

# Overview: Economic and Market Considerations

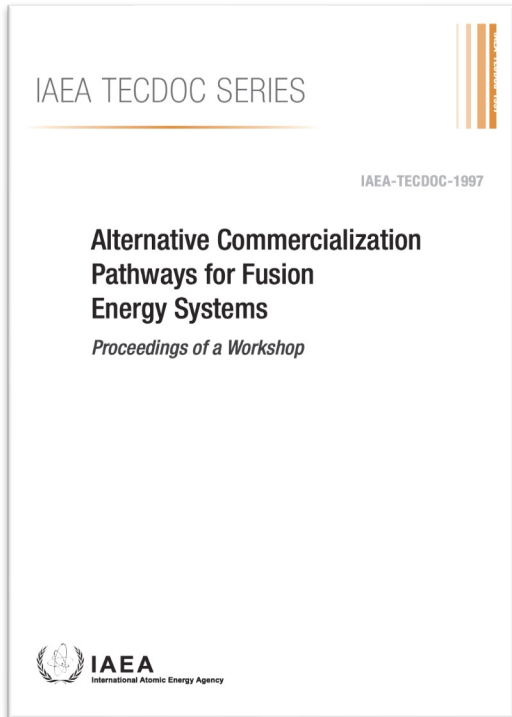
**Henri Paillere (IAEA)**

**Shutaro TAKEDA (Kyushu University)**

**Alik van HEEK (IAEA)**



- This week, IAEA published IAEA-TECDOC-1997 “*Alternative Commercialization Pathways for Fusion Energy Systems*”



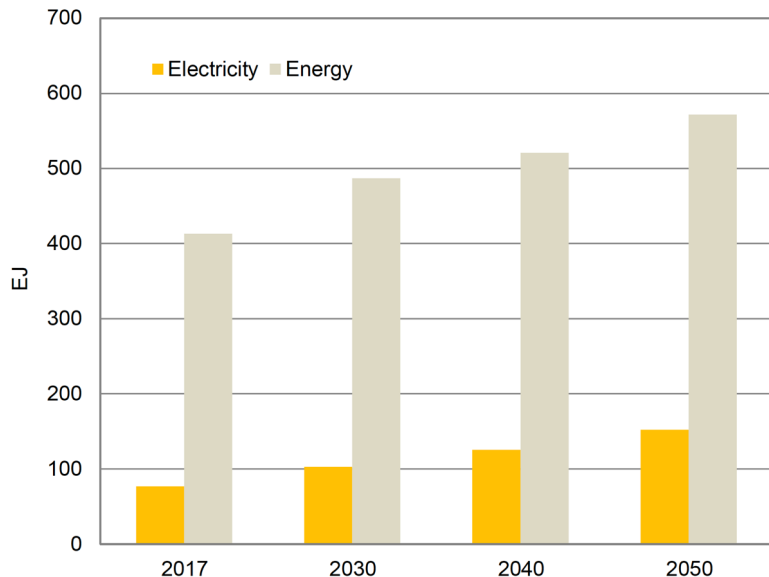
This document details:

- **Market**
- **Commercialization Pathways**
- **Fusion Power Core Design**
- **Constraints of Fusion Energy Systems**
- **Technologies of Fusion Enterprises**

of the “alternative pathways” (the private sector) for fusion energy for the first time.

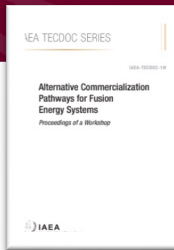
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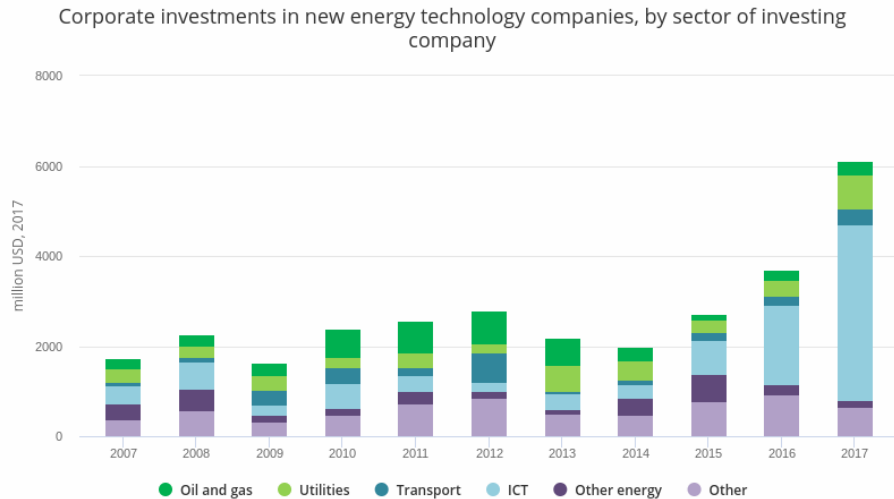


The IAEA's Projection of World Final Consumption of Energy and Electricity (IAEA, 2018)

- The IAEA expects the world energy consumption to increase by 18% by 2030 and by 38% by 2050.
- Among all energy sectors, the electricity use is projected to grow at more than double the pace of overall energy demand (IEA, 2021).
- Nuclear demand falls in developed countries although makes up 1/6 of total demand in developing countries by 2040.

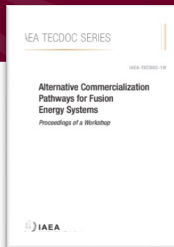


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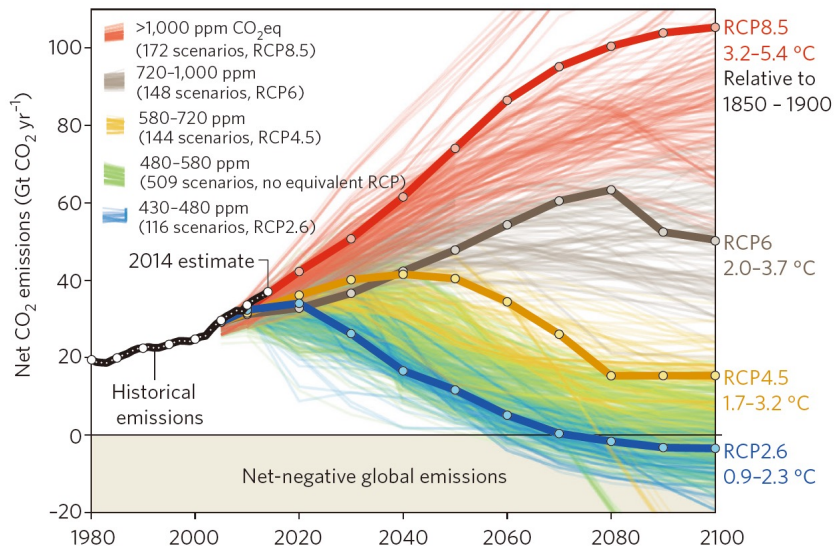


Investment in new energy technology companies by sector of investing company (IEA, 2019)

- Renewables and clean energy investment is on the rise (globally by 13% in 2017, driven by US spending) .
- Corporate investments in new energy technology companies are growing strongly, reaching their highest ever level of just over USD 6 billion in 2017
- However, fusion is a technology viewed with low technology readiness. Small programs are starting in a few member states to support the ambitions of private fusion enterprises (e.g. ARPA-E).

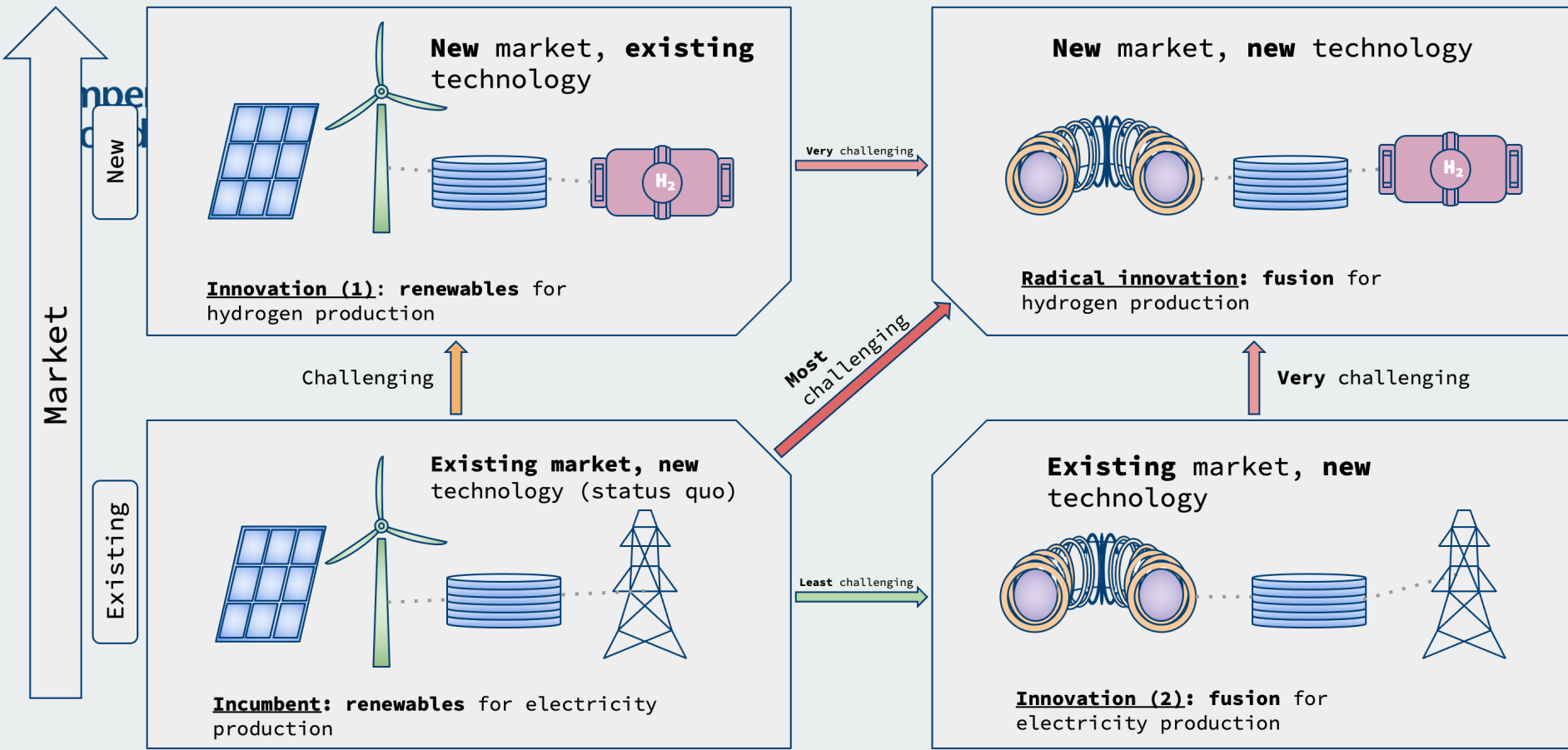


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Emission projections based on the IPCC Representative Concentration Pathways (RCPs)

- Fusion energy may have a potential in contributing to achieving this ambitious global goal.
- to achieve the Paris Agreement goals, the energy transition to low-carbon sources in the power sector would have to be completed by as early as 2040.
- **For fusion energy systems to make a significant contribution to the global energy transition, it is desirable that the technology becomes commercialized in the first part of the 21st century with the initial installed capacity of a few GW by 2050.**

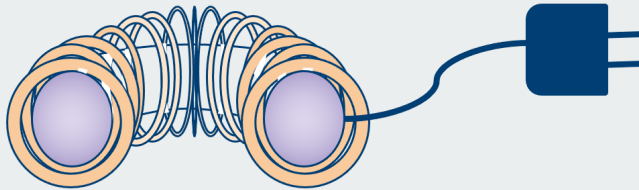


**Mr. Griffith's presentation on Monday:  
FUSION FOR THE ENERGY MARKET: ECONOMIC AND MARKET CONSIDERATIONS**

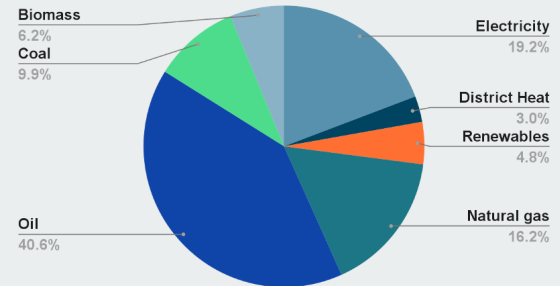
1. **The Role of fusion** - When commercialised, **what** form does it take? **Where** does it fit into the future energy system?

Electricity - 3 main findings:

- A. When there are **no** climate change drivers, fusion is **not** an emergent technology
- B. Fusion obtains a market share when climate change drivers are **in place**, with the inclusion of carbon taxes.
- C. Cost has the **biggest** impact on fusion's emergence



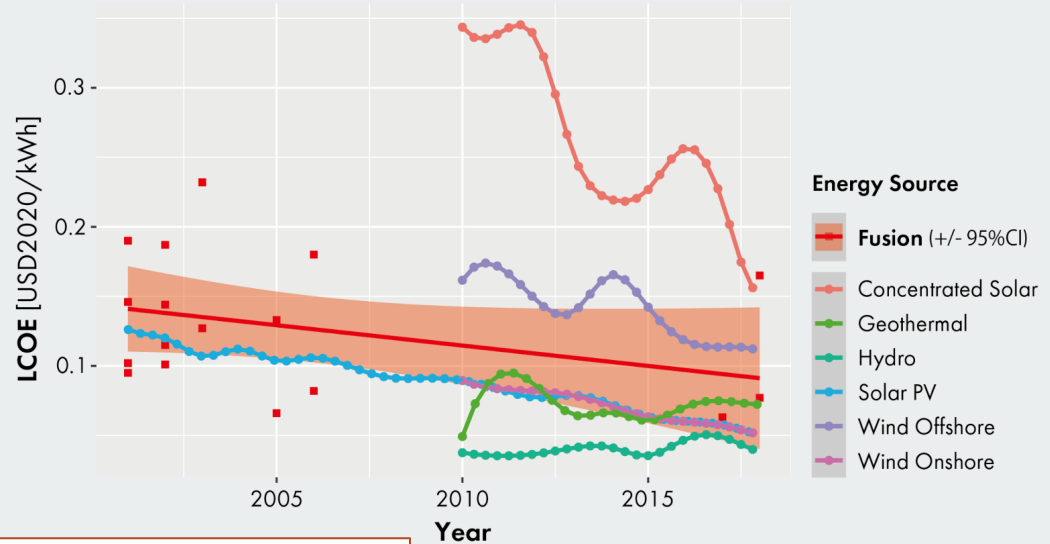
Final Energy Consumption by Sector 2018 (1)



## 2. Cost of fusion: compared to other technologies, how much will fusion cost?

Areas of technology R&D that can reduce uncertainty [20]:

- plasma physics,
- divertor physics,
- structural and functional materials (including fuel),
- waste handling and management (including remote handling),
- regulation, licensing, and associated activities.

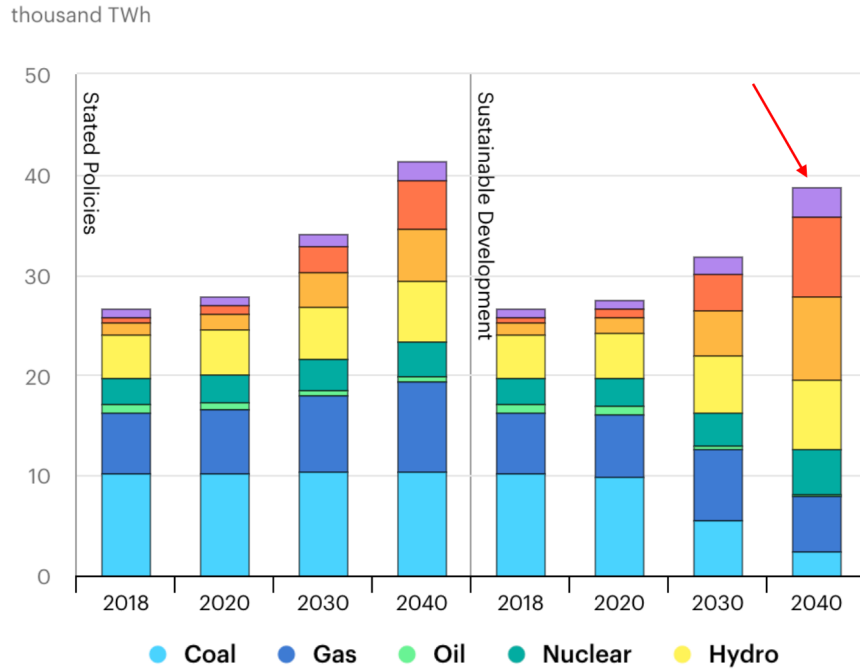


**Mr. Griffith's presentation on Monday:  
THE COMMERCIALISATION OF FUSION FOR THE ENERGY MARKET:  
A REVIEW OF SOCIO-ECONOMIC STUDIES**

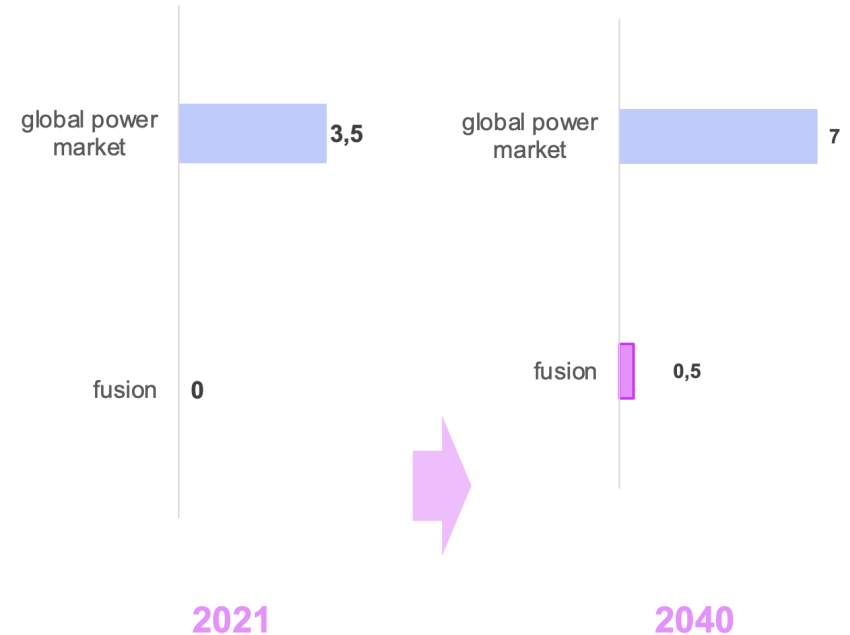


# Possible fusion energy market size in 2040 – floor estimation

## Actual and forecasted generation by fuel



## Power market size and fusion share, \$ trln

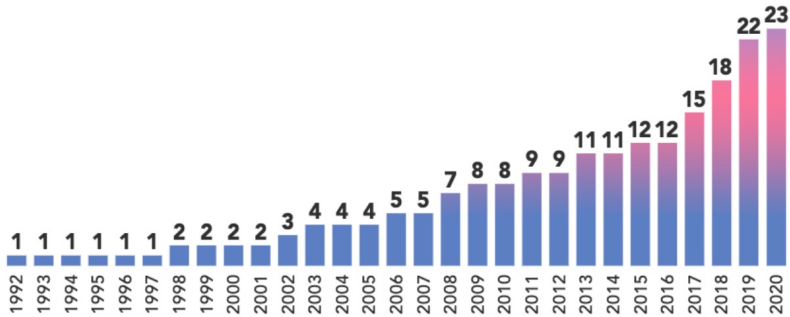


**Ms. Soldatova's upcoming presentation:  
FUSION ENERGY INDUSTRY: FROM DREAM TO REALITY**

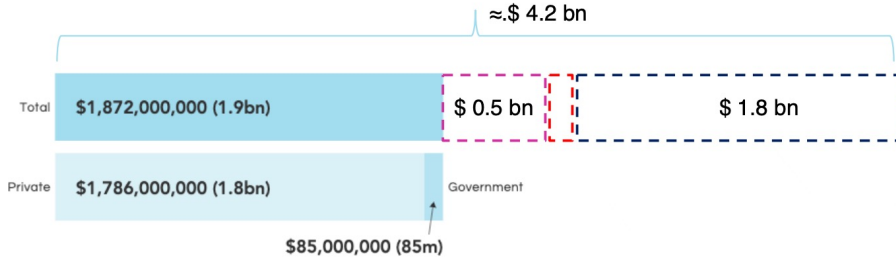
# SpaceX moment of fusion industry

Climate urgency and tech breakthroughs bring private fusion companies on the stage

Number of private fusion companies, #



Funding for fusion companies, \$ M



Technical approach taken by fusion companies



General approach

- 13 Magnetic confinement
- 5 Magneto-inertial
- 2 Hybrid electrostatic confinement
- 2 Inertial confinement
- 1 Non-thermal laser fusion
- 0 Cold fusion/LENR
- 0 Muon-catalysed fusion



Specific approach

- 3 Field Reversed Configuration
- 3 Tokamak
- 2 Spherical tokamak
- 2 Stellarator
- 2 Z-pinch
- 1 Dense plasma focus
- 1 Direct laser-driven pB11
- 1 Inertial-electrostatic confinement
- 1 Laser-driven inertial confinement (quantum enhanced)
- 1 Magnetic-electrostatic confinement
- 1 Magnetized target fusion
- 1 Plasma jet driven magneto-inertial fusion
- 1 Plectoneme
- 1 Shock-driven inertial confinement
- 1 Spheromak
- 1 undeclared
- 0 Laser-driven inertial confinement

**Ms. Soldatova's upcoming presentation:  
FUSION ENERGY INDUSTRY: FROM DREAM TO REALITY**



UK Atomic  
Energy  
Authority

# The 2nd IAEA **WORKSHOP**

## **ON FUSION ENTERPRISES**

**Virtual Event**

**11 - 12 July 2022**



**Sehila Gonzalez  
de Vicente (IAEA)**



**Taka Omae  
(ITER Organization)**



**Carly Anderson  
(Prime Movers Lab)**



**Ian Chapman  
(UKAEA)**

and 20+ pioneers from the field!

For more info, please visit: <https://conferences.iaea.org/event/304/>

# The 2nd IAEA WORKSHOP on Fusion Enterprises

Virtual Event  
11 - 12 July 2022

This IAEA workshop discusses the commercialization paths for fusion by bringing together the pioneering actors in fusion enterprises. The IAEA expects professionals from diverse fields to provide their views on the market demands for fusion, and whether the private sector could deliver what the market is demanding.

This event is suitable for a broad audience, including investors, policymakers, entrepreneurs, and scientists working on fusion energy. Prior expert knowledge on fusion is not assumed.

This is a virtual event.  
Registration is required by 20 June.

Register  
from here:



## Meet Our Speakers



Ian Chapman  
(UKAEA)



Carly Anderson  
(Prime Movers Lab)



Taka Omae  
(ITER Organization)

and 20+ pioneers from the field!

### CALL FOR POSTER: Private Enterprise Showcase

The organizing committee welcomes abstract submissions for the **on-line poster session**, titled the **Private Enterprise Showcase**. The Private Enterprise Showcase will be held on-line during the event, allowing participants to present their effort toward commercialization.

**Abstract Submission for the Private Enterprise Showcase (Poster Session) is open until 13 June.**

Please visit <https://conferences.iaea.org/event/304/> for more details.

## PROGRAM

**DAY 1** Times are all indicated in British Summer Time [UTC+1]

### Opening & Keynote [9:00 am – 9:45 am]

Chaired by Shutaro Takeda (Kyushu Univ./Kyoto Fusioneering)

Opening Remarks

**Ian Chapman** (UKAEA)

**Sehila Gonzalez de Vicente** (IAEA)

**Carly Anderson** (Prime Movers Lab)

Keynote Presentation

### Session 1: Market & Economics [10:00 am – 11:15 am]

Chaired by Ronald Miller (Decysive Systems)

1.1 Fusion in the Future Energy Market

1.2 Market Analysis for Fusion

1.3 Economic Constraints on Fusion

**Kirtsy Gogan** (Lucid Catalyst)

**Ailij van Heek** (IAEA)

**Niek L. Carodo** (Eindhoven Univ. of Technology)

### Session 2: Investment Environment [12:45 pm – 2:00 pm]

Chaired by Tim Bestwick (UKAEA)

2.1 Recent Trends in Investment

2.2 Driving the Energy Transition

2.3 From Funding to Financing

**Philip Larochelle** (Breakthrough Energy Ventures)

**Uwe Krueger** (Tamasek)

**Adam Baker** (BEIS, UK)

### Session 3: Enabling Technologies [2:15 pm – 3:30 pm]

Chaired by Simon Woodruff (Woodruff Scientific)

3.1 Wider Engineering Challenges

3.2 Enabling Technologies

3.3 Fusion Startup Ecosystem

**Andrew Sowder** (EPRI)

**Taka Nagao / Richard Pearson** (Kyoto Fusioneering)

**Toru Fukushima** (SuperPower Inc)

**Valerie Jamieson** (UKAEA)

## DAY 2

### Session 4: Commercialization [9:00 am – 10:40 am]

Chaired by Melanie Windridge (Fusion Energy Insights)

4.1 Road to Commercialisation: China

4.2 Road to Commercialisation: UK

4.3 Road to Commercialisation: Japan

4.4 Road to Commercialisation: US

TBD (ENN)

**David Howgate** (Atkins)

**Satoshi Konishi** (Kyoto University)

**Ahmed Diallo** (PPPL)

### Session 5: Private Fusion Roundtable [10:55 am – 12:55 pm] (Speakers TBA)

Chaired by Andrew Holland (Fusion Industry Association)

### Session 6: Future Considerations [2:30 pm – 4:00 pm]

Chaired by Shutaro Takeda (Kyushu Univ./Kyoto Fusioneering)

6.1 Establishing a Regulatory Framework

6.2 Supply Chain Challenges

6.3 Towards a Global Industry

**Sally Forbes** (UKAEA)

**Sehila Gonzalez de Vicente** (IAEA)

**Taka Omae** (ITER Organisation)

### Session 7: Review of Recent Progress [3:30 pm – 4:30 pm]

Chaired by Sehila Gonzalez de Vicente (IAEA)

7.1 Review of Technical Advances

7.2 Review of Private Enterprise Showcase

**Sam Wurzel** (DOE, US)

**Andrew Holland** (Fusion Industry Association)

## ONLINE POSTER SESSION

[Day 1: 11:15 am – 12:45 pm, 3:30 pm – 5:00 pm]

[Day 2: 2:25 pm – 3:55 pm]



IAEA  
International Atomic Energy Agency

### Scientific Secretary

Sehila M. González de Vicente (Ms.)  
Department of Nuclear Sciences and Applications  
International Atomic Energy Agency

Vienna International Centre 1400 Vienna, Austria  
S.M.Gonzalez-De-Vicente@iaea.org

- **A must-attend event! Registration closing very soon**
- **Poster presentation abstract submission is in due in 3 days.**
- Please ask me (Shutaro Takeda) or Sehila Gonzalez de Vicente if you have any questions.



- In this session, we will hear from the following experts:
  - Ms. Anna Soldatova, FUSION ENERGY INDUSTRY: FROM DREAM TO REALITY
  
- C.f. There was a related session on Monday, *2.02 Economic and market considerations on nuclear fusion power plants*:
  - Mr. Thomas Griffiths and Mr. Shutaro Takeda, FUSION FOR THE ENERGY MARKET: ECONOMIC AND MARKET CONSIDERATIONS
  - Mr. Thomas Griffiths, THE COMMERCIALISATION OF FUSION FOR THE ENERGY MARKET: A REVIEW OF SOCIO-ECONOMIC STUDIES