

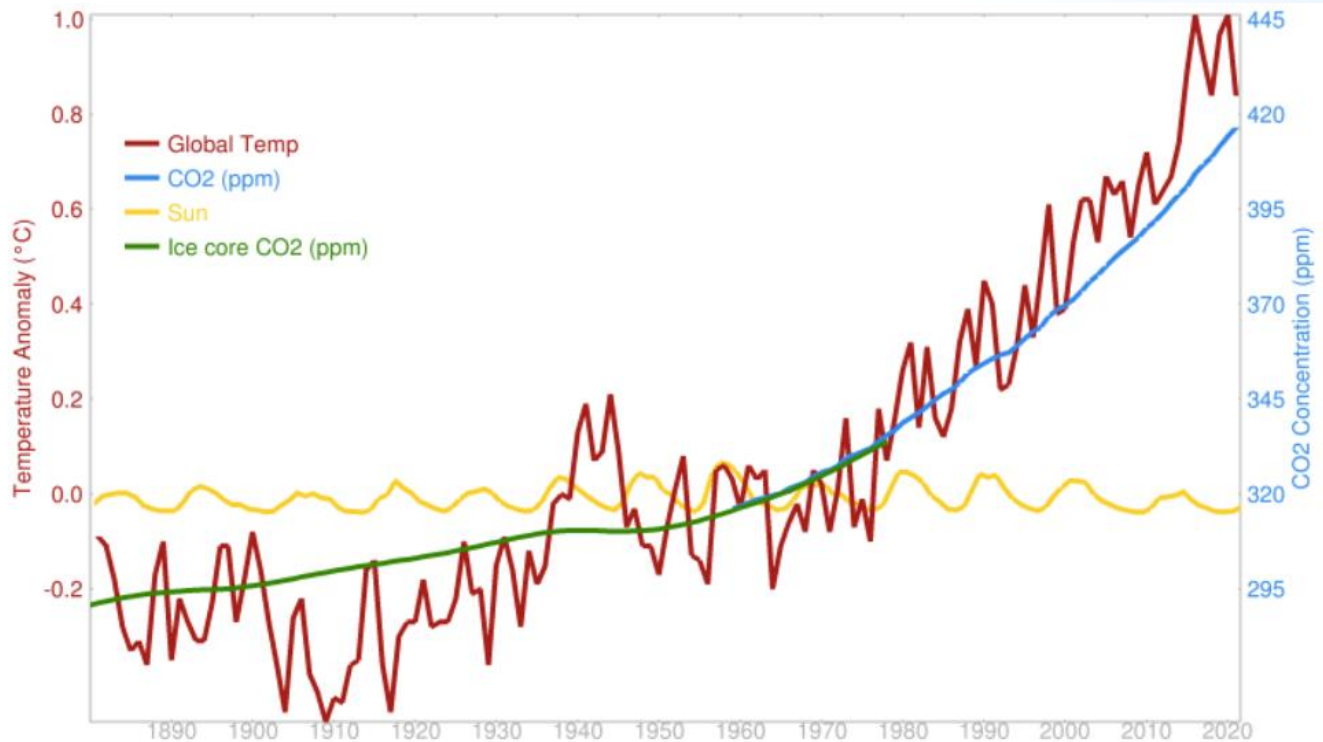
# The Investment Climate for Nuclear Fusion

**Alik van Heek**  
**Suyoun Choi**  
**Saied Dardour**

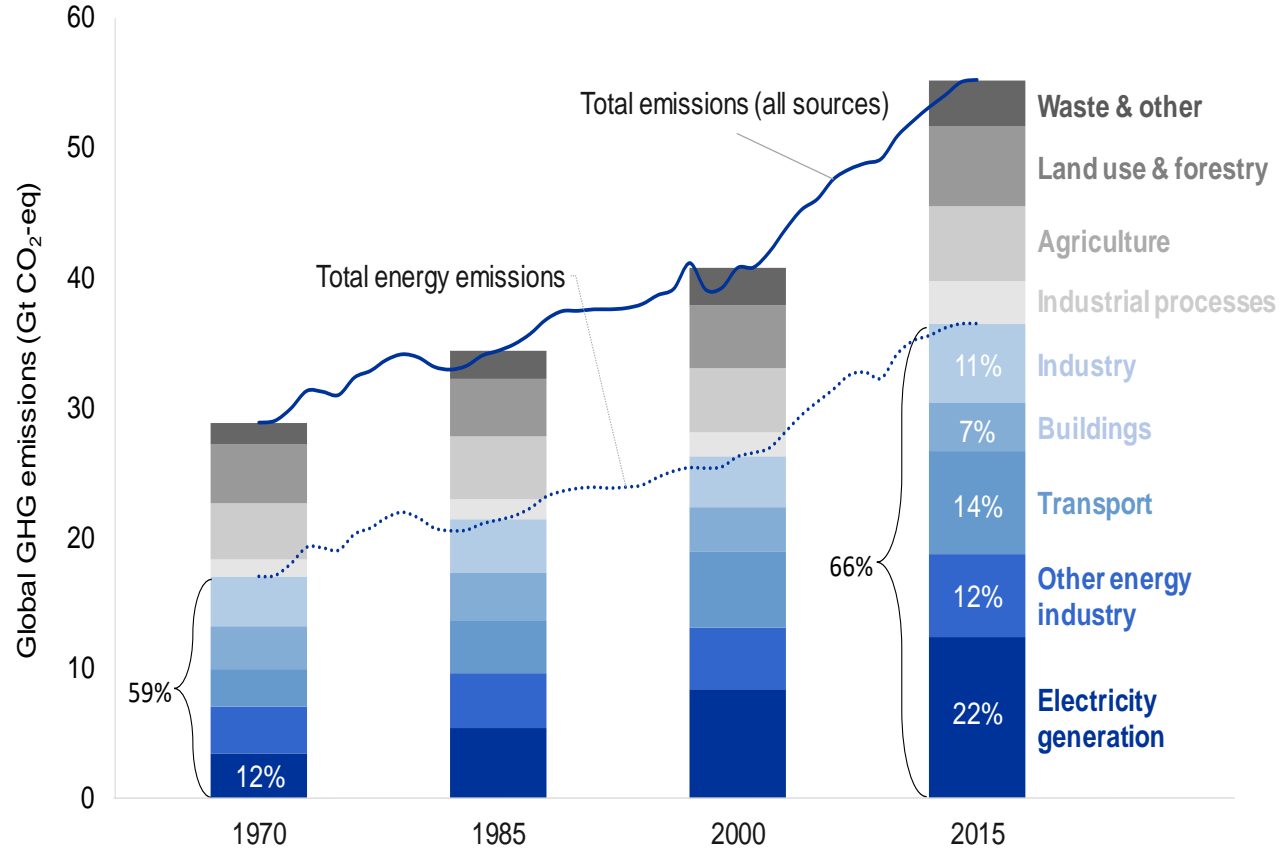
Planning and Economics Studies Section, Unit 3E Analysis  
Division of Planning, Information and Knowledge Management  
Department of Nuclear Energy  
International Atomic Energy Agency

The 2<sup>nd</sup> IAEA Workshop on  
Fusion Enterprises,  
Oxford, United Kingdom,  
11-12 July 2022

# Global Temperature and Atmospheric CO<sub>2</sub>

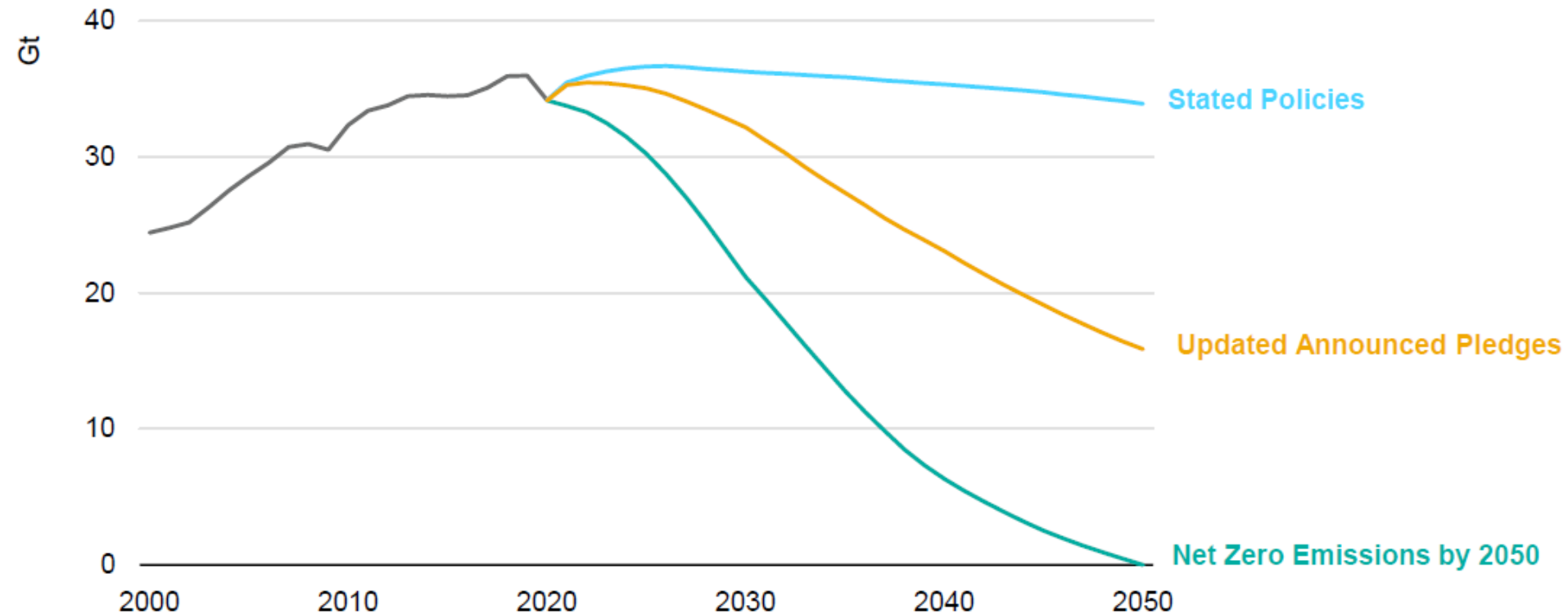


# Global greenhouse gas emissions by sector

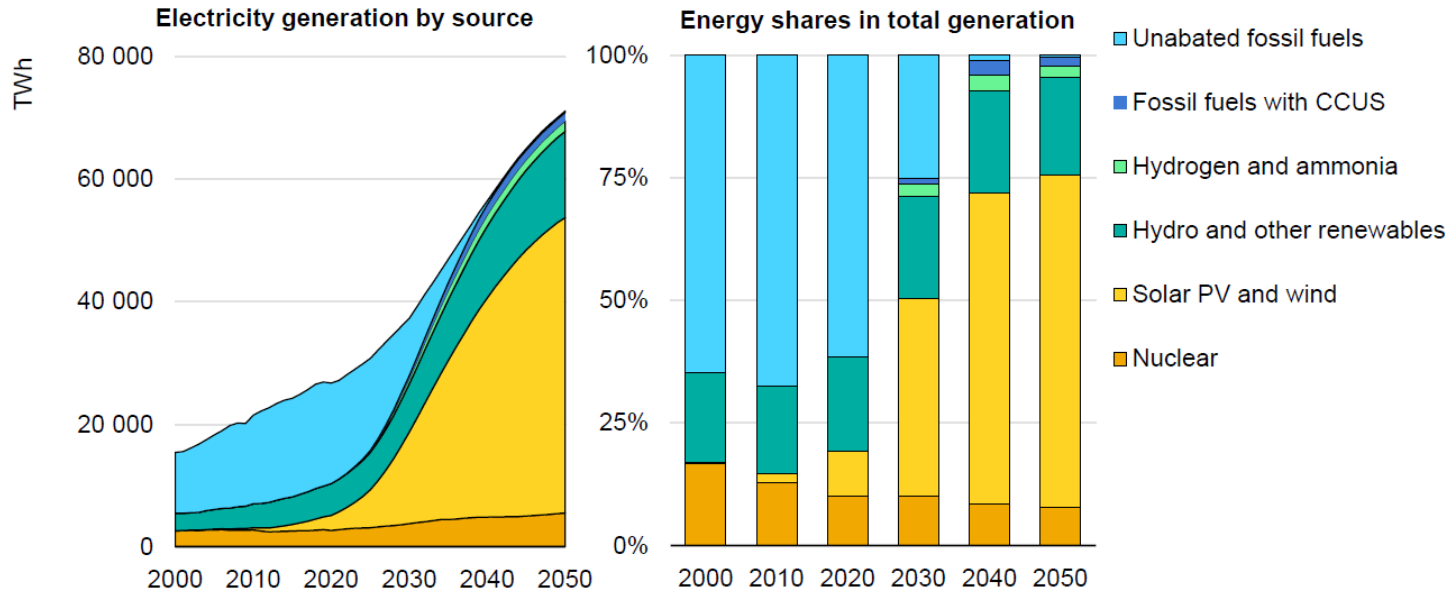


Source: IAEA, Climate Change and Nuclear Power 2020, based on IEA data

# Global energy sector CO<sub>2</sub> emissions by scenario, 2000 to 2050

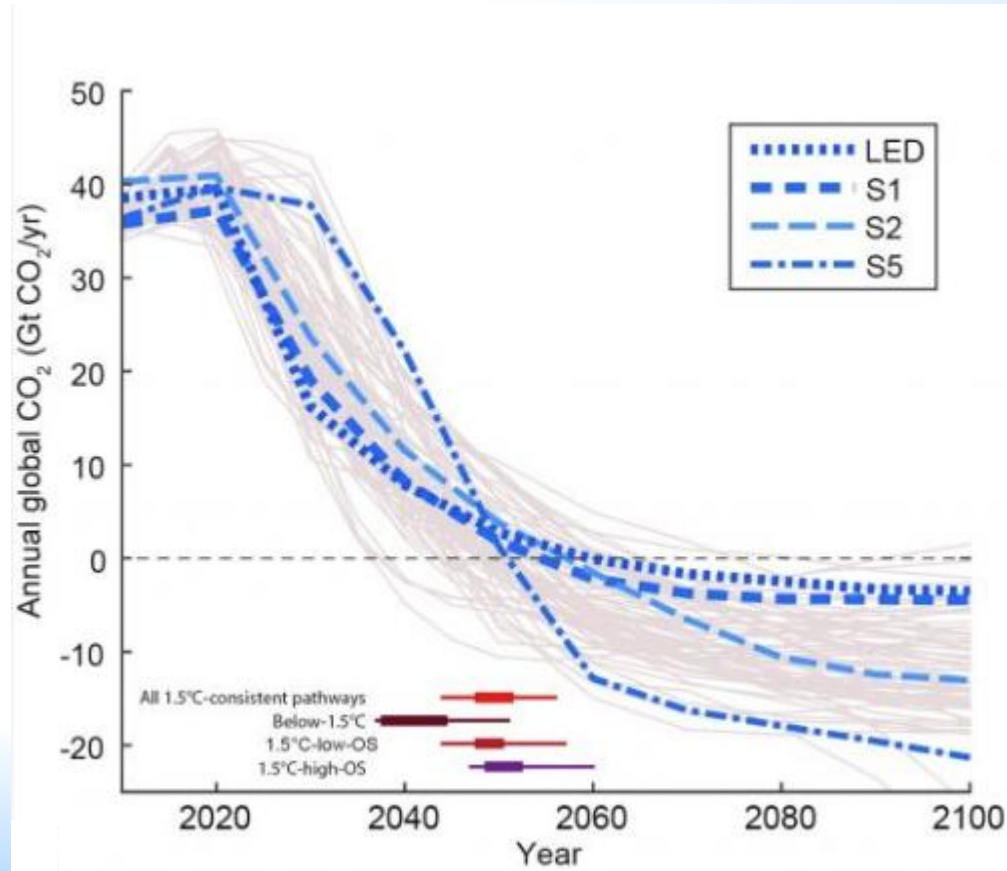


# Global power generation by type of energy in the IEA Net Zero Emissions by 2050 Scenario



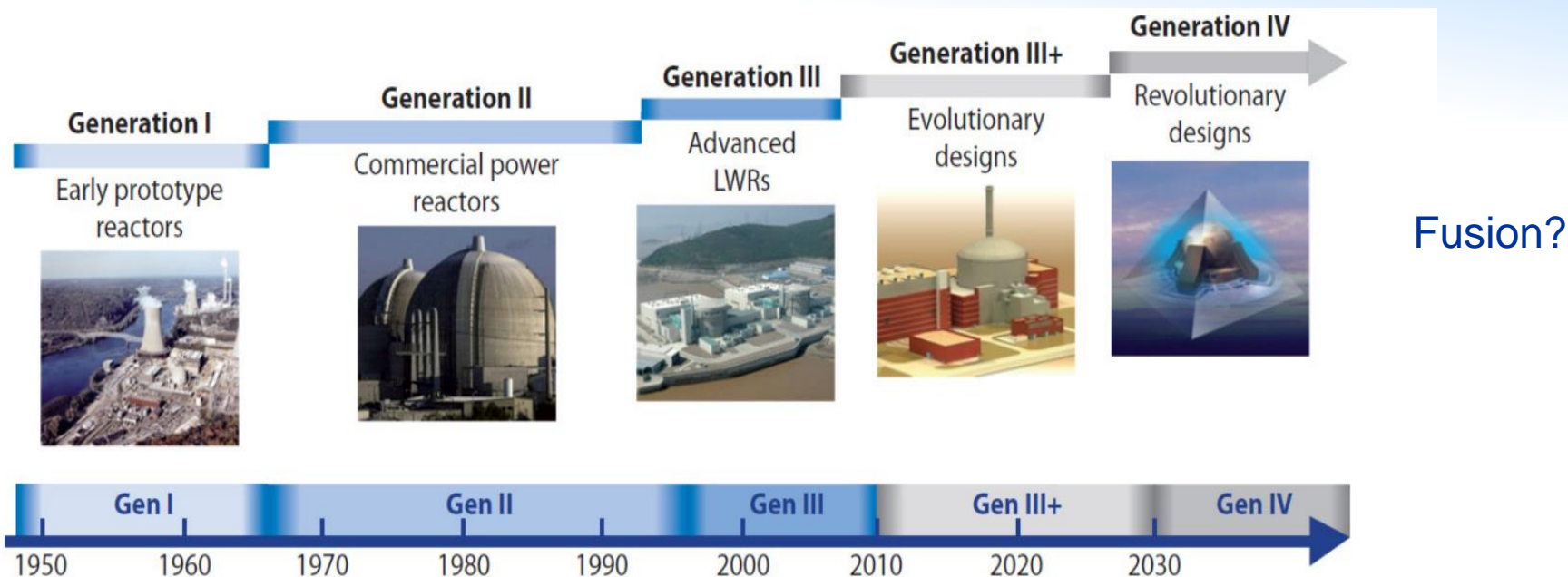
Nuclear fusion is not included in the NZE due to significant uncertainty about its technical and economic feasibility.

# Evolution of global anthropogenic CO<sub>2</sub> emissions until 2100



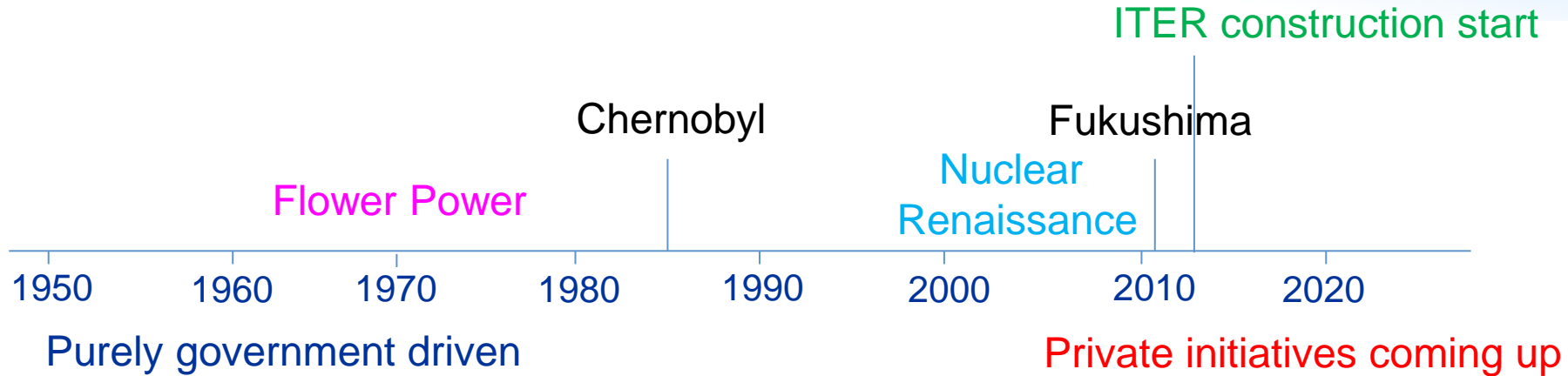
IPCC Special Report Global Warming of 1.5 °C, 2018

# Generations of nuclear (fission) reactors



# An observation

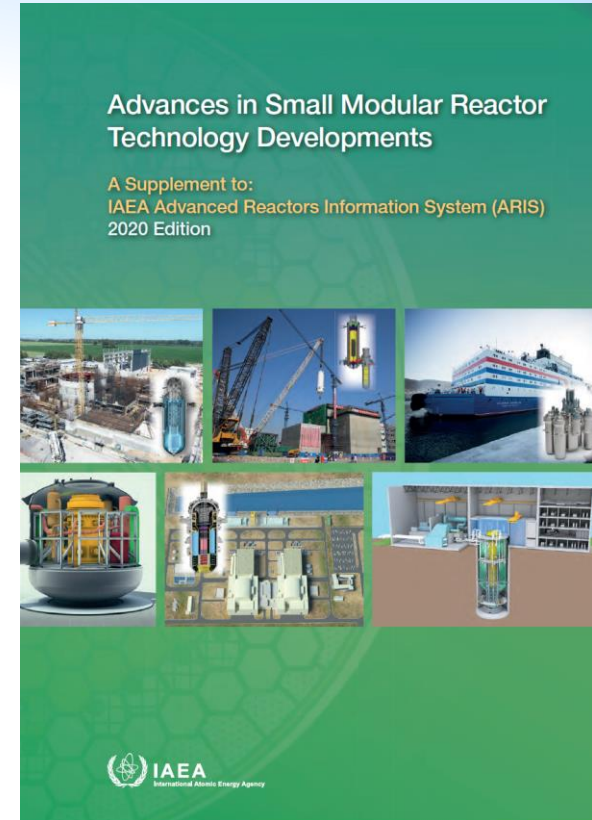
## Timeline of nuclear development






# Nuclear “start-ups”


- IAEA collects information in ARIS database
  - [aris.iaea.org](http://aris.iaea.org)
- Publication “**Advances in Small Modular Reactor Technology Developments**”
  - 72 design descriptions
  - Ca. 15 nuclear “start-ups”
  - From 6 countries
- Used as based for further research into nuclear startups and their funding



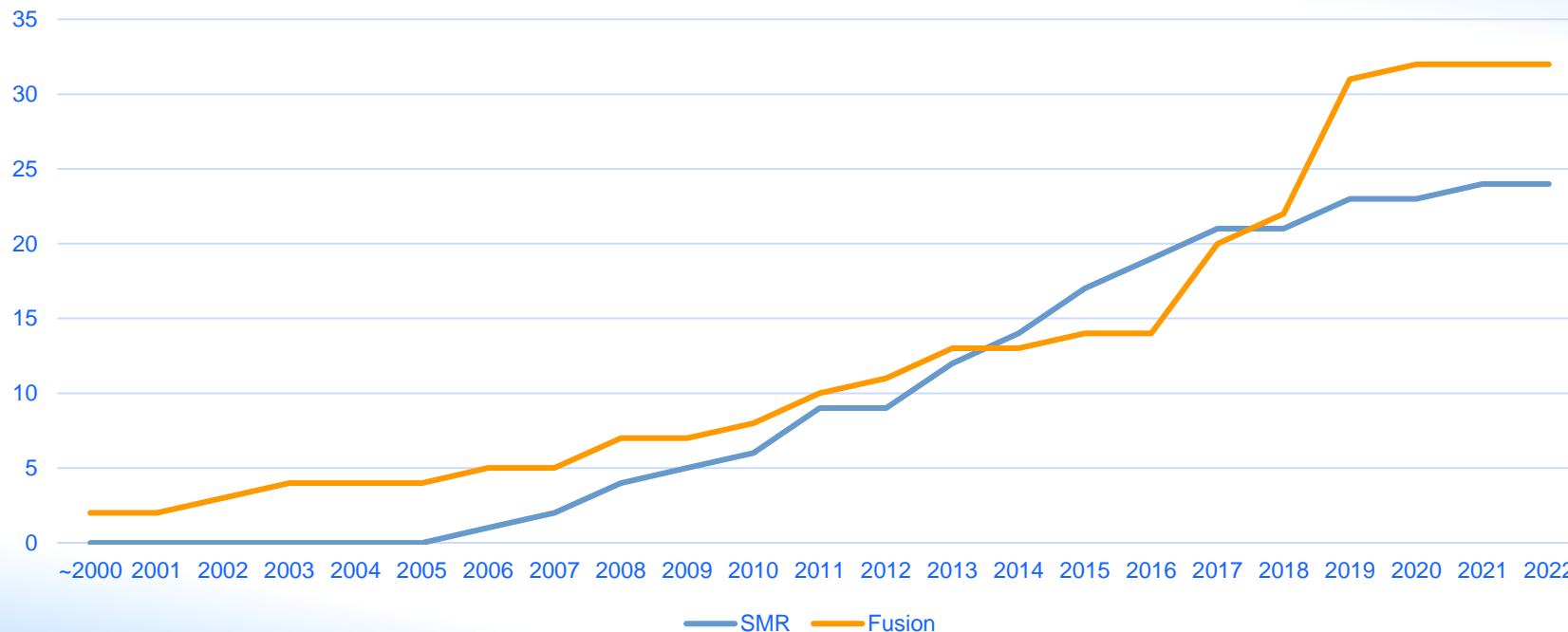
# Nuclear Startup Companies by Country

Country	# SMR Companies	# Fusion Companies
Australia	0	1
Canada	4	3
Denmark	2	0
Estonia	1	0
France	0	1
Germany	1	1
Japan	0	1
Luxembourg	1	0
South Africa	2	0
Spain	0	1
Sweden	2	0
UK	0	4
USA	11	20
<b>Total</b>	<b>24</b>	<b>32</b>

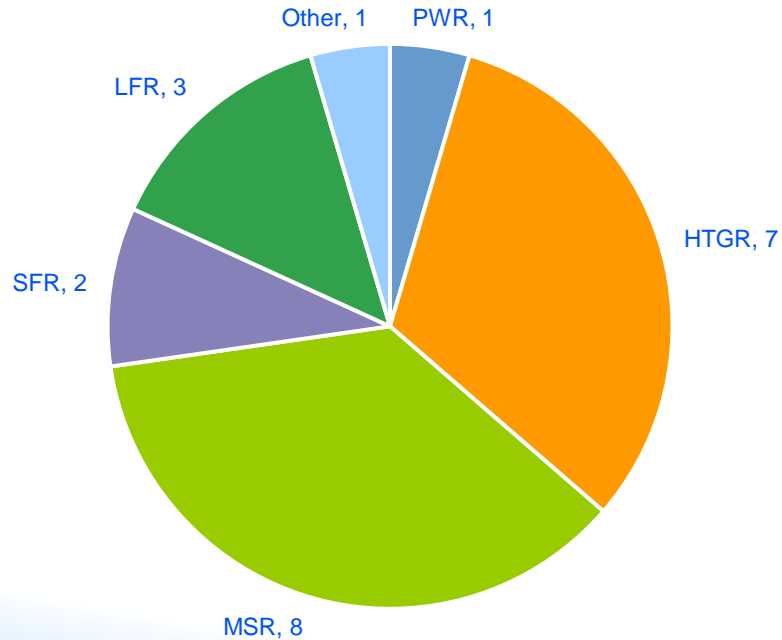
 nuclear country

 non-nuclear country

# Cumulative Number of Startup Companies by Founding Year



# SMR Reactor Types



PWR: Pressurized Water Reactor

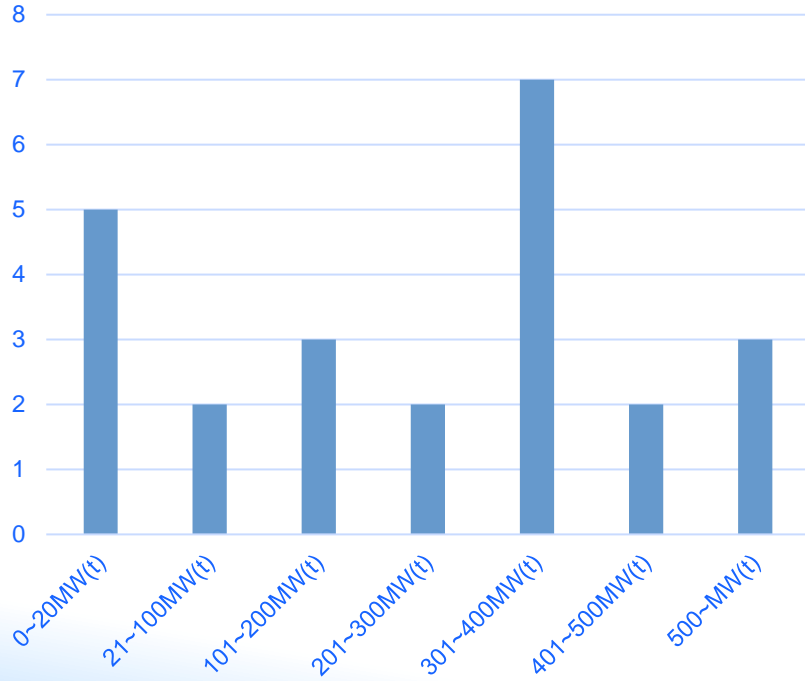
HTGR: High Temperature Gas Reactor

MSR: Molten Salt Reactor

LFR: Lead Fast Reactor

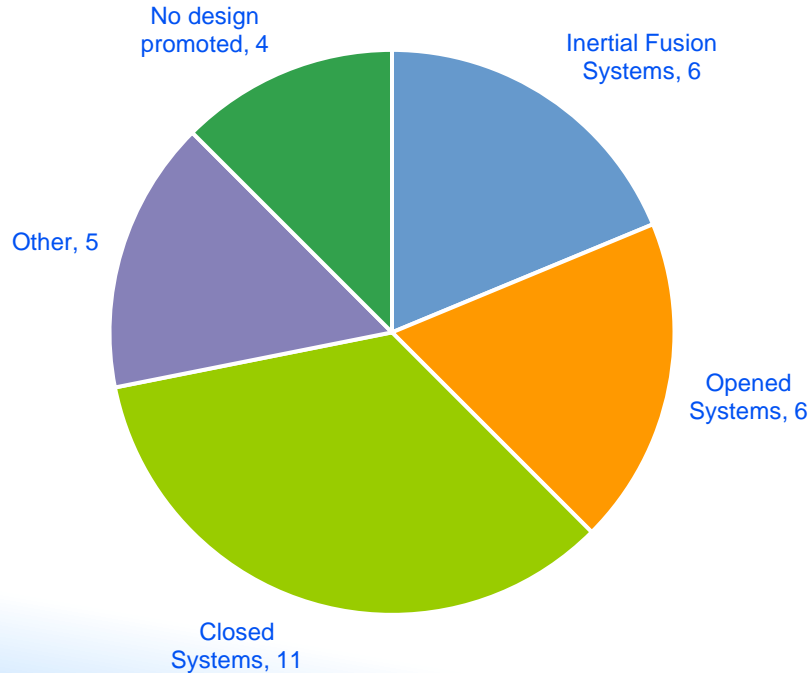
SFR: Sodium Fast Reactor

# SMR thermal power output



- Of 24 companies 5 will use microreactors <20 MW(t)

# Nuclear Fusion Reactor Types



## Inertial Fusion Systems

- Particle accelerators
- Lasers
- Electrostatic potential wells

## Opened Systems

- Pinches
- Magnetized target

## Closed Systems

- Field reverse configuration
- Tokamak
- Stellarator

# Target markets other than electricity

## SMR

Process heat  
District heating

Hydrogen  
Ammonia  
Other 'clean' fuels

Seawater  
desalination

## Fusion

Marine propulsion  
Space propulsion

Medical  
applications

# Investments in fusion companies

- Funding for fusion companies: \$1,9 bn, based on responses from 23 companies (FIA, 2021)
- The fusion sector has attracted nearly \$5 billion of capital funding in recent years, almost \$3 billion in 2021 alone (scientificamerican.com, 18 March 2022)

**E&ENews**

CLIMATE CHANGE

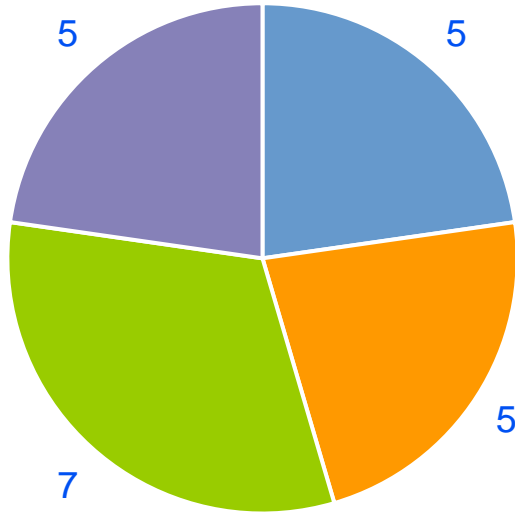
**To Help Tackle Climate Crisis,  
White House Touts Nuclear Fusion**



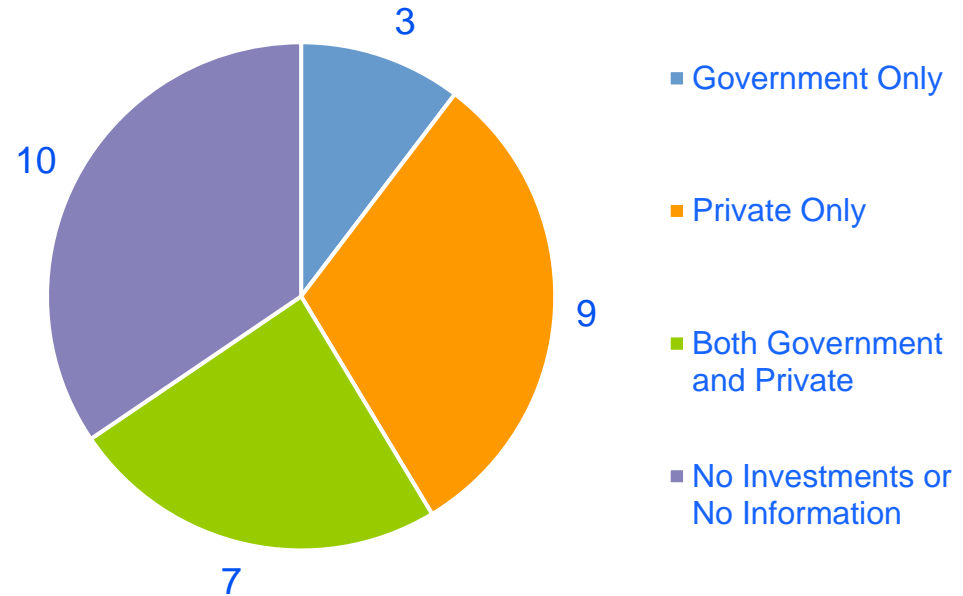


# Funding for SMR and Nuclear Fusion Startup Companies

SMR



Fusion



# Funding Rounds on SMR and Nuclear Fusion Startup Companies



## Angel Round:

- small round designed to get a new company off the ground.
- Investors include:
  - individual angel investors
  - angel investor groups
  - friends & family

## Seed Round:

- typically comes after an angel round
- among the first rounds of funding a company will receive
- round sizes range \$10k–\$2M

## Venture Round:

- coming from a venture capital firm

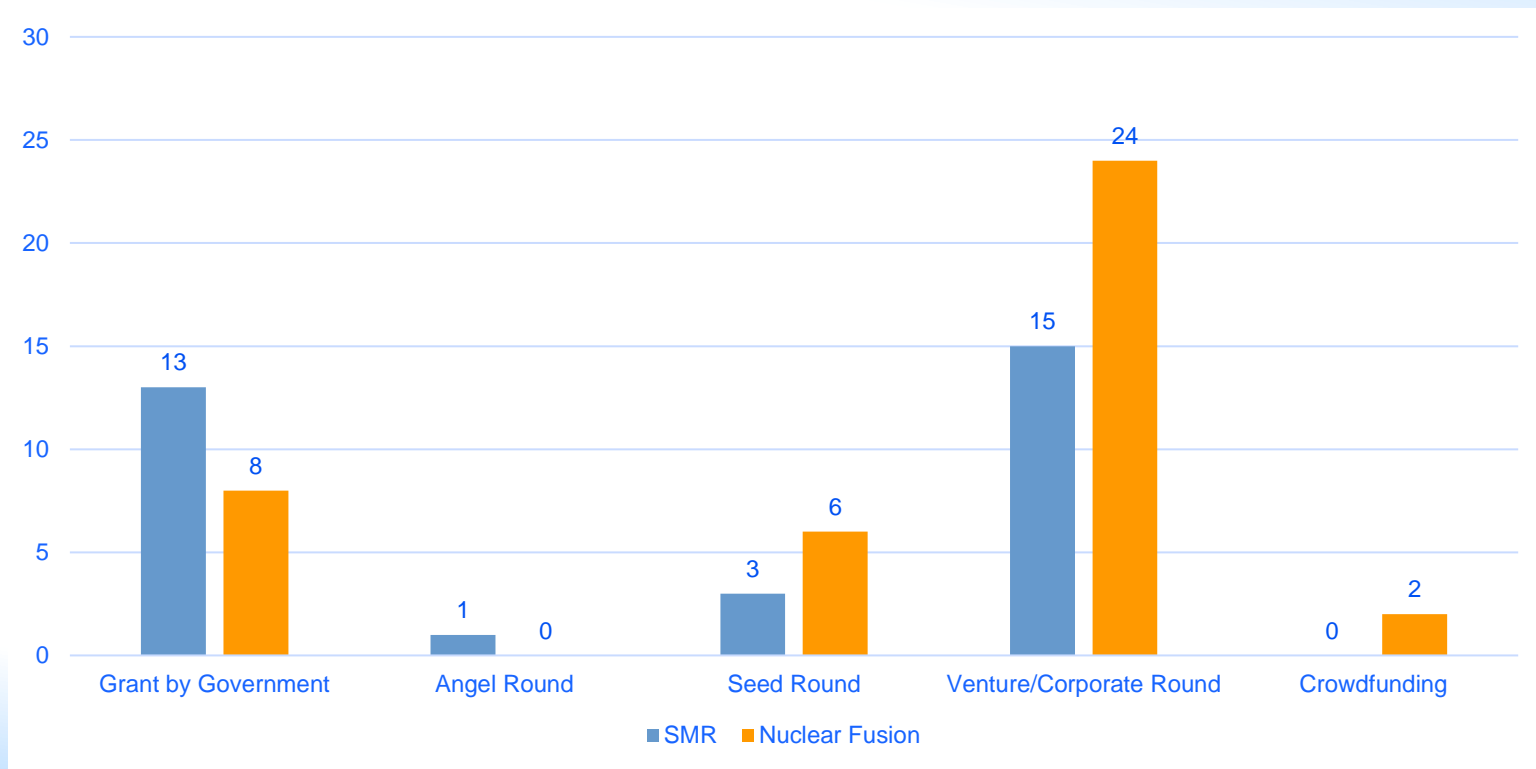
## Corporate Round:

- when a company, rather than a venture capital firm, makes an investment in another company.
- often for the purpose of forming a strategic partnership.

## Equity Crowdfunding:

- individual users invest in companies in exchange for equity.
- Typically the investors invest small amounts of money

# Funding Rounds on SMR and Fusion Startup Companies



# Preliminary findings

- Significant number of startup companies both in SMR (24) and fusion (32), for SMR mostly in advanced reactor types
- SMR companies have a larger proportion of grants from governments while there are more private investors for nuclear fusion companies
- Insufficient statistical information on amount of funding
- Caveat: gap between funds needed for demonstrator and currently available funding

*Thank you for your attention!*

