

Institute of Physics submission to the House of Commons Science and Technology Committee on a new UK research funding agency

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What gaps in the current UK research and development system might be addressed by an ARPA style approach?

The ARPA model, in which funding is allocated by programme managers, is largely absent from the existing UK R&D funding system, in which funding is generally allocated either through individual research grants, which are almost always awarded according to the decisions of a peer review panel, and/or through block grants to institutions.

In recent years, the Research Councils' flat cash budgets have diminished their scope for funding genuine blue skies and high-risk research. The government's intention to establish a new funding agency focused on 'blue skies' and 'high-risk, high-reward' research is welcomed, and its creation will be an important step towards achieving the 2.4% R&D investment target.

In line with the ARPA approach, funding should not be targeted at purely theoretical advancements in knowledge nor at incremental innovation, it must be for truly disruptive research, aiming to achieve step changes in technological capability and the solution of difficult challenges that require a critical mass of cross-disciplinary researchers and innovators. The ARPA model's focus on the future would also be a welcome addition to the UK's R&D funding system, scanning the horizon for areas of research and technology development that may not have an obvious immediate market application but that are likely to benefit the industries of tomorrow, in 10, even 20 years' time.

In addition, by international standards, the UK invests relatively little in research at the more developmental end of the spectrum, with support at intermediate TRL levels lacking. Funding for large-scale R&D projects, which place significant focus on technology demonstration, as being proposed, would be particularly welcome in this space.

What are the implications of the new funding agency for existing funding bodies and their approach?

The funding allocated to the new agency must be truly additional and not come at the expense of support for research and innovation provided by UKRI. Moreover, these existing funding mechanisms must be strengthened to ensure the continual generation of a broad range of high-potential leads that can be pursued by the new agency. The additional flexibility that would be enabled by an increase to the Research Councils' budgets would also ensure they can provide reciprocal support, for example, to fundamental research questions which may arise from the new agency's programmes.

The new agency should not duplicate existing activity and there must be a clear distinction between its remit and that of UKRI and its councils, to avoid complicating the R&D funding landscape – this is particularly important at the innovation end of the spectrum, where any additional complications are likely to disproportionately affect small and medium-sized enterprises' ability to access government support.¹

¹ For example: House of Commons Science and Technology Committee (2019). Balance and effectiveness of research and innovation spending <https://publications.parliament.uk/pa/cm201719/cmselect/cmsctech/1453/145308.htm>

Establishing a truly radical approach to research funding in the UK may be more easily achieved in the first instance outside of UKRI and its existing processes, especially given the centrality of an ARPA-like agency's risk-taking culture, and would have the additional advantage of ensuring the agency is not in competition with the other councils for funding. A more direct reporting link to government may also benefit the agency; this is discussed further in our response to the third and fifth questions. If the agency is ultimately established outside of UKRI, there must be mechanisms for alignment and collaboration between their programmes where appropriate, to ensure effective use of the government's significant investment in R&D.

What should be the focus be of the new research funding agency and how should it be structured?

A clear mission will be essential to the successful operation of a UK-based ARPA. One of the elements underpinning DARPA's success is the bringing together of experts from academia, industry and government to solve clearly defined problems. As a nation, we must understand where the greatest technological opportunities lie and make strategic decisions about which areas we want to prioritise and lead the world in, and an initial exercise should be undertaken to synthesize the outputs from existing horizon scanning efforts across government and highlight a small number of key areas which could form the basis of the new agency's programmes. The government should agree these very broad areas (for example, at the level of 'net zero emissions'), but the underpinning detail should be for the director and associated programme managers to resolve.

Accordingly, appointment of the director and programme managers is a critical initial step and will significantly shape the agency's ultimate programmes. Both roles will require individuals with strong technical skills, expertise in commercialisation and experience outside of academia, as well as being adept at risk management. Limited terms of appointment (typically of three to five years in DARPA and ARPA-E) act both as a motivational driver and ensure turnover of fresh skills, perspectives and ideas, and should be adopted in the UK agency.

DARPA's flat, non-hierarchical, non-bureaucratic structure, with a relatively small number of staff, enables it to act with agility and flexibility. The agency needs to be granted considerable autonomy if it is to take risks and maximise the impact of its funding; this will also help attract exceptional individuals. DARPA and ARPA-E, for example, are both granted special regulatory hiring and procurement powers which allow them to act with agility. Given the risks inherent in this approach, and the emphasis on individuals, an advisory board should be established to provide advice and make recommendations on the overall direction and operation of the agency to the director.

What funding should ARPA receive, and how should it distribute this funding to maximise effectiveness?

Funding should be allocated at the discretion of the programme managers, who are entrusted with considerable autonomy, in a streamlined process without lengthy funding rounds and peer review.

Given the high-risk, high-reward nature of the research being funded, a high failure rate is to be expected, and a different approach will be required to project management to that employed in many of the UK's existing R&D funding programmes. DARPA and ARPA-E employ a portfolio approach, distributing funding widely across a range of research teams and projects, often within a single programme, to manage risks and maximise the chance of

success.² Clear milestones should be agreed at the outset of projects and regular assessments should be conducted throughout to assess whether programme goals are being achieved. Projects which fail to make adequate progress should be curtailed.

The funding provided should cover the full costs of research. This will be especially important to encourage industrial involvement - in particular, that of SMEs, which can struggle to participate in funding programmes with significant matched funding requirements. It will also provide security to encourage researchers to embark on projects with a relatively high likelihood of failure without being reliant on other sources of grant and institutional funding.

The new agency must actively seek the participation of international researchers, innovators and industrialists in the agency's programmes, if it is to generate the greatest possible benefit for the UK. This will be of utmost importance following the UK's departure from the EU and potential withdrawal from EU research funding programmes.

What can be learned from ARPA equivalents in other countries?

One critical aspect underpinning DARPA's success is the involvement of a single dedicated customer in the US Department of Defense. It will be essential that all projects funded by the new agency have a clearly defined customer involved from the outset, to create commercial pull-through and keep programme managers focussed on customer needs, particularly when prioritizing projects across their portfolios. Given the scale and long-term nature of the challenges being tackled by an ARPA-like agency, an effective way to achieve this could be through greater and more intelligent use of public procurement budgets.

In addition, the Director of DARPA reports to the Under Secretary of Defense for Research and Engineering via the Deputy Under Secretary; this reporting structure provides valuable weight within the federal government and ensures the agency's operating conditions allow it to act with autonomy and agility. This would support our observation in response to the second question, regarding the benefits of a more direct reporting link into government than that provided through UKRI.

ARPA-E, which also lacks DARPA's clear primary customer, established a Tech-To-Market team to ensure projects are aligned with customers' needs, advise project teams on commercialisation of their technologies, and expedite progress from lab to market. The need for such a function should be considered when establishing the new UK agency, given the likely similar broader, civil focus.

It is reported to us that ARPA-E participants are not motivated by more traditional academic drivers such as publications, or the development of knowledge for knowledge's sake; funding recipients are however given full rights to any IP generated. (The US Government can reclaim unused IP, though this has never been needed in practice.) There are a small number of restrictions including the requirement that products resulting from ARPA-E funding are predominantly manufactured in the US.

Another successful initiative of ARPA-E is its Fellows programme, in which recent PhD graduates work with programme managers and experts across government, industry and academia to generate new ideas and develop them into technological solutions over a two-year period. A similar fellowship programme could be an effective mechanism for

² Bonvillian, Van Atta and Windham (2019). *The DARPA Model for Transformative Technologies: Perspectives on the US Defense Advanced Research Projects Agency*. <https://library.oapen.org/handle/20.500.12657/23446>

encouraging academic engagement with the new agency and developing the next generation of technological leaders in the UK, with alumni taking their enhanced commercial expertise into the wider research and innovation sector beyond the terms of the fellowship.

What benefits might be gained from basing UK ARPA outside of the 'Golden Triangle' (London, Oxford and Cambridge)?

Significant disparities in R&D funding exist between the regions and nations of the UK. Operating under an ARPA-like model, the new agency is unlikely to have its own research facilities, but its headquarters should be based outside of the golden triangle, both to contribute to local economic growth through the creation of jobs, and to demonstrate the feasibility of other new research and innovation organisations being based outside this area.

Funding should be awarded to researchers and innovators who are most likely to enable the agency's programmes to achieve their goals. Different research and technological strengths exist across the country and it will be vital that the new agency's director and programme managers have a deep understanding of these.

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