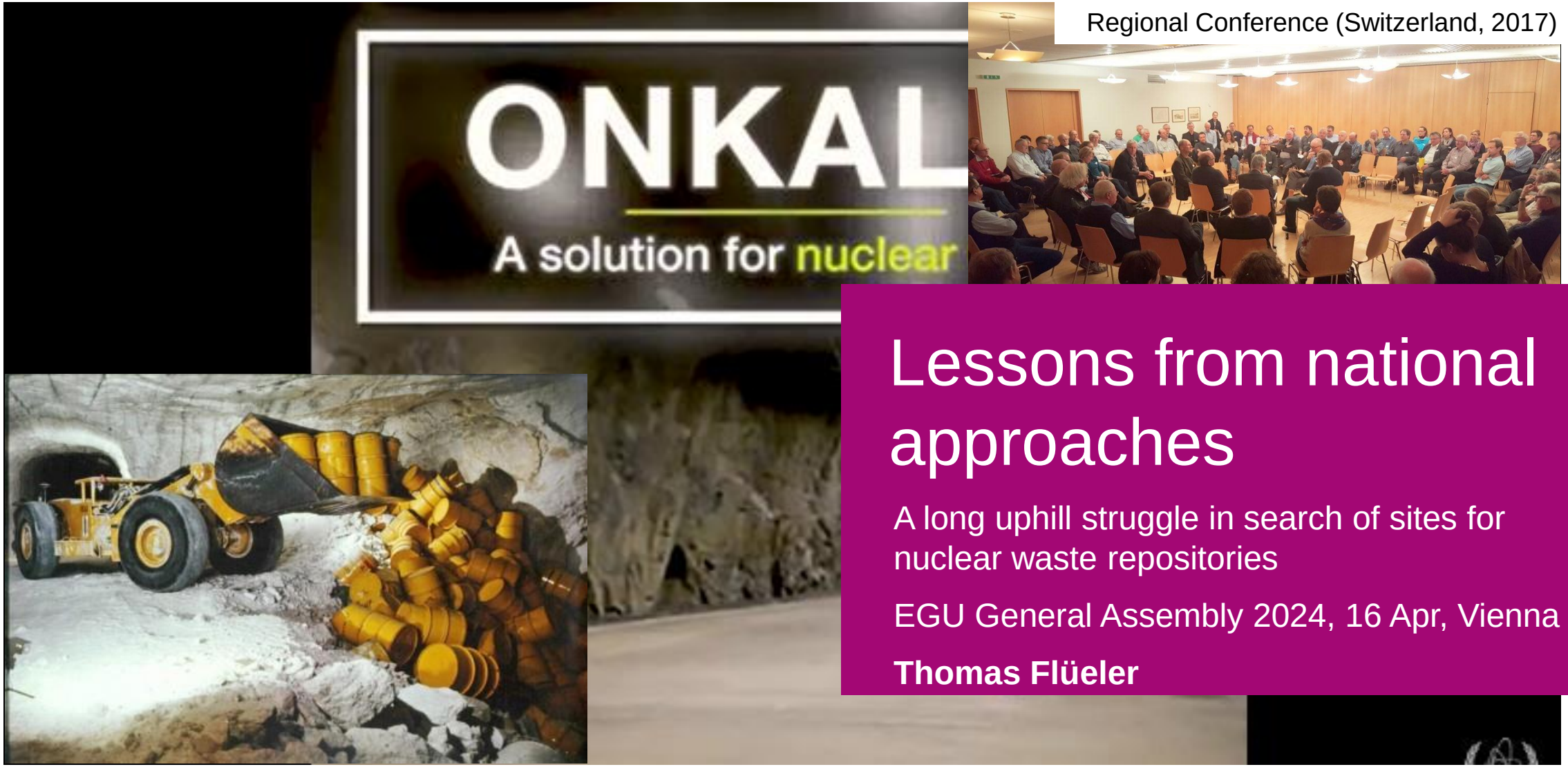
Institute for
Environmental Decisions



Regional Conference (Switzerland, 2017)

Lessons from national approaches

A long uphill struggle in search of sites for nuclear waste repositories

EGU General Assembly 2024, 16 Apr, Vienna

Thomas Flüeler

Asse (Germany, 1975)

Onkalo (Finland, 2020)

Where do we stand?

Success!

Failure?

IAEA International Atomic Energy Agency

Press centre Employm

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Finland's Spent Fuel Repository a "Game Changer" for the Nuclear Industry, Director General Grossi Says

Laura Gil, IAEA Office of Public Information and Communication

Related stories

Facility for the S of Spent Fuel

Solving the Back Finland's Key to Disposal of Sper Fuel

Volume 19, Issue 4

Pages: 527-758

August 1999

The management of spent nuclear fuel and high-level nuclear waste has the deserved reputation as one of the most intractable policy issues facing the United States and other nations using nuclear reactors for electric power generation. This paper presents the author's perspec-

What do we have?

Cask storage hall, Switzerland

zwilag.ch ↓2024-04-09

Small modular reactor AP300
info.westinghousenuclear.com
(waste factor 2-30 of today's reactors, Krall et al. 2022)

Fuel bundle
framatome.com

1-3% volume
99% toxicity

Solid waste	2016 data Disposal
VLLW (m^3)	11 842 000
LLW (m^3)	18 499 000
ILW (m^3)	133 000
HLW (m^3)	0
Total	30 474 000

latest official data
iaea.org ↓2024-04-09

439 power plants
(Mar 2024)
world-nuclear.org
↓2024-04-09

High-level waste (HLW): >250,000 metric tonnes
(USA >90,000 t, Europe >60,000 t)

It depends from what angle you look at it …

Reality seen through a prism:
Everyone has another view on things

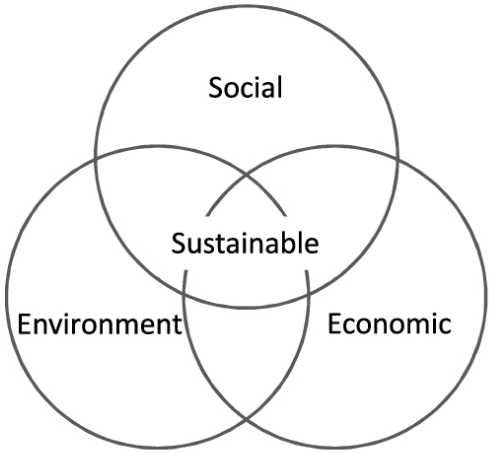
From technical issues …

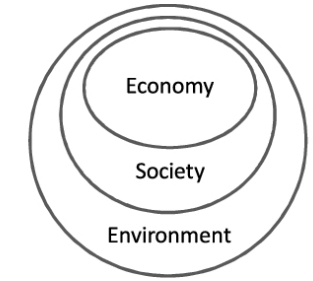
"The problem of radioactive waste is, in principle, solved. The remaining obstacles … primarily are of a political and emotional nature."

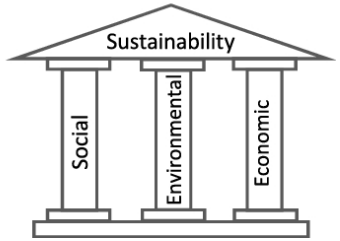
AVES 1984

(Swiss pronuclear organisation)

… to sustainability …

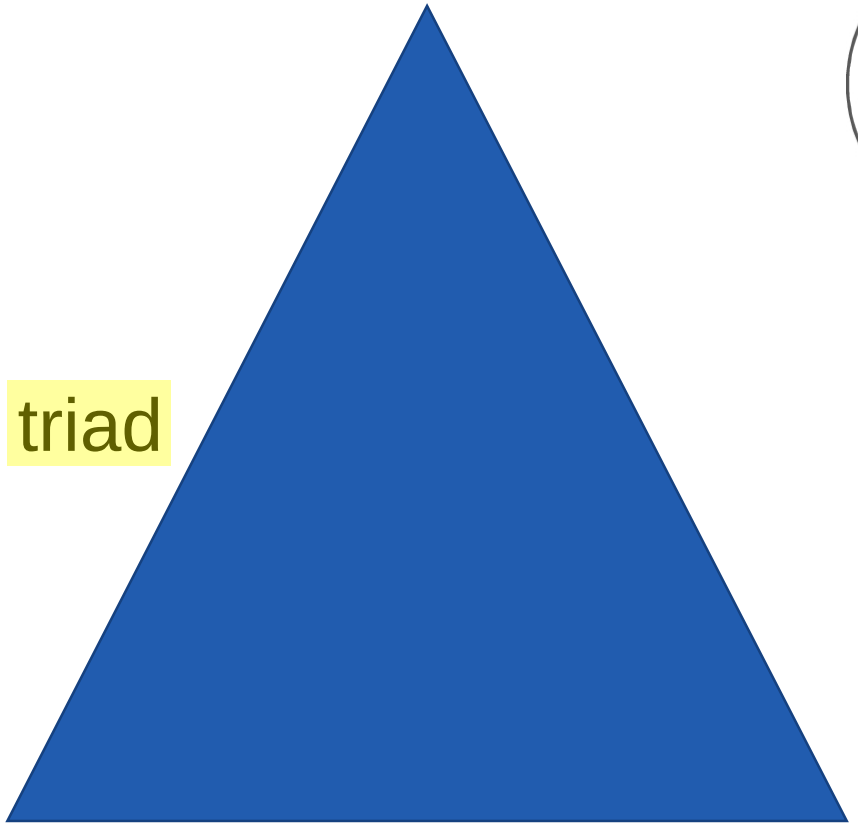




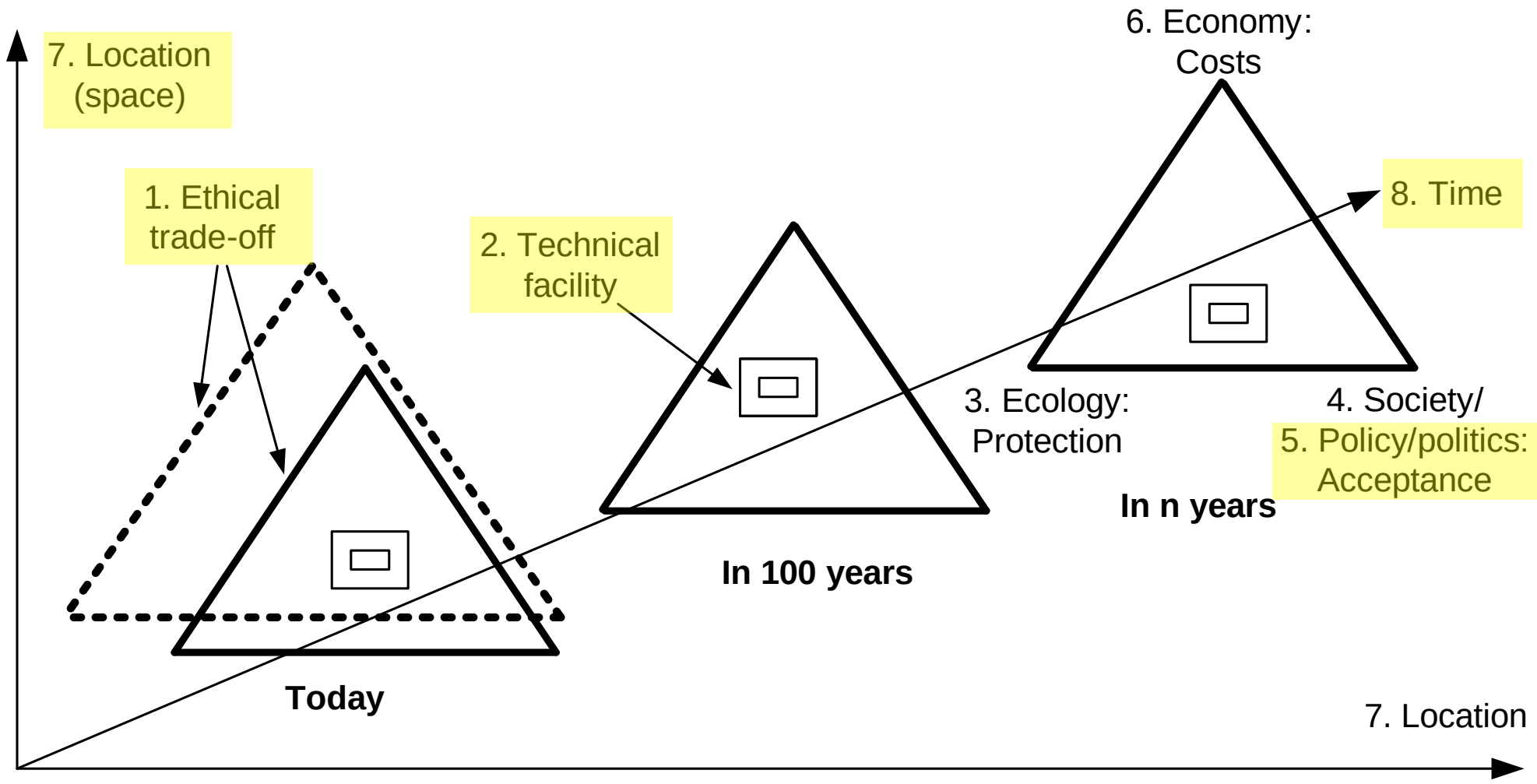


Purvis et al. 2019

Sustainability triangle: triad



… to 8 dimensions of sustainable development ….



Flüeler 2001

From technical issues …

"The problem of radioactive waste is, in principle, solved. The remaining obstacles … primarily are of a political and emotional nature."

AVES 1984

(Swiss pronuclear organisation)

"The challenge is that nuclear waste is a political problem, not a technical one, and we need the government to lead …."

Jessica Lovering, Good Energy Collective 2023

Reverse handling of dimensions …

Dimensions have often been debated in reverse order, especially pertaining to a technological constraint like waste:

- first technical and commercial,
- then political and economical,
- afterwards social and, last and least,
- under ethical aspects.

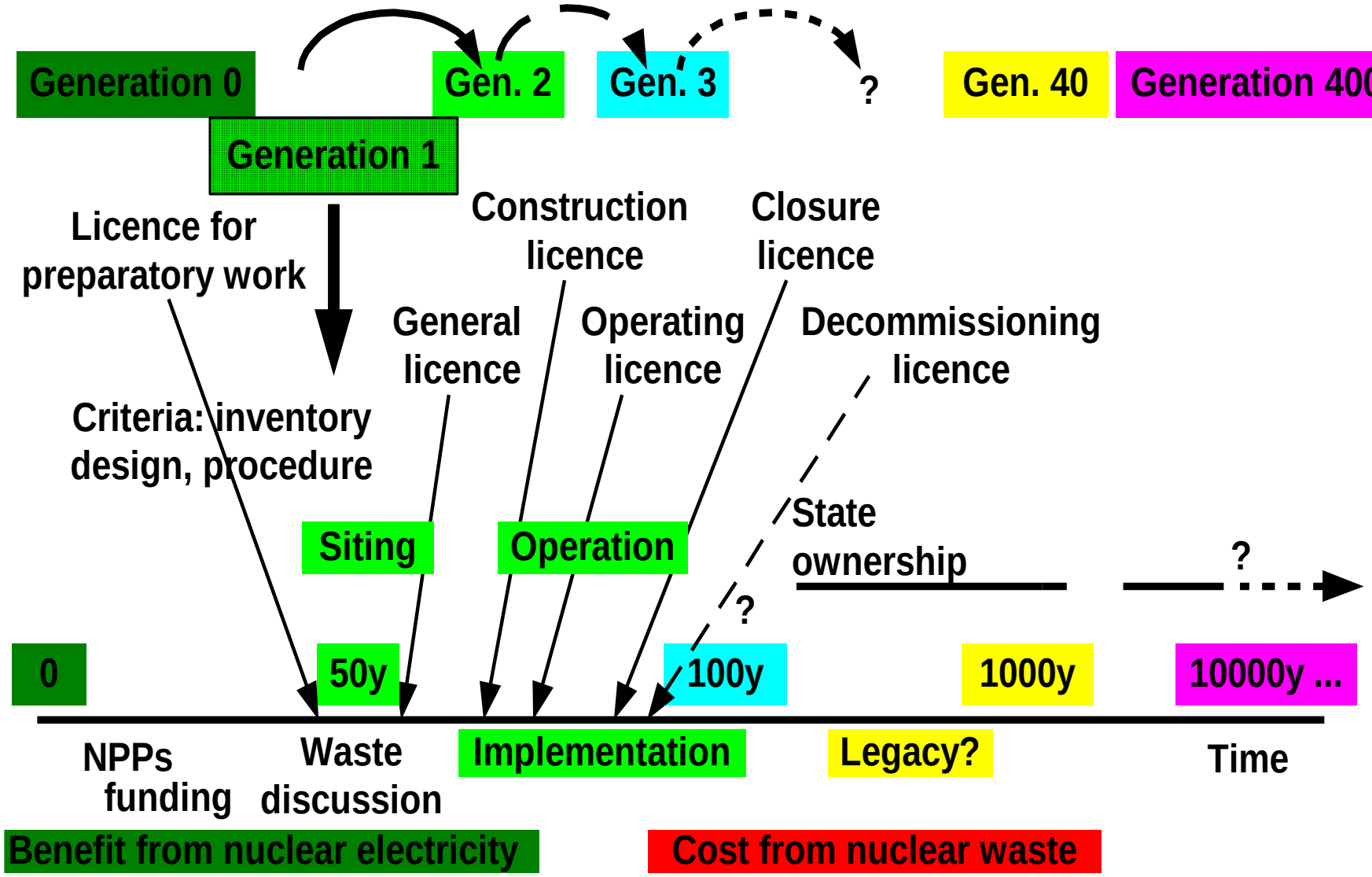
Theoretically, it should be the other way around:

- First, one should have a broad debate and decision on political principles over ethical guidelines, this should in turn

- lead to the selection of the corresponding optimum technical variant, in consideration of ecology, economy and society (“magic” triangle of sustainability).

Long-term dimension and complexity: 3 asymmetries

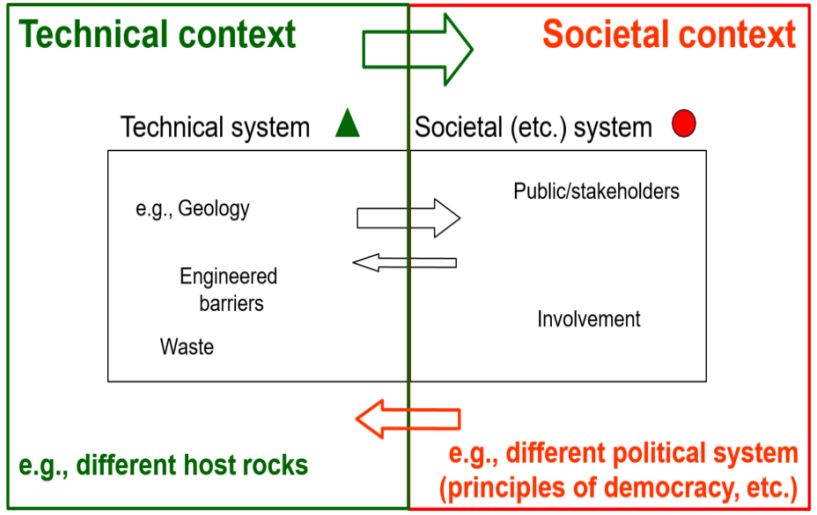
Handing over the baton from generation to generation …



1. Local cost vs. general benefit
2. Laypersons' vs. experts' perspectives
3. Today's vs. future generations

Flüeler 2004

Sociotechnical 3-level approach



Socio-technical system.
Waste as a technological constraint in the (geo-)technical and sociocultural context.
This technological "overprint" is denoted by thicker arrows from left to right

1. Problem recognition

The waste exists, the problem must be "solved", at least set on track

2. Main goal consensus

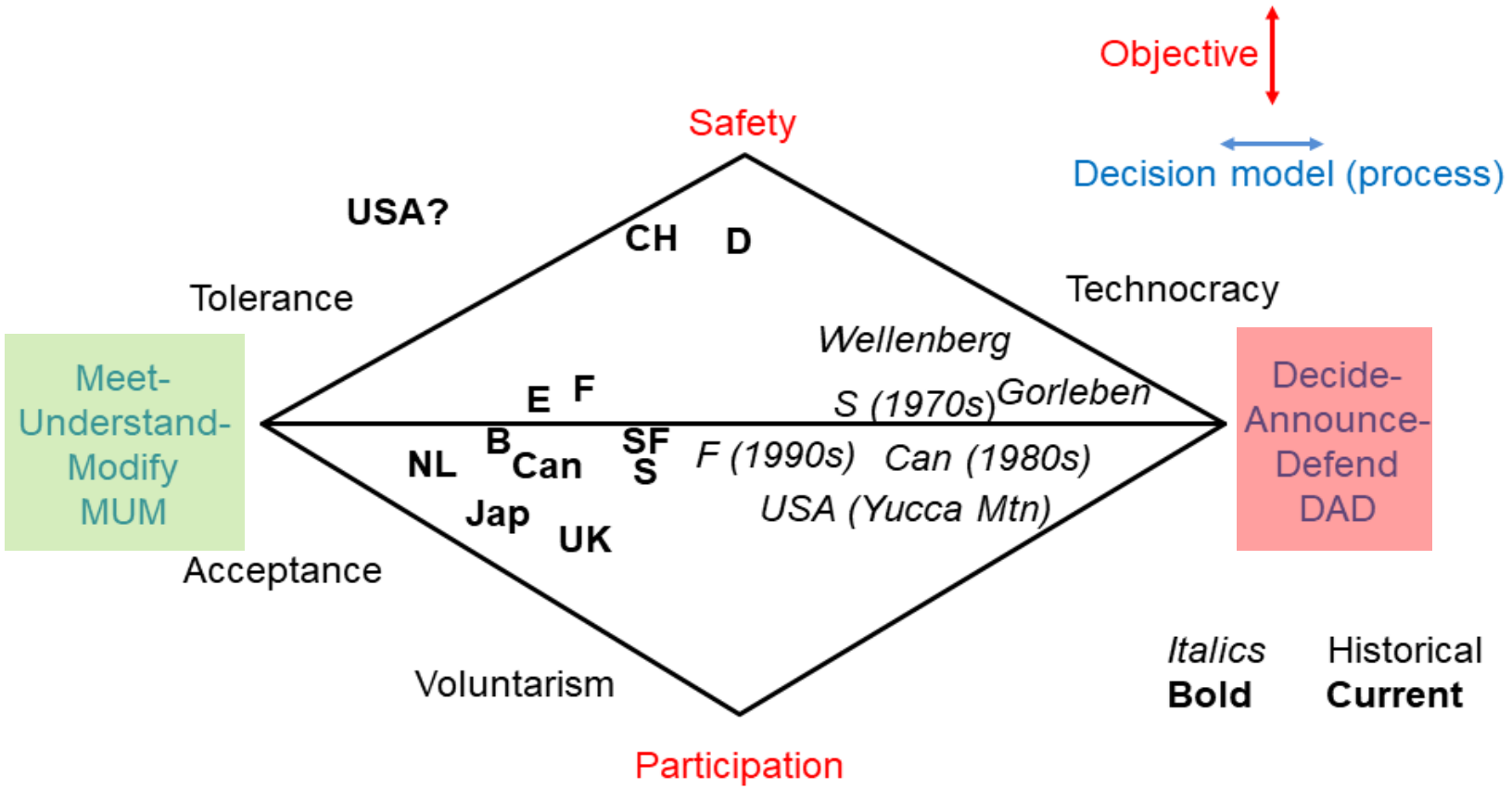
The degree of protection and intervention must be defined. According to the scientific consent, passive safety must prevail

3. Procedural strategy

The "rules of the game" (to find a suitable site and to implement disposal) have to be clear from the outset

Flüeler 2023

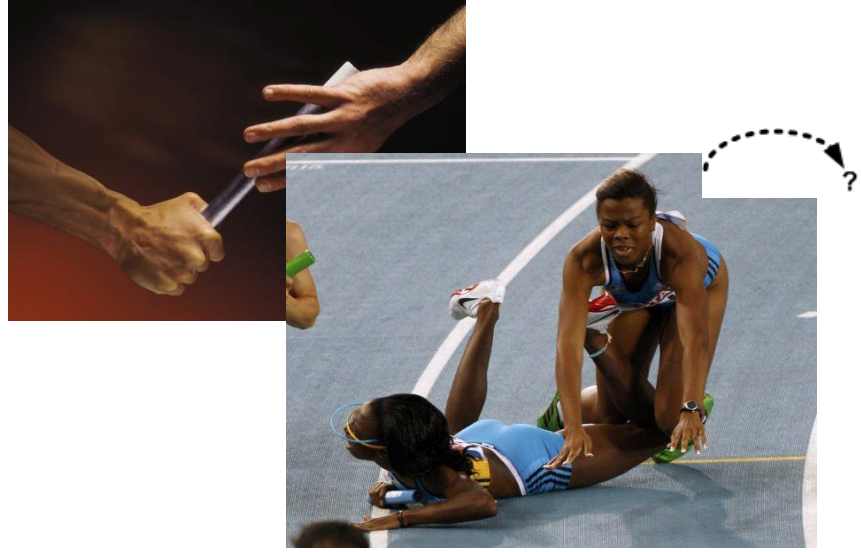
Experience in various countries along the timeline



Approaches:
from technocratic
to more pluralistic

Flüeler 2016/2023

Experience …



Handing over the baton does not always work

27 Apr 2022

Failure WAS reality, always happens, must be learned.

Nov 2023

Experiences … towards more participation

Voluntarism/voluntariness:

Japan (Jap), United Kingdom (UK), also Spain (E): “working with communities”

Sweden (S), Finland (SF): given host rock at any site, agreement with “nuclearized” municipalities

Belgium (B) (low-level waste): agreement within “local partnerships”

Incentives and concession:

France (F): undefined retrievability option in parallel with massive technological investments into economically deprived region

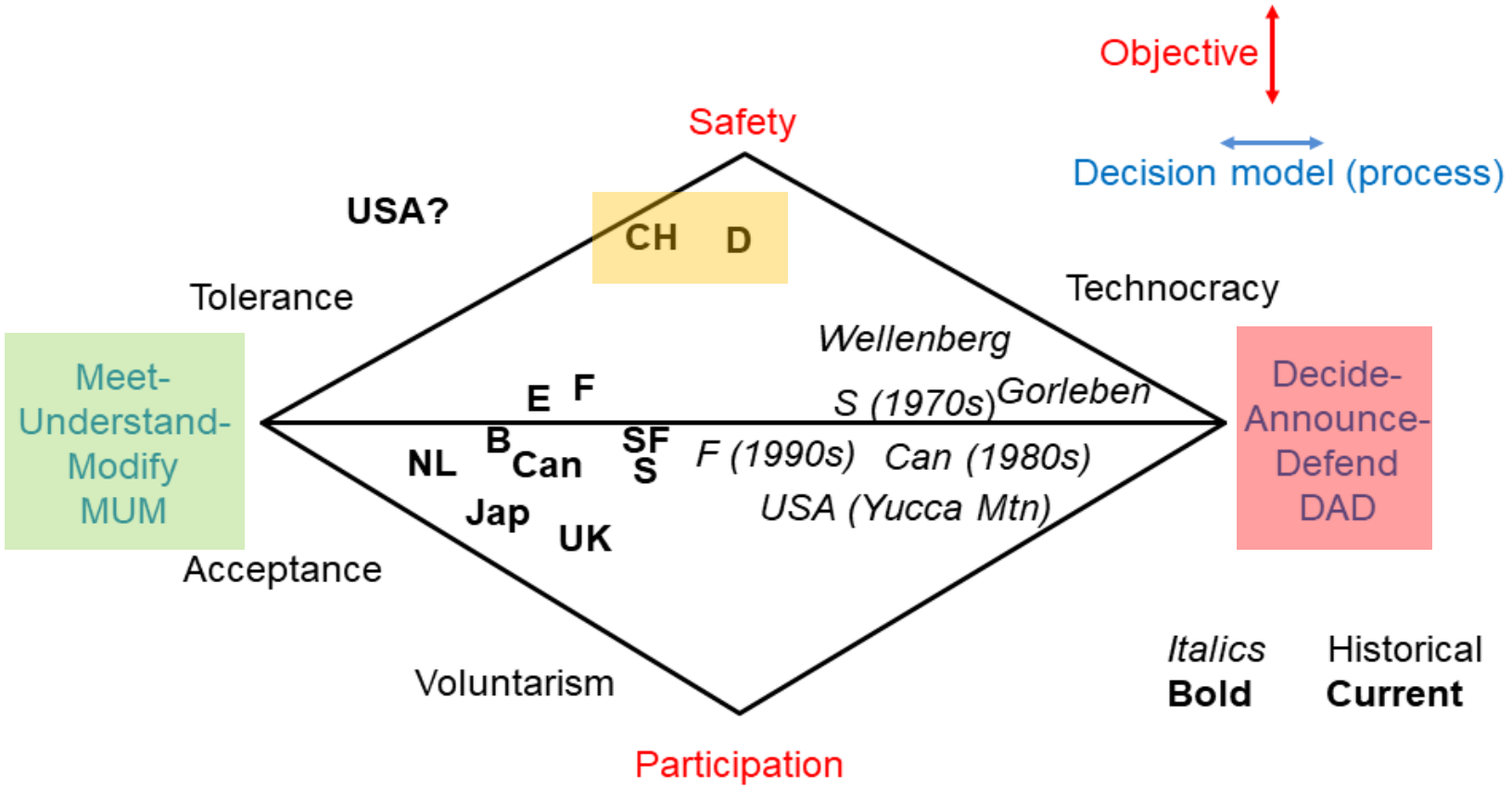
Open: USA (Yucca Mtn?), Canada (2 potential sites), Netherlands (NL) (storage)

Combined safety/participation approach:

Germany (D), Switzerland (CH)

Flüeler 2024

Experience in various countries along the timeline



Approaches:
from technocratic
to more pluralistic:

Safety, participation
and systematic
procedure

Flüeler 2016/2023

What can we obtain with dialogue (participation)?

Level	Conflict type	State of agreement	Perspective/goal/fields (examples)
Secondary beliefs			
Implementation (dependent on policies, funding, authority)	Judgement/interest/relational conflict	Compromise	"Real" project/site
Procedure/methodology	Judgement/target/interest conflict	Consensus	Siting, monitoring
Roles, decisions (instrumental and institutional goals)	Judgement/target/distributional/ interest conflict		Performance assessment, quality assurance, inclusive reviewing
Protection goals (passive protection, active control, involvement, power of decision) (= "success criteria")	Value/target/distributional/ judgement conflict	Consensus	Safety and control goals
Factual constraints	Judgement/interest conflict	Consensus	Waste existent
Concept of sustainability	Value/target conflict	Compromise ("weak" sustainability[a])	Practical trade-off of dimensions (technical and social goals)
Core beliefs			
Attitudes of stakeholders	Value/target conflict	Dissent	Pro- *versus* anti-nuclear
Models of rationality	Value/target conflict	Dissent	Technocentric/anthropocentric *versus* biocentric or even ecocentric worldview

[a] "Weak" sustainability allows for substantial substitutability of resources (Solow 1974)

Societal agreement varies:

Compromise, consensus and consent

Flüeler 2023

German and Swiss site-selection procedures: Challenges & "solutions"

Aspects		
Approach	**Safety and participation, etc. safety first**	**Safety and participation, etc. Safety first**
Host rocks	**Opalinus clay**	**"Crystalline",** salt, clay(s)
Law, procedure	Deep geological repository **Pilot facility, sectoral plan**	Final repository **Learning, self organisation**
Time frame	Open, sectoral plan (~2031)	**2031**
Society	6 → 3 → 1+ reg. conf., etc.	**Sub-areas conference,** etc.
Techn. public	**Techn. Forum Safety, etc.**	**Sub-areas conference**
State levels	**Cantons (with experts)**	**German Länder?**
History	**Wellenberg**	**Gorleben, Asse, Morsleben**
Reflection	**1 PhD thesis**	**ENTRIA, TRANSENS**
Oversight	**Advisory Committee**	**Natl. Citizens' Oversight C. NBG**
Discourse	**Nagra → Nagra**	**BfS/DBE → BGE**
"Dropouts"	**Few (local Green party)**	**BUND, citizens' initiatives, etc.**

- **Allot sufficient time!**
- **Oversight:** National Citizens' Oversight Committee (NBG)
- **Reflection:** Research platforms
- **Discourse:** Corporate culture transitions

Flüeler 2022, 2024 (transl.)

Long uphill struggle

Combined approach:

- Safety first (and overriding)
- Participation of the public (Germany: national to regional, Switzerland: regional, national referendum)
- Systematic procedure

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