

The National Fluid Mechanics Hub

Outline Proposal

November 19, 2024

This document presents a vision for a National Fluid Mechanics Hub. This vision has emerged from the collective effort of the UK fluid community through a series of surveys and away days between 2023 and 2024 solicited by the UK Fluid Network (UKFN). This document has been written by multiple authors who have summarised this collective vision and are named at the bottom of the document.

1 Executive Summary

The National Fluid Mechanics Hub aims to harness and secure fluid mechanics as a major national asset by positioning it as a strategic resource within policy, industry, and education at a national scale. Creating a cohesive framework will make fluid dynamics expertise accessible across sectors, providing thought leadership in emerging global challenges, from climate change to sustainable transport. The Hub will provide leadership and coordination within the fluid community, enabling ambitious and bold initiatives that can only be achieved through a nationwide effort. It will act as an ambassador for stakeholders in academia, industry, government and the public. It will be the point of call for policy briefings, coordinating fluids expertise from across the country and providing neutral advice to The UK Government and international calls for expertise.

The Hub will comprise three Centres with distinct areas of focus. The Future Fluid Mechanics Centre will be dedicated to advancing the science of fluid mechanics, exploiting the formation of a cohesive, fluid community to establish UK flagship, cross-institutional, cross-disciplinary and cross-Council projects reflecting the national research agenda to address major societal challenges. This approach will harness UKFN's collaborative spirit and amplify its impact by enabling transformative, long-term research streams. The Future Fluids Impact Centre will directly address the gap between academia, industry, and policy, building on the UKFN's initial industry engagement to establish a structured knowledge exchange programme, driving economic impact and policy alignment. This coordinated approach will enable industry collaborations and policy guidance to be systematic and impactful, fast-tracking innovation into real-world change for businesses and society. The Future Fluids Leaders Centre will develop people and talent within the fluid mechanics community. This centre will ensure that the network nurtures new talent with a deliberate focus on inclusive, representative engagement. By developing early career researchers and advocating for diversity in all dimensions, this centre will ensure a forward-looking and resilient UK fluid community delivering sustained international leadership. Integrating outreach, education, and public engagement will inspire future generations, increase awareness of fluid mechanics applications, ensure the community's growth aligns with societal needs and create a lasting impact on how fluid mechanics is perceived and valued by the public.

The UKFN's Special Interest Groups (SIG) will be integrated into Regional and Specialist Committees, providing a sustainable structure for SIG scientific coordination and regional engagement. The committee structure will enable a platform for a diverse and accessible representation of disciplines and regions. It will create a sustainable structure that is not only responsive to local needs but also links them to national and international opportunities. The Hub will be governed by a Steering Committee, a Council with representatives of the centres and the committees, and Advisory Boards across the industry, academia, and facilities. This governance structure ensures transparency, aligns the Hub's activities with the fluid mechanics community, gives a voice to a diverse set of stakeholders, and empowers a unified entity that can influence policy and national strategies effectively.

It will provide leadership and coordination that will underpin new globally leading initiatives. It will contribute to the government's mission-led agenda by spreading opportunities across the UK

community to facilitate industry advances for economic growth, clean energy, and innovation in health prevention and treatment. It will support growth priorities across the industrial strategy, particularly enabling new and faster techniques for analysis, innovation and impact. It will foster a new generation of leaders who will ensure the sustained excellence of UK fluids and provide the people, skills and innovation for multiple sectors.

2 Vision

We aim to create a cohesive, inclusive UK-wide fluid mechanics community that will position the UK as a world leader in fluid mechanics. This is particularly timely given the increasing complexity of global challenges requiring fluid mechanics solutions, rapid advances in data science and artificial intelligence that are reshaping research methodologies, and growing international competition in research and innovation. This community will be recognised for pioneering solutions and policy-relevant research across academia, industry and government, responding rapidly to global needs, supporting fluid-dependent industries and driving breakthrough discoveries.

Current gaps that the Hub will address include fragmented collaboration across fluid mechanics sub-fields, limited channels for industry and policy engagement, and insufficient opportunities for large-scale cross-discipline research. The extraordinary success of the UKFN is that it has established a UK fluid mechanics community. While this community is already highly collaborative, it lacks a structure to provide a unified voice representing the UK on the global stage. This limits the community's impact on industry, policy, and international leadership. Furthermore, the lack of comprehensive training and inclusion limits talent diversity and development.

This Hub, with clear leadership and representation, will create a strong national presence that can drive high-impact collaborations, attract international partnerships, and significantly influence both industry innovation and policy development. It will build a resilient, diverse people pipeline to ensure sustained excellence and impact, with success measured through the number of multi-institutional research projects initiated, increases in fluid mechanics patents and start-ups, increases in the representation of underrepresented groups in senior positions, and improvements in citation impact and international collaboration metrics. Missing this opportunity would result in fragmented progress, reduced policy influence, and a loss of international leadership, limiting the UK's potential impact on critical societal challenges.

3 The Future Fluid Mechanics Centre

This centre will set the agenda for the next advances in fluid dynamics. It will lead five multi-institutional projects, providing inspiring, world-leading collaborative research to address complex societal challenges that require transdisciplinary research across fluid mechanics, medicine, biology, geology, chemistry, informatics, social sciences, and others. Projects will be identified over the coming months by world-leading senior UK researchers and industrialists in the areas identified at the September 2024 Away Day: Machine Learning (ML) in fluids, parallel computing, fluids for healthcare, environmental sustainability and clean energy. These projects will include inspiring and bold moonshots, such as unlocking the rapidly growing potential of ML and exascale computing resources for fluid simulations capable of real-time prediction of complex, multiscale, multiphysics fluid behaviours. This will enable breakthroughs in real-time modelling, control and optimisation to address previously intractable challenges across industries such as renewable energy, aerospace, and environmental sciences. These projects will also focus on delivering new methods that underpin a wide range of applications. The Future Fluids Centre will connect the science activities of these projects. It will coordinate a summer school to train a cohort of researchers on specialised methods and transdisciplinary research. It will coordinate national and international technical forums and administer seedcorn funds to explore new branching-out ideas and widen engagement within the scientific community.

4 The Future Fluids Impact Centre

This centre will enable industry and policy knowledge exchange and impact. It will coordinate activities such as industry and policy networking and showcase events. It will lead activities to link academia and industry and support secondments, training activities, innovative and knowledge transfer partnerships, links to knowledge transfer networks, match-making databases, entrepreneurship for early career researchers, etc. It will coordinate a network of regionally-led activities to connect local companies with skills and expertise. The Future Fluids Impact Centre will administer seedcorn funding for innovation and impact projects aimed at strengthening the impact of the UK fluid community and knowledge exchange with industry and policymakers. Project proposals will be reviewed by panel experts in the field, using international reviewers where possible to reduce conflicts of interest.

5 The Future Fluids Leaders Centre

This centre will develop inclusive and creative fluids researchers. The Centre will coordinate training, mentoring, and activities aiming at widening and strengthening the fluids community, increasing diversity and inclusivity, and ensuring equal opportunities and representation. Specific initiatives include targeted recruitment practices to ensure diverse representation, structured mentoring programmes for under-represented groups, mandatory diversity training for senior management and regular monitoring and reporting of diversity metrics. It will host a forum for Early Career Researchers in Fluids (ECRf), which will lead a comprehensive programme of activities providing mentorships, networking opportunities, and grant writing workshops and ensure ECRf representation in all Hub's activities. The main objective of the Future Fluids Leaders Centre is to lead community-based activities that will shape, define and promote equality, diversity and inclusion, and responsible research in fluids, increase diversity in all its dimensions and foster and disseminate good practice across the community. The centre will promote, make accessible, and communicate the value of fluids research to the public, including providing educational and teaching resources and outreach activities at local and national scales. It will produce a range of high-quality media and become a hub for open resources to increase awareness and impact of fluids research, including showcasing the diverse applications of STEM research to inspire the youngest generations. Furthermore, building on the existing NFFDY summer programme, it will establish a permanent residential summer programme to be held every two years. The programme will attract internationally leading researchers worldwide by providing travel funding and access to experimental and computational facilities in the UK, as well as fostering collaborations with UK researchers.

6 Hub Coordination and Governance

The role of the Hub is to coordinate activities across the three Centres and facilitate interactions between existing EPSRC investments such as the CDTs, the National Wind Tunnel Facility, the National Supercomputing Centres, etc. It will act as a gateway to international initiatives and networks such as ERCOFTAC and will lead workshops and networking activities to foster UK participation in international bids. It will administer a small fund to support strategic initiatives with the potential to significantly strengthen the global impact of the UK fluid community, such as travel costs to establish international consortia, etc.

It will achieve this through a committee-based structure with inclusion and diversity in all of its forms at its core and with strong involvement of the ERCs, including (fig. 1) a Steering Committee, formulating and implementing strategies within the scope allowed by a Council, which will include representatives of the Regional Committees (RCs), the Specialist Committees (Scs) and the wider community. The Steering Committee will include the two Co-Directors of each centre, one of whom will be an early career researcher and a Hub Coordinator. The Hub will also be supported by three Advisory Boards: an Industrial Advisory Board that will monitor and advise on the economic impact of the Hub on the UK economy; a Research Alignment Board including all UKRI-funded Principal Investigators in fluid mechanics, who will advise on new research trends and opportunities; and a National Facilities

Board that will advise on the need and opportunities for major national infrastructures. A well-defined governance model, as proposed, would not only ensure transparency and inclusion but would also enable a structured approach to integrating diverse voices within the community. This governance model would create a foundation for strategic partnerships and establish consistent standards and best practices, reinforcing the UK's position as a global leader in fluid mechanics.

6.1 Regional Committees (RCs)

Building on successful regional networks such as the Midland's Fluid Mechanics Group and the Scottish Fluid Mechanics Conference Series, the Hub will establish Regional Committees (RCs) that will lead regional networking activities aiming at engaging with local stakeholders (including researchers, industry, policymakers, etc.). The regional network will promote and facilitate access to national resources, facilities, training, and initiatives (including those of the ECRf), provide a gateway to the global fluid network, and link to local industry with nationwide skills and expertise.

6.2 Specialist Committees (SCs)

The Hub will promote and support the continuation of the Special Interest Groups established within the UKFN through Specialist Committees (SCs). These will continue to be community-proposed topic-specific forums and serve as expert committees for reviewing seedcorn proposals and advice on technical issues. Furthermore, the Hub will foster proposals for non-technical committees on, for example, rising ethical challenges, participation of minorities in fluids, gender bias in the perception of fluids research in school, etc. The Hub will facilitate in-person meetings at, for instance, the annual meetings of the Hub, the UK Fluids Conference, etc.; it will provide a web platform to promote the activities and the outputs of the committees, such as white papers and good practice guidelines; and will disseminate the outputs through a newsletter, etc.

7 Funds for the First Five Years

Funds are requested for the first five years to establish the Hub. Total funds are estimated at £8M. For the first five years, the Hub coordinators will be the Principal Investigator of this proposal, while they will successively be elected by the Council together with the members of the Steering Committee. The cost of the coordination activities of the Hub for the first five years is estimated at £1M. The five pillar multi-institutional projects will include ten Co-Investigators and ten researchers who will work on the Hub activities for 2.5 years full-time equivalent each (£3M in total). The budget of the Future Impact Centre and the Future Leaders Centre is estimated at £3M in total. Finally, a total of £1M will be allocated nationwide competitively across the three Centres as seedcorn grants.

8 Future-Proofing and Sustainability

To ensure long-term self-sustainability, the Hub will adopt a diversified funding model, drawing on the successes of institutes like the Royce Institute. First, the Hub will implement professional training and educational programs tailored to industry needs. These programs will include certification courses, advanced workshops, and CPD opportunities for industry practitioners and academics. By offering specialized training in areas like AI-driven fluid simulations, environmental fluid dynamics, and real-time modelling, the Hub will create a revenue stream while building essential skills within the fluid mechanics community. Furthermore, building on the success of the summer school established by the NFFDY Hub, an annual summer school will be established, attracting national and international participants, creating a regular flow of funds and fostering global partnerships.

The Hub will engage in industry-funded research contracts that address real-world fluid dynamics challenges faced by sectors like renewable energy, aerospace, and healthcare. These partnerships will provide financial backing for applied research projects while enabling industry stakeholders to leverage cutting-edge expertise and facilities. Beyond contracts, the Hub will actively seek sponsorship for networking events that bring together academia, industry, and policymakers, allowing partners to

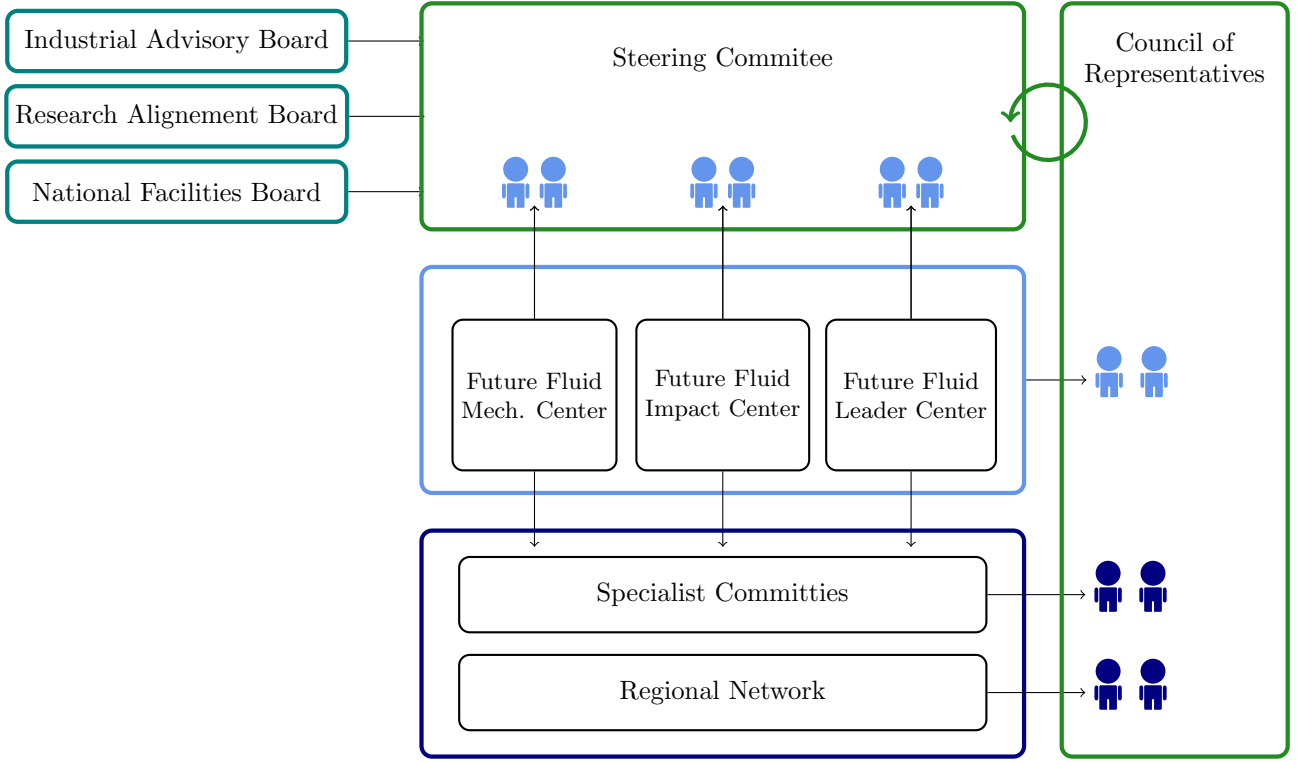


Figure 1: Structure of the proposed National Fluid Mechanics Hub

engage with the Hub’s community meaningfully. Sponsorship will offer companies visibility and access to talent, research insights, and early findings, incentivising their continued investment in the Hub.

Furthermore, the Hub will prioritise outreach and public engagement initiatives to raise public awareness and inspire future generations in fluid mechanics. This program will include public lectures, STEM events, and exhibitions supported by sponsorship from industry partners seeking positive visibility and association with educational and societal contributions. This approach will ensure that the outreach activities become self-sustaining while strengthening the Hub’s national profile as a leader in fluid mechanics. Through these diverse funding mechanisms, the Hub will secure its operations and amplify its impact beyond the initial funding period.

Finally, in the long term, the Hub may also introduce individual and institutional membership fees, following the example of successful international organizations like the American Physical Society Division of Fluid Mechanics. Membership options would offer tailored benefits such as early access to research publications, discounted fees for workshops and training sessions, and exclusive networking opportunities. Institutional memberships could offer additional privileges, including participation in the Hub’s advisory or technical committees and access to customized reports and research insights. This membership model would create a stable, ongoing revenue stream while fostering deeper engagement from individuals and institutions, encouraging long-term commitment to the Hub’s mission and enhancing its capacity to deliver impactful, community-driven initiatives.

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