

Proposed research funding
must be agreed by the
European Parliament.



EU SCIENCE

THE NEXT €100 BILLION

The European Union has partially approved the shape of its next giant research-spending programme, but it faces political tensions.

Politicians don't win prizes for speed, but the European Union's parliament and the leaders of its member states made record time this year when they hammered out an agreement that could supply researchers in Europe with more than €100 billion (US\$113 billion) over 7 years.

One day before the last parliament dissolved, on 17 April, negotiators signed off on the general outlines of the union's next giant research programme, known as Horizon Europe, which runs from 2021 to 2027. The EU's much sought after multi-year research programmes support academic and commercial research across its 28 member states and other countries that pay to join in (see 'Core club'). They set the agenda

**BY ALISON ABBOTT AND
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for science across the bloc and give rise to major initiatives: in the current version of the fund, called Horizon 2020, these have included €1-billion projects on brain science and quantum technologies.

The successful negotiations, which took only four months, have given some comfort to researchers and science leaders who are worried about the results of the EU parliamentary elections being held this week. The last election was in 2014, before the United Kingdom voted to leave the EU and before the sharp rise in support for populist parties in Poland, Italy and other EU countries. The EU devotes more than 8% of its trillion-euro, 7-year budget (2014–20) to its research programme, and some bureaucrats speculate that shifting political winds might alter

FREDERICK FLORIN/APP/GETTY

SOURCE: EUROPEAN COMMISSION
FROM HORIZON 2020 TO HORIZON EUROPE

the union's appetite for spending so much on science in the future. "Europe is not the same as it was during the last election. Thank God we managed at least to get the partial agreement so early," says one insider.

Plenty remains up for grabs with Horizon Europe. The new parliament could shrink its provisional budget — currently proposed at around €107 billion, which includes a €13 billion fund for defence-related research (see page 476). It could reapportion funding within this programme. And it might stymie the hopes of the European Commission, the EU's executive branch, to further open up Horizon Europe to distant non-EU partners, such as Canada or South Korea, and to the United Kingdom after Brexit.

The EU funds other research-related activities, including a proposed €16-billion space programme, to be overseen by a new EU agency in Prague — which might also see changes with budget negotiations. And later this year, the parliament, together with the heads of member states, will appoint new leaders for the commission's departments, including its research directorate.

Even if politicians don't fiddle with future budgets for research or shift the EU's science vision, geopolitical tensions could intensify perennial debates around how the bloc can commit to supporting only the best research while tackling inequality. The member states that joined the EU after 2004 gain less (per capita) from its research-funding programme than do richer members such as Germany and France, although the EU helps out poorer newcomers with other funds for science infrastructure.

However this month's elections pan out, arguments over the size and scope of the next research framework programme are sure to shape the future of EU science. "Horizon 2020 has a well-deserved international reputation. There's nothing else quite like it, and any individual country would struggle to replicate it," says Paul Nurse, a Nobel-prizewinning geneticist who heads the Francis Crick Institute in London. "If the UK is to remain a serious scientific player after Brexit, we need to be a part of Horizon Europe," he says.

EUROPE'S COLLABORATION ENGINE

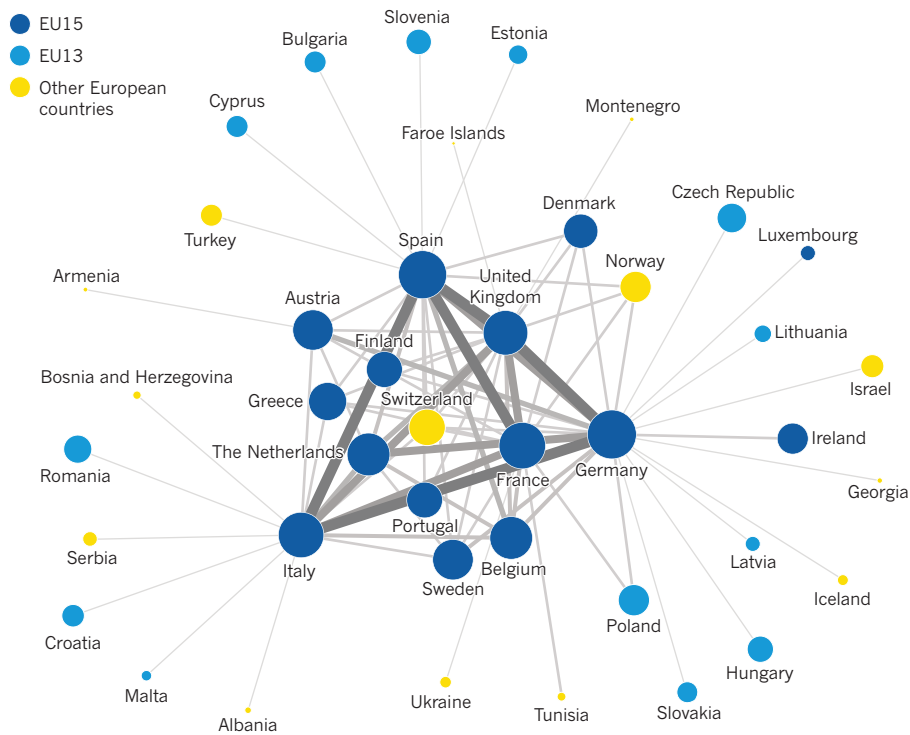
Why is Horizon Europe so important? It will be the ninth instalment of the EU's series of broad-ranging research programmes, which began in 1984. A unique aspect of these funding schemes is that, to achieve political objectives such as spurring the economy or improving the health and well-being of citizens, they insist on large collaborations that work across borders. "No other research system in the world operates this way," says mouse geneticist Nadia Rosenthal, science director at the Jackson Laboratory in Bar Harbor, Maine, who took part in EU research consortia when she worked at the European Molecular Biology Laboratory in Rome. Because the EU sets out its overall budget in multi-year chunks, the finances of the framework programme are also relatively stable.

On average, the research programmes and other EU research funds account for around 10–15% of what the 28 EU member governments spend in total on research and development (R&D) each year. (The programmes have an even greater influence in spurring research than these figures suggest, because in many cases the EU requires participants to match its funds with their own spending.)

Early programmes focused their funding almost exclusively on industrial and cross-border collaborations, but each successive one has grown larger and extended its repertoire

CORE CLUB

The older EU countries dominate collaborative research projects in Horizon 2020. In this network chart, the size of the node represents how influential a participant is (on the basis of its connections), and the width of the links reflects the number of collaborations.



(see 'Rising research cash'). A cross-border programme of Marie Curie research training fellowships, now known as the Marie Skłodowska-Curie actions, was added to the fourth framework programme in 1994; the prestigious European Research Council (ERC), which awards large grants to outstanding individual scientists, launched with the seventh programme in 2007. The ongoing eighth programme, Horizon 2020, added the European Institute of Innovation and Technology, a series of large-scale European partnerships addressing specific global challenges. A new element of Horizon Europe will be the European Innovation Council, a funding scheme designed to support entrepreneurs launching start-up firms and researchers developing commercially innovative ideas.

ALL PULL TOGETHER

The mainstay of the EU's research programmes are multinational academic-industrial collaborations, which comprise almost half the suggested Horizon Europe budget and cover areas such as health, climate, the digital economy, security and food. Politicians love these collaborations, but scientists tend to be ambivalent: they are a welcome source of money, but their bureaucracy can be tortuous. The application process is complicated, says biomedical researcher Seppo Ylä-Herttuala at the University of Eastern Finland in Kuopio, who since 1995 has been involved in nearly a dozen such collaborations to develop gene therapy for cardiovascular disease. "You need courage and experience," he says. His current consortium in Horizon 2020 is now running a clinical trial. Because Finland is small and sits on the geographical edge of the EU, Ylä-Herttuala says, it wouldn't have been possible for him to recruit the number of patients the trial needs without the wider geographical reach of the EU consortium.

The collaboration programmes are heavily oversubscribed. The overall success rate of applicants to collaborations in the first half of Horizon 2020 was just 12.6%, and reviewers rated one-third of the rejected applications as worthy of funding, the commission has reported. (The success rate has



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now dropped to 12%.) The ERC is similarly overwhelmed with keen applicants, and has just as low success rates. Horizon Europe's larger budget is an effort to address the problem.

Although Horizon 2020 is still running, the EU counts it as a success so far; an interim evaluation released in 2017 found that the programme has had a pronounced impact. According to projections made by macro-economic models, it will generate more than €400 billion in economic gains by 2030. And more than four-fifths of projects funded through Horizon 2020 wouldn't have gone ahead without the EU cash, the evaluation found. But the reviewers said that not enough was being spent on sustainable development and climate-related research — and that the programme has not reached young, fast-growing companies and innovators working on breakthrough technologies. The new European Innovation Council is intended to help with this.

Some other changes will also come with the new programme. In Horizon 2020, the commission launched three 'flagship' programmes, in which single consortia were promised €1 billion each over a decade to focus on, respectively, the brain, graphene and quantum technologies. The flagship idea has now been abandoned, although the three under way will continue, and concepts that were being developed for new ones will find homes in other parts of the Horizon Europe programme, says Robert-Jan Smits. He helped to design the original Horizon Europe proposal as the commission's director-general for research, a post he left in March to become president of Eindhoven University of Technology in the Netherlands. The big new idea in the programme is for 'missions': heavily financed collaborations intended to have a measurable impact in areas relevant to a significant proportion of the EU population. Rather than focus on single consortia as flagships did, such missions would put out calls for proposals and pick a constellation of winning bids. In a 3-year testing phase, up to 10% of Horizon Europe's budget will concentrate on a handful of missions. Five proposed areas written into April's agreement are climate change; cancer; oceans and other waters; smart cities; and soil and food.

UNFAIR SYSTEM?

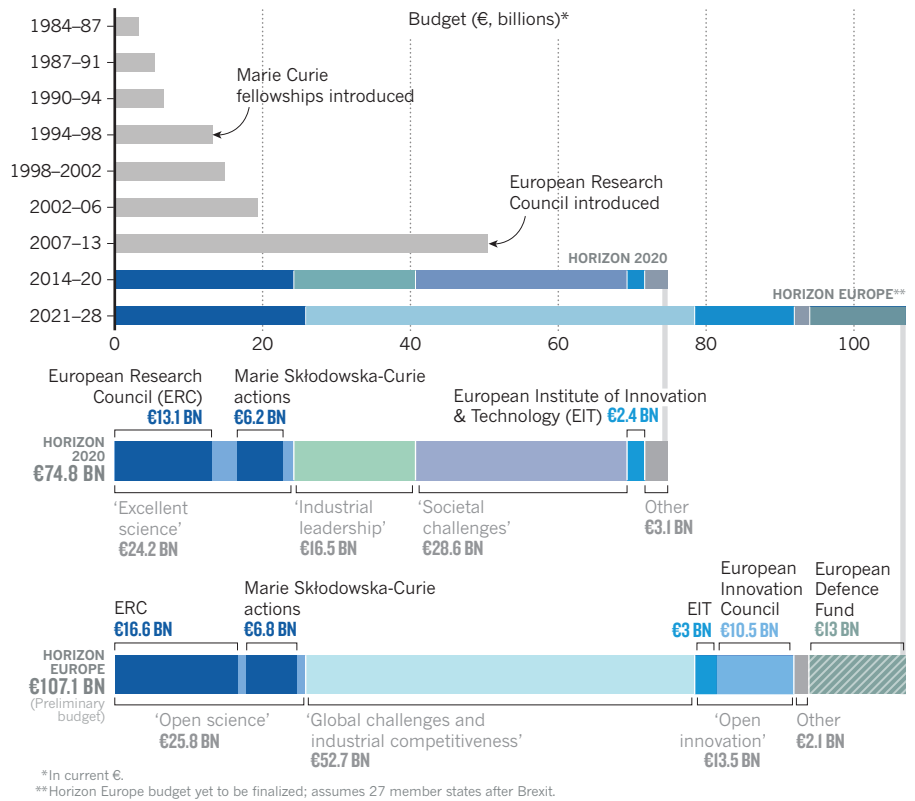
For scientists from countries that spend little on research, the EU's centralized research programmes represent hope. "EU research money is absolutely vital for us," says Igor Papič, an electrical engineer at the University of Ljubljana in Slovenia who is involved in a Horizon 2020 project aimed at integrating renewable-energy sources into the European electricity grid. "We just wouldn't be able to participate in this kind of research if we relied solely on local funding sources."

The majority of these nations with smaller research budgets are former communist countries in central and eastern Europe, which — together with the small states of Cyprus and Malta — joined the EU after 2004 and are known collectively as the EU13. As a group, they have won just 5% of the money from Horizon 2020 so far, even though they contribute 9% to its total budget. Three of the EU13 nations — Cyprus, Estonia and Slovenia — have received more out of the programme than they paid in. But others have been less successful: for every €1 that Poland and Romania have paid into Horizon 2020 so far, they have received only €0.33 back (see 'Winners and losers').

The EU has tried to help scientists and institutions in weaker

RIISING RESEARCH CASH

The European Union has steadily increased the value of its large framework research programmes.



“NO OTHER RESEARCH SYSTEM IN THE WORLD OPERATES THIS WAY.”

countries to improve their participation. It has partnered leading research institutions with those in poorer countries, given grants to endow top researchers with research-chair positions at new member-state institutes, and offered training to improve the quality of grant proposals through pre-proposal checks and advice. "But we simply lack the capacity to compete successfully with stronger countries for grants and talent," says David Smith, director of the multidisciplinary Ruder Bošković Institute in Zagreb, Croatia's largest public research institute.

Horizon 2020 dedicates around €1 billion to these efforts to improve the capacity of scientists from the EU's least-research-intensive regions to compete for funding. But Horizon Europe proposes to triple this amount.

Further help for the EU13 comes from another EU source in the form of structural funds: subsidies to poorer EU regions to improve the quality of their infrastructure. The cash must be partly matched by the receiving nation. Although recipient countries have tended to use the money for projects such as roads, over the past couple of decades the commission has encouraged them to use it to bolster research and innovation. Croatia, for instance, reserved €72 million earlier this year for a sweeping expansion of the Ruder Bošković Institute. That was the largest research investment ever financed by structural funds in the country. And in Horizon 2020, the commission has — for the first time — allowed structural-fund money to pay for research projects, through a scheme called the Seal of Excellence, which supports proposals that scored highly but missed out on funding.

From 2014 to 2020, the EU made €461 billion in structural funding available, and it had set a target for member states to put 30% of this towards research. In fact, nations decided to use less than 10% (€44 billion) for research. Bottom of the list was Romania, which devoted only 4.5% of its structural funds to science. The total structural funds in Horizon Europe haven't been negotiated yet, because they will depend on the EU's overall budget, which member states and the new parliament should decide on before the end of the year.

Among the EU13, the fault for not making the most of the EU's opportunities really lies with national governments, says Christian Ehler, a German politician who helped to shepherd the Horizon Europe package through the European Parliament. "They need to develop a larger appetite for science," he says. "Countries that currently only have a few competitive research units will have a hard time being successful if they don't substantially strengthen their overall research capacity."

No matter how generous, structural funds aren't enough to completely counter inequality, says Janusz Bujnicki, head of bioinformatics at the International Institute of Molecular and Cell Biology in Warsaw and a member of a high-level group of scientific advisers to the commission. "Our governments and science institutions must also ensure that the structural funds are used in a sustainable way," he says. "Just pouring seed money into research infrastructures, and then praying that God will send more money to do the science, isn't a good idea."

OPENING UP TO THE WORLD

Some non-EU countries are already 'associated members' of Horizon 2020, giving them essentially the same status as EU members to apply for money. Eligible countries include geographical neighbours, such as Norway and Switzerland, and those as far away as Israel, along with countries that have applied for EU membership, such as Turkey. Each of these countries pays in to participate on the basis of how big its economy is.

But the commission wants Horizon Europe to open up eligibility to other strong science countries, such as Canada, Australia and perhaps South Korea, to join as associate partners. "Europe's grand societal challenges, such as climate change, infectious disease and food security, are increasingly global challenges — we need to work together at a global level," explains Smits.

Far-flung nations already get a small amount of money from the EU — because researchers can involve them in multinational collaborations. But they cannot apply for money from the ERC and they cannot be the lead coordinator of multi-country programmes.

The suggestion to open up the EU's science programme to the world could face some opposition — especially from a new parliament with a populist flavour, says Christian Naczinsky, an official in Austria's research ministry. Associate members Israel and Switzerland have already together won nearly 12% of ERC grant money, to the chagrin of EU members that have captured less. And the United Kingdom is the most successful ERC country, winning 20% of its cash. If it leaves the EU but continues to participate in its research programmes, that will only increase the proportion of prestigious grants going to non-EU members.

The commission has proposed a different idea: that non-EU partners pay for the exact grants they receive. This pay-as-you-go system would have successful partners adding to the ERC pot rather than taking from it. In theory, countries such as the United Kingdom could simply fund this research on their own, without the ERC — but in practice, they might struggle to recreate the agency's high standards that result from Europe-wide competition.

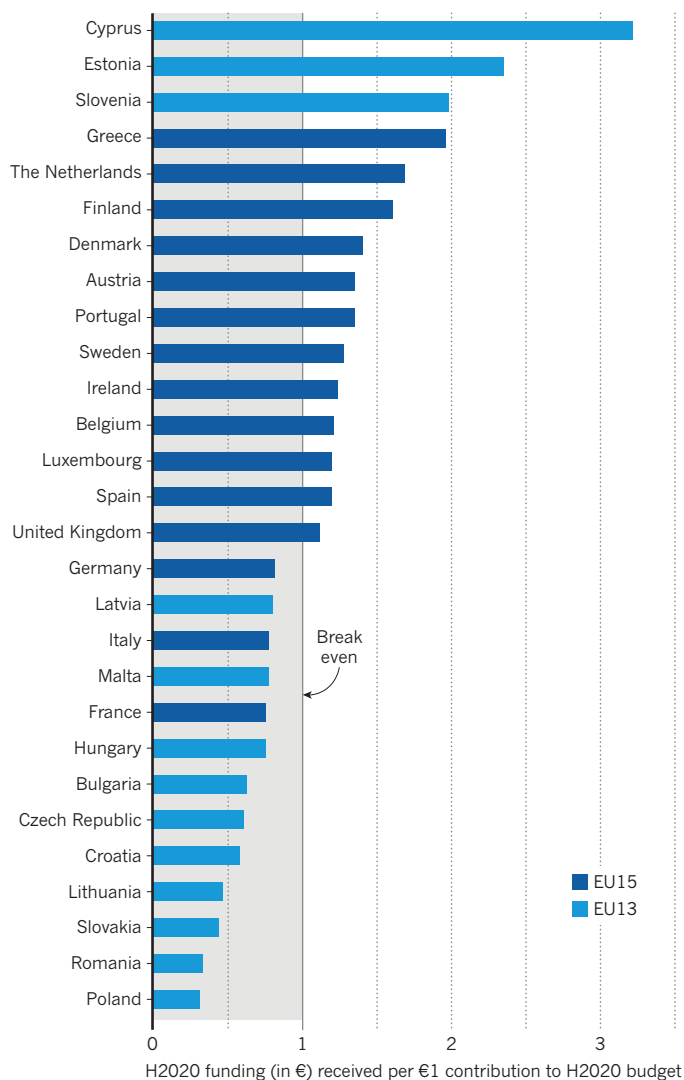
SCIENCE LEADERSHIP

The EU does not just hand out money for research; it also passes science-related laws that often affect the rest of the world. A prime example is the 2007 REACH legislation that makes firms register safety information for chemicals they wish to market in the EU. That EU law has forced firms around the world to match European standards. And recent data-protection laws have had wider impact because they affect all private companies that want to operate in Europe. The EU's push for 'open science', which demands open access to research papers and their data, has less economic clout but is setting an example that other nations may follow. The EU is also at the forefront of the battle against plastics pollution: one of the outgoing parliament's last acts was to approve a ban on single-use plastic items such as cutlery and straws by 2021.

For the next decade, action on climate change is soaring up the bloc's legislative agenda, and it is expected to be a major part of the next research programme as well. The EU is aiming to cut its greenhouse-gas emissions by at least 40% (from 1990 levels) by 2030. Last year, the

WINNERS AND LOSERS

Cyprus has won more than three times the money that it pays into Horizon 2020 (H2020), but other countries pay more cash in than they get out.



commission proposed that €320 billion, one-quarter of its proposed 2021–27 spending package, be spent on meeting those targets — up from €206 billion (one-fifth) of the current budget. More than one-third of the Horizon Europe budget is supposed to be committed to this effort.

The shape and budget of Horizon Europe won't be fully agreed until the end of next year, after the parliament and member-state governments have set the overall EU budget. A new commission will be well into its stride then: the terms of office of the current 28 commissioners — one for each EU country — will end on 31 October this year.

It might also be clear by then when and how the United Kingdom will exit the union, leaving 27 member states behind. The proposed budget for Horizon Europe is currently predicated on the assumption that Brexit will happen: it would rise if Britain did not leave.

Perhaps in no other member state do scientists so keenly appreciate the importance of EU science funding — as scientists in the United Kingdom have now had three years to ponder the consequences of losing it. "The level of collaboration on large European grants, funded by EU Framework Programmes, isn't replicated in any other mechanism I have been part of," says Bernard Siow, who develops ways of imaging biomedical tissues at the Francis Crick Institute. "Missing out on the opportunity to be involved in such projects would be a great loss to me and my fellow researchers." ■

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