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OPTIMIZATION OF ELECTRIC POWER SYSTEMS

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CHILE

Chile.

Technical report: Development and Control of Chile's
Electric Power Systems*

Prepared for the Government of Chile
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of A. Brameller
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Vienna

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INTRODUCTION

The UNIDO project is timely and relevant to current economic progress of electrical energy management in Chile. As a result of the National Energy Commission recommendation, the Government of Chile has promulgated a new Electrical Generation Services Act. The result of this is that there are now two independent large electrical companies, ENDESA and CHILECTRIC-generation, and a number of smaller companies. A central body by the name of CDEC made up of members of the two largest companies is set up to oversee the economic operation of the electrical sector. The improvement in electrical energy management is obtainable from the security risk evaluation and minimisation of fuel cost. The latter is achieved by more judicious scheduling of generation and minimisation of transmission losses, saving in fossil fuel cost (oil and coal) and conservation of water energy for dry seasons. In order to help the industry, the UNIDO project has been instituted on the initiative of a group of Universities in Chile and in this context I have examined a number of issues, such as:

- Current practice
- Current equipment
- Rate of progress
- Technological involvements of
 - Consultants
 - Industries
 - Universities

The associated problems are complex, interrelated and staged in time. The report is particularly concerned with the UNIDO financial aid to the Chilean Universities to help the Chilean utilities in technological areas. The project can be broadly divided into two timescales:

- (a) Short term
- (b) Long term

and three main objectives:

- (c) Academic
- (d) Industrial
- (e) Training

I have been specifically involved in the following areas:

- (1) Course
- (2) Progress examination
- (3) Technical consultancy
- (4) General discussions
- (5) Recommendations

I was received with a great deal of warmth, courtesy and enthusiasm; I was made very welcome and feel that my visit was appropriate and useful in a number of different ways.

1. COURSE

I gave a 12-hour course at the VI Congreso Chileno de Ingenieria Electrica, attended by some 83 participants drawn from universities and industries on the subject of on-line control. I covered, in addition to the structure of on-line control, environment and functions, also specific topics on state estimation, modern advances on sparsity, and security monitoring. I supplied 156 pages of typewritten notes, a copy of which was distributed to all participants. In addition, I also provided 92 pages of typewritten notes on optimisation and economic scheduling. It is the intention of the universities to use all my notes for their own courses.

In addition, I also gave a seminar at the Federal University of Santa Maria in Valparaiso, attended by staff, students and local industry.

2. PROGRESS EXAMINATION

The universities gave an account of their work in the particular areas of:

- Load prediction
- Transmission loss calculations
- Economic dispatch
- Security
- Equivalents

I was most impressed with their enthusiasm, technical knowledge and competence. The total current manpower of the three universities devoted to the UNIDO project is 5 man days per week by staff members, 6 research assistance, 7 Ph.D. students, and 7 graduate students. Due to historical and other reasons, there is practical collaboration between the universities and the CHILECTRIC Company. The practical collaboration between the universities and ENDESA was established during my visit.

3. TECHNICAL DISCUSSIONS

3.1 ENDESA

In the presence of the universities' representative, full and open discussion took place. The industry has outlined their interest to take advantage of the UNIDO project and also give an account of their difficulties. A specific area of interest in security was identified.

In order to proceed with an on-line control in the security and economy areas, it is necessary to have a higher confidence in data. The precise data for generators and associated generator controllers are not always available or obtainable, because of the varying age and the variety of manufacturers involved. For this reason, ENDESA considered that the first and essential step is to endeavour to establish such data. They have invited the universities to collaborate with them in a project of parameter estimation, as a first step to a longer term objective of frequency control and transient security assessment.

I was very impressed with the clarity and honesty of the presentation, the choice of the subject and the industry's willingness to devote their time and effort in a collaborative link with the universities. ENDESA stressed that currently they are only interested in a practical end product. They are still at an early stage of experience with on-line control involving a limited number of application functions.

3.2 CHILECTRIC-Generation

A very warm, frank and detailed presentation was given in the presence of the university team in the area of operational planning and supervisory control. Interest was shown in the universities' involvements and the UNIDO project. Certain unresolved, relevant and interesting questions relating to economic dispatch were raised and noted by the universities.

Another presentation was given on the economic and technical justification for the SCADA system. Currently they are evaluating tenders for it. A number of technical questions were raised and I was able to help as a consultant.

There is already an established link between the University Catolica and the CHILECTRIC companies on various related topics. It was evident that the utility had confidence in the work the university carried out for them and were looking forward to continuation of the co-operation under the UNIDO project.

3.3 National Energy Commission

A shorter but equally full discussion took place in the presence of the university team on the current policies for economic operation of the Chilean system. The formation of the new central body called CDEC was outlined. It is constituted from the members of the largest utilities, currently ENDESA and CHILECTRIC, and its objectives are concerned with the overall economy of the national system.

The Commission welcomed the involvement of the universities and in this context the UNIDO project has a contributory role by injecting foreign expert knowledge. The Commission were cautious to point out that it is not their intention to impose any specific course of action on the industry. In this respect, the universities have a contributory role by helping industry with technology transfer.

3.4 CHILECTRIC V Region - Vina del Mar

A smaller but equally enthusiastic and forward-looking distribution company outlined their interest in SCADA. After their presentation, a discussion followed, where a number of questions were raised. I was able to give them some assistance in terms of consultations. Their interest in the UNIDO project is in terms of the overall effect on the operation of their company. The discussions took place in the absence of the university members.

3.5 CONAFE

This is a small distribution company with a number of young and very enthusiastic engineers. They showed interest in two specific areas; one concerned with current European switchgear practices and the other in the computer application to distribution design. I was able to discuss with them at some length a number of issues and practices, particularly in the area of distribution design.

4. GENERAL DISCUSSIONS

During the numerous meetings, I was able to give various opinions concerning a wide range of subjects, many of which were of a specific technical nature. At a summary meeting attended by the universities' team, ENDESA and CHILECTRIC, I addressed myself specifically to the project objectiveness through the collaborative role of the universities and industries.

The prime role of the universities is to teach and, secondly, to do research. Whenever possible, the research should be relevant to current practical problems. Universities should not be used for commercial purposes, for example, as computer code writers, nor should they attempt to solve industrial problems completely. They should complement industry by being involved with such research which can be identified as having both academic and practical industrial contexts.

The industries should benefit from universities' research by their involvement through associations with such projects. This entails giving assistance in terms of data and experience, but even more importantly, identifying relevant issues, giving general guidance, and creating environment for technology transfer.

Such co-operative research can have various different objectiveness, for example, short-term or long-term investigation. Each investigation should be clearly identified in its objectiveness, for example:

- Efficiency improvement
- Comparison evaluation
- Man/machine interfaces
- Fundamentals

Invariably, there is a certain amount of overlap and often a number of objectives can be simultaneously achieved.

In order to achieve any practical objectiveness, there must be a strong co-operation between universities and industries and the projects should be identified and narrowed down to specifics. This is best done by some kind of formal contractual arrangement which will take into account, among others, such things as:

- End product identification
- Timescale of the investigation
- Methods of solution established
- Means of accomplishing:
 - Computer resources
 - Financial resources
 - Man resources
- Preparation of reports and other documents
 - Intermediate
 - Final
- Arrangements for regular meetings

- Quality assurance
- Means of technology transfer
- Property
- Confidentiality
- Continuity of work
- Individual responsibility

Best success is achieved by:

- Co-operation
- Sharing
- Relevant, practical and stimulating project

5. RECOMMENDATIONS

The universities should identify:

- Short-term practical investigations
- Long-term practical investigations
- General investigations

As a short-term practical investigation, the universities should accept the invitation of ENDESA to carry out practical research on the specific project of parameter investigation. This has a very essential practical end product with sufficient academic contents. Certain of the equipment purchased under the UNIDO project could be used for that purpose.

The process of investigation should be clearly defined in terms of a contract.

Long-term investigation should be narrowed down to one or two specific objectives, such as:

- Digital Protection
- Economic Dispatch
- Interactive computer aids
- Security

Any one of the above projects should aim at a comparative evaluation in the context of Chilean requirements of hydro-thermal mix, transmission configuration and current technological/economical position.

Broad long-term but low-key involvement in the general security/economic aspect should be carried out more in terms of higher academic education/research than an endeavour to provide an on-line control system for the industry.

Due to the delays in providing an expert consultant in Chile, the duration of the UNIDO project should be extended by at least another year.

A joint team made up from universities, ENDESA and CHILECTRIC should have the opportunity to take advantage of the UNIDO funds for visits abroad. The team visit is in preference to a group of any two out of the three.

6. CONCLUSIONS

The UNIDO project is helpful to the Chilean industry by encouraging the universities' technical involvement and by providing funds for visits by foreign expert consultants, courses and equipment creating an environment of co-operation between universities and industries. In the long term, it will shape the universities' activities into relevant research, provide better trained and more knowledgeable personnel for the industry. It will make it possible for the universities to be involved as an independent body.

In the short term (duration of the contract), it is hoped to establish the vital links between universities and industries and to accomplish certain specific tasks.

It is unrealistic to expect as an outcome of the project that the industry could obtain a complete on-line security economy system. Care must be taken to obtain a correct balance between the universities'

duties and capabilities and the industrial requirements. It is desirable and recommended for the universities to assist the industries with independent consultancies on relevant technology or modern numerical processes. In this context, the universities' proper activities could be defined as engagement in a specific practical investigation, like the parameter estimation defined by ENDESA or the evaluation of modern technology in relation to the current Chilean situation. The UNIDO project gives the impetus and invaluable assistance in this direction and is to be highly commended.