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1 Introduction

This document is a result of a mapping activity performed by EERA members, which was organised by the EERA secretariat to help energy research stakeholders to identify research options to progress with their intended actions. Furthermore the EERA summer strategy meeting was used to discuss with all EERA governance levels a general policy paper for sharing data.

This document tries to help the users to find information on **access rights, conditions and costs of the available energy research infrastructures**. In several energy research fields no research infrastructure database systems are available. In this case this document will list expert contact points or simply information on existing research infrastructures, which were collected by JP participants.

In general, open science is an important issue for the EERA research performers. In summer 2017 a general discussion started and an EERA position paper on open science with a focus on open publishing was elaborated and approved by the EERA ExCo in spring 2018 (see Appendix B.). The topic on shared data is a bit different from open publishing, because it needs more resources for a useful implementation of an open data strategy. This was specially discussed in the EERA Summer Strategy Meeting 2018.

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Structure of this report:

- a.) Discussion on EERA open data activities and the process to develop a policy paper.
- b.) Listing of existing research infrastructure data bases and/or contact points. In case Joint Programme members are already using open data management systems or relevant discussions are ongoing, this is mentioned under the corresponding EERA Joint Programme sub-section.

2 Open Data

Open data is data that may be used, disseminated and reused by anyone without any restrictions. The European Commission has recognized that data should be as open as possible and as close as necessary, to respect proprietary data that might be available under [Non-disclosure agreements](#) (NDAs).

The demand for this is based on the assumption that freely usable data leads to greater transparency and cooperation. The economic value of open data from public administration was estimated by the Konrad Adenauer Foundation at 43.1 billion euros annually in 2016.

A next step already under development is a fully open tracking path from open publications to open “raw” data by the next generation of research data management systems. This will include direct access to all algorithms used from the raw data to the scientific conclusions. With this fully open tracking system collaboration will become much more efficient, as data evaluation will be much easier. Applications of new mathematical models on raw data will improve understanding. Finally, also raw data of previous work will be accessible and could be combined with newer data to generate new understanding. There are already few examples of these combinations of full electronic traceability from electronic publications back via open algorithms back to open data, but Europe should take the chance for Horizon Europe to take the lead on the benefits of next generation digital publishing.

Several EERA members have already signed open access to knowledge declarations. Some of them were identified and an EERA draft declaration was elaborated, which was adapted to the EERA framework and originates from the Open Science Working Group of the Helmholtz Association (see Appendix A.). The overall open data framework was discussed and concluded in EERA Summer Strategy Meeting.

In the discussion, it was anticipated that “Horizon Europe”, the new EU Research Framework programme, will mandate open data, just in H2020 open access publishing of papers was mandated. It was also anticipated that there will be some funding for this, which will be taken from the project budget. The EERA secretariat will address how to enable open access to data in the future. This should include

- Standards for databases
- Questions around confidentiality

A number of member states already have implemented ‘open science’ initiatives, including the support of member state authorities. A recommendation from the EERA Summer Strategy Meeting is to build on what is already there and available. Many rules are already defined for national projects that have public funding. It will be a challenge to harmonize those.

The European University Association (EUA) has made a survey on Open Access

(<http://eua.be/Libraries/publications-homepage-list/open-access-2016-2017-eua-survey-results.pdf?sfvrsn=2>), concluding that researchers should be rewarded for the effort in curating data. “Universities and research funders must change their assessment practices, moving away from the

impact factor, and providing incentives for researchers to engage in open science practices”. This statement was supported in the EERA Summer Strategy Meeting. But it was also discussed that “the reward” is to have public funding in the first place and it is a condition of getting the funding that you curate the data and make it available. So what is the reward then?

One of the rewards is ‘profile’ or ‘visibility’. One ‘rule’ or convention should be to mention a source of data in a way that gives some kind of recognition. Analogous to open access software: individuals contribute something, and everyone, eventually, benefits (and there are standard ‘good practice’ or ‘good behaviour’ rules).

EERA should add value by reviewing what is already being done among the members and to establish

- what seems to be best practice in respect of database standards or structures,
- what might be possible in terms ‘meta-databases’.

Don’t re-invent the wheel, if you can avoid it, was a statement. EERA – whose main unique selling point is as the best-established network of energy researchers in Europe – can disseminate the gathered best practice, including good conventions on how contribute to and benefit from the general good in respect of access to data, e.g. security, uses of data, etc..

The discussion concluded that, for now, it is not important to release another policy document, detailing the EERA open data management, but start activities to harmonize the open data management and to exchange best practices. The EERA position paper on open science (see Appendix B) is sufficient for now.

In the framework of the EERASE 3 project the Secretariat organized different horizontal meetings on which 10 Joint Programmes teamed up and submitted the FET Flagship proposal Clean Energy, which has the aim to shape a Autonomous Materials Develop Platform. This platform will rely on the communication between High Performance Computing -, robotic – and material characterization systems using Artificial Intelligence (AI) intermedia methods. This topic is in the core of the Mission Innovation challenge 6 and the world wide data exchange will be important. The open data exchange protocols and the data management will be a key topic in the next year.

In this context, it is intended to organize a workshop with the experts from different member states or/and associate members in a room, discussing best practices of managing open data.

3 Existing Research Infrastructure in Different Research Sectors

Joint Programme	Online data base available	Information on conditions	RI contact points
Ampea	partially	partially	no
Bio-energy	no	no	no
CSP	yes	no	yes
CCS	partially	partially	partially
E3S	no	no	no
Energy Efficiency in industry processes	yes	no	no
Energy Storage	no	no	yes
Energy System Integration	no	no	no
Fuel Cells & Hydrogen	until 2015	yes	yes
Geothermal Energy	no	no	yes
Nuclear Materials	under construction	partially	soon
Ocean Energy	yes	yes	yes
PV	yes	yes	yes
Smart Cities	no	no	yes
Smart Grids	yes	yes	yes
Wind Energy	no	no	yes

Summary table of research infrastructure data-bases.

Only EERA Joint Programmes having received Commission funding for setting up a online data-base of existing research infrastructures have a data-base with detail information on access possibilities, access rights and contact points. After have created EERA the first Joint Programme Description of Works (DoWs) contained lists of research infrastructures and partially contact information.

Nowaday, the participants of the Joint Programmes are focussed on the necesesary work to progress in cooperating with each other. Workshops are organised for discussing upcoming new research ideas. If research infrastructures are needed for new research projects, this will be well discussed between the partners. Of course for non-EERA members this information source is not accessible.

3.1 AMPEA

JP Contact Point	Frederic Chandezon (frederic.chandezon@cea.fr)
RI - Online - Data base	Only for Synchrotron and free-electron-laser facilities https://www.leaps-initiative.eu/synchrotrons/european_facilities/
Information on access rights, conditions and costs	info@leaps-initiative.eu
Contact information for research infrastructures	none

Advanced experimental characterization and analysis by physical and chemical methods are considered absolutely essential for significant advancing of materials and processes for energy applications. Development of today and tomorrow's key experimental techniques is complex, requires multidisciplinary skills, is costly and takes long time. Consorted efforts involving teams of technique experts, material scientists and engineers are thus required and a joint European program is considered an optimal route towards this goal. Furthermore synergetic use of multiple techniques is in most cases beneficial which underpin the need for joint European actions even more.

Sub-programme 3 of the AMEPA EERA Joint Programme establishes a characterization platform.

The main objective of this subprogram is twofold:

I) to create a forum which can help the technique experts to be world leading in developing the best possible new advanced characterization techniques for the scientific problems in mind. This will include meetings and workshops focussing on technique aspects, platforms for exchange of analysis and imaging, simulation and modelling software, as well as dedicated meetings between technique experts and scientists within the other subprograms to quantify optimal technique parameters, *e.g.* spatial and time resolutions, penetration depths, temperatures etc. As material development is always a balance between costs, performance and life time, characterization of a material has to cover all three dimensions with a physical, often a mechanical and a chemical analysis as well as monitoring characterization during processing and finally studying life time under operating conditions. The later often also includes life time prediction using models based on measured properties as well as basic physical constants. In future cases all data should be made accessible to support both material method development and also life time model development and validation as improved life time models could save enormous amounts of time and money.

II) to provide *one* entrance point to the suite of advanced techniques and thus help the users to get an overview of experimented possibilities. This will be addressed via a dedicated homepage. This subprogram represents a lead

to: a.) Synergy in developments of advanced experimental techniques with special attention to *in situ* and *Operando* techniques, b.) Further use of multiple complementary techniques, c.) Access of data for model validation, d.) Establishment/consolidation of European networks for technique developments, e.) Cross fertilization between experts in advanced characterization techniques and materials scientists, f.) Time and money savings.

Contact points: Dr. Astrid Besmehn (a.besmehn@fz-juelich.de) and Dr. Amelia Montone (Amelia.montone@enea.it)

Synchrotrons



European Synchrotron and Free-Electron-Laser (FEL) facilities are important for materials research and are summarised by the LEAPS initiative

3.2 Bio-Energy

JP Contact Point	Juan Carrasco from CIEMAT (juan.carrasco@ciemat.es)
RI - Online - Data base	No
Information on access rights, conditions and costs	Not available
Contact information for research infrastructures	no

No detailed list or online data base of research infrastructures relevant for the EERA Bioenergy Joint Programme (JP) is available at the moment.

However, the Joint Programme participants have a very outstanding and extensive facilities network for R&I&D on advanced biofuels production pathways. A detailed mapping of scientific capacities, like research infrastructures and human resources is underway in the EERA Bioenergy Joint Programme. Up to now, it is not foreseen to set up an online data-base, because of missing resources. Without being exhaustive, some important laboratories and pilot facilities for sustainable biomass feedstock and advanced biofuels production are listed in the Appendix F.

3.3 Concentrated Solar Power

JP Contact Point	Julian Blanco from CIEMAT (julian.blanco@psa.es)
RI - Online - Data base	http://www.eusolaris.eu
Information on access rights, conditions and costs	No
Contact information for research infrastructures	yes

The EU-SOLARIS ERIC vision is to become the European reference research infrastructure in the technological development of CSP/STE and related applications (solar chemistry, materials, desalination, water treatment, thermal energy storage, process heat, etc) development.

The EU-SOLARIS ERIC mission

To offer the most favourable conditions for the development of CSP/STE technologies and the deployment of advanced pilot projects for the scientific and industrial communities.

EU-SOLARIS ERIC strategic objectives

- To coordinate, as a unique infrastructure of distributed character, main existing R&D installations in Europe, providing the most complete and high quality scientific infrastructure portfolio at international level to the CSP/STE sector.
- To offer, to Research Communities and Industrial stakeholders, a single contact point where highly specialized facilities, resources and research services are effectively and optimally offered to users demanding CSP/STE related services.
- To reinforce the collaboration between the scientific institutions, academia and industry, also fostering the collaborative research among main European research centers of the sector.
- To identify new requirements for the improvement of the research facilities, and for the construction of new ones (when needed), also optimizing and promoting the specialization of existing ones avoiding unnecessary technological duplication and repetition.
- To identify and establish the best research and experimental practices, leading and coordinating the open dissemination of results and experimental data, contributing to the reinforcement of the European leadership position at an international level.
- To maintain Europe at the forefront and leadership of CSP/STE technologies development.



Status report on existing capacities, technological and Human Resources

http://www.eusolaris.eu/Portals/0/documents/EUS_WP3_MS15_Final.pdf?ver=2016-02-25-193705-483

Report portfolio of existing available technical services of partner centres and Report containing the portfolio of available technical services as EU-SOLARIS

<http://www.eusolaris.eu/LinkClick.aspx?fileticket=dUPa85RcDI0%3d&portalid=0>

3.4 Carbon Capture Storage (CCS)

JP Contact Point	Marie Bysveen from SINTEF (Marie.Bysveen@sintef.no)
RI - Online - Data base	www.eccsel.org and then browse the catalogue of open facilities (currently focussed on ECCSEL members but this includes most of the pilot scale facilities relevant to CCS in Europe, as well as other specialist infrastructure).
Information on access rights, conditions and costs	Partial information available from www.eccsel.org
Contact information for research infrastructures	See www.eccsel.org for contact details for each infrastructure currently providing open access as part of the ECCSEL ERIC

The JP on CCS has the ambition to coordinate both national and European R&I programmes in order to maximise synergies, facilitate knowledge sharing and deliver economies of scale via world-class, pan-European research infrastructures. Key deliverables include a **Strategic Research Agenda (SRA)**,¹ which provides the Commission and Member States with a consistent priority plan for R&I and infrastructure needs for both the short and long term.

The CCS-JP is fully represented in other key CCS initiatives – in particular, the Zero Emissions Platform (ZEP), the European Industrial Initiative on CCS (CCS EII), CO₂GeoNet, the CCS Project Network Advisory Forum and the European ESFRI infrastructure project, ECCSEL (now established as an ERIC). It is also participating in the SET-Plan IWG on CCUS.

Several members of the JP CCS are members of the ESFRI ECCSEL ERIC consortium. (<https://www.eccsel.org>). The CCS-JP works with the ECCSEL consortium on open access to RI. To avoid duplication of effort, the CCS-JP has not established an additional European CCS RI database.

¹ Web-link to SRA

3.5 Economic, Environmental and Societal Impact of Energy Technologies (E3S)

JP Contact Point	Daniela Velte from Tecnalía (daniela.velte@tecnalia.com)
RI - Online - Data base	No
Information on access rights, conditions and costs	No
Contact information for research infrastructures	No

The EERA Joint Programme for Economic, Environmental and Societal Impact of Energy Technologies (e3s) generates policy advice to support a better understanding of the complex interaction of a variety of socio-technical elements, such as consumer behaviour and acceptance, markets and technologies. Online data bases for users with access information for research infrastructures are not available for these kind of challenges.

3.6 Energy Efficiency in industry processes

JP Contact Point	Petter Rokke from SINTEF (Petter.E.Rokke@sintef.no)
RI - Online - Data base	https://e3p.jrc.ec.europa.eu
Information on access rights, conditions and costs	No
Contact information for research infrastructures	no

This Joint Programme does not have special research infrastructures which is managed through EERA or the JP EEIP network, but rather separate infrastructures at the partners sites related to each of the partners' R&D activity. E.g. HighEFF lab in Norway, at NTNU and SINTEFs premises. This will be aligned with the international Centre of Excellence HighEFF (50 M€ over 8 yrs); <https://www.sintef.no/projectweb/higheff/>

The web-site <https://e3p.jrc.ec.europa.eu/> contains many relevant information on energy efficiencies in industry processes. . E.g. a link to a web-site <https://e3p.jrc.ec.europa.eu/articles/databases-and-websites-interest> with information of different databases and websites of interest for this subject. But there is no information on existing research infrastructures or contact points.

3.7 Energy Storage

JP Contact Point	Mathias Noe from KIT (mathias.noe@kit.edu)
RI - Online - Data base	No European data base is available
Information on access rights, conditions and costs	No
Contact information for research infrastructures	Maria Elisa Gil Bardaji from KIT (elisa.gil@kit.edu)

There is no up to date online or web-based database available for relevant energy storage research infrastructures in Europe. But several information sources support the storage research community with information on available facilities. The JP on energy storage collected a list of research infrastructures or facilities, which are available for access by other JP members. A copy of this list is available the appendix D of this document.

An offline storage data base, developed by FZJ and KIT, is available. Unfortunately the information is not up-to-date. There is an online publication describing more details:

https://www.researchgate.net/publication/269297116_Database_development_and_evaluation_for_techno-economic_assessments_of_electrochemical_energy_storage_systems .

The DOE Global Energy Storage Database provides free, up-to-date information on grid-connected energy storage projects and relevant state and federal policies (<http://www.energystorageexchange.org/projects>).

Life cycle assessments information on batteries can be found in the database HIU (<http://lci-database.hiu-batteries.de/>).

3.8 Energy System Integration

JP Contact Point	Laurens de Vries from TU Delft (L.J.deVries@tudelft.nl)
RI - Online - Data base	No
Information on access rights, conditions and costs	No
Contact information for research infrastructures	No

The Joint Programme in Energy Systems Integration is designed to develop the technical and economic framework that government and industries will need to build the future efficient and sustainable European energy system. Online data bases for users with access information for research infrastructures are not available for these kind of challenges.

3.9 Fuel Cells and Hydrogen

JP Contact Point	'Stephen McPhail' (stephen.mcphail@enea.it)
RI - Online - Data base	H2fc.eu (on line until November 2015)
Information on access rights, conditions and costs	yes
Contact information for research infrastrucres	Olaf Jedicke from KIT (olaf.jedicke@kit.edu)

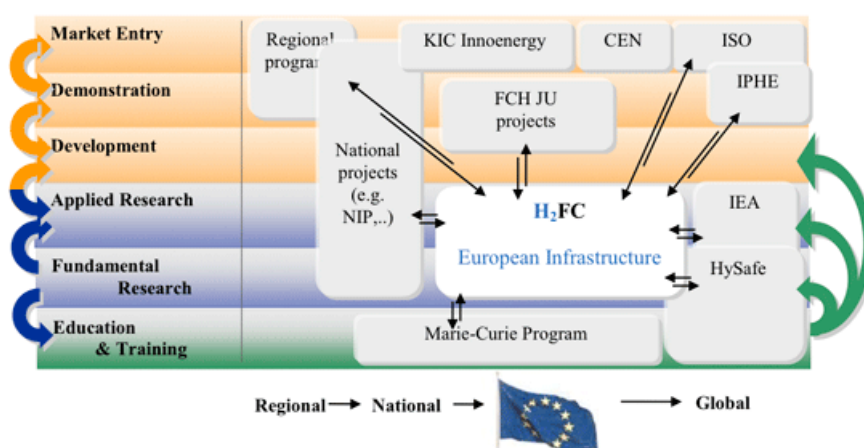
The *H2FC European Research Infrastructure*-project was granted support from the FP7 Capacity-programme. The initiative was led by Karlsruhe Institute of Technology (KIT), and incorporated 19 European research institutions, some of which are also partners in the JP FCH. *H2FC European Research Infrastructure* gathered a joint European effort for enhanced utilisation of facilities. By mapping the needs and identifying gaps, this framework formed the basis for involving more laboratories in agreement and close collaboration.

H2FC European Infrastructure generated a structured and integrated alliance based on complementary, state-of-the-art, or even beyond state-of-the-art, unique infrastructures to serve the needs of the scientific hydrogen and fuel cells community and facilitate future research:

- a single integrated virtual infrastructure to accommodate hydrogen and fuel cell communities' test and analysis facilities.
- transnational access for the hydrogen and fuel cell research communities to member state infrastructures.
- expert working groups to enhance work at the provided facilities and to seek more general coordination in the aspects of safety, performance and durability.
- central databases and libraries of safety, performance and durability data and modelling codes.

http://www.h2fc.eu/files/downloads/public_deliverables/D4.4_H2FC_vers.1.1%20draft.pdf)

- coordinated education and training, pertinent to the set-up, use and maintenance of hydrogen and fuel cell research, test and asseent facilities.



Positioning of H2FC European Infrastructure:

H2FC European Infrastructure as a funded project ended in November 2015, which forced the web-based platform to go off line. The main outcomes of the project are contained in the Deliverables and Reports that are available through the SESAM pages of the European Project Participant Portal.

The EERA JP FCH organised a joint public workshop together with *H2FC European Infrastructure* in April 2015 (at the Royal Flemish Academy of Belgium for Science and the Arts in Brussels) to present the outcomes of the former's research implementation plan and the latter's assessment of research infrastructures and bottlenecks.

Since *H2FC European Infrastructure* there have been sporadic initiatives to recuperate and build on the vast work done by the FP7 project. Lack of opportunities within H2020 to gain funding for this has paired with a major focus of the FCH community (research as well as industry) towards the Fuel Cells and Hydrogen Joint Undertaking (FCH JU, <http://fch.europa.eu/>), the public-private technology initiative that manages the budget for development and deployment of hydrogen and fuel cells in Europe. This platform has been particularly successful in bringing these technologies to market entry, over the course of 10 years of intensive collaboration, aligned advocacy and market focus. This has led to a highly valuable portfolio of studies, interest groups, partnerships, roadmaps, policy papers and results. However, no opportunity has materialised for generating a comprehensive, online database of research infrastructures.

Within EERA, three attempts to create a network of infrastructures were initiated, one of which gained funding (BALANCE, Grant Agreement 731224) but which focuses mainly on a survey of stakeholders and research programmes across the EU Member States. The other two attempts focused on creating an open numerical platform for simulation of fuel cells and electrolyzers using open source codes (OPENUP, submitted twice as a COST Action) and a test bed of research infrastructures dedicated to high-temperature materials (HEAT-ME, submitted to the 2018 NMBP-TO-IND call), but both were unsuccessful. Nevertheless, it appears that the EERA JP FCH would be the right environment where these databases of research infrastructures should be born and nurtured, possibly in collaboration with Hydrogen Europe Research, the research pillar of the FCH JU.

The FCH JU has recently established a platform for gathering information and data from all the funded projects (TRUST) which forms the basis for a future instrument for management of open access data.

3.10

Geothermal Energy

JP Contact Point	Inga Berre (University of Bergen) E-mail: inga.berre@uib.no
RI - Online - Data base	No
Information on access rights, conditions and costs	No
Contact information for research infrastructures	Yes, via the JP secretariat

There is no online or web-based database available for relevant geothermal energy research infrastructures. The JP on geothermal energy collected a list of research infrastructures, which are available for access by other JP members in JP Description of Work. A copy of this list is available the appendix C.

The list includes the existing pan-European infrastructure of experimental test and monitoring facilities and infrastructures (Geo Energy Test Beds, GETB see also <https://www.epos-ip.org/data-services/community-services-tcs/geo-energy-test-beds-low-carbon-energy>).

3.11

Nuclear Materials

JP Contact Point	Lorenzo Malerba from SCKCEN (lorenzo.malerba@sckcen.be)
RI - Online - Data base	In construction
Information on access rights, conditions and costs	Partially available
Contact information for research infrastructures	Will be available

In the frame of the EU Project MatISSE (Materials' Innovations for a Safe and Sustainable nuclear in Europe) one task was identification of existing research facilities within JPNM but also outside if relevant for nuclear material research. An overview of the research infrastructures had to be created and missing facilities identified.

As similar databases have been summarized already for other purposes and goals an analysis of already existing information was made, finding these in six different databases (EERA: <http://kmproyectos.ciemat.es>, Euratom programme (STC_IWG) (Excell sheet), Nugenia+ (Excell sheet), IAEA data base on hot cells: <https://infcis.iaea.org/Default.asp>, ARCADIA database: <http://projectarcadia.eu/>, MERIL database: <http://portal.meril.eu/converis-esf/publicweb/startpage?lang=1>).

The result of the search was a single document with facilities and infrastructures summarized in one table giving information about the Technical Area of the JPNM relevant material research the facility is used for. The Institution/Company being the owner and a Contact Person are named. A short Description of the facility and its main Technical Characteristics is in the table as well as the information if Trainees are able to visit the facility and how the Access is organized and of course the link to the original Database.

Database/Project of use	Country / City	Institution/Company	Facility Name	Link with which Data Base	Contact person	Facility short description	Main technical Characteristics	Offered services	Willingness to receive visitors (Yes/No)	How can facilities be accessed by third parties
1	Austria / Vienna	Vienna University of Technology/Industrietechnik (VWIAT)	TRIGA Mark II 250 kW research reactor	ITC-Euratom Facility		Part of the Institute of Atomic and radiobiological physics.	A maximum continuous power output of 250kW (thermal)	The reactor core consists of 80 fuel elements. One day is operated in pulsed mode (with a rapid power rise to 250 MW for roughly 40 ms)	yes	web-ohio/contact person
2	Belgium / Mol	SCK-CEN	Radiochemical analysis http://radiochem.sckcen.be/infrastructure/FuelCycle/FuelCycle.html	Nopaki, webpage	Marc Scibetti	The Radiochemistry (RCA) expert group can determine the chemical and radiochemical composition, the solubility or diffusivity (gels, bars and gases solubility), and quantify the trace elements and chemical impurities in both reactor irradiated (fuel, waste, reactor cooling water, waste water, etc.) and not irradiated (industrial waste, environmental and spent nuclear fuel, reactor effluents, soil samples, etc.).	whole laboratory		yes	web-ohio/contact person
3	Belgium / Mol	SCK-CEN	SMA Structural/Materials Analysis http://radiochem.sckcen.be/infrastructure/FuelCycle/FuelCycle.html	Nopaki, webpage	Marc Scibetti	Nuclear environments such as liquid fuel blanket or PuO ₂ /H ₂ O water chemistry can be replicated and their effect on mechanical behavior studied.	whole laboratory	Experimental development, Pre and post test examination.	yes	web-ohio/contact person
4	Belgium / Mol	SCK-CEN	LMMA - Laboratory for high and medium level activity http://radiochem.sckcen.be/infrastructure/cn/MS/MSMA	Nopaki, webpage	Marc Scibetti	The Microstructural and Non-Destructive Analysis (MNDA) expert group builds up, reports, manages and maintains the infrastructure required for high-quality non-destructive and microstructural research on highly active and schedule-binding materials, including full size irradiated fuel rods in response to the requirements of external clients, the SCK-CEN materials scientists (structural materials and fuel materials) and the international scientific community.	whole laboratory	pre-report test code: chemistry - material - collated sampling in RT	yes	web-ohio/contact person
5	Belgium / Mol	SCK-CEN	LMMA - Laboratory for high and medium level activity http://radiochem.sckcen.be/infrastructure/cn/MS/MSMA	Nopaki, webpage	Marc Scibetti	The Microstructural and Non-Destructive Analysis (MNDA) expert group builds up, reports, manages and maintains the infrastructure required for high-quality non-destructive and microstructural research on highly active and schedule-binding materials, including full size irradiated fuel rods in response to the requirements of external clients, the SCK-CEN materials scientists (structural materials and fuel materials) and the international scientific community.	whole laboratory	pre-report test code: material - microscopy	yes	web-ohio/contact person
6	Belgium / Mol	SCK-CEN	LMMA - Laboratory for high and medium level activity http://radiochem.sckcen.be/infrastructure/cn/MS/MSMA	Nopaki, webpage	Marc Scibetti	The Microstructural and Non-Destructive Analysis (MNDA) expert group builds up, reports, manages and maintains the infrastructure required for high-quality non-destructive and microstructural research on highly active and schedule-binding materials, including full size irradiated fuel rods in response to the requirements of external clients, the SCK-CEN materials scientists (structural materials and fuel materials) and the international scientific community.	whole laboratory		yes	web-ohio/contact person

Figure 1: Cutout of the complete list of research and infrastructures

In the design of this database a system of query of facilities was created, where the users can do their searches through different easy mechanisms (a search box, a filtered search by different criteria, etc.). The categories included in the data base are those involved in Generation IV reactors.

The available formats to export the database are

- Any format that can be collected directly from the Excel file.
- The Matisse database can be exported in CS



Figure 2. The data base of research infrastructures

The database is presently located at the CIEMAT server (<http://kmproyectos.ciemat.es>), and will be exported and displayed at the EERA JPNM web page to be used by the JPNM members

www.eera-jpnm.eu

In a second step the complete document of research infrastructures was used to identify the missing facilities and infrastructures for nuclear material research as well as to detect possible gaps and a another table was set up.

Thematic area	Investigation	AUTIST	BELOW	EXIGANS	CRONA	CICR	IRELAND	FRANCE	GERMANY	GREECE	HUNGARY	ITALY	NORWAY	POLAND	PORTUGAL	ROMANIA	SLOVENIA	SPAIN	SWEDEN	SWITZERLAND	THE NETHERLANDS	UK
1. Materials	R&D on material corrosion/erosion in HLM											CIEMAT JRCOR						UNIT FENIX	Comprehensive program liquid metal, etc.		WPL	loops at Arnes Foster Wheeler (new wood plc.)
2.												UPJUSI TOTAL CORALITHUM						FESE	Facility for investigating liquid metal spreading, etc.			
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4.																						
5.																						
6.																						
7.																						
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9.	R&D on material corrosion/erosion in HLM											BBST (new HLM)						LET-HE				
10.																						
11.																						
12.	R&D on mechanical properties											GOORD						R-08 CIEMAT	Mechanical testing of materials, etc.		ANALJIA	Facilities at Arnes Foster Wheeler (new wood plc.)
13.																		BBST			DOIRA	Rutherford Appleton Laboratory (RIS)
14.																						
15.																						
16.												UT-FIST-CATNUG						R-08 CIEMAT	Material analysis, etc.		WPL	Material Research Facility (MRF) at Culham
17.												BRAD							European operation source, Lund		MCL	Facilities at Arnes Foster Wheeler (new wood plc.)
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Figure 3: Cutout of data base defining gaps of research infrastructures

In this overview the infrastructures are listed per country to see easily possible national gaps. Those facilities/devices presently nowhere available are highlighted in orange.

3.12

Ocean Energy

JP Contact Point	Henry Jeffrey - university of Edinburgh (henry.jeffrey@ed.ac.uk)
RI - Online - Data base	http://rid.eurocean.org/
Information on access rights, conditions and costs	See data base EurOcean_RID
Contact information for research infrastrucres	Yes, please see the web-site

The data base project EurOcean_RID has the objective to offer a comprehensive list of all existing facilities in Europe which are dedicated to marine sciences broad range of activities. It provides the first level of knowledge and characteristics for each facility, as well as the links and contact to access the further details provided by the operator. It was conducted under the JPI Oceans and EurOcean, with the support of FP7 SEAS-ERA and "CSA Oceans", in order to foster all forms of open access and joint actions involving these research infrastructures.

EurOcean_RID

CONTRIBUTE YOURSELF TO UPDATE THE DATABASE

If you are aware of any Infrastructure that is not yet in this infobase or any other updates please contact [EurOcean](#) or insert yourself a new record and updates

SEARCH

NAME

COUNTRY

OPERATOR

MRI CATEGORY

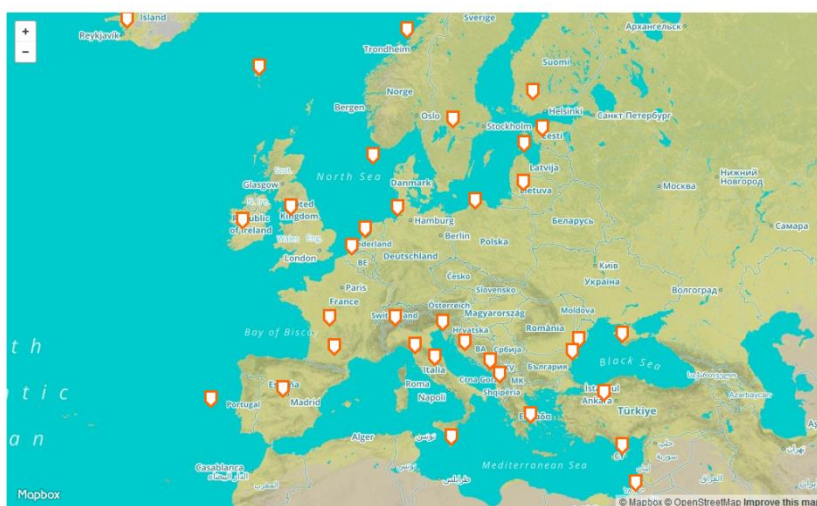
MRI SUBCATEGORY

MRI TYPE

OPERATING AREAS

DISCIPLINES

DISPLAY RESULTS ON THE MAP

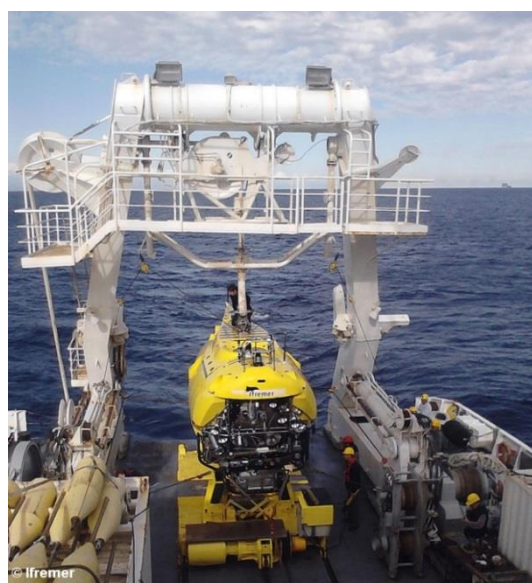


This database is intended for all stakeholders - scientists, engineers, policy makers, private companies, universities, - for their respective needs, either as user or as operator, or as designer, or as funder.

Search criteria plus an iterative map allow any targeted search of information for every type of request. For more information one can consult a [Search Tips](#) Area.

The landscape of marine research infrastructure is complex, a choice of descriptors was done to provide as much as possible a clear and consistent vision, to provide all relevant information for this “discovery” level of the facilities. All explanations necessary to understand each descriptor are given in [Technical Notes](#).

This database took in consideration the most recent overviews available, especially the one done in the context of the ERA-Net Seas-Era. But the landscape is constantly evolving, new infrastructures appear, others have significant up-gradings, some disappear from the service, characteristics change. Therefore a procedure was proposed to allow all contributors to continuously update the database.



Remontée du Nautille sur le pont de L'Atalante

3.13

Photovoltaic Solar Energy

JP Contact Point	Ivan Gordon from IMEC (Ivan.Gordon@imec.be) and Simon Philipps from Fraunhofer (simon.philipps@ise.fraunhofer.de)
RI - Online - Data base	https://www.cheetah-exchange.eu/infrastructure.asp
Information on access rights, conditions and costs	Yes
Contact information for research infrastructures	Yes, for each site

Cheetah was one of the Integrated Research Programmes (IRPs) funded by the European Commission in FP7. One of the tasks was to establish this data base. The main goal was to disseminate information on existing infrastructures of CHEETAH and EERA-PV partners, to making available some of the existing top-class PV Research Infrastructures for the benefit of the whole European photovoltaic community.

CHEETAH
Knowledge Exchange Web Area

This is proposed on the base of the establishment of reciprocal collaboration framework within funded projects or in perspective of them based on agreements between parties

The extended database with the description of the research facilities classified according to several criteria (research organisation, technical topic, category of infrastructure), is periodically update and it serves to prevent duplication by stimulating access, and to promote future developments in the circumstance of necessity of demand and lack of availability on the other site.

Search

Text Search :

Order by: default - alphabetical

by Organisations

by Equipment

by PV Technologies

☐ BIPV Building Integration Photovoltaics
☐ CdTe-Cadmium telluride
☐ CH₃NH₃PbX₃-Perovskite
☐ CIGSS- Copper indium gallium diselenide

☐ CPV Concentration Photovoltaics
☐ cSi Wafer Based Technology
☐ CZTS-Kesterite
☐ DSSC- Dye Sensitized Solar Cells
☐ Education & training

☐ Emerging/Novel concepts for high efficiency at low cost
☐ Environmental impact, waste reduction and recycling
☐ III-V Solar cells and Concentrator Arrays

☐ Material and Device Characterization
☐ Material and Device Modelling
☐ OPV- Organic Photovoltaics
☐ Photovoltaics. interface to the grid & Storage

☐ PV Components & systems energy performance Rating
☐ PV Module qualification & Reliability
☐ PV Module realization & Development

☐ PV RTD Networks, coordination of research efforts, strategy and PV RTD projects management
☐ TFSi-Thin Film Silicon

☐ Ultra-thin and kerfless silicon wafer development

SEARCH



UTV-Centre for Hybrid and Organic Solar Energy” (CHOSE)

🔧 Research and development for the industrialization of organic and hybrid organic-inorganic technologies

Organisation: UTV



ZSW-PV Module Encapsulation lab

🔧 Infrastructure for the realization and optimization of different types of encapsulations in glass-glass and other PV module types.

Organisation: ZSW

3.14

Smart Cities

JP Contact Point	Annemie Wyckmans from NTNU (annemie.wyckmans@ntnu.no) and
RI - Online - Data base	No
Information on access rights, conditions and costs	No
Contact information for research infrastrucres	Yes , by contacting corresponding JP participants



Relevant research infrastructures and facilities to be used in the context of the Joint Programme on Smart Cities are listed in the annex E. This information was provided by the members of the Joint Programme participants. During the set-up period of the Joint Programme all the partners already agreed to teamwork, to promote and to facilitate the access to their facilities to the maximum extend to researchers from other participating organisations. This way, the high added value due to the synergies among the different institutions is explicitly given. (text was taken from COMMERCIAL-IN-CONFIDENCE part of JP DoW 2013)

3.15

Smart Grids

JP Contact Point	Luciano Martini from RSE (luciano.martini@rse-web.it)
RI - Online - Data base	http://der-lab.net/services/servicesdatabases/ http://infrastructure.der-lab.net/ http://www.gridcodes.der-lab.net/database/databaseSearch.php
Information on access rights, conditions and costs	Contact information is available, see databases
Contact information for research infrastructures	Yes , for each research infrastructure

Database of DER and Smart Grid Research Infrastructure


The Database of “DER” and Smart Grid Research Infrastructure contains systematic information on research infrastructure and related assets, testing capabilities, services of DERlab members and project partners. It presents an overview of more than 45 research institutes and companies, 215 facilities, including universities and companies from Europe and the US with focus on Distributed Energy Resources (DER) and smart grids.

The [Generator to Grid Database](#) is the access point to European grid connection requirements for Distributed Energy Resources (DER). You can find public documents available for download and links to purchasable documents.

Generator to Grid Database


Grid Connection Requirements for Generators

The STARGRID database on Smart Grid standardisation provides information to the stakeholders on Smart Grid standards and related documents, as well as organisations and committees active in the field. This includes the classical standardisation organisations on International and European levels, and also open industrial initiatives. Documents covered include standards and specifications, both published and in draft status, as well as roadmaps and guidelines. The database does not contain any standards themselves, but provides a classification and meta-information, and links to a download page or online shop wherever possible.



The web interface allows to search for either documents (standards and related publications) or institutions (organisations and committees). Within these two search classes a free text search is supported, as well as filtering by a given set of categories. By combining different categories it is possible to narrow down the selection to the desired level. For documents, the available categories include document type, publication status, issuing organisation, referencing inventories (roadmaps), and the actual classification by content in terms of the Smart Grid Architecture Model categories. See the [Reference Architecture document](#) of the Smart Grid Coordination Group for an explanation. Details pages display all the relevant information on a given item. A lot of information contained in the database has been gathered from external sources, like standardization roadmaps ([IEC roadmap](#), [Set of Standards and Interoperability tool of the CEN-CENELEC-ETSI Smart Grid Coordination Group](#)), committee websites, and other publications about Smart Grid developments.

3.16

Wind Energy

JP Contact Point	Peter Hauge Madsen from DTU (npha@dtu.dk)
RI - Online - Data base	No
Information on access rights, conditions and costs	No
Contact information for research infrastructures	Paul McKeever- ORE Catapult (paul.mckeever@ore.catapult.org.uk)

One of the EERA JP Wind objectives is promoting alignment plus focusing of national research activities through joint experiments carried out in European research facilities and its effective joint use. Support for experiments granting procedures will be set in the IRP Wind project with the general objective of supporting the strategic research of the EU as contained in the EERA JP Wind by aligning and focusing on its most relevant topics. In the IRP Wind project the focus and alignment was gained by means of:

- 1) Creation of access protocols to selected European research facilities and definition of prioritization procedures for selecting the most urgent and relevant experiments in the European context.
- 2) Implementation of a technical committee to select the experiments that will benefit the most national research activities and promote cooperation and alignment and to match experiment with the most appropriate European research facility.
- 3) Funding of selected strategic joint experiments, including infrastructure use, at chosen national facilities supporting national R&D efforts. The promotion will be provided through the creation of awareness about existing facilities and their specific characteristics, the application of common and transparent access procedures for experiment and facility selection and the required support both for the host and the guests. Synergy and effectiveness will be derived from networking for data and exchange of best practices. By doing this, the joint use of European research facilities shall be carried out in a strategically focused and coordinated way, in which selected nationally operated facilities get employed to run specific high value carefully designed and chosen experiments, to ultimately support coordinated joint research nationally supported actions.

As there were no joint Open Data initiatives in the Wind Energy field, the IRPWind consortium made of 27 EERA JP Wind Energy partners recognised the necessity to take the initiative and start an action to implement an open data strategy. The core working group included scientists from DTU(DK), CENER(SP), ECN (NL), ForWind (GE) and SINTEF(NO).

The initial picture was that data are stored in each organization on different media, formats, mainly without standard metadata describing the datasets, with tags left to the single individual.

The first step was to scan the major European initiative providing data repositories. Data Repositories such as Zenodo and OpenAIRE have communities and single researchers have setup a general Wind Energy communities but the tags, again, not from a domain specific taxonomy but rather left to the expertise of each scientist. The result is that it is difficult for a data user to find exactly the needed data.

The main goal has been then to lay the basis to create a web data portal where to find datasets distributed in the several institutions by creating taxonomies and metadata standards for the wind energy community.

The IRPWind has produced two deliverables on - the Taxonomy and Metadata for wind energy (Deliverable D2.3) and - the roadmap for dissemination (Deliverable D2.14) , explaining this in all details.

4 Appendix:

A.) Draft EERA position paper on the management of research data

Making information resources more usable

Research data provide the foundation for research processes and in many cases also for economic and social innovation. The ways in which research data are used are changing fundamentally as a result of the digital revolution and the open science movement. In particular, the strong increase in the volume of digitally available data - including research data - and the ever increasing speed in which these are generated, open to the science and the economy new potentials. Use of these data calls for extensive investment in the expertise, research and infrastructure needed to manage and analyse them. Also required is a transformation of scientific culture and of the business models on which the publishing of texts, data and software is based; it is this transformation that is termed “open science”. Many members of the EERA AISBL provide already infrastructure for the management of research data supporting important national and international hubs.

An open access on research data is now part of the core strategy of the industrialized countries and the European Union. This policy is also regarded by the **many (several)** national governments, like the German federal, the Ministry of Education and Culture of Finland (<https://openscience.fi/>)... as a decisive instrument for successful positioning in the global scientific competition.

The establishment of national research data infrastructures as a component of globally distributed information infrastructures for science has been included in the national Council recommendations in Germany (?) and have a top priority.

The members of EERA would like to take on a leading role in this regard and will continue to expand the activities and will make recommendations on research data management.

In view of the potential of research data and the changing way in which they are handled, it is clear that the need for the EERA community to strengthen this position, and in doing so, to develop cross-cutting competences of their research areas and to make them more effective. In this spirit, the members of EERA will strengthen its "digital science" to significantly increase the information and research finding potential.

To achieve this the EERA members will jointly:

- *foster focused research in the field of information technology and pursue the development and operation of corresponding information infrastructures for scientists of EERA, for its cooperation partners, and for the users of the research infrastructures that it operates;*
- *store research data from the EERA partners, within suitable data infrastructures and make them available openly and free of charge for subsequent use by science and society;*
- *play an active part in national and international initiatives to coordinate the establishment of the necessary infrastructures; and*
- *provide training to enable scientific and non-scientific staff to utilise the opportunities thus created.*

In agreement with the general policy of the European Union and many member states, EERA members will seek for resources, which will enable them to:

- *further stabilise the financing mechanisms for data infrastructures;*
- *further improve the coordination and networking of their distributed data infrastructures nationally and internationally;*
- *further promote a new data culture; and expand human resources.*

As a first step, the members of EERA will specify the details of this research data management in publicly accessible guidelines. There may be legitimate – and sometimes discipline-specific – reasons for the temporary withholding or permanent strict control of access to information, for example in order to protect personal data, the rights of third parties, or the carefully considered interests of the researchers concerned. In specific cases, it may also be necessary to consider restricting subsequent commercial use, which should in principle be permitted.

The members of EERA will advise scientists on the responsible and effective management of research data. They will develop and operate reliable research data infrastructures to facilitate the safeguarding and use of internally and externally acquired research data. The members of EERA will work together in this process and cooperate nationally and internationally with other institutions and initiatives. These principles are intended to promote the quality, productivity, sustainability and competitiveness of science. They also provide a basis for knowledge transfer. The principles apply to EERA member staff and to external users of largescale devices and infrastructure operated by members of EERA.

This text was produced by the Open Science Working Group of the Helmholtz Association and adapted to the EERA framework.

B.) EERA position paper on open publication

EERA Input to FP9 mandate on Open Access

EERA shares the views and concerns of the EUA as stated in their document "Towards Full Open Access in 2020 - Aims and recommendations for university leaders and National Rectors' Conferences" June 2017. We believe that **ensuring the authors copyright is an important single factor** and that it is useful to distinguish between pre-competitive and close to market stages in the innovation chain. Maximizing openness in the initial stages should be duly balanced with protecting IPR for industry to ensure a fair and level competition in the marketplace. This is essential to ensure that innovative ideas are put to work.

The current situation for scientific publishing

Seen from the researcher's point of view they do the research, they write the papers, they review the papers, they edit the journals, and they pay to access and read their colleagues' work. In all stages they either pay or invest own resources, while the publishing business harvests considerable profits.

The main sources of funding for research are governments, on a principle of covering real costs, to fuel innovation and create wealth. To ensure the efficiency of turning a spent Euro on research into an innovation as efficiently as possible, it is essential to maximize the sharing of new insights and knowledge widely and at low cost. This is the main rationale behind increasingly stricter Open Access requirements tied to public research funding.

However, this positive development has put the researcher in a difficult situation. On the one hand, the funder demands immediate open access to published results. On the other hand, researchers want to publish in the most prestigious journals to gain recognition and build a career: respecting the freedom of researchers of publishing where they consider it most suitable for the dissemination of their work and for their career is an essential principle. The existing open access rules, however, face researchers with the high costs related to freeing the article in the journal of choice of the embargo period of 1-3 years. Even if this cost can be refunded using project money, it reduces the amount of funding that goes to actual research. The typical effect is that the researcher publishes a required minimum of the project results as open access and saves the rest for career building journal articles that enforce embargo times or even do not allow open access publishing.

The described situation is quite typical in Europe, although it can vary from region to region, depending on national regulations and historic traditions for how copyright and scientific merit is handled. Europe should learn from the best of these schemes when shaping its future regulation.

Recommendations

- Scientific publishing is a public responsibility – it should be based on the principle of cost coverage but not high profits, even when private actors are involved
- The EU should join national governments to regulate scientific publishing (as the US do)
 - State non-negotiable requirements that authors automatically retain copyrights to own articles when publicly funded
 - Regulate scientific merit criteria for university hiring to be based on Open Access considering both quality of content and number of reads/quotations
 - Provide Open Publishing repositories if not already available
- Provide template for Open Publishing platforms (use IEEE as a model?) – certify those following it
 - Ensure quality
 - Keep track of reads, referencing etc
 - Evaluate review process – transparent or confidential
- Carefully evaluate the progress along the innovation value chain to effectively balance the need for openness in the early exploratory, pre-competitive stage with the need for IPR protection in the close to market, competitive stage to attract investments and ensure that knowledge is put to work in the marketplace and creates wealth to the benefit of the public research funder.

C.) List of Geothermal Energy Research Infrastructures

List of research infrastructures listed by the JP DoW

Research Organisation	Infrastructure: technical characteristics	Type of access
BGS	Public research organization. National databases for onshore and offshore UK: geothermal, geological, geophysical (e.g. gravimetry, magnetotelluric, heat flow), geochemical (surface waters, ground waters, stream sediments, gases). National repository of core material. Laboratory facilities: elevated pressure/temperature geochemistry to supercritical conditions, fluid flow, mechanical properties of rocks, fluid chemistry, mineralogy, isotopes, microbiology. Range of field equipment including: gas monitoring, surface geophysics, down hole geophysics. Modelling: fluid chemical, fluid flow, 3D geological visualisation. Contact :	for joint efforts
BRGM	Database on French territory. Contact :	public access
CNR	Geothermal Information Platform of Italy. Geophysical (gravimetry, magnetotelluric, heat flow and thermal conduction), geochemical (fluid, gas and isotope geochemistry), experimental mineralogy, petrology, fluid inclusion, tectonic modelling equipments and laboratories. Remote sensing tools. Software packages: TOUGH2 and THOUGH-REACT, Petrel, WinGLink, COMSOL MultiPhysics. Public library. Rock samples.	for joint efforts
CNRS	Public research organization, geological, geophysical, geochemical instruments and laboratories.	for joint efforts
CRES	Natural laboratory for testing EGS exploration and exploitation technology: CRES RES park in Lavrio, Attica; Software packages: EASY genetic evolution optimisation code, TOUGH2 with the PETRASIM; will use the software package "SimaPro 7".	for joint efforts
ENEA	Public research organization. Environmental Geochemistry, Seismology and earthquake engineering: seismic microzoning, vulnerability analysis. Support to public administration in the normative field.	for joint efforts
ETHZ	High pressure laboratory, pilot and laboratory facility for spallation drilling with supercritical water (with optical access), laboratory for chemical analysis and particle analysis, CFD- software, public library; Shallow borehole logging equipment.	for joint efforts

GFZ	<u>Geothermal Research Platform Groß Schönebeck (doublet 4200 m; thermal water loop installation for well-logging, monitoring, geophysical testing, and material testing); ATEs Research Platform TU Berlin; Geophysical Instrument Pool Potsdam (GIPP); Borehole measurement facilities; High pressure laboratories available with simulation of in-situ conditions for rock testing and experiments</u>	for joint experiments
GZB	Multi-scale core facility: in-situ Laboratory (research, observation and production wells; > 500 m, >35 in total); Mobile dual drive drilling rig (60t; hp-pumps, mud cleaning and auxiliary equipment); i.BOGS: in-situ Borehole and Georeservoir Simulator for testing of drilling technologies under in-situ reservoir conditions and large scale fluid/rock experiments (L=300cm/D=50cm; 180°C/1200bar); Seismic monitoring equipment; Borehole logging (e.g. natural gamma, acoustic televiewer, full waveform sonic, flowmeter, temperature / conductivity, caliper, NIMO-T, deviation, EGRT); 3D-surface roughness analysis and microscopy; Hard-rock laboratory: rock physical characterization (Vp/Vs, porosity, density, thermal conductivity), thermo-triaxial testing system for mechanical tests under reservoir conditions up to 5 km depth, high-pressure high temperature equipment for μ CT-scanning (225 kV) and in-situ flow-through experiments; geochemical analysis (e.g. ICP-OES, MIP-GC, spectrophotometre); Heat-Pump Laboratory with Geo.Star (BHA 20x200m; incl. glasfibre-monitoring);.	for joint efforts
IRIS	Full-scale (offshore type) drilling rig with access to seven wells. Testing and qualification of equipment, training of personnel etc.; Tension and compression testing of tubulars; Flow loop for drilling fluid testing, testing of down hole equipment, erosion testing, etc.; High pressure/high temperature test site capable of testing at full-scale dimensions and extreme energy levels whilst fulfilling extensive safety requirements; Plug & abandonment test site under establishment. Barrier verification, pressure/leakage testing, cementing testing, sealant materials; Virtual Arena – drilling simulator for research, technology development, testing and training/education. Remote (web based) access; Petroleum laboratories for special core analysis, petrophysical measurements and improved oil recovery.	for joint efforts
ISOR	Various geophysical instruments for prospecting; many test sites of different physical state with deep boreholes where results of geophysical exploration can be compared with borehole data; Admittance to numerous boreholes and power plants as tests sites covering reservoir temperatures up to 340°C and borehole depths up to 3 km IDDP well in Krafla; Admittance to numerous reservoir monitoring systems; Admittance to fields and plants with variable chemical composition of geothermal fluid; 5 logging trucks and various logging equipment; owns specialized chemical laboratory for analysis of geothermal substances.	common projects within international cooperation

KIT	Thermal and fluid-dynamic laboratory; corrosion loops instruments and laboratories, public library.	public access to partners, but at no costs for KIT
LIAG	Logging Truck (10t) for geothermal logging with 6000 m / 3000 m cable winch, 4 conductor cable, temperature resistant up to 240 °C, several sensors, laboratory facilities. Database on German territory.	for joint efforts
LTTT/ ZET	Small-scale ORC test rig (1 kWel) for simultaneous measuring of heat transfer coefficients and power output; Software packages for transient and steady-state simulation of geothermal power plant systems	for joint efforts
OGS	Public research organization. Geophysical, Geothermal, CCS research activity, seismology, geological interpretation, marine geology. Borehole geophysics facility (wells), surface and borehole seismic instrumentation (shallow and up to 2000 m depth) and monitoring. Seismic sources (vibro, air gun). Seismological monitoring network. Gravimetry and remote sensing. Surface seismic and borehole data acquisition and processing (imaging and inversion). Rock physics research and seismic wave propagation numerical modelling in hot rocks (including melting and supercritical).	for joint efforts
RWTH/E.ON ERC	Slimhole logging equipment up to 1.5 km (P/T/Sal, Caliper, Gamma and spectral Gamma; Induction, Neutron-Porosity, Sonic); instrumented borehole heat exchanger array (41 boreholes, 100 m each); parallelized, high-performance simulation code with (supercomputer access) for single/multi-phase flow, species and heat transport, and geochemical reactions between fluid and rock; petrophysical lab for measuring thermal and hydraulic rock properties (thermal conductivity, spec. heat capacity, porosity, permeability); collaboration with RWTH Geotechnical institute with triaxial cell for acoustically monitored hydraulic fracturing experiments on samples of dimension 30×30×45 cm ³ .	1 available for joint projects or consulting work
SSSUP (ENERGEA)	Geothermal Database of Tuscan territory (Italy). Software and database for LCA, LCC and SMCE (Bousted and Ecoinvent for LCA, Gabi4 for LCC, Musiasem for SMCE). Technical and logistic support to primary data investigation (including in-field case study analysis).	for joint efforts
TNO	Database on Netherlands territory; Data assimilation techniques for reservoir modelling; analytical fast models for fracture formation and subsidence; Techno-economic performance tools (EGS-DSS).	for joint efforts
TUDa	International PetroPhysicalProperty Database; Hydrothermikum: lab for measuring petrophysical, thermal, hydraulic and mechanic rock properties (thermal conductivity, thermal diffusivity, spec. heat capacity, rad. heat production, porosity, permeability, uniaxial	for joint efforts

	and triaxial strength) and hydrochemical fluid properties (AAS, ICPMS). High pressure, high temperature labs available with simulation of in-situ conditions for rock testing and experiments; Parallelized, high performance simulation code for BTES systems and multiple commercial codes for heat and mass transport simulations (with supercomputer access).	
Uni CIPR	Lidar, photogrammetry and hyperspectral outcrop analysis hardware and software. Thermal conductivity*, VpVs, spectral gamma, tiny perm, microscopy including fluid inclusion*. Flow Laboratories for (petroleum) special core analysis, high P&T core, Petrophysical measurements, core & slab X-ray under flow, rock-fluid interaction, flow-front progression. Biological processes in reservoirs. Basin & reservoir modelling and fluid flow simulation software. Seismic recorders, land cables* & geophones* (* through UiB).	for joint efforts
UNITO	Fully monitored Living lab on underground heat storage (www.gtes.unito.it); Analogic thermal box aimed at simulation of soil behaviour at heat perturbations; near surface geophysical monitoring and investigations; petro-physical characterization; modelling porous and fracturing rock mass (Feeflow, Comsol, Tridec, ...) at different P-T conditions, living lab on public acceptance aimed at environmental impact minimizing and human comfort maximization.	for joint projects or consulting work
UU	Integrated analogue – numerical modelling facilities for crustal and lithosphere deformation, stress analysis and thermal evolution; Analytical facilities for high-resolution dating in low-temperature geochronology	for joint efforts
VITO	Balmatt geothermal site open for testing innovative exploration, monitoring techniques.	for joint research

D.) List of Energy Storage Research Infrastructure Facilities

Research Organisation	Country	Infrastructure and facility
CEA	France	<ul style="list-style-type: none"> - Full pack battery production line (for EV) and testing devices for cell to pack battery - High pressure (up to 1000 bars) hydrogen vessels manufacturing and hydraulic test facilities - Metal hydrides testing (degradation, ageing...) facilities - Integration of solid storage tank into a H₂ chain - Fresnel CSP demonstration power plant (1000 m²) - Adsorption/desorption solar cooling - High temperature thermochemical storage based on fluidized bed. - Test loops : PCM operation in heat exchangers - Large scale gas or liquid heat regenerator
CIEMAT	Spain	<ul style="list-style-type: none"> - Smart grid testing facility - Fly wheel testing facility - Access to renewable energy plants for demonstrators integration
CNR	Italy	<ul style="list-style-type: none"> - Processing facilities for batteries and supercapacitors - Complete facilities for gravimetric and volumetric H₂ sorption/desorption measurements - Fully equipped labs to study thermal storage materials - Test facility for MgB₂ and B Synthesis, Critical current characterization systems - Facilities for metallurgical deformation to produce wires and tapes
DLR	Germany	<ul style="list-style-type: none"> - SKOOP – Thermal oil, 4 kW, 400°C - Birkhof – Thermal oil, 100 kW, 400°C - WÜTA II – Steam or thermal oil, 25 kW, 250°C - HERTA – Flue gas, 50 kW, 1300°C - HOTREG – pressurized air, 160 kW, 830°C, 10 bar - Lab-scale thermo-chemical storage, 1 kW LIFT – flexible test bed for hydrogen production, 10kW - Thermo-physical Laboratory
ENEA	Italy	<ul style="list-style-type: none"> - Dry room for lab scale pouch cell assembly

		<ul style="list-style-type: none"> - Large test facilities for modules and systems with drivetrain test facility - Application-oriented pilot tests on large SC systems - Test facility for small metal hydride tanks - Preparation and test laboratory for dynamic PCT on H2 storage materials
FZJ	Germany	<ul style="list-style-type: none"> - Processing facilities for cells and batteries - Complete manufacturing line for high-temperature battery (solid-state, Li-free)
ICMAB	Spain	<ul style="list-style-type: none"> - ReBCO Coated Conductor Laboratory set for development - Medium size pilot plant for low cost high quality production. - Full tape characterization
IFE	Norway	<ul style="list-style-type: none"> - Material synthesis and characterization including neutron scattering facilities - In-situ SR-XRD and neutron powder diffraction setups - Cell and battery testing facilities - Customized half cells for testing new materials for Li-ion batteries - Access to HyNor Lillestrøm hydrogen fuelling station - Renewable energy laboratory equipped with energy storage system (Hydrogen/Battery), Windmill, PV - Thermodynamic (PCT) and kinetic characterization of hydrogen storage materials
Institut für Physikalische Chemie, WWU Münster	Germany	<ul style="list-style-type: none"> - Full 18650 cell production line
Institute IMDEA Energy	Spain	<ul style="list-style-type: none"> - Test facility for battery and supercapacitor modules
ISEA, RWTH Aachen	Germany	<ul style="list-style-type: none"> - Test facilities for battery packs - Full test facility for integrating batteries in grid or vehicles (stationary or mobile) - Test facility for destructive test - Full size low voltage grid (1 MW) for integration storage systems in grids
	Poland	<ul style="list-style-type: none"> - Prototype pouch cells assembly line

Jagiellonian University and AGH – University of Sci.& Tech. (Krakow)		<ul style="list-style-type: none"> - Recycling facility for Li, Ni, Co
Karlsruhe Institute of Technology (KIT)	Germany	<ul style="list-style-type: none"> - Magnetron sputter facilities and high-tech lasers for surface and 3D structuring - Prototype pouch cell assembly line - Large cell ARC calorimeter, Isothermal cal., drop-solution cal. - In-situ XRD, XAS on synchrotron source - H storage laboratory with synthesis and characterization, H safety center - MgB2 RTR wire fabrication up to 200 m - VATESTA facility for test of cables, windings
NRI Řež	Czech Republic	<ul style="list-style-type: none"> - Infrastructure for regulation of photovoltaic power plant
Risø DT	Denmark	<ul style="list-style-type: none"> - Winding facilities for HTS race track coils - Stand-alone grid for long-term in field testing of the SMES technology
RSE	Italy	<ul style="list-style-type: none"> - RES Active Network test facility
SINTEF	Norway	<ul style="list-style-type: none"> - Fabrication of electrodes and coin cells - Electrochemical testing of cells, cycling of battery packs - Modelling tools
UKERC	UK	<ul style="list-style-type: none"> - materials testing facilities for supercapacitor electrode and electrolyte materials - Large scale battery testing facility, test car - Hydrogen center Baglan Bay - Pilot scale (grid connected) CHP system - Small scale grid connected compressed air energy storage system
Vito	Belgium	<ul style="list-style-type: none"> - Smart grid, microgrid test platform - PHEV test facilities, logging infrastructure - High temperature Borehole TES test field
	Belgium	<ul style="list-style-type: none"> - Battery test infrastructure lab:

Vrije Universiteit Brussel, ETEC		<ul style="list-style-type: none">o 40 channels for characterization on cell level, 5V/600Ao 12 channels on module level, 80V/600Ao 3 climate chamberso Impedance spectroscopy- Electrotechnical lab for power electronics systems testing up to 800 kVA
VTT	Finland	<ul style="list-style-type: none">- Test facilities for battery packs- Pilot scale printing facilities for Supercaps

E.) List of JP Smart Cities Research Infrastructures

Austrian Institute of Technology (AIT)

The Austrian Institute of Technology (AIT) – the former Austrian Research Centres (ARC) and arsenal research – is Austria's largest non-university research organization, founded in 1956, and takes a leading position in the Austrian innovation system and a corresponding key role in the field of "Smart Cities" and other key research areas in Europe. The researchers at AIT Energy Department are very well connected to high ranking universities and research organizations in Europe, Asia and the US and are continuously presenting their research projects at international conferences. As a high level research organization AIT focuses on key infrastructure issues of the future within 5 different departments consisting of highly interdisciplinary and international teams. In the Energy Department the following energy related research fields are covered:

- The research team focusing on *Electric Energy Systems* helps the industry to develop emerging technologies for electricity networks (smart grids) and PV. A group of highly qualified specialists with internationally recognised research competence in the fields of electrical engineering, computer science, mechanical engineering and physics ensures solutions based on solid scientific principles. Researchers use numerical simulation to tackle complex problems: techniques range from the use of commercial software tools for stationary and transient analyses of electricity networks in the context of smart grids and the integration of distributed generation as well as coupled simulation techniques for the development and optimisation of network components and photovoltaic modules. A high voltage and high power laboratory as well as testing labs for photovoltaic modules and inverters are part of a comprehensive research infrastructure. A state-of-the-art simulation technology lab equipped with real-time computer and network simulator is currently being built for demanding "Power-Hardware-in-the-Loop" simulations. Electric Energy Systems is part of the ISO 17025 accredited test centre and IECEE CB Scheme Testing Laboratory (CBTL) and represents the AIT on the DERlab European Network of Excellence (NoE).
- The *Sustainable Building Technologies* research group develops efficient, cost-effective and sustainable solutions for the buildings and cities of tomorrow. The research and development activities are based on a comprehensive understanding of the physical and functional relationships within and between buildings. The team is well placed in terms of the research and control of these complex interdependencies, with interdisciplinary expertise in physics, mathematics, architecture, urban planning, mechanical engineering, electrical engineering, automation technology and computer science. Tools include modelling and numerical simulations, which are validated using measuring and monitoring techniques. For the dynamic simulation of physical systems the division has a wide range of software at its disposal. Examples of these are Modelica, TRNSYS, Energy+ and Matlab for the field of buildings and building technology, Star CCM+ and Fluent for numerical flow simulation, AutoCAD, Archiphysik, Ecotect and Radiance for building physics and daylighting as well as GIS applications for urban development and energy system analysis. In addition the team also develops its own tools for specific research areas.
- Regarding research on *Sustainable Thermal Energy Systems* AIT Energy Department is a competent partner to innovative Austrian as well as international companies in the fields of heat pumps and solar thermal technologies. An interdisciplinary team is dedicated to the

development of new and innovative approaches to improving and further developing existing components and systems. Researchers have several years' experience in the simulation and analytical calculation of fundamental thermodynamic and physical processes, such as heat and mass transfer, and material physical phenomena. For experimental analyses, a unique portfolio of accredited indoor and outdoor test facilities for solar thermal collectors, heat pumps and ventilation systems is available. Furthermore, a comprehensive range of training and staff certification programmes ensures ongoing knowledge transfer among planning and installation specialists.

In addition to the scientific excellency in the above mentioned areas, AIT Energy Department gained vast experience over the last years in managing and steering complex processes with multiple stakeholder participation. Based upon the involvement in the European CONCERTO project, AIT Energy Department is currently working closely together with 10 Austrian cities within the national call “Fit4Set” towards the transformation into Smart Cities. The core competences within those stakeholder processes cover a broad range of activities including process design, stakeholder engagement, visioning exercises, roadmap development and project management. These national projects shall be extended to the European level soon in the context of upcoming Smart Cities Calls within FP7. Furthermore, AIT Energy Department is a driving force in Europe within the European Electricity Grid Initiative (EEGI) collaborating with the EC on the steering and guidance processes of the European research landscape towards large-scale implementation projects for smart electricity networks.

CEA

CEA is a 15000 employee's French research centre which R&D activities cover a wide range of topics, ranging from civil and military applications of Nuclear power to renewable energy, software engineering, fundamental physics and biology. In SEAMSO, three R&D institutes belonging to CEA are involved: CEA LIST and CEA LITEN and CEA LETI.

The CEA LIST is the Laboratory of applied research on software-intensive technologies. With a staff of approximately 650 people, the LIST is a key software systems and technology research center working in three areas with vital societal and economic implications: Embedded systems, Interactive systems, Signal detection and processing. With the strong project-centred culture of its researchers, engineers and technicians, the LIST is able to perform research work in partnership with the major industrial players in the nuclear, automotive, aeronautical, defence and medical fields and thus investigate and develop innovative solutions corresponding to their requirements. LIST teams are also working as partners with numerous university laboratories, engineering schools and other research establishments on collaborative research projects.

The CEA LITEN is a CEA institute located for the most part in Grenoble and Chambéry (on the INES site – French National Institute for Solar Energy). It is one of Europe's newest and most important research centres in the new energy technology field. Involved in 350 research partnership contracts every year, LITEN works hand in hand with French industry. It is one of the CEA laboratories with the most patents - 134 new applications filed in 2009 and a portfolio of 400 international patents. Liten's research activities are focused on solar energy, low-energy buildings, future transport applications (hydrogen, fuel cells and batteries), as well as nanomaterials for energy and methods guaranteeing their safe use.

The CEA LETI is a CEA institute located for the most part in Grenoble. At the heart of the MINATEC innovation campus, Leti is an applied research center for microelectronics and for information and healthcare technologies. Providing a unique interface between industry and academic research, it is responsible each year for the development and transfer of innovative

technologies in a wide variety of sectors. In addition to Leti's 1,500 employees, there are more than 250 students involved in research activities, which makes Leti a mainspring of innovation expertise. Leti's portfolio of 1,500 families of patents helps strengthen the competitiveness of its industrial partners. LETI is one of the most important European laboratories for applied research in microelectronics. As a major player in micro and nanotechnology, it focuses on technologies of miniaturization, on their integration, and on their dissemination within systems.

CIEMAT

The CIEMAT, an Organism of the Ministry of Science and Innovation of Spain, is a Public Research Agency for excellence in energy and environment, as well as in many vanguard technologies and in various areas of fundamental research. CIEMAT is technically and geographically diversifying to better care for the R&D needs of Spain in general and its Autonomous Regions in particular. CIEMAT activities are organised around research projects that span the bridge between R&D and the interests of society. The CIEMAT team is made up of approximately 1200 people, of whom 47% are university graduates.

Main projects related to Smart Cities:

ARFRISOL R&D Project on High efficient Research demonstrator's containers. Building up of 4 new research demonstrator containers and retrofitting of an old office building into a bioclimatic research demonstrator container. Private and public cooperation: 2005-2012, 3 mill. €/y.

- Bi-directional work between the architect and the researches to carry out the thermal simulations and their analysis, both new and retrofitting building.
- Installation project supplements the rest of the energy demand not supplied by passive strategies with active strategies.
- Solar Chimneys for natural cross ventilation.
- Shadowing on south façade.
- Natural lighting.
- Renewable air conditioning based on solar energy.

DEPOLIGEN R&D Project on energy efficiency and Zero Emission Buildings. Private and public cooperation: 2010 – 2014, 1.3 mill. €/y.

ENVITE R&D Project on High efficient Research demonstrator's containers. Building up of two research demonstrators containers. Private and public cooperation: 2009-2011, 2.35 mill. €/y.

Bi-directional work between the architect and the researches to carry out the thermal simulations and their analysis.

- Installation project supplements the rest of the energy demand not supplied by passive strategies with active strategies.
- Solar Chimneys for natural cross ventilation.
- Shadowing on south façade
- Natural lighting.
- Renewable air conditioning based on solar energy.
-

Technical support on the design and construction of the NATIONAL CENTRE FOR HYDROGEN AND FUEL CELL TECHNOLOGY EXPERIMENTATION (CNH2). 0.75 mill. €/y.

CELSIUS R&D Project on high efficient and low consumption systems. Private and public cooperation: 2010 – 2014, 1 mill. €/y.

Infrastructure

R&D laboratories for building components (LECE-PSA):

- Building components analysis.
- Enclosures analysis.
- Carpenter + metalwork and components.
- Vegetation on façade.
- Passive components for natural heating and cooling.

Particle image velocimetry laboratory: optical method of flow visualization for ventilation simulation.

Indoor air quality laboratory.

7 Research demonstrator's containers: bioclimatic office buildings constructed under energy efficiency criteria

CSTB

The Centre Scientifique et Technique du Batiment (CSTB, France) provides the following research facility in the context of research on Smart Cities:

The Le Corbusier Immersion Space is a unique facility in the construction sector, intended to facilitate project design, consultation and communication processes for project owners and designers, in terms of architecture, urban development and regional development. It was devised in partnership with researchers from INRIA, the French National Institute for Research in Computer Science and Automation. The combination of virtual environments and scientifically valid simulations enables a projected 3D representation of projects in their future environment under immersive and interactive conditions. In this way, studying the project in the Le Corbusier Immersion Space improves communication between the client and the design teams, makes it possible to verify the future performances of the structure in different areas (acoustics, lightning, thermal comfort, aerodynamics, pollution, fire, etc.) and test and validate design options. Various applications:

- New building or retrofit
- Urban development (on a district scale)
- Regional development (roads, transport, infrastructures, structures, etc.)

Objectives of the Le Corbusier Immersion Space:

- Monitor projects at their different phases
- Work in close connection with the clients and design teams
- Check the effect of changes in real time
- Communicate more effectively with users and the public
- Have a continuous base of comprehensive, consistent and up-to-date information for project maintenance

The Le Corbusier Immersion Space is equipped with the latest cutting-edge equipment:

- Silicon Graphics and PC technology multi-processor graphic supercomputers
- Three DLP (Digital Light Processing) technology video-projectors
- A conical screen used to project an image of approximately 33m²
- A general room sound installation system
- Fifteen removable seats, three of which are equipped with an individual 3D spatial sound reproduction system (CSTB patent).

DTU

Technical University of Denmark (DTU) is one of the leading universities in the Scandinavia countries. It has 19 high international standard individual departments and a number of research centers in the Copenhagen area.

The Building Physics and Services section at the Civil Engineering Department at DTU works in the technical, social and environmental issues through the development of sustainable building design based on energy conservation and sustainable energy systems. It includes 3 groups: building physics, building energy and services and solar energy.

- **Building Physics:** the research is carried out with coupled heat and mass transfer to investigate the transport mechanisms in construction material, ventilated cavities and the internal and external construction surface. The overall objective of the activities in this area is to establish and provide a basis for buildings with durable structures, buildings that are healthy to live in and require a minimum of energy for heating.
- **Solar Energy:** the research in solar energy is to study the solar thermal energy technologies and their integration with building domestic hot water and space heating system
- **Building Energy and Services:** The aim of the research is to develop knowledge of new or improved types of building envelope design, window systems, HVAC and building services, which can make complete buildings independent of energy supplies from fossil fuel. The district heating subgroup is under this group with major research activities as low temperature district heating concept development, district heating system design and optimization as well as in-house substation improvement

ENEA

ENEA - the Italian National Agency for New Technologies, Energy and Sustainable Economic Development – was established with the Law no. 99 of July 23rd, 2009, art. 37, and is based on the expertise, staff and facilities of the former ENEA – Italian National Agency for New Technologies, Energy and the Environment. The present day ENEA's expertise is the result of more than 50 years of research and innovation carried in the fields of energy, new technologies and the environment by the former ENEA. ENEA is the largest Italian non-university research agency, and its mission is to support Italy's competitiveness and sustainable development through research and innovation technology activities and agency services, in support to public administrations, private enterprises, particularly with regard to SMEs, and citizens. ENEA carries out, in a national and international contest, studies, multidisciplinary research, implementation, validation and application of innovative technologies and methodologies, technology transfer, scientific and technical support, dissemination and training; in some of its Research Centres ENEA also designs, realises, tests, operates prototypes, sometimes also at pre-industrial scale, innovative instrumentations and plants operating in its main sectors of interest. ENEA is organized into 23 Technical Units, with a permanent staff of approximately 2.800 among researchers, technicians and administrative staff, operating in 12 Research Centres all over Italy, plus a liaison Office in Brussels.

Main clients at national level are the Ministries of the Economic development, Research and University, Environment, Regions and Municipalities, as well as several industrial sectors; to these organisations ENEA provides scientific and technical support, advisor and services and cooperates in joint R&D projects. ENEA acts also in Italy as the National Agency for the Energy. At international level ENEA has been participating since the 60's not only as a project partner in European programmes, but also in decision making processes to define EU programmes, through the participation of its experts working committees and groups and cooperating directly with EU bodies.

ENEA's activities are thus focused mainly on the following sectors:

- EURATOM
- Projects funded by EU Programmes (e.g. Framework Programmes, INTERREG, LIFE+, Intelligent Energy Europe, Competitiveness and innovation programme, initiative financed under the European Regional Development Fund)
- European Technological Platforms (Networked European Software and Services Initiative, Advanced Engineering Materials and Technologies, Photonics 21, Robotics, Wind Energy Photovoltaics, Future Textiles and Clothing, Hydrogen and Fuel Cell Platform, European Biofuels Technology Platform, Zero Emission Fossil Fuel Power Plants, Sustainable Nuclear Energy⁹)
- Committees and Groups
- Associations and networks (e.g. the European Energy Network, the Europe Enterprise Network, the Mediterranean Association of National Agencies for Energy Conservation – MEDENER, the European Water Partnership).

The Technical Unit for Advanced Technologies for Energy and Industry - ENEA UTTEI carries out research, technological innovation and delivery of advanced services through the implementation of advanced energy industry, for the sustainable use of fossil fuels and energy efficiency, and development of robot for wide-ranging industrial applications. Activities are mainly focused on:

- Design, construction and operation of experimental facilities and equipment; research focused on developing advanced technologies for energy (improved energy efficiency in production and end-use, with particular attention to reducing the environmental impact) and the industry

(the field of refrigeration, environmental conditioning, aerospace, shipbuilding, electronics, process):

- Design and construction of sensors and sensor systems dedicated to the creation of robots for industrial applications, broad-spectrum (land, sea, ocean, space, environment);
- Development of engineering and technological systems, components and processes for the sustainable use of fossil fuels and energy end-use, with particular reference to the development of vehicles with low environmental impact and optimization of electrical appliances

UTTEI also invest in innovative research on the accumulation of energy in various forms and methods for mobile and stationary applications (advanced lithium-based batteries, electrochemical supercapacitors and other alternatives) and development of advanced technology systems for the production of energy-efficient production systems and the eco-industry, smart cities and sustainable urban dynamics.

Recent Projects Related to the Smart City Context:

- **PAR 2010**

The goal is to develop an integrated system that includes the adaptive management of public lighting, monitoring of mobility and support to the fleets of public transport (electrical in particular), monitoring and remote diagnostics of buildings (especially public buildings). All applications share integrated sensor network at urban level and the same transportation network data together to unique environment for the intelligence data fusion. On an existing building it will be developed and tested a prototype, playing two feasibility studies, to extend the network created by ENEA Lumiere (400 countries) toward solutions Smart Town.

- **PAR 2008-2009**

Two tasks, the first one oriented to the development of sensor technology and the modelling for " Smart Street Project"; second a development-oriented modeling for controlling of "Smart Buildings"

- **CITY 2.0**

It's a project to build an integrated model for smart town (public lighting, mobility, and building, environmental monitoring, culture and communication at an urban level). The project is expected to pilot applications in a city of medium or small dimensions.

Loughborough University (LBORO)

Loughborough University is a research intensive institution with a demonstrable commitment to energy research. It is one of three universities that comprise the Midlands Energy Consortium (MEC) and on their behalf, hosts the UK Energy Technologies Institute (ETI): this government and industry collaboration aims to inject £1BN into UK energy research over its 10 year life. The University recently invested over £8m in energy-related research staff and facilities and is currently implementing low-carbon solutions on its 437 acre campus to create a prototype sustainable community. There are around 12 departments active in energy-related research co-ordinated through the Sustainability Research School (SRS).

Two key centres for energy research are based at Loughborough: The Department of Civil and Building Engineering is one part of the largest collection of schools of engineering in the country with world class research into engine technology, fuel cells, and construction and building performance: it has secured four of LU's six Queens Anniversary prizes for applied research. The E.ON UK / RAEng Research Chair in Low Carbon Energy. The Centre for Renewable Energy Systems Technology (CREST) is part of the School of Electronic, Electrical and Systems Engineering. Research activities at CREST cover a range of technical applications, including wind power, solar PV (Involved in the current EERA Joint programme on PV), energy in buildings, grid connection & integration and energy storage (including thermal and hydrogen). A selection of supporting projects are:

- LEEDR (Low Effort Energy Demand Reduction) focuses on people in the home, their behaviours and how and why energy is used in relation to every day practices. The project uses social sciences and high resolution monitoring and will develop and implement energy reducing interventions.
- CALEBRE project is investigating retrofitting demand reducing and energy saving technologies into solid wall housing stock, seeking to identify the barriers and opportunities for possible energy saving and low carbon energy supply technologies, from the perspective of the home and the householders.
- CCC (Carbon, comfort and control) investigates design of control systems for the home that create comfort for householders as well as energy demand reduction.
- Further role of thermal storage; clarify both the potential for, and limitations of, the role of thermal energy storage in the transition to a sustainable low carbon energy supply system in the UK.

SINTEF and Norwegian University of Science and Technology (NTNU)

The Norwegian Research Centre on Zero Emission Buildings (ZEB) is jointly managed by NTNU and SINTEF. NTNU and SINTEF already have extensive research, development and testing facilities for building materials, components, and larger building structures. In order to achieve the vision and goals of ZEB, six additional laboratories are being established and developed. These are:

1. Advanced Material Technologies Laboratory
2. Climate and Building Technologies Laboratory
3. Energy and Environmental Laboratory
4. Full Scale Test Cell Laboratory
5. Living Laboratory
6. Pilot Building Measurement In Situ Laboratory

Equipment installed or under installation in the ZEB laboratories (2009-2011):

Advanced Material Technologies Laboratory

- ☐ *Thermal Insulation Materials Development, Characterization and Testing Laboratory*

Focus on developing, characterizing and testing of new and advanced materials and solutions for ZEB, such as robust vacuum insulation materials (VIM), nano insulation materials (NIM) and dynamic insulation materials (DIM). Fundamental theoretical studies aimed at understanding the basics of thermal conductance at an elementary and atomic level will be carried out alongside with experimental investigations. The ultimate goal of these studies is to develop tailor-made high performance thermal insulation materials and dynamic insulation materials.

- ☐ *Smart Window Development, Characterization and Testing Laboratory*

Focus on properties, requirements and possibilities for materials able to dynamically regulate the solar radiation through smart windows for application in ZEB, such as electrochromic and other controllable materials. The smart window materials will be studied both at a material, component and structural level.

Climate and Building Technologies Laboratory

- ☐ *Large Scale Accelerated Climate Simulator Ageing Apparatus*

A large scale test apparatus for accelerated climate ageing of building materials, components and structures is essential for advanced and comprehensive studies within this field. The apparatus consists of an outdoor and an indoor climate box, with the necessary control and measuring equipment. The apparatus includes weather exposures such as solar radiation, wind-driven rain, moisture, air pressure differences, temperature cycles including freezing/thawing. The apparatus will simulate outdoor and indoor exposures as close to real life as possible under controllable conditions. The unit will also be applicable for short term dynamic monitoring of thermal and hydrothermal properties of building elements.

- ☐ *Solar and Thermal Radiation Measurement Portable Field Laboratory*

A solar and thermal radiation measurement portable field laboratory to measure and have control of the various solar and thermal radiation exposures the different materials, components and structures are subjected to in the field and in the laboratory. In addition to the outdoor climate exposure, several accelerated climate ageing apparatuses are in use, where the solar and thermal radiation exposure is one of the key climate factors, both in the ultraviolet, visible, near infrared solar and infrared thermal radiation regions.

□ *Rotatable Hot-Box Apparatus*

A rotatable hot-box apparatus for measurements of thermal transmittance (U-value), thermal conductivity, natural convection in thick porous insulation layers and high resolution temperature measurements (infrared thermography) is very important for experimental studies of these properties of insulation materials. The angle is to be varied between 0° and 180°.

Full Scale Test Cell Laboratory

Full Scale Test Cell at Existing Field Station

A full scale test cell makes it possible to test the overall performance and interactions of envelope elements, HVAC equipment and energy producing systems. The test cell will be equipped to measure heat flows, air flows, energy use (heating, cooling, electricity), humidity and temperature in detail, both for short term measurements (days/weeks) and on a long term basis (months/year). The goal with the test cell/building is to make it possible to test and to better understand the performance and robustness of innovative ZEB concepts before they are employed in pilot buildings. This test cell will be a supplement and extension to more detailed and constrained laboratory experiments of single elements. It will also make it possible to test system performance under real conditions.

Energy and Environmental Laboratory

Energy Supply and Building Services Systems Test Chamber

The Energy Supply and Building Services Systems Test Chamber complements and extends already existing laboratory infrastructure and facilities. The chamber allows to generate satisfactory variation in and control of various crucial outdoor climate conditions, such as solar radiation, temperature, relative humidity and wind. The chamber can be used separately or in combination with the existing solar test rig and other existing installations. The goal is to perform controlled tests under all kinds of realistic climatic conditions (i.e. solar radiation, temperature, relative humidity, and wind) with an emphasis on renewable energy, for instance heating systems based on solar energy and/or heat pumps.

Planned ZEB laboratories (2012-2013)

Living laboratory

The living laboratory will consist of a test facility which is occupied, in this case as a working environment. This requires a different scale and layout of the unit compared to a test cell that is user independent. The mission of the living lab is to study technology and design strategies in context:

- User centred development of new and innovative solutions (UCD): The test facility is used within a comprehensive design process which focuses on user needs and experiences.
- Performance testing of new and existing solutions: Exploring the various mismatch types between calculated and real life performance.
- The unit gives the possibility for detailed monitoring of the physical behaviour of building/system layout and user influence on the systems.

In this facility the experts in ZEB within social science, material science, building technology, energy technology, indoor climate and architecture will jointly study the interaction between the physical environment and the users.

Pilot Building Measurement In-Situ Laboratory

Six pilot buildings will be equipped with a comprehensive monitoring system, including equipment for measuring heat flows, air flows, energy use (heating, cooling, DHW, electricity), humidity and temperature. Since these pilot buildings will be situated in different parts of Norway, an on-line logging system with a web-based user interface for remote collection and handling of monitoring results has to be developed and adapted.

University of Nottingham

Nottingham has a wide range of energy research activities and is home to the Energy Priority Group and the Horizon Digital Economy Research a £40 million investment by Research Councils UK (RCUK), bringing together over 100 academic and industrial partners; in both a Research Hub and Doctoral Training Centre within the RCUK Digital Economy programme. The research focuses on the role of ‘always on, always with you’ ubiquitous computing technology. In addition, the Accelerating a Low Carbon Economy (ALCE) initiative bring two projects together that will contain multiple energy generation devices, loads (including offices, domestic appliances, EV charging points and H electrolyzers) and energy storage (including solid state hydrogen, compressed air and batteries). They will form a client cell within the experimental smart microgrid under development.

- Energy Technologies Building (ETB) is home to a 2100m² space dedicated to low carbon RD&D and facilities. It is designed to the highest sustainability codes as an exemplar of low carbon practice and will attract new partnerships with businesses and research tilize zed s. Included in the building is a smart microgrid laboratory equipped with tilize zed electrical circuitry to enable: A high degree of energy management, control and metering; flexible incorporation of renewable generation including experimental facilities; research into micro-grids, remote grid emulation and virtual grids.
- Creative Energy Homes (CEH) comprises seven low energy buildings designed to demonstrate a variety of energy efficient designs and technologies. The homes are occupied and fully monitored, providing a unique social as well as technology research tool. The seven houses tilize different renewable energy sources (PV, micro-CHP, solar thermal, biomass boilers, heat pumps).
- Mixed Reality Lab (MRL) is a dedicated studio facility where computer scientists, psychologists, sociologists, engineers, architects and artists collaborate to explore the potential of ubiquitous, mobile and mixed reality technologies to shape everyday life.
- C-Aware, DESIMAX, WiBe consider deployment of energy, occupancy an activity monitoring technologies in domestic and commercial settings, the construction of cloud based information services and situated displays and other interventions we probe consumers’ understanding of the social, financial and environmental context in which they use energy with the aim of encouraging more informed choices and migrating towards consumer awareness of the implications of demand side management. Using this domestic and commercially deployed platform, together with other data sources, we also aim to build models of consumer use, including how they will respond to demand side control signals such as time varying pricing controls.

University of Zaragoza, GiTSE – Thermal Engineering and Energy Systems Group

The Thermal Engineering and Energy Systems Group (GITSE is its acronym in spanish) is one of the research groups of the Aragón Institute of Engineering Research (I3A) that has been registered as Grupo Emergente de Investigación by the Regional Government of Aragón. Its academic activity is developed in the Engineering Schools of the University of Zaragoza, teaching all the subjects round to thermal engineering and energy systems like thermodynamics, heat transfer, HVAC, renewable energy, thermal engines, turbomachinery, power plants, energy optimization, combustion and so on. This includes undergraduate and graduate studies; currently participates in the interuniversity Doctoral Program in Air Conditioning and Energy Efficiency in buildings with other nine spanish universities, also in the Doctoral Program Advanced thermodynamics and energy optimization inside the Engineering Mechanical Department of the University of Zaragoza. Besides, the group collaborates in other activities as scientific conferences, courses and seminars, and one of its members is part of the Spanish entity for accreditation of laboratories ENAC. GITSE is involved in promoting collaborations and coordinated projects with other research groups, departments and european and American universities; takes part in national, european and international networks and collaborates in several Annex of the International Energy Agency.

GITSE members carry out basic and applied research in the areas related to the analysis, simulation and design of thermal devices and energy systems by using both numerical and experimental methods. The main research lines are: energy optimization, HVAC, thermal storage, cogeneration, solar energy and domestic ovens. Work has being carried out in applied research with companies via contracts and in basic research through the support of national and international projects. Our staff includes five professors (Prof. Miguel Angel Lozano coordinates the group), two associate professors, and one assistant professor from the Mechanical Engineering Department at the University of Zaragoza (UZ). Another seven additional members are predoctoral students sponsored by the Spanish Research Program, the Regional Government of Aragón (DGA), and other privately funded projects.

In the structure of the group we distinguish six subgroups: thermal storage, HVAC, solar energy, design and simulation of thermal devices, modelling and simulation of energy systems, and thermoeconomics.

GITSE is located at the Agustín de Betancourt Building. There we have the offices of the professors, doctoral students and administrative staff, together with some hardware facilities, meeting rooms, a research laboratory, a teaching seminar, three teaching labs and a bigger industrial building containing a HVAC installation for research and teaching purposes.

VITO

VITO (Flemish institute for technological research), located in Mol Belgium, is a leading independent European research and consulting centre developing sustainable technologies in the area of energy, environment, materials and remote sensing.

VITO provides intelligent and high quality solutions, offering a competitive advantage to large and small companies. It also provides objective research, studies and advice enabling industry and government to establish future policies. VITO's research finds its application in sustainable process and production technologies or cleantech, environment, energy efficiency, renewable energy, smart grids, advanced material and analysis techniques, secondary materials, healthcare, etc., as well as in mapping and monitoring the effects of climate change on the one hand and mitigation on the other hand. In 2010, the total VITO budget was nearly 90 million euro of which the contribution by contract research was 52 million euro. VITO counts approximately 600 highly qualified employees from diverse specialisations and collaborates with sector federations and their research centres, universities, colleges and European research institutes. Internally VITO is organised in eight research units.

VITO has lead and participated in a series of large research projects on energy technology, smart cities or transition programmes towards smart cities with a strong focus on real life pilot projects.

For the expertise in smart cities VITO mainly relies on 3 units: the unit Energy Technology the unit Transition Energy and Environment and the unit Spatial Modeling and Assessment, bringing together about 150 in this specific field.

In addition VITO can build on EnergyVille which is a strategic cooperation initiated by VITO and KULeuven (Energy Institute) with the ambition to combine the competencies and capacities on Smart Grids and Smart Energy Systems in a new common energy research building to be constructed in Waterschei/Genk. The future EnergyVille infrastructure and alliance also intends to host strategic cooperations with industrial partners aiming at new joint ventures and/or spin-offs. Furthermore, it is the Flemish base for the participation in the InnoEnergy project.

With EnergyVille Vito is partner of the EIT-KIC InnoEnergy on sustainable energy, with focus on “intelligent and energy efficient cities” (<http://eit.europa.eu/kics1/kic-innoenergy.html>). The KIC InnoEnergy on Sustainable Energy started its preparatory actions in 2010 with partners from universities, research centers and industry, clustered in geographically concentrated topics: the Co-location Centers. Apart from Co-locations on sustainable nuclear energy (FR), bio-energy (D), Smart Grids (S), PV and CS (E/Por) and CCS (P), the Benelux coordinates the Co-location on intelligent energy-efficient buildings and cities.

VTT

VTT, the Technical Research Centre of Finland, is a government organisation established by law and operating under the auspices of the Finnish Ministry of Employment and the Economy. VTT operates under the public mandate established for it by The Technical Research Centre of Finland Act (144/72). VTT's mission is to produce research services that enhance the international competitiveness of companies, society and other customers at the most important stages of their innovation process, and thereby creates the prerequisites for growth, employment and well-being.

VTT is a multitechnological contract research organisation providing high-end technology solutions and innovation services. From its wide knowledge base, VTT can combine different technologies, create new innovations and a wide range of world-class technologies and applied research services, thus improving its clients' competitiveness and competence. Through its international scientific and technology networks, VTT can produce information, upgrade technology knowledge, and create business intelligence and value added for its stakeholders. VTT Profit Centres are: Business Solutions, Expert Services, Strategic Research, and Ventures. VTT is serving the following customer sectors: Biotechnology, pharmaceutical and food industries, Process industry and environment, Electronics, Energy, Pulp & paper, ICT, Machines and vehicles, Real estate and construction, Services and logistics.

VTT's key technology fields include: Applied materials, Bio- and chemical processes, Energy, ICT Industrial systems, Microtechnologies and electronics, Technology in the Community (including energy efficiency of buildings and communities), and Business Research. In order to allow VTT to carry out the high-risk strategic research necessary to generate the knowledge and know-how required for fulfilling its public mandate, it receives substantial funding directly from the Finnish government. This funding presently amounts to 33% of VTT's total income (in 2007). By virtue of its status as a government organisation, its public mandate, its substantial research programmes with dedicated public funding, VTT is the largest public applied research activity in Finland with a staff of 2740 and turnover 232 M€ (in 2007). In the past 20 years, VTT has participated in more than 1000 European R&D Framework Programme projects, within various thematic programmes.

Expertise in area of proposal

VTT develops and offers solutions for energy efficient buildings and cities with the aim of saving energy, opposing climate change and reducing its effects. VTT's solutions cover the comprehensive evaluation and development of buildings and cities, ranging from urban planning to the functionality of buildings and cities at the occupation stage. Our broad file materials and effective tools allow for the reliable investigation of eco-efficiency. VTT's Finnish High-Tech Ecocity™ concept has been designed for use as a development tool for entire cities. The aim is to contribute to a comfortable low or zero emission city with first-class energy efficiency and services. The concept is ideal for developing new and existing cities alike. It allows for the development of unique, eco-efficient solutions for the needs of different types of cities. VTT offers cities energy efficient, economical lifecycle concepts which are based on well functioning regional, structural and spatial solutions. VTT coordinates the FP7 supported IntUBE project (Intelligent Use of Buildings' Energy Information) where one work package aims to develop a prototype of neighbourhood management system (NMS) which will control the community of independent but co-operating buildings, with common aim to maximise their energy efficiency.

F.) List of JP Bio-energy Laboratories and Pilot Facilities

Laboratories for biomass, biofuels and process emissions characterization

- Laboratories fully doted for characterization of advanced solid biofuels (including torrefied biomass), according to CEN/ISO standards, when applicable.
- Laboratories for full advanced characterization of liquid and gaseous products, byproducts and emissions resulting of biomass conversion processes, and materials.

More than fifty advanced analytical methods available.

Biomass feedstock availability development

- Installations for full development and monitoring of non-food biomass and oil crops.
- Laboratories of plant selection and genetic improvement
- Laboratories and pilot plants for macro, and micro-algae biomass production (different reactor technologies).
- Laboratories for genetic improvement of micro algae strains.

Thermochemical conversion processes

- Laboratories (bench scale plants) and pilot plants (different technologies) for the study of biomass conversion into advanced biofuels by gasification, fast pyrolysis, torrefaction, hydrothermal gasification ,hydrothermal pyrolysis, and intermediate bioenergy carriers upgrading to advanced biofuels and bioproducts.
- Laboratories for preparation, characterization and optimization of catalysts for biofuels upgrading. Also large scale facilities for in-situ research of catalysts and materials with X-rays and neutrons.
- Laboratories and pilot plants for study of the sintering and corrosion effects of biomass ash on the materials of thermochemical plants.

Biochemical conversion processes

- Bench scale and pilot plants for pretreatment of biomass (steam explosion, thermal treatments...)
- Bio reactors for fermentation of (pretreated) biomass to advanced biofuels (alcohols, hydrocarbons, H2...) and bioproducts.

The very notable infrastructure described has allowed a prominent participation of EERA Bioenergy partners in relevant projects like BRISK I (co-ordinated by one member of EERA Bioenergy JP) and BRISK 2 (on-going). BRISK2 (www.brisk2.eu) is a strong initiative with 24 leading EU project partners in the bioenergy field to align and improve research infrastructures in Europe concerning thermochemical and biochemical biomass conversion. Moreover, it provides a mechanism to make this research infrastructure available to a wider research community, allowing non-BRISK2 partners to use the research infrastructure for answering their research questions at financially attractive conditions. Ten out of 24 partners in BRISK2 of 11 European countries are members of EERA Bioenergy JP.

Demonstration facilities

Moreover, some relevant facilities for demonstration of advanced biofuels technologies and biofuels production in a biorefinery context are also available by some participants in EERA Bioenergy JP. This is the case of:

- ✓ “BiEnFuel” Project, consisting of a technology platform based on thermos-chemical conversion of biomass and residues. The core technology for the Flagship Project is a thermos-catalytic reforming patented process.
- ✓ “MefCO2” Project (<http://www.mefco2.eu/>) . Plant for demonstration of methanol production from captured CO2 (including from biomass combustion/gasification streams) using surplus electricity (1t/d methanol). As in the case of “BiEnFuel”, this plant has also been selected as a Flagship Project in the Set Plan Action 8 (Bioenergy and renewable fuels) Implementation Plan, recently endorsed by the Set Plan Steering Group.