IAEA</td>
<td>ANL, USA</td>
</tr>
<tr>
<td>1992</td>
<td>37</td>
<td>12</td>
<td>IAEA</td>
<td>ANL, USA</td>
</tr>
<tr>
<td>1994</td>
<td>30</td>
<td>11</td>
<td>IAEA</td>
<td>Paks, Hungary</td>
</tr>
</tbody>
</table>

The number of trained experts in the use of ENPEP has been further increased when considering on-the-job training that has been provided by ANL/IAEA experts during the conduct of national training planning studies that were carried out under the regional World Bank/UNDP energy project previously mentioned and as part of the regular Technical Cooperation (TC) Programme of the IAEA.

ENPEP is also being used for mitigation analysis by several countries as part of the United States Country Studies Program (CSP). Several U.S. governmental agencies are sponsoring this analysis.

Table 2 lists countries in which ENPEP studies are currently being conducted along with the sponsoring agencies.
Table 2  Current ENPEP Country Activities

<table>
<thead>
<tr>
<th>Sponsoring Organization</th>
<th>Active Country Analysis</th>
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<tbody>
<tr>
<td>IAEA</td>
<td>Belarus, Colombia, Indonesia, Peru, Poland, Pakistan, Romania</td>
</tr>
<tr>
<td>World Bank</td>
<td>Nepal, Pakistan, Philippines, Turkey, Uruguay, Zambia</td>
</tr>
<tr>
<td>Country Studies Program</td>
<td>Hungary, Kazakhstan, Peru, Slovakia, Thailand, Ukraine, Venezuela</td>
</tr>
</tbody>
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