APPENDIX 6 - Energy

Table A6.1 International research infrastructures by subdomains, countries and continents, (for more information see Chapter 6).

	Number of contacted RIs	RIs interviewed	Continents	
Total	37	11		
Energy Systems Integration	6	3	North America	5
			South America	
			Europe (non-EU)	
			Asia	
			Australia	1
Renewable Energy	17	6	North America	9
			South America	2
			Europe (non-EU)	
			Asia	6
			Australia	
Efficient Energy Conversion and Use	4	2	North America	3
			South America	
			Europe (non-EU)	
			Asia	1
			Australia	
Nuclear Energy	19	6	North America	8
			South America	2
			Europe (non-EU)	2
			Asia	6
			Australia	1
Cross-sectional RIs	13	1	North America	4
			South America	2
			Europe (non-EU)	
			Asia	7
			Australia	1

Table A6.2 Energy RIs investigated

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
Russia	nuclear energy	Joint Stock Company "State Scientific Center Research Institute of Atomic Reactors"	**JSC "SSC RIAR"**	interview, on-line survey	http://niiar.ru/eng
	Description/background: JSC "SSC RIAR" is a research and development center located in Dmitrovgrad (Ulyanovsk region, Russian Federation). Founded in 1956 as a nuclear testing center, granted a status of State Scientific Center in 1994. In 2008 it also became also a joint stock company.				
	Infrastructure: six test reactors; post-irradiation examination facilities; radiochemical facility to perform NFC-related research activities, SNF, RW and minor-actinides handling; radionuclides production area; fuel development and manufacturing area; full-cycle infrastructure, incl. nuclear fuel production, spent nuclear fuel and radioactive waste management, treatment of minor actinides; R&D-related lab-scale, research and design infrastructure. Currently, the new multipurpose fast reactor MBIR is under construction.				
	Services provided: access to local research facilities, databases, research methods and guidelines; production of radioisotopes; practical training of scientific and technical personnel, conferences, seminars, meetings on research and production activities of JSC "SSC RIAR".				
Russia	nuclear energy	Russian-Italian Project of Tokamak IGNITOR	**IGNITOR**	web-site	http://eng.nrcki.ru/pages/eng/international_megaprojects/ignitor/index.shtml
	No data.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
Canada	renewables, energy systems integration	National Research Council Canada Energy, Mining and Environment Research Centre	**NRC EME**	on-line survey	https://nrc.canada.ca/en/research-development/research-collaboration/research-centres/energy-mining-environment-research-centre
	Description/background: EME is one of 14 research centres within National Research Council (NRC) Canada, uniting R&D capabilities and facilities in energy, mining and environment research. In energy research, EME focuses on bioenergy systems, energy storage and novel material for clean energy and aims to support Canadian industry in bringing the latest science and technology achievements to the market. According to expert estimation, the largest part (about 75%) of funding for EME comes from Parliamentary grant through the Department for Innovation, Science and Economic Development with investment plans done for five years and program plans – for eight years. EME also receives funding from "other government funding programs and revenue from industry" with shorter time horizon on one to three years.				
	Infrastructure: EME has facilities to conduct bioenergy research and energy storage research. A new facility related to energy materials development is under construction.				
Canada	renewables	Wind Engineering, Energy and Environment Research Institute	**WindEEE**	on-line survey	http://www.windeee.ca
	Description/background: WindEEE Research Institute was established in 2011 within Western University in Canada. The Research Institute includes a WindEEE Dome facility, which was commissioned in October 2014[1]. According to expert, "the main objective of the WindEEE RI is to advance the development of wind energy, wind engineering, and wind environment through research, education, innovation and collaboration". Since 2015 Wind EEE is recognised by the Group of Senior Officials as part of Global Research Infrastructures[2].				
	Infrastructure: The major infrastructure is WindEEE Dome – a 3D wind chamber, located in Ontario, Canada. WindEEE Dome can accommodate multi-scale, three dimensional and time dependent wind testing[3].				
	Services provided: WindEEE provides physical access to local research facilities and virtual access to datasets either through collaboration on projects or on the commercial basis (fee for use). According to expert estimation, from 95 to 100% of facilities are provided to external parties and actually used.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
Canada	renewables	Fundy Ocean Research Centre for Energy	**FORCE**	web-site	http://fundyforce.ca/
	Description/background: FORCE is a private, non-profit institute, supported by the Governments of Canada and Nova Scotia and participating developers. It is Canada's lead demonstration facility for tidal in-stream energy conversion (TISEC) technology[4].				
	Infrastructure: The natural test site is located in the Bay of Fundy with the world's highest tides. The site is used for testing TISEC devices.				
	Services provided: FORCE acts as a host to TISEC developers, providing a shared observation facility, subsea power cables and grid connection at its test site. FORCE also provides environmental studies, environmental monitoring and applied research acting as a steward of the test site[5].				
Canada	nuclear energy	Canadian Nuclear Laboratories	**CNL**	web-site	http://www.cnl.ca/en/home/default.aspx
	Description/background: Established in the middle of 20th century, Canadian Nuclear Laboratories has been a primary national nuclear research laboratory in Canada. In the past years, CNL recognized the need to formulate a new vision. The modern strategy for years 2016-2026 has a special focus on the revitalization of Chalk River Laboratories site. For the coming years, CNL sets the following priorities in energy R&D: (1) life extension and long-term reliability of existing reactors, (2) development of new methods for next-generation fuels fabrication, (3) small modular reactors, and (4) decarbonisation of transport sector through demonstration of hydrogen-based bulk transport.				
	Infrastructure: For decades until the shutdown in 2018, the National Research Universal reactor was one of the world's most versatile high-flux research reactors. Currently CNL has a ZED-2 research reactor and a number of research facilities for materials research, fuel testing etc.				
	Services provided: CNL offers collaboration opportunities to universities, small and medium-sized enterprises and other interested third parties.				
USA	nuclear energy, renewables, cross-sectional	Oak Ridge National Laboratory	**ORNL**	web-site	https://www.ornl.gov/
	Description/background: ORNL is a multi-program national laboratory under the USA Department of Energy. The scientific portfolio in energy research includes nuclear energy technologies, fusion science and technologies, energy efficiency and renewable energy. ORNL is a member of ITER project.				
	Infrastructure: ORNL provides several user facilities which are open to researchers outside the laboratory. Facilities that can be related to energy research are: High Flux Isotope Reactor, Building Technologies Research and Integrated Center, Carbon Fiber Technology facility and National Transportation Research Center.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
USA	nuclear energy, renewables, energy systems integration	Sandia National Laboratories	**SNL**	web-site	https://energy.sandia.gov/energy/
	Description/background: SNL came to existence in 1945 as a single-mission organization to engineer non-nuclear components of nuclear weapons within a Manhattan project. In 1948 SNL became a Laboratory and in 1979 – a US Department of Energy National Laboratory. Primarily the national security mission and the mission of maintaining national technological direct activities of SNL. Energy studies is a part of SNL's research portfolio and include multiple research areas, namely: energy storage, hydrogen power, electrical grid, solar power, nuclear energy.				
	Infrastructure: SNL includes a number of Technology Deployment Centres assessable by not only US industry, governmental organizations, universities and academic institutions, but by a general scientific community. Some of these user facilities[6] are relevant for energy research, namely: National Solar Thermal Test Facility (solar power), Nuclear Energy and Fuel Cycle Programs (nuclear energy), Advanced Power Source Engineering Facility (energy storage), Combustion Research Facility (hydrogen power), Distributed Energy Technology Laboratory (electrical grid), Nuclear Facilities Resource Center (nuclear energy), Photovoltaic Laboratories (photovoltaics).				
USA	renewables	National Renewable Energy Laboratory	**NREL**	web-site	https://www.nrel.gov/
	Description/background: Many of the most prominent identified RIs are organised as parts of the National Renewable Energy Laboratory under the USA Department of Energy. NREL includes several laboratories, research centres and research programs: **National Bioenergy Centre** conducts research in bio energy, fuels and bioproducts. The research areas comprise analysis and characterization, bioenergetics, studying biochemical and thermochemical processes. **National Centre for Photovoltaics** focuses on increasing solar cell conversion efficiency, cost reduction of solar cells, modules, and systems, improving the reliability of PV components and systems				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Concentrating Solar Power Research focuses on developing materials for use in CSP, materials characterization, field characterization, engineering and techno/economic analysis. **National Wind Technology Centre** conducts research in wind energy, waterpower and grid interaction **Geothermal Program** aims to conduct the full spectrum of research on geothermal energy including geothermal impact analysis, evaluation of hybrid systems (geothermal systems combined with renewable and fossil energy technologies), geothermal exploration and resource assessment, sedimentary and enhanced geothermal systems.				
	Infrastructure: NREL include multiple research facilities: • *For bioenergy studies: Integrated Biorefinery research facility, Thermal and Catalytic Process Development Units.* • *For photovoltaics studies: Solar Energy Research Facility, Science and Technology Facility, Outdoor Test Facility and Related Facilities, Regional Test Centres.* • *For concentrating solar power research: Thin-Film Deposition Laboratory, Advanced Thermal Storage Materials Laboratory, Receiver Test Laboratory, Optical Characterization Laboratory, Large-Payload Solar Tracker, High-Flux Solar Furnace.* • *For wind energy studies: Field research validation sites for wind energy studies (including six wind research turbines, four meteorological towers), Dynamometer research facilities, Structural research facilities, Controllable grid interface.* • *For geothermal energy studies: Energy Systems Integration facility, High-Performance Computing Data Center, Solar Radiation Research Laboratory, Thermal Test Facility.*				
	Services provided: NREL offers opportunities for partnerships and collaborations with industrial, governmental organizations, as well as research and non-profit organizations. NREL provides opportunities to use facilities, to develop technology partnerships and to license technology.				
USA	energy systems integration	Pasific Northwest National Laboratory	**PNNL**	on-line survey	www.pnnl.gov
	Description/background: PNNL is included in the list of national laboratories under the USA Department of Energy. It receives funding mostly from US federal agencies and its projects that typically last for one to five years. The scientific domains that PNNL mostly focused on are catalysis, earth sciences, data analytics, cybersecurity, the electric power system and nuclear science and technology. In energy research the core problem that PNNL aims to address is the creation of energy resilient systems.				
	Infrastructure: PNNL holds several user facilities which are opened for access by a broader scientific community.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Services provided: Facilities provide physical, remote and virtual access to users which is mainly determined by peer review process.				
USA	cross-sectional	Lawrence Berkeley National Laboratory	**LBNL**	web-site	https://www.lbl.gov/
	Description/background: LBNL was founded in 1931 by Ernest O. Lawrence, a Nobel Prize winner in Physics. Now LBNL positions itself as a leading basic sciences national laboratory. It is also a US Department of Energy National Laboratory. Energy Sciences area in LBNL encompasses multiple scientific disciplines with major activities concentrated in Materials Sciences Division and Chemical Sciences Division. In addition to these divisions Basic Energy Sciences programs funded by the US Department of Energy also conducted within Joint Centre for Energy Storage Research (JCESR), led by the Energy Technologies Area), the Centre for Advanced Mathematics for Energy Research Applications (CAMERA, led by the Computational Research Division), and the Centre for Nanoscale Controls on Geologic CO2 (an Energy Frontier Research Centre led by the Earth and Environmental Sciences Area). Implications of Basic Energy Studies relate to multiple energy areas: photovoltaics, photosynthesis, biofuels, energy storage, combustion, catalysis, carbon capture/sequestration.				
	Infrastructure: National user facilities within Energy Sciences area at LBNL include Advanced Light Source, Molecular Foundry, Energy Sciences Network, National Energy Research Scientific Computing Centre.				
	Services provided: Provides external access to its national user facilities.				
USA	nuclear energy	DIII-D National Fusion Facility	**DIII-D NFF**	web-site	http://www.ga.com/diii-d
	Description/background: DIII-D National Fusion Facility is a laboratory operated by General Atomics for the U.S. Department of Energy. The laboratory investigates a broad range of fusion energy research topics from fundamental plasma science to the work of fusion power plants.				
	Infrastructure: DIII-D tokamak operated since mid-1980s.				
	Services provided: In order to provide access to the research facility General Atomics organizes a DIII-D Research Program that is open to research proposals from all countries having a cooperative agreement with US Department of Energy.				
USA		National Energy Technology Laboratory	**NETL**	web-site	https://www.netl.doe.gov/

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Description/background: NETL is owned and operated by US Department of Energy and supports its mission. NETL is the only laboratory among US Department of Energy National Laboratory that specializes in fossil energy studies. Due to its research focus in fossil fuels this laboratory is perhaps less interesting partner for European RIs, as we do not see a European fossil fuel RI.				
USA	nuclear energy	Idaho National Laboratory	**INL**	web-site	https://inl.gov/
	Description/background: INL is one of the US Department of Energy National Laboratories focused on nuclear energy studies.				
	Infrastructure: INL offers numerous user facilities for researchers, such as beamline, ion irradiation, post-irradiation examination and gamma-irradiation facilities. The laboratory also offers access to 10 nuclear reactors each of those offer different capabilities for nuclear research.				
	Services provided: For researchers INL offers access to user facilities, computing resources, access to library and publications as well as access to nuclear infrastructure database.				
USA	nuclear energy, renewables, cross-sectional, efficient energy conversion and use	Savannah River National Laboratory	**SRNL**	web-site	https://srnl.doe.gov/
	Description/background: Established in 1951 Savannah River National Laboratory belongs to US Department of Energy National Laboratories. It is a multi-program applied research and development laboratory working to achieve goals in environmental management, national and homeland security, as well as energy security. SRNL regards as its core capabilities: environmental remediation and risk reduction, nuclear materials processing and disposition, nuclear detection, characterization and assessments, gas processing, storage and transfer systems. In addition, SRNL has research programs and facilities related to hydrogen, bioenergy and energy materials.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Infrastructure: In addition to the main campus (which concentrates the nuclear-related research facilities), SRNL comprises Aiken County Research Laboratory (research portfolio includes research in bioenergy), Hydrogen Technology Research Laboratory and Energy Materials Research Laboratory.				
	Services provided: SRNL provides opportunities of cooperation to industry, government and academic institutions.				
USA	efficient energy conversion and use, energy systems integration, renewables, nuclear energy, cross-sectional	MIT Energy Initiative	**MITEI**	web-site	http://energy.mit.edu/
	Description/background: MIT Energy Initiative is an institute-wide initiative that brings together energy researchers within MIT and promotes collaborations with industry and governmental partners. MITEI focuses on energy solutions that mitigate greenhouse gas emissions and address climate change issues. The Initiative prioritizes eight areas for energy research (advanced nuclear energy systems, carbon capture, utilization and storage, electric power systems, energy storage, energy bioscience, materials in energy and extreme environments, mobility systems, solar energy) and organizes them into corresponding Low-Carbon Energy Centres.				
	Infrastructure: No information about any specific infrastructure/facilities for energy research.				
	Services provided: MITEI provides funding for research and development projects at MIT, promotes collaborations with industry and government, organizes educational programs and disseminates results.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
USA	renewables, nuclear enrgy, energy systems integration, efficient energy conversion and use	Stanford Precourt Institute for Energy	**Stanford Energy**	on-line survey	https://energy.stanford.edu/
	Description/background: Stanford University Precourt Institute for Energy is a focal point for Energy Research across various academic departments, labs and research programs of Stanford University. It focuses on supporting energy research projects in the following areas: renewables (bioenergy, geothermal, photovoltaics, renewable fuels, solar thermal, wind), energy storage and grid modernization, policy and economics, end use and efficiency, fossil and nuclear energy, environmental impacts.				
	Infrastructure: Stanford University Precourt Institute for Energy does not itself operates any user research facilities. However, there are research facilities available at Stanford University.				
	Services provided: funding allocation through a seed grant program, organization of educational programs, disseminations of research results.				
USA	energy systems integration, cross-sectional, renewables	Argonne National Laboratory	**ANL**	web-site	https://www.anl.gov/
	Description/background: ANL was established in 1946 as a chemistry, materials and nuclear engineering laboratory focused on developing peaceful uses for nuclear energy. Nowadays, ANL is a multidisciplinary research centre and a U.S. Department of Energy Office of Science national laboratory. ANL includes a variety of research groups, centres, initiatives and testing facilities related to studies and development of energy storage technologies, transportation, energy networks and hydropower. ANL has strong computational and energy systems modelling capabilities.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Infrastructure: There are five national user facilities some of those are actively used in energy studies, namely: Advanced Photon Source (APS) that includes a Transportation Beamline used by a transportation research team and Argonne Leadership Computer Facility (ALCF). In addition, there are multiple other facilities available at ANL. Among those relevant for energy research are, for example: Advanced Mobility Technology Laboratory, Distributed Energy Research Center, Engine Research Facility, Virtual Engine Research Institute and Fuels Initiative and others.				
	Services provided: ANL provides access to its national users facilities for researchers from industry, universities and other laboratories.				
Brazil	nuclear energy	Centro de Desenvolvimento da Tecnologia Nuclear	**CDTN**	interview, on-line survey	http://www.cdtn.br/en
	Description/background: CDTN is a nuclear institute that conducts research on radiochemistry, radioprotection, radiological metrology and dosimetry, nuclear/radiological safety, radioactive waste management, and nuclear technology (thermodynamics and neutronics). In addition to research activities, this is also an educational organization that holds the Graduate programme (PhD & M.Sc.) of Science and Technology of Radiations, Minerals and Materials.				
	Infrastructure: The main nuclear/radioactive facilities of CDTN are Nuclear Research Reactor TRIGA IPR-R1, Unit for Research and Production of Radiopharmaceuticals –UPPR, and Laboratory of Gamma Irradiation.				
	Services provided: CDTN plays a significant role in the technological development and the provision of specialized services for the mineral and metallurgical sectors. For example, CDTN offers radiopharmaceuticals production for applications in positron emission tomography, calibration of radiation dosimeters and individual monitoring to the community for the health area.				
Brazil	renewables	Brazilian Centre for Research in Energy and Materials	**CNPEM**	interview, on-line survey	http://cnpem.br/
	Description/background: CNPEM is a private non-profit Social Organization supervised by the Ministry of Science, Technology, Innovation and Communications (MCTIC). Located in Campinas, São Paulo State, it consists of four National Laboratories open to the scientific and technological communities, with competencies in biosciences, materials, renewable energies, and advanced instrumentation.				
	Infrastructure: Four laboratories: The Brazilian Synchrotron Light Laboratory (LNLS), The Brazilian Biosciences National Laboratory (LNBio), The Brazilian Bioethanol Science and Technology Laboratory (CTBE), and The Brazilian Nanotechnology National Laboratory (LNNano).				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Services provided: CNPEM implements, maintains, and operates open-access facilities to ensure the access of researchers from all over the country and abroad, including UVX, Sirius, microscopy characterization, the Electron Microscopy and Cryomicroscopy facilities, Atomic Force Microscopy, the microfabrication and functional systems and devices, the nanostructured soft materials facilities, proteomics (MAS), spectroscopy and calorimetry (LEC), nuclear magnetic resonance (RMN), protein crystallization (RoboLab), and the Pilot Plan for Process Development (PPDP).				
Brazil	nuclear energy, renewables	Instituto de Pesquisas Energéticas e Nucleares	**IPEN**	interview, on-line survey	https://www.ipen.br/portal_por/portal/interna.php?secao_id=723
	Description/background: Nuclear and Energy Research Institute is an autarchy of the São Paulo State, associated to the University of São Paulo for educational purposes, supported and operated technically and administratively by the National Nuclear Energy Commission (CNEN). It is recognized as a national leader in research, development and applications in the areas of radiopharmacy, radiation technology, nuclear physics, materials, lasers, biotechnology, environment and clean energy, and also in design and operation of nuclear reactors and radioactive facilities.				
	Infrastructure: There are 11 Research and Development Centres on the campus of University of São Paulo. Other facilities include nuclear electric power plants and petrochemical facilities. The new facility in plan is Brazilian Multipurpose Reactor (RMB).[7]				
	Services provided: Analysis of radionuclides in environmental and food samples; environmental radiological impact evaluation; external and internal individual monitoring and dose calculation; clinical and high-dose dosimetry; production of dosimetric materials; calibration of radiation detectors; radiation protection services; treatment of radioactive waste, and responses to radiological emergencies.				
China	nuclear energy, cross-sectional	Institute of Plasma Physics, Chinese Academy of Science	**ASIPP**	web-site	http://english.ipp.cas.cn/
	Description/background: ASIPP was founded in September 1978 for the peaceful utilization of fusion energy through the tokamak approach. As one of the most important laboratories in China, ASIPP has been conducting researches in high temperature plasma physics and magnetically confined fusion engineering, and it has built the world's first non-circle cross-section full superconducting tokamak, namely Experimental Advanced Superconducting Tokamak (EAST). ASIPP is a major contributor in China for ITER, having undertaken up to 73% of China's ITER Procurement Packages tasks which include superconducting conductors, correction coils, superconducting current leads, and so on. It has established close cooperation relationship with more than 30 countries and regions such as EU, the US, Russia and Japan.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Infrastructure: ASIPP has built various tokamak fusion experimental facilities including HT-6B, HT-6M, HT-7 and EAST.				
	Services provided: ASIPP has established nearly 20 companies which create both economic and social benefits. Hainan New Energy Research Centre is one example, forming a complete chain from basic researches to industrialization. ASIPP hosts various international seminars and workshops, and actively support fusion research in the developing countries. *Plasma Science and Technology* is the journal founded by ASIPP for reporting novel experimental and theoretical results in the fields related to plasma.				
China	nuclear energy, cross-sectional	Nuclear Power Institute of China	**NPIC**	web-site	http://en.npic.ac.cn/
	Description/background: Founded in 1965, NIPC is the only large-scale comprehensive R&D base in China incorporating reactor engineering research, design, test, operation and small batch production. It has established a complete research and development system, including nuclear power engineering design, reactor operation and application research, nuclear fuel and material research, nuclear technology application research and services, etc.				
	Infrastructure: NIPC has established 90 laboratories, including two national key laboratories and two national energy R&D centres. It has designed seven nuclear facilities on self-reliance such as the first High Flux Engineering Test Reactor in China. There are 18 large scale test installations for R&D of reactor engineering. It has developed nuclear power plants CP600/CP1000/CPR1000, and undertakes the R&D of next generation of nuclear power plants ACP100, ACP600 and ACP1000. A new comprehensive R&D base in under construction.				
	Services provided: NIPC provides a series of specialized technical services for nuclear power plants and research reactors, such as the overhaul and regular maintenance, supply of special tools, qualification of nuclear equipment and treatment of radioactive wastes. It has also developed a series of primary products. [8]				
China	nuclear energy, cross-sectional	Shanghai Synchroton Radiation Facility	**SSRF**	web-site	http://e-ssrf.sinap.cas.cn/
	Description/background: SSRF is the largest synchrotron research facility to date in China, and it is one of the advanced third generation light sources in the world, supporting and pushing the cutting-edge scientific research and the innovation.				
	Infrastructure: SSRF is composed of one 150 MeV linear accelerator, one 3.5 GeV booster, one 3.5 GeV storage ring, beamlines and experimental stations[9].				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Services provided: Since 2009 SSRF has provided bright x-ray beams to more than 10000 users from universities, institutes, hospitals and high-tech companies around China and the world. The facilities has been used in various areas of scientific research and industrial development, including biology, physics, material science, chemistry, environmental science, archeology, biomedical applications, medicine and drug development, etc. SSRF is also actively involved in the training and education of the next generation of scientists and engineers.				
China	renewables	Institute of Electrical Engineering, Chinese Academy of Science	**IEE,CAS**	web-site	http://english.iee.cas.cn/intro/
	Description/background: IEE is a national research institution oriented to the development of electrical science and engineering, and it is also one of the important institutes which engages in energy research in CAS. Its research fields include renewable energy technologies, new electric power technologies, and frontier inter-discipline subjects of electrical science. It has become a strategic backbone of innovations in related fields of China.				
	Infrastructure: IEE has six Laboratories and one Interdisciplinary Research Centre[10].				
Japan	nuclear energy	Japan Atomic Energy Agency	**JAEA**	on-line survey	https://www.jaea.go.jp/english/
	Description/background: As Japan's sole comprehensive nuclear research and development institution, JAEA aims to make contribution to welfare and prosperity of human society through nuclear science and technology. Its priorities are the research into improving nuclear power safety, basic and fundamental research of nuclear power, and R&D on nuclear fuel cycle. In response to the accident at Fukushima Daiichi Nuclear Power Plant, it has been conducted the R&D for decommissioning and environmental restoration. It also strives for the promotion of international cooperation, and has developed cooperation with countries in Europe, North America, Asia, and so on[11].				
	Infrastructure: "Fugen", "Monju" and Tokai Reprocessing Plant.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Services provided: In an event of nuclear or radiological incident, Nuclear Emergency Assistance and Training Centre, launched by JAEA, provides support to central and local governments in various technical ways including prompt dispatch of experts for emergency radiation monitoring and provision of technical advice to the governments and the public[12].				
Japan	cross-sectional	Global Research Centre for Environment and Energy Based on Nanomaterials Science	**GREEN**	web-site	https://www.nims.go.jp/GREEN/en/index.html
	Description/background: GREEN was established in October 2009 with NIMS as the host institution. Building upon the strength of Japan in the field of nanotechnology and materials science, GREEN engages in the fundamental research of environmental technology, contributing to the creation of new materials for solving environmental and energy problems.				
	Infrastructure: NanoGREEN Building was opened in 2012. It is an eco-friendly laboratory featuring solar panels, LED lightings and photocatalyst glass watering systems,etc. It consists of research facilities such as super dry room (DP of SA <-90°C), Femtosecond Laser System, and Photocatalysis Reaction System.				
	Services provided: GREEN invites researchers from universities and research institutes in Japan to work on the topics well linked to GREEN's mission through a public recruiting process. GREEN open-lab guest researchers have the opportunity to communicate with NIMS researchers from various fields, and jointly analyse the experimental results obtained by using the cutting-edge facilities at NIMS. Green is also the host of Green Symposium, NBCI-NIMS Joint Seminar, Battery Research Platform, and Analysis Forum for Battery Materials[13].				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
Japan	renewables, efficient energy conversion and use, cross-sectional	Research Institute for Energy Conservation, The National Institute of Advanced Industrial Science and Technology	**iECO, AIST**	on-line survey	https://unit.aist.go.jp/ieco/en/
	Description/background: Description/Background: iECO is one of the research institutes of the Department of Energy and Environment, AIST[14]. It conducts R&Ds on energy technologies to improve the efficiency of utilization and conversion. Infrastructure: iECO has eight research groups: Thermofluid System Group, Thermal Energy Applications Group, Thermoelectric Energy Conversion Group, Energy Interface Technology Group, Energy Conversion Technology Group, Energy Storage Technology Group, Turbomachinery Group and Engine Combustion and Emission Control Group. It has three laboratories: Collaborative Engine Research Laboratory for Next Generation Vehicles, Energy NanoEngineering Research Laboratory and Advanced Technology Laboratory for Solid State Energy Conversion (ALSEC)[15]. Description/background: AIST is one of the largest public research organizations in Japan. It focuses on the creation and practical realization of technologies useful to Japanese industry and society, and on bridging the gap between innovative technological seeds and commercialization. Infrastructure: AIST consists of five departments and two centres which are Department of Energy and Environment, Department of Life Science and Biotechnology, Department of Information Technology and Human Factors, Department of Materials and Chemistry, Department of Electronics and Manufacturing, Geological Survey of Japan, and National Metrology Institute of Japan. AIST has eight research bases throughout Japan for improving regional innovation. Fukushima Renewable Energy Institute, AIST (FREA) is established in Fukushima, promoting R&D in renewable energy and open to the world.				
	Services provided: AIST promotes collaborative work with leading companies, research institutions and universities worldwide. It strives to build international cooperative relationship between academia and industry through its global research network. It is one of the major research and innovation hubs where there is a high potential for creating new business opportunities[16].				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
Japan	renewables	The New Energy and Industrial Technology Development Organisation	**NEDO**	web-site	https://www.nedo.go.jp/english/index.html
	Description/background: As one of the largest public research and development management organizations in Japan, NEDO has two missions, namely addressing energy and global environmental problems, and enhancing industrial technology. NEDO coordinates and integrates the technological capabilities and research abilities of industry, academia, and government instead of employing its own researchers. NEDO aims to introduce advanced Japanese technologies to countries and regions around the world having diverse needs and infrastructures[17].				
	Infrastructure: Barge-type floating offshore wind turbine system demonstrator, Real-grid operation of high-temperature superconducting cables, Demonstration facilities for oxygen-blown IGCC, Environmentally-friendly waste oil recycling system demonstration plant, High-efficiency wind lens turbines, and so on.				
	Services provided: NEDO provides small and medium-sized enterprises and venture businesses with support at various phases, ranging from support for technology seeds to practical application by businesses. NEDO has been offering support for practical application in renewable energy and welfare equipment fields. It has also built systems that allow experts to provide advice on topics such as venture capital financing, legal issues, accounting, and intellectual property as they relate to commercialization.				
India	nuclear energy, cross-sectional	Bhabha Atomic Research Centre	**BARC**	web-site	http://www.barc.gov.in/index.html
	Description/background: The establishment of BARC dated back to 1954, for multidisciplinary research program essential for the ambitious nuclear program of India. It is the parent body of the R&D institutions such as IGCAR, RRCAT, VECC, etc. It carries out pioneering research on nuclear and accelerator technologies and industrial establishments. Infrastructure: BARC has active groups for R&D in reactor technologies, fuel reprocessing and waste management, isotope applications, radiation technologies, and so on. There are multiple research reactors constructed by BARC such as APSARA, ZERLINA and CIRUS Reactor[18].				
India	renewables	Solar Energy Research Cente for India and the United States	**SERIIUS**	web-site	https://www.seriius.org/

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Description/background: SERIIUS facilitates joint R&D and related activities on clean energy by teams from India and the United States. Through an environment of cooperation and innovation "without borders", it will develop and ready emerging and revolutionary solar electricity technologies. It will achieve this goal by lowering the cost per watt of photovoltaics (PV) and concentrated solar power (CSP). Infrastructure and Services Provided: SERIIUS has three research thrusts, including Sustainable Photovoltaics, Multiscale Concentrated Solar Power, and Solar Energy Integration, to ensure high-impact research and development to address key technical barriers in solar electricity generation. Under each research thrust there are respective infrastructures and services provided[19].				
India	renewables	DTB-ICGEB Centre for Advanced Bioenergy	**DTB-ICGEB**	web-site	http://icgeb-bioenergy.org/
	Description/background: Thriving upon ICGEB, DBT-ICGEB is established for strengthening the existing capacity in synthetic biology and to promote the cutting edge research in biofuel area. It mainly performs research in molecular biology and biotechnology, using advance genetic tools, metabolic engineering and system biology approaches, and will serve as platform for the synthetic biologists to work in diverse bioenergy areas such as microbial engineering, biochemical engineering, algal engineering and systems biology.				
	Infrastructure: There are 41 facilities in DBT-ICGEB. The detailed list of facilities can be found here http://icgeb-bioenergy.org/facilities/				
	Services provided: DBT-ICGEB involves in skill development programs and organizes various workshops and training programs. It supports Mission Innovation of India in which it will coordinate the activities of Mission Innovation initiatives of India with other partnering countries, and it will sync with the main/apex Mission Innovation Secretariat worldwide. The Unit will encourage liaising between public/private partnership in India and other partner countries for various collaboration activities, share information and coordinate with interested potential business investors.				
South Korea	nuclear energy	National Fusion Energy Institute	**NFRI**	web-site	https://www.nfri.re.kr/eng/index
	Description/background: NFRI is the national institute dedicated to conducting research and development of fusion energy. It has constructed the world's highest-ranking fusion research device named Korea Superconducting Tokamak Advanced Research (KSTAR), and has been actively involved in ITER. It collaborates with other RIs in countries such as the US, Russia, China, Japan, India as well as European countries including the UK, Netherlands, France, Germany, Italy and Hungary.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Infrastructure: NFRI has constructed KSTAR, the high efficient tokamak. The research for Korean Fusion Demonstration Plant (K-DEMO) is carried out.				
Australia	nuclear energy	OPAL at Australian Nuclear Science and Technology Organization	**OPAL (ANSTO)**	on-line survey	https://www.ansto.gov.au/
	Description/background: ANSTO is the home of Australia's most significant landmark and national infrastructure for research. It partners with scientists and engineers, and applies new technologies to provide real-world benefits. Its work improves human health, saves lives, builds industries and protects the environment.				
	Infrastructure: ANSTO operates much of Australia's landmark infrastructure including one of the world's most modern nuclear research reactors, OPAL; a comprehensive suite of neutron beam instruments; the Australian Synchrotron; the National Imaging Facility Research Cyclotron, and the Centre for Accelerator Science.				
	Services provided: health products, mineral consultancy, radiation services, Silicon irradiation, Gamma irradiation, Neutron Activation Analysis and Neutron Irradiation, measurement, and ANSTO Synroc-Waste Treatment Technology[20].				
Australia	energy systems integration	Centre of Excellence in Exciton Science, Australian Research Council	**ACEX**	web-site	https://excitonscience.com/
	Description/background: The Centre is funded by the Australian Research Council, working with researchers and industry, to research better ways to manipulate the way light energy is absorbed, transported and transformed in advanced molecular materials. It finds innovative solutions for renewable energy in solar energy conversion, energy-efficient lighting and displays, ad security labelling and optical sensor platform for defence.				
	Infrastructure: The Centre is a collaboration of researchers at the University of Melbourne, Monash University, RMIT, University of NSW and the University of Sydney. It works with Industry Partners such as Reserve Bank of Australia, CSIRO and Department of Defence: Defence Science & Technology Group. The Centre has extensive infrastructure for device fabrication including complete solar cell characterisation systems, wide range of printing and deposition technologies, clean room access, wide range of deposition methods and roll-to-roll printing and slot die coating facilities at CSIRO.				

Country	Sub-domain	Long name	Short name	How information was collected	Web-page
	Services provided: one of the Centre's core drivers is translating research into commercially viable products and services. In 2018, the Centre ran Entrepreneurship Bootcamp for its postdocs and researchers. It engaged a more strategy-based entrepreneurial focus by taking on Availer as consultants to audit its research and to determine if any has the potential to be commercialized.				
Australia	cross-sectional	Australian National Fabrication Facility	**ANFF**	web-site	http://www.anff.org.au/
	Description/background: ANFF links eight university-based nodes to provide researchers and industry with access to state-of-the-art fabrication facilities. The nodes, located across Australia, draw on existing infrastructure and expertise. Each offers a specific area of expertise including advanced materials, nanoelectronics & photonics and bio nano applications.				
	Infrastructure: ANFF has a network of eight nodes including 21 institutions throughout Australia[21]. Its facility portfolio consists of over 500 instruments with projects valued over $200 million[22].				
	Services provided: ANFF provides services for both academic researchers and industry. It enables users to process hard materials (metals, composites and ceramics) and soft materials (polymers and polymer-biological moieties) and transform these into structures that have application in sensor medical device, nano photonics and nanoelectronics. Researchers are able to either gain direct access to facilities under expert guidance, contract for specialised products to be made or undertake contract research projects				