Challenges on Re-use/recycling and Long-Term Storage of Caesium-Containing Waste Food for thought?

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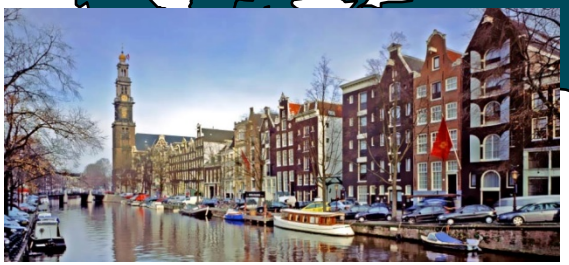
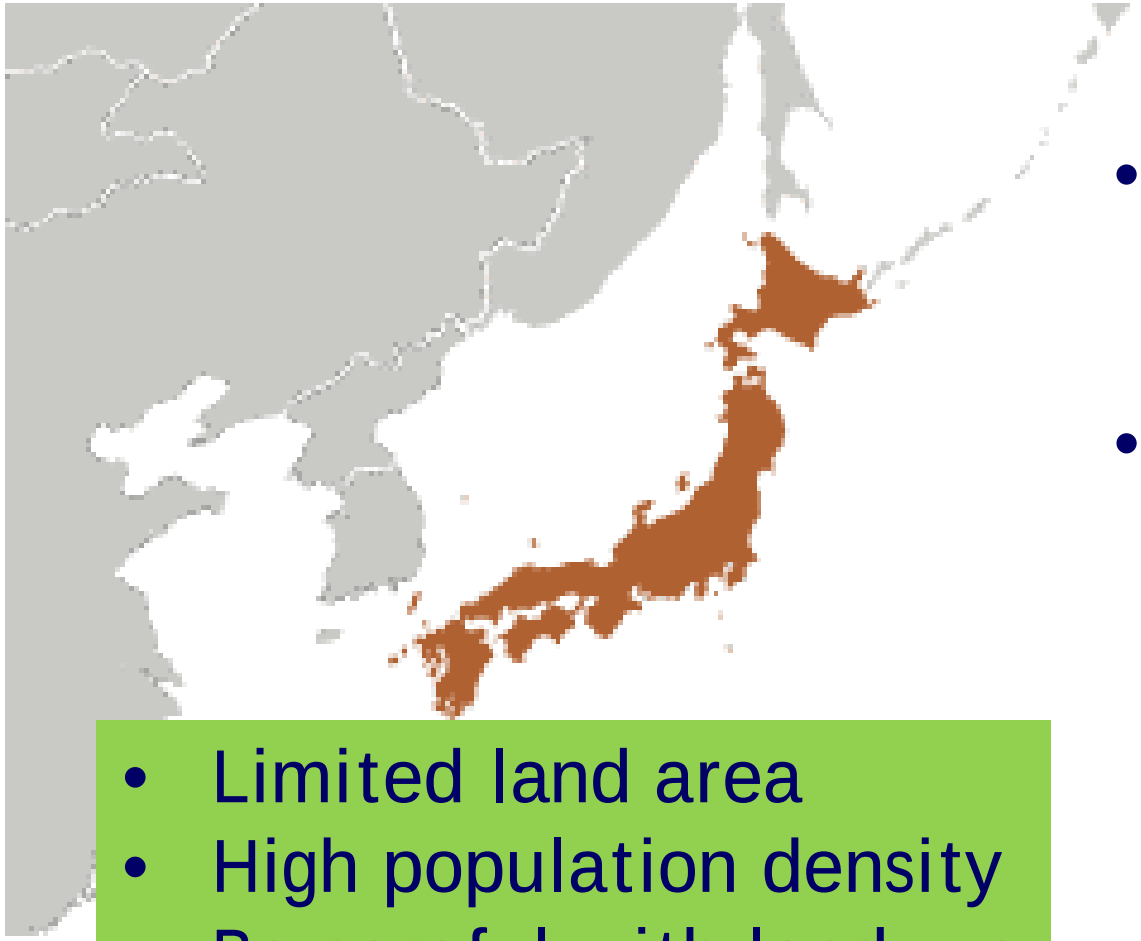
The Netherlands

- small country
  42,000 km^2
- 17 million people



Japan



- Large country
  378,000 km^2
- 128 million people

- Limited land area
- High population density
- Be careful with land use

small country
42,000 km^2

17 million people

Status

IAEA-MOE expert visit November 2016:

- It is absolutely impressive to see what has been achieved in cleaning the contaminated Fukushima area!
- Widespread use of dosimeters for the public should be acknowledged as good practice
- But there still is a lot to do

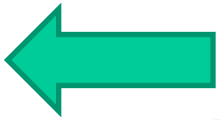
The challenge

Huge amounts of contaminated soils:

A. 10 million m^3 soil <8,000 Bq/kg

B. 10 million m^3 soil >8,000 - <100,000 Bq/kg

C. 2 million m^3 ashes + other >100,000 Bq/kg



- Limit for recycling <3,000 Bq/kg
- A decays within 30y (=period of control)
- B decays within 120y (=period of control)

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Waste above 100,000 Bq/kg

- No other solution than final disposal: shallow land disposal
  cf - Rokkasho Mura, Japan
  - Centre de l'Aube, France
  - El Cabril, Spain
  - Drigg, United Kingdom
    others

Waste below 100,000 Bq/kg

Huge volume of soil:

- Recycle/re-use
- Volume reduction treatment
- New decontamination technologies:

- classification
- chemical and heat treatment
- heat and washing treatment
- innovative techniques

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Volume reduction treatment

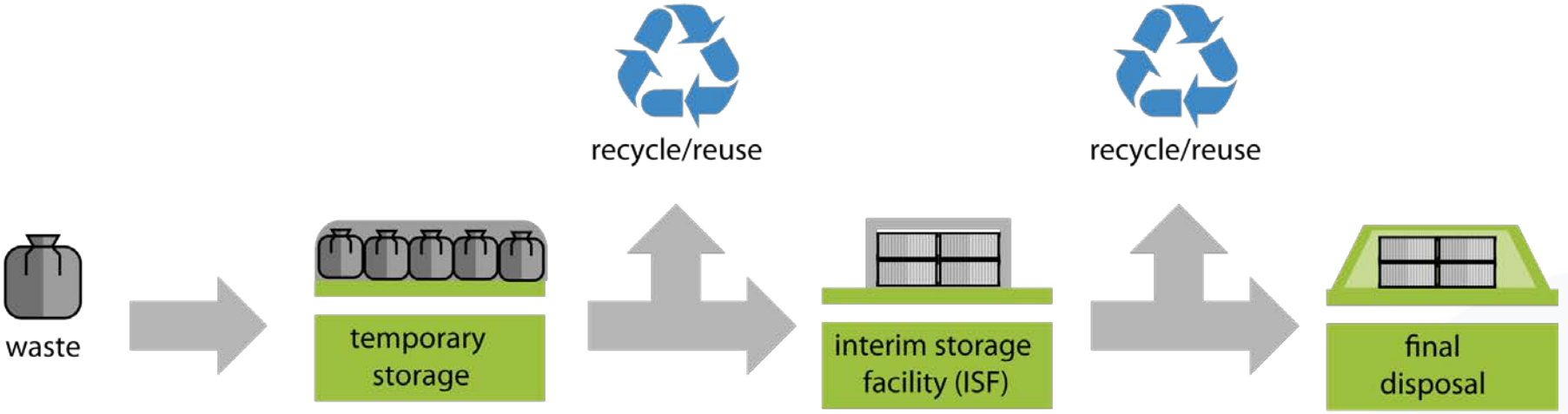
- Volume reduction techniques should result in better products for the next steps

- Volume reduction increases Bq/kg!
  - VR a factor 100
  - waste with 8,000 Bq/kg >>>>800,000 Bq/kg
  - control period 30 years>>>>240 years
  - final disposal!

New decontamination technologies

- Dry pyro caesium removal: treatment of ashes to concentrate caesium is in operation
- Soil up to 30,000 Bq/kg can be treated with classification and grinding to reduce contamination level to 8,000 Bq/kg
- Concentrated activity >>>>final disposal

Flow scheme

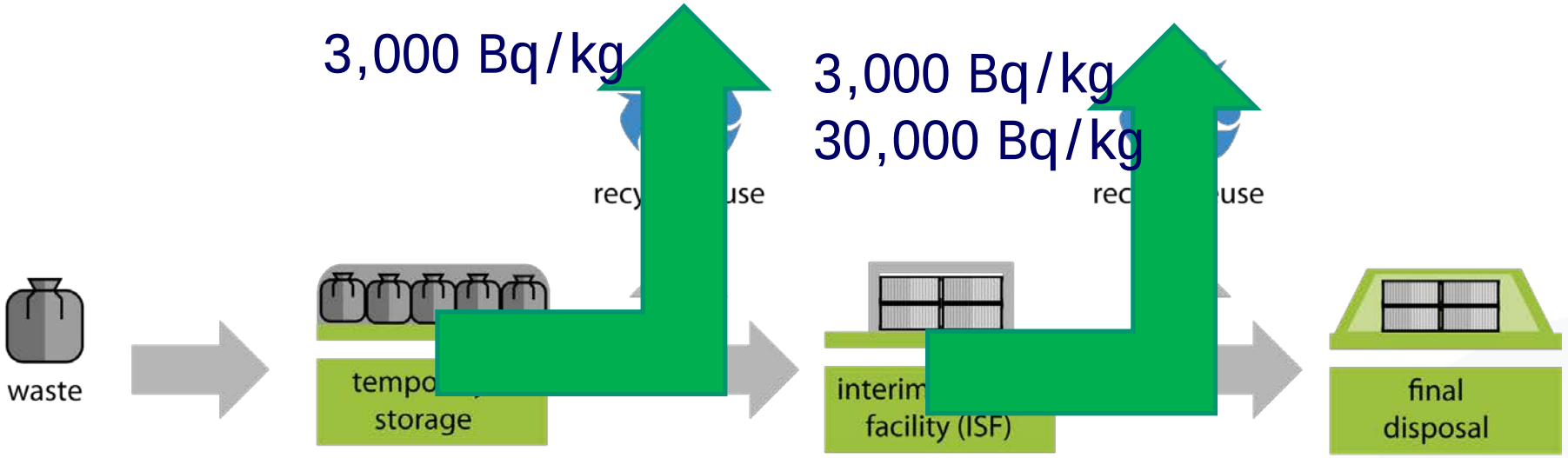


as soon as possible

max 30 years

assure safe handling after 30y!

Flow scheme



as soon as possible

max 30 years

Every time you handle the waste, measure and take out the recycle/re-use part

ISF is 30 years decay storage

- All soils < 30,000 Bq/kg can be recycled/re-used after 30 years
- Long-term thinking and long-term planning is needed
- Is experience with long-term decay storage in the Netherlands useful?

Decay storage in The Netherlands

- Calcinate waste from phosphor industry with natural radioactivity
- Waste volume expected: 50,000 - 100,000m^3
- Activity present: alpha emitting radionuclides:
  Pb-210, Bi-210, Po-210 ($t_{½}$ 22y, 5d, 138d)
  500,000 – 4,000,000 Bq/kg
  decays within 150 y to recycle/re-use level

- Solution: long-term decay storage

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Decay storage in The Netherlands

- calcinate waste dried at production plant
- calcinate waste loaded in 20-ft ISO container
- polyethylene bag inside container
- 30m^3 waste per container
- containers stored in steel building

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Decay storage in The Netherlands

- Simplicity in design
- Humidity control very important
- Modular structures, built as needed

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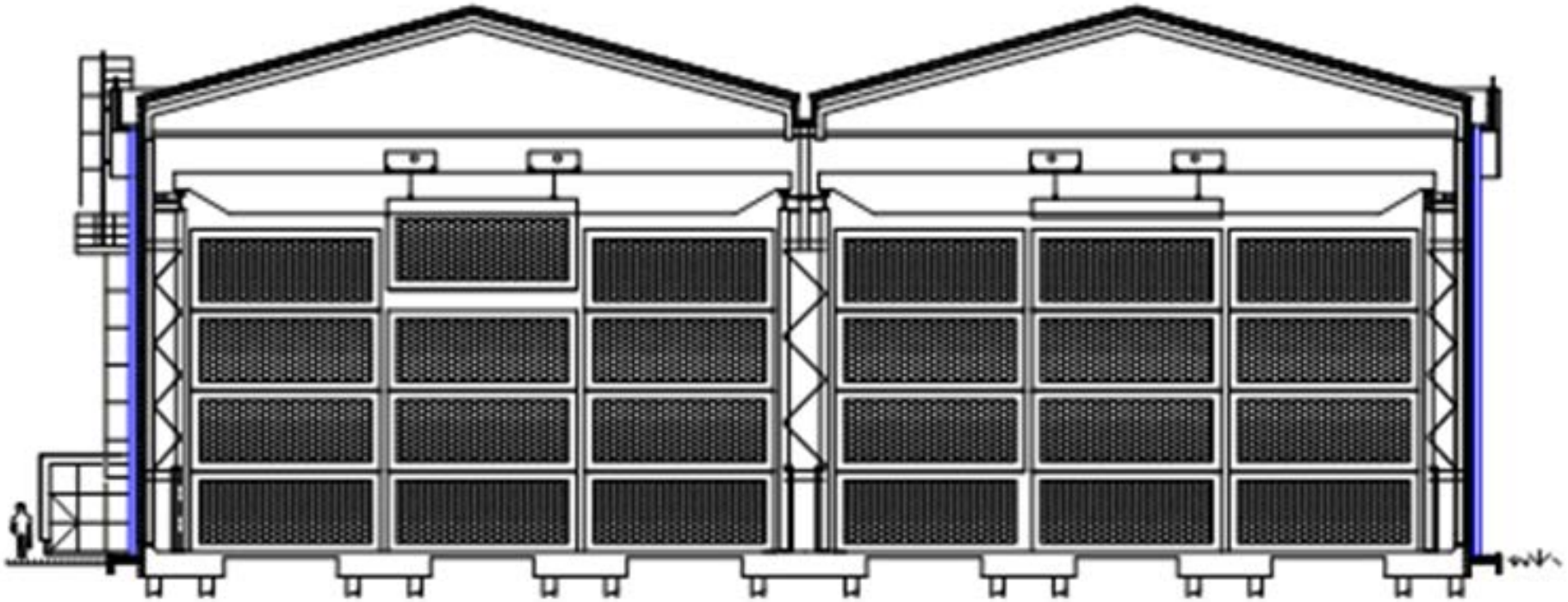
Decay storage in The Netherlands

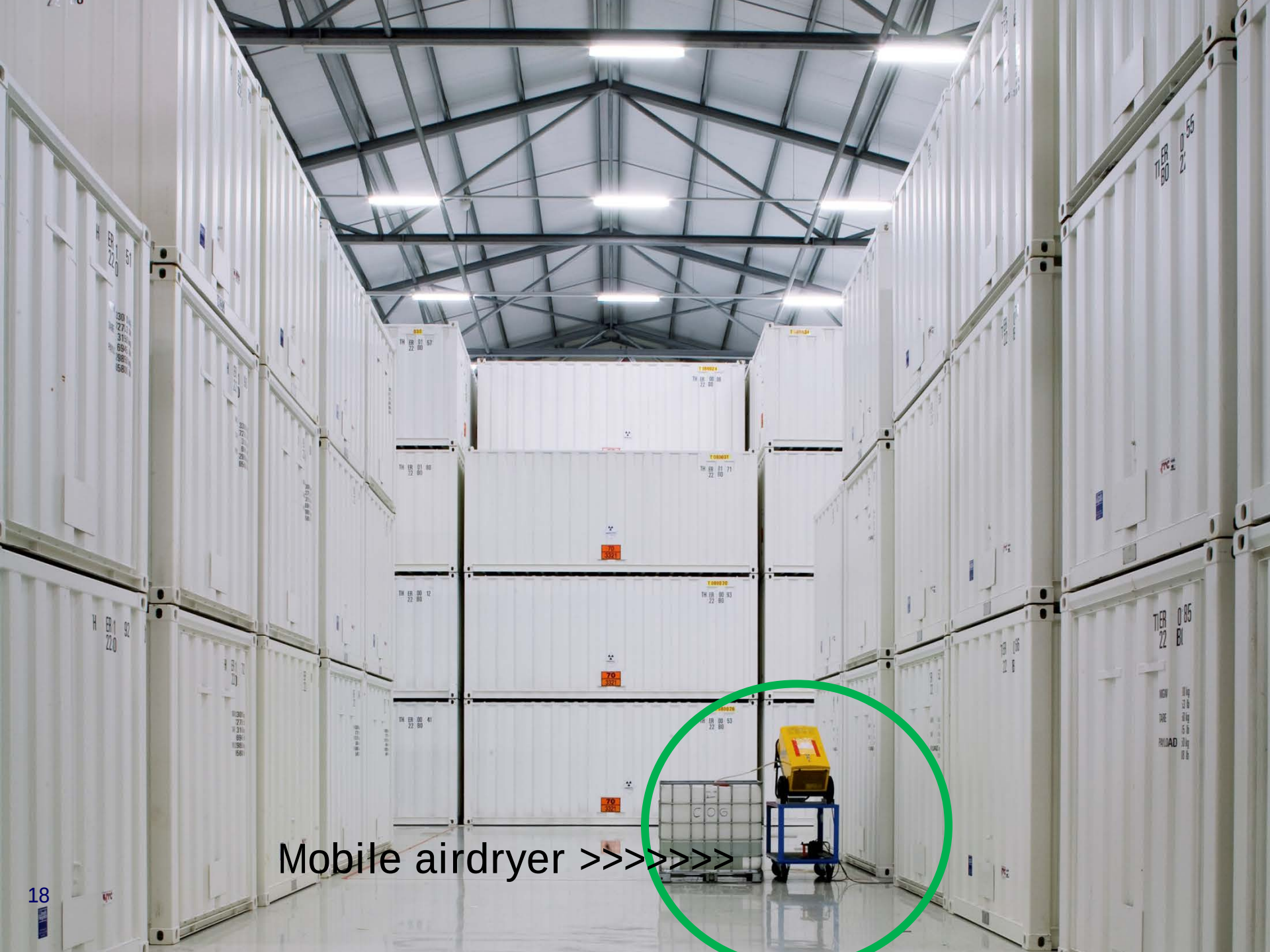
Cross section of storage building, 2 modules are shown. In operation since 2000.



Decay storage in The Netherlands

- simple modular building:
  - no ventilation
  - no floor drains
  - only electricity
- steel construction
- good insulation
- containers 4 high
- humidity control

Necessary to avoid condensation on containers


Mobile airdryer >>>>>>>

Climate control

- Inside temperature between 8 and 15 degree C
- Air humidity below 50%
- Mobile dryers are cheap/ easy to maintain/ place as many units as needed

Decay storage in Fukushima an option?

- ISO containers 33m^3
- 10 mil m^3 soil results in 300,000 containers
- Stacking 4-high: area of 1x1 km needed
- Recycling/reuse after 30 years for soil group A, and 120 years for soil group B

- Economics? Compare with other options
- **Simplify where possible!**


S.W.L. 41Te
UNDER SPREADER
MITSUBISHI
SR4
S.W.L. 41Te
MITSUBISHI
RR4
APL
K LINE
YANG MING
tex
RMG 47

300,000 containers means 16 ships

Decay storage an option?

Simplify the storage:

- Can pellets be used?

- Can big bags last 30y (or even 120y) in a controlled environment?

A second approach ??

- A waste storage site can be perceived as negative
- Careful land use is a necessity in Japan

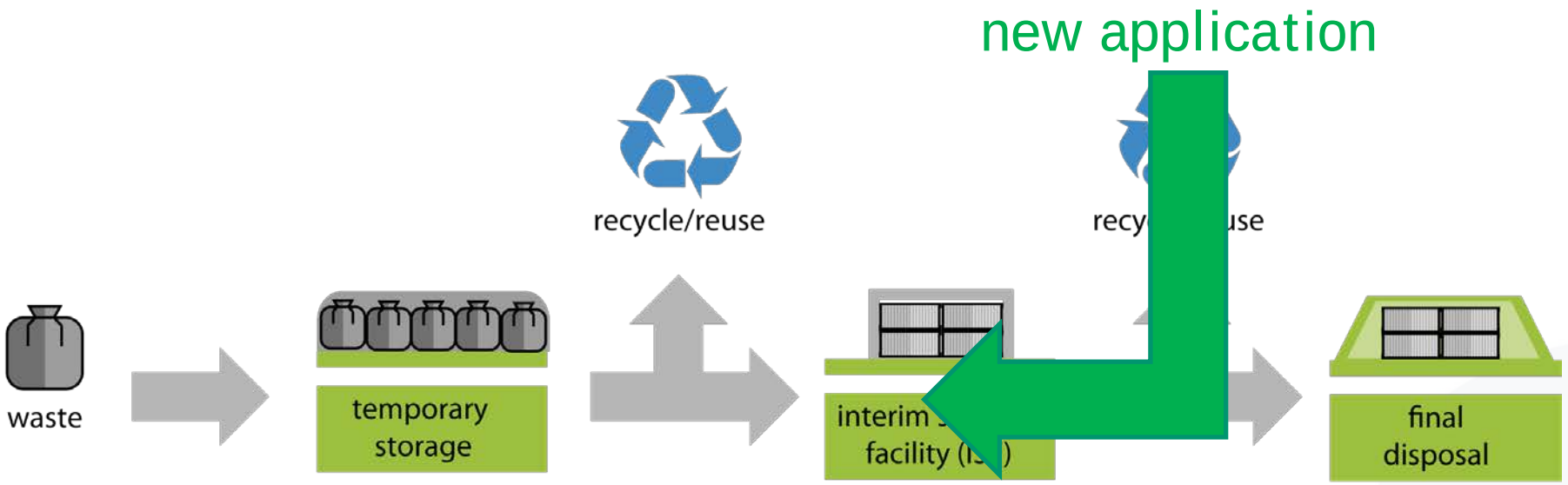
- Combine decay storage with another activity that is perceived as positive

A second approach

What is needed in the region?

- Positivism
- New economic activities
- Challenges for the young generation
- Something to be proud of

Flow scheme



Find applications and see what waste can be used

A second approach

What could be thought of?

- Solutions within the nuclear sector
- Solutions outside the nuclear sector

A second approach

Solutions within the nuclear sector

- Create wide walls around large temporary storage areas for the decommissioning waste of npp Fukushima
- Create protective sea-dykes in order to decommission npp Fukushima safely
- Re-use material in the final shallow land disposal design (filling/overlaying layer/compartmentation)

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France ANDRA

A second approach

Solutions **outside** the nuclear sector:

- Landing and take-off strips of an airfield for peace forces
- or… of a civil airfield

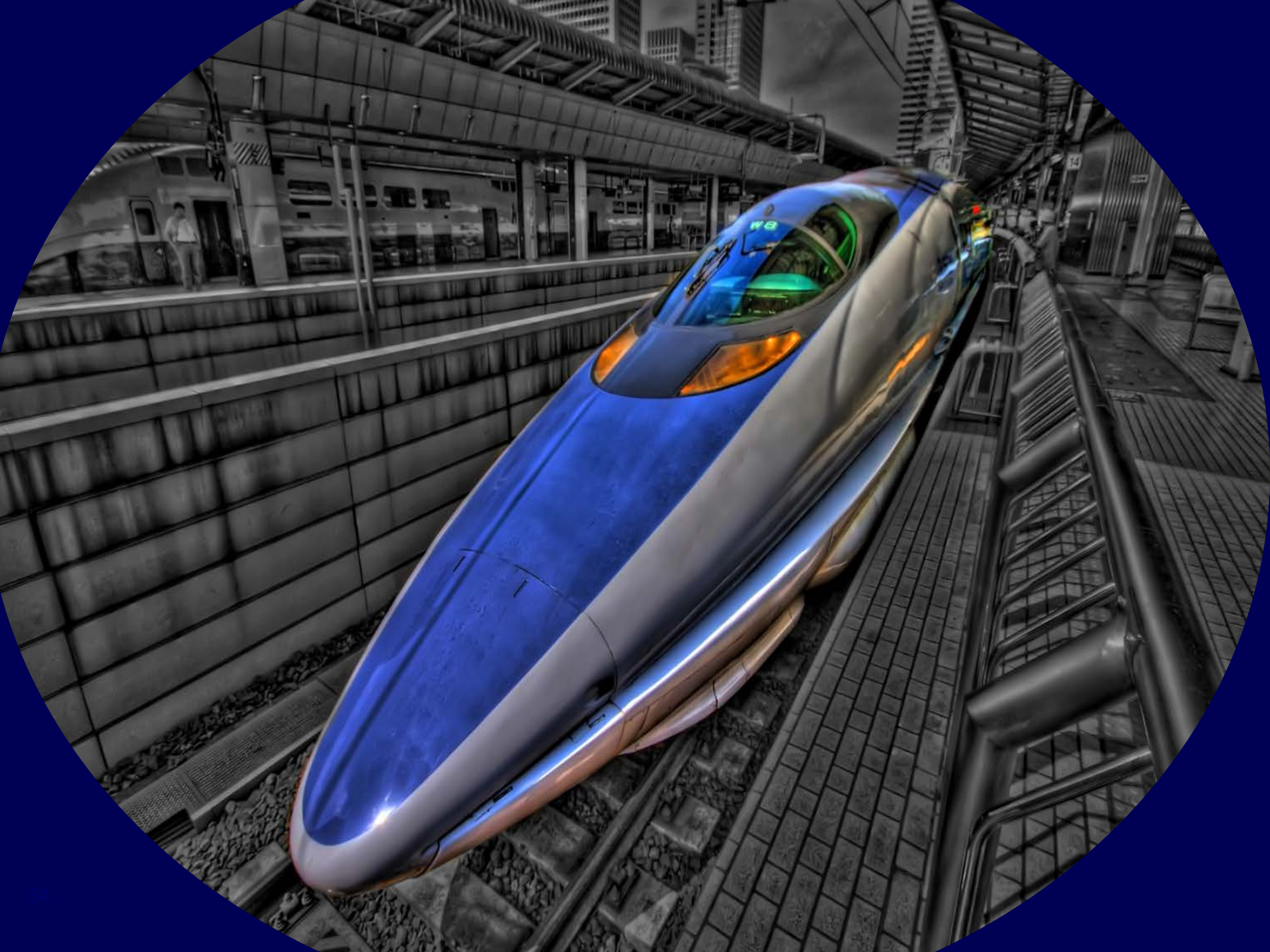

25

Kansai Island

A second approach

Solutions **outside** the nuclear sector:

- Landing and take-off strips (military) airfield for peace forces
- or… for a civil airfield
- Bullet train testing circuit



A second approach

Solutions outside the nuclear sector:

- Landing and take-off strips (military) airfield for peace forces
- or… for a civil airfield
- Bullet train testing circuit
- The world most innovative racing circuit
- The world largest solar panel park
- Other…..

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Fill the base with contaminated soil

Artificial island with solar panels

A second approach

- Start with possible solutions
- Make a safety case to prove that doses will be lower than 10 microSv/year:
  - during construction
  - during 30 years operation (even 120 years)

A second approach

- Avoid a DAD (Decide-Announce-Defend) proces
- ADD (Anounce-Discuss- Decide) process is more likely to be supported by the public

A second approach

- Form a high level group of artists, designers, futurologists, creative people, local people, etc.
- Ask for ideas where large volumes of material/soil are needed
- Everything is possible!
- **Let it be the project/idea of the public**
- Technology will assure the dose limit

A second approach

- These creations exist in reality!!
- Everything is possible!

www.Most bizarre monuments/houses/buildings

A second approach

"Every disadvantage has an advantage"

Johan Cruijff, soccer player

それぞれの欠点利点があります。


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