FNCA Open Seminar, Hanoi, 15 Nov. 2011

Application of Nuclear Technology for Development and Welfare

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Former Commissioner, Japan Atomic Energy Commission
Former Deputy Director General, IAEA

Talking Points

- Roles of nuclear power for sustainable development
- Lessons learned from Fukushima nuclear accident
- Nuclear technology for:
  - Food and agriculture
  - Human health
  - Industrial applications
  - Environmental protection
- Japan's nuclear cooperation with Asian countries

Nuclear Power for Sustainable Development

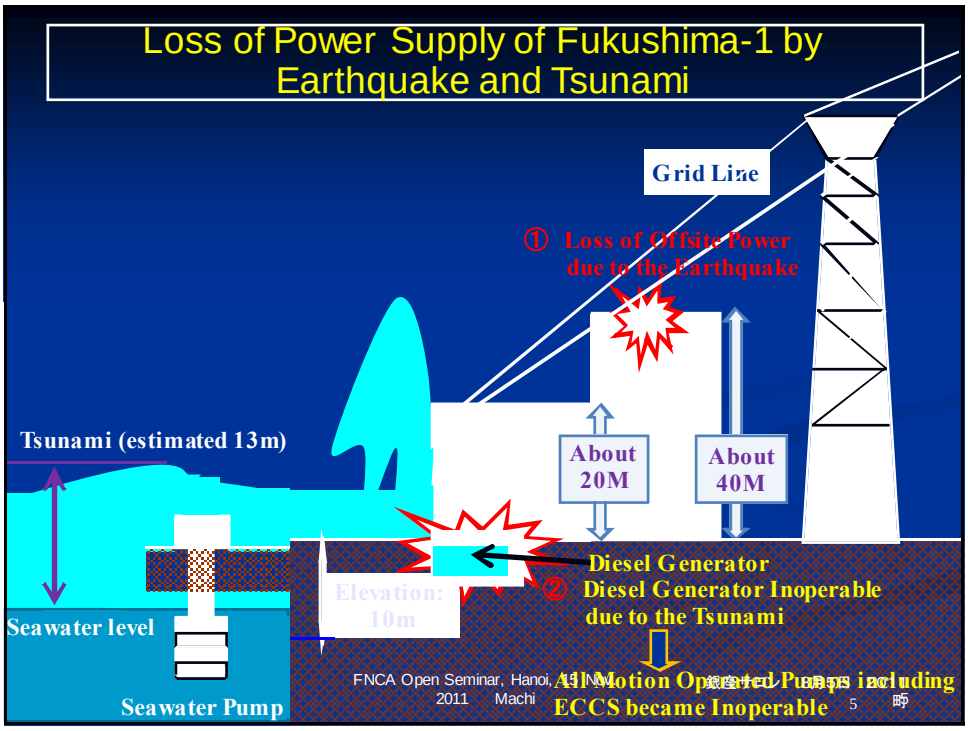
- Nuclear power is essential to secure energy supply to meet rapid development with limited amount of fossil fuels
- Nuclear power can reduce carbon dioxide emission and mitigate climate change
- The safety is the first for nuclear power

14m High Tsunami Attacked Fukushima-1NPS 45 minutes after Earthquake (14:46 March 11, 2011)

19867 lives were lost by tsunami and earthquake (25/Aug. 2011)

No death by the nuclear accident

Flooded by tsunami


Loss of Power Supply of Fukushima-1 by Earthquake and Tsunami
Grid Line
① Loss of Offsite Power due to the Earthquake
Tsunami (estimated 13m)
About 20M
About 40M
Diesel Generator
② Diesel Generator Inoperable due to the Tsunami
Elevation: 10m
Seawater level
Seawater Pump
All Motion Operated Pumps including ECCS became Inoperable
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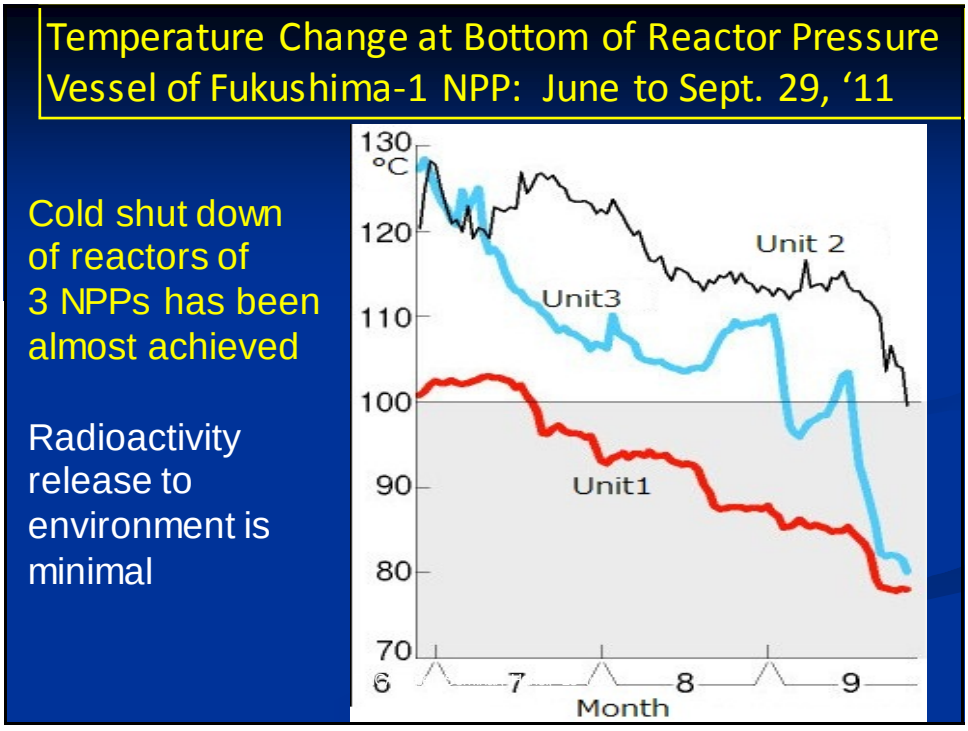

Temperature Change at Bottom of Reactor Pressure Vessel of Fukushima-1 NPP: June to Sept. 29, '11
Cold shut down of reactors of 3 NPPs has been almost achieved
Radioactivity release to environment is minimal
130 °C
120
110
100
90
80
70
Unit 2
Unit3
Unit1
6
7
8
9
Month

Lessons Learned from Fukushima-1 Nuclear Accident: Japan shares lessons with international community

Causes for the Severe Accident: Loss of cooling by malfunction of emergency power generator by tsunami

Important lessons

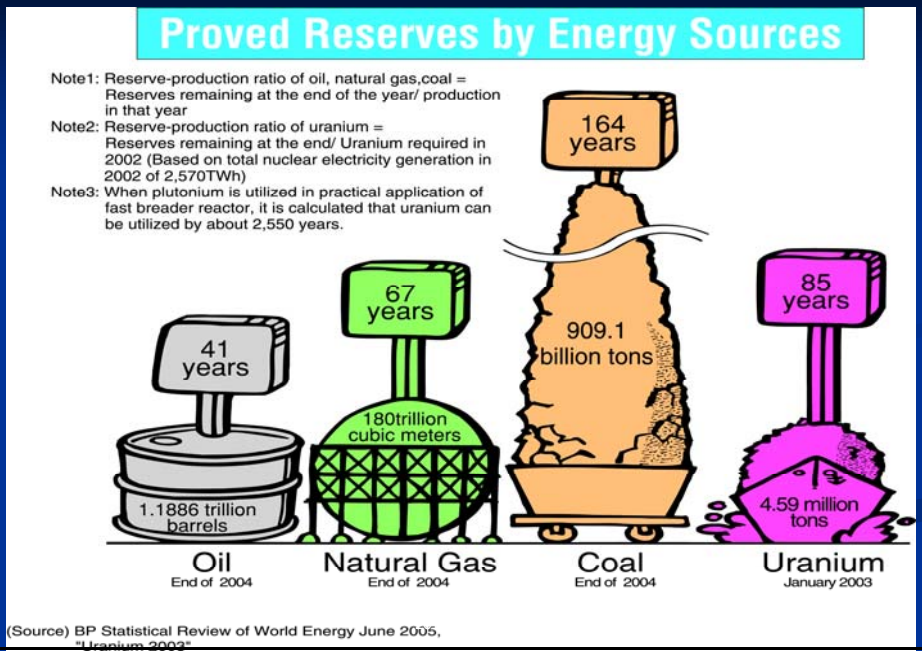
- To place emergency power supply at the place higher than possible tsunami height and in water tight room
- To prepare mobile power supply for emergency
- To ensure ventilation of building for reactor containment vessel and to install hydrogen re-combiners in the building to avoid hydrogen explosion

Energy; Essential for Poverty Reduction and Sustainable Development

- World population is 7 billion (Oct. 2011) huge (1 billion) increase the past 12 years
- No development without energy
- 1.6 billion people have no access to electricity

  In Bangladesh 50% of population have no access to electricity
- Global energy consumption increase; over 50% by 2030 (70% of increase comes from developing countries)

Fossil Fuel Reserve Is Very Limited

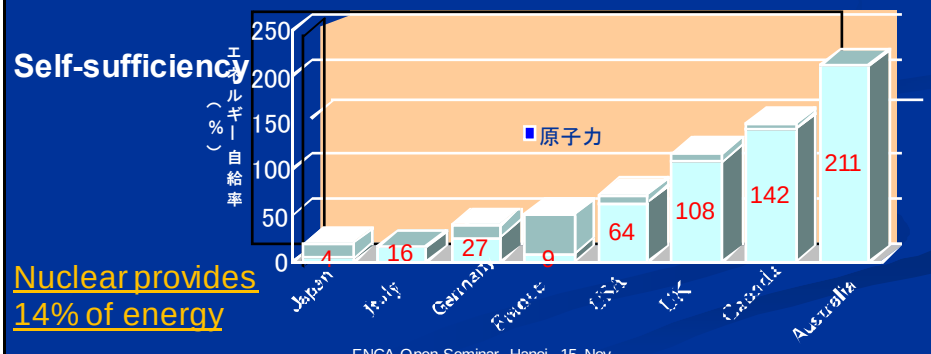


Energy Security : Priority Issue of Japan

◎ Japan's Energy self-sufficiency : 4 % (Hydro)

◎ 89% of oil is imported from Middle East

Energy security is very fragile



Nuclear provides 14% of energy

Prof. R.K.Pachauri, IPCC, **Nobel** Prize **'07**

- Pachuri said: Scientific consensus on the fact that climate system is changing
- The climate changes have taken place very likely by the results of human activity
- IPCC4 Report:①Temperature increase by 2100;1.8-4.0C,②Sea level raise by 2100;28-43cm,③Increase of heat wave, ④Stronger cyclones in tropical zone

Tuvalu suffers see level rising and high tide (1996)

南太平洋のツバル。
1996年の高波の被害の写真

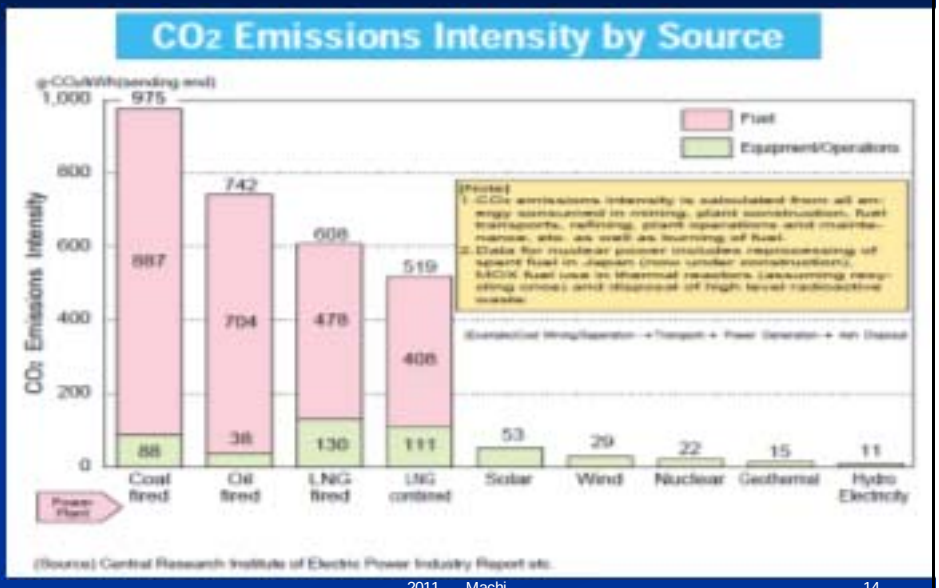
Reduction Target of GHG Emission

- Submitted to UNFCCC following COP-15 agreement (Jan. 31, '10 by 55 countries):

Reduction by 2020

- Japan: −25% from '90 level
- EU: −20~30% from '90 level
- USA: −15% from '05 level (-7% from '90 level)
- China: −40 - 45% in GHG/GDP (70% increase in GHG emission)

Nuclear Power to Reduce CO2 Emission



Basic Law on Energy Policy of Japan

(effective 14 June, 2002)

Three basic policies

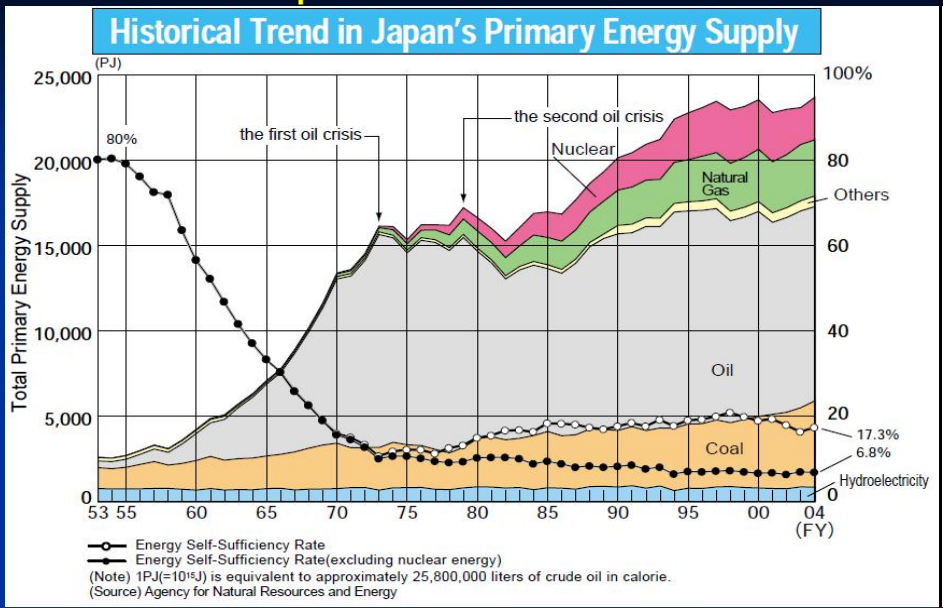
Energy Security and Stable Supply

Compatibility with Environment

Cost Competitiveness

The Government is responsible for strategic planning of energy supply and demand

Gas & Nuclear Replaced Oil after Oil Crisis in 1973 Oil



Japan's Energy Basic Plan to 2030 (METI, 2010)

(Currently 54 nuclear plants in operation)

- **Significant increase in nuclear power:**
  - More than 14 additional NPPs by 2030
  - Increase in operation factor to 90%
- 70% of power is from non-CO2 emission source
- Increase in renewable energy to 10%
- 70% of new cars with hybrid and/or electric
- 100% light source by LED and/or Organic EL

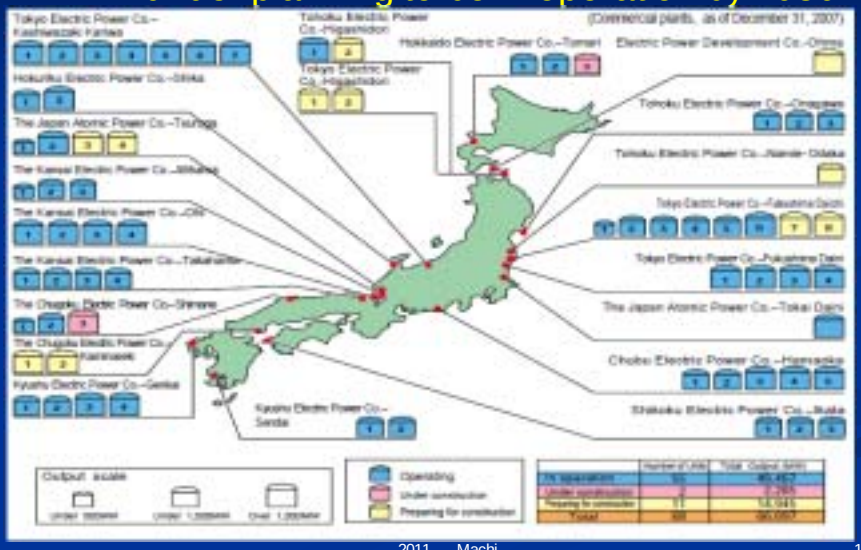
After Fukushima Nuclear Accident

Japan's New PM, Mr. Noda Stated:
At UN Nuclear Safety Summit, 22 Sept. 2011

- Improvement of nuclear safety of Japan to the world highest level
- Achieving the cold shut down of Fukushima-1 nuclear reactors
- Continuation of use of nuclear power
- Sharing fully lessons learned from Fukushima-1 accident with international community

Nuclear Power in Japan

54 units 48.84GW in operation, 2 under construction, 12 under planning to be in operation by 2030



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IAEA Projection

World Increase of Nuclear Power

- Projection after Fukushima: **Mr. Amano, DG stated** NPP of 432units (2011) will increase by 90 —350 units (total 522 – 782) in 2030
- Projections in '09

  -Increase from 372GW to 473GW (low case)-748GW (high case) in '30
- Status in '09 IAEA:

  -438 NPPs (372GW) in operation in 30 countries sharing 14% of global electricity: 44 NPPs under construction (28 are in Asia)

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Asian countries keep their nuclear power program after Fukushima nuclear accident

- Korea: 21 NPPs in operation, 6 under construction, 2 under planning,38 NPPs by 2030 to supply 60% of power; Established Nuclear Safety Commission on 26 Oct. 2011
- Thailand: Plan of 1GW NPP in 2020, 1GW in 2021 is postponed for 3 years
- Vietnam: Four NPPs (1GW each) in '20, 15-16 GW in '30 First 2 units by Russia; second 2 units by Japan
- Indonesia: Four NPPs (1GWeach) before 2025
- Pakistan:2 NPPs (462 MW), 1 (300MW) under construction, 2 under planning
- Bangladesh: Rooppur NPP project: 2 NPPs 2018 by Russian support
- Malaysia: FS to start operation 2 NPPs in 2021

India and China keep policy to expand nuclear power after Fukushima accident

- India:15 NPPs, 3.4 GW; 25-30 GW increase by 2020 including FBR 0.5 GW by 2011

  Prime Minister of India, Mr. Singh announced to establish the Nuclear Safety Regulation Agency independent from Atomic Energy the Commission to strength nuclear safety (April, 2011)
- China: Has carefully checked safety of 13 NPPs under operation and 24 NPPs under construction and decided to continue operation and construction of plants

UAE, Poland, Turkey, Jordan, Egypt, Saudi Arabia Planning to Start Nuclear Plants Operation

- UAE: 1st NPP to be operated in 2017; Contract of 4 NPP construction with ROK in Dec. 2009
- Poland: PM Tusk said "We are convinced nuclear energy constitute good alternative to other energy sources. Germany's decision will not have any influence on our decision" 31 May, 2011
- Saudi Arabia will construct 16 nuclear power plant by 2030. The first 2 plants in 10 years: (1 June, 2011)
- Argentina signed MOU with Russia for possible partner of 4th NPP construction: 14 May, 2011
- South African Energy Minister reiterated government commitment to nuclear power (22.6% of primary energy in 2039): 26 May, 2011
- Sweden continues to operate 10 NPPs as before to produce 50% of power. 60% of public support nuclear power in opinion survey in April.

Challenges of States Introducing The 1st Nuclear Power Plant

- Establishment of Infrastructure
  - Human resources development
  - Local supply chain
  - Legislation for NPP license, non-proliferation of nuclear arms and safety regulation
  - Public acceptance and site selection of NPP
- IAEA is supporting about 60 Member States for NPP FS and planning

To Improve Public Acceptance of Nuclear Power after the Fukushima Accident in Japan

- **Full and Transparent Communication with the Public on Following Points:**
  - Lessons learned from the Fukushima accident
  - Re-assessment of risk for natural hazards and increase of safety assurance
- Prompt effort for remediation of contaminated area in vicinity of the Fukushima Daiichi NPS

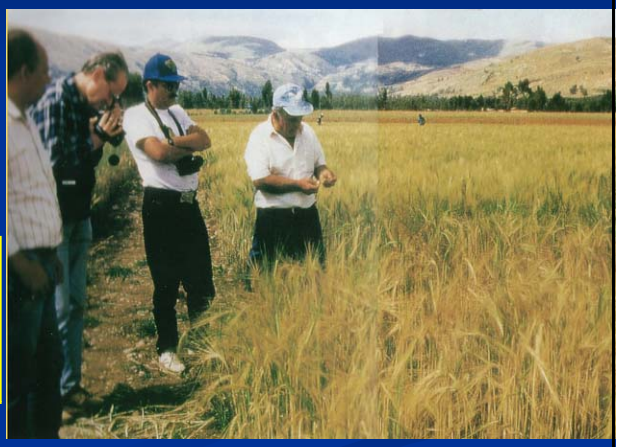
Nuclear Technology for Everyday Life

- Nuclear applications for improving human welfare
  - More productive agriculture
  - Better human health
  - Improved industrial process
  - Environmental protection

3000 Better Varieties Developed by Radiation-Induced Mutation Breeding

- Higher yield
- Disease resistant
- Early maturity
- Drought resistant
- Dwarf
- Salt resistant

Vietnam has success story of new variety of rice to grow in saline Mekong Delta



Barley of Early Maturity in High Land of Peru (IAEA)

Recent Success in Japan

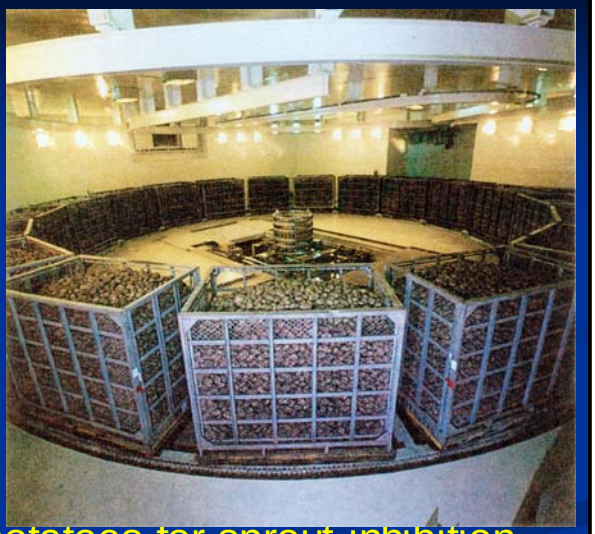
Parent

New variety

Disease (brack spot) resistant mutant variety of pear to avoid excess use of pesticides for better economics and environment

Food Irradiation Expanding Worldwide

-Sprout inhibition:
Garlic, Potatoes,
Onions
-Disinfection:
Spices, Shrimps
Sausage, Beef,
-Disinfestation:
Citrus, Mangos,
Papaya, Cucumber
300,000 tons/year



Irradiation of potatoes for sprout inhibition in Japan using Co-60 (9,000 ton/year)

Irradiated Food Increasing

Sprout inhibition, Disinfestations, Sterilization Permitted in 57 countries

World total of irradiated foods	**ca. 500,000**ton
China : Garlic, Dried vegetables, etc.	146,000 ton
Vietnam : Frozen shrimps, etc.	14,000 ton
Japan : Potatoes	8,000 ton
USA : Spices, Ground meats, Fruits	92,000 ton
Ukraine: Wheat grain	70,000 ton
Brazil: Spices, Fruits	23,000 ton
South Africa : Spices	18,000 ton
Belgium : Spices, Frozen chicken	7,000 ton
Others:	ca.120,000 ton

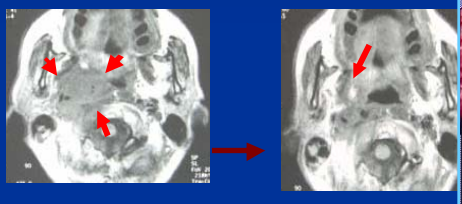
Linear Accelerator (LINAC)

X-ray Radiotherapy Machine

これは患者さんのセットアップの写真です。
治療中は、患者さんのみ治療室内に残り、技師さん達は治療室にいません。

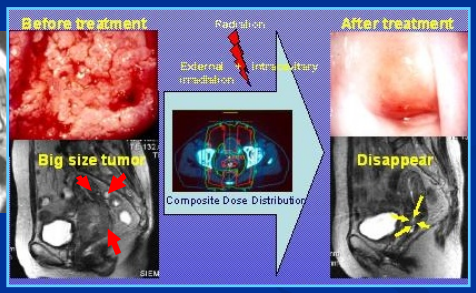
Project on Radiation oncology

Joint Protocol Studies for Radiation Therapy of Head and Neck Cancer and Uterine Cervix Cancer



Before CRT

NPC after CRT



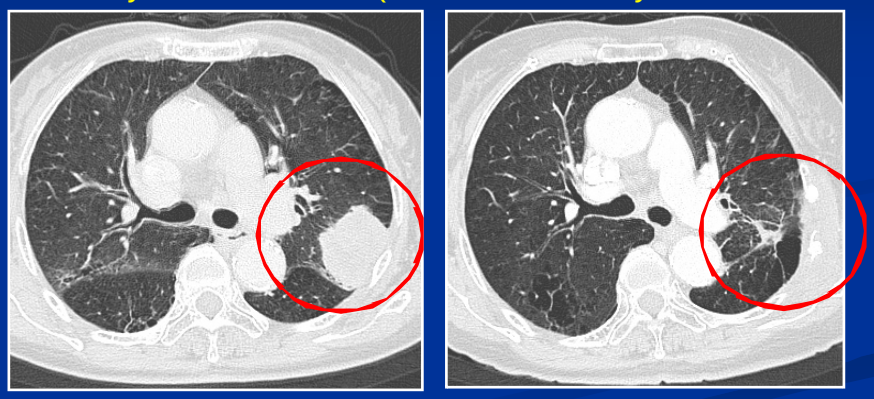
Head and neck cancer
(Chemo-radio therapy)

Uterine cervix cancer
73% survival rate, 5 years

Advanced Technology for Cancer Therapy by Heavy Ion Beam Facility in Japan (NIRS)

Lung Cancer: One time irradiation of Carbon-12 ion

71years old Female(扁平上皮がん） by NIRS

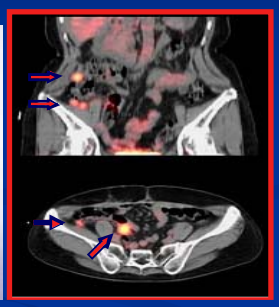


Before treatment After treatment

PET(Positron Emission Tomography)-CT Advanced Nuclear Medicine for Early Diagnosis

Cyclotron

PET camera



PET-CT image (ovarian cancer)

300 PETs in Japan

Industrial Applications

- Radiation processing for better products and environmental protection
- Nucleonic control system for efficient process
- Radiography for non-destructive testing
- Radio-tracer technique for chemical engineering study

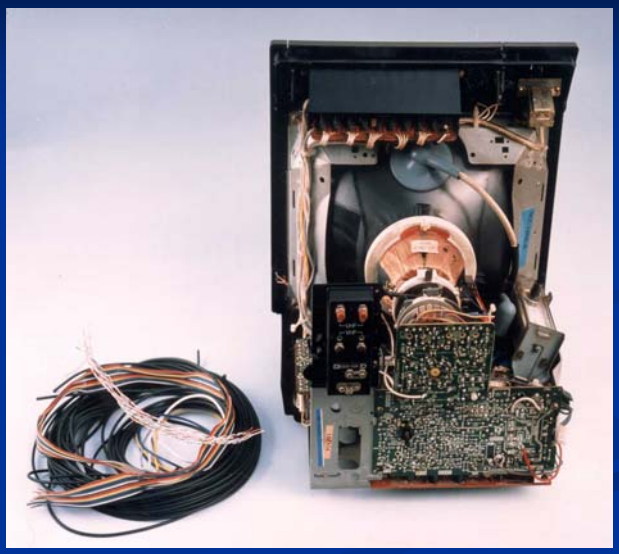
Commercially produced cross-linked or grafted polymers by radiation processing – 1

Products	Applications
Cross-linked polyethylene and PVC	Wire insulation resistant to heat and chemicals, pipes for heating systems
Cross-linked foamed polyethylene	Insulation, packing, floating materials
Heat shrinkable tubes and sheets	Food packaging, insulation, protection against corrosion
Cross-linked rubber sheets	Automobile tires (high quality)
AA grafted PE film	Battery separator
Cross-linked polyurethane	Cable insulation for antilock brake sensor

Heat Resistant Wires and Cables by Radiation Crosslinking

Cables for home electrical appliances

Cables for car



Crosslinking of rubber to control flow properties

Memory Effect by cross-linking

Automobile tires

Heat shrinkable tubes and sheets

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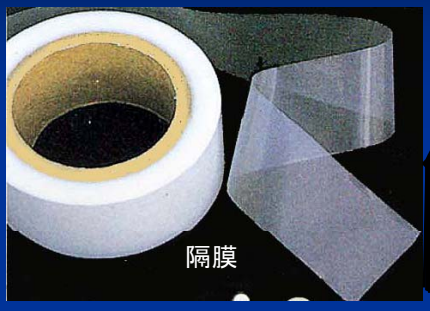
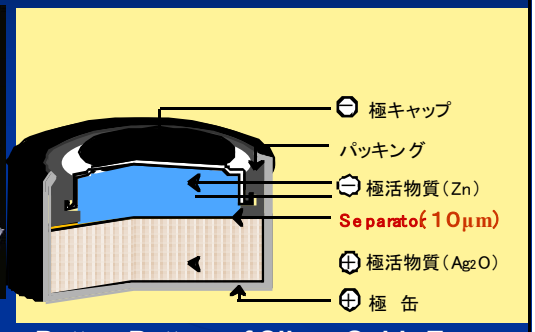
Battery Separator Membrans by Radiation Grafting



AAc grafted PE film



Button Battery of Silver Oxide Type
Production: 1 Billion/year in Japan

Polyethylene thin film (10μm) by radiation graft-polymerization of acrylic acid

Brazil CEBRI, Rio, Dec. 6, 2010 S. Machi

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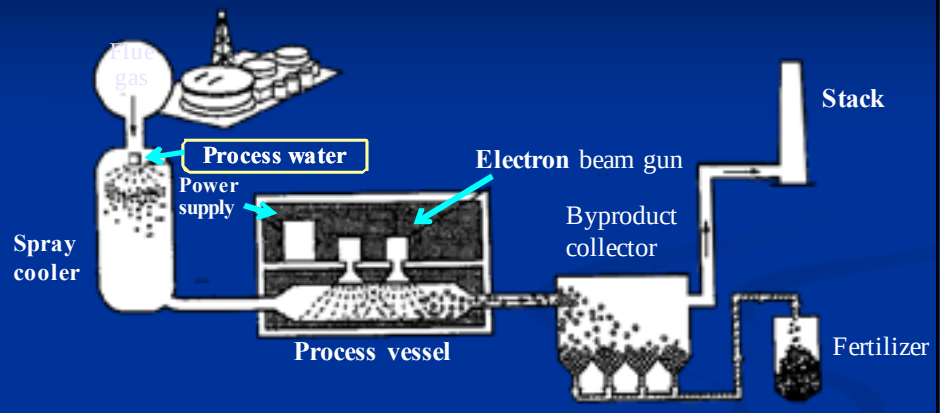
Innovative Technology for Cleaning Flue Gases by Electron Beams



Removal efficiency: SO_2 90% Absorbed dose: 10~15hGy
Temp: 65~70℃

Industrial Electron Beam Flue Gas Treatment (EBFGT) Plant in Poland

EB Accelerator:
700 keVx375 mA 4 unit

Treatment Capacity:
270,000 m3/h from coal power plant of 100 MW

Japan's Cooperation for Nuclear Science and Technology with Asian Countries

- Nuclear Scientists Exchange Program (MEXT) since 1986: 1500 scientists and engineers have been invited in Japan for a year
- FNCA（Forum for Nuclear Cooperation in Asia） since1991: 11 projects & study panel (MEXT, CAO)
- Training programs for nuclear instructors since 1996, 97 instructors (MEXT)
- Seminars on nuclear safety (MEXT)
- Bi-lateral cooperation for nuclear power with Vietnam and Indonesia (METI)

FNCA（Forum for Nuclear Cooperation in Asia）

Participating Countries: Australia, Bangladesh, China, Indonesia, Japan, Korea, Malaysia, the Philippines, Thailand, Viet Nam (Observer: , Kazakhstan, Mongolia)

Ministerial Level

Senior Official

Coordinator (one in each country)

Project Leader 11 Projects

FNCA Vision Statement (adopted 2000)

The FNCA is to be recognized as an effective mechanism for enhancing socioeconomic development through active regional partnership in the peaceful and safe utilization of nuclear technology.

Ministerial Meeting (Nov. 2, 2006)

Coordinators Meeting (Feb.7-9,'07,Tokyo)

The 11th Ministerial Meeting
Nov. 18, 2010, Beijing, China

Heads of 12 Delegations

Dr. Tien, Deputy Minister, Science and Technology, Vietnam (middle): Dr. Tan, President, VINATOM (left) at 11th FNCA MM

Thank you for your attention