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KEBIJAKAN DAUR BAHAN BAKAR NUKLIR DI INDONESIA

Hudi Hastowo

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Badan Tenaga Nuklir Nasional-BATAN
Jl. Kuningan Barat, Mampang Prapatan, Jakarta, 12710

Sistimatika

1. Pendahuluan
2. Perkembangan Penggunaan PLTN di dunia
3. Perkembangan Teknologi Daur Bahan Bakar
4. Daur bahan bakar di Indonesia
5. Kesimpulan

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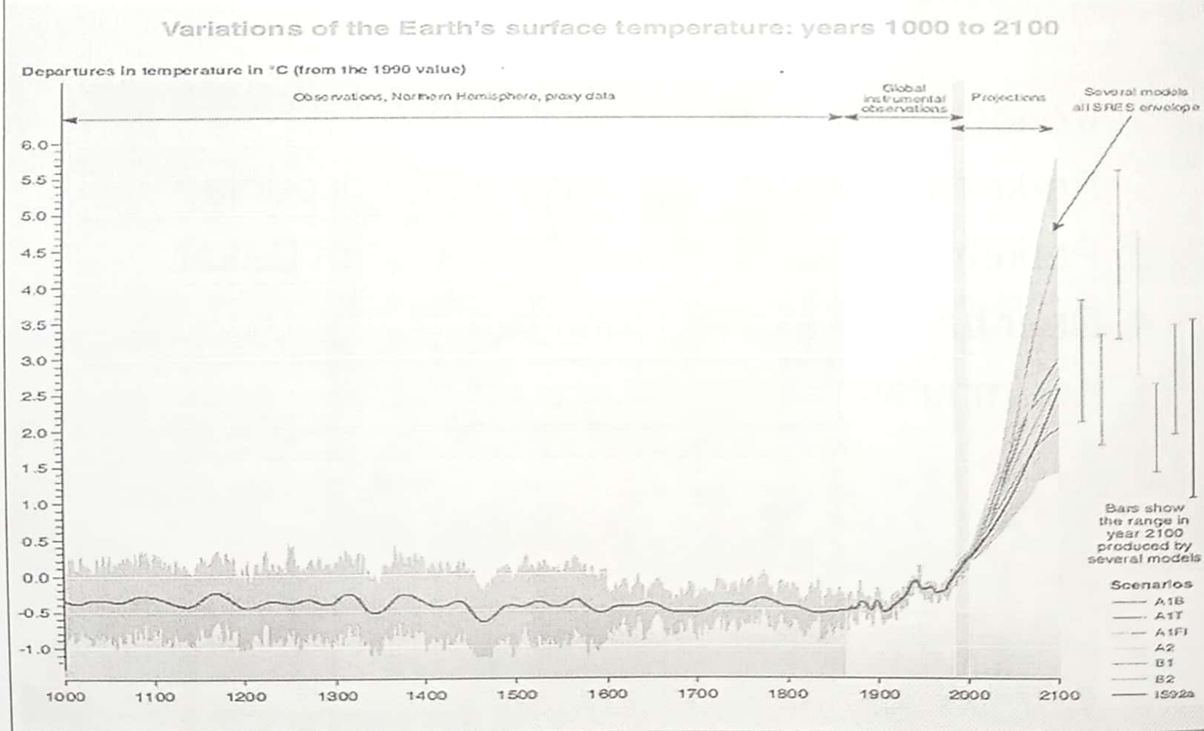
I. INTRODUCTION

- **Current energy trends are patently unsustainable: Socially, Environmentally, Economically.**
- **Oil will remain the leading energy source but ....**
  - The era of cheap oil is over, although price volatility will remain.
  - Oil field decline is the key determinant of investment needs.
- **To avoid abrupt and irreversible climate change we need a major decarbonisation of the world's energy system.**
  - Limiting temperature rise to 2 $_0$C will require significant emission reductions in all regions and technological breakthroughs.
  - Mitigating climate change will subtantially improve energy security.
- **The present economic worries do not excuse back-tracking or delays in taking action to address energy challenges.**



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- **There are several drivers for rising expectations for Nuclear Power growth, some of which are :**
  - Growing energy needs.
  - Security of energy supply.
  - Environmental concerns and constraints.
  - Rising and volatile prices of fossil fuels.
  - Improved relative economic competitiveness of nuclear power.
  - Nuclear power's increasing experience and good performance.
  - Interest in advanced applications of nuclear energy.

Change of Nuclear Energy Environment

- TMI (1979) & Chernobyl (1986) Accident
- Nuclear Industry has stagnated for the past 20 years

↓ Early 2000's

Increase of Electric Power Demand | **Global Warming** | **Soaring Oil Price**

↓ Late 2000's

- Renaissance of Nuclear Energy
- IAEA : Nuclear Units 2030

  Units/Share : 439 (16%) → 700 (27%)

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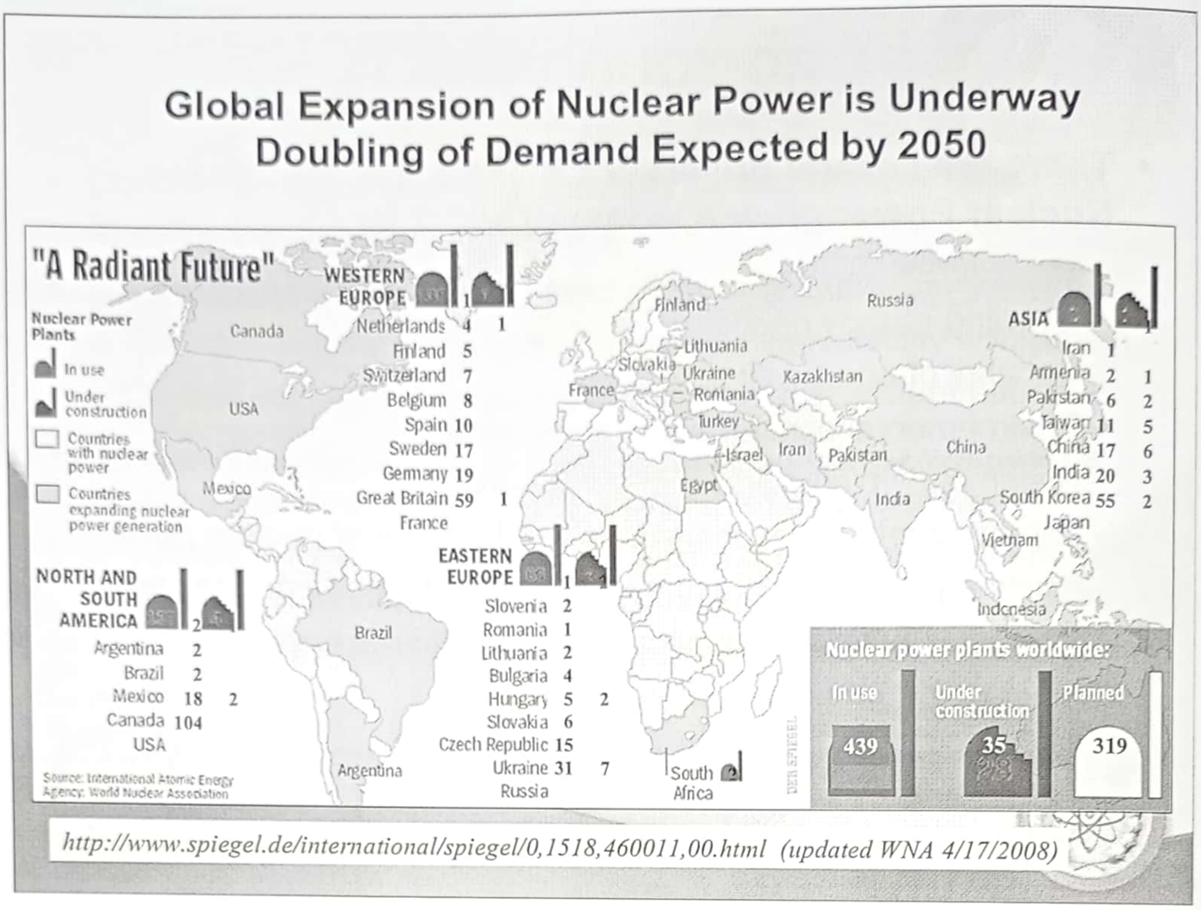

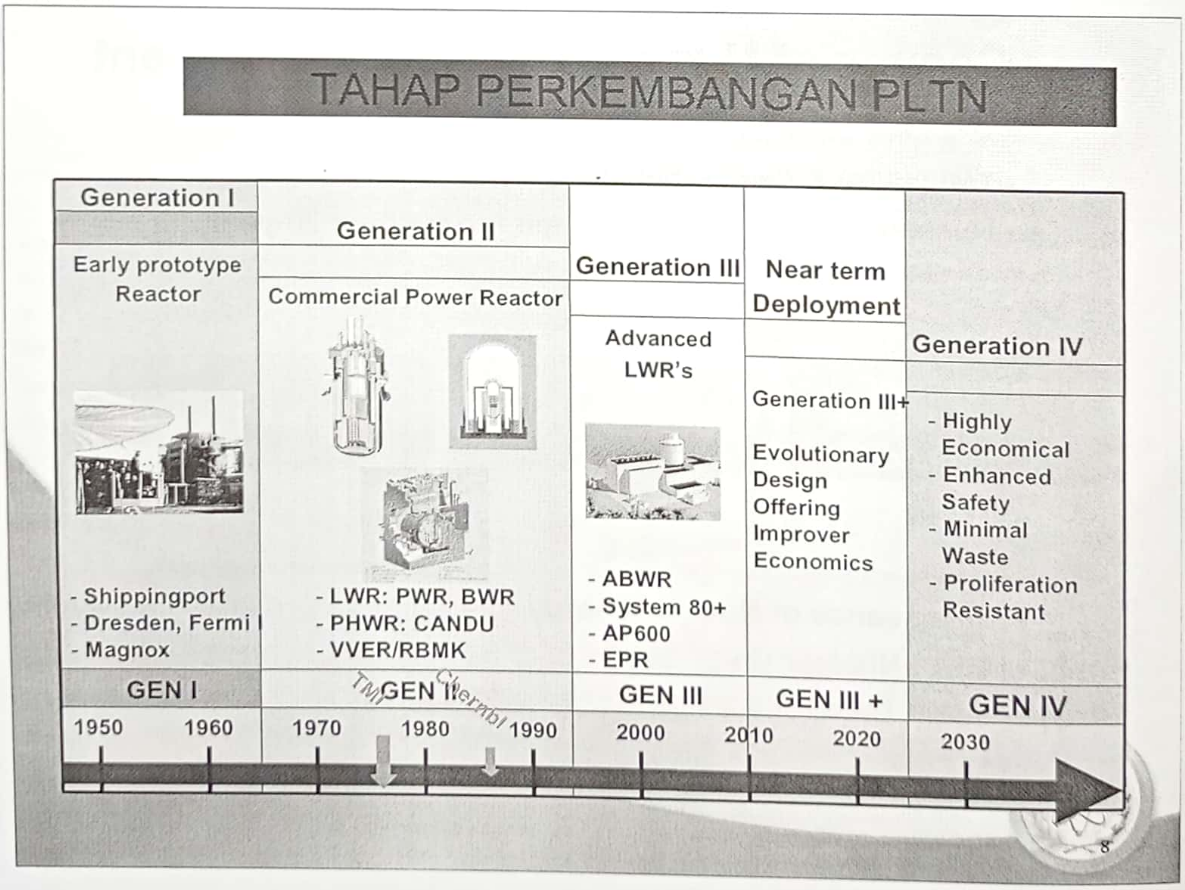

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EVOLUSI DESAIN PLTN

PARAMETER	GENERASI I	GENERASI II	GENERASI III	GENERASI IV
Ciri khusus	Prototype PLTN, Berbagai jenis dan ukuran	PLTN Komersial, daya besar untuk mencapai eff. *Plant factor* >	PLTN maju, *simplified system*, ukuran besar, *Plant factor* >	> kompetitif, aman, non-proliferasi terjamin, < limbah, SMR, Ko-generasi
Ragam keselamatan yang spesifik	Sistem keselamatan redundansi	*Inherently safety feature*, sistem keselamatan redundasi	Sistem pasif, keselamatan berganda	*Core density* <, Sistem pasif, *Em. Prot Area* < 800 m
Core Damage Frequency (*CDF*)	< 10_{-4} / rt*	< 10_{-4} /rt*	ABWR: 1,84 ×10_{-6}/ rt SBWR: 2,8 ×10_{-7}/ rt AP-600:3,3 ×10_{-7}/ rt	< 10_{-6} / reaktor-tahun
Contoh PLTN	Shippingport, Magnox, JPDR,	PWR, BWR, CANDU,	*ABWR*, AP-600, AP-1000, ACR-700, EPR, System +80	PBMR, ADS, VHTR, dll.

rt* = reaktor- tahun

CONCERN ABOUT URANIUM

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Uranium Resources

- Plentiful Uranium resources about 16 MtU.
- Consumption about 60 – 70 kT/y.
- Well distributed (Australia, Canada, Africa).
- Expandable

  Unconventional resources :

  - Phosphate : 22 MtU.
  - Seawater : 4000 MtU.
- Technology exists to improve energy yield (over x 50) with the fast neutrons reactor and closed cycles.

Lifetime of Uranium Resources

(Years of 2008 nuclear electricity generation)

	IR1	TCR2	TCR+Ph3
Current LWR once through	100	300	700
Fast Reactor	5000	15000	35000

1. Identified Ressources = Reasonable Assured Resources + Inferred Resouces = 5.5 MtU
2. Total Conventional Resources = (Reasonably Assured + Inferred + Prognosticated + Speculative) resources = 16 MtU
3. Phosphates = Uranium contained in phosphates = 22 MtU

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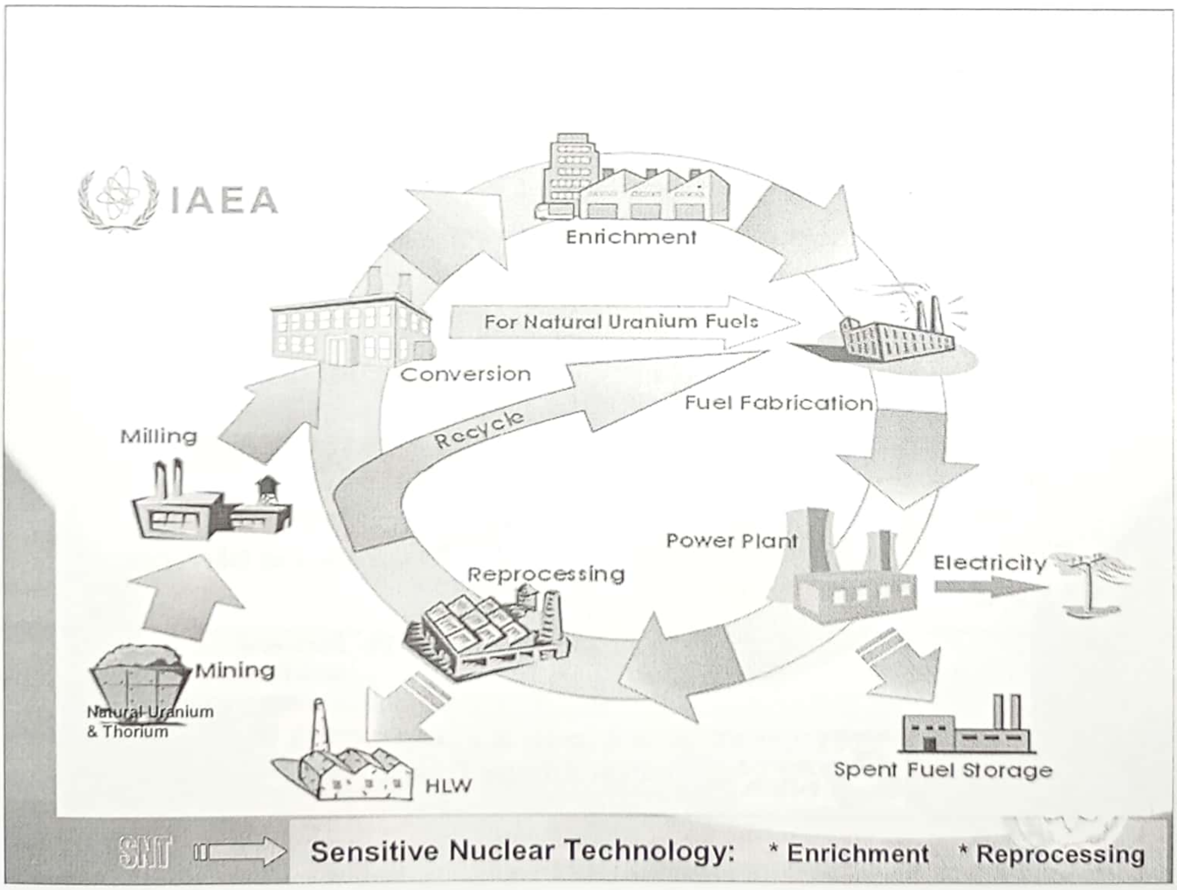
PERKEMBANGAN DAUR BAHAN BAKAR DUNIA



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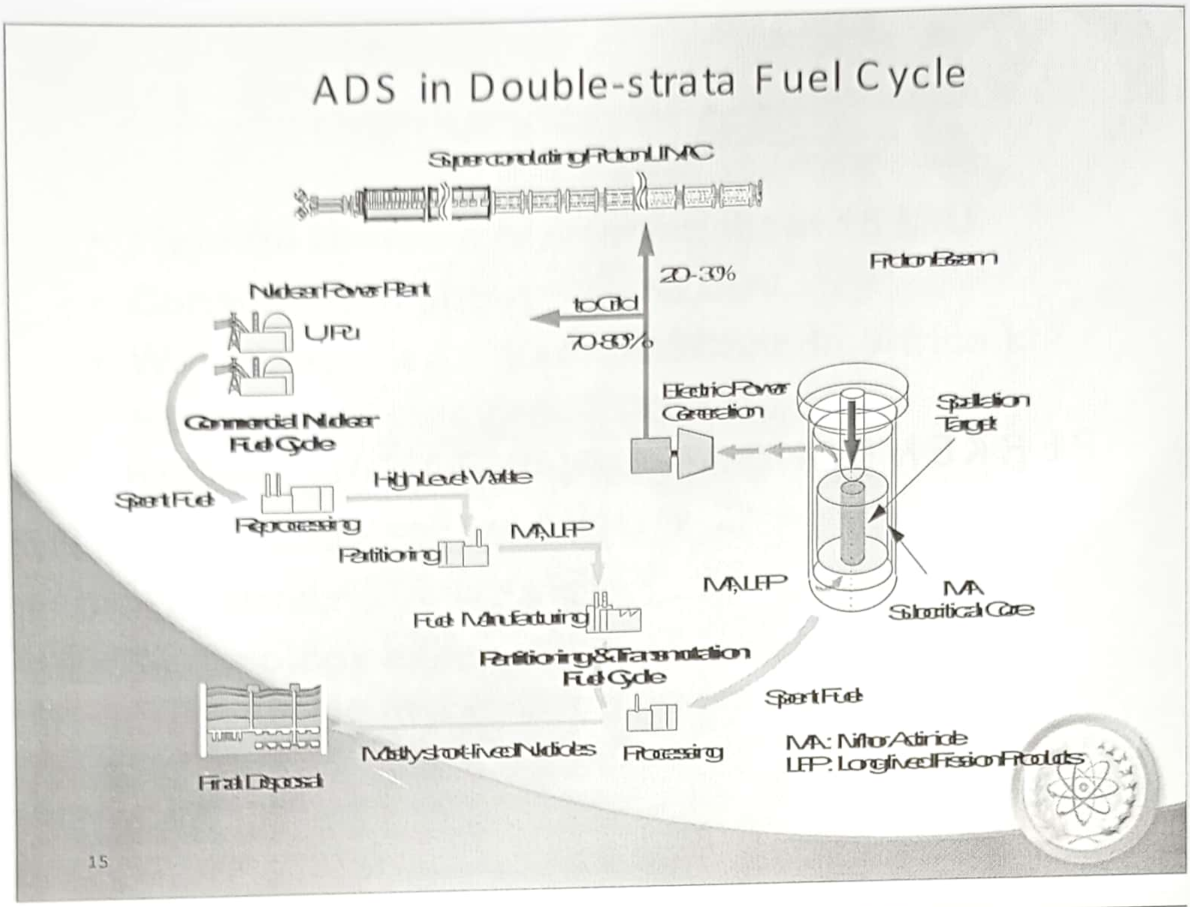

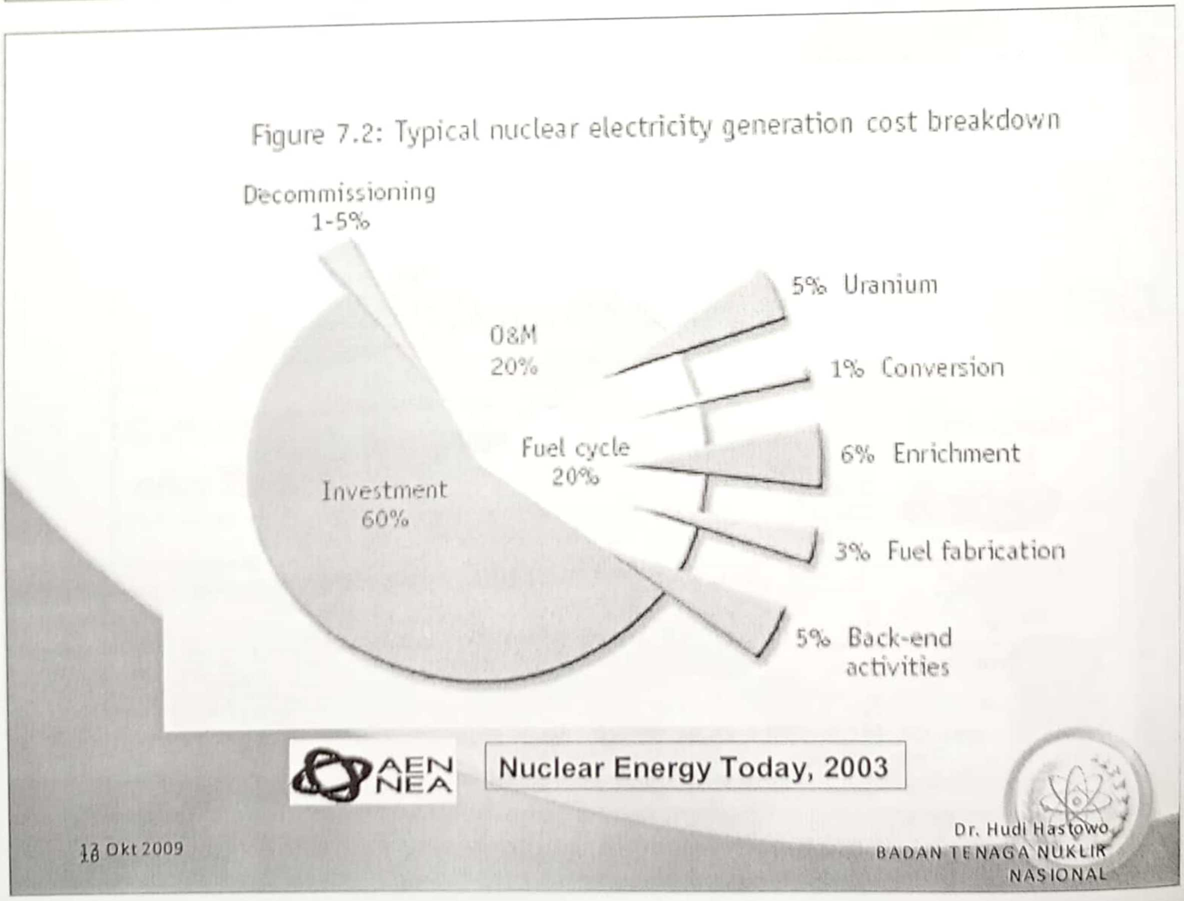

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Table 3.2: Major uranium enrichment facilities worldwide

Country	Site(s)	Technology
China	Lanzhou	Centrifuge[1]
	Shaanxi	Centrifuge
France	Tricastin	Gaseous diffusion
Germany	Gronau	Centrifuge
Japan	Rokkasho-mura	Centrifuge
Netherlands	Almelo	Centrifuge
Russia	Angarsk	Centrifuge
	Ekaterinburg	Centrifuge
	Krasnoyarsk	Centrifuge
	Seversk	Centrifuge
United Kingdom	Capenhurst	Centrifuge
United States	Paducah	Gaseous diffusion

1. Under construction.

Table 3.1
Major uranium conversion facilities worldwide

Country	Site(s)
Canada	Blind River and Port Hope, Ontario
France	Malvési; Pierrelatte
Russian Federation	Angarsk; Ekaterinburg
United Kingdom	Springfields, Lancashire
United States	Metropolis, Illinois

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Nuclear Energy Today, 2003

13 Okt 2009

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Table 3.3: Commercial spent nuclear fuel reprocessing plants worldwide

Country	Facility/location	Year of commissioning	Fuel type
China	Diwopu (Ganzu)	2002	LWR
France	La Hague	1976	LWR
India	Kalpakkam	1998	PHWR
	Tarapur	1974	PHWR
Japan	Rokkasho-mura	2005 *(planned)*	LWR
	Tokai-mura	1977	LWR, ATR
Russian Federation	Tcheliabinsk-65 Mayak	1984	VVER
UK	B205/Sellafield	1964	Magnox GCR
	Thorp/Sellafield	1994	LWR, AGR

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Thorium Cycle ?

India : dalam jangka panjang 80 % PLTN menggunakan Thorium, sisanya dengan Uranium

USA: ?

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DAUR BAHAN BAKAR NUKLIR DI INDONESIA ?

Walaupun bundel elemen bakar PLTN dapat dijamin pasokannya dengan "long term contract", dari sisi ekonomi sebagian industri daur sangat menarik untuk didomestikan sekaligus meningkatkan kehandalan pasokan

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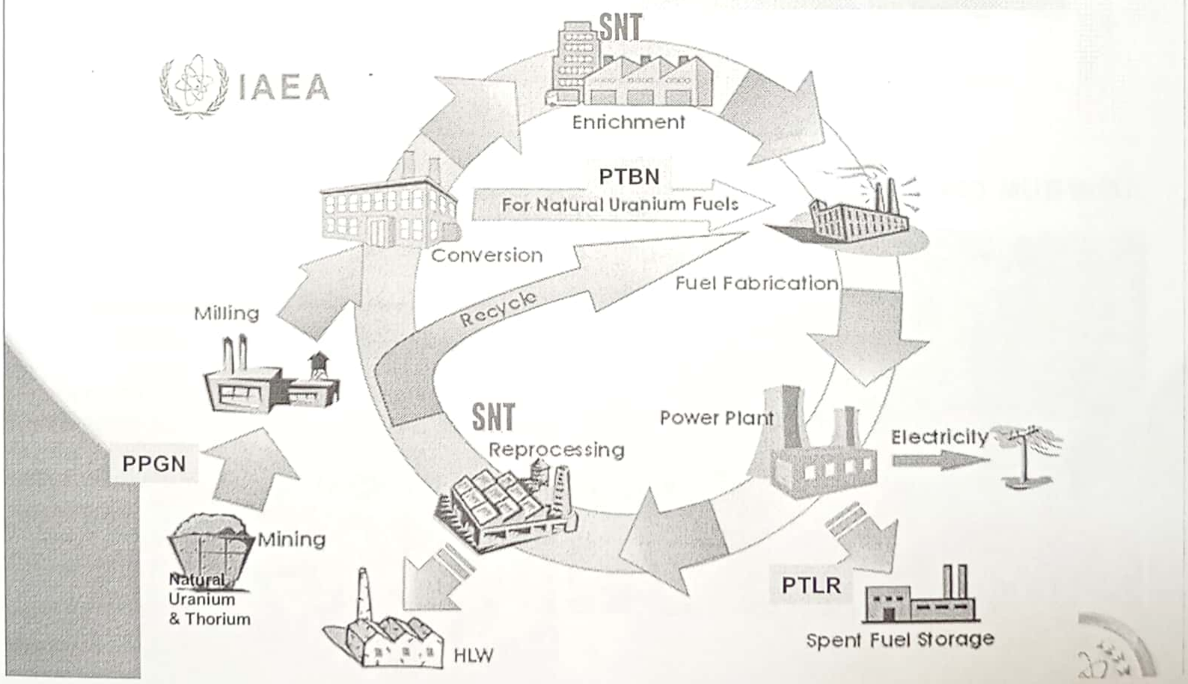
DAUR BAHAN BAKAR NUKLIR



SNT ⇨ sitive Nuclear Technology
* Enrichment
* Reprocessing

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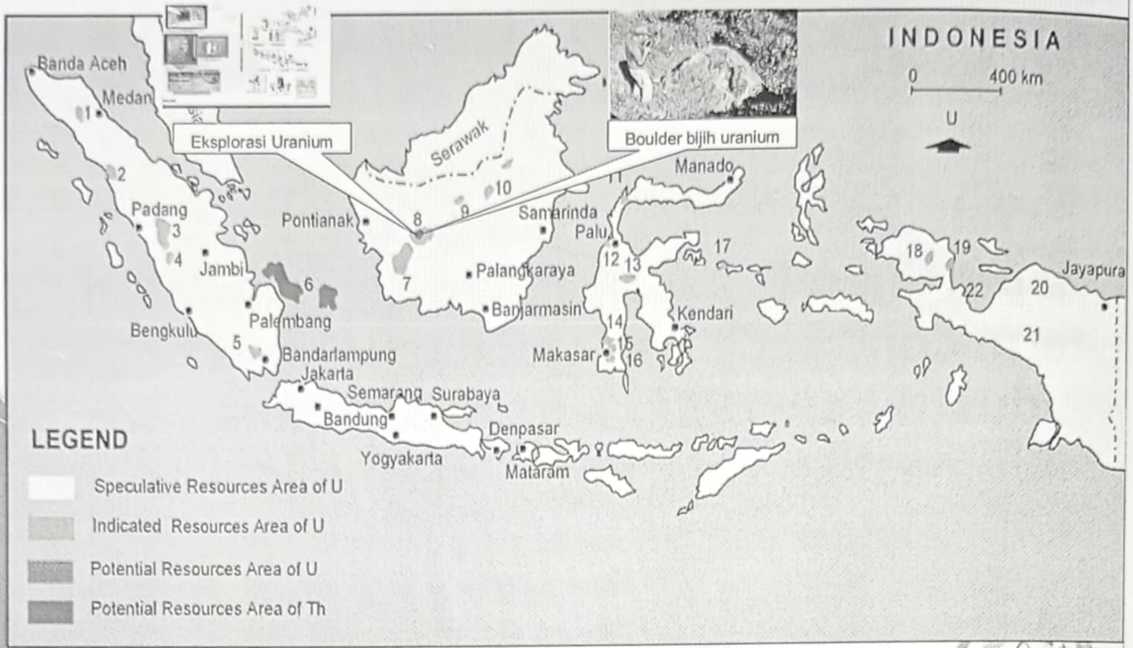
PETA SUMBERDAYA MINERAL RADIOAKTIF



Cadangan Uranium di Kalan (Kalimantan Barat): hanya akan ditambang apabila diperlukan oleh pemerintah. Jumlah cadangan 24.112 ton U3O8 dengan status teknis berupa Cadangan terukur, tereka, terindikasi dan spekulatif

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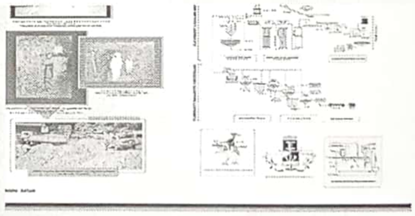
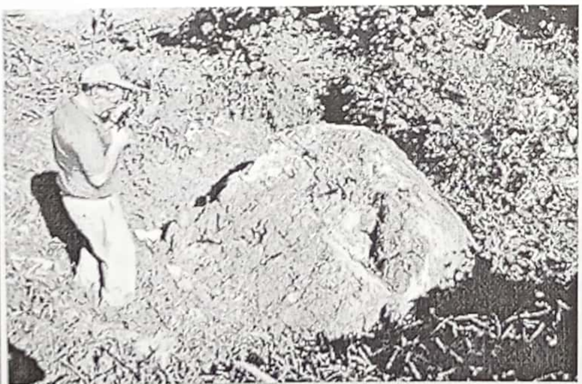
KALAN (WEST KALIMANTAN) PROSPECT

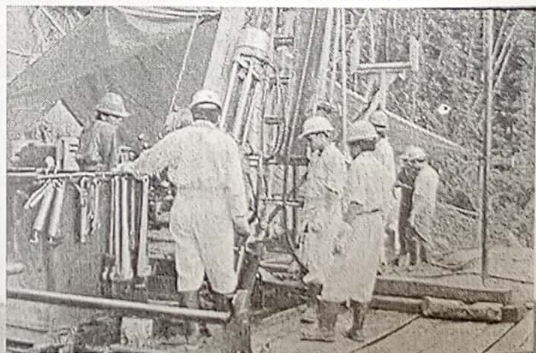
URANIUM EXPLORATION TUNNEL



URANIUM ORE BOULDER IN RIRANG AREA



URANIUM EXPLORATION DRILLING



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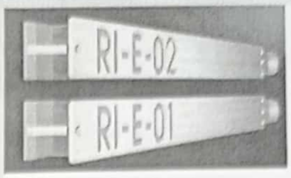
KEMAMPUAN PENGUASAAN TEKNOLOGI

INSTALASI PRODUKSI ELEMEN BAHAN BAKAR REAKTOR RISET



- Instalasi selesai dibangun dan diresmikan awal operasi pada 20 Agustus 1987 oleh Presiden RI. Sejak Mei1996, semua aset telah dihibahkan kepada PT.Batan Teknologi (persero).
- Instalasi Fabrikasi menggunakan bahan baku U diperkaya asal impor menghasilkan produk berupa Elemen Bahan Bakar Reaktor Riset (EBRR) dan Elemen Kontrol dengan tipe plat untuk reaktor RSG 30 MW
- Kapasitas produksi per tahun 70 - 210 unit EBRR/Elemen kontrol, dengan *burn-up* EBRR sekitar 60%
- Kinerja produksi selama 20 tahun operasi mempunyai standar kualitas tinggi tanpa cacat/kegagalan produk yang berarti, dan dirancang mampu untuk fabrikasi BBN PLTN di masa depan

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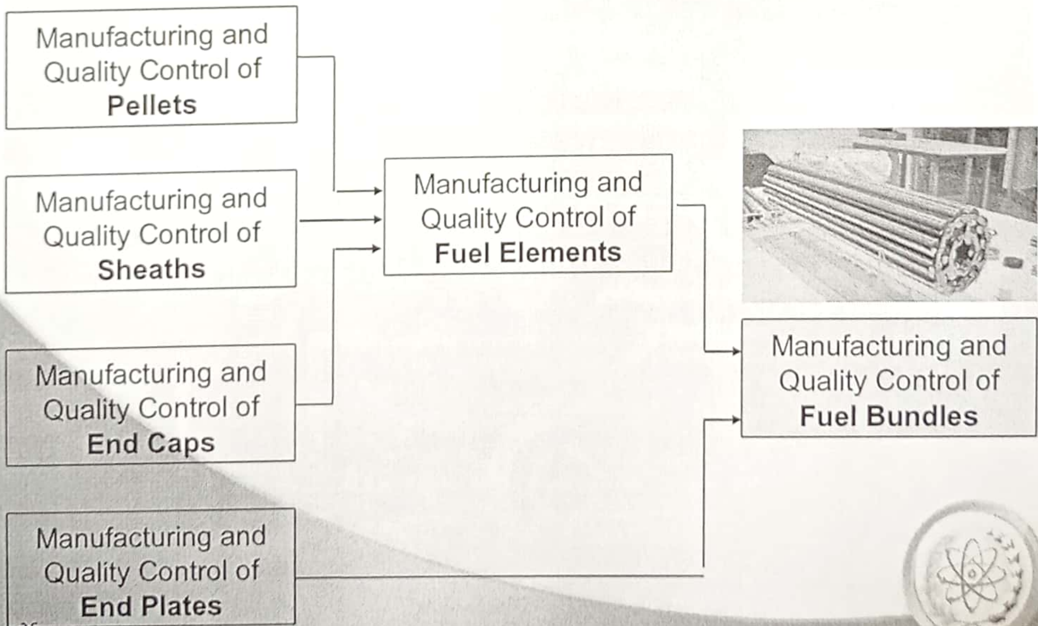
KEMAMPUAN PENGUASAAN TEKNOLOGI

INSTALASI EKSPERIMEN ELEMEN BAHAN BAKAR REAKTOR DAYA

HWR / PHWR Fuel Bundles Manufacturing Flow Sheet



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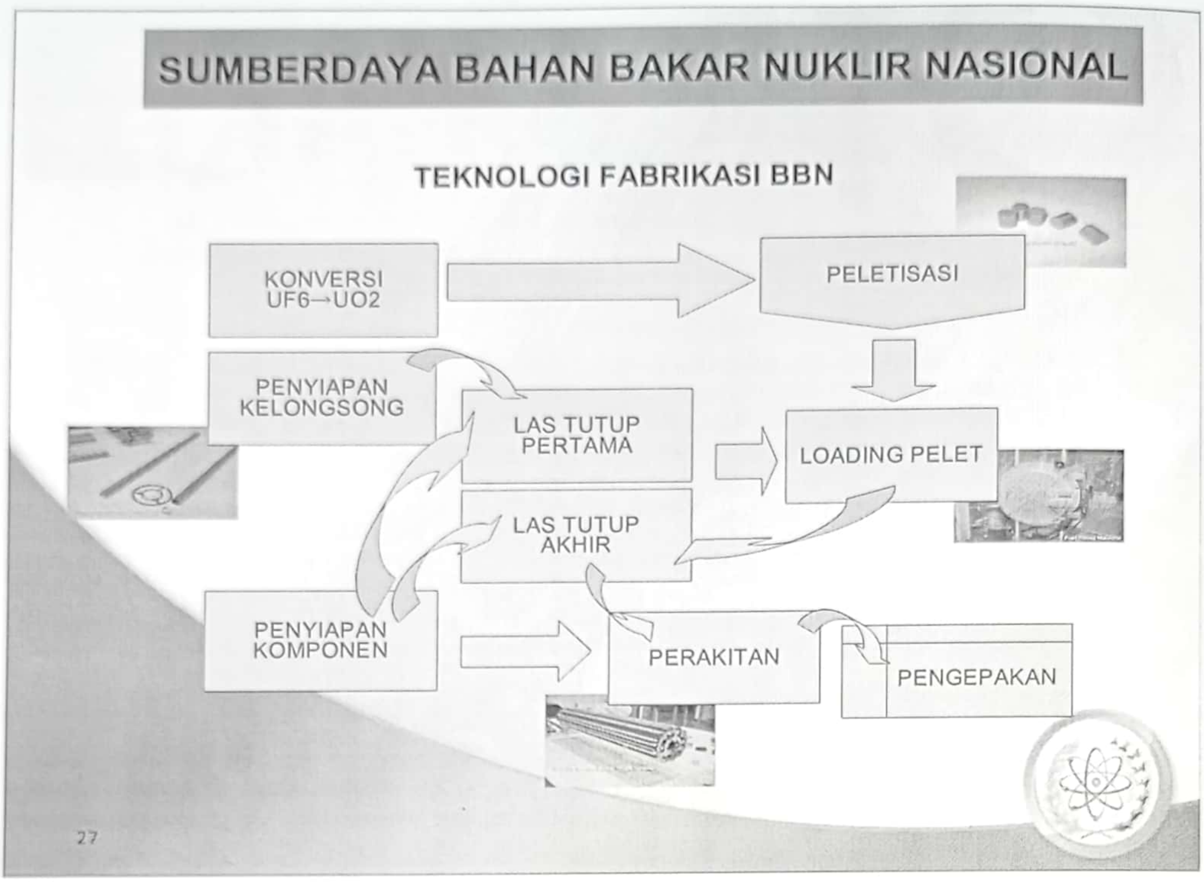

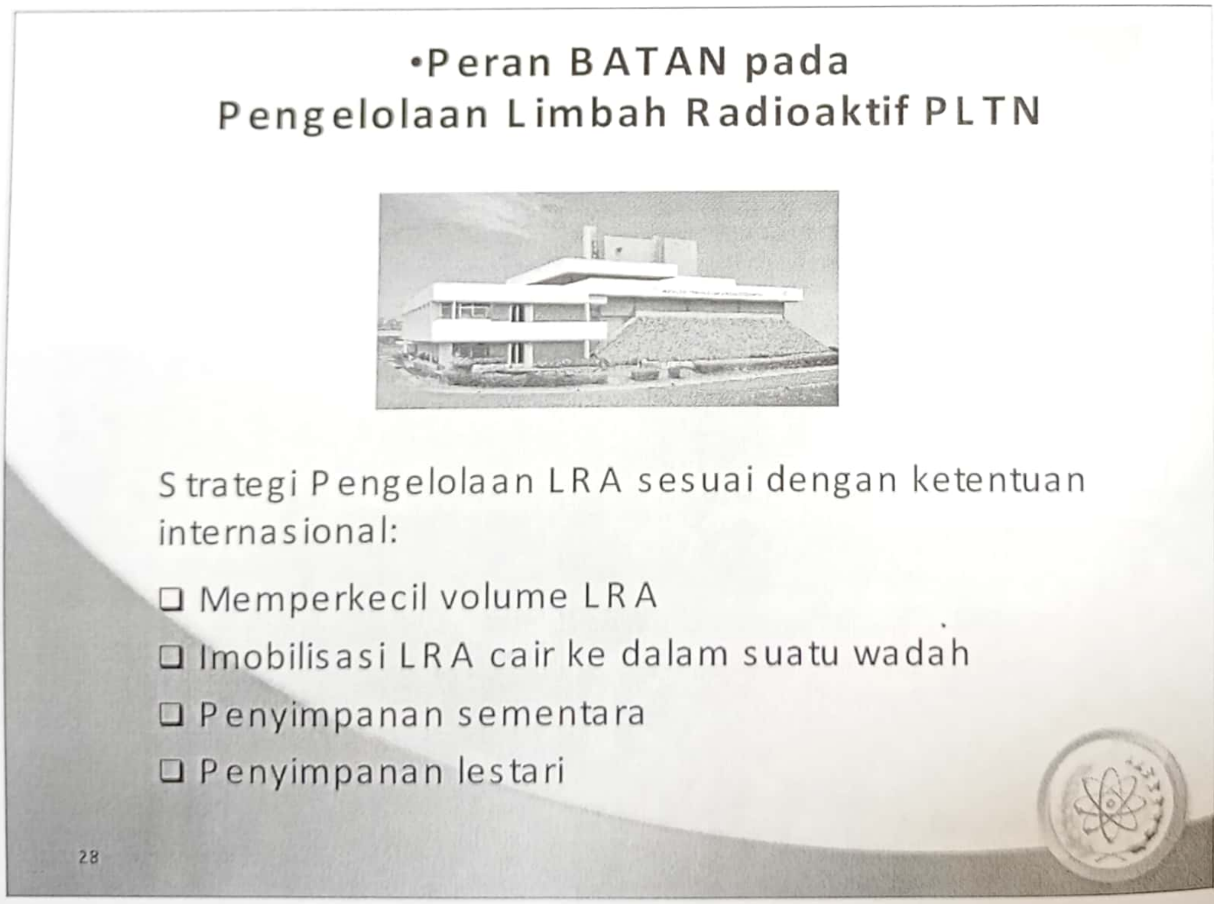

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Lingkup Manajemen Limbah Radioaktif PLTN

- LRA Operasional PLTN
- LRA Bahan Bakar Bekas
- Pembuangan/Disposal LRA & Bahan Bakar Bekas

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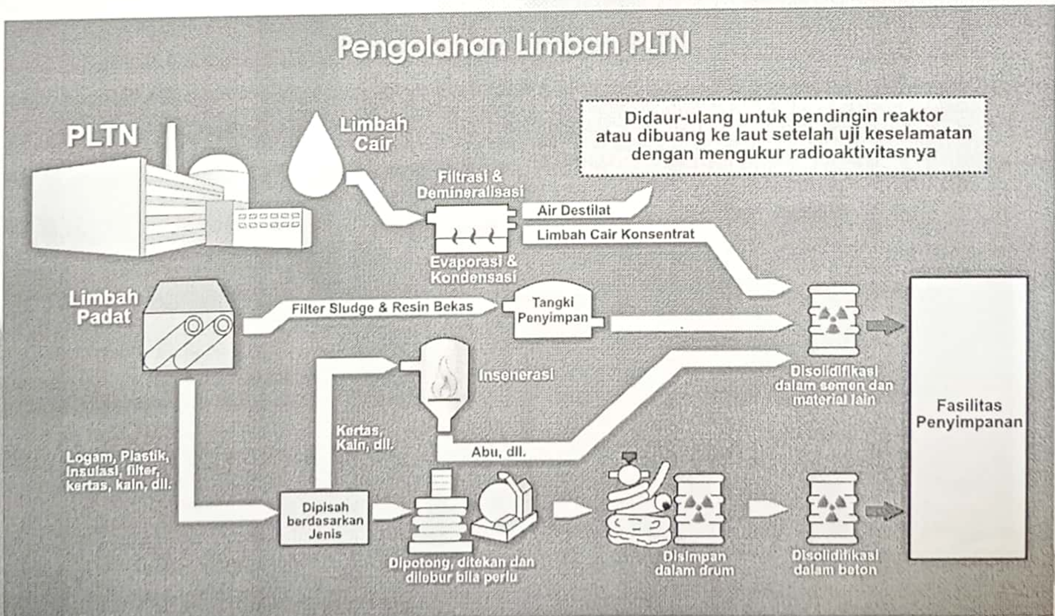
Pengolahan Limbah Radioaktif PLTN tingkat rendah dan sedang



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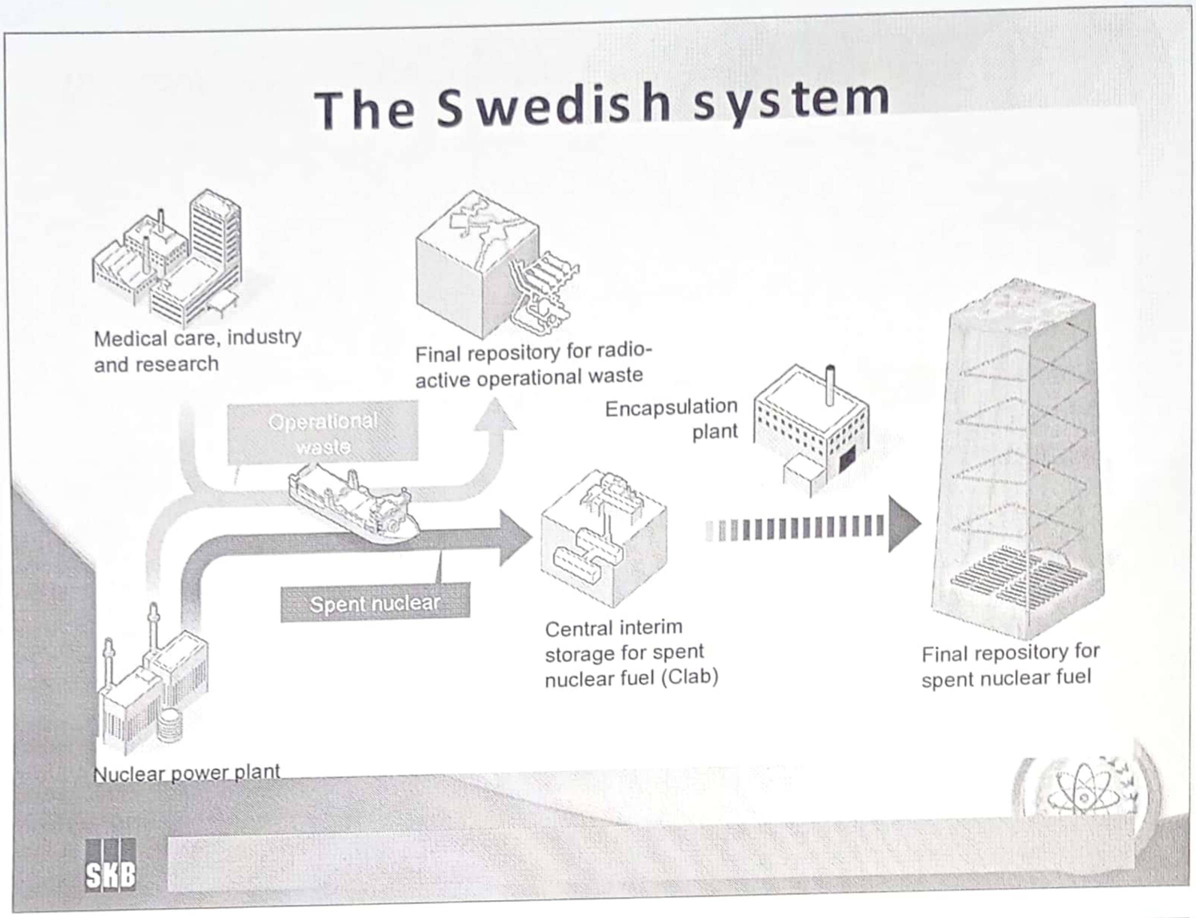

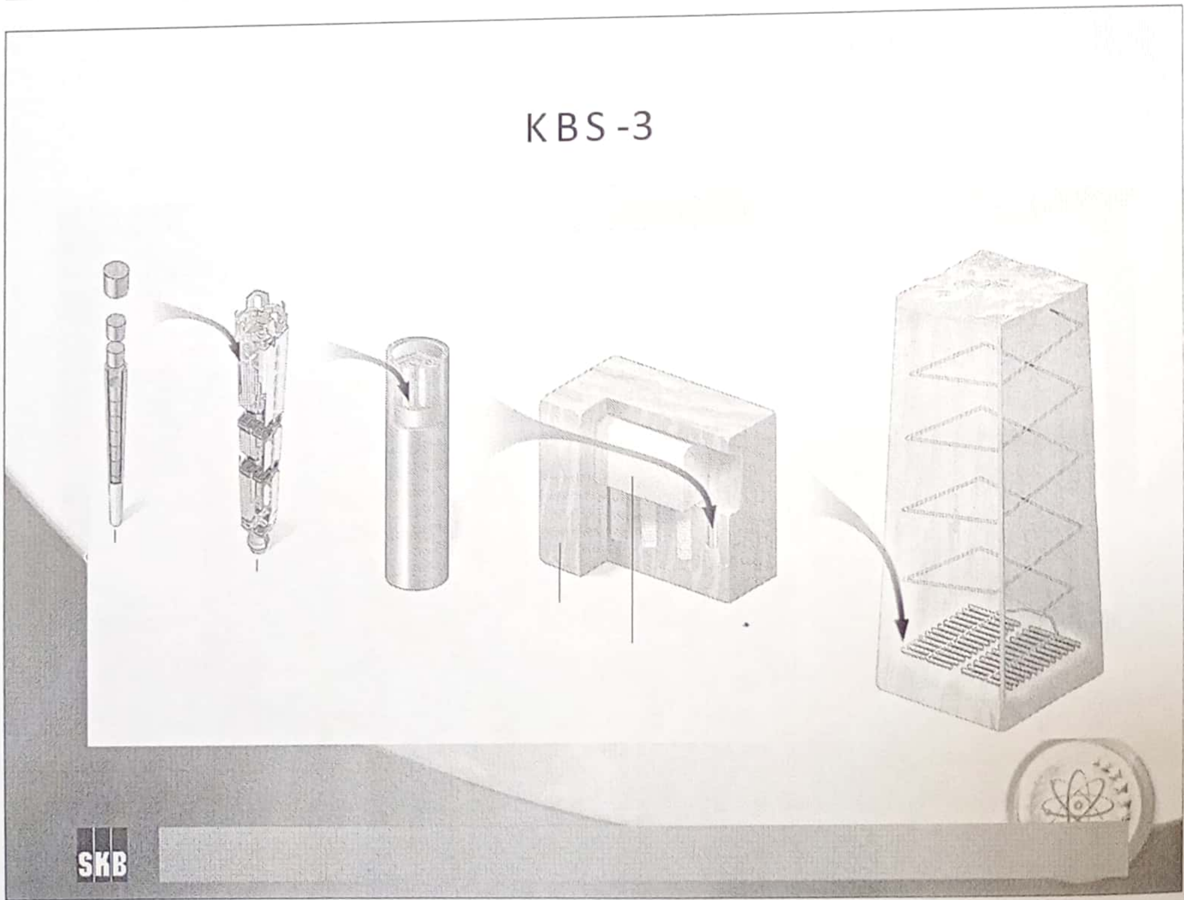

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KESIMPULAN

Penggunaan energi nuklir saat sekarang ini berkembang sejalan dengan kesadaran akan pengurangan emisi gas buang untuk pengurangan laju pemanasan global

- Hal ini akan mengakibatkan diperlukannya desain PLTN yang evolusioner untuk mendapatkan peningkatan keselamatan dan peningkatan efisiensi penggunaan bahan bakar dan menghasilkan limbah nuklir yang lebih sedikit
- Harus dibarengi dengan daur bahan bakar yang lebih baik
- Penggunaan strategi daur bahan bakar, dan kemungkinan penggunaan bahan bakar berbasis Thorium
- Partisipasi industri dalam negeri di bidang daur bahan bakar nuklir di Indonesia akan meningkatkan nilai tambah penggunaan opsi nuklir.

THANK YOU