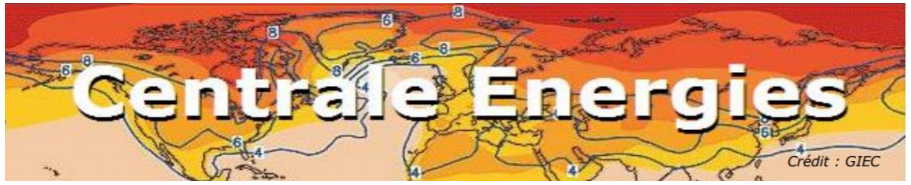
Fission Liquide - 10 nouveaux paradigmes

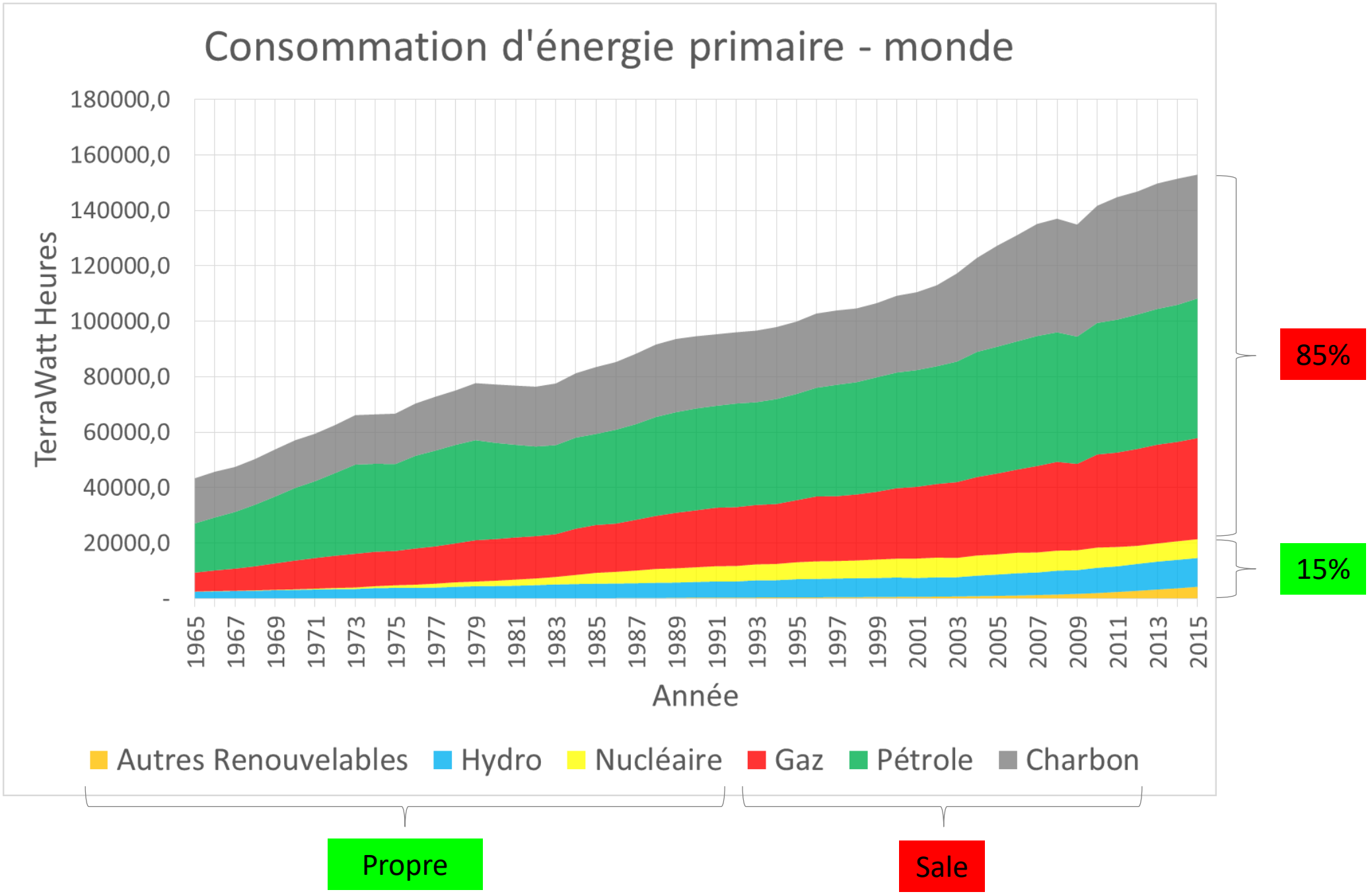


John Laurie

http://fissionliquide.fr

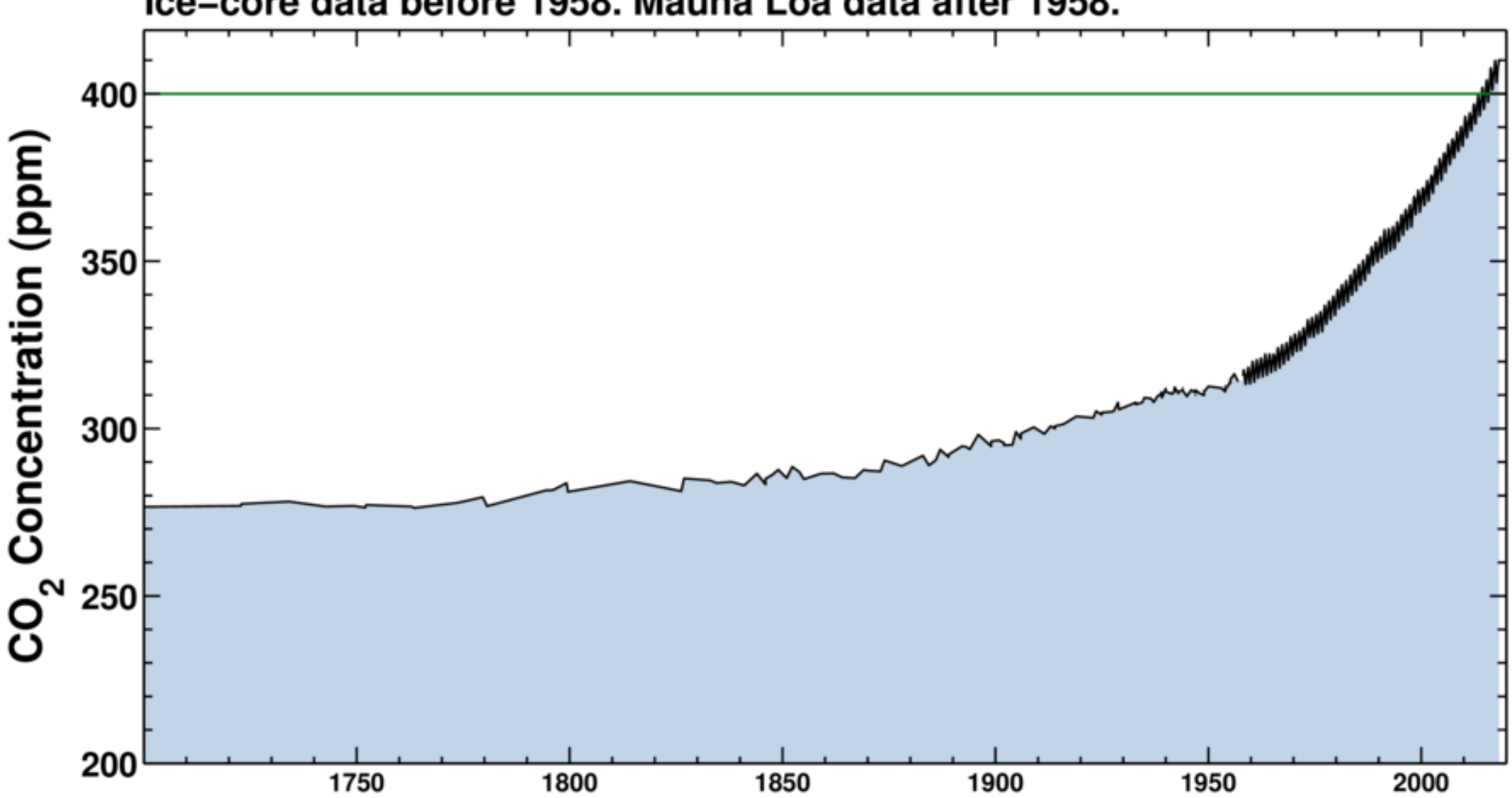
Mercredi 13 juin 2018

Source : [BP Statistical Review of World Energy Juin 2016]



Latest CO_2 reading
May 29, 2018

411.90 ppm



One Example of Technology

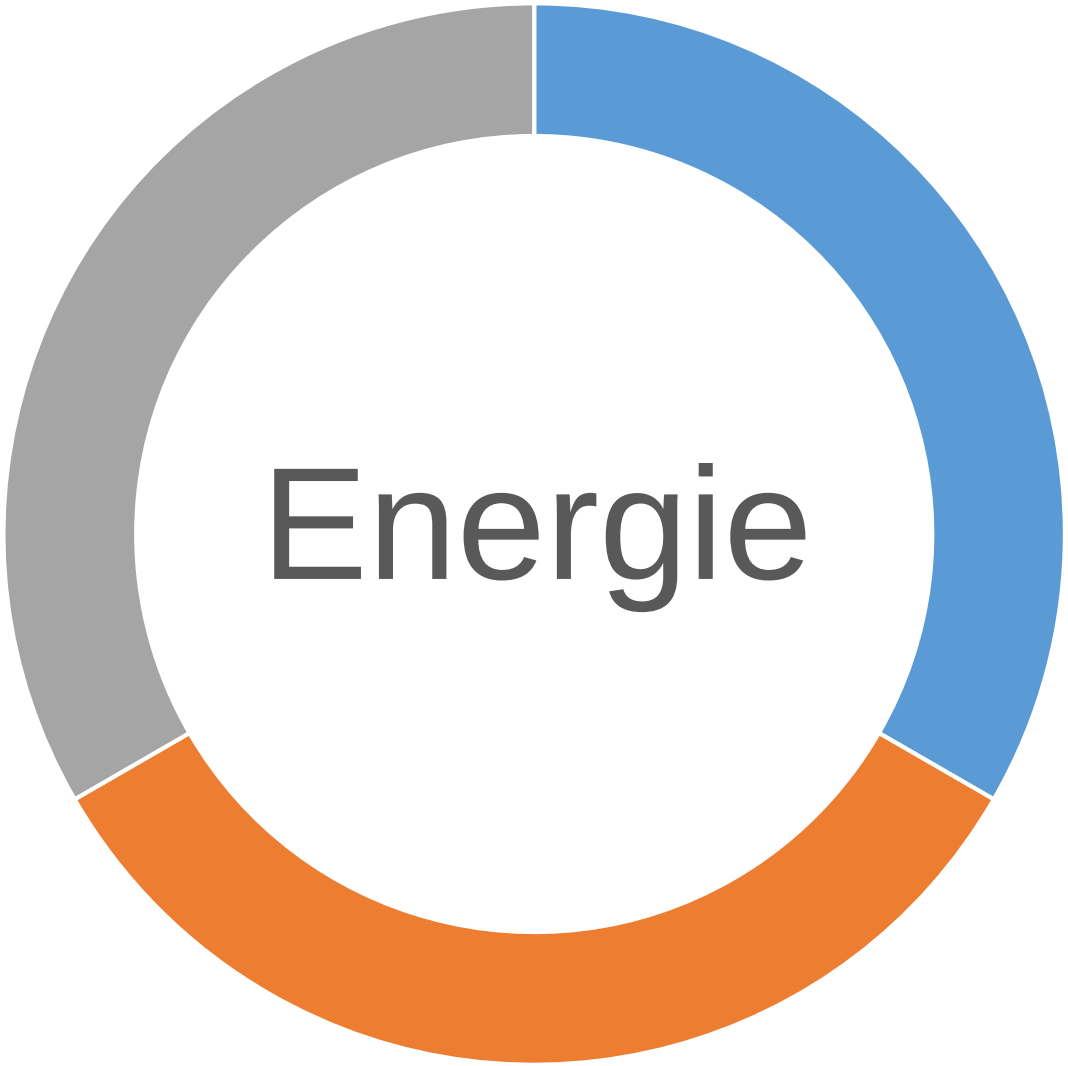
Thorium-Powered Molten Salt Reactor

- Operates near Atmospheric Pressure
- Factory or Shipyard Construction
- Inexhaustible Fuel Supply
- Reduced Waste, Shorter Half-Life
- Passively Safe Operation
- Not Well-Suited for Weapons Material

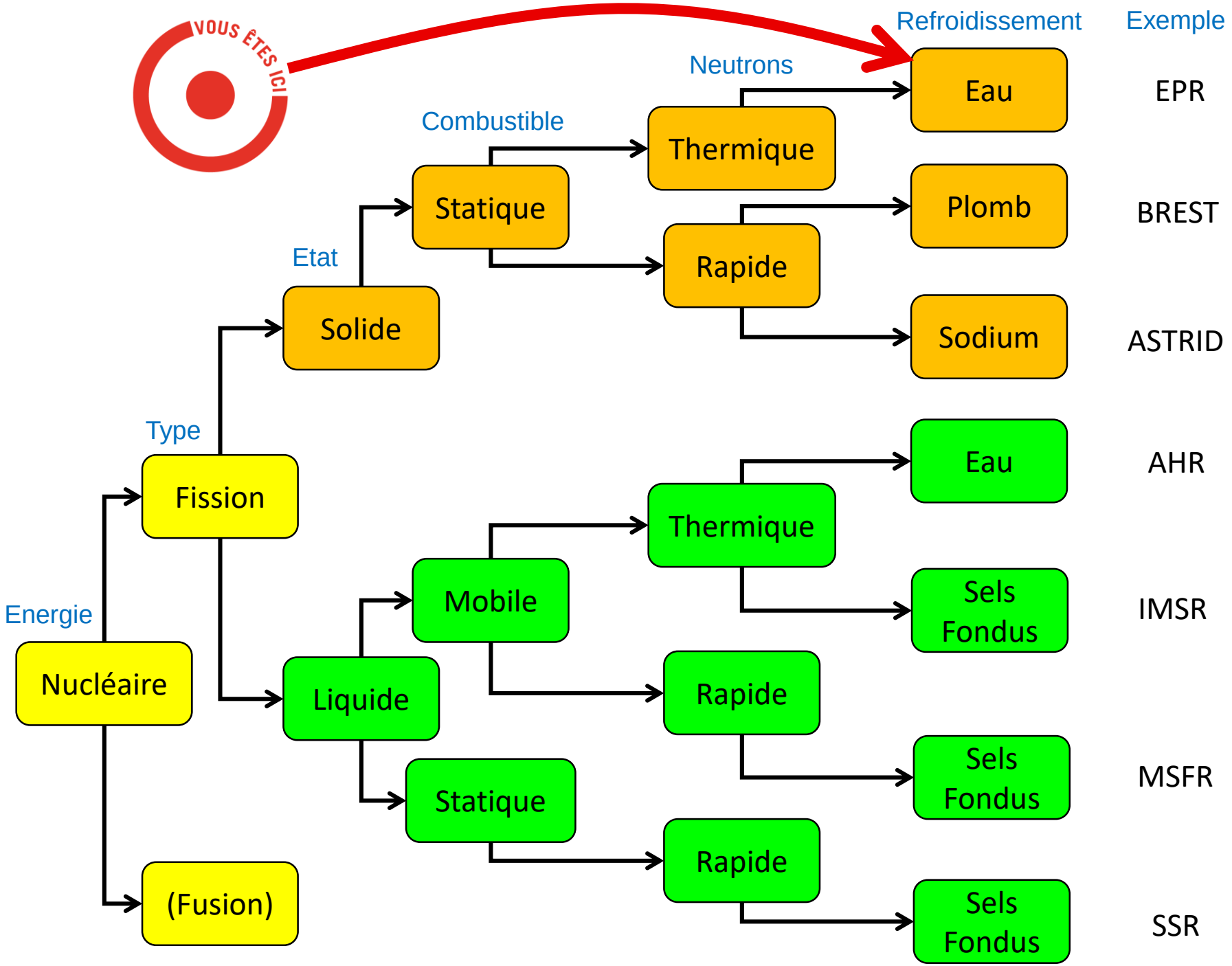
James Hansen, COP23, Bonn, novembre 2017

« Nous savons depuis des décennies, en fait depuis le début de l'ère nucléaire, qu'il existe de meilleurs moyens de produire de l'énergie nucléaire, qui traitent de nombreuses questions liées à l'énergie nucléaire. [Le réacteur à sels fondus] est un exemple de l'un des types de technologies que nous devrions avoir disponible en ce moment. »

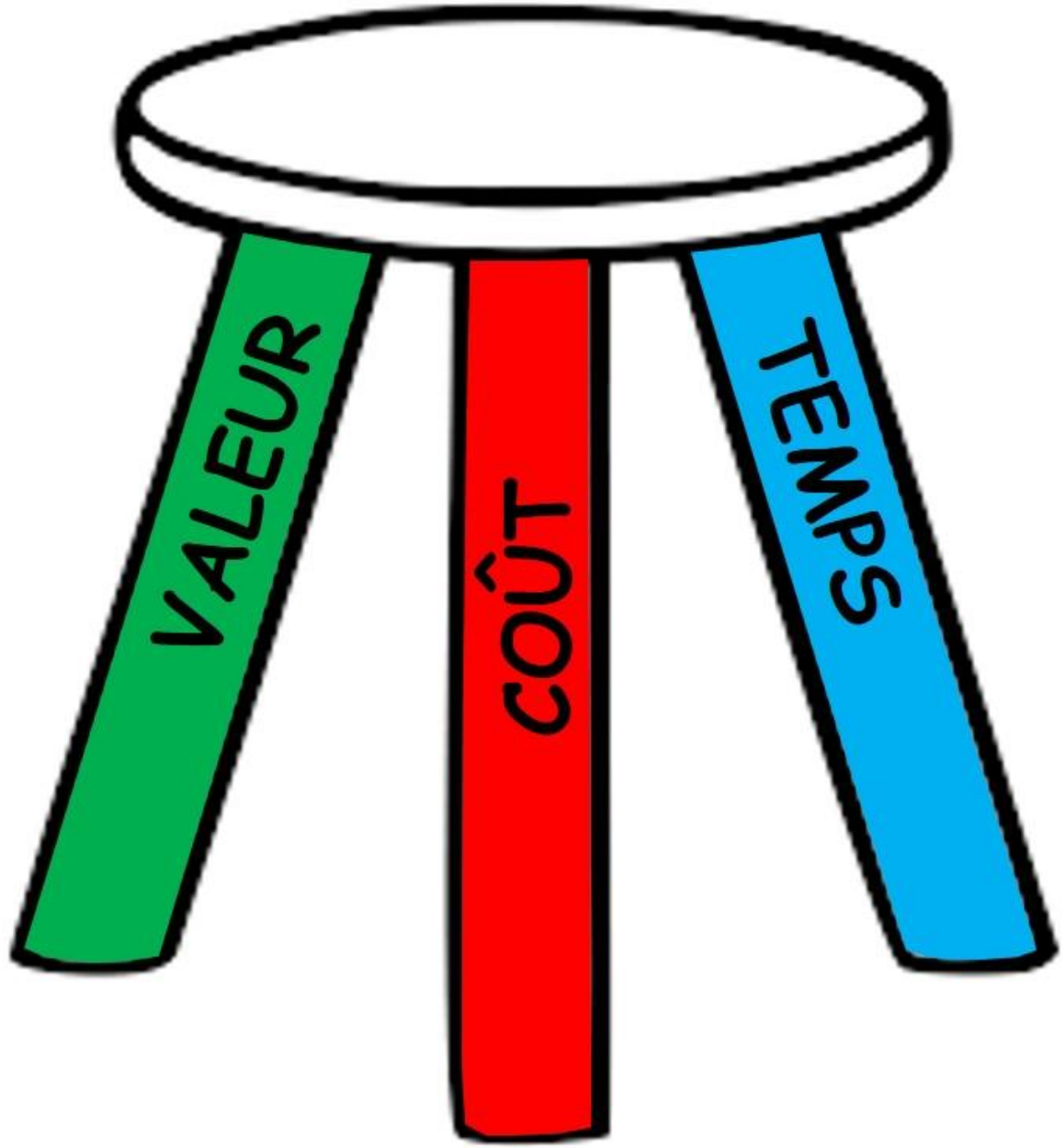
1. Marché



- Electricité
- Chaleur
- Mobilité


VOUS ÊTES ICI
Refroidissement
Exemple
Neutrons
Combustible
Etat
Type
Energie
Nucléaire
Fission
(Fusion)
Solide
Liquide
Statique
Mobile
Statique
Thermique
Rapide
Thermique
Rapide
Rapide
Eau
Plomb
Sodium
Eau
Sels Fondus
Sels Fondus
Sels Fondus
EPR
BREST
ASTRID
AHR
IMSR
MSFR
SSR

2. Equilibre


VALEUR
COÛT
TEMPS

Coût

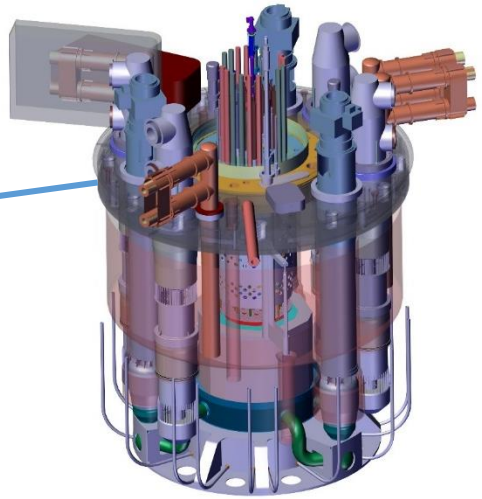
Valeur

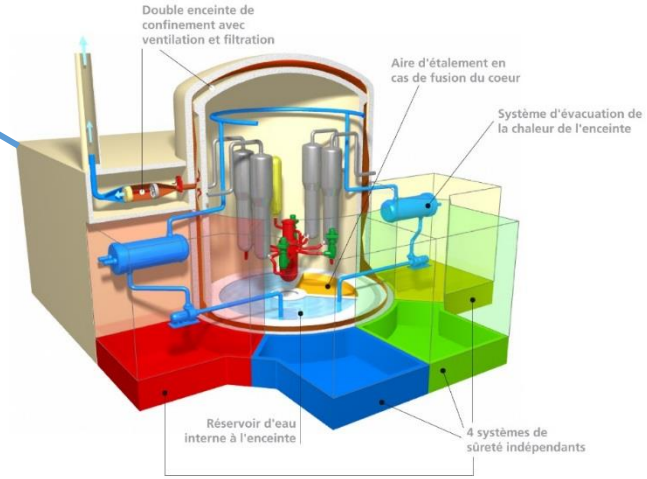
Petits réacteurs modulaires

Génération 2

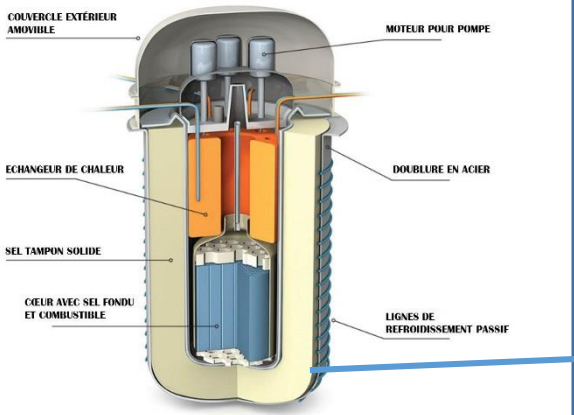
Génération 3 (EPR)

RNR Sodium






Asseyez-vous !
C'est un peu bancal, non ?
INVESTISSEUR
VALEUR
COÛT
TEMPS
PUBLIC
MARCHÉ
CLIENT



TERRESTRIAL ENERGY

Coût

Valeur

Petits réacteurs modulaires

Génération 2

Génération 3 (EPR)

RNR Sodium

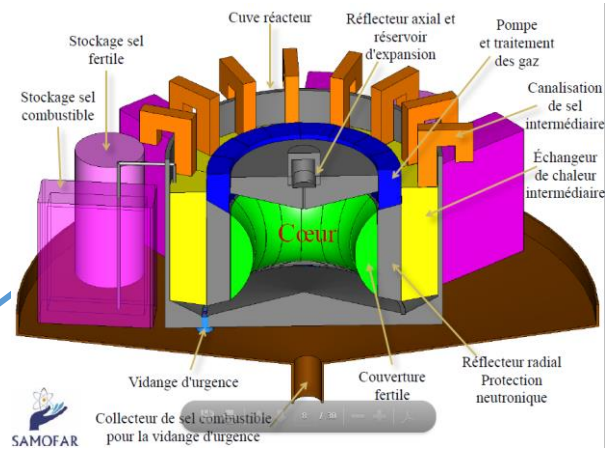
Seuil de la fission solide

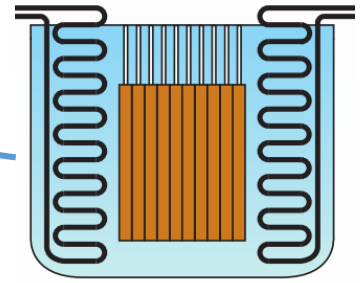
IMSR

SSR

MSFR

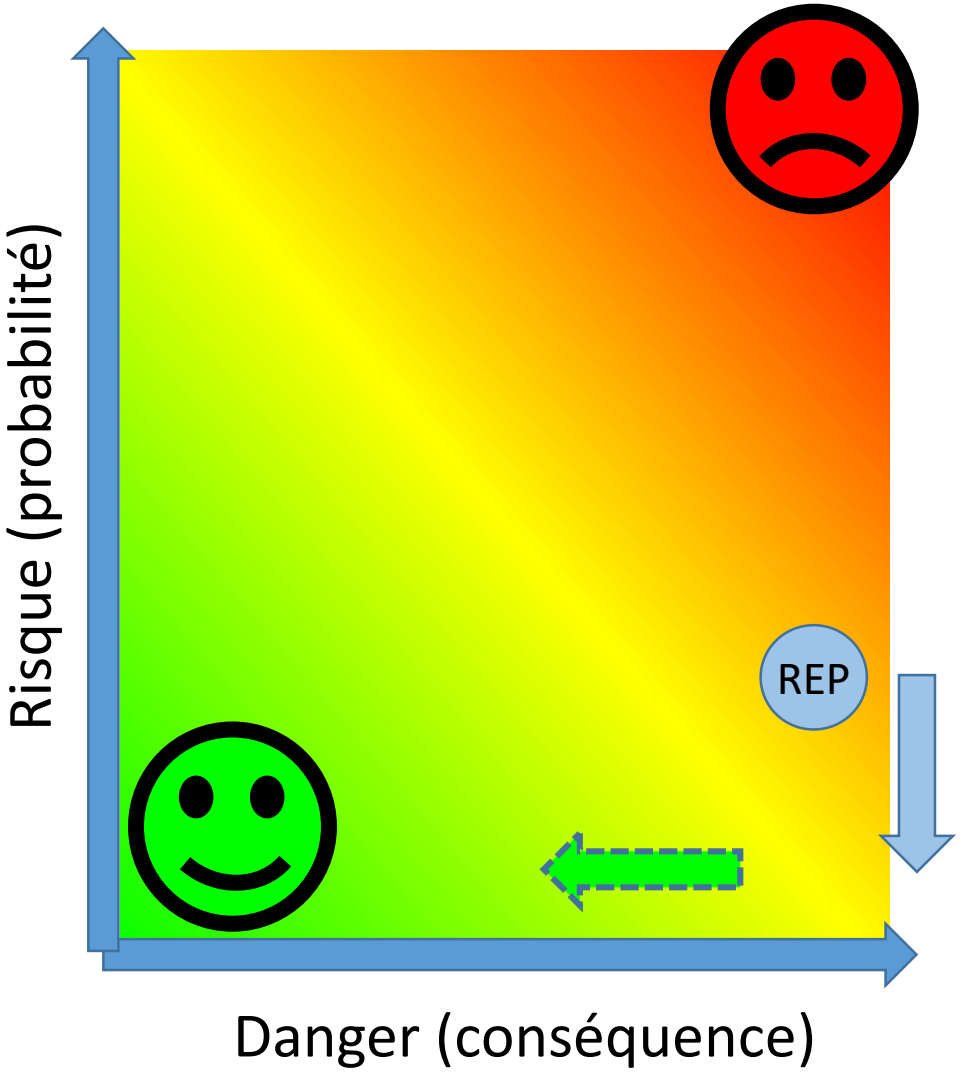
Seuil de la fission liquide



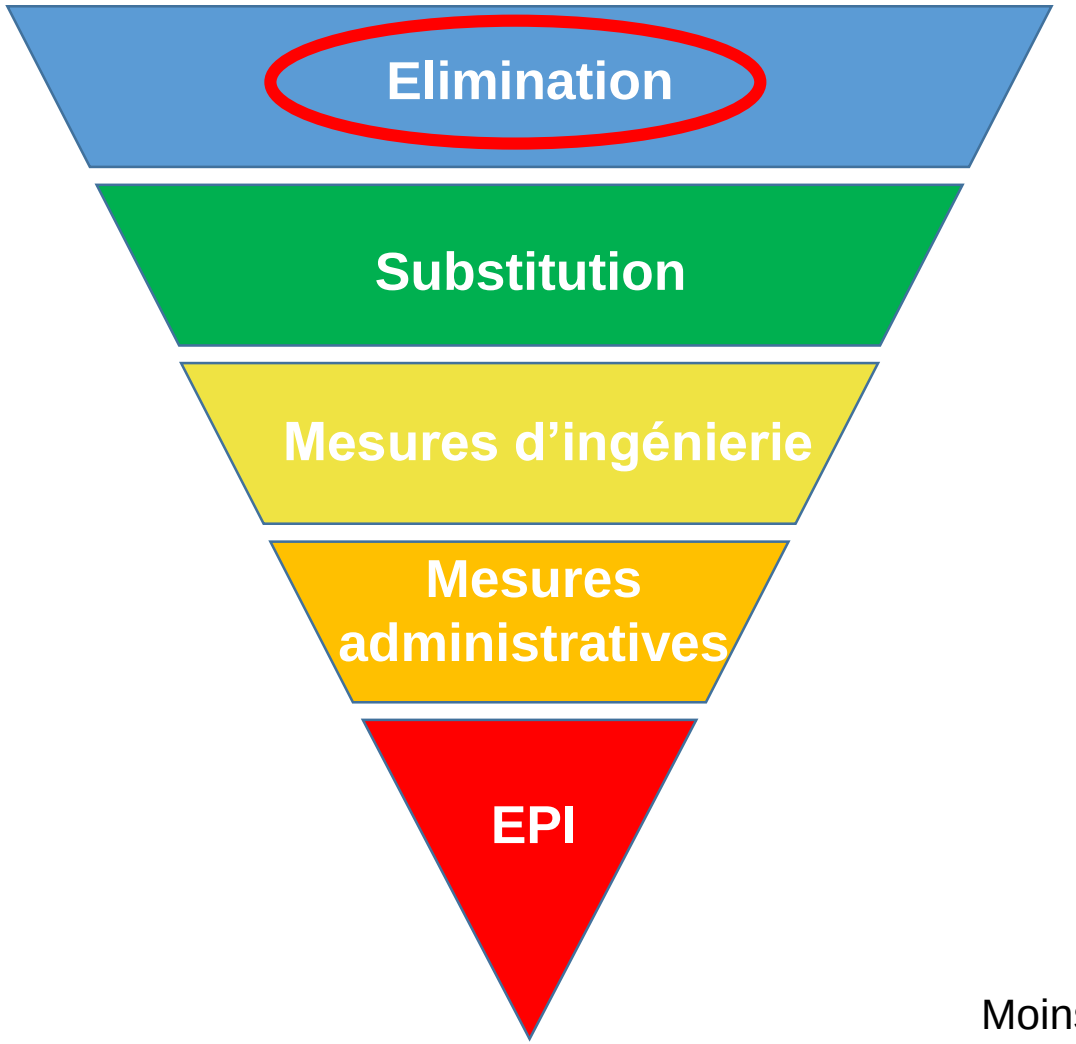


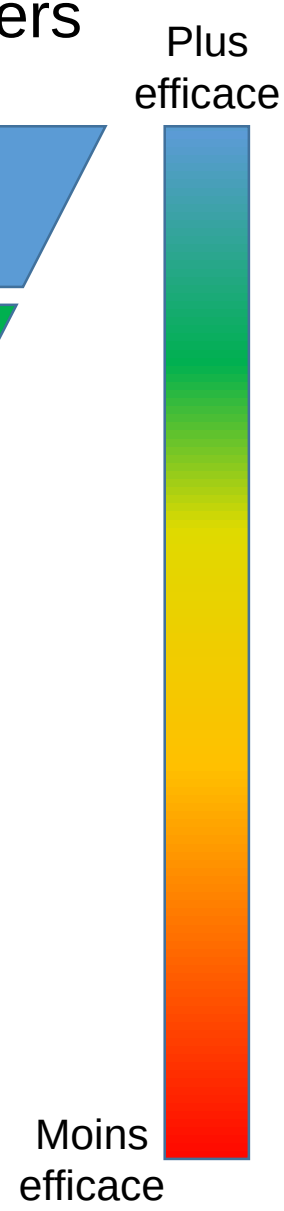
moltex energy
safer, cheaper, nuclear

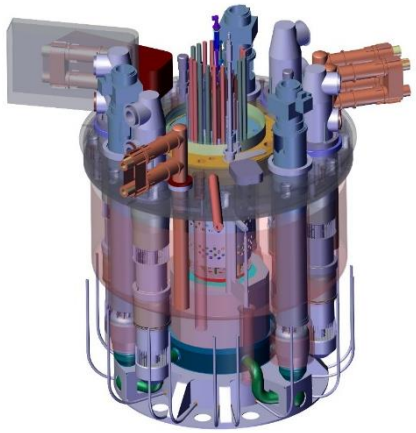
3. Dangers



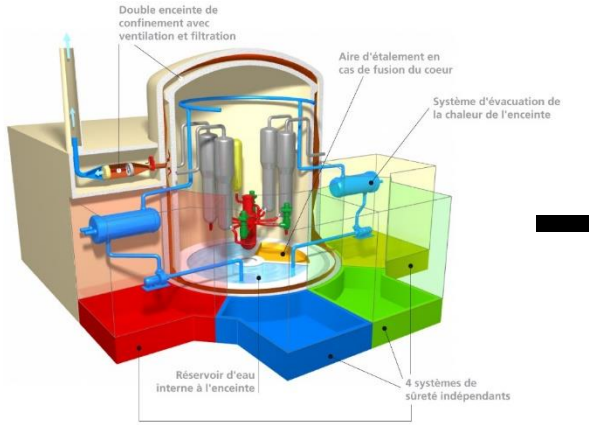
Hiérarchie de contrôle des dangers







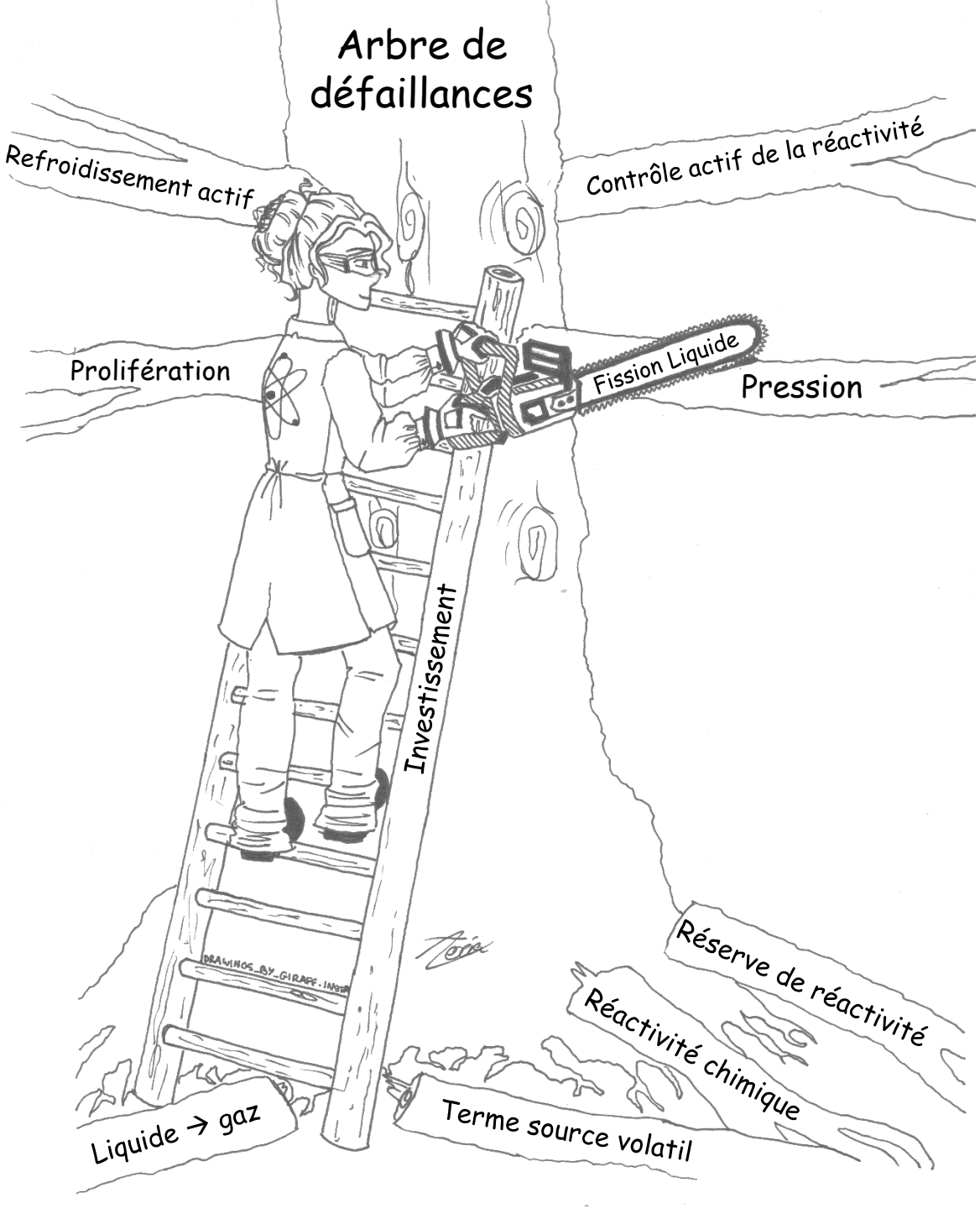
=

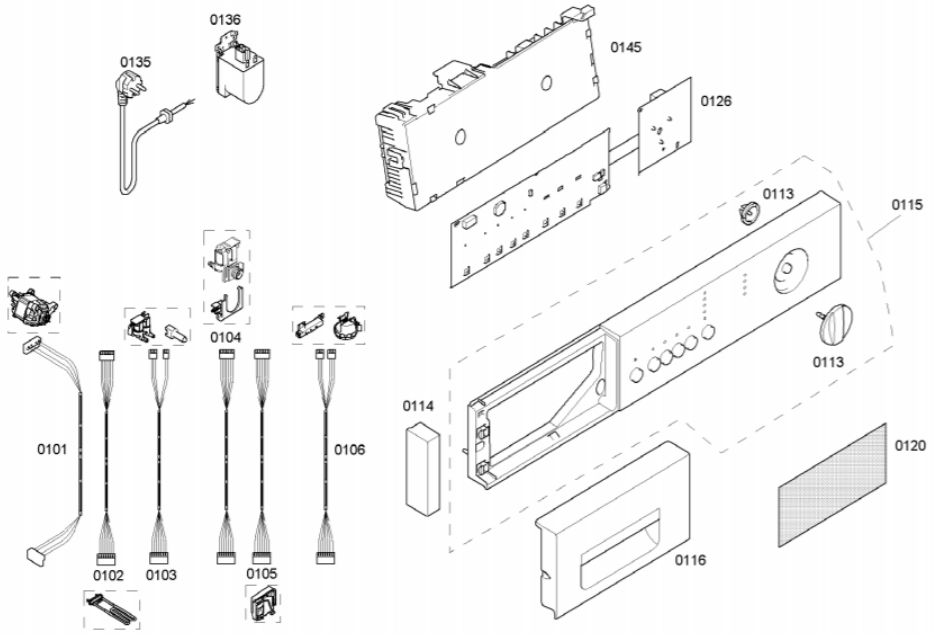


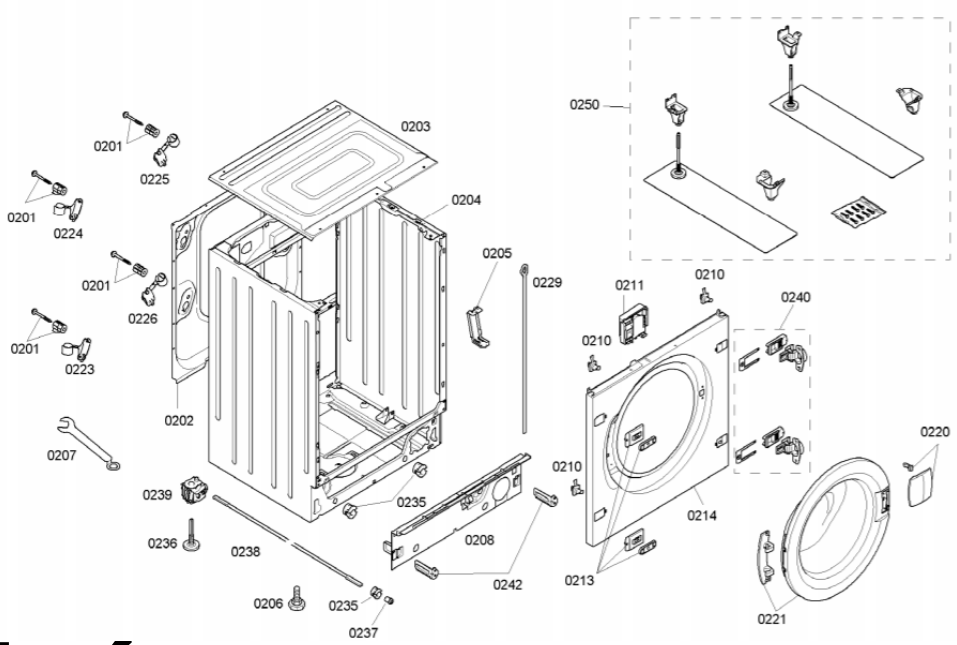
-

+

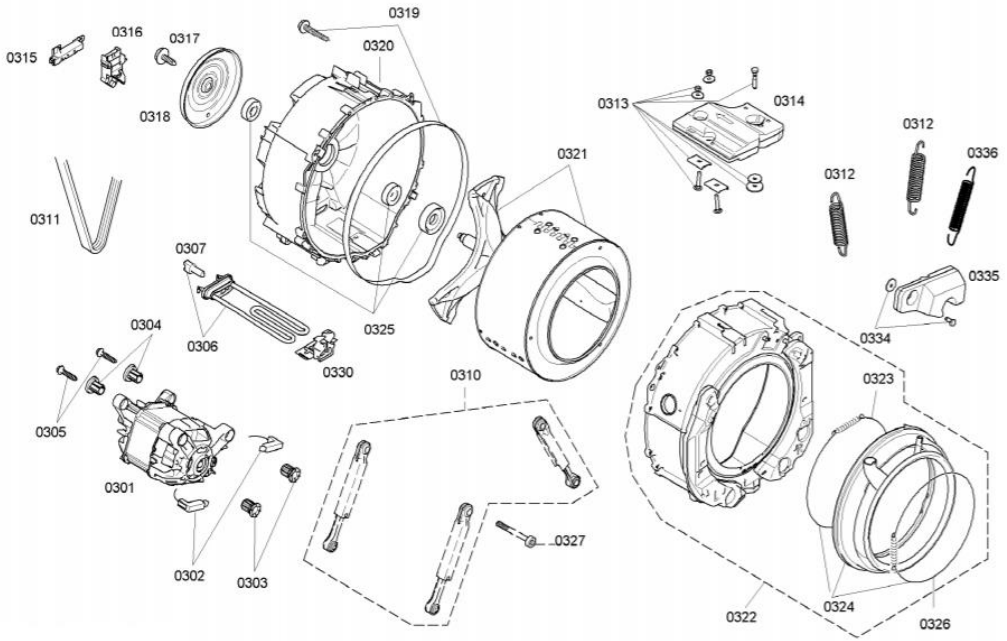
ASTRID = EPR - PRESSION + RÉACTIVITÉ CHIMIQUE

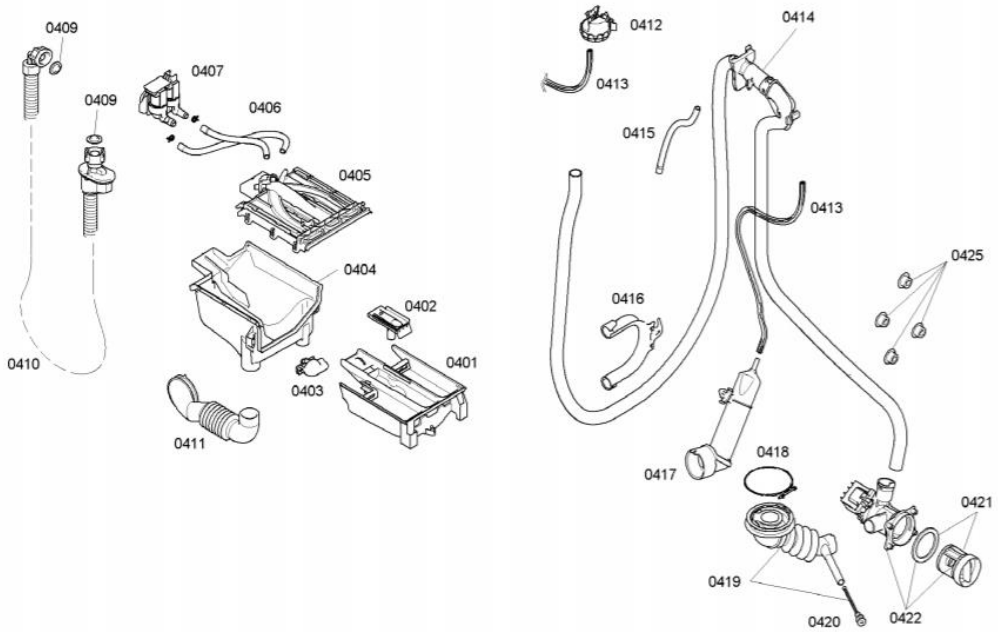

Arbre de défaillances
Refroidissement actif
Contrôle actif de la réactivité
Prolifération
Fission Liquide
Pression
Investissement
Réserve de réactivité
Réactivité chimique
Terme source volatil
Liquide → gaz



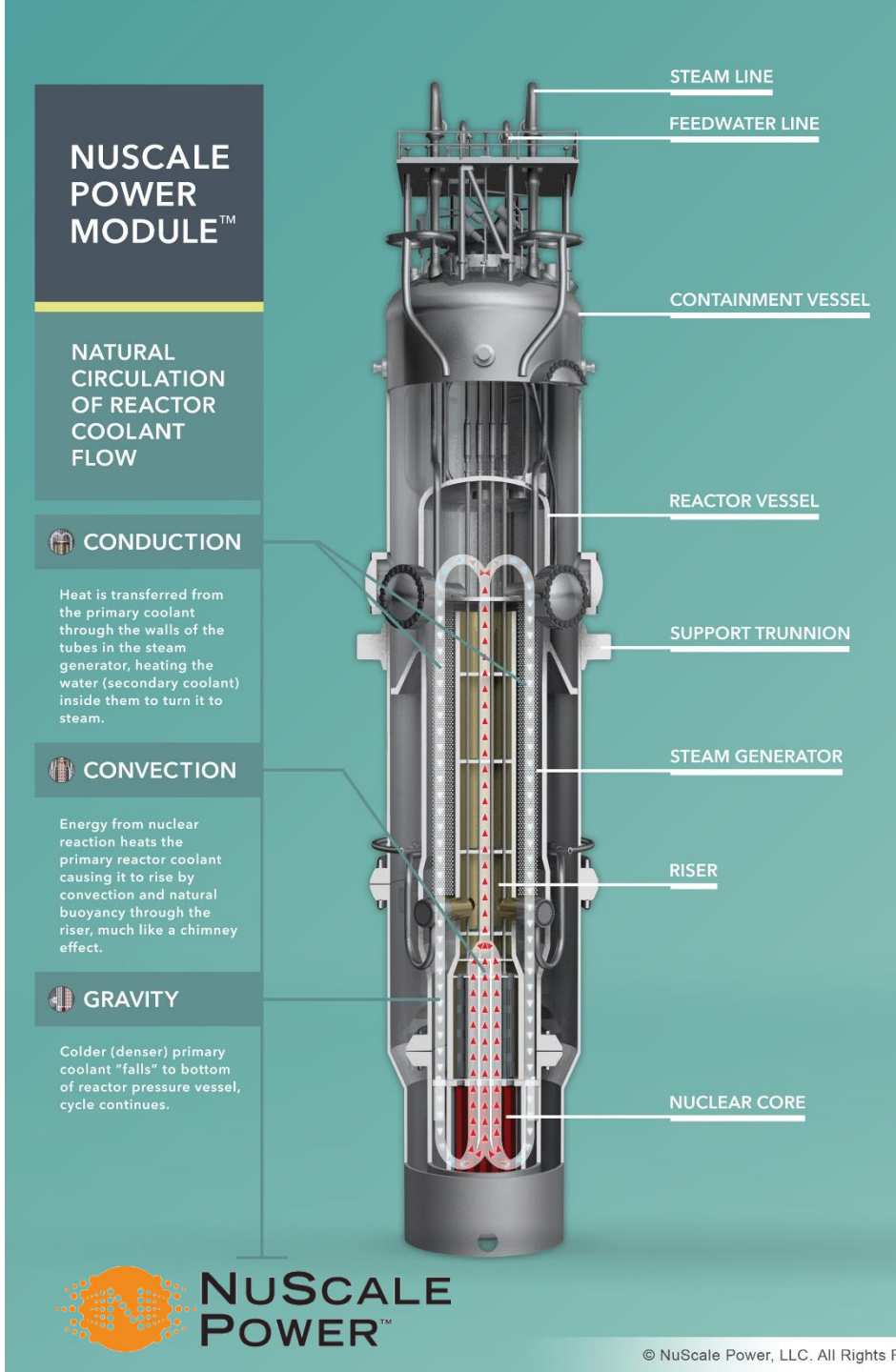


4. Modularité





Petits Réacteurs Modulaires



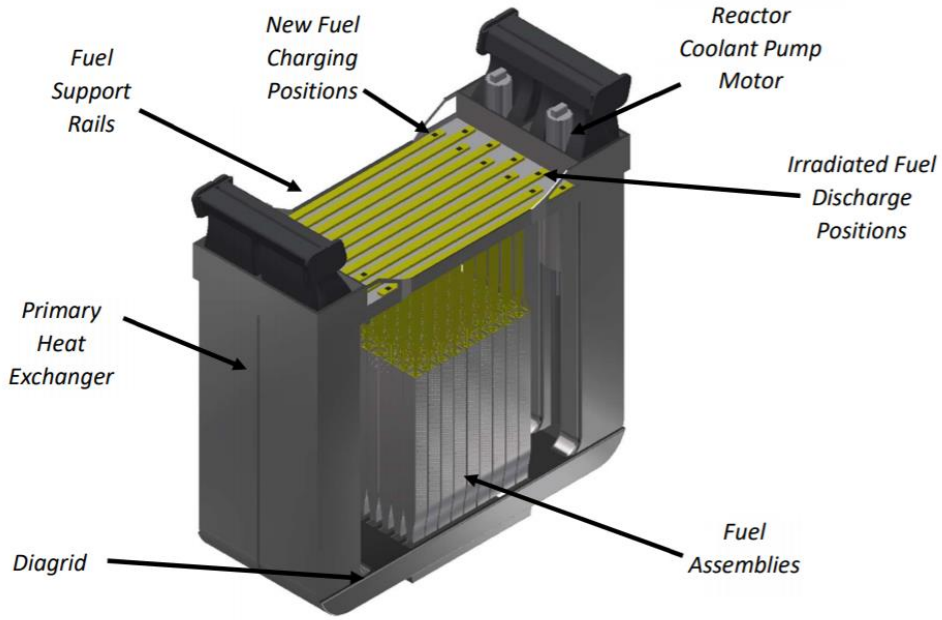

NuScale

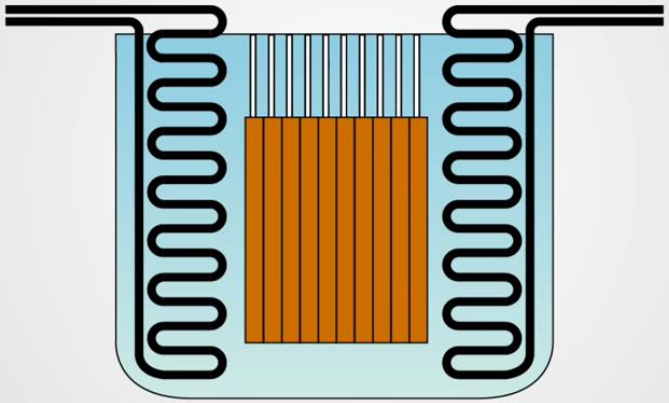
5. Livraison

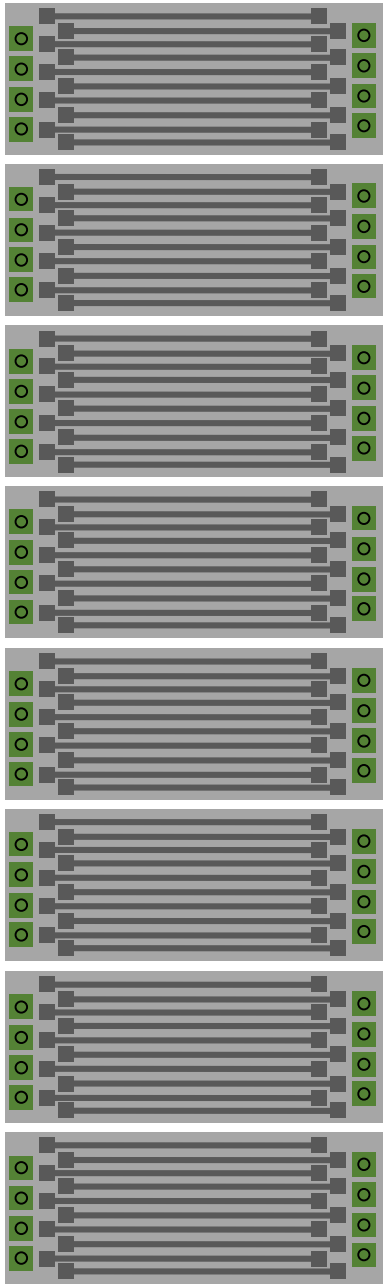

15' - 0" CLEAR


Integral Molten Salt Reactor
Core Replacement Delivery

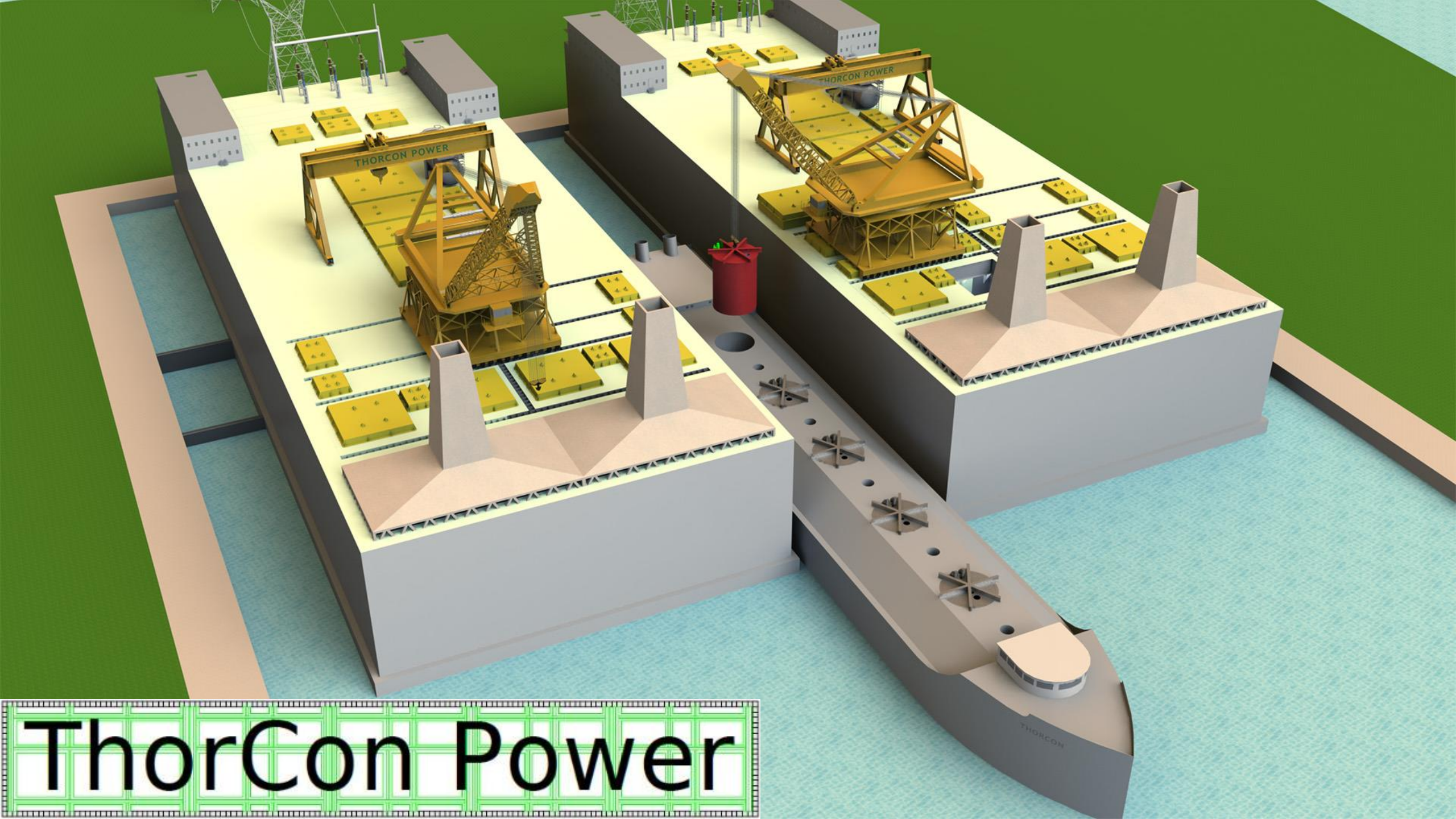
moltex energy
safer, cheaper, nuclear





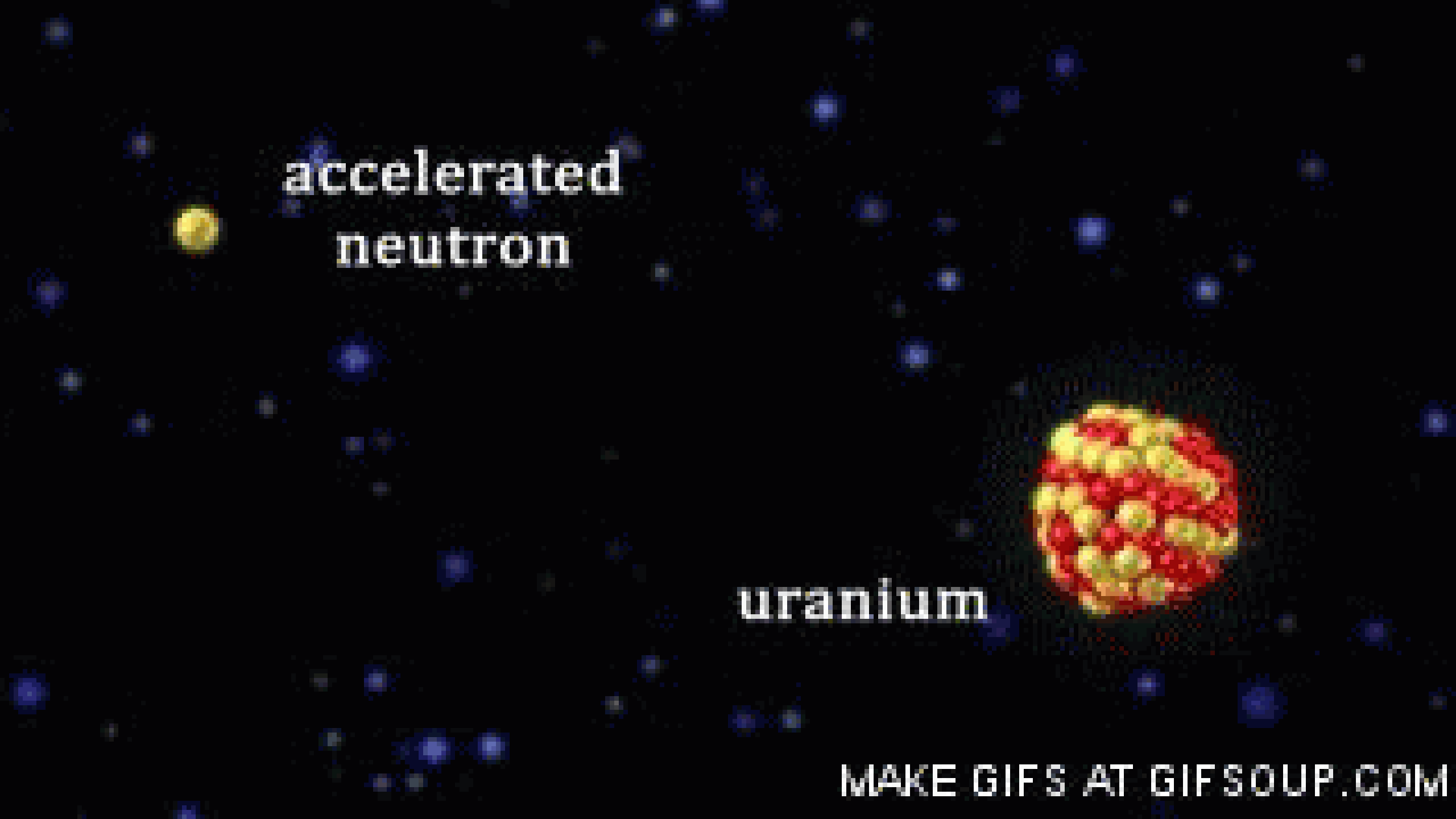


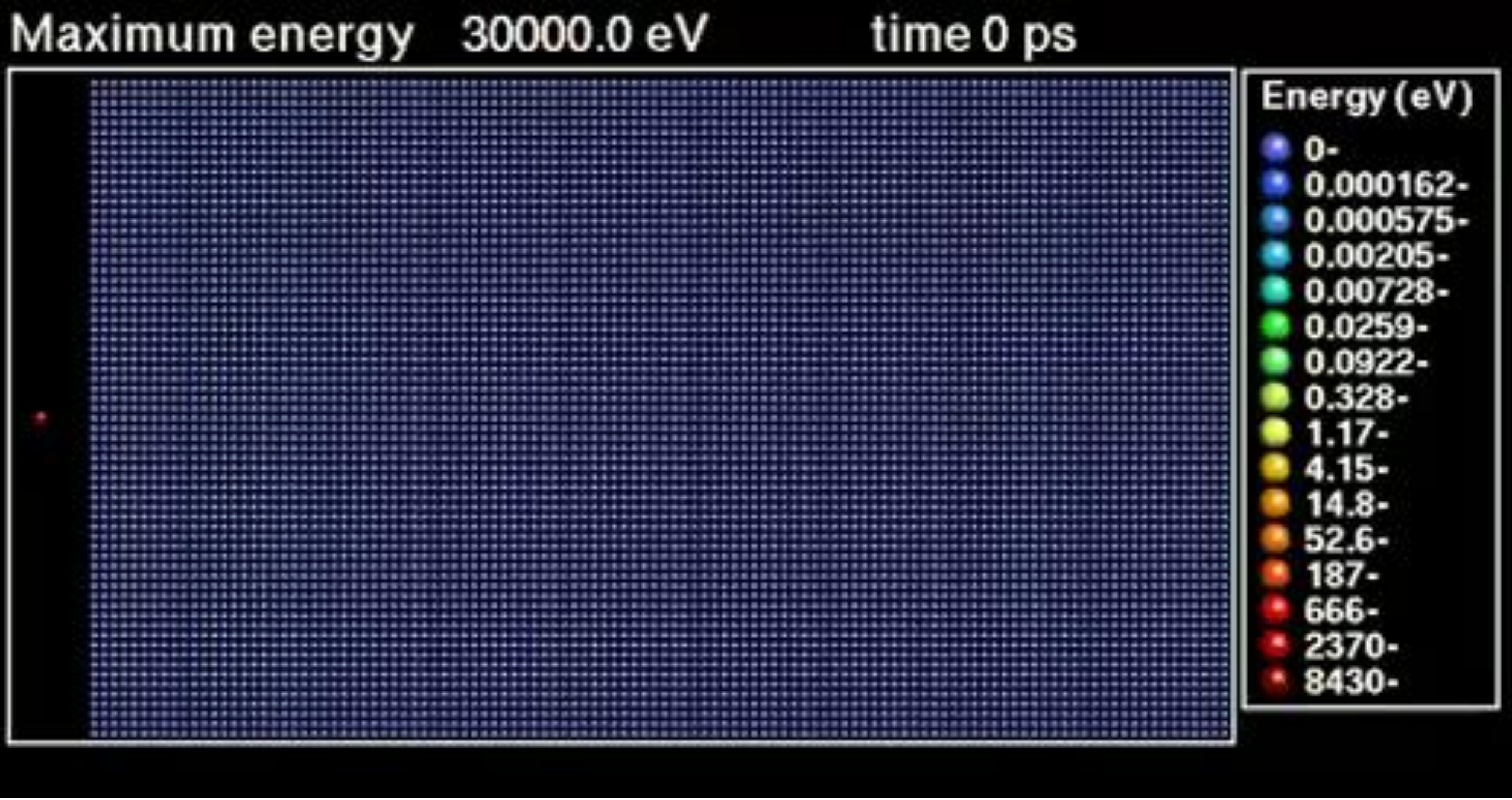
8 modules : 1200MWe



ThorCon Power

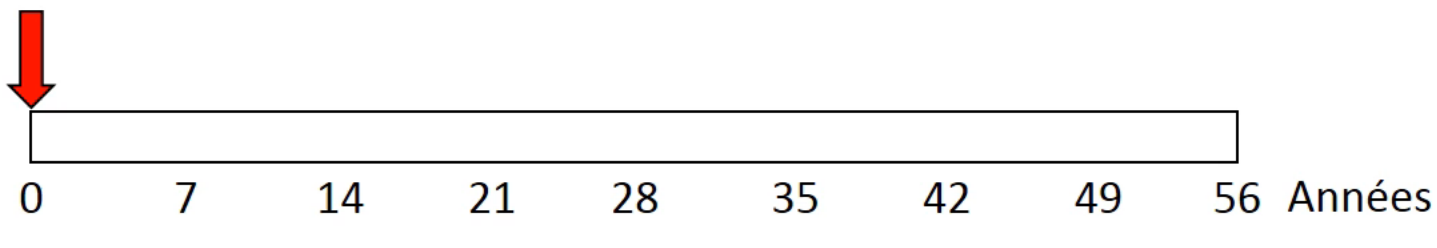
6. Matériaux

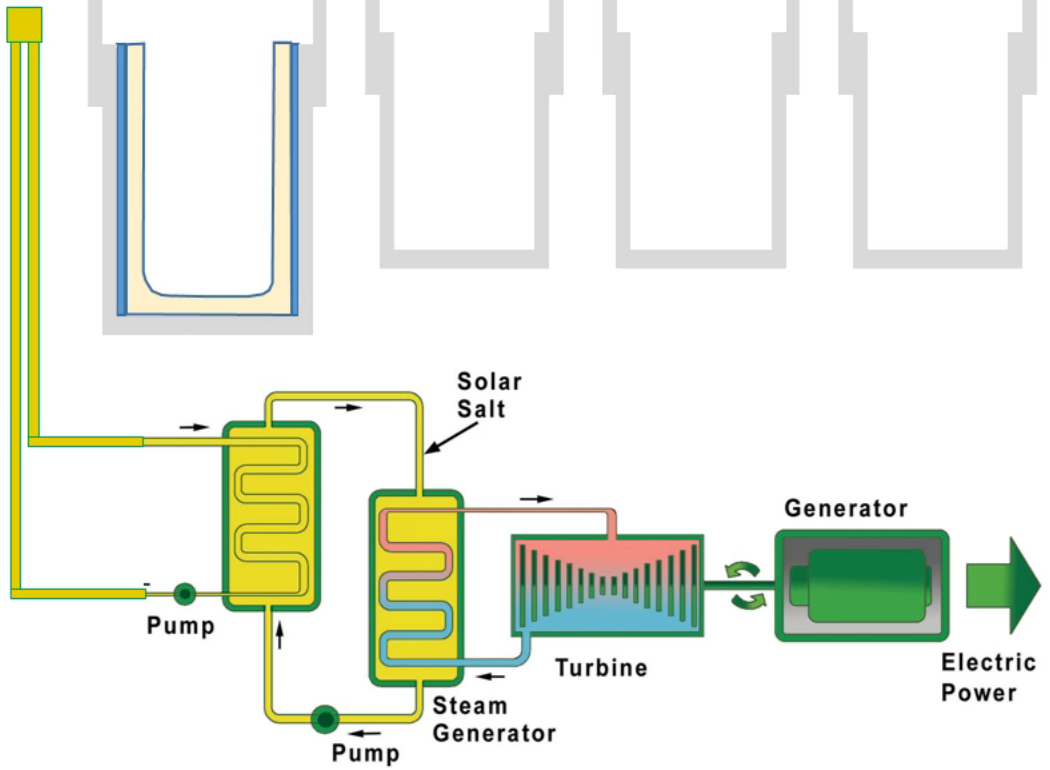




https://www.youtube.com/watch?v=TyYBIj-A9tY

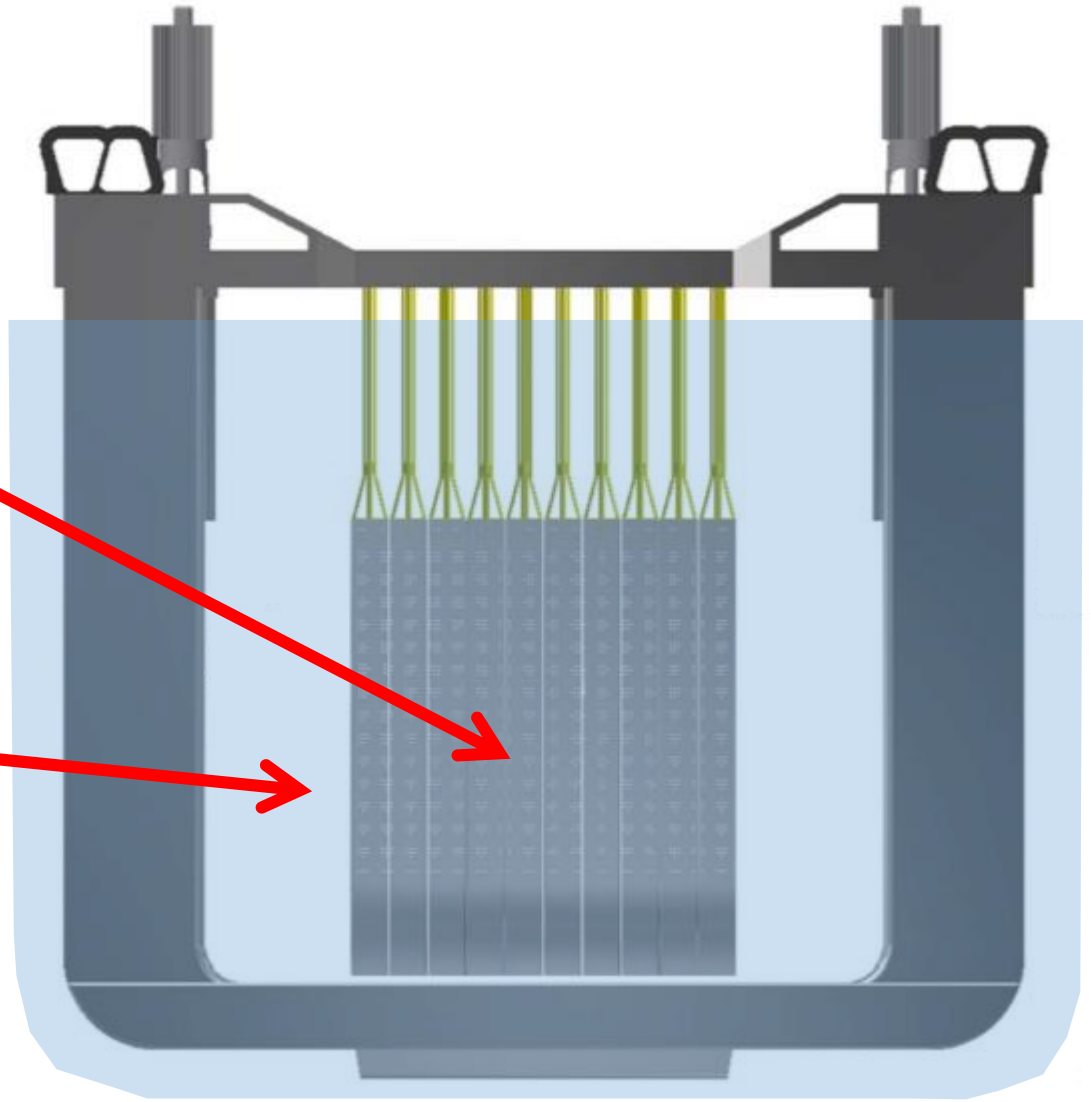
TERRESTRIAL
ENERGY





moltex energy
safer, cheaper, nuclear

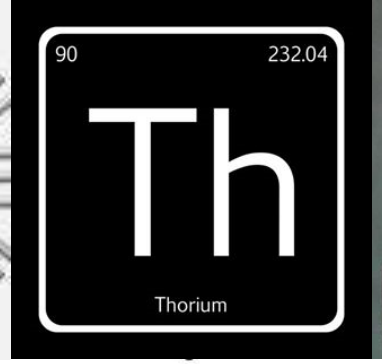
Assemblages avec combustible liquide :
temps dans réacteur environ 4 ans

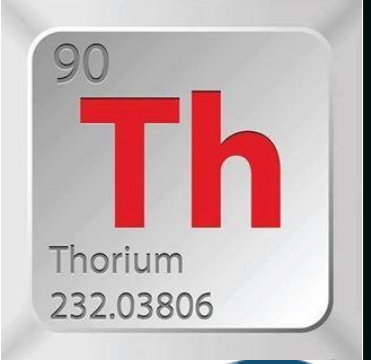


Sel fondu de refroidissement :

- Contient du fluorure de zirconium
- Le zirconium contient du hafnium
- Le hafnium est une barrière au flux de neutrons
- Les autres composants sont protégés

7. Thorium


THORIUM
ENERGY
ALLIANCE

90
232.04
Th
Thorium

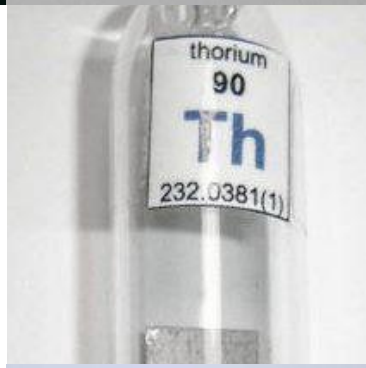

90
Th
Thorium
232.03806

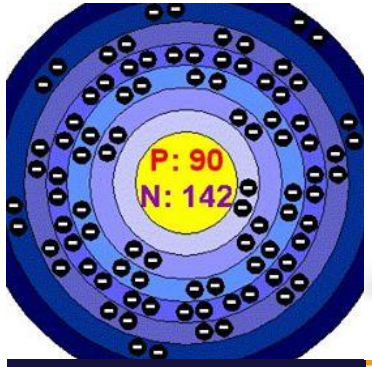
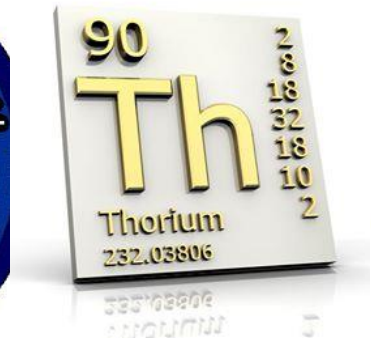
Think
Th

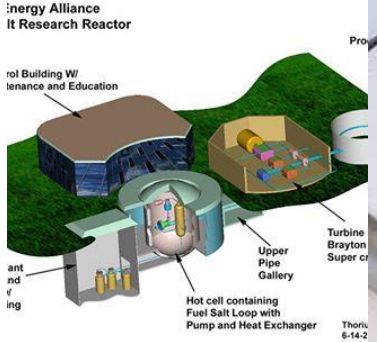
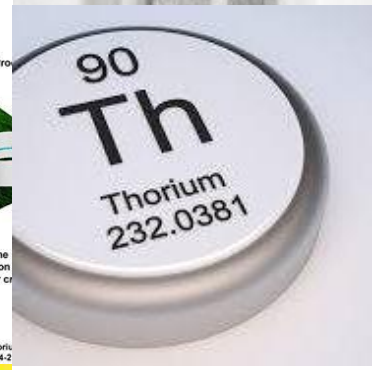


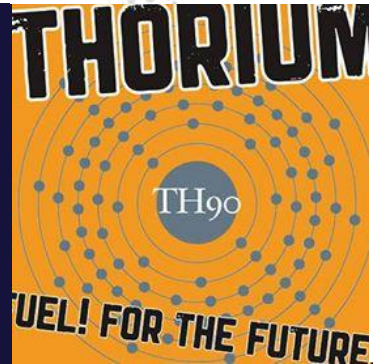
THE
THORIUM
REVOLUTION

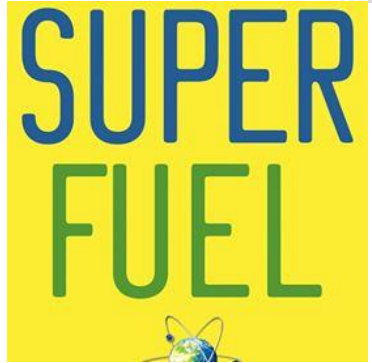

90
Th
232.04


thorium
90
Th
232.0381(1)

ITHEO

P: 90
N: 142

90
Th
Thorium
232.03806
2
8
18
32
18
10
2

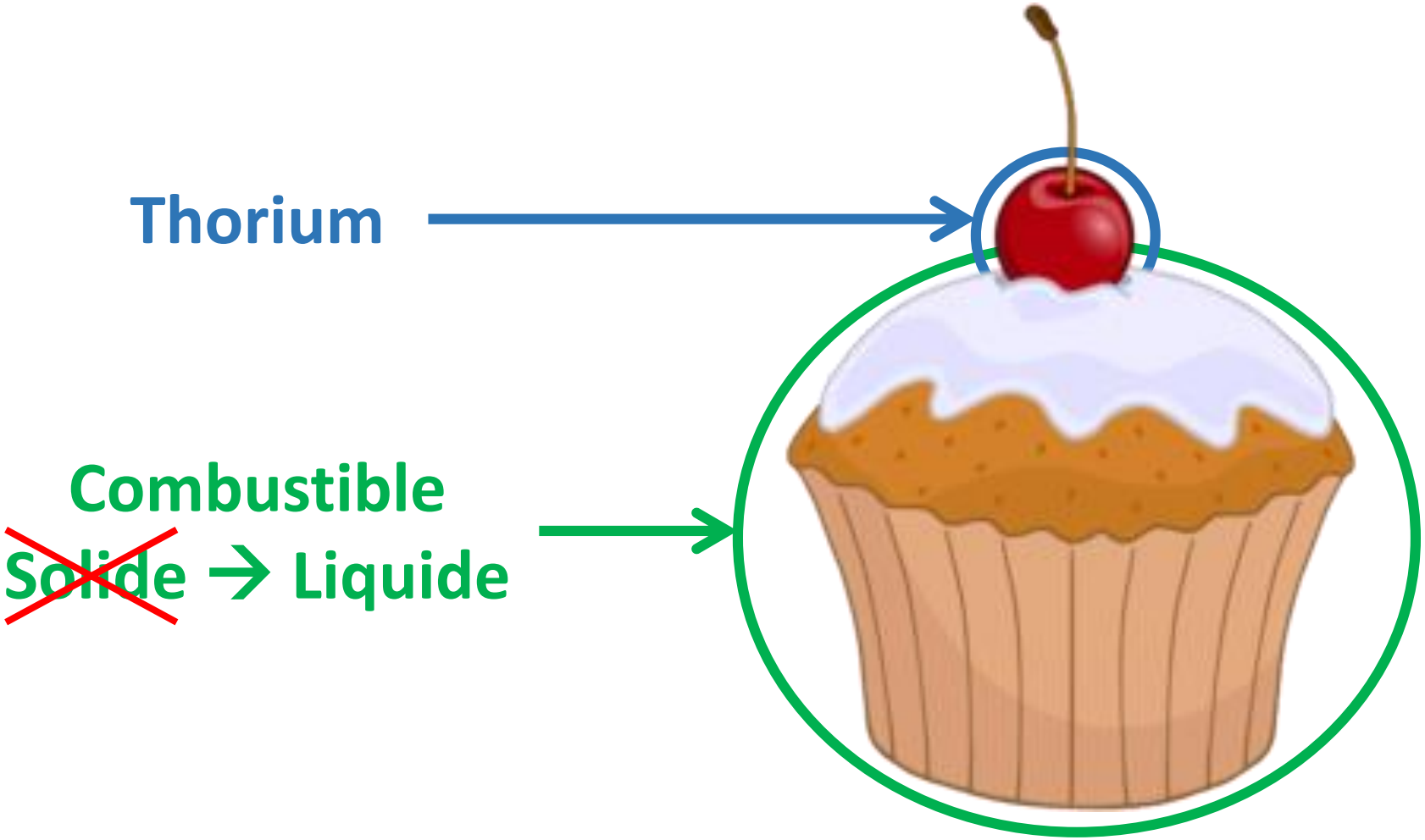
UTAH THORIUM ENERGY

Energy Alliance
Research Reactor
Upper
Pipe
Gallery
Hot cell containing
Fuel Salt Loop with
Pump and Heat Exchanger

90
Th
Thorium
232.0381


90
Th
THORIUM

THORIUM
TH90
FUEL! FOR THE FUTURE

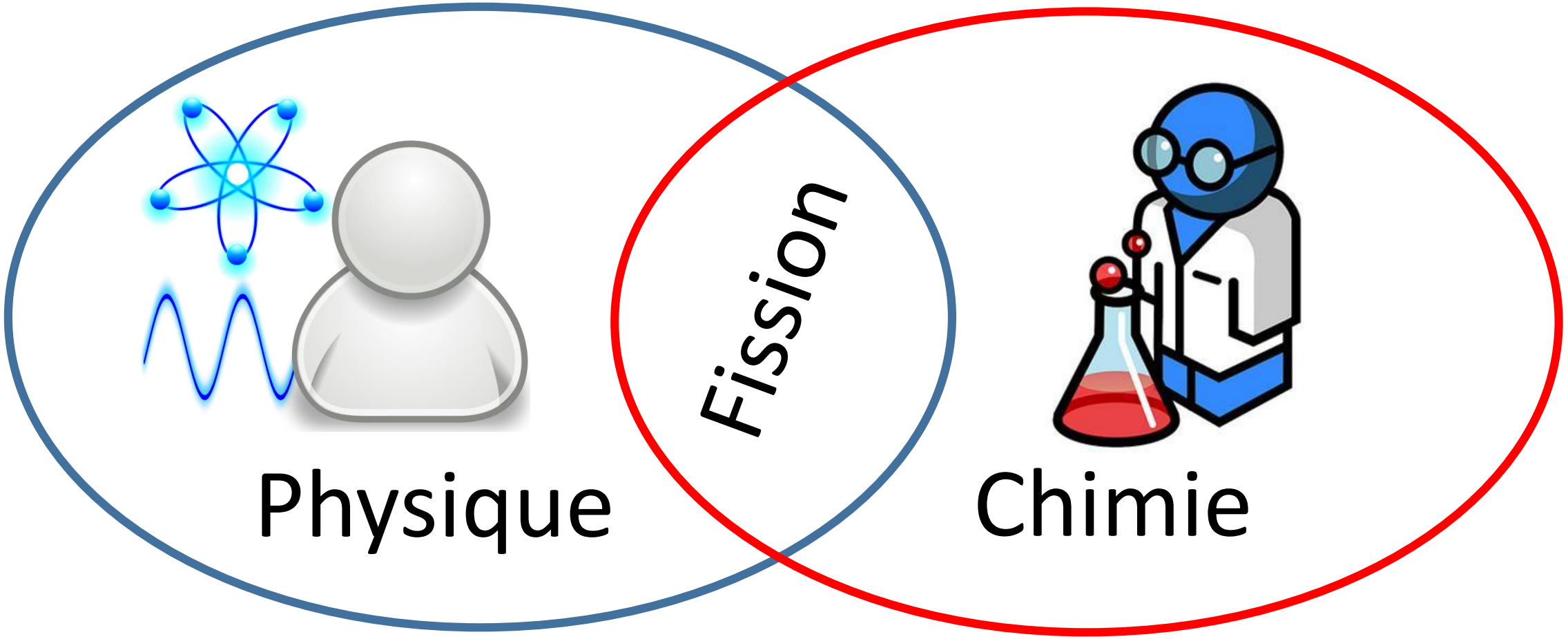
THORIUM

SUPER
FUEL

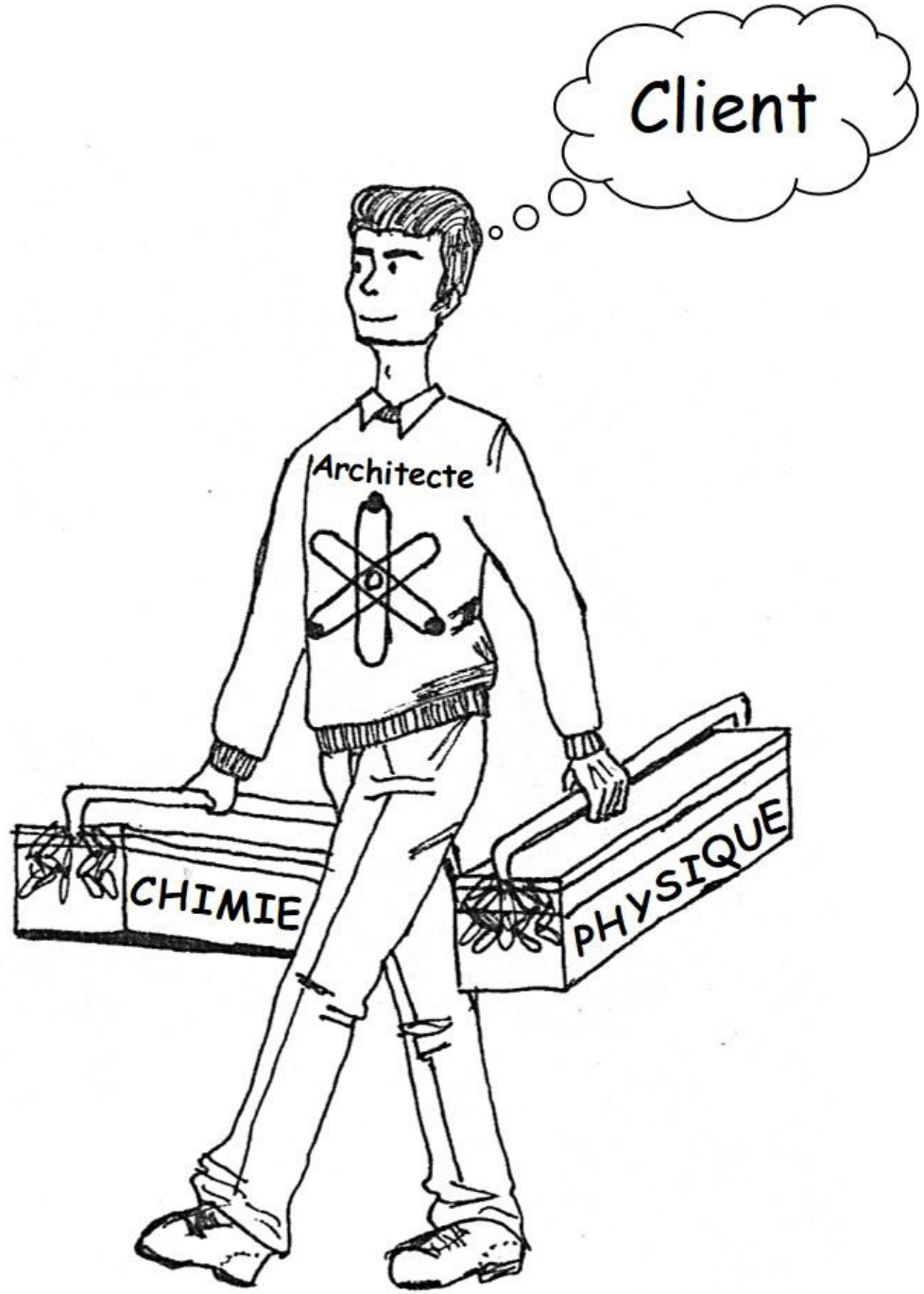
Thorium
Energy
World

Le Thorium est la cerise sur le gâteau

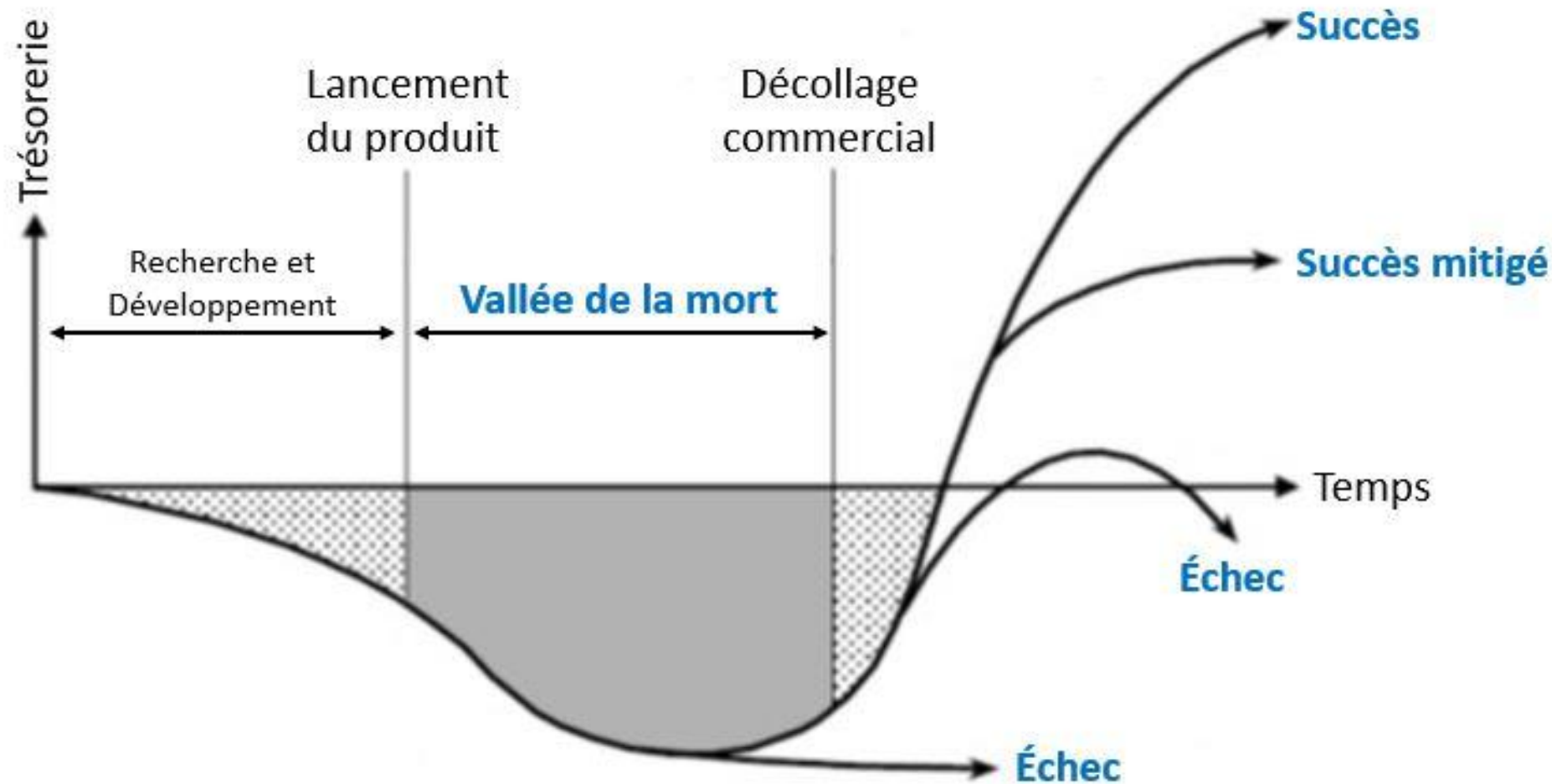


8. Physique + Chimie > Physique


Physique
Fission
Chimie


Client
Architecte
CHIMIE
PHYSIQUE

9. Gouvernance


Trésorerie
Lancement du produit
Décollage commercial
Succès
Succès mitigé
Recherche et Développement
Vallée de la mort
Temps
Échec
Échec

$$\frac{1}{v}\frac{\partial\psi(\vec{r},E,\vec{\Omega},t)}{\partial t} = -\vec{\Omega}.\vec{\nabla}\psi(\vec{r},E,\vec{\Omega},t) - \sum_k N_k(\vec{r},t)\,\sigma_k(E)\psi(\vec{r},E,\vec{\Omega},t) \quad (1)$$

$$+\sum_k N_k(\vec{r},t)\int_0^\infty dE'\int_{4\pi} d\vec{\Omega}'\,\sigma_{s,k}(E'\to E,\vec{\Omega}'\to\vec{\Omega})\psi(\vec{r},E',\vec{\Omega}',t)$$

$$+\frac{1}{4\pi}\sum_k N_k(\vec{r},t)\int_0^\infty dE'\,\nu_{p,k}(E')\sigma_{f,k}(E')\chi_{p,k}(E'\to E)\phi(\vec{r},E',t)$$

$$+\frac{1}{4\pi}\sum_k \nu_{p,fs,k}\lambda_{fs,k}N_k(\vec{r},t)\chi_{p,fs,k}(E)+\frac{1}{4\pi}\sum_k \lambda_{d,k}N_k(\vec{r},t)\chi_{d,k}(E)+S_{ext}(\vec{r},E,\vec{\Omega},t)$$

Économique avant Neutronique

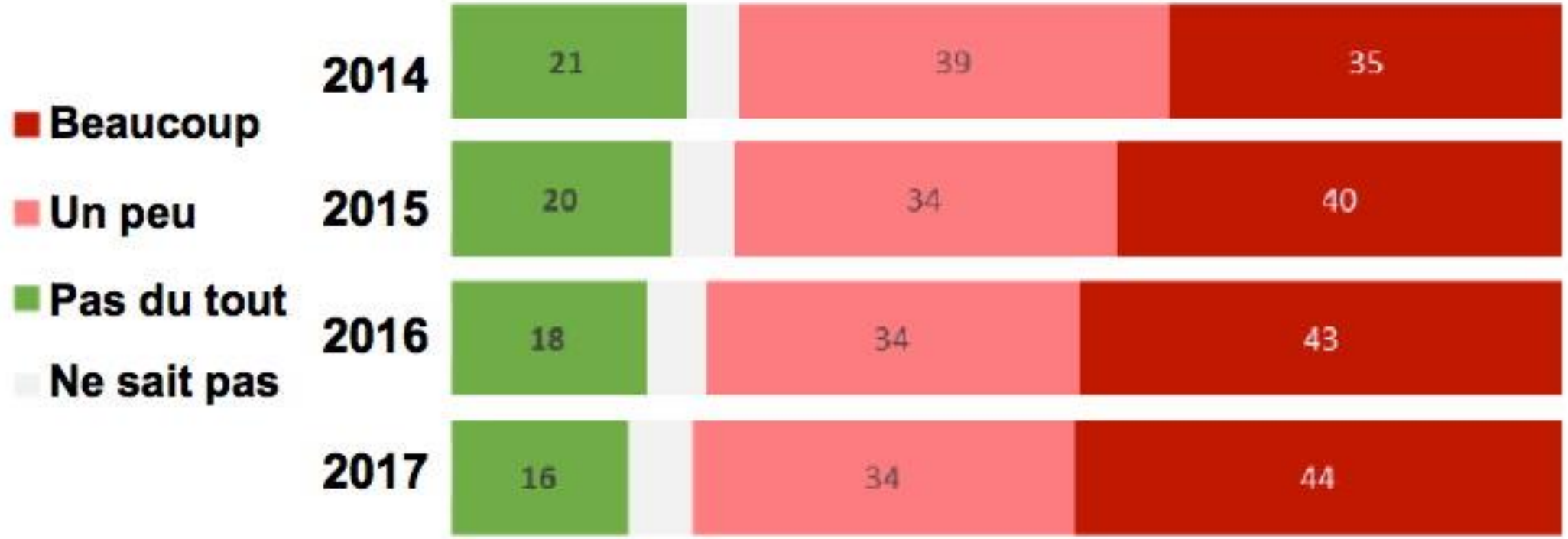
Ceci n’est pas une bombe

Ceci n’est pas une centrale

10. Culture

Echec de la communication nucléaire

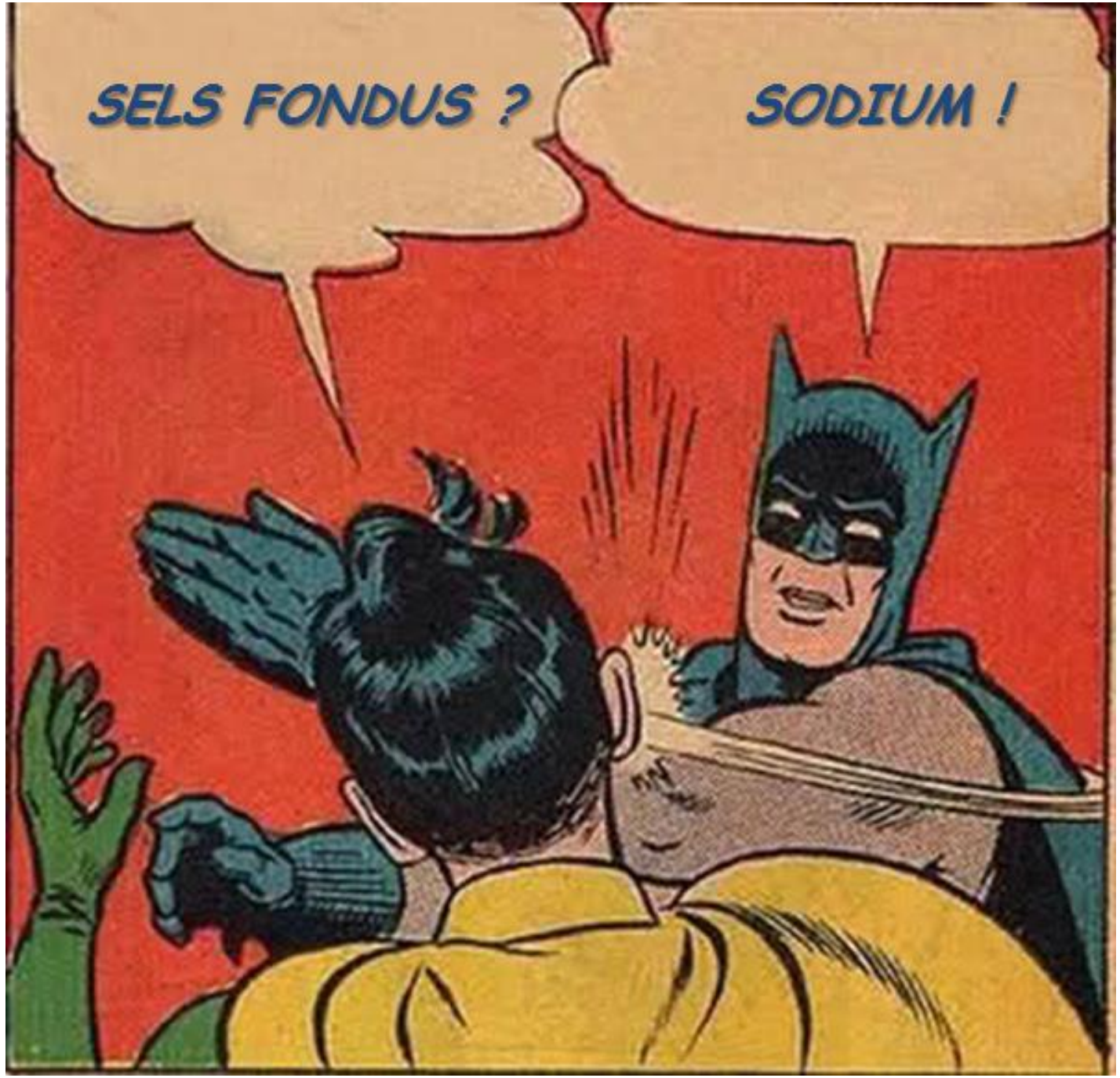
Pour chacun des éléments suivants, indiquez si, selon vous, il contribue à l'effet de serre (au réchauffement de l'atmosphère) : - les centrales nucléaires ?

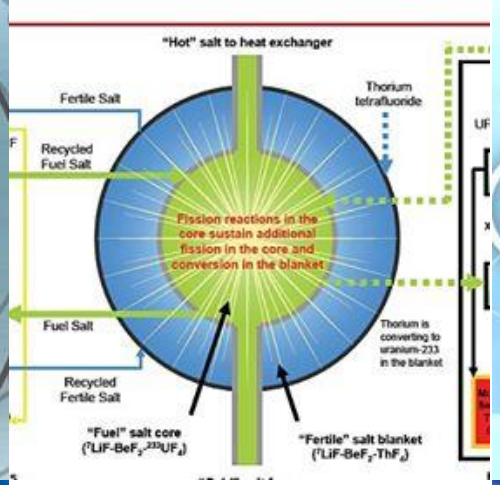


Source : EDF BDD France 2014-2017

Figure 12 : distribution des réponses selon l'année d'interrogation

Lecture : en 2017, 44% des personnes de 18 ans ou plus vivant en France estiment que les centrales nucléaires contribuent beaucoup à l'effet de serre.


SELS FONDUS ?
SODIUM !

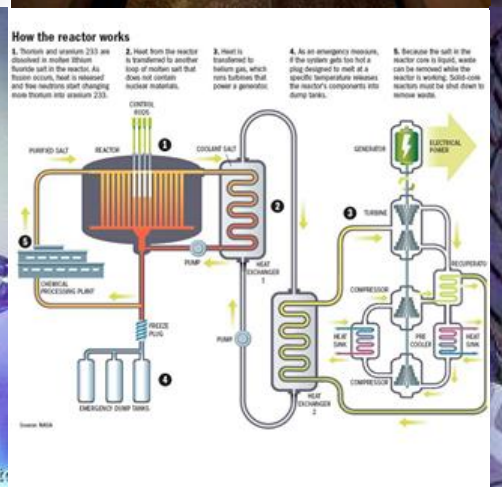

"Hot" salt to heat exchanger
Fertile Salt
Recycled Fuel Salt
Thorium tetrafluoride
Fission reactions in the core sustain additional fission in the core and conversion in the blanket
Fuel Salt
Thorium is converting to uranium-233 in the blanket
Recycled Fertile Salt
"Fuel" salt core
"Fertile" salt blanket


The Good Reactor

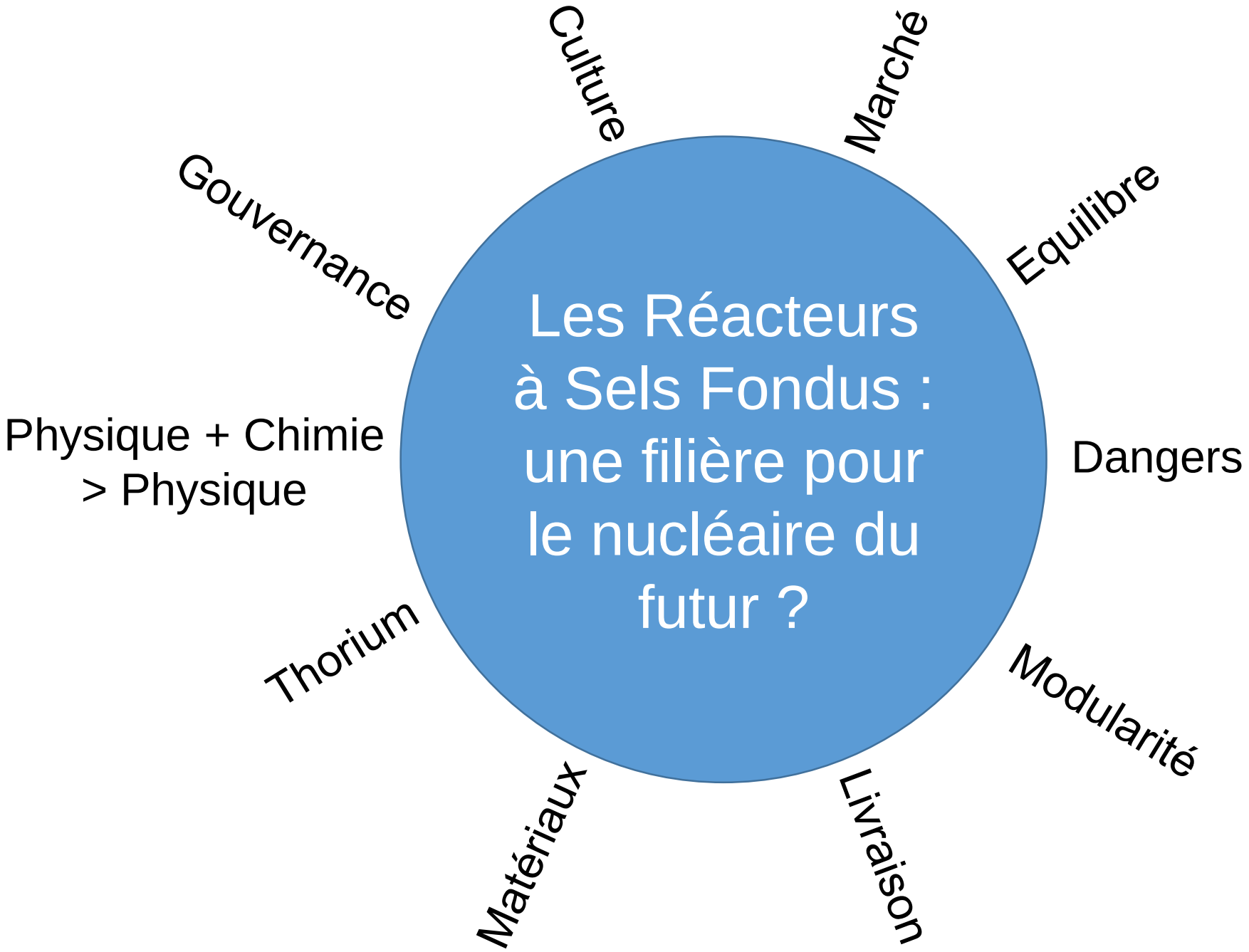

CLEAN POWER FOR ALL


America Needs
MOLTEN
SALT
REACTORS

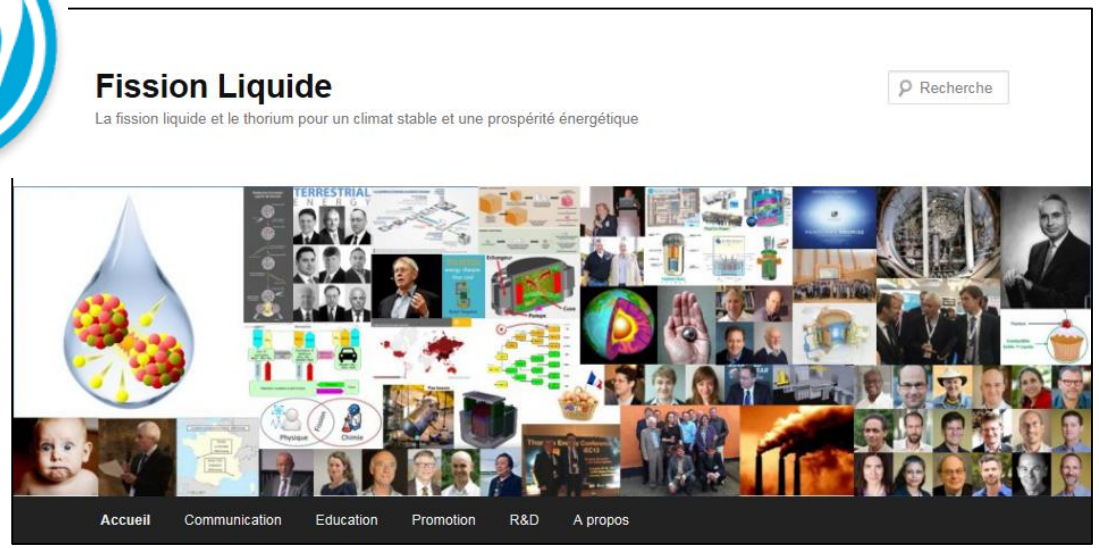

COOKIN UP SOME
DANK MEMES


How the reactor works


SHURE


Les Réacteurs à Sels Fondus : une filière pour le nucléaire du futur ?
Culture
Marché
Equilibre
Dangers
Modularité
Livraison
Matériaux
Thorium
Physique + Chimie > Physique
Gouvernance

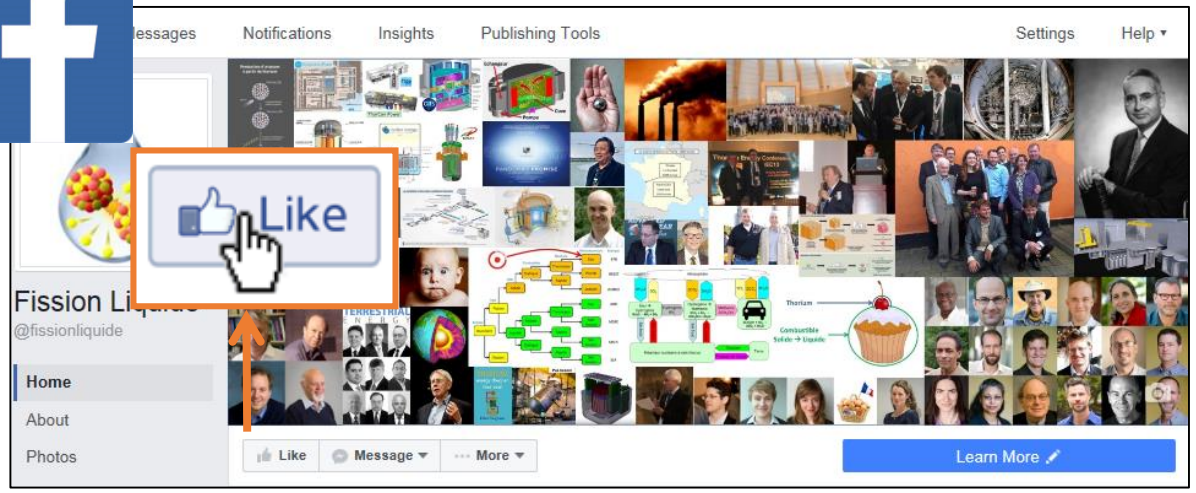
Pour en savoir plus :



http://fissionliquide.fr

YouTube

http://youtube.com



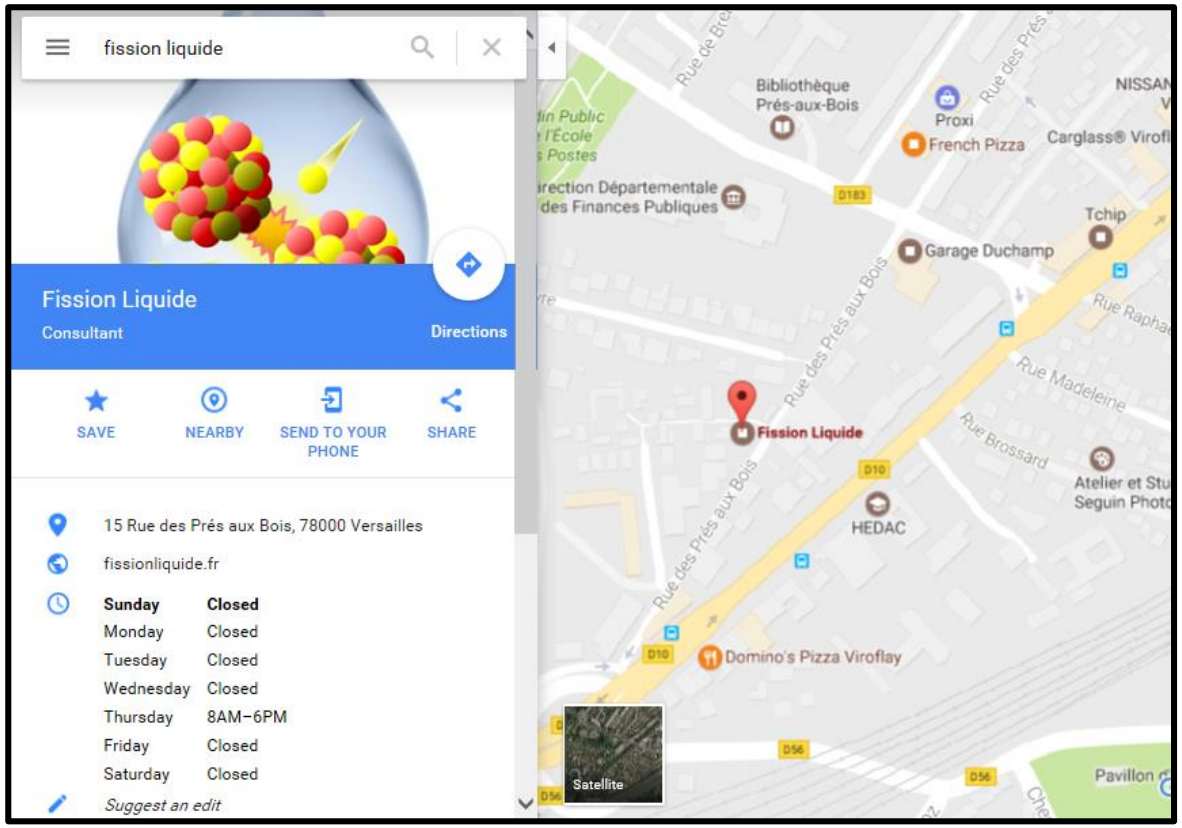
https://www.facebook.com/fissionliquide

https://twitter.com/FissionLiquide

Fission Liquide

La première entreprise française dédiée aux réacteurs à sels fondus.

- Mission : Connecter les parties prenantes dans cette technologie
- Offre : Conseil indépendant, bilingue français / anglais
- Création : 1er janvier 2017
- Siège : Versailles



progrès nucléaire

L'association Progrès Nucléaire a pour but de promouvoir le progrès pour l'humanité et pour la nature, par l'amélioration des systèmes d'énergie nucléaire.

Lancement : 27 juin 2018, stand 7-G157,
World Nuclear Exhibition, Paris Villepinte

http://progresnucleaire.org