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# Fusion Foresight & strategic public-private partnership approach to foster innovation in fusion energy

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Matthew Smith

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[www.trinomics.eu](http://www.trinomics.eu)

# Trinomics – who we are



*A strategic consultancy working on energy, climate change and environmental topics from an economics angle for EU, national, and international clients.*

Founded in  
Rotterdam in 2012

>60 consultants

~25 nationalities

Diverse backgrounds  
Engineering, economics,  
law, science ...



+ associates based in:  
**Germany, Greece, UK, Türkiye,  
Canada, and Tanzania**

## Energy markets & infrastructure

- Infra & system integration, energy regulation & markets

## Decarbonisation

- Industrial decarbonisation technologies + policies (e.g. ETS), Energy efficiency

## Energy & climate policy

- Governance, adaptation

## Green Finance

### Environment

- Nature & biodiversity, water, agriculture, cross-cutting

### Green economy

- Eco-design, resource efficiency, waste management, consumer behavior, green jobs and skills

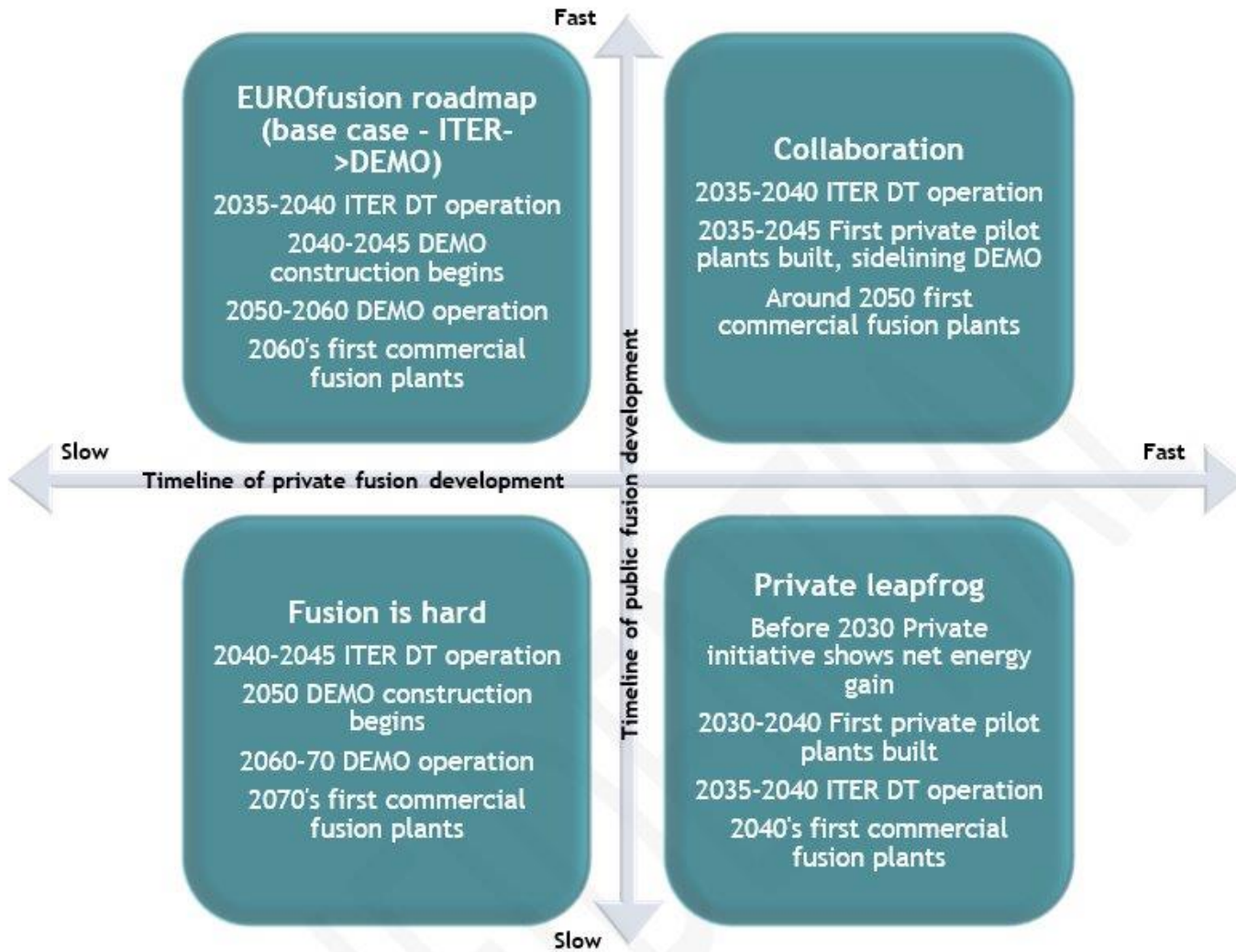


- Foresight study on fusion
  - <https://op.europa.eu/en/publication-detail/-/publication/83bc3ecd-b19c-11ed-8912-01aa75ed71a1/language-en>
- Benefits of the Broader Approach
  - <https://op.europa.eu/en/publication-detail/-/publication/c54c336d-bdce-11eb-8aca-01aa75ed71a1/language-en/format-PDF/source-search>
- Economic impact of ITER
  - [https://trinomics.eu/wp-content/uploads/2019/04/impact\\_of\\_the\\_iter\\_activities\\_in\\_the\\_eu-trinomics.pdf](https://trinomics.eu/wp-content/uploads/2019/04/impact_of_the_iter_activities_in_the_eu-trinomics.pdf)
- Governance framework for ITER
  - [https://energy.ec.europa.eu/system/files/2019-04/supporting\\_analysis\\_for\\_an\\_ia-trinomics\\_0.pdf](https://energy.ec.europa.eu/system/files/2019-04/supporting_analysis_for_an_ia-trinomics_0.pdf)

# Trinomics – Foresight context

- Public initiatives progressing globally
  - Records at JET, NIF, K-STAR, others
  - Continued advances in plasma science and other areas
- However, ITER flagship is suffering delays
  - FOAK project, regulatory issues, design changes
  - Delays push an already long timeline further back into 2050's or later – too late?
- Private industry has started to emerge in last 5 years
  - Handful of firms secured significant financing
  - Many new start-ups each year – not (yet) a Dutch fusion start-up
  - Exciting times, promising fusion in 2030's

Approach	Initiative	2020-2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050
MCF - Tokamak	ITER / DEMO		First plasma 2026		DT operation 2036		2050
	ARC / SPARC (CFS)		2025	2031-2032			
MCF - Spherical Tokamak	MAST-U / STEP (UK)	2020				2040	
	NSTX-U (US)	2024					
	EXL50 - ENN		2030		2037		
	Tokamak Energy		2026	2033			
MCF - Stellarator	WX-7 (EU-DE)	2015					
	Renaissance Fusion		2027	2032			
	Type One Energy		2028	2034			
MCF - Z-pinch	Zap Energy	2024	2030				
MCF - Compact Toroids (FRC, Spheromak)	CT Fusion		2026	2034			
	TAE Technologies	2025		2032			
IFE	(ICF) NIF (US)	2009					
	First Light Fusion	2024					
	Focused Energy		2028- 2030	2035			
	HB11		2027		2030's		
	Marvel Fusion		2027				
MIF - FRC	Helion Energy	2024	2030				
MIF - MTF	General Fusion		2026	2032			



## Scenarios for fusion development

- Speed of public and private development can be axes to define possibilities
- Private leapfrog - promises to do it all
  - But healthy scepticism
- EUROfusion roadmap – public leads
  - Misses main benefit of private industry innovation and speed, locked into tokamak approach
  - Needs to adjust to new private industry reality
- Collaboration
  - Scenario based around contributions from both
  - EU should look at public-private partnership (PPP) programmes that can help move in this direction
  - Examples of PPP in the US (ARPA-E, INFUSE) and UK (STEP related), and in other sectors in the EU and globally

# Overview of most recent study



Carried out by Trinomics and associated experts for the European Commission DG Energy in 2023.

The goals of this study were three-fold:

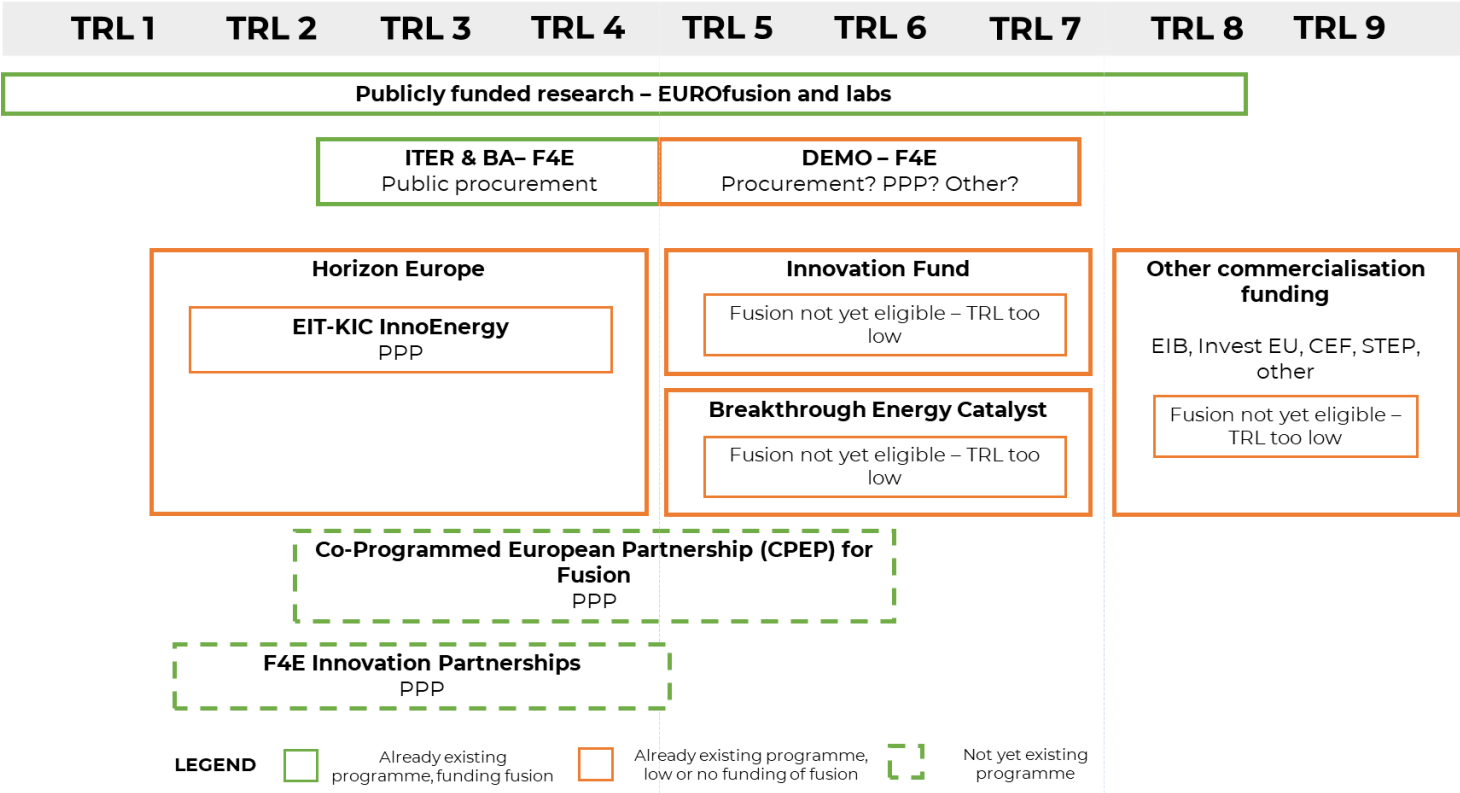
- **Analysing Public Private Partnership (PPP) schemes around the world**, both within and outside fusion energy, to inform the EC on an EU PPP design, understanding their key characteristics, strengths and weaknesses;
- **Using the analysis of PPP schemes to set out the key design features of an EU PPP scheme for fusion energy** which fits with the broader strategic, organisational, legal and financial context;
- **Additionally, mapping and identifying stakeholders in the European fusion sector that are keen to engage in a PPP and further innovation** in the field of fusion.

The study methodology combined desk review, interviews, workshops, and validation focus groups to inform the design of an EU PPP scheme for fusion energy.

# Existing landscape

## Summary of EU funding

- Significant past and continuing funding (ITER, Broader Approach) for industry innovation
- Continuing funding for scientific work (EUROfusion)
- But limited funding (IFMIF-DONES, other small) for further industrial innovation in short-medium term
- DEMO would be next major industrial involvement but funding scale-up remains probably >10 years away
- Almost no specific support for start-ups
- National funds also play a role, e.g. DE, FR, IT



# Potential objectives of an EU PPP

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In the context of an overarching EU objective of a future fusion power plant, for an EU PPP two main objectives were considered:

- 1. DEMO as the primary objective:** emphasizing partnerships between public research and engineering firms, accelerating conceptual design development for DEMO. It further leverages existing DEMO-focused work streams at F4E and EUROfusion.
- 2. Key Enabling Technologies (KETs) as the primary objective(s):** this approach directs attention toward addressing remaining key technical challenges, such as the tritium fuel cycle, first wall materials, remote handling, etc. It aligns with a long-term strategy toward fusion power plants and complements DEMO work streams.

In either case any EU PPP should look to create a framework for industrial investment in fusion innovation, with technology transfer from research institutions, leveraging the strengths of public and private sectors and taking advantage of the lessons learnt from ITER.

It should also retain flexibility for the EU and find a way to support EU start-ups.

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# Options considered for an EU fusion PPP

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## Basis for a PPP

- **Co-Programmed European Partnership** – between EC and private or public partners, involving both labs and the fusion community. Most interesting from the Horizon options
- **EIT/KIC** – institutionalised alternative under Horizon, has funded one fusion start-up under InnoEnergy KIC
- **F4E Innovation Partnership** – existing contractual mechanism potentially suited as vehicle for fusion
- **Other instruments** (take more time and political effort)
  - EC directly funds a new PPP instrument
  - Separate legal entity (example: PLT)
  - Innovation Fund, EIB, other (TRL too low)
  - Following US and UK models



# Overview - recommendations

**Create a Co-Programmed European Partnership for fusion innovation**

Partnership arrangement under Euratom  
Objectives based on a **Strategic Research and Innovation Agenda (SRIA)**  
Partnership projects contracting consortia of industry and research  
50:50 cost sharing  
Focused on Key Enabling Technologies – those with short-medium term commercialisation possibilities

**Evolve F4E activities:  
F4E Innovation Partnerships**

Contractual PPP arrangement under F4E  
Partnership projects contracting consortia of industry and research (10-30% own contributions)  
Focused on Key Enabling Technologies – those with few short-medium term commercialisation possibilities  
Following Technology Development Plan – aligned to DEMO  
Additional to existing work on ITER, BA, IFMIF-DONES

**EIT-KIC InnoEnergy  
Ensure seed funding for fusion start-ups**

Seed funding for innovative fusion start-ups and SMEs

## Create CPEP for Fusion Innovation under Euratom

- Budget of in range of tens of millions (or more) annually is recommended – should envisage this potentially growing over time
  - To begin as soon as practical – 2025-2027 if possible, otherwise from next MFF
    - If from next MFF, then it becomes more important to make use of the F4E instrument in the short term
  - Strategic Research and Innovation Agenda (SRIA) should target Key Enabling Technologies – focus on those with clearer short-medium term commercialisation possibilities
  - Advise for a split in funding, e.g. 75:25, split
    - Largest share: DEMO aligned KETs - development and demonstration
    - Smaller share: Other fusion approaches (not only MCF) – high risk but high potential
  - DEMO focused share – should help to position EU industry in global supply chain
  - Consortia bidding for calls will most likely be led by industry (including start-ups) and involving research labs
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## Opportunities for NL science and industry

- Not yet any Dutch fusion start-ups...
    - ...hope we have some aspiring entrepreneurs in the audience
  - PPP offers opportunities for public support to start-ups
  - Opportunities for other industry players to position in supply chain for the fusion
    - Start-ups and new public projects each offer opportunities
  - Research community should see more collaboration opportunities
    - Also positive in growing employment opportunities from research -> industry
  - **What should be organised & funded by the Dutch government?**
    - Germany has new strategy and has increased funding significantly
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Thank you for your attention, please contact us for more information



**Matthew Smith**

matthew.Smith@trinomics.eu

# Back-up slides

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## Maintain existing funding to EUROfusion, ITER, IFMIF-DONES

- A new PPP should be additional
  - Main scientific and other work to continue unchanged
  - Including early conceptual design work for DEMO (which has a small industry partnership element)
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# What would this mean?

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## For stakeholders

### Industry – supply chain

- Significantly increase opportunities for work on innovation in fusion
- Boost innovation, staff and knowledge retention and competitiveness
- Requires matching investments (in-kind contributions)

### Start-ups

- New mechanisms to access public funding – especially relevant for MCF firms.
- Opportunities to lead consortia on KETs
- Opportunities for non-MCF start-ups
- Access to public funding helps to access further private funding

### Research labs

- New opportunities for funding and technology transfer
  - Increased research opportunities and potential scientific knowledge from development and demonstration projects
  - Provide improved career pathways for staff and students
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# What does this mean?

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## For stakeholders

### EUROfusion

- Continue to drive scientific work and early DEMO work
- New opportunities, especially through CPEP, to work with industry to address KETs needed for DEMO
- Important role in supporting alignment of work under PPPs towards eventual needs of DEMO – especially in contributing to development of SRIA

### F4E

- Innovation partnerships provide a short-medium term goal – making use of technical capabilities and industrial network
  - Aligns priorities towards future work on DEMO to ensure efficient use of current available budgets
  - Can play an important role in formation of industry representative groups
  - Also an important contributor to a coherent EU SRIA for fusion
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# What does this mean?

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## For DEMO

- Continued conceptual and design work through EUROfusion and F4E procurement
  - New instruments support necessary technology development for DEMO
    - Whilst the purpose of the proposed instrument would not be DEMO...
    - ...the SRIA of each programme should be coherent and aligned to DEMO to ensure that a large part of the work and outputs contribute towards this purpose in future
  - Longer term, e.g. in 10 years, progress on ITER and via the PPPs should ensure that more concrete actions can be taken towards DEMO as necessary, i.e. creation of a joint undertaking (also PPP) for DEMO construction
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