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PERSPECTIVE

Generation fusion: the human factor in the fusion equation

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Abstract

The human factor in fusion energy development is about those who will take fusion from the laboratory to the grid and under what conditions. While this is among the most strategically important dimensions of the field, it is also among the least formally discussed. During the 51st European Physical Society (EPS) Conference on Plasma Physics in Vilnius, Lithuania, *Generation Fusion* was held as a satellite event on 9th July 2025. It was set-up as a panel discussion and was a direct sequel to the *Visions for Fusion* event held at the 50th EPS Conference. The panel brought together six researchers and industry representatives from different career stages, working in magnetic confinement fusion, inertial confinement fusion, and related fields. Using live audience polling of approximately 100 participants, panel discussions, and an open Q&A, the event explored topics including motivation and retention of early-career researchers, the role of mentoring and soft skills, public-private partnerships, mobility between institutions and countries, interdisciplinary collaboration, and communication with society and policy-makers. A clear and consistent finding emerged: the field faces not a lack of motivation, the overwhelming majority of attendees expressed a desire to remain in fusion, but rather structural barriers such as employment instability, limiting mentoring frameworks, and insufficient permeability between academia and industry. The panel closed with a strong consensus calling for greater diversity, more equitable career paths, and a shift away from metrics such as the H-index towards broader definitions of scientific impact, including, for example, public communications.

1. The human factor: context and motivation

> *'This year we are looking at something that was not there last year, a very important aspect: the human factor. We want to look at the generation that is hopefully going to bring fusion to reality, and we want to look at their perspectives, their expectations, their challenges.'*
>
> –Kristel Crombó

The fusion energy landscape has changed significantly over the past decade. Record-breaking results from the JET tokamak [1] or the Wendelstein W7-X stellarator [2], and the scientific break-even achieved at the National Ignition Facility [3] have generated unprecedented public, political, and industrial interest. A new ecosystem of private fusion companies has emerged [4] alongside established national programs,

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offering researchers career paths that did not exist a decade ago. Yet this momentum brings its own pressure: unrealistic public expectations about timelines [5], intensifying competition for skilled personnel between academia and industry [6], and the persistent structural fragility of early-career positions.

Building on the success of the previous *Visions for Fusion* panel discussion held in 2024 [7], the EPS Plasma Physics Division Board, chaired by Kristel Crombó, organized the *Generation Fusion* event as its direct sequel. Where the former event focused on scientific and technological roadmaps and the mechanisms of public-private partnerships, Generation Fusion placed the human element at its center: the researchers themselves, their motivation and anxieties, and the community habits and expectations, its unwritten rules and assumptions, some helpful, some not, that shape careers in the fusion community and thus also the community itself.

The event was held on the evening of 9th July 2025, as a satellite event of the 51st EPS Conference on Plasma Physics in Vilnius, Lithuania. It was moderated by the lead author of this paper, Alf Köhn-Seemann (University of Stuttgart, chairman of FuseNet), and featured six panelists from a diverse range of career stages, institutional settings, and scientific subfields (listed in no particular order):

- Felicity Maiden (PhD candidate, magnetic confinement fusion, University of York/UKAEA/Tokamak Energy),
- Duncan Barlow (postdoctoral researcher, inertial confinement fusion, LULI Paris/Taranis),
- Hervó Besaucèle (CTO of GenF, inertial confinement fusion startup),
- António J Coelho (transport physicist, Gauss Fusion GmbH, magnetic confinement fusion startup),
- Mažena Mackoit Sinkevičienė (postdoctoral researcher, quantum optics, Vilnius University), and
- Andrius Tamosiunas (deputy director, Lithuanian Energy Institute, low-temperature plasmas).

Sinkevičienė and Tamosiunas, two researchers from adjacent disciplines to fusion research, were included intentionally to enrich the discussion with perspectives on community-building, science policy, and the broader quantum and plasma ecosystem in Eastern Europe.

The event was live-streamed and recorded on YouTube[11]. Audience participation was organized via the Mentimeter platform [8], yielding quantitative polling data from approximately 75 active attendees, and via an open Q&A in which attendees (online and at the event) submitted questions or asked them directly at the microphone. A reception after the event was generously sponsored by Renaissance Fusion and Hiden Analytical.

2. Audience snapshot: polling results

Before the panel discussion began, a few short polling questions were posed to the audience. These served both as an icebreaker and as a way to get a sense of who was in the room. Three of the questions were directly relevant to the panel discussion and are thus reported here.

Have you ever considered leaving the field? This question yielded probably the most striking result of the evening: 36 of 59 respondents, corresponding to 61%, had answered 'yes, absolutely', as illustrated in figure 1(left). This result provided an important foundation for the discussion that followed, as it basically set the emotional tone of the discussion: the field is not losing researchers because they lack passion or motivation, but rather because structural barriers hinder them to stay, as became apparent throughout the discussion.

What would you prefer, in an ideal world? The follow-up question revealed a sharp contrast to the previous one: as illustrated in figure 1 (right), 46 of 66 respondents, corresponding to 70% stated they would prefer to stay in the field, with only 3 (5%) actively wishing to leave. The gap between the 61% who have at a certain point in their career considered leaving and the 70% who wish to stay is the clearest quantitative signal from the event: there is a substantial group of researchers who are loyal to fusion but feeling structurally pushed towards the exit.

What is the biggest bottleneck in fusion? Among 76 respondents, engineering challenges led this poll with 33 votes (43%), as illustrated in figure 2, followed closely by funding (37%). Physics challenges

[11] The recording of the event is available at www.youtube.com/live/AQRDWUfPUOQ.

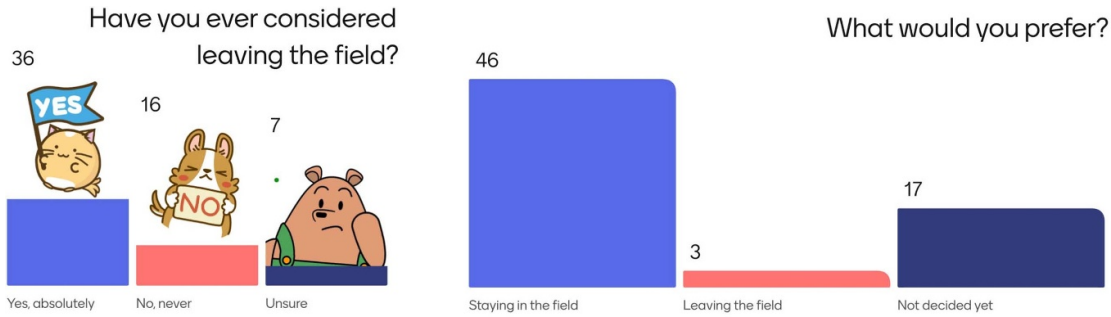


Figure 1. Results of two polls, where the audience was asked, if they have every considered leaving the field (left) and what would they prefer (right). Graphic produced by Mentimeter.

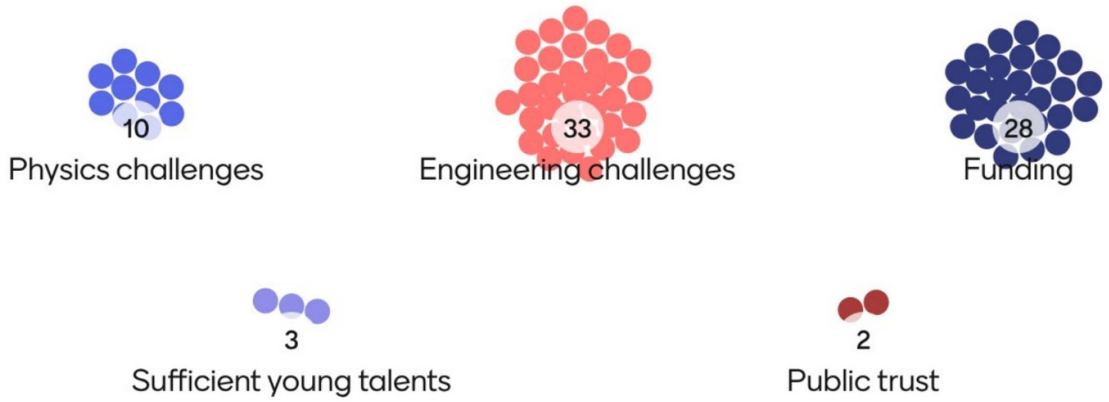


Figure 2. Result of a poll, where the audience was asked, what they consider the biggest bottleneck in fusion. Graphic produced by Mentimeter.

(13%)follows with a gap, sufficient young talents (4%) and public trust (3%) with another gap. The low ranking of 'sufficient young talents' and 'public trust' is noteworthy: the community does not perceive itself as struggling to attract young researchers, there seems to be no shortage of people wanting to enter fusion, as the polling data indicates. Notably, this stands in some contrast to a broader consensus among decision makers that workforce development needs to be strongly accelerated [9]. The community itself, however, seems to feel the real problem lying further down the road: retaining the people. A field in which 61% of attendees have considered leaving at a certain point, yet 70% would prefer to stay, is not failing at recruitment but instead failing at creating conditions that allow committed people to build a career. This distinction emerged repeatedly in the panel discussion.

The low vote for public trust is interesting, as it stands in contrast to the panel's later emphasis on science communication. A likely explanation is that engineering and physics challenges feel immediate and concrete to researchers working on them every day. Public acceptance problems, however, follow much slower timescales, such as budget decisions, political will, or planning permissions that most researchers will not encounter directly. Yet the history of nuclear fission serves as a clear warning: a technology that successfully overcame its main scientific and engineering challenges, but whose deployment has been constrained by public and political opposition that the research community had not adequately addressed [10]. The fusion community should treat public trust as a challenge that requires sustained investment, beginning long before the technology is ready to be deployed [11]. It is worth noting that concerns about climate change have recently prompted a renewed interest in fission in several countries [12], illustrating that public attitudes towards energy technologies can change. This should encourage the fusion community to invest more in public communication, rather than waiting until it becomes urgent.

As a note on the polling data, one should keep in mind that the audience at the Generation Fusion event was relatively small, around 100 people of which between 60 and 76 responded to the questions. It was furthermore predominantly European and skewed towards MCF, reflecting the composition of the EPS conference itsel which typically consists mostly of MCF researchers. The results should therefore not

be read as a representative survey of the global fusion workforce. Instead, they offer a meaningful snapshot of the attitudes and concerns of an engaged group of fusion researchers. The patterns that emerged from the polling were consistent and were reinforced throughout the panel discussion, which gives us some confidence that they reflect real and widespread tensions in the community, even if the precise percentages should be treated with appropriate care.

3. Entering the field: motivation, role models, and the adjustment of expectations

> *'My physics teacher said fusion is the ideal energy source, but it is impossible. And I was like 'Oh, well, that's a shame'. Then I found out I was working on a fusion power plant that was going to be built by 2040. That was just mind-blowing. You come into it with very green eyes. And now, throughout my PhD, I have learned a few more of the challenges. But I am still optimistic.'*
>
> –Felicity Maiden

A recurring pattern among researchers entering fusion is that the decisive moment was not a deliberate career choice, but an encounter by chance with the right person at the right time. Maiden's story illustrated that clearly, where Roddy Vann, her undergraduate supervisor at the University of York, was explicitly credited as playing a key role, someone who offered a summer project and, in doing so, opened a career path. Maiden also mentioned the gradual adjustment of expectations as the true scale of the scientific and engineering challenges became clear.

Tamosiunas' story revealed a similar pattern: an invitation from a lecturer during his master's studies set him on a research path he has followed for sixteen years, eventually leading to his appointment as Deputy Director of the Lithuanian Energy Institute, a position he had never imagined for himself. Sinkevičienė described her own path in the quantum optics community, pointing out that informal mentoring encounters and her participation in the EPS Young Minds programme [13] and the Lindau Nobel Laureate Meetings [14], had shaped her career at least as much as formal supervision had.

Maiden was open about how her views had shifted as she learned more: a week-long module on material science for fusion during her doctoral training had left her wondering whether the whole thing could ever actually work. This oscillation between optimism and doubt was acknowledged by the audience polling, revealing that 61% had considered leaving at a certain point, yet the panel unanimously agreed that such moments of doubt are normal [15] and even a productive and normal part of a scientific career [16], rather than evidence of fundamental disillusionment.

Besaucèle offered a different and deliberately provocative entry point: he came to fusion as a CTO in his fifties, after a career in high-power laser development for the semiconductor industry. His message was basically that fusion is not exclusively a young person's field, and the skills developed in adjacent high-technology sectors are transferable and urgently needed. His own path from extreme ultraviolet light sources for chip manufacturing to inertial confinement fusion illustrated the kind of cross-sector mobility the field increasingly requires at senior levels.

4. Staying in the field: structural barriers

> *"One of the major obstacles is more stable employment for early-career professionals. It puts a lot of people off, and it is also a self-selecting criterion, selecting towards those who are willing to move, change their lifestyle, be adaptable. Which can be beneficial. But it is also narrowing our field of selection."*
>
> -Duncan Barlow

Employment stability emerged as the single most consistently identified structural barrier driving researchers away from the field. The sequence of two- to three-year contracts, each requiring relocation, a common requirement in academia [17], narrows the field towards those who happen to be in a position (financially, personally, geographically) to handle that instability. Barlow, on his third postdoctoral position at the time of this event, spoke from a direct experience. This self-selection is real and costly: it silently excludes researchers with caring responsibilities [18], with partners who have immovable careers, or simply those who value continuity and community belonging alongside a scientific career.

Besaucèle pointed to another problem: academic employment tends to offer only two options, a short fixed-term contract or a permanent position, with very little in between. This binary choice is not

just inconvenient, it is rather a failure of the system. He suggested some possible middle-ground solutions, such as longer rolling contracts, joint positions between universities and industry, and co-funded positions, none of which are currently used as widely as they could be.

The question of the postdoctoral pay was raised directly by the audience. While acknowledging that academia cannot really compete with industry on salary [19], Tamosiunas described the approach at his institute, the Lithuanian Energy Institute: supplementary funds for accommodation, support for relocation of families, and a path towards permanent employment for high-performing researchers. Coelho supported this concept, arguing that stability matters more than salary to many researchers. The offer of a permanent position at a moderate salary may be more effective at retaining talent than a well-paid but time-limited postdoc.

> *'When people say, 'Do you want to stay in fusion', I really want to stay in fusion. But if the question is, 'Do you want to stay in fusion and move to a different country, where they might not speak your language, leave your family, your partner, your friends?', it becomes a huge ask. We are automatically disregarding an entire proportion of the population that cannot or will not make that jump.'*
>
> –Felicity Maiden

The conventional academic expectation that geographic mobility is essential for career development [17] and that an unwillingness to move reflects limited ambitions, was challenged from multiple directions. Maiden articulated its cost on a personal level most directly: mobility is not neutral, and the implicit expectation of international relocation constitutes a structural filter that disproportionately affects those with domestic commitments. Coelho offered a historical counter-argument: stellarator pioneer Lyman Spitzer at Princeton [20] and the Soviet tokamak pioneers Igor Yevgenyevich Tamm and Andrei Dmitrievich Sakharov [21] produced foundational plasma physics in relative isolation, demonstrating that excellence does not require constant mobility. It should be noted, however, that these were exceptional individuals working under very specific historical circumstances, and their examples may not directly generalize to the broader researcher population today (but may still serve to inspire them). Tamosiunas raised a geographical dimension that is often overlooked in Western European discussions: in Eastern Europe, researchers have historically been significantly less mobile than their Western colleagues, in part due to stronger family ties and community roots, although this simplifying statement should be treated with care as socio-economical factors are likely to be the underlying cause [22]. This lack of mobility should not be misunderstood as a cultural deficit but it rather reflects a different set of social priorities that the field should acknowledge instead of penalizing it.

It should be noted here that FuseNet provides short-term mobility grants, funding internships of a few weeks for Master students at partner institutions [23]. This can be considered a practical instrument for providing networking opportunities and international exposure without requiring the full commitment of a multi-year relocation [24]. Similar lightweight, low-boundaries-to-enter mechanisms deserve wider adoption and publicity.

5. Mentoring, soft skills, and the infrastructure of career development

> *'We can get excellent technical support when working on a specific project. But there is very little guidance on how to actually build a scientific career. We barely train early-career researchers in the critical skills: how to apply for funding, prepare proposals, build networks, manage a team, or transition into a leadership position. Soft skills, I know they are not our strong association as physicists. But they are learnable, and in the long term they pay off.'*
>
> –Mažena Mackoit Sinkevičienė

The fusion community excels at technical training through summer schools [25, 26], specialized programs [27, 28], and direct project supervision. It neglects, however, the non-technical skills that determine whether a researcher can actually build and sustain a career: grant writing, network formation, team leadership, and the ability to communicate science to the public and to political audiences. This structural gap was articulated most clearly by Sinkevičienė, drawing on her experience co-authoring the Lithuania National Quantum Technology Roadmap and representing her country in the European Quantum Flagship's Quantum Community Network [29].

Barlow validated this from his own experience: the colleagues he had seen leave academia had, in most cases, done so not because of scientific disillusionment, but because of poor supervision, i.e. supervisors who were technically very skilled but provided poor personal development guidance, left

doctoral students isolated, or created environments that have the potential to transform into toxic relationships [30, 31]. It should be noted, however, that mentoring is also challenging and demands institutional infrastructure, not just individual good will [32].

The panel broadly agreed that the solution lies not in more summer schools but in dedicated institutional investment: dedicated HR support for supervision, explicit mentoring training for group leaders, and formal mechanisms for doctoral students and postdocs to raise concerns confidentially. International programs like the EPS Young Minds programme, FuseNet's or EUROfusion's network can be particularly helpful at institutions that lack a critical mass of plasma physicists to create the just mentioned programs.

Barlow mentioned his own recent experience of drafting a long-term research proposal for a permanent position, in which he had to provide a five- to ten-year scientific plan. He described the process being unexpectedly formative: it forced him to position his individual expertise with the broader community landscape and to articulate what he could offer collaborators, not only what he needed from them. Such a structured forward planning, he argued, is a precondition for taking eventually leadership responsibility, and institutions should provide support for early-career researchers undertaking it.

6. The public-private partnership: collaboration, tension, permeability

> *'The collaboration between public and private is fundamental. We have to build more bridges to allow careers to move from academia to private, and back! It is the 'back' that is more difficult today. Moving to a start-up can be seen as a deal-breaker for an academic career, and that has to change.'*
>
> –Hervó Besaucèle

The permeability of the boundary between publicly funded research and private fusion projects is among the structurally most important questions the community faces at the moment. Maiden, who had worked during her doctoral studies at a university, a national laboratory, and a private company, described a full spectrum: from acquiring knowledge for the sake of it in academia, via the mission-focused but still scientifically open environment at national laboratories, to the investor-driven goal orientation of private companies. Each has its own advantages, and each suits different researchers. The emergence of private fusion companies has, she argued, created opportunities that did not exist previously, as they can capture researchers who would have left the field entirely otherwise (instead of accepting another fixed-term academic position somewhere).

Besaucèle and Coelho both emphasized that the fusion industry requires researchers trained in fundamental plasma physics on the way to the first fusion power plant. Researchers like Barlow or Maiden who move (almost) frictionless between national laboratories or universities and start-ups are crucial for the success of the private initiatives.

The tension identified by Besaucèle, that moving from academia to industry is still perceived by some as a career exit from academia, was widely recognized. The panel argued that cultural change within academic institutions, supported by policy changes in how a researcher is evaluated, is necessary to allow for academia → industry → academia career paths. It was noted that such paths are appearing more often now and should actively be embraced and celebrated rather than treated with skepticism.

7. A multidisciplinary endeavor

> *'At ETH Zurich, there is no plasma experiment. So all those brilliant engineers being educated there will never be exposed to fusion. They will not know that they are needed. We are going to need a lot of mechanical engineers, electrical engineers, material engineers. And they need to encounter fusion early enough to consider it as a career.'*
>
> –António J Coelho

The interdisciplinary dimension of fusion is nicely illustrated by a characterization offered by Andreas Dinklage: 'fusion is a pentathlon, a heptathlon, maybe even a decathlon, a combination of plasma physics, engineering, material science, computer science, and more'. Coelho, drawing on his experience from the Swiss Plasma Center, gave a concrete example of where interdisciplinary collaboration works, and where it does not. At EPFL, students from materials science, mathematics, and computer science regularly work with the plasma physics group, simply because the experiment, the TCV tokamak, is there and visible. Students who have lunch next to a tokamak will eventually ask what this thing is.

At ETH Zurich, by contrast, there is no plasma experiment and so an entire cohort of brilliant engineers graduates without ever considering fusion as a career option. This is not their fault as they were simply never exposed to it. This pattern applies elsewhere: the University of Cambridge, for instance, is approximately a 2 h drive away from the Culham Centre for Fusion Energy (CCFE), and has only a very small fusion program. The University of Oxford, in contrast, which is about a 15 min drive away from CCFE, has strong fusion activities. FuseNet and university outreach programs can help to close this gap, but only if they make a deliberate effort to reach beyond institutions that already have fusion on site.

The question of communication between MCF and ICF communities was raised by both the moderator and the audience. Barlow, who had originally applied for MCF doctoral positions before ending up in ICF, spoke positively about the knowledge exchange already happening between the two communities. His own collaboration with GenF had benefited directly from MCF expertise in first-wall physics, and he saw a lot of potential in joint works on diagnostics, materials, and numerical modeling. The conference format of this EPS, with plenary sessions covering both MCF and ICF, was highlighted as a useful starting point for building more of these connections.

Sinkevičienė drew a parallel with her own quantum optics community in Lithuania, where a dedicated satellite meeting, 'Quantum Computing in Plasma Physics', held during the same EPS conference as the Generation Fusion event, which brought the quantum and plasma communities together for the first time. It was a small event, but it showed how a modest, well-targeted meeting can spark collaborations that would not have happened otherwise.

8. Communicating fusion

> *'Scientists who are willing to speak not only inside the lab but outside, to the public or to policymakers, can make a change. And we need to show the human face of our work and inspire young people. If we do not pay enough attention, fusion can seem boring. It is not. So we need to communicate.'*
>
> –Mažena Mackoit Sinkevičienė

Communication with the public, with policymakers, with other scientific communities, and within the fusion community itself, was mentioned in almost every topic the panel discussed. Sinkevičienė had the most elaborated statements on this, drawing from her experience working with Lithuanian government ministries. Her message was rather simple: scientists who are willing to speak outside the laboratory and can adjust how they talk about their work to a ministry official or a parliamentary committee, can make a real difference to the political and financial environment their research depends on. It is a slow process, and it takes practice, but it can be learned, and the impact builds over time.

The history of nuclear fission can serve as a warning example for fusion: even a fully successful fusion energy technology could face the same public acceptance challenges that is constraining nuclear fission [33], if the community fails to invest in creating a clear and honest social narrative around fusion. Public awareness and knowledge of fusion energy is still relatively low [11], and thus now is the right time to make these investments and commitments. The movie 'Do not Look Up' was mentioned by Sinkevičienė as an example of what happens when scientific urgency and public communication fail to connect [34], a failure that the fusion community must actively avoid.

Coelho gently pushed back the idea that fusion researchers always need to justify their work through its energy applications. The fundamental science of plasma physics, neoclassical confinement theory, for example, has real intellectual value in its own, and produces knowledge and skills that are useful beyond fusion, regardless of whether a commercial power plant is ever built. This is not to be understood as an argument against the energy goal, it just broadens the case for fusion research and is likely to resonate with policymakers who support basic science as a principle, not only because of its immediate applications.

An audience member posed a question about how to deal with geopolitical constraints: certain research institutions (and numerical codes) restrict access based on nationality. Besaucèle and Barlow both acknowledged that these constraints are real and unlikely to disappear quickly, but argued that the commercial viability argument is beginning to actively open doors. The 1958 declassification of fusion research, and the 1969 UK delegation visit to the Soviet Union to verify the T-3 results (for an excellent overview of the history, the interested reader is referred to the book by Braams and Stott [35]) was mentioned as evidence that the fusion community has successfully navigated political barriers to openness before and can do so again.

9. Values, leadership, and diversity

> *'I would like there to be women here. Or just generally more diverse in every way.'*
>
> –Felicity Maiden

> *'Not only is it not fair, we are wasting 50% of the population. Better gender parity is paramount, not just for our community but for all scientific and engineering communities.'*
>
> –Hervé Besaucèle

When asked what single change the panelists would make to the culture or structure of fusion research, their responses converged around two topics: diversity and evaluation criteria.

On diversity, the panel spoke with one voice. Barlow extended the call beyond gender to encompass racial, national, and disciplinary diversity. The moderator pointed out that the field's long history of international collaboration makes this not only a matter of fairness, but also of practical necessity: the workforce needed to eventually build and operate fusion power plants around the world cannot come from the small and relatively homogeneous group currently represented at events like this one. Furthermore, research consistently shows that diverse teams are more creative, more rigorous, and better at solving complex problems, exactly the qualities fusion needs [36].

On evaluation criteria, Coelho and Tamosiunas criticized the H-index [37] and publication count as proxies for scientific value. The H-index rewards publication in high-ranking journals, a metric poorly suited to measure the contribution of researchers who develop diagnostics [38], build industrial partnerships, train junior colleagues, put some effort into teaching [39], or communicate science to non-specialists [40]. Sinkevičienė argued that these contributions, which she explicitly refused to accept as secondary, are precisely what the field needs most urgently as it transitions from pure laboratory research to industrial deployment.

Tamosiunas, speaking from the perspective of someone who hires researchers, identified consistency and visible activity as the qualities that had distinguished him in his own career and that he looks for in candidates. It is not a stellar publication record, but more a sustained engagement, reliability, and the willingness to make contributions that impresses him. Besaucèle added, from the start-up perspective, that curiosity is the single quality he prioritizes in hiring: a candidate who asks good questions about the company, their approach, and the technology signals more about their future performance than a candidate with an impressive CV.

The discussion of leadership asked how people in positions of authority can ensure that early-career researchers' voices are actually heard and not just tolerated (and probably ignored). Barlow's answer centered on planning: early-career research can only actively shape their career by developing a serious long-term vision for their own research which also enables them to contribute to shaping their field itself. Maiden offered a complementary observation from a PhD student's perspective: five-year plans are more reasonably expected from those who actually have the power to implement them, i.e. group leaders, program directors, funding agency heads, than from PhD students who are more focused on the next six months.

10. Staying motivated across decades

> *'When I started my career, extreme UV light sources for semiconductors seemed like they would never make it into an industrial product. Thirty-five years later, they are the only technology producing the most advanced chips, running 24 hours a day. It took a lot of science, engineering, cross-fertilization, and it did work! If I look at fusion today, the challenges taken one by one can be solved with the right amount of innovation, funding and human resources.'*
>
> –Hervé Besaucèle

Working on a decades-long project without the guarantee of success but the realistic possibility that the technology may never reach commercial deployment within one's own career instead, was recognized as a psychological challenge both from the panel and the audience. Besaucèle's analogy with extreme ultraviolet lithography was well-chosen: it is a concrete example of a technology that seemed just incredibly difficult for decades, but was sustained by a community that refused to abandon it, and eventually became foundational to the global semiconductor industry. The lesson is not that persistence always pays

off, but that the probability of success is substantially increased by a sustained, coordinated, and cross-disciplinary effort.

> *'Consistency, and being active and visible. I never imagined getting that position, I just kept working.'*
>
> –Andrius Tamosiunas

The competitive energy landscape deserves to be taken seriously. The possibility that advances in renewables and battery storage could make fusion economically redundant is not remote [41]. Coelho acknowledged this directly, arguing that the community should engage with it rather than dismiss it. Even if such a scenario becomes reality, the science developed along the fusion energy way, e.g. plasma diagnostics, high-temperature superconductor technology, plasma heating, will have been worth pursuing. Maiden added that the act of a sustained, serious effort towards a transformative goal has value in itself, regardless of the final outcome.

Sinkevičienė's closing contribution put the early mentioned stability-mobility tension in thermodynamic terms: we are most comfortable in our local minima, but the most productive and interesting part of a scientific life begins when a phase transition occurs, when circumstances force a move to a different configuration. The challenge for the community is not to eliminate uncertainty but to build enough structural support that researchers can tolerate and even thrive within the inherent unpredictability of a long-horizon scientific endeavor.

11. Conclusion and recommendations

The Generation Fusion discussion reached several clear conclusions, each with implications for research institutions, funding agencies, and the broader fusion community. These are, in no particular order:

1. **Retention, not recruitment, is a primary challenge.** The polling data made this clear: 61% of the attendees have considered leaving the field, yet 70% wish to stay. Employment instability, i.e. short contracts, mandatory mobility, the absence of mid-career paths, is the primary source for this.
2. **Mentoring should be institutionalized.** Good supervision transforms careers, poor supervision ends them. Institutions should invest in dedicated mentoring infrastructure, including HR support for supervisors, confidential reporting mechanisms, and mentoring.
3. **The academia-industry boundary must become permeable in both directions.** The perception that moving to a private company ends an academic career is a dangerous misconception. Joint positions and structured return paths should be developed and become a norm.
4. **Soft skills are essential skills.** Grant writing, science communication, team leadership, stakeholder engagement, and political engagement are not peripheral accomplishments for fusion researchers that are nice to have, they are essential capabilities for a field that requires public and political support for decades. Those skills should be taught and valued in career evaluation frameworks.
5. **Evaluation criteria must evolve.** The H-index and publication count are inadequate proxies for the full range of contributions a researcher can make to the field. Career evaluations should be broaden to account for public communication, industrial collaboration, teaching, and community leadership. Those are all contributions the field needs and should thus value them.
6. **Diversity is a strategic imperative, not just an ethical one.** The demographic narrowness of the current fusion workforce (gender, nationality, disciplinary background), is not only unjust, but also operationally limiting. As Roddy Vann put it once, 'Diversity is key to success'. Actively broadening participation, through outreach activities at universities without fusion programs, through international mobility support, through eliminating unconscious bias in selection processes, is simply a practical necessity.
7. **Curiosity, consistency, and communication.** The panel identified these three qualities that distinguished successful and fulfilled careers in the field. The curiosity to continue asking questions and looking beyond one's project. The consistency to sustain effort over years without guaranteed reward. The communications capabilities to make fusion's progress and potential understandable to audiences outside of the fusion community.



Figure 3. Result of the final poll at the end of the event, where the audience was asked, what feeling or emotion they have after this discussion. The more often a certain answer was given, the larger the font size. The appearance of 'beer' in the word cloud is acknowledged, the event was held on a warm July evening and refreshments were available. It may also reflect the collegial atmosphere the organizers were pleased to have achieved. Graphic produced by Mentimeter.

The final poll asked the audience what feeling or emotion they were leaving the event with. The word cloud that formed, see figure 3, was dominated by *motivation*, *hope*, *enthusiasm*, and *curious*. Smaller terms, *concern*, *doubt*, *pessimistic*, were present but clearly outweighed. This is perhaps the most accurate summary of the event's mood: no naive optimism, but a justified, grounded and collective sense that the challenges are real, that people are capable of taking these challenges, and that the work is worth doing.

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Data availability statement

All data that support the findings of this study are included within the article (and any supplementary files).

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References

[1] Kappatou A *et al* (the JET contributors and the EUROfusion Tokamak Exploitation Team) 2025 *Plasma Phys. Control. Fusion* **67** 045039
[2] Grulke O *et al* 2026 *Nucl. Fusion* **66** 1741–4326
[3] Abu-Shawareb H (The Indirect Drive ICF Collaboration) 2024 *Phys. Rev. Lett.* **132** 065102
[4] Fusion for Energy 2025 Global investment in the private fusion sector *Technical report* (Fusion for Energy Barcelona)
[5] Giacometti A 2025 *Environ. Res.: Energy* **2** 045015
[6] Fasoli A, Belonohy E and Tran M Q 2025 *Eur. Rev.* **33** 380–90
[7] Dinklage A *et al* 2025 *Plasma Phys. Control. Fusion* **67** 063701
[8] Khan M A 2026 *Int. J. Changes Educ.* **3** 1–10
[9] Paz-Soldan C *et al* 2025 *Plasma Phys. Control. Fusion* **67** 083701
[10] Devanney J 2021 *Why Nuclear Power Has Been a Flop at Solving the Gordian Knot of Electricity Poverty and Global Warming* (CTX Press)
[11] Oltra C *et al* 2026 *Fusion Eng. Des.* **226** 115692
[12] Feder T 2024 *Phys. Today* **77** 22–24
[13] Valderrama C M, Rodríguez-Fernández C D and Ostinato M 2025 *Europhys. News* **56** 4–5
[14] Evans Ogden L 2024 *Nature* **630** 1021–3
[15] Chamandy M and Gaudreau P 2019 *J. Vocat. Behav.* **110** 155–67
[16] Larsen Ryberg M 2023 *STS Encounters* **15** 53–76
[17] Brechelmacher A, Park E, Ates G and Campbell D F J 2015 *The Rocky Road to Tenure – Career Paths in Academia* (*Academic Work and Careers in Europe: Trends, Challenges, Perspectives*) ed T Fumasoli, G Goastellec and B M Kehm (Springer) pp 13–40
[18] Cox R, Hope J, Jenkins K and Ray C 2024 *Area* **56** e12909
[19] Sainburg T 2023 *Res. Policy* **52** 104714
[20] Stix T H 1998 *J. Plasma Fusion Res.* **1** 3–8 (available at: www.jspf.or.jp/JPFRS/PDF/Vol1/jpfrs1998_01-003.pdf)
[21] Smirnov V 2009 *Nucl. Fusion* **50** 014003
[22] Sovič S 2008 *Cult. Soc. Hist.* **5** 141–63
[23] Cruz Malagon D A, Jaspers R and Juarez R 2026 *Fusion Sci. Technol.* **82** 4
[24] Di Pietro G 2022 *Rev. Educ.* **10** e3363
[25] Van Dam J W 2011 *Fusion Sci. Technol.* **59** III–IV
[26] Reiser D 2022 14th Carolus Magnus Summer School on Plasma and Fusion Energy Physics *Technical Report* (Forschungszentrum Fülich GmbH Zentralbibliothek)
[27] Stockel J, Cavalier J, Mlynar J, Hron M and Panek R 2021 *Eur. J. Phys.* **42** 045703
[28] Van Oost G, Beyer P, Devitre A, Guirlet R, Noterdaeme J M and Thienpondt H 2021 *Eur. J. Phys.* **42** 024002
[29] Riedel M, Kovacs M, Zoller P, Mlynek J and Calarco T 2019 *Quantum Sci. Technol.* **4** 020501
[30] Levecque K, Anseel F, De Beuckelaer A, Van der Heyden J and Gisle L 2017 *Res. Policy* **46** 868–79
[31] Wollast R, Aelenei C, Chevalère J, Van der Linden N, Galand B, Azzi A, Frenay M and Klein O 2023 *Stud. Higher Educ.* **48** 813–28
[32] Nnabuife K N, Nuel O I E, Peace N N and Ifechi A N 2021 *Educ. Q. Rev.* **4** 130–40
[33] Agyekum E B, Tarawneh B, Rashid F L, Kumar P, Odoi-Yorke F, Togun H, Mbasso W F and Velkin V I 2025 *Energy Explor. Exploit.* **43** 2276–302
[34] Angelone S 2022 *Sci. Commun.* **44** 375–82
[35] Braams C M, Stott P E and Braams C M 2002 *Nuclear Fusion: Half a Century of Magnetic Confinement Fusion Research* (Institute of Physics Publishing)
[36] Kamerlin S C L 2020 *EMBO Rep.* **21** e51994
[37] Hirsch J E 2005 *Proc. Natl Acad. Sci.* **102** 16569–72
[38] Akhtar M K 2024 *Front. Res. Metr. Anal.* **9** 1385080
[39] Nunn R and Pillay A 2014 *Higher Educ. Res. Dev.* **33** 848–50
[40] Erdt M, Aung H H, Aw A S, Rapple C and Theng Y L 2017 *PLoS One* **12** e0183217
[41] Nicholas T E G, Davis T P, Federici F, Leland J, Patel B S, Vincent C and Ward S H 2021 *Energy Policy* **149** 112043