Japan's Ways to Promote the R&D of Innovative Nuclear Systems in the Future

Sep.16,2003

Tetsuo Takeuchi
Atomic Energy Commission, Japan

Japan's Nuclear Energy Utilization

1st stage: Commercialization of LWRs

2nd stage: Establishment of LWR Fuel Cycle

3rd stage: Establishment of FBR Fuel Cycle

Social Objectives of R&D for Innovative Nuclear Systems in the Future

- Energy Security
- Maintaining high levels of technology
- Contributing to Economy
- Improving Public Acceptance

Limitation of Current LWR systems

- Low Utilization of Uranium resources
- Used only for Power Generation
- Disposal of Radioactive Waste
- Non- Proliferation

Social Needs to Innovative Nuclear Systems

- Effective Use of Nuclear Fuel Resources
- Flexibility in Electric Power Demand and Equipment Investment
- Substantial Enhancement of Economic Efficiency
- Diverse Uses of Nuclear Energy
- Reductions in the Environmental Load
- Greater Safety
- Improvement of Non- Proliferation

Preparing the U.S. Market for New Nuclear Plants

Joe F. Colvin
President and Chief Executive Officer
Nuclear Energy Institute

GENES4/ANP 2003 Conference
September 16, 2003

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NUCLEAR ENERGY INSTITUTE

The Nuclear Energy Era Begins

President Eisenhower giving the signal to start construction at Shippingport, Sept. 1954

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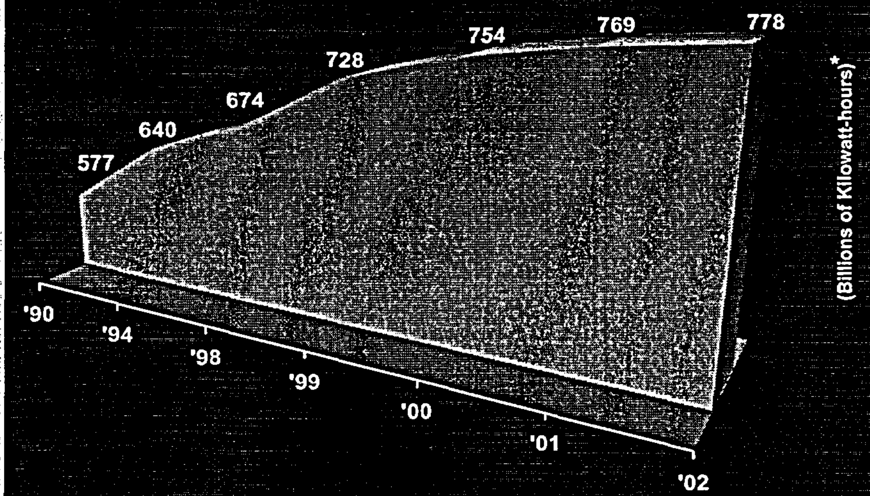
Record Nuclear Electricity Production Is Sustainable



* Nuclear Energy Institute estimate

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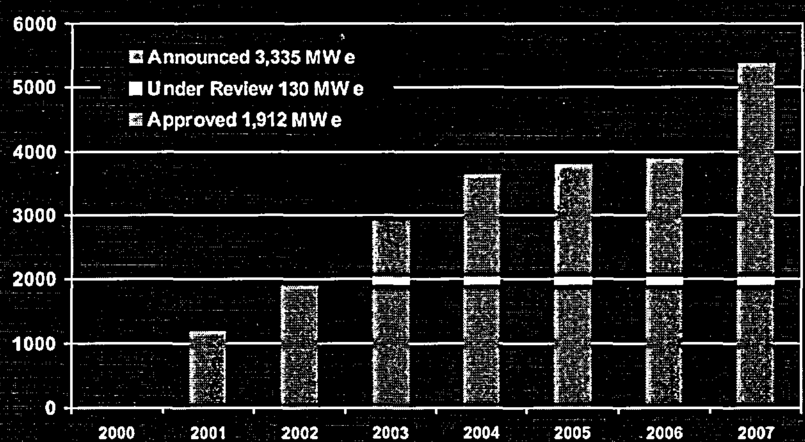
Nuclear Capacity Additions at Existing Facilities



Source: NRC, includes Browns Ferry 1 restart

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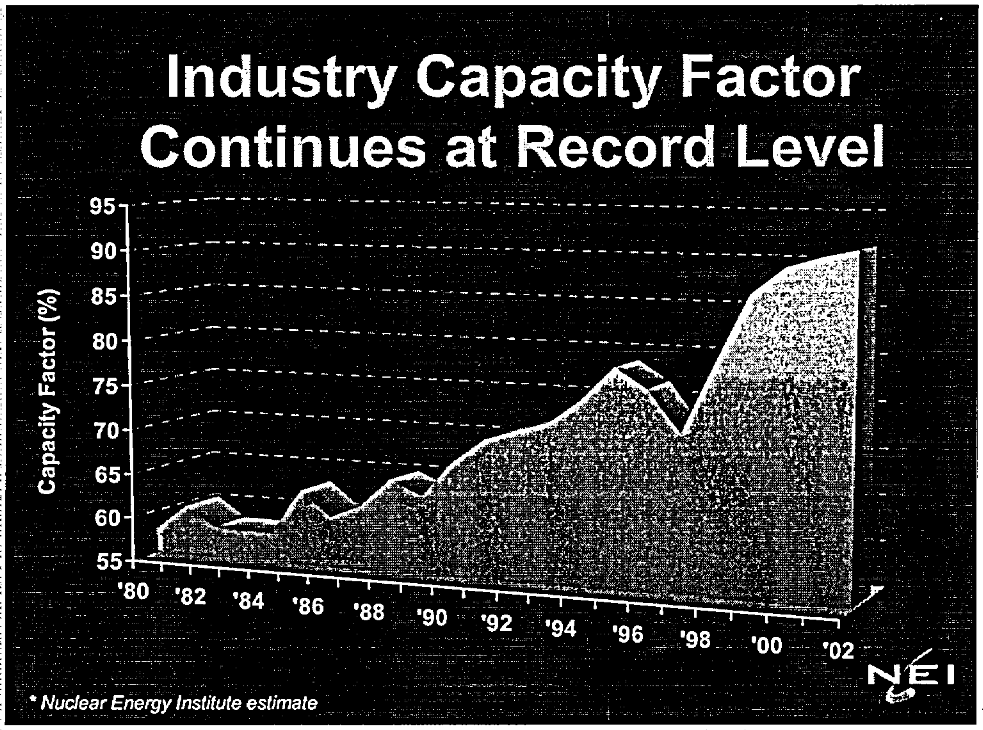
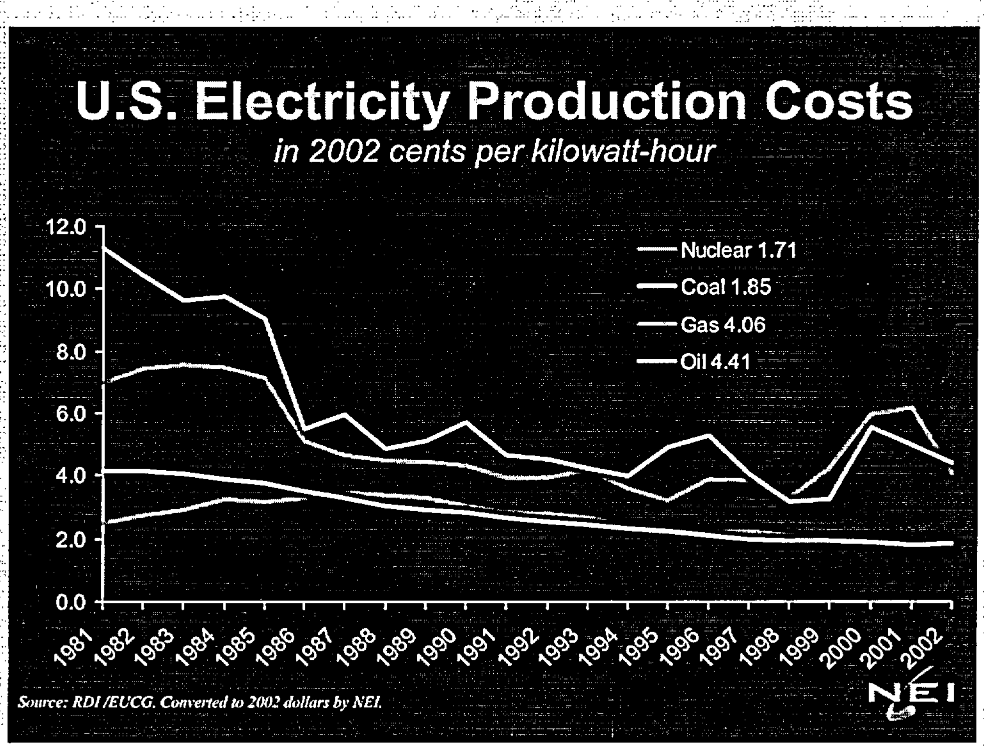
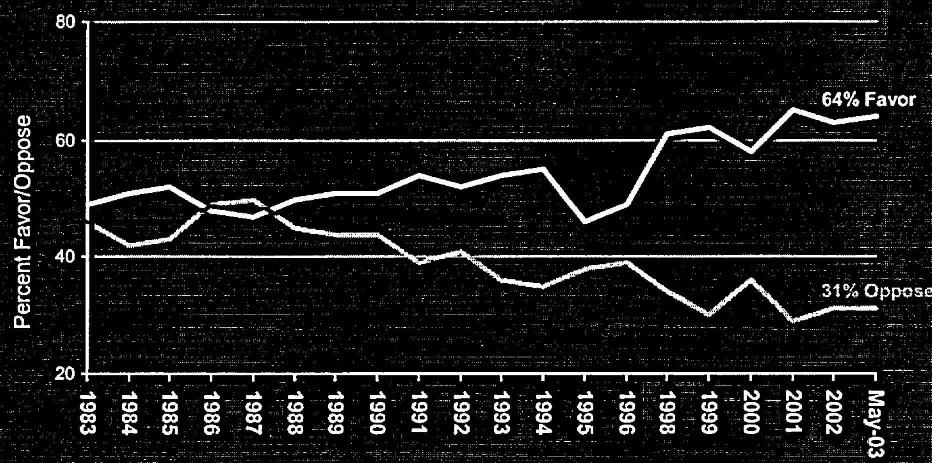

Industry Capacity Factor
Continues at Record Level
95
90
85
80
75
70
65
60
55
Capacity Factor (%)
'80
'82
'84
'86
'88
'90
'92
'94
'96
'98
'00
'02
NEI
* Nuclear Energy Institute estimate


U.S. Electricity Production Costs
in 2002 cents per kilowatt-hour
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Nuclear 1.71
Coal 1.85
Gas 4.06
Oil 4.41
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Source: RDI /EUCG. Converted to 2002 dollars by NEI.
NEI

Favorability of Nuclear Energy: Growing Public Support



Source: Bisconti Research Inc.

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Favorable Action in Washington

- President's $1.2 billion hydrogen program
- DOE $388 million budget request for R&D
- Comprehensive energy legislation
  - Indefinite Price-Anderson extension
  - Financial assistance for new plants
  - New R&D funding for hydrogen demonstration, research projects

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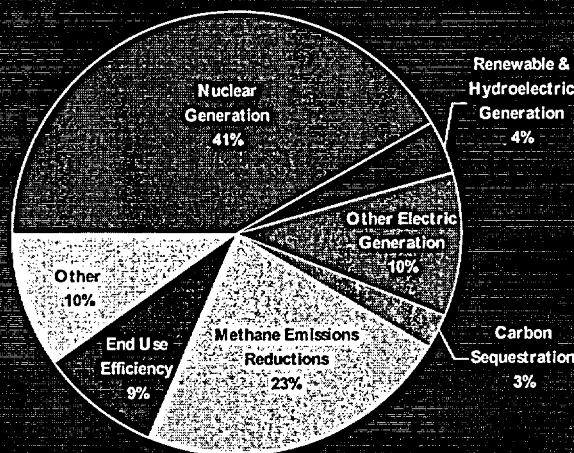
Nuclear Power Dominates Voluntary Carbon Reductions



Source: EIA's "Voluntary Reporting of Greenhouse Gases: Current Data"

NEI

Growing Regulatory Certainty

- NRC certifies advanced reactor designs
- One-step licensing process
- Three companies—Dominion, Entergy, Exelon—will test NRC's early site permitting

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Electricity Marketplace

- Marketplace segmentation separates generation, marketing, transmission and distribution in 1990s
- Electricity brokering collapses, merchant generators suffer
- Utilities no longer plan long-term, rather use gas-fired capacity for quick fix
- August blackout may prompt corrective action

NEI

Challenges and Future Prospects of Nuclear Power in Korea

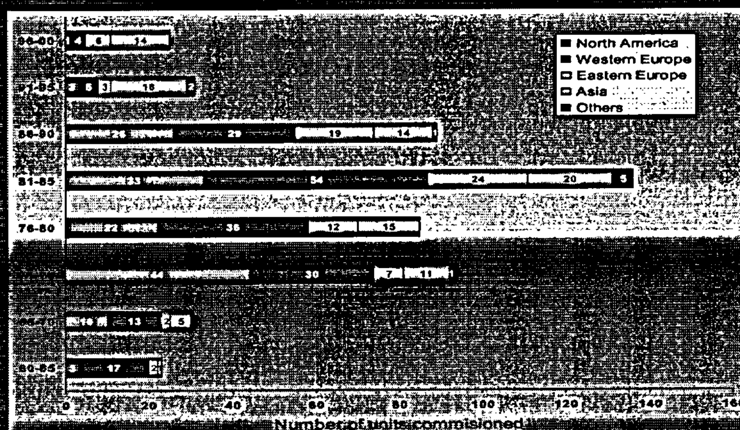
September 16, 2003, GENES4/ANP2003

Joong-Jae Lee
Senior Vice President
Korea Hydro & Nuclear Power Company

1. Introduction

- Energy is the hot issue recently confronted in the world today and one of the national strategic agenda.
- Nuclear power was once at the center of national energy portfolio in many countries and one of the promising business.

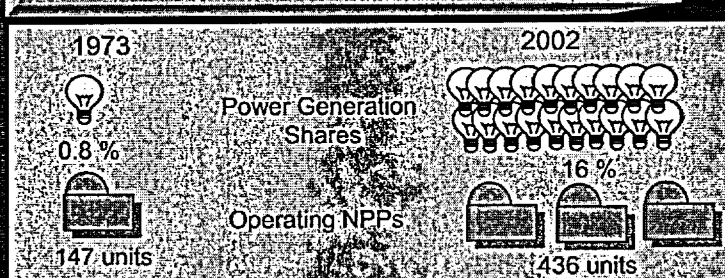
Up and Down of Nuclear Power Business

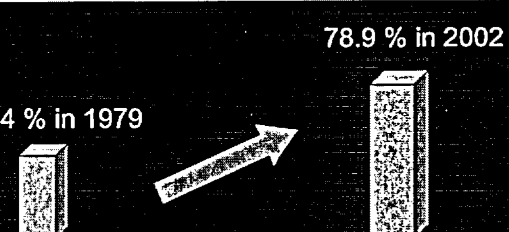


Number of nuclear power plants* commissioned - grouped in 5 year interval

* Counting units larger than 100 MWe (Source : IAEA PRIS database)

Contribution and Growth of Nuclear Power





World-wide Nuclear Power Reliability Improvement

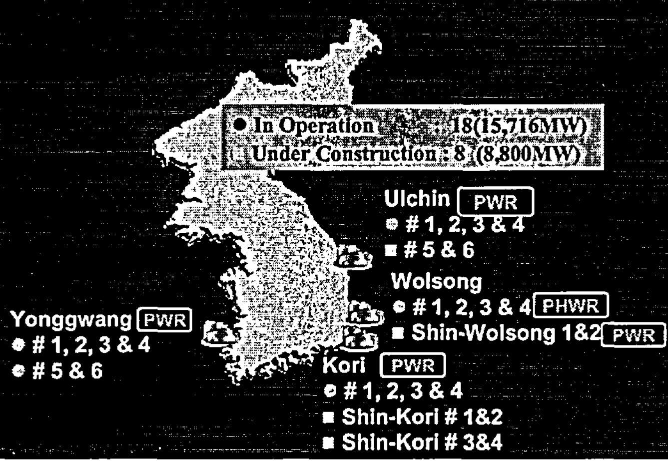
Nuclear Power at Turning Point

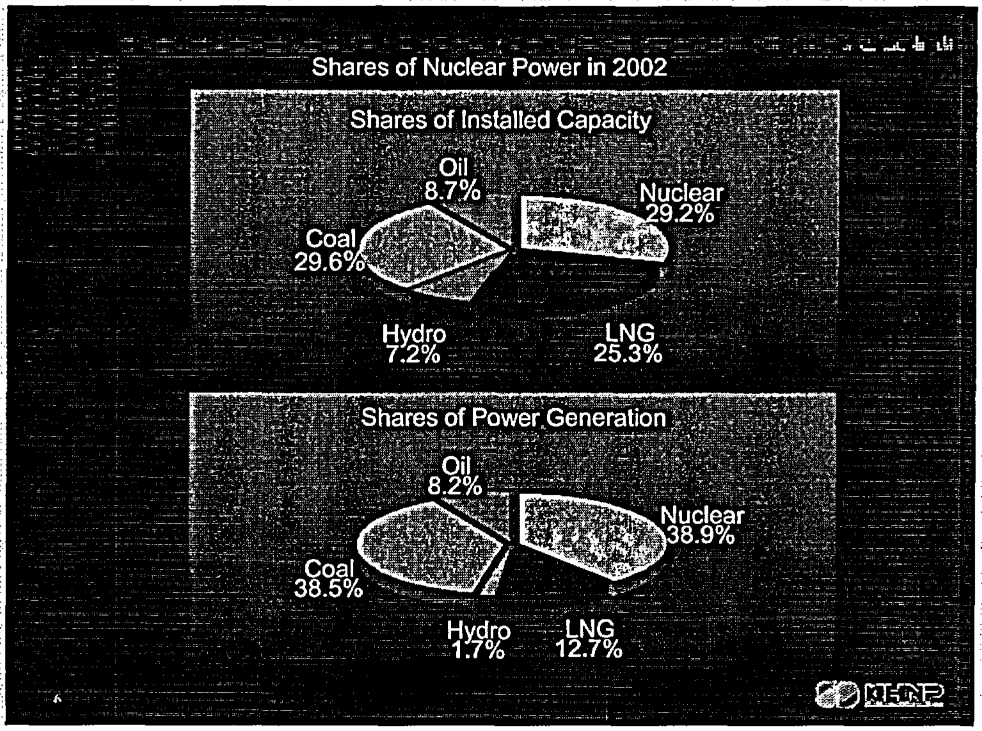
- Change of atmosphere
  - Global warming issue is being enforced
  - Concept of sustainable development prevails
  - Improvement of plant performance continues
- Issues yet to be resolved
  - Ceaseless arguments about nuclear safety
  - Radwaste disposal
  - Competition in the deregulated electricity market

Positive trend in the nuclear power industry seems to be apparent, but the lingering issues still remain

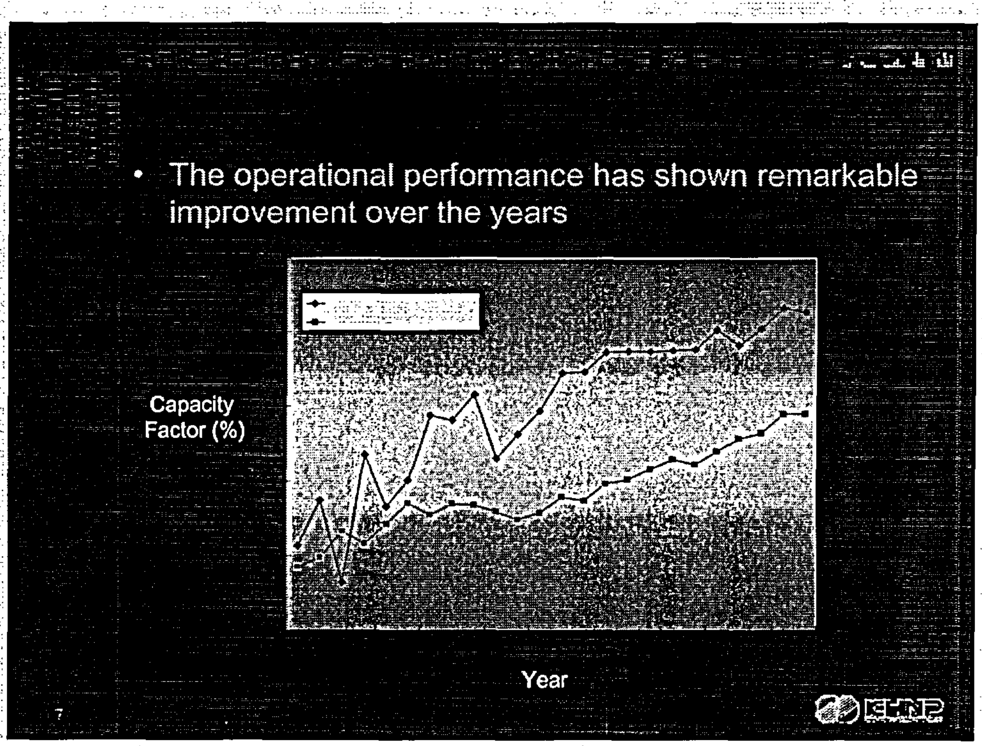
2. Status of Nuclear Power in Korea

- Nuclear power is less affected by overseas variables and almost domestic energy resource
  - A key role for energy security in Korea





Shares of Nuclear Power in 2002
Shares of Installed Capacity
Oil 8.7%
Nuclear 29.2%
Coal 29.6%
Hydro 7.2%
LNG 25.3%
Shares of Power Generation
Oil 8.2%
Nuclear 38.9%
Coal 38.5%
Hydro 1.7%
LNG 12.7%
KHNP



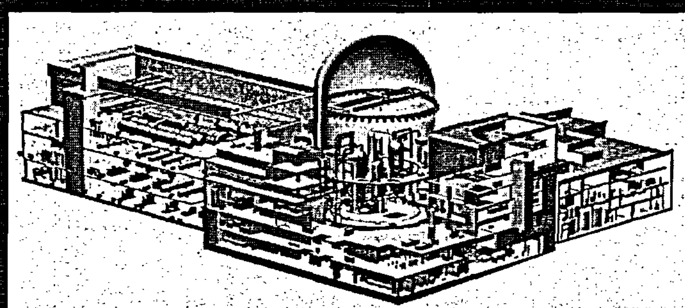
• The operational performance has shown remarkable improvement over the years
Capacity Factor (%)
Year
7
KHNP

Status of Construction: 8 Units (8,800MW)

Project		Reactor Type	Capacity (MW)	Plant Type	Commercial Operation
Ulchin	#5	PWR	1000	KSNP	June 2004
	#6	PWR	1000	KSNP	June 2005
Shin-Kori	#1	PWR	1000	KSNP	Sep. 2008(*)
	#2	PWR	1000	KSNP	Sep. 2009(*)
	#3	PWR	1400	APR1400	Sep. 2010
	#4	PWR	1400	APR1400	Sep. 2011
Shin-Wolsong	#1	PWR	1000	KSNP	Sep. 2009
	#2	PWR	1000	KSNP	Sep. 2010

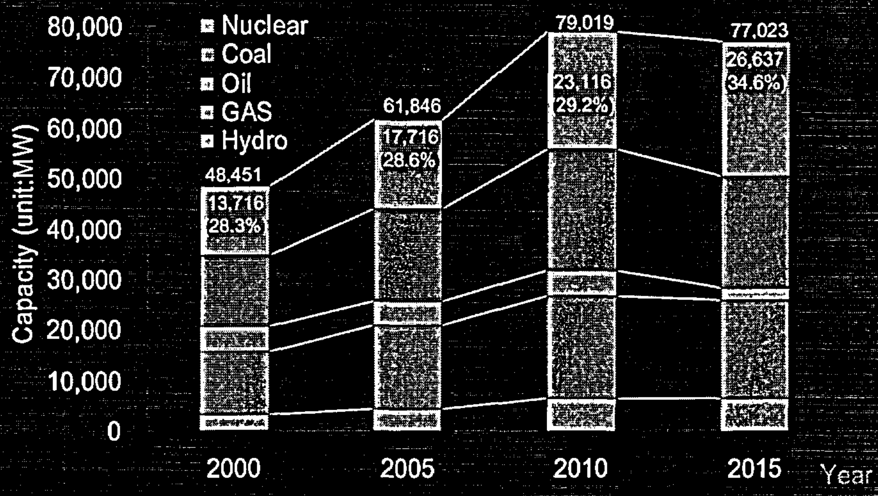
* The target dates for commercial operation are being adjusted due to the local governments' construction work approval process

APR 1400



- Advanced Power Reactor 1400
  - 1400 MWe Evolutionary PWR with safer and more competitive features
  - Developed since 1992 with the state-of-the-art technology
  - Standard Design was certified in May, 2002
  - Construction schedule was established targeting the commercial operation in 2010

Power Development Prospects



Future Prospects

- Electric power is one of the key factors in the economy.
  - Supplying high-quality and reliable power at affordable prices
  - Securing stability and diversity in energy supply are essential elements for energy portfolio.
- Maintaining nuclear power in the national energy portfolio has been an underlying consideration in Korea.
- Therefore, nuclear power in Korea is expected to take an important role in the future as well.
- However, challenges for nuclear industry to overcome are growing in Korea.

Future Development and Applications of Nuclear Power in Canada

Dave Torgerson
GENES4/ANP2003
2003 Sep 15

Canada

AECL
Atomic Energy of Canada Limited

Outline

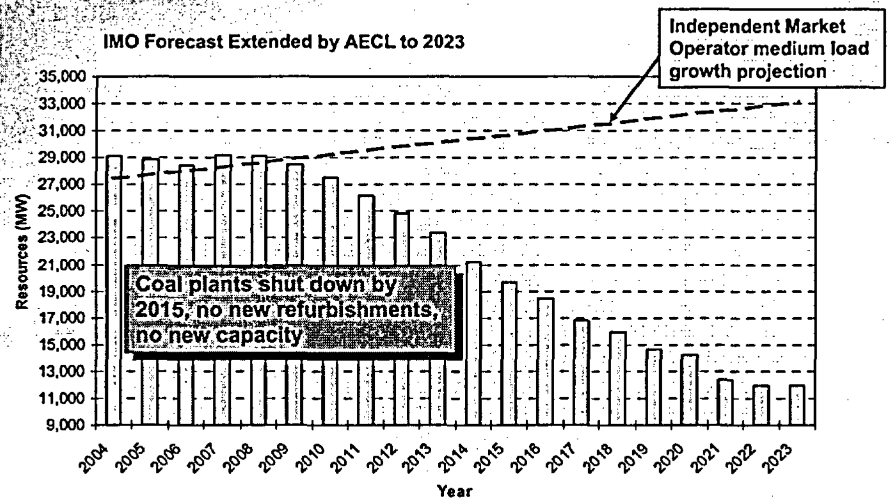
- Opportunities: new & refurbished plants
- Oil Sands Applications
- Environment/Hydrogen
- Development priorities

Refurbishments and New Builds

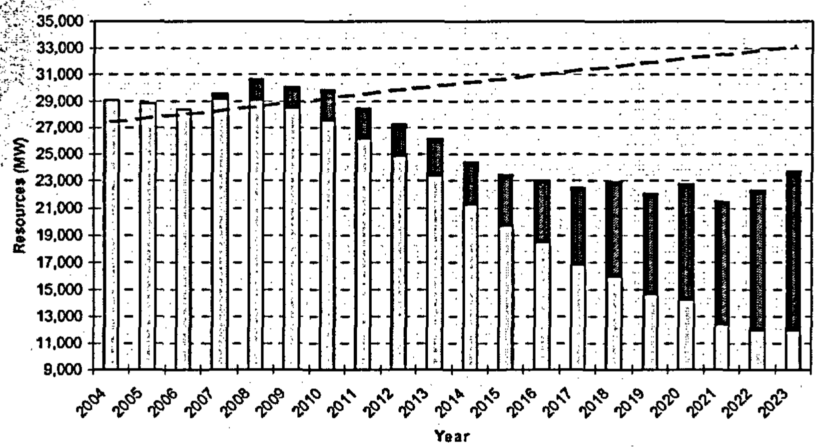
New Nuclear Plants in Canada: Potential Ontario Scenario

- Ontario situation
  - Policy Direction: phase-out coal by 2015
  - Targeting 3000 MWe of renewables
  - Ontario Independent Market Operator has predicted that demand will exceed supply by 2013
- Potential initiatives
  - Refurbishments
  - New nuclear and other plants

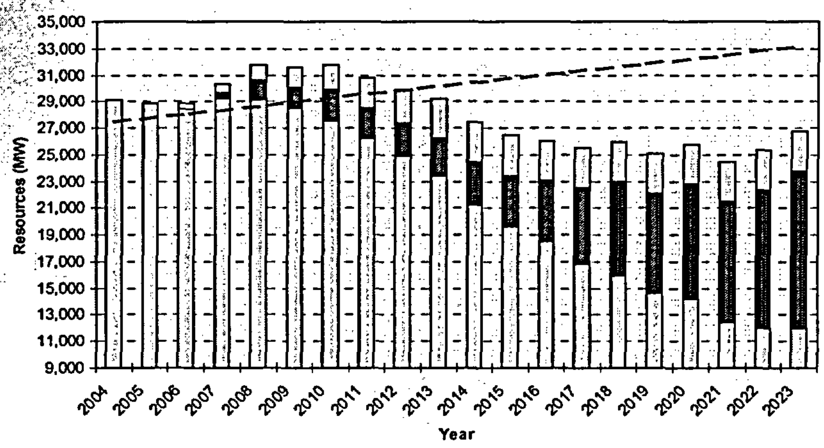
Starting Point



Add Nuclear Refurbishments

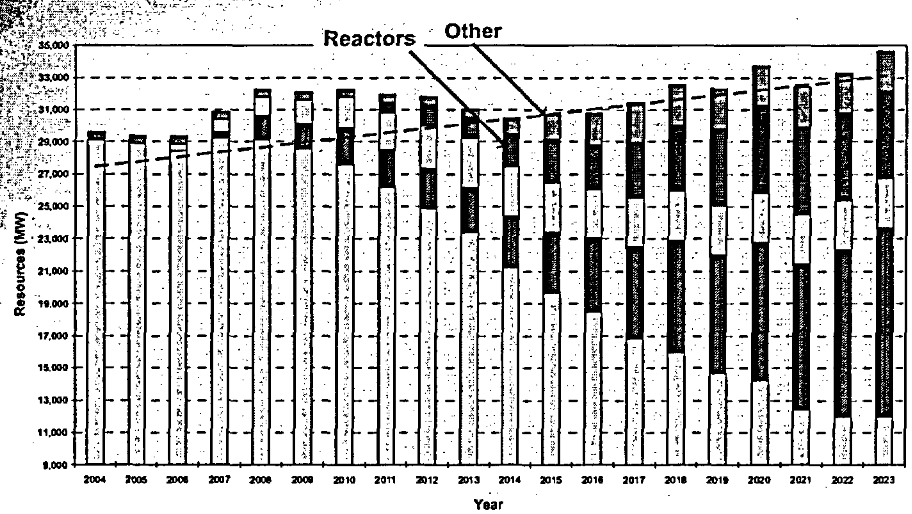


Add Renewables



Pg 7

Add New Builds

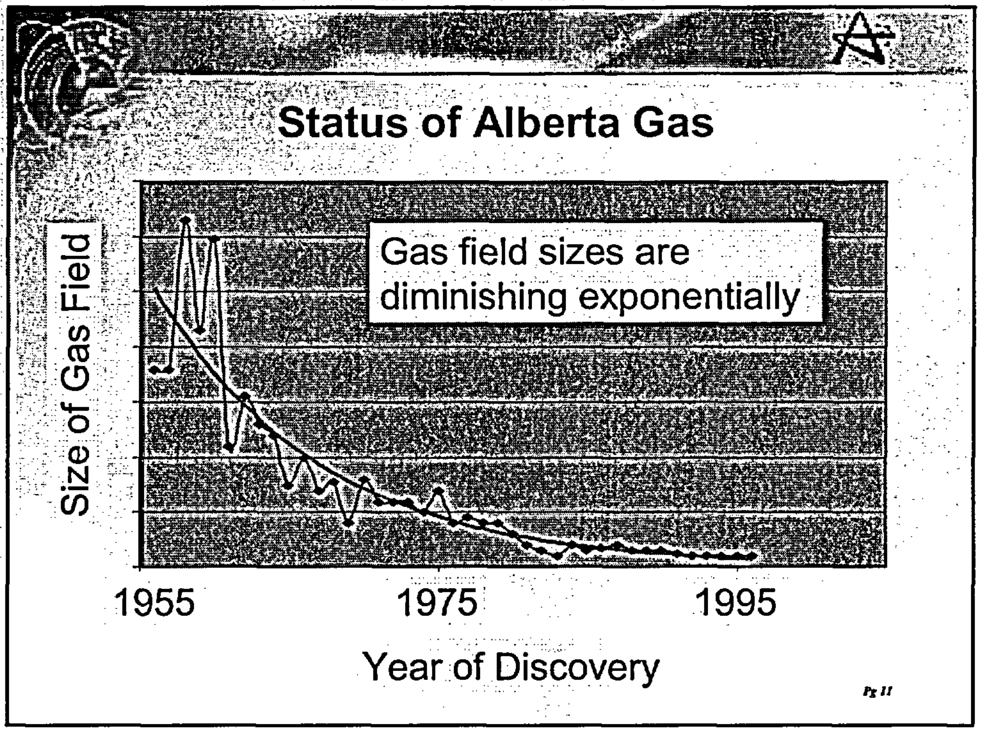


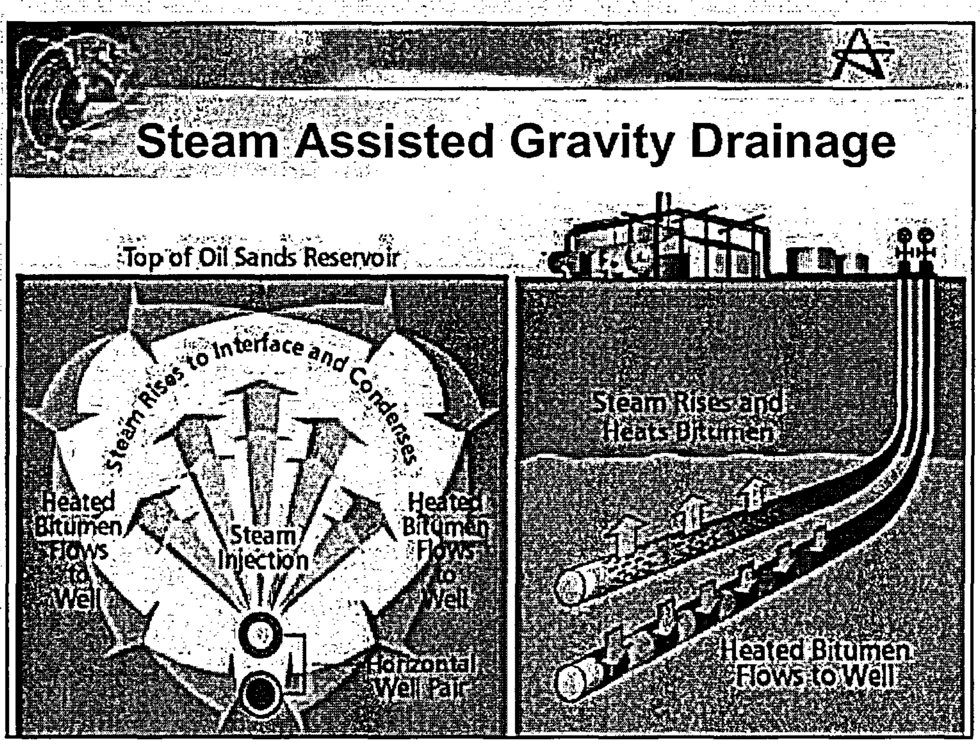
Pg 8

Oil Sands Applications

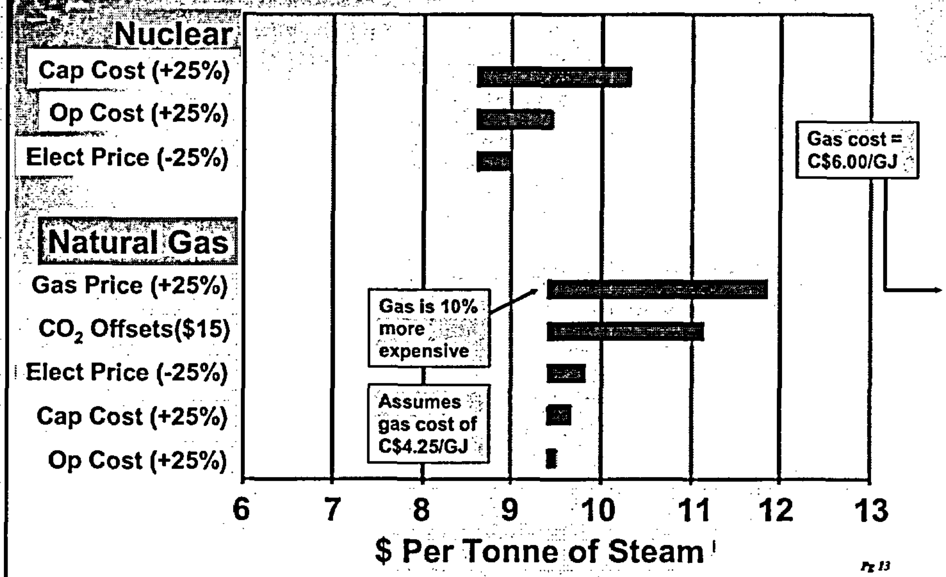
Oil Sands

- Canada has second largest oil reserves in the world
- Oil Sands crude oil production exceeds conventional crude oil production
- Mining or in-situ process
- Extraction is very energy intensive
  - Currently provided by natural gas
- Large hydrogen requirements
  - Currently provided by natural gas


Status of Alberta Gas
Gas field sizes are diminishing exponentially
Size of Gas Field
1955
1975
1995
Year of Discovery


Steam Assisted Gravity Drainage
Top of Oil Sands Reservoir
Steam Rises to Interface and Condenses
Heated Bitumen Flows to Well
Steam Injection
Heated Bitumen Flows to Well
Horizontal Well Pair
Steam Rises and Heats Bitumen
Heated Bitumen Flows to Well

Steam Costs and Cost Sensitivities: CERI Results



Nuclear Power Could Assist

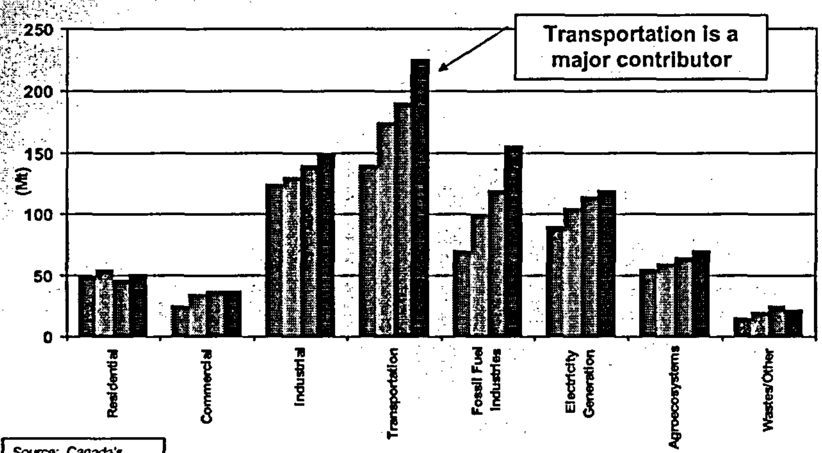
- Steam from new generation nuclear power is competitive with natural gas
- Stable costs over 30 years or more
- Sufficient fuel supply for foreseeable future
- Even more natural gas needed for hydrogen
- Nuclear power would free natural gas for other uses

Hydrogen and the Environment

Impact of Nuclear Power on GHG Reductions

- Canadian reactors have avoided ~1.4 billion tonnes of emissions since 1972
- Without nuclear plants, annual Canadian CO_2 emissions would increase by 15-20%
- Refurbished and new plants can make a large contribution to future CO_2 reduction in Canada

Canada's GHG Emissions by Sector



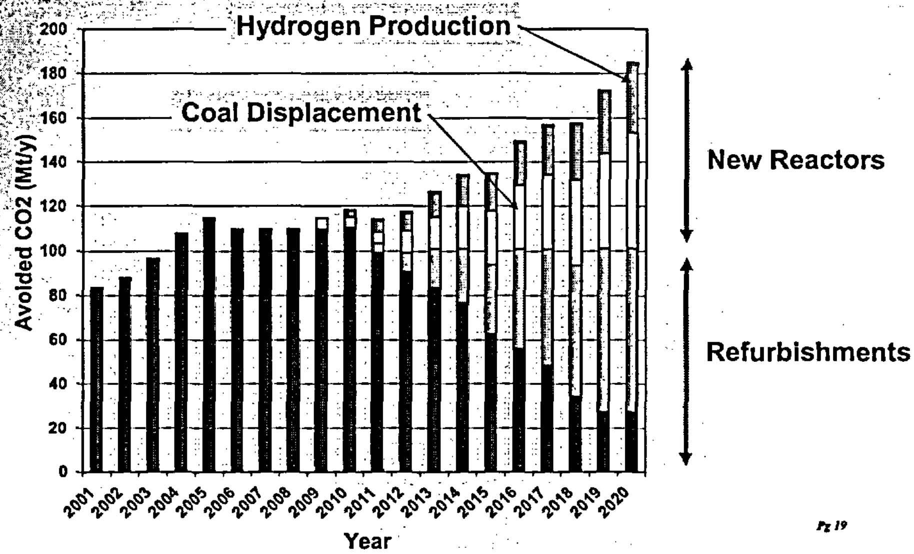
Source: Canada's Emissions Outlook: An Update 1999

Hydrogen

- H_2 sources:
  - Natural gas ($CH_4 + 2H_2O$ (steam) $= 4H_2 + CO_2$)/Other C-fuels
  - Electrolysis of water ($2H_2O = 2H_2 + O_2$)
  - Future may be high temperature electrolysis or "direct cycles"
- Natural gas is a valuable resource for heating
  - Hydrogen from natural gas produces 39% more CO_2 than simply burning the gas directly

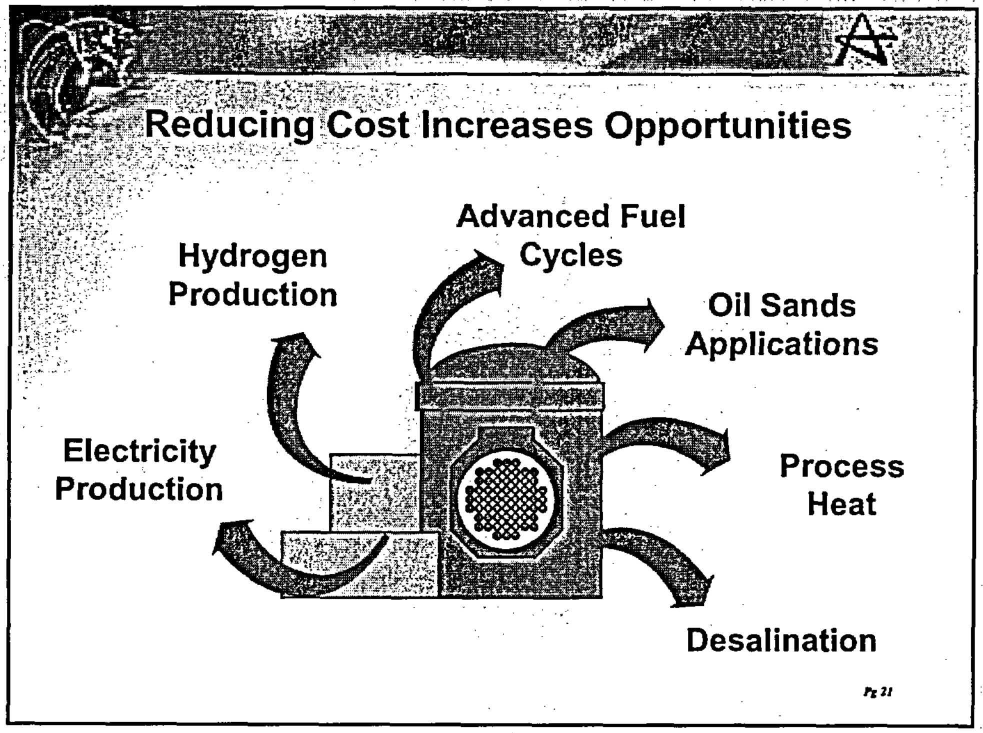
Only ~20 ACR-700 reactors could provide sufficient hydrogen for Canadian vehicles

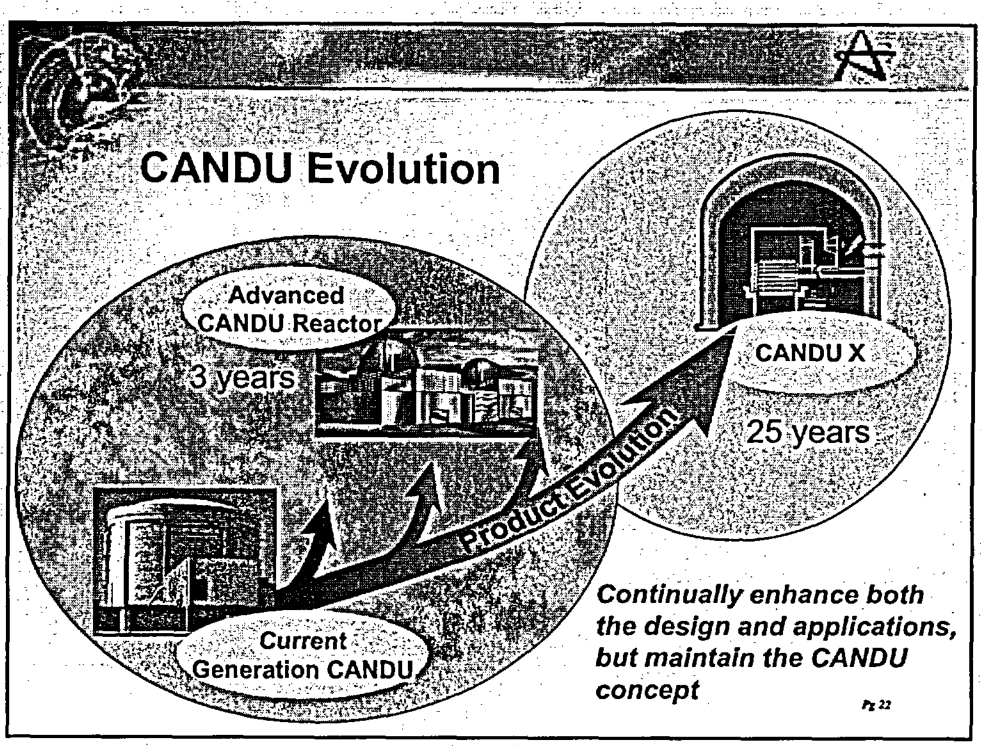
Potential for Avoided Canadian Emissions



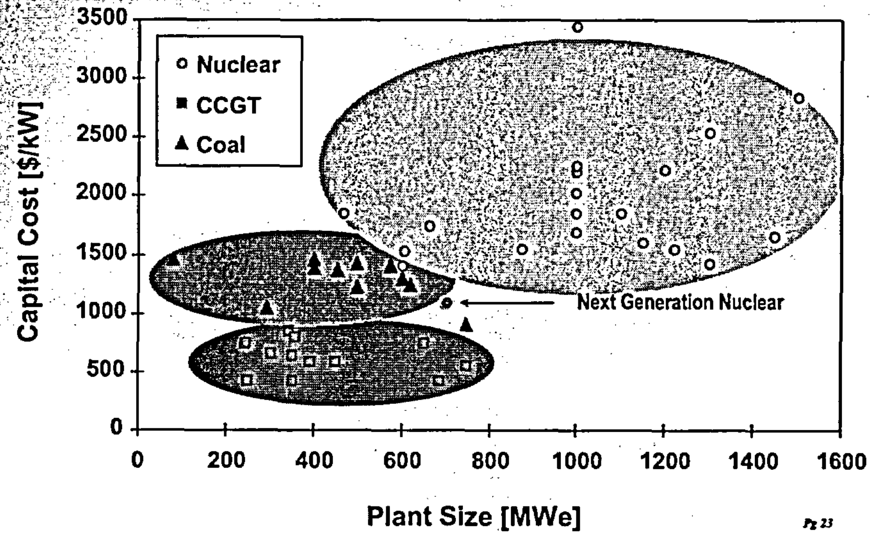
Development Strategy

(Reduce Cost)


Reducing Cost Increases Opportunities
Advanced Fuel Cycles
Hydrogen Production
Oil Sands Applications
Electricity Production
Process Heat
Desalination

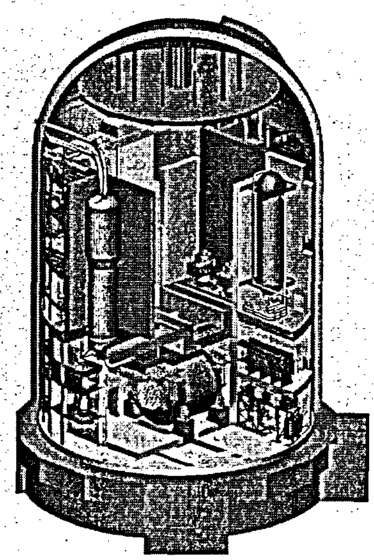

CANDU Evolution
Advanced CANDU Reactor
3 years
CANDU X
25 years
Product Evolution
Current Generation CANDU
Continually enhance both the design and applications, but maintain the CANDU concept

Capital Cost of Electricity Production



Current Focus: Advanced CANDU Reactor

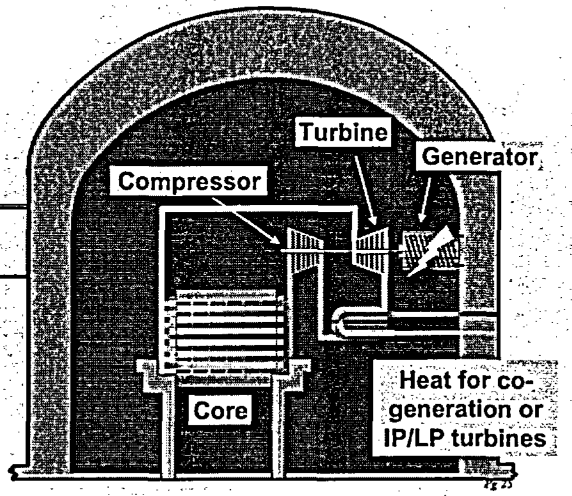
- Reduced costs
- Reduced project length
- Enhanced safety
- Enhanced operability



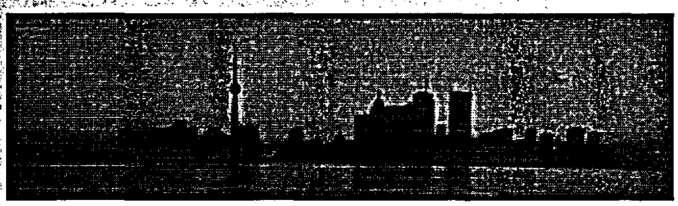
Longer-Term Vision - CANDU X

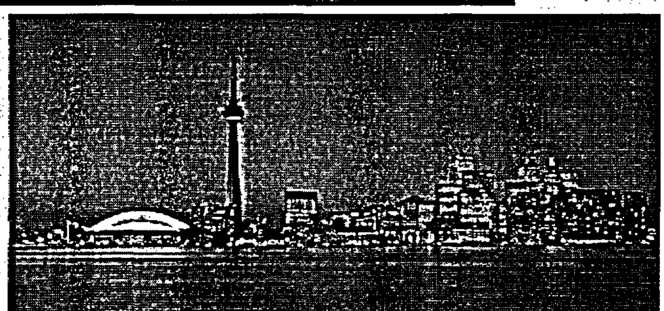
Gen IV Super Critical Water Reactor

- Even lower costs
- Much higher thermal efficiencies
- High temperature hydrogen production
- New applications ...



Toronto





AECL

William F. Martin
Chairman, Nuclear Energy Research Advisory Committee

US Perspectives on the Future of Nuclear Power

GENES4/ANP2003 Conference
Kyoto, Japan
September 16, 2003

I am honored to speak in Kyoto before this conference -- jointly sponsored by the Atomic Energy Society of Japan and the American Nuclear Society -- to provide some US perspectives on the outlook for nuclear energy.

Perspectives on the US Situation:

- The US nuclear industry is a key component of the current Administration's energy security strategy.
- Over the long-term, nuclear energy can contribute to lowering oil imports (mainly through hydrogen production) and become a central part of the US and international strategy to reduce harmful environmental emissions, including CO2 and other greenhouse gases.
- In recent years the DOE, industry and the NRC have taken a number of important steps to optimize the performance of the current fleet of US nuclear power plants.
- The industry's efforts to consolidate, improve safety and increase plant performance are paying off and have improved the economics of existing reactors.
- In terms of production, the 104 reactors operating in 31 states during 2002 set an electricity production record for the fourth straight year at 780 billion kilowatt-hours -- the industry operated at a record 91 percent capacity factor.
- Today, commercial reactors are the largest U.S. source of emissions-free electricity generation with a 72 percent share.
- The NRC is responding with improvements in the regulatory framework – moving toward risk-informed regulation, approving plant life extensions, supporting "early site permitting" for licensing construction of new reactors and responding appropriately to the post-9/11 terrorist threat environment.
- The DOE is strongly supportive of expanding R&D on advanced nuclear systems (GEN-IV), building a new reactor within the next decade and moving to ensure timely completion of the Yucca Mountain waste repository by 2010. This progress began late in the last administration and has accelerated under the Bush Administration.
- Yet, even has the industry's prospects are improving, challenges remain:
    - Capital cost projections remain high (although new advanced designs offer the potential for cost reductions).
    - Investors are concerned about length of construction (although present experience in Japan suggests that a plant can be built in five years).

- In a deregulating and increasingly short-term oriented market, utilities are not ready to make a firm commitment to building new reactors.

- The outlook for nuclear power in the US should improve as a higher natural gas price environment and constraints on coal use make building the next generation of new nuclear plants more appealing.
- The passage of comprehensive energy legislation is now pending negotiations by the House-Senate conference committee. The nuclear provisions will likely include increased support for nuclear R&D and there is also an outside chance that government-sponsored incentives for building new reactors will be added to the compromise legislation.
- President Bush, Vice President Cheney and Secretary Abraham continue to support the expansion of nuclear energy for economic, environmental and energy security reasons.

Perspectives on the Japanese Nuclear Situation

- The Japanese nuclear industry now appears to be emerging from a challenging period in which a data falsification scandal in combination with previous challenges eroded public support of nuclear energy.
- I am pleased to see in recent months that reactors closed due to the scandal are now steadily being restarted, helping to ensure that Tokyo will not face power shortages.
- The Japanese government and private sector are working hard to restore public confidence in nuclear energy and it is my hope that the Japanese people will remember that nuclear power is critical to ensuring Japan's long-term energy security.
- During the oil shocks of the early 1970s the Japanese economy was battered by its precarious dependence on Middle East oil. Today, nuclear energy is a secure source of energy for Japan.
- Almost exactly a year ago, I visited the spent fuel reprocessing plant nearing completion at Rokkasho along with Ambassador Baker and Under Secretary of Energy Card.
- We came away from that tour with a high regard for Japan's strict adherence to nuclear non-proliferation safeguards in its efforts to move forward with the spent fuel reprocessing program. Through its commitment to nonproliferation Japan stands as positive example for the world.
- I hope that the industry will be successful in its efforts to improve quality control measures related to the long-term Japanese nuclear energy program and be able to move forward in the near future with its MOX utilization plans.
- I would also note that Japan continues to build new nuclear power plants, including the BWR reactor at Higashi-Dori set for completion in 2005.
- With the recent ratification of the revised Electric Utilities Industry Law, Japan is in the midst of looking to balance the needs of deregulation with long-term plans to expand nuclear energy. The challenge Japan faces is similar to the current situation in the US – finding a way to ensure that the burden of cost recovery is shared appropriately between the public and private sectors.

US-Japan Relations and Cooperation

- US-Japan cooperation on the development of advanced nuclear systems is essential to meeting the global economic, environmental and security challenges that we face in the coming decades.
- As incoming chairman of DOE's Nuclear Energy Research Advisory Committee (NERAC) and a long-time sponsor of the Santa Fe Energy Seminar Series in collaboration with Dr. Fuji-ie and others, it is very clear to me that nuclear expansion can only be achieved if our two countries support each other through R&D and sharing our regulatory and policy experiences.
- Key R&D priorities for the DOE include moving forward on GEN-IV (with the possible development of a GEN-IV prototype at the new Idaho National Laboratory), the Advanced Fuel Cycle Initiative and the President's Hydrogen Fuel Initiative (which offers a major role for nuclear power). These are all R&D efforts where international cooperation will be essential for success.
- We will be holding the next Santa Fe seminar on November 24-25 in Washington. Key areas of discussion will include nuclear power's competitive prospects, advanced fuel cycle R&D efforts, reprocessing and nonproliferation issues and strengthening public confidence in nuclear power. Our distinguished speakers from Japan will include Dr. Fuji-ie; Mr. Fuji, President of Kansai and Chairman of FEPC; Mr. Katsumata, President of TEPCO and a number of other top executives.
- As I conclude, I would like to touch on the importance of the overall US-Japan relationship. The Bush Administration deeply appreciates the strong support it has received from Prime Minister Koizumi on foreign policy issues. The commitment of Japanese forces to help stabilize post-war Iraq is viewed very favorably in Washington.
- When it comes to strengthening energy security, I see a complementary aspect to US and Japanese efforts. Over the past several decades, the US has spent billions of dollars in defense expenditures to ensure the free flow of oil from the Middle East (much of it going to East Asia). We have undertaken these actions to help ensure a stable global oil supply. At the same time, over the past several decades Japan has invested in the development of its nuclear energy program, offsetting a substantial amount of oil imports.
- While critics have long argued that the costs associated with Japan's nuclear reprocessing program are uneconomical, particularly as the electricity sector deregulates, they fail to take into account the long-term energy security benefits of pursuing these technologies. Just as the US has paid a higher price to help stabilize the global oil supply, Japan has paid a premium to lower its dependence on imported oil. As we all know, there is a price to be paid for energy security.
- Together, the US and Japan can share our resources and know-how to ensure the development and deployment of the next generation of advanced nuclear energy systems which will be even safer and more proliferation-resistant than today's models.

Mr. Martin is Chairman of Washington Policy & Analysis, an international energy consulting firm. He currently chairs the DOE's Nuclear Energy Research Advisory Committee. He also serves as an advisor to Deputy Secretary of Defense Paul Wolfowitz. Mr. Martin previously served as Deputy Secretary of Energy and as Special Assistant to President Ronald Reagan.

Nuclear Power in Japan

Sep. 16th, 2003

Yoshihiko Sumi
President
The Japan Atomic Power Company

—#?

International Conference on Advanced Nuclear Power Plants
and Global Environment, GENES4/ANP2003
Plenary Session, Tuesday 16th September

BNFL

European Perspectives on the State of the Nuclear Industry and Future Prospects

Dr Sue Ion
(Director of Technology)

Energy and the European Union

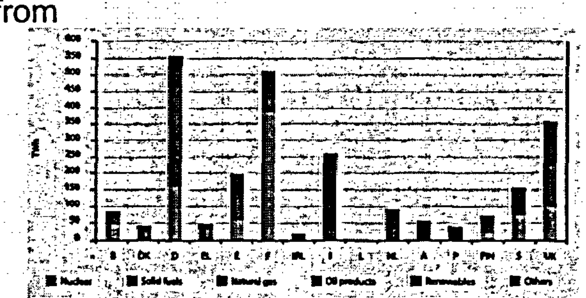
" The European Union must take better charge of its energy destiny. We are obliged to acknowledge that, despite the various crises besetting the European economy in the last 30 years, there has not been a real debate on the choice of energy sources and even less on energy policy regarding security of supply"

European Commission Green Paper, 2001

BNFL Westinghouse

Situation in EU

- EU current capacity is ~ 600 GWe
- Expected to rise to 900 GWe by 2020
- Electricity is generated from
  - nuclear (35%)
  - solid fuel (27%)
  - natural gas (16%)
  - hydro/renewables (15%)
  - oil (8%)



Source: European Commission

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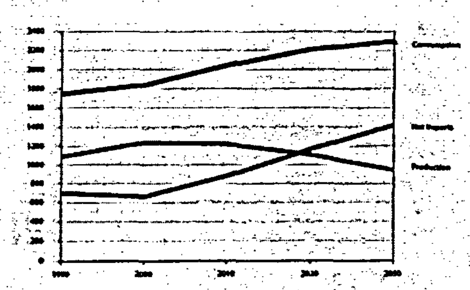
Situation in EU - 2

- World's largest energy importer
  - imports increasing - 50% today, could rise to 70% by 2030
- World's second largest energy consumer
  - consumption could rise by ~ 2% per year
- Largest predicted energy increases are in the household and transport sectors



Source: European Commission

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Future significant factors

- Depletion of North Sea oil stocks
- Nuclear power stations reaching end of operating lifetimes
- Gas demand outstripping other energy sources
- Adequacy of infrastructure investment
- Rate of renewables take-up
- Inter- European electricity trading

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Objectives for the EU

- Address reliance on energy imports
- Address rising energy demand and implications for gas/electricity infrastructure
- Achieve target reductions in greenhouse gas emissions (Kyoto and beyond)
- Achieve integrated, competitive and stable energy markets
- Keep energy security of supply under control

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Where does nuclear fit?

"Nuclear energy is, in my opinion, indispensable for the future security of European energy supplies. It is not only an important element for diversification of our supply but it also allows us to avoid several hundred million tonnes of greenhouse gases."

Loyola de Palacio, European Commission Vice President, WEC Congress 2001

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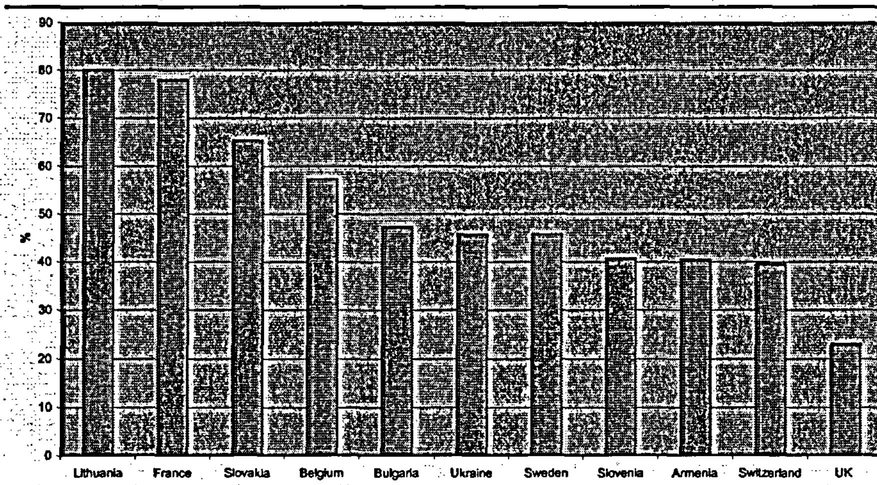
Reliance on Nuclear Power



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Europe's challenges are also the UK's challenges

UK's Energy White Paper -

"Our energy future - creating a low carbon economy"

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UK Energy Policy (White Paper) Key Points - Nuclear

- No overt support for nuclear, but the door remains open.
- Recognition that it is an important source of carbon-free electricity
- Does not rule out possibility that future new nuclear build might be necessary if carbon targets are to be met.
- However current economics make it unattractive and "Issues" around waste need to be resolved.
- There will be "the fullest" public consultation and a further White Paper before any final decision on new build is taken.

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Keeping the nuclear option open - a justification for nuclear R&D

1. Providing support for existing nuclear programme
2. Maintaining and Developing Competence in Waste management
3. Maintaining competence to Select, License and Operate New reactor designs
4. Keeping abreast of international developments in Next Generation of Nuclear Reactor Systems

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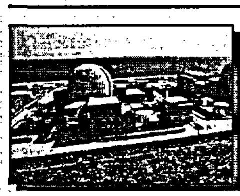
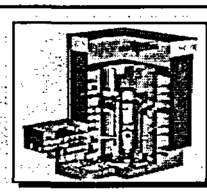
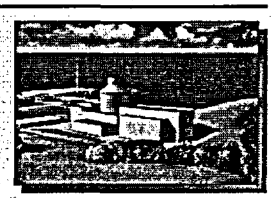
BNFL / Westinghouse Has a Broad Portfolio of Nuclear Plant Designs to Meet Projected Market Demands



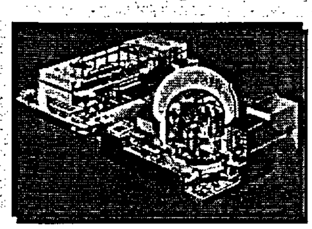
System 80 and System 80+ for Korean Program



BWR 90+ Evolutionary ALWR Design

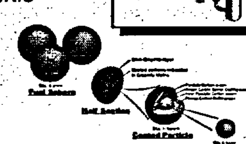


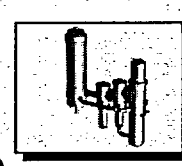
AP1000 Passive Plant

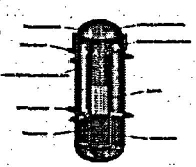


APWR in Japan

BNFL and Westinghouse are Supporting Development of the PBMR and IRIS designs







IRIS

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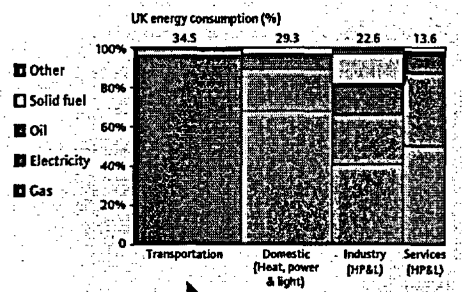
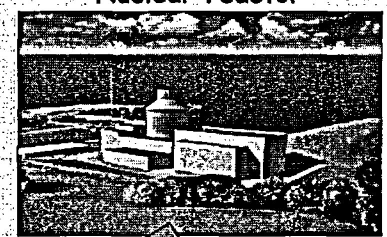
The Hydrogen Economy - certain low-carbon energy



Nuclear reactor



energy

Hydrogen Production

(eg electrolysis or thermo-chemical splitting of water)

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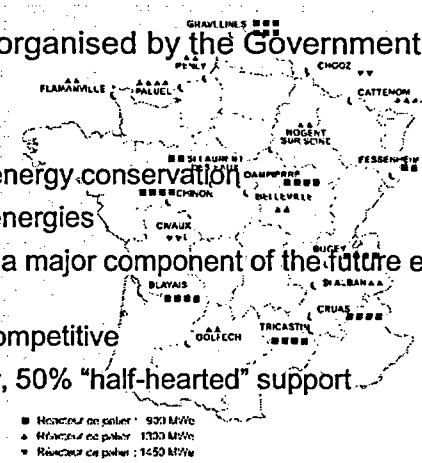
France: National Survey

- Public debate on energies organised by the Government during first half of 2003
  - efficient use of energy and energy conservation
  - development of renewable energies
  - nuclear energy shall remain a major component of the future energy mix
  - nuclear power is currently competitive
  - 25% are in favour of nuclear, 50% "half-hearted" support



Source: CEA

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France: A nuclear renaissance?

- Debate in parliament this fall for a long-term French energy supply policy
- Parliamentary commission has investigated ageing of existing nuclear reactors and new types of reactors (May 2003)
- Important to extend the life of NPP beyond 40 years
- Build a new EPR reactor
- Develop 4th generation reactors for longer term within an international framework

Source: CEA

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France: Waste Issues

- Deadline of the 1991 nuclear waste management R&D law is 2006
- Government plan to deal with nuclear waste before the end of current tenure (general election in 2007)
- Working on international consensus that deep geological repositories are proper way to dispose of long-lived waste

Source: CEA

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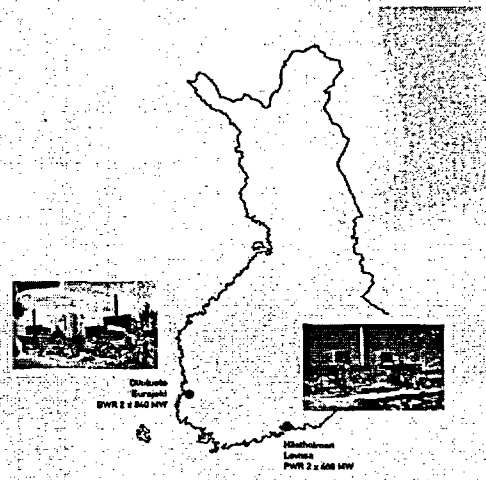
Status of Nuclear Power in Finland

- 4 operational reactors (VVR - 440's and ABB PWR's)
- Operational underground repositories for solid LLW and ILW at both reactor sites
- Interim (Wet) storage facilities exist for irradiated fuel at both reactor sites
- Approval given for final disposal of irradiated fuel in deep underground repository at Olkiluoto
- Approval given for 5th reactor



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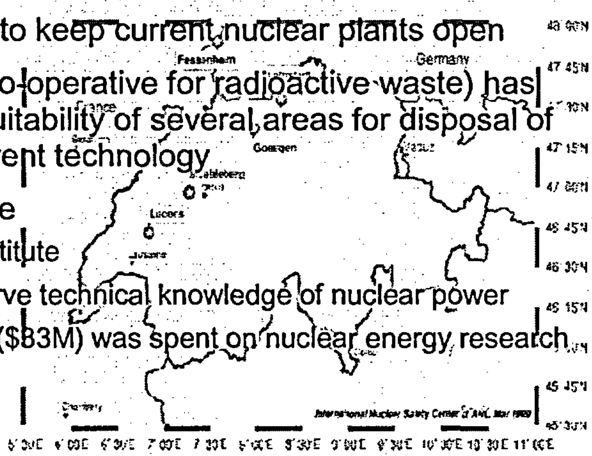
Nuclear Power in Switzerland

- Swiss people voted to keep current nuclear plants open
- NAGRA (National Co-operative for radioactive waste) has demonstrated the suitability of several areas for disposal of HLW/ILW using current technology
- Paul Sherrer Institute
  - Energy research institute
  - One aim is to preserve technical knowledge of nuclear power
  - In 2002 ~CHF 45M ($33M) was spent on nuclear energy research



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To meet the energy challenge...

- Need to understand real value of security of supply
- Recognise what components can help achieve this whilst meeting other energy/environmental objectives
- Others have already recognised that nuclear has a significant future contribution to make
  - "Nuclear Power 2010" initiative in US
  - Finland ordered 5th reactor
  - 29 projects underway around the world
  - Swiss people voted to keep nuclear
  - China approved plans to build 4 1000MW plants

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Obstacles to Implementation

- Appropriate treatment of nuclear's carbon-free benefits
- Licensing and Regulatory Approvals
- Public perception of nuclear waste
- Industrial and Government commitment to demonstrate more progress
- Long-term electricity supply contracting
- Availability of nuclear skills, expertise and experience

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Current awareness of energy

- Hydro depleted (less rain)
- Not much wind
- Contribution of gas, coal and oil to CO_2 emissions
- Nuclear curtailed due to lack of cooling water

- Energy Gap
  - *Major international security of supply issue*

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Concluding Thoughts

- Nuclear power meets the environmental and economic criteria for energy in the new millennium.
- There are new avenues for nuclear power (e.g. Hydrogen production).
- Global companies like BNFL/Westinghouse are developing reactor systems to meet future customer needs in the UK and elsewhere
- Challenges remain in to bringing new nuclear power plants into operation, however these challenges are political, rather than technical, and require Government action to help overcome them.

BNFL Westinghouse

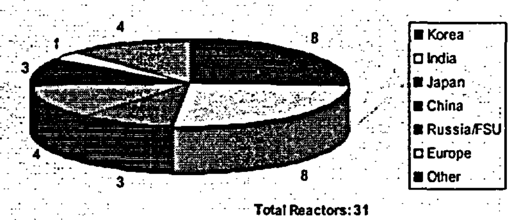
A Vendor's Perspective on the Business Climate for Advanced Nuclear Power Plants

By
Dr. Regis A. Matzie

September 17, 2003
Kyoto, Japan

A Modest New Plant Market Continues Today

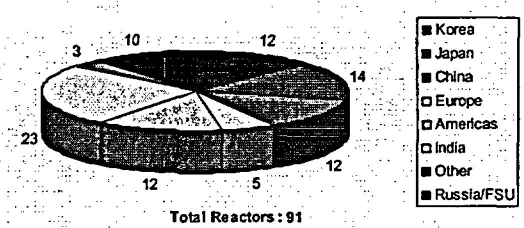
- Mostly concentrated in Asia
- Consists of Generation II and III designs primarily
- Reconfiguration of system designs to improve safety and reliability
- Advancements in materials and Instrumentations & Controls
- Characterized by National Programs



Projects Underway in 2003

Forecast Continued Modest Worldwide Market (even without a Renaissance)

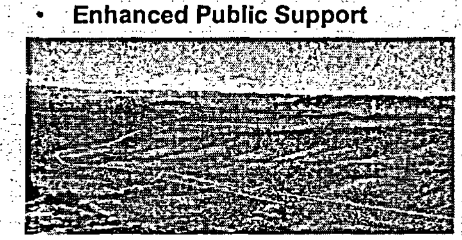
- Still dominated by New Build in Asia
- Russia expands its Nuclear Build Program
- US and Europe start to build new plants cautiously
- Some new markets emerge, e.g., South Africa



Projected Orders Through 2015

Positive Signs of Changing Attitude Toward Nuclear in US

- Yucca Mountain approved as site for repository
- Price Anderson legislation extended
- Widespread License Renewal and Power Upgrades
- New enrichment production planned
- DOE Nuclear Programs Initiated for new plants, fuel cycles, and space
- Generation IV Nuclear Energy Systems Program growing
- Congressional legislation addressing incentives for new plant construction anticipated
- Linkage between nuclear energy and hydrogen generation
- Enhanced Public Support

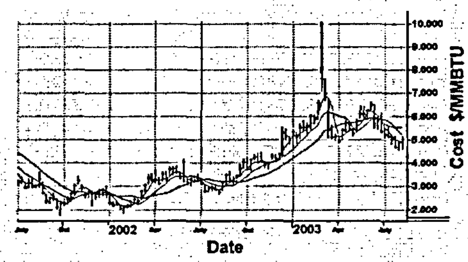


Yucca Mountain Site

What Will Drive A Nuclear Renaissance?

- Continuing excellent performance of existing reactors
- Need for base load electricity capacity
- Nuclear's contribution to clean air recognized and credited
- Importance of energy security and/or diversity included in capacity planning
- Competitive economics of new nuclear plants compared to alternatives
- Government support and/or incentives for initial projects
- Strong tie between nuclear and hydrogen economy

Natural Gas Price



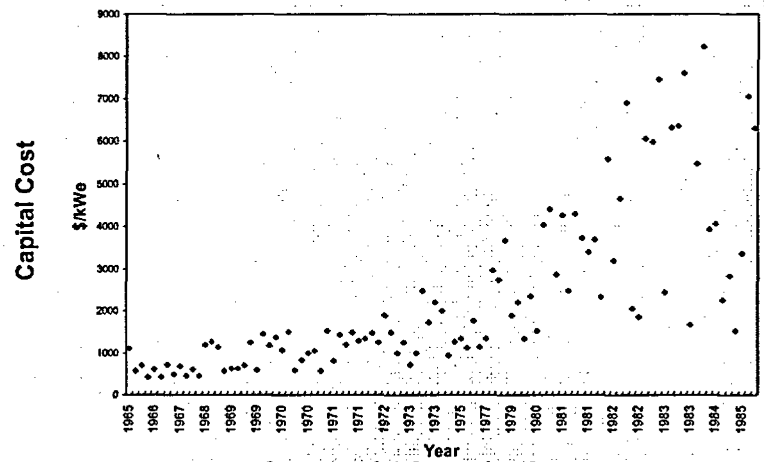
Critical Issues for New Plants in US

- Capital Cost of the Plant
  - Historical record of meeting project targets sporadic
  - Long time since start of last project
  - Current lack of skilled workforce
  - Complicated design of past plants
  - Vast majority of current plants were custom designed

Reluctance to Accept Current Cost Estimates

Capital Cost of Existing US Nuclear Plants

(Year 2000 $/kWe, including interest / AFUDC)



Commercial Operation Date

Critical Issues for New Plants in US (Cont'd)

- Perceived Risk of a Construction Project
  - Local public or anti-nuclear group opposition
  - Permitting delays
  - Design changes after project start
  - First time implementation of new regulatory processes
  - Regulatory changes after construction start
  - Procurement and/or construction delays
  - Increased concerns over fuel disposal issues
  - Latent technical defects found after start of operations
  - Electric market / price fluctuations

Financial Community Concerns Manifested by Unwillingness to Provide Project Financing

How We Will Achieve a Competitive Capital Cost

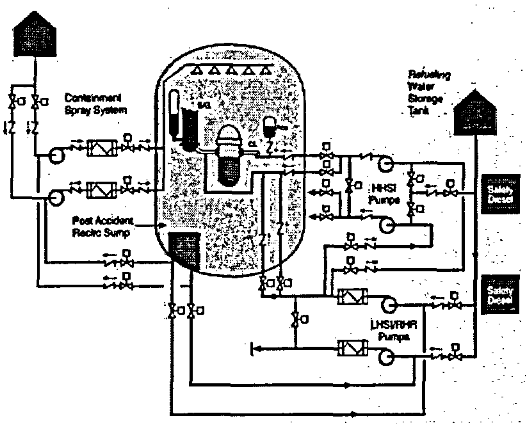
- Basic Design - Simplification
- Power Level - Economics of Scale
- Project Schedule - It Must be Short
- Standardization - A Necessary Commitment
- Modularization - An Integral Part of the Design Process
- Information Technology - Use of Advanced Information Management System
- Project Organization and Structure - Sharing Risk and Rewards

Simplicity of Design Drives Economics

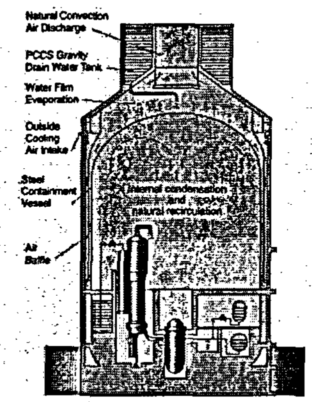
- Simplicity in Design through reduced number of components and bulk commodities
- Simplicity in Safety through use of passive safety systems
- Simplicity in Procurement through standardization of components from strategic suppliers
- Simplicity in Operation and Maintenance through use of proven standardized systems, components and procedures, and man-machine interface advancements

Simplification of Safety Systems in Advanced Passive Plants

Standard PWR



AP1000

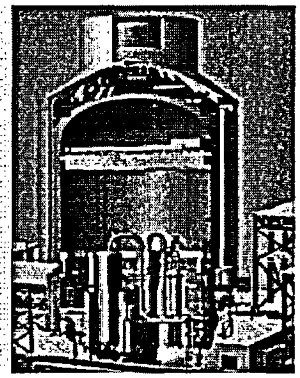


How We Will Reduce the Perceived Risk of a Construction Project

- Improved and Tested Regulatory Processes
  - Standard Plant Licensing Regulation (10CFR52)
  - Implementing Guidance, e.g., Construction Inspection Procedures, ITAAC Procedures
- Government Support for Initial Projects
  - Grants for early activities, e.g., design certification, early site permits, combined construction and operating licenses, and first-of-a-kind engineering
  - Direct loans or loan guarantees (problematic at this time)
  - Accelerating the depreciation schedule
  - Providing investment tax credits
  - Establishing production tax credits
  - Obtaining long-term power purchase agreements

The Path Forward - Standardized ALWRs

- Maturity of Design
  - High level of design detail
  - Already licensed
- Availability of Components
  - Supply chain exists
  - Competition through worldwide sourcing
- Understanding by Regulator
  - Large body of regulatory guidance
  - Implementing procedures
- Operator Familiarity
  - Operating philosophy well grounded
  - Easy transition from prior LWR experience



If ALWRs are not built soon, the industry will not be capable of building other plants later

Westinghouse's View of Viability of New Nuclear Projects in the US

- New ALWR designs are today competitive with fossil alternatives
- They will be needed because of the volatility of natural gas prices and the predictability of nuclear costs
- National concerns regarding energy security and environment will help "tip the scales"
- US Government will need to provide incentives for the first new plants to address first time costs and reduce financial risks

Westinghouse's View of Viability of New Nuclear Projects in the US (Cont'd)

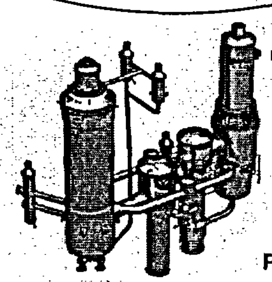
- Generation IV designs have enormous challenges to commercialize
  - Technologies stretch our capabilities, particularly in the materials area
  - Economic hurdles will be even more difficult
  - Very High Temperature Reactor (VHTR) is the most promising
- The tie of nuclear to carbon free generation of hydrogen can jump start the VHTR
  - Nuclear co-generation project proposed in draft Congressional legislation

PBMR Provides Bridge to Generation IV VHTR Design

PBMR R&D
- Fuel Particle Manufacture & Testing
- Materials Qualification (900 C outlet temperature)
- Helium Systems Design
- Computer Codes Verification

VHTR

VHTR R&D
- CFRC and Metallic Materials Development (1200 C outlet temperature)
- IHX for Process Heat & Hydrogen Production
- Advanced Fuel Particle Design
  - Accident Temperature ~2000 C
  - Burnup >200 GWd/t
  - Improved oxidation resistance



PBMR

Westinghouse Believes there Can be a Nuclear Renaissance in the U.S.

Let's all work together to make it Happen !

The Promise of New Nuclear

Dan R. Keuter
Vice President, Nuclear Business Development
Entergy Nuclear

International Conference on Global Environment and Energy Systems IV and Advanced Nuclear Power 2003

September 16, 2003, Kyoto, Japan

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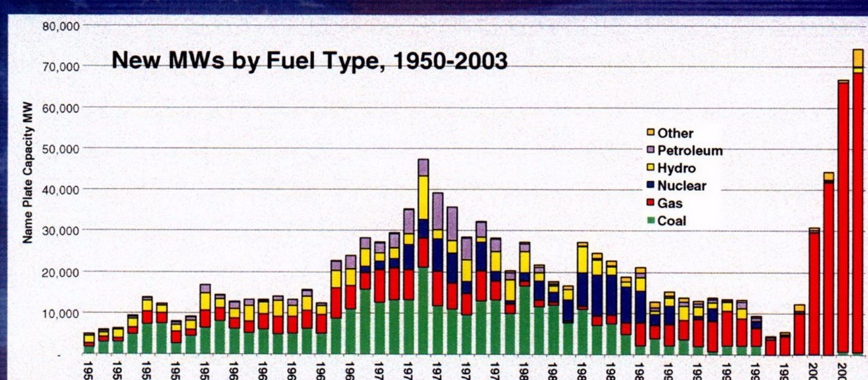
We Cannot Keep On Like This



We need energy diversity.

GO NUKE:
Because you **care** about the **Air**

NEI and Utility Data Institute

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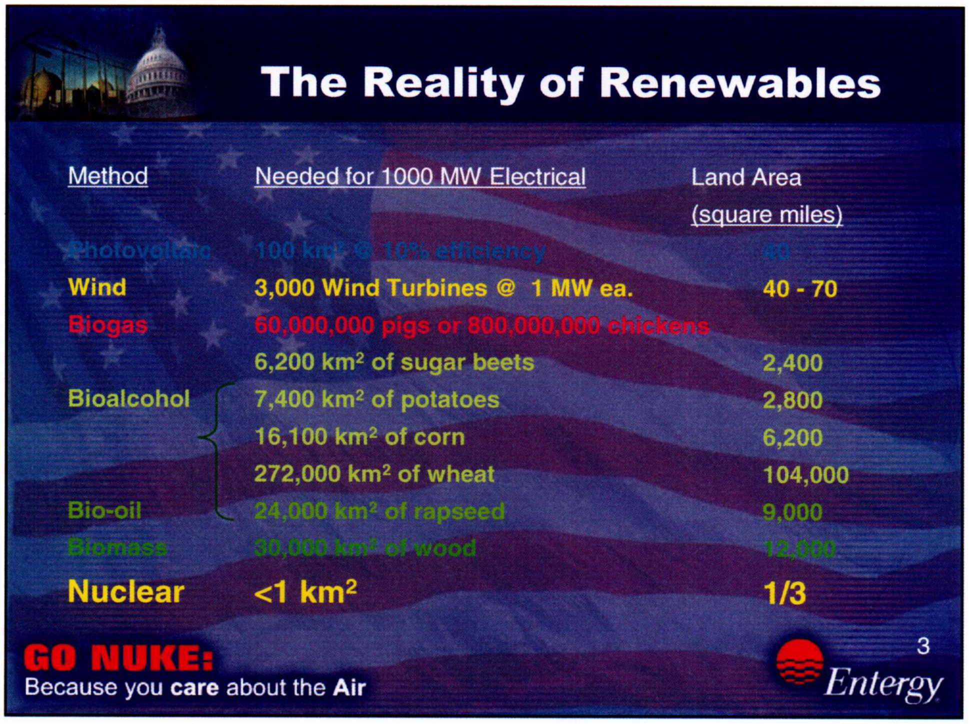

The Reality of Renewables

Method	Needed for 1000 MW Electrical	Land Area (square miles)
Photovoltaic	100 km² @ 10% efficiency	40
Wind	3,000 Wind Turbines @ 1 MW ea.	40 - 70
Biogas	60,000,000 pigs or 800,000,000 chickens	
	6,200 km² of sugar beets	2,400
Bioalcohol	7,400 km² of potatoes	2,800
	16,100 km² of corn	6,200
	272,000 km² of wheat	104,000
Bio-oil	24,000 km² of rapseed	9,000
Biomass	30,000 km² of wood	12,000
Nuclear	<1 km²	1/3

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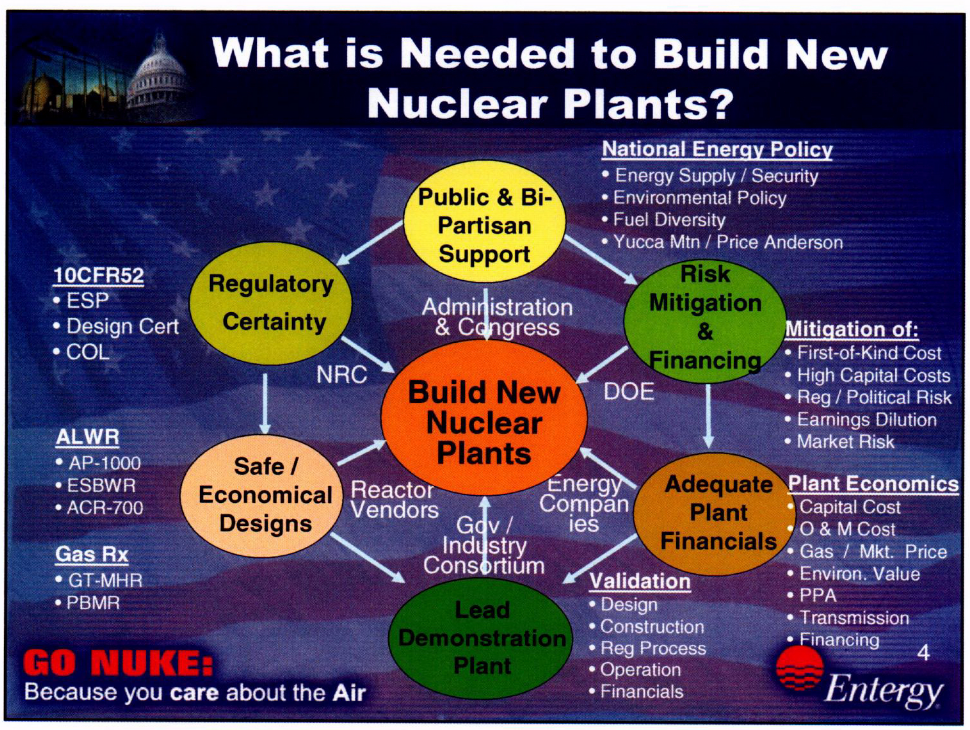

Entergy Nuclear's 2-track approach

- Selection and deployment of Advanced Light Water Reactor (Track 1)
  - Maturity of technology permits earliest deployment
  - Increases U.S. fuel diversity (reduces dependence on fossil fuels)
  - Reduces production of greenhouse gases
- Selection and deployment of High Temperature Gas Reactor (Track 2)
  - Technology most suited for low-cost, large volume hydrogen
  - Improved safety to near meltdown proof
  - Increase proliferation resistance
  - Long-term domestic fuel

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Advanced Light Water Designs

Risk

No Design Cert	GT-MHR ESBWR	PBMR ACR700	IRIS
Design Cert		AP1000	AP600 Sys 80+
Been Built	CCGT Coal		ABWR
	<$30/MwHr <$1000/KW <$10/MwHr		>$40/MwHr >$1500/KW >$15/MwHr

Cost

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Goals to Build First Plant

- Consortium of 4-5 utilities
- Validate design, construction, regulatory, financials, O&M
- Common site with transmission to all owners
- One reactor with option for second unit
- Break ground by 2008 & operate by 2012
- Competitive bid of at least 2 designs
- Phased Schedule with decision points to continue
- Government support for FOAK costs, financing, risk

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Mitigating Financial Risk

Risk	Mitigation
Delays caused by regulatory, political	Government cover interest cost during regulatory delays
High capital cost	Direct, non-recourse government loan OR Government guaranteed loan AND Accelerated depreciation (15 to 7 yrs)
Earnings dilution during construction	Investment OR production tax credit (like wind turbines) OR accelerated depreciation
Market price and risk	Power purchase agreement OR price guarantee
First of a kind costs, government fees	Federal R&D support of new Rx designs AND COL, either direct investment or loans

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Long Term Sustainability

- After lead plants, government support should diminish
  - Conventional debt should be available
  - Retain 7-year accelerated depreciation
  - Need program to provide long-term infrastructure financing for large capital projects (coal, nuclear, transmission, refineries)
  - Need long-term PPAs with regulated distribution company
  - Nth of a kind costs should be less than for initial units, ~\$1000/KWe
  - Need Environmental Value for long-term sustainability
    - Cap & Trade Process for NO_x, SO_2, Hg & CO_2
    - Allocations of Credits Based on MWH Output or Auctions

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Environmental Value of Nuclear

2001 Avoided Air Emissions (assuming fossil mix) E-GRID

* No current market, estimated based on \$2/MWH

	Tons	Price (\$/ST)	Value
SO_2	4.1×10^6	\$160	\$ 656 M
NO_x	0.6×10^6	\$6500	\$ 3,900 M
Hg	*	*	\$ 1,590 M
CO_2	769×10^6	\$5	\$ 3,847 M

\$ 10 Billion in 2001 alone

Nuclear generation has avoided substantial costs for fossil plants but has not been compensated

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Environmental Legislation Needed

- Four air pollutants controlled (SO_2, NO_x, Hg, CO_2)
- Cap and trade control for flexibility
- Auction based on generation output regardless of fuel

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What is the Future ?

What if I Told You There is a Solution To:

- Safe Clean & Economical Electric Supply
- Air Pollution & Global Warming
- Over-dependence on Foreign Energy Sources
- Eliminating Stockpiles of Nuclear Weapons Materials
- Disposal of High Level Radioactive Waste
- Preserving Oil & Gas Resources for Future Generations

The Solution is a New Advanced Nuclear Plant:

- Super Safe / Meltdown Proof / Terrorist Hardened
- 50% More Efficient in Making Electricity
- Can Burn Weapons Grade Plutonium & Highly Enriched Uranium
- Economical Production of Hydrogen from Water
- Eliminates Long-Lived Radioactive Waste
- Effective Way to Desalinate Water

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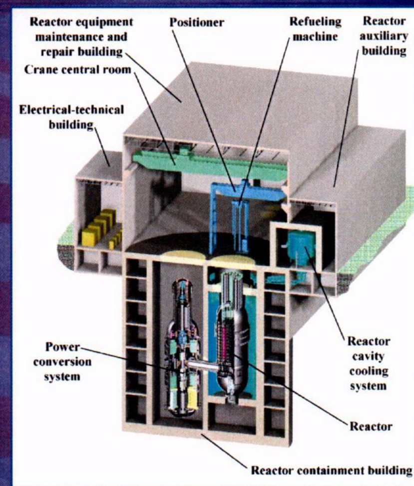
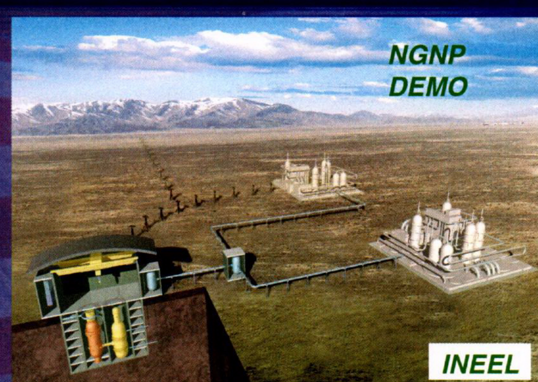
The Freedom Reactor©

- **Modular Construction**
  - 288 MWe / Unit - - 4 Units / Site
  - Simple Design & Factory Built
  - Significantly Less Expensive Equipment
  - Below Grade Silo & Terrorist Hardened
- **Low Cost**
  - Construction Time < 3 years
  - Capital Cost ~ $1120/kW (n^th-of-a-kind)
  - O&M + Fuel Costs < $15 / MWHr)
  - Low Staffing Levels
  - Low Decommissioning Costs
- **Proven Demonstrated Technologies**
  - 40 Years - Gas Reactor Experience
  - Core / Fuel Design - Fort St. Vrain
  - State-of-the-Art Large Turbine Design
  - New Compact Heat Exchangers



Thermo-Chemical Water-Splitting

High temperature electrolysis – four ways
- Sulfur Iodine
- Westinghouse hybrid
- Sulfur bromine
- Copper Chlorine (Argonne low temperature cycle)



Gas reactors can produce large volumes of hydrogen at low cost without emissions

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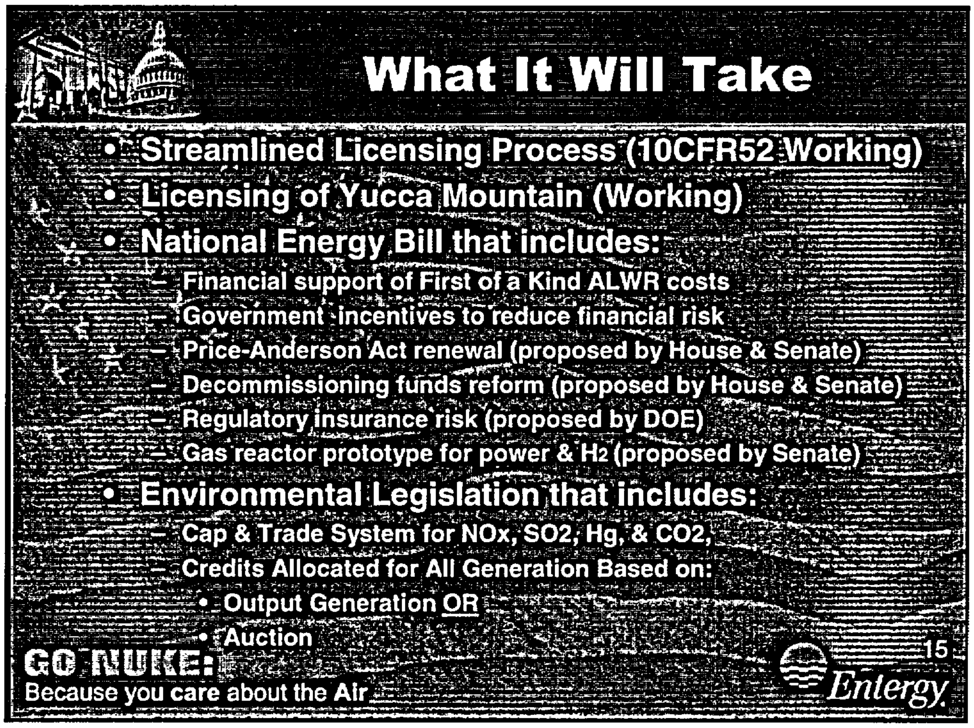
What It Will Take
• Streamlined Licensing Process (10CFR52 Working)
• Licensing of Yucca Mountain (Working)
• National Energy Bill that includes:
– Financial support of First of a Kind ALWR costs
– Government incentives to reduce financial risk
– Price-Anderson Act renewal (proposed by House & Senate)
– Decommissioning funds reform (proposed by House & Senate)
– Regulatory insurance risk (proposed by DOE)
– Gas reactor prototype for power & H2 (proposed by Senate)
• Environmental Legislation that includes:
– Cap & Trade System for NOx, SO2, Hg, & CO2,
– Credits Allocated for All Generation Based on:
• Output Generation OR
• Auction
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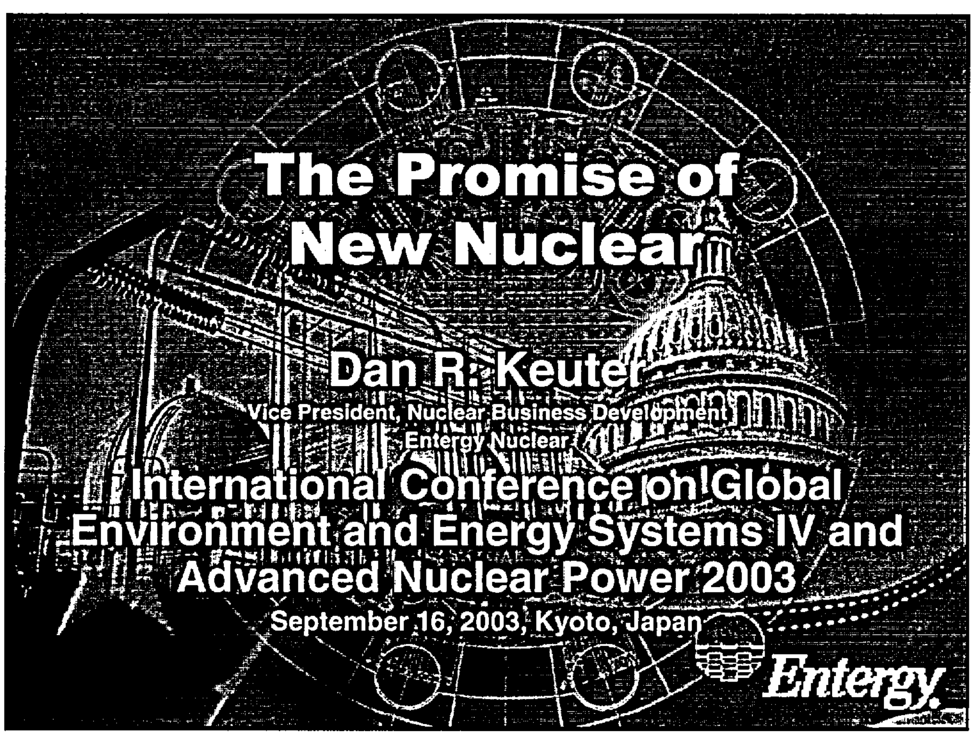
The Promise of New Nuclear
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International Conference on Global Environment and Energy Systems IV and Advanced Nuclear Power 2003
September 16, 2003, Kyoto, Japan
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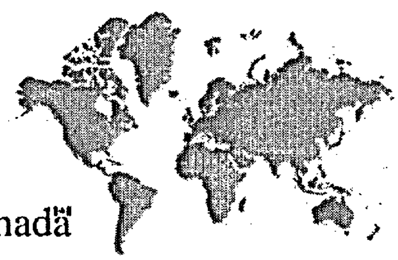
Creating the Winning Conditions for a North American Nuclear Renaissance and ACR Program Status

Ken Hedges
GENES4/ANP 2003 Conference
Kyoto, Japan
September 2003



Canadä

AECL
Atomic Energy of Canada Limited

The Challenge

Expectations for a renaissance:

- US:

"The NEPD Group recommends that the President support the expansion of nuclear energy in the United States as a major component of our National Energy Policy."
US National Energy Policy [for the Bush Administration], page 5-17, May 2001.

- Canada:

Ontario Conservation and Supply Task Force created to identify barriers to the development of long-term electricity supply, including nuclear, and recommend solutions
June 2003

So why aren't we there yet?

Common Perception...

- Nuclear
  - Cost is high
  - Projects are long
  - Generally over budget and late
- This thinking is pervasive
  - Government (EIA and CBO)
  - Financial Institutions (S&P)
  - Academics (MIT)

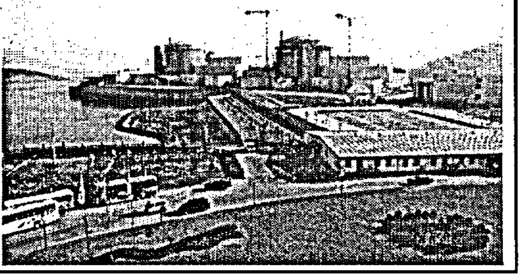
AECL's Reality as a Vendor...

In-Service Date	Plant	Status
1996	Cernavoda Unit 1, Romania	On budget, on schedule
1997	Wolsong Unit 2, Korea	On budget, on schedule
1998/99	Wolsong Units 3 and 4, Korea	On budget, on schedule
2003	Qinshan Phase III, Unit 1, China	On budget, ahead of schedule
2003	Qinshan Phase III, Unit 2, China	On budget, ahead of schedule
2006	Cernavoda Unit 2, Romania	On-going

China Project

Contract signed on 26 Nov 1997
Contract effective date was 12 Feb 1997

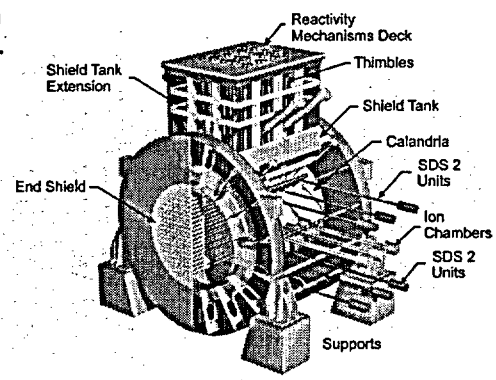
	Gross Output (MWe)	First Concrete	Projected First Criticality	Actual First Criticality	Projected In-Service Date	Actual In-Service Date
Unit 1	728	8 Jun 1998	Oct 2002	20 Sept 2002	12 Feb 2003	31 Dec 2002
Unit 2	728	24 Sept 1998	July 2003	29 Apr 2003	12 Nov 2003	9 July 2003



ACR – Power Reactor for the Longer-Term

- Based on proven and highly successful CANDU 6 design
- Meeting the needs of the de-regulated marketplace

- Low cost
- Short schedule
- Proven and innovative reactor design
- Advanced construction and delivery technologies
- Enhanced safety
- High performance
- Longer plant life



ACR Cost Reductions

Reduction from CANDU 6	Cost Reduction	Notes
Reduction of heavy water due to core optimization	7.5%	Heavy water volume reduced by 75%
Reactor core size reduction from core optimization	6%	100 fewer fuel channels
Systems & Components Innovations	11.5%	Elimination, simplification, improved materials
Balance of Plant Optimization	5%	Size of turbine hall reduced by 1/3
Modularization, Engineering Tools, Constructability Advances	10%	Open top construction, manufacturing technology
Total Cost Reduction	40%	

Experience Builds Confidence

- AECL is developing business models to meet the needs of investor driven customers in deregulated electricity markets
- AECL has strong partnerships to deliver new nuclear projects (e.g. Hitachi, Bechtel)
- AECL is prepared to take commercial risk with "turn-key" project model
- Project model has been successfully applied in previous CANDU projects globally
- These are important building blocks in managing risk for both utilities and financial institutions

Is this enough?

Ongoing Issues

- Regulatory Risk
  - New processes are not yet proven in the US
- Market Risk
  - Deregulation is in its early days and markets are still evolving
- Public Acceptance Risks
  - Support is high and growing, but opposition is well organized and effective
- Financial Risk
  - EPS dilution and ability to attract debt and equity financing is of concern to utilities, particularly for early units

Creating the Right Environment
The Role of Government

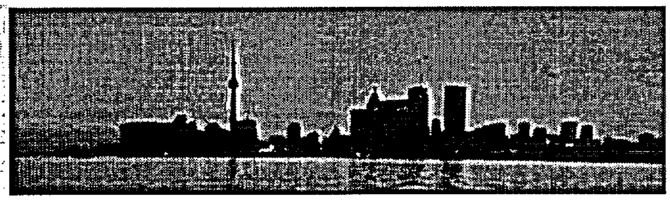
- Governments must provide the necessary leadership to help manage these risks
  - Help demonstrate the regulatory process
  - Help mitigate market risk (e.g. PPAs)
  - Create incentives for building the first units
- For example
  - US: comprehensive energy legislation is progressing to move these issues forward; expectations are high
  - Canada: Ontario government has introduced tax incentives for clean technology, including nuclear

ACR 700 – Ready for Deployment

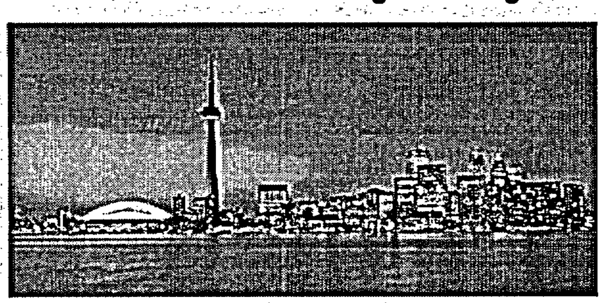
- ACR: In-service in 2011 (Canada) and 2012 (US)
  - Staff of 300 in place
  - Concept is complete
  - Construction strategy and schedule defined
  - Concurrent licensing in Canada and US

AECL's Contribution

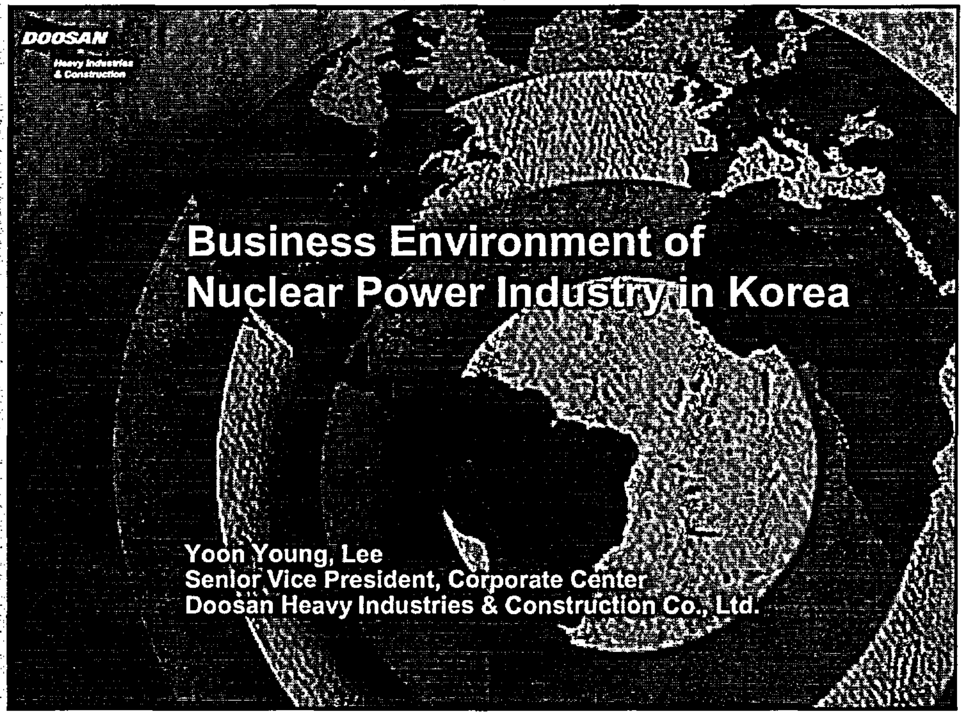
- Cost competitive ACR product
- Turnkey project model
- Successful delivery system
- Experienced and successful project team
- Active licensing program

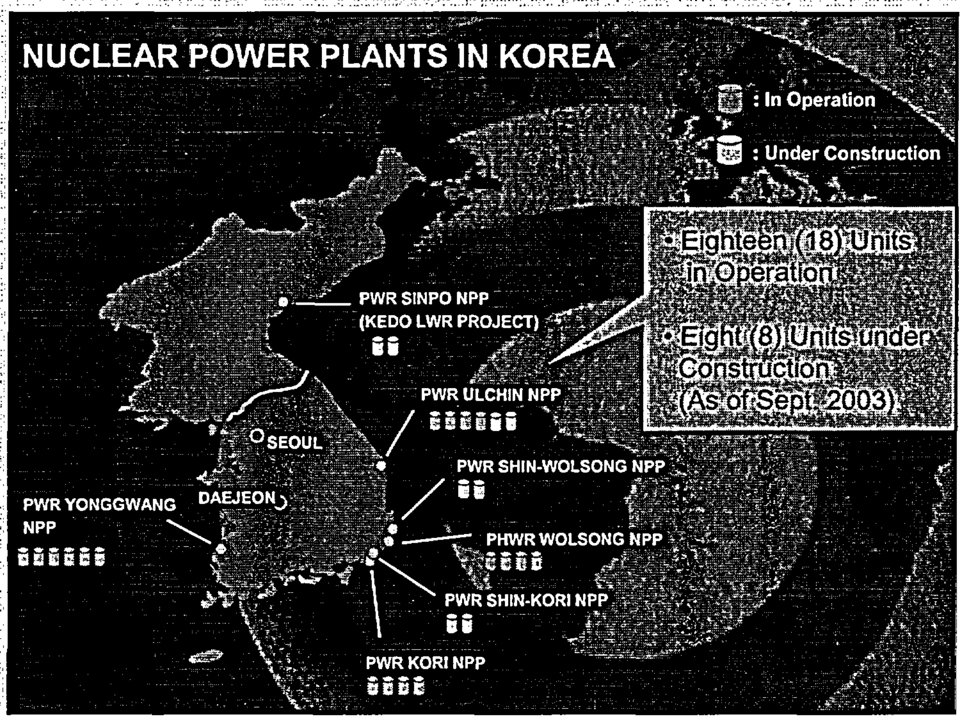


Leadership and cooperation amongst government, utilities, financial institutions and vendor groups will enable us all to meet the challenge and begin the renaissance.



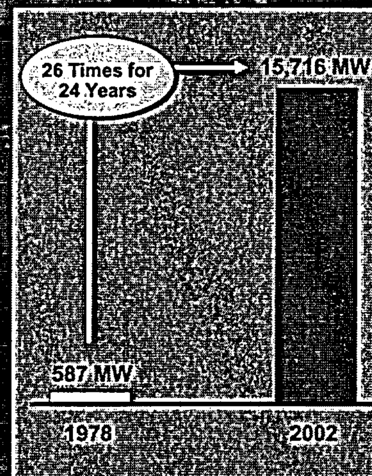
AECL


DOOSAN
Heavy Industries & Construction
Business Environment of
Nuclear Power Industry in Korea
Yoon Young, Lee
Senior Vice President, Corporate Center
Doosan Heavy Industries & Construction Co., Ltd.


NUCLEAR POWER PLANTS IN KOREA
: In Operation
: Under Construction
• Eighteen (18) Units in Operation
• Eight (8) Units under Construction (As of Sept. 2003)
PWR SINPO NPP (KEDO LWR PROJECT)
PWR ULCHIN NPP
SEOUL
DAEJEON
PWR SHIN-WOLSONG NPP
PWR YONGGWANG NPP
PHWR WOLSONG NPP
PWR SHIN-KORI NPP
PWR KORI NPP

NUCLEAR POWER PLANTS IN OPERATION

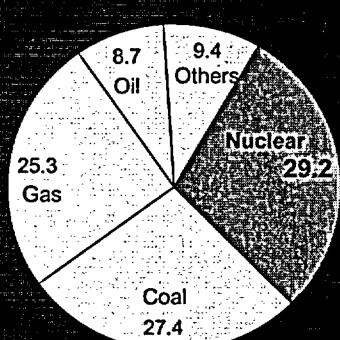
Plant	Reactor Type	Capacity (MW)	Operation Date
• Kori #1	• PWR	• 587	• 1978.04
• Kori #2	• PWR	• 650	• 1983.07
• Kori #3	• PWR	• 950	• 1985.09
• Kori #4	• PWR	• 950	• 1986.04
• Wolsong #1	• PHWR	• 678.7	• 1983.04
• Wolsong #2	• PHWR	• 700	• 1997.06
• Wolsong #3	• PHWR	• 700	• 1998.06
• Wolsong #4	• PHWR	• 700	• 1999.06
• Yonggwang #1	• PWR	• 950	• 1986.08
• Yonggwang #2	• PWR	• 950	• 1987.06
• Yonggwang #3	• PWR	• 1,000	• 1995.03
• Yonggwang #4	• PWR	• 1,000	• 1996.03
• Yonggwang #5	• PWR	• 1,000	• 2002.04
• Yonggwang #6	• PWR	• 1,000	• 2002.12
• Ulchin #1	• PWR	• 950	• 1988.09
• Ulchin #2	• PWR	• 950	• 1989.09
• Ulchin #3	• PWR	• 1,000	• 1998.08
• Ulchin #4	• PWR	• 1,000	• 1999.12



POWER INTSALLED CAPACITY & POWER GENERATION

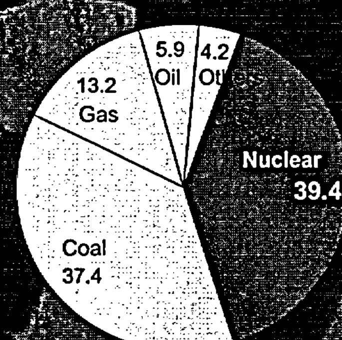
Installed Capacity (2002)

100% = 53,801 MW



Power Generation (2002)

100% = 302,033 BWh

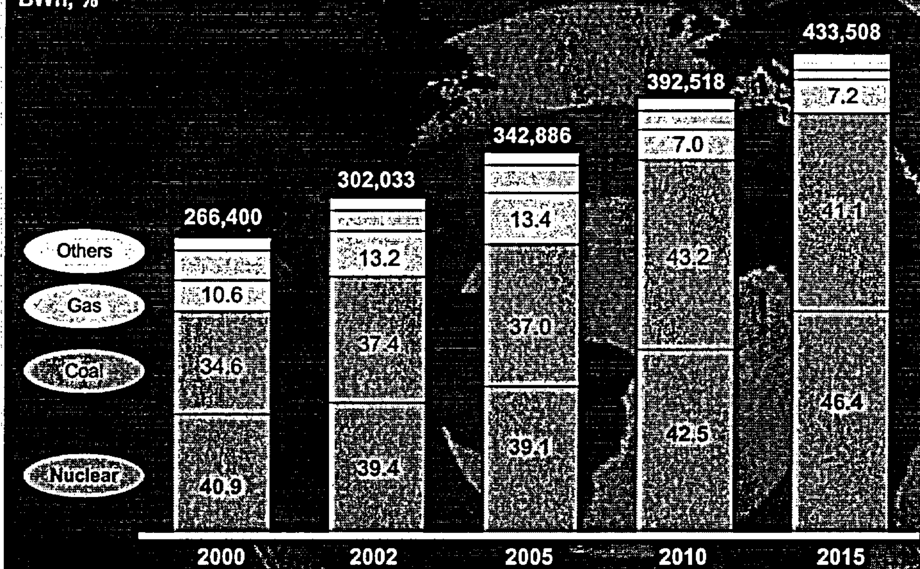


NUCLEAR POWER PLANTS UNDER CONSTRUCTION

	Plant	Reactor Type	Capacity (MW)	Planned Operation
Under Construction	Ulchin #5	PWR	1,000	2004.06
	Ulchin #6	PWR	1,000	2005.06
	Shin-Kori #1	PWR	1,000	2008.09
	Shin-Kori #2	PWR	1,000	2009.09
	Shin-Wolsong #1	PWR	1,000	2009.09
	Shin-Wolsong #2	PWR	1,000	2010.10
Contract Phase	Shin-Kori #3	PWR	1,400	2010.09
	Shin-Kori #4	PWR	1,400	2011.09

POWER GENERATION PLAN BY 2015

BWh, %



KEPCO's RESTRUCTURING PLAN

Competitive Power Generation	Competitive Wholesale Power	Competitive Retail Power
• KEPCO's Power Generation Units Spin-Off • Privatization of Power Generation Companies	• Power Transmission Grid Deregulation • Completion of Regional Power Distribution Monopolies	• Power Distribution Network Deregulation • Consumer's Selection of Power Providers
2000 ~ 2005	2005 ~ 2008	2009 ~

GENCOs

MW

KEPCO

	KOSEP	KOMIPO	KWP	KOSPO	KEWP	KHNP
Installed Capacity	• 5,565	• 6,393	• 6,846	• 6,075	• 7,500	• 14,250
Business Field	• Thermal • Combined Cycle • Pumped Storage	• Thermal • Combined Cycle	• Thermal • Combined Cycle • Pumped Storage	• Thermal • Combined Cycle • Pumped Storage	• Thermal • Combined Cycle • Pumped Storage	• Nuclear • Hydro

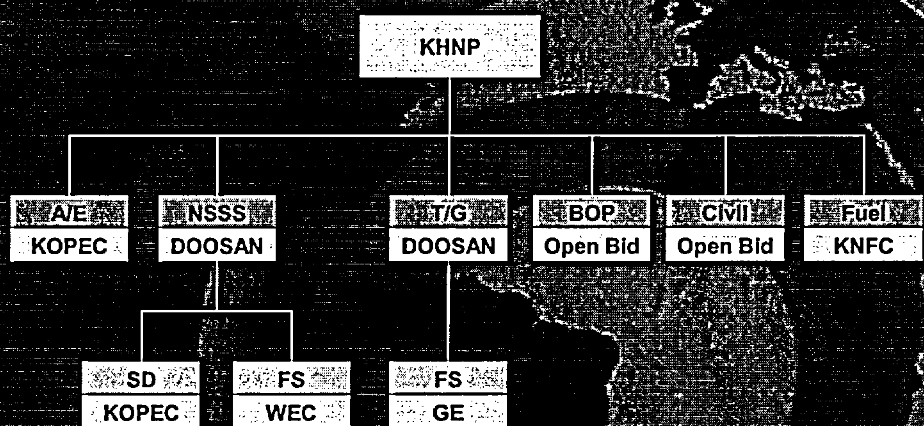
KEPCO : Korea Electric Power Co.
KOSEP : Korea South-East Power Co.
KOMIPO: Korea Midland Power Co.
KWP : Korea Western Power Co.
KOSPO : Korea Southern Power Co.
KEWP : Korea East-West Power Co.
KHNP : Korea Hydro & Nuclear Power Co.

APR1400 DESIGN FEATURES

	Design Parameter	KSNP	APR1400 (Shin-Kori 3&4)
Performance	Thermal (MWt)	2,825	4,000
	Electric Power (Mwe)	1,000	1,400
	Design Life (Year)	40	60
	RCS Coolant Flow (lb/Hr)	121.5×10^6	166.6×10^6
Safety & Reliability	Core Damage Frequency	1×10^{-5} Year	2×10^{-6} Year
	ECCS Method	Cold Leg Injection	Direct Vessel Injection
	ECCS Suction Source	Refueling Water Tank	IRWST
	Seismic Design (g)	0.2	0.3
	Instrumentation & Control	Analog (Partially Digital)	Digital MMIS

APR: Advanced Power Reactor
KSNP: Korea Standard Nuclear Power Plant
IRWST: Incontainment Refueling Water Storage Tank
MMIS: Man Machine Interface System

VENDOR ORGANIZATION



KHNP: Korea Hydro & Nuclear Power Co.
KOPEC: Korea Power Engineering Co.
KNFC: Korea Nuclear Fuel Co.
WEC: Westinghouse Electric Co.
SD: System Designer
A/E: Architecture Engineering
FS: Foreign Supply

DOOSAN SUPPLY EXPERIENCE

	Plant / Project	Utility	Reactor Type
Domestic	• Yonggwang #1 ~ #6	• KHNP	• PWR
	• Ulchin #1 ~ 4	• KHNP	• PWR
	• Wolsong #2 ~ 4	• KHNP	• PHWR
	• Shin-Kori #1 ~ 4	• KHNP	• PWR
	• Shin-Wolsong #1 ~ 2	• KHNP	• PWR
Oversea	• Qinshan #1, 2	• TQNPC, China	• PHWR
	• Sequoyah #1	• TVA, USA	• RSG
	• Watts Bar #1	• TVA, USA	• RSG
	• KEDO #1, 2	• KEDO, DPRK	• PWR

IS THE NIMBY SYNDROME REAL AND REMEDIABLE?

A CASE OF COMPLEX DECISION-MAKING

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PSYCHOLOGICAL BACKGROUND OF THE "NIMBY" SYNDROME:

TWO BASIC CATEGORIES OF HUMAN AND ANIMAL BEHAVIOR

1. "APPROACHING" BEHAVIOR
   HUMANS AND ANIMALS TEND TO "APPROACH" TO A THING OR AN EVENT WHICH GIVE THEM "PLEASURE", "COMFORT" OR "REWARD"

2. "AVOIDANCE" BEHAVIOR
   HUMANS AND ANIMALS TEND TO "AVOID" A THING OR AN EVENT WHICH GIVE THEM "DISPLEASURE", "DISCOMFORT" OR "PUNISHMENT"

ECONOMIST ARROW'S NOTION OF "UTILITY" AND "HUMAN BEHAVIOR"

1. "POSITIVE" UTILITY CORRESPONDS TO "APPROACHING" SITUATIONS

2. "ZERO" UTILITY CORRESPONDS TO "INACTION"

3. "NEGATIVE" UTILITY CORRESPONDS TO "AVOIDANCE" SITUATIONS

Table 1. Probabilistic Risk Assessment and Risk Perceptions are Different Systems.

- Probabilistic Risk Assessment •
  One death in approximately one billion per 100 reactors
- Perception of Safety•

Very safe	1.40%		
Fairly safe	39.80%	Subtotal	41.20%
Fairly unsafe	43.30%		
Totally unsafe	10.00%	Subtotal	53.30%

- Scariness of Nuclear Accident•

Very scary	66.90%		
Fairly scary	18.90%		
Somewhat scary	11.90%	Subtotal	97.70%
Not scary	2.10%	Subtotal	2.10%

Table 2. The Major Concerns About Nuclear Energy in the Japanese.

Question; What makes you worry about nuclear energy?		
Choose as many as you want. (Only the top 5 are listed below.)		
(1) Effects of radioactivity on body and future generations	43	••) •
(2) Nuclear waste management and disposal	39	
(3) Radioactive (radiation) leaks by accident	39	
(4) Insufficient information about accidents and troubles	31	
(5) Invisible radiation behavior	29	

Table 3. Segmentation of 500 Tokyo Housewives.

Cluster-1: <Conservative Activists> (n=72; 14•)

Mostly in a 30-40 age group; mostly high-school graduates; many are working;
Interested in participating in anti-nuclear-weapon, anti-nuclear-power, anti-pollution protests; interested in political and economic affairs; and perceiving nuclear energy as dangerous but beneficial.

Cluster-2: <Optimistic Silent Majority> (n=121; 24•)

Some in 20-30 and many in 30-40 age groups; mostly high-school graduates;
few are working; not interested in environmental problems, political and economic affairs, and nuclear-energy issues; and perceiving nuclear energy as both safe and beneficial.

Cluster-3: <Socially Indifferent> (n=56; 11•)

Mostly in a 40-50 age group; mostly high-school or trade-school graduates; not interested in environmental problems, political and economic affairs; not interested in participating in anti-nuclear-weapon, anti-nuclear-power, or anti-pollution protests; and perceiving nuclear energy as not needed.

Cluster-4: <Highly Sophisticated Progressive Activists> (n=56; 11 •)

Mostly college graduates;only few are working; interested in political, economic, and international affairs; interested in participating in volunteer activities, anti-nuclear-weapon and anti-nuclear-power protests and peace demonstrations; perceive nuclear energy as both dangerous and not beneficial; criticizing nuclear power plants as not safely operated; and believing that science does not contribute to enrichment of life.

Cluster-5: <Average Silent Majority> (n= 195; 39•)

Mostly in a 30-40 age group; many trade-school graduates; few are working; interested in viewing TV's sports programs and reading shopping magazines; not interested in anti-nuclear-weapon and anti-nuclear-power, anti-pollution protests; and perceiving nuclear energy as beneficial.

Table 5. Predicting Fears from Personality Characteristics

<ADR> (Adverse Drug Response>: The more the people are "health attentive" and "aggressive", the more they are inclined to fear <ADR>.

<ILLNESS>: The more the people are "medication dependent", "inventive" and "health-attentive", the more they are inclined to fear <ILLNESS>.

<DEATH>: The more the people are "health-attentive" and "aggressive", the more they are inclined to fear <DEATH>.

<EARTHQUAKE>: The more the people are "mysticism-believing", "food-safety-conscious" and "health-attentive", and the less they are "inventive" and "accepting technology", the more they are inclined to fear <EARTHQUAKE>.

<NUCLEAR ACCIDENT>: The more the people are "food-safety-conscious" and "health-attentive", and the less they are "accepting technology", the more they are inclined to fear <NUCLEAR ACCIDENT>.

Table 6. The Acceptance and the Perceived Safety and Necessity of Different Kinds of Power Plants

	Acceptance	Perceived Safety	Perceived Necessity
<Solar>	93(%)	90(%)	94(%)
<Geo-thermal>	91	86	88
<Oil-thermal>	64	48	62
<Hydro>	86	81	89
<Nuclear>	32	11	46

Table 7. Prediction of Acceptance from Perceived Safety and Perceived Necessity

	R squared	• •for Perceived Safety	• •for Perceived Necessity
<Solar>	0.55	0.54	0.33
<Geo-thermal>	0.50	0.51	0.33
<Oil-thermal>	0.47	0.48	0.36
<Hydro>	0.40	0.45	0.33
<Nuclear>	0.53	0.36	0.56

TOWARD A RATIONAL MODEL FOR THE EFFECTIVE RISK COMMUNICATION STRATEGY

1. THE SOURCE (THE SENDER)

2. THE MESSAGE

3. THE DESTINATION (THE RECEIVER)

4. THE CHANNEL

5. FEEDBACK AND THE EFFECT

Communication between Electricity Production Regions and Consumption Regions

a s c a e n e r g y f o r u m

September 18, 2003

Etsuko Akiba

Representative, Asca Energy Forum

Gap in Awareness between Urban Consumers and Consumers Living near Nuclear Power Stations

<Urban consumers>

Uninterested in electricity and energy issues

Vague sense of opposition to nuclear power

<Consumers living near nuclear power stations>

Although we do not use much electricity, we are being victimized by the major cities that use large amounts of electricity.

asca energy forum

What is the Asca Energy Forum?

- A group of advisory specialists for consumers' affairs who think about and take action on energy issues
- Established in July 2001, with 15 operating staff (nationwide)

- Activities
  - Energy talk salons
  - Lectures on energy and environmental issues
  - Preparation of textbooks and pamphlets
  - Study sessions and tours

What is an Advisory Specialist for Consumers' Affairs?

- Public certification recognized by the Minister of Economy, Trade and Industry
- Certification system begun in 1980
- Currently approx. 10,000 specialists in Japan (30% men, 70% women)
- Roles

  * Serve as a bridge between consumers and companies

  * Listen to the complaints of and give advice to consumers, while at the same time reflecting the opinions of the consumers in proposals to the companies and government

Energy Talk Salons

- Nov. 2001 Fukushima City, Fukushima Prefecture
- Mar. 2002 Kashiwazaki City, Niigata Prefecture
  Tsuruga City, Fukui Prefecture
- Jun. 2002 Tomioka-machi, Futaba-gun, Fukushima Prefecture
- Nov. 2002 Fukushima City, Fukushima Prefecture
- Jan. 2003 Aomori City, Aomori Prefecture
- Apr. 2003 Fukui City, Fukui Prefecture


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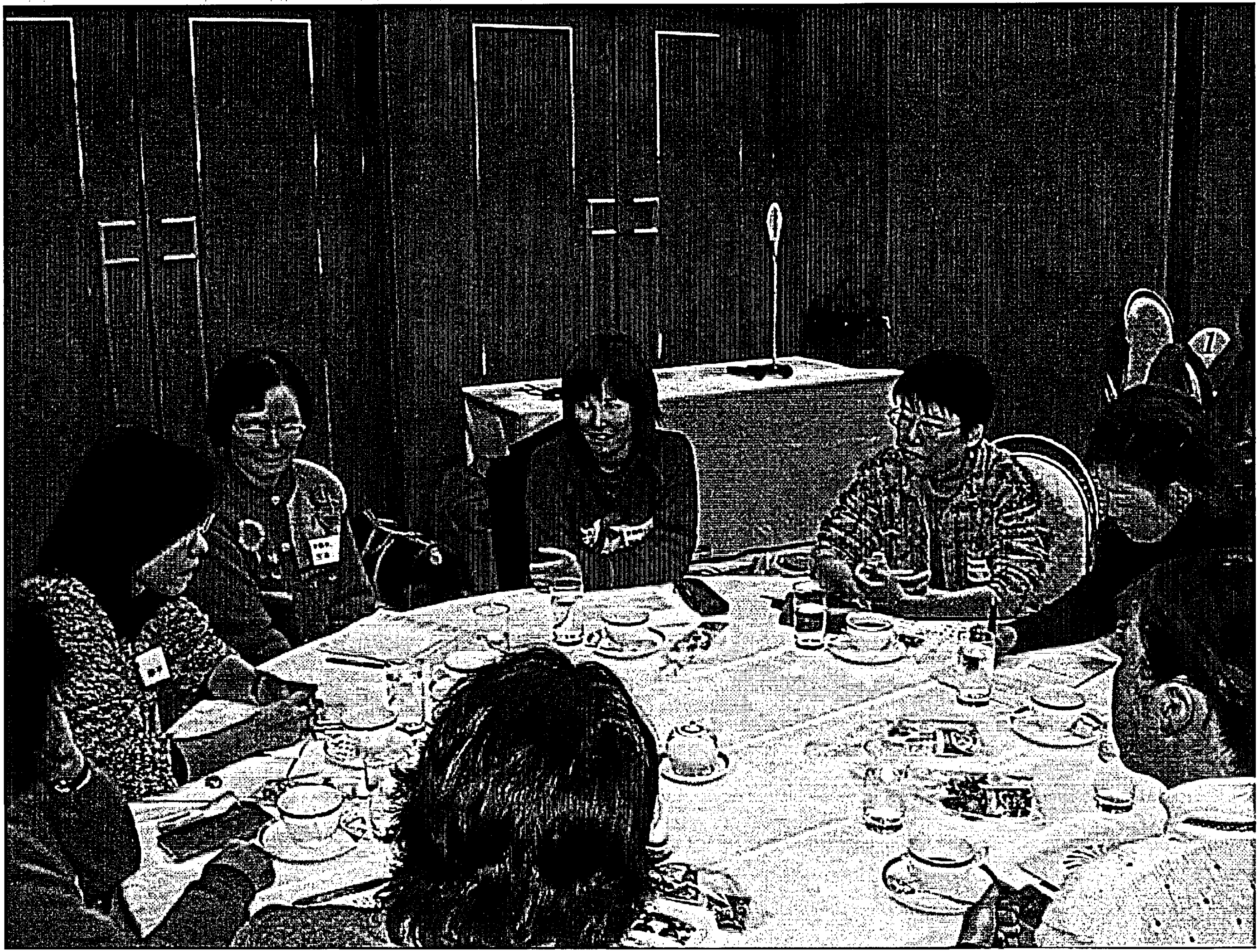


Details of the Discussions

<Questions from urban consumers>

- Do you feel any unease or fears during everyday life? Do you live without anxieties?
- What countermeasures are there in the event of an accident? Do you hold emergency drills?
- Is press coverage accurate?
- Has the existence of nuclear power stations expanded employment and revitalized industries?
- Are you proud of nuclear power stations?
- How do local schools educate students about nuclear power generation?

Details of the Discussions

<Opinions from residents living near nuclear power stations>

- It is precisely because we live near nuclear power stations that we are serious about safety.
- It is only the regions with nuclear power stations that carry the danger of accidents. The costs and benefits do not add up. A nuclear power station should be built in Tokyo.
- Speaking your opinion in the community results in being labeled as a supporter or opponent and makes life difficult.
- It is always the mass media and people who flock in from the large cities who make the big fuss.

Keywords of the Discussions:
"Community lifestyle," "press coverage," "education"

<Comments from urban consumers>

I feel embarrassed that I consume electricity without any awareness of it. I would like to study the issue with more interest

<Consumers living near nuclear power stations>

I wish that urban consumers become more interested in energy issues.

Approach to Communication

1) Power companies ⇔ Consumers

Interactive communication

2) Consumers ⇔ Consumers

Grass-roots activities, exchange forums

3) Consumers ⇔ Asca ⇔ Consumers

Activities network suitable to the community lifestyle

Asca Energy Forum

http://www.asca-ef.org

Energy Education

~ Using a Picture-Card Show ~

September 18, 2003

Sumiko Masano, Chairperson of Fukui Prefecture Women's Energy Group

What is the Women's Group for Energy studies at Fukui?

The Women's Group for Energy studies at Fukui is a private organization in which members learn about energy issues actively. The Group mainly consists of representatives of the women's networks in Fukui Prefecture, which includes 35 municipalities.

◆Chairperson: Sumiko Masano, Director of the Fukui Prefecture Life-long Learning

◆Establishment: 2000 (activities have started in 1996)

◆Management committee: Composed of representatives of the women's networks in Fukui Prefecture

◆Members: About 330 women who support the purpose of the Group (most of them are members of women's networks in Fukui Prefecture)

Activities

★Female cultural exchange forums for women living in energy-producting regions and energy –consuming regions

- Women's organizations of energy-producting regions and energy –consuming regions visit each other, to discuss and deepen their understanding of energy issues.
- Held every year since 1997 (total of 7 times)

★Publication of newsletters

- Newsletters that introduce our activities

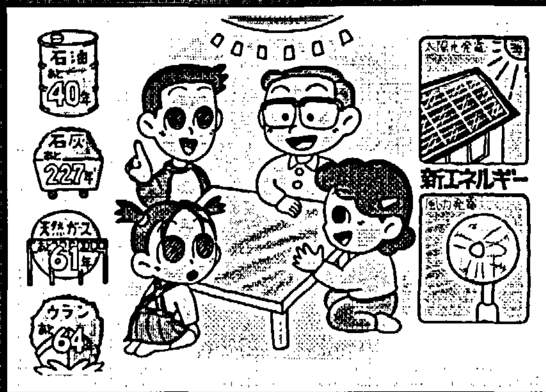
★Providing the "Energy Advisor Training Course"

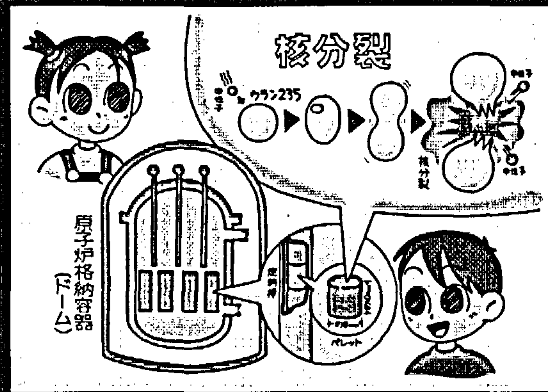
- 10-session study course to learn about energy
- Started in 2000

★Tours of nuclear power stations and other facilities

The Energy Picture-Card Show

★Title: "A Story of future energy"





★Description: This story features an elementary school boy and a girl who are interested in the energy issues in their everyday lives. They talk with their families, and go to field trips to understsnd the issues. They deepen their understanding of the future energy issues (nuclear power, nuclear fuel cycle, natural energy, etc.)

★Number of performances: 100 times

Total number of participants: 2,200

(as of the end of March 2003)

Public Opinion and Communications about Nuclear Energy

Ann Stouffer Bisconti, Ph.D.
Bisconti Research, Inc. (BR*i*)
ann@bisconti.com

GENES 4
Kyoto – September 2003

Public Opinion and Communications about Nuclear Energy in the U.S.

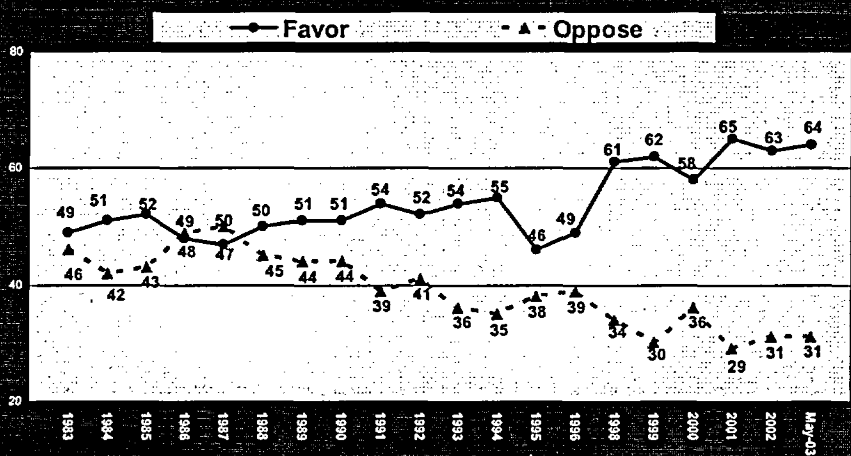
1. Public opinion about nuclear energy has become more favorable in recent years
2. Support for building more nuclear power plants increases when the public believes they are needed
3. Basic concepts about energy are not familiar
4. Communications can change public opinion

BR*i*

Public Opinion
Has Become More Favorable

BR*i*

Percent Favor/Oppose Use of Nuclear Energy
(Annual Averages until 2003)



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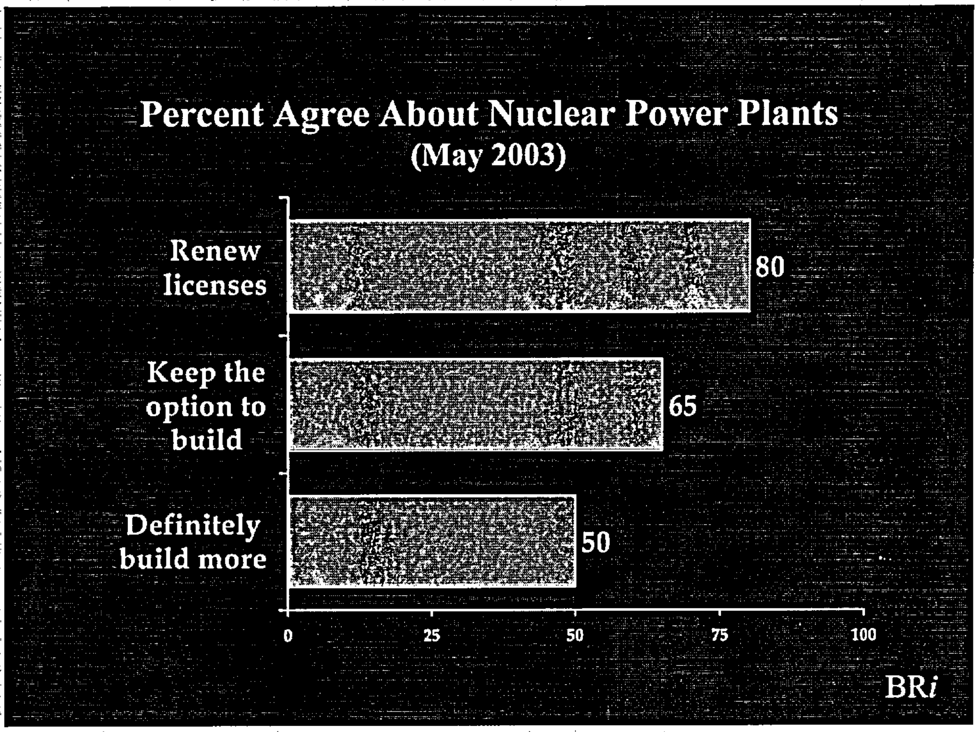
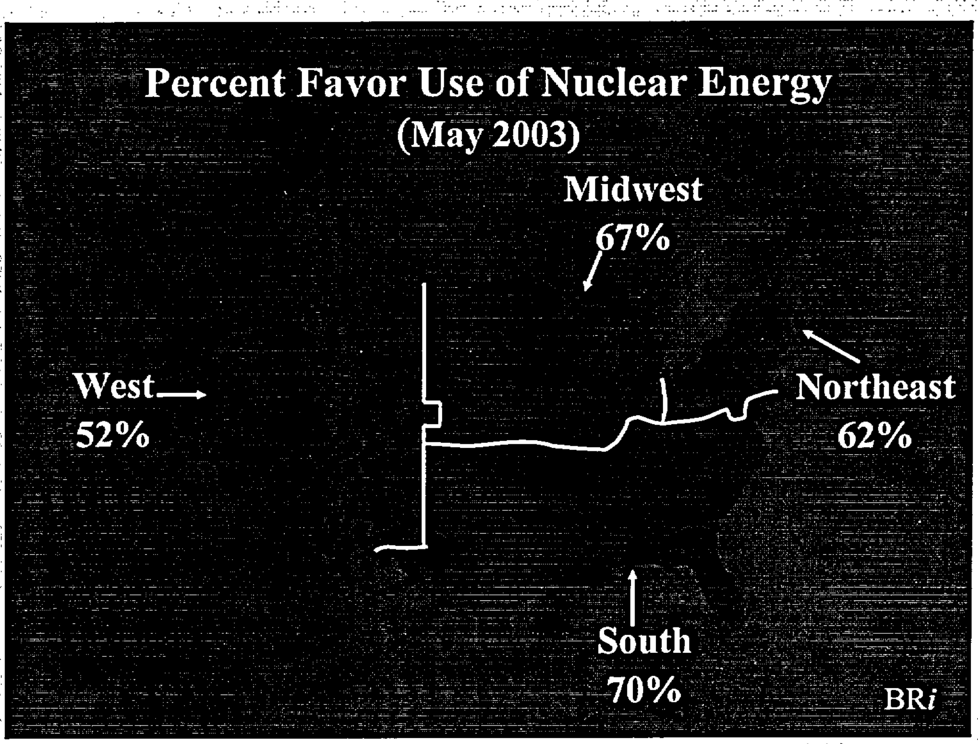


Percent Agree About Nuclear Power Plants
(May 2003)
Renew licenses
80
Keep the option to build
65
Definitely build more
50
0
25
50
75
100
BRi



Percent Favor Use of Nuclear Energy
(May 2003)
Midwest
67%
West
52%
Northeast
62%
South
70%
BRi

Percent Favor Nuclear Energy
(May 2003)

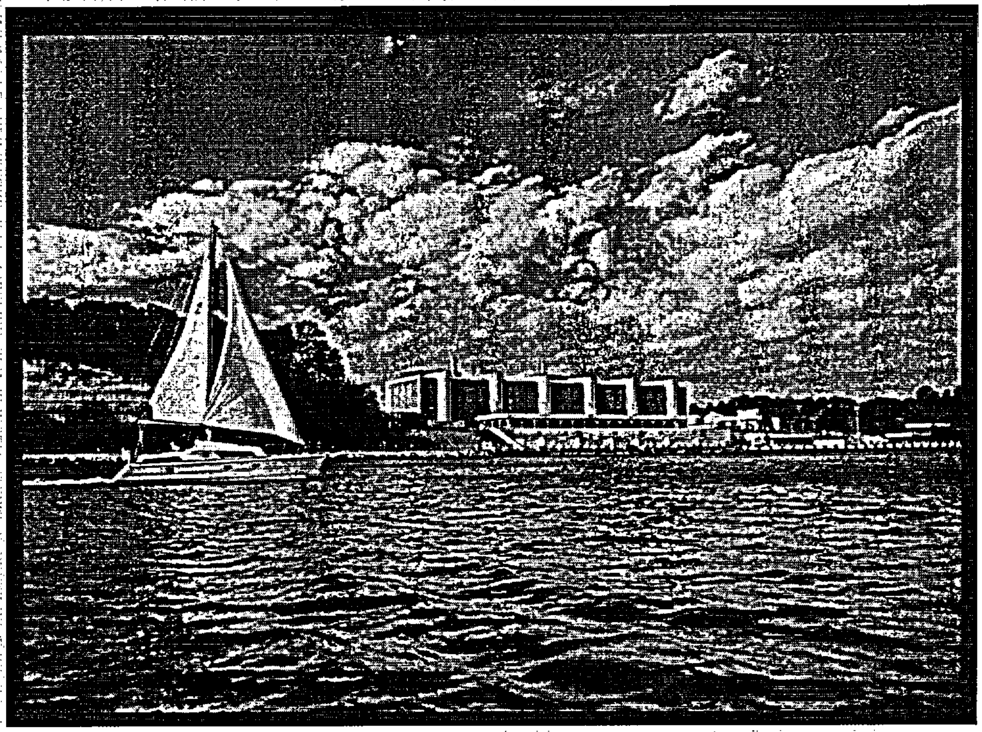
Men	68
Women	60
Electric company operates a nuclear power plant	72
Opinion leader	67
Environmentalist	64

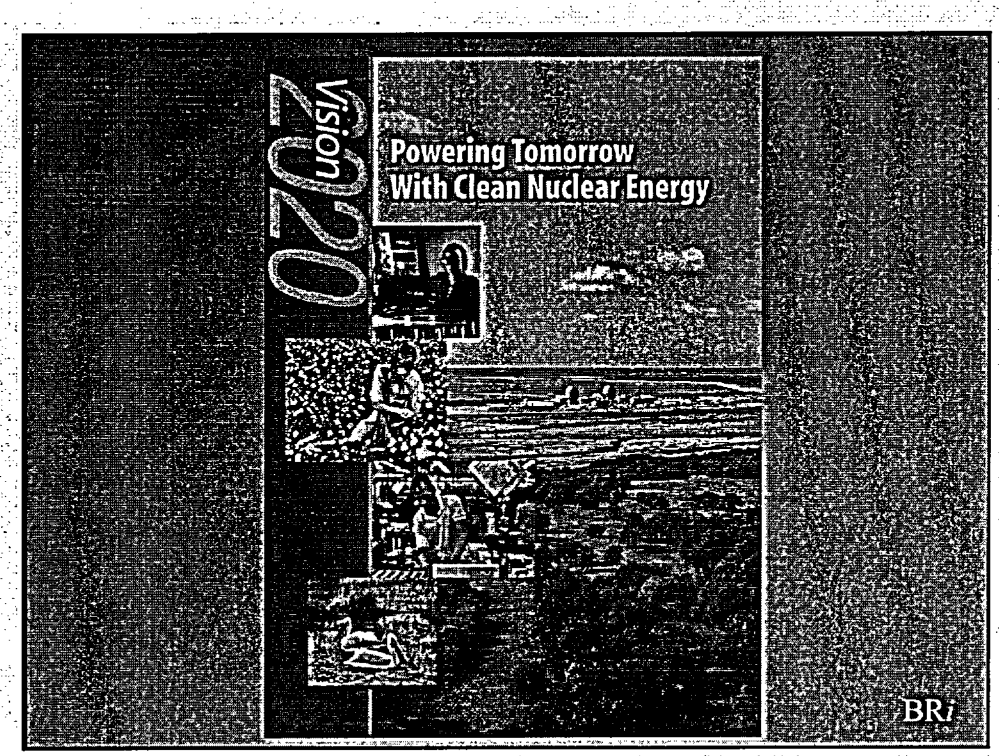
BR*i*

Percent Support Nuclear Power Plant License Renewal
(May 2003)

Men	83
Women	77
Electric company operates a nuclear power plant	80
Opinion leader	78
Environmentalist	82

BR*i*




Vision 2020
Powering Tomorrow
With Clean Nuclear Energy
BRi

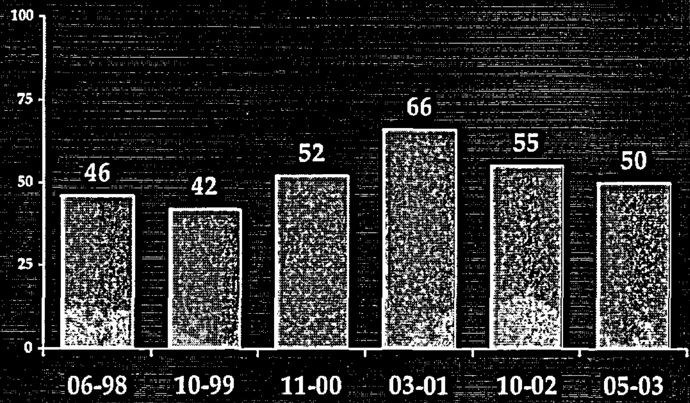
Nuclear Power in the News

BRi

Support for Building More Nuclear Power Plants Increases When the Public Believes They are Needed

BRi

Percent Agree We Should Definitely Build More Nuclear Power Plants



BR*i*

Basic Concepts About Energy Are Not Familiar

BR*i*

Unfamiliar Concepts

- Where electricity comes from
- NRC
- Greenhouse gases, global warming, climate change

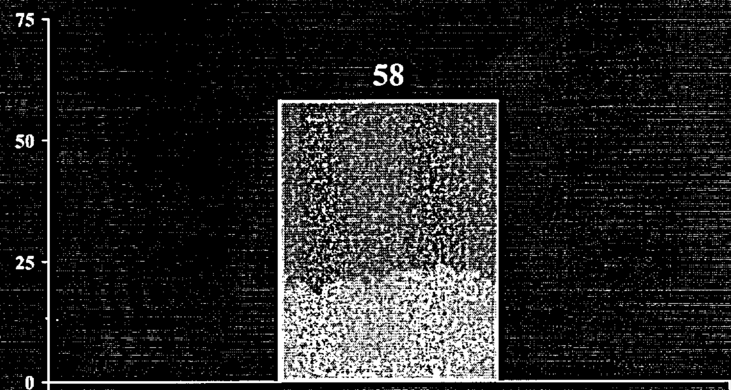
BR*i*

Communications Can Change Public Opinion

BR*i*

Percent Favor Nuclear Energy

June 2002

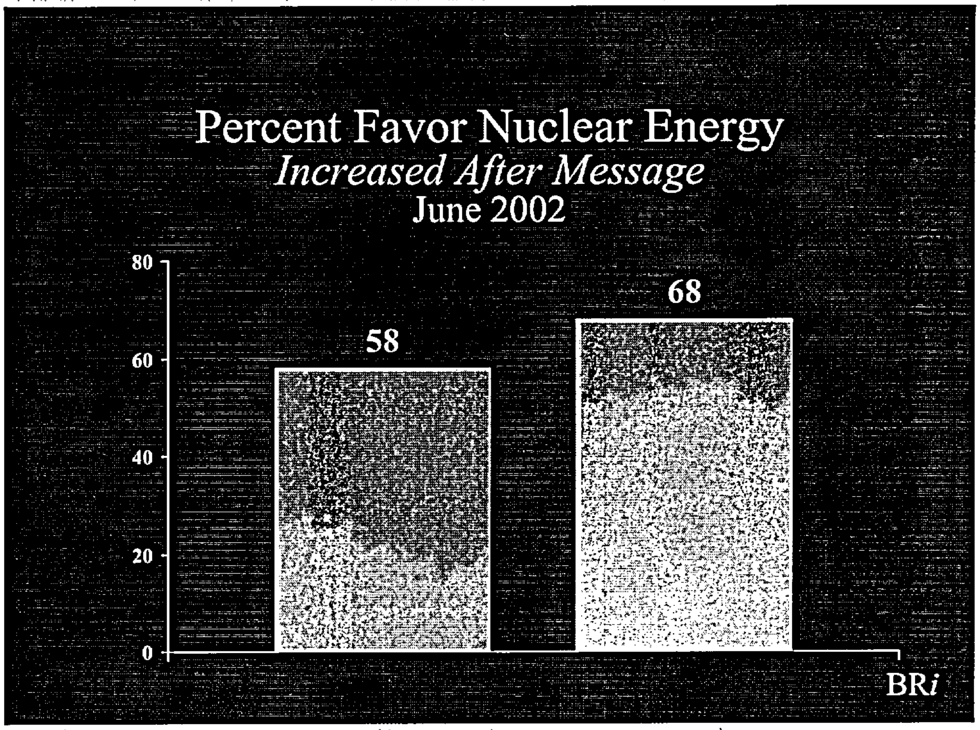


BR*i*

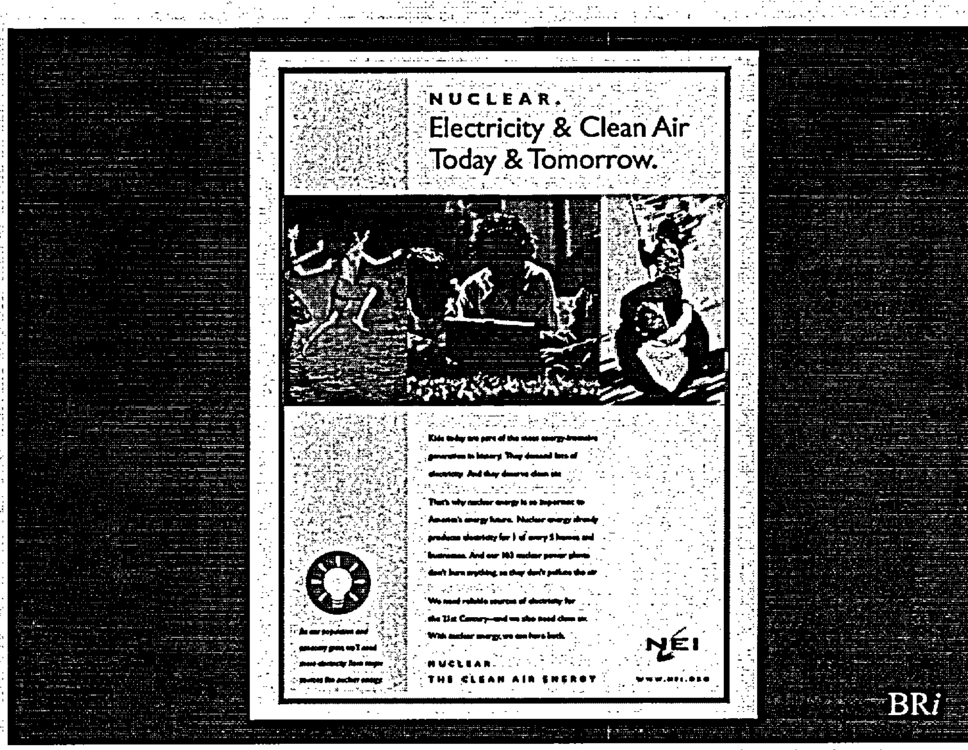
Message

"There are more than 100 nuclear power plants in the United States that generate 1/5th of all the electricity we use in the United States without producing any greenhouse gases or other air pollution."

BR*i*



Percent Favor Nuclear Energy
Increased After Message
June 2002
80
60
40
20
0
58
68
BRi



NUCLEAR.
Electricity & Clean Air
Today & Tomorrow.
NUCLEAR.
THE CLEAN AIR ENERGY
NEI
BRi

New Campaign is Most Effective Nuclear Industry Advertising Since 1983

- 79% "more favorable" after seeing ad
- 69% would give greater importance to nuclear energy's clean air benefits in the future
- Comforting, gives sense of security (nonverbal message)

BR*i*

Values Related to Energy

- Planning for the future
- Reliable sources of electricity
- Clean air
- Not having to make tradeoffs—having all the energy we need and a healthy environment

BR*i*

Communications Recommendations

1. Main verbal message to increase favorable attitudes—new ideas or reminders

- We need reliable sources of energy for the 21st century
- We also need clean air
- With nuclear energy we can have both

BR*i*

Communications Recommendations

2. Nonverbal messages to communicate safety and security—positive presence

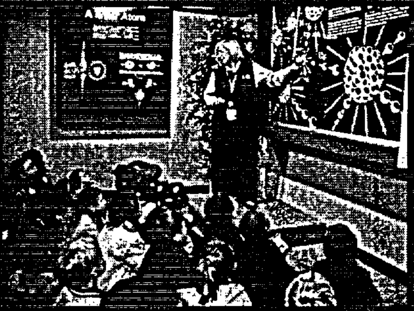
- Communicate message about *"reliable sources of electricity for the 21st century and clean air"* often and in many ways
- Visibility of employees who live near the plant with their families
- Visibility of regulators
- Good performance

BR*i*

Communications Recommendations

3. Details about safety for attentive audiences

- Simple terms and basic explanation
- Pictures or hands-on demonstrations



BR*i*

International Conference on Global Environment and Advanced Nuclear Power Plants, GENES4/ANP 2003

September 15-19,2003 *Kyoto Research Park* Kyoto, Japan

"Role of Nuclear Energy in Thailand"

Somporn Chongkum <somporn@oaep.go.th>

* Vice President of Nuclear Society of Thailand
* Director of Physics Research and Advanced Technology
Office of Atoms for Peace
Bangkok, THAILAND

Role of Nuclear Energy in Thailand

Contents

Nuclear Energy Development in Thailand

1954 : Thai Atomic Energy Commission was initiated.
1961 : Atomic Energy for Peace Act was enacted.
1961 : Office of Atomic Energy for Peace was established.
1966 : Nuclear Electricity Sub-committee was set up.
1976 : Cabinet approved NPP 600 MW.
(the project was opposed by public)
1984-88 : Economic aspect of NPP was studied with support from IAEA.
1992-96 : NPP policy was put in the National Development Plan 7.
1997 : Study for NPP in Thailand was re-initiated,
NPP are not suitable during economic crisis.
2002 : Restructuring into Office of Atoms for Peace .

Roles of Office of Atoms for Peace (2002)

- Regulatory Body for Safety of Users & Operators (Radiation Safety & Nuclear Safety, Including NPP

- Research & Development of Nuclear Technology & Utilization.

- Co-ordination Role in Nuclear Science & Technology.
  (will be separated to the Public Agency)

Nuclear Energy for National Development(1)

User Statistics

Medicine	100	Institutes
Education	150	Institutes
Industry	267	Factories
Lightning Arrestors	333	Sets
Smoke Detectors	959	Sets
Electrostatic Eliminators	4,000	Sets

Nuclear Energy for National Development(2)

Main Nuclear Facilities

- 2 MW Thai Research Reactor : TRR1/M1
- (10 MW TRR 2)
- Gamma Irradiators(^{60}Co)
- Electron Beam Accelerators(10-40 MeV)
- Synchrotron(1 GeV)
- Neutron Generators
- Radioactive Sources

Energy Generation in Thailand (2001)

- Installed Capacity : 22,034 MW
  - EGAT* : 15,000 MW (68%)
  - Private Producers : 7,034 MW (32%)

* EGAT = Electricity Generating Authority of Thailand

Natural Resources of Electricity Generation

- Gross Energy Generation 103,165 M-kWh

EGAT's Power Plant	M-kWh	%
- Natural Gas	34,872	33.80
- Lignite	17,306	16.78
- Hydro	6,310	6.12
- Fuel Oil	3,110	3.01
- Diesel Oil & etc.	157	0.15
Subtotal	61,755	60%
Purchase	41,410	40%

Current Status of Nuclear Program (1)

- FS: The consideration on NPP is postponed to the next 5 years from 2003.
- Siting, EGAT - 4 candidate sites were selected.
- EIA Studies to be pursued.
- Nuclear Regulatory Body was established.
- Nuclear Legislation has been prepared.

Current Status of Nuclear Program (2)

Human Resource Development

In nuclear field has been delayed owing to the uncertainty of nuclear policy.

Public Understanding / Public Acceptance

People must be educated about nuclear.

Safety Control & Waste Management

Government must ensure these aspects to public.

Nuclear Energy Prospective for Thailand

- Within the next 10 years, increased confidence in economical and safe operation of nuclear plants will likely be demonstrated and recognized. This in turn will also increase confidence in nuclear waste disposal.
- Natural Resources (Gas, Lignite) have been diminished.

Nuclear Energy Prospective for Thailand

- As the concern over the global climate change grows in magnitude, nuclear power become an environmentally desirable source of energy.
- Nuclear energy should remain as an option in the long-term energy strategies.

ROLE OF NUCLEAR ENERGY IN VIETNAM

by
Hoang Anh Tuan
and Le Van Hong

Vietnam Atomic Energy Commission

GENES4/ANP2003,
Kyoto 15-19 September 2003

CURENT PROJECT ACTIVITIES FOR NUCLEAR POWER INTRODUCTION

Projects on Pre-feasibility studies: 2002-2004

- **May 2001, Prime Minister assigned MOI in collaboration with MOSTE to carry out a *Pre-feasibility study* for the first NPP construction in Vietnam;**
- **June 2001, *Master Plan* on Electric Power Expansion (2000-2010) with vision to 2020 including consideration of NPP's construction around 2020 was approved by Prime Minister;**
- **March 2002, The Steering Committee for Nuclear Power was established by Prime Minister.**

CURENT PROJECT ACTIVITIES FOR NUCLEAR POWER INTRODUCTION

Projects on Pre-feasibility studies: 2002-2004

- The Committee is composed of two main ministries MOI and MOST and some other members from various ministries.
- Main responsibilities of Committee are:
  - Establish national strategy and long term program for nuclear development, in charge by MOST, VAEC
  - Study on Pre-feasibility for first NPP, in charge by MOI
- The Committee have to submit his result by the end of 2003 to the Prime Minister.

MAIN ORGANIZATIONS INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

- **VIETNAM ATOMIC ENERGY COMMISION** (VAEC, MOST)
- **INSTITUE OF ENERGY (EVN, MOI)**
- **NUCLEAR SAFETY AND RADIATION PROTECTION BUREAU** (NSRP, MOTS)
- **OTHER INSTITUTIONNS OF VIETNAM**
- **INTERNATIONAL COOPERATION** (IAEA, Japan, France, Canada, Korea, Russian, India and others)

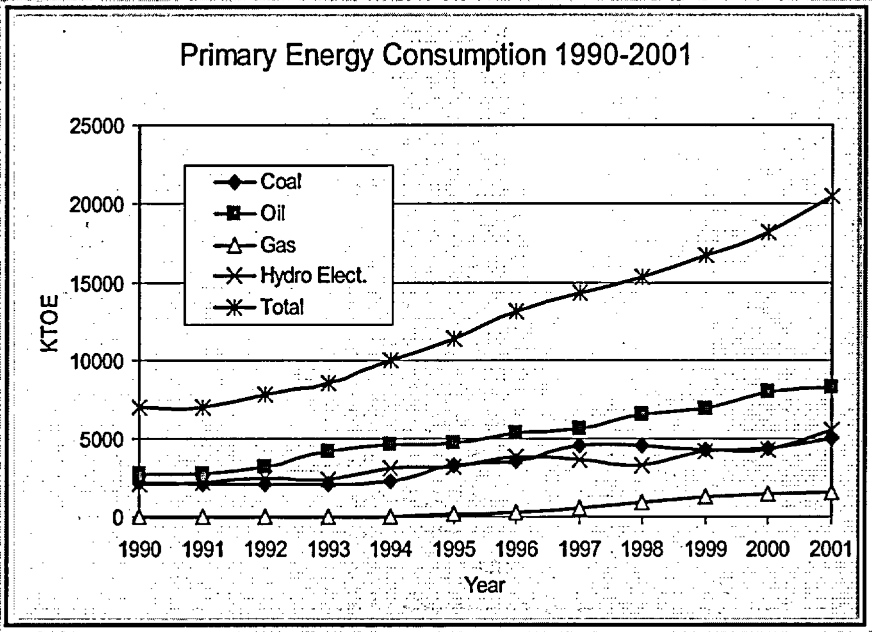
GENES4/ANP2003, Kyoto 15-19 September

CURRENT STATUS

OF ENERGY SYSTEM IN VIETNAM

ENERGY PRODUCTION IN VIETNAM (1990-2001)

Year	90	91	92	93	94	95	96	97	98	99	00	01
Coal. mil. ton	4.6	5.0	5.0	5.9	5.7	8.4	9.8	11.4	10.7	9.63	11.6	12.9
Crude Oil. mil. ton	2.7	3.96	5.5	631	7.07	7.67	8.8	10.9	12.5	15.2	16.3	17.1
Gas, mil.m3	183	290	540	1018	1414	1580	1720	183	290	540	1018	1414
Gas for Elect. mil. m3	182	281	532	900	1227	1224	1229	182	281	532	900	1227



Import and Export of Energy in the period of 1990-2005 (*x 1000 ton*)

Source: Customs Bureau

Year	1990	1991	1992	1993	1994	1995
Oil Product Import	2888	2599	3134	4094	4531	5004
Crude Oil Export	2617	3917	5446	6153	6949	7652
Coal Export	789	1173	1623	1432	2068	2821

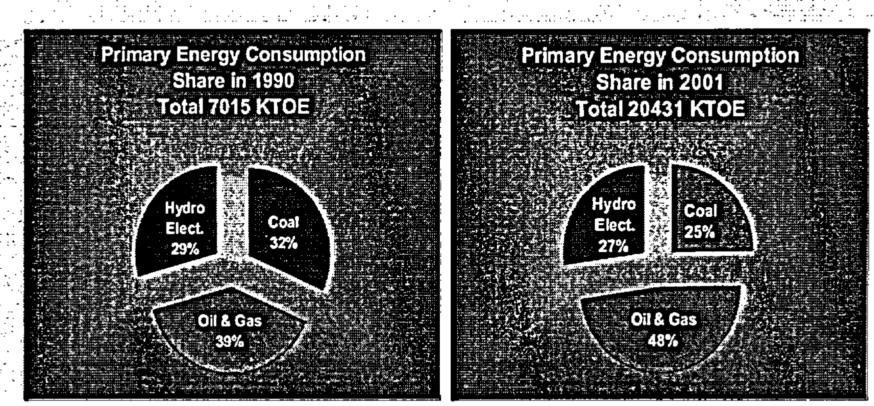
Year	1996	1997	1998	1999	2000	2001
Oil Product Import	5899	5958	6852	7426	8748	8998
Crude Oil Export	8705	9638	12145	14882	15423	16732
Coal Export	3647	3454	3162	3260	3251	4290

PRIMARY ENERGY CONSUMPTION for the period of 1990-2001, KTOE (*Source: Energy Inst.*)

Year	1990	1991	1992	1993	1994	1995
Coal	2212	2138	2143	2073	2291	3314
Oil	2737	2717	3186	4172	4624	4713
Gas	3	25	17	21	23	186
Hydro Elect.	2063	2152	2477	2336	3141	3237
Total	**7015**	**7032**	**7823**	**8602**	**10079**	**11450**

Year	1996	1997	1998	1999	2000	2001
Coal	3579	4544	4577	4277	4372	5024
Oil	5420	5630	6576	6938	8004	8271
Gas	282	506	935	1292	1440	1563
Hydro Elect.	3829	3625	3281	4157	4314	5573
Total	**13110**	**14305**	**15369**	**16664**	**18130**	**20431**

PRIMARY ENERGY CONSUMPTION in 1990 and 2001

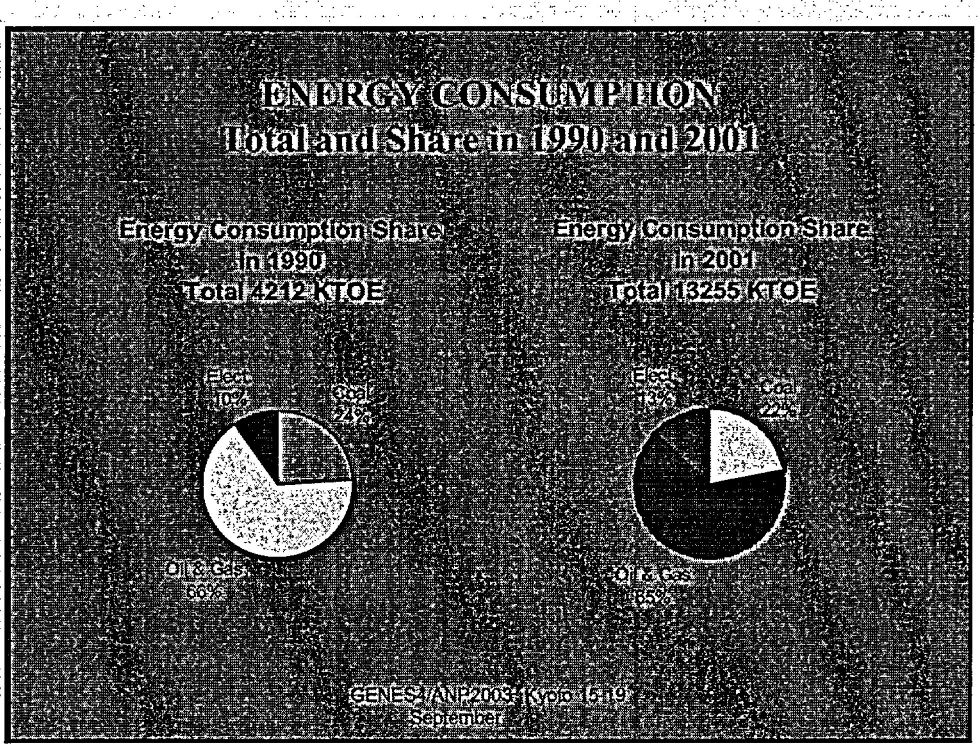


Average Consumption growth rate of 10.2%/year for 1990-2001. Gas consumption growth rate is 77%/year.

ENERGY CONSUMPTION 1990-2001, KTOE

(Source: Energy Inst.)

Year	1990	1991	1992	1993	1994	1995
Coal	1324	1600	1770	1782	1823	2603
Oil &Petroleum	2356	2286	2716	3678	4064	4344
Gas		9	15	14	16	22
Electricity	532	566	596	674	798	963
Total	4212	4461	5097	6148	6701	7932
Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Coal	2692	3327	3302	3166	3223	3743
Oil &Petroleum	4944	5001	5538	6222	7007	7283
Gas	21	20	19	19	18	15
Electricity	1150	1316	1524	1681	1927	2214
Total	8849	9664	10383	11088	12175	13255



Energy-economic indexes of vietnam in 1990 and 2001

ITEM	1990	2001
▪ GDP (USD/capita)	114	405
▪ Commercial Energy Consumption (KgOE/capita)	63	167
▪ Commercial Electricity Consumption (KWh/capita)	94	329
▪ Energy Density (KgOE/1000USD)	344	488
▪ Energy Elastic Coeff. (1990 – 2001)	1.40	
▪ Electricity Elastic Coeff. (1990-2001)	1.85	

SUMMARY OF CURRENT STATUS OF ENERGY SYSTEM IN VIETNAM

1. Diversified energy resources can basically meet the demand of economic and social development although Vietnam has a low energy production and consumption per capita in the region. The situation is caused by war consequence and the lack of investment for the period of 1990 - 2001.

2. The transition of economy from the central planning mechanism to a market one in which the energy sector is provided with a certain level of priority by the government. Therefore, the period of 1999-2001 is a strongly developing period of energy production and consumption.

3. The lack of energy processing factories leads to the import dependence of energy.

SUMMARY OF CURRENT STATUS OF ENERGY SYSTEM IN VIETNAM

4. The efficiency of energy system is still low. the energy production bases are using backward technologies of low efficiency (30% for thermal plants and 50-60% for industry steams facilities).
5. Electricity lost by transport is as high as 22% in 1995 but it has been down to 14% in 2001.
6. Non-commercial energy shares with more than 60% of the energy consumption mechanism.
7. Although the energy environment is still not significantly harmed, it should be taken into account with taking the advantage of CDM.
8. The macro energy management system of the government should be improved.

POTENTIAL OF COAL, OIL &GAS AND HYDRO-ELECTRICITY IN VIETNAM

GEOLOGIC COAL POTENTIAL IN VIETAM

(Source: General Planning of Coal Development for the Period of 2001-2010 including 2020)

Area/Grade	A+B+C1+C2 (mil. ton)	A+B (mil. ton)	C1 (mil. ton)	C2 (mil. ton)
Quang Ninh Area	3171.9	385.3	1552.8	1233.9
Total in VIETAM	3808.5	438.7	1980.5	1389.3

Of 3880 million tons of coal potential, 3414 mil. tons are owned by the Vietnam Coal Corporation

PLAN OF COAL EXPLOITATION FOR 2002-2020

(Source: General Planning of Coal Development for the Period of 2001-2010 including 2020)

Year *Unit: 1000 ton*	2002	2005	2010	2015	2020
Exploitation of others	649	800	957	1 144	1 491
Exploitation of Vietnam Coal Corp.	13237	17192	23243	26256	28429
Total Exploitation of Vietnam	13886	17992	24200	27400	29920

Coal exploitation can reach to 40 million tons in 2030

GAS POTENTIAL IN VIETAM

(Source: Energy Institute)

	Oil (mil. ton)	Gas (bil.m3)	Natural Gas (bi.l m^3)	Condensate (mil. m^3)	Total (mil. m^3 OE)
Total potential	2370	594	1877	225	5066
Found potential can be exploited	652	89	593	46	1380
Exploitation	60	14			74
Total can be exploited	592	75	593	46	1306

Crude oil production is 16-18 mil. tons for 2002-2020 but the domestic production will be decreased after 2010.

CRUDE OIL PRODUCTION FORCAST FOR THE PERIOD OF 2000-2020

(Source: Energy Institute)

Year Unit: 10^6 ton	2000	2005	2010	2015	2020
Basic scenario	16.5	17.2	20.6	16.1	10.7
Domestic exploitation	16.5	17	17.6	12.3	4.7
High scenario	16.5	17.8	21.6	21.8	18
Domestic Exploitation	16.5	17.01	17.6	15.5	10.2

FOCAST OF OIL, GAS AND HYDRO ELECTRICITY PRODUCTION

GAS PRODUCTION FORCAST FOR THE PERIOD OF 2000-2020

(Source: Energy Institute)

Year *Unit: bil.m^3*	2000	2005	2010	2015	2020
Base scenario	1.6	6.7	12	13	14
High scenario	1.6	6.7	14	17	18

HYDRO-ELECTRICITY POTENTIAL

(Source: Energy Institute)

Parameter	Power (MW)	Elect. Energy (TWh)	Density (MWh/km2)
Total of 11 main rivers in the country	20560	83.4	250

The estimate of the technical potential of hydro-electricity is 123 billion kWh, being equivalent to 31000 MW. The realistic potential is about 70-80 billion kWh, being equivalent to 20000 MW.

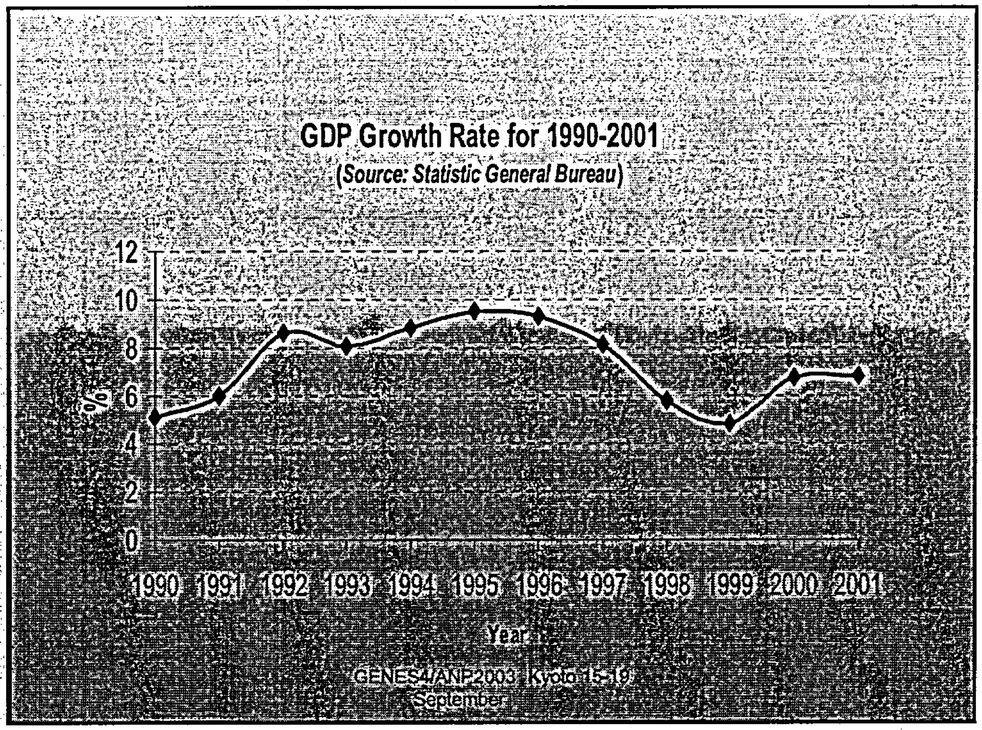
SUMARY OF ENERGY RESOURCE FORCAST FOR THE PERIOD OF 2000-2020

- Coal: 26-30 mil ton/year, of which 15 mil. ton for elect. generation.
- Crude oil: 10-20 mil. ton/year
- Gas: 14-18 bil. m3/year, of which 12-15 bil m^3 for electricity generation.
- Hydro-electricity: 55-60 bil. kWh/year
- Uranium: 14500 tons U3O8 (C1+C2+P1 grades) with production price is lower than 130 USD/kg
- New and renewable energy resources equivalent to 700 MW power station.

SUMARY OF ENERGY RESOURCE FORCAST FOR THE PERIOD OF 2020-2030

- Coal: 40 mil. ton/year (source: VINACOAL)
- Crude oil: 25-30 mil. ton/year
- Gas: 20 bil. m^3 /year
- Hydro-electricity: 75-83 bil. kWh/year

ECONOMIC DEVELOPMENT IN 1990-2001 AND FORCAST TO 2050


GDP Growth Rate for 1990-2001
(Source: Statistic General Bureau)
12
10
8
6
4
2
0
%
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Year
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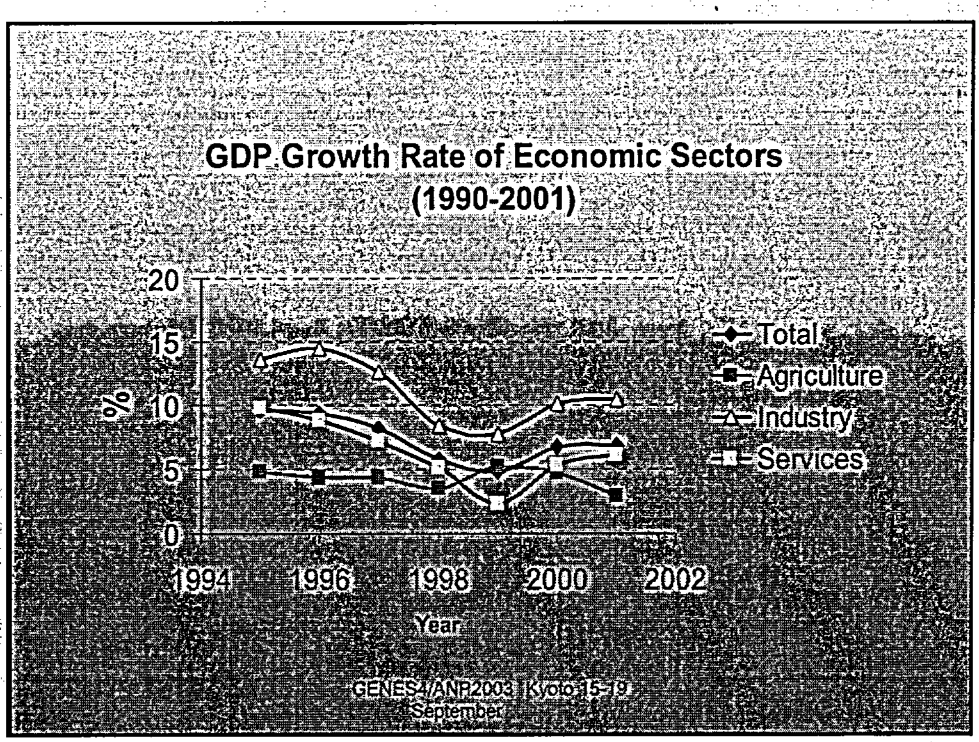
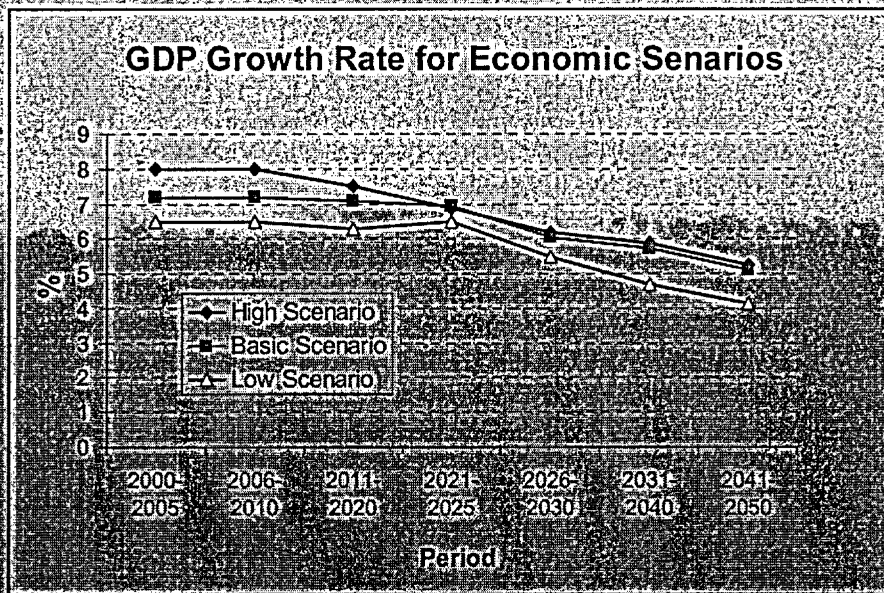
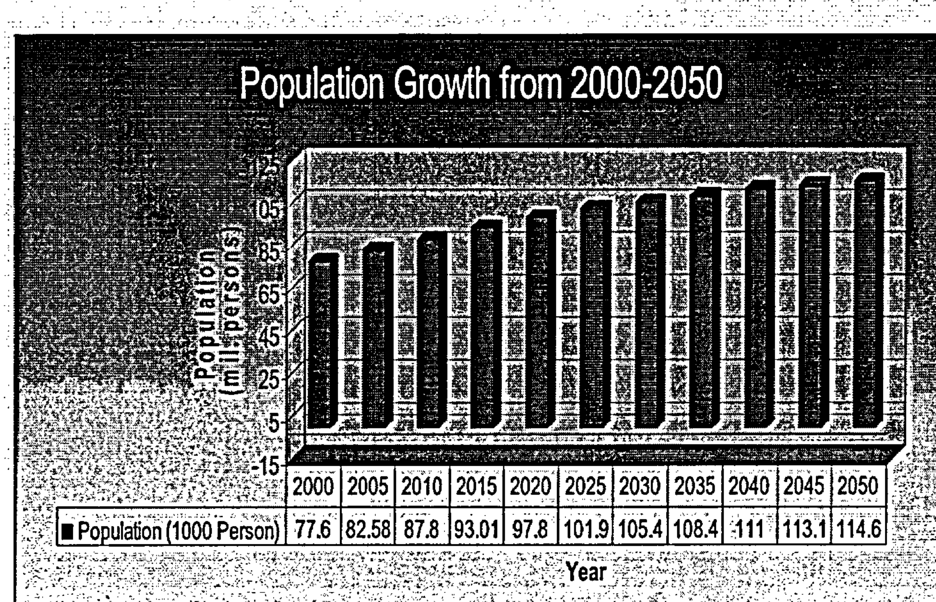

GDP Growth Rate of Economic Sectors
(1990-2001)
20
15
10
5
0
%
1994
1996
1998
2000
2002
Year
Total
Agriculture
Industry
Services
GENES4/ANP2003 Kyoto 15-19
September



GENES4/ANP2003 Kyoto 15-19 September



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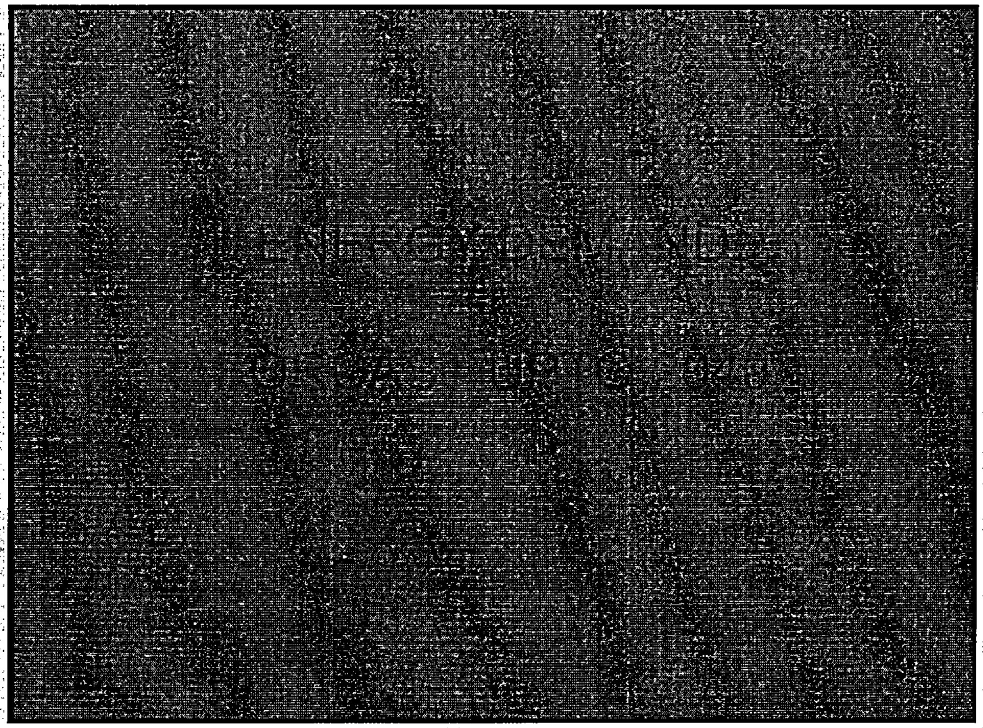

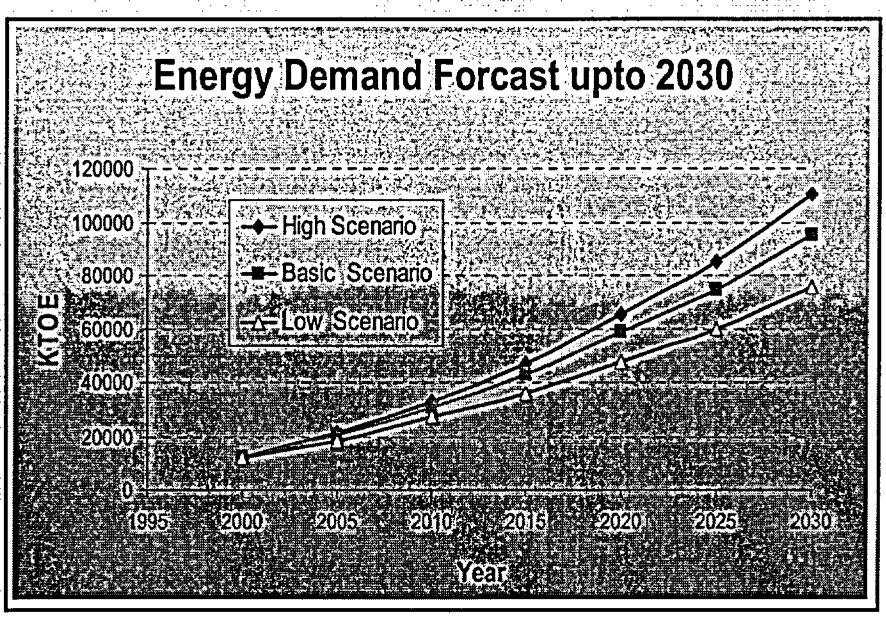

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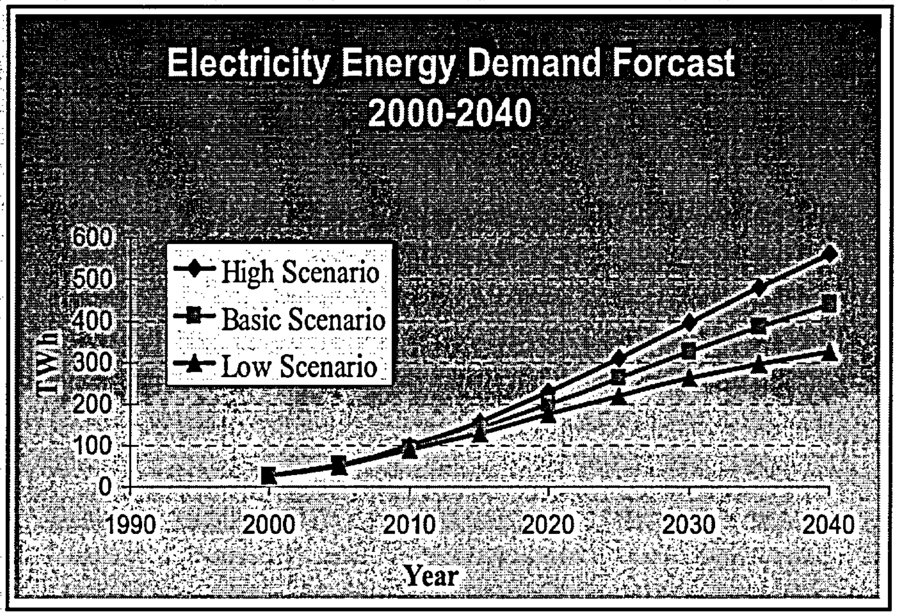

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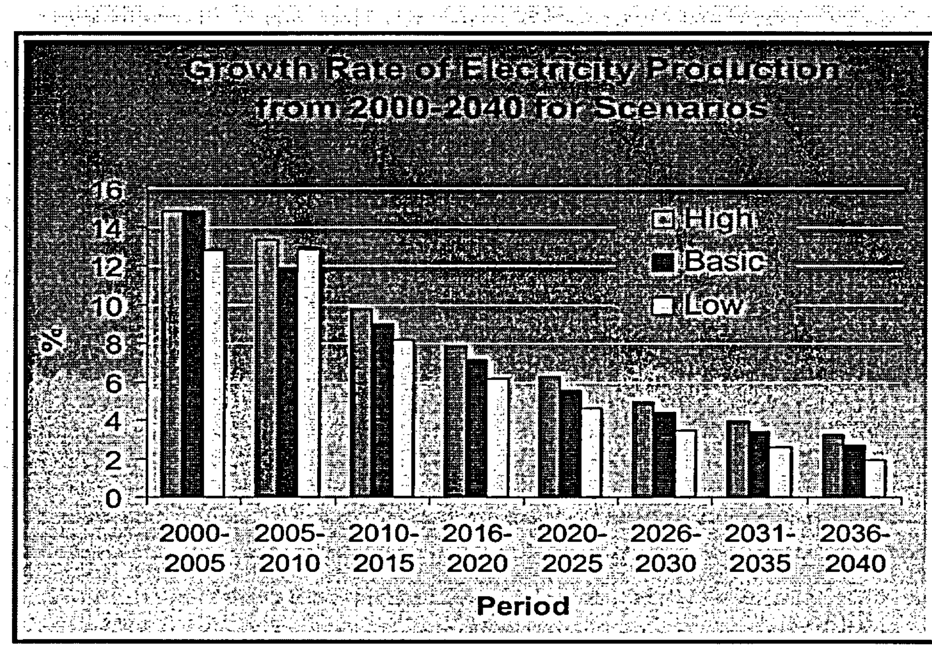
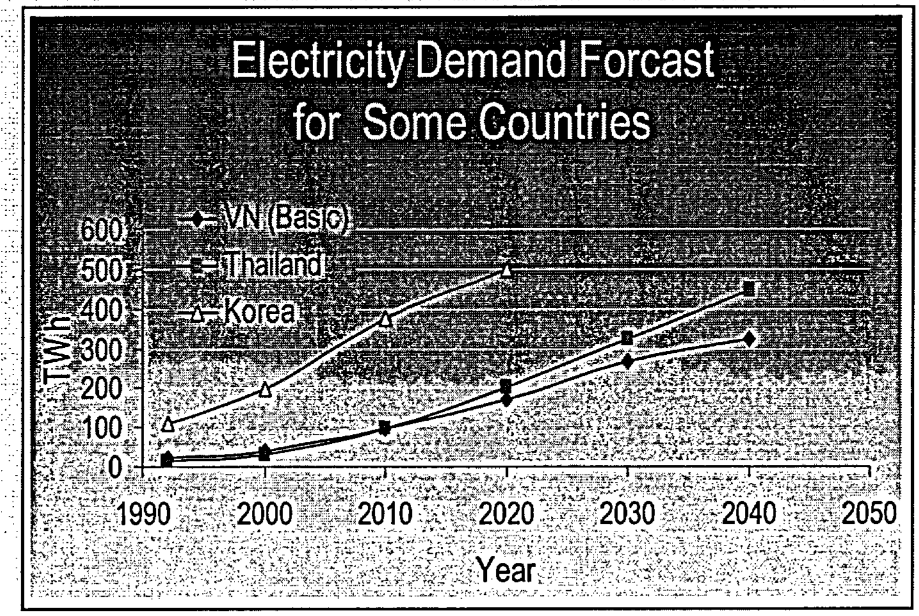


GENES4/ANP2003 Kyoto 15-19 September



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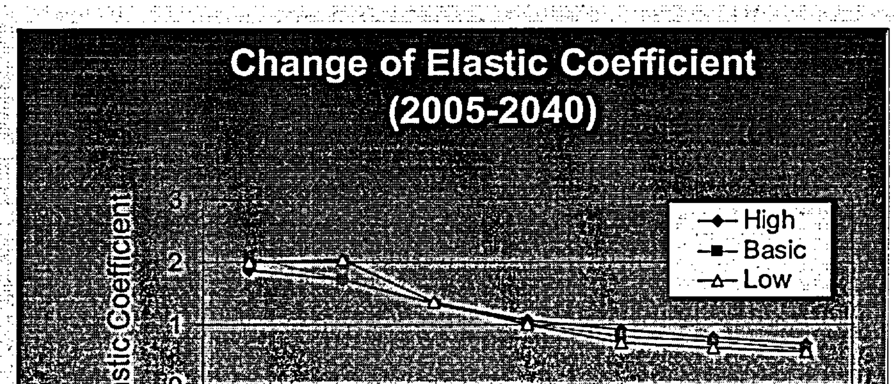
September



	2005-2010	2011-2015	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
High	1.868	1.722	1.35	1.067	0.905	0.795	0.672
Basic	2.076	1.717	1.312	1.029	0.803	0.717	0.596
Low	1.99	2.048	1.353	1.006	0.706	0.623	0.552

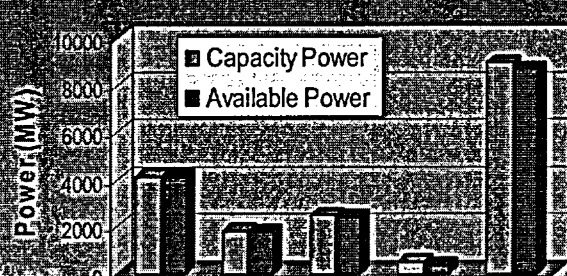
GENES4/ANP2003 Kyoto 15-19
September

Vietnam Electricity System

Long-Term Planning

to the Year 2020

Power of Electricity Plants



	Hydro	Ther	Gas	Diesel	Total
Capacity Power	4115	1818	2482	494	8909
Available Power	4127	1768	2413	346	8654

Plant Type

Balance of Electricity Production-Demand (2015-2020)

Year	2015		2020	
	Exploitation	Production (bil. kWh) low/basic/high Scenarios	Exploitation	Production (bil. kWh) low/basic/high Scenarios
Coal (mil. ton)	27.40	32.00	30.00	36.00
Gas (bil. m3)	16.00		18.00	78.00
Hydro Power	1300 MW	49.00	15100 MW	58.00
New Energy	500 MW	1.50	700 MW	2.00
Total Production, TWh		149.00		165.00
Total Demand, TWh		131/142/158		176/201/230
Shortage, TWh		-18/-7/9		11/36/65

Balance of Electricity Production-Demand For 2030

Year	2030			
	Exploitation	Low Scenario Production, TWh	Basic Scenario Production, TWh	High Scenario Production, TWh
Coal (million ton) Domestic Gas (bil. m3) Hydro Power New Energy Resources	40.2 20		50.4 71.5 83 3	
Total Domestic Production, TWh		208	208	208
Total Demand, TWh		263	327	396
Shortage, TWh		55	119	188

WHY NEED

NUCLEAR POWER ?

ADVANTAGES OF NUCLEAR POWER

- The country's balance of energy demand and supply resources.
- The security of energy supply and diversity of energy sources.
- The economical availability – Economic energy production and competition with other kinds of power.
- Nuclear power is popular and commercialized in the world.

ADVANTAGES OF NUCLEAR POWER

- Nuclear power is clean and friendly with the environment - sustainable development.
- Nuclear technologies are advanced and have long-term experience in many developed countries.
- The nuclear safety and radioactive wastes management can be ensured.
- Nuclear power can help the country for the [illegible] and industrialization need.

ELECTRICITY DEVELOPMENT

CONSIDERING NUCLEAR POWER

ELECTRICITY DEVELOPMENT

2003-2020: BASIS SCENARIO

- Hydro Power: 60-65 bil. kWh/year
- Natural Gas: 15 bil. m3/year
- Coal: 15 mil. ton/year
- Import: 17 bil. kWh/year
- Nuclear Power and Imported Coal can be competed

To meet demand of 93 bil. kWh in 2010 and 201 bil. kWh for 2020, the total power of plants should be 35100 MW for 2020, of which Hydro is 12000 MW, Gas Turbine is 8400 MW, Coal Thermal is 4400 MW, Regional Import is 3700 MW

and Nuclear Power is 2000 MW operating in 2019.

ELECTRICITY DEVELOPMENT

2003-2020: HIGH SCENARIO

1. 2003-2010:

- Building and expansion of 42 power plants of 14000 MW, of which 26 Hydro plants, 11 Gas Turbine Plants, 8 Coal Thermal Plants

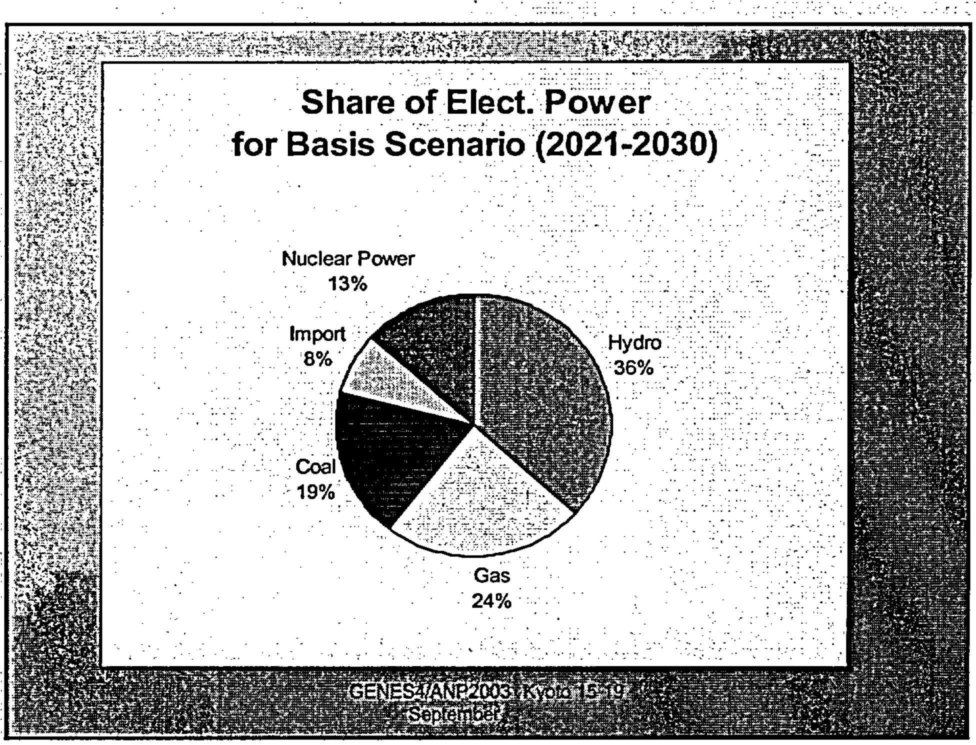
2. In 2020, total power can reach 44 800 MW of which

- Hydro: 17200MW (38.3%)
- Gas Turbine: 12300 MW (27.5%)
- Coal Thermal: 6600 MW (14.7%)
- Regional Import: 4700 MW (10.4%)
- **Nuclear Power: 4000 MW operating in 2017 (8.9%)**

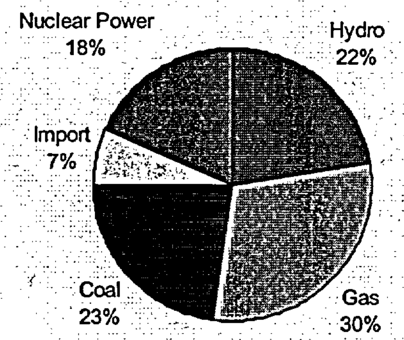
ELECTRICITY DEVELOPMENT

2021-2030: BASIS SCENARIO

Plant Type	Total Power (MW)	Production, TWh
Hydro Power	22200	73.2
Gas	14300	96.8
Coal	11200	74.3
Import	4700	22.6
Nuclear Power	8000	59.4
Total	60200	326.3



Share of Elect. Production for Basis Scenario (2021-2030)

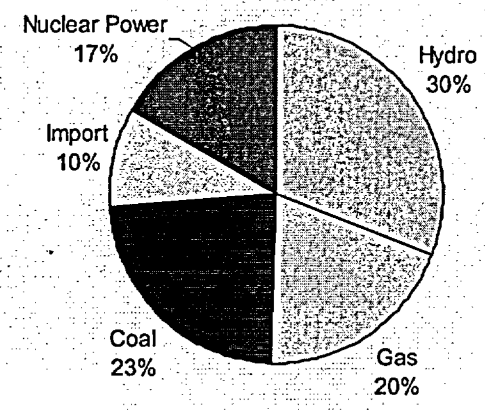


ELECTRICITY DEVELOPMENT

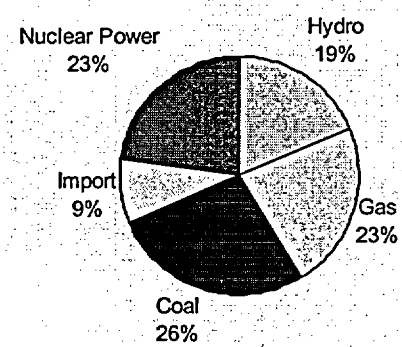
2021-2030: HIGH SCENARIO

Plant Type	Total Power (MW)	Production (TWh)
Hydro Power	22200	73.2
Gas	14200	90.1
Coal	16700	108.5
Import	6900	34
Nuclear Power	12000	89.8
Total	**71900**	**395.6**

Share of Elect. Power for High Scenario (2021-2030)



Share of Elect. Production for High Scenario (2021-2030)



GENES4/ANP2003, Kyoto 15-19
September

CONCLUSION REMARKS

- The "Doimoi Policy" - innovation - of Vietnam has created the country social-economic development that leads to the development of electricity system. Therefore GDP and foreign and domestic invesment increased remarkably since 1990.

- Energy demand and supply can be met with taking into account the introduction of nuclear power for the period of 2017-2020 and beyond with the total nuclear power of 2000MWe or 4000MWe for the basic and high economic development scenarios, respectively.

CONCLUSION REMARKS

- Vietnam views a peaceful and environmentally-clean nuclear policy for the country industrialization and modernization.

- Vietnam has potential of uranium resources although it relies on imported nuclear fuels for first nuclear power plants.

- International cooperation in the field of using nuclear power for peace is essential for Vietnam.

GENES4/ANP2003

Thank You Very Much For Your Attention !

GENES4/ANP2003 Kyoto 15-19 September

The Role of Nuclear Energy in Indonesia in The 21st Century

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INTRODUCTION

- Economical crisis crushing many countries in Asia including Indonesia around 1997-1998 has changed many plan dramatically, including electrical power plan planning
- Many investment in electrical power plant has been suspended along with the decrease of electrical consumtion at that time

INTRODUCTION (continued)

- However 3 years later the electrical consumtion grows fast steadily so that the balance between electrical production and consumtion become critical
- In many area outside Java Island the pereodic cut of electricity in turn has appeared
- Many additional obstacle : the disfuction of electrical power generation and distribution system due to accident or by the natural situation such as the shortage of water resource [illegible]

Introduction (continued)

- The electrical line network in Indonesia usually divided into two groups: Java-Bali area, and the outer area. In Java-Bali area, the electrical network is relatively stable. Therefore installation new large electrical power plant is a good option to add production capacity.
- However for outsite area the consumtion rate is relatively small, global electrical line network is not yet establish and widespread in large area. Therefore the installation of small electrical power plant becomes realistic option to add production capacity for this area.

Power Plant for Emergency

- In some area the electrical line network is not stable enough so that there is still probability of the occurrence of the trouble with this line network, especially for the outer area. Therefore building mobile electrical power plant becomes good option to anticipate such situation.

General Situation in Indonesia

- The above situation give us a description about the possibility to introduce nuclear power plant to increase the electrical production capability.
- For the Java Bali Area the small or large nuclear power plants are both possible
- For the outer area the small or medium power plants area the best choise.
- In addition, the mobile nuclear power plant based on the ship can be best solution to anticipate temporal electrical energy deficit in many part of outer area.

The Basic Characteristic of Electrical Energy Consumtion in Indonesia

- In Table 1 : Java-Bali Island which consist of about 7% land area, has electrical consumtion more than 75% of total electrical consumtion in Indonesia. This is because the population of Java-Bali is about 65% of that in Indonesia.

The Basic Characteristic of Electrical Energy Consumtion in Indonesia(continued)

- As the consiquence the electrical network system in Java-Bali area can be established. On the other hand to build electrical network around the Kalimantan Island is not economical.
- Threfore for the area outside Java-Bali the electrical network is basically local and each sub area should have their own small electric power plants.

Characteristic of Electrical Energy Consumtion in Indonesia

Description	2001	2002	2003	2004	2005	2006
Jawa-Bali						
Energy Sales (TWh)	69,12	74,82	81,74	89,27	97,47	106,22
Growth Rate (%)	11,5	6,5	6,7	7,0	7,3	7,2
Peak Demand (GW)	13.326	14.174	14.862	15.844	16.965	18.168
No.Of Customers (Mio)	20.12	20.78	21.74	22.80	23.95	25.16
Outer Island						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Growth Rate (%)	7.3	7.4	10.0	10.4	10.8	10.8
No.Of Customers (Mio)	9.48	9.95	10.69	11.50	12.38	13.32

Characteristic of Electrical Energy Consumtion in Indonesia

- Electric consumtion growth rate for 2003
  - Outside Java-Bali area : 10%
  - Java-Bali area : 7%
- At the present time electric power plant in Java-Bali is dominated by oil, gas and coal electric power plant. The others, hydro power plant contribute 14%, while geothermal contribute 4% of total Java-Bali electric generation capacity.

Major Electric Power Plant in Indonesia at The Present Time

Power Plant Type	Installed Capacity	
	MW	%
Oil Fired Power Plant	4,240	23
Gas Fired Power Plant	4,417	24
Coal Fired Power Plant	6,650	36
Hydro Power Plant	2,536	[illegible]
[illegible]	[illegible]	[illegible]

Plan for Development of Nuclear Power Plant in Indonesia

- In 1997 Indonesia prepared to introduce nuclear power reactors which according to the prediction of electric power consumtion at that time must be implemented at 2007 or earlier.
- However due to the crisis all of the planning was cancelled.

Plan for Development of Nuclear Power Plant in Indonesia (continued)

- Few years after the start of the crisis the electrical energi consumtion tend to increase unpredictably. Therefore the general energy planning then revised, including reconsideration of the nuclear power plant.
- In January the seminar on 'National Energy Planning with Nuclear Energy Option' has been performed. The Energy and Mineral Resources Ministry has planed to introduce first Nuclear Power Plant [illegible]

Electrical Energy Consumtion in Indonesia

Tariff Group	1997	1998	1999	2000	2001	Share (%)
Residential	23,199,115	24,903,376	25,833,618	26,796,675	27,885,612	93.5
Business	793,055	847,940	982,281	1,062,955	1,172,247	3.9
Industry	51,046	43,088	42,575	[illegible]	46,014	[illegible]
Others	[illegible]	[illegible]	666,138	691,418	[illegible]	[illegible]
TOTAL	24,640,587	26,433,489	27,524,612	28,595,385	29,827,728	100.0

Progress of nuclear Energy Usage in Indonesia

- On the other hands, the use of nuclear energy for desalination has better progress.
- In October 2001 Indonesia and South Korea signed memorandum of understanding to develop nuclear power plant for desalination in Madura. The design study on this topic is still in progress.

Progress of nuclear Energy Usage in Indonesia (continued)

- Another prospect for introduction of nuclear energy in Indonesia is by introduction of small nucelar power plant (20 - 100 MWe) to be installed in outside of Java-Bali.
- At the present time some area has electrical energy deficit. This data is shown in the following table

Electrical Energy Shortage in Some Part Outside Java-Bali Area

No.	Area/Province	Capacity	Peak Load	Deficit
1.	Aceh	31	46	-15
2.	West Sumatra and Riau	210	234	-24
3.	South part of Sumatra	654	665	-11
4.	Bangka Belitung Island	19	23	[illegible]
5.	West Kalimantan	[illegible]	[illegible]	[illegible]
6.	East Kalimantan	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

New Prospect in Indonesia

- By considering the trend of electrical energy consumtion growth the small nuclear power plant with capacity 20-100Mwe will match to most of the province in Indonesia out side Java and Bali.
- The Autonomous policy in Indonesian government give head of local government flexibility to arrange their own energy policy. Some rich provnce with electrical energy shortage such as in many part of Sumatra and Kalimantan maybe will consider the introduction of small nuclear power plant in their area.

The Characteristic of Nuclear Power Plant Suitable for Indonesia

1. Highly reliable and high utilization factor

→ Considering that the electric distribution line network is rather limited outside Java and Bali Islands, the long maintenance period will possibly create trouble to the customer.

→ Innovative long life water reactor, long life high temperature reactor, or long life lead or lead/bismuth cooled LMFBR can be considered as good candidates.

The Characteristic of Nuclear Power Plant Suitable for Indonesia (continued)

2. **Inherent safety capability**

→ **Due to Chernobyl accident the public acceptance to the nuclear power plant need to be improved**

→ **By introducing the inherently safe small nuclear power plant is expected to increase this public acceptance level**

→ **The possibility of super prompt critical accident should be eliminated.**

The Characteristic of Nuclear Power Plant Suitable for Indonesia (continued)

2. Inherent safety capability

➔ Innovative high temperature gas cooled reactor which can survived to hypothetical accident such as depresurrization accident, severe rod withdrowal accident, and other severe accident is expected to be good candidate

➔ Innovative small water reactor which can survive severe LOCA and UTOP accident is also considered as good candidate

The Characteristic of Nuclear Power Plant Suitable for Indonesia (continued)

2. Inherent safety capability

➔ innovative lead or lead-bismuth fast reactors are also strong candidate

➔ For very small reactors, especially of lead or lead bismuth cooled fast reactors the use of high internal conversion factor to control the reactivity to be well below one dollar is very useful to avoid super prompt critical accident

The Characteristic of Nuclear Power Plant Suitable for Indonesia (continued)

3. **Long life operation without refueling and shuffling**

➔ **This factor is to support very high utilization factor and also non proliferation characteristics. By such type of core there is no need to open the reactor core in operation area therefore enhance proliferation aspect**

The Characteristic of Nuclear Power Plant Suitable for Indonesia (continued)

4. Proliferation resistant

➔ the design of the reactor core so that there is no need to open the reactor vessel in the operation area is considered as one important way to improve proliferation resistancy.

➔ However many paralel steps also need to be performed such as the choose of fuel so that there is no possibility to easily use it for nuclear weapon.

➔ For plutonium fuel high content of Pu-240 will improve the operation capability without refueling or shuffling, proliferation resistant and economical.

➔ The use of particle bed with strong coated is also an alternatif

The Characteristic of Nuclear Power Plant Suitable for Indonesia (continued)

5. Economical

➔ This aspect is of course very important consideration. The proposed nuclear power plant will be benchmarked to any other electric power plants such as gas, oil, and coal based electric power plants.

➔ However, the standar price for electric power generation in out side Java-Bali area is significantly higher than that in Java-Bali. This aspects will help the possibility to introduce small nuclear power plants which in many cases need larger operational cost per kWh.

The Characteristic of Nuclear Power Plant Suitable for Indonesia (continued)

- 6. Mobile

➔ This criteria is just for those reactors set to be emergency electric generation system, especially that reactors can be moved by a ship or can be operated on the ship.

➔ This situation need that the reactor is still be possible to be operated in small sea wave environment.

➔ In severe accident should have inherent safety characteristics, and no possibility of the occurrence of recritical accident.

CONCLUSION

- Indonesia need many new investment in electric power generation to overcome energy deficit especially in outside Java-Bali area, and also to anticipate the growth of electric energy consumer.
- For Java-Bali area, the introduction of nuclear power plant in the future is possible for large or medium nuclear power plant.
- For outside Java-Bali area, due to the limitation of electric line network, small or medium nuclear power plant is a good option but the nuclear power plant should have specific characteristic: reliable and high load factor, inherently safe, long-time operation without refueling, [illegible]

The Role of Nuclear Energy in Myanmar

Tin Hlaing
Myanmar Academy of Technology

Beginning

- Early start in 1950's, UBAEC formed
- Joined IAEA 1957
- Leader – Mr U Hla Nyunt, a Japanese trained physicist
- Engineers and scientists recruited and trained abroad- 6 at Argonne National Lab in 1956, 11 abroad in 1957

Discontinuity

- Activities stopped after 1962
- Only very small staff at UBAEC
- Radiotherapy and nuclear medicine introduced
- In agriculture successful new mutant Shwewartun(Golden Yellow Mutant)

Present

- 1990 -Thein Oo Po Saw initiates revival of AEC
- Atomic Energy Committee formed
- Renewed links with IAEA and joined RCA in 1995
- DAE organised under MOST in 1997

Non-power Applications

- Reviewed by Xian in IAEA Bulletin vol 43 and A K Anand in RCA-30 Scientific Forum, Seoul, March 2002
- Applications are IAEA Technical Cooperation activities

Food and Agriculture

- Cultivated area about 10 million hectres
- Except for mutant Shwewartun no other successes or attempts
- Veterinary dept introduces RIA techniques for improving artificial insemination and disease diagnosis
- Need to introduce food irradiation and isotope methods for irrigation and water resources and develop radiation induced mutants

Health

- Population 51 million, increasing 2%
- Only 3 hospitals have radiotherapy
- Only 1 nuclear medicine dept + 1 new just created
- Medical research uses RIA
- Large demand for radiopharmaceuticals
- Need national production of radiopharmaceuticals and gamma sterilization of medical products

Industry

- Economic development after 1990 brings increased use of radiation and isotopes
- NCS and Nuclear Gauges in factories
- Radiography ,NDT and radio tracers
- Nuclear Analytical Techniques (NAT) for exploration and mining and environmental monotoring

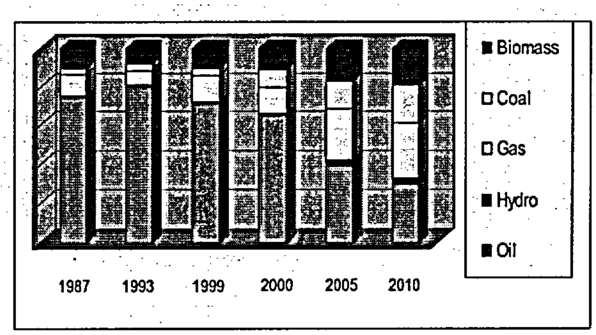
Energy

- Heavy reliance on fire-wood
- Important sources: Biomass, natural-gas, oil and hydro (little use of coal – recently some coal deposits discovered)
- Hydro: potential 100,000 MW
- Identified sites 38,000 MW
- under construction 1960 MW
- Total electricity installed capacity1220 MW

Primary Energy Mix In Myanmar

MTOE	1987	1993	1999	2000	2005	2010
Biomass	6.00	7.9	7.29	7.85	8.66	9.10
Coal	0.03	0.02	0.03	0.13	0.64	1.06
Gas	0.92	0.71	1.39	1.56	5.88	8.49
Hydro	0.25	0.36	0.39	1.14	3.11	5.96
Oil	0.82	0.77	1.04	1.33	3.84	5.9
Total	8.02	9.76	10.14	12.01	22.13	30.51

Source : Soe Myint and Soe Aung, ASEAN Energy Bulletin, First Qtr. 2000



Beyond 2010

- Need to sustain forests
- Some hydro-sites may need environmental review
- Nuclear power introduction desirable for long term

Asean Context

- Seems to have no interest in nuclear energy outside nuclear centres
- Asean Center for Energy (ACE) has no mention of nuclear energy in it's bulletin
- Asean Committee on Science and Technology(COST) has not engaged nuclear institutions

Human Resources

- Graduates in science and engg available, but they need nuclear orientation and training
- Sustainability and self-reliance of nuclear institution is important – for employment and expansion business sector should evolve

Prospects for Nuclear Power

- Large reactors not appropriate
- Should consider small reactors (100-400 MW)
- 2025 reasonable date for introduction
- New developments in small reactors expected
- Preparatory period now
- Suggest ASEAN Cooperation

THANK YOU