THE 23RD JAIF
ANNUAL CONFERENCE
第23回原産年次大会

APRIL 9～11, 1990

JAPAN ATOMIC INDUSTRIAL FORUM
日本原子力産業会議

お知らせ

・4月9日（月）の開会セッション(14:30～16:30)における大島原子力委員長の所感は、向坊原子力委員長代理の所感に変更になりました。

・4月10日（火）のセッション2（ 9:00～11:30)におけるエレーラ仏原子力庁国際局長の演題は「相互に依存する世界の原子力の将来―フランスの見解」に変更になりました。

・4月11日（水）のビュッフェランチ(12:00～13:30)における武藤通商産業大臣の所感は額賀通商産業政務次官の所感に変更になりました。

Announcements

・On behalf of Chairman Oshima, remarks were given by Dr.Mukaibo, Acting Chairman, representing Atomic Energy Commission of Japan in Opening Session, on Monday, April 9.

・Title of the presentation by Mr.Gérard Errera, CEA in Session 2 on Tuesday, April 10, was changed to "Nuclear Energy Future in an Interdependent World -- a French View."

・On behalf of Minister Muto, remarks were given by Mr.Nukaga, Parliamentary Vice-Minister, representing Ministry of International Trade and Industry at Buffet Lunch on Wednesday, April 11.

目　次

C O N T E N T S

第２３回原産年次大会総括プログラム

基調テーマ：原子力と社会 ── 調和への課題
平成２年４月９日（月）～１１日（水）
於：国立京都国際会館　大会議場（京都・宝ヶ池）

	第　１　日 ４月９日（月）	第　２　日 ４月１０日（火）	第　３　日 ４月１１日（水）
午前	［受付］ 12:00 ～ 13:40 於：京都宝ヶ池ﾌﾟﾘﾝｽﾎﾃﾙ 14:00 ～ 於：国立京都国際会館	セッション２ （ 9:00 ～ 11:30） 「変わるか世界の原子力政策」 ［講演と討論］	セッション４ （ 9:00 ～ 11:30） 「原子力のない経済社会は･･･」 ［講演と討論］
午後	ウェルカム・レセプション （12:30 ～ 14:00） 於：京都宝ヶ池ﾌﾟﾘﾝｽﾎﾃﾙ	午　餐　会 （12:00 ～ 14:00） 於：京都宝ヶ池ﾌﾟﾘﾝｽﾎﾃﾙ 特別講演 映画上映 （12:30 ～ 13:45）	ビュッフェランチ （12:00 ～ 13:30） 於：国立京都国際会館 通商産業大臣所感
	開会セッション （14:30 ～ 16:30） 原産会長所信表明 原子力委員長所感 準備委員長大会基調 ＜特別講演＞	セッション３ （14:15 ～ 17:45） 「なぜこうなった ── 原子力への国民の意識」 ［パネル討論］	セッション５ （14:00 ～ 17:00） 「これからのエネルギー・ 原子力は・・・」 ［問題提起と討論］
	セッション１ （16:30 ～ 18:20） 「エネルギーフロント ── 各国のアプローチ」 ［講演と討論］		フェアウェル・レセプション （17:00 ～ 18:30） 於：国立京都国際会館

4月9日（月）

ウェルカム・レセプション（12：30～14：00）

於：京都宝ヶ池プリンスホテル　地下2階「プリンスホール」

開会セッション（14：30～16：30）

議長：小　林　庄一郎　　（社）日本原子力産業会議副会長、関西電力㈱会長

原産会長所信表明

圓城寺　次　郎　　（社）日本原子力産業会議会長

原子力委員長所感

大　島　友　治　　原子力委員会委員長、科学技術庁長官

「わかっていないことは何か－大会の基調」

大　前　研　一　　年次大会準備委員長
マッキンゼー・ジャパン会長

＜特別講演＞

「世界のエネルギーと環境・政治」

L．アレグザンダー　　テネシー州立大学学長
前米国テネシー州知事

「日本のエネルギー・原子力を考える」

稲　葉　秀　三　　（財）産業研究所理事長

セッション1（16：30～18：20）
エネルギーフロントー各国のアプローチ

議長：生　田　豊　朗　　（財）日本エネルギー経済研究所理事長

「２０００年に至るハンガリーのエネルギー政策の考え方」

Ｉ．サ　ボ　　ハンガリー産業大臣代行

「インドのエネルギー・環境問題と原子力開発」

M．R．スリニバサン　　前インド原子力委員会委員長

「ソ連における原子力発電：現状と将来展望」

E．N．ポジシェフ　　ソ連原子力発電・産業省次官

＜参加者との討論＞

4月10日（火）

セッション2（9：00～11：30）
変わるか世界の原子力政策

議長：村　田　　浩　　（社）日本原子力産業会議副会長

「米国の原子力復活は可能か」

M．ワロップ　　米国共和党上院議員

「エネルギーと環境」

J．A．カニンガム　　英国労働党下院議員

「連邦野党のエネルギー政策と原子力開発への対応」

W.-M．カーテンフーゼン　西ドイツ社会民主党連邦議会議員

「岐路に立つ原子力ー世界的な相互依存の必要性」

G．エレーラ　　フランス原子力庁国際局長

＜参加者との討論＞

午餐会（12：00～14：00）　　於　京都宝ヶ池プリンスホテル地下2階「ﾌﾟﾘﾝｽﾎｰﾙ」

特別講演「日本画の美とは何か」（仮題）

加　山　又　造　　日本画家

映画上映（12：30～13：45）　　於　国立京都国際会館　大会議場

●伝統と創造のまち京都（京都市文化観光局観光部宣伝課）

●信頼性向上をめざして（原子力工学試験センター）

ー原子力発電所の耐震設計・評価に関する試験について

●豊かなくらしとエネルギー（科学技術庁）

セッション3（14：15～17：45）
なぜこうなったー原子力への国民の意識

議長：勝　部　領　樹　　（株）ＮＨＫエンタープライズキャスター

＜問題提起＞

「エネルギー・原子力についての国民の意識」

中　村　政　雄　　読売新聞社論説委員

＜パネル討論＞

パネリスト

石　橋　忠　雄	弁護士
大　宅　映　子	ジャーナリスト
木　下　冨　雄	京都大学教養部教授
野　坂　昭　如	作　家
中　村　政　雄	同　前

＜参加者との討論＞

4月11日（水）

セッション4（9：00～11：30）
原子力のない経済社会は・・・

議長：岸　田　純之助　　（財）日本総合研究所会長

「温室の中の生活－チェルノブイリ後の原子力発電」

R．ウィルソン　　ハーバード大学教授

「エネルギー開発と環境影響－フランスの事例」

H．ブシャドー　　フランス社会党国民議会議員

「原子力をやめた場合の経済、社会的コストを考える」

武　井　満　男　　名古屋経済大学経済学部教授

＜参加者との討論＞

ビュッフェランチ（12：00～13：30）　於　国立京都国際会館　地階宴会場「サクラ」

後援　関西電力㈱、住友電気工業㈱、三菱重工業㈱

通商産業大臣所感

武　藤　嘉　文　　通商産業大臣

セッション5（14：00～17：00）
これからのエネルギー・原子力は・・・

議長：田　原　総一朗　　評論家

パネリスト

三　塚　　博　　衆議院議員、自由民主党前政務調査会長

伊　藤　　茂　　衆議院議員、日本社会党政策審議会長

大　前　研　一　　同　前

＜参加者との討論＞

コメンテータ

武　部　俊　一　　朝日新聞社論説委員

柳　瀬　丈　子　　フリージャーナリスト

他に数名を予定

大会まとめ－何がわかったか

大　前　研　一　　同　前

フェアウェル・レセプション（17：00～18：30）

於　国立京都国際会館　宴会場「スワン」・庭園

23rd JAIF ANNUAL CONFERENCE
PROGRAM OVERVIEW

MON. APRIL 9

Registration
12:00-13:40 at Hotel
14:00- at Hall

Welcome Reception
12:30 - 14:00
Takaragaike Prince Hotel

Opening Session
14:30 - 16:30

Session 1
16:30 - 18:20

Energy Front --
National Approaches

TUE. APRIL 10

Session 2
9:30 - 11:30

Diversifying Nuclear Power Policies in the World

Luncheon
12:00 - 14:00
Takaragaike Prince Hotel

Films
12:30 - 13:45

Session 3
14:15 - 17:45

Public Awareness of Nuclear Power
-- Why this?

WED. APRIL 11

Session 4
9:00 - 11:30

Economic Society -- Without Nuclear Power?

Buffet Lunch
12:00 - 13:30
Kyoto International Conference Hall

Session 5
14:00 - 17:00

How will Energy and Nuclear Power be Tomorrow?

Farewell Reception
17:00 - 18:30
Kyoto International Conference Hall

Basic Theme
Nuclear Energy and Society — Our Tasks for Harmony

MONDAY, APRIL 9

REGISTRATION
12:00 — 13:40
KYOTO TAKARAGAIKE PRINCE HOTEL

14:00 —
KYOTO INTERNATIONAL CONFERENCE HALL

WELCOME RECEPTION

12:30 — 14:00

PRINCE HALL
KYOTO TAKARAGAIKE PRINCE HOTEL, B2

14:30 — 16:30
OPENING SESSION

Chairman:
Shoichiro Kobayashi
Vice Chairman
Japan Atomic Industrial Forum, Inc.
Chairman
Kansai Electric Power Co., Inc.

JAIF Chairman's Address
Jiro Enjoji
Chairman
Japan Atomic Industrial Forum, Inc.

Remarks by Chairman of Atomic Energy Commission
Tomoji Oshima
Chairman
Atomic Energy Commission
Minister for Science and Technology

"What are not understood — Conference Keynote"
Kenichi Ohmae
Chairman
Program Committee
Director
McKinsey & Company, Inc.

. . . . . .

Special Lectures

"Energy, Environment and Policies"
Lamar Alexander
President
University of Tennessee
Former Governor of State of Tennessee
U.S.A.

"On Energy and Nuclear Power in Japan"
Hidezo Inaba
Chairman
Japan Industrial Policy Research Institute

16:30 — 18:20
SESSION 1 ENERGY FRONT — NATIONAL APPROACHES

Chairman:
Toyoaki Ikuta
President
Institute of Energy Economics, Japan

"The Hungarian Government's Energy Policy Conceptions to the Year 2000"
Imre Szabó
Secretary of State
Ministry of Industry
Hungary

"Energy in India — Environmental Problem and Nuclear Power Development"
M. R. Srinivasan
Former Chairman
Atomic Energy Commission
India

"Nuclear Power in the USSR: Status and Prospects"
Erik. N. Pozdyshev
Deputy Minister for Nuclear Power and Industry
U.S.S.R.

Discussions

TUESDAY, APRIL 10

9:00 — 11:30

SESSION 2 DIVERSIFYING NUCLEAR POWER POLICIES IN THE WORLD

Chairman:

Hiroshi Murata
Vice Chairman
Japan Atomic Industrial Forum, Inc.

"Rebirth of Nuclear Power in USA"

Malcolm Wallop
U.S. Senator

"Energy and the Environment"

Jack A. Cunningham, M P
House of Commons
United Kingdom

"Energy Policy of the Social Democratic Party and Nuclear Power Development"

Wolf-Michael Catenhusen
Member of the Federal Diet
Federal Republic of Germany

"Nuclear Energy at the Crossroads — The Need for a World Interdependent Answer"

Gérard Errera
Director for International Affairs
Atomic Energy Commission (CEA)
France

Discussions

LUNCHEON

12:00 — 14:00

PRINCE HALL

KYOTO TAKARAGAIKE PRINCE HOTEL

Special Lecture

"Beauty of Japanese Painting"
Matazo Kayama
Painter

12:30 — 13:45
FILMS (In Japanese only)

Films will be shown on the following topics
——— Culture in Kyoto
——— Reliability of nuclear power
——— Energy in daily life

14:15 — 17:45
SESSION 3 PUBLIC AWARENESS OF NUCLEAR POWER — WHY THIS?

Chairman:
Ryoju Katsube
TV Caster
NHK Enterprises

"Public Consciousness of Energy and Nuclear Power"
Masao Nakamura
Editorial Writer
The Yomiuri Shimbun

Panelists:

Tadao Ishibashi
Attorney at Law

Eiko Oya
Journalist

Tomio Kinoshita
Professor
Kyoto University

Akiyuki Nosaka
Writer

Masao Nakamura

Discussions

WEDNESDAY, APRIL 11

9:00 — 11:30

SESSION 4 ECONOMIC SOCIETY — WITHOUT NUCLEAR POWER?

Chairman:
Junnosuke Kishida
Honorary Chairman
Japan Research Institute

"Living in a Greenhouse — Nuclear Power after Chernobyl"
Richard Wilson
Professor
Harvard University

"Energy Development and Environmental Effects — A Case of France"
Huguette Bouchardeau
Member of the National Assembly
France

"Non-nuclear Power Society and its Socio-economic Impacts"
Mitsuo Takei
Professor
Nagoya Economics University

Discussions

BUFFET LUNCH

12:00 — 13:30

ROOM SAKURA
KYOTO INTERNATIONAL CONFERENCE HALL

Remarks

Kabun Muto
Minister for International Trade and Industry

14:00 — 17:00

SESSION 5 HOW WILL ENERGY AND NUCLEAR POWER BE TOMORROW?

Chairman:

Soichiro Tahara
Critic

Panelists:

Hiroshi Mitsuzuka
Member
House of the Representatives
Former Chairman
Policy Affairs Research Council
Liberal Democratic Party

Shigeru Ito
Member
House of the Representatives
Chairman
Policy Board
Socialist Party of Japan

Kenichi Ohmae
Chairman
Program Committee
Director
McKinsey & Company, Inc.

Discussions

Commentators:

Shunichi Takebe
Editorial Writer
The Asahi Shimbun

Takeko Yanase
Journalist

(Other commentators to be announced)

. . . . . .

"Summarizing the Conference — What have been understood now"

Kenichi Ohmae

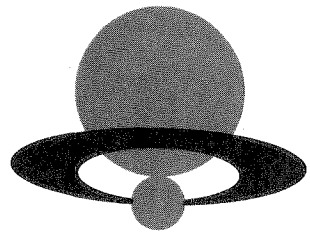
FAREWELL RECEPTION

17:00 — 18:30

ROOM SWAN & GARDEN

KYOTO INTERNATIONAL CONFERENCE HALL

開会セッション



原産会長所信表明
（社）日本原子力産業会議会長
圓城寺　次　郎

原子力委員長所感
原子力委員会委員長，科学技術庁長官
大　島　友　治

わかっていないことは何か－大会の基調
年次大会準備委員長，マッキンゼー・ジャパン会長
大　前　研　一

＜特別講演＞
世界のエネルギーと環境・政治
テネシー州立大学学長，前米国テネシー州知事
L．アレグザンダー

日本のエネルギー・原子力を考える
（財）産業研究所理事長
稲　葉　秀　三

第二十二回原産年次大会　会長所信表明

平成二年四月九日

国立京都国際会館

議長、御臨席の皆様、第二十二回原産年次大会の開催に当たり、主催者を代表いたしまして、一言御挨拶を申し上げます。

私どもは、今、世界が、イデオロギーを超えて、世界平和と相互協力に基づく新秩序を構築しつつある、まさに歴史的な時期におります。このような時に、原産年次大会において、エネルギー政策の重要項目であります原子力問題について、広範囲に検討し、将来のあるべき姿、その進むべき方向について議論できることは、たいへん意義深いことではないでしょうか。

これまでのエネルギー政策は、各国のそれぞれの安全保障政策のもとに、その国独自の政策が別々につくられてまいりました。しかし、経済の規模が大きくなるにつれて、一国のエネルギー政策が、世界のエネルギー需給バランスに、大きな影響を及ぼすようになりました。このような傾向は、今後の世界のエネルギー需要の大幅な拡大を考えれば、さらに大きなものとなることが、容易に予想されます。

石油ショックの時には、国際エネルギー機関（ＩＥＡ）を中心に、石油火力発電所の建設の中止など、石油を節減するためのエネルギー政策が、各国の間で調整されてきました。このような国際レベルでの調整は、将来の世界のエネルギー安定供給、並びに環境への影響の低減などのために、量と質の両面について、引き続き行われるべきであります。すなわち、世界全体のエネルギー政策について、開発途上国を含めた世界規模での検討を行う時期に来ていると思われます。そのような世界規模でのエネルギー政策の検討には、日本は積極的に、その役割を果たしていく必要があります。

原子力の平和利用は、技術によって、その膨大なエネルギーを引出すことができることから、エネルギー資源のほとんどを海外に依存する日本では、これまで原子力発電を積極的に導入する政策を、進めてまいりました。そして、日本の原子力発電は、エネルギー源の多様化によるエネルギーの安定供給に、大きく貢献してまいりました。技術によりエネルギーを引出すということでは、太陽光発電などの新エネルギー技術の実用化も急がれますが、大規模なエネルギー供給が可能ということでは、今後の原子力発電の利用の伸び如何が、将来の世界のエネルギー情勢に、今まで以上に大きく影響するものと考えられます。

日本は、原子力の利用に当たって、安全性に対する最大限の配慮と、対策を施してきました。今後もより安全な施設・設備の開発が行われるのは当然であります。一方、原子力技術の安全性に不安を持ち、その利用を中止すべきだとする意見もあります。しかし、これでは、技術の進歩を否定し、より安全性の高いエネルギー技術を子孫へ提供していくことと、子孫のエネルギー源選択の自由を、私どもの世代が否定することに他なりません。安全性への不安は、原子力を否定するのではなく、より安全な技術の開発を要求することに、向けられるべきではないでしょうか。

現在、先進工業国、開発途上国を問わず、原子力発電は、多くの国々で、建設・導入が計画されています。もともと技術の進歩というものには、取扱いのむずかしい装置を、誰にでも安心して扱える装置へと改良していくことも、含まれています。これまでの原子力技術の開発には、そうした点での努力と工夫が足りなかったように思えます。これからは、より小型の発電炉の必要性や補完的な役割なども念頭におきながら、各国それぞれの得意の技術を生かし、より安全で、扱い易い原子炉の開発を進めるべきでしょう。また、開発途上国へのこのような原子力平和利用技術の移転については、国際原子力機関（ＩＡＥＡ）が、さらに積極的に貢献することを期待します。

原子力を技術エネルギーとして、最大限に利用するには、長期的に見て原子燃料サイクルの完成を待って、はじめてそれが実現することは言うまでもありません。我が国が、原子燃料サイクルの実用化にチャレンジしているのは、あたかも米ソが人類の未来を開こうとして、宇宙開発に挑戦しているのと同様に、我が国が先進国の中で、技術フロンティアの長期的に重要な一つであるこの分野で、パイオニアとして、その役割を果たそうとしているからであります。しかしこの分野は、きわめて繊細なものであり、この仕事には、国の内外に十分な理解と協力を得る努力を怠ってはなりません。

日本のみならず、各国の原子力政策で、一般にもっとも理解されていない分野に、高レベル放射性廃棄物の処分があります。この分野は、その対応期間が超長期であるため、感覚的に把握しがたい技術であります。政府並びに原子力関係者は、より具体的で、分かりやすい考え方、スケジュール、方針などを打ち出し、国が責任をもって進めていることが国民にわかるような計画を、できるだけ速やかに提示する必要があると思われます。原子力委員会におかれまして、その積極的な対応を期待いたします。

考えてみますに、原子力がこのように大きな問題となったのは、原子力文明が未だ成熟していないからではないでしょうか。私共は、原子力文明が次の世代、二十一世紀に向かって、他の文明の模範となるように、努力する必要があります。このためには、原子力関係者が、一層、多くの分野の方々の意見を、真剣に、謙虚に受け止めて、今後の原子力の推進に生かしていかなくてはなりません。そういう意味において、今回の年次大会は、準備委員長に、経営戦略などの分野で世界的に有名な、マッキンゼー・ジャパン会長の大前研一さんをお願いし、開催することとなりました。原子力問題の根本に立ち返って、忌憚なく話し合い、将来への課題を大胆に提示されることを願っております。

最後になりましたが、年次大会の準備委員長、及び準備委員、各セッションの議長の方々、この大会のために御参集いただきました海外からの発表者、国内の発表者の方々、並びに会場の皆様に、心よりお礼を申し上げ、私の所信とさせていただきます。

以上

JAIF Charman's Address
23rd JAIF Annual Conference

Kyoto International Conference Hall
April 9, 1990

Mr. Chairman, ladies and gentlemen, it is a great honor for me to give this opening address of the 23rd Annual Conference on behalf of the Japan Atomic Industrial Forum.

First, for those participants who are all the way from corners of the world to participate in the Conference in Kyoto, the ancient capital of Japan, may I express most hearty welcome.

We are now in a historic period of time when, irrespective of differences in ideology, the world is building a new order based on world peace and mutual cooperation. The JAIF Annual Conference we are holding at this time is of great significance, I would say, in that it gives us the opportunity to review a wide range of problems concerning unclear power, an important task in energy policy, and to discuss the way it ought to be and the course to be pursued in the future.

So far, independent energy policies have been made among the different countries, as each has built them on separate security policies. But the scale of economic expansion means that the energy policies of any country will have a significant influence on the world balance of energy supply and demand. With further growth in the world demand for energy, one can easily predict a still greater influence in the future.

At the time of the oil crisis, the International Energy Agency (IEA) used its influence to adjust energy policies among countries, for example, calling for a halt to the

construction of oil-burning thermal power plants to reduce oil consumption. More of such international adjustments now needs to be made, both in quantity and quality, to ensure the stability of energy supply and minimize its environmental effects throughout the world. In other words, it is time for comprehensive reviews to be made on world energy policies, including the policies of developing countries. Japan has an active role to play in such reviews of world energy policies.

The peaceful uses of nuclear energy have been promoted in Japan, dependent as we are on foreign imports for most of our energy resources, under the policy of introducing nuclear power as a technological means of getting what nuclear energy offers in abundance. This policy has encouraged the diversity of energy sources in Japan, with nuclear power contributing largely to the stability of energy supply. Photovoltaic power generation and other new energy technologies are also in the course of development for practical application. But nuclear power, depending on its use as a technological means of supplying large volume of energy in the future, will have a greater influence than ever on the energy situation in the world.

The utilization of nuclear energy in Japan has been with the utmost consideration and measured for safety ever conceived. Of course, we are prepared to develop facilities and equipment that will be still safer. Some are worried about the safety of nuclear technology, arguing for a halt to its use. But this would mean a denial of technological advancement and preclude us from handing on to posterity a choice of energy technologies, with all the provisions that have been made for higher safety. Any concern for safety should not lead people to rule out nuclear energy but to demand the development of safer technologies.

Plans are afoot to build nuclear power plants in many countries, industrialized and developing alike. Any advancement in technology should involve improving intricate devices to make them easy enough for anyone to handle. In this respect, it would seem that not enough efforts have been made in the development of nuclear power. From now on, in view of the need for and supplementary role of smaller generating reactors, each country should improve its favorite technologies by developing nuclear reactors that will be safer and easier to handle. The International Atomic Energy Agency (IAEA) will be asked to use its efforts to ensure that these nuclear technologies for peaceful application are transferred to developing countries.

Nuclear energy will not be used to the best advantage as a technological source of energy until in the long run the nuclear fuel cycle is completed. The commercialization of the nuclear fuel cycle is a challenge for Japan, because this country is trying to do its part as a pioneer in the frontiers of technology to open a new horizon for mankind just as the United States and the Soviet Union take up the challenge of space exploration. However, it is a very sensitive field of technology which Japan is trying to advance, and so sustained efforts must be made to gain sufficient understanding and cooperation for it from within and outside this country.

One of the least understood lines of nuclear policy among the public of Japan and all other countries is the disposal of high level radioactive waste. This policy line can hardly appeal to the people's sensibilities because it takes a very long time for the technology to elicit a response. The government and nuclear interests are well advised to speed up to form concrete ideas, schedules and principles that will

make it easier to understand - to show the people a total plan that will convince them that their country is responsible for the technology. A positive response to this may well be expected from the Atomic Energy Commission of Japan.

On reflection, we realize that nuclear energy poses a serious problem because the nuclear civilization has not attained maturity. We are called on to see that the nuclear civilization is handed on to the next generation and to the 21st century as a model for all civilizations. To achieve this, nuclear interests must listen seriously and humbly opinions of many more people so that they can be reflected in the development of nuclear energy in the years ahead. That is why Dr. Kenichi Ohmae, Director of McKinsey & Company, was entrusted with this task of making program of this Annual Conference we are now having. You are all invited to discuss nuclear issues from the ground up and without reserve, and then to come up with all the problems you may propose for solution.

May I close by expressing my heartfelt gratitude to the chairman and members of the program committee for this Conference, the chairmen of all the sessions, the speakers from within and outside Japan, and all those present in this place of meeting.

Thank you,

日本原子力産業会議年次大会

向坊委員長代理御挨拶

本日、第二十三回日本原子力産業会議年次大会が内外から多数の原子力関係者の出席のもと、かくも盛大に開催される運びとなりましたことは、誠に慶賀にたえません。円城寺会長、大前準備委員長を始め、大会の開催に御尽力された皆様方に心からお祝いを申し上げますとともに、原子力分野で指導的な役割を果たされている皆様方とこの場に会する事ができ、大変うれしく思っております。

今日、世界の政治・経済は、各国が相互依存性を強めてきており、エネルギー政策についても、エネルギー資源の有限性、地理的偏在性等に鑑みると国際的視点が不可欠であります。特に、資源の乏しい我が国に

おいては、長期的な観点から適切に政策を展開するとともに、世界への貢献という先進国の一員としての責務を果たすことが重要であります。

世界のエネルギー需要の伸びは、第二次石油危機以降、基調としては鈍化する傾向にありましたが、近年、開発途上国を中心とした人口増加や生活水準の向上等により、世界のエネルギー需要の伸びは増加傾向にあり、今後は開発途上国の動向が国際的なエネルギー需給を大きく左右するものと予想されます。

このような中で、原子力については、現在、世界全体で四二五基、約三億四千万キロワットの原子力発電所が運転中であり、世界全体の総発電電力量に対し原子力が十七パーセントを占め、毎年着実に増加してきており、これは、年間約四億トンの石油消費に相当する量に至っております。このように原子力は、電力供給の主要な担い手としての地位を築いてきております

。今後とも石油依存度を低減し、世界のエネルギー需給の安定化を図るためには、エネルギー消費大国である我が国をはじめとする先進各国が引き続き原子力をはじめとする石油代替エネルギーの開発を積極的に推進し、世界のエネルギー問題の解決に貢献していくことが重要です。

また最近、二酸化炭素等による地球温暖化、窒素酸化物等による酸性雨などの地球規模での環境問題に対して、世界的に関心が高まってきておりますが、この問題を解決するに際して、エネルギー開発利用が環境に及ぼす影響を考慮する必要があります。石油、石炭等の化石燃料は、その燃焼に伴い、地球温暖化や酸性雨の原因と考えられている二酸化炭素、窒素酸化物等を発生させることから、これらに過度に依存することは好ましくなく、また、太陽エネルギー、風力エネルギー等の新エネルギーは、環境影響は小さいものの、

未だ供給安定性、経済性等の面において技術開発の課題が多く、規模の面からも、化石エネルギーに代替することは困難であります。

原子力に関しては、二酸化炭素、窒素酸化物等を発生させないという優れた特長を有していることから、アルシュ・サミット等の国際会議の場においても地球規模の環境問題の解決に重要な役割を果たすことが確認されており、こうした観点からも原子力の開発利用は大きな意義をもっております。

昨今、原子力については、国際的にも種々の議論がなされておりますが、我が国においても、原子力に対する反対運動が、原子力施設立地周辺地域だけでなく、都市部の主婦層や若年層をも含んで全国的に広がっております。これらの中には、原子力に対する漠然とした不安に基づくものや、原子力に関する誤解に基づくものなどもあるのが現状であり、誠に残念でありま

す。

申し上げるまでもなく、原子力の開発利用を円滑に推進していくためには、国民の皆様の理解と協力を得ることが不可欠であります。このため、今後とも、安全確保により一層努力し、安全運転の実績を積み重ねるとともに、政府及び関係機関が一丸となって、従来にも増して、国民の皆様の原子力に対する理解の増進に努めて参ることとしております。

その際、従来のような新聞、テレビ等のマスメディアを活用した、ともすれば一方的になりがちな広報だけでなく、全国各地に講師を派遣するなど国民の皆様の疑問や不安に懇切丁寧に答えていく対話形式などにより、適時的確に草の根的な広報活動を行っていることろであります。また、パブリック・アクセプタンス対策の推進に当たって、国際的な連携も重要であるとの認識の下に、海外諸国や国際原子力機関等とのパブ

リック・アクセプタンスに関する協力の強化を進めております。

原子力を巡る情勢は、厳しい状況下にありますが、自主的な核燃料サイクルの確立を目指し、現在、青森県六ヶ所村において核燃料サイクル施設計画が進展しております。政府は、民間における核燃料サイクル事業化計画が円滑に進められるよう、広報活動の強化、技術的支援等を積極的に行っております。

将来の原子力発電の主流となる高速増殖炉については、二十一世紀前半の実用化を目指して原型炉「もんじゅ」の建設を行い、現在、進捗率は約八十パーセントに至っており、一九九二年の臨界の計画を着実に進めているところであります。

一方、今後の原子力の研究開発については、技術革新の牽引車としての先導的な役割を果たしていくことが期待される領域を重視して参っております。

人類の究極のエネルギー源である核融合については、日本原子力研究所の臨界プラズマ試験装置（ＪＴ－６０）が臨界プラズマ条件の目標領域に到達したことを踏まえ、現在、その高性能化のための改造等、実用化に向けた研究開発が進められております。また、日、米、ＥＣ、ソ間で進められている国際熱核融合実験炉（ＩＴＥＲ）共同概念設計活動についても主体的に参加しております。

熱エネルギー供給による将来の原子力利用分野の拡大を担うものとして期待の高い高温工学試験研究炉については、高い固有安全性等の面において優れた特性を有する高温ガス炉の技術基盤の確立・高度化及び高温工学に関する先導的基礎研究を行うための中核的な研究施設であり、その建設を積極的に推進しているところであります。

このほか、放射線利用の分野においても、一層の普

及・拡大及び利用技術の高度化を図るための研究開発が行われているところであります。このうち、がん治療成績の著しい向上が期待されている重粒子線がん治療装置については、放射線医学総合研究所において建設が着実に進んでおり、また、物理、化学等幅広い分野での応用が期待されている大型放射光施設（ＳＯＲ）についても、その建設計画が進められているところであります。

また、原子力船の研究開発については、将来の原子力利用分野の拡大を図る上で重要であり、今後の舶用炉の研究開発に必要な実験データ、知見等を得るため、原子力船「むつ」による実験航海を実施することとしております。「むつ」につきましては、現在行われている出力上昇試験において、十六年ぶりに原子炉が臨界に達するなど、実験航海のための準備が進められております。

さらに、材料、人工知能、レーザー等に関する基盤技術の開発についても、産・学・官の研究交流の下に積極的に行っていくこととしております。

原子力を今後とも魅力あるものとするためには、原子力分野における優秀な人材の育成に努め、これまで述べてきたような積極的・創造的な研究開発を推進することが重要であります。

次に、原子力分野における我が国の国際貢献についてでありますが、開発途上国との協力については、相手国の国情を勘案しつつ、研究基盤、技術基盤の整備に重点を置き、協力を進めております。このうち、我が国と歴史的、地理的、経済的に密接な関係にある近隣アジア地域とは、我が国を含めた地域として一体の協力が有効であり、合意を得つつ地域協力を積極的に進めることにより、本地域全体の原子力技術水準の向上に貢献して参ります。具体的には先月、第一回アジ

ア地域原子力協力国際会議を行い、地域協力についての検討をすすめるなど、積極的な対応を行っているところであります。さらに、先進諸国との間においても核融合、高速増殖炉、高レベル放射性廃棄物の処理処分等の協力を積極的に進めております。

また、現在建設中の高速増殖炉原型炉「もんじゅ」の燃料製造等に必要なプルトニウムについては、平成四年には不足が生じる見通しであり、英仏への再処理委託により得られるプルトニウムの返還輸送を、平成四年度秋頃までに行うこととしております。このため、関係省庁の密接な協力の下、輸送に万全を期すこととしております。

原子力の開発利用を進めるにあたっては、安全の確保が大前提であり、私としても全力を尽くしてこれに当たる所存でありますので、皆様方におかれましても、宜しくかかる趣旨を御理解頂き、旧に倍する御支援

、御協力をお願いする次第であります。

以上、私の所感を御披露致しましたが、本日から11日間、「原子力と社会－語和くの課題」というテーマのもと、内外の多数の有識者・専門家の方々の間で忌たんのない活発な意見交換が行われ、貴重な提言がなされ、本大会が盛況のうちに成功を収められんことを心から祈念致しまして、私の挨拶とさせていただきます。

原子力委員会委員長代理

向坊　隆

The New Mission:

Energy, Jobs and a Safer Environment

by

Lamar Alexander
President, The University of Tennessee

April 9, 1990

Office of the President
The University of Tennessee
Knoxville, TN 37996-0180 USA

Tel. (615) 974-2241 / Fax (615) 974-3753

EXECUTIVE SUMMARY

In 1979, as Governor of Tennessee, I came to Japan on a new mission: To encourage Japanese investment in Tennessee so that the people of my state could have better jobs. Today more than 80 Japanese companies have major plants in Tennessee. It has been an important factor in creating a higher standard of living for Tennesseans. Ambassador Mike Mansfield always said that the two-country relationship between Japan and the United States is the most important two-country relationship in the world. The bridge across the Pacific between Japan and Tennessee is perhaps the strongest bridge between any American state and Japan.

I'm here today, as president of The University of Tennessee, on a new mission: To create new partnerships between Tennessee and Japan that will create jobs and improve our standard of living while keeping our environment safe.

Tennessee is one of the world's most important centers for energy research. The University of Tennessee, Knoxville is one of America's 50 major research universities. Just a few miles away from The University of Tennessee is the Oak Ridge National Laboratory--one of the U.S. Government's largest energy research laboratories. Knoxville is also the home of Tennessee Valley Authority, the largest electric utility in the United States.

We want to create a partnership between Tennessee's energy research center and the universities, corporations and utilities of Japan. Our two countries have a third of the world's money, the world's best jobs and a disproportionate amount of the world's scientific know-how. We should combine these relationships, money and knowledge so we can produce energy in ways that will create a safe environment for our two countries and all the people of the world.

I have with me two of The University of Tennessee's most distinguished scientists: Dr. Bill Colglazier, the director of UT's Energy, Environment and Resources Center; and Dr. Lee Riedinger, the director of the Science Alliance, a joint center of UT and Oak Ridge National Laboratory. I invite you to talk directly with me or with them if you would like to learn more about this partnership.

INTRODUCTION

Eleven years ago I came to Japan for the first time. I was on a mission at the direction of the President of the United States. I was the newly elected Governor of Tennessee. I had gone to my first White House dinner where President Jimmy Carter said in no uncertain terms, "Governors: Go to Japan. Persuade them to make in the United States what they sell in the United States. Bring their plants and those jobs to your states."

When I campaigned for Governor one year earlier, I had walked across my state. I had walked more than 1,000 miles. It had taken me six months. I had seen that people needed better jobs. It never occurred to me then that the solution to our need for better jobs might have something to do with Japan which was 7,500 miles away from my home in the Great Smoky Mountains of Tennessee. Not one Tennessean had said to me on my walk, "When you're elected, go to Japan." Tennesseans wanted better jobs, but getting them from Japan was not on their minds. My own idea of Japan then was a picture postcard stereotype: hot springs, Mt. Fuji, and Madam Butterfly somewhere on the other side of the world.

When I arrived in Japan I found that the people of this country did not know much more about us than we knew about them--the singer, Brenda Lee, the Tennessee Waltz and Jack Daniels whiskey. I found it

necessary to carry a map with me on my visits to businesses. And in one case, a very polite Japanese businessman after we had talked for a long time about why he should put a plant in our state said, "Thank you very much. Now please tell me just what *is* a Tennessee?"

I think today we know each other much better. Former Ambassador Mike Mansfield says the most important two-country relationship in the world is between Japan and the United States. I would argue that the best relationship between Japan and any state in the United States is between your country and the State of Tennessee. Over the last 11 years, more than 80 Japanese businesses have found their home in our state including major investments by Nissan, Bridgestone, Komatsu, Sharp, Toshiba, Nippondenso and Matsushita. Trade has become more of a two-way street. Japanese companies are the largest purchasers of our Tennessee agricultural products. We have learned a great deal more about each other through conferences and exchanges and friendships. We have learned that the dogwoods and the cherry blossoms bloom at about the same time, that the maple leaves in the mountains of Nikko and the Great Smoky Mountains turn their colors together. Our state flower, the iris, began in Japan. We exchange students, and now there is even a new Japanese high school, Tennessee Meiji Gakuin in Sweetwater, Tennessee not far from The University of Tennessee where I am now President. There is a strong bridge across the Pacific between Tennessee and Japan.

Eleven years ago, on my first trip to Japan, my mission was to recruit better jobs for the people of my state. Today, as President of The University of Tennessee, I am here on a new and different, but equally important mission. This new mission is to seek your cooperation in working together to discover new and better ways to help our countries and the world improve our standard of living without destroying the human environment.

Just two weeks ago I was privileged to attend a weekend meeting of the U.S./Japan Commission for the 21st Century. The commission includes a dozen distinguished representatives of Japan and a dozen representatives of the United States. The commission members recognized the difficulty of trade talks between our countries and the importance of finding solutions to those problems. There was one conclusion that I believe it is fair to say was unanimous among all of those attending, Japanese and American. It was this: The greatest and most important potential area of cooperation between the United States and Japan during the 1990's would be to use our disproportionately large share of the world's money, brain power and new technology to protect our environment while we are gaining new wealth.

In summary, what Ambassador Mike Mansfield has described as the most important two-country relationship in the world needs to put its energies and resources together in a powerful way in one simple model:

better jobs and a safer environment. Eleven years ago, I discovered that Tennessee had a unique opportunity to play a central role in the efforts to persuade Japanese businesses to make in the United States more of the products that they sold in the United States. By a simple accident of fate, Tennessee happens to be located in the center of the United States population. One of my favorite photographs is a picture that a satellite took of the United States in the early evening when all the lights are turned on. I would show this to my Japanese friends. They would find it fascinating. East of the Mississippi River, all the lights are on and Tennessee is in the center of the lights. West of the Mississippi River, it looks like all the lights are turned off, at least until you get to California. Companies that were interested in making products and transporting them at a low cost would find it better to come to Tennessee.

Tennessee is equally well positioned to participate in the new mission between Japan and the United States; to find new ways to create better jobs as well as a safer environment. The reason for that is the solution to the problem depends more than anything else upon how the production of energy affects the environment. In other words, can we find ways to produce energy that do not destroy the environment? In Tennessee there exists today one of the world's most important research centers for energy and environment. At the center of that is The University of Tennessee, one of America's major 50 research universities.

President Bush visited our university just two months ago, proclaimed it as one of America's major research universities and spent time studying the application of biotechnology to solving environmental problems. A few miles away is the Oak Ridge National Laboratory, America's largest and most diverse energy research and development institution. Also in Knoxville, Tennessee is the headquarters of Tennessee Valley Authority, the largest electric utility in the United States. These three major institutions already are hard at work on research and development concerning energy and the environment. I will detail in my remarks today how we propose to accelerate those efforts.

The reason I am in Japan, however, is because I know that we can do much more if we work together. We need to widen the bridge across the Pacific between Tennessee and Japan. Instead of only pursuing jobs, we must pursue how to have better jobs as well as a safer environment. In working together on the environment we do not have the same kind of competition that has led to acrimonious disputes between our two countries over trade. There is, after all, only one environment. The winds blow all the way around the world. There is only one ozone layer. If global warming changes the weather, it changes the weather everywhere.

I have accompanying me on this mission two of the most distinguished scientists from The University of Tennessee, Dr. Bill Colglazier, who is the director of our Energy Institute, Environment and

Resources Center, and Dr. Lee Riedinger, who is the director of the Science Alliance between the Oak Ridge National Laboratory and The University of Tennessee. I have been authorized by Dr. Alvin Trivelpiece, the Director of the Oak Ridge National Laboratory and Marvin Runyon, the Chairman of the Tennessee Valley Authority, to say that they and their institutions join with us at The University of Tennessee in welcoming a partnership with Japanese universities, businesses and government in this mission. Dr. Trivelpiece is the former executive director of the American Academy for the Advancement of Science. Marvin Runyon is well known in Japan because he was the first president of Nissan Motor Manufacturing Company in the United States.

THE DECADE OF THE ENVIRONMENT

We expect the 1990's to be the decade of the environment. We expect Japan and the United States working together to lead the world in finding ways to have better jobs as well as a safer environment. And we expect the well-established bridge across the Pacific from Tennessee to Japan to be one of the most important pathways as we work together for what will be the most important two-country mission of the 1990's: new relationships between energy and the environment to produce better jobs as well as a safer environment for the people of our countries and for the world.

We have entered into an era of expanding democracy around the world in the 1990's. The remarkable ascendancy of democratic institutions, affirming the interdependence of political and economic freedoms, may be the most significant development of this century. Continued flowering of liberty and human rights will depend in part on maintaining economic growth among the growing number of democratic countries with market economies.

But that economic growth requires energy. After the respite of the past decade from oil market instabilities, the expectation for the mid-1990's is increased dependence on OPEC oil and possible price increases. The oil market problems of the 1970's had a disastrous effect on world economic growth leading to international and domestic tensions. The same potential exists in the 1990's. James Schlesinger recently warned the U.S. Congress that rising oil prices and growing demand will soon push the U.S. bill for imported oil higher than the nation's 1990 trade deficit; he and many other experts expect a price surge for oil of 30 percent to 40 percent in the decade. So, one of our most important challenges for the 1990's will be to provide cost-effective and secure energy supplies to fuel our economic growth and to avoid the instabilities experienced in the 1970's.

We have learned as well from hard experience that economic growth is not an end in itself. The 1990's, I believe, will also be known as the "decade of the environment." It was the top TV news story in the U.S. last

year, accounting for 400 stories on our national networks. In 1988 it was, for the first time, an important issue in a U.S. presidential election. Protecting the environment has become a priority issue around the world as well, even a political issue in Eastern Europe, the Soviet Union and developing countries. Increasing concern about global environmental issues--greenhouse warming, ozone depletion, and acid rain--have made the environment a topic of international negotiations and summit meetings. At universities such as mine, students are not only vitally interested in topics ranging from solid-waste recycling at home to protection of tropical forests overseas, they are attempting to do something about their concerns. At home at our dinnertable, our daughters insist that we recycle in our family. This month we will celebrate at universities and cities across the United States the second Earth Day, exactly 20 years since the first helped to launch the environmental movement.

Protection of the environment can have economic impacts. In the United States, 80 percent of the public believes, according to recent public opinion polls, that protecting the environment is so important that requirements and standards cannot be too high, and continuing environmental improvements must be made regardless of cost. When faced with real choices, however, it is unlikely that the public would be willing to forgo everything else to protect environmental values. But the price that the public is willing to pay for safeguarding the planet is quite high

and growing. And failure to protect the environment can have staggering economic costs as well, as we have seen with the recent oil spill in Alaska and our nation's Superfund program to clean up contaminated hazardous waste sites. The current environmental debate in the U.S. Congress is over the new Clean Air Act, and how stringent it should be. Yet no one is arguing against having a strengthened law because the public wants clean air.

The vital connection between environment and economic development was elegantly stated by Saburo Okita last year in his speech to the Ecology '89 International Congress and Exhibition. "The environment," he said, "is basic to continued human survival, and long-term prosperity for mankind is inconceivable unless we ensure that future generations are also able to receive full benefit of the blessings of nature. But at the same time, development is also necessary in order to solve the problem of poverty in the developing countries and to enable all people everywhere to live civilized lives in a better environment. Environmental protection and economic development must thus be seen as mutually complementary concerns."

Minimizing conflicts between the environment and economic development, especially energy production, becomes a critical task for politicians and technologists. Energy and environment are intimately related; some of the greatest potential threats to the environment, such as

global warming, are impacts of energy production. The challenge is to provide the energy essential for continued growth necessary to ensure a better life and a peaceful political climate for all people, while at the same time providing a clean and protected environment essential for our quality of life and well-being. With attention to energy and environmental issues in the 1990's by both political leaders and technologists, we can chart a course for the next century that will ensure that our children and grandchildren have productive, healthy and happy lives on this magnificent planet.

As Governor of Tennessee, I created a Safe Growth Cabinet Council to coordinate state efforts in promoting environmentally-sound economic development. Japanese corporations have helped to provide that safe growth for Tennessee. Japan will play a major role in helping the world to expand its technological possibilities to provide the tools needed to sustain economic growth and to protect the environment. I have come here to tell you what we are doing on these issues, to seek your input, to find out more about what you are doing, and to explore possible areas of collaboration.

UNIVERSITIES SOLVE REAL-WORLD PROBLEMS

Only relatively recently have universities, industry, and state governments in the U.S. recognized the relevance of research universities

to economic development and the importance of universities having focused research centers to attack complex real-world problems. Both trends are counter to the "ivory tower" model of the university. Within the U.S., states are engaged in a competition with their neighbors over attracting new industries and jobs and developing high technology corridors. Almost simultaneously, the private sector, state governments and the federal government have realized that a first-rate higher education system is a key ingredient in maintaining and expanding industrial competitiveness. State governments now see the importance of research universities in attracting industry and fostering new jobs and start-up ventures. Universities have recognized that focused research centers can be used to target intellectual resources on vital societal problems. These focused research centers often cut across departments and disciplines because complex problems cannot be neatly compartmentalized. These centers are proliferating at universities, often with help from the private sector. The U.S. government has moved in a big way towards support of these research centers as well. These two very important trends at research universities in the U.S. in the 1980's--stressing their relevance to national and regional economic development and utilizing focused research centers for solving important problems--have been stimulated and enhanced by the growing partnership between universities, government and the private sector.

ENERGY AND THE ENVIRONMENT AT THE UNIVERSITY OF TENNESSEE

As one of the 50 major research universities in the United States, The University of Tennessee has been involved in energy and environmental research for more than two decades. In 1973, the university created the Energy, Environment, and Resources Center to bring together faculty and students from many different disciplines to work on real-world problems. The center conducts over $8 million in research each year. The university also has a major interdisciplinary program in ecology, a Center of Excellence in waste management research and education, and strong programs in nuclear, chemical, and environmental engineering. Much of this research is in collaboration with Oak Ridge National Laboratory and the Tennessee Valley Authority--two energy and environment institutions that I shall speak about shortly. The university also has one of the best research programs in the U.S. on the application of biotechnology to environmental problems. When President Bush visited the university in January of this year, he was shown how microorganisms can be used to degrade toxic chemicals in the environment. Scientists at the university are involved in research on environmental issues ranging from global warming and acid rain to radioactive, hazardous and solid waste management. Research on energy production ranges from inherently safe nuclear reactors and fusion to clean coal and solar. Most importantly, the scientists and engineers work hand-in-hand with economists and social scientists, since

public perceptions about a technology and its economic feasibility are crucial factors in deciding whether or not its potential can be realized.

UT & THE OAK RIDGE NATIONAL LABORATORY

The University of Tennessee is fortunate to have nearby as a "sister campus" the nation's largest and most diverse energy research and development institution: The Oak Ridge National Laboratory. The laboratory has 4,400 employees and a budget of $400 million per year. Its two primary missions are to conduct applied research and engineering development in support of the U.S. Department of Energy, and to perform basic scientific research in selected areas of the physical and life sciences. Energy research at the lab covers fusion, nuclear fission, conservation, renewable energy and fossil fuel. Environmental work covers global warming (with a new Center for Global Environmental Studies), acid rain, toxic chemicals and many other areas of environmental science. The laboratory is playing a major role in developing new technologies to reduce the cost of cleaning up environmental problems at Department of Energy facilities and developing new technologies to help alleviate global warming. It is also helping to develop the new energy plan for the U.S. being formulated now by Secretary of Energy James Watkins.

The University of Tennessee and Oak Ridge National Laboratory have developed a close working relationship, including the Joint Institute

for Heavy Ion Research, the Graduate School of Biomedical Sciences, the Graduate Program in Ecology, and the crown jewel: The Science Alliance. The Science Alliance promotes joint research and education between the two institutions. By letting the two institutions pool their intellectual and financial resources, it creates a more fertile environment than either could achieve on its own. The partnership's cornerstone is the Distinguished Scientist Program, through which esteemed researchers are appointed to joint positions. The 11 Distinguished Scientists--ranging in fields from nuclear engineering to environmental biotechnology--have brought outstanding research groups, external funding and prestige. Several of the Distinguished Scientists are engaged in environmental research and energy technology research.

UT & THE TENNESSEE VALLEY AUTHORITY

The Tennessee Valley Authority is a wholly owned corporate agency of the United States. It was created in 1933 as part of President Franklin Roosevelt's economic development program. TVA operates the largest electric power system in the U.S and manages America's fifth-largest river system. Originally, TVA built multi-purpose dams for electric power, flood control and navigation. Today the agency operates hydroelectric, coal, and nuclear facilities for generating electricity, continues to provide flood control and navigation on the Tennessee River, and carries out a variety

of economic development and natural resource programs. TVA has about 25,000 employees and a budget over $5 billion. By focusing on efficiency, productivity, and accountability, TVA has been able to hold electric rates fixed for the past two years.

TVA is aggressively pursuing improvements in energy production and environmental protection. It has cut sulfur dioxide emissions in half and reduced particulate emissions by 93 percent. Its fossil plants have been operating in recent years at 20 to 25 percent below the allowable rate for sulfur dioxide emissions. The agency is developing and testing new pollution-control and clean-coal technologies, such as its Atmospheric Fluidized Bed Combustion pilot plant. TVA is also striving to be a leader in protecting water quality and recreational opportunities in its river reservoir system. Its National Fertilizer Development Center, which has developed 75 percent of the world's fertilizer technology, has changed its name to the National Fertilizer and Environmental Research Center to focus on environmental problems of agriculture. After several years of problems, TVA is again operating its nuclear power plants with high efficiency and rigid safety standards. Its Sequoyah plant ranked second in the U.S. and eighth in the world last year in the generation of electricity.

PARTNERS: UT, TVA & ORNL

TVA, ORNL, and The University of Tennessee--all with their headquarters in the Oak Ridge corridor in the valley of the Great Smoky Mountains--have many collaborative efforts. Together the three institutions created several years ago the Consortium of Research Institutions. They found that there was a major synergism in combining the resources of a major research university, a major national laboratory and the largest U.S. electric utility. The consortium members meet quarterly to discuss topics of mutual interest in energy and environment and to plan cooperative ventures. One example is the Power Electronics Application Center, which the consortium put together. This center was successful in winning a national competition and is now supported by the Electric Power Research Institute, the research organization for all the electric utilities in the U.S.

A priority for The University of Tennessee is to develop additional joint institutes and other collaborative endeavors with ORNL and TVA. One that is being formed now is the Joint Institute for Computational Science to address important issues related to high-performance computing. The institute will unite computing and scientific experts at UT and ORNL for research, development and educational purposes. Its activities will center on developing the science and technology base to make "massive parallel" computing widely useful.

Another new institute being created is the Joint Institute for Energy and Environment. It will focus on energy technologies to combat global warming, applications of biotechnology to protect and clean up the environment, and new technologies to improve management of solid, hazardous, and radioactive waste. It will be able to call upon all the considerable resources engaged on energy and environmental research at The University of Tennessee, Oak Ridge National Laboratory, and TVA.

A third new institute, the Joint Institute for High Energy Physics, will play a role in the design, construction and eventual use of the super conducting Supercollider, the spectacular accelerator that will dominate the field of high energy physics well into the next century.

FRIENDS: USA & JAPAN

I have come here today to get your input and advice on how we might work together. Collaboration between the U.S. and Japan on energy and environmental issues will grow in the 1990's and beyond. I serve on a Commission on U.S.-Japan Relations for the 21st Century, which is examining potential areas of cooperation between our two countries. The major focus of our discussions within the commission has been on energy and environmental topics. The institutions that I represent-- the University of Tennessee, the Oak Ridge National Laboratory, and the Tennessee

Valley Authority--are especially interested in expanding our connections with Japan in the area of energy and environment.

I look forward to working with you on my new mission: To create a partnership between Tennessee's energy research center and Japan so that we can create better jobs and a safe environment for our two countries as well as the people of the world.

一九九〇・四・九・原産会議年次大会

日本のエネルギー・原子力を考える

稲葉　秀三

一

稲葉でございます。始めに私ごとを申して恐縮ですが、私は丁度八十三年前の今月、今日、この講演を申し上げております「京都」で生れたものであります。内外の皆さま方を前に、おそらく老年の私にとって最後となるかもしれないお話しを申し上げる機会を与えていただきましたことに心からお礼を申し上げます。

ところで日本の皆さんはもうご存じのことと思いますが、政府とエネルギー関係者の間では日本のエネルギー問題とエネルギー政策を全面的に再検討してみようという試みが昨年以来進行しております。その中心になっているのは政府の総合エネルギー調査会ですが、私は高齢の故もあり、この調査会の委員長と総合部会長をつとめております。この調査会の結論はこの五月か六月頃に出るはずで、まだ纏まってはおりません。私はこの調査会や

部会での討論だけではなく、その他の機関で行われています討議にも参加しておりますが、これらを通じ、「エネルギーは日本にとって、予想以上に大変な問題となりつつある。一九七三年の第一次、また一九七八年から九年にかけての第二次石油危機に匹敵するような、場合によってはそれ以上かもしれないような事態に直面しているのではなかろうかと感じるようになりました。このようなこともあり、もっと多くの人たちに経済活動や国民生活とエネルギー、また環境とエネルギーの関係などについて知っていただかなければならないと思うようになってきました。事態をそのまま放置することは許されず、いかに対処すべきかをもっとはっきり考え、訴えていかねばならない、こう思うようになってきたのです。

日本のエネルギー問題と政策については、いずれ公式的な見解が一、二か月後に発表されるでありましょう。しかし、私は自分に与えられましたこの機会に、痛切に感じておりますエネルギーと環境、産業、国民生活との関係、さらには原子力について個人的な見解を申し上げ、皆さんのご批判をうけたいと思います。

まず第一点として私の強調したいのは、エネルギーについて日本では前途楽観論がなお支配的であるように思いますが、これでよいかどうかについて再検討してみてはどうかということであります。一九八〇年（昭和五五年）からごく最近まで日本のエネルギーの消費の伸びはそれ以前に比べ著しく低くなっています。このようなこともあり、今後も大丈夫だろうという見方、考え方が政府、エネルギー業界、さらには一般国民の間に強まっているように思うのです。

このようなこともあり、私はここで皆さんと一緒にエネルギーの歴史を振返ってみたいと思います。我が国では一九五五年（昭和三〇年）から経済や産業の発展、国民生活の向上、近代化にともない、エネルギーの消費が急上昇しています。たとえば、一九五五年から第一次石油危機の起こりました一九七三年（昭和四八年）までに、エネルギーの総消費量は約六倍上昇しています。もっと具体的にいえば一か年平均一一～一二％も伸びているのです。この間エネルギーの主力を石油に転換しましたために、石油は実に二六倍も増加

し、一九七三年には全エネルギーの七八％が石油によって占められています。しかし第一次石油危機が発生し、石油の輸入価格は一バーレル三ドル弱から一〇ドル強にまで、さらに第二次石油危機のもとで四〇ドル弱にまで上昇してしまった。また石油の入手が不安定になるかもしれないという状況にもなっていった。このようなこともあり、我が国では「財政金融のひきしめによって経済活動の上昇を抑制し、エネルギーの需要を引下げよう。省エネルギー、省石油政策を強化していこう。またエネルギー多消費型産業（アルミ、電気製鉄、鉄鋼、石油化学など）を抑制していこう。それから原子力、石炭、天然ガス、その他の新エネルギーを使用するようにしていこう。さらには産業構造、環境問題をも配慮して機械工業、電子工業などに転化していこう。これらの方策を推進して、石油をはじめエネルギー全体の消費を下げていこう」という道を進めていったのです。こうした各面での省エネルギーの推進、また原子力や石炭などの活用は大きな効果を発揮したのです。一九八〇年代に入りますと、日本の経済の伸びは鈍化し、それとともにエネルギーの伸びや弾性

値も下がり、石油も、全体のエネルギー消費も下がっていったのです。また、「エネルギーについては先行きをそう心配することはない」というムードが日本のなかで支配的になっていったのも、この時期でありました。

しかし、その後の動きをみておりますと、一九八五年（昭和六〇年）頃を転機に、日本のエネルギーの需給は変化し、現在に至っています。しかも、これはわが日本だけのことではなく、世界的な傾向でもあります。多くの国々でエネルギーの伸びがまた大きくなってきているのです。

上述しましたように、今、私たちはエネルギー政策の全面的改訂のため、日本のエネルギー、経済、その他についての動向を見直していますが、現行の一九八七年につくられました政府の一九八七年から二〇〇五年に至る長期エネルギー見通しは、一か年平均一・六％アップ位で今後、エネルギー需要は伸びていくだろうということを前提としています。しかし、一九八七、八八、八九年については実績は四％を上回っています。ことに昨八九年、また今九〇年に入ってからの状況を見ておりますと、五％アップ位になりそうであり

ます。これについては更に検討を要すると思いますけれども、三～四％アップ位の伸びはまだ当分続きそうに思われてならないのです。かりにそうしますと、日本のエネルギーの将来はそう楽観できません。

次に第二点として指摘したいのは、エネルギーの供給増加が今のままではあまり期待できないということであります。もっとも、ごく最近になりまして事態は少し変ってきているようには思いますが、まだまだ楽観は許されません。そのひとつとしましては、「原子力発電所を日本で全部やめても、自分たちの使っている電気が不足することはない。」こう思っている人たちがまだ国民の半分以上もあることです。これも上述しました日本のエネルギー消費の低下が原因の一つであるように思うのです。原子力が発電力の三〇％強を供給しているということをまだ知らない人が多いようです。また原子力発電所をやめても太陽熱や天然ガスを利用すれば、電気や熱は簡単に供給できると思っている人もこれまた多いようです。つまりエネルギーがいるときには努力すれば発電所はすぐ建てられる、このような方が多数おられるように思われるの

であります。

私が個人的に心配していますのは、上述しました政府の年一・六％アップのエネルギー増加の長期エネルギー見通しすら今のままでは実現できそうもないということです。たとえば、二〇〇〇年には日本は今の三、〇〇〇万キロワットの能力に対し五、三五〇万キロワットの原子力発電所をもたねばならないことになっています。ところが私個人の調査では、「これから相当努力致しましても、五〇〇～七〇〇万キロワットはこの目標より設備建設は減らざるをえません。それでは原子力にかわる石炭、石油、天然ガス、その他の発電設備を計画よりもさらに余計に建設することができるのかといいますと、それも難しい」、こういわざるをえないのです。これが本当かどうかについて政府や電力業界に私は再検討をお願いしています。

三

第三点として私の指摘したいのは原子力建設の遅れのほかに、最近のエネルギーを取巻く事情、なかでも環境問題のあり方を考えますと、日本でエネルギーの最低限を保証していくことはそう簡単なものではないことです。

原子力については、日本はアメリカ、オーストリア、スエーデンのような国々ほど深刻ではないのです。つまり、これを直ちにやめてしまおうとか、ある時期までに全廃しようとかいうことにはなっておりません。しかし、一九八七年のソ連のチェルノブイリの事故以後、わが日本でも消極論が多いことはご存じのとおりです。それだけではなく、原子力以外の環境問題が最近国際的な背景もあり、大きく登場しております。これに今後対処していかねばならないのです。

その上これからは地球温暖化、また低硫黄化や森林開発などにどう取り組むかについて私たちはもっと本格的に対処していかねばなりません。ご存じのようにCo2や低硫黄化エネルギーなどの大気汚染では、日本は世界に先がけていろいろの対応策をこれまでも実行してきております。しかし、最近のように貿易が大幅黒字となり、外貨の大保有国となっていることを考えますと、私たちは国内のことだけではなく、地球規模での環境対策のため、より一層国際的に積極的な活動をしていかねばなりません。ことに最近のように世界の先進国の間で何時何時までにこれだけの

環境の改善をしていこうという申し合せがされていきますと、日本もこれらに積極的に協力をしていかねばなりません。すでにやってきているのだから当分は外国のやり方を見ていようというだけでは済まないのです。

以上の三点のほかにも触れなければならないことも沢山ありますが、これらだけでも楽観論は許されません。私は、「今のままで進んでいきますと、三、四年先、つまり一九九三年か一九九四年頃になりますと、電力の需給に問題が起こってくるのではなかろうか」、こう思うようになってきたのです。つまり、ピーク時での電力の供給が問に合わないという可能性も生じてくることになりそうなのです。それから先にはもっとアンバランスが起こってくるでありましょう。そうなりますと、今まで原子力発電所の建設に反対していた人たち、そうでなくとも消極的であった人たち、また電力の需給の将来にあまり心配はないと思っていた人たちは、今度はてのひらをかえしたように、「一体政府と電力会社は何をしていたのか」と非難し、攻撃するようになってくるでしょう。

このようなこともあり、私自身は、エネル

ギー関係者だけではなく、国民の皆さんに対して、「果してこのようなことになるのかどうか。みんな一緒に検討し、調査してみてはどうでしょうか」と主張したいのです。というのは原子力発電所を作るには十年、十五年以上の歳月がかかります。また石油、石炭、天然ガスの発電所についても、いざこれらをつくろうとしたところで、急いでも五年から七年の歳月がかかるのです。更に新エネルギーといわれております太陽熱、地熱、石炭液化、風力、海水利用等の発電についてはこれ以上の時間がかかるのです。またこれらのコストもそれほど安価になるとは思われないのです。

四

最近私はエネルギーの問題は政府や電力会社、その他のエネルギー担当機関だけで検討していくだけではなく、消費者である国民の皆さんもこれらを解明し、どうしていくかを検討していかなければならない、そうでないと事態は打開できない、こう思うようになってきました。「需要が予想以上に伸びている。年率一・六%の供給の伸びを予想している政府の長期エネルギー見通しを再検討せざるを

えない」、その上「原子力への反対運動だけではなく、世界的に高まってきている地球温暖化や低硫黄化その他大気汚染、水汚染などの環境問題からの要請に対処していかねばならない」こうなりますと、本当に容易なことではないのです。しかも、エネルギーについてはただ数量をどうするかだけではなく、個々のエネルギーのコストを比較しながら、どれをとるかを考えていかねばならないのです。私にいわせますと、今までと違いまして、これからのエネルギー問題と対策は、多くの要素をならべ、これらをにらんで多元方程式をどう解くかというやり方でやっていかねばならないのです。

五

さて私は本報告の終りにあたり、原子力について私見を申し上げたいと思います。皆さんもご存じのように、一九六〇年代、また七〇年代を通じ、原子力は世界的に大きく進展しました。一九七〇年代の前半までは、「エネルギー、なかでも電力の供給では、これからは原子力が主たる役割を演じるようになる。石油にかわるエネルギー源となっていく。しかも現行の軽水炉中心の原子力発電は高温ガ

ス炉、高速増殖炉におきかえられていくだろう」こういう見解が有力でありました。私たちの国日本は原子力発電に対しては安全性の観点から極めて慎重かつ真剣に対処していきました。そして、今日三〇〇〇万キロワットの発電設備をもち、発電力の三〇%、全エネルギーの一〇%弱を供給しています。しかし、一九七九年のアメリカのスリーマイル・アイランドや八六年のチェルノブイリ発電所の事故を転機として、消極的なムードが高まっています。その上今までは、原子力以外でもエネルギー面では環境問題が大きくクローズアップしています。正直にいってこれが最近の実情です。

このようなときに私たちは、「原子力はもう駄目だ、エネルギー問題の解決は非常に困難だ」といってしまってはなりません。「こういうときだからこそ、今一度原子力のあり方を再検討してみよう」、こういう気持になって、行動を起こしていくことこそが大切であり、必要であります。このことを私は強調したいのです。

その一つのありかたは原子力のPAについて考え直すことでありましょう。

今まで日本で行われてきておりました原子力発電のＰＡは、主としてこれから発電所を建設しようとする地方の住民の方たちを対象に「原子力は必要かつ安全なものであり、地方の住民の方たちの生活や経済活動にもプラスになるものであります。また日本だけではなく、世界的にも進められているものであります。ですから、発電所建設に皆さんも賛同し、協力して下さい」こういうことを訴えようとするものが中心だったと申せましょう。

ところが、チェルノブイリの事故以来状況は変化し、地域関係者だけではなく、都市住民および婦人方にもっとエネルギーや環境問題、原子力問題について知っていただくことが大切になってきているのです。いうなれば受け身ではなく、国民の皆さんにエネルギーのことを自ら考えていただくことが必要となってきたのです。もっと具体的に申しますと、今から二一世紀までは、日本のエネルギーの伸びは年平均三から四％弱ぐらいになっていかざるをえないのに、そうなってはいきそうもないのです。そうしますと私たちは一九七〇年代のように省エネルギーをもっと本格的にやっていかねばなりません。それでもエネ

ルギーの伸びはこれから年平均三％アップ位にはなっていきそうです。一九八七年の政府の長期エネルギー見通しの年平均一・六％では済みそうもなく、しかも日本はこれからはもっと本格的に環境問題にも対処していかねばなりませんが、石油も、石炭も、天然ガスも、そのほかの新しいエネルギー開発もこれからやっていきましても、現在の政府の長期計画の目標ぐらい、あるいはそれを若干上回るくらいの原子力発電をやっていかねばならないのであります。昔のように原子力をやればエネルギーは大丈夫だというのではありませんん。省エネルギーもやる、環境対策に対してももっと積極的な措置もとる、また海外の環境対策にも積極的に協力していく。このようなことをやっていくには、私たちは原子力発電を増強していかねばならないのです。そうでないと、最小限のエネルギーの充足もできないのです。私たちは従来以上に原子力を見直し、また推進していかねばならないのです。

私たちがこれからもっと積極的にやっていかねばならないのは、生活や産業とエネルギーの関わりあいを国民の皆さんに広く知って

いただくよう努力していくことです。またエネルギーと環境との関係、さらには原子力の安全性確保のため、どのようなことを行っているか、さらに行おうとしているかを知ってもらうことです。反対すればことは済むというのではなく、どのようにことを運べばマイナスが少なくなり、また、比較的安価にエネルギーが確保できるかなどについて、国民の各層の方たちに判断材料を提供していくことです。

このように諸般の事情を訴え、多元的にことを進めていけば、私は原子力発電の効果的な面を多くの方たちが認識されるようになると思うのです。

最後に私は総合エネルギー調査会の見解がまとまってから、関係者の皆さんの了解をえて呼びかけようと思っておりましたが、昨年十月のエネルギー政策の中間とりまとめの際、私見として申し述べ、同僚の方たちからあなたの見解として公表してはどうかといわれました、「エネルギーについての国民の皆さんへのメッセージ」を申し上げたいと思います。これは三つの部分からなっています。第一のメッセージは「もし国民の皆さんが、各々の

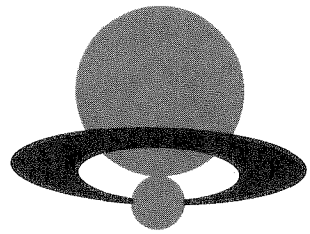
生活レベルを向上させたい、ゆとりや豊かさを実現したい、そして貧しい発展途上国の人々にも援助したいと思われるならば、日本には一定の経済成長が必要となります。エネルギー消費はかなり増えていかざるをえません」こういうものです。

第二のメッセージは「今後増大していくエネルギーの供給を考えますと、今の状態のもとではスーパースターはいません。つまり石油も、天然ガスも、石炭も、原子力も、新エネルギー等も、セキュリティ、コスト、地球環境問題、さらにはその実現の可能性の時期や量などを考えますと、どれをとっても問題があるといわねばなりません。ですから今後エネルギーの供給増加のためにはこれらすべてを活用し、組合せていくしかないことを知っていただきたいのです。原子力はこれらのなかで消極的でなく、積極的な役割を果たしていかねばならない」というものです。

第三のメッセージは次のようなものであります。「私たちは今後、どうするのが一番良いかを考えていかねばなりません。しかし、国民の皆さんも、もう一度生活と経済の基礎であるエネルギーの問題、特にエネルギーの

効率的使用について考えていただきたいのです。また、地球温暖化問題の解決に向って、わが国が果たさねばならない役割についても考えていかねばならない」というものです。

セッション1
エネルギーフロントー各国のアプローチ



２０００年に至るハンガリーのエネルギー政策の考え方
ハンガリー産業大臣代行
Ｉ．サ　ボ

インドのエネルギー・環境問題と原子力開発
前インド原子力委員会委員長
Ｍ．Ｒ．スリニバサン

ソ連における原子力発電：現状と将来展望
ソ連原子力発電・産業省次官
Ｅ．Ｎ．ポジシェフ

Prepared for the Conference of the Japan Automic
Industrial Forum to be organized between April 9-11, 1990

Prof.Dr. Imre Szabó
Secretary of State
Ministry of Industry

The energy political concept of the Hungarian Gevernment till the turn of the millenium

The objective of the energy policy concept:

The determination of
- the time span, the time horizont of the energy policy
- the expected development of energy demands, which are to be satisfied economically taking into consideretion the movement space of the economy
- the rationalization of use, as well as
- the composition of the energy resources ensuring the fulfilment of the energy demands.

Efficient energy policy in all nations is a strategic task.

In preparing the energy political concept - contrary to previous practice - greater attention is to be given to the movement space of the economy. The uncertainties appearing in long-term energy demands have to be thoroughly analized. Deterministic energy prognosis are of the past, they are to be replaced by possible demand development zones.

The present energy political concept - having a time horizon of the

turn of the millenium - considers:

- the past development of energetics
- the expected development of energy demands
- the possibilities of ensuring the necessary energy resources, including the analysis of the electric power station construction alternatives
- the expectable economic environment of energetics
- the environment protection conditions of the development of energetics
- research-development tasks related to the energy political concept, and finally it summerizes the most important, urgent tasks related to the development of energetics.

In the past 3 decades energetics met continuously and practically smoothly the energy demands of the production sectors and of the public-communal sphere. However this achievement has tied down considerable investment resources. Simultaneously our import dependance has also increased.

However the transformation of the economic structure did not take place so far, thus its energy need could neither decrease in the required pace.

Energy policy has to count with a capital limited economic environment, strictly limiting energetic investments. Moreover it will remain an essential requirement to meet the occurring energy demands with an acceptable safety. As a consequence the following appear as economic policy objectives which are to be aided by the means of the energy policy as well:

- to decrease the energy requirement of the economy (the quantity of energy needed for one unit of national product)
- the moderation of the pace of increase of electric energy and power.

The above postulates demand that the energy requirement of the material sectors on the level of the national economy - including electric energy - should not increase.

In the event of transformation of the economic structure forced out by the market forces, production activities may also develop at the present or an even lower level of energy demand.

Nevertheless the estimation of the factors determing the energy demand contain numerous uncertainties.

The future energy demand of the economy in the present situation may be predicted only widely. Simultaneously we may nearly state with certainty that the pace of energy demand increasing up till the turn of the millenium will not exceed the increase pace of the 80ies, even its dropping back may be expected.

Thus e.g in the case of electric energy the annual demand increase of the public-communal sector in the 90ies will be 2.5-3 % p.a. compared to the 6 % p.a. experienced in the past ten years. In case of the material sectors the increase pace of the demand will drop from 2.59 % p.a. to a 1.3-1.4 % p.a.

This means that on the long run we may calculate with a 1.5-2 % annual increase of electric energy use.

Since in respect of the direct application of fossil fuels in the future we may not count with a considerable increase, depending from the development of electric

energy demands, a total domestic energy utilization increase of 0.6-0.8 % p.a. may be predicted.

The resource side of the energy system should be prepared by involving in the plan appropriately flexible elements and reserves based upon a continuously maintained demand prognosis in order to achieve that it should become possible to meet the realistically expected demands with at least an acceptable safety.

The energy efficiency of the Hungarian economy (the quantity of GDP produced with one unit of energy) between the years of 1971 and 1987 has increased with the round figure of 30 %. In spite of this, our lagging behind the developed - market economy capitalist countries is considerable.

The difference in energy efficiency is caused to a smaller extent by the worse specific energy utilization of the energo-technological processes of the industries. The decisive part of the difference, however, is caused by the low net income content of the products produced using the energy.

In this field the basic task of the economic policy is to implement the changes and through them to improve the energy efficiency as well.

So the best way to increasing energy efficiency is through restructuring the economy, however the energy policy may not be without saving, rationalizing activities.

From among the energy saving activities an extremely important one is the moderation of the electric energy output requirements of the peak periods. Besides this, the utilization of the local electric energy producing possibilities representing a lower energy output capacity may also mean economic output resources. These might reduce the burdens of the investments of the power station construction program.

Another impoertant field of energy rationalizing is the energy user "infrastructure" (background industry, instruments, up-to-date bricklaying materials and door-window structures, etc.). The implemented investments in this field may result in the saving of about 28 PJ p.a.

Towards these products in the recent times - compared to the earlier ones - the demand has become lively, and the offer side has to be geared up to meet its level.

The realization of the outlined opportunities basically depends from the economicalness of the investments. In order to foster energy rationalizing activities, to promote energy efficiency, there is a need for an adequate stock of means, within which - by turning into a market economy - the dominating elements should be the following ones:

a/ Energy pricing and tariff policy. The prices of the energy carriers should reflect the cost expenditures of securing the resources and that of energy distribution and they should stimulate cost oriented management. Production prices are to be adjusted according to the world market prices and the still existing energy price subsidies are to be gradually demolished.

b/ A harmonized financial policy stimulating saving and rationalization, which - e.g. through tax allowances - should promote the improvement of energy efficiency.

c/ For extended reproduction it is essential to gradually achieve the self financing of the economic units of the energy sector, as well as the transforming of their management in order to raise their interest in cost saving, in economic resource development. The local resource extension possibilities should also be incorporated economically into this system with an appropriate tariff policy.

d/ The enfrocement of the energy saving policy requires the establishment of consistent interests. Without management personal interests, through only financial and sanctioning means, the existing energy saving potential may not be exploited in its full extent.

In order to meet the predicted energy demand the energy resources from the 1420 PJ p.a. of 1990 have to be geared up to about 1560 PJ by 2000. Within the resources the share of the domestic ones will decrease to 570-605 PJ, and thus import demand will raise from 730 PJ to 920-970 PJ. (The increment of import is corresponding to about 5-6 Mt p.a. natural oil equivalent.)

The decisive proportion of energy carrier import so far - using the advantages of the constructed transportation systems - we obtained from the Soviet Union. Since delivery capacity will meet our import demands for about 10-15 years to come, our aim is to exploit it in the future as well.

We also have to make steps towards diversifying import. In this respect:

- a new electric long-distance cable connection has to be built out in the direction of Western-Europe (Austria)
- we have to get connected to the East-West natural gas transportation system
- the Adriatic natural oil line - provided Soviet-Yugoslavian transit stops - would be suitable with some modifications for transporting to Hungary a considerable volume of oil.

The exploitation of the domestic coal reserves is determined by economic and market forces. In the interest of transforming the production structure with the

aim of improving production efficiency - which may be achieved by exploiting faster and shutting down the uneconomical deep-level mines, as well as by the expansion of economical surface mined lignite production - and with the aim of reducing the subsidies, the orders of the State Planning Committee (ÁTB) of 1986 and of the Social Economic Committee (TGB) of 1988 introduced the measures necessary.

The economic requirements were worded by the Social Economic Committee (TGB), which - deducing from the present cost of substituting import energy carriers - determined the cost limit of coal production at the 1988 price level, for power station coals at 100 Ft/GJ, for public coals at 160 Ft/GJ.

These cost limits are to be adjusted regularly according to the changes of the internal and external factors of the economy.

In the past two years seven - from this in 1988 three - deep-working mines had been closed down.

In 1989 34 deep-working mines were operating, whose production estimatedly was 15.5 Mt, while the volume of surface lignite production was estimated to reach the level of 5.5 Mt. From this production 137 PJ (15.1 Mt) was to be handed over to the power stations being under reconstruction, of this amount 37 PJ (5.5 Mt) is lignite and 100 PJ (10 Mt) is black and brown coal.

In the interest of increasing the economicalness of coal production the started production structure shift has to be carried on. Accordingly in 1989-1990 the operation of further six deep-working mines will be stopped. Between 1991-2000, primarily due to the depletion of the coal resources e further eight deep-working mines will be shut down. A significant element of production restructuring is the running up of economic surface lignite production up to 8-9 Mt which is to ensure the fuel supply of the reconstructed Gagarin Thermal Power Station.

The production capacities of the shut down deep-working mines, the decreasing coal production may be substituted with the 2 Mt p.a. capacity Dubicsány Mine Works and/or with the establishment of the 2 Mt p.a. capacity

Ajka II. mine works, as well as several coal resource substituting investments (e.g. Márkushegy II., III., Alagútmező, etc.) whose economic appraisal has already been started by international experts. Simultaneously the further program of the economic production structure of coal mining is being worked out - on the basis of a method approved by the World Bank.

Provided based upon the results of the international appraisal the World Bank will take an affirmative attitude, by the turn of the millenium we may plan with an 11-12 Mt p.a. level deep-working coal mining which adds up together with surface-working lignite to a production of 19-21 Mt p.a.

In case of a lower than introduced level coal production - without opening new mines and without coal resource substituting investments -the amount of coal which may be handed over to the power stationsby 1995 will decrease to the marginal value of 125 PJ p.a., and by 2000 to 105 PJ. This would require the reconstruction of the boilers of the reconstructed brown and black coal fuelled power stations, or the establishment

of new hydrocarbon fuelled capacities, together with ensuring fuel import (coal or/and hydrocarbon) necessary for their supply. These surplus expenditures have to be taken into consideration when evaluating the economicalness of domestic coal production. The offer of public coal and briquette - in case of 1.0-1.2 Mt briquette import - in this version will decrease to 4, or 3.5 Mt.

By implementing the version of higher production, the basic requirement of the coal power works (125 PJ p.a.) could be met till the turn of the millenium, and for the population - with about 0.8 Mt briquette raw material import - 4.5-5.0 Mt p.a. coal and briquette could be ensured. This version even besides decreasing deep-working coal production is in harmony with market demands.

The required coal and briquette import in 1990 is 2.7 Mt. From this amount the quantity of briquette ensured by inter-state contracts is 0.67 Mt, and about 2.0 Mt coal may be used by the population for direct heating, or as briquette raw material or for the purpose of cokifying.

In the case of the higher level coal production version the import demand of coal and briquette by 2000 will increase expectedly to 3.5 Mt p.a. (the quantity of briquette would be practically the same as the present level). In the case of the lower level coal production version in 2000 4 Mt coal and 0.9 Mt briquette, that is altogether an import of 4.9 Mt is essential.

Domestic hydrocarbon production reached its peak level in 1985. In the future even by applying economic secondary-tertiary production processes resulting in a higher yield, it is to be expected that the production will decrease. It is to be expected that:

- the present natural oil production from the annual 1.8 Mt will decrease by 1995 to 1.75, and by the turn of the millenium to 1.5 Mt
- natural gas production will decrease from the present annual 6.1 billion m^3 by 1995 to 5.5 billion m^3, and by 2000 to a value of about 4 billion m^3.

The decrease of domestic production, as well as the increase of the demand against natural oil and gas is to be covered by surplus import.

The essential volume of natural oil processing - and thus of natural oil import - is basically determined by the demand against fuels and chemical industrial raw materials. According to present calculations by the turn of the millenium there will be a need of processing about 10-11 Mt p.a. natural oil, in contrast to the present 8.5-9.0 Mt p.a.

The relatively low processing increment may be achieved only if the depth of natural oil processing will be increased. The increasing number of cars, the gas turbine power station development and petrol chemistry raises the demand against petrol-gas oil fractions. Due to environment protection requirements their lead and sulphur content is to be reduced.

The available natural oil long-distance lines (Friendship II, and the Adriatic line), their transport capacities, as well as the already existing primary natural oil processing facilities allow the meeting of energetic demands flexibly, quickly equally by Soviet, or by Western procurements. In case of Western procurements - by terminating the present transit

transportation contract - the Adriatic natural oil line could be used for transportation.

In the recent times and even in our days the natural gas system has been and is dynamically developing. The volume of natural gas used in the country in 1985 was 11.1 billion m^3, in 1990 12.5-13.0 billion m^3, and for 2000 16-17 billion m^3 may be expected.

In natural gas consumption the demand of the population increases. In 1985 within the country 336 settlements were supplied by gas lines. In 1990 the number of connected settlements will be 380, by 1995 420, and by the turn of the millenium it is expected to be 480. The number of connected household consumers in 1990 will be 940,000. Subsequently - depending from the financial possibilities - annually the connection of 60-80 thousand flats may be calculated with.

Besides the population the electric energy industry is also a consumer of increasing importance. In the event of the realization of the gas turbine power station development program the present 2.5 billion m^3 power works consumption by the end of the 90ies may even exceed the volume of 4 billion m^3.

Since the establishment of underground gas stores is limited by geological endowments and their establishment is rather investment demanding, in the winter period - lacking peak capacity - the gas turbines have to be operated with gas oil.

The falling back of domestic natural gas production, the increasing of the demand of the population and of the power works make dynamic import increase essential. The present approximately 6 billion m^3 p.a. natural gas import by 1995 has to be increased up to 8.5-9.5 billion m^3, by 2000 to 11.0-12.5 billion m^3p.a. At present procurement in clearing arrangement - provided they will be still in force after 1990 -, the Orenburg and Jamburg contracts cover 5.5 billion m^3, thus for 2000 a further amount of about 5.5-7.0 billion m^3p.a. natural gas is to be contracted still.

The natural gas and oil imported in clearing arrangements after 1990 (for the years of 1991-1995) will have to be ensured by the consequent plan co-ordination negotiations and it would be practical to conclude agreements also for longer terms with a higher share of clearing arrangement imports.

The electric energy and output requirement increase determining the required extent of power work constructions due to the previously enlisted facts may be planned only in a wide range.

On the basis of the executed appraisals we consider as the lowest limit of the range of electric output demand increase till the turn of the millenium an annual increase of 1.5 %, which already calculates with the effects of the already prescribed output decreasing measures. The estimation of the lowest range is considerably influenced by the expected economic environment of the coming decade demanding an investment saving policy.

Thus based on the demand calculations the lowest limit of electric surplus output demand by the turn of the millenium may be estimated to be 900-1050 MW.

The meeting of the demand is to beexamined in two versions:

a/ The river barrage of Bős-Nagymaros will be built and operated according to the original plans.

The output achieved thus will be 450 MW, so the missing output would be 450-600 MW.

b/ The river barrage of Nagymaros will not be built, thus the river barrage of Bős may not be operated at its peak. In this event only 150 MW would be produced by the establishment, thus the missing output would be 750-900 MW.

In meeting the demand basically there are three alternatives to be considered:

- gas turbine heat producing capacities
- atomic power stations
- the Heat Power Station of Bükk of 1200 MW (based upon lignite).

Evaluating the different aspects, but primarily taking into consideration the investment saving environment, the following conclusions may be drawn: the increases till 1998-2000 may be most practically ensured by the gradual construction of gas turbine blocks of combined cycles.

The atomic power station and/or the lignite based coal power station construction may be fitted into the program afterwards. According to the examinations executed, the establishment of heat producing combined cycle gas turbine units of up to 700 MW capacity connected to the power station reconstruction is a more economic solution than establishing basic power stations, thus their inclusion in the program preceeding basic power stations is founded economically as well based on the present data.

The above program contains consciously accepted risks:

- The development of the electric energy demand to a considerable extent depends from the development of the national economy.

- The energy efficiency improving and output decreasing measures of the entrepreneur sphere may exert their effects only under the circumstances of a developing market economy.

- From the present Soviet electric energy import of 1850 MW only 1100 MW is secured through long-term

contracts, and 750 MW has to be ensured in each five year plan within the frameworks of the plan co-ordination negotiation. In the Soviet Union during the oncoming decades - primarily in the Western part of the Soviet Union - considerable electric energy deficiencies may be predicted. Already in this year there may be such Soviet endeavours experienced, which intend to decrease the electric energy import coming to Hungary, increasing the possibility of this risk.

- The combined cycle blocks increase hydrocarbon import, which increases the import dependency of the electric energy system.

- The expectable development possibilities of coal mining most probably will not be able to ensure fo MVMT even that volume of coal which is necessary for the peak level operation of the coal power stations. In this event during the second half of the 90ies besides the introduced ones, further surplus power station capacities are to be ensured based on another type of fuel.

Due to the above risk factors during the following decade it may become necessary to ensure further output capacities exceeding the above estimated demands. Such a volume of further capacity extention already may not be undertaken with hydrocarbon based gas turbines with a rational risk. The primary task of the energy policy and of the electric energy industry is to implement an active development program which is able to - on one side by the greater availability of the existing capacities, and on the other side by the implementation of a development program capable of flexibly adopting itself to the changes of the demand - bridge over this transitional period of high risk factors with the least possible disturbance or limitation in meeting the demands of the production sphere and of the population.

In the interest of decreasing the risk of electric energy supply those solutions are necessary which strengthen our relations with the Western electric energy system union. Such is the establishment of the DC junction point of 550 MW forwerding capacity which will be built between the Austrian and the Hungarian energy systems due to the fact that even in the case of the abandonment of the river barrage

of Nagymaros our energy delivery obligations towards Austria of 1.2 billion kWh p.a. will still be in force from 1996 on, for a period of twenty years. The 550 MW DC insert does not represent a permanently tied down power station substituting import technical facility for it will be built just in order to establish the technical conditions of electric energy deliveries to Austria, and it will provide a chance only for occasional electric energy backing which is to be bought for convertible currencies.

Similarly those negotiation are to be carried on which with the involvement of Western capital are concerned with implementing power station constructions in Hungary with the objective that a part of the power stations would serve as a permanent energy delivery resource for the Western countries (e.g. WER atomic power blocks, Candu-type of atomic power station blocks, Framatin-KWU-Siemens).

In meeting the energy demands we are also counting with the gradual increase of the application of the renewable energy resources (sun, wind, geothermics, biomasses).

By this in 10 years time realistically a few per cent of the volume of domestic and imported fossil energy carriers may be saved. With these energy resources primarily we may calculate with as being capable of meeting complementary local demands due to their temporary and low concentration availability. The renewable energy resources are characterized by environment saving utilization, their larger portion is reproduced in large quantities each year together with the main crops (corn, maize, etc.).

The primary future role of energetics is not that of its function in the energy policy, but rather its function in the economic policy - and within it especially in the industrial policy.

Thus the conscious reduction of energy demands basically may not be ensured within the sphere of energy management, but in the production of material goods, by the application of the general system of means of economic development.

In respect of the future of the energy carriers' price system the demand may be put forward that the production and consumer prices should follow the world market

prices based upon a united principle (for the users the prices should not represent any preferences or dispreferences on the longer run).

Under these circumstances the self-financing capability of energy production and supply is an essential aspect.

Parallelly with the cutting back of the budget subsidies the government undertook also the obligation that within 5 years time it will increase the consumption price of the energy carriers up to the level of the production prices (world market prices). This may basically alter the increasing trend and structure of the consumption of the population.

Energetics is a vertical activity chain (from mining to final utilization), it exerts diverse economic, social, health care, ecological, etc. effects on the environment.

These effects appear as significant social factors. Consequently it is essential to revaluate the relation between energetics and environment protection.

In the field of energetics contaminations belonging to all the special branches of environment protecion do appear, thus the problems have to be treated weightedly, but in a complex manner.

Solving the problems today we have two alternatives:

- The implementation of additional environment protective investments (passive environment protection)

- In the case of new establishments the application of environment friendly technologies (active environment protection).

In the area of energy industry our present tasks are strongly influenced by the domestic environment processes and the international commitments of the companies, hence the chief objective is the reduction of air pollution.

The environment damaging, destroying effect of the waste products produced during the energetic activities is also gaining more and more attention.

The issue of the already accumulated and continuously produced wastes - with special attention in the interest of the protection of the country-side and the avoidance of soil and water contamination - has to play an important role among the tasks to be solved during the coming period:

- More strict steps are to be taken for the utilization of cinders and flying ashes formed at the coal fuelled power stations, which is solved only to a minor extent.

- Power station slime treatment, delivery, storing technologies are to be modernized.

- The recultivation of filled up slime spaces is to be solved.

- The deposableness of the produced final products should influence the selection of the technology of smoke gas desulphurization to be established.

Since in the future instead of the extention of the energy resources the improvement of utilization efficiency

will be in the center of energy policy, the expansion of research and development activities directed towards this end is essential.

Research and development tasks:

- The technical-economic conditions promoting the improvement of the efficiency of final energy utilization are to be worked out.

- In case of line carried energy carriers - primarily in the case of electric energy - in the interest of decreasing peak output demands multidirectional developments are to be implemented at the enrgy consumers and at the producers of energy consuming equipment.

- In the interest of assessing the still possible savings the collection and processing of information, the development of accounting, as well as the formation of new and up-to-date measuring and regulating devices are to be carried on.

- The development of the technologies of energy transformations, of up-grading energy carriers is to be taken care of due to the continuous increase of the quality demands of energy utilization, as well as in the interest of saving.

- In order to moderate the increasing of energy demands, as well as to back the environment protective objectives in the field of renewable energy resources the up-dating of the equipment and the technologies allowing the extensive technical utilization of different biomass fuels, the development of the means necessary for the complex utilization of geothermic energy, the development of a market ready system of passive and active solar energy utilization should be taken care of.

ENERGY IN INDIA - ENVIRONMENTAL PROBLEM AND NUCLEAR DEVELOPMENT

Dr. M.R. Srinivasan
former Chairman,
Atomic Energy Commission of India

.....

During the forty years after India became independent, energy development has received high priority and substantial investments have been made in this sector. However, demand for energy, in various forms, has time and again been higher than what is available. There have been in the past, shortages in the availability of coal, kerosene and diesel and electricity. Shortages in availability of electricity have been almost chronic and manifest in practically all parts of India. The population of India has more than doubled in the last forty years and is presently about 800 million. At the time of independence, the main source of energy was fire wood, agricultural refuse and cowdung. The exploitation of commercial sources was then minimal. Even now some 45% of the primary energy used in India comes from firewood, agricultural waste and cowdung. The contribution of wood alone comes to some 150 million tonnes of coal replacement. The loss of tree cover as a consequence has been serious; the forest cover has declined to a precarious 10% of land area. Ideally wood as fuel should be substituted by coal, coke, kerosene and gas. Unfortunately, most people who use wood as fuel have very low purchasing power and cannot afford the alternatives. To them, wood is available at no cost, though the cost to

society is high. The population is continuing to grow and vigorous population control measures have not yet become a feature of Indian society as a whole. We must, therefore, expect continuing growth in demand for coal, oil and electricity and other forms of energy.

In this paper, I shall naturally discuss the electric supply situation. Starting off with an installed capacity of a mere 2000 MW some forty years ago, the installed capacity is now about 58,000 MW. The nearly thirty fold increase certainly is impressive. But the per capita consumption of electricity in India is one of the lowest. The installed capacity is expected to rise to 100,000 MW to 110,000 MW by the year 2000. Electrical energy which accounts for some 20% of the primary energy now is likely to grow to 30% of the primary by 2000 A.D. In the earlier phase of electric power development, India had placed greater emphasis on hydro electric power as many of the schemes were also linked to irrigation and flood control measures. We are facing increasing opposition to new hydro electric projects due to submergence of remaining forest areas, adverse ecological aspects and opposition from people who need to be resettled from the areas of submergence. In the seventies and eighties, the emphasis shifted to coal fired generation. Beginning initially with unit sizes of 60 and 120 MW, now most of the coal fired units are of 210 MW size. A limited number of 500 MW sets have been commissioned. 500 MW sets in larger numbers are expected to be commissioned in the nineties. Coal is not distributed uniformly in the country and has to be transported over distances of 1000 to 1500 Kilometres to consuming centres. The ash content of Indian coals is high, going almost

as high as 50%, and this increases the cost of delivered calorific energy. The high ash content also results in higher investment in the generation equipment.

Planning for electricity in the country from the sixties has taken note of the potential role of nuclear power as a supplement to coal and hydro electric power. A decision to install the first nuclear power station was taken in 1959. Our first nuclear power station (at Tarapur) consisting of two Boiling Water reactors of U.S. origin went into operation in 1969. It has completed twenty years of successful operation and has been producing the lowest cost non hydro electric power in the country. Around the late fifties and early sixties, a policy decision was taken to build natural uranium reactors, which could be fuelled by indigenously available uranium, independent of overseas enrichment services. The reactor type chosen was heavy water natural uranium type (PHWR). Two reactors of this type were imported from Canada. Thereafter the country embarked on building PHWR reactors on its own technology with Indian industry making practically all the components locally. Three reactors each of 235 MWe have been commissioned. Eleven more reactors of 235 MW capacity are under execution and are expected to be commissioned by 1997.

Building the nuclear power units entirely locally has meant setting up of a comprehensive nuclear component manufacturing capability. This activity was carried out intensively during the decade of 1975-1985. Not unexpectedly, the initial efforts were associated with substantial delays in the supply of equipment due to the learning process. In recent years, progress made in cutting down the manufacturing times has been

significant. Standardisation of designs and batch ordering of components, even before specific siting decisions are taken, have helped in ensuring timely supply of major components. Learning from the earlier projects, a higher degree of mechanisation has been planned in the newer projects. This has been facilitated by a decision to locate four or even six identical units at a given site. Following the 235 MW PHWR line, a new line of 500 MW reactors has been taken up. Twelve 500 MW reactors are expected to be commissioned by the year 2001. Design work has reached an advanced stage and manufacture of equipment for the first few units is in progress. Infrastructural works at the proposed sites have been started.

When the programme outlined above is implemented, India will have 10,000 MW of nuclear power generation. This should supply about 10 to 15% of the electric supply around 2000 AD. In addition to the national reactor line, there is a proposal to build two 1000 MW VVER reactors, Soviet PWRs, in the southern tip of India. The plan is to commission these two reactors before the year 2000. Some discussions have been held with France on the possibility of installing two PWR units of 1000 MW each. These discussions have not yet reached a definite decision making stage. There has been a debate in the country on the need to import reactors when they can be built within the country usisng local technology. The justification for import is the need to augment electric power supply quickly. The growth of the indigenous nuclear power programme is dictated by the capacity of local industry and more importantly by the rate at which heavy water and nuclear fuel can be produced. Substantial produc-

tion increases of heavy water and nuclear fuel have been foreseen in the decade of the nineties. Even so, the extent of contribution nuclear power has to make is such as to warrant import of a certain number of nuclear power units. These will be of the VVER and PWR types and thus widen the technological base of the Indian nuclear power programme.

In the longer term, India has a strong interest in fast breeder reactors. A 45 MW thermal (15 MWe) Fast Breeder Test Reactor is operating; at present at low power. A 500 MW Proto type Fast Breeder Reactor is under design; development work on components has been taken up. The target for commissioning this reactor is 1997-98. A number of reactors of this type are expected to enter commercial service during the first decade of the next century. On an even longer time frame, there is a strong interest in utilising thorium, of which India has a large resource. Thorium has to be converted to U-233 in the blanket of a fast reactor or using some other source of neutrons. They could be accelerators or fusion reactors. It is difficult to predict when successful fusion reactors producing power will be developed. Some scientists believe that fusion reactors as a source of neutrons may become feasible in a shorter time frame. The pressurised heavy water reactor could well be a suitable reactor to use the U-233-Thorium cycle.

I shall now discuss the problems of public acceptance of nuclear power in India. At the political level ; namely the central parliament and state legislatures (India has a number of states and the state governments enjoy a high degree of autonomy in many areas; the central government is in charge of many important activities affecting the running of the country as a whole) and of the political leadership

at both the centre and states, there is recognition that nuclear power development is necessary as a supplement to power generation from coal, oil, gas and hydro. This sentiment finds wide spread support at many levels in the bureaucracy and civil services. Till about five years ago, the attitude of the public and media was to leave the matters to the experts and accept their decisions. The situation then changed and a certain degree of opposition to siting of nuclear power plant has got generated. The opposition is a coalition composed of local elements, who may be unhappy at having to move out of lands where they have lived for a long time, environmentalists who are concerned with issues of reactor safety, nuclear wastes and long term effects of higher than natural radiation, and certain intellectuals who oppose all nuclear energy development on moral grounds.

With regard to people who have to be moved out of the immediate environs of the site, we find that number of persons to be rehabilitated in the case of nuclear power station sites is much smaller when compared to hydro electric projects. In fact, in two of the proposed sites on the coast, we have no population residing and no agricultural activity. But at one of the coastal sites, the fishermen living in the neighbourhood protested on the ground that their livelihood would be jeopardised. Fortunately, we had two earlier coastal locations where there has been no adverse impact in fishing. In fact the fishermen at these developed sites have found that their catch is now fetching better returns in view of increased purchasing power created around the nuclear power station. Before this development, the fishermen were obliged to sell their catch to wholesalers who generally drove a hard bargain. We have taken representa-

tives of the protesting fishermen to visit the developed sites and shown them how there has been no reduction of the fish catch and to talk to the fishermen of the developed sites directly to allay their fears. This approach has had positive effect.

On reactor safety, the public at large continues to entertain fears. In addition to the standard arguement heard elsewhere, one more is added in our context. This arguement is "if advanced countries such as U.S. and U.S.S.R could have serious accidents, how can developing countries without a tradition of high technology operate these plants safely?". This arguement is much more difficult to rebut at the level of lay people. In the Indian context, the answer to this question is that a greater reliance has been placed on training of people. Some five thousand graduate scientists and engineers have been at the training school at the Bhabha Atomic Research Centre on an inter-disciplinary programme over the last thirty years. About five thousand technicians have been trained at the training schools at the operating nuclear power stations in the last twenty years. It is the availability of this large trained manpower that gives us confidence that the nuclear installations will be managed safely. A conservative approach to containment design has been adopted at all nuclear power units designed after 1975. This is the use of a double containment - an inner prestressed concrete building enveloped by a reinforced concrete building. The only way that public confidence can be won is by the safe and trouble free operation of nuclear power units on a sustained basis. Visits by the school children of the surrounding villages and the elders from the neighbourhood, and close community inter-

actions are other confidence building measures. We have embarked on these measures in recent years and found them to be effective.

On the question of nuclear wastes, the assertions made by the nuclear technologists that we are unique in following a 'cradle to grave approach' are dismissed as misleading by the critics. They confound the common people by referring to the long half lifes of some of the actinide nucleii. When this arguement is countered on the ground that there is much greater amount of radioactivity in the earth, even if we were to confine to the top 50 metres of the earth's crust, than what would be generated even if nuclear power were expanded a few orders of magnitude, there is disbelief. The nuclear community should provide facts and figures to convince the general public in this matter. There is an even bigger communication gap on the question of long term waste disposal. The claims that long lived vitrified wastes can be stored safely away from the biosphere would be strengthened if at least one or two ultimate storage facilities were developed in the next few years.

We may now discuss the question of increase, if any, of radiation levels around operating nuclear power units. We have established background radiation measurements at all our nuclear installations which are started some five years before the installation is commissioned. At our first nuclear power station site, the base line measurements started twenty years ago. We collect samples of water, milk, vegetables, fruits, fodder, meat and fish in a radius of thirty kilometres around the installation. We have found very little increase in the background levels even at the fence limits, let alone in the general environ-

ment. In fact, the variation in background levels due to natural causes, between different locations, is substantially more significant. The experience at most of the operating reactors in the world would be similar. However, the public at large forms a different impression from reports about leukemia clusters around the reprocessing plants at Sellafield (U.K) or the reports of genetic aberrations of flora and fauna around Chernobyl (USSR). It is important to segregate the effects attributable to earlier work practices at Sellafield when the waste treatment practices were inadequate. Similarly factual information on observable changes in the immediate environs of Chernobyl is required. The USSR has proposed an international cooperative study of the radiation effects around Chernobyl and this proposal is a welcome development. After the Nagasaki and Hiroshima studies, only the Chernobyl situation can give a satistically significant observable opportunity. At one of our sites located in the vicinity of a tropical rain forest, some environmentalists were concerned that the increase in background radiation due to the nuclear power station might affect the orchids in the forest. While this was an exaggerated fear, information to rebut it based on observations, was not readily available.

We may now discuss the attitude of certain intellectuals who oppose nuclear energy development on moral grounds. Such people are to be found in many countries and they maintain strong connections amongst themselves. They percieve all nuclear energy development as evil as they choose not to distinguish between civilian and military applications. Many of them are

not aware that no civilian nuclear power installation has made any direct contribution to weapons capability. All countries that have developed nuclear weapons have done so from facilities specifically dedicated for the purpose. The prime reason is that it is more practical and economic to produce weapon grade materials in dedicated facilities. Of course the safeguards system administered by the International Atomic Energy Agency has ensured that there is no diversion from civilian nuclear power installations which are subjected to its inspection. Major changes taking place in super power and international relations favour significant progress in reduction of nuclear weapons in 1990. It is the expectation that further progress in nuclear disarmament globally will take place in the decade of the nineties. In view of these developments, there should be less objection to nuclear power amongst the intellectuals and moralists who are now taking an antinuclear posture.

Those who are favouring nuclear power argue that this form of energy generation does not add to the carbon dioxide burden of the global atmosphere. While this is factually so, the arguement tends to be weak because in the foreseeable future of say four or five decades, nuclear energy can only be a supplement to coal, oil, gas, wood and agricultural refuse. With the latter forms of energy continuing to dominate the scene, nuclear energy, in practical terms, will only reduce the rate of carbon dioxide build up and not eliminate it. Till recently, the consensus amongst atmospheric scientists was that the green house effect would lead to melting of polar ice caps, rising of sea levels and drastic changes in rainfall patterns. Very recently some scientists, admittedly a minority,

have speculated that the consequences of the green house effect may in fact not be all that adverse and that the world may even become a 'Garden of Eden'. It is important that this question is understood with precision and a reliable consensus arrived at so that policy options can be formulated on a sound scientific basis.

Till recently, the economics of nuclear power had been accepted as favourable compared to coal and oil fired generation in many parts of the world, except at sources of low cost fossil fuels. The decision taken in the United Kingdom a few months ago not to proceed with the PWR programme, on economic grounds, has certainly been a serious set back. That this situation was brought about by the particular manner in which privatisation of the electric supply industry was carried out and is not an indictment of nuclear power on economic grounds generally is an arguement the public at large will not easily understand. The experience of France, Japan, South Korea and Taiwan when referred to is dismissed as special or manipulated in some way. An issue that confuses matters is the allowance for decommissioning in the cost of power. Published information on decommissioning gives a wide range of options and associated costs. Some times the specialists merely take the position that this should not be a problem, that techniques will be available when needed and at any rate this is only a problem to be tackled after a couple of decades or more. It is important that at an international level all available experience is thoroughly analysed and a consensus on likely methods and costs is reached. It is also necessary to look at low cost but safe options through more intensive research and development.

Some discussion on the economics of nuclear power as experienced to date in India is appropriate. Our

first nuclear power station which has completed twenty years of service supplies the lowest cost non hydro electric power and has accumulated handsome surpluses over the years. We have also financed contingent investments such as an away from reactor spent fuel store and substantially augmented the waste treatment facilities. The tariff includes an appropriate allowance for decommissioning and a fund is being built up. In the case of some of the operating nuclear power units, profits in some years have been eroded due to unexpected extended outages. Such outages have been due to failures of turbine blades and generator transformers, and problems on the nuclear equipment. In some instances, there has been limitation on power output due to technological problems. Much stricter control on quality and designs of equipment, nuclear and conventional, is being applied to ensure more reliable performance. In due course of time, we expect to get from the PHWR units performance comparable to what the Canadians are getting. In that situation, the PHWRs will certainly be economic producers of electricity.

In 1987, the nuclear power activity in the country was made into a commercial activity under a state owned corporation - the Nuclear Power Corporation of India Ltd. This body has entered the capital market several times and investors have responded favourably. The budgetary support given as equity capital from Government funds has lately shown a declining trend due to competing pressures on Government funds. An important reason for India entering into an agreement with the Soviet Union for import of two 1000 MW VVERs was the need to augment power generation, for which

the Soviet Union was prepared to extend concessional financing. Discussions are proceeding between India and France on the possible supply of two 1000 MW PWRs, but an important consideration would be the availability of low interest long term credits. This matter is still under discussion between the two countries. It is not clear at present what the outcome on this project would be. The achievement of 10,000 MW of nuclear power by the year 2000 would depend on adequate funds being available at the appropriate times. It is hoped that with the enlightened support of the Government, the financial institutions and the public, this programme will be implemented successfully.

NUCLEAR POWER IN THE USSR: STATUS AND PROSPECTS

E.N.Pozdyshev, Minatomenergoprom, USSR

Presently the Soviet Union is one of 26 countries having nuclear power plants; it occupies the third place in the world by the number of operating units and NPP total installed capacity after the USA and France. USSR NPP operational experience numbers about 420 reactor years out of 5000 reactor years of the world experience.

As of beginning of 1990 the USSR had 15 operating NPPs with 45 units and total installed capacity of 36425 MW. The distribution of capacity and electricity production by reactor types is given in table 1 and 2 respectively.

Presently 3 units with total capacity of 470 MW have been decommissioned due to expiration of their design lifetime and the Armenian NPP has been shut down because of public protests.

Table 1

Installed capacity distribution by reactor types

Reactor type	Number of units	Total installed electric capacity, MW
VVER-365	1	365
VVER-440	8	3412
VVER-1000	16	16000
RBMK-1000	13	13000
RBMK-1500	2	3000
EGP-6	4	48
BN-600	1	600

Table 2

Distribution of NPP electricity generation by reactor types

Reacror type	Percentage %		
	1987	1988	1989
VVER-440	15.7	13.7	11.2
VVER-1000	31.5	34.7	35.6
RBMK-1000, 1500	43.8	48.1	49.0
BN-600	9.0	3.5	4.2
AMB-200			

All NPPs operate in baseload mode with the exception of Bilibinskaya NPDHP which operates in load following to meet region electricity and heat demands. NPP electricity production was 186.9 bln .kWh in 1987, 215.7 – in 1988 and 212.6 bln .kWh or 12.5% of total electricity production in 1989.

In other developed countries the share of electricity produced by NPPs is considerably higher – from 20% to 70%. In Japan it is more than 26% , in France –about 70%.

While describing the soviet NPP operational experience let's address such indices as load factor, causes and frequency of operational occurrences, radioactive releases into the environment and economic efficiency of NPPs. Tables 3 and 4 show some of these data.

As table 3 shows, load factor of NPPs with VVER-440 and RBMK-1000 reactors is higher as compared with NPPs with other reactor types. Units with VVER - 440 and RBMK-1000 are more stable in operation and have the least outage time taking into account all aspects (see table 4).

The main reason for reduction of the load factor at NPPs with VVER-1000 in 1989 is durable outages due to replacement of failed steam generators.

Table 3

Soviet NPPs installed capacity utilization factor

N P Ps	Load factor, %			
	1986	1987	1988	1989
Total averaged NPPs	65.3	69.2	71.4	69.3
including:				
VVER-440	72.7	79,2	79.4	79,7
VVER-1000	65.2	65.5	65.5	59.1
RBMK-1000	63.0	71,9	79,7	77.4
RBMK-1500	75.2	50.6	49,1	63.4

Table 4

Capacity underutilization factor and its components

Capacity underutilization factor	1989/1988				
	for all NPPs	VVER-1000	VVER-440	RBMK-1000	RBMK-1500
T o t a l, %	30.7	40.9	20.3	22.6	36.6
	29.1	34.9	21.8	20.3	51.4
including:					
1. Due to capacity limitations (power system, cooling water temperature, etc.), %	4.3	2.4	5.0	3.5	16.5
	3.7	3.0	1.9	1.1	19.9
2. Due to scheduled maintenance outages, %	21.1	28.7	13.3	16.4	18.0
	18.1	22.0	15.3	16.6	19.4
3. Due to operational occurrences(unscheduled outages, capacity decrease), %	5.4	8.5	1.1	2.5	0.8
	6.6	9.3	3.4	2.3	12.1

Table 5 shows the load factor of NPPs in the USSR and other countries. When analyzing these data one should take into account that for the soviet NPPs the load factor is approximately equal to the availability factor and for other NPPs the load factor is less or equal to availiability factor.

Figures 1-4 show unsheduled outages at Soviet NPPs and comparison with some foreign units. 183 unit unsheduled outages including 53 due to personnel error occurred at NPPs with VVER and RBMK plants in 1988 and 113 and 47 respectively occurred in 1989. The number of unsheduled outages per unit was 4.0 in 1988 and 2.7 in 1989.

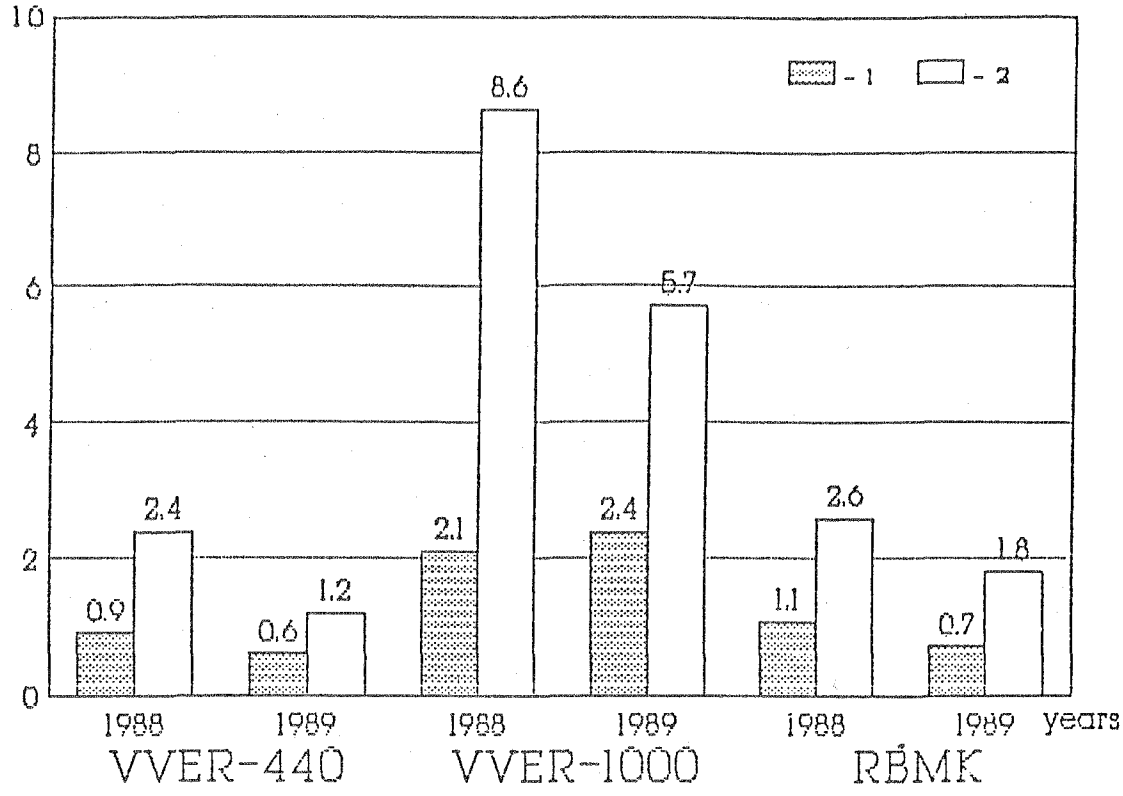
All the above data show the icrease of soviet units stability and the similarity to american units performance. Japanese units show excellent performance.

Table 5

NPP capacity utilization factor

for a number of countries

Country	Load factor , %	
	1987	1988
USSR	69.2	71.4
USA	59.8	62.5
Japan	76.7	70.1
FRG	74.6	73.4
France	62.9	59.6
Great Britain	50.8	52.4



1 - shutdowns due to personnel faults

2 - number of shutdowns per unit

Fig.1. Number of shutdowns per unit.

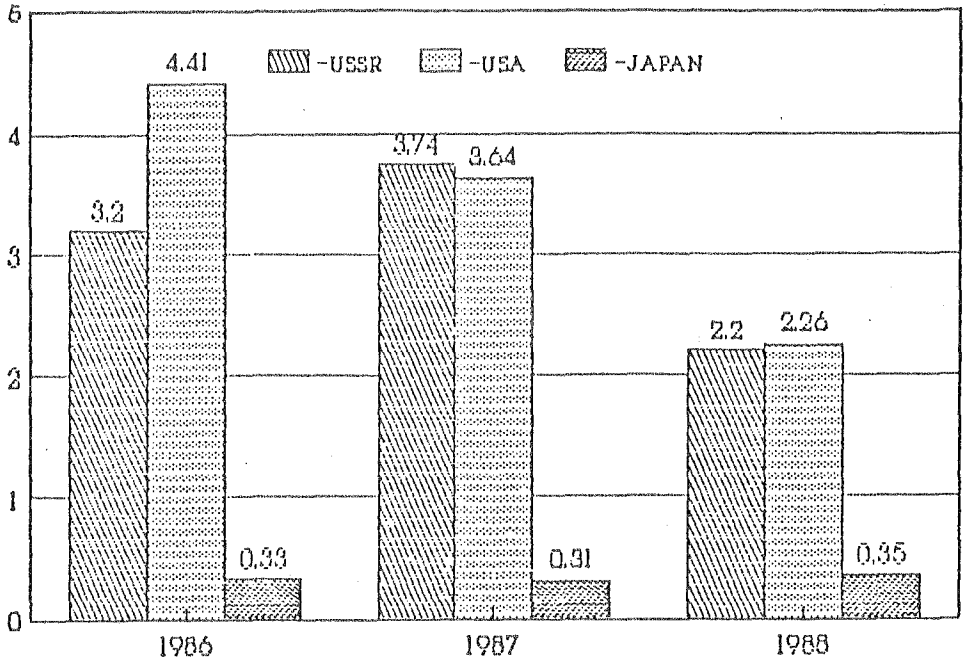


Fig. 2. Number of emergency protection actuations at Soviet American and Japanese NPPs during the period from 1986 to 1988 per unit.

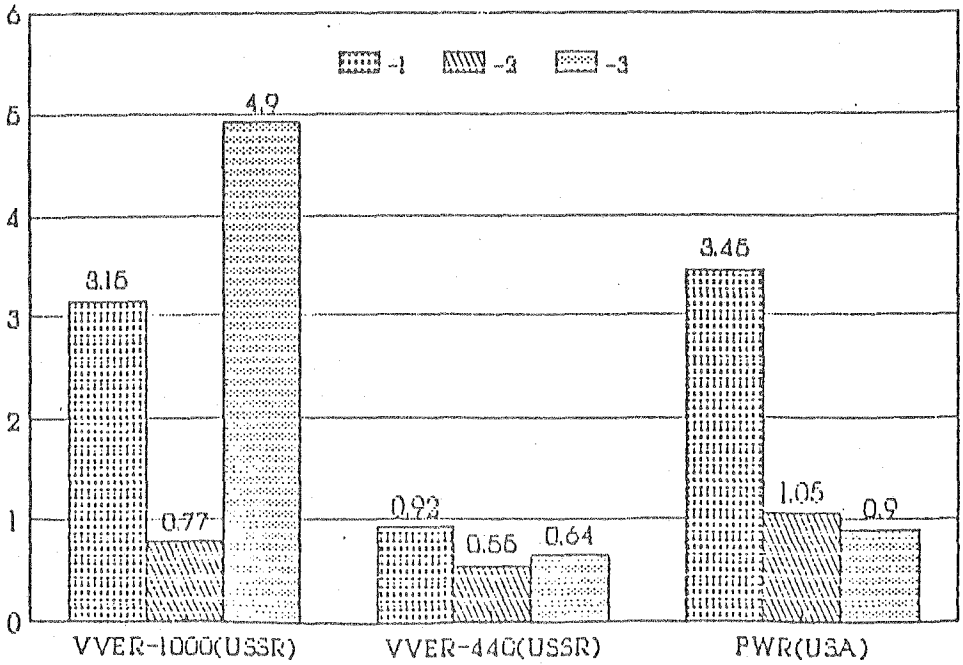


Fig. 3. Specific number of shutdowns and emergency protection actuations at Soviet NPPs with VVER reactor and at American NPPs with PWR reactors in 1988.

1 - actual actuations of emergency protection.
2 - spurious actuations of emergency protection.
3 - shut down without EP actuation (scram).

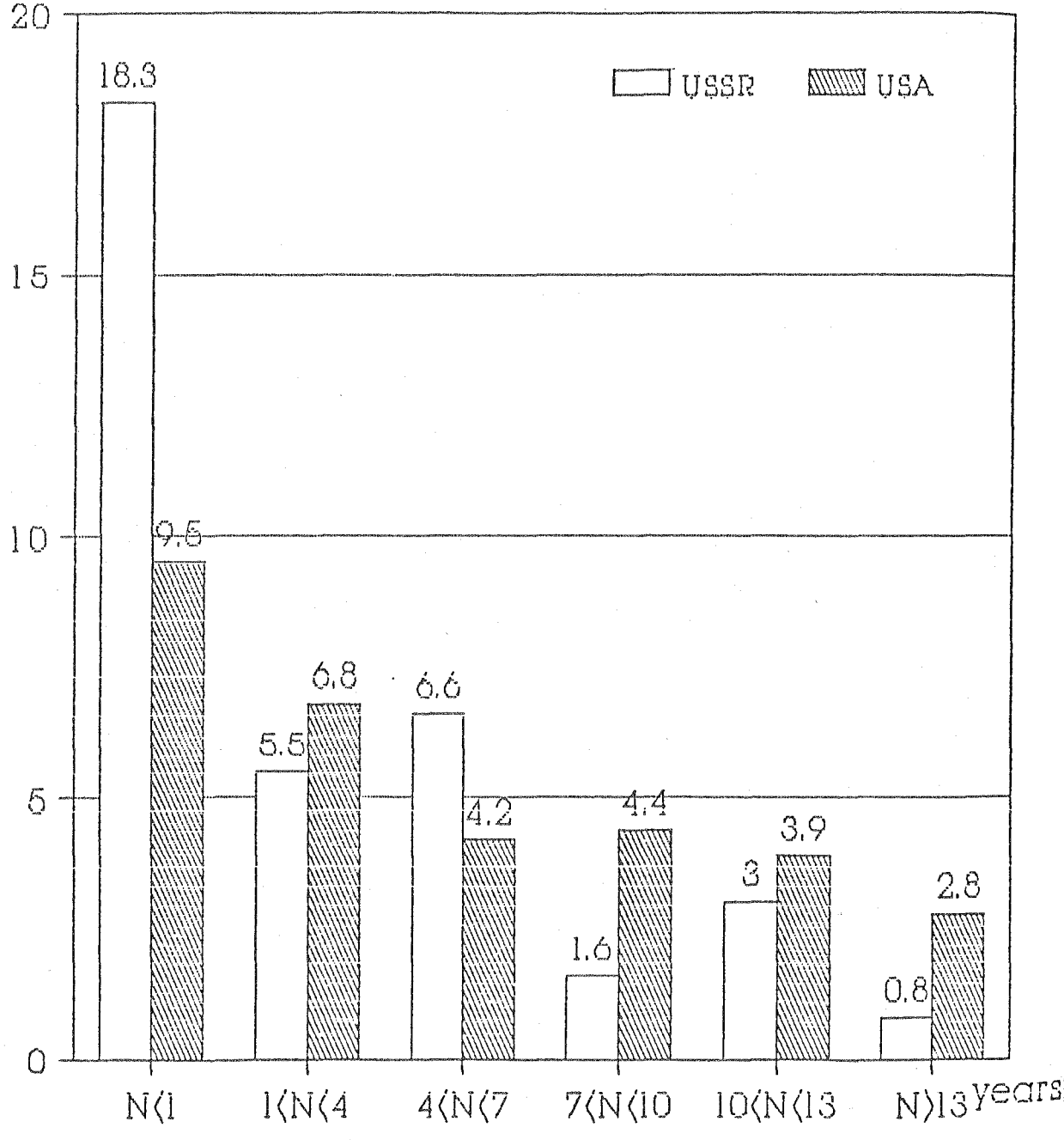


Fig.4. Number of shutdowns per unit at Soviet NPPs with VVER reactors and at American NPPs with PWR reactors in 1988 depending on unit operating experience.

Radiational Safety

Radiation and NPP personnel exposures are under constant serious control in the USSR. The following data characterize NPP personnel exposures.

Personnel average individual irradiation dose for NPPs with VVER reactors is within the limit of 0.1–0.7 cSv/year and for NPPs with RBMK reactors within the limit of 0.3–1.0 cSv/year. Collective doses for NPPs with VVER reactors lie within the limit of 2.0-(8-10) manSv/year, for NPPs with RBMK within the limit of 7.0–20.0 manSv/year.Standardized units with VVER-1000 reactors have the lowest personnel collective doses. These figures meet world standards. The collective dose at some Japanese units in 1988 was,for example,2.6 manSv/year. It is possible to decrease doses at such units up to 0.1 cSv/year for individual dose and up to 1.0 manSv/year for unit personnel collective dose.

During normal operation radioactive gas and aerosol releases constitute (5-20) Ci/day for VVER plants and (100-200) Ci/day for RBMK plants. The standard value is 500 Ci/day for one unit or 3000 Ci/day for the whole NPP. Low levels of radioactive and aerosol releases containing mainly short lived radionuclides allow to maintain radiological situation in NPP region such that personnel doses are considerably below the permissible level.

Soviet NPP Economic Efficiency

NPP electricity production in the USSR as well as elsewhere is often cheaper than at fossil fuel power plants. This is true for NPPs with VVER

and RBMK reactors.

Fast Breeders

BN-350 fast breeder (750MWt) has been in operation since 1973. For a long time it has been a significant energy source of the region. Presently its significance has decreased. During the last years the reactor has been operating to generate steam only (410°C,45atm) with the load factor close to 90 %.

BN-600 vessel type breeder has been operating since April 1980. This is the third unit of Beloyarskaya NPP. By January 1, 1990 it has generated about 35 bln.KWh. Cumulative load factor was 66.5 % and in 1988 - 76.5 %. Radiation situation is quite adequate. Average annual personnel exposure was 0.2 cSv/year in 1988. Radioactive releases through the vent stack do not exceed 1.5 Ci/day. These values are excellent as compared with VVER and RBMK plants.

Safety Improvement of the Operating NPP and the Units to be Commissione

The TMI-2 and Chernobyl accidents are the part of world NPP operational experience.

The Chernobyl accident and its consequences showed the necessity to perform comprehensive safety analysis of operating NPPs and NPPs under construction. Safety problems became of major priority. On the basis of this analysis a set of primary scientific and practical measures was implemented which significaly enhanced safety of the operating NPPs. Positive reactivity void coefficient of RBMK plants was reduced to 0.1 β by placing additional poison rods in the core thus increasing reactivity margin compensated by RPS rods and using fuel with higher enrichment (2,4 %). At the same time with the change of core characteristics measures have been taken to improve emergency protection system response. Modifications of some RBMK plants resulted in reduction of reactivity void coefficient to negative values.

Priority measures to improve safety and reliability of the operating VVER plants were implemented to reduce the probability of brittle failure of the reactor vessel and main circulating pipes, to improve emergency protection system response and to improve core characteristics. Techniques of reactor vessel remedial annealing have been developed. Plant operating procedures are improved by introducing more stringent requirements. Operating and maintenance personnel requalification was conducted at all NPPs.

Public Attitude to Nuclear Power

Powerful antinuclear public movement has evolved in the Soviet Union after the Chernobyl accident which is still gaining momentum. The roots of this movement are public fears of the nuclear hazard and of the possibility of recurrence of Chernobyl-type accidents as well as poor understanding of the advantages of the nuclear option and the new trends in NPP safety improvement. It should be admitted that in the USSR efforts to achieve public acceptance of nuclear power have been pretty late. At present great emphasis is being placed on these efforts since the future of nuclear power and of the country's progress depend on the achievement of this public acceptance.

The nuclear power today is the most ecologically clear source of commercial electricity which has no viable alternative in meeting the growing electricity demand. It would be unwise to rely upon conventional electric power using coal, oil and gas-fired plants. Discharges of carbon dioxide, sulphur and nitrogen oxides have reached unacceptable limits causing enormous damage to public health and environment which may lead to global chahges in the climate. Ecologists have concluded that already now it is imperative to consistently reduce these discharges. Severe damage to the nature and all the living beings is inflicted also by the so called secondary effects related to organic fuel storage and transportation,i.e. accidents at oil and gas pipelines and storages, tanker accidents resulting in the pollution of large sea and coastal areas.

Reductions in New NPP Capacities Commissioning

The result of Chernobyl and its circumstances on the one hand and of the new understanding of NPP safety issues on the other has been the reduction in the number of new plants to be commissioned. Only 8 nuclear units have so far been commissioned since Chernobyl (7 VVER-1000 units and 1 RBMK-1000 unit) at operating plant sites. Of course, earlier mentioned safety improvement measures have been implemented at these units. 34 units at 17 plant sites are under construction. However for the coming 5 years only 6-11 mln KW of new capacities is expected to be commissioned with another 12 mln KW to be added before the year of 2000. Meanwhile total nuclear electricity generation shall amount to 350-390 bln.KWh. These plans are rather modest since construction organizations' capacities and nuclear industry capabilities allow to commission more than 45 mln KW before the

year of 2000. The existing fuel reserves can assure the operation of 100 mln KW of NPP total capacities operating in the "open" cycle.

At present at a number of NPPs construction of new units has been deferred or frozen. Besides, the decision has been taken to give up the construction of earlier planned plants and update the siting policy. Significant difficulties arose with the siting of new NPPs because of protests from the public and local authorities.

Improvement of NPP Operating Personnel Training Level

NPP operational experience demonstrates that a large number of occurences during normal operation occurrs due to operating and maintenance personnel errors. To assure appropriate conditions for skilled operator training, a comprehensive program of simulator construction is being implemented in the USSR which incorporates the development of full - scope, functional/analytical simulators and special training tools. A network of Training Centres (TCs) and Training Points (TPs) is being established. A full-scope simulator is expected to be commissioned in 1992 in the All-Union Research Institute for Nuclear Power Plant Operation (VNIIAES). Efforts in this area are being undertaken in cooperation with US companies. At present two TCs are in operation: one at Smolensk NPP for RBMK plant personnel training and the other at Novovoronezh NPP for VVER plant operators training. In 1989 about 2000 of NPP personnel have taken training in these centres.

In addition to TC and TP training, plant personnel will have to pass psycho-physiological tests. In view of the important role of human factor in assuring NPP safety, certain emphasis is placed on the development of man-machine interface tools and operator support systems.

NPP Safety Regulation

Elaboration of NPP safety regulation matters in the USSR started as soon as we embarked on our nuclear program. Later, under the auspices of the regulatory body - the USSR State Nuclear Power Inspectorate - a systems approach to NPP safety regulation has evolved. The importance of the development of a unified set of NPP safety Codes and Standards has been

convincingly confirmed by the Chernobyl accident. The need to modify NPP safety concept based on Soviet and worldwide NPP operational experience has become evident. The existing concept takes into account the probability of beyond-design-basis accidents and the need to manage these accidents. These efforts were reflected in the basic principles of assuring nuclear safety developed by the IAEA INSAG group. A number of documents in this series have already come into force, others are under development.

Phase out of the RBMK Program

Analysis of the Chernobyl accident and its consequences highlighted the non-compliance of RBMK reactors with the present safety requirements being the reason for RBMK program phase out.

Absence of containment isolating the reactor from the environment is a major deficiency of RBMK reactors. RBMK reactors presently in operation are supposed to be decommissioned on expiration of their lifetime and commissioning of the new generation plants.

Program of nuclear power development for the 10-20 year period.

Presently the understanding of NPP safety problems is based on a severe accident acceptable risk concept. It is the acceptable risk of severe accident which is the main criterion currently impeding the construction and commissioning of new units.

The following steps in the nuclear power program in the USSR are planned:

- decommission units which can not be improved to meet the 10^{-5} 1/reactor year severe accident probability criterion in the near future;
- modify the remaining units to meet the current safety requirements and achieve severe accident probability of 10^{-5} 1/reactor year;
- subsequently, decommission units having severe accident probability of 10^{5} 1/reactor year replacing them by new generation reactors with this probability increased to 10^{-7} 1/reactor year.

In the near future the leading role in the nuclear power is supposed to be taken by pressurized light water reactors. This trend is observed now worldwide. The reasons for this are quite obvious and can be explained by significant experience in operation of these reactors and the existing specific industry infrastructure.

Besides, operational experience shows that new generation plants can be developed based on the currently operating NPP's designs.

The first in this series is the NPP-88 design with VVER-1000 reactor, for which development of the following systems is required:

- passive reactor afterheat removal system during loss of power;
- core cooling system in case of reactor vessel depressurization;
- core catching and cooling system;
- contaminated water steam mixture removal system.

The first unit of this type is supposed to be commissioned in 1993.

Improved version of this reactor is the NPP-92 design incorporating the following features:

- significantly simplified reactor design and plant layout;
- improved passive reactor afterheat removal system;
- reduced core power density;
- improved reactor control system involving operator support system;
- diagnostic systems;
- double containment.

Commissioning of 1000 and 500 MW reactors is planned for 1998-1999.

Besides advanced VVER-based reactors, the possibility to develop BWR-based reactors (VK-50 research reactor has been operating since 1965), steam cooled reactors, modular reactors is considered in the USSR.

The scientists in the USSR are seeking for the new technical solutions to develop inherently safe reactors. Liquid metal fast breeder reactors are rather promising from this point of view.

Large experience in the development and operation of fast breeders has been accumulated in the USSR. BN-350 has been operated since 1973 and BN-600 - since 1980. BN-800 and BN-1600 designs have been developed. Due to slowing down of nuclear power development and the respective decrease of demand for nuclear fuel, the interest in fast breeders has reduced to some extend. However this situation must be temporary.

Inherently safe reactors are very likely to restore acceptance of nuclear power. Thus, we regard the period of 1990-2000 as renovation period and the period of NPP safety enhancement and comparatively small increase of NPP total capacity.

The period of 2000-2010 is regarded as the period of extensive NPP capacity growth based on reactors of new generations.

Operational experience	420 reactor years
In operation:	
NPPs	15
units	45
total installed capacity	36425 MW
Decommissioned:	
NPPs *	-
units	3
total installed capacity	470 MW

---

* Armenian NPP is shut down	2 units with VVER-440 reactors

Installed capacity distribution by reactor types

Reactor type	Number of units	Total installed electric capacity, MW
VVER-365	1	365
VVER-440	8	3412
VVER-1000	16	16000
RBMK-1000	13	13000
RBMK-1500	2	3000
EGP-6	4	48
BN-600	1	600

Distribution of NPP electricity generation by reactor types

Reacror type	Percentage %		
	1987	1988	1989
VVER-440	15.7	13.7	11.2
VVER-1000	31.5	34.7	35.6
RBMK-1000, 1500	43.8	48.1	49.0
BN-600 / AMB-200	9.0	3.5	4.2

N P P electricity generation:

1987 - 186.9 bill KW/h

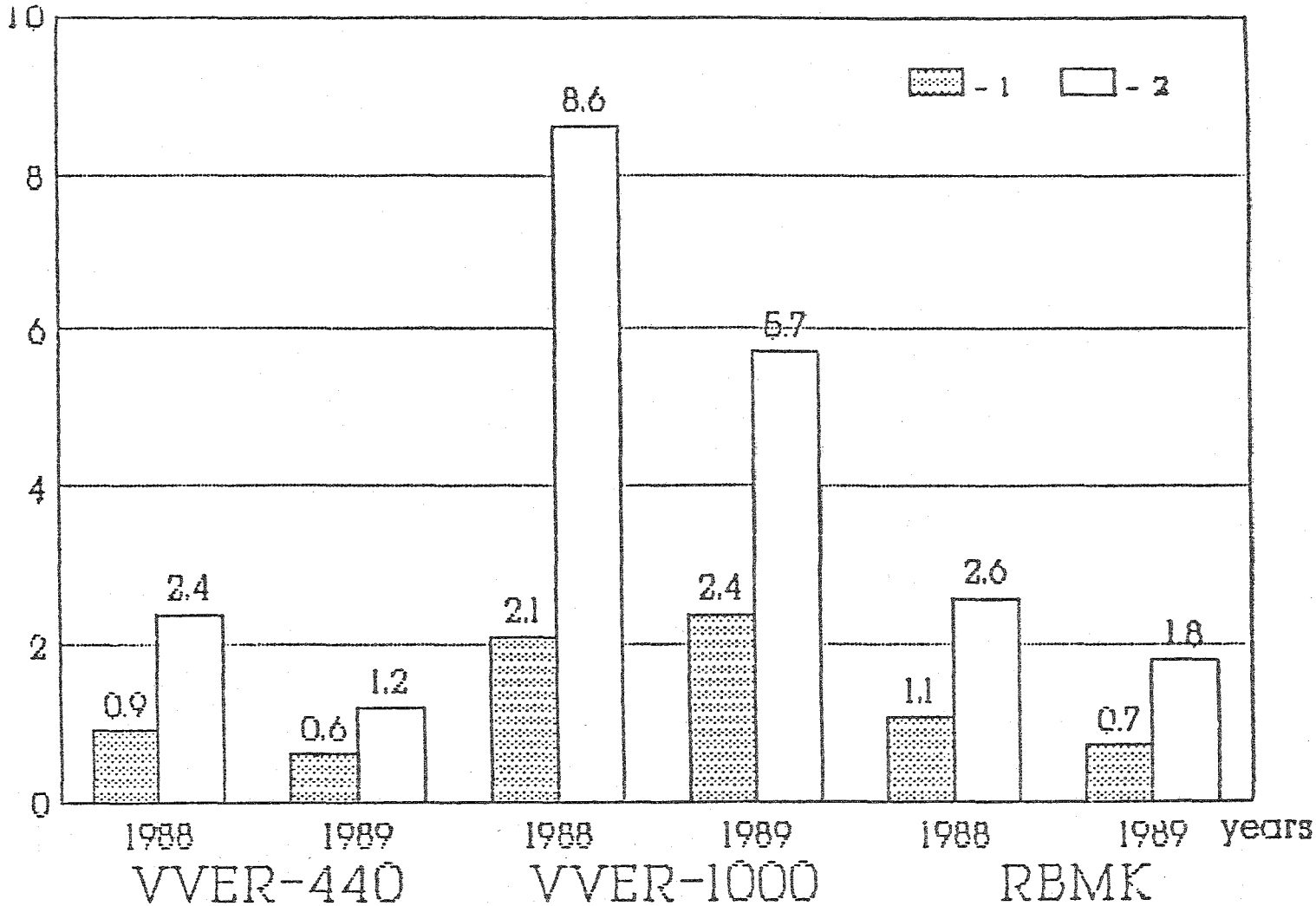
1988 - 215.9 bill KW/h

1989 - 212.6 bill KW/h (12.5%)

Soviet NPPs installed capacity utilization factor

N P Ps	Load factor, %			
	1986	1987	1988	1989
Total averaged NPPs	65.3	69.2	71.4	69.3
including:				
VVER-440	72.7	79,2	79,4	79,7
VVER-1000	65.2	65,5	65,5	59.1
RBMK-1000	63.0	71,9	79,7	77.4
RBMK-1500	75.2	50,6	49,1	63,4

NNPs with VVER-440 and RBMK-1000 reactors have bette performance. The main reason for relatively low load factor value of NPPs with VVER-1000 reactors are outages due to SG replacement.



1 - shutdowns due to personnel faults

2 - number of shutdowns per unit

Fig.1. Number of shutdowns per unit.

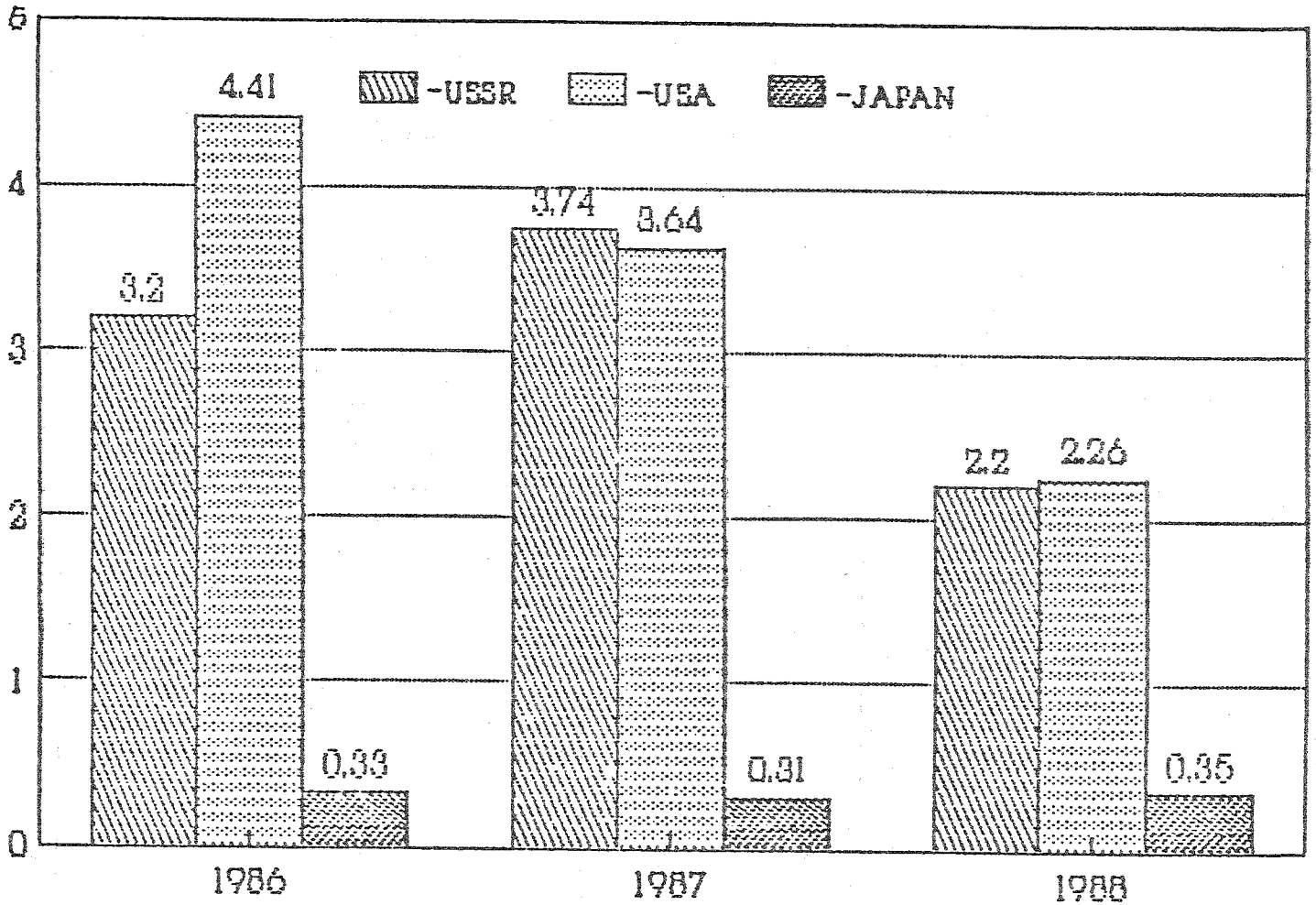


Fig. 2. Number of emergency protection actuations at Soviet American and Japanese NPPs during the period from 1986 to 1988 per unit.

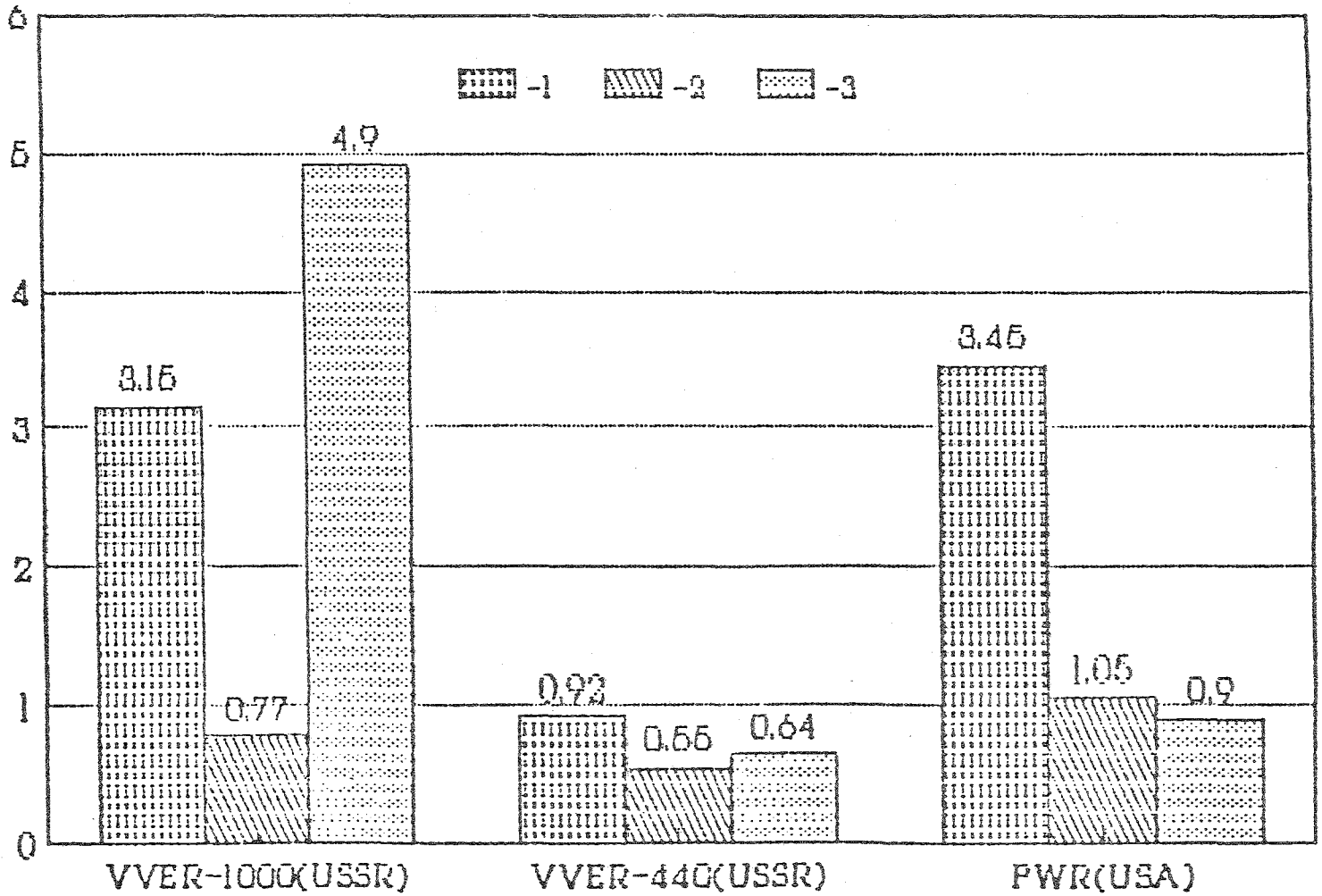


Fig.3. Specific number of shutdowns and emergency protection actuations at Soviet NPPs with VVER reactor and at American NPPs with PWR reactors in 1988.

1 - actual actuations of emergency protection.
2 - spurious actuations of emergency protection.
3 - shut down without EP actuation (*scram*).

releases through the vent stack

	VVER	RBMK	BN (fast breeder)
Average individual dose , cSv/year	0.1-0.7	0.3-1.0	0.2
Total dose , ManSv/year	2-10	7-20	
Releases , Ci/day	5-20	100-2000	1.5

In operation

in 1987-1990	8 new units,
including:	7 with VVER-1000
	1 with RBMK-1000

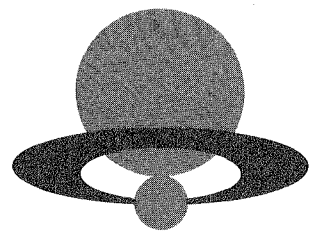
Planned:

in 1990-1995	6-11 mln KW
in 1996-2000	12 mln KW

Period of 1990-2000 we qualify as renovational, the period of NPP significant safety growth and relatevely small growth of NPP total capacity.

Period of 2000-2010 is considered as the period of NPP capacity intensive growth on the basis of reactors of new generations.

セッション2
変わるか世界の原子力政策



米国の原子力復活は可能か
米国共和党上院議員
M．ワロップ

英国労働党のエネルギーおよび環境政策
英国労働党下院議員
J．A．カニンガム

連邦野党のエネルギー政策と原子力開発への対応
西ドイツ社会民主党連邦議会議員
W．－M．カーテンフーゼン

21世紀をめざした原子力政策
フランス原子力庁国際局長
G．エレーラ

"Seize The Day"
A SPEECH TO THE JAPANESE ATOMIC INDUSTRIAL FORUM
Senator Malcolm Wallop

The opportunity to appear in Kyoto to address the Japanese Atomic Industrial Forum is fascinating. The fascination is created by the atmosphere of tragedy and hope in Kyoto.

The sense of the tragic reflects the dark side of nuclear power, namely, your experience with nuclear war. Several years ago, Richard Rhodes published a remarkable study, "THE MAKING OF THE ATOMIC BOMB". This history described the most important scientific achievement of the century -- the discovery of the nuclear energy of atomic particles. Sadly, it was an achievement driven by the force of war. Nuclear energy is the most powerful physical force developed by the human race. Here in Kyoto one can truly understand both the power and the controversy of that force.

Kyoto is an ancient capital of Japan. It is also a religious center with many historic sites. During what were to be the closing days of the Second World War, Kyoto was the primary target for the atomic bomb. However, Secretary of War Stimson decided otherwise because of the cultural and political significance of this city. This is one of those incredibly sane decisions taken during the insanity of war. But, other decisions were made, and the first knowledge that the world received about atomic energy was the attack on Hiroshima.

The initial use of nuclear power as an instrument of war created the unique burden of this energy source. The scientists who worked on the Manhattan Project, some of the greatest intellects of our age, recognized this problem. While they were able to control the violent forces ignited by splitting the atom, they had no solution for dealing with the human passions unleashed by the nuclear age. And, we are still dealing with those passions today.

Recently, I was asked by a student in Cheyenne, Wyoming whether a nuclear power plant could set off a nuclear explosion. Though her question may seem naive, this student did have a certain frame of reference. We have no nuclear power plants in the Cheyenne area, but there are MX nuclear missiles. Public opinion soured on nuclear power because too many people believe that a nuclear power plant is capable of exploding like an atomic bomb. They do not understand the nuclear fuel process -- that the fuel in a power plant contains only three percent of the active Uranium 235 isotope, while a nuclear weapon assembly requires ninety percent. Perhaps one answer would be to require every student, and every critic of nuclear power, to read Rhodes' history of the atomic bomb. They would receive a useful education on the nature of atomic reactions, as well as how political and scientific leaders have dealt with this issue.

Along with the overblown fears that have accompanied nuclear energy, there has also been the problem of grandiose expectations. Back in the early 1950's, proponents argued that nuclear power would be so cheap that power companies would not bother to meter the electricity provided to their customers. But, by 1957, when the our first commercial nuclear power plant was put into operation, nuclear power was no longer free! Still, it was very cost competitive compared to fossil fuels and hydro power. We were entering the Nuclear Age.

In 1975, it was predicted that by the year 2000, the U.S. would generate 1250 Gigawatts of electric power from nuclear power plants. Since a nuclear plant provides about One Gigawatt of power, this meant about 1200 nuclear power plants. In 1990, the reality is that we have 112 nuclear plants providing about 104 Gigawatts of electricity. That is less than one tenth of what was projected fifteen years ago.

One has to wonder whether the Nuclear Era is a short-lived phenomenon, or whether the current stagnation is temporary. Before making a judgement, consider the reasons for the current weak nuclear market. They can be summarized as fear, loathing, and greed.

The public's sense of fear towards nuclear energy is based on a reaction to a technology that is unfamiliar and foreboding. Nuclear energy and atomic bombs are inseparably mingled in popular mythology. The Cold War created the foreboding dread of global nuclear destruction. The Bulletin of Atomic Scientists had the doomsday clock ticking off the minutes until nuclear war would occur. We had missile gaps, backyard bomb shelters, and the China Syndrome. And, then one unit at Three Mile Island had a breakdown due to human error. Even today, the popular understanding of the damage is badly skewed.

There never was a public health threat. The only lasting damage was to the financial soundness of the utility which owned TMI, and to the proponents of nuclear power as a reliable and safe source of electricity.

While the nuclear industry stumbled over TMI, it fell flat on its face ten years later because of Chernobyl. The most unfortunate aspect of the Chernobyl disaster is that few understand that this accident represented the abuses of a centralized command economy. The system that created Chernobyl is collapsing, but its effect will linger as a sort of mental radioactive waste. The public in Europe and the U.S. has completely misunderstood the lessons of the Chernobyl incident. The mental cloud from Chernobyl lingers on in Eastern Europe, where there is now an aversion to nuclear power. However, nuclear power is the most sensible solution to the power needs of that region.

The incredible pollution from their coal-fired plants is a public health disaster. The average life span in that region has actually declined over the past forty years. Yet, there is no fear of the coal that kills them while they express their horror of nuclear power. It is a climate of irrationality.

Over the past decade, the growing fear of nuclear power has been abetted by those who loathe nuclear power as inappropriate for their program to reorganize the industrial world. Make no mistake, these advocates of "Soft Energy" and "Appropriate Technology" understand nuclear power. They do not like it. These New Age Luddites believe that the our global village of the future should be cottage industries with windmills in the backyard. A nuclear power plant is intellectually incompatible with their vision.

These articulate critics of nuclear power are partly responsible for the incredibly complex permitting process which has evolved in the U.S. nuclear power industry. Their influence and deleterious impact has most recently been felt both in New Hampshire and on Long Island. The "no nukes" advocates waged a furious battle for more than a decade against the Seabrook and Shoreham nuclear power plants. Seabrook will open. Shoreham will not. And, New York will buy its electricity from Canadian nuclear or hydro power producers. The Canadian hydro project to provide this power is being vigorously fought in Quebec as an ecological disaster. This is only a luddite's victory, immoral, uncomprehending, and self-serving.

To be sure, the nuclear power community faces both public fear and intellectual arrogance, but, there are also the effects of the greed and avarice so ineptly pursued by the OPEC nations. Ten years ago, the producers of oil thought they could increase prices without limit. But, the invisible hand of supply and demand struck back. The cartel collapsed, along with oil prices. Oil suddenly became abundant and cheap. Energy conservation practices had reduced the demand for electricity. The market for nuclear power evaporated overnight, and, the U.S. found itself dependent for more than half of our oil supply from abroad.

The collapse of the nuclear market is an internal as well as external problem. The U.S. has the most intensive, costly, lengthy regulatory process for the operation of a nuclear power plant. No other electric generation source goes through this process. Yet despite this regulatory burden, the system did not prevent TMI. It is not surprising that there is little public confidence in nuclear energy. To summarize the problem, one can turn to a report on nuclear power by the congressional Office of Technology Assessment. OTA stated that many of the problems with the construction and operation of nuclear power plants stem from mismanagement and inexperience.

This is the real Achilles heel of nuclear energy. We can deal with fear, loathing, and greed. But, how do we respond to incompetence? As much as I would like to argue that market forces will carry the day, we do not have that alternative. The electric power industry is not a free market. Access is limited, prices are fixed, and territory is set.

If a nuclear plant is poorly constructed or managed, there are minor market penalties to the owners, that is, the utility. One only has to look at the WHOOPS fiasco for verification of cost-free incompetence. The Washington Public Power Supply System collapsed under the financial burden of building several nuclear power plants. Costs escalated four-fold, as the need for electricity in the region dropped. So, WHOOPS defaulted on its debt. But, as the sole source of electricity for a number of communities, it survived.

To simplify a complex problem, utilities control their markets through transmission access. Their rates are regulated by public utility commissions, but the rate procedure is an ineffective discipline. Other moderating influences, such as investor confidence or Nuclear Regulatory Commission penalties, are minor annoyances. The bottom line is that communities need electricity. Utilities do not compete for markets. The only spirit of competition occurs with the Independent Power Producers -- minor players who do not build 1000 megawatt nuclear plants.

This atmosphere could explain the poor performance of some of our utilities and their nuclear plants. I cannot understand why the U.S. operating performance is among the worst of all the nations using nuclear power. In Japan, the operating capacity is 77%, while in the U.S., it is only 63%. One looks at the Canadian or the French nuclear power industry, and finds few of the problems that afflict the American industry. Are we learning anything from this foreign experience with nuclear power? Will the U.S. industry grow out of the mistakes of the past? I did say earlier that the atmosphere included an element, a glimmer, of hope. I believe there is a future for the U.S. nuclear industry, if its basis is realism not optimism.

There are four factors which will secure a future for the American nuclear industry. First, there is the issue of demand for electricity. In the U.S., we have not only stopped building nuclear power plants, but virtually everything else as well. The drop in energy prices and our success with energy conservation has created the illusion that we have the physical resources to meet future demand.

The Senate Energy Committee, on which I serve, has held a number of hearings over the past few years regarding demand. It is true that demand today is one half of what was projected in 1970. Twenty years ago we assumed that demand would continue to increase at an annual rate of up to seven percent. The current projection is a maximum rate of two percent. However, in recent years, actual demand has been increasing by about three to four percent. Even at the two percent rate, we will be energy short by 35 gigawatts by the end of the decade. At higher growth rates, the shortages will be even more severe, by as much as 200 gigawatts. This past winter, there were rolling blackouts in Florida when temperatures dropped below normal. Such blackouts will become a reality for other regions of the country.

It is obvious that before the end of the decade, my country will require new sources of electricity. Some planning is underway, but we have not begun to build new power plants. For the moment, the environmental movement has effectively blocked any form of new power. In the Washington area, the utility cannot build combined turbines at existing power plants to assist with peak loads. They use a clean fuel, natural gas. But, there is a "Know-nothing" environmental objection.

If this nonsense continues, and it will, we will have areas with major power shortages in a few years. The public will then begin to demand new power plants.

The second factor involves the latest craze regarding environmental disaster. Some nuclear supporters sense that concern over the greenhouse effect will mean that the new power plants will be nuclear. Several weeks ago, Senator Chafee of Rhode Island stated that he was moving away from his opposition to nuclear power because of its potential to replace fossil fuels, a major contributor to the greenhouse through carbon dioxide. The Union of Concerned Scientists have reversed their longstanding opposition to nuclear power because of the greater fear of the greenhouse effect.

I am no subscriber to the greenhouse hysteria. This is another subject under investigation by the Energy Committee. The most recent evidence argues that the earlier doomsday predictions were overblown.

Ten years ago, we were worried that a new ice age would be the result of the greenhouse. Who knows what it will be ten years from now. While the greenhouse effect is overblown, it is forcing past critics to make a realistic, rather than ideological, assessment of nuclear power.

The third issue is nuclear waste. The current Light Water Reactors which we use in the United States produce potent radioactive waste with extreme lifetimes. We have had a bitter debate on how to manage this waste. It is the same problem in every country with nuclear units. No one wants a nuclear waste

site in their vicinity. Congress forced the issue by selecting a site in Nevada, but the problem is far from resolved.

The waste controversy could be resolved by the fourth issue, new reactor technology. The Light Water Reactors are dinosaurs. We cannot afford the luxury of huge custom designed power plants. We need a standardized design which can produce a finished plant in a reasonable time frame, of four to five years compared with the current twelve years construction schedule. This will require smaller units, which is why there is a focus on the 600 megawatt unit. This would allow utilities more rapid deployment in reaction to their energy requirements.

The technology is underway. Tokyo Electric is now buying an Advanced Light Water Reactor. This is a technology which will be available over the next few years. The two alternative technologies, the High Temperature Gas Reactor and the Liquid Metal Reactor, will not be commercially available until after the year 2000. But, the advantage of the latter two is that they will have a modular design, and will reflect a "passively safe" capacity. The Liquid Metal Reactor has an additional attraction in its internal fuel cycle which will burn off all long-lived radioactive wastes. The remaining waste will have a half life radioactivity of 100 to 200 years, which would effectively remove the major concern over nuclear waste.

With the possibility of such technology, I have to wonder why any utility would not wait ten years for either of these technologies, and avoid many of the headaches which they will inherit with any form of Light Water Reactors.

In closing, nuclear power will be part of America's energy future. The industry has an opportunity to recover and maintain its role as the second major source of electric power in the United States. It is unlikely that nuclear power will grow much beyond its current share of twenty percent of our market. Half of the current nuclear plants will be decommissioned by 2010. At the very least, we will need new facilities to replace the lost output.

Last week, the Senate adopted a Clean Air Act which will ensure the near term use of coal as our primary source of electric generation. Coal will retain its market share of about fifty-five percent. The question facing the nuclear industry is how effective it will be in capturing new market shares for nuclear power.

New, safe, economical nuclear technology is under development. There is no question that federal funding through the Department of Energy will be a struggle as Congress faces a difficult budget process over the next several years. Such research funding is critical if my country aspires to continue to participate in the development of high technology. The other house of Congress must move on legislation approved by the Senate to revitalize our uranium production and enrichment programs. There must also be action on legislation to consolidate and simplify the licensing approval process.

Our Nuclear Regulatory Commission has already bravely begun this task. We are fortunate in having Admiral Watkins as Secretary of Energy. Not only does he have a nuclear background, but he is aggressively attacking our nuclear waste fiasco. His current work on a National Energy Strategy has the potential for resurrecting nuclear power.

There are numerous challenges and opportunities for the nuclear industry and its supporters. Now is the time for us to seize the initiative, and prepare America for its energy needs in the 21st Century.

HOUSE OF COMMONS
LONDON SW1A 0AA

Energy Policy and the Environment

- the role of nuclear power -

- a political perspective -

Speech by Dr. J.A. Cunningham M.P.

at the Japan Atomic Industrial Forum

Annual Conference - Kyoto - 10 April 1990

Dr. J.A. Cunningham MP

I HOPE IT WILL BE HELPFUL TO BEGIN BY DESCRIBING MY BACKGROUND AND POLITICAL EXPERIENCE IN RELATION TO THIS CONFERENCE.

I AM A SCIENTIST AND FOR TWENTY YEARS HAVE BEEN A LABOUR MEMBER OF THE BRITISH PARLIAMENT. IN THAT TIME I HAVE VARIOUSLY BEEN A MEMBER OF THE SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY, MINISTER FOR ENERGY IN THE LAST LABOUR GOVERNMENT OF JAMES CALLAGHAN, AND PRINCIPAL OPPOSITION SPOKESMAN ON THE ENVIRONMENT FOR SIX YEARS. AS PART OF THE RECENT LABOUR PARTY POLICY REVIEW I ALSO CHAIRED THE GROUP WHICH REPORTED ON THE PHYSICAL AND SOCIAL ENVIRONMENT .

DURING THOSE TWENTY YEARS I HAVE BEEN FULLY INVOLVED IN THE NATIONAL AND INTERNATIONAL DEBATE ABOUT ENERGY POLICY AND THE ENVIRONMENT. FOR THOSE TWENTY YEARS I HAVE REPRESENTED THE SAME CONSTITUENCY IN THE HOUSE OF COMMONS - THE CONSTITUENCY WHICH INCLUDES THE HUGE AND CONTROVERSIAL SITE OF BRITISH NUCLEAR FUELS AT SELLAFIELD.

I CAN THEREFORE DISCUSS THE ISSUES WITH YOU TODAY AGAINST A BACKGROUND OF EXPERIENCE OF POLITICAL ARGUMENTS AND DEBATES ABOUT ALL THE MOST CONTROVERSIAL ASPECTS OF THE DEVELOPMENT OF ENERGY POLICY IN GENERAL AND NUCLEAR POWER IN PARTICULAR. IT HAS NOT ALWAYS BEEN AN EASY TASK!

LOOKING FORWARD TO THE PROSPECT OF A LABOUR GOVERNMENT IN 1991 OR 92:-

* WHAT ARE THE PROSPECTS FOR NUCLEAR POWER IN BRITAIN IN THE 1990'S?

* HOW CAN THE FUNDAMENTAL ISSUE OF PUBLIC ACCEPTANCE OF THE INDUSTRY BE RESOLVED?

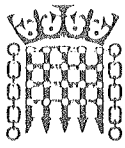
* WHAT ARE THE MERITS OF NUCLEAR POWER COMPARED WITH COAL, OIL AND GAS, RENEWABLE SOURCES AND ENERGY CONSERVATION?

* WILL REPROCESSING OF FUEL ELEMENTS CONTINUE TO BE ACCEPTED?

* HOW WILL BRITAIN DEAL WITH THE LONG TERM STORAGE OF RADIOACTIVE WASTE RESIDUES?

* JUST WHAT SHOULD OUR PRIORITIES BE?

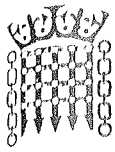
I WANT TO SHARE MY VIEWS ON THESE MATTERS WITH YOU AND TO PROPOSE SOME IDEAS FOR MOVING THE POLICY DISCUSSIONS FORWARD. MOST INDUSTRIALISED COUNTRIES APPEAR TO HAVE AN OVERCAPACITY OF ELECTRICITY GENERATION AT PRESENT AND BRITAIN IS NO EXCEPTION. I BELIEVE THAT IS THE MAJOR REASON WHY INVESTMENT IN NUCLEAR POWER WILL BE LOW IN BRITAIN IN THE COMING DECADE. FURTHERMORE DEVELOPING NATIONS, EVEN IF IT IS FELT TO BE APPROPRIATE, CANNOT AFFORD THE CAPITAL INVESTMENT NEEDED.



THE NUCLEAR POWER SITUATION IN THE U.K. IS DOMINATED BY THE EFFECTS OF THE PRIVATISATION OF THE ELECTRICITY SUPPLY INDUSTRY. EFFECTIVELY THE FINANCIAL INSTITUTIONS IN BRITAIN HAVE FORCED THE THATCHER GOVERNMENT TO RETAIN ALL NUCLEAR POWER STATIONS IN ENGLAND WALES IN THE PUBLIC SECTOR IN A NEW COMPANY - 'NUCLEAR ELECTRIC'. FURTHER P.W.R. BUILDING BY NUCLEAR ELECTRIC AFTER SIZEWELL B HAS BEEN DEFERRED. THUS POLITICAL DECISIONS HAVE AGAIN RESULTED IN AN ADVERSE EFFECT ON THE U.K. NUCLEAR POWER PROGRAMME. IT WOULD APPEAR THEREFORE THAT THE IMMEDIATE FUTURE PROSPECTS FOR THE INDUSTRY ARE NOT ENCOURAGING. BNFL HOWEVER CONTINUES TO MANAGE ITS OWN NUCLEAR STATIONS AT CALDER HALL, CHAPELCROSS IS CURRENTLY CONSIDERING THEIR REPLACEMENT.
BUT ELECTRICITY DEMAND IS FORECAST TO GO ON GROWING AT PERHAPS 2 OR 3 PER CENT PER ANNUM FOR THE FORESEEABLE FUTURE.

THE SITUATION FACING THE COAL INDUSTRY IS EQUALLY DEPRESSING. PLANS FOR THREE LARGE NEW COAL FIRED STATIONS HAVE ALSO BEEN ABANDONED IN FAVOUR OF SMALLER GAS FIRED PLANT, BECAUSE OF DOUBTS ABOUT FUEL QUALITY AND COST, AND THE DEREGULATION OF THE GAS SUPPLY INDUSTRY.

THERE IS THUS AN INCREASING POSSIBILITY OF A DIFFICULT SITUATION DEVELOPING IN ENGLAND AND WALES BY THE YEAR 2000 BY WHICH TIME THERE MAY WELL BE A SHORTFALL IN GENERATING CAPACITY. I DO NOT NEED TO STRESS TO THIS AUDIENCE JUST HOW DEMAGING THAT WOULD BE.

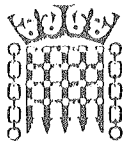


THE READY AVAILABILITY OF FOSSIL FUELS SUPPLIES AT DEPRESSED PRICES, TOGETHER WITH THE LOWER CAPITAL COSTS, MAKES FOSSIL FUEL ELECTRICITY GENERATION SUPERFICIALLY ATTRACTIVE RELATIVE TO NUCLEAR POWER AT PRESENT. BUT THE GROWING SCIENTIFIC DEBATE AND POLITICAL AND PUBLIC AWARENESS OF THE NEED TO CONTROL FLUE GAS EMISSIONS MEANS THAT FOSSIL FUELS TOO NOW FACE A PROBLEM OF PUBLIC ACCEPTABILITY.

WHILST THERE IS CONSIDERABLE DEBATE AND DISPUTE ABOUT THE CAUSES OF GLOBAL WARMING THERE IS REASONABLE CAUSE TO ASSUME THAT IT IS ACTUALLY HAPPENING. THE 1980'S WAS UNQUESTIONABLY THE WARMEST DECADE OF THE TWENTIETH CENTURY. INTERNATIONALLY SCIENTIFIC EFFORTS ARE INTENSIFYING IN AN ATTEMPT TO CLARIFY THE DIRECTIONS AND RATES OF CHANGE IN GLOBAL CLIMATE.

EVERYONE ON OUR PLANET FACES THE COMMON PROBLEM OF GLOBAL WARMING DESCRIBED BY THE WORLD COMMISSION ON THE ENVIRONMENT AND DEVELOPMENT - THE BRUNDTLAND REPORT - THUS:

"ENVIRONMENTAL THREATS TO SECURITY ARE NOW BEGINNING TO EMERGE ON A GLOBAL SCALE. THE MOST WORRISOME OF THESE STEM FROM THE POSSIBLE CONSEQUENCES OF GLOBAL WARMING CAUSED BY THE ATMOSPHERIC BUILD UP OF CARBON DIOXIDE AND OTHER GASES".

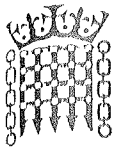


THE GROWTH IN WORLD POPULATION AND THE CONSEQUENT INCREASE IN DEMAND FOR ENERGY WILL PLACE EVEN GREATER STRAINS ON OUR COMMON ENVIRONMENT PRODUCING IMPERATIVES FOR CHANGED PRACTICES AND PROCEDURES.

THERE IS GENERAL AGREEMENT ABOUT THE NEED TO REDUCE THE EMISSIONS OF ACID RAIN GASES SO2 AND NOX. TECHNOLOGIES EXIST TO DO THIS BUT ONLY AT SIGNIFICANT COST.

THE GREENHOUSE GASES CARBON DIOXIDE, METHANE, NITROUS OXIDE AND CHLOROFLUOROCARBONS ARE MUCH MORE DIFFICULT MATTERS. IN ELECTRICITY PRODUCTION CARBON DIOXIDE EMISSIONS ARE THE DOMINANT CONCERN AND THIS CAN ONLY BE DEALT WITH BY A MAJOR SWITCH FROM USING FOSSIL FUELS IN PARTICULAR COAL.

ENERGY PRODUCTION, WHATEVER FORM IT TAKES, POSES PARTICULARLY DIFFICULT PROBLEMS FOR THE ENVIRONMENT. FUEL EXTRACTION, BURNING AND CONVERSION ALL INVOLVE RISK AND CAUSE POLLUTION AND RESULT IN WASTES NEEDING DISPOSAL. ACID RAIN, THE 'GREENHOUSE EFFECT', NUCLEAR DISCHARGES, NUCLEAR WASTE, 'NOX' GASES ARE NOW FAMILIAR WORDS IN THE WELCOME INCREASE IN WELL-INFORMED DISCUSSION OF THE URGENT NEED TO SAFEGUARD FRAGILE ECOSYSTEMS. EVEN RENEWABLE ENERGY SOURCES INVOLVE SIGNIFICANT ENVIRONMENTAL IMPACT.



YET WE NEED ENERGY TO SUSTAIN, LET ALONE IMPROVE OUR QUALITY OF LIFE AND THAT OF MILLIONS OF PEOPLE IN THE THIRD WORLD. THE NEED FOR ENERGY IS CERTAIN TO GROW OVERALL IN WORLD TERMS, BECAUSE EVEN THOUGH IT MAY FALL SIGNIFICANTLY IN DEVELOPED NATIONS IT WILL RISE SIGNIFICANTLY IN DEVELOPING COUNTRIES TO COPE WITH BOTH POPULATION GROWTH AND THE REASONABLE WISHES FOR IMPROVEMENTS IN THE QUALITY OF LIFE FOR HUNDREDS OF MILLIONS OF PEOPLE.

ENERGY PRODUCTION INDUSTRIES ARE HUGE CONSUMERS OF LAND, FINANCE AND OTHER RESOURCES SUCH AS WATER. ENERGY PRODUCTION, PARTICULARLY THE ELECTRICITY AND PETROLEUM INDUSTRIES, OFTEN PRE-EMPT LARGE AND ENVIRONMENTALLY SENSITIVE COASTAL AND ESTUARINE SITES.

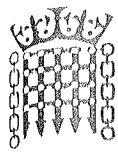
THERE ARE THUS MANY VERY IMPORTANT REASONS FOR US TO USE ENERGY MUCH MORE EFFICIENTLY THAN WE DO NOW. THE CONFLICT BETWEEN ENERGY NEEDS AND ENVIRONMENTAL PROTECTION AND CONSERVATION PRESENTS US WITH A REAL DILEMMA. FOLLOWING THE DISASTER AT CHERNOBYL, NUCLEAR POWER LOST SUPPORT - PEOPLE WERE RIGHTLY CONCERNED FOR THEIR FUTURE HEALTH AND WELL-BEING AND THE ENVIRONMENT.

YET BOTH NUCLEAR AND FOSSIL FUELS HAVE CONSEQUENCES THAT TRANSCEND NATIONAL BOUNDARIES. WE HAVE TO RECOGNISE THAT IN THE MEDIUM TERM, IN OUR INTERDEPENDENT WORLD WITH ITS INTERDEPENDENT ECONOMY COAL, OIL, GAS AND NUCLEAR POWER WILL ALL REMAIN IN USE.

OUR IMMEDIATE TASK THEREFORE MUST BE TO MAXIMISE THE EFFICIENCY AND SAFETY OF THAT USE AND TO SHARE KNOWLEDGE INTERNATIONALLY ON THE SAFEST WAYS OF DECOMMISSIONING AND MANAGING NUCLEAR WASTE AND DEALING WITH TOXIC AND HAZARDOUS WASTES FROM ENERGY PRODUCTION GENERALLY.

AS OUR UNDERSTANDING OF THE SCIENCE OF THE ENVIRONMENT DEVELOPS, SO WE SEE THE PERSPECTIVES CHANGING AGAIN. THE BURNING OF FOSSIL FUELS - COAL, OIL, GAS - IS THE BIGGEST SOURCE OF GREENHOUSE GASES AND THE MOST IMPORTANT CAUSE OF GLOBAL WARMING. REDUCING CARBON DIOXIDE EMISSIONS MUST BE A PRIORITY IF WE ARE TO SLOW DOWN THE INDUCED CLIMATIC CHANGE THAT GLOBAL WARMING WILL PRODUCE. THIS NEED HAS IMPLICATIONS FOR TRANSPORT POLICY TOO, SINCE VEHICLE EMISSIONS ARE MAKING AN INCREASING CONTRIBUTION TO THE TOTAL OF GREENHOUSE GASES.

THE BRITISH LABOUR PARTY BELIEVES THAT THE BEST, THE QUICKEST, AND MOST COST-EFFECTIVE AND ENVIRONMENTALLY SOUND WAY TO BEGIN TO TACKLE THESE PROBLEMS IS A MAJOR LONG-TERM GOVERNMENT POLICY COMMITMENT TO ENERGY CONSERVATION. THIS NECESSITATES INTERVENTION IN THE ECONOMY. IT IMPLIES THE NEED FOR A BALANCED ENERGY POLICY. WE RECOGNISE THAT FOSSIL FUELS WILL BE THE ESSENTIAL MAINSTAY FOR MANY DECADES TO COME, BUT IN ALL THE CIRCUMSTANCES WE SHARE THE VIEW OF THE BRITISH TRADES UNION CONGRESS AND OTHERS THAT:
"IT WOULD BE UNWISE TO RULE OUT NUCLEAR ENERGY AS A STRATEGIC SOURCE FOR THE LONG TERM."



WE RECOGNISE THE NEED TO SUPPORT GREATER RESEARCH EFFORTS INTO IMPROVING ENERGY CONSERVATION, ENERGY TRANSMISSION, COMBUSTION AND ENERGY USE, AND WE ACCEPT THE NEED FOR GREATER URGENCY IN THE DEVELOPMENT OF ALTERNATIVE ENERGY RESOURCES.

IT IS OUR VIEW THAT GOVERNMENT HAS TO SUPPORT THE INVESTIGATION OF THE POTENTIAL OF NEW IDEAS AND NEW TECHNOLOGIES TO ENABLE A SAFE AND COHERENT TRANSITION TO MORE SUSTAINABLE ENERGY SYSTEMS WHICH MAY BE ENVIRONMENTALLY BENIGN.

HERE, I HAVE TO PAY TRIBUTE TO THE ENORMOUS PROGRESS WHICH THE JAPANESE GOVERNMENT AND PEOPLE ARE MAKING IN THE FIELD OF ENERGY CONSERVATION. AS A COUNTRY, AN ECONOMY, WHOLLY DEPENDENT ON IMPORTED FUELS THEIR LONG EXPERIENCE OF THE PROBLEMS WHICH CHANGES IN THE WORLD MARKET MAY BRING, HAS LED TO AN ENTHUSIASM WHICH OTHER DEVELOPED COUNTRIES SHOULD BE COPYING. WE CAN LEARN A LOT FROM THEM.

I THINK THAT THE CHANGING NATURE OF THE DEBATE ON ENERGY AND THE ENVIRONMENT MUST PRESENT AN OPPORTUNITY TO IMPROVE THE PUBLIC PERCEPTION OF NUCLEAR POWER. WE MUST INSIST ON A 'LEVEL PLAYING FIELD' WITH A FULL ENVIRONMENTAL COST AUDIT FOR ALL ENERGY SOURCES ESSENTIAL FOR INFORMED JUDGEMENTS TO BE MADE. THAT VIEW IS POWERFULLY SUPPORTED BY THE BRITISH UNIONS REPRESENTING EMPLOYEES IN THE NUCLEAR INDUSTRY.

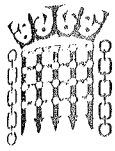
NOR CAN OUR QUALITY OF LIFE BE SAFEGUARDED BY ABANDONING DEVELOPMENT EITHER FOR INDUSTRIAL NATIONS OR THE THIRD WORLD. TO DO SO WOULD BE TO BETRAY MILLIONS OF PEOPLE, TO CONDEMN THEM TO SQUALOR, POVERTY, DISEASE, STARVATION AND DEATH.

INDEED POVERTY IS ITSELF ONE OF THE MAJOR CONTRIBUTIONS TO ENVIRONMENTAL DEGRADATION. THE BRUNDTLAND COMMISSION STRONGLY EXPRESSED THE VIEW THAT ENVIRONMENTAL PROBLEMS WOULD ONLY BE SOLVED BY ECONOMIC DEVELOPMENT AND AN END TO THE GROSS IMBALANCES BETWEEN NORTH AND SOUTH.

THE THIRD WORLD CURRENTLY USES 15 PER CENT OF TOTAL WORLD ENERGY AND HAS OVER HALF THE WORLD'S POPULATION. ENERGY USE PER HEAD IS ABOUT ONE QUARTER OF THE WORLD AVERAGE AND LESS THAN A TENTH OF THAT OF OECD COUNTRIES.

IF THE INDUSTRIALISED NATIONS WERE TO ABANDON NUCLEAR POWER WORLD DEMAND FOR FOSSIL FUELS WOULD INCREASE TO A POINT WHERE DEVELOPING NATIONS AND THE THIRD WORLD WOULD BE PRICED OUT OF THE MARKET.

SO AGAIN I SAY THAT NUCLEAR POWER HAS AN IMPORTANT ROLE TO PLAY IN HELPING TO SUPPORT THE ECONOMIC DEVELOPMENT NECESSARY TO ALLOW US TO AID THE MORE BALANCED AND ESSENTIAL DEVELOPMENT OF ALL PEOPLES.

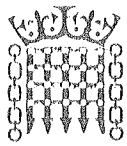


BUT IF NUCLEAR POWER IS TO WIN MORE GENERAL PUBLIC ACCEPTANCE OTHER POLICIES MUST BE CHANGED AND OTHER ARGUMENTS WON.

BETTER AND MORE RIGOROUS INTERNATIONAL STANDARDS AND MANAGEMENT PRACTICES AND TECHNIQUES SHOULD BE PRIORITIES. AS THE INDUSTRY IDENTIFIES COMMON PROBLEMS IT SHOULD LOOK FOR COMMON SOLUTIONS BY SHARING KNOWLEDGE AND SKILLS. THE INDUSTRY HAS BEEN SLOW TO THINK GLOBALLY AND TO ORGANISE ITS AFFAIRS IN CONTRAST TO ITS CRITICS IN THE ENVIRONMENTALIST MOVEMENTS WHO HAVE BEEN MUCH BETTER ORGANISED.

I HAVE IN MIND THE UNDERSTANDING AND MANAGEMENT OF FUEL REPROCESSING, NUCLEAR WASTE MANAGEMENT AND DECOMMISSIONING OF NUCLEAR PLANT. IF THE INDUSTRY WANTS A LONG TERM FUTURE IT MUST MORE SERIOUSLY ADDRESS THESE FUNDAMENTAL LONG TERM POLICY QUESTIONS.

THE MISMANAGEMENT WHICH LEAD TO SUCH AN APPALLING CATASTROPHE AT CHERNOBYL WILL LINGER LONG IN PEOPLE'S MINDS. LIKE THREE MILE ISLAND EARLIER, IT INEVITABLY RESULTED IN WIDESPREAD FEAR AND CONCERN ABOUT WHETHER NUCLEAR POWER CAN BE EFFECTIVELY MANAGED. PAST ACCIDENTS AT SELLAFIELD CAUSED SIMILAR ANXIETIES.



I AM PLEASED TO SAY THAT AFTER A SUSTAINED PROGRAMME OF MAJOR INVESTMENT IN NEW PLANT AND TECHNOLOGY THE SELLAFIELD SITE OF BRITISH NUCLEAR FUELS IS IN MUCH BETTER SHAPE. NEW FUEL RECEIPT AND STORAGE FACILITIES, NEW EFFLUENT TREATMENT PLANTS, AND MORE EFFECTIVE MANAGEMENT HAVE MEANT THAT FOR THE EIGHTH YEAR IN SUCCESSION LIQUID DISCHARGES TO THE MARINE ENVIRONMENT WERE DOWN AGAIN IN 1988.

EARLIER THIS YEAR BNFL WON A COMMENDATION IN THE UK BETTER ENVIRONMENT AWARDS FOR INDUSTRY IN RECOGNITION OF THE EFFECTIVENESS OF THE SITE ION EXCHANGE PLANT (SIXEP) IN REDUCING DISCHARGES.

DISCHARGES OF THE MOST RADIOLOGICALLY IMPORTANT RADIONUCLIDES ARE EXPECTED TO REMAIN LOWER THAN THOSE RECORDED BEFORE 1986. THE INTENTION IS TO MAINTAIN OR FURTHER CUT DISCHARGE LEVELS AND A FURTHER £500 MILLION IS COMMITTED TO LOW-ACTIVITY LIQUID EFFLUENT MANAGEMENT OVER THE NEXT FEW YEARS.

IN 1988 ALL THE DISCHARGES AND DISPOSALS OF RADIOACTIVE WASTE FROM SELLAFIELD WERE INSIDE LIMITS SET INDEPENDENTLY BY GOVERNMENT DEPARTMENTS. THE SAME HELD TRUE FOR BNFL'S OTHER FACILITIES AT CHAPELCROSS IN SCOTLAND, AT SPRINGFIELDS AND AT CAPENHURST IN ENGLAND.

FOR MEMBERS OF THE GENERAL PUBLIC, THE AVERAGE RADIATION EXPOSURE FROM SELLAFIELD DISCHARGES REMAINS AT 0.01 MILLISIEVERTS, WHILE THE MOST EXPOSED GROUP OF PEOPLE NEAR SELLAFIELD - THOSE WHO EAT A LOT OF LOCAL SHELLFISH - RECEIVED AN EXTRA DOSE OF ABOUT 0.4 MILLISIEVERTS. THIS IS WELL BELOW THEIR AVERAGE YEARLY DOSE FROM ALL OTHER NORMAL SOURCES OF 2.5 MILLISIEVERTS.

THE DOSE TO THE 'CRITICAL GROUP' IS BELOW THE LEVELS RECOMMENDED BY BRITAIN'S RADIOACTIVE WASTE MANAGEMENT ADVISORY COMMITTEE AND THOSE RECOMMENDED BY THE NATIONAL RADIOLOGICAL PROTECTION BOARD. HOWEVER, THE LATEST STUDIES OF THE UPTAKE OF RADIOACTIVE MATERIAL FROM SELLAFIELD BY EATING SHELLFISH SUGGESTS THAT THE REAL DOSE RECEIVED IS IN FACT LESS THAN THE CRITICAL GROUP DOSE QUOTED.

FOR ITS OWN WORKFORCE BNFL VOLUNTARILY APPLIES AN OPERATIONAL LIMIT FOR RADIATION EXPOSURE OF 30 MILLISIEVERTS PER PERSON PER YEAR, COMPARED WITH THE 50 MILLISIEVERTS ANNUAL 'WHOLE BODY DOSE' LIMIT SPECIFIED IN THE IONISING RADIATIONS REGULATIONS. NO SELLAFIELD EMPLOYEE EXCEEDED THE STATUTORY LIMIT.

FOR MANY YEARS IN BRITAIN A DEBATE HAS CONTINUED ABOUT LINKS BETWEEN NUCLEAR INSTALLATIONS AND LEUKAEMIAS IN CHILDREN AND YOUNG PEOPLE AND RECENTLY ANOTHER STUDY WAS PUBLISHED. THE 'GARDNER REPORT' SET OUT TO:

"EXAMINE WHETHER THE OBSERVED EXCESS OF CHILDHOOD LEUKAEMIA AND LYMPHOMA NEAR THE SELLAFIELD NUCLEAR PLANT IS ASSOCIATED WITH ESTABLISHED RISK FACTORS OR FACTORS RELATED TO THE PLANT."

IN WEST CUMBRIA A TOTAL OF 52 CASES OF LEUKAEMIA AND 22 CASES OF NON-HODGKINS LYMPHOMA, WERE DIAGNOSED FROM 1950 TO 1985.

OF THOSE 74 CASES IT WAS FOUND THAT 10 OF THE FATHERS HAD WORKED AT SELLAFIELD, AND OF THOSE 10, 5 OF THE FATHERS LIVED AT SEASCALE AND 5 LIVED ELSEWHERE IN WEST CUMBRIA.

IT WAS ALSO FOUND THAT 4 OUT OF THE 10 FATHERS HAD RECEIVED AN ACCUMULATED EXTERNAL RADIATION DOSE OF 100 MILLISIEVERTS OR ABOVE PRIOR TO CONCEPTION, AND 4 OF THE 10 HAD ALSO RECEIVED AN EXTERNAL RADIATION DOSE OF 10 MILLISIEVERTS 6 MONTHS PRIOR TO CONCEPTION.

THE STUDY SUGGESTS THAT THE RADIATION DOSE TO THE FATHERS PRIOR TO CONCEPTION MAY HAVE AFFECTED THE SPERM AND COULD HAVE PRODUCED THE LEUKAEMIA IN THE CHILD.

THIS IS A COMPLETELY NEW FINDING QUITE DIFFERENT FROM PREVIOUS STUDIES. IF CONFIRMED IT HAS MAJOR IMPLICATIONS FOR EMPLOYMENT PRACTICES, PROTECTION OF NUCLEAR INDUSTRY WORKERS, AND DOSE LIMITS TO EVERYONE EXPERIENCING THE RISK OF EXPOSURE TO RADIATION IN THEIR EMPLOYMENT. WORK IS ALREADY IN PROGRESS TO CARRY OUT SIMILAR STUDIES IN OTHER AREAS WHERE NUCLEAR SITES ARE LOCATED.

I HAVE ALREADY HAD DISCUSSIONS WITH THE MINISTER FOR HEALTH ABOUT WHAT ACTION THE GOVERNMENT INTENDS TO TAKE AS A CONSEQUENCE OF THE REPORT. WHAT HAS NOT BEEN MADE CLEAR IS THAT THE GARNER RESEARCH SHOWS THAT THE RELATIVE RISK TO CHILDREN LIVING NEAR

SELLAFIELD OF CONTRACTIVE LEUKEMIA OR NON HOJGKINS LYMPHOMA IS HIGHER FOR THOSE WHOSE FATHERS WORK IN FARMING OR IN THE STEEL INDUSTRY THAN FOR THOSE WHO WORK AT SELLAFIELD.

THE REPORT LEAVES UNANSWERED QUESTIONS ABOUT THE CAUSE OF LEUKAEMIA IN CHILDREN WHOSE PARENTS ARE NOT EMPLOYED AT SELLAFIELD. PROFESSOR GARDNER CONCLUDES THAT THERE IS NO EVIDENCE OF RISK ASSOCIATED WITH CHILDREN PLAYING ON THE BEACH IN WEST CUMBRIA, NOR TO FAMILIES EATING LOCAL FISH. THERE ARE NEVERTHELESS FURTHER IMPORTANT QUESTIONS TO BE ANSWERED ABOUT THE CAUSE OF LEUKAEMIA AMONG CHILDREN IN WEST CUMBRIA.

THE TRADE UNION RESPONSE IS TO VIEW WITH CONCERN THE FINDINGS OF THE STUDY AND UNTIL OTHERWISE DISPROVED ACCEPT ITS CONCLUSIONS. TO THAT END OUR PRIME OBJECTIVE IS TO CONTINUE TO REDUCE THE RADIATION DOSE TO WORKERS.

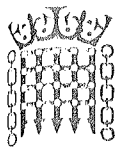
THIS OBJECTIVE IS NOT NEW IT IS SOMETHING THAT HAS BEEN ON-GOING SINCE THE 1970'S WHEN MOST OF THE HIGH RADIATION DOSES WERE RECORDED. THIS STUDY, HOWEVER, HAS PUT A NEW EMPHASIS ON THE NEED TO REDUCE RADIATION DOSES EVEN FURTHER. NOTWITHSTANDING THESE ISSUES URGENT ACTION WILL BE TAKEN TO REDUCE THE DOSE LEVELS TO EMPLOYEES.

BNFL IS CONTINUING TO BUILD PLANTS TO CUT DISCHARGES STILL FURTHER, NOTABLY THE SELLAFIELD ENHANCED ACTINIDE REMOVAL PLANT AND ITS SISTER FACILITIES: THE WASTE PACKAGING AND ENCAPSULATION PLANT; THE EFFLUENT PLANT SERVICES BUILDING; AND, THE EFFLUENT PLANT MAINTENANCE FACILITY. THE £500 MILLION BEING INVESTED WILL SECURE OVER 1000 JOBS ON SITE AND AT DESIGN OFFICES IN THE REGION.

THIS INVESTMENT UNDERLINES THE ESSENTIAL COMMITMENT TO GREATER ENVIRONMENTAL PROTECTION AND SAFEGUARDS SO NECESSARY TO SECURE PUBLIC CONFIDENCE. JAPANESE REPROCESSING BUSINESS IS VERY IMPORTANT TO THE DEVELOPMENTS AT SELLAFIELD IN PARTICULAR THE INVESTMENT IN 'THORP'.

THE CALDER HALL MAGNOX STATION HAS NOW BEEN OPERATING FOR MORE THAN THIRTY YEARS. IT WILL NEED TO BE REPLACED AND BNFℓ ARE ACTIVELY CONSIDERING THE MATTER. BNFℓ HAS SAID THAT IT SEES NOTHING IN THE GOVERNMENT'S DECISION ON NUCLEAR POWER AND PRIVATISATION DESIGNED TO DETER OTHER ORGANISATIONS FROM DEVELOPING THEIR OWN NUCLEAR PLANT IF THEY CONSIDER THIS TO BE COMMERCIALLY JUSTIFIED. BNFℓ WILL CONTINUE TO WORK ON ITS FEASIBILITY STUDY TO INVESTIGATE THE POSSIBILITY OF INVESTMENT IN NEW NUCLEAR GENERATING PLANT AT ITS CALDER HALL AND CHAPELCROSS SITES.

WE RECOGNISE THAT BNFℓ REPROCESSING HAS A SECURE FUTURE. IT WILL BE REQUIRED FOR THE CONTINUING MAGNOX SYSTEMS AS WELL AS FOR THERMAL OXIDE FUEL REPROCESSING.



I BELIEVE AND LABOUR POLICY MAKES CLEAR THAT THE LOGICAL STEP IN THE DEVELOPMENT OF NUCLEAR WASTE MANAGEMENT IN BRITAIN WILL BE THE CONSTRUCTION OF A SPECIALLY ENGINEERED DEEP MINED FACILITY WHERE VITRIFIED ENCAPSULATED WASTE CAN BE STORED AND MONITORED IN A RETRIEVABLE FORM. THE RESPONSIBILITY FOR POLICY DEVELOPMENT RESTS WITH THE GOVERNMENT AT WESTMINSTER AND A LABOUR GOVERNMENT WOULD INSIST ON THE HIGHEST STANDARDS OF ENGINEERING, ENVIRONMENTAL CONTROL AND SCIENTIFIC MONITORING.

IT IS TOO EARLY TO CONCLUDE WHERE SUCH A FACILITY WILL BE LOCATED BUT RESEARCH DRILLING IS ALREADY UNDERWAY AT TWO SITES.

COMPLETE OPENNESS AND HONESTY ARE ESSENTIAL IN THE CONTINUING DEBATE ABOUT WHETHER OR ON WHAT SCALE NUCLEAR POWER SHOULD CONTRIBUTE TO FUTURE ENERGY POLICY.

IT IS WRONG TO 'OVERSELL' THE INDUSTRY AND COUNTER-PRODUCTIVE TO PRETEND THAT NUCLEAR POWER IS THE CONPLETE ANSWER TO GLOBAL WARMING. THERE IS NO SINGLE ANSWER BUT IT IS SURELY RIGHT TO CONCLUDE THAT NUCLEAR ELECTRICITY CAN MAKE A SIGNIFICANT CONTRIBUTION TO THE REDUCTIONS REQUIRED IN CARBON DIOXIDE EMISSIONS.

BRITAIN HAS OVER SEVERAL DECADES ACCUMULATED A GREAT DEAR OF SCIENTIFIC TECHNOLOGICAL EXPERTISE IN ALL ASPECTS OF CIVIL NUCLEAR POWER. WE WANT TO PUT THAT KNOWLEDGE, SKILL TECHNOLOGY TO GOOD USE.

GREATER EMPHASIS SHOULD BE PLACED ON PUBLIC EDUCATION AND INFORMATION TO ENSURE A BETTER INFORMED DIALOGUE. MY OWN CONCLUSION IS THAT CIVIL NUCLEAR POWER WILL BE NECESSARY IN INDUSTRIAL ECONOMIES FOR THE FORESEEABLE FUTURE. WE MUST THEREFORE NOT ONLY DEVELOP THE INDUSTRIAL AND MANAGERIAL SKILLS NECESSARY TO SUSTAIN A SAFE AND EFFICIENT INDUSTRY, BUT WE MUST DEVELOP ALSO THE POLITICAL SKILLS AND THE POLITICAL WILL TO ENSURE THAT BALANCED RATIONAL DECISIONS ARE TAKEN ABOUT ENERGY POLICY AND THE ENVIRONMENT.

Ends

Jack Cunningham M.P.
10 April 1990

The Energy Policies of the Social Democratic Party and the Nuclear Energy Situation

Wolf-Michael Catenhusen
Chairman of the Bundestag Committee on Research, Technology and Technology Impact Assessment
Federal Republic of Germany

Current situation:

The Federal Republic of Germany is a highly developed industrial country with a large energy requirement. Per capita primary-energy consumption in 1986 amounted to 5.7 TCEs (tonnes of coal equivalent) as compared with 3.6 tonnes for Japan. In 1987 primary-energy consumption in the Federal Republic amounted to approximately 390 million TCEs. 86% of the energy requirement was covered by fossil fuels, 11% by nuclear energy and 2.1% by hydroelectric energy. The Federal Republic has extensive anthracite and lignite deposits.

In 1987 overall electricity-production capacities amounted to 101,000 MW, of which 6,700 MW (6.6%) was accounted for by water power, 39,900 MW (39.5%) by anthracite, 13,500 MW (13.4%) by lignite, 10,100 MW (10%) by fuel oil, 15,700 MW (15.5%) by gas, and 20,000 MW (19.8%) by nuclear energy. Actual electricity production was distributed among the primary-energy categories as follows:

- water 4.9%
- coal 48.7%
- oil 2.5%
- gas 8.9% and
- nuclear energy 31%.

Since the end of the 1970s growth in energy consumption in the Federal Republic has been slower than growth in the economy in general. From 1973 to 1985 the gross national product grew by 24% whereas there was only a 4% increase in energy consumption. In this context it should be said that the increase in electricity consumption has continued to be greater than the growth in overall energy consumption. After the completion of a number of 1,300 MW nuclear power plants, we now have considerable excess capacities in electricity production, estimated at between 10% and 50%. For this reason there are currently no new nuclear power plants either on order or under construction. The ordering of new large-scale power plants will not be realistic until the end of the 1990s at the earliest.

SPD decision to get out of nuclear energy

After the Second World War all of the major organizations in the Federal Republic of Germany, including the SPD, hoped the peaceful use of nuclear energy would provide a safe and almost inexhaustible source of energy on the basis of which it would be possible to achieve social progress. The conflict surrounding the use of nuclear energy began in the Federal Republic in the early 1970s. This conflict also involved the SPD and the trade unions. In 1986 the SPD finally put an end to a controversy that continued for ten years in the party ranks on the peaceful use of nuclear energy by passing a resolution at the annual party conference. The resolution says: "We will do everything we can to see to it that an energy-supply system is established in the Federal Republic of Germany without nuclear power within a period of ten years." According to the SPD resolution, dropping nuclear energy as a means of electricity production should involve:

- Stopping the further development of advanced versions of the fast-breeder and high-temperature reactor types. The construction of a fast-breeder prototype in Kalkar should not be completed. The high-temperature reactors should be shut down. (In the meantime this reactor has in fact been shut down due to technical defects.)

- Abandoning the strategy of disposing of spent fuel elements by means of reprocessing them (the plan to construct a nuclear-fuel reprocessing plant in the Federal Republic was abandoned) and switching to direct final storage of existing radioactive waste.

- Not issuing construction or operation permits for new light-water reactors.

- Conducting safety inspections of older nuclear power plants with a view to modernizing them or to shutting them down for safety reasons.

- Passing a "nuclear energy phase-out act" aimed at making it possible to take existing modern light-water reactors off the grid gradually -- within a period of ten years. Compensation based on the present value of the facility in question should be paid over a period of thirty years.

- Changing electricity prices so as to create a financial incentive for saving electricity.

- Carrying out a medium-term research and development programme for the further development of regenerative energy sources to an extent comparable to past government spending on nuclear energy. In its resolution the SPD also made it clear that the desired

objective can only be achieved if government and industry work together. It should be said, however, that a public consensus on this objective still does not exist in the Federal Republic of Germany.

The SPD's reasons for the decision to give up nuclear energy

1. The long-term effects of even small doses of radiation on human health are a great deal more serious than was previously assumed. We should avoid additional radiation as much as possible.

2. Even in the case of slight probabilities of occurrence, the possibility of serious accidents in connection with the operation of nuclear power plants is unacceptable. There is no absolute safety in connection with nuclear facilities.

3. Nuclear energy involves a technology that is very capital-intensive, on the one hand, and one that provides very few jobs, on the other. The overall costs involved in the use of nuclear energy, including waste disposal and the tearing down of phased-out facilities was underestimated.

4. The use of nuclear energy does not provide the economy any significant advantages in terms of international competition.

5. The disposal and final storage of highly radioactive waste materials continues to be an unresolved problem worldwide.

6. The use of nuclear energy, in particular plutonium, makes it necessary to take surveillance and control measures which, in the long run, will constitute a threat to the democratic structures of a society.

7. Surplus electricity-production capacities in the nuclear power sector are crowding domestic German coal out of the electricity-producing industry. The use of 40 million tons of domestic coal for electricity production is contractually guaranteed, along with government subsidies, up until 1995.

Consequences for the structure of the energy and electricity-producing sector in the Federal Republic of Germany

The Federal Republic of Germany can do without the use of nuclear energy. The energy-related, economic and ecological effects of this move can be coped with. However, it will not be enough simply to change the percentages of the different technologies used in producing electricity on the supply side. Abandoning the further use of nuclear energy will also mean bringing about a profound change in the structure of the electricity-producing sector. This structural change must be integrated into a change in the overall energy-supply sector, particularly on the heat market, and must exert an influence on energy demand.

Energy-sector scenarios for the Federal Republic developed at the request of SPD-led state governments and the federal government are based on an assumed economic growth in the Federal Republic of approximately 2% and a further one-to-one, 5% annual increase in electricity consumption. The latest scenarios even go as far as to assume the possibility that energy consumption will stagnate by the year 2000, given the requisite energy-price increases

achieved on the basis of increased energy taxation. Even the more cautious scenarios show in this context that:

1. Electricity savings can make an important contribution towards successfully abandoning nuclear energy. By this means up to one-third of the amount of electricity generated by nuclear power plants could be replaced by the year 2010.

2. Combined electricity and heat generation could compensate for another third.

3. The remaining third would have to be made up for primarily by means of an expanded and environment-friendly use of fossil fuels. In this context, the emission of pollutants such as sulphur dioxide and nitrous oxides could be greatly reduced. This is not the case, however, with regard to carbon dioxide emissions. By the year 2000 it will only be possible to increase the percentage of regenerative energy sources -- in particular hydroelectric energy -- in the overall electricity-producing sector in the Federal Republic from a current level of 5% to somewhere between 8% and 10%.

An annual 5% to 6% increase in electricity-producing costs is assumed in these scenarios. In the Federal Republic this could result in a loss of as many as 30,000 jobs in energy-intensive industries (such as the aluminium industry). This of course stands in contrast to supplementary investments in the combined power and heating sector. Considerable innovation effects can be expected on the basis of the considerably broader spectrum of technological developments necessary. A greater degree of dependency on imported energy would not occur for the Federal Republic of Germany as a result of abandoning nuclear energy due to the fact

that the country has sizable energy resources of its own. As such, the process of phasing ourselves out of the nuclear energy sector can be carried out in an economically, ecologically, and socially acceptable manner.

Abandoning nuclear energy and the climate question

The threat posed by potential climatic change is becoming an increasingly important factor in the SPD's environmental and energy policies. Unbridled energy consumption on the part of the 20% of the human race that lives in the industrial countries accounts for up to 90% of global air pollution caused by major pollutants -- and even as much as 25% in the case of substances such as methane. Heat production is responsible for 45% of global carbon dioxide emissions, electricity production accounts for 35%, and motor vehicles generate approximately 20%. In 1988 the Federal Republic of Germany accounted for as much as 3.7% of global carbon dioxide emissions, equivalent to around 750 million tonnes. The Social Democratic Party has not revised its posture with regard to getting out of the nuclear energy sector in view of the public discussion being carried out with regard to climate factors. It did initiate a discussion, however, on whether or not it might be necessary to extend the period of time over which nuclear energy is phased out, so as to avoid an increase in carbon dioxide emissions. If the abandonment of nuclear energy is carried out over a period time shorter than ten years this will result in a conflict of ecological objectives.

Any of the approaches to satisfying the energy requirement of the Federal Republic of Germany over the medium term involve risks. However, we continue to see no sense in merely exchanging one unacceptable long-term risk for another in connection with energy production, in other

words the risks involved in producing electricity from fossil fuels for the risks involved in using nuclear energy. Nuclear energy is not the answer to our climate problem, since it would only be able to replace fossil fuels in the electricity-producing sector and, there, only in part. This emerges clearly from the energy scenarios discussed at the World Energy Conference held in Montreal in 1989. In the scenarios, the share of nuclear energy is increased over a period of 35 years by factors of 3.4, in one case, and 2.5 in the other. At the same time, the use of fossil fuels increases by factors of 1.65, in one case, and 1.4 in the other, using 1985 as a basis of comparison. Over the long term we want to see an energy-supply structure in the Federal Republic of Germany without nuclear energy, with a drastically reduced use of fossil fuels and an increased use of lower-risk and ecologically more compatible energy sources. According to a Harvard Business School energy report published in 1980, saving energy is probably the cheapest, safest and most productive energy alternative and, in addition, available in large amounts over the short term. It is also a highly valuable source of energy. It neither threatens to undermine the international monetary system nor is it associated with the release of carbon dioxide into the atmosphere. This will require considerable energy-saving efforts and efficient energy use. Since 1985 investments in this sector have been on the decline in the Federal Republic of Germany. In its election platform the SPD will advocate the following measures:

- the creation of a new energy-sector law and a new electricity price system in which incentives for energy and electricity savings will be integral factors

- an increase in energy taxes and levies in order to generate impetus for energy savings and efficient energy use in all areas of energy consumption, particularly in the transport sector

- the creation of financial incentives in order to improve the effectiveness of energy conversion and to promote combined power and heating schemes as the most efficient and most environment-friendly form of energy use

- the creation of a 20% investment subsidy for measures aimed at efficient energy use as well as the creation of forms of market-introduction assistance for regenerative energy sources.

The objective is to reduce the per capita level of absolute energy consumption.

The SPD also urges the formulation of a strategy aimed at developing and introducing a solar-hydrogen sector in a cooperative European context. The objective would be to produce hydrogen initially on the basis of water power and, in a longer-term perspective, on the basis of solar energy. Hydrogen could initially serve as a replacement for fossil fuels on the world heat and transport markets. Europe has its EURATOM. What it needs now is a EUROSOLAR. It is still not clear how soon direct electricity production from solar energy will become commercially feasible on a photovoltaic basis. There is still no clarity at all as to whether nuclear fusion will ever be technically feasible, whether it will offer safety advantages over light-water reactors and whether it will ever be commercially feasible.

A drastic reduction of carbon dioxide emissions is being called for worldwide. We need to ask ourselves soberly where carbon dioxide emissions can be reduced most rapidly, most effectively and at the lowest cost. The Social Democratic Party in the Federal Republic of Germany takes the view that investments aimed at energy savings should have priority in the heating market (where at least 30% savings in coal and gas consumption can be achieved at acceptable costs) and in the transport sector. It will be possible to bring about major savings in these areas over a relatively short period of time.

Thank you.

NUCLEAR ENERGY FUTURE IN AN INTERDEPENDENT WORLD -- A FRENCH VIEW.

G. Errera
Director for International Affairs
Atomic Energy Commission (CEA)
France

Mr. Chairman:

May we applaud your selection of the theme for our XXIIIrd Conference: Nuclear Energy and Society. I am not speaking out of courtesy, but to express my deep conviction that, at this juncture, the wisest course the nuclear community could take is to embark on a debate on this theme.

Nuclear energy is indeed at a crossroads, and, as we are all aware, tomorrow's nuclear world will be somewhat different from yesterday's. The reasons for this relate in part to the technologies involved, but perhaps even more to current societal trends, among which the strongest may well be the citizens' desire to comprehend, and even to control, the State's technical decisions. The relationship between the major technical options and psycho-sociological factors is likely to become closer, more complex and, for any government, increasingly difficult to manage.

These are facts all of us now have to reckon with, even in those countries where differences of opinion on the subject of nuclear energy have seemed traditionally absent. This trend is, in effect, to be welcomed, since the nuclear community now has more opportunities to state the case for this form of energy, and is not short on arguments in its favour.

Our topic is thus of immediate interest, particularly at a time of rather contrasted situations; of slow-going nuclear programs in a context of growing energy requirements; of lingering reservations, but also of new awareness in public opinion; of a general outlook still lacking stimulus, but offering new prospects.

These contrasts provide us with opportunities for action. Nothing is yet settled, one way or the other. The future is, largely, ours to make. And we should bear in mind that the heavy investment and extensive lead times characteristic of the nuclear industry require that we adopt a long-term outlook in our projections and anticipations.

We are all aware of the growing feeling that a new start of nuclear power is possible, even likely, in the present decade, and that it will most probably occur in the industrialized countries. At this time, it is only an act of faith. We should however prepare ourselves for this event by developing products to meet the anticipated requirements, and at the same time by attempting to solve the problem of nuclear energy acceptance by public opinion. The future is indeed largely dependent on our answers to citizens' concerns, worldwide.

We know what these concerns are: first of all, safety-related matters. More than ever, safety is an essential requirement in keeping or restoring public confidence in nuclear power. France has always felt that its commitment to nuclear power was inconceivable without extremely high safety standards. An exacting, uncompromising safety policy is not only an obligation to the country's citizens, but also a duty to the international community.

This is why we favor and actively participate in all the efforts of international cooperation related to safety, either on a bilateral or a multilateral basis, such as those of IAEA, which carries out an efficient work in this field.

Operating plants must be subject to the same level of safety requirements, irrespective of the country or type of system involved, since populations cannot accept feeling threatened, either by plants operating in their own country or by others across the border. And, as regards future reactors, everyone knows that new safety concepts are central to some projects, and that significant research efforts are made in this area.

Another matter of prime importance to public opinion is that of radwaste storage, a problem addressed in similar ways by the major nations. Nuclear opponents frequently base their hostile attitude on the alleged inability of the industry to solve the problem of final storage. It is not enough for the international research effort to have made large advances in this area; these achievements must be publicized, and public acceptance obtained. This is indeed a key area in the development of nuclear energy.

The role of nuclear energy in tomorrow's world will also depend on the conclusions drawn by the governments as regards environmental problems (and specifically of the greenhouse effect) in

the formulation of their energy policies. The growing concern for the environment at worldwide level helps create a new relationship between nuclear power and the environment. We see that the contribution of nuclear power to the reduction of CO2 releases is a subject of growing interest for international meetings, as evidenced by the Paris Summit of last July. The role of nuclear energy in that area should certainly not be over-estimated; but, since many steps are required to curb the greenhouse phenomenon, the part of nuclear energy should also be acknowledged. However, it is clear that the environmental status of nuclear energy will gain full acceptance only if the problems of the fuel cycle back end are given solutions which are satisfactory, and recognized as such.

Another legitimate concern of public opinion is the proliferation of nuclear weapons. Indeed, the development of nuclear energy for peaceful purposes cannot be dissociated from appropriate steps against weapon dissemination. This was already true in the early days of the nuclear industry, and even more so today, at a time when the present disarmament effort is justifiably associated with increased vigilance as regards nuclear proliferation. In this respect, France and more generally the EEC nations, attach great importance to an effective, international non-proliferation system, the keystone of which is the IAEA Safeguards System.

Last, I should point out that the place of nuclear energy in tomorrow's world will of course depend on its competitivity as compared with fossil energy sources. To meet the growth in demand, turning to other forms of energy offers limited possibilities. In the years 2000-2005, the basic choice will be between coal and nuclear energy.

Energy conservation -- essential as it may be, especially in those countries where consumption is highest -- is soon confronted with a law of diminishing returns; its impact on electricity consumption may be slight. Although renewable energy sources may provide useful solutions in certain areas, they are not yet commensurate with demand in large industrial countries. According to the World Energy Conference, their contribution should remain at an approximate level of 5% in the next two or three decades.

As to the fossil fuels, which will continue to cover a large part of energy requirements, their disadvantages are well-known: their price fluctuations are directly reflected in the KWh price. Besides, much of the oil production is concentrated in a politically unstable area. Coal, gas and oil are affected, to a considerable extent, by transport costs. Last, the environmental impact is important, and, although it can be mitigated in plants equipped with desulfurization systems, this involves a significant increase in building cost.

On the other hand, a satisfactory cost analysis of nuclear energy should cover depreciation and end-of-life cost, including radwaste storage and plant dismantling.

Mr. Chairman:

Individual nations strive to address adequately these essential issues, in the context of their needs, capabilities and constraints. But the overwhelming truth which confronts us is the international character of anything related to nuclear energy. This statement may sound banal: after all nuclear energy has been international from the very beginning, and, it is the only form of energy which has given rise to an organization, the IAEA, to which the member States willingly delegated part of their prerogatives -- within the Agency's safeguards system -- to permit the development of applications of that energy.

What is new is the effect that an event occurring in one part of the world, however remote, can have on all the other parts. Since Chernobyl, this has been a major fact and an irreversible trend. It may also have a positive side; we now realize that better international cooperation is required to deal with the broad issues of nuclear energy future. I believe it can be said that not just our problems, but also our search for solutions, have now crossed national borders. This is especially true with respect to safety and waste management but also regarding major issues such as nuclear non-proliferation.

In this context, may I dwell briefly on our view of the development of the French nuclear program, since for us the preparation of the future has an essential international dimension.

As regards the reactors, the problem is to operate, as safely and effectively as possible, the 50 nuclear units which supply 75% of the country's electricity.

The future is also the R & D work necessary to create the next generation of reactors which will replace the present one in the years 2010-2015. This is a technical and economic challenge for the research organizations, for the industry and for the utility. As one of the foremost countries in nuclear power generation, France wishes to make a significant

contribution to the innovative effort in this field, especially as regards conceptual moves towards improved safety, better environmental protection and enhanced competitivity.

When considering plant replacement, attention must be given to the disposal of de-commissioned reactors. Therefore, we are now determined to improve our dismantling experience, and to develop innovative techniques.

In the fuel cycle area, we are actively pursuing the development of uranium enrichment using laser techniques, the development of MOX fuel, and of course our re-processing effort. The UP3 plant at La Hague, part of which was very successfully started-up, will be totally commissioned this year. This is a very important phase of our program. Meanwhile, new technologies are being explored, leading to more advanced reprocessing.

We also give our utmost attention to the problem of radwaste storage. The second site for low-activity waste storage is now under construction. The importance attached to the public acceptance of our nuclear program has prompted the government to call a one year moratorium on high level waste deep storage site studies, for the purpose of giving technical options further consideration, and holding fruitful discussions with the public.

The way of the future is, above all, the granting of absolute priority to safety issues, as well as reliable, fast, exhaustive and understandable information.

The French nuclear program is also resolutely open to international cooperation. We highly value the development of our cooperative efforts, especially with Japan, which is one of our major industrial partners. I am happy to announce that the new French-Japanese nuclear cooperation agreement was signed yesterday in Paris, at 4 p.m.(Paris time) by the ambassador of Japan and the French Vice-Minister of Foreign Affairs. This achievement will allow our cooperation with Japan, already significant, to expand even more. It is however natural for France to privilege international cooperation under the colours of Europe.

Cooperation with the Federal Republic of Germany has entered a new phase with the recent agreements between French and German companies in the reactor and fuel cycle areas. The significance of the FRAMATOME-KWU agreement is not limited to the creation of a joint company (NPI) for exporting plants using current technology. The purpose of the partnership is also the capability to develop jointly a common type of reactor for export. This naturally implies safety

options which are, if not strictly identical, at least compatible enough to be acceptable to the licensing authorities of both countries. The extension of French-German cooperation to the area of reprocessing services is also a highly significant development.

In the European context also, we are proceeding -- in association with the U.K. and the F.R.G. -- with fast breeder reactor development. The implementation of R & D, patents and engineering agreements signed last year confirms the commitment of all three countries to the development of that system. This event gives full significance to the work jointly undertaken by the European utilities within the EFR (European Fast Reactor) project, to design a new type of reactor. These studies should materialize in an actual design in the first half of the present decade.

Cooperation in Europe is, of course, the strengthening of ties within the European Economic Community, with the advent of the Single Market in 1992, and the free circulation of energy, especially electrical, throughout the Community.

But European cooperation has now gone beyond the borders of the Community. The establishment of closer relations with the nations of central and eastern Europe was one of last year's most important events. New exchanges are taking place, and new actions have been decided; such is the case, in particular, with Czechoslovakia, Hungary and the German Democratic Republic.

All these are hopeful signs. The basis of a new cooperation with the Soviet Union has also been established, in the scientific, technical and industrial areas.

We come now -- last but not least -- to the developing countries. One of the great challenges of the future will undoubtedly be the broadening of the energy spectrum available to those nations, by ensuring their access to nuclear energy under conditions acceptable to all concerned. We know that this is subject to two prerequisites: the meeting of safety requirements, and the avoidance of proliferation risks. One must admit that neither is readily achievable. But we cannot continue to affirm the right of developing nations to the benefits of nuclear energy while, in practice, denying them access to that energy. This is why we are pursuing the

implementation of a nuclear foreign policy based on the need to harmonize two general principles: help nations to meet their nuclear power needs, while preventing weapon proliferation risks. Anyway, it will be difficult for industrialized countries to continue to shun the environmentally negative effects of a massive use of fussile fuels while denying third world nations access to nuclear energy.

Mr. Chairman:

For many years, international meetings have provided opportunities to dwell on the interdependence of the major decision-makers in the nuclear field. With the close ties between our research activities and our industrial companies, and at a time when public opinion trends are moving in the same direction irrespective of hemisphere or continent, interdependence is becoming even more obvious and significant. Nuclear energy is no longer a matter for experts only, but a social issue. What matters is to look for understandable, convincing answers, which are in tune with the concerns expressed by society.

Among these concerns, let me single out those which I consider the most crucial:

- The fear resulting from the association or confusion between nuclear weapons and nuclear electricity generation;

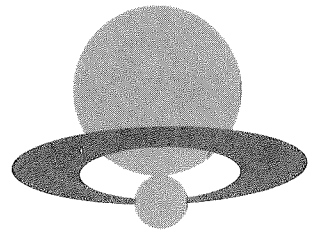
- The fear deriving from the health effects of radioactivity both for the present and for the long term;

- The perception of nuclear energy as being part of a centralized, secretive, insensitive power structure, especially at a time when, all over the world people strive for individual freedom and demand control at the local level. Therefore, the more nuclear energy will appear user-friendly, in terms, of economic benefits, energy supply, access to information and sharing in the decision making process, the more it will be accepted.

- Finally let us not pit the scientific rigor of the experts against the non-rational attitudes of public opinion. Such a disregard of legitimate public concerns would be both contrary to basic democratic principles and counterproductive.

Let us not forget that satisfying society's energy needs must and can be achieved while responding to these simpler but basic needs of the people.

セッション3
なぜこうなった－原子力への国民の意識



＜問題提起＞
エネルギー・原子力についての国民の意識
読売新聞社論説委員
中　村　政　雄

＜パネル討論＞
弁護士
石　橋　忠　雄

ジャーナリスト
大　宅　映　子

京都大学教養部教授
木　下　冨　雄

作　家
野　坂　昭　如

読売新聞社論説委員
中　村　政　雄

「エネルギー・原子力についての国民の意識」

読売新聞社論説委員

中　村　政　雄

日本原子力産業会議が昨秋実施した原子力に関する意識分析調査を土台に、原子力に対する国民の意識がなぜこうなったかを考えてみたい。

この調査で「積極的に原子力発電を増やす」は 0.8%、「徐々に増やす」が28.9%、合わせて29.7%が推進だった。「現状程度」の中間派が45.7%、「減らす」11.7%、「止める」 7.2%、合わせて18.9%が反対だった。

1987年８月から88年10月までの１年間に、総理府、朝日新聞社、読売新聞社、ＮＨＫの４者が原子力に関する世論調査を実施した。今回の調査をその４つの調査に比べると「廃止しろ」という意見は確かに減ったが、「積極的に増やせ」という意見も減っている。現状は認めるが、積極的に支持しかねるという人が多数派のようだ。建設推進に支持率が高くないのは、石油の供給量が豊富で、エネルギーの需給に緊張感がないからだろう。

日本にはエネルギー問題を楽観視する人が多いことを今回の調査は示していた。「国際情勢の変化により第三の石油ショックが起きる」と考える人は２人に１人しかいない。1988年９月に読売新聞社が日米同時に実施した世論調査にも同じ傾向が出ていた。「今後５年くらいの間にエネルギー問題が深刻化するという不安を感じますか、感じませんか」との問いに対し、多少とも感じていた人は51.3%、米国は71.4%だった。エネルギー自給率が、原子力を国産エネルギーに含めても20%（含めなければ10%）しかない日本が、自給率88%の米国より楽観的だったのである。

原子力発電に反対する、あるいは否定的な考えを持つ人に共通する意識のうち最大のものは「そもそも原子力発電は必要なのか」という不要論である。意識調査によれば、反対理由のなかで不要論が「放射線に対する不安」、「推進派に対する不信」に比べ圧倒的に

多い。

不必要の理由の一つは、原子力発電がなくてもエネルギー需要に支障を生じないという楽観論、もう一つの理由は、原子力を使ってまで豊かな生活をする必要はないという文明論である。

推進派は、現在の豊かさや経済成長を積極的に肯定し、持続させるために原子力が必要だと考えるが、反対派は日本社会の多消費型の豊かさの質を見直そうという立場に立っている。快適さを求め過ぎるために危険性のある原子力が必要となり、次世代につけを回すことになると反対派は考える。原子力発電に反対する人ほど、生活レベルを下げてもエネルギーを節約する必要があると思っている。つまり、原子力は人々の生活哲学を問う存在になってきた。

だが、意識調査で、質問されるとそのように答える人も、実際に、その意識通りに行動しているかどうかは疑問だと思う。

この調査でも、77%の人が「日本はエネルギーを使いすぎる」と考えながらも、「生活の豊かさを落としてまで節約する必要があるかどうか」に「どちらともいえない」人が54%もあり、過半数の人は生活哲学があいまいな状態にある。

原子力の可否について公平な判断をするには幅広い情報が必要である。今回の調査は、情報提供に工夫の余地があり、原子力支持率を高め得る可能性のあることを示している。

情報量が多いほど原子力の支持率が高まりやすいと考えられる。たとえば「これから10年間で主流となると思うエネルギー」を質問した意識分析でも読み取れる。「これからは原子力」と答えた人は、「これからは石油」、「これからは太陽熱、太陽光」と答えた人より、エネルギー消費と温暖化について密接な関係があると思う人の割合が6～7%高い。第三次石油ショックが起きると思う人の割合も、石油や太陽支持者より原子力支持者のほうが7～8%多い。

情報提供方法にも問題がある。推進側の情報は反対派に比べ説得力が弱い。原発推進の説明を「まあ納得できる」人は17.9%、原発反対の説明に納得する人は37.5%。説明を聞

いて納得しない人も反対派の説明に10.9%、推進派の説明に27.5%。推進側の説明は明らかに説得力を欠いている。

推進側の説明が納得できない理由に、約6割の人が「都合の悪いことは公表しない」、「実際に米ソで大事故が起きている」、「事故が起きても“安全”としか言わない」、「国民の不安や疑問に十分に答えていない」ことを挙げている。

原子力発電の必要性に比べると、安全性に対する信頼は低い。「非常に安全だと思う」人は1.4%、「まあ安全だと思う」39.8%を合わせて、安全だと思う人は41.2%。「あまり安全ではない」43.3%と「全く安全ではない」10.0%を合わせた53.3%が安全ではないと思っている。原子力発電所の存在をまあ肯定する人も安全性については幾分疑念を抱いていることを示している。

原子力発電について安全でないと思う人ほど安全性に関心が高い。「原子力発電を専門家だけに任せておくのは不安である」と思う人が45%いる。安全対策は専門家から見た判断だけでは不十分で知恵をしぼる必要がある。私は、素人の質問、疑問に専門家がうまく答えることができるかどうか、その広報技術にも左右されると思う。

原子力発電については厳しい見方をする人が多い。原子炉は停止もしないし放射能もれもない程度の「もしもの事故」に対しても「非常に問題だ」、「やや問題だ」と思う人が53.9%もいる。放射線については「自然界のもの」でも29.3%が「心配である」し、胸や歯、胃のレントゲンについても約20%の人が「心配だ」と答えている。過敏なのは原子力発電に限ったことではないようだ。

原子力発電について不安や疑問を感じたことのない人は18.1%、残る81.9%は不安や疑問を感じたことがある。情報に対する需要は十分ある。放置すると、勉強した人ほど原子力発電否定に回る。Ｙｅｓの人までＮｏに変りかねない。

マスコミが公平な報道をするかどうかは大事な要素だが、この調査報告によれば、マスコミ報道の評判は悪い。「マスコミは故障も事故という」、「興味本位に情報を流すので不安感をあおる」などである。

原子力が特別に嫌われる理由は、放射能の得体の知れないこわさにある。必要性を認める人にも、ぬぐい切れない不安がある。この不安を解消するだけの情報がない。原子力の危険性は自動車や飛行機の危険性と違い、自己防衛できない。しかもチェルノブイリ事故が潜在的不安を一気に身近な存在に引き上げた。

マスコミに「１００％大丈夫」と言い切れる自信がないため、「心配ですね」、「事故はこわいですね」といった自分に安全弁を残した言い方をしがちだ。「本当に大丈夫か」と突っ込まれた時に十分返答できる自信がないため反対派に寄った言い方になる。

一般の人々も、「大丈夫だ」というより「危険だ」というマスコミの方を信用することが今回の調査で分かった。新聞については、推進より反対の人ほど新聞報道が信用できると答える比率が高い。「反対」の方が信用されるのは、自分の心の中にある不安感とマッチするからだろう。それがまた新聞を反対側に寄せる。戦時中、新聞が軍部にすり寄って行ったのと同じ構造だ。

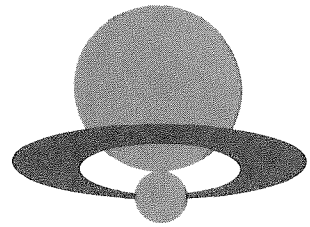
マスコミがそうなるのは、ある程度世論に動されるからでもあるが、専門家が「大丈夫だ」とわかり易い表現で断定してくれないからでもある。反対側の専門家は大胆に発言するが、推進側の専門家は自分を傷つけないよう慎重に発言する。それが「まだ安全性は不十分なのだな」と映る。

大学の理工系に進んだ人でないかぎり、放射能や原子力について教わらない学校教育、国のエネルギー政策よりも目先の自分の選挙を重視しがちな政治家の姿勢などにも問題がある。スウェーデン、オーストリア、イタリア、日本などに見られる原子力と政治家の関係は世界的な重要課題だ。

政治家はもっとエネルギー問題に関心を持ってほしい。社会経済国民会議が今年１月下旬、全国の主な総選挙立候補予定者に実施したアンケート調査によれば、優先政策に「資源・エネルギーの確保」を取り上げたと回答したのは全体の14%。「10年以内にエネルギー供給危機が起こる」と回答した人は全体の19.6%だった。日本原子力産業会議の調査では国民の約50%が危機感を持っていたのに比べ楽天的だ。

省エネと原子力、石炭で過去のオイルショックは切り抜けられた。環境問題に南北問題が重なった現代、次のオイルショックが省エネと太陽などの新エネルギーだけで切り抜けられるだろうか。切り札は原子力発電だが、その推進には強力な政治力が欠かせないと思う。

セッション4
原子力のない経済社会は・・・



温室の中の生活－チェルノブイリ後の原子力発電
R．ウィルソン
ハーバード大学教授

エネルギー開発と環境影響－フランスの事例
H．ブシャドー
フランス社会党国民議会議員

原子力をやめた場合の経済、社会的コストを考える
名古屋経済大学経済学部教授
武　井　満　男

Living in a Greenhouse: Nuclear Power after Chernobyl

Talk at meeting of JAIF.
April 12th 1990
Kyoto, Japan.

Richard Wilson, Department of Physics
Harvard University

In 1970 electricity generated by nuclear energy in the USA was cheaper than that from coal, competitive with that from oil. By 1990, nuclear energy has priced itself out of the market. ↑ There is no consensus cost
all of the reasons for this increase but the following certainly contribute:

① Delays caused by public opposition
② Increased regulatory requirements imposed in response to public demand.

Public opinion is therefore one key to reducing cost
The USA is still an important country, & other countries of the world catch our diseases. unless they are careful. Moreover we all can use each others' help in finding the cures to the diseases.

For any resurgence of the nuclear option the cost must be reduced again.)

Our early leaders, such as Benjamin Franklin, knew the importance of energy. (slide)

"In travelling I have observed that in those parts where the inhabitants can have neither wood nor coal nor turf but at excessive prices, the working people live in miserable hovels and have nothing comfortable about them, but where fuel is cheap, or where they have the art of using it to advantage, they are well furnished with necessaries and have decent habitations.

(next)

In the slide I showed man has developed the use of energy. Firstly 100. he only used the energy from the food he consumed. about 100 watts Then he domesticated animals & could use 1000 watts per animal. 2000 years ago he developed windmills & waterwheels. 250 years ago Then, the industrial revolution began with the steam engine followed soon by the internal combustion engine. Now we have the revolution of nuclear energy.

In the next slide I show how the large (1980) consumption in the USA and canada (11.4kw) is accompanied by a "small" population of 237 million. Even if we reduce this, the big environmental pressure will be the increasing consumption of the billions in the rest of the world, and the increasing billions as their population increases.

There is another pressure. In the next slide I show the fraction of oil used in the USA that is imported. You will remember the world upheaval that occurred as the fraction came to 50% in 1973. It is now 55% and rising fast.

The next slide shows our best estimate of oil reserves. I note that the US looks small & Japan isn't on the list! Our near term future is in the hands of the oil ministers of Kuwait & Saudi Arabia, Ali Khalifah Al-Sabah and Hisham Nazer.

I also note that whereas total energy consumption has been constant in the last 15 years, electricity use has risen 50% and is increasing fast.

(4)

An anti-nuclear power movement began about Earth Day 20 years ago. But it received strong impetus after the accident at Three Mile Island in 478 and even more after Chernobyl. Each left the (false) impression that nuclear energy is uniquely dangerous & out of control. and could cause world-wide problems.

Now another fear has reached the public - of ~~world~~ global climate change caused by burning of carbon in fossil fuels. Although the first calculation was done by Arrhenius in 1896 that a doubling of CO_2 would lead to a 3°C temperature increase, nearly as recently as 1988 has this information reached the public, newspapers & congress.

They now realize that there are no easy solutions, & the time is ripe for reconsidering the practical solution of nuclear power.

People have been slow to understand nuclear energy. Nuclear fission is not like burning carbon atoms.

People have been ready to accept, but slow to understand, the role of energy in society, & the role that it has played.

This is shown in the transparency
In this simple statement are contained all of the advantages and all of the disadvantages of nuclear energy.

The amount of energy that can be derived from one kilogram of uranium 235 is 3 million times that from burning one gram of carbon. It takes time to understand the implications of this.

As you in Japan know better than I, it is possible, & relatively easy, to make a bomb 3 million times as powerful as with TNT

On the positive side, this factor of 3 million, brings enormous environmental advantages.

There is less mining needed (100 times less when account is taken of isotope ratios and ore concentrations) and therefore fewer casualties in the mines

Because the quantities are relatively small, it is possible, and usual, to chemically purify the nuclear fuel before burning, & to purify the material after burning so that the quantity of toxic waste products is thousands of times less. It is therefore possible to keep them out of the environment for ever — a plan proposed for no other waste product in society.

(unique to nuclear energy)

According to this plan, there are few environmental effects of nuclear energy, & there should be no effect on public health. But what of the inevitable mistakes?

The actually identified effects of nuclear power on public health (outside the USSR) have been zero. No one has died, no one is known to have gotten cancer, we must emphasize this.

Because the effects are small, we must estimate of the effect on public health must be based on extrapolation to low doses. When this is done in a comparable manner for other technologies one gets a poor perspective.

One must also include all aspects of the electricity generating cycle. On the next slide I show a selection of the items which be included.

The best and most complete study was done some 12 years ago by Dr Leonard Hamilton and collaborators at Brookhaven National laboratory. They considered a 1000 MWe power plant operating 65% of the available time for a year. They used historical data whenever possible.

On the next 2 slides I show their calculation of the effect on public and occupational health for a coal plant slightly modified for more recent information. The only important effects on the public are from living near uranium mines, & the calculated average effects of severe accidents. The effect of nuclear waste is particularly small. The total is 0.7 deaths/year, mostly occupational

In contrast the effect of burning coal, with the best technology available in 1975. The numbers are far larger; accidents in transport play a large role; & note that nearly 40% of all rail transport in the USA & USSR is moving coal; the next slides show it moving by train (USA) by ship (China) & even on the human back (China)

8

When these results were presented there were two items that caused controversy. Firstly, some public health scientists were unwilling to admit that increases in air pollution variables (total suspended particulates & sulphate particulates) led to increases in death rate, based on statistically significant correlations at higher levels.

[illegible] I state the reason for my personal bias: I was born in London, near a large polluting coal fired power plant.

Also the number of average public fatalities from nuclear accidents was not believed. The range here includes as an upper limit, the number from the estimates of the Union of Concerned Scientists which was then antinuclear.

This number must now be reduced; the number calculated by Rasmussen 15 years ago are now known to be pessimistic; as shown, for example in NUREG 1150.

There are occupational casualties. These are mostly not radiation related and can occur in any facility. (F

At a meeting in Paris in 1981, British, French & Italian numbers were also present

In the next two slides I show the risk, not now in deaths but in working days lost for the US & the French studies. There is remarkable agreement that in order, coal is worst, oil is next, & nuclear & natural gas about equal.

They believe radiation is worse than the experts say; and so nuclear accidents more probable.

These numbers when understood, are convincing.

Most people do not understand numbers, probabilities and risks generally. Wherever there is misunderstanding there are politicians willing to exploit it for their own ends. We must respond with the facts: carefully explained. In these days of Glasnost, this happens in the USSR too. Last week a Soviet politician [illegible] Chernobyl described the effects of chernobyl — with reports of health effects not yet described, and so far denied by soviet

I will take 3 examples. In the decade 1950-1960 there were many atomic bomb tests in Nevada, USA. Originally popular, such activities are now regarded with disfavour and all the ills of society are blamed upon those who were responsible. In 1979 Lyon et al examined mortality from leukemia downwind in Utah. He claimed that in those counties where the fallout was high, leukemias went up when testing was in progress; & went down afterwards. When he showed his data his graph (which I reproduce here, modified) did not show the errors; I have added the error bars.

The statistical claimed effect was just significant.

But more important, he based his selection of counties on the wind for one shot bom

explosion (smoky). In the next slide I show the fallout actually measured. The "low fallout counties" of Lyon actually had more fallout.

For 20 years Dr Mancuso had an AEC contract to study the health of workers at Hanford, Washington. After his contract was cancelled, he joined by Stewart & Kneale wrote a series of papers claiming an effect. Excellent epidemiologists, Ethyl Gilbert of Battelle NW Labs responded with superior analyses, but they did not directly respond.

I show in the next figure the results of Mancuso et al with error bars added.

It is no longer so clear that there is a large increase at low radiation doses. Finally I note that each of the workers was not only exposed to natural background radiation, but also to medical X rays because of his job. I shift the origin on the X axis to allow for this. I also add a point at high dose corresponding to the cancers "expected" according to the usual model. It is now much less obvious that the data fit.

Near Plymouth, Massachusetts there is a nuclear power plant. It was claimed that there was an increase in infant mortality between the years 1982-1983, when there was a small increase of radioactive material. This is shown in the next transparency. However when the error bars are added the data are less convincing. They become less convincing still when other years are added (with similar errors) which show that changes of this amount have occurred regularly.

Also at Plymouth, an increase of Chronic Lymphocytic Leukemia was noticed in town just north of Plymouth. It was claimed that this was due to winds blowing radioactivity along the shore line from Plymouth.

However there was no increase in the 5 counties nearest to the plant (next slide) and moreover, the historical record shows that the wind did not blow along the shore line.

The average death rate due to accidents is small. But in the USSR it was larger, & the Chernobyl accident occurred. (slide). But even this accident can be cleaned up, & a year later I took this photo 300m from the reactor. At this time the radioactivity had been reduced 10,000 times. One can recover from accidents.

not unique to nuclear energy

We must never forget that accidents are common in other technologies. In the next series of figures I show a selection of such accidents - a dam in California just before (slide) it failed 50 years ago killing several hundred people (slide) air pollution 30 years ago in New York City; (slide) an oil tanker fire (slides) where toxic smoke fortunately went out to sea. (in the UK) New York City; an oil tanker accident & its consequences; (slide). & the destruction of a home as the land below subsided (slide). Compared with these, nuclear fission is benign.

There are two emotional issues that are hard to address. Nuclear waste, & nuclear war. Because nuclear energy is so concentrated, & we can afford to keep the vast majority of the waste out of the environment for ~~for~~ indefinitely. This can be done for no other waste produced by Society. For example the next slide shows a coal tip in S Wales, where the mine waste (~~radioactivity~~ with its natural radioactivity) is piled. It is not secure mechanically. At the bottom right, the waste slid into a school & killed 137 children. This is Aberfan, S Wales. The important point to stress is that, compared to coal burning, there is over 10,000 times less waste. With coal, we inevitably let out 1% of the fly ash

Many ordinary people to whom I have talked had the incorrect impression that there is as much high level nuclear waste as there is coal ash - fly ash & residues combined; yet high level nuclear waste is more toxic. The failure to understand the magnitude that the quantity is much less leads to a complete failure to understand the problem is manageable. In fact, it is the only waste product of society for which we have a long term technological solution.

In the USA there is often a cry of Not In My Back Yard (NIMBY). But a detailed look shows that often people want nuclear waste — & the taxes it pays. It is the population of the next town that objects. Examples are the objection of the state of Kansas in 93 to a waste site in Lyons, Kansas desired by the local town. The people of the town of Martindale, Tx, want a low-level waste facility (and may get it) but the next town objects.

The detailed calculations, such as those of Hamilton, I described earlier showed that the effects of waste leakage on health are minuscule. Expert committees, and committees of distinguished scientists viewing the problem from outside such as a committee of the American Physical Society of 12 years ago, all conclude that "there is no scientific obstacle to a sensible disposal of nuclear waste."

Why is not this explained to every physicist? Why were two professors of Physics at Waikato, excellent in their field, (to whom I talked on Friday) unaware of these simple, elementary calculations of such public importance? It is my profession — education of scientists & public leaders — which has so far failed the technology & the public. To change that we need your help.

Everyone in the world abhors war; & most people became aware of nuclear fission on August 6th 45, when the bomb was dropped on Hiroshima. Since then, bombs & power plants have tended to be connected. I can give a hundred examples of prominent antinuclear power scientists who started by crusading for peace. Many of them feel, that making nuclear power plants makes it easier, & inevitably encourages, a country to make nuclear bombs. I disagree; in fact the peace & prosperity of the world may depend upon our ability to make the distinction. In this you in Japan, with your unique tragic experience of 1945, can take the lead.

But we must beware of allowing scientific nonsense to spread and propagate merely because it reinforces our peace loving ideas. Too many scientists allow this. We must repudiate nonsense wherever it exists. The atomic bomb tests in Nevada may have been undesirable — but that does not justify the claims of Lysenko et al described earlier. A leading English left-wing scientist, Joseph Rotblat of London, emphasized this 20 years ago. The late Andrei Dmitrevich Sakharov, at a Forum for a nuclear free world in Moscow, reproved some German "green" delegates & asked upon them to spend their energies making nuclear

— because the world needs energy, and energy in particular.

My plea for a clear understanding of "impunbrides applies to "alternative technologies".

In the next slide I show a "windmill farm" at Techechapi pass, California. Some people regard it as more beautiful; and a nuclear power plant as ugly!

I am asks you to note the number of windmills & the small size of the transformer. This, & other farms has had large subsides & tax rebates, both federal & state, so no one knows whether it is truly economic or not.

On the next slide you will see the name of the well known company MITSUBISHI, that is capturing the US market.

Public education is crucial. education of the non-specialist scientist is a vital first step. Scientists must actively repudiate nonsense, not only in their own field, but in related fields. They must learn to explain the facts to the non-specialist, & willing to listen to the societal values of the have & bring them into their thinking.

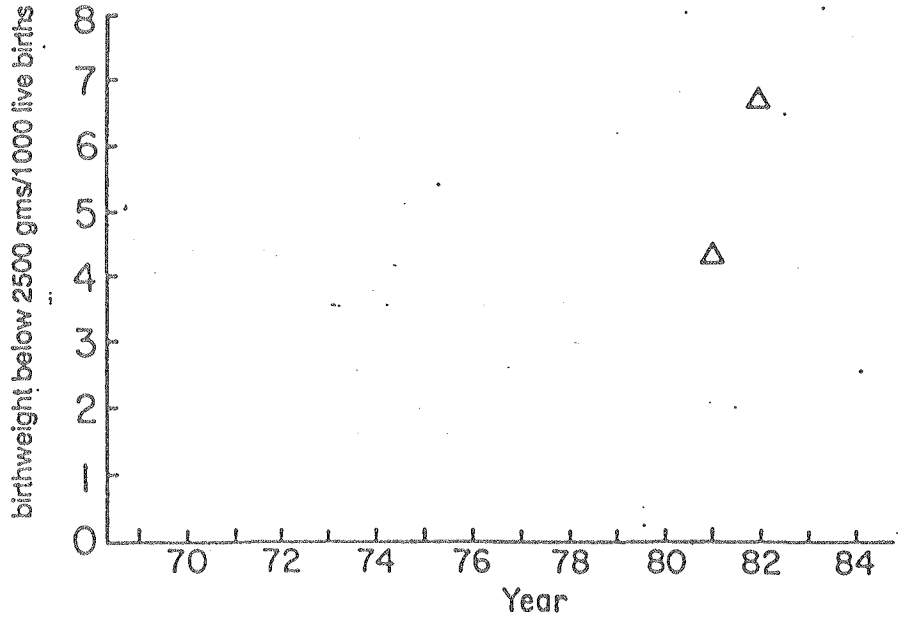
In the USA, some of the pioneers of nuclear energy, Bethe, Teller, Wigner are tainted by work on the bomb & their views are discounted. I earnestly call on the younger generation of "pure" scientists to include these practical matters in their broad vision & to explain them to their students. In this, they will need the help of you, technologists.

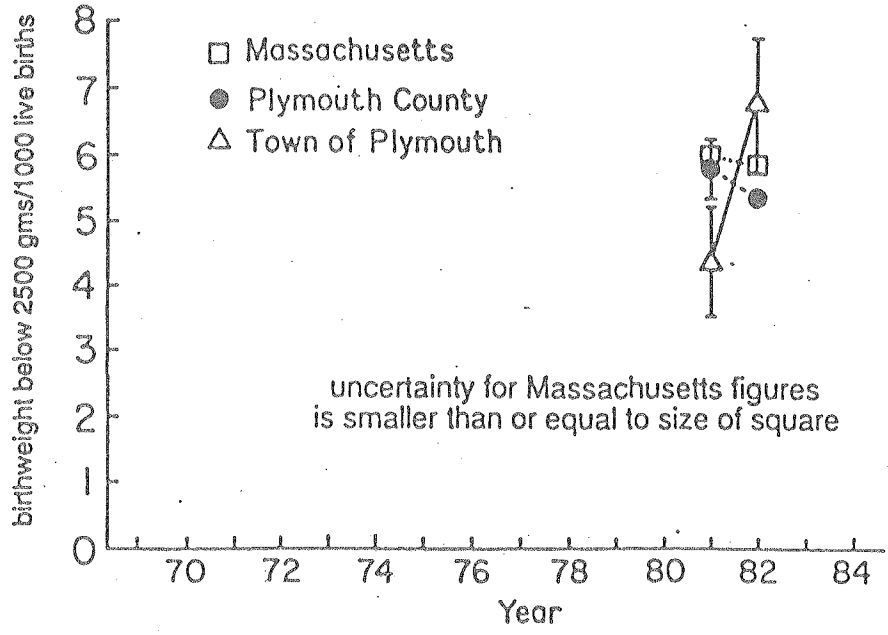
Finally I thank you for the honor of being invited to address you.

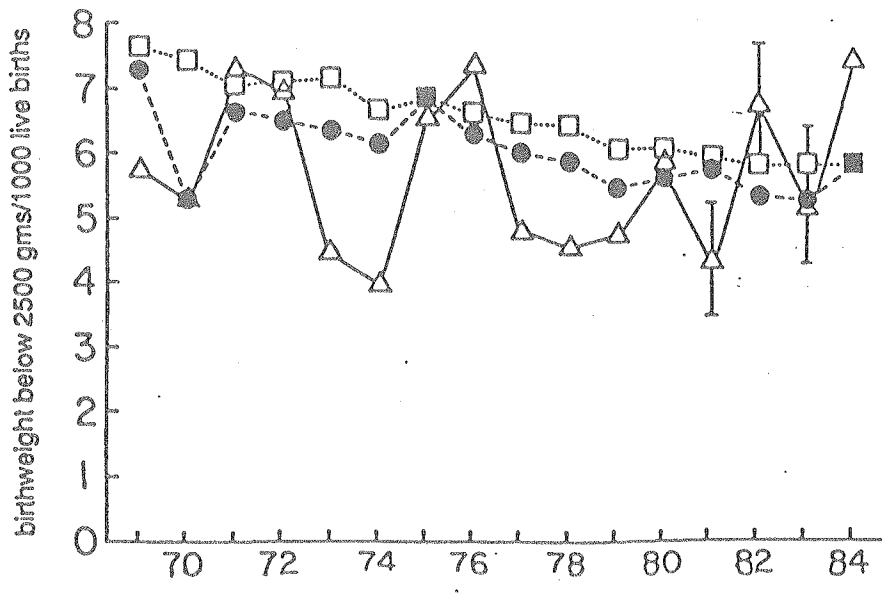
FUEL	ENERGY PER UNIT WEIGHT
COAL	1
OIL	1 ½
GAS	2
URANIUM 235	3,000,000

Percent of Low Birthweight in Plymouth, Plymouth County, and Massachusetts 1969 - 1984

4/11
9:00~







Energy Development and Enviromental Effect
-- A Case of France

H.Bouchardeau
France

Mr. Chairman,
Ladies and Gentlemen,

I must indicate to you, from the start, the limits to my statement. I am neither a scientist nor am I responsible for French energy policy I was Minister of the Environment for three years in France between 1983 and 1986. Last year, in 1989, I was made responsible for animating a debate in the French National Assembly on energy policy. It is in this capacity that I have been invited to take part in your conference. I shall therefore be stating here the essential elements of the report that I submitted to Parliament, on the 12 of December 1989 - in the name of a mission of 12 members from all political horizons.

It is not without interest to stress that, for the first time, the french government has decided to introduce reflection and public debate on energy by a person known for her commitments to the environment, and for her opposition to certain prior choices as to the "all nuclear" policy.

The report that I am submitting to you will stress the following points:

I. The Link between energy and environmental issues. Research into energy saving and diversifying the energy sources.

II. Reflections on the evolution of nuclear energy in France.
- on the breeder reactor
- on the closing of the fuel cycle
- on the transparency in connection with decision and control in the nuclear industry

I. The international dimension of energy problems has grown greater in the past few years. Thus the accident at Chernobyl has made us

aware of the impossibility of considering nuclear energy as a problem only depending on each country concerned. In fact, the problems of safety and the consequences of a possible accident disregard frontiers. Under these conditions, any decision to build a new nuclear power plant or installation involved with the nuclear industry has repercussions not only in the country which takes it but in all neighbouring countries, if not throughout the world. This planetary dimension is still more evident given the growing concerns about the preservation of the environment.

In fact, the prospect of an upset of the planet's climates, as from the middle of the 21st century, owing to the greenhouse effect and the existence of acid rain, are the subjects of a vast international public and political debate. This strengthening of these concerns cannot remain without effect on the energy problems given that fossil fuels are responsible for almost 80% of the emissions of sulfur or nitrogen oxides and carbon dioxide, suspected of being responsible for the greenhouse effect. This new fact in the debate re-emphasizes the mastery of energy, given that the least pollutant energy is that which is not consumed. Above all, the partisans of nuclear energy see in it the chance to forget Chernobyl and praise the cleanliness of an energy which is still controversial.

In any event the energy practitioners have somewhat left aside the fears of an energy shortage in favor of anxieties arising from excessive discharge in the atmosphere.

Since 1983 the world energy situation has in fact been deeply modified.

In 1987, 5 billion human beings consumed 7.8 tonnes of petrol equivalent, of which almost 6 billion tonnes in the industrialized countries with a population only corresponding to a quarter of the world population. Thus the energy consumption per inhabitant of these countries is on average ten times higher than in third world countries. This difference reaches 30 times between the Asian countries and North America.

As to the future, three projections of primary energy consumption at cut-off point 2020 show the opening up of the field of possibles.

In the World Energy Conference scenarios, the consumption of primary energy will increase, between 1980 and 2020 from 7.8 to 14.5 billion tonnes of petrol equivalent in the low assumption. It is the first scenario. The second: from 7.8 to 18.5 billion in the high assumption. Moreover, 60% of consumption will remain localized in the industrialized countries. The third scenario "Goldemberg study", assumes on the contrary the application of an energy control strategy in the industrialized countries and in the countries of the third world. Not only would world consumption be stabilized but rebalancing would take place in favor of the developing countries. Thus, the dangerous tensions as to the resources raised by the World Conference study, such as North-South imbalances, could be mastered.

What policy for energy saving in France?

With a production of some 100 million tep of primary energy in 1988, it has around a 50% energy independence rate. In 1970 the greater part of the production was from coal and hydraulic electricity. Today owing to the increase in the number of nuclear power stations, almost two-thirds of the country's production are obtained from electricity of nuclear origin.

In 1988 the consumption of primary energy for the first time exceeded the figure of 200 million t.e.p., i.e. a 30% increase over 1970. Nevertheless, the evolutions by form of energy are somewhat different. Today, five times as much electricity is consumed as in 1970 and three times as much as. In return, the consumption of oil products has dropped and the consumption of coal reduced by half.

Although since 1973, the total consumption of final energy has increased at a slower rate, this evolution is highly variable according to the sectors. The residential-tertiary sector is by far the largest consumer sector. For 15 years its consumption has increasedby 25% owing to the development of central heating and services. The consumption of the transport sector has increased regularly since the first oil shock. The increase in the number of private vehicles is one of the main causes.

Efforts in favor of energy savings in France

The first act of this policy goes back to 1974, to the days following the oil crisis. Two lines of energy policy were then adopted by the French government: developing nuclear energy on the one hand, saving energy on the other. The corresponding means were instituted: an act covering energy savings, regulations concerning thermal insulation and heating temperatures, the creation of the Agency for Energy Savings.

The second act of this policy was instituted in 1981 when the Parliament adopted the National Energy Independence Plan.

The results have been considerable. Today the annual energy savings are assessed at 34 million t.e.p.

The first effect of this saving was to reduce the overall final energy consumption per inhabitant from 2.73 to 2.47 t.e.p. between 1973 and 1986. Thus from 1973 to 1988, the merchant GNP has increased by 38% whereas final energy consumption has only increased by 12% in the same time, the greater part of which, 90%, has been obtained through gains in energy efficiency.

The oil counter-shock and a relative abundance of oil, combined with the implementation of a liberal policy, persvaded the government to reduce or even suppress as from 1986, the instruments of the energy mastery policy.

The consequence of this reduction in the efforts to master energy did not take long to appear.

In 1988 the consumption of primary energy exceeded its historical record of 1979.

The report that I submitted to the National Assembly therefore stresses the need to institute new measures for energy savings.

II. Reflections on nuclear energy in France

With 55 units installed, France is the second world generator of nuclear electricity after the United states.

In 1988 nuclear electricity corresponded to almost 70% of French electricity generation, thus placing France in the front world rank.

The success of the French nuclear program has been based on 4 decisive elements: the choice of a single and progressively French sized technology (pressurized water reactors), a very high level of standardization, highly centralized decision structures and a concentration of the industry on two main manufacturers: Framatome for the nuclear boiler, Alsthom for the turbo-alternator unit. Moreover, the major role played by EDF, both designer, manufacturer and operator, deserves to be highlighted. In this respect, the French situation is distinct from the one prevailing in most other countries.

But we think, now, that the French nuclear programme has been implemented too rapidly. This over-equipment is the result of 3 phenomena:

- greater availability of nuclear power stations than was taken into account when determining the investment programs at the start of this decade.

- price estimates for fossil fuels greater than the current estimates, which has involved over-estimating the relative competitiveness of nuclear energy as compared to coal.

- over-ambitious consumption forecasts in relation to current prospects.

This "bad passage" period is both a challenge and a chance.

A challenge because such a long period of activity recession create difficulties as to the manufacturers' work load plan.

The "bad passage" is also an opportunity because it leaves sufficient time for reflection. We must ask ourselves 4 questions:

1. At what rate should the renewal of the existing units be implemented? - How should this renewal be financed?

2. What type of reactor for the future?

At present, the most recent type available to Framatome is the 1400 MW N.4. Nevertheless Framatome has, in conjunction with EDF, already undertaken to reflect on the future reactor.
The studies are only at their beginnings. It will probably be of smaller size than the reactors currently sold (1000 MW), which should make it more suitable for foreign markets.

In connection with this future reactor we must be vigilant and remain attentive as to what is being done abroad, particularly the dimension of strengthened passive safety.

3. What is the future for the breeder reactor?

In France, the studies of Superphenix commenced in 1971. In 1974, EDF associated itself with a number of European electric companies to construct and then operate, within the NERSA Company, a Superphenix nuclear power station.

Today the world situation does not appear to be very favorable to the development of breeders. The cost of the Kilowatt-hour supplied by Superphenix is 3.4 times higher than that supplied by a pressurized water reactor. The drop in the price of uranium, due to the slowdown in nuclear programs throughout the world, has cancelled one of the major justifications for the exploration of this sector.

4. Should the preferential option in favor of nuclear be preserved?

We think that greater diversification would also enable our country to deal better with geopolitical or accidental events which could affect the energy scene.

The question notably arises of the place to be given to co-generation. In France this high efficiency system, given that it both generates heat and electricity, has not yet gained much ground.

All these questions have led the French members of Parliament to stress the need of firstly making a retrospective assessment of the previous choices; and secondly to commission prospective studies

designed to determine as exactly as possible the energy situation, especially in terms of the price of energy or level of consumption, which will occur when the decisions required by the renewal of the existing nuclear plants have to be taken.

Ensure the closing of the fuel cycle

The closing of the nuclear fuel cycle, whether reprocessing or storing the resultant waste, arouses anxieties in public opinion.

France is the undoubted world leader in reprocessing which according to the official doctrine, is the only acceptable solution to the problem of managing fuels irradiated in nuclear power stations. Two series of justifications are commonly put forward.
- The first is of an economic order. Non-reprocessing would involve a waste of strategic raw materials.
- The second justification is relevant to safety given that reprocessing guarantees long term safe management of the waste, by separating their different categories, according to their specific characteristics.

At present only 4 countries (France, Great Britain, West Germany and Japan) possess commercial reprocessing plants in activity not in construction.

The reprocessing option is criticized on the grounds of economy and for reasons involved with the use of the plutonium resulting from the reprocessing operations.

The economic criticism order are based partly on a study published in 1985 by the Agency for Nuclear Energy (dependent on the OECD).

The second criticism concerns the use made of the plutonium extracted from the irradiated fuels. Initially this plutonium was to be used by the breeders. The halting of this reactor has made it necessary to explore new solutions to avoid storing it at great cost. This is why plutonium is at present recycled in the manufacture of mixed uranium-plutonium fuels (known as MOX). Used in West Germany, Belgium, Switzerland and France, these fuels would only appear to be amakeshift solution.

It is clear that the fate of the plutonium resulting from reprocessing is a key element in this file. Indeed, the plutonium from fuels irradiated in pressurized water reactors has only a very low military value. Nevertheless the fears involved with the risk of proliferation remain present in certain sections of public opinion.

A third series of criticisms against reprocessing is based on the fact that the problem of the storage of waste has not yet been finally solved. It is however necessary to acknowledge that the storage as is of irradiated fuels has not been solved either.

The French radioactive waste management policy

The technical solutions are founded on two basic principles: the absence of any short and long term harmful effects for persons in the environment on the one hand, the existence of minimum constraints for future generations on the other.

1. Short lived waste (less than 30 years or around 30 years)
This waste is processed which, according to its nature, consists in reducing its volume by incineration, evaporation, chopping and compaction. The solid product thus obtained is then packaged in a block of concrete or coated in bitumen or polymers.

Since 1969, this short lived waste has been stored at the La Manche storage site close to the La Hague plant.
This site will be saturated early in the 1990s. A new site has been found: The capacity of this site is approximately 30 years of short lived waste production in France.

2. Long lived waste
The basic principle according to which long term storage should entail minimum constraints for future generations, makes it impossible to consider long term storage on the surface which would require surveillance over a period which should extend over several thousand years. Thus the technical solution proposed is an in-depth storage in suitable geological formations.

The announcement of these studies on the 4 pre-selected sites has aroused a certain emotion in the populations concerned and the govern-

ment has decided to break off the studies for one year.

The members of Parliament consider it indispensable that the French document be explained in all its aspects so as to be submitted to comments or criticism from scientific circles, notably foreign ones. This is the choice made by Sweden with the KBS 3 report. There is no doubt that this would be a mark of confidence liable to reduce doubts or fears from national or international opinion.

My conclusion: In France we have to ensure greater transparency and a better democratic control of the nuclear policy.

Few interlocutors express doubts as to the responsibility of the agents concerned by problems of nuclear safety or the reliability of their work. It is clear that if the level of safety existing in the nuclear industry were imitated in other industrial sectors the situation in terms of industrial risks would sometimes be of far less concern.

The essentials of the criticisms addressed to the French system of nuclear safety are explained by its present organization. The stakes in the debate can be summarized by evoking the existence of an "institutional consensus".

Opinion tends to consider, as a unified and closely bound unit, sometimes christened "nuclear lobby", the firms and institutions concerned by nuclear energy.

This is not a satisfactory situation and could be redoubtable at the least difficulty encountered in the operation of the nuclear sector. The people responsible for French nuclear policy have always put forward the consensus which would appear to exist in public opinion on this subject. It is true that this has placed France in a quite specific situation. This consensus must not be lost through resignation, or bad information, because it would no doubt have difficulty in surviving another Chernobyl.

Although the domestic aspect is crucial, the improvement to the French system would also be a major argument in front of our foreign neighbors. Whereas France hopes that the single market will go together

with increased exports of electricity for EDF, the image of the French nuclear industry should become a priority concern for our country. The protests observed beyond our frontiers in connection with Superphenix or another plants are all warnings.

We propose to play the card of transparency: international supervision; independent expertise at the request of the local authorities; autonomy for institute of nuclear research (IPSN) etc...

As rapporteur of the mission on energy in the National Assembly, I have also proposed instituting a High Authority of Nuclear Security. The objective is to set up an authority, independent of the authorities of the country, provided with an expertise capability and which would have significant powers in connection with security, covering prevention, the measures to be adopted in case of accident or incident and information to the public.

* * *

Here, ladies and gentlemen, are some of the orientations that I have had the opportunity of submitting to the French National Assembly, I think that they will indicate to you the problems to which public opinion is sensitive in France today.

I remain at your disposal to discuss all these questions with you.

原子力をやめた場合の経済、社会的コストを考える

名古屋経済大学経済学部
教授　武　井　満　男

このセッションで、私に与えられたテーマは、「もしある時期に、原子力発電というエネルギー供給手段が失われたとすると、われわれの社会は、そのためにはどれだけのコストを支払うことになるのか」という問題である。支払うべきコストを算出するという方法で、この問題の答を出すのは、そう簡単ではない。また、仮りに大がかりなモデル計算を行ったとしても、その結果を説明することが、このセッションの討論にどれほど役に立つかわからない。私としては、むしろいくつかの断面を描くことで、会場のみなさんとの討論の材料を準備したいと考えた。

エネルギー供給と原子力

「原子力発電が停止された時、そこではどんな社会的、経済的インパクトが起こるか」を考えるのに先立って、原子力発電はこれまで「エネルギー需給の上でどんな役割を果たしてきたのか」という断面をまずとりあげてみたい。

第１図では、わが国における１９７３年から８６年に至る間の、国内総生産（ＧＤＰ）と最終エネルギー需要の対前年伸び率を示した。１９７３年の石油危機のインパクトから１９７４～７５年では、エネルギー消費を大幅に切下げ、インフレと不況に見舞われた。その後、１９７８～７９年の第２次危機に遇わなければならなかったが、この間の経緯をわれわれはまだ生々しく思い出すことができるはずである。日本の場合、それでも前半の１９７３～７９年では平均３．６％、後半の１９７９～８６年では４．０％のＧＤＰ平均伸び率を確保することができた（ＯＥＣＤでは、２．６％と２．２％であった）。エネルギー供給に制約が多いなかで、経済成長率を維持するためには、とくに省エネルギーと石油代替の実現が不可欠な条件であった。

第２図は、それを示している。１９７３～８６年で、一次エネルギー需要の増加は石油換算で約５７０万ｋℓにすぎなかったが、一方で石油消費が８，０１５万ｋℓ減少したので、国内の天然ガスの減産分を加えて、一次供給は８，５８６万ｋℓの増加が必要であった。増加分―実際には石油代替―の４１％をまかなったのが、原子力であった。原子力発

電容量は、この間、１８２万ｋＷから２，６７８万ｋＷに拡大して、発電量の２８％を占めた。

エネルギー代替と併せて、原子力はもう一つの大きな寄与を果たしている。わが国の場合、高度成長の後半期にあたる１９６５年から７０年の５カ年間で、炭酸ガスの年間排出量は４１１×10^6 トン(CO_2) が８０７×10^6 トンまで、約２倍へ増大したと推計されている。それが８５年には９５４×10^6 トンまで増加したと推計されるが、１９７０～８５年の増加率は１．１８倍、１９７５～８５年では１．０３倍と、著しく改善された。炭酸ガスの排出抑制は原子力発電だけが果たしうる直接的な効果である。

この事実はＯＥＣＤについても明らかである。そこでは炭酸ガスの年排出量は１９６５年を１００として７０年では１３３であったが、１９７０～８５年では１１２、１９７５～８５年では１０５に抑制された。この間の世界の原子力発電規模は、ＩＡＥＡによると、第３図のとおりで、原子力発電のシェアの伸びが上記の抑制を可能とした。

原子力規模（１９８８年）＝９００万Ｂ／Ｄ

同じくＩＡＥＡによると、ここ数年の原子力発電の運転規模は第４図に示すとおりである。１９８８年６月末の開発国は２６カ国で、運転規模は３億３，２９２万ｋＷ、４２３基に達した。ほかに９，９８７万ｋＷ、１１１基が建設中である。運転中の８５％（ＰＷＲ６３％、ＢＷＲ２２％）が軽水炉によって占められている。他方、建設中には、中国を含めて５カ国が新たに加わり、２，６００万ｋＷを数える。

２０００年あるいは２０１０年まで、上記の建設量がどこまで拡大されるかという予測は、いくつかの機関による見通しから得られている。しかし、ここではそれらの当否を考えるのではなく、ごく大摑みに、いまあげた建設中の容量が２０００～２０１０年の時期に運転規模に加わるとする。

１９８８年６月末の時点で、世界で動いている原子力発電所を、石油火力で置き換えると仮定すると、第５図のように約９００万Ｂ／Ｄの石油が必要である。また、それに建設中の容量を加えると、約１，２００万Ｂ／Ｄに相当する（注、上記の計算は次のとおりである。１００万ｋＷの石油火力を稼働させるには、負荷率７０％、発電効率３８～４０％で、概算で年間１４０万ｋℓの重油（９，８００ｋｃａℓ／ℓ）を必要とする。１４０万ｋℓを原油とすると、それは２．７万Ｂ／Ｄに相当する。例えば、第５図で、Ｊａｐａｎ１３５万Ｂ／Ｄは５，０００万ｋＷの発電能力を示す。ここでは、重油取得のための精製

得率を考慮していない）。

いま、この石油相当量を１９８８年の世界の石油生産量と置き換えてみると、その大きさをより現実的に理解することができる。

まず、現在稼働中の原子力発電規模を置き換えるために必要な約９００万Ｂ／Ｄは、サウジアラビア５００万Ｂ／Ｄ、クウェート１４０万Ｂ／Ｄ、ＵＡＥその他２６０万Ｂ／Ｄの、イラン、イラクを除く中東のアラビア湾岸諸国の生産量に等しい。また、この量はＯＥＣＤ諸国と、わが国に近い韓国、台湾を加えた原子力規模と建設中の容量を併せた能力に対応する。

２０００～２０１０年の間に、現在の運転規模に建設中の約１億ｋＷを加えた約１，２００万Ｂ／Ｄには、非ＯＰＥＣの場合をとって、アメリカ８１０万Ｂ／Ｄ、北海３９０万Ｂ／Ｄ、メキシコ２００万Ｂ／Ｄの合計１，４００万Ｂ／Ｄが対比される。また、この生産量は、上記の湾岸諸国にイラン、イラクの産出量を加えたものに等しい。

石油経済と原子力

こうした石油の追加需要が「世界のエネルギー供給のバランスにどのようなインパクトを及ぼすか」を検討するためには、石油経済の現実を見直してみるのが早道である。

第６図に、１９７０年から８８年に至る世界の石油生産の推移を、いくつかの時点で示した。そこではまず、１９７３年以降、石油生産に占める石油輸出国機構（ＯＰＥＣ）のシェアが、７３年５６％から８５年３０％まで――８８年には３４％に高められたが――大幅に低下していることに気付くはずである。それは、８０年代に入って、新たに北海、アラスカ、メキシコなどの新しい油田が加わって、非ＯＰＥＣ地域の生産が伸長したからである。非ＯＰＥＣ地域の生産量は、７３年の１，５００万Ｂ／Ｄが８０年には１，８００万Ｂ／Ｄへ、８５年には２，３００万Ｂ／Ｄに達し、ＯＰＥＣの産油量１，６００万Ｂ／Ｄを大きく超えた。この生産量は１９８８年にも維持されている。しかし、１９８６年から世界の石油需要が上向きに転じ、増加分はＯＰＥＣの生産増加によってまかなわれた。他方、ソ連、東欧、中国の産油量は、８０年代に入って１，４５０万Ｂ／Ｄから１，５５０万Ｂ／Ｄまで、１００万Ｂ／Ｄ増加している。

（１）第６図では、何よりも１９７０年から７３年へのわずか３年間に世界の石油生産が１，１００万Ｂ／Ｄ増加していることに着目したい。この増加分はすべてＯＰＥＣの増産によって吸収されたが、それが第１次石油危機をひき起こす直接の要因であった。

原子力発電を停止することによってひき起こされる９，０００万ないし１億２，０００万Ｂ／Ｄの追加需要を今度はどこに求めることができるだろうか？

石油資源の分布や、石油生産の歴史からみて、この大きな追加供給は、中東のアラビア湾岸諸国に求めるほかはないのは明らかである。それはどうすれば可能となるのか。

第７図では、ＯＰＥＣ生産における湾岸諸国のウエイトを示した。ＯＰＥＣの生産協定による国別枠では、現行１，９５０万Ｂ／Ｄの６６％が、また１９９０年上期２，２０８万Ｂ／Ｄでは６７％が割当てられている。他方、１９９０年第１四半期のＯＰＥＣ生産は２，２６３万Ｂ／Ｄと推定され、うち２，０７０万Ｂ／Ｄ、７１％が湾岸諸国から産出された。

このような石油生産の実績は、現実にはその国、あるいは地域の石油生産能力を基礎として維持される。ここで、石油生産能力とは、一般に「石油貯留層へのダメージなしに１年間（あるいは数カ月）持続し得る最大生産レート」を指す。１９９０年の生産実績となっている上記の生産能力は２，９２０万Ｂ／Ｄで、うち２，０００万Ｂ／Ｄ、７１％が同じく湾岸諸国によって占められている。生産能力に対する生産実績の比は、ＯＰＥＣが７７％、湾岸諸国が７３％である。

（２）２０００年に至る石油需給の見通しについて、ここではＯＰＥＣ事務局の予測を用いた。第７図のＯＰＥＣ生産見通し３，０２０万Ｂ／Ｄは、その時の世界生産（ソ連、東欧、中国を除く）５，６４０万Ｂ／Ｄの５４％を占める（湾岸諸国の比率は明らかでない）。それを２０００年の生産能力３，４２０万Ｂ／Ｄ（各年の数値は何れもＭＥＥＳによる）と対比すると８８％に当たる。

両者の比を稼働率とすると、２０００年の予想される生産能力の余剰は、１９９０年に比べて減少する。ＯＰＥＣは「妥当で漸進的な能力の利用」を目指しているが、２０００年に向かう何れかの時期に能力の増強に迫られるとみられるが、それが可能なのは中東諸国、なかでもサウジアラビアやクウェートなどに限られるだろう。

また、ＯＰＥＣは上記の見通しで２０００年に至る石油価格を実質１８ドルで一定（名目価格は９５年２３．４ドル、２０００年２９．４ドル）とみており、世界のＧＤＰの年平均伸び率は９５年まで３．４％、２０００年まで２．８％、また石油需要は年間で７０万Ｂ／Ｄあるいは３００万Ｂ／Ｄの増加を見込んでいる。

「おだやかな成長を安定して持続したい」という前提条件は、ＩＥＡその他機関の見通しにも共通しており、実質でみた大幅な価格上昇を予想していない。

（３）原子力発電の停止による大量の追加需要の生起は、それが仮りに漸進的に進むとしても、こうしたデリケートな枠組みに立つ石油経済に対して甚大な、ほとんど吸収不可能な擾乱を与えることになる。１９７３年の経験と比べて、２０００－２０１０年ごろの経済、エネルギー環境は次のような点で、大きく異なっていると考えられる。

－ＩＥＡの予測によると、発展途上国のエネルギー需要は１９８８－２００５年で年率４％（ＯＥＣＤでは同１．０～１．５％、世界平均は１．３％）で増大するとみて、２００５年における世界の一次エネルギー需要の２４％を占める。途上国で地域内の石油生産が拡大されると予想されるが、経済成長への誘因、非商業エネルギーの急速な減少などの要因が、その効果を吸収してしまうのは明らかであろう。

－ソ連、東欧、中国などのＣＰＥ諸国はこれまで、エネルギー需給バランスの予測では、その他の地域に対して中立化されてきた。ソ連、東欧の新しい変革は、長期的には世界のエネルギー需要を増大させる有力な誘因となり、また、需給バランス上の中立化も勿論困難となり、かえって援助、協力を通ずる多大な投入を避けられない。

－ＯＥＣＤなどの工業国は、途上国やＣＰＥ諸国へ、次第にそのウエイトを移し、上記のＩＥＡ予測では、現在の５１％が４１％まで減少する。しかし、８０年代を通じて実現されてきた省エネルギー、あるいは産業構造の変化などの需要抑制の効果は、今日ほとんど失われており、石油供給の制約に対抗する経済手段に乏しい。

－炭酸ガスの排出抑制という全世界的な課題。

－これだけの供給力の欠落を補うことができる新エネルギーの欠除。

こうした背景や要因を織り込んで、社会的、経済的コストを算出することは、困難というよりは、余り意味がないというべきかも知れない。なぜなら原子力発電の将来を含めて、１９９０年代以降のエネルギーには少なからぬ不確定さが残されているからである。あるいは、それを「われわれが移行期の入口に立っていることは確かだが、それが向かおうとしている長期の、新しい型のエネルギー・システムの可能性は定かではない」（モスクワ・エネルギー・クラブ）といいかえることができるだろう。

上記で引用したＯＰＥＣの見通しやＩＥＡの予測は、何れも「おだやかで、ゆるやかな成長」を前提としていたが、上記のような変化要因がどのような動きをみせるかによって、この前提は大きく崩れることになる。

何れにせよ、原子力発電は９０年代の移行期を含めて、長期のエネルギー・バランスに包摂されており、それを維持する上の不可欠の、有力な構成要素である。むしろ、そこで

は原子力発電の将来にかげりがでて、不確定さの幅が大きくなることが問題である。

原子力発電の開発規模

ここで、その国、あるいは地域にとって望ましい原子力発電規模、あるいは、そのエネルギー・バランスにとって適正な規模を、次のように考えることができるだろう。

原子力発電規模（ｋＷ）＝（人口×１人あたり最終エネルギー需要）×電力化率×原子力比率×８，７６０時間×利用年／１

上記の算出式の３つのパラメータの推移を、１９８０年代について、第８図に示した。

わが国の場合、１人あたりエネルギー消費の水準は安定して推移してきたが、１９８８年に前年の２．２４ｔｏｅから２．３６ｔｏｅへ著増した。この水準は９９年にも更新されるとみられる。

また最終エネルギー消費における電化率は、エネルギー消費の水準が高い時には相当的に低くく、逆の場合は高くなるが、傾向的には３年間に１％程度高められ、８８年では１９－２０％とみられる。この水準は、ＯＥＣＤの平均的な水準より高い。逆に、原子力比率の３０％は、フランスの７０％、ベルギー６６％、スウェーデン４７％、スイス３７％、スペイン３６％、西ドイツ３４％（８９年１２月１０日付、Ｔｈｅ　Ｔｉｍｅｓ紙より）に比べて相対的に低い。

電力化率はエネルギー間競合や、あるいは社会、生活の環境によって決まるが、一般的にみて、その上限を４０％程度とみてよいだろう。原子力比率は、系統の負荷パターンと、その経済配分によって決まり、国や地域で差がある。わが国では５０％程度とみてよい。原子力比率はむしろ政策によって決まる。いま目標とする開発規模がエネルギー・バランスにとって、どんな意味をもつかを示すことは、主要な留意点だと考える。

Figure 1. Annual Growth Rate (%),GDP,Final Energy Demand

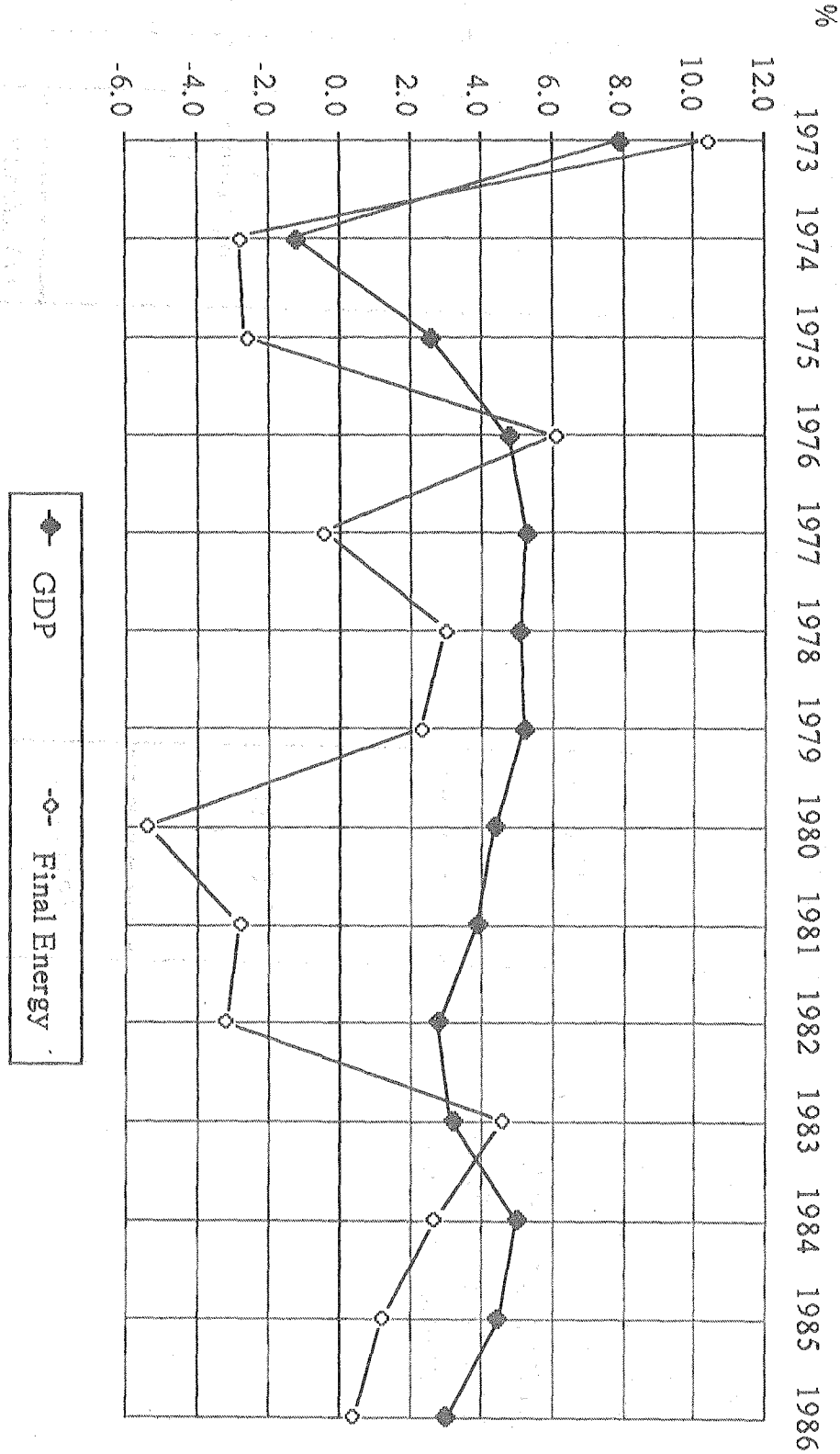
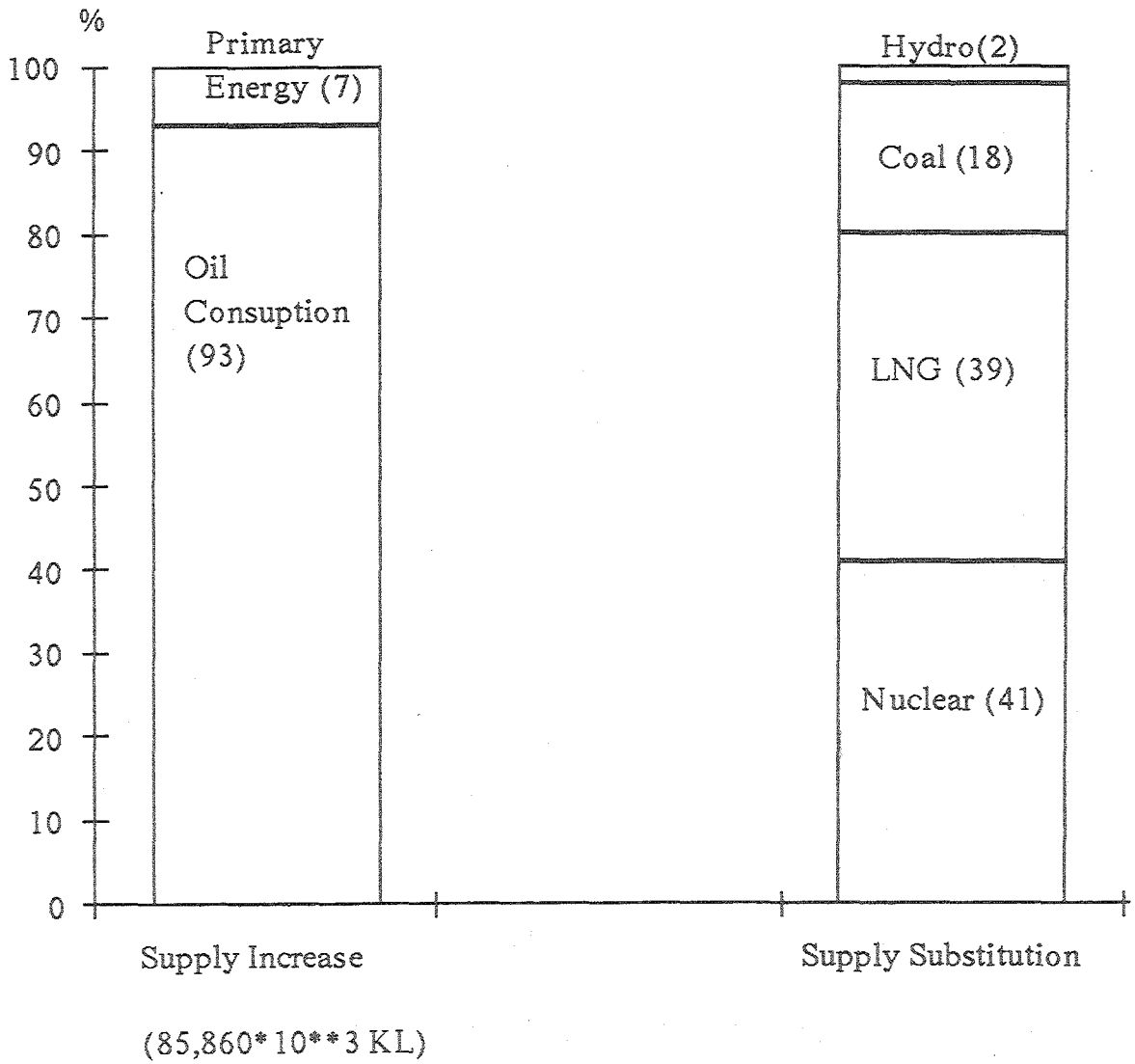


Figure 2. Energy Supply Balance (1973-1986)



(85,860*10**3 KL)

Nuclear Capacity

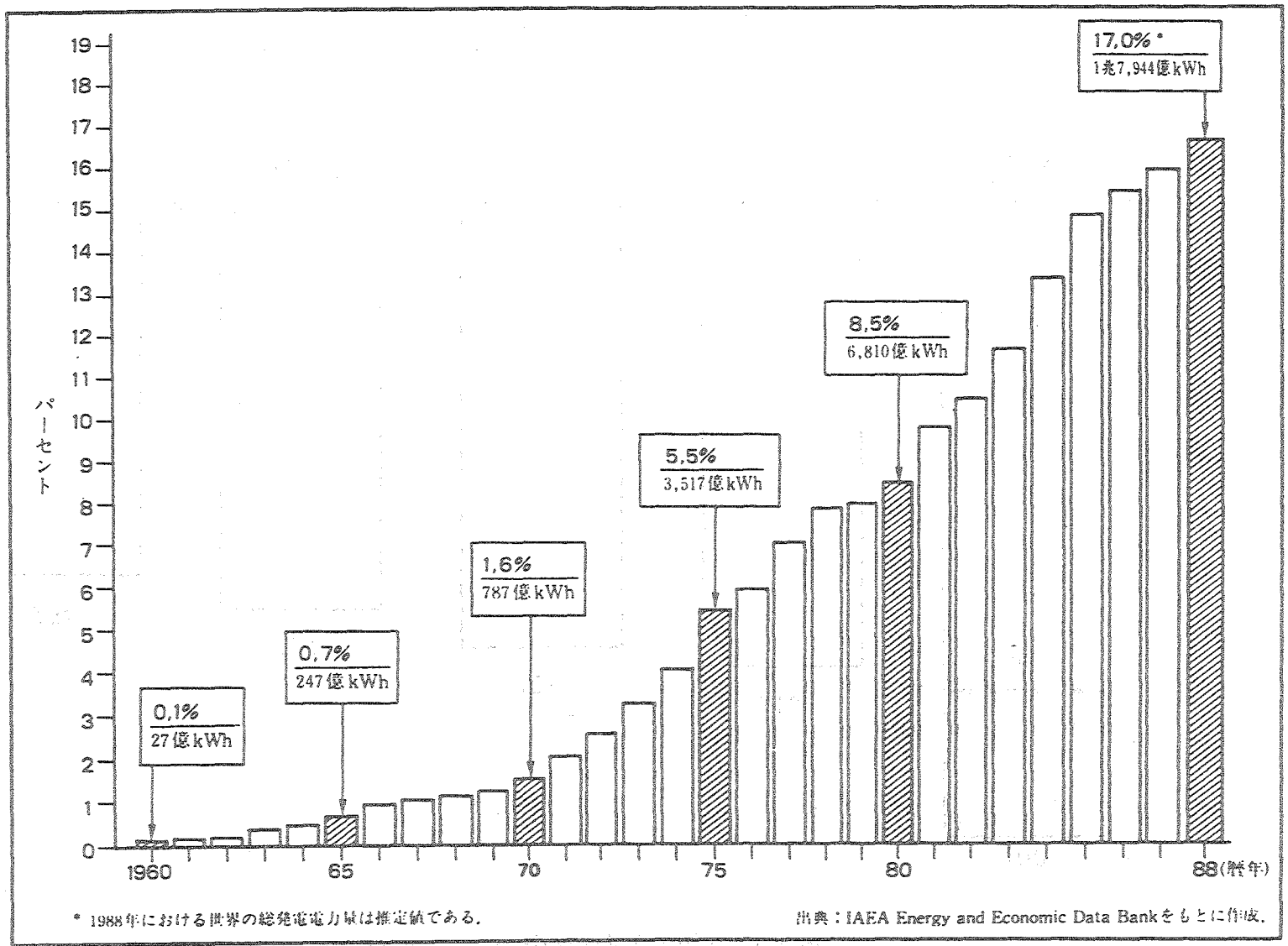
1973	1,820 MW
1986	26,780MW

Share In Total KWH

1973	2%
1986	28%

Figure 3. 原子力発電電力量と原子力発電の総発電電力量に占める割合（原子力発電シェア）

（1960年から1988年までの実績）



＊ 1988年における世界の総発電電力量は推定値である。

出典：IAEA Energy and Economic Data Bankをもとに作成。

1989.10.1

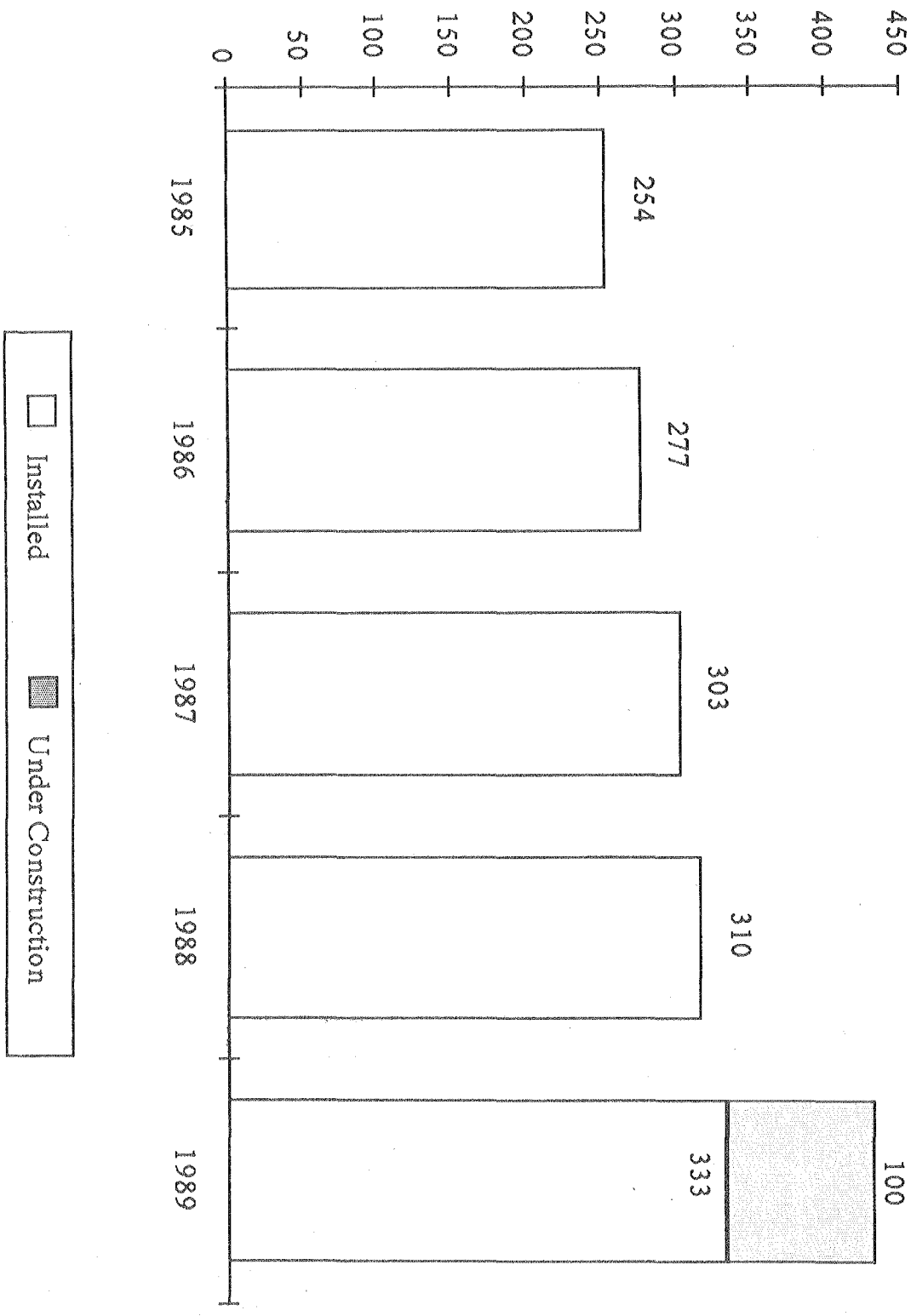
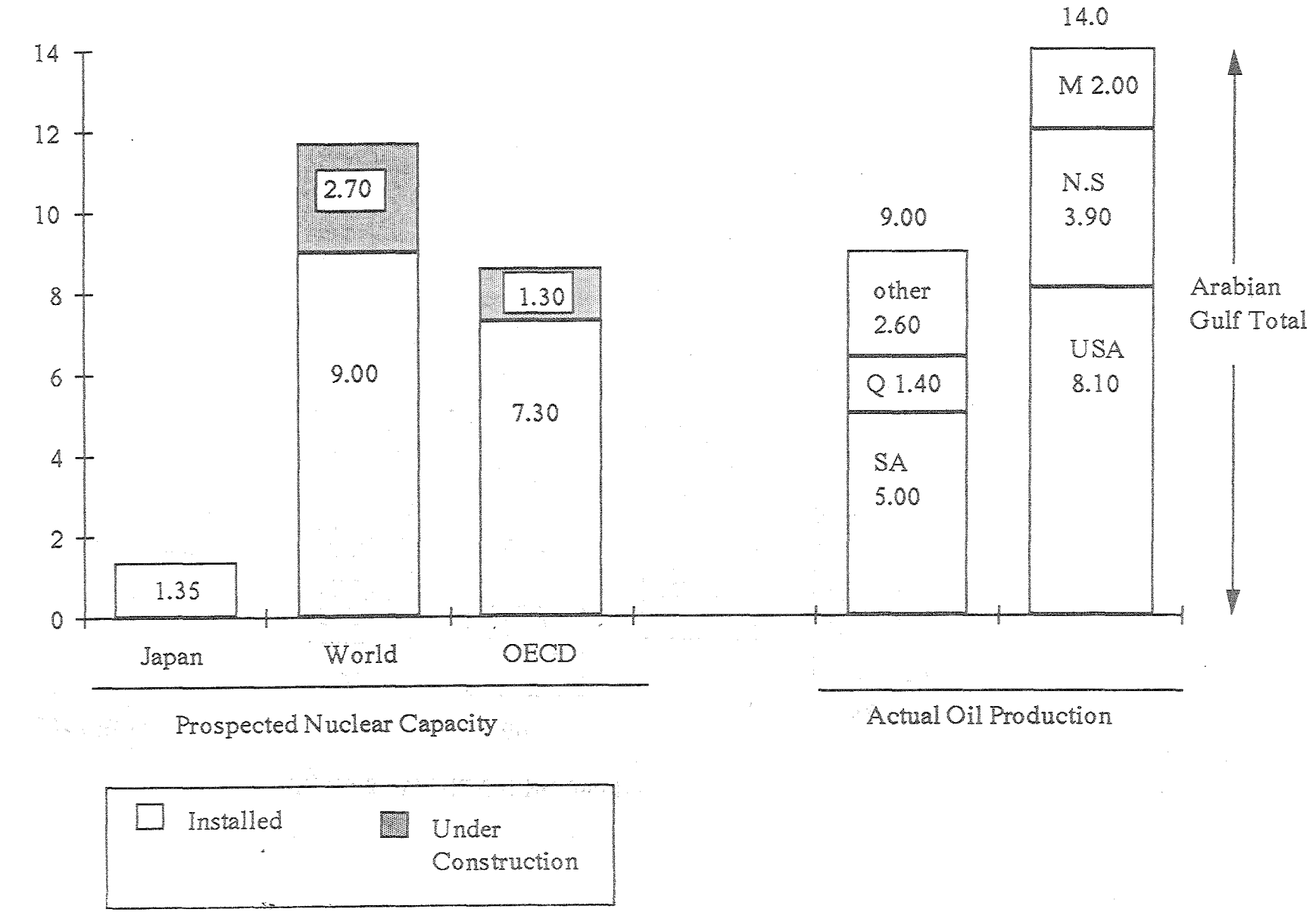


Figure 4. Installed Nuclear Capacity (World Total)

Figure 5. Equavelent Oil Consumption (2000-2010)



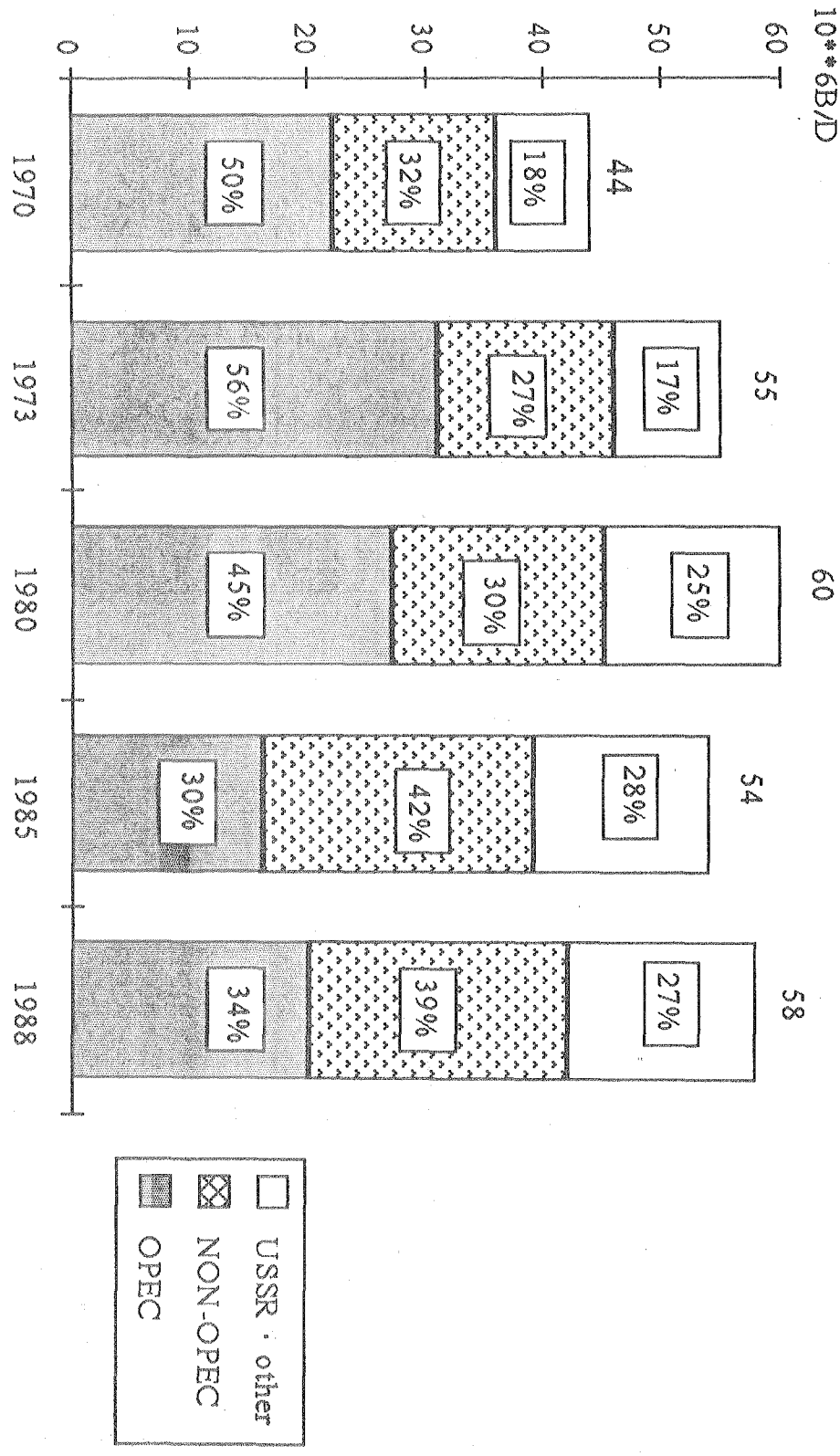


Figure 6. World Oil Production

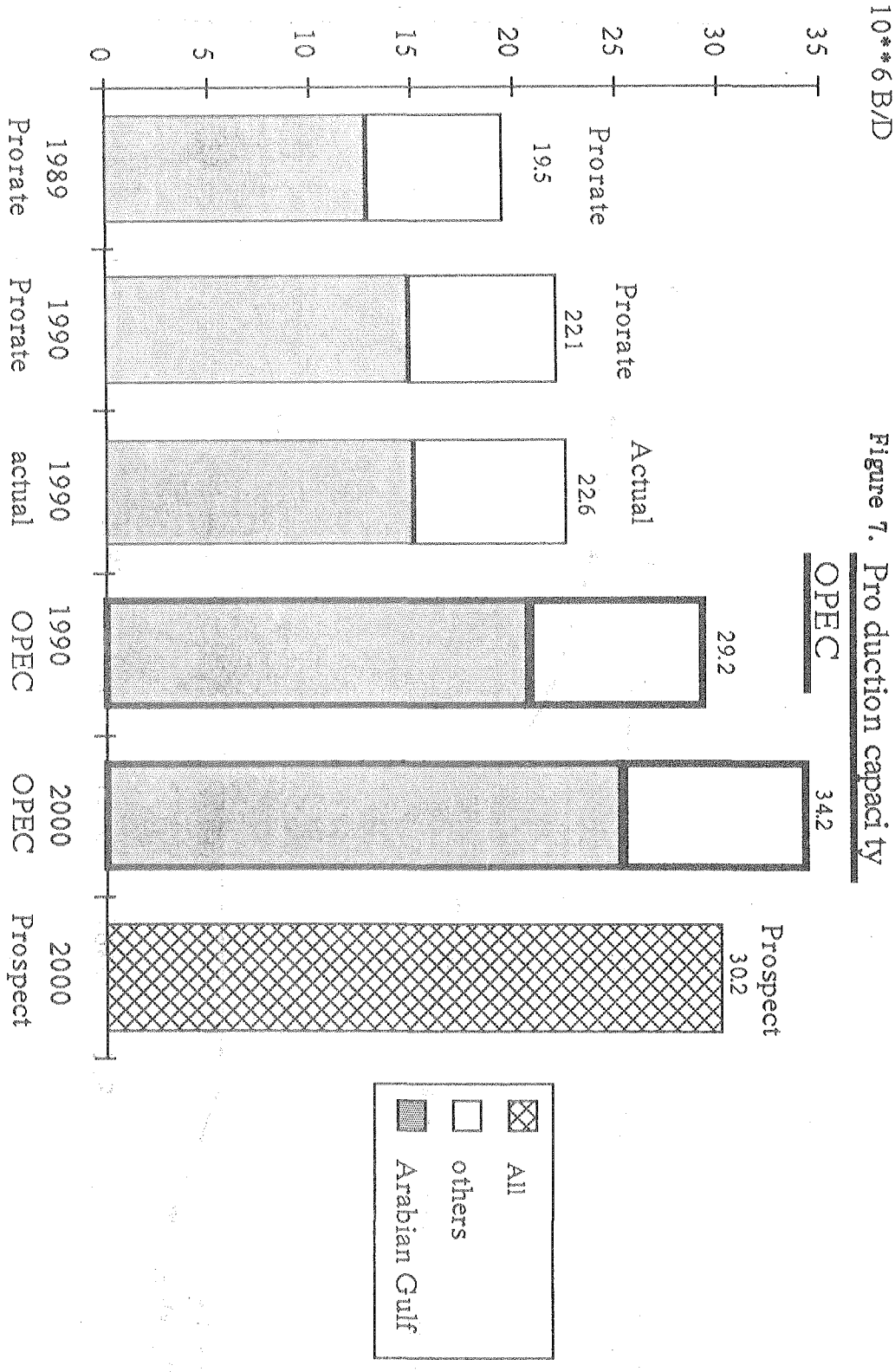
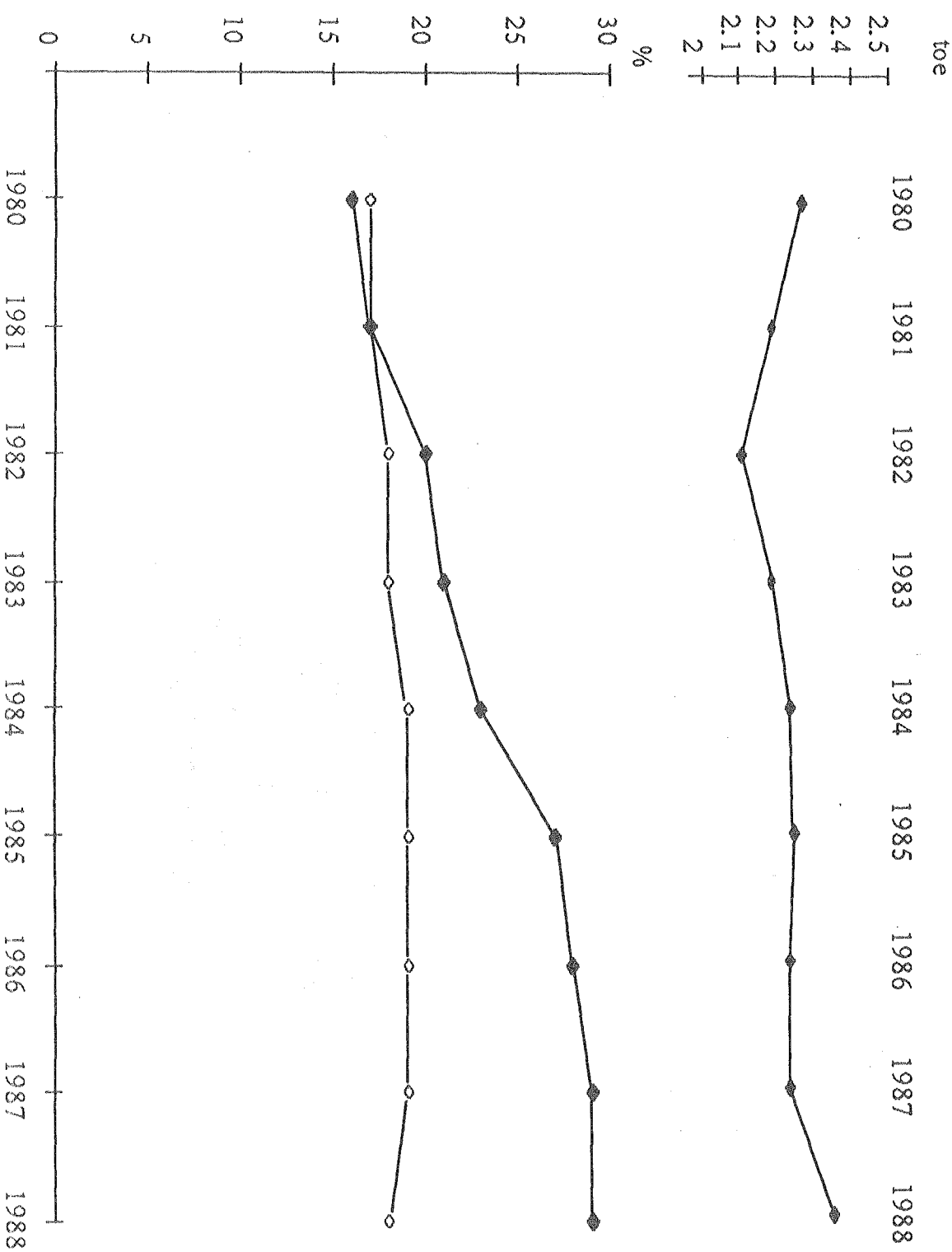
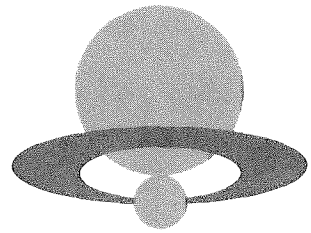


Figure 7. Production capacity

Figure 8. Historical Trends Of Electricity, Nuclear Share, Energy Consumption



セッション5
原子力開発への提言



＜パネル討論＞

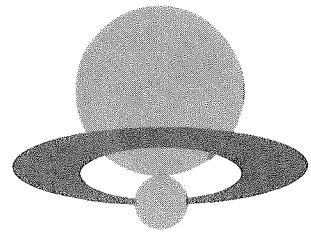
衆議院議員、自由民主党前政務調査会長
三塚　博

衆議院議員、日本社会党政策審議会長
伊藤　茂

年次大会準備委員長、マッキンゼー・ジャパン会長
大前研一

大会まとめ－何がわかったか

年次大会準備委員長、マッキンゼー・ジャパン会長
大前研一



午餐会

＜特別講演＞
日本画の美とは何か
日本画家
加　山　又　造

ビュッフェランチ

通商産業大臣所感
通商産業大臣
武　藤　嘉　文

午餐会加山又造氏講演

「はじめに」

本日は、私が尊敬いたしております、圓城寺　次郎、日本原子力産業会議会長の懇切なお招きにより、この原産年次大会午餐会にお話することになってしまいました。

今大会では、１９９０年代における世界のエネルギー需給問題、又、温室効果など地球規模の環境問題の世界的論議の中、現在および未来のエネルギー、そしてその中の原子力の位置付け等々について、国内外の権威者、専門家による討論が行われているとの事です。

このように極めて大切な時間の中、私のように、何も知らなく絵を造り描くことのみに６０年を過ごしてきた、日本の一絵描きの一人言のような話を、見、聞きしていただくのは、一寸、申し訳のないような気がいたします。しかし、今、皆様が、フル稼動なさっていられる非常に貴重な脳細胞に多少の休養を與えられますように願いながら、もう一つの片側のいってみれば情緒的なやさしさの部分について、日本の美とか、文化について、美とは何か、そして日本の美とは何か、日本の文化とは何か、絵を描きながら、画室の中で、一人日頃考えていることを申し上げたいと思います。

その手だてとして、先ず私の絵画製作現場の記録を見て頂きます。

「天井画」

今、御覧いただいたものは、１９８１年製作した、寺院本堂の天井画であります。

この絵は、一枚の絵としては、私の描き造ったものの中、最大の絵であります。

素材のデータを簡単に申し上げますと、杉材を骨組みとした、約１平方メートル強のパネルに、日本画用和紙を張り込み、その上に厚手の純金箔を二重に張り込んだものを、１２１枚並べ一つの画面にしたものです。

その上に、ご覧いただいたように、墨だけで描き上げました。使用した墨は、中国の古墨で、松煙墨、油煙墨等を使用いたしました。

技法は、日本画の中の水墨画と云う事になります。

ここに使用した日本の伝統的な、和紙について少々申し上げたいと思います。紙は、中国に於いて、B.C.１世紀頃造られ、日本には、６世紀には渡来していたようであります。

そして、９世紀頃日本独自の流し漉きの技法を開発しました。

渡来した紙、そして又後年１２世紀頃から西洋で行われた製紙法は、溜め漉きの技法であります。この日本の流し漉きの製紙法は、より強く美しい紙として、世界で最も美しく又、最も長い年月の保存にたえ得る優れたものであります。１３世紀頃には、中国に輸出したようで、中国宋の朝廷の重要文書には、日本製の麻紙が使用されたようです。

そして、ここに使用した和紙は、この技法で現在造られているものであります。

次に墨ですが、これも、古代中国で造られたものであります。このたび使用したものは、中国製の古墨で、１７世紀中国明代に造られたもの、１８世紀清代に造られたものであります。

なお、墨には、油煙墨、松煙墨があり、油煙墨は桐の木の油を燃やし得た煤を膠で固めたものであり、又、松煙墨は、松の油を燃やし造ったものです。墨色は油煙墨の方は、淡墨にしますと、やや赤味を帯び、松煙墨は、少し青味を感じさせ、更に古墨には、微妙な色合があります。

次に、これに使用した金箔について少し申し上げます。佛教寺院の荘厳に金を使われる伝統があります。

それと別にして、日本に於ける、文化、美術に対する貴金属、特に金について考えてみたいと思います。御覧くださった天井画に使用した金箔は、純金製で約１２センチ四方のやや厚手のもの２万３千余枚を使用しました。厚手とはいいながら、日本の伝統技により１ミクロン近くに引き伸ばしたもので、金箔は陽に透かしてみると青紫のセロファンのような色をして向う側がはっきり透過して見えます。

金は、貴金属としての希少価値がありますが、その質は柔らかく、装飾以外の実用性はほとんどありません。

ところで、古代エジプト、ギリシャ、古代ローマに生れた、金に対する想いから生じた錬金術があります。鉛を金に変化させ造りかえるという思想で、不老不死の霊薬造り等の事です。そこから化学が起こり、一つの文化文明が造られましたが、それは、金塊に対する思想でもあります。

そして日本の文化の中には、その錬金術的発想は全くなく、ただ、金色の美しさ、未来永遠の思いで造る黄金空間の想いはありました。従って、日本美術、工芸は、金を塊として使用するという考え方は皆無で、金は、薄いまくとして、金箔にし、又鍍金され、金泥（金粉）として美の為の平面にかぶされるためのみに使われ、使用目的の価値は、鉛、鉄

、銅、と同等に近かったように思われます。

国をあげ人生をぶちこんで錬金術に没頭した金に対する質的な欲望感覚は、本来日本にはなかったようです。唯だ美としてわずかな風に吹き飛ぶ箔にし、 微小な粉にし美術の空間をかざったのです。錬金術思考の欠除してきた、不思議に美しい美術、それが日本の美術であり、又文化ではないかと思います。

それが１５世紀頃のマルコ・ポーロあこがれの黄金の国ジパングの実態であったと思います。

「　龍　」

次に、ここに描いた「龍」ですが、「龍」は、これも古代中国で生れた想像上の動物で、霊獣とされて居り、中国では、他に麒麟、鳳凰、亀、と四つの霊獣が居ります。

「龍」は、海又は、湖沼に住み、神秘的な力を持ち、天空を自由に飛行します。又正しい政治を行う天子を守護するもので、不正なものを攻め亡ぼす力を持つとされ、古来より、佛教寺院の天井には、他のものとよく描かれて居ります。

龍は亜細亜では、風雨、漁業を司るものとされ、信仰されてきました。日本に渡来してからは、瑞祥の象徴とされ、海神・水神として、航海や漁労、そして農耕に結び付いています。

おもしろい事に、中東あたりを境にして西欧ではドラゴンとして、翼を持ち、悪の象徴のようで、恐怖の対象になり、軍旗や楯の飾りに用いられたようです。

その龍を、このたび天井画にしたのは、寺院の飾りとしての伝統的な事もありますが、この前の本堂が、約百年程前原因不明の出火で消失したものですから、その意味でも、水の神に祈りを込めたものです。

なお、金箔地に水墨で描く技方は、過去の作例では、非常に少ない技法であります。

「自分のこと」

私は１９２７年、この京都に生まれ、１６才迄京都で育ちました。私の父方の家系は絵描きの家系でした。祖父は、日本画家でありましたが、４０代で亡くなり、私は祖父の記憶はありません。父も、日本画家を志しておりましたが、事情があって日本の伝統的な和

装、着物や帯の染織の図案家を家業として居りました。父も４０代の半ばで亡くなりましたが、京都で日本の伝統的な、美しい友禅染めや、西陣織りの素晴らしい工芸品のもとになる図案、デザインをして居り、今日でいえば、優れたデザイナーであったと思われ、かなり高い収入を得て居りました。私が子供の頃は、当時としてかなり裕福な生活をしていました。私は幼少のときから、体がきわめて弱く、先天的に近い小児病を数種持っていたようです。又、私は、極端な左利きでした。そのような事で、両親にきわめて心配をかけて育ちました。したがって、幼時は、医家の向い側に住居があり、毎日通院させられ、何かの治療を受け、定期的に宗教的な占術を受けた程でした。

父は、そのように宿命的に思える虚弱で短命の家系に生れた生後間もない弱い赤ん坊の私を自分の体温で暖めながら、絵を描いていたそうです。ですから、私がようやく目が見え始めたころ、父の描くきらびやかな、染色図案の絵を見ながら育ったことになったようです。

ですから、私は父の描く日本の装飾的な形、色彩の父の手もとを見ながら育ったことになり、自然天然の物象を見る以前にまず絵ができる形から、ものを見るという奇妙な発育をしたようです。ですから、例えば、桜の花はその桜の花の本物を見る以前に絵としての桜の花を見、知っていたことになります。そして、それが桜の花と呼ばれることを知ったのは、それよりはるか後になり、桜の花は、一つのパターンとしてすべて正面を向きながら白い画面すなわち、ブランクスペースに突然のように出現する形としての認識で始まったことになるのでしょうか。

ですから、私の内側の型としての物象と、外で見る私の外側の自然と、妙な平行性を持って認識させられ、その幼児体験は現在にも私の内側にあるようです。思えば父は、私にどえらい、幼児教育をしてくれたと思います。そしてその時父の描いていたデザインは、純日本的に様式化されあらゆる物象であり、日・月・山・川・樹木・草・花・鳥、外に龍等霊獣を含み、そして靄・雲・波涛、それに様式化された人物と多岐をきわめていました。そして父は、それらを収集した多くの海外からの図録、画集をみながら造り上げて行ったようでした。このような小児体験をしながら両親の努力と深い愛情によって私はどうやら生き抜き、今日に至って居ります。このような事から、小学生の頃まで私は常に家に閉じこもり、父の収集した多くの画集を見ながらそれを写したりして絵ばかり描いていました。このように内に閉じ込もる性質は、いまも大して変わらず、海外に出たのは四十八才の時、中国へ渡ったのが初めてです。以来中国には、教わる事が多く十数度、台湾、中国

に出かけています。

しかし、ヨーロッパをはじめ、他の国にはまだ一度も出かけた事がありません。（もっとも、余談ながら今年は、ヨーロッパに出かける事になりそうですが。）しかし、先に申し上げた通り、ようやく目が見えはじめた頃より見た父の描く絵は、日本古来からの美術は当然ですがかなりの部分海外から渡来したものが多く、海外の事物に対しての関心には、特別なものがありました。それは現在も続いて居ります。とにかく、古代中国をはじめとして、古代ギリシヤ、エジプト、古代ローマ、中近東、東南アジアから、近代欧米のものが、日本の様式化された文様と重なって結局、優美で洗練された型としての日本美術が成り立った様子をきわめて自然に、もの心がつく以前に、私に、認識させられてて来たような気がします。このように、絵を描き造る事に対する気持ちと方法を、習慣にして自然のかたちで育ちました。

爾来、６０年、激動の時代の中、幸いなる事に、大事なく絵を描きつづけて来られました。

もっとも、それにしてはあまりよいものも出来ないでおりますが。

とにかく、この日本で、画家の家系に生まれ、両親、兄弟の深い愛情につつまれ、非常なめぐり合いのよさの中で、偉大な師に合い友に恵まれ今日に至って来ました。

東西から南北に伸びる日本列島は、いわば地球文化圏の極東に位置しその外側に宇宙的空間である太平洋が在り、日本では当然のように、他民族と異なった不思議な文化形態を持つようになりました。

これは私個人の考えですが、日本人の祖先は、数万年来、何らかの宿命的な経緯を経て日本に渡来して来ました。それは、大陸を追われた王族、嵐で漂流した旅人、又、古代の探険家等々、数種のパターンによって、西方から又、南方から、北方から日本にたどり着き、日本を形成してきたと想像いたします。その祖先達は、この極東洋上の日本列島に留まるほかなかった多種多様な渡来者であったと思います。それらが次第に造りあげてきた不思議な結合の運命共同体として。日本列島に棲みつき日本を造り上げていったのてしょう。

そこで彼らは創造背おってきた文物、習慣、個性さらにはその宗教までよせあい、結び合わせて共同し生き続けて来たのでしょう。かれらの故郷に比し、温暖で四季の変化にとんだ日本列島は、彼等の心にどのような影響を與えたのでしょう。

その結果、海外からの多様な渡来者、文物に驚くべき受容能力と選択醇化する適確な価

値評価力を育てあげて来ました。

日本には、祖先等と共に来た八百万（やおよろず）の神佛がすみ、それぞれに祭事が行われて来ました。ですから現代の日本人の平均的な宗教感は祖先からの神々に均等につき合い、祈り事、其他をその神々に合わせて等分に参拝します。農業、海水産、病気又けがの治癒、それも、頭、目、口、　等々それぞれに司る神があり、更に経済、学問と参拝する神々は、多く大変たのもしく、日本に鎮座されて居ります。ですから、できるだけ数多くの神佛に参拝する事が、御利益も多いわけですし、信仰深い事になります。又信仰深い人は熱心に参拝します。

日本の伝統的な家庭では、早朝から神棚に燈明を上げ、佛壇に在る祖先の靈に香をたき、更に四方拝、東西南北世界の神々に向かって参拝し、一日をはじめます。そして、その神佛に対しては、御覧になられた通りそれぞれに立派な社殿、寺院があり、時期毎に伝統的な、あるいはユニークとも云える固有のお祭りが行われます。日本人の神・佛に対する形としては、それぞれの固有な教義には、多分ほとんど関心を示しません。それより、その神佛のよって来る系譜に強い関心を持って居り、その神々に捧げる祈りもそれだけに単純で純粋と云えるでしょう。

もっとも、個々の内側には「さわらぬ神に祟りなし」と云った都合のよい選択をしているようです。

文化の一つの基となる宗教感をこのような全く自由な形で持って居る日本の文化資質は、いついかなる時にも又、あらゆる地方から日本に渡来する多様な事物に対し敏感に反応し許容します。

そして、渡来する他民族の文化の持っているその源となる精神、体質、血液、要するにそういう本質の臭気を帯びた強烈な個性、（それはそれとしてそっと棚上げにして）実体の中のその形式だけを取りだし、形骸だけにしてしまう、そして、極論すれば、日本の文化・日本の美とは、これら形骸であり、更に形式化する事であり、それが更に様式美となり、日本の装飾美に昇華されて来ました。ですから、日本の美は、彼岸のように高度で淡く情緒的であり、美しく装飾的であります。そのような、土壌の上に、最盛期の中国文化が伝来し、先程申し上げた非常に優れた、潜在的な咀嚼能力資質で非常に高度な、形式的な文化を造りました。

それは、日本語に対する文字も同様で、佛教と共に伝来した漢字、一字一字に、中国本来の韻はそのまま尊重し、それに日本語の読みと和・漢二種の音をつけ巧妙に使いわけ

て来ました。このように余裕にのある文化の二重構造は、注意してみると日本文化にごく自然に多く存在しています。その文字も日本語の音標のみを表示する音節文字を、漢字の書体、楷書・行書・草書と在る中からその最も高度に略化された草体のかたちから平仮名という音節文字、書体を造り今日に至っています。そして、１１世紀頃には、日本独自の美しい仮名文字による書道美術が完成して居る。

中国で造られた漢字は、中国の本来的な形で日本に存在し、同時に和訳の読みが附加され更にそれの美しい形の音標文字が平仮名、片仮名と二種造られ日本文化の微妙な表現に適応して居る。しかし、日本に伝来した時の韻と現在の中国の韻には大きなずれが生じ、現代中国言語の韻として通用はしなくなった。日本の文化資質により漢字は漢字として日本語になり、今、どの家庭にも、１４００年前の漢字を和訳する漢和辞典がありまして、日常に実用しています。もち論その外に、国語辞典も存在しているのです。

当然の事ながら漢和辞典は現代中国語には、全くと云ってよいほど機能しません。

話がいろいろになりましたが、佛教伝来に伴って日本に渡来した、中国隋・唐の美術文化は素晴らしく、日本に現存している、８世紀以後の佛教彫刻、佛画、寺院堂塔建造物の美しさは、素晴らしく、世界の佛教美術の中でも傑出した存在になっています。

それらは、非常に優れた、日本に帰化した国外の芸術家の作品も少なくないと思いますが、それを受けつぎ助けた当時の日本の潜在能力の素晴らしさを思います。

日本の言う美術が佛教芸術、美術文化として、日本ではじまったのは、当然のなりゆきながら非常に幸運だったと云えます。印度からシルクロードを通り、中国の大文明文化により更に発展しながら、そのシルクロードの終着地日本に来て、実に美しく昇華し、伝承され、世界の中で固有な日本の美を造り上げました。

その素晴らしく美しく完成された佛教絵画ではじまり、今日迄続いて来た日本画を２０世紀の現代の私がやって居ります。おそらく、使用している絵絹、用紙、毛筆、絵の具も千数百年前のものと大差はないものと考えられます。

しかし、残念なのは、千数百年前の祖先の大画家、大芸術家の優れた遺品に比して現在の私達のものがあまりよくない事です。

時代が下って来ているという想いが私達日本画をやっている想いの中にあります。

私達の文化には、再三申し上げるように、海外のあらゆる刺激に無限の潜在能力を発揮しそれを更に醇化昇華して極めて優れたものを造りあげ完成させて来ました。しかし、このような優れた文化ではありますが、他の国、民族から見ると、何かもの足りなさを感

じるかもしれません。

つまり時に応じた、オリジナルな、力強さにいささか欠ける点であります。日本の文化の資質は、他から習うことによってその能力が発揮されるようです。ですから、今迄の日本では、全くのオリジナルな生なものには忌避感を持つ場合さえあるような気もします。