



UNIVERSITIES IN THE SET-PLAN

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Executive Summary

The UNI-SET project, an FP7 Coordination and Support Action running from 2014 to 2017, aimed to mobilise European universities to contribute to the goals spelled out in the SET-Plan, the Energy Union [strategy](#) and the EU Energy and Climate targets. Its objective was to “mobilise the research, innovation and educational capacities of Europe’s universities in the SET-Plan”. Through a range of activities, including a mapping of universities and employers active in the field of energy, six Energy Clustering Events in five countries, the production of scientific policy input and strategic documents for universities to upgrade energy research and education activities, the project generated a range of different results and outputs with potential for exploitation and follow-up actions.

The project was conducted with the intention to mobilise universities’ capacities in a specific societal challenge field to spur higher education involvement in European-level initiatives (SET-Plan, Energy Union). Concretely, the four “essential elements” of the project were listed in the Grant Agreement as follows: (i) Mobilising European universities’ capacities to address the major “societal challenge” field of energy which requires both specific disciplinary expertise and interdisciplinary collaboration; (ii) Establishing an “Open” Platform led by EUA-EPUE and EIT KIC InnoEnergy bringing together existing university actors and networks and importantly creating opportunities for new entrants; (iii) Creating synergy of efforts across university and non-university research institutions and other stakeholders to maximise research and education contributions to the SET-Plan activities; (iv) Developing a model for the future sustainability of the Platform to be taken forward by Europe’s universities when the support action ends.

The main lines of work and achievements based on these objectives can be summarised as follows:

- The **UNI-SET Universities Survey** provided a first ever Europe-wide collection of data about the state of energy research and education at more than 130 European universities. It showed activity in all SET-Plan priority areas and the strategic importance of energy research and education for many of the participating universities. It confirmed a need for European programmes which support universities in conducting excellent research and education together with other European partners.
- The **European Atlas of Universities in Energy Research & Education** stems from the UNI-SET Universities Survey and allows universities, employers, students and others to find energy-related master programmes and research topics in 30 European countries. A new survey wave in 2018/2019 to update existing information is currently discussed and would give a longitudinal view on the subject and would allow the inclusion of new types of programmes (e.g. short-courses, bachelor’s programmes) - making the Atlas an even more useful repository of energy-related learning opportunities in Europe.
- The **UNI-SET Employers Survey** was a first-of-a-kind EU-wide study of employers’ views on future skills needs in the energy sector at more than 180 organisations in Europe. It confirmed a need for more interdisciplinary education and training, including both technical and socio-economic aspects. Employers highly value practical and project experience and entrepreneurship. The findings of the UNI-SET Employers Survey and the series of events named ‘Profile Profile Identification Workshops’ fed into the ‘Action Agenda’ and its recommendations and can be directly translated into action by universities.
- A community of UNI-SET scientific experts contributed to the **SET-Plan process**, coordinating 15 Input Papers and giving scientific input in six Temporary Working Groups of the SET-Plan. The input papers informed the respective Declarations of Intent and will be used to develop the SET-Plan Implementation plans and other measures (e.g. R&I actions and programmes) by European institutions and members states.

- The **Energy Clustering Events** were six pan-European events addressing energy-related education and research challenges along the SET-Plan priorities, convening more than 770 people and 251 speakers. Throughout the events, UNI-SET succeeded to increase industry participation, reinforcing the intersectoral discussions. The Energy Clustering Events have been established as a brand recognised by universities, stakeholders and partners, and created a community of academics and universities ready to move on through joint projects and policy work. EUA-EPUE will continue to organise Energy Clustering Events as a direct results of the positive experience during the UNI-SET project.
- The '**Roadmap for European Universities in Energy**' - represents a strategic approach and suggestions for university activity in energy research and education until 2020. It details a range of follow-up actions to be implemented by EUA beyond the project duration As the agenda for EUA-EPUE to carry on the different threads of activities launched through the UNI-SET project. It defines the vision and range of possible activities and the role of EUA-EPUE as the vehicle to implement them, where feasible in partnership with other organisations or through external funding. The roadmap therefore provides the direction for the continuation of the activities of the UNI-SET CSA through EUA-EPUE.
- The '**Action Agenda**', published in the report "Energy Transition and the Future of Energy Research, Innovation and Education: An Action Agenda for European Universities", is a flexible framework for the development of programmes, modules and courses offered by European universities. Universities can consult and expand the examples and create new actions based on the suggestions. The 'Action Agenda' spells out the UNI-SET project's ideas ideas for mobilisation of universities and cooperation with other stakeholders in in a tangible framework that can be used by the project partners but also other interested parties. The framework in written form ensures the sustainability of the ideas generated through UNI-SET and their future use, therefore it enables the future uptake of the UNI-SET knowledge.
- A pivotal role for the future exploitation will be play for the **EUA Energy and Environment Platform (EUA-EPUE)**, which will lead the actions outlined in the Roadmap and carry on different strands of activities that started with UNI-SET. The platform will also expand its range of activities to more actively integrate university activities in other societal challenges such as environment to the ongoing activities related to the energy transition.

In terms of impact and further use of the project outputs outlined above, the use and exploitation of UNI-SET are broadly divided in four main areas:

- 1) the use of outputs and the exploitation of them for further mappings and policy development, e.g. to support decision-making for the Energy Union and SET-Plan initiatives;
- 2) the implementation of the Action Agenda by universities in order to facilitate interdisciplinary education in the field of energy to support long-term competitiveness and European leadership in clean energy solutions;
- 3) the realisation of strategic activities outlined in the Roadmap through EUA-EPUE, which aims at continuous mobilisation through Energy Clustering Events and the creation or more opportunities for synergies among universities and between universities and other stakeholders;
- 4) the further consolidation of EUA-EPUE as the main open platform carrying forward the work of the UNI-SET project and as the main platform in Europe working for and with universities to reform energy research and education along the goals of the Energy Union. EUA is committed to continue these activities, where feasible, using its own resources and through collaborative projects with other stakeholders and partners, to maximise the impact of each measure for the fulfillment of SET-Plan and Energy Union. The partnership with EIT InnoEnergy has proven a successful collaboration and follow-up projects here will be prepared jointly by EUA-EPUE and EIT InnoEnergy.

5) UNI-SET policy recommendations and political messages for energy research, education and innovation policy on a general level, for instances in the context of the next Research and Innovation Framework Programme (FP9) or the future successor programme to Erasmus+, e.g.: the crucial role of collaborative European research projects at different stages (from ‘fundamental’ to ‘applied’ research); better conditions to link interdisciplinary research and education within EU framework programmes for research and education; a high interest of universities in the societal challenge and thus potential for “European University networks” active in clean energy; universities potential role in mission-oriented research and innovation in the field of energy; and a closer alignment of the SET-Plan process with the Framework Programmes would yield important synergies between EU-level funding (Framework Programme) and national initiatives coordinated.

Summary Description of Project and Objectives

PROJECT CONTEXT

One of the goals of the European Union is to create a low-carbon society within the next decades, including a 40% cut of greenhouse gas (GHG) emissions, a 27% reduction of energy use and a 27% share of renewable energy in the energy mix by 2030. By the year 2050, the EU aims to reduce its GHG emissions by 80%-95% compared to 1990 levels ([COM\(2011\)885](#)). The European Commission, under President Jean-Claude Juncker, has stressed its ambition to be the world's "number one in renewable energy and leading the fight against global warming" with its high priority for the realisation of the [European Energy Union](#).

These far-reaching goals require a transformation of the entire energy system and a paradigm shift using new and yet-to-be-developed technological solutions or a combination of them in what is known as "energy mix". This includes solutions to improve energy-efficiency, to ensure a clean and secure energy supply, and to enable the optimal inter-connection and integration of the different energy production and consumption points, in view of the development of an integrated European energy system. "Significant efforts in technical innovation and investment" ([COM\(2010\)639](#)) are therefore needed to make these technological solutions affordable, cost-effective and competitive.

In order to "accelerate the development and deployment of cost-effective low carbon technologies" ([COM\(2007\)723](#), [COM\(2009\)519](#)), the European Commission formulated the European Strategic Energy Technology Plan ([SET-Plan](#)) as the cornerstone of a coherent European energy research and development policy. An Integrated Roadmap was also developed to define the actions to be taken to implement the SET-Plan and accelerate the move towards a low-carbon society. The SET-Plan Integrated Roadmap and Action Plan includes actions mostly to boost technological advancements, but also actions to remove institutional, behavioural and financial barriers such as increasing the engagement of all energy stakeholders concerned in policymaking, mobilising the consumers, developing new professional competences and skills, and lever in additional funding.

The way to move forward with the Energy Union is spelled out in European Commission's 'Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate' ([COM\(2015\)80](#)). The strategy puts "citizens at its core" and emphasises the need to develop a "forward-looking, energy and climate-related R&I strategy". The 15 action points listed in the communication include the development of new technologies, the utilisation of new financial, legislative and policy instruments and the engagement of consumers.

Moving towards a low-carbon society, a process known as the 'energy transition', creates demand for new and well-educated professionals in the energy sector, as well as for an upgrade of the competencies and skills of professionals already employed in the field. The International Energy Agency ([IEA, 2010](#)), the International Labour Organization ([ILO, 2011](#)) and the International Renewable Energy Agency ([IRENA, 2010](#)), identified education and training as critical obstacles to the near-term development and deployment of renewable energy on a larger scale and point out that cooperating with the private sector to develop curricula and educational contents is vital to meet the skills required by the energy sector. In addition, the European Commission ([COM\(2015\)80](#)) stresses the potential of "an innovation-driven transition [...] for growth and jobs and that business models or job profiles will have to adjust".

European universities are strategically important to the SET-Plan and [Energy Union](#) processes as they are major actors in research and innovation, and the main source for highly educated professionals and graduates needed in the energy sector. The 'energy transition' is a grand challenge that requires collaboration between professionals with diverse backgrounds and expertise in energy systems, the

energy sector and other societal aspects of the ‘energy transition’. It calls therefore for a more interdisciplinary and holistic approach in the development of educational and research programmes.

The [SET-Plan Education & Training Roadmap](#) highlighted the need to equip graduates with interdisciplinary skills. It reckons that university programmes should combine technical knowledge with management, entrepreneurial and communication skills, as well as with critical thinking and problem solving competences. It also emphasised the need for a “more responsive education system” that allows curricula development based on the skills requirements of the energy sector stakeholders and employers, facilitates knowledge exchange across Europe and enhances the mobility of university students and teaching and research staff.

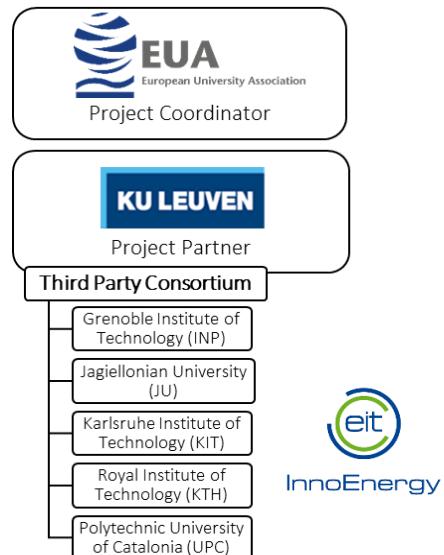
Quantitatively, the [SET-Plan Education & Training Roadmap](#) estimated that an additional five million people will be employed in the European energy sector by 2020, and another 6.3 million people between 2020 and 2030. Researchers, engineers and technicians are to take the lead in implementing the SET-Plan and Energy Union. However, to secure the move towards a low-carbon society, Europe also needs capable and qualified professionals from other scientific fields, such as management, finance and economics, law and social sciences.

To respond to the labour needs of the continually evolving and expanding European energy market, European universities need to strengthen multidisciplinary and intra-European cooperation, upgrade existing educational and research programmes and create new ones. It is, therefore, essential to build platforms that allow universities to identify synergies and common research and educational interests in the thematic areas of the SET-Plan. Additionally, it is important to identify and specify the knowledge, skills, competences and, generally, the professional profiles required by energy sector stakeholders and employers active in the SET-Plan.

MAIN ACTIVITIES

Considering the context outlined above, the UNI-SET (UNIversities in the SET-Plan) project aimed to mobilise European universities to contribute to the ambitious European energy goals spelled out in the SET-Plan, the Energy Union [strategy](#) and the 2030 and 2050 Energy and Climate targets of the European Union. Its objective in brief was to “mobilise the research, innovation and educational capacities of Europe’s universities in the SET-Plan”.

UNI-SET was thus supported as a Coordination and Support Action funded by the European Union’s Seventh Framework Programme for Research and Innovation (FP7). It began in September 2014 and lasted until December 2017. UNI-SET was coordinated by the European University Association (EUA) and implemented jointly with [KU Leuven](#), which represents the universities in EIT InnoEnergy, who participated in a Third Party Consortium.



The mobilisation of universities should, following the Grant Agreement, entail four ‘essential elements’ which sought to realise the growth and consolidation of a university platform in the SET-Plan and the involvement of universities in SET-Plan-related activities and networks with a long-term perspective:

- (i) Mobilising European universities’ capacities to address the major “societal challenge” field of energy which requires both specific disciplinary expertise and interdisciplinary collaboration,*
- (ii) Establishing an “Open” Platform led by EUA-EPUE and EIT KIC InnoEnergy bringing together existing university actors and networks and importantly creating opportunities for new entrants,*
- (iii) Creating synergy of efforts across university and non-university research institutions and other stakeholders to maximise research and education contributions to the SET-Plan activities,*
- (iv) Developing a model for the future sustainability of the Platform to be taken forward by Europe’s universities when the support action ends.*

The four essential elements of the project were overarching in relation to the activities of the projects described below, i.e. they often would relate to several activities of the project at the same time. Some elements are stronger represented in some of the achievements.

The project concretely aimed to identify opportunities for universities to engage in new energy-related, multi-disciplinary activities tackling energy-related challenges. It also sought to reduce fragmentation of European universities’ research, education and training capacities in the energy field, by connecting universities and providing opportunities to create new partnerships among universities and between universities and other actors such as companies and societal organisations. Additionally, it intended to provide opportunities for universities to contribute to policy discussions and to engage in dialogues on the development of the SET-Plan, [Horizon 2020](#) and to participate in consultations on European energy matters and related areas.

Main activities of UNI-SET included the mapping of existing energy-related Master, Doctorate and Research programmes at European universities and by that the collection of empirical data about the range of university activities in disciplines and scientific fields related to the SET-Plan. UNI-SET also identified the skills and professional profiles needed in the current and future European energy sector.

In addition, UNI-SET organised a series of Energy Clustering Events to support the creation of thematic clusters of universities active in different areas of the SET-Plan. The events also served the purpose to exchange good practices and ideas, and to provide a venue for universities to be involved in European

decision-making processes. This supported also the last goal of UNI-SET, which was to provide input from the university sector to policy-makers in different domains of the energy transition and the SET-Plan. Concretely, the main lines of activities of UNI-SET based on the Description of Work were:

***** Collect information about and map energy-related Master, Doctorate and Research programmes across Europe *****

UNI-SET sought to develop interactive online maps displaying the spread and diversity of energy-related Master, Doctorate and Research programmes offered by European universities. The basis for these web-based maps was the implementation of a European-wide survey for universities aiming to gather information about the three types of activities and strategic relevance of the energy field for individual institutions.

***** Identify the skills and professional profiles required by the European energy sector *****

UNI-SET aimed to identify the skills and professional profiles needed in the European energy sector, both in the short and long term, through a survey designed for employers and through a series of professional profile identification workshops organised by KU Leuven and the projects Third Party Consortium.

***** Discuss the strategic role of universities and facilitate cooperation *****

UNI-SET intended to create a sustainable open platform to facilitate the creation of synergies between universities, foster intra-European and multidisciplinary collaboration and provide a welcoming and inclusive forum for new entrants into the European energy research landscape. The online maps displaying the energy-related Master, Doctorate and Research programmes across Europe allow energy stakeholders to identify institutions that work on energy topics and SET-Plan areas of their interest. The UNI-SET ‘Energy Clustering Events’ (ECEs) also provided an opportunity for institutional and research leaders from universities to discuss the strategic role of universities in meeting the objectives of sustainable, low-carbon European society and to facilitate the establishment of new consortia to develop joint Master, Doctorate and Research programmes in the energy field.

***** Strengthen the voice of universities in European energy policymaking *****

UNI-SET aimed to bring together European universities to present a collective voice in parallel with other major organisations that are part of the SET-Plan, such as the European Energy Research Alliance ([EERA](#)) and the European Technology and Innovation Platforms (ETIPs). Both [EUA-EPUE](#) and [KIC InnoEnergy](#) are observers in the EERA Executive Committee and have established a number of links with EIIs. UNI-SET also envisioned to use its outcomes and deliverables to inform energy, research and innovation policies at the European level.

Description of the main results/foregrounds

As mentioned above, the activities of the project were conducted with broader targets in mind, i.e. to establish a platform of universities engaging in the societal challenge field of energy and the SET-Plan, working together with other stakeholders and developing a strategy to sustain the activities of the network after the initial funding through the UNI-SET CSA. Concretely, the four “essential elements” of the project were listed in the Grant Agreement as follows:

- (i) *Mobilising European universities' capacities to address the major “societal challenge” field of energy which requires both specific disciplinary expertise and interdisciplinary collaboration,*
- (ii) *Establishing an “Open” Platform led by EUA-EPUE and EIT KIC InnoEnergy bringing together existing university actors and networks and importantly creating opportunities for new entrants,*
- (iii) *Creating synergy of efforts across university and non-university research institutions and other stakeholders to maximise research and education contributions to the SET-Plan activities,*
- (iv) *Developing a model for the future sustainability of the Platform to be taken forward by Europe's universities when the support action ends.*

Based on the main project objectives outlined above, the work programme and the four essential elements agreed in the project grant agreement, a range of results and foregrounds stemming from the activities of UNI-SET were generated. They can be summarised under seven main achievements and are described in the next sections. The main achievements were:

- Achievement 1) Mapping and analysis of university activities in energy (WP2)
- Achievement 2) Analysis of energy-sector employers and future skills needs (WP3)
- Achievement 3) A European atlas of universities in energy (WP2)
- Achievement 4) Scientific policy input from the university perspective (WP5)
- Achievement 5) Higher awareness and creation of critical mass among universities (WP4)
- Achievement 6) A long-term roadmap for enhanced future impact (WP5)
- Achievement 7) New ideas on innovation in energy education through the ‘Action Agenda’ (WP5)

The four essential elements of the project were overarching in relation to these achievements, i.e. they often would relate to several activities of the project at the same time. Some elements are stronger represented in some of the achievements. Broadly speaking, the following explicit connections between main elements and project achievements were made during UNI-SET.

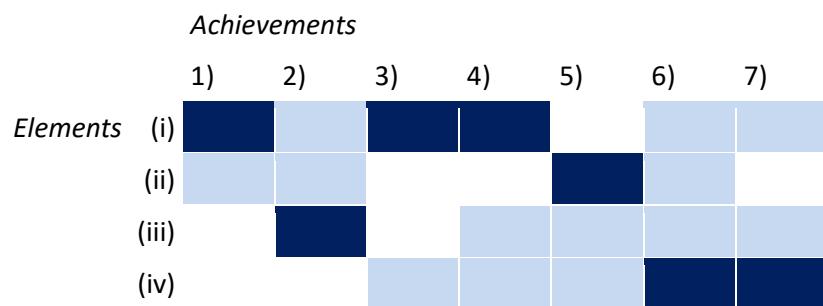


Figure 1 Matrix display of essential elements and achievements of UNI-SET
(dark blue = primary link; light blue = secondary links)

Element (i) linked strongly to achievement 1, 3, 4, and 5 in which universities were strongly involved. Element (ii) related mainly to the achievements 1, 2, 5 and 6 as it relates to the openness of the platform and the opportunity for new entrants. Element (iii) on synergies among actors was clearly represented in the activities leading to achievements 2, 5 and 7 because they involved substantial collaboration between universities and other actors such as companies. Lastly, element (iv) was reflected in many of the activities resulting in achievement 3, 4, 5, 6 and 7 because they either represent activities which will be continued after the end of the UNI-SET project or they were activities defining the way for the university platform to continue operations after the end of the Coordination and Support Action. Overall, elements could link to different activities and achievements not specifically mentioned.

Please note that the main achievements are ordered according to the main “essential elements” they relate to. I.e. Achievements 1, 3, and 4 are listed first (element i). They are followed by achievement 5 (element ii) and achievement 2 (element iii). Lastly described are achievements 6 and 7 (element iv).

The main project activities, findings and achievements are described below. The impact of these activities on the realisation of the main elements, and specifically the generation of a sustainable and open platform for universities to contribute to the SET-Plan and Energy Union Process are reported under the heading “Potential impact and exploitation of results”.

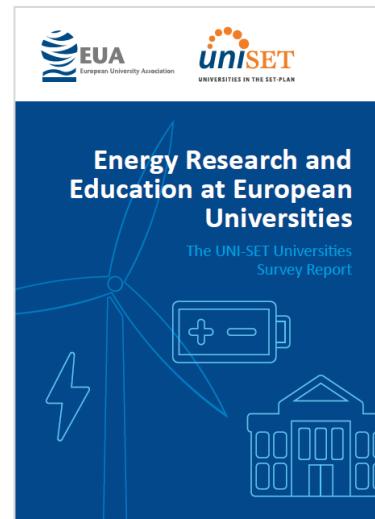
Achievement 1) Mapping and analysis of university activities in energy

The UNI-SET Universities Survey was conducted to gather information about energy research and education programmes at Europe's universities. It sought to identify and collect data on university research and education programmes at master and doctorate level in all areas of knowledge related to energy as a first step towards mobilising universities under the SET-Plan, thereby supporting element (i) of the project. It surveyed programmes covering the entire spectrum of academic fields, from 'hard sciences' to social sciences, arts and humanities as these graduates and researchers can help Europe move towards a low-carbon society using the skills acquired through their studies, research and other university activities. The main results of the survey are available in the report "Energy Research and Education at European Universities: The UNI-SET Universities Survey Report" (see link below).

Data collection and methodology

The questionnaire intended to collect data and insights to identify multidisciplinary educational and research needs and opportunities and to develop recommendations for European energy research, innovation and higher education policy. The final questionnaire was structured into four main sections.

- **Part 1** contained information about the university itself, e.g. the size of the student body, staff numbers, network membership, funding levels and, importantly, questions regarding specific energy initiatives that are of (strategic) relevance to the university.
- **Part 2** asked questions about master programmes, e.g. student population, cooperation with other organisations, Fields of Education and Training, SET-Plan areas and whether they are dual/joint degrees.
- **Part 3** addressed Research Topics and Doctoral Programmes, specifically, and analogous to Part 2, inquired about research staffing and collaboration with other organisations.
- **Part 4** identified development stage activities at participating universities through questions about the type and stage of the activities.



The survey was carried out in recurring phases. So far, four survey waves have been conducted since the April 2015 launch. At the time of writing this report in February 2018, 231 universities had signed up to the survey. All results in this report are based on the input received before the end of the 2nd wave, i.e. before 15th December 2015.

From the full or partial responses received from 202 universities before December 2015, 864 individual research topics, including 451 with associated doctoral programmes, were identified. In total, these topics represent 9,833.28 full-time equivalent (FTE) research staff and 6,286.57 doctoral candidates (FTE). The survey also identified 579 master programmes with a total of 36,903 master-level students.

One of the survey's main objectives was to identify the scope of university activities in priority areas of the SET-Plan in order to meet the objective of mobilising universities under the SET-Plan. Each master programme and research topic was therefore assigned up to five different SET-Plan areas.

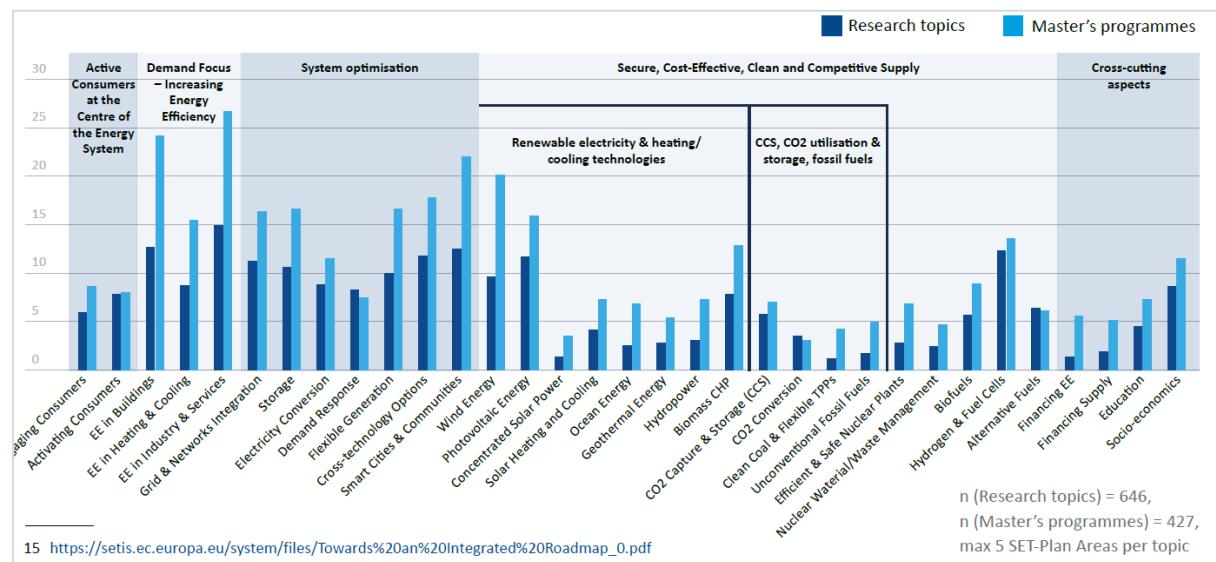
The classification was based on the categorisation used in European Commission document *Towards an Integrated Roadmap: Research and Innovation Challenges and Needs of the EU Energy System* (https://setis.ec.europa.eu/system/files/Towards%20an%20Integrated%20Roadmap_0.pdf). The SET-Plan areas were selected as they provide a comprehensive classification of research activities in the field of sustainable energy. Two further classification systems were used in the survey to be able to

accommodate any programmes that did not fit into SET-Plan areas (for example, some universities reported activities relating to the oil and gas sector).

Findings

The findings of 646 research topics and 427 master programmes demonstrated that universities are active in a broad range of areas. Strong activities could be found in the broader areas of energy efficiency (in buildings, heating and cooling, industry and services) and system optimisation (network integration, storage, demand response, storage, flexible generation, smart cities and communities). Individual programmes can be counted multiple times under several SET-Plan Areas. More than 10% of research topics and master programmes address these areas. In renewable energy technologies, high activity was reported in the fields of wind energy, photovoltaic energy and biomass combined heat and power: between 7 and 12% of research topics include aspects of these technologies. Other areas, with smaller research communities are CSP, solar heating and cooling, ocean energy, geothermal and hydropower, with around 1 to 4% of topics addressing these issues. CCS and CCU research is roughly on a similar level – around 5% of research topics covering it. Higher research activity was again reported in the fields of biofuels, hydrogen and fuel cells and alternative fields (between 5 and 12% of research topics).

Broadly similar patterns are visible for research topics and master programmes in all SET-Plan areas. Master programmes show higher percentages in most fields. The average number of SET-Plan areas in a master programme is 3.5, while the average SET-Plan areas per research topic is 2.9. This could reflect master programmes' broader orientation than research topics.



In some areas (e.g. under *Active Consumers*, *Electricity Conversion*, *Hydrogen and Fuel Cells*, and others), there are little to no gaps between the percentages achieved by research topics and master programmes. This pattern is only reversed in *Alternative Fuels*, *Demand Response* and *CO2 Conversion*, where slightly higher research activity is reported.

Overall, the percentages range from 20-25% in energy efficiency-related fields to less than 5% in areas such as *Concentrated Solar Power*, *CO2 Conversion* or *Clean Coal*. Research into the financial aspects of clean energy technology is only present in 1-2% of research topics.

One of the goals of this mapping was to identify the level of multidisciplinarity of master programmes and research activities. In order to allow for a basic typology of multidisciplinarity, a question about "broad fields of knowledge" was introduced. It was included, slightly tailored, for each master programme and research topic.

The findings highlighted that both master programmes (70%) and research topics (75%) were highly concentrated on *science, technology engineering and mathematics* (STEM) fields. *Economics, social sciences and humanities* areas accounted for the second-highest monodisciplinary area at 6% of each programme type. Multidisciplinary studies were most prevalent in the combination of STEM and ESSH with 18% of master programmes and 12% of research topics combining both fields. Activities consisting of or being conducted in combination with LSMH had only a marginal presence in this sample. Master programmes or research topics combining all three broad fields of knowledge represented 3% of both samples.

Master programmes appeared to be more multidisciplinary, displaying higher numbers of cross-disciplinary activities than research topics. This may reflect a trend of educational programmes covering broader areas than research activities.

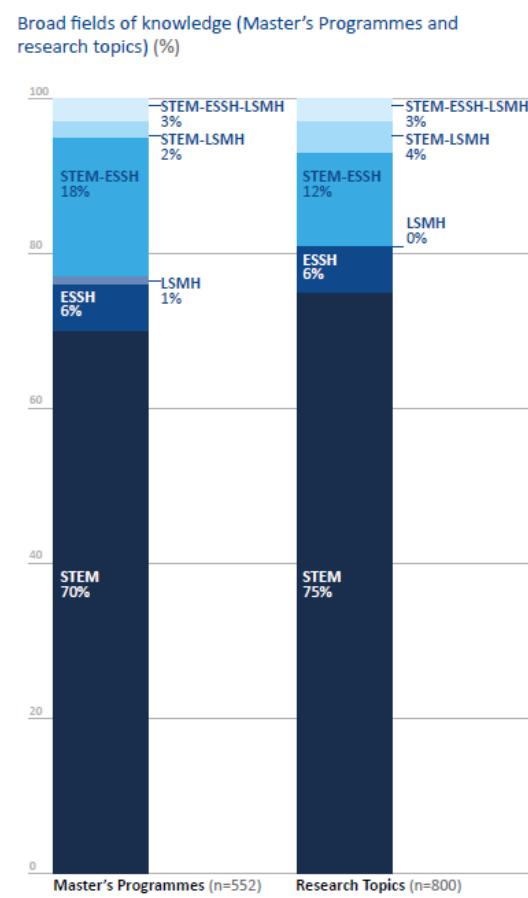
Overall, the UNI-SET Universities Survey charted a thriving landscape of research activities and educational programmes in Europe. Universities are active in all areas of the SET-Plan and therefore contribute to a wide range of clean energy solutions and technologies. They contribute to advancing knowledge and teaching students and professionals to tackle the energy challenge.

Yet, the data also shows that multidisciplinary research spanning different fields of knowledge, is still more of an exception than the rule. Energy research and education is rooted in STEM disciplines and other areas such as SSH or LSMH are only a marginal part of the research topics and master programmes surveyed. Given the socio-technical nature of energy transition, universities and stakeholders need to work more closely together to make multidisciplinary research and education more attractive and more visible. Other dimensions, such as the connection between digitisation and energy transition opportunities could also warrant stronger action given its political prominence.

Analysing the data collected on student bodies and master programmes revealed other notable findings. Almost a quarter of students are international students, meaning that they study abroad or enter a full degree programme in another country. English is widely used in teaching, preparing students for European and international positions and cooperation. The gender ratio shows that, on average, thirty percent of students are women.

More than 6,000 doctoral candidates are involved in the research topics covered by the survey, likely the tip of the iceberg of a larger number of young researchers working on energy-related research questions. Research topics were also found to be more productive where doctoral candidates are involved. The main university output found by the survey was still scientific publications – both peer-reviewed and others. The survey also showed that new, structured approaches to doctoral education are widespread in the field of energy.

The data further highlighted that University-Business Cooperation is common in the field of energy. Both master programmes and research topics are strongly connected to industry partners or other



government and social institutions. This shows the need for instruments that support collaborative research and education throughout Europe.

The universities charted by the survey also emphasise the importance of energy research for their institutional strategies. They embrace the societal challenge of energy and use their own means and resources to provide answers and offer learning opportunities to train the next generation of researchers and professionals for the energy sector. This is reflected in the expectation that energy-related research budgets at institutional level will rise. European public funding, such as that awarded through the Framework Programmes for Research and Innovation, is seen as a major source of research financing, alongside national funding. Although it varies per country, this also demonstrates the need for European programmes that support universities conductin excellent, multidisciplinary or interdisciplinary research and education together with other European partners. Participation in the survey also entailed representation in the European Atlas of Universities in Energy Research & Education, also produced by UNI-SET (see Achievement 3).

“Energy Research and Education: The UNI-SET Universities Survey Report” is available for download at <http://bit.ly/EREEUg>

MAIN OUTCOMES AND USE: The UNI-SET Universities Survey provided a unique collection of data about the state of energy research and education at more than 130 European universities. The Survey demonstrated university activity in all SET-Plan priority areas and the expectation of universities that research and education in energy-related topic will continue to thrive in the future, also thanks to European funding sources. This also demonstrates the need for European programmes that support universities conductin excellent, multidisciplinary or interdisciplinary research and education together with other European partners.

Achievement 3) A European atlas of universities in energy

A major UNI-SET goal was to not just collect and analyse university activities, but also to make information about them available for everyone to use. The project therefore created the *European Atlas of Universities in Energy Research and Education* as a resource for the public to search and identify master programmes and opportunities for doctoral training and research activities at participating universities.

Higher education institutions, policy makers, industry and other stakeholders can use this information to pool capacities and build new multidisciplinary and inter-European networks and cooperation. Specifically, the Atlas allows potential master students and doctoral candidates to find educational and research programmes that are relevant to their professional and research interests.

These maps can help energy companies or employers identify research and education opportunities for the continuing education and training of staff, and to identify potential opportunities to offer students relevant work placements, as well as to identify partners engaged in joint R&D projects with universities across Europe.



The findings and data of the UNI-SET Universities Survey are valuable to develop indicators for the Energy Union progress and the monitoring of the SET-Plan. After UNI-SET, EUA will therefore continue the cooperation with external partners such as the European Commission's Joint Research Centre (JRC), especially on the development and use of progress indicators for the Energy Union monitoring, and Directorate-General Research and Innovation (DG RTD).

The atlas can also support the identification of regional clusters and research and education hubs in specific fields of energy technologies.

At the time of writing this report in February 2018, more than 130 universities from over 30 countries agreed to make their data publicly available. After UNI-SET, EUA assumed responsibility for the *European Atlas of Universities in Energy Research and Education* and will maintain it for the future under the activities of the EUA Energy and Environment Platform. EUA will continue to promote the Survey and the Atlas to relevant audiences online and at relevant events. Universities and other higher education institutions will be able to add or update information to create a more complete picture of the energy research and education landscape.

For this purpose, EUA is currently scoping the feasibility of a new survey wave in 2018/2019 to update existing information about master programmes and research topics. This would allow a longitudinal perspective on the energy research and education activities of universities and offer insights into the evolution of these activities. More dimensions, such as online learning programmes or professional development opportunities could augment the already substantial information about master programmes and research activities. The atlas therefore has the potential to monitor the impact of certain activities and policies on university based research and education in the field of energy.

The Atlas is available at <http://atlas.uni-set.eu> and <http://energy.eua.be>.

MAIN OUTCOMES AND USE: The European Atlas of Universities in Energy Research & Education is a main output of UNI-SET and allows universities, employers, prospective students and others to find energy-related master' programmes and research topics in 30 European countries. EUA is currently scoping the feasibility of a new survey wave in 2018/2019 to update existing information about master programmes and research topics. This would allow a longitudinal perspective on the energy and the inclusion of new types of programmes, such as for example short-courses, bachelor's

programmes and others, making the Atlas an even more useful repository of energy-related learning opportunities in Europe.

Achievement 4) Scientific policy input from the university perspective

Part of the main objectives of UNI-SET as a Coordination and Support Action was to provide input to energy-related processes at European level. A specific need to generate input emerged with the SET-Plan consultation process in November 2015, which was not foreseen in the initial project proposal.

In brief, EUA-EPUE was involved in different fora in European energy R&I policy, worked closely together with different stakeholders, networks and linked with other projects to disseminate university expertise and UNI-SET findings and establish positive synergies with other organisations. EUA-EPUE coordinated this input through the UNI-SET activities and the network of experts created through UNI-SET.

Policy activities in this period included active participation in the SET-Plan process in different dimensions (e.g. Input Papers, participation in Working Groups, representation in events such as the annual SET-Plan conferences etc), regular exchanges and cooperation with the European Energy Research Alliance, different services of the European Commission, participation in the Governing Board of the European Technology and Innovation Platform Smart Networks for the Energy Transition (ETIP SNET) and other related activities.



SET-Plan Input Papers

The input to the SET-Plan process, which started in late 2015, continued throughout the entire Period 2 of UNI-SET. UNI-SET has coordinated scientific input of university experts to all consultations about targets and priorities of the Key Actions of the SET-Plan. More than fifteen Input Papers were written and submitted as highlighted in Table 9. In total, 50 experts from 29 countries participated in these activities and contributed to the positions and working groups. The contributing experts were nominated by the UNI-SET Steering Committee or identified through the Energy Clustering Events and worked together in topical groups mirroring the SET-Plan Key Actions. The full list of input papers is provided below:

Key Actions 1 and 2

- Photovoltaics (November 2015)
- Solar Thermal Electricity (November 2015)
- Offshore Wind (November 2015)
- Deep Geothermal Energy (June 2016)
- Ocean Energy (June 2016)

Key Action 3 and 4

- Energy systems (August 2016)
- Smart Cities and Communities (August 2016)
- Smart Solutions for Energy Consumers (August 2016)

Key Action 5

- Energy Efficiency in Buildings (February 2016)
- Heating and Cooling for Buildings (including Heat Pumps) (November 2016, revised September 2016)

Key Action 6

- Energy Efficiency in Industry (February 2016)

Key Action 7

- Batteries/e-mobility (May 2016)

Key Action 8

- Renewable fuels (May 2016)
- Bioenergy and renewable fuels (November 2016)

Key Action 9

- Carbon Capture Storage and Use (April 2016)

Key Action 10

- Nuclear safety (April 2016)

All input papers are available for download at <http://energy.eua.eu/reports-publications.html>.

****Participation in SET-Plan Temporary Working Groups****

Following the submission of the 15 Input Papers, UNI-SET also coordinated scientific and knowledge-base input of university experts to the Temporary Working Groups (TWG) which work on the SET-Plan Implementation Plans. This concerned six different TWGs starting in May 2017. UNI-SET took responsibility for three proposed 'Activity Fiches' in three TWGs as of the writing of this report.

- The TWG "Energy efficiency in industry" had nine meetings so far and UNI-SET is leading the Activity Fiche "Improving exchange of technological, economic, behavioural and social knowledge; training, capacity building and dissemination".
- The TWG "Batteries for e-mobility and stationary storage" had three meeting so far, with UNI-SET taking charge of the Activity Fiche "Improving exchange of technological, economic, behavioural and social knowledge; training, capacity building and dissemination".
- The TWG "Smart Cities & Communities" has similarly had three meetings so far. UNI-SET was leading the Activity Fiche "Capacity building and education - trainings and curricula that build future knowledge base".
- UNI-SET representatives are also participating in the TWG "Energy efficiency in Buildings" (three meetings), the TWG "Energy consumers" (three meetings) and the TWG "Bioenergy and renewable fuels" (two meetings).

More information about the SET-Plan Temporary Working Groups is available online at <https://setis.ec.europa.eu/towards-an-integrated-SET-Plan>. The work of the Temporary Working Groups is an ongoing process and the UNI-SET network is still active in providing policy input.

****Other policy-related activities****

UNI-SET maintained a range of other activities aiming at the transmission of university input to policy process at European level. UNI-SET representatives participate in all SET-Plan conferences during the project duration, using them as an opportunity to engage in discussions with other stakeholders about the role of universities in the SET-Plan. In Rome 2014, UNI-SET representatives presented the project and its objectives and activities to the stakeholder community. In Luxembourg 2015, the first insights from the UNI-SET Universities Survey were published. At the 2016 SET-Plan Conference in Bratislava, UNI-SET Steering Committee Chair Prof. Torbjørn Digernes released the 'Roadmap for European Universities in Energy' (see Achievement 6).



Finally, at the 2017 SET-Plan Conference, again in Bratislava, Lidia Borrell-Damian, EUA Director for Research and Innovation and EUA Project Coordinator, presented the ‘Action Agenda’ (full title “Energy Transition and the Future of Energy Research, Innovation and Education: An Action Agenda for European Universities”) and its relation with other SET-Plan stakeholder (for a description of the ‘Action Agenda’ see achievement 7).

In addition, UNI-SET had steady contact with the European Commission, in particular the Directorate-General for Research and Innovation, the Directorate-General for Energy and the Joint Research Centre. This allowed the project consortium to update European Commission services about different aspects of the project and the progress of project activities. Representatives of the different European Commission services also attended the Energy Clustering Events as speakers and panellists to provide participants with direct information about recent political developments.

With the formation of the European Technology and Innovation Platform Smart Networks for the Energy Transition (ETIP SNET) in 2016, UNI-SET was invited to nominate a member for the platform’s Governing Board representing the academic community. Since then, UNI-SET representatives have participated in the Governing Board meetings giving a university perspective on the activities of ETIP SNET.

In sum, UNI-SET provided different kinds of input to political process in energy research and education. The many input papers for the SET-Plan informed the respective target agreements and can be used to further develop the SET-Plan Implementation plans in this area, as well as other measures in the same field (e.g. R&I actions and programmes) by European institutions and members states. They represent a main foreground of the project with possible future use in the SET-Plan and future Framework Programmes for Research and Innovation, as well as national initiatives. Overarching political messages are listed under point 5 “Recommendations for energy research and education policy” under in the section “potential impact and exploitation of results.”

MAIN OUTCOMES AND USE: UNI-SET has contributed extensively to the SET-Plan process, coordinating 15 Input Papers and providing science-based input in six Temporary Working Groups of the SET-Plan. The many input papers informed the respective Declarations of Intent and can be used to further develop the SET-Plan Implementation plans in this area, as well as other measures in related areas (e.g. R&I actions and programmes) by European institutions and members states.

Achievement 5) Higher awareness and creation of critical mass among universities

Bringing together the university around the SET-Plan objectives and mobilising them to contribute in different ways was a main objective of UNI-SET.

The major vehicle to create a community and critical mass of university leaders with knowledge of and interest in the SET-Plan were the six UNI-SET Energy Clustering Events (ECEs) between 2016 and 2017. The objectives pursued in the framework of the ECEs are reported below:

- The ECEs sought to foster exchange and collaboration between European universities and between universities and other energy stakeholders.
- The ECEs explored how universities can enhance their contribution to the EU energy policy development, framed by the European Strategic Energy Technology Plan (SET-Plan) and the European Energy Union.
- The ECEs produced a Roadmap for European Universities in Energy, validated by a large number of participants and their contributions during the conferences.

Following the plan in the description of work, the ECEs specifically sought to facilitate the “development of university-based clusters of excellence based on areas of core competence in research and education and training”, with the objective of offering insights into innovative programmes and approaches from a multidisciplinary perspective through examples and good practices. Therefore, they were organised along SET-Plan priorities where feasible (see below).

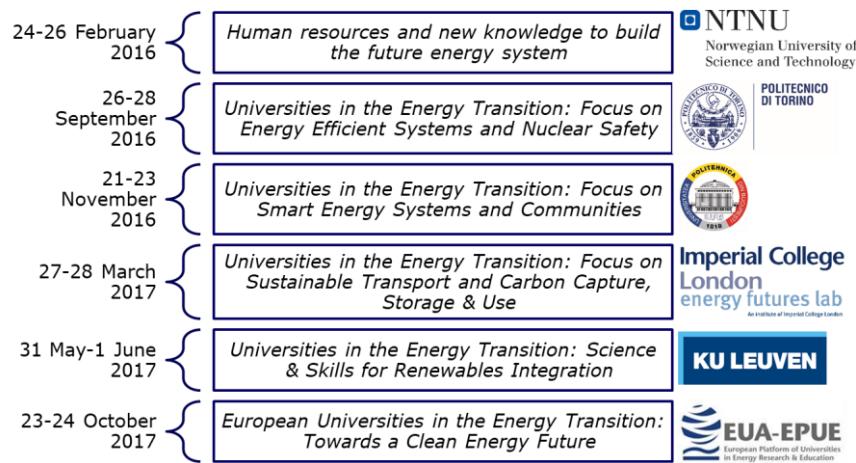


They served as a platform for networking and exchange of views with a forward-look towards the future energy society and the need to better prepare the next generation of Master and Doctorate graduates. Specifically, the events were targeted to an audience of university leaders in the field of energy (e.g. rectors and vice-rectors, deans, heads of institutional energy initiatives), with an interest in innovative approaches for energy research and education. The ECEs sought to bring together institutional and research leaders from universities to discuss the strategic role of universities in meeting the objectives of a sustainable and low-carbon European society.

By following these objectives, the Energy Clustering Events were pivotal to realise different ‘essential elements’ of the project. For instance, they provided a platform for mobilisation of universities along the SET-Plan priorities (element (i)), they were opportunities for new entrants to engage with the open platform created through UNI-SET (element (ii)), they facilitated the generation of synergies through involvement of industrial or societal actors and other networks area in energy research and education (element (iii)), and finally they are one of the activities which will be continued through the EUA Energy and Environment Platform (EUA-EPUE) after the project ends (element (iv)).

UNI-SET also aimed to include representatives from other stakeholders such as companies or EU-level initiatives and networks in the events. Based on the strong link with EERA, representatives of relevant EERA Joint Programmes were invited. InnoEnergy as an entity were co-organisers of all events and participated actively in the identification and acquisition of panellists and keynote speakers. European Commission speakers, for example from DG RTD and DG Energy, participated in each event, too.

Four of the six ECEs were programmed according to the SET-Plan Priorities and Key Actions, while the first and last event sought to initiative and finalise the project activities with a broader perspective than the closely defined SET-Plan topics. The first event in Trondheim, hosted by the Norwegian University of Science and Technology (NTNU), was therefore followed by four topical conferences addressing SET-Plan and Energy Union priorities. The sixth event was implemented as a final project conference in Brussels – aiming at disseminating the project outcomes and follow-up activities to the European stakeholder and policy environment in Brussels.



- The first event was organised at the Norwegian University of Science and Technology (NTNU) in Trondheim (NO) on 24-26 February 2016. The topic of the conference was “[Human resources and new knowledge to build the future energy system](#)”.
- The second conference was hosted by Politecnico di Torino in Turin (IT) on 26-28 September 2016. Its title was “[Universities in the Energy Transition: Focus on Energy Efficient Systems and Nuclear Safety](#)” and as such it was linked to the SET-Plan priorities on energy efficiency and nuclear technology.
- The third event, titled “[Universities in the Energy Transition: Focus on Smart Energy Systems and Communities](#)”, took place at University Politehnica of Bucharest in Bucharest (RO) on 21-23 November 2016. The topic was based on the SET-Plan priorities on energy systems and smart cities and communities.
- The fourth event was organised at Imperial College London in London (UK) on 27-28 March 2017. The programme was developed with the priorities sustainable transport and CCS/U in mind. It was titled “[Universities in the Energy Transition: Focus on Sustainable Transport and Carbon Capture, Storage & Use](#)”.
- The fifth conference – and the last one based on a specific SET-Plan priority – was hosted by KU Leuven in Leuven (BE) between 31 May and 2 June 2017. Entitled “[Universities in the Energy Transition: Science & Skills for Renewables Integration](#)”, its programme focussed on renewable technology and system integration.
- The sixth and final ECE was organised by EUA and hosted at the Flemish Parliament in Brussels (BE) on 23-24 October 2017. The topic was “[European Universities in the Energy Transition: Towards a Clean Energy Future](#)” and it served as a conference to disseminate project results to European policymakers and stakeholders, as well as the presentation of the ‘Action Agenda’.

In total, the conferences attracted 778 people (number of registered participants) over all six instances, averaging to 129,6 per event. In total, during the six events, 251 speakers presented their projects, organisations, institutional strategies, and keynote speeches on the energy transition or participated in panel discussions. The highest number of registrations was received for the sixth event in Brussels with 204 registered participants. Throughout the series of sex events, it was possible to increase the number of delegates coming from companies and stakeholder organisations, also thanks to increased efforts in acquiring non-academic speaker, allowing for inter-sectoral inputs and discussions at the events.

Even though each conference covered different thematic areas, a common thread was to include a number of cross-cutting topics in the event programming. Each event was organised in three well-defined types of sessions, all thematic conferences included a series of “parallel sessions” with the aim to share good practices in Multidisciplinary Research, Innovation and Education. The objective of these sessions was to present initiatives and projects based on an open call by the conference organisers as a means for good-practice learning. This was usually followed by so-called “clustering sessions”, which sought to support the development of new research ideas and cross-disciplinary perspectives on the different topics. They aimed at interdisciplinary and intersectoral discussions about the topic at hand. Finally, participants gathered in “outlook sessions” with the objective to identify trends in university-based energy research and education with relevance for society. They sought also to detect emerging challenges and trends in research and propose recommendations for policy makers.



Another aspect of the programming throughout the series of events was the interactive character of the conferences. Each time, rapporteurs from the different parallel sessions reported back to the plenary the topics and outcomes of the various discussions, which helped create a common understanding and joint ownership of the conference discussions and outcomes. All reports, in the form of PowerPoint slides, have been made available on the respective conference websites. The reports and issues raised by participants in the form of challenges and opportunities for university activities in the field of energy, as well as messages to policy makers, constitute part of the foreground generated by the project with potential for future use.

In sum, the Energy Clustering Events have resulted in different types of results:

- The collection of inputs through the reporting informed the ‘Roadmap’, the ‘Action Agenda’ and the SET-Plan Input Papers developed by UNI-SET. Therefore the Energy Clustering Events were crucial to generate the results and foreground of the project.
- By convening more than 770 participants throughout Europe – at events spanning over five different countries – the Energy Clustering Events have raised awareness of the SET-Plan process among the European university community.

- By including policy makers, chiefly representing the European Commission, in the different Energy Clustering Events, they served as vehicles to inform European policy with input from the university sector.
- By offering opportunities for informal and formal networking between participants, the Energy Clustering Events contributed to the generation of new connections and networks among the university community, with the potential to spur new research and education initiatives.
- The Energy Clustering Events have been established as a brand recognised by universities, stakeholders and partners. EUA therefore intends the continuation of the series of Energy Clustering Events to further mobilise the university community under a common and recognised framework.
- The discussions and messages from the six Energy Clustering Events form the background of the objectives and actions presented in the 'Roadmap for European Universities in Energy'. Similarly, the four topical events resulted in the 'Action Agenda' developed by the UNI-SET consortium. The issues raised during the conferences were part of the material that influenced the contents and recommendations of the 'Action Agenda'. Concepts and ideas for the 'Action Agenda' were actively discussed and validated at the Energy Clustering Events.
- In general, the Energy Clustering Events created a community and critical mass of academics and universities ready to move on through joint projects and policy work, for example using European programmes such as Horizon 2020, Erasmus+ or the future Framework Programme for Research and Innovation, together with other networks and partners.

MAIN OUTCOMES AND USE: The Energy Clustering Events were a series of unique events addressing energy-related education and research challenges along the SET-Plan priorities, convening more than 750 people and 251 speakers over all six instances. Throughout the series of events, UNI-SET could increase industry participation, reinforcing the intersectoral approach of the conferences. After six events, the Energy Clustering Events have been established as a brand recognised by universities, stakeholders and partners, and created a community and critical mass of academics and universities ready to move on through joint projects and policy work.

Achievement 2) Analysis of energy-sector employers and future skills needs

In parallel with the UNI-SET Universities Survey, UNI-SET also aimed at bringing in the voice of employers within the energy sector. With the UNI-SET “Employers Survey”, employers such as companies, public organisations or research centres were given an opportunity to indicate which professional skills are needed for a successful long-term implementation of the European energy objectives within their organization.

The collection of data and insights through the UNI-SET Employers Survey and Professional Profile Identification Workshops supported the creation of synergies with industrial partners and informed the development of the ‘Action Agenda’ and the ‘Roadmap’ along the targets of essential element (iii).

The UNI-SET activities related to the identification of professional skills were coordinated by KU Leuven, representing five other third-party InnoEnergy universities. Each of the universities in the Third Party Consortium investigated a specific SET-Plan area throughout the project, as summarised below:

- **KU Leuven:** smart grids
- **UPC BarcelonaTech:** renewable energy technologies
- **Grenoble INP:** sustainable nuclear technologies
- **Royal Institute of Technology (KTH):** energy efficient buildings
- **Jagiellonian University:** clean coal technologies
- **Karlsruhe Institute of Technology (KIT):** energy from chemical fuels

Together with the UNI-SET University Survey, this action was part of the main deliverables which provided empirical evidence about the role of European universities in the development of new professional profiles for the energy sector.

The rationale behind including the employers’ perspective on emerging skills needs was the rapid pace of change in the energy system in Europe, which naturally impacts the spectrum of professional skills required in the energy sector. The high-paced evolution of renewable technologies requires a continuous upgrade of professional skills to understand the latest energy technologies and services and to be able to effectively implement them. Moreover, the need for better energy systems integration pushes businesses and organisations with different fields of expertise to collaborate and benefit from each other’s energy-related products and services. Europe’s ambition to realize the Energy Union also broadens the variety of stakeholders involved in this process, leading to even more opportunities for cross-linkage of professional activities within the energy field. The fact that more and more technologies are shifting towards the use of power electronics controlled by ICT, also affects the energy sector and is potentially creating new requirements in terms of technical skills for professionals in the energy sector.

In other words, change management and cross-disciplinary communication skills seem to become, in addition to core scientific and technical expertise, essential assets for organisations within the energy field. The question of how professional profiles within the energy sector required change within the organisations that are driving Europe’s energy transition is crucial for the sustainability of the current measures which aim at reducing greenhouse gas emissions and is important for the long-term competitiveness of Europe’s energy sector.

Data collection and methodology

The questionnaire for employers was semi-structured in order to minimize completion time for respondents and allow for a quantitative analysis of the responses.

- **Part 1** gathered information about the profile of the respondent, e.g. educational background, role within the organisation, familiarity with the SET-Plan, etc.
- **Part 2** requested general information about the organisation and/or the organisation’s department/unit working on energy-related topics, including current staff profiles, and the size and the type of the organization.

- **Part 3** collected information about the thematic SET-Plan activities in which the organisation is mainly active.
- **Part 4** identified the current and future educational background required for professionals in the energy field. For instance, information was asked about the required level of education, which course topics are relevant, how important academic performance is, etc.
- **Part 5** focused on identifying the currently required skills (technical and non-technical) and professional profiles of graduates needed in the energy field, as well as the future requirements.

The UNI-SET Employers Survey was developed by KU Leuven in cooperation with the other five universities in the Third Party Consortium. The design was related to the that of the UNI-SET Universities Survey to extract complementary findings and conclusions from both activities. In addition to the web-based survey, seven professional profile identification workshops were organized as complementary non-structured ‘focus groups’ of employers and were held with a qualitative approach. Different types of information were collected by the survey:

Findings

At the end of the project, 182 individual organisations or business units within organisations provided full or partial responses to the UNI-SET Employers Survey. The majority of organisations were active in the three broad areas of energy efficiency, consumer services, system optimisation, and renewable technologies. They were almost evenly distributed between companies, governmental bodies, education institutions (universities) and research organisations, as well as in size ranging from companies with less than ten employees to large organisations with more than 250 employees. In terms of SET-Plan activities, the majority was active in the area of system optimisation. Furthermore, the development of renewable energy and the demand focus, meaning increase of energy efficiency, are also common activities.

Staff in the majority of surveyed organisations had a higher education degree. A master degree was the most common one followed by the bachelor’s degree. Only in the field of System Optimisation a doctoral degree was more common than bachelor’s degree. Perhaps unsurprisingly, the majority of organisations reported to hire master graduates from the energy and electricity field of education, with no change expected for the future. Other fields, such as management and administration, mechanics or software development were important as well, but contingent on the broader SET-Plan area of the respective organisation. A similar pattern could be observed for doctorate holders.

Employers hiring preferences were found to be influenced by factors such as university ranking, relevance of education programmes, specialisation of applicants and multi-disciplinary experience of applicants. Individual factors with positive impact for graduates were grades and extracurricular activities. Participants in the area of System Optimisation agreed that for extracurricular activities, other engineering specialisations are most relevant. On the other hand, in the SET-Plan areas Active Consumer, Energy Efficiency and Renewable Energy a clear preference of Economics/ Finance as extracurricular education could be seen. Internship experience was also highly relevant for companies from the field System Optimisation. Industry involvement in master/doctoral thesis was preferred in the areas of Energy Efficiency and Renewable Energy, whereas for Active Consumer companies Professional experience over all was claimed to be most important. To conclude it can be said that practical knowledge on top of high quality technical knowledge was most relevant for companies in all SET-Plan areas.

The most relevant technical skills for the fields Active Consumer, Renewable Energy and System Optimisation were Electrical Engineering, Power Systems and Renewable Energy. For the fields Energy Efficiency, Active Consumer and System Optimisation it was also beneficial to have knowledge in Energy Management. Many other skills were dependent on each SET-Plan area. For the field Active Consumer, skills in Informatics and Energy Policy were gaining importance in the future, whereas for Energy Efficiency the Total Quality Management increased its relevance, for Renewable Energy

Informatics was gaining on importance and for System Optimisation it was also Informatics as well as Management and Information Technology.

Respondents were also asked about the most important engineering methods. In all SET-Plan areas Project Management was mentioned as an important method or even the most important. Companies in the fields Active Consumer, Energy Efficiency and System Optimisation agreed that Business Development and Analysing, Comparing and Evaluating processes are relevant methods.

Furthermore, skills in Innovation Management and Optimization of Processes were required in the fields of Active Consumer, Renewable Energy and System Optimisation. Additionally, companies in Energy Efficiency, Renewable Energy and System Optimization claimed that skills in Entrepreneurial/Economical Aspects are advantageous. In terms of soft skills, all SET-Plan areas ranked Teamwork among the five most important soft skills. Furthermore, in the areas of Active Consumer, Energy Efficiency and System Optimisation being organised was seen as highly important. Additionally, the fields Active Consumer, Renewable Energy and System Optimisation also estimated Innovation as relevant. Overall there was a broad variation between the SET-Plan areas in reference to soft skills.

Another notable result was that the overall majority of responding organisation held that bilingualism between Professional working proficiency and Full professional working proficiency was required with a tendency of most SET-Plan areas towards Full professional working proficiency. Only the field of Energy Efficiency tended rather towards Professional working proficiency.

To sum up, a master's degree was the most common higher education degree to employment in industry and the most important profile for all SET-Plan areas was a master in Electricity and Energy. Notable was that, in the future, knowledge in Informatics and Energy Policy will be needed in the field of Active Consumer, Total Quality Management will be needed in Energy Efficiency, Renewable Energy also will need Informatics, which was also required in System Optimisation plus Management and Information Technology. The most important methodological skill was seen in Project Management and Teamwork was one of the most relevant skills in all SET-Plan areas. Lastly, Practical Knowledge was regarded as highly important gain out of extracurricular activities but the activity itself in which it is obtained differs between the SET-Plan areas.



The overall results of the UNI-SET Employers Survey are similar despite differences in the fields. The results validated the outcomes of the seven professional profile identification workshops organised in 2015 and 2016. Interdisciplinary profiles, internship experience and student mobility are highly valued by employers. Master graduates are in high demand, while doctoral holders are sought after for more

specific roles and industries with specialist background or research management contents. Skills such as the ability to work in teams, entrepreneurial thinking and understanding of business processes were frequently mentioned in the workshops and throughout the survey.

The specifics of certain skills needs and preferred hiring profiles were contingent upon each role, industry sector and company. Nonetheless, to synthesise the survey and workshop findings in a few words, it can be stated that interdisciplinary learning experiences and the acquisition of practical skills, for example in project management and innovation methodologies, are useful for future graduates from higher education programmes. Sound, in-depth knowledge and understanding of the scientific principles underlying clean energy technologies, solutions, and policies are the foundation for the application of these skills. The findings of the UNI-SET Employers Survey and the Profile Identification Workshops fed directly into the development of the 'Action Agenda' and its recommendations for energy-related master' programmes. They can be directly translated into action by universities.

Activities related to the UNI-SET Employers Survey concluded in December 2017 and the publication of results is planned for Q1 2018.

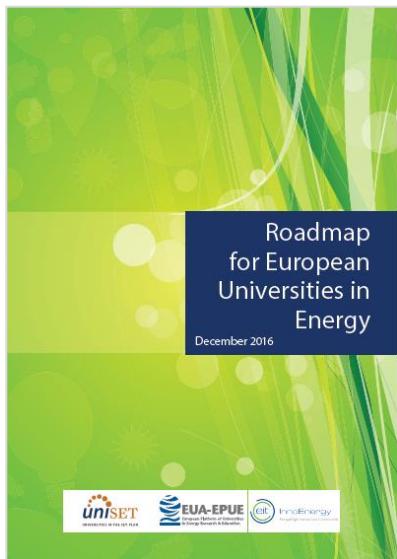
MAIN OUTCOMES AND USE: The UNI-SET Employers Survey was a first-of-a-kind study of employers' views on future skills needs in the energy sector, covering more than 180 organisations across Europe. The results highlight a need for more interdisciplinary education and training, including both technical aspects and socio-economic issues in the energy transition. Employers also highly value practical experience, project experience and entrepreneurship skills, depending on specific company and job profile. The findings of the UNI-SET Employers Survey and the Profile Identification Workshops fed directly into the development of the 'Action Agenda' and its recommendations for energy-related master programmes. They can be directly translated into action by universities.

Achievement 6) A long-term roadmap for enhanced future impact

In order to develop a long-term strategy and vision for the engagement of universities in the SET-Plan and Energy Union beyond the duration of the UNI-SET project, the consortium together with the Steering Committee agreed to develop a “Roadmap for European Universities in Energy”. Discussed at several Energy Clustering Events throughout the UNI-SET project, the ‘Roadmap’ was validated by more than 300 university participants who attended the conferences. The final version of the ‘roadmap’ was published in December 2016 and presented to the SET-Plan stakeholder community at the 2016 SET-Plan Conference in Bratislava on 1 December 2016 by Prof. Torbjorn Digernes, Chair of the UNI-SET Steering Committee.

The Roadmap developed the concept for an open platform where universities can share their knowledge and make their voices heard at the European level. It also outlined concrete actions to be implemented in the areas of research, education, collaboration and outreach. The Roadmap spells out objectives for the university community and provides a vision for a strategic agenda for universities and stakeholders in order to maximise their impact in the field of energy.

In relation to the sustainability of the university platform (element iv), the Roadmap represents the strategic agenda for EUA-EPUE to carry on the different threads of activities launched through the UNI-SET project. It clearly relates to the other main elements too – from mobilisation, to openness and the creation of synergies. It defines the range of possible activities and the role of EUA-EPUE as the vehicle to implement them, where feasible in partnership with other organisations or through external funding. The roadmap therefore provides the direction for the continuation of the activities of the UNI-SET CSA through EUA-EPUE.



A vision for universities in energy

The Roadmap defines a specific vision for the university community to work towards. It states that universities envisage an energy research, innovation and education system that is integrated, mutually reinforcing and embedded in a political framework that facilitates the uptake of innovative solutions for the energy challenge. In the vision, the grand societal “energy challenge” is addressed as a global issue, and activities aim at moving towards a low-carbon or even a “negative-carbon” society. In the vision, university-based research contributes even stronger to the development of a sustainable and affordable energy system for the benefit of all European citizens. Mutually beneficial cooperation between stakeholders is encouraged and brings innovative technologies and nontechnological innovations more swiftly to the market and to society.

The Roadmap’s vision further explains that multidisciplinary approaches in research and education should support the integration of all dimensions of the energy system, technological and non-technological. Basic and applied research and innovation need to enjoy sustained funding support and the integration of research and education are the norm. Universities should take measures to increase the impact of research and education and expand their outreach activities. University researchers contribute as key providers of in-depth knowledge and understanding for policy development and science-based decision making. Universities inform and engage with local communities, stakeholders and civil society at large.”

Actions for the university community

The Roadmap further continues by explaining that EUA-EPUE seeks to contribute to the achievement of this vision in the next six years (i.e. until approximately 2022) by providing the platform where universities can share their knowledge and make their voice heard at the European level and to support

universities in their outreach to society. The major goals of the platform for the next years include the following specific objectives:

1. Foster structured dialogue with other university networks and other stakeholder networks of the SET-Plan and the Energy Union.
2. Coordinate input from the university sector in energy policy development at the EU level (European Parliament, European Commission), including: SET-Plan, Framework Programme, Structural Funds, other EU programmes, infrastructures, and other policy instruments.
3. Provide support for up-to-date, high-quality higher education programmes, skills upgrading and life-long learning activities fit for an evolving energy sector.
4. Support and facilitate
 - 4.1. the creation of flexible university structures for multi-disciplinary and collaborative research and education in the field of energy, in particular for the support of energy system integration and other technologies enabling the energy system transformation;
 - 4.2. the adoption of policies in the digital area that facilitate the sharing and dissemination of knowledge (e.g. copyright exceptions for teaching materials and research outcomes; open access to research publications; text and data mining);
 - 4.3. the creation of partnerships between universities, university networks, and between universities and other research and innovation organisations.
5. Promote
 - 5.1. long-term support for fundamental research, including use-inspired basic research, for next-generation and breakthrough knowledge to decarbonise the economy and society;
 - 5.2. sustained support for the training of researchers and professionals to understand the systemic challenges of energy generation, transmission, distribution, conversion and consumption and the impact on nature and climate change;
 - 5.3. excellent, research-based innovation to create the technological solutions for the realisation of the Energy Union;
 - 5.4. multidisciplinary education and research (science engineering and technology; bio and life sciences; economics social sciences and humanities) for the benefit of society.
6. Encourage universities to engage in their social environment, at different levels from local to national and international.
7. Create an international forum of dialogue to unite efforts with other universities and university associations in the world, for example in the context of the Paris Agreement and “Mission Innovation”.

In sum, the Roadmap directs a range of UNI-SET follow-up activities to be implemented by EUA beyond the project duration. The support it received during the Energy Clustering Events also demonstrates the support and commitment of the wider university community to work towards the vision embodied in the Roadmap.

The Roadmap for European Universities in Energy is available for download at <http://bit.ly/2IKL4Jw>

MAIN OUTCOMES AND USE: The ‘Roadmap for European Universities in Energy’ produced by UNI-SET represents a strategic approach to university engagement and activity in energy research and education, validated and supported by the UNI-SET consortium partners and the EUA Energy and Environment Platform. It points out a range of UNI-SET follow-up activities to be implemented by EUA beyond the project duration and demonstrates the support and commitment of the wider university community to work towards the vision embodied in the Roadmap and the UNI-SET project.

Achievement 7) New ideas on innovation in energy education through the ‘Action Agenda’

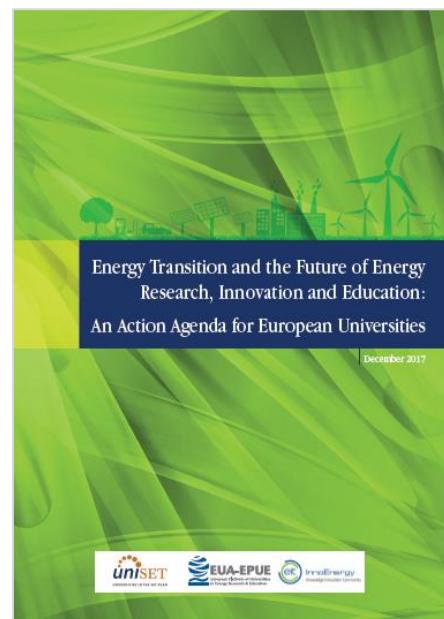
The ‘Action Agenda’ – with the full title being “Energy Transition and the Future of Energy Research, Innovation and Education: An Action Agenda for European Universities” – responded to a bottom-up demand for a European approach from the many university leaders and research experts engaged in the project who are committed to realising the energy transition and who seek to integrate this goal fully within their education and research programmes. As the work of the UNI-SET project progressed, the Steering Committee recognised that a framework was emerging that could be highly-effective in the implementation of the *‘Roadmap for European Universities in Energy’*, in particular the intended action supporting the take up of interdisciplinary and innovative learning and teaching methods.

The ‘Action Agenda’ spells out the UNI-SET project’s ideas for mobilisation of universities and cooperation with other stakeholders in a tangible framework that can be used by the project partners but also other interested parties. The framework in written form ensures the sustainability of the ideas generated through UNI-SET and their future use, therefore it enables the future uptake of the UNI-SET knowledge. As a tangible output it can be disseminated and updated in the future. The writing of the ‘Action Agenda’ was a conscious step to ‘codify’ UNI-SET expertise to contribute to main element (iv). Initial feedback received from universities after the publication of the document points to a positive impact, in particular through the level of detail provided by the framework of the ‘Action Agenda’ encompassing social, technical, economic and political ‘building blocks’ for energy-related educational programmes.

The Action Agenda, therefore, puts forth the ideas developed through UNI-SET for the design and delivery of energy-related programmes across all disciplines in Europe. It also provides a new approach and framework for structuring new energy-related programmes along technical, political, economic and societal contents and challenges. It covers a set of thematic areas for action (general aspects, energy efficiency, systems integration, renewables integration) while highlighting the multi- and cross-disciplinary nature of the energy challenge. One of the key aims is to define an approach that helps universities address the energy challenge by improving education in general. The framework is also flexible and allows for further use in other energy-related fields (such as energy storage, e-mobility, smart cities) and related areas with highly interdisciplinary aspects (e.g. climate change, digitalisation or health).

The Action Agenda primarily addresses universities that are responsible for developing, establishing, managing, operating, and delivering energy-related education and training programmes at the master and doctoral level. However, it can be used by all parties interested in energy education, including those with political and policy perspectives. There is a clear need for greater interaction between universities and other energy stakeholders including European and national policy makers, industry and society in order to overcome some of the challenges. These new collaborations should span existing disciplinary boundaries and transcend national borders. The framework defined in the Action Agenda allows thus universities and their partners to exploit synergies as expected by main element (iii) of the UNI-SET concept.

The Action Agenda was designed to articulate a new paradigm for energy education, training and research, to create and adapt university master and doctoral programmes and life-long learning programmes, using new knowledge generated by research. Based on this foundation, future work can also address the renewal of bachelor’s degree programmes, as these feed into post-graduate



programmes and will need to change accordingly. In order to achieve the SET Plan ambitions, the key objective is to develop new scientific and technical expertise and skills in the sciences, anthropology, sociology, psychology, economy, and law and regulations.

The integration of a broad range of social perspectives and technology challenges into university energy education and research programmes is therefore key. Such interdisciplinary work across engineering, social sciences, sciences and the humanities must be firmly embedded in university energy programmes. It requires all academic disciplines to recognise that energy-related perspectives backed by knowledge from all disciplines create added value and help achieve real progress and change. This inter-disciplinary approach must also span a range of technical areas. After all, a holistic approach needs to address all components of the future smart system with an understanding of the social and human interactions at play.

The UNI-SET project has already identified a number of examples of innovative, inter-disciplinary approaches. The Action Agenda builds on the success of these innovative programmes and puts forward further recommendations and an associated framework that will allow all universities to adopt and implement much-needed inter-disciplinary energy work and training.

Specialist knowledge and skills - the core of master' and doctoral programmes, must be supplemented, informed and enhanced by the development of a broad energy perspective. Including technical, social, policy, economic and legal aspects will allow university master and doctoral graduates to understand the wider context of their specialist work. It will also ensure that expertise is effectively focussed on developing solutions to energy challenges - the focus of the Energy Union.

The key need for energy specialisation enhanced by a broader perspective can, for instance, be illustrated by the integration of T-shaped skills profiles into programmes at several universities. The vertical bar of the T represents the depth of skills and expertise related to a specific field, while the horizontal bar represents a more general understanding of other disciplines, creating an ability to work with experts in other areas and apply knowledge in other areas of expertise. For future energy specialists, the horizontal T bar should include opportunities to learn about other technical areas as well as a range of social, economic, regulatory, human and political topics, to provide an understanding of whether and how different technical approaches will be adopted. Social science and humanities specialists (e.g. Market Economists, Lawyers, Political Scientists, Urban Planners) will need to know about a range of technical topics as part of their horizontal T bar. They will also need to learn about views across the social sciences.

In developing this framework, the editorial group which wrote the Action Agenda made extensive use of the different findings and foregrounds created by other UNI-SET activities. This included the results of the UNI-SET Universities Survey, the UNI-SET Employers Survey and the Professional Profile Identification Workshops. The editorial board and the authors of the report also consulted the outcomes of the Energy Clustering Events and discussed preliminary versions of the 'Action Agenda' at some of the events organised in the context of UNI-SET. In total, 37 authors contributed to the writing of the document and 60 external reviewers provided feedback and comments to it.

The Action Agenda is available for download at http://bit.ly/action_agenda

MAIN OUTCOMES AND USE: The 'Action Agenda' produced by UNI-SET represents a flexible framework for the further development of programmes, modules and courses offered by European universities. Universities can consult and expand the examples and create new programmes and project based on the suggestions provided in it. By itself, the framework employed in the Agenda can be scaled and adapted to other societal challenges and sectors with high needs for more interdisciplinary education and training.

Potential impact and exploitation of results

UNI-SET generated a broad range of different results and outputs with different character and potential for exploitation. As earlier described, the consortium developed a 'Roadmap' and 'Action Agenda' documents outlining future strategic developments for the community nurtured through UNI-SET. Reports and resources such as the Atlas will continue to be useful after the project's lifetime. This is in line with the goal of UNI-SET to develop an open platform for universities (main element (ii)) and a planning for sustainability of this platform (main element (iv)).

A pivotal role for the future exploitation will be reserved for the EUA Energy and Environment Platform (EUA-EPUE), which will lead the actions outlined in the Roadmap and Action Agenda and carry on different strands of activities that have started with UNI-SET. Also resulting from the positive experience of UNI-SET, EUA-EPUE has expanded its topical focus to explicitly include environmental matters. The evolution of EUA-EPUE through UNI-SET and the role as the main open platform to continue the activities and further the objectives of the project are described under Part 4 of this section.

The use and exploitation of UNI-SET results can broadly be divided in four main areas: 1) the use of UNI-SET outputs and the exploitation of them; 2) the exploitation and implementation of the Action Agenda by universities; 3) the realisation of strategic activities outlined in the Roadmap through EUA-EPUE; and 4) the consolidation of EUA-EPUE as the main platform in Europe working for and with universities engaged in energy research and education along the goals of the Energy Union and the SET-Plan. A final section 5) provides a series of policy recommendations and political messages about European initiatives for energy research and education, especially with a view on the development of the future Research Framework Programmes (FP9) and the successor of the Erasmus+ programme. These recommendations are built on the overall experience of the project through its surveys and events collecting ideas and suggestions from the university community on the role of European research and education policy in the field of energy.

1) Using UNI-SET outputs

UNI-SET has generated a set of concrete outputs in the form of tools, reports and networks with potential for future action in a variety of domains. The exploitation of these results and continuation of certain tasks will take place along the following lines:

- Promoting the European Atlas of Universities in Energy Research & Education and continuing the mapping of universities in energy: the Atlas was created with long-term use in mind. EUA will continue the operation of the Atlas and conduct additional survey waves which will A) increase the utility of the Atlas for the different user groups and B) allow longitudinal comparisons and follow-up studies of the UNI-SET Universities Survey. EUA will also further disseminate and communicate the Atlas to potential users. Additional categories, such as MOOCs, lifelong learning programmes, bachelor's programmes and others can be added to the Atlas. It can also be employed to measure the impact of European policies with regards to the role of universities in energy research and education, e.g. in the context of Energy Union and SET-Plan monitoring.
- Data and foreground generated by UNI-SET will continue to be relevant for policy input and positions. This concerns the data and findings generated by the UNI-SET Universities Survey, the UNI-SET Employers Survey and the respective Professional Profile Identification Workshops, as well as the outcomes of the Energy Clustering Events. The different types of information will be relevant especially for the future SET-Plan process but can also inform discussions about the future Framework Programmes for Research and Development and the

successor programme for Erasmus+. The dialogue with stakeholders and organisations active in the Energy Union process, such as the Joint Research Centre (JRC)'s role in monitoring the progress of the Energy Union, will likely be continued in the future. Further using the data and tools developed through UNI-SET will be a priority of EUA-EPU, which has already established contacts with the unit responsible for the monitoring of the Energy Union progress.

- The knowledge generated by through the 'Action Agenda' and the connections made by participants in events have the potential to spur development and upgrading of education and training programmes in all three cycles of higher education (bachelor, master and doctoral) as well as lifelong learning activities by universities. It supports innovative and inter-disciplinary education and training programmes using new learning and teaching tools. The 'Action Agenda' can moreover be expanded to other highly interdisciplinary and complex fields, for instance grand societal challenges such as climate change, environment, health and more. As such, it is a framework with many use cases throughout the higher education sector or other sectors which offer educational programmes, e.g. Lifelong learning and professional training providers other than universities.
- The community created through the different strands of activities of UNI-SET comprises a diverse group of people strongly committed to the advancement of education and research in the field of energy and to solving the energy and climate challenge. They are a resource for scientific and policy input which EUA plans to nurture and develop further. The objective is to continue and further improve the connection of knowledge and expertise represented in the university sector with EU policymaking, based on the experience of UNI-SET.

2) Putting the 'Roadmap' into action

The Roadmap for European Universities in Energy not only details a vision and objectives of the universities contributing to the UNI-SET project, it also lists concrete and equally important actions which follow the objectives of the UNI-SET project and represent the strategic planning of the community generated by UNI-SET. It provides the framework under which the open platform will continue to operate and generate synergies between universities and other stakeholders. The Roadmap, as a UNI-SET output, will be implemented by the EUA Energy and Environment Platform (EUA-EPU).

As mentioned under Achievement 4, the Roadmap represents the strategic agenda for EUA-EPU to carry on the different threads of activities launched through the UNI-SET project, thereby giving direction to element (iv). It clearly relates to the other main elements too – from mobilisation, to openness and the creation of synergies. It defines the range of possible activities and the role of EUA-EPU as the vehicle to implement them, where feasible in partnership with other organisations or through external funding.

The different types of activities are structured in three main areas, namely research and education, collaboration and outreach to society, building on the experience of UNI-SET.

2.1) Research and education

1. Map the education and research infrastructures in universities in the field of energy. This is to be added to the collection of maps in the European Atlas of Universities in Energy Research & Education. Update other maps in the Atlas, including those of Master, Research and Doctorate programmes which were generated by UNI-SET.
2. Build a repository of teaching and learning materials and other learning materials (e.g. data, lab simulations).
3. Consolidate the Energy Clustering Events as the European forum where university leaders from all over Europe discuss education, research energy programmes in relation to the needs of society. This ensures the continuation of the Energy Clustering Events beyond the lifetime of the project.

4. Establish a platform for high-level dialogue among universities and between universities and policy makers, as part of the university platform.
5. Issue guidelines on multidisciplinary approaches in higher education and research programmes (particularly in Master, Doctorate and Research Programmes). The publication of the 'Action Agenda' during UNI-SET already created a foundation for this task.
6. Issue statements on major trends and propose ways forward for the university sector, including trends in specific areas of energy. Again, the publication of the 'Action Agenda' during UNI-SET already created a foundation for this task.

2.2) Collaboration

7. Coordinate dialogue between university networks in research and education to maximise the opportunities to upgrade educational programmes. These would include, for example, dialogue with the European Energy Research Alliance (EERA), EIT InnoEnergy, Climate-KIC, and European Technology and Innovation Platforms (ETIPs) at Energy Clustering Events.
8. Foster university-business cooperation with the private sector to inform the development of new or updated curricula and educational contents on the development of an integrated and sustainable energy system and the deployment of renewable energy on a larger scale, through structured surveys and interviews.
9. Foster cooperation between organisations in different sectors through platforms of dialogue, including higher education institutions, research and technology organisations, industry and enterprises, and public authorities, to bring technological and non-technological innovation to the market and to society.
10. Develop an international agenda to unite efforts with other universities and university associations in the world.

2.3) Outreach to society

11. Increase interaction with society in order to encourage citizens to play a role in the future energy system (e.g. consumer, prosumer, supplier and system manager) and to shift to a low-carbon society. Informed, educated and critical citizens, a core mission of higher education in Europe, are key in achieving this.
12. Support the role of universities in their local, regional or national contexts in education, training and research.
13. Support the involvement of universities in solutions to energy challenges, such as in advising policy and industry or engaging with local communities and other stakeholders.

Realising the objectives and implementing concrete activities will require a collaborative effort by EUA-EPUE, member universities and partners and other stakeholders. Initial steps have already been made during UNI-SET and through the publication of the 'Action Agenda', which are part of the first phase of the Roadmap's implementation and seek to stimulate university action in the next years.

EUA-EPUE is committed to conduct these activities, where feasible, using its own resources and through collaborative projects with other stakeholders and partners, in order to maximise the impact of each measure for the fulfillment of SET-Plan and Energy Union. The partnership with EIT InnoEnergy has proven a successful collaboration and follow-up projects implementing some of the future actions outlined here will be prepared jointly by EUA-EPUE and EIT InnoEnergy, in particular in the area of innovating education through new learning and teaching methods, testing new delivery modes for education and training, and collaborative efforts with industry and societal partners.

3) Taking up the 'Action Agenda'

Successful implementation of actions to achieve the new approach to energy education, training and research set out in the 'Action Agenda' will require significant effort over an extended period. While the publication is primarily aimed at universities, other key energy stakeholders, such as policy makers, industry and civil society all share a responsibility of working together to achieve the anticipated outcomes.

The 'Action Agenda' is a usable framework how to create new education partners in synergy with other stakeholders in the spirit of main element (iii) of the project, i.e. to create and use synergies with non-university stakeholders. It also represents a means to support mobilising universities towards the research and education goals of the Energy Union and SET-Plan (main element (iv)).

Actions taken by universities will differ based on location, cooperation partners and available resources. Some universities already developed and deliver energy programmes along the principles outlined in the Action Agenda. These universities will continue to develop these programmes and the EUA Energy and Environment Platform will engage with them to share more successful good practices and case studies. EUA-EPUE will thus continue to play the role of facilitator previously assumed through the UNI-SET project consortium.

One of the key factors for progress is more cooperation. Success will require cooperation within universities, between different universities, between universities and industry, between universities and policy makers, and between universities and societies through outreach. This will require a common, shared university vision supported by senior academic leaders and the staff responsible for developing and delivering the teaching and research programmes advocated in this agenda. This common vision should be developed through cooperation to ensure that all parties benefit. The proposed changes to university structures should also help them become more flexible to address the challenges related to cooperation and the need to develop at the pace of society.

The 'Action Agenda' challenges some long-standing approaches - to achieve change universities cannot carry on doing the same thing. It also raises important questions about how experts from different disciplines can work effectively together towards a shared goal. For example, it requires universities to place more emphasis on the development of skills and training in addition to specialist academic knowledge. New learning and teaching approaches must be embedded in new programmes through the appropriate integration of learning technologies and other approaches that focus on students and use more challenge-based approaches.

Universities have a unique responsibility to bridge the gap between advanced research and education, for students and other actors who contribute to the transition to a low carbon society. *The SET Plan Roadmap for Education and Training* highlights the need for continuous professional development and to provide workers with a suitable background in the energy area relevant to their profession, while also providing them with the more holistic perspective needed to help them apply newly acquired knowledge, through e.g. interaction with people from different backgrounds or areas of expertise.

The Action Agenda framework has a focus on for master and doctoral programmes. Yet it has potential to inform lifelong learning as well as bachelor's programmes and pre-university education. In principle, the suggestions aiming to include stronger interdisciplinary perspectives should not only be employed in tertiary education programmes. Universities have an important role to play in providing suitable training for school teachers and vocational training institutions. This is a long-term perspective on the transformation of energy-related education and training at all levels, which goes beyond the scope of activities done so far in UNI-SET and the current work of the EUA Energy and Environment Platform. Such activities will further support cooperative links between universities and other energy stakeholders.

To aid the development of these new programmes, a course module repository that can be used for distance learning and sharing good practice across European universities and institutions in other

developed/ developing nations would be useful. A comprehensive repository of modularised distance learning material dealing with energy issues set out in the framework described in the Action Agenda, would be a valuable resource for use within an institution as well as for sharing more widely.

To achieve the cooperation required at European level, it is important to further develop a university energy network to further refine and implement this agenda through discussions, sharing good practice and case studies. The EUA Energy and Environment Platform and the partners represented in UNI-SET will therefore continue to support continuing reforms to university programmes in line with this 'agenda'. An important aspect will be continuing to provide an independent, scientific perspective for energy policy and position papers.

Universities are strongly encouraged to engage with the EUA Energy and Environment Platform and share their experiences in implementing this Agenda. This will help other institutions learn from existing cases, and will also help compile the necessary evidence of successful implementation of this Action Agenda. As with all major societal challenges, the energy transition is an opportunity for universities to enhance impact, quality and excellence, by adding a new emphasis on cooperation within and between universities as well as with new partners. This will allow universities to mobilise their pivotal role in tackling the challenge of achieving a low carbon economy.

4) Consolidating and expanding the energy platform for universities (EUA-EPUE)

Through the activities of the UNI-SET project, the EUA Energy and Environment Platform (EUA-EPUE) attracted the interest of a high number of universities and created a community of university leaders committed to tackle the challenges of the energy transition in a coordinated way at EU level. Through the UNI-SET project, this community has been able so far A) to discuss ways forward for the advancement of knowledge and higher education reforms; B) to provide high quality scientific policy input to the SET-Plan process; and C) to be an open platform facilitating new partnerships and projects in the context of SET-Plan and Energy Union.

The objective of EUA-EPUE is to pool the collective resources and knowledge available in European universities and to become an interface between European universities and the European institutions. Building on the UNI-SET experience, EUA-EPUE consolidated as the main platform in Europe working for and with universities to reform energy research and education along the goals of the Energy Union. EUA-EPUE is working as an open platform for universities interested in energy-related research, education and innovation. The initial continuity of the UNI-SET outcomes will be ensured by EUA, the managing entity of EUA-EPUE, through the input of its own resources. The main focus areas of the platform's work have been defined as "strengthening research and education", "supporting policy and advocacy at EU level", "fostering outreach and societal engagement", and "facilitating networking and clustering", building directly on the UNI-SET Roadmap.

The experience of UNI-SET in coordinating university activities in an intersectoral and interdisciplinary societal challenge field such as energy also led to a broader scope of activities of EUA-EPUE, now seeking to integrate environmental aspects. This change is reflected in the title of the platform, having changed from "European Platform of Universities in Energy Research and Education" to "EUA Energy and Environment Platform" in early 2018. The acronym 'EUA-EPUE' has been kept by EUA, which formally launched EUA-EPUE in 2012, to ensure a degree of continuity in external communications. The decision to change the focus of the platform was supported by the EUA Council.

The expansion of focus illustrates the intention of EUA to translate the UNI-SET experience into other societal challenges, especially given the proximity and interconnectedness of the energy transition with environmental issues and climate change. This will also support the take-up and development of the 'Action Agenda' as a tool for university activities in other societal challenges.

5) Recommendations for energy research and education policy and political messages from the project

Main inputs to political decision-making have been described under the heading of achievement 6 "Scientific policy input from the university perspective". This was mainly expressed in formal inputs to the SET-Plan process and the participation in the different Temporary Working Groups, as well as the organisation of ad-hoc inputs to relevant initiatives (e.g. public consultations). UNI-SET representatives also participated in all four SET-Plan Conferences which occurred during the project duration (see Achievement 4).

As highlighted in the Roadmap, the contribution of universities to the energy system transformation needs to be enhanced through active policy measures from universities themselves, and from political authorities both at the national and European level. The full mobilisation of the capacity of the universities according to the 'Roadmap':

* 1) performing research at low Technology Readiness Levels (TRL), to provide new solutions and new low-carbon technologies with long-term prospects;

* 2) contributing to research at medium-range TRLs together with Research and Technology Organisations (RTOs) and industry to facilitate the deployment and integration of low-carbon technologies;

- * 3) performing research and generating cross-disciplinary knowledge on the societal changes needed to realise a low-carbon society;
- * 4) renewing and adapting study programmes for students through all three cycles (Bachelor, Master and Doctorate), embedded in new knowledge generated by research activity;
- * 5) providing continuing education on new energy technologies and knowledge to the existing work force;
- * 6) strong engagement in providing policy advice and public debate, reaching out to their communities.

Policies that facilitate these measures should be designed as soon as possible in order to maximise the contribution from universities. This is the responsibility of university leaders as well as of political leaders and policy makers at local, regional, national and European levels. UNI-SET has built a foundation for some of these actions, notably points four, five and six, through the issuing of the ‘Action Agenda’ and its involvement in the SET-Plan process.

In addition to these messages, UNI-SET generated a large amount of data and outputs with relevant findings for energy research, education and innovation policy, e.g. in the context of the next Research and Innovation Framework Programme (FP9) or the future successor programme to Erasmus+.

The Universities Survey for example demonstrates that universities are active throughout all domains of energy research in Europe, often in partnership with companies, research organisations or other societal actors. Universities are thus well-placed to future collaborative research programmes, e.g. under the umbrella of currently debated mission-oriented research approach, provided the rules of participation are flexible enough for diverse consortia and research themes ranging from more “fundamental” to more “applied” research.

In addition, the survey showed room for improvement for interdisciplinary research and education. EU research and education funding programmes could fund excellent initiatives with the aim to link both interdisciplinary research and education projects with EU added-value. Likewise, better connections between education and research, as emphasised through the UNI-SET outputs, could be made through projects at EU level. This would support the up-skilling of the European workforce and the competitiveness of the European clean energy sector(s) in the long run, given international competition in research and innovation is accelerating.

The high interest of universities in the societal challenge energy also demonstrates potential for “European University networks” active in clean energy and related areas currently under consideration for the next European education and/or research programme.

Finally, to increase the impact of the SET-Plan, a closer alignment with the Framework Programmes would yield important synergies between EU-level funding (Framework Programme) and national initiatives coordinated through the SET-Plan, point often raised by universities and other stakeholders active in the SET-Plan process.

6) Next steps

Following UNI-SET, the platform will seek further consolidation and assume the responsibility to continue the dissemination and communication of the project results and facilitate the exploitation of results by policy makers, higher education institutions and partners. This will include the sustaining of the following activities which directly stem from the UNI-SET activities (see ‘Description of main results/foregrounds’)

- Further using of the European Atlas of Universities in Energy Research and Education and the promotion of related activities, such as surveying and mapping universities, as well as exploring

the possibility to develop it as a repository for higher education education and training activities in the field of energy (builds on achievement 1 and 3).

- Promoting the implementation of the ‘Roadmap’ and the ‘Action Agenda’ through own activities, and partnerships; (builds on achievements 6 and 7).
- Continuing the successful Energy Clustering Events which started through UNI-SET as main opportunities for exchange among universities and between universities and other stakeholders active in the field of energy; (builds on achievement 5).
- Expanding collaboration and interaction with main partners during UNI-SET such as EIT InnoEnergy, the European Energy Research Alliance (EERA), European Commission services and other partners (builds on achievements 5 and 6).
- Promoting the exploitation of UNI-SET outputs such as SET-Plan inputs, ‘Roadmap’ and ‘Action Agenda’ through projects and initiatives at European, national or institutional level (builds on Achievement 4, 6 and 7).
- Providing additional scientific input to the SET-Plan and Energy Union process through consultation processes and other relevant fora (builds on achievement 4 and 6)

Concrete activities of the EUA Energy and Environment Platform in the trajectory of the UNI-SET project already started in early 2018. An additional Energy Clustering Event hosted by the University of Lorraine was organised in Nancy, France on 21 and 22 March 2018 and co-organised by EUA-EPUE, University of Lorraine, EIT InnoEnergy, and the Conférence des présidents d'université (CPU). This conference aimed to further develop ideas and partnerships to realise the ‘Action Agenda’.

Another event is planned for the second half of 2018. The universities survey will also be re-launched in the first half of 2018 to update existing data and to increase the number of participating universities.

A further tangible step for the continuation of the partnership between EIT InnoEnergy, EUA and the community of universities in UNI-SET is the plan to apply for project funding through the Horizon 2020 call “Research, innovation and educational capacities for energy transition” (LC-SC3-CC-5-2018). If successful, this would allow the translation of UNI-SET outputs (e.g. the Action Agenda) into educational programmes, as well as the exploitation of the partnerships and synergies between universities and industry created through UNI-SET.