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India Smart Grid Forum

India SMART UTILITY Week 2024

Supporting Ministries

Session : Nuclear Renaissance and the Role of SMR in Net Zero Power Systems

POTENTIAL OF SMR FOR ENERGY TRANSITION EXPERIENCE

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INTRODUCTION

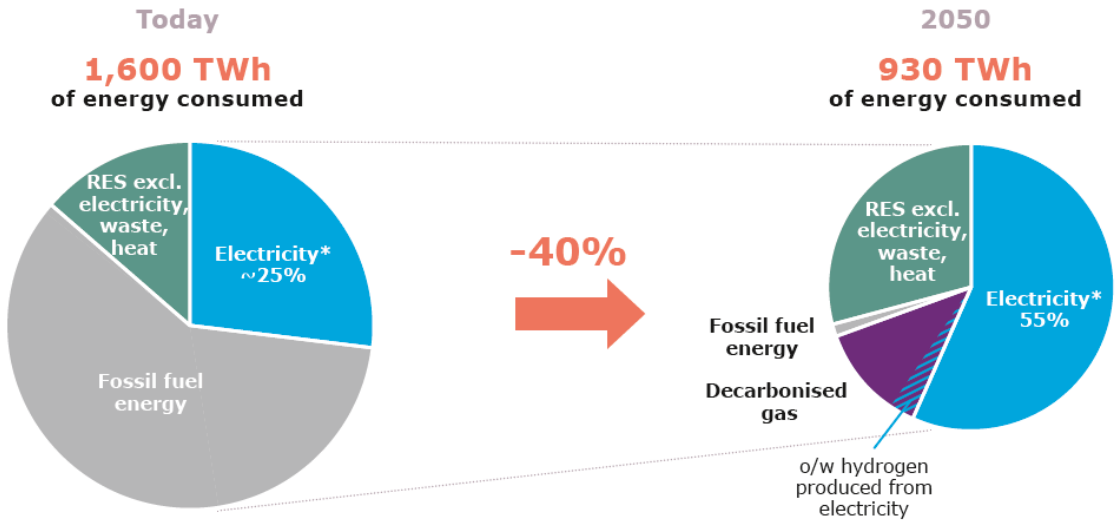
- France: pathways to carbon neutrality by 2050

- SMR for international market to decarbonize electricity
  - Nuward™ initiative
  - Innovative reactors

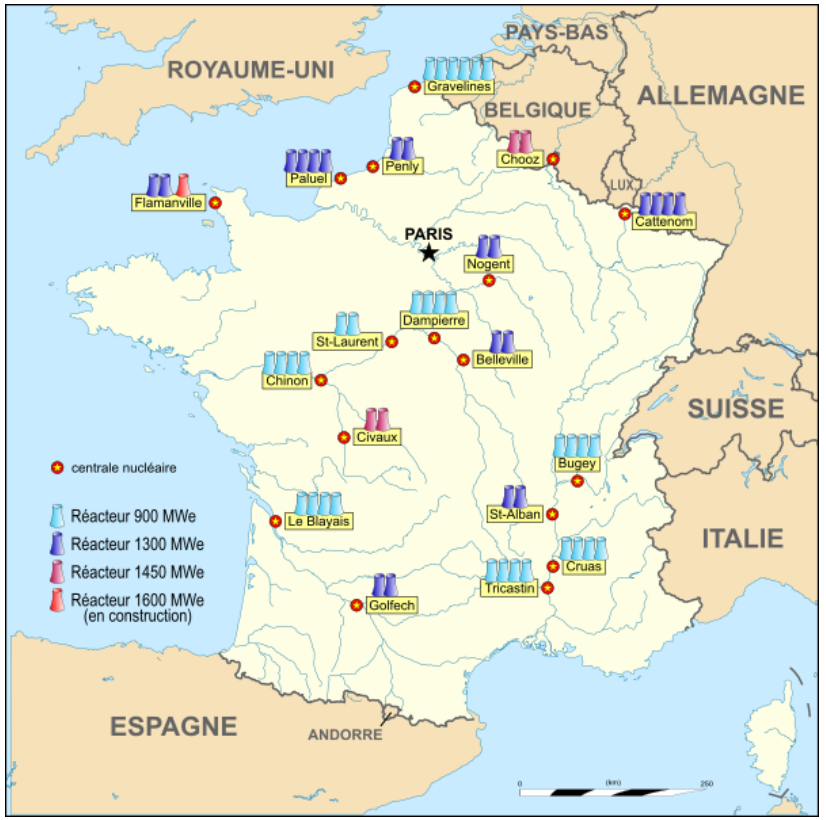
- Hybrid systems studies using SMR/AMR and renewables
  - Innovative decarbonized nuclear energy systems initiative
  - Market driven approach of energetic system
  - Multienergy vectors for nuclear application

France: pathways to carbon neutrality by 2050

- French electricity mix scenarios



* Final electricity consumption (excluding losses, excluding consumption related to the energy sector and excl. consumption for hydrogen production)
Total electricity consumption in RTE's baseline trajectory = 645 TWh

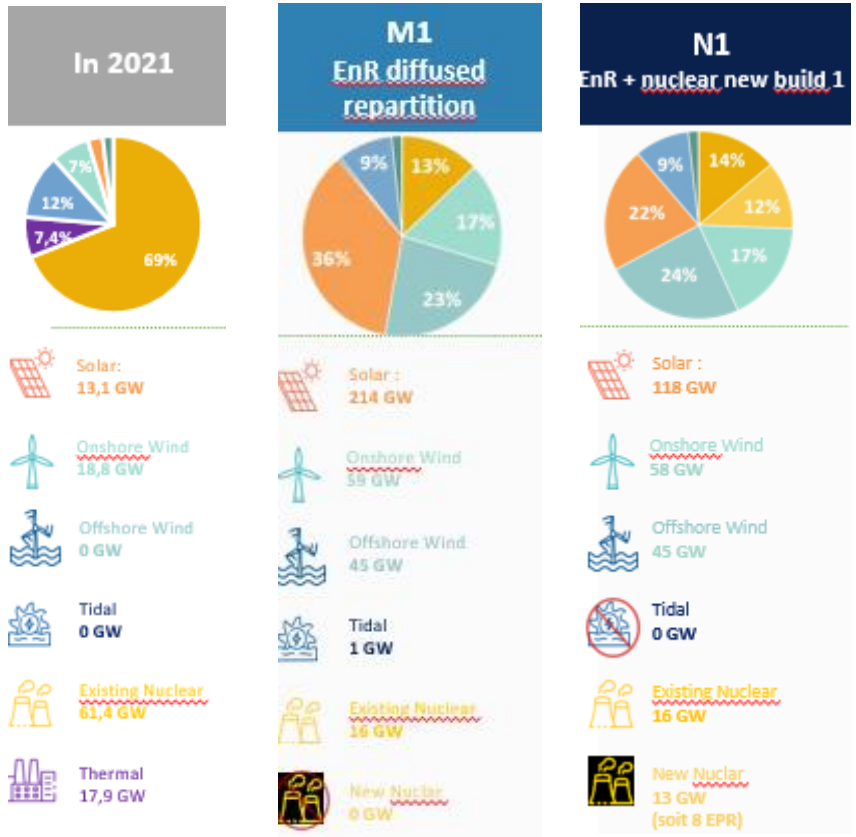


- Nuclear power plant fleet: 56 PWR
- Total installed capacity: 61,3 Gwe
- Production in 2023: 320,4 TWh

France: pathways to carbon neutrality by 2050

- Scenarios - French electric network operator (RTE):

https://assets.rte-france.com/prod/public/2022-01/Energy%20pathways%202050_Key%20results.pdf



➔ Nuclear energy will significantly increase chances to achieve decarbonization

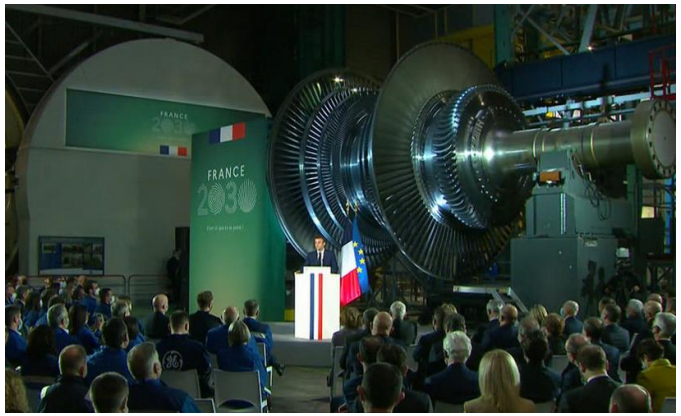
➔ Building new nuclear reactors is relevant from an economic point of view

➔ Massive development of renewable energies is necessary

Growth in electricity consumption: +35%
(475 TWh in 2019 to 600-700 TWh in 2050)

France: future of nuclear energy

- **Decision to build 6 + 8 EPR**

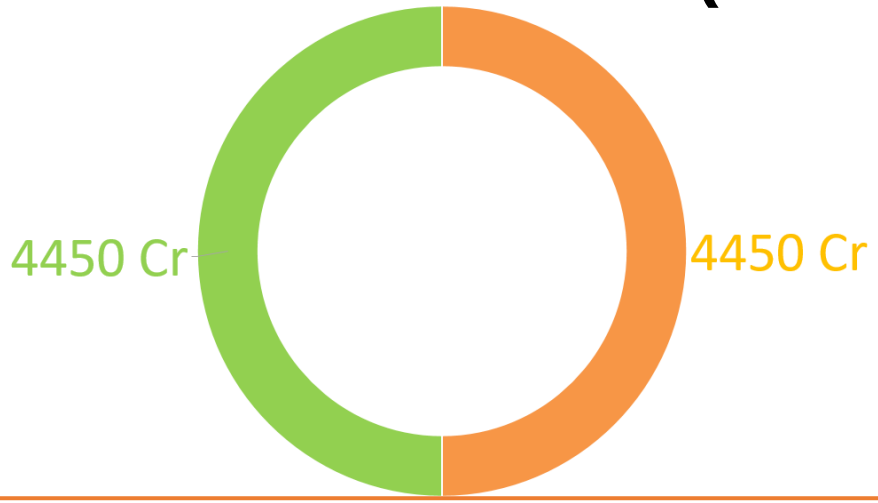


- Diversification of nuclear technologies

- **Investment plan for the future: includes promotion of small and innovative nuclear reactors (SMR/AMR)**

NUWARD™ SMR

1st unit by 2030



Innovative reactor

Projects (call for projects)

High-temperature, sodium, molten salt…

Innovative reactor projects

- Call for projects: on-going process – SMR & AMR

BLUE CAPSULE TECHNOLOGY

- **HTR type Reactor**
  - **150 MWth**
- Industrial heat and electricity

CALOGENA

- **PWR type reactor**
  - **30 MWth**
- District heating

Jimmy

- **HTR type reactor**
  - **15 MWth**
- Industrial heat

HEXANA

- **Sodium cooled fast reactor**
  - **400 MWth / 150 MWe**
- Industrial heat and electricity

naarea

- Molten salts reactor
- 80 MWth / 40 MWe
- Industrial heat and electricity

newcleo
Futurable Energy

- Lead cooled fast reactor
- 30 or 200 MWe
- Electricity, heat, radio-isotopes

otrera

- **Sodium cooled fast reactor**
  - **110 MWe**
- Industrial heat and electricity

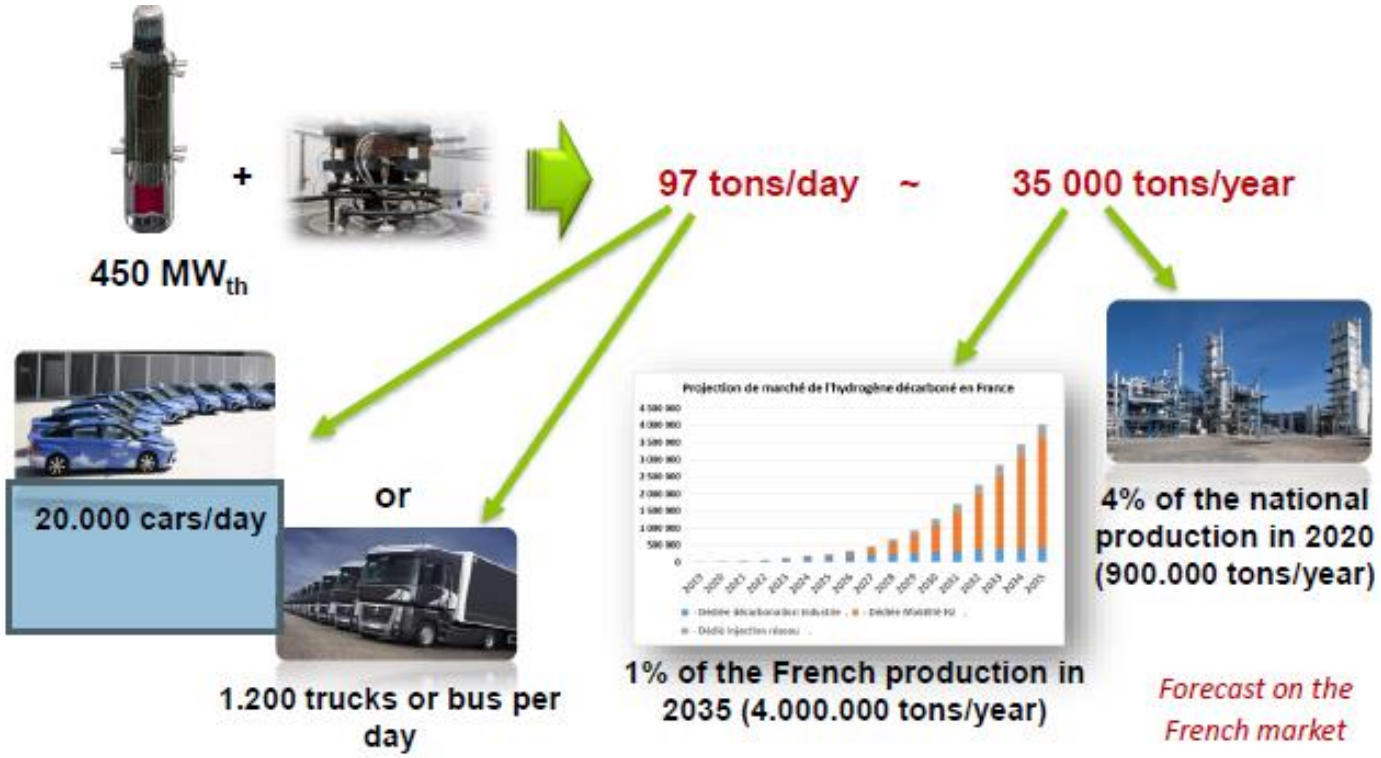
RENAISSANCE FUSION

- **Fusion type reactor**
  - **1 GWe**
- Electricity

R&D new applications – hybrid systems

➢Studies on SMR dedicated to decarbonated H2 production

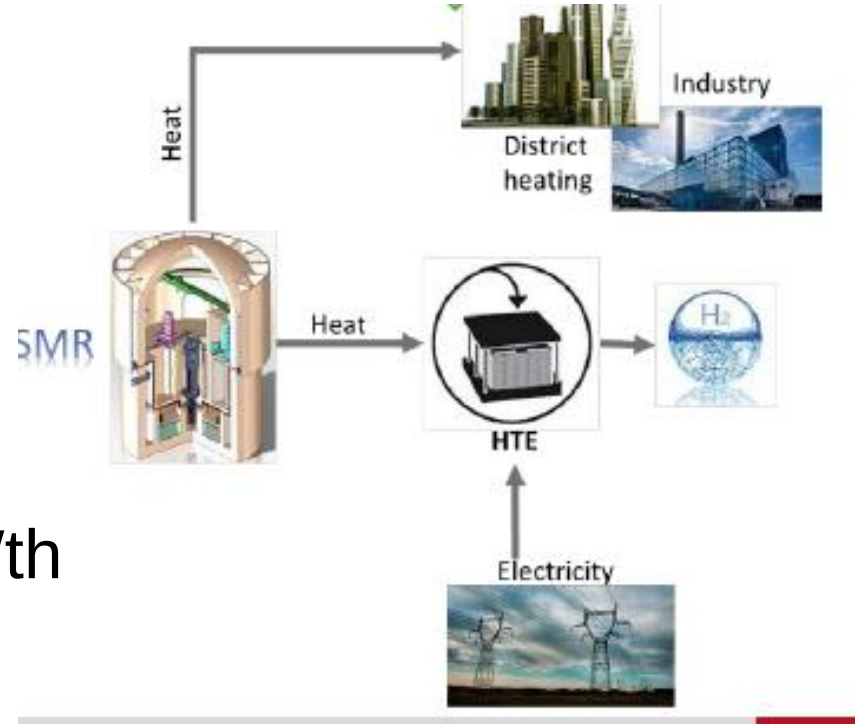
- Coupling SMR / high temperature electrolysis
- Heat and electricity supply in cogeneration mode
- Assessment
  - performance
  - cost versus market needs
  - safety



R&D new applications – hybrid systems

➢Studies on SMR dedicated to heat production

- Market analysis for district heat & industrial needs
- French market: need for heat <250°C
  - 100 TWh for industrial needs
  - 450 TWh for district heating
  - Average power of district network 40 MWth

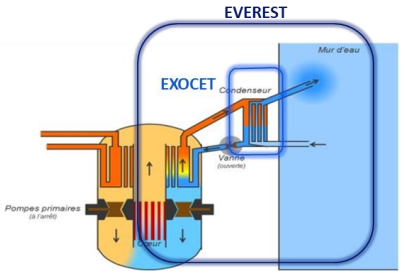


- Preconception studies on heat-supply SMR concepts + downsizing nominal power to 20 MWth
- Assessment
  - performance
  - cost versus market needs
  - safety

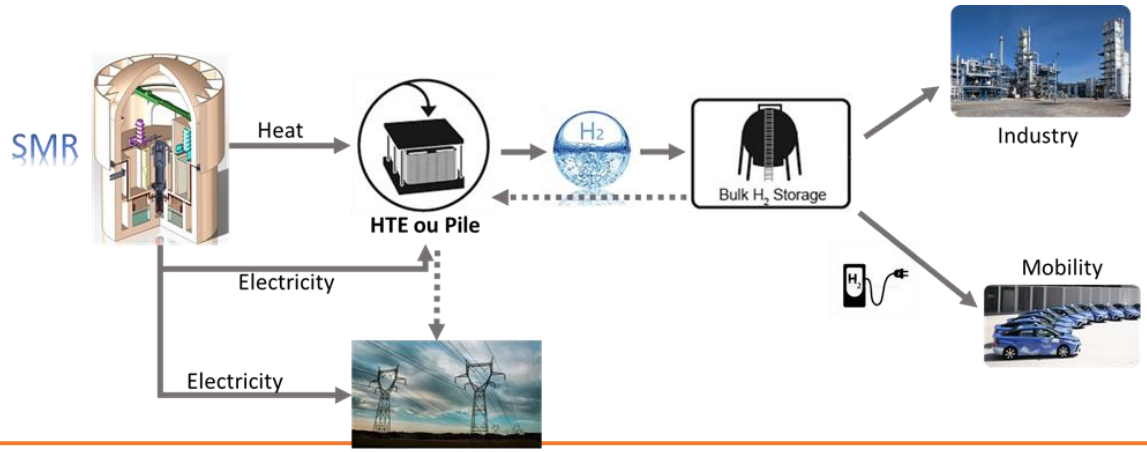
R&D new applications – hybrid systems

➢R&D on innovative energy conversion system (ECS)

- Study on multi-vector ECS (power, heat, H2, drinking water)
- Optimization with storage solutions (battery, thermal energy, gas...)
- Integration with other energy sources : solar, wind turbines, fuel cells...



- Priorities for R&D program
  - SMR & AMR
  - Hybrid solutions for decarbonizing regional energy systems (power, heat, hydrogen…)
  - Economical assessment
  - Training sessions

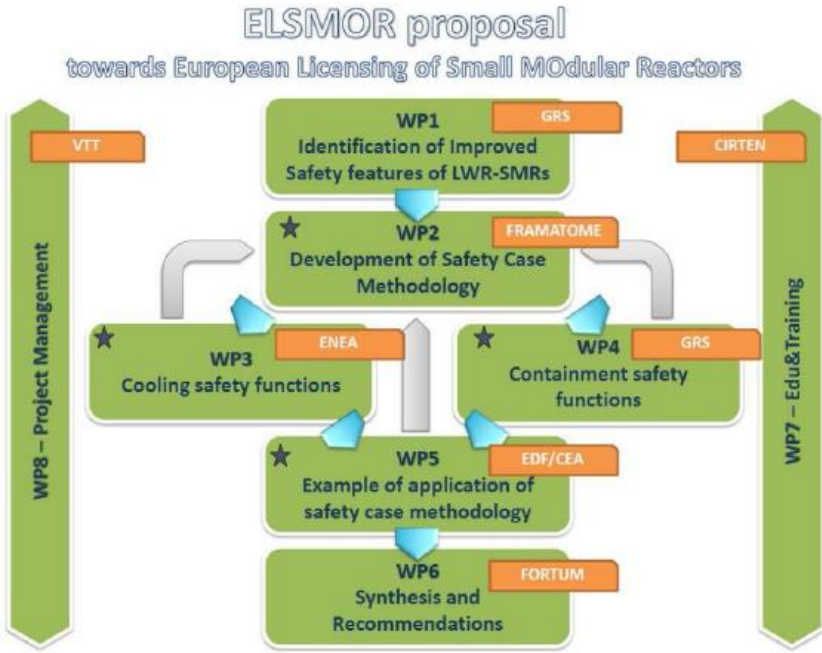


Some key points to address

- Uses / applications to be defined
- Pre-Licensing – ensure compliance with safety requirements
- Training and skills development

Government of India
AERB
Atomic Energy Regulatory Board

AUTORITÉ DE SÛRETÉ NUCLÉAIRE



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KEY TAKEAWAYS / RECOMMENDATIONS

- SMR/AMR : promising way to accelerate energy transition
- Identify best opportunities (electricity, industrial needs, hydrogen production…)
- Essential to anticipate (licensing, training, supply chain…)
- International cooperation is key for the success of SMR deployment

THANK YOU

For discussions/suggestions/queries email: ***isuw@isuw.in***

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Links/References:

https://www.nuward.com/en
https://www.naarea.fr/en
https://www.newcleo.com/
https://www.jimmy-energy.eu/en/home
https://renfusion.eu/

Scenarios on French energy pathways:
https://assets.rte-france.com/prod/public/2022-01/Energy%20pathways%202050_Key%20results.pdf