

# Le Nucléaire à la croisée des chemins

***Plaidoyer pour une politique de l'énergie durable***

***Marc Deffrennes SEII 26 mai 2023***

# Content

- Nuclear history and state of play in Belgium
- The European Union level
- Sustainable energy – well beyond green
- Sustainable nuclear energy – closing the fuel cycle and fast reactors
- What to do in the next ten years
- Policy expectations for political programmes and tools to help policy makers

# A brief history of nuclear in Belgium 1/2

- Once upon a time **Shinkolobwe** – residue of Radium, but...
- King's gift: the Belgian nuclear research center **SCKCEN founded in 1952 in Mol.**
- **4 reactors were built in Mol:** BR1 (1956, graphite air-cooled), BR2 (1962, Material Test Reactor, beryllium water-cooled), BR3 (1962 till 1987, 10MWe, first prototype PWR in Europe Westinghouse (W), now undergoing decommissioning), VENUS (1964, zero power reactor – 2011, Guinevere project).
- 1957 – 1990 Joint Undertaking **OECD NEA Reprocessing Eurochemic** Pilot Plant in Dessel/Mol for the separation of U and Pu from spent fuel – now decommissioned.
- 1973-1985: commissioning of **7 large PWRs** (D1/2 2x500 W Mwe, T1 W 1000 Mwe, D3 and T2 W 2x1000 MWe, D4 and T3 W 2x1000 Mwe. Over years on average these nuclear plants produced 50% of the Belgian consumption of electricity.

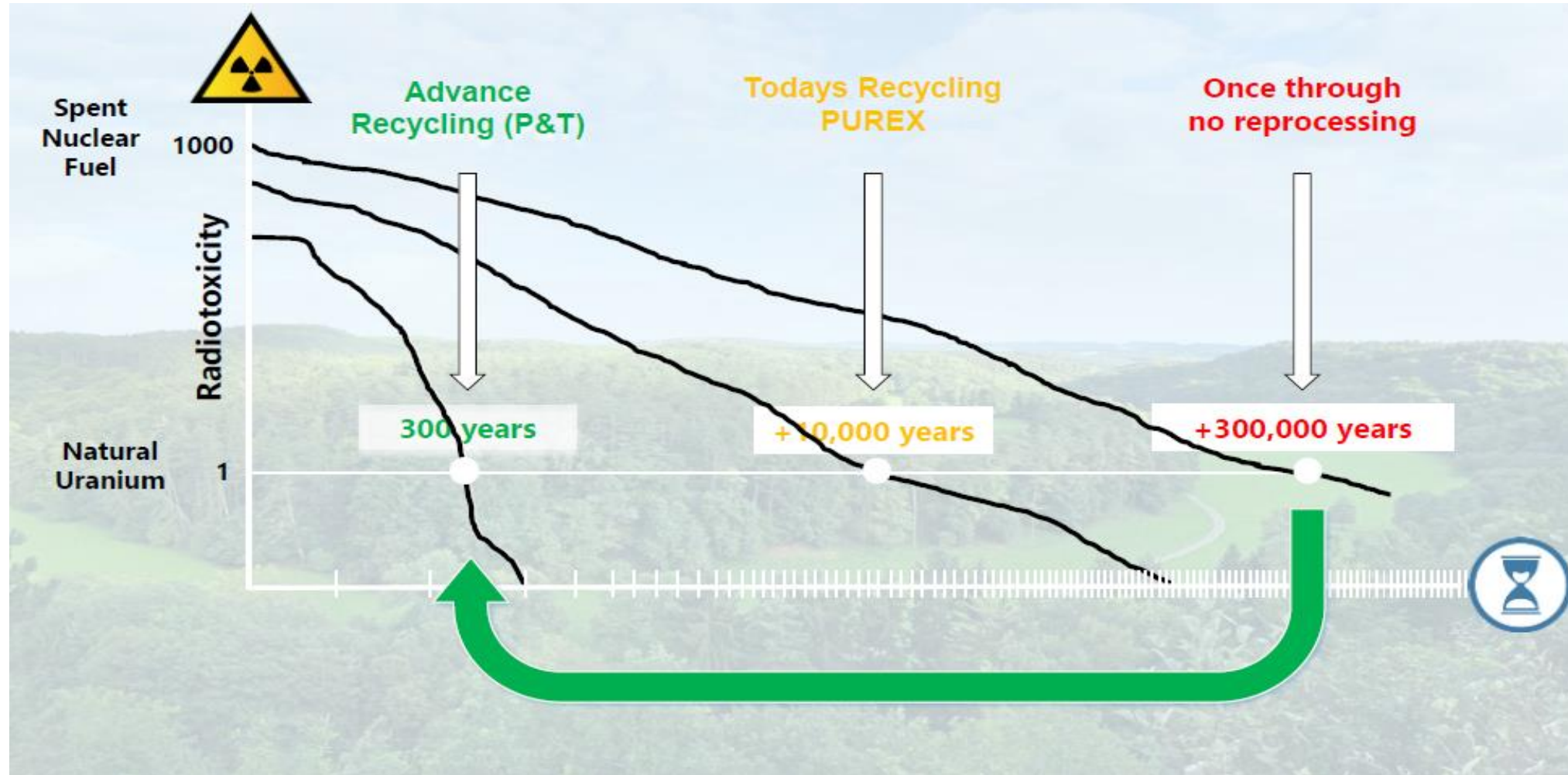
# A brief history 2/2

- 1973 creation **FBFC in Dessel**, 1987 first MoX fuel assemblies, stop 2012 and decommissioned.
- 1973 **Belgonucleaire plant in Dessel/Mol to fabricate MoX fuel** – initially for BR3 (as test phase) and the planned SNR-300 fast reactor. In 1986 the facility fabricated MoX fuel for some of the Belgian PWRs. Stopped, with the reprocessing, for political reasons in 2000. Now decommissioned to green field.
- **Fast reactor SNR-300** (DE BE NL in Kalkar Germany). Project start in 1972, plant completed in 1985, Belgonucleaire MoX fuel ready but not loaded, project cancelled in 1991, now Wunderland Park.
- **IRE** (RadioElements Institute) created in 1971 in Fleurus – dedicated to the production of medical radioisotopes in collaboration with SCKCEN
- **Waste Management under responsibility of Waste Agency Ondraf Niras** with final disposal site for LLW in Dessel (under final stages of construction) and, since 1980, deep Underground Research Laboratory HADES (operated jointly with SCKCEN) for geological repository of HLW in clay.
- Education: 2002 creation of **BNEN** consortium of Universities for a master-after-master degree in nuclear engineering, in collaboration with SCKCEN

# State of play

- **2003 Nuclear PhaseOut Law** under a political governmental coalition with the Green Party. Stop NPP operation after 40 years: D1/2 and T1 in 2015, D3 in 2022, T2 in 2023, D4 and T3 in 2025.
- **2013** changing decision: T1 allowed to go for 50 years till 2025.
- **2015** changing decision: D1/2 allowed to go for 50 years till 2025.
- **Elections 2019, October 2021**, confirmation of the complete PhaseOut for 2025 (D3 in 2022 and T2 in 2023) based on study by the TSO ELIA – to be compensated by new gas plants (under CRM) and imports.
- **March 2022**, changing decision: update by ELIA - D4 and T3 allowed to go for 50 years (until max 2037)
- **October 2022 Shutdown of D3, January 2023 Shutdown of T2**
- Negotiations ongoing between the Govt and the Operator on the conditions, including the financing of the legacy (waste management).
- **550 Meuros ADS FR MYRRHA + 100 Meuros for SMR...SCKCEN report proposing LFR**

# Why MYRRHA ?



# MYRRHA's Application Portfolio



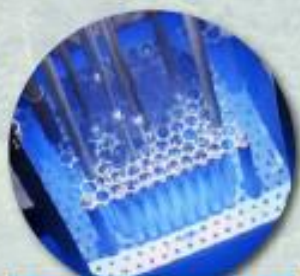
**Radio-isotopes**



**SNF\* / Waste**



**Fusion**



**Mat. & Fuel  
GEN IV**

**Multipurpose  
hYbrid  
Research  
Reactor for  
High-tech  
Applications**



**Fundamental  
research**



**Support to  
SMR LFR**

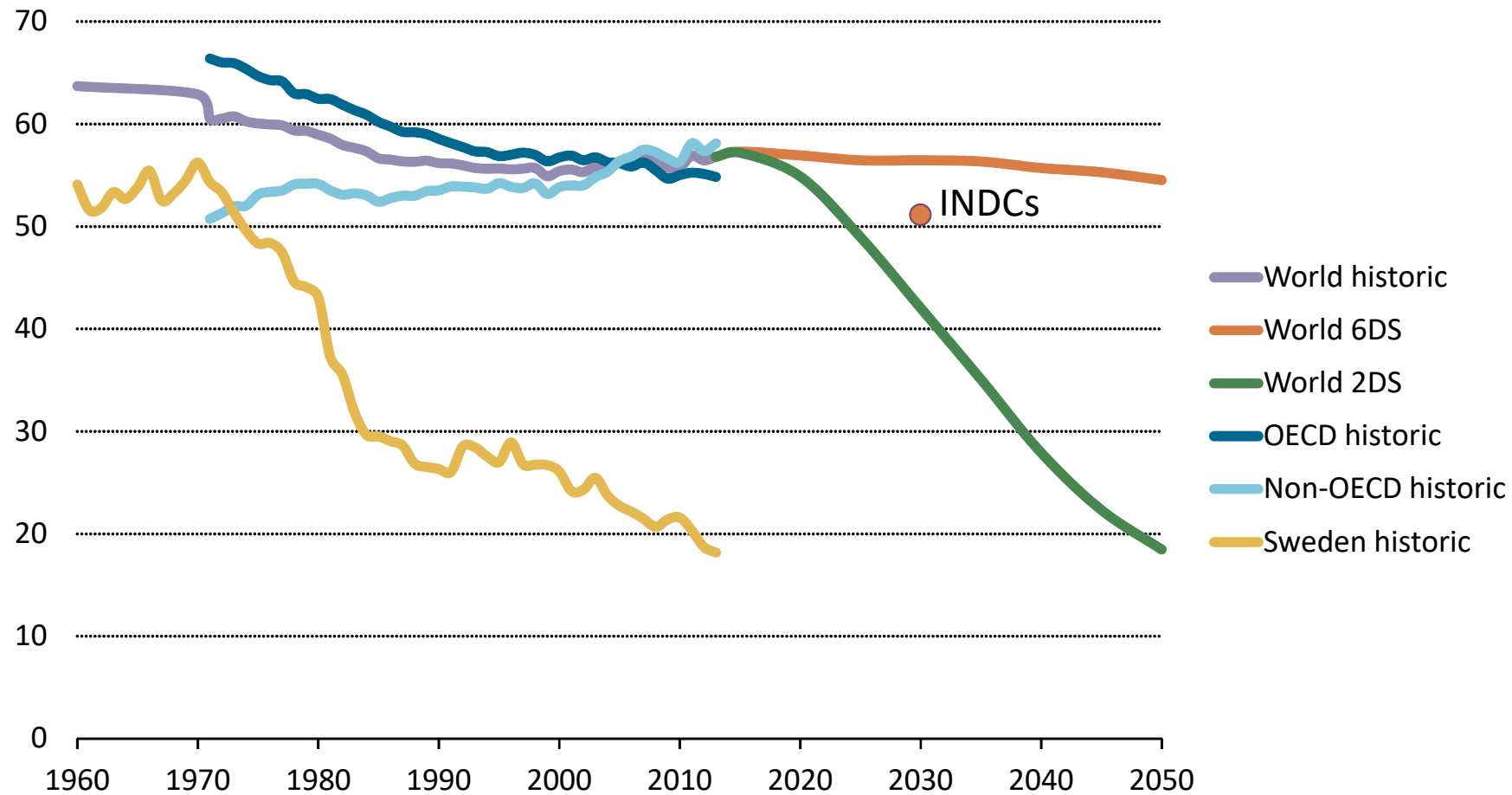
\*SNF = Spent Nuclear Fuel

# Nuclear at EU level

- A good start: **Euratom Treaty**: (nuclear) energy at the core of EU
- But then came GHG... and renewables... and E-market...
- From **3x20 in 2020** (already mixing goal and tools), to **Clean Planet for All to Green Deal**
- **Fit-for-55 in 2030 and NZ 2050... and for 2030 RES 42.5% (?) of energy consumption in EU, and EE -12% in 2030 vs the estimation made in 2020. NECPs revision in 2024.**
- **Financing ?** Tools: InvestEU, Just Transition Fund – exclude nuclear...
- And **more**: Taxonomy, REPowerEU, REDIII and H2, E-market Reform, NZIA (vs IRA), CRMA... nuclear sidelined.
- **Alliance** of 11+ MS led by France – a wake-up ?



# 2°C requires a drop in the carbon intensity of primary energy (tCO<sub>2</sub>/GJ)

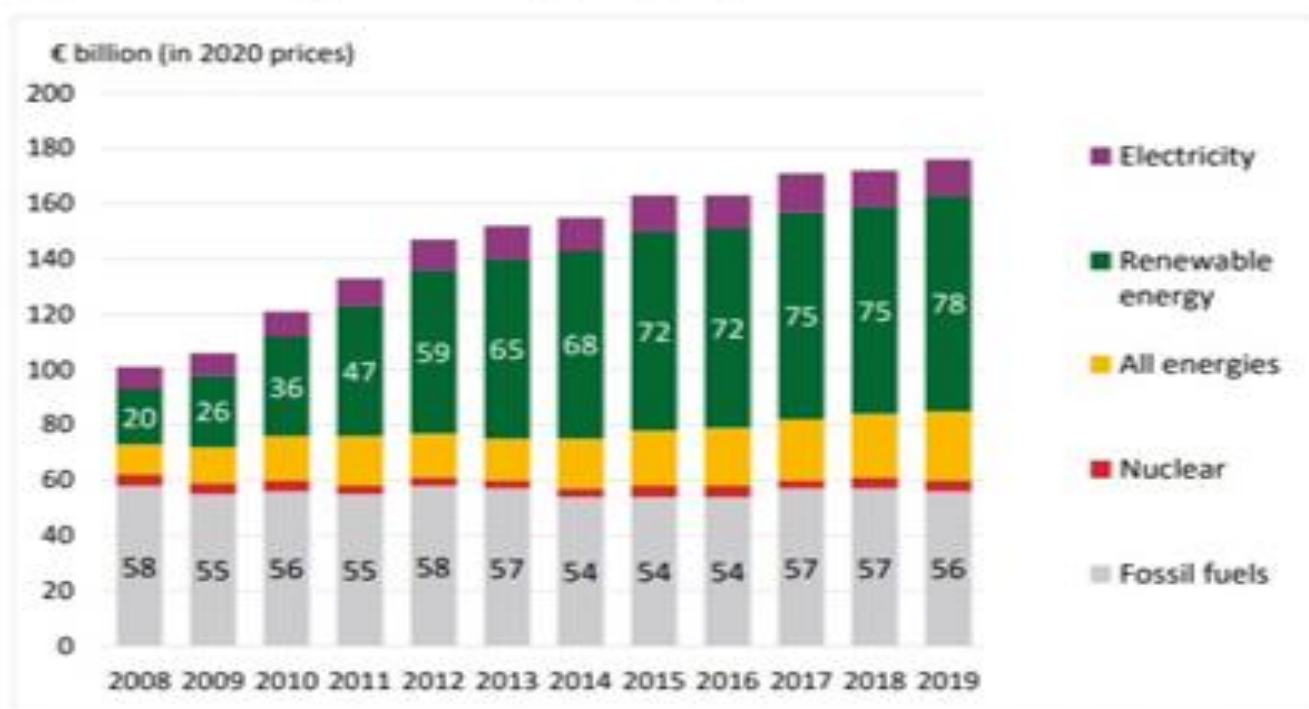


...which has been stable on a global level over the last 50 years.

# Energy Subsidies in EU

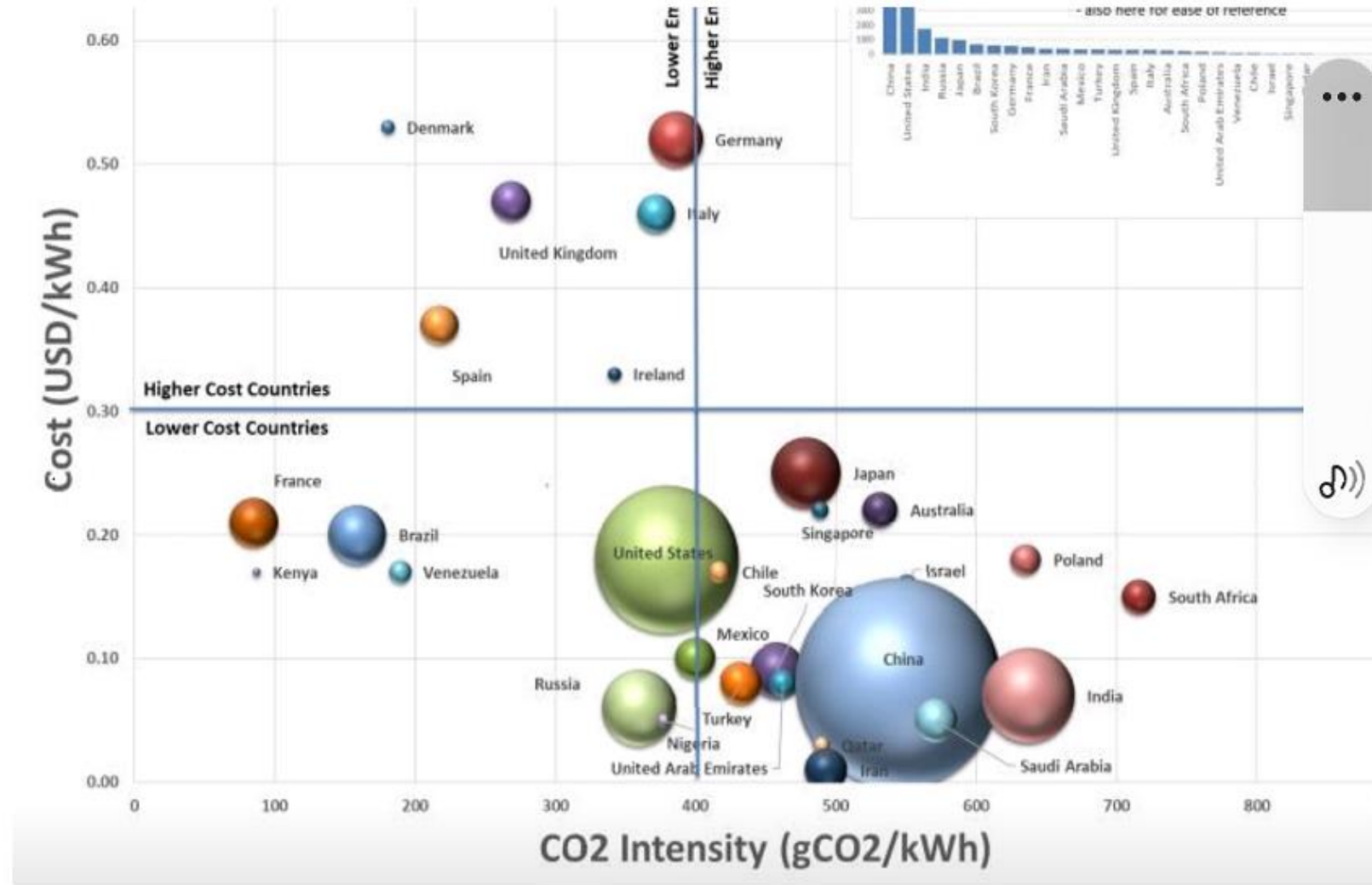
European Court of Auditors 2022

Figure 10 – Energy subsidies by category between 2008 and 2019



Source: ECA based on the *Study on energy subsidies and other government interventions in the European Union*, October 2021.

**Cout de production moyen et Intensité Carbone de l'électricité dans divers pays en 2022.**



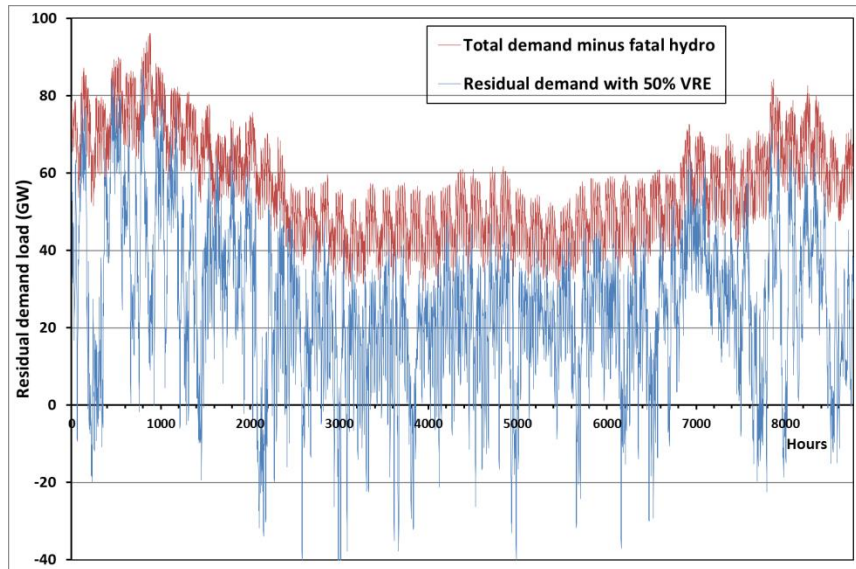
# It is time for a paradigm shift !!!

- We are in a Climate + Energy + Economic + Social Crisis = a Societal Crisis
- Time to shift from Green to Societal Sustainability (Brundtland's Definition): Energy Policy at **SYSTEM** LEVEL

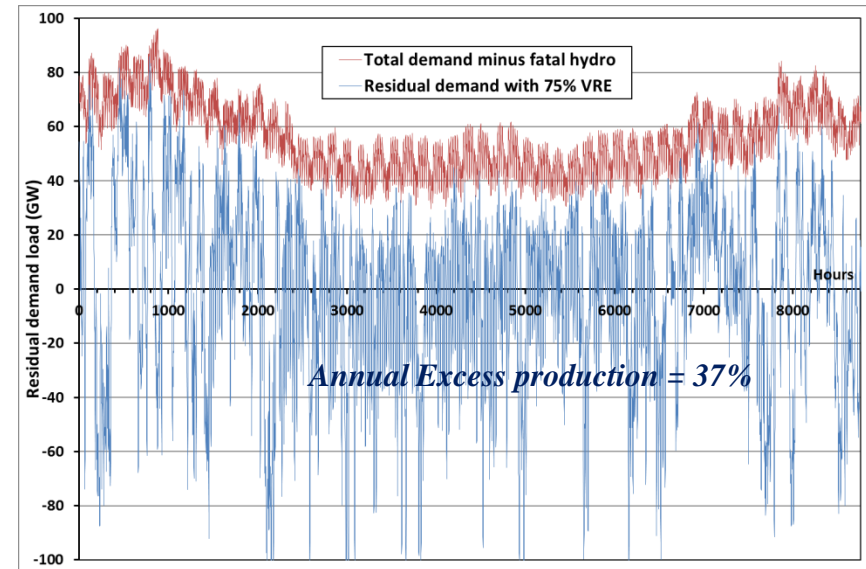


## High VRE share de-structures the remainder of the system II

### 50% Variable Renewables



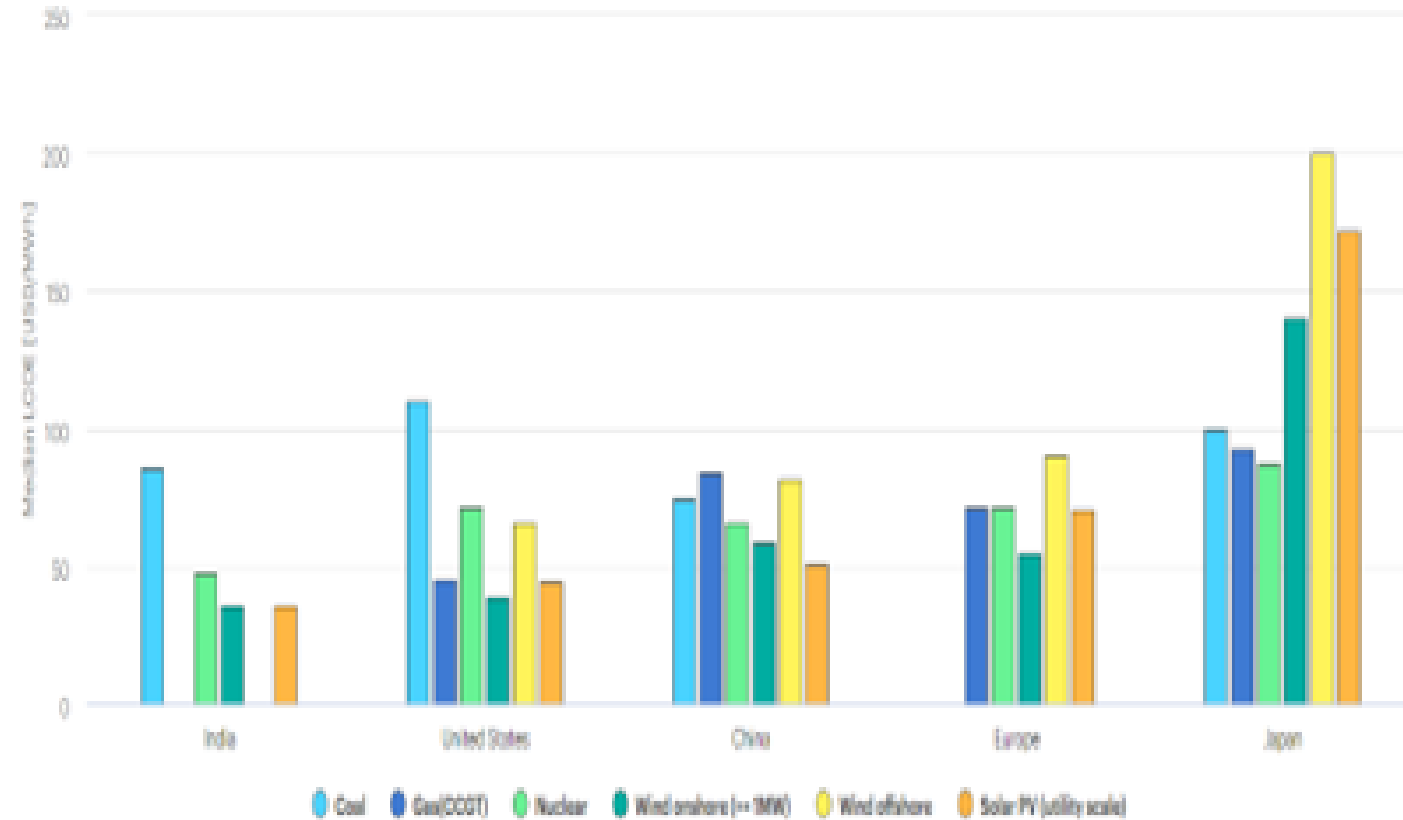
### 75% Variable Renewables



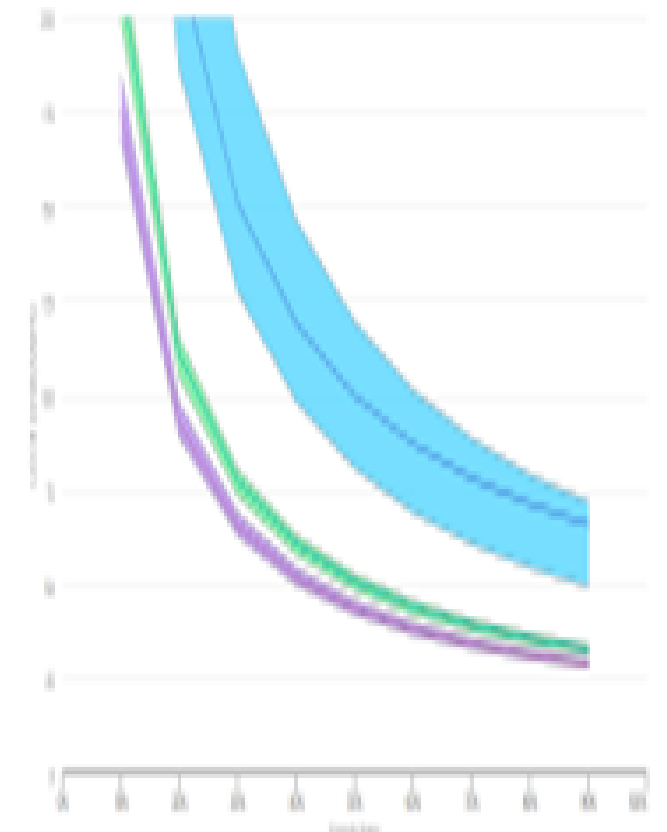
- Residual demand for dispatchable thermal operators loses its characteristic daily, weekly and seasonal patterns and becomes more volatile and unpredictable.

# LCOE – LEVELIZED COST OF ELECTRICITY – Source IEA PCGE Report 2020

Median technology costs by region, discount rate of 7%

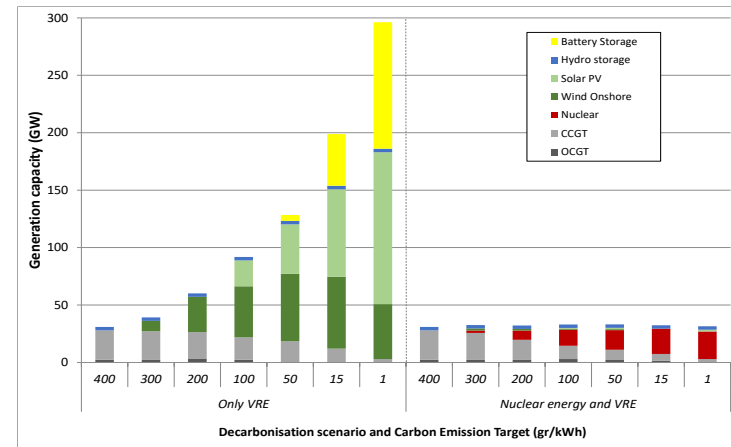
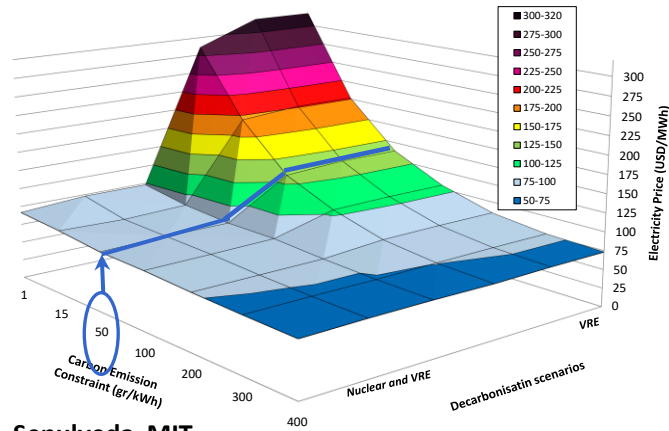


Cost from variable fuel and fixed cost of energy plant (€/MWh)



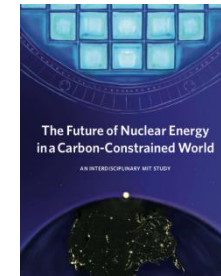
IEA. All rights reserved.

## The Cost of Electricity Is a Function of (1) Carbon and (2) VRE Targets (How Do the Results of the NEA SC2 Study Compare with Alternative Targets?)



Source: N. Sepulveda, MIT

- The average cost of electricity increases with the stringency of the carbon constraint. The increase is much more significant in scenarios where only VRE are deployed.
- The structure of the optimal generation mix changes drastically as the decarbonisation target becomes more binding.



# *Cost vs Price !!!*

## ELEMENTS FOR A DEEP ELECTRICITY MARKET REFORM (weCARE at EESC Hearing)

- Electricity is a **common good** – not commodity (it needs permanent balance supply/demand)
- The Public Service nature of electricity should be recognised
- **EC Proposal: OK** for tackling some flaws of the market design: ia “short term energy only” not giving right signals for investment = CfD and PPAs are helping solving these flaws
- Danger creating multiple connected markets: electricity, capacity, storage, hydrogen, CO2,... unmanageable
- **But** need a much deeper reform of the electricity **system**
- Put the **final consumer at the centre** of the interest: electricity must be the **cleanest, cheapest, fully reliable in supply when needed** (covid or Russian gas induced restrictions are not the model to follow)
- **Cleanest** = very low carbon: nuclear and RES
- **Cheapest and Reliable** = the **price paid by the final consumer must reflect the true costs** – but the full costs not only the marginal cost, in a **simple** way for people to understand. **This true cost should define the merit order** (if one wants to keep the merit order). The actual merit order (marginal cost only) mixes apples and pears (RES and nuclear) and gives undue advantage to RES – with subsidies and system costs pushed under the carpet for the consumer/taxpayer to pay at the end. Make sure **all low carbon sources enter the market on equal footing = be dispatchable.**



# Sustainable nuclear energy (GIF)

- Targeting full use of the Uranium energy content: 0,7% U235 (fissile) and 99.3% U238 (fertile). Conversion of U238 in Pu239 (fissile)
- NEED closing the fuel cycle = Reprocessing and Recycle !
- Thermal neutrons reactors (light coolant as moderator, U235) versus fast neutrons reactors (heavy coolant not moderator, Pu239)
- From Recycling Pu 239 in MoX fuel for thermal reactors (7% Pu239 instead of 4% U235)
- To Recycling Pu239 in fast reactors (20% Pu239) and breeding more U238 into Pu239
- No limits in resources and major impact on the waste management

# What we could/should do in the future...

- Based on a fast reactors fleet
- **Separate** U, Pu, MAs and FPs of the spent fuel
- **Fabricate new fuel** containing Pu and MAs, treat FP as waste (vitrification):  
Possibly two types of fuel – for power reactors (with a few % of MAs) and for deep MA burners (with high % of MAs)
- **Power and heat production** in fast breeder reactors, transmutation of MAs in **dedicated transmuters** (MYRRHA)
- **Reprocess** the spent fuel and recycle
- **NEED MORE RD&D** – timeline... 2045... if we start proactively now...

# What could/should we do in the next 10 years

- Evaluate realistically the **demand** in energy (electricity and heat) to tackle the economic and social challenges – target societal sustainability. Evaluate the reliability and affordability requirements.
- Perform **global System (full cost) studies** to determine the balance of nuclear and RES (with their piggybag for intermittency).
- Keep all safe (Saf Authority decision) NPPs **in LTO** (if economic).
- Evaluate and decide for new built **GenIII - large vs SMRs** (based on specific needs and pro and cons).
- Pursue proactive collaborative RD&D (prototypes) on **GenIV systems – large vs SMRs, Hybrid** – seek standardisation (licensing, supply chains).
- Engage dynamically the **YG** and the supply chain.
- Develop the effective **financing** mechanisms

## Conclusion...

*Above all we need a conducive political environment with long term vision, stability over time, ability to develop a strategy, to convert it in concrete programmes, readiness to engage with the society...*

# Un outil... exemple du « Comité des Sages »

- Commission d'évaluation en matière d'énergie nucléaire créée en mars 1975 par le Ministre Oleffe sous la présidence de André Jaumotte (ULB) et Julien Hoste (RUG).
- Livre BNS Un Demi-Siècle de Nucléaire en Belgique – 1994  
Chapitre page 669 rédigé par A Jaumotte  
Conclusion du chapitre :

*« Pendant plus de dix ans, la Commission a joué un rôle d'évaluation des programmes nucléaires et a informé les pouvoirs législatif et exécutif. Pour la première fois, les pouvoirs publics avaient chargé une grande Commission indépendante, interdisciplinaire, d'un travail de préparation technique et économique des décisions politiques à prendre. La voie suivie est un des moyens possibles pour que les pouvoirs législatif et exécutif disposent de l'information spécialisée nécessaire à leurs décisions ».*

# Autre exemple en France...

## Commission Schellenberger... ou OPECST...

- Outils de l'Assemblée Nationale et du Sénat
- Jeudi 25 Mai 2023 !!!  
Colloque Palais du Luxembourg  
Transmutation: technologies, impacts économiques, industriels et politiques.  
Gérard Longuet, Sénateur, VP OPECST  
Speakers: Peter Baeten, Hamid Ait Abderrahim, Roger Garbil, Bernard Salha, Dominique Vignon, Brice Lalonde, Jean-Pol Poncelet...

# Time for a political paradigm shift in BE !!!

- BE PM Alexander De Croo... interviewed 22 Nov RTBF by C Deborsu:  
« ... les centrales au gaz à construire pour sortir du nucléaire vont engendrer une pollution supplémentaire... »
- Answer of PM : « *Oui, mais, toujours suivant Elia, il s'agit d'une nouvelle génération de centrales au gaz qui pourra, à terme, on parle de 10 ans, brûler de l'hydrogène. Le virage sur une économie basée sur l'hydrogène, ça, c'est le futur et la Belgique va être à la pointe de la technologie* »

# Time for societal sustainability not lobby !!!

- [JJ Delmée PDG ENECO interviewed by Fran Herpelinck Dec 2020](#)
- Les plans énergétiques fédéraux prévoient une sortie du nucléaire, mais aussi la construction de nouvelles centrales au gaz pour compléter l'approvisionnement en énergie solaire et éolienne. Le [think tank britannique Ember](#) prévient que d'ici 2030, la Belgique sera l'un des pays d'Europe qui émettra le plus de CO2. Comment [Eneco](#) voit-il ces centrales électriques?
- «Les centrales au gaz font en effet partie de la solution, en ce sens qu'elles sont une source d'énergie pour une période transitoire. Pour l'instant, ces centrales fonctionnent toujours au gaz traditionnel. Cependant, elles sont tout à fait prêtes pour un passage total à l'hydrogène. Le surplus d'énergie renouvelable est stocké et réutilisé dans une centrale électrique que vous pouvez facilement allumer ou éteindre selon les besoins. Le passage à l'hydrogène ne sera pas non plus long à venir. Bien sûr, je comprends le scepticisme, mais de telles centrales sont essentielles pour devenir un monde dans lequel nous pouvons générer et stocker une énergie verte abondante, de sorte que nous n'ayons plus à utiliser ces mêmes centrales électriques alimentées au gaz fossile. Le choix entre les centrales à gaz et les centrales nucléaires est (aujourd'hui) facile.