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FIRST SESSION:

INTERNATIONAL NUCLEAR DEVELOPMENT AND COOPERATION

Current Assessment and Future Potential

of the

International Nuclear Market

By

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**CURRENT ASSESSMENT AND FUTURE POTENTIAL  
OF THE  
INTERNATIONAL NUCLEAR MARKET**

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**ABSTRACT/COMPENDIO**

Al hacer un estudio de la situación actual o del futuro del mercado nuclear internacional, uno si tiene que hacer proyecciones para un mercado que es afectado por muchos aspectos de la economía mundial, con el efecto subsecuente de esta economía al crecimiento de la fuerza eléctrica.

Esta ponencia examina los puntos sobresalientes de los pronósticos no solamente de Bechtel sino también de la comunidad nuclear internacional.

Los aspectos principales a estudiarse son:

- Proyecciones del crecimiento de la energía eléctrica
- Porcentaje de la generación probable para nuclear
- Servicios de operación para centrales nucleares existentes
- Ciclo de combustible nuclear
- Mercado para centrales nucleares pequeñas

El mercado a examinarse, por lo tanto, incluye no solamente las instalaciones para generación sino también el ciclo de combustible nuclear. De igual importancia hoy en día y para el futuro son los servicios de operación y mantenimiento, con énfasis en la mejora del rendimiento y de la disponibilidad.

## **1. INTRODUCTION**

In making any assessment of the current and future potential of the international nuclear market in satisfying the anticipated worldwide growth of electric power, one is faced with making projections for a market that is affected by many aspects such as, the overall world economy, financing, nuclear non-proliferation policies, international safeguards, nuclear regulations, technology transfer and public attitudes to nuclear power.

It is the intention of this presentation to highlight in summary form the projections as seen not only by Bechtel, but by the international nuclear community.

These projections will focus on the following:

- Electrical Power Growth Projections
- Nuclear Power Generation Share of Market
- Operating Services for Installed Nuclear Plants
- Nuclear Fuel Cycle
- Small Nuclear Power Plant Potential

The nuclear market to be assessed, therefore, includes not only power generation facilities, but also the fuel cycle operations of Mining, Conversion, Enrichment, Fuel Element Fabrication, Spent Fuel Storage, Reprocessing, and Waste Management. In addition, the Operating Services market relating to plant betterment, outage, and maintenance work of already installed nuclear plants is a rapidly expanding sector of the market.

## **2. ELECTRIC POWER GROWTH PROJECTIONS**

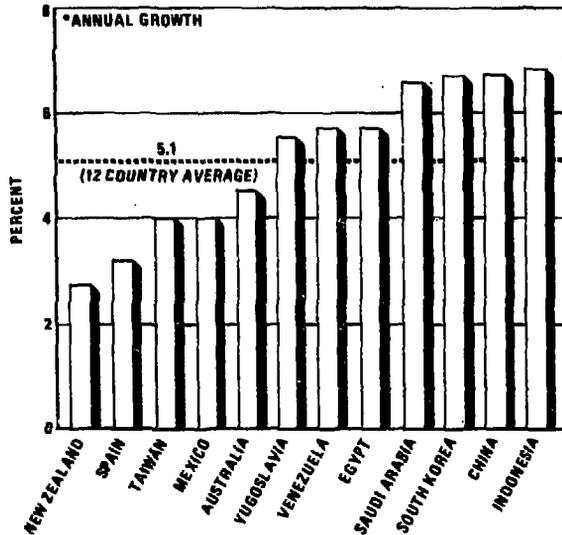
Gross National Product (GNP) projections can be used to forecast the potential electrical load requirements of particular countries. However, there is an interrelationship between the desired electrical growth and the amount of GNP that can be made available from social/economic/political considerations to construct the required electrical facilities.

The worldwide GNP growth rate for the rest of the century is projected to be well below the growth rates that were experienced during the pre-Arab oil embargo era. A number of countries have recently revised their energy plans reflecting the slowdown in demand.

The projected electric load growth and the projected generating capacity additions for 12 representative nations is shown in Figure I and Figure II, respectively.

FIGURE I

PROJECTED ELECTRIC LOAD GROWTH\*  
1982—2000

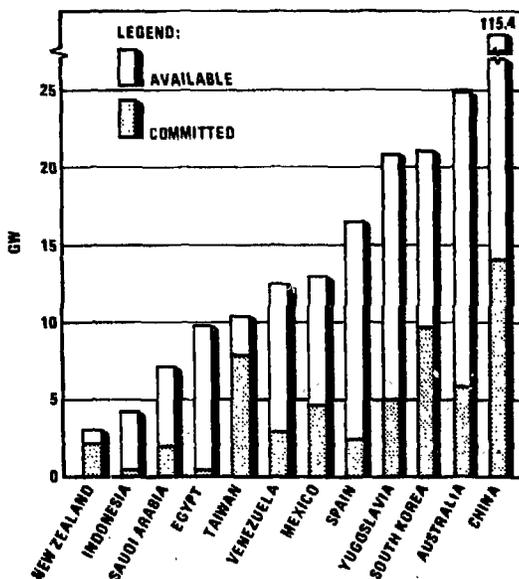


Source: Country Forecast Models - BECHTEL

South Korea, the People's Republic of China, and Indonesia are some of the high growth countries with growth in excess of 6% per year. Future possible oil price reductions may further depress Indonesia, Saudi Arabia, Venezuela, and Mexico's growth rates.

Associated with these growth rate predictions are the projected generating capacity additions for each of the 12 countries. This is indicated in Figure II.

**FIGURE II**  
**PROJECTED GENERATING CAPACITY ADDITIONS**  
**1982-2000**



Source: Country Forecast Models - BECHTEL

Analysis of these growth rates in terms of potential capacity addition, and how much of this capacity has yet to be committed, indicates that, excluding China, the countries shown in Figure II will add, based on the growth rate shown, approximately 145 GW thermal capacity between now and the year 2000. To date, approximately 45 GW of this capacity has been committed, leaving 100 GW to be contractually committed.

The start of these commitments will need to be initiated in 1984/85 if the predicted electrical power requirements are to be satisfied. This is especially true for countries where the commitments made to date have fallen behind schedule, and where further delay will result in less cost effective generation of electric power, or the less pleasant alternative of non-achievement of the particular country's desired long-range economic planning goals.

### 3. NUCLEAR POWER GENERATION

Today, on a worldwide basis, Nuclear Generation provides 9 to 10% of the electrical installed capacity. By 1990, nuclear should provide some 18 to 20%.

The nuclear contribution today can be highlighted by the share in the following major industrialized countries:

France-	40%
Switzerland-	28%
Belgium-	25%
West Germany-	15%
Japan-	17%
USA-	12%
USSR-	6%

Additionally, in the new industrial areas of the Far East, such as Taiwan and Korea, which are both basically oil dependent economies, the share of nuclear power today is 30% in Taiwan and 15% in Korea.

In making an assessment of the future nuclear market, many technical, economic, and political factors must be considered. Some of these major factors are:

- The slow recovery from the present worldwide recession has caused the ambitious energy plans of many countries to be adjusted to reflect the slower load growth.
- The lack of nuclear reactor orders in the USA has caused certain concerns in overseas developing countries regarding the viability of economic nuclear power generation.
- The resources and trained manpower for design, engineering, manufacturing and construction in the industrialized countries are already being diverted to alternative business activities. A prolonged lack of reactor orders in the near future could have a critical effect on the nuclear industry's ability to respond to the projected needs.
- Financing of nuclear projects by Government lending agencies and international banks is becoming more difficult due to recent international experience in loan repayments.

- Advanced developing countries who have planned major nuclear power programs are requiring technology transfer so that they can develop "in country" capabilities in the engineering, manufacturing, and construction areas.
- The public acceptance of nuclear power remains a problem in many countries. Some examples of these concerns are waste management, safety and plant security.

What, then, is the short-term and long-term potential market for nuclear power plants?

In the short term, the increased share of the electrical power to be generated by nuclear has already been committed and plants are under construction. There are only a few new nuclear orders anticipated.

Examples of the short term nuclear plant construction activities and planning are as follows:

- Korea and Taiwan are continuing with their present nuclear programs even though with delayed schedules and on a reduced scale.
- Egypt is still in active negotiation for its first two 900 MW nuclear units, and is also proceeding with bids for a second set of two units.
- The People's Republic of China, while developing their own 300 MW reactor, is committed to building a twin 900 MW plant in the Guangdong province in association with a Hong Kong utility. The Peoples Republic of China has also announced that there will be an additional two-twin 900 MW units to be located in central China and on the east coast. Discussions with France, the United Kindom, and USA continue on the Guangdong plant, especially with regard to non-proliferation issues and project financing.
- The French nuclear program is still proceeding, but proposed cutbacks in the program may see orders reduced to perhaps 2 units per year.
- The much discussed review of the Spanish nuclear program, as proposed by the government, leads to uncertainty of both the short-term and long-term prospects.
- The Eastern European Bloc are proceeding with a standardized nuclear reactor program with joint manufacturing participation with the USSR.

- Japan, like other countries, is cutting back on their planned nuclear growth based on a lower GNP growth projections (4%) for the next 10 years. Even so, it appears that in the early 1990's, some 35% of electrical power will be nuclear. Japan is by and large self-sufficient in satisfying their own nuclear market. Also Japan is taking a lead in association with the U.S.A. in the development of advanced PWR's and BWR's.
- The USA will bring 70 GW of committed nuclear plant capacity on line between now and the year 2000; however, there have been no new orders placed for nuclear power plants since the Three Mile Island incident in 1979.

Considering the long-term market for nuclear power, we see the US and the other highly industrialized countries leading the world out of the current world recession. With resumption of economic growth on a worldwide basis, the demand for electrical power production will be created. Even if lower oil costs prevail, we do not see countries reverting to using oil in major power plants. If a country lacks adequate hydro resources, then the coal or the nuclear alternative will be considered.

The nuclear alternative still remains competitive with coal, and, if countries are to survive in the world marketplace, then the most economical form of electrical power production must be utilized. For countries that do not possess abundant coal resources the alternative is for power production by nuclear power.

#### **4. NUCLEAR POWER OPERATING SERVICES**

There are over 300 operating nuclear reactors in the world today, and with the downturn in nuclear plant orders the market for providing operating services to plant owners has become increasingly important.

The elements of these services are:

- Retrofit, because of regulatory requirements
- Plant Betterment Programs
- Operation and Maintenance
- Decontamination and Restoration
- Training
- Records Management

The international demand for these services is already on the increase and is required in the short-term. The downturn in nuclear reactor orders internationally, due to social/economic factors, has meant that owners in overseas countries are seeking to protect their investment in, and improve the efficiency of the operation of, their existing plants.

The determination of the need for nuclear operating services must be handled on a case-by-case basis for each owner and for each operating reactor. Experience gained in the U.S.A., and other countries with major nuclear plant installations, will be of benefit to these international owners.

## **5. NUCLEAR FUEL CYCLE**

The current assessment and future potential of those operations that make up the Nuclear Fuel Cycle can be summarized as follows:

### **Uranium Supply - Mining and Milling**

- Cutbacks in nuclear power worldwide have led to large inventory buildup. Current prices are low and will sustain only the most cost effective mining companies.

### **U235 Enrichment**

- Enrichment capacity in the USA, Europe, and USSR is still expanding, with new efficient centrifuge plants under construction and new enrichment techniques under development.
- Internationally, opportunities for the enrichment market may arise in Australia and Japan, however, USA participation in this potential work is very dependent on the then current regulations.

### **Spent Fuel Storage and Fuel Reprocessing**

- Spent fuel storage represents a growing market opportunity in many countries. Storage in additional new pools, dry storage in silos or drywell are other developing techniques. This has been precipitated by delays in the reprocessing of spent fuel.

- Reactivation of reprocessing of spent fuel is under active consideration in the USA. Reprocessing, although currently not operating in the U.S., is active overseas, with the U.K. and France having considerable commercial scale operating experience. In addition, Japan, India and other countries are involved in pilot plant operations.
- Although the reprocessing technology is proven, the market for the produced plutonium for recycle in thermal or fast breeder reactors has yet to develop.

#### **Fuel Cycle Centers**

- From time to time the suggestion has been made that multi-national fuel cycle centers be established to handle several countries' requirements for, at least, spent fuel storage, reprocessing and waste disposal. The situation in the Far East presents a possible application of this approach, e.g. Australia, Taiwan, Korea and the Philippines.

#### **Waste Management**

- There is operating experience in most countries in the handling of low level and intermediate level wastes. The market here pertains to efficiency of disposal by volume reduction and other efficiencies.
- Further work is still necessary to demonstrate systems for disposal of high level wastes. Practical technology is available, and this major aspect of nuclear power utilization and acceptance by the public is receiving intensive international investigation and cooperation.
- The recent passage of the "Nuclear Waste Policy Act" in the USA, will have a significant effect in removing some of the obstacles to future nuclear power development in the USA, with subsequent effect on the worldwide market.

#### **6. SMALL NUCLEAR POWER PLANTS**

Nuclear plant capacities of 600/900/1200 MW ranges as presently designed and in operation in the nuclear programs of advanced countries are too large for use in some of the developing countries desiring to replace the oil alternative.

France, Germany, Japan China and India foresee both a national and international market for small reactors, in the range of 100 to 400 MW, and are studying, or are active in their design.

Small nuclear plants would involve:

- Expansion of power companies electrical generating system in smaller units.
- Shorter construction schedule.
- Lowered construction costs due to increased shop fabrication of modular components.
- Lower capital costs and hence reduced interest and escalation charges.
- Earlier financial return.

The following should be considered in deciding whether to proceed with small nuclear power plants:

- Generating costs of these plants in comparison to the oil and coal alternative. Higher capital costs/Kw will occur; however, the lower fuel costs compared to oil and coal may well provide the economic incentive to install the small nuclear plant.
- The design/development status of the now available small reactors, including licensing issues and technology export regulations.
- The need for a developing country to have a basic national organizational structure, facilities, staffing i.e. adequately developed infrastructure. This may require many years depending on the particular countries state of development.
- Financing of the plants and the required infrastructure.

## **7. CONCLUSION**

As the worldwide recession abates, the worldwide demand for electrical energy will increase.

The share that the nuclear power industry will achieve against the oil, coal, and hydro alternatives in each country will depend upon the availability and location of the indigenous fuel resources.

Nuclear power financing, design standardization, regulation normalization, clearly applied treaty obligations, and public acceptance of the benefits of nuclear power are all aspects which will influence the future market for the nuclear industry.

Each country's goals for the development or upgrading of its manufacturing and human resources become another important factor in considering the nuclear alternative.

All aspects of the overall nuclear fuel cycle will need in-depth consideration.

Small nuclear plants may play an important future role in the satisfaction of electric power requirements.

If the lack of nuclear power plant orders persists for too much longer, then the ability of the worldwide nuclear industry to respond to a later resumption in orders is in question, due to the ongoing diversion of all sectors of the nuclear related industry to other business activities.

There seems to be general agreement that the recovery of the nuclear market worldwide would be helped if the nuclear industry continues to:

- Demonstrate the economic advantages of nuclear power generation.
- Contribute to the improvement of public attitudes to nuclear power.
- Continue to review and simplify the regulatory process for all types of nuclear installations.
- Offer technology transfer programs to assist developing countries achieve the necessary technical and management expertise required to proceed with the nuclear option.
- Pursue the development of advanced reactor systems and also develop the commercial viability of small nuclear units.
- Participate in developing international agreement on the legal aspects of nuclear power.
- Demonstrate the viability of nuclear power to the various government lending agencies and the international banking community.
- Utilize continuing analysis and operating experience to simplify systems and improve operations and safety.

If the nuclear industry succeeds in its efforts, we believe that the worldwide nuclear market will recover, and that a few orders for nuclear plants will develop in the next two years. We further believe that there will be continued growth of electric load and that the economies for nuclear plants will continue to be favorable to the investor-client.

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