Mission-oriented R&I policies: In-depth case studies

Case Study Report

Human Brain Project (EU)
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European Commission
Directorate-General for Research and Innovation
Directorate A — Policy Development and Coordination
Unit A.6 — Open Data Policy and Science Cloud
Contact Arnold Weiszenbacher
E-mail arnold.weiszenbacher@ec.europa.eu
RTD-RISE@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu

European Commission
B-1049 Brussels

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Mission-oriented R&I policies: In-depth case studies

Case Study Report

Human Brain Project (EU)

Eva Arrilucea

A Study coordinated by the Joint Institute for Innovation Policy

February 2018  Directorate-General for Research and Innovation
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1 Summary of the case study

This document analyses the case study of mission-oriented R&I policy initiatives in the field of the human brain in Europe. The following table describes the main components of the case study:

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<th>Human Brain Project</th>
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<tbody>
<tr>
<td><strong>Title:</strong></td>
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<tr>
<td><strong>Country:</strong></td>
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<tr>
<td><strong>Thematic area:</strong></td>
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<td><strong>Objective(s):</strong></td>
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<tr>
<td><strong>Main Governing Body</strong></td>
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<td><strong>Timeline:</strong></td>
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<tr>
<td><strong>Budget:</strong></td>
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<tr>
<td><strong>Brief description of the case (250 words)</strong></td>
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<td><strong>Implementation and organisation</strong></td>
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<tr>
<td><strong>Observed / expected outputs, outcomes, and impacts</strong></td>
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</table>
- 29 research agreements (target: 10)
- 805 platforms users (target: 500)
- 111 PhD students and postdocs recruited (target: 150)
- 73 workshops organised (target: 50)
- 2 courses organised by the HBP Education Programme (target: 2)
- 1 school organised by the HBP Education Programme (target: 1)
- 6 partnering projects joining the project (target: 5)
- The HBP has been active in collaborating with other brain initiatives, especially with US Brain, to combine complementary forces and minimise duplication of efforts.
- 124 industry / academia collaborations (target: 4)
- 1855 HBP mentions in public media (target: 3000)
- 5 press releases (target: 14)
- HBP analysis capacity is strengthened with the four supercomputing centres combined using the PRACE high-speed networks and Unicore. A pre-commercial procurement approach has been put in place, procuring R&D work for designing and delivering next generation prototype computing machines that are HBP compliant in terms of specifications related to interactivity and high-memory integration. This action has resulted in the delivery of two test machines for validation and test usage. The first versions of Physical Model and Multi-Core neuromorphic computing systems are available. Both systems are accessible remotely.
- 272 scientific publications (target: 180)
- 891 citations (target: 759)
- 1 patent application
- 3000 model building, simulations, analysis and validation job runs on the Platforms (target: 2000)

### Main elements of mission-oriented R&I initiative

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<tr>
<th>Directionality (links to societal challenges, industry transformation):</th>
<th>Yes. Oriented to solve health challenges related to neuro-diseases, the HBP is following a multi-disciplinary approach to accelerate brain research, brain medicine and brain-inspired technology.</th>
</tr>
</thead>
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<tr>
<td>Intentionality (specific, well-articulated targets):</td>
<td>Yes. The project objectives have been adjusted to achieve a multilevel integrated understanding of the human brain and its diseases.</td>
</tr>
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</table>
| Clearly set timeline and milestones: | Yes. The HBP has three main phases:  
• Preparation and selection phase (2009-2013);  
• Ramp-up phase (2013-2016);  
• Operational phase (2016-2023). |
| Mobilises public and private investments: | To certain degree. The largest chunk of mobilised funds came from EC and National Funds. 50% is funded by EC and the other 50% by national public and private organisations. |
| Focused on new knowledge creation (basic research, TRLs 1-4): | To certain degree. HBP is mainly focused in basic research. Although HBP includes both basic research and knowledge application, more effort should be done to involve SMEs in the HBP. There is a shared perception that HBP research is very far from the market. |
| Focused on knowledge application (applied research, TRLs 5-9): | To certain degree. There are some initiatives but they are still emerging, e.g. a pre-commercial procurement approach has been put in place, procuring R&D work for designing and delivering next generation prototype computing machines that are HBP compliant in terms of specifications related to interactivity and high-memory integration. This action has resulted in the delivery of two test machines for validation and test usage. The first versions of Physical Model and Multi-Core neuromorphic computing systems are available. |
| Demand articulation (involves instruments for inducing demand): | Yes. HBP joins interdisciplinary expertise with neuroscience, computer science, big data, informatics, physics and mathematics. |
| Multi-disciplinary (inter-disciplinary and/or trans-disciplinary) | Yes. |

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1 Assessment: Yes, To certain degree, No or Not known.
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<tr>
<th>Category</th>
<th>Description</th>
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<tr>
<td>Joint coordination (multi-level and/or horizontal governance of policies/finance):</td>
<td><strong>Yes.</strong> In the HBP there are 116 partners from 19 countries, of which 87 universities, 26 research institutes and two companies. There are also nine associated members in seven countries.</td>
</tr>
<tr>
<td>Reflexivity (flexible policy design, timely monitoring):</td>
<td><strong>To a certain degree.</strong> The initiative has experimented a change after the criticisms of part of the scientific community but the results are not clear yet.</td>
</tr>
<tr>
<td>Openness (connected to international agenda and networks):</td>
<td><strong>To a certain degree.</strong> The “Canberra Declaration” (Dec 2017) wants to create an International Brain Initiative IBI and has been signed by HBP, Australian Brain Alliance, Brain/MINDS project Japan, Korea Brain Initiative and US Brain Initiative.</td>
</tr>
<tr>
<td>Involvement of citizens:</td>
<td><strong>To a certain degree.</strong> One of the main points of criticism made by the community of scientific experts in 2014 was related to the project communication. In fact, one of the main recommendations was to improve communication with the general public based on realistic goals. During this time, the HBP has tried to communicate its aims to the community though the website, presentations at the European Parliament, direct partnering projects with research institutions and letters to academic journals. However, there is still a field of improvement increasing the transparency and communication with the community.</td>
</tr>
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2 Context and objectives of the initiative

This Chapter contains the description of the HBP initiative as well as its strategic and operative objectives and milestones.

2.1 Contextual factors and origins of initiative

In October 2013, after a preparatory period of three years, the Commission launched two FET Flagships, Graphene and the Human Brain Project. Each of them was implemented initially as an FP7 project preparing the ground for what would be a new kind of partnership. As a complement to these two projects, the Commission also launched a coordination action bringing together Member States to jointly define and implement activities and finance projects in support of the Flagships.

These two Flagships were the result of a Communication adopted in April 2009, in which the Commission stressed the need for Europe to address grand scientific challenges through sufficiently long-term multi-disciplinary research initiatives, termed FET Flagships. The Commission started the selection process in early 2010 with an open consultation with the scientific community to share and discuss initial ideas for potential Flagships. Following this, in July 2010 the Commission published a call for preparatory actions. Each action aimed to develop, over a year, the full blueprint for a Flagship through broad interactions with the relevant scientific communities, industry and other stakeholders. Out of 21 eligible proposals received, the Commission selected six proposals and launched them as pilots in June 2011. In July 2012, the Commission opened a second call for proposals for selecting two proposals out of the six pilot topics to be launched as Flagships. In the evaluations, a panel of high-level experts including leading scientists, industrialists and specialists from a broad range of disciplines, science and policy advisors evaluated the Flagship proposals. The evaluation was based on S&T excellence, sound implementation plans, and creation of the greatest value for Europe in terms of impact on science, technology, society and economy. After this, in January 2013, the Commission selected "Graphene" (Graphene-based Revolutions in ICT and Beyond) and the Human Brain Project (HBP).

The HBP was scheduled to run for ten years, and represents a new partnering model for visionary, long-term European cooperative research in the European Research Area, demonstrating the potential for common research efforts. HBP strives to accelerate the fields of neuroscience, computing and brain-related medicine. This acceleration will be achieved by a strategic alignment of scientific research programmes in fundamental neuroscience, advanced simulation and multi-scale modelling with the construction of an enabling research infrastructure.

In 2014, more than 800 expert scientists defined the project as too narrow and too complex in an open letter to the European Commission and asked for a review. The signatories requested an evaluation of the HBP's governance and scientific approach, and called for an independent external steering committee. If these objectives were not achieved, the signatories threatened to boycott the project.

Therefore, the Commission ordered an independent report that pointed out several improvement areas such as governance and the project’s science:

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3 Open message available here: https://docs.google.com/document/d/1rxl_663xC39hk5UBLzBqsDgerfiPyzX5aHls7wymq68/pub

Focus the Research Programme on the HBP’s Mission and Objectives. Define a set of concrete and achievable long-term objectives, which can be realised within the projected timeframe and with the financial resources available;

(Re-)Integration of Systems and Cognitive Neuroscience. Cognitive and systems neurosciences should be (re-)integrated by means of a new subproject comprising at least 3-4 work packages;

Scientific Project Management and Coordination. Scientific project management should be revised to facilitate the assignment of properly defined research tasks to research teams with excellent track records and to allocate the budget in a transparent manner;

Partnering Projects. The research objectives and programme should be viable even if funding is only available for the core projects. Part of the core budget should be devoted to the integration of scientists outside the HBP by suitable means;

Interaction between the HBP and the Science Community. The HBP and the EC have a fundamental responsibility to clearly and faithfully communicate the HBP’s sharpened mission and objectives. Furthermore, the HBP should systematically take and create opportunities for constructive scientific dialogues with scientists, with science policy makers and with the interested public;

Establishment of a Legal Entity in Belgium. It is essential that the responsibility of the HBP and the role of the coordinator be transitioned from École Polytechnique Fédérale de Lausanne to a new legal entity jointly represented by those institutions that most strongly contribute to the project. Such a distribution of responsibilities will help the HBP grow into an international hub;

Guiding Principles for a Revision of the Governance Structure. The revised governance of the HBP shall adhere to good governance practice. The separation of functions and responsibilities and a robust system of strong checks and balances will have to be implemented. In particular, scientific strategy development, executive and administrative management, as well as supervisory, auditing and advisory committees will have to be clearly distinguished;

Governance Structure. To ensure transparency of the process, decision-making and supervisory bodies will have to be entrusted to external experts who are not beneficiaries of their own decisions;

Transition Phase, A migration process from the current to the new governance is suggested which ensures appropriate participation of the whole partnership of the HBP.

The report concluded that the HBP should focus on goals that can be realistically achieved and concentrate on enabling methods and technologies.

Currently, the HBP is structured around 12 sub-projects:

- **Mouse brain organisation** that generates neuroscientific concepts, knowledge, experimental datasets and tools, which are used to build models for the simulation of the brain;

- **Human brain organisation** that develops neuroscientific concepts, tools, knowledge and datasets to contribute to a better understanding of the human brain;

- **Systems and cognitive neuroscience** that uncovers the neural mechanisms underlying cognitive processes, such as learning, perception, sleep, consciousness, and associated systems phenomena;
- **Theoretical neuroscience** that develops theoretical algorithms which play a key role in many areas of neuroscience research, including modelling of biological processes, analysis of brain activity patterns, and input into brain-derived computation;

- **Brain simulation platform** that provides an internet-accessible collaborative platform, designed for predictive reconstruction and simulation of brain models;

- **Neuromorphic computing platform** that provides brain-inspired computer architecture and makes them available for applications and experiments in neuroscience and generic computing;

- **Neurorobotics platform** that allows researchers to give any simulated brain model its own body — virtual or even real — and explore how it controls movement, reacts to stimulus and learns in a virtual environment;

- **Ethics and society** that promotes Responsible Research and Innovation practices within the HBP, and helps to shape the direction of the HBP in ethically sound ways that serve the public interest.

The HBP follows a unique, multi-disciplinary approach to accelerate brain research, brain medicine and brain-inspired technology. The infrastructure makes available a growing range of data, models, software tools and hardware capabilities to scientists and industry. The HBP also looks at the social and ethical implications of its work; this includes reflection on our understanding of consciousness, animal research, patient anonymity, etc., and engages with the public on these issues. It also runs a comprehensive education programme to increase scientists’ and engineers’ ability to work in cross-disciplinary teams.

The timeline of the Project is split into **multiple phases** (see Figure 1), each of which will be covered by a separate funding agreement. The current phase is Specific Grant Agreement One, which spans the two-year period from April 2016–April 2018.

![Figure 1: HBP Timeline. Source: European Commission (2017).](image-url)

The HBP is the first of a series of world-wide initiatives to foster the brain research (see Figure 2).
### Major brain initiatives and years of launch

- **EU**: The Human Brain Project, 2013
- **USA**: The BRAIN Initiative, 2014
- **Australia**: The Australian Brain Alliance, 2016
- **China**: The China Brain Project, 2016
- **Japan**: Brain/MINDS project, 2016
- **Canada**: Government/Brain Canada joint funding, 2017

Figure 2: Major brain initiatives and years of launch. Source: The HBP.

The following table summarises the main external drivers and barriers for facing and managing the HBP initiative:

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Barriers</th>
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</table>
| **Political** | • The European Commission provided extensive support for brain research in FP7. Brain research was considered a priority. More than two billion euro were dedicated to brain-related research since 2007, with a yearly allocation of more than 300 million euro. Such investment supported the foundation of a novel and active community dedicated to brain research, which has joined forces to reach an unsurpassed and essential multidisciplinary effort.⁵  
  • The “Canberra Declaration”⁶ (Dec 2017) wants to create an International Brain Initiative IBI and has been signed by HBP, Australian Brain Alliance, Brain/MINDS project Japan, Korea Brain Initiative and US Brain Initiative.  
| • A total of 24% of countries have stand-alone neurological health policies, although there is a major deficit in low- and middle-income countries.⁷  |
| **Economic** | • Total European 2010 cost of brain disorders was EUR 798 billion, of which direct health care cost 37%, direct non- |

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<table>
<thead>
<tr>
<th>Societal</th>
<th>Technological</th>
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<tr>
<td>• 179 million people, 27% of the European adult population, had experienced at least one of a series of mental disorders in the past year (this included problems arising from substance use, psychoses, depression, anxiety, and eating disorders).&lt;sup&gt;10&lt;/sup&gt;</td>
<td>• Over the past decade, owing in large part to substantial technological innovation, the field of neuroscience has expanded massively, tackling complex topics with profound policy and social implications.</td>
</tr>
<tr>
<td>• Neurological disorders ranked as the leading cause group of disability-adjusted life-years (DALYs) in 2015 and the second leading cause group of deaths. &lt;sup&gt;11&lt;/sup&gt;</td>
<td>• The privacy of medical information and the lack of informed consent in some cases may be a barrier to collect and use the data and a reason to rethink</td>
</tr>
<tr>
<td>• The prevalence of neurological diseases increases because of the growing and ageing global population. In particular, Alzheimer's disease and other dementias had increases in prevalence and mortality, especially in some high-income regions.</td>
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<tr>
<td>• Illness and suffering are afflictions of human beings in specific social and cultural conditions. Brain diseases are not just a technological challenge but also social and neurological, and to overcome it requires collaboration between neurobiologists and researchers in human and social sciences. &lt;sup&gt;12&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>• The HBP is committed to civil research only, and all partners have undertaken not to accept funding from (or use data or knowledge acquired for) military applications. But DARPA is a major funder of the US Brain Initiative and the HBP is committed to an open data policy, so this difference may be less significant than it seems, for the HBP cannot control the uses of the knowledge it produces or the strategies of its commercial partners. &lt;sup&gt;13&lt;/sup&gt;</td>
<td></td>
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These new scientific advances promise fundamental insight into the organisation and function of the brain, and potentially the treatment of mental and neurological disorders.\textsuperscript{14}

- To bring together and integrate all the data and findings in a coherent platform that researchers can readily access.
- Main scientific challenges are: making the brain, understanding the casual mechanisms of how it works and goes wrong, information processing, emerging new technologies, neurological and psychiatric brain disorders of children and adults and computational neuroscience.\textsuperscript{15}

\begin{tabular}{|c|p{0.5\textwidth}|p{0.4\textwidth}|}
\hline
\textbf{Legal} & A total of 41\% of countries report the existence of legislation on epilepsy, and 30\% report the existence of legislation relating to people with dementia; 29\% of countries report legislation on “other” neurological disorders.\textsuperscript{16} & Ethical priorities of privacy and consent.\textsuperscript{16}
\hline
\end{tabular}

- Some of existing datasets are still incompatible.
- Every practising neuroscientist’s productivity is limited due to computational resources, access to data or algorithms, or struggling with determining which data and algorithms are best suited to answer the most pressing questions. Each project related to brain research will require computational capabilities (including collecting, storing, exploring, analysing, modelling and discovering data) that will bring a whole suite of new challenges.\textsuperscript{17}

- Legal

\begin{itemize}
\item Establish Europe as a global leader in the domain and an attraction pole for international cooperation: building on European S&T excellence; creating collaboration among the best teams in Europe; forming leading initiatives and poles of attraction; creating opportunities for intense international cooperation and for regularly communicating European achievements in the field;
\end{itemize}

\begin{itemize}
\item To bring together and integrate all the data and findings in a coherent platform that researchers can readily access.
\item Main scientific challenges are: making the brain, understanding the casual mechanisms of how it works and goes wrong, information processing, emerging new technologies, neurological and psychiatric brain disorders of children and adults and computational neuroscience.
\end{itemize}


\textsuperscript{18} World Health Organisation (2017) op.cit.

• Develop new talents and new skills: nurturing creativity and talent; attracting the best minds; helping educate and train a new generation of skilful researchers;

• Create a long-lasting structuring effect on research efforts in Europe: creating collaboration amongst hundreds of European research teams across disciplines and across academia and industry; achieving a lasting integration of efforts and resources beyond their duration; creating synergies and coordinated planning among European, national and regional activities; reducing fragmentation and optimising complementarities between EU and national research programmes;

• Deliver a significant impact on competitiveness and society: bridging the gap between fundamental research and innovation; jointly developing and implementing a strategy for the efficient translation of scientific advances into concrete innovation opportunities; addressing some of Europe’s major societal challenges.

Specifically, the HBP Flagship has the following main objectives:

• Create and operate a European scientific Research Infrastructure for brain research, cognitive neuroscience, and other brain-inspired sciences;

• Gather, organise and disseminate data describing the brain and its diseases;

• Simulate the brain;

• Build multi-scale scaffold theory and models for the brain;

• Develop brain-inspired computing, data analytics and robotics;

• Ensure that the HBP’s work is undertaken responsibly and that it benefits society.

During the ramp-up phase (2013-2016) the goals of the project have been to:

• design and deploy six ICT platforms dedicated to neuroinformatics, brain simulation, high performance computing, medical informatics, neuromorphic computing and neurorobotics;

• create a user community of research groups from within and outside the HBP;

• set up a European Institute for Theoretical Neuroscience;

• complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute;

• develop the scientific and technological capabilities required by future versions of the platforms;

• implement a policy responsible innovation and a programme of transdisciplinary education;

• develop a framework for collaboration that links the partners under strong scientific leadership.

HBP is expected to have a potentially massive impact in areas such as neuroscience, new treatments for brain disease and future brain-inspired neuromorphic computing and robotics technologies.

From the beginning HBP establishes different strategies to boost innovation:

• PPPs with industries on advancing or using the platforms for novel R&D;
An internet site that aggregates IP owned by HBP partners and semantically matches it to a database of European industries related to neuroscience, medicine, computing and ICT in general, triggers automatic alerts informing industry about HBP’s IP basket and explains the process and models for licensing the IP;

An online service centre where industry can apply to use the HBP platforms or access HBP expertise to meet specific needs;

Thematic and national technology innovation & prototyping hubs for young entrepreneurial scientists, clinicians and engineers formed in collaboration with national governments;

Dedicated VC funds to drive start-ups and company formation.

HBP brings the full spectrum of expertise and initial IP, serves as an incubator to develop products and services, and prepares business concepts, strategies, and plans. In addition, HBP works with WIPO\textsuperscript{20} to increase IP awareness and strategy amongst researchers and hold regular industry information days.

In 2016, HBP announced the launch of the ICT platforms that embody the key objectives of the project. The platforms consist of prototype hardware, software tools, databases programming interfaces and initial data-sets, which be refined and expanded in close collaboration with end users.

Lately, the project objectives have been adjusted to achieve a multilevel integrated understanding of the human brain and its diseases. The infrastructure is underlined more explicitly as the building of a European infrastructure for brain science. These goals have been endorsed by the EC in a more detailed roadmap for the successive funding phase.

By 2018, the ICT platforms developed for the HBP will be fully operational and start delivering on future neuroscience (first in silico neuroscience experiments on parts of the mouse brain), future medicine (biologically-based classification of brain diseases), computing (neuromorphic chips and interactive visualisation with supercomputers). By 2021, it is foreseen to have a high-fidelity model of the whole mouse brain for in silico behavioural experiments, while for 2023, the project is expected to be ready to deliver a high-fidelity model of the human brain for in silico science, medicine and technology implementation and a first map of major brain diseases. HBP will also organise a dedicated annual conference.

\textsuperscript{20} World Intellectual Property Organisation www.wipo.int
3 Resources and management

The next section contains the HBP governance model as well as the financial model and the key actors, key technologies and main platforms involved in the initiative.

3.1 Governance and management model

The HBP is funded by the European Commission Directorate General for Communications Networks, Content, and Technology (DG CONNECT) in the framework of the EU’s Horizon 2020 research funding programme and is one of the first two Future and Emerging Technologies (FET) Flagship projects.

Flagships are long-term, very large-scale research initiatives aiming to solve an ambitious challenge such as understanding the human brain. With Flagships, the Commission proposes a new partnering model for long-term European co-operative research in the European Research Area, demonstrating the potential for common research efforts. This model is based on the combination of a large Core Project playing a leading role for the whole duration of the initiative and a set of Partnering Projects. In this model, the research community drives the process of defining and selecting the grand challenge of the Flagship, and developing the related research roadmap. Half of the Flagship budget will be invested by the Commission into the Core Project, while the Commission expects that the other half will be invested by the Member States and private funding sources into Partnering Projects.

In the HBP, there are 116 partners from 19 countries\(^{21}\), of which 87 universities, 26 research institutes and two companies. There are also nine associated members in seven countries. HBP gathers expertise on and across the borders of disciplines: from computer science and neuroscience: bio-informatics, computer architecture, software engineering, databases, bio hardware (neuromorphic), simulation, visualisation, brain imaging, genetics, cognitive science, theoretical neuroscience and physiology, medical practice, and also experts in innovation, industrial exploitation, ethics, education, programme management and communication.

By becoming part of a Flagship, research organisations and industry endorse the overall goals of the initiative and commit to work together to realise the Flagship Action Plan. By setting up collaborations between research teams, sharing resources and exchanging results, they create the conditions for fostering and bringing together research talent across Europe. In addition to the funds they receive from the Commission and/or the participating countries, the participating organisations co-finance their activities and provide in-kind contributions to the Flagship, e.g. in the form of access to infrastructure, experimental facilities and equipment, etc. For its part, Commission signs a Framework Partnership Agreement (FPA) to formalise its long-term commitment to work with the core project consortium along the agreed Flagship Action Plan. The FPA creates a stable and structured environment, enabling the funding of the implementation of the successive phases of the Flagship Action Plan, and the collaboration frameworks between the core project and the partnering projects throughout the lifetime of the Flagship.

On the other hand, the Commission expects that the participating countries, together with private funding sources, will contribute the other half of the Flagship's supporting funds. The contribution of the participating countries to the Flagships will come mostly through regional or national programmes and dedicated transnational calls.

A Flagship governance structure is illustrated in Figure 3 and includes:

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\(^{21}\) Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and Israel.
• **Framework Partnership Board (FPB)** linking the Commission and each of the EU-funded core project consortia. FPB provides the mechanisms to discuss the commitments of the participating organisations and the Commission to the Flagship. It will mainly contribute to maintaining relations of mutual co-operation and regular and transparent exchange of information on the planning, implementation and follow-up of the activities;

• **Board of Funders**, bringing together representatives from the participating countries and the Commission with the purpose of programming of activities in support of the Flagships. The role of this Board is essential for defining and planning the financial support to the Flagships for their whole duration;

• **Flagship Governance Forum (FGF)**, linking the Commission, the participating countries and representatives from the Core Projects and Partnering Projects consortia. The FGF has the form of a non-binding discussion forum which aims at achieving an efficient synchronisation of the main stakeholders involved in the implementation of the Flagships and their respective activities.

![Figure 3: The governance structure of Flagships. Source: SWD (2014) 283 final](image)

The Interim Evaluation (2017)\(^{23}\) suggests that the strategy boards of the Flagships need to be more positioned within an international context and the linking mechanisms between the Flagships and national initiatives are still under development and need to be further improved. The operational management aspect of the implementation model is a key to effectiveness. Nowadays, this model is very similar to that used for smaller-scale projects, which is problematic in terms of the flexibility to manage activity and associated budgets.

Also, the document points that the relationship between partnering projects and the core projects should be improved.

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Recently, a governance structure has been put in place ensuring a clearer separation between scientific steering, strategic and financial decision-making and the daily implementation (see Figure 4).

Now three bodies are responsible for coordinating the HBP: Stakeholder Board, Science and Infrastructure Board, and Directorate.

- **Stakeholder Board** is the project’s ultimate decision-making body and is comprised of one representative from each HBP Member State so it can create country-based support structures for the HBP.

- **Science and Infrastructure Board** is central to the HBP, providing scientific leadership of the Core Project. It is responsible for managing the implementation of the scientific and infrastructure work plan and for proposing work plans and roadmaps.

- **Directorate** is responsible for the management of the Core Project.

For 2018-2020 period, is planned to create a HBP Legal Entity in Belgium to manage the scientific research infrastructure and ensure the long-term sustainability after the FET Flagship ends. The new legal entity will take over the coordination of the HBP Core Project and oversee the integration of research infrastructure components from various member countries into an operational-grade facility.

### 3.2 Financing model

The estimated EU funding for 2013-2023 is EUR 406 million and the estimated national and private funding is EUR 600 million. According to the model of a FET Flagship, the Core

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Project is funded by the Commission and the Partnering Projects are funded by Member States and Associated Countries (see Figure 5).

![Figure 5: The model of FET Flagships. Source: SWD (2014) 283 final.](image)

The 2017 Interim Evaluation\(^\text{27}\) suggests that a longer funding cycle should be implemented to improve the flexibility needed to respond to changing circumstances and opportunities and to reduce administrative overhead. Funding models and funding time-scales should be changed to reflect the nature of the Flagships. It is recommended that to achieve improved funding-cycle budget flexibility, other schemes at national and EU level should be examined to see what can be transferred across to the Flagship.

### 3.3 Key actors and key technologies and platforms involved in the initiative

The HBP draws on the academic prowess of Europe’s leading universities and research institutions, backed by the computing and data-analytics power of four major supercomputing centres in the EU.

**ICT Platform / HBP JOINT Platform**

The HBP is creating an advanced ICT platform to support researchers studying the brain and its diseases, empower brain-inspired computing and drive technological development. It includes cloud-based collaborative virtual experiments, data analytics, and computing services and databases that enable meta-data handling and provenance tracking. Leading-edge supercomputers, brain-inspired neuromorphic computers, and neurorobotic systems combining simulated brains with robotic bodies, are being provided to scientists.

The HBP is developing advanced software for big data analytics, modelling and simulation at all levels of brain organisation – from the level of single molecules to the whole brain – to understand how the different levels of brain organisation interact and generate complex behaviour. Researchers can access all these from their own laboratories and collaborate with other labs.

The supercomputing centres involved in the platform are:

- Jülich\(^\text{28}\) (Germany) conducts research to provide comprehensive solutions to the grand challenges facing society in the fields of energy and environment, information and brain research. Jülich contributes their expertise primarily in the areas of structure and

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\(^{28}\) Jülich: [http://www.fz-juelich.de](http://www.fz-juelich.de)
function of the brain, as well as supercomputing and simulation. Forschungszentrum Jülich and its institutes are involved in several areas of research within the HBP;

- Swiss National Supercomputing Centre\textsuperscript{29}. Founded in 1991, CSCS develops and provides the key supercomputing capabilities required to solve important problems to science and/or society. The centre enables world-class research with a scientific user lab that is available to domestic and international researchers through a transparent, peer-reviewed allocation process. CSCS’s resources are open to academia, and are also available to users from industry and the business sector;

- CINECA\textsuperscript{30} is a non-profit consortium, made up of 70 Italian universities, eight Italian Research Institutions and the Italian Ministry of Education. It is the largest Italian computing centre. With more seven hundred employees, it operates in the technological transfer sector through high performance scientific computing, the management and development of networks and web-based services, and the development of complex information systems for treating large amounts of data. CINECA develops advanced Information Technology applications and services, acting like a \textit{trait-d’union} between the academic world, the sphere of pure research and the world of industry and public administration;

- Barcelona Supercomputing Center\textsuperscript{31} is the national supercomputing centre in Spain, specialised in high performance computing (HPC), BSC manages MareNostrum, one of the most powerful supercomputers in Europe. With a total staff of more than 500 R&D experts and professionals, BSC has been successful in attracting talent, and the research focuses on four fields: Computer Sciences, Life Sciences, Earth Sciences, and Computer Applications in Science and Engineering.

For 2018-2020 period, High-Level Support Teams and a new voucher scheme will be created to make expertise and resources available to support external users in exploiting and enriching the research infrastructure for specific cutting-edge applications.

**Neuroinformatics Platform**

The Neuroinformatics Platform serves as the Human Brain Project’s search engine for distributed data, curated data repositories, brain atlases and knowledge about the brain. The Platform consists of APIs for querying and a web-based platform and application programming interface (APIs), i.e. a set of standards, protocols and tools for building software applications. Users can search and collate high quality neuroscience data generated within and outside the HBP. Data can be examined by species, contributing laboratory, methodology, brain region, and data type, thereby allowing functionality not currently available elsewhere. The data are predominantly organised into atlases (HBP Strategic Rodent Brain Atlases and HBP Human Brain Atlases) and linked to the Knowledge Space – a collaborative community-based encyclopaedia linking brain research concepts to the latest data, models and literature.

**Brain Simulation Platform**

Released in April 2016, the Human Brain Project’s Brain Simulation Platform (BSP) is one of six internet-accessible ICT Platforms for collaborative brain research. The goal is to offer scientists user-friendly tools to reconstruct and simulate data-driven models of neurons and whole brain tissue. The Platform is the result of a co-design process in which HBP scientists and engineers worked hand in hand to provide an effective technical solution that satisfied the scientists’ needs. A key driver was the Blue Brain Project’s work to reconstruct and simulate neocortical micro circuitry in somatosensory cortex, and the application of

\textsuperscript{29} CSCS: http://www.cscs.ch/
\textsuperscript{30} CINECA https://www.cineca.it
\textsuperscript{31} Barcelona Supercomputing Center: https://www.bsc.es
Blue Brain techniques and workflows to other brain regions, notably cerebellum, hippocampus and the basal ganglia. The Platform provides reconstruction and simulation pipelines, packaged into web-accessible workflows or showcased as use cases. Many of the fundamental software packages are freely available as open-source software. The BSP hosts team-science Collabs that use these workflows to model different types of neurons and synapses, and different brain regions. The unique functionality of the Platform also allows members of the worldwide neuroscience community to create their own Collabs, accelerating collaborative brain research and tackling research questions that are difficult to address through other means.

High Performance Analytics and Computing Platform

The High-Performance Analytics and Computing (HPAC) Platform provides neuroscientists with the high-performance computing, storage and data processing capabilities they need to run simulations of sophisticated, detailed brain models and to analyse large, complex datasets. It also provides software tools and frameworks for scientific visualisation, interactive and visual data analytics, performance analysis of parallel applications, data management, time-series analysis, dynamic load balancing, parallel programming models, and numerical models for brain simulations. Some HPAC Platform users need computing resources themselves; others also would like to access datasets and results produced and stored at the HPC centres. The HPAC Platform offers software tools developed by the Platform partners for both groups of users. The execution of some of these tools, for example for visualisation and data management, does not necessarily require a supercomputer, but they can be used on standard computers and notebooks.

Medical Informatics Platform

The aim of the Medical Informatics Platform is to provide researchers with the ability to access and analyse large amounts of anonymised clinical data from hospital, research, and pharmaceutical clinical trial databases through an innovative data management system. The system integrates heterogeneous data formats seamlessly and federates data sources into a harmonised virtual database with a customised interface for navigation and data mining. The patterns discovered in the data will generate new hypotheses about brain diseases for investigation, and will lead to novel disease classifications based on biological, physiological and anatomical features, in addition to the classical patterns of phenomenology expressed in symptoms, signs and syndromes. The data will also be available to answer public health and medical epidemiological questions proposed by the community of medical scientists and planners. In the long run, we believe that unlocking the wealth of information stored in medical and research databases will provide a credible and rapid path to precision medical care.

Neuromorphic Computing Platform

The Neuromorphic Computing Platform developed in the HBP provides remote access to two complementary, large-scale neuromorphic computing systems built in custom hardware at locations in Heidelberg and Manchester. The NCS are programmable, brain-inspired computing devices which enable high-speed, low-energy simulations of spiking neural networks with synaptic plasticity.

The BrainScaleS system is based on physical emulations of neuron, synapse and plasticity models with digital connectivity, running up to ten thousand times faster than real time. The SpiNNaker system is based on numerical models running in real time on custom digital multicore chips using the ARM architecture. Models and simulation experiments are described in a Python script using the PyNN API.

Neurorobotics Platform

The Neurorobotics Platform is an internet-accessible simulation system that allows the simulation of robots and environments controlled by spiking neural networks. The Platform enables simple virtual closed-loop experiments in cognitive neuroscience to be performed.
using brain models developed within the HBP, with the capability to customise several variables, such as the environmental and physical parameters, using a Robot Designer, Environment Builder and a Closed Loop Engine. The Neurorobotics Platform is a collaborative tool that enables researchers to easily share and re-use experiments.

**European Institute for Theoretical Neuroscience**

The European Institute for Theoretical Neuroscience (EITN) is a structure created as part of the Theoretical Neuroscience activities of the Human Brain Project (HBP) and is operated by the Unit of Neuroscience Information and Complexity of the *Centre National de la Recherche Scientifique*.\(^{32}\)

The EITN is an open place to foster theoretical neuroscience activities related to the HBP, and has been planned to create strong interactions with the theoretical neuroscience community to bring new ideas and theories to the project. The EITN finances external researchers through an extensive workshop and visitor programme.

### 3.4 Monitoring system and evaluation of the initiatives

The Commission invites the Core Project consortium every two years to submit a new proposal for funding the implementation of the next phase of the Flagship Action Plan. The scope and specific activities that such proposals need to address are defined in the H2020 work programmes.

While this necessitates additional efforts both for the Core Project consortium to submit such proposals and for the Commission to evaluate them, it provides at the same time the opportunity for the Core Project consortium to:

- Update and revise the research roadmap, which must be a living document to ensure that maximum possible benefits are drawn from new ideas and S&T progress, as these emerge both outside and inside the Flagship;
- Evolve its composition and structure to cope with the evolving implementation needs. The evolution of the Core Project consortium needs to follow open, transparent and fair criteria.

Since the Core Project involves the participation of different partners, the integration of their efforts is addressed by setting up a management framework that:

- allows the project leaders to constantly check the work plan execution, be informed of any potential deviations and evaluate the Flagship positioning with respect to the state of the art;
- uses project collaboration platforms that enable efficient team development and sharing of results; and
- allows the project management team to continuously assess progress achieved through a well-defined project monitoring scheme based on Key Performance Indicators.

The interim Evaluation (2017)\(^{33}\) points that some Key Performance Indicators chosen to monitor the project are very traditional in the sense that they are too oriented to describe typical research outcomes. The document suggests including the means of assessing future potential and measure the meaningful engagement of industry. KPIs measuring the differences between Flagships and traditional research and innovation projects should be

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\(^{32}\) Centre National de la Recherche Scientifique: http://www.cnrs.fr

developed and a common system of assessing the Flagships should be created so that comparisons of KPIs across Flagships can be made. KPIs should reflect the objectives of the Flagship instrument and not just be oriented towards counting.

Also, the document suggests that external advisors must be involved in continuous assessment of the initiative.

3.5 Level and type of citizen engagement in the initiative

From the beginning, an effective communication and dissemination strategy is essential for Flagships. It needs to involve a broad range of stakeholders, particularly researchers, industry, policymakers and the general public. Such strategy can also support the achievement of other Flagship activities, like innovation, education and training or responsible research and innovation.

The participating organisations, the Commission and the participating countries have a shared responsibility to the Flagship’s communication strategy. This includes developing their own communication strategies and coordinating with each other to make sure messages are coherent and to obtain an amplification effect.

Dialogue with society, ethics and safety are of paramount importance for the Flagships. The Flagships need to engage not only with specialists but also with the organised civil society and the public, through consultation and dialogue, in order to verify and support the Flagship goals and approach and, in particular, the related socio-economic and ethical dimensions. HBP has established two levels of control, one addressing the wider prospective uses of the projects results and a second one, dealing with the activities carried out within the initiative:

- HBP has established a foresight lab for analysing industrial, economic and social consequences of foreseen results. It has also started a philosophical analysis on the implications of the research on our understanding of the mind and consciousness. HBP will run online debates and conventions for engaging with the general public, and set up dedicated fora for dialogue with specific stakeholders. An external advisory Ethical, Legal and Social Aspects Committee is supporting all these activities;

- Regarding its direct R&D activities, HBP has set up an independent team for ethics, reporting directly to all levels of the management structure, and which, as part of their monitoring, maintains a registry of tasks requiring ethics control and of their approval. This internal group is complemented by an external advisory Research Ethics Committee.

One of the main points of criticisms made by the community of scientific experts in 2014 was related to the project communication. In fact, one of the main recommendations was to improve communication with the general public based on realistic goals. During this time, the HBP has tried to communicate its aims to the community though the website, presentations at the European Parliament, direct partnering projects with research institutions and letters to academic journals. However, there is still a field of improvement increasing transparency and communication with the broader community.34

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4 Policy instruments and wider policy mix used for implementing the initiative.

4.1 Description of the R&I policy instruments used for implementing of the initiative

The FLAG-ERA project.35

The FLAG-ERA project is a consortium of most of Europe’s regional and national funding organisations to support the Flagships. To enhance complementarities and synergies of regional, national and European research programmes and initiatives, the organisations share information on the programmes and initiatives, identify gaps and overlaps and adapt their thematic programme and launch new initiatives according to the identified needs.

The TAIPI project.36

Tools and actions for impact assessment and policy makers information (TAIPI) project aims to support and strengthen the Flagships by undertaking impact assessment activities and collecting information need for policymaking. The TAIPI project has four objectives:

• Develop assessment methodologies along with the required took kits which will be applied to HBP;

• Carry out an impact assessment of HBP by applying the specifically developed methodology and tools;

• Collect and provide information for policymakers and funding organisations participating in Flagship initiatives; and

• Transfer the developed toolkits to HBP, and to enable it to use these tools after the end of TAIPI.

The project began work in 2015 providing scientific, technological, economic and societal impact assessments, including the contribution of HBP to the EU level of excellence and leadership in the scientific area, the impact of competitiveness of industry by leading to breakthrough technologies, potential effects on the creation of new industries and new jobs, societal benefits as well as funding capacity of HBP including different public and private sources.

HBP Curriculum37

HBP has an education programme designed to equip researchers and developers with the knowledge necessary to train scientists, to exploit the convergence between ICT and neuroscience and to create new capabilities. The programme offers different teaching formats, such as student conferences, workshops and schools, coupled with a curriculum of formal courses.

The curriculum consists of several online courses covering brain medicine, ICT and neuroscience, alongside complementary subjects of research ethics and the societal impact of research, intellectual property rights and translation of research.

35 FLAG-ERA: https://www.flagera.eu/
36 TAIPI Project: https://www.taipi.eu/
4.2 **Connection with other policies**

Many of the other brain international initiatives such as **US Brain** have objectives and approaches complementary to those of the HBP. There are four main levels of interaction between them:

- Direct collaboration via joint projects involving HBP researchers and researchers from other countries working in any of the six research platforms;
- Collaboration through Partnering Projects. A Partnering Project can be any project with funding from outside HBP that has a specific goal, complementary to the HBP, that exploits and refines the HBP research infrastructure;
- Collaboration involving joint, coordinated activities with large-scale private, national or international research initiatives;
- Collaboration through the education programme.

The 2017 Interim Evaluation\(^ {38} \) suggests enhancing the openness of the Flagships towards new directions, being open to external inputs that can challenge assumptions and direction. Also, the document points to more interaction between initiatives under H2020 and beyond.

Furthermore, it is suggested to improve the engagement with national initiatives using national Partnering Projects. The document considers that there was not enough consideration given to alignment with national priorities in the selection process.

### 4.3 Key turning points of the initiative and policy adaptation measures

The following table shows the major changes and turning points of Human Brain Project, as well as a description of the main flexibility mechanisms and policy adaptation measures.

<table>
<thead>
<tr>
<th>Major changes / turning points of the initiative</th>
<th>Description of the flexibility mechanism / policy adaptation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>In 2014, more than 800 expert scientists defined the project as too narrow and too complex in an open letter to the European Commission and asked for a review. The signatories requested an evaluation of the HBP’s governance and scientific approach, and called for an independent external steering committee.</td>
<td>The Commission ordered an independent report that pointed out several improvement areas, such as the governance and the project’s science.</td>
</tr>
</tbody>
</table>

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5 Realised or expected outputs, outcomes and impacts

This section is focused on the outputs, outcomes and impacts resulted from the whole initiative. In this respect, it is important to notice that the 2017 Interim Evaluation suggests that HBP “needs to work further to achieve a more uniform level of research excellence across the project” and that “the future effectiveness supporting innovation still needs to be demonstrated”. In particular, HBP needs to create stronger interactions among some of the sub-projects and to prove the value of research infrastructures to all HBP communities.

Also, it is important to demonstrate how the focus of the Flagship shifts across TRLs with time demonstrating that the Flagships have strategic research and innovation agenda aligned with industrial interests. The conditions that make a Flagship an effective structure for undertaking research must be clearly defined in advance. Clarity about the outcomes that are sought is needed.

In addition, more effort should be done to involve SMEs in the Flagship.

5.1 Outputs and New Instruments

- **New Platforms** (2016): *Neuroinformatics Platform*, a search engine for distributed data, curated data repositories, brain atlases and knowledge about the brain; *Brain Simulation Platform* that allows extrapolation of highly representative static models and simulations of brain activities, within brain regions or whole brains, using sparse data sets; *Neuromorphic Computing Platform* to simulate learning processes faster than real time, provides insight into neural information processing and anticipates devices that mimic strengths of the brain; *Medical Informatics Platform*, allows researchers to look for patterns in data from patients while preserving patient confidentiality using big data techniques; *Neurorobotics Platform*, to test brain simulations by connecting them to virtual or real robots; *High-Performance Analytics & Computing Platform*, integrating and operating hardware and software components of the supercomputing, data and visualisation infrastructure to run extensive, large-scale simulations and manage large amounts of data and complex workflows. All the platforms are integrated through a web-based collaborative scientific hub: the Collaboratory. The Collaboratory is a social networking system to enable collaborative science around the fluid sharing of data, theories, applications and models prior to publication while still maintaining proper attribution.

- HBP analysis capacity is strengthened with the four supercomputing centres combined using the PRACE high-speed networks and Unicore. A pre-commercial procurement approach has been put in place, procuring R&D work for designing and delivering next generation prototype computing machines that are HBP compliant in terms of specifications related to interactivity and high-memory integration. This action has resulted in the delivery of two test machines for validation and test usage. The first versions of Physical Model and Multi-Core neuromorphic computing systems are available. Both systems are accessible remotely.

- The Brain Simulation Platform has demonstrated transdisciplinary research that integrates modelling with experimental data-sets. It enables a close interaction of simulation, experimental, and data science that lead to theory and simulation-driven experiments, which is of great value. This multi-partner integrated approaches a prime example of a successful interaction across several HBP pillars and theory-guided

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40 Partnership for Advanced Computing in Europe: http://www.prace-ri.eu/
41 Uniform Interface to Computing Resources. https://www.unicore.eu/
experimental work. Use-cases include large-scale simulations and reconstructions across several scales of the system. The platform will now enable both the HBP community and the non-HBP community to run simulations of the neuronal systems on several levels, ranging from molecular dynamics to large scale populations of neurons.43

- Regarding data, new multi-level data from the mouse brain, covering a first version of transcriptome for major types of neocortical neurons, high resolution scans of the whole brain vasculature system, and numbers and distributions of neurons and glia, will now feed into the HBP Mouse Brain atlas and models. New valuable data are also available concerning the human brain morphology, connectome, patterns of cortical segregation, cells and neurotransmitter receptors. Human-to-rodent comparison of single neuron morphology and function has progressed faster than planned, with excellent collaboration for studying homologies between human and non-human primates. Multi-modal and multi-level information is now available in a unified approach. The work on cognitive tasks was found to be of an outstanding quality: the new data-sets can provide goals and constraints for the HBP modelling regarding perception and action, motivation, decision and reward, learning and memory. Work on mathematical and theoretical foundations has also delivered significant algorithms for synaptic learning and for inferring effective connectivity from neuro-imaging data.44

- 29 research agreements (target: 10)45
- 805 platforms users (target: 500)
- 111 PhD students and postdocs recruited (target: 150)
- 73 workshops organised (target:50)
- 2 courses organised by the HBP Education Programme (target:2)
- 1 school organised by the HBP Education Programme (target: 1)
- 6 partnering projects joining the project (target: 5)

5.2 Outcomes

- The HBP has been active in collaborating with other brain initiatives, especially with US Brain, to combine complementary forces and minimise duplication of efforts. The European Institute for Theoretical Neuroscience46, an open place to foster theoretical neuroscience activities related to the HBP, facilities communication with scientists from the non-HBP community.
- 124 industry / academia collaborations (target: 4)
- 1855 HBP mentions in public media (target: 3000)
- 5 press releases (target: 14)

5.3 Impacts

- 272 scientific publications (target: 180)
- 891 citations (target: 759)
- 1 patent application
- 3000 model building, simulations, analysis and validation job runs on the Platforms (target: 2000)

5.4 Summary of the key indicators

Next table shows the main indicators related to Human Brain Initiative:

45 All the quantitative indicators and its targets are related to the Key Performance Indicators for the Ramp-Up phase as provided by the HBP Flagship in September 2016.
46 European Institute for Theoretical Neuroscience: https://www.eitn.org/
<table>
<thead>
<tr>
<th>Key indicators</th>
<th>2013-2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeline:</td>
<td>2013-2023</td>
</tr>
<tr>
<td>Objective and targets:</td>
<td>The HBP is a ten-year European Flagship project, aiming at a comprehensive understanding of the human brain. The HBP aims to combine all existing knowledge and data about the human brain for building a realistic computer model of the brain by 2023. Such a model will help researchers understand how the human brain works and the diseases affecting it.</td>
</tr>
<tr>
<td>Total budget:</td>
<td>EUR 1 billion</td>
</tr>
<tr>
<td>Annual budget:</td>
<td>N.A.</td>
</tr>
<tr>
<td>Share of budget, public funding:</td>
<td>The estimated EU funding for 2013-2023 is EUR 406 million and the estimated national and private funding is EUR 600 million.</td>
</tr>
<tr>
<td>Share of budget, private investment:</td>
<td>N.A.</td>
</tr>
<tr>
<td>Leverage effect (additional public/private investments the initiative has triggered):</td>
<td>N.A.</td>
</tr>
</tbody>
</table>
| Key (official/public) indicators applied for monitoring the progress towards the targets: | • Number of research agreements  
• Number of scientific publications  
• Number of citations  
• Patent applications  
• Industry/academia collaborations  
• Research platform prototypes / demonstrators  
• Number of platforms users  
• Number of model building, simulation, analysis and validation jobs run on the platforms  
• PhD students and postdocs recruited  
• Number of workshops organised  
• Number of courses organised by the HBP education programme  
• Number of schools organised by the HBP education programme  
• Number of partnering projects joining the project  
• Number of HBP mentions in public media  
• Number of press releases  |
| Other key indicators (e.g. outputs/outcomes/impacts):                         | N.A.                                                                                                                                       |
## Conclusions and lessons learned

### 6.1 Identification and assessment of key strengths and weaknesses of the initiative

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| This second phase of the project has taken into account the expert recommendation about taking a more democratic approach to reorganising the governance structure and reintroducing cognitive neuroscience as one of 12 core sub-projects. | The HBP was criticised from the start for being too ambitious, in view of the number of neurons and connections in the human brain and their variation between people and even within individuals throughout life.  

| The HBP has been active in collaborating with other brain initiatives, especially with US Brain, to combine complementary forces and minimise duplication of efforts. | HBP has not fully developed the recommendations given by the experts in 2015 related the refocussing of the project on technology development jointly with the neuroscience community, and related to improving communication with the general public based on realistic goals.  

| There is a legal entity for HBP which ensures that no single institution has too much control over its direction. | More effort should be done to involve SMEs in the HBP. There is a shared perception that HBP research is very far from the market. After several years of execution, HBP needs to pay attention to the identification, assessing of maturity, and definition of roadmaps in order to move HBP emerging results to the market.  

| Every group involved in the consortium must reapply for funding every two years. | Need to work further to achieve a more uniform level of research excellence across the project.  

| | HBP needs to create stronger interactions among some of the sub-projects and to prove the value of research infrastructures to all HBP communities.  

| | Need to improve the engagement with national initiatives using national Partnering Projects.  

| | Need to enhance the openness of the Flagships towards new directions, being open to external inputs that can challenge assumptions and direction. Also, the document points to more interaction between initiatives under H2020 and beyond.  

| | Neuroscientists worry that the Human Brain Project will drain all the EU and Member State funds on neuroscience research. |

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6.2 Lessons learned and key messages for European R&I policy

- Objectives should be relevant to the involved research communities, should be achievable and the relevant research communities and Member States should support the objectives.\(^{49}\)

- A way must be found to ensure the coordination between Flagships and future missions in FP9. While Flagships put money into emerging fields that promise significant economic returns, missions tackle societal challenges.

- The “data-driven” paradigm in neuroscience argue that harnessing the large quantities of data generated across laboratories worldwide has numerous methodological, ethical and economic advantages, but it requires the neuroscience community to adopt a culture of data sharing and open access to benefit from them.\(^{50}\)

- It is not possible to coordinate these kinds of projects with multiple organisations and researchers by using the same approach used by traditional R&D projects. Big projects require to set up specific governance structures with full-time professionals and to keep close contact with all stakeholders.\(^{51}\) A balanced system of separation of powers between scientific steering, strategic and financial decision-making and the day-to-day management is a must to establish from the outset.

- FET Flagships is a good instrument to coordinate research when the main challenge is quite mature but it still requires long-term efforts.\(^{52}\)

- Flagships are not the appropriate instrument for every type of research. They should be considered particularly when goals such as pushing forward a technology over a longer time frame or enabling a new type of scientific exploration that requires a collective effort, can only be reached through a long-term, large scale coordinated effort. Such initiatives can be appropriate to secure the knowledge transfer between the different tiers of the value chain. A Flagship can only be envisaged in a field that has reached sufficient maturity. There should be at least a core of industrial or societal partners who have entered the field and can motivate it from their long-term interests. There should be also a large enough academic community that can take up the challenge and constructively interact with the industrial and societal stakeholders so as to enable the creation of a major European service-based research infrastructure.\(^{53}\)


\(^{52}\) Idem.

References:


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OPEN DATA FROM THE EU
The EU Open Data Portal (http://data.europa.eu/euodp/en/data) provides access to datasets from the EU. Data can be downloaded and reused for free, both for commercial and non-commercial purposes.
The Human Brain Project HBP is a 10-year European Flagship project, aiming at a comprehensive understanding of the human brain. The HBP aims to combine all existing knowledge and data about the human brain for building a realistic computer model of the brain by 2023. Such model will help researchers understand how the human brain works and the diseases affecting it. The HBP represents a new partnering model for long-term European cooperative research in the European Research Area, demonstrating the potential for common research efforts. HBP strives to accelerate the fields of neuroscience, computing and brain-related medicine. This acceleration will be achieved by a strategic alignment of scientific research programmes in fundamental neuroscience, advanced simulation and multi-scale modelling with the construction of an enabling research infrastructure.

Studies and reports