

Working Paper 10**The Urgent Problem-Oriented R&D Needs of G7 Nations**

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When the G7 leaders and senior ministers meet at the end of June they should agree to move forward quickly and collaboratively on a focused set of critical problem-oriented R&D initiatives.

In 2020 and 2021, climate change and the COVID-19 pandemic moved G7 nations toward understanding the importance of collaborative problem-oriented R&D to address common and shared challenges. In the year since the 2021 G7 Summit, world economic and geopolitical news has been dominated by growing concern about China's state-directed and often predatory strategy for technological and economic dominance, and by the Russian-made war in Ukraine. These events should fully awaken the G7 nations to the techno-economic character of modern geopolitical competition and confrontation, and to their critical leadership role — as the leading R&D-intensive liberal democracies — in the economic and national security of all democracies.

The six techno-economic geopolitical challenges to market-based democracies below are characterized by the immediate need for a significant surge in cross-border problem-oriented research and development. Globalized companies, and market systems in the G7 and other democracies, will help make the needed security-improving economic transformations but the scale, scope, and cross-border nature of these challenges demand that the G7 nations collaborate on research; development; demonstration; cross-border regulatory alignment and coordination; support for entrepreneurship in these areas; and early scaled-up deployments of new technology.

Current and emerging economic and geopolitical tensions mean that the G7 needs to lead; these problems need to be tackled immediately through cross-border coalitions of G7 nations working in concert with companies based in those nations. The approach needs to allow for, but cannot wait for, full engagement of democracies outside the G7.

Six Techno-Economic Challenges Where G7 Nations Should Collaborate Now

This list of six challenges where G7 collaboration is critical is not exhaustive. These areas of technology-dependent economic activity are, however, widely recognized as important to the economic and national security of liberal democracies.

Next Generation Wireless and Mobile Device Systems. Wireless technology enables a host of new industries and is the core of AI applications in areas as diverse as autonomous systems, health care and agriculture. The depth and breadth of the existing wireless (cellular) industry, the critical integration of wireless with optical fiber and satellite systems, and the increasing complementary and substituting role of wifi (internet service) providers means that this industry is fragmented. While this allows considerable technical entrepreneurship, the future wireless system – knitted together as it must be by standards and interoperability – needs to be a scalable, collaborative, secure platform to maintain the pace of innovation without opening major new vulnerabilities. The G7 democracies need to work together with companies based in (and regulated by) those nations for both economic and national security. As a first step, the G7 nations should join to establish a problem-oriented public-private research collaboration — designed with close attention to the downstream processes of international standard setting — for the immediate development of next generation wireless systems.

Mobile and Stationary Hydrogen (H2) Power Systems and Infrastructure. There is an immediate need for crash program in H2 as part of the solution to reduce the dependence of Europe and other nations on Russian oil and gas. The near-term goal of increasing the viability of H2 as a “replacement” fuel for Europe is completely aligned with a global push toward an alternative energy future that incorporates a low-environmental impact fuel to complement renewable, stationary electric power sources. While the exposure of liberal democracies to authoritarian regimes controlling fossil fuel reserves has diminished in recent decades, this process – as the knock-on impacts of Russia’s invasion of Ukraine have demonstrated – is far from complete and has not translated as completely as it needs to into an approach which also reduces the release of greenhouse gases. As a first step, G7 nations should establish a public-private initiative to develop and license (and provide guidance on national regulation) approaches to scalable green H2 production, distribution, storage, and combustion/use in both stationary and transportation applications.

Rare Earth Minerals Security. The consolidation of rare earth minerals production in a megafirm (China Rare Earth Group) is an upstream value chain oligopoly that threatens production and deployment of technologies as diverse as electric vehicles, wind turbines, many electronics and related defense industries. The G7 should launch a collaborative crash program of research, development and design of new/alternative materials, innovative metallurgy, and device design approaches. This R&D and innovation initiative needs to be launched in combination with near-term G7 collaborative approaches (light research, some development, considerable investment) to mining and extraction of rare earth minerals in market-based democracies within and outside the G7. The shared goal for these G7 activities — one in materials research and a related activity in mining — is the creation and maintenance of supply markets adequate to meet the needs of democracies.

Sustainable Orbital Space. The world is teetering on the edge of complete dysfunction, and potential disaster, in orbital space and the liberal democracies need to a) collectively acknowledge that space-capable authoritarian regimes such as Russia and China will not willingly collaborate (because of the history of national security and intelligence uses of space) and b) act quickly to coordinate data and forecasts (e.g., Space Situational Awareness), to align regulations and licensing so orbital space does not become an unmanageable and unusable junk yard of fast moving debris. There are large, long-term research, development, demonstration, and deployment challenges to commercial uses of orbital space. In recent years the largely

uncontrolled environment of orbital space has been a tremendously attractive sand box for inventors and entrepreneurs but without substantially increased (and cross-border coordinated) regulation the whole “system” is likely to crash with serious detrimental implications for everything from communication systems to weather assessment and forecasting, to environmental sensing, agriculture, and marine navigation. The G7 nations, recruiting all space capable liberal democracies as possible, should establish an enforceable treaty-based collaborative activity — going beyond the “lite” regulation of space through the UN — for the sustainable regulation and development of orbital space. Exercising sovereign regulatory powers, the G7 nations (plus other democracies) need to draw on existing private and public activities in democracies to establish an internationally governed entity to provide robust, reliable Space Situational Awareness. This initial data-and-algorithm-sharing-based collaboration is the first step to enabling effective, safe, and fair commercial research, experimentation, and development of orbital space.

Cross-Border Digital Epidemiology. The COVID-19 pandemic has made it apparent that the epidemiological tools necessary to track and halt, or more effectively manage, infectious diseases have not kept pace with globalization (population growth and dispersion combined with ease of local, regional, and cross-border travel). Data privacy and data sovereignty concerns have been a barrier to cross-border collaboration on these approaches but technological advance in this field is such that “design for privacy” is an obtainable R&D goal. Such approaches can protect privacy and national security and, if effectively implemented in cross-border applications, would allow national and regional public health entities and health care companies to substantially improve their ability to contain and/or respond to diseases. The G7 need to quickly launch an R&D collaboration entity with cross-border access to health and a wide range of other epidemiologically-relevant data – first for applied research and then for operations – in a way maintains personal privacy and addresses national security concerns. This is a need shared by all liberal democracies (where consent of the governed is a matter of law and practice) so a G7 initiative is not the final word but an exercise in leadership.

Petroleum-Free and Carbon Negative Plastics and their Precursors. While energy dependence on imported petroleum and natural gas is a recognized and immediate vulnerability of G7 nations there is an additional critical dependence on oil and gas as the dominant feedstocks for petrochemicals and plastics critical to any modern industrial economy. There has been steady progress on both bio-derived and inorganic approaches to non-petroleum-based plastics and their precursors but there is an immediate need for additional and cross-border research, development, production prototyping and scale-up investment to displace petroleum with more environmentally benign feedstock and processes both in and supplying G7 nations. To the extent that these approaches create new “sinks” for CO₂ or methane (greenhouse gases) the pursuit of alternative processes have the potential to make a substantial contribution to climate change mitigation. G7 nations should immediately establish a large-scale public-private research consortium for such approaches. A key feature of such a consortium, in addition to working out major research, development, and scale-up challenges, is to prosecute the work in such a way that there is adequate incentive for private companies to participate. This means structuring intellectual property ownership and licensing approaches that encourage market competition and speed the diffusion of new knowledge developed.

The G7 is not, of course, an operating entity so the pursuit of any or all of these collaborative approaches will require collective action, and perhaps even treaties, by and among the nations. Regardless of this, by formally

adopting these goals and approaches at the late June 2022 Summit at Schloss Elmau in Germany, G7 agreement can be the falling stone that triggers an avalanche of topic specific action-oriented negotiations. While the sovereign nations (i.e., governments) need to call for and host such negotiations it is critical that they be broadly consultative among the national research funding entities and companies, research and technology organizations (RTOs), and universities in G7 nations.

What is Needed Now from 2022 German Leadership of G7

To drive toward effective collaboration on these topic the G7 should immediately form a standing G7 Working Group on Problem-Oriented R&D made up of representatives of the major public research funders from each of the G7 nations. Publicly-funded R&D in the G7 nations totals approximately \$225 billion annually. Although only 20-25 percent of total R&D, the structural characteristics of publicly funded R&D – taking risks individual companies will not, integrated with government procurement, less inherently proprietary than private R&D, and often linked to higher education and a nation’s research-capable workforce – means that publicly funded R&D plays a leadership role in economic change.

The charge to this G7 Working Group — which should be assembled and start work under German leadership of G7 in 2022 — is to work out the “how” of cross-border collaborative public and private R&D funding. To address the challenges outlined above, G7 collaborative public R&D investments need to function — at minimum — for fundamental applied research; the construction and management of multinational applied research infrastructure; public-private pre-competitive R&D consortia; and one-off activities such as G7 collaboration to establish an entity providing — and pushing the frontiers of — Space Situational Awareness. To accomplish this the major public research funders from G7 nations will need to figure out how to issue multiparty paired solicitations, structure attractive multi-sovereign working relations with companies in pre-competitive research, and to handle paired (single or multiple) pre-award and post-award grant and contract management.

Public research funders from the G7 nations will need to work through a set of international operational challenges that mirror those in their current domestic activities. These include questions about how to select specific areas for investment, ownership of intellectual property, the relative benefit of research investments to citizens vs. companies, and the relative weight put on research advances vs. talent development. And, of course, the need to justify public (taxpayer funds) expenditures as benefitting the taxpayers of the nation.

Further, as publicly funded problem-oriented R&D activities in G7 nations broaden to include cross-border international collaboration there are a host of additional operational issues rooted in adequate alignment among the industrial policies and economic, privacy, and regulatory policies of participating nations. Harmonizing the establishment and implementation of export controls on core technologies and components is a particularly important aspect of this work.

The need to work out the mechanics of international collaboration is not an insurmountable barrier to action but the solutions will require some new principles and plenty of operational innovation. Some of the principles can be drawn from a long history of trade and investment treaties, anchored around national treatment and reciprocity. Another principle, important to taxpayers and politicians, is that public funds

support primarily activities that clearly benefit national interest, such as buying access for national researchers and companies to research facilities located in other countries, the support of domestic researchers, and the research-focused education of those who will remain engaged in the national economy.

The good news is that the needed operational innovations for internationally collaborative problem-oriented research can be drawn from a deep and broad history of public-private R&D collaborations and company-company collaborative R&D ventures. While out of sight for most policy makers, there is a robust capability in this regard in places such as the US NSF, the German BMBF, Japanese JST, and UK UKRI as well as in more-industry and innovation oriented operations such as the US DARPA, Fraunhofer Institutes, Innovate UK or Japanese METI/NEDO. The international operational challenge is for these groups to work together, and closely with economic and regulatory agencies in their respective nations, to make cross-border initiatives work.

The Importance of Japan's Leadership of G7 in 2023 and Widening Beyond G7

The G7 agreements and actions called for in this brief piece reflect a substantial expansion of G7 scope firmly built on, among other things, the G7 Research Compact and Space Debris agreements from the 2021 Summit in Cornwall when the UK was in the lead. Effective German leadership in 2022 can make sure that this and the further agreements at the 2022 Summit are quickly converted into positive actions. This, however, is a substantially new direction for the G7 and solidifying 2022 progress in any or all of the initiatives depends on an effective hand off to Japan when it assumes leadership for 2023. And, of course, it is important that the the German and Japanese G7 leadership treat initial steps in this new direction as a quick-start activity which opens the door for problem-oriented R&D collaboration with other democratic technology powerhouses such as Sweden, South Korea, the Netherlands and Israel.

Operational challenges aside, the techno-economic ideas articulated here can help address the blended technical, economic, and geopolitical challenges facing democracies. Further, each of these initiatives — properly structured and launched — affords the ability for G7 nations to make common cause around national and economic security with all democracies.

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