Sustainability and Circular Economy Principles in Nuclear Decommissioning

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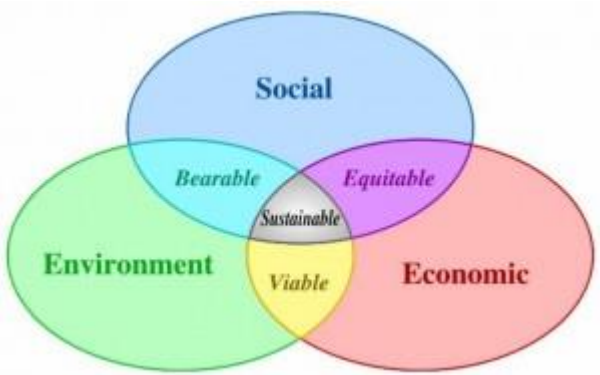
Circular economy – comprehensive approach

https://www.ecologique-solidaire.gouv.fr/leconomie-circulaire

- Produce sustainable goods and services, by limiting
  - consumption and et waste of resources (primary raw materials, water and energy)
  - production of waste.
- Break with the linear economy model (extract, make, use, throw) for a circular model ».
- Be aware of the planet's limited resources and the need to save them.
- New production and consumption models generating activities and creating sustainable and non-relocatable jobs.

- The challenges of the circular economy are at the same time environmental, economic and social.



Circular economy – comprehensive approach

• **Responsible Sourcing** : taking into account the environmental and social impacts of the resources used, in particular those associated with their extraction and exploitation.

• **Eco-conception** : take into account the environmental impacts over the entire life cycle of a product and integrate them from its design.

• **Industrial and territorial ecology** : mettre en synergie et mutualiser entre plusieurs acteurs économiques les flux de matières, d'énergie, d'eau, les infrastructures, les biens ou encore les services afin d'optimiser l'utilisation des ressources sur un territoire.

• **Economie of functionality** : favor use over possession, sell a service rather than a good.

• **Responsible Consumption** : take into account the environmental and social impacts at all stages of the product's life cycle in purchasing choices, whether the buyer is public or private.

• **Extending the duration of use** of products by recourse to repair, sale or second-hand purchase, by donation, as part of reuse and reuse.

• Improvement of **prevention**, **management** and **recycling of waste**, including by reinjecting and reusing waste materials in the economic cycle.

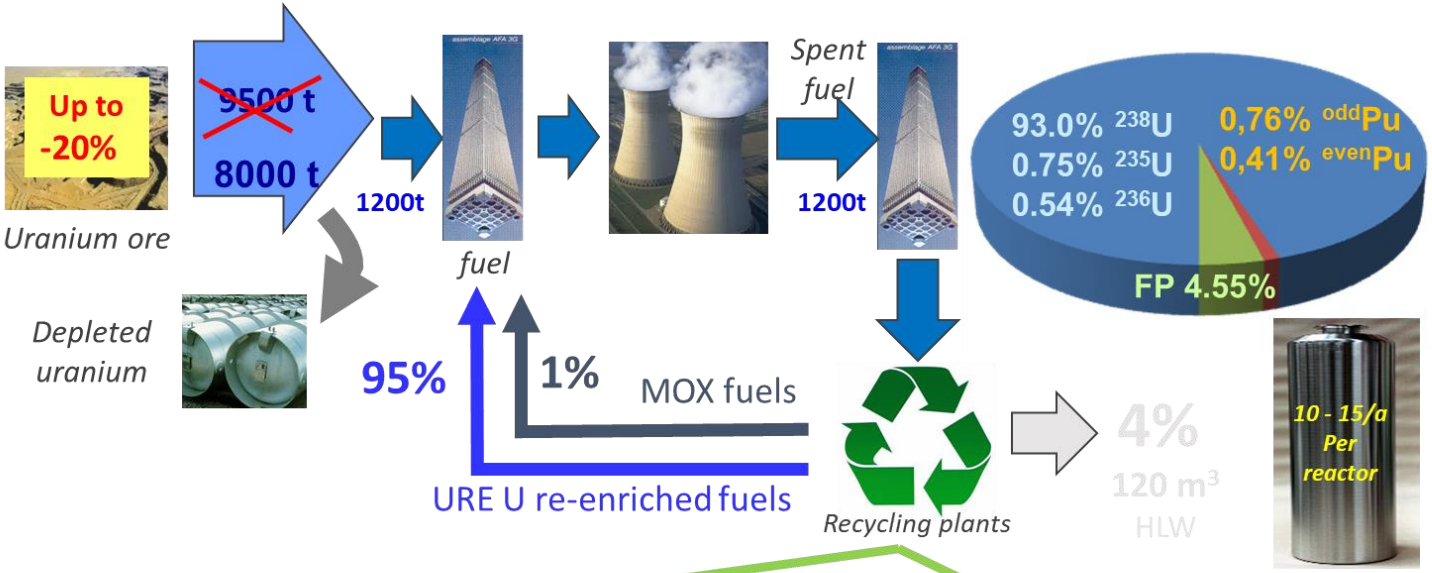
ADEME

Developing a circular economy model is not addressing one of the pillars, it is combining them!

And it is ECONOMY!

In nuclear…

Recycling save resources – French case



La Hague

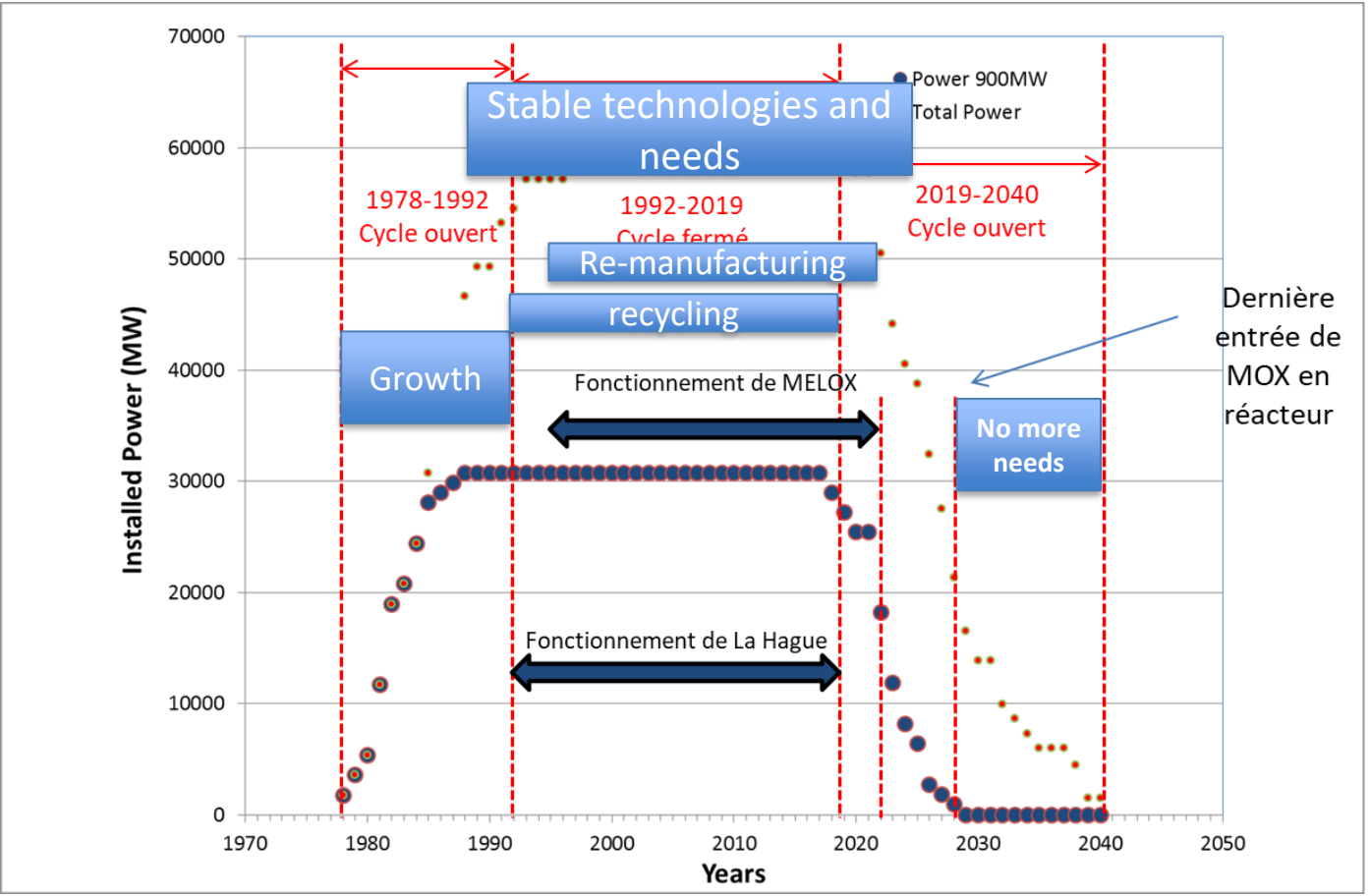
AREVA

MELOX

>33 000 tHM reprocessed

>2 000tHM of MOX fuel produced

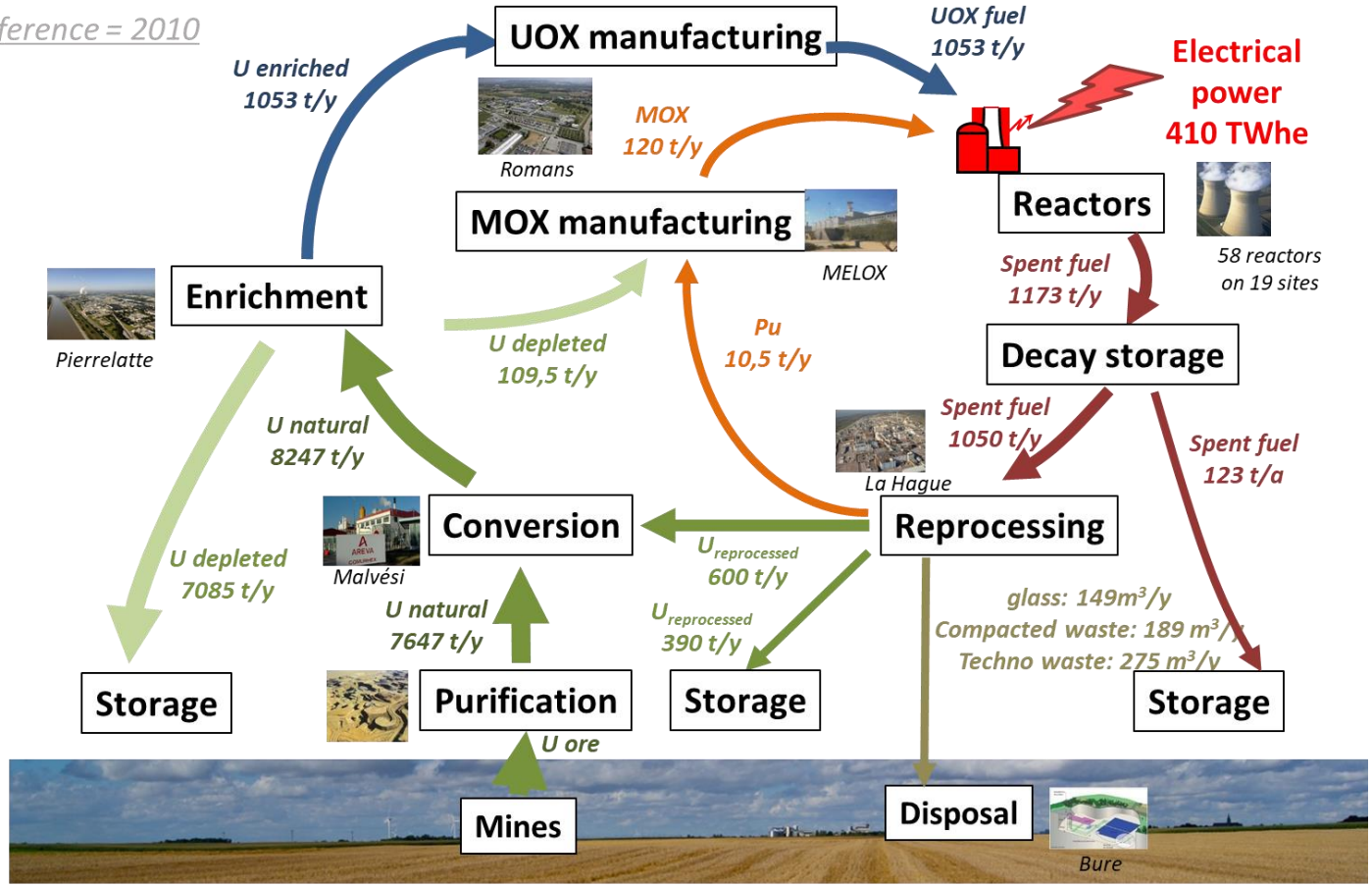
Why recycling makes sense in France



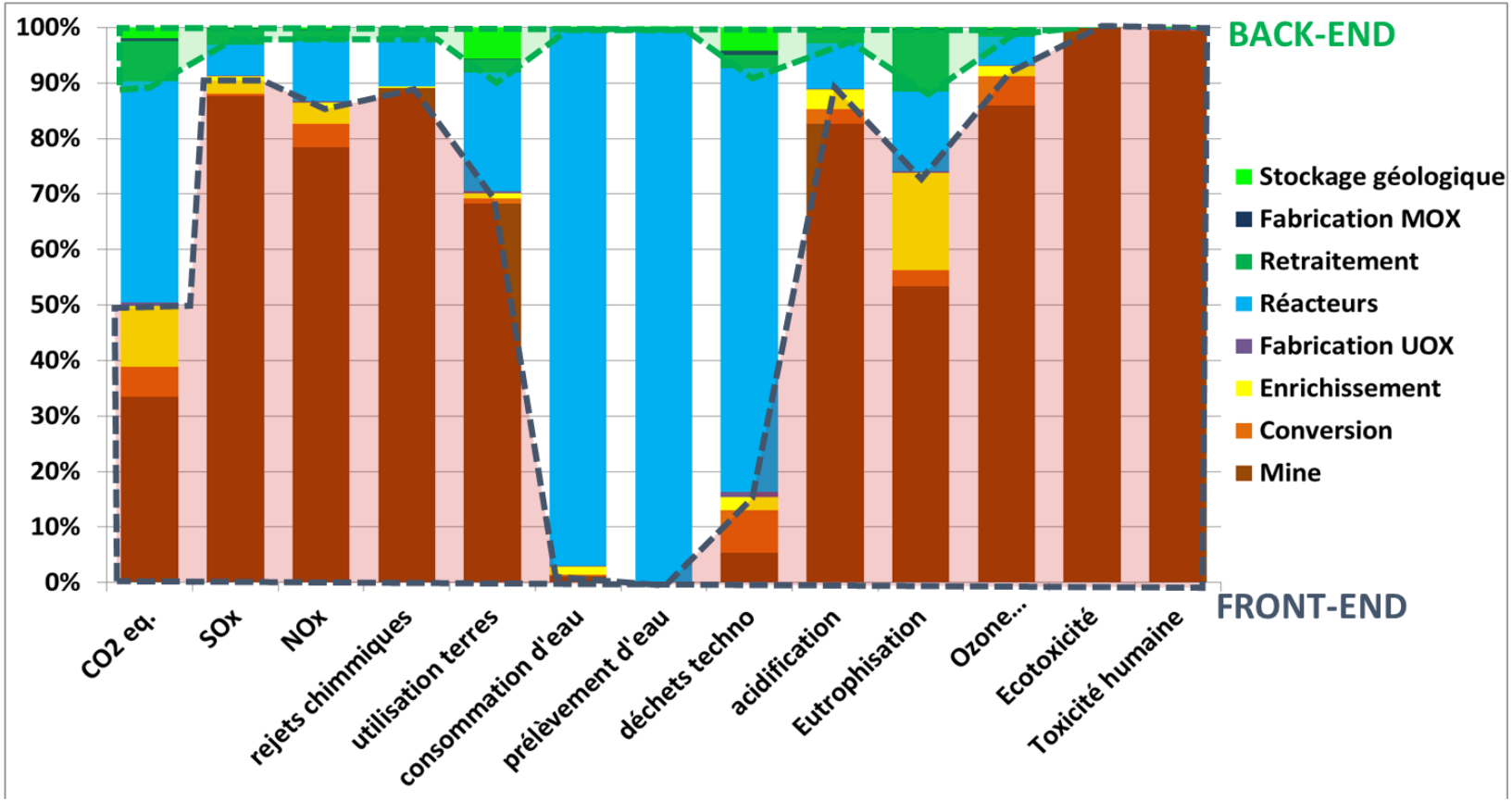
In nuclear, closed loop fuel recycling makes sense because the development strategy has led to a technological plateau with a defined and stable need.

But there too, a day will come when this recycling will no longer make sense. …

Recycling saves resources – French case



Fuel cycle impacts – French case



A focus on construction/dismantling (C/D)

Impact	Unité	Total	Share C/D	Estimation D
Radioactive waste	m3/MWh	6,87011E-05	70%	70%
Very low activity	m3/MWh	4,27135E-05	80%	80%
Low and medium activity, short life	m3/MWh	1,8318E-05	70%	70%
Medium activity, long life	m3/MWh	4,91357E-07	30%	30%
Low activity, long life	m3/MWh	7,17835E-06	49%	49%
Impact	Unité	Total		
IMP2002+_Aquatic ecotoxicity	t TEG/MWh	0,247868117	62%	25-30%
IMP2002+_Global Warming	tCO2/MWh	0,001269774	35%	10-20%
IMP2002+_Carcinogens	t C2H3Cl/MWh	2,9287E-05	49%	20-30%
IMP2002+_Non-carcinogens	t C2H3Cl/MWh	3,57805E-05	60%	20-30%
IMP2002+_Ozone-layer-depletion	t CFC-11/MWh	4,54752E-10	3%	1-2%
IMP2002+_Aquatic-acidification	tSO2/MWh	7,57009E-06	14%	5-10%
IMP2002+_Aquatic-eutrophication	tPO4/MWh	5,25184E-07	42%	15-25%
IMP2002+_Terrestrial-acid/nutri	tSO2/MWh	3,45379E-05	25%	10-20%
IMP2002+_Ionizing-radiation	MBq/MWh	0,000250201	0,1%	0-0,1%

Other business models… economy of functionality

Raw material trading ➔ speculation

Propriétaire1	Propriétaire2	Propriétaire3	Propriétaire4	Propriétaire5	Propriétaire6	Propriétaire7
Déchet	Composant	matériaux	matières	matériaux	Composant	Produit

Vente/Achat Vente/Achat Vente/Achat Vente/Achat Vente/Achat Vente/Achat

Trading of the transformation services

Propriétaire1

Déchet → Transformation1 → Composant → Transformation2 → matériaux (Propriétaire1) → Transformation3 → matières → Transformation4 → matériaux (Propriétaire1) → Transformation5 → Produit (Propriétaire1)

Propriétaire1 Propriétaire1 Propriétaire1

PGM trading activity of Renault to control prices on these PGM and avoid speculation and unjustified margins at OEM

A focus on construction/dismantling (C/D)

The (French) nuclear fuel also is already a good example of circular economy

- Responsible sourcing
- Constant improvement of facilities and processes – quite low impacts
- Mainly managed at the (French) territory level (but mines) ➔ wealth and job creation
- Based on service supply more than raw materials/products trading
- Recycling implemanted not only for fuel but also for reagents in several plants

The dismantling has quite an important impact on some indicators

- ➔ progress margins

Could some waste be a resource?

- Challenges: economic, regulations, acceptance…