MISSION INNOVATION

Accelerating the Clean Energy Revolution

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Clean Energy Materials Innovation Policies and Programs in Mission Innovation Member Countries

An Annex to the Report "Materials Acceleration Platform: Accelerating Advanced Energy Materials Discovery by Integrating High-Throughput Methods with Artificial Intelligence"

January 2018

This Annex provides a summary compilation of current and planned policies and programs pertaining to clean energy materials innovation. The compilation is limited to Mission Innovation Members countries that submitted information in response to an information request. It is envisioned that this document can be used to help identify potential opportunities for intergovernmental collaboration among Members on related and complementary research programs and also to provide information that could further Member engagement with investors, businesses, and other private sector entities.

Mission Innovation Members providing information for this compilation:

European Commission

The interest of the European Commission in Innovation Challenge 6 (Clean Energy Material Innovation Challenge - IC6) is a) to support participating member countries and b) to explore synergies on how to approach the more theoretical work of Innovation Challenge 6 and the more application related NMBP programme for a fruitful collaboration

The EC is not leading or co-leading this challenge. The EC participates as an observer both for itself as well as other participating EC countries, namely; Denmark, France, Germany, Italy, Finland, Norway, Sweden, the Netherlands, and the United Kingdom.

The EC provided experts and participated with an observer in the first IC6 related workshop in Mexico City from 11 to 14 September 2017, in order to set the basis for a report on the basic research needs related to this challenge.

Initiatives, Policies, and Programs Related to Clean Energy Materials Discovery and Development

Current Initiatives, Policies, and Programs

The EC contributes, outside Mission Innovation, to materials research and innovation, including discovery, characterization and synthesis through its different research and innovation (R&I) programmes and infrastructures. On the more basic and frontier research side this is done partly through the European Research Council. More applied industrial research in materials is done in the Horizon 2020 NMBP "Nanotechnologies, Advanced Materials, Biotechnology and Processing" programme. In October 2017 the NMBP Work Programme for 2018-2020 will be published that shows funding opportunities also in the area related to IC6.

WP 2018-2020 has no specific call foreseen for direct collaboration with Mission Innovation Challenge 6. However, H2020 and the NMBP calls are open for collaboration to all IC6 involved countries (non-EU countries should provide their own funding). In particular, calls related to "Catalytic transformation of Hydrocarbons" and "Photocatalytic Synthesis" are specifically flagged for international collaboration.

Future Initiatives, Policies, and Programs

This challenge is working towards a platform for fast and automated new materials discovery, synthesis and characterisation of nanomaterials and composites and functional materials, and thus has a strong focus, by its nature, on theoretical research work that is far away from market application. The focus of the NMBP programme is, on the contrary, aimed at bridging the gap "from the lab to the market", and is focusing for example on upscaling of materials and preparation of pilot plants, with R&I at technology readiness levels (TRLs) from 4 to 7. It is thus positioned more downstream in the materials discovery and production value chain. As for now, the IC6 - NMBP collaboration with respect to specific funding and synergies still has to be looked at (H2020 - WP 2020 and FP9).

Potential areas of interest are catalysis, modelling, characterization, lightweight materials for energy applications and other areas to be explored in the future.

Publicly-Supported Laboratories and Major Facilities Specializing in Clean Energy Materials Discovery and Development

The European Union has supported research capacities that are distributed widely in its different Member states (see specific Member country information).

The EU itself also has its own research capacity through institutions like the DG JRC, the Joint Research Centres of the European Union, or the EIT, the European Institute of Technology.

Some major European R&I Institutions in the area are:

- Belgium: IMEC
- Finland: VTT
- France: CEA and CNRS
- Germany: Fraunhofer Institutes
- Italy: ENEA
- Netherlands: TNO
- Spain: Tecnalia and CSIC

Europe has some major companies in energy materials discovery and development. Many of them are part of EMIRI, the Energy Materials Industrial Research Initiative (http://emiri.eu).

Some leading EU groups for computational methods for accelerated/autonomous discovery of clean energy materials include:

- Denmark: Technical University of Denmark:
  - Prof. Tejs Vegge (IC6 Technical Expert),
  - Prof. Kristian Thygesen,
  - Prof. Karsten W Jacobsen.
- EU: European high-capacity screening network
- Finland: Finnish Institute of Molecular Medicine at the University of Helsinki
  - Prof. Krister Wennerberg
- France: LAAS-CNRS
  - Dr. Thierry Siméon
- Germany: Fritz Haber
  - Prof. Dr. Matthias Scheffler, Prof. Stefano Curtarolo, Prof. Alexandre Tkatchenko
- Germany: Institut für Technische Informatik und Mikroelektronik
  - Professor Dr. Oliver Brock
- Germany: Leibniz-Institut für Molekulare Pharmakologie (FMP) im Forschungsverbund Berlin e.V.
- Spain: ICIQ

    - Prof. Nuria Lopez
- UK: Kings College London
    - Prof. Alessandro de Vita
- UK: University of Cambridge
    - Prof. Gabor Csanyi (Molecular modelling)

For specific contacts please contact the specific EU member countries directly.

For more information on the European Commission's clean energy materials innovation programs, please contact George Kotsikos (George.Kotsikos@ec.europa.eu) or Martin Gieb (Martin.Gieb@ec.europa.eu).

Germany

Initiatives, Policies, and Programs Related to Clean Energy Materials Discovery and Development

Current Initiatives, Policies, and Programs

Basic research on new materials for the energy transition (Energiewende) is covered by the 6th Energy Research Programme of the Federal Government. Several research calls and initiatives address this topic either directly or as parts of application-oriented calls.

One exemplary research call is the funding initiative "Material Research for the energy transition (Energiewende)". The initiative triggers innovative research projects in the area of basic research for materials for the upcoming challenges. It addresses key challenges of material research in the areas of energy generation and distribution and energy efficiency. This initiative is open to all technologies and projects that deal with materials development in the following fields:

- Energy efficiency in buildings;
- Heat transport, transformation and storage;
- Hydrogen generation and storage;
- Electrolysis and fuel cells;
- Photovoltaics;
- Wind energy;
- Power plant technology; and
- Electrochemical storage, especially for metal-air batteries.

Besides intensive cooperation between universities, research institutions and companies, a special focus is also laid on supporting junior research groups. Another aim is to support research projects that focus on international cooperation. The main focus here is on European cooperation through the interlinking of national initiatives with the programs of other Member States as well as EU framework program calls.

Future Initiatives, Policies, and Programs

Research funding for clean energy materials will be continued within the Energy Research Program of the Federal Government. For example, the research call DeuGrInZus2 (German-Greece International Cooperation, Phase 2) addresses in part the topics of the Clean Energy Materials Innovation Challenge.

Publicly-Supported Laboratories and Major Facilities Specializing in Clean Energy Materials Discovery and Development

Helmholtz Gesellschaft (HGF)

The Helmholtz Association of German Research Centers (HGF) is a union of 18 autonomous research centres. These research centers run large scale infrastructure and devices and conduct basic as well as applied research. Materials and energy research is prominent within the Helmholtz Association. Particularly relevant for

the clean energy materials innovation challenge is the Helmholtz Energy Materials Characterization Platform (HEMCP), through which access to specialized infrastructure in seven research centers is organized. One such infrastructure is EMIL, the Energy Materials In-situ Laboratory Berlin. In a concerted effort, HGF and the Max Planck Society (MPG) develop and operate the Energy Materials in Situ Laboratory (EMIL), a world-wide unique facility at the BESSY II synchrotron light source. In addition, six research centers are involved in the Helmholtz Energy Materials Foundry (HEMF), another distributed infrastructure with a focus on synthesizing energy materials.

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Fraunhofer Gesellschaft (FhG)

The Fraunhofer Society is a German research organization with 69 institutes spread throughout Germany, each focusing on different fields of applied science. The Fraunhofer Group MATERIALS integrates the expertise of 15 Fraunhofer Institutes working in the field of materials science. The research covers the entire value chain, from new material development and improvement of existing materials through manufacturing technology on a quasi-industrial scale, to the characterization of properties and assessment of service behavior. The same research scope applies to the components made from these. In all these fields, experimental studies in laboratories and technical institutes are supplemented by numerical simulation and modelling techniques – across all scales, from individual molecules up to components and process simulation. The group's expertise is concentrated specifically in the fields of energy and environment, mobility, health, machine and plant construction, building construction and living, microsystems technology and safety.

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Max-Planck-Gesellschaft (MPG)

The Max Planck Society for the Advancement of Science (MPG) is a formally independent non-governmental and non-profit association of German research institutes. According to its primary goal, the Max Planck Society supports fundamental research in the natural, life and social sciences, the arts and humanities

in its Max Planck Institutes. Research in several institutes, including the Max Planck Institute for Solid State Research, the Max Planck Institute for Chemical Energy Conversion and the Max Planck Institute for Plasma Physics, will be relevant for clean energy materials discovery and development.

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Leibniz Gemeinschaft

The Leibniz Association is a union of German non-university research institutes from various branches of study. Several institutes specialize in clean energy materials discovery and development including

- INM – Leibniz-Institute for New Materials: i.a. new materials for energy applications.
- IFW - Leibniz Institute for Solid State and Materials Research Dresden

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Fax +49 (0)681-9300-22
E-Mail contact@leibniz-inm.de

Many universities also conduct world-class materials research, but a comprehensive list is not included here.

For more information on Germany's clean energy materials innovation programs, please contact Dr. Peter Vach (peter.vach@bmwi.bund.de).

India

Initiatives, Policies, and Programs Related to Clean Energy Materials Discovery and Development

Current Initiatives, Policies, and Programs

The government conducted an event on the clean energy materials innovation challenge, a Mission Innovation-India Workshop on Clean Energy Material Innovation Challenge on 17 August 2017 at TERI University, New Delhi. The event was attended by scientists, industry, utilities and other stakeholders, who came together to discuss & deliberate on the work done in the area of clean energy materials and explore collaboration opportunities under Mission Innovation. Five experts made thematic presentations and discussed R&D gaps and current developments in "Clean Energy Materials: Indian Experience and perspective". Presentations focused on five major areas:

1. Computation modelling of energy material;
2. Batteries;
3. Supercapacitors;
4. Fuel cells and devices; and
5. Thermal energy storage.

An Indian initiative has been developed to meet these challenging goals through consistent focus on three main domains:

- Development of materials for energy generation
- Development of materials for energy storage
- Computational approach for materials screening and shortening the time-scale of invention-innovation-commercialization cycle.

Future Initiatives, Policies, and Programs

Under the Innovation Challenge on Clean Energy Materials, India has specific plans to double clean energy R&D investment by: (1) intensifying research efforts on setting up of technology platforms led by industry for Clean Energy Technologies and (2) scaling-up of funds to academic and R&D institutions as well as R&D units in industry for research on identified topics relevant to clean energy. Plans include:

2017-18 - Announce and Launch of MI- centric and national funding opportunity for development of MI network of leading industry & research organizations.

2018-19 - Initiation of the MI-India projects.

2019-20 - Documentation of case studies and lessons learnt from MI-India projects, consolidation of outcomes, best practices document and sustained research to prepare the Innovation Challenge goals.

2020 - Development of a platform for computational materials for energy applications.

Publicly-Supported Laboratories and Major Facilities Specializing in Clean Energy Materials Discovery and Development

Table A-1. Institutions specializing in clean energy materials discovery and development headquartered in India.

Institute Name	Contact person	Website
CSIR- Central Electrochemical Research Institute	Prof. Vijayamohanan K Pillai	www.cecri.res.in
Indian Institute of Science	Prof. S Sampath Prof. A K Shukla Prof. S Munichandraiah	http://ipc.iisc.ac.in/~sampath/home.html http://sscu.iisc.ernet.in/a k Shukla.html http://ipc.iisc.ac.in/~muni/research.html
Centre for Materials for Electronics Technology	Dr. N C Pramanik	www.cmet.gov.in
Indian Institute of Technology (Bombay, Madras, Kharagpur)	Prof. C Subramaniam Prof. Smruthiranjan Parida Prof. S Ramprabhu Prof. C R Raj	www.iitb.ac.in www.iitm.ac.in www.iitkpg.ac.in
Indian Institute of Science Education and Research, Pune	Prof. Satishchandra Ogale	www.iiserpune.ac.in
International Advanced Research Centre for powder metallurgy and new materials (ARCI)	Dr. R Gopalan Dr. Tata Narasinga Rao Dr. R Prakash	www.arci.res.in

The major capabilities of research institutes and laboratories supporting Clean Energy Materials Research listed in the table above include:

1. Investigating electrochemical properties of carbonaceous materials for application in batteries and Supercapacitors.
2. Development of advanced multifunctional materials for electrochemical Energy Devices, electrode materials for Li-ion, Na-ion and Mg-ion batteries, high performing and field ready rural lighting solutions using rapidly rechargeable hybrid ultra-Supercapacitors and hybrid Pb-C and Li-C based capacitors.
3. Development of graphene Supercapacitors for power electronics, carbon based super capacitors and hybrid energy storage systems.
4. Design and fabrication of nanostructured materials for Supercapacitors and Development of flexible Supercapacitors and supercapacitors for portable, wearable, and micro-electronics applications.

Industry research capabilities include:

1. Extensive commercialization of Supercapacitors for applications ranging from power electronics to electric vehicles.

2. Installation of energy storage units in conjunction with solar photovoltaic units.
3. Energy generation through fuel cell systems for electric vehicles.

For more information on India's clean energy materials innovation programs, please contact:

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Italy

Initiatives, Policies, and Programs Related to Clean Energy Materials Discovery and Development

Current Initiatives, Policies, and Programs

The Ministry of Education, University and Research (MIUR) and the Ministry of Economic Development (MISE) have issued coordinated laws regulating public financial aid to R&D projects. According to these laws, R&D projects primarily focused on Industrial Research will be funded by MIUR while projects primarily focused on Precompetitive Development will be funded by MISE. For several years, the Ministry of Economic Development - General Directorate for Nuclear Energy, Renewable Energy and Energy Efficiency has set up the Research Fund for the Italian Electrical System.

Research and development investments in low carbon technologies are implemented through a number of mechanisms including cost-shared projects with the private sector, R&D activities at the R&D National Agencies, grants to universities and Cohesion Funds at a regional level. Further resources have been budgeted to fund R&D through tax breaks from 2015-2020 to the benefit of the private sector and of public-private research projects.

To date there are two different mechanisms for funding the research on clean energy materials in the frame of the Research Fund for the Italian Electrical System:

1. Under Contract Agreements between the Ministry of Economic Development and the following three public research institutions: CNR, ENEA and RSE. Within the first mechanism, roughly 56 M€ is provided to ENEA, RSE and in a lesser extent to CNR annually for performing studies and experimental activities. Those research activities dealing directly with clean energy materials discovery and development are provided approximately 10 M€ more or less equally distributed between ENEA and RSE.
2. Open calls for research projects, either industry (Bandi B) or academic (Bandi A) driven. Bandi B calls are already in operation while Bandi A calls are not open yet. The overall amount of funding available in the Bandi B framework is 26M€ over three years, and 12-15% of the projects deal with clean energy materials. Bandi A calls are expected to be mainly focused on advanced materials for photovoltaics and electrochemical storage of energy, and the funding size has been declared on the order of 16M€. Roughly 10M€ of the overall funding is expected to be devoted to studies on graphene for either PV and electrochemical storage. Advanced materials for the use of biomasses, photovoltaics (planar and concentrated), concentrated solar power, electrochemical storage of energy, electric power transmission and distribution components, efficient industrial processes and efficient buildings, are some of the topics included in this frame.

The annual CNR expenditure on energy material research (basic and applied) is estimated to be around 5 M€. Research (50% funded by MIUR) is mainly concerned with advanced materials for storage of energy, electric power transmission and distribution components, photovoltaic (third and four generation) generation, artificial photosynthesis, graphene-based materials.

Future Initiatives, Policies, and Programs

A significant increase in decarbonization technologies has been undertaken, and the 2016 budget will be doubled from 2017-2020 based on the commitment made through Mission Innovation (www.mission-innovation.net). This important research effort will be devoted in a large fraction to new clean energy materials discovery, characterization and applications to device and processes useful for power generation from renewables, with special emphasis on solar energy and bio-energies, electrochemical energy storage and, energy efficiency in process industries and buildings. Furthermore, a not negligible fraction of the budget will be devoted to basic research and cross cutting technologies, in the field of materials modelling and synthesis.

The MIUR National Operational Programme "Research and Development" will fund public institutions-industry joint projects in 2018-2019. Budgets of 30 M€ and 29M€ will be devoted respectively to energy and green chemistry projects. A consistent part (20 M€) is expected to be used for industrial research on clean energy materials.

Publicly-Supported Laboratories and Major Facilities Specializing in Clean Energy Materials Discovery and Development

Apart from the CNR, ENEA, RSE and the Italian Institute of technology (IIT), most of the 100 Italian Universities have internationally renowned laboratories working on clean energy materials discovery and development, but only a few have a remarkable size.

Laboratories are equipped with experimental facilities for synthesis and characterization (physical-chemical, functional and in operating conditions) of materials and related devices. Research activities in Italian academic Laboratories focus on all the types of materials discussed in the Clean Energy Materials Innovation Challenge Workshop. Several groups are active in developing new materials for photovoltaics, electrochemical, thermal and thermochemical storage, thermoelectricity, water splitting, hydrogen storage, fuel cells, catalysis, solar fuels, among other topics.

The most important experimental facility located in Italy is Elettra Sincrotrone Trieste where several synchrotron and free electron laser (Fermi) beam lines are available for a wide range of applications, including clean energy materials.

Italy also has some supercomputing facilities part of a more wide international network.

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Kingdom of Saudi Arabia

Initiatives, Policies, and Programs Related to Clean Energy Materials Discovery and Development

Current Initiatives, Policies, and Programs

Saudi Arabia is involved in many activities in the clean energy materials field, including solar cells fabrication; smart lighting using LEDs and LD; fuel cells; highly efficient capture, separation, storage of CO_2; novel technology for instant hydrogen from crude oil for fuel cell car; and development of additives for high-efficiency clean fuel production.

Future Initiatives, Policies, and Programs

Saudi Arabia has plans for future initiatives, policies, and programs that will depend on the outcomes of this initiative.

Publicly-Supported Laboratories and Major Facilities Specializing in Clean Energy Materials Discovery and Development

Saudi Arabia has major tools, including state of art clean room for growth, fabrication and processing of advanced materials. Also, it has most of the major equipment for characterization, such as XRD, TEM, NMR, CL, SEM, EDAX, XRF.

Also, it has 2 super computers, one at KACST and the other one at KAUST.

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Norway

Initiatives, Policies, and Programs Related to Clean Energy Materials Discovery and Development

Current Initiatives, Policies, and Programs

The Research Council of Norway have three main activities to support R&D for clean energy materials:

- **ENERGIX:** The ENERGIX program provides funding for research on renewable energy, efficient use of energy, energy systems, and energy policy. This encompasses both natural science and engineering as well as social science-based research and development. ENERGIX has a wide range of funding instruments, and both industry, research institutes and universities can apply for funding. The program is a key instrument in the implementation of Norway's national RD&D strategy, Energi21, as well as for achieving other energy policy objectives.

  ENERGIX funds many projects from universities, institutes and industry within the clean energy materials space.

- **Centres for Environmentally-Friendly Energy Research (FME)**: The scheme of the Centres for Environment-friendly Energy Research (FME) seeks to develop expertise and promote innovation through long-term research in selected areas of environment-friendly energy. There are today 11 FME centres within renewable energy, energy efficiency, social sciences and CO_2 management. The centres are hosted by either research institute or universities. The research activity is carried out in close cooperation between prominent research communities and industry partners.

  The following two FME centres work with material research:
  - **Research Centre for Sustainable Solar Cell Technology**
  - **Mobility Zero Emission Energy Systems – MoZEES**

- **NANO 2021:** NANO2021 aims at enhancing the national knowledgebase within nanotechnology and advanced materials to meet high international standards. The programme's main objectives are to develop sustainable technological solutions as basis for innovation and address central societal challenges

- **ENERGIX-Visiting researcher grants and mobility grants:** All ENERGIX-projects can apply for "Visiting researcher grant" and "Mobility grants". These grants covers extra expenses connected to visiting researchers (for a period up to 12 months) or Norwegian researchers that visit research groups in other countries (for periods between 3 and 12 months).

- **ERA-NET Cofund Materials**: ERA-NET collaboration over many years in Europe.

- **Horizon 2020**: Norwegian R&D groups and companies participate in H2020-projects

Future Initiatives, Policies, and Programs

Norwegian support for energy R&D is organized through the broad programs ENERGIX, FME and CLIMIT (CCS). These are broad activities set up to finance research necessary to implement national strategic goals for a more efficient and sustainable energy system. It is therefore likely that these programs will be the most important instruments in following up on MI initiatives

ENERGIX and CLIMIT operate through annual calls for proposals. When a Norwegian research group or entity applies for funding for an R&D-project, they can bring in R&D-partners from other countries. Projects in these programs could therefore be suited to follow up on MI initiatives.

Also, all ENERGIX-funded projects can apply for extra funding for expenses connected to guest researchers or mobility grants.

Publicly-Supported Laboratories and Major Facilities Specializing in Clean Energy Materials Discovery and Development

The two FME centres have lab facilities on their fields:

FME on Material research: Research Centre for Sustainable Solar Cell Technology	Solar cell technology, Technology breakthroughs	IFE, Erik Marstein
FME on Material research: Mobility Zero Emission Energy Systems - MoZEES	MOZEES concentrates on Hydrogen and Battery technology in transport sector. Materials research is central part.	Øystein Ulleberg

In addition there are extensive labs at the main universities:

- University of Oslo (UiO)
- Norwegian University of Science and Technology (NTNU)
- University of Bergen (UiB)
- The University College of Southeast Norway (USN)

And in many of the Research Institutes:

- SINTEF Materials and Chemistry
- Institute for Energy Technology (IFE)
- SINTEF Energy Research

Private companies in the field include:

- Elkem Solar
- REC Solar
- Norwegian Crystals
- Tegma
- Dynatec
- Norsun AS
- Scatec AS
- Grenland Energy AS
- Protia AS
- PBES AS
- ZEM Semergy AS

For more information on Norway's clean energy materials innovation programs, please contact Birgit Hernes (bih@rcn.no), Aase Hundere (amh@rcn.no), or Ane Brunvoll (atb@rcn.no).

United Kingdom

Initiatives, Policies, and Programs Related to Clean Energy Materials Discovery and Development

Current Initiatives, Policies, and Programs

The UK has led a number of activities of varying scales and scopes revolving around the theme of clean energy materials. The examples below are meant to provide an overview of these activities (most recent ones).

Involvement of the UK in MI Clean Energy Materials Innovation theme

- Appointment of a UK Mission Innovation lead, Dr Jennie Dodson, from the Department of Business, Energy and Industrial Strategy (one of the government departments).
- Attendance of the Clean Energy Materials Innovation Challenge Workshop by the UK Mission Innovation Lead as well as other delegates from UK universities (September 2017).

Government initiatives and facilitating platforms

- Industrial Strategy Challenge Fund: This is an overarching framework, created in 2016, that aims to bring together the UK's world-leading research and industry to address future industrial and societal challenges. Within this framework, six main challenges have been identified, three of which relate directly or indirectly to IC6: **Robotics and artificial intelligence, Clean and flexible energy, Driverless vehicles, and Manufacturing and materials of the future**.
- Innovate UK: This organization, created in 2007, aims to foster the growth and productivity of businesses by accompanying them from innovation to idea development to commercialization. The organization runs funding competitions that cover a large number of innovation areas including **materials** and **energy**. One major funding route relies on the collaboration between a business entity and a research institution. The former typically leads the project.
- UK Catapult: This network was established by Innovate UK in 2011 as one potential route towards supporting innovation by UK businesses. UK Catapult is a Network comprising 10 centers providing technical expertise and equipment as a way to accelerate research development and translation. The 10 centers covering specific areas and particularly: **High Value Manufacturing**, **Energy Systems** and **Compound Semiconductor Applications**.

The aforementioned initiatives/organization provide a framework for a number of projects on clean energy materials to take place, some of which are described in a subsequent section.

Future Initiatives, Policies, and Programs

Aligned with the initiatives mentioned above, the Engineering and Physical Science Research Council (*i.e.* British Research Council providing government funding for grants to undertake research and postgraduate degrees) has issued a **Delivery Plan** 2016/2017-2019/2020. Examples of priority areas for this strategic program, that are relevant to the Clean Energy Materials theme include: **Data-driven economy, Energy security and efficiency**.

A number of **grand challenges** have also been identified by the EPSRC. Those relevant to IC6 are: **Nanoscale Design of Functional Materials, Dial-a-Molecule - 100% efficient synthesis Directed Assembly of Extended Structures with Targeted Properties, Systems Chemistry: Exploring the Chemical Roots of Biological Organisation, Utilising Carbon Dioxide (CO_2) in Synthesis and Transforming the Chemicals Industry**.

The EPSRC research portfolio covers a number of **research areas** and those of **Materials Engineering, Materials for Energy Applications, Manufacturing technologies, Catalysis, Functional Materials and Artificial Intelligence**, all of which are related to IC6, will continue to be part of the research portfolio for the EPSRC Delivery Plan period of 2016-2020. In addition, the share of the **Robotics** research area is expected to increase for that same period.

As part of the Delivery Plan 2016/2017-2019/2020, the EPSRC aims to foster and facilitate **international collaborations**, with a particular focus on Europe, USA, Japan, China and India.

Publicly-Supported Laboratories and Major Facilities Specializing in Clean Energy Materials Discovery and Development

Below are recent examples of funded programs that directly or indirectly involve aspects of clean energy materials. These programs are fully or partially publicly-supported.

- **Faraday Institution**: Funding of the Faraday Institution has just been announced. The institution will be based at the Harwell Campus. Its goal is to drive and accelerate fundamental research in developing battery technologies, and enable their commercialization.
- **National battery manufacturing**: Funding of the national battery manufacturing development facility has just been announced. The facility aims to provide the facilities required to enable the development of the next generation of battery systems.
- **Institute for Molecular Science Engineering**: The institute vision's is to combine aspects of science and engineering through all the stages of a product development process as a way to accelerate innovation. This is done by linking molecular structure and final system function.

- **Henry Royce Institute**: The institute focal point is on advanced materials research and innovation, bringing together academics and industry to ensure commercialization of fundamental research. Particular focus is given to novel battery technologies and energy storage for electric vehicles.
- **Materials Innovation Factory**: The factory ains to transform the approach to materials discovery through Computer Aided Material Science (CAMS).
- **Supergen**: The goal of the programme is to deliver sustained and coordinated research on Sustainable PowER GENeration and supply. The key research areas include: bioenergy, energy networks, energy storage, fuel cells, hydrogen and other vectors, marine, wave and tidal, solar technology, and wind power. The program is currently undergoing a review of its activities to plan the next phase.
- **Future Manufacturing Research Hubs**: Through these Hubs, the goal is to support UK manufacturing industries. A number of these hubs have a particular focus on clean energy materials (e.g. Future Compound Semiconductor Manufacturing Hub).
- **EPSRC Centres for Innovative Manufacturing**: These centers have been created to maintain resources, foster collaborations, carry out feasibility studies, and support research projects in particular sectors involving aspects of manufacturing.

Contact details for these programs are provided in the table below.

Faraday Institution	**Prof. Nigel Brandon** Imperial College London n.brandon@imperial.ac.uk	http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/administration/energyfutureslab/newssummary/news_3-10-2017-10-23-9
National battery manufacturing	**Professor Lord Bhattacharyya** University of Warwick S.K.Bhattacharyya@warwick.ac.uk	https://warwick.ac.uk/newsandevents/pressreleases/greg_clark_announces/
Henry Royce Institute	**Prof. Phil Withers** University of Manchester p.j.withers@manchester.ac.uk	http://www.royce.ac.uk
Materials Innovation Factory	**Prof. Andy Cooper** University of Liverpool Aicooper@liverpool.ac.uk	https://www.liverpool.ac.uk/materials-innovation-factory/
Institute of Molecular Science Engineering	**Prof. Claire Adjiman** Imperial College London c.adjiman@imperial.ac.uk	http://www.imperial.ac.uk/molecular-science-engineering/
Supergen	The contact depends on the Supergen Hub considered. To see a list of the Hubs: http://www.rcuk.ac.uk/document	http://www.rcuk.ac.uk/research/xrcprogrammes/energy/energyresearch/supergen/

	s/energy/supergenintroductionbackground-pdf/	
Future Manufacturing Research Hubs	**Dr Rebecca Williams** Engineering and Physical Sciences Research Council Rebecca.Williams@epsrc.ac.uk	https://www.epsrc.ac.uk/research/centres/manufacturinghubs/
EPSRC Centres for Innovative Manufacturing	**Dr Rebecca Williams** Engineering and Physical Sciences Research Council Rebecca.Williams@epsrc.ac.uk	https://www.epsrc.ac.uk/research/centres/innovativemanufacturing/

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Department of Business, Energy and Industrial Strategy (BEIS)
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