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UNIVERSITIES IN THE SET-PLAN

MOBILISING THE RESEARCH, INNOVATION AND EDUCATIONAL CAPACITIES OF EUROPE'S UNIVERSITIES IN THE SET-PLAN

UNI-SET – Background and Achievements

Professor Torbjørn Digernes
Chair of EUA-EPUE and the UNI-SET Steering Committee

23 October 2017

EUA-EPUE
European Platform of Universities in Energy Research & Education

KU LEUVEN

eit InnoEnergy
Knowledge Innovation Community

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S SEVENTH FRAMEWORK PROGRAMME FOR RESEARCH, TECHNOLOGICAL DEVELOPMENT AND DEMONSTRATION UNDER GRANT AGREEMENT No 609838.

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The UNI-SET project

- **Duration:** Sept. 2014 - Dec. 2017

- **Consortium**:
  - ✓ **European University Association,** coordinator
  - ✓ **KU Leuven,** project partner and third party coordinator

- **Funding: FP7** Coordination and Support Action

EUA European University Association
Project Coordinator

KU LEUVEN
Project Partner

Third Party Consortium
- Grenoble Institute of Technology (INP)
- Jagiellonian University (JU)
- Karlsruhe Institute of Technology (KIT)
- Royal Institute of Technology (KTH)
- Polytechnic University of Catalonia (UPC)

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UNI-SET project

- ***ACRONYM:*** **<u>UNI</u>**versities in the **<u>SET</u>**-Plan (Strategic Energy Technology Plan)

- ***AIM/ OBJECTIVES:*** Provide a platform and information for

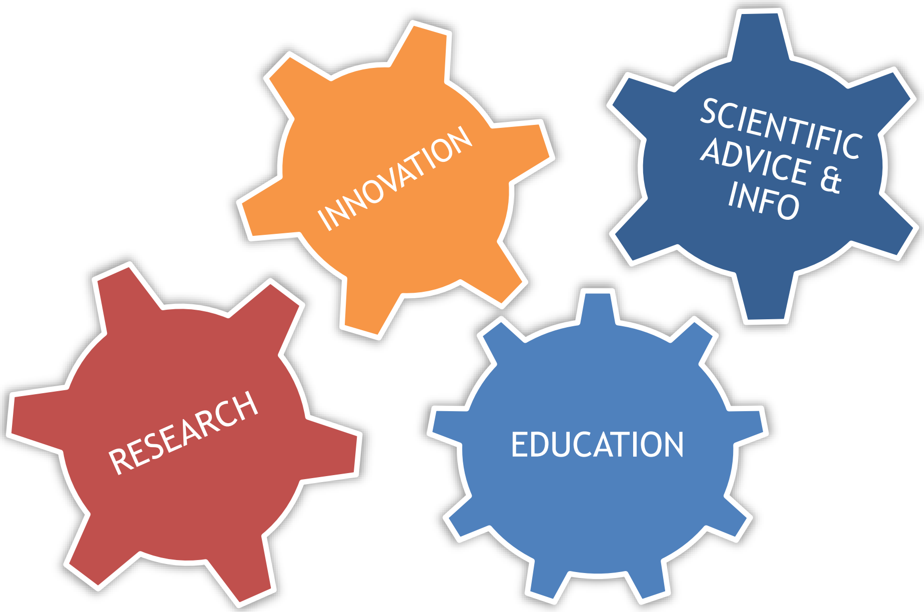
  Mobilising the

  <u>research</u>,

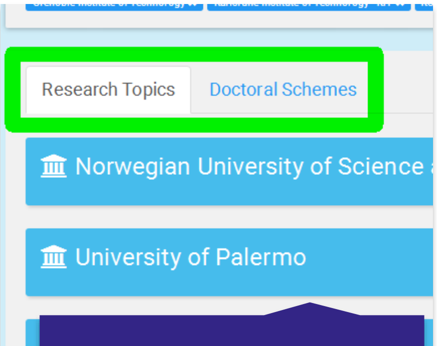
  <u>innovation</u> and *<u>educational</u>*

  capacities of Europe's universities in the

  SET-Plan



Main Activities of UNI-SET



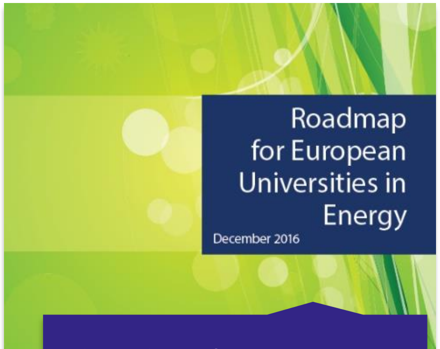
2 surveys on universities and businesses at European level

1st European Atlas of Universities in Energy Research & Education

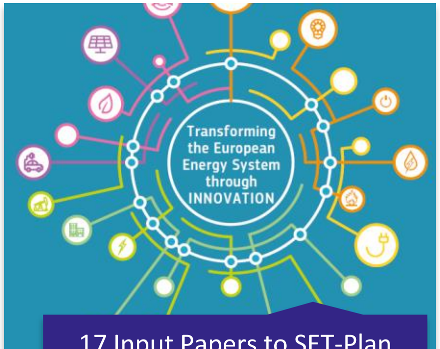
7 Professional Profile Identification Workshops

1 conference "Human Resources for the Energy Transition"

5 conferences addressing Research & Education for SET-Plan Priorities



1st Roadmap for Universities in Energy



17 Input Papers to SET-Plan Consultation Process & Implementation Plan

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UNI-SET Universities and Employers Surveys

- Main Outcomes -

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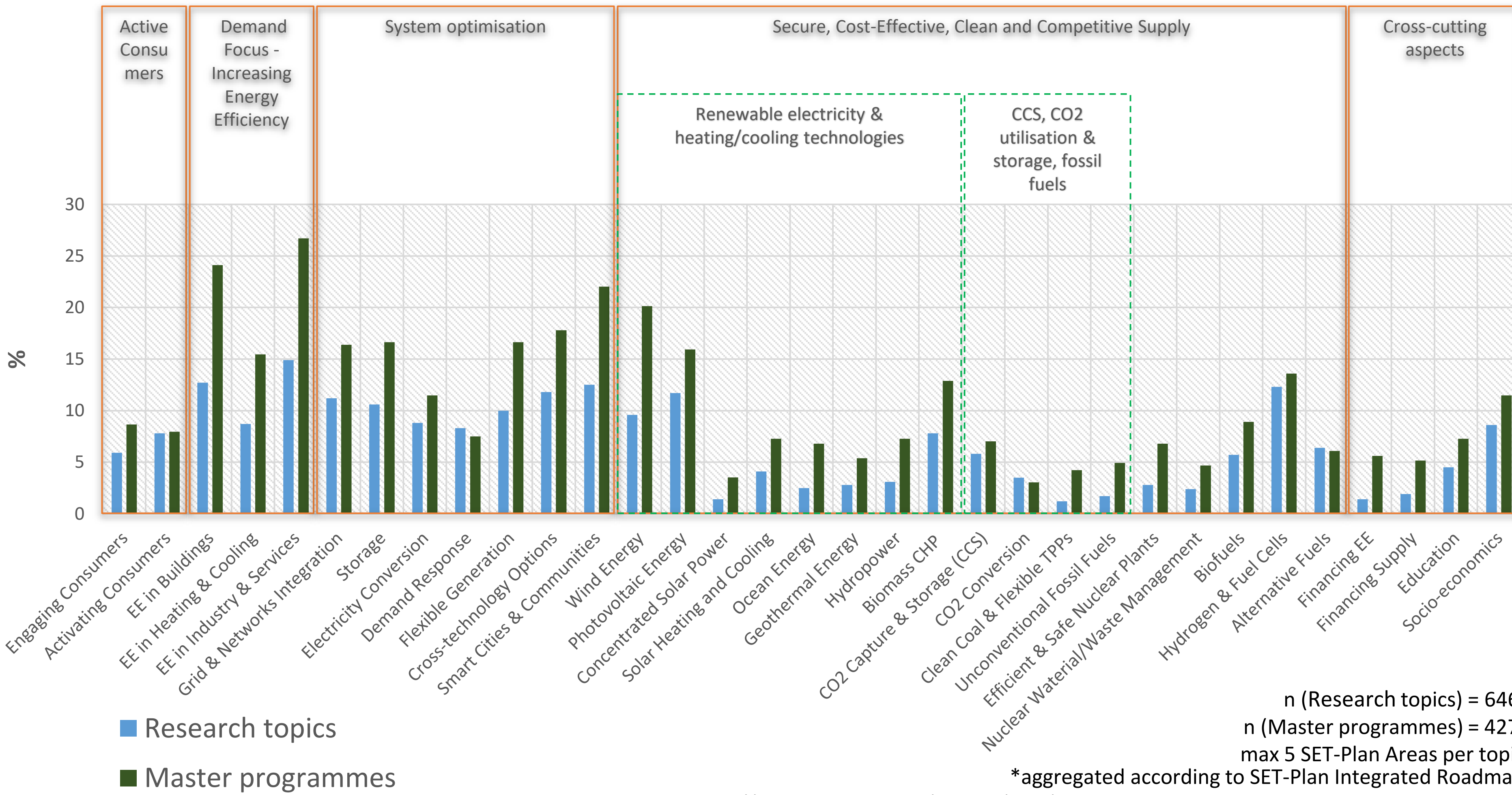
2015 UNI-SET Universities Survey (Phase II*)

- 202 universities
- 864 research topics
- 451 Doctoral schemes
- 579 Master programmes
- Research staff 9,833 (FTE)
- Doctoral candidates 6,287 (FTE)
- 36,903 Master-level students

*End of Phase II: 15 December 2015

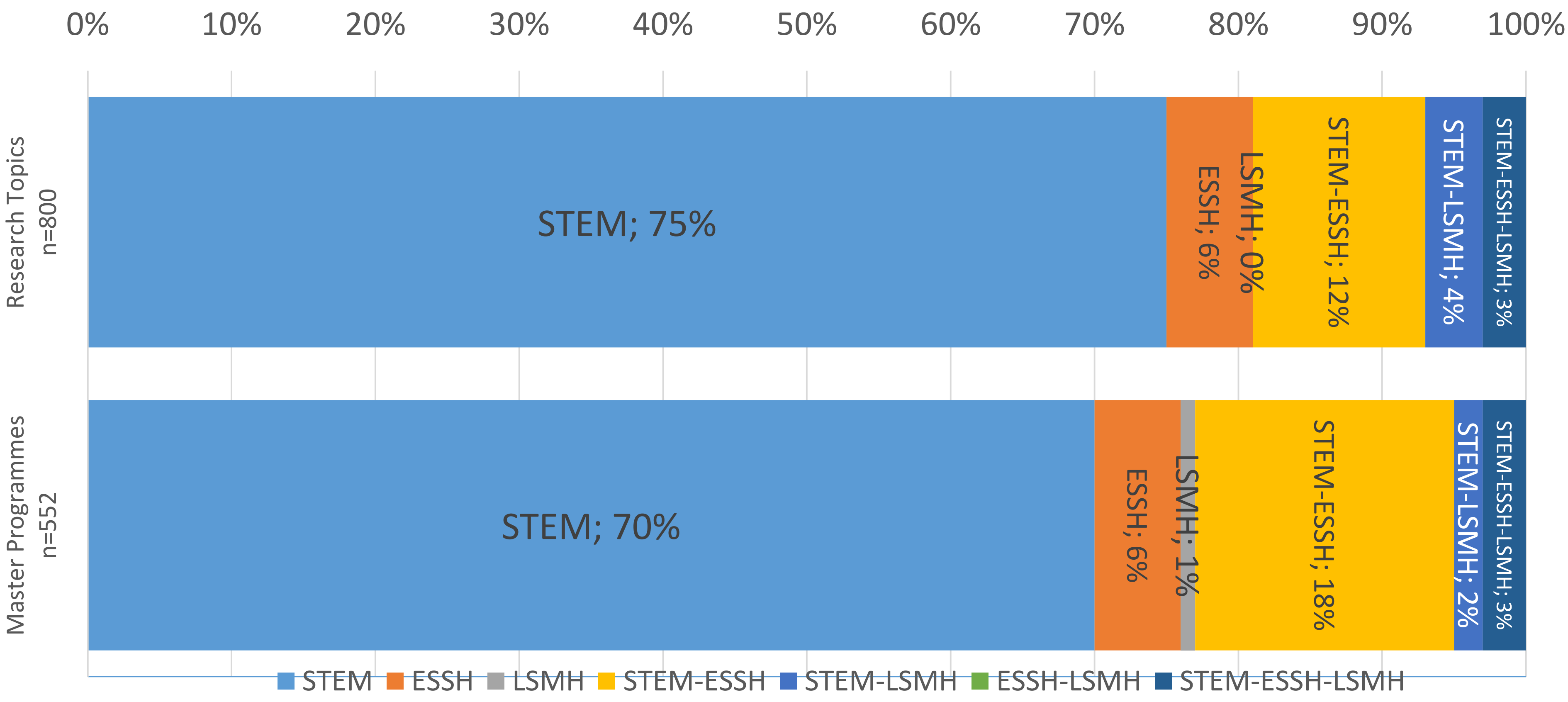
SET-Plan Areas* - Masters and Research topics



n (Research topics) = 646,
n (Master programmes) = 427,
max 5 SET-Plan Areas per topic
*aggregated according to SET-Plan Integrated Roadmap
(https://setis.ec.europa.eu/system/files/Towards%20an%20Integrated%20Roadmap_0.pdf)

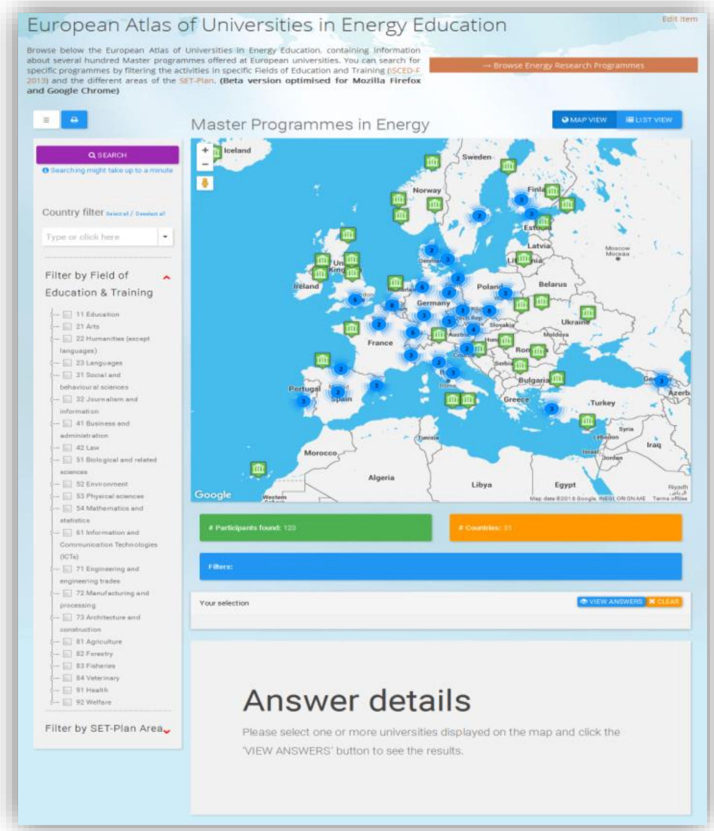
Multidisciplinarity STEM/ESSH/LSMH

- **Broad fields of knowledge** covered by Master and research programmes
  - STEM (Science, technology, engineering, mathematics)
  - ESSH (Economics, Social sciences and Humanities)
  - LSMH (Life science, medicine, health)

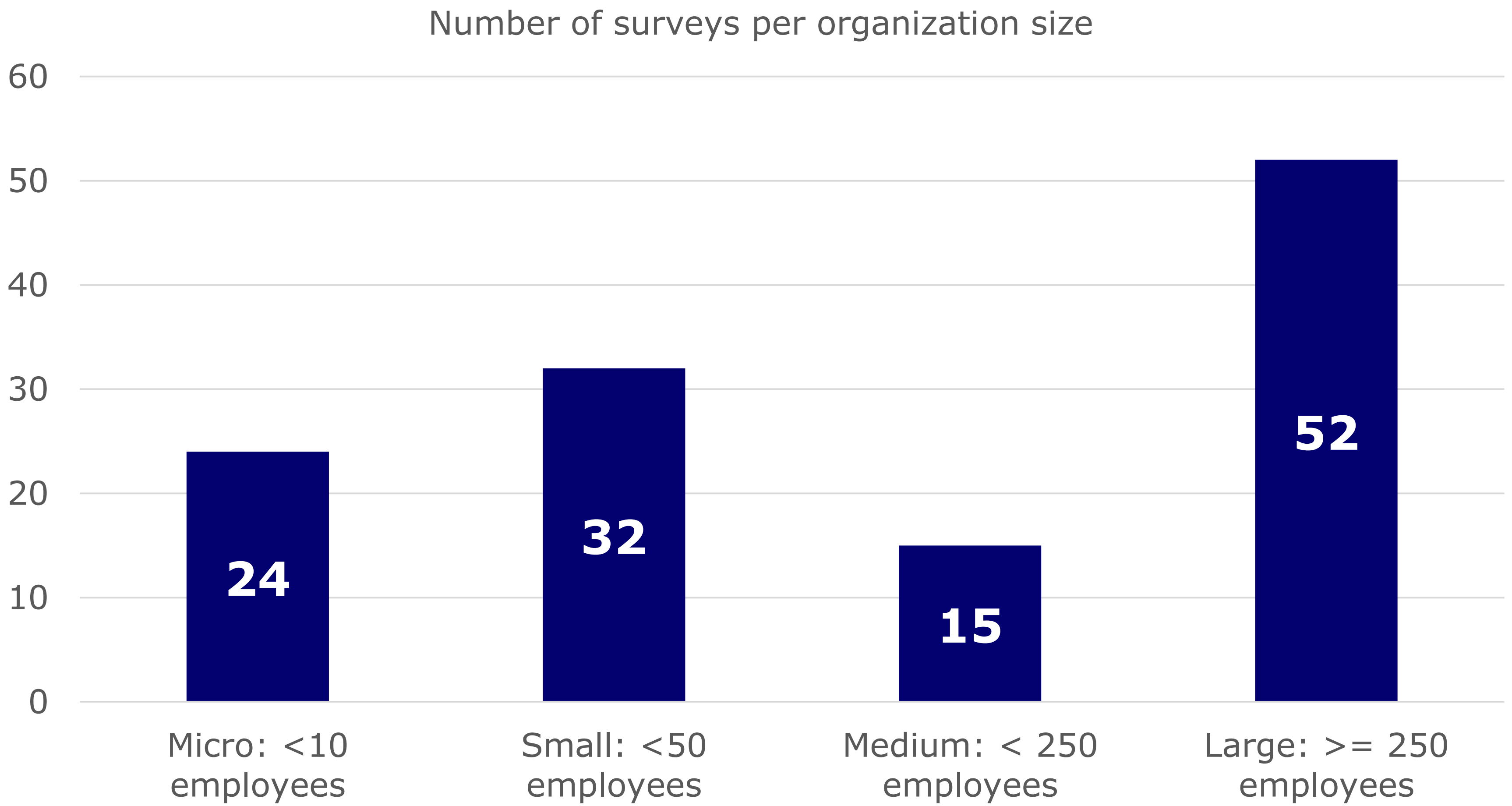


EUROPEAN ATLAS OF UNIVERSITIES IN ENERGY RESEARCH & EDUCATION

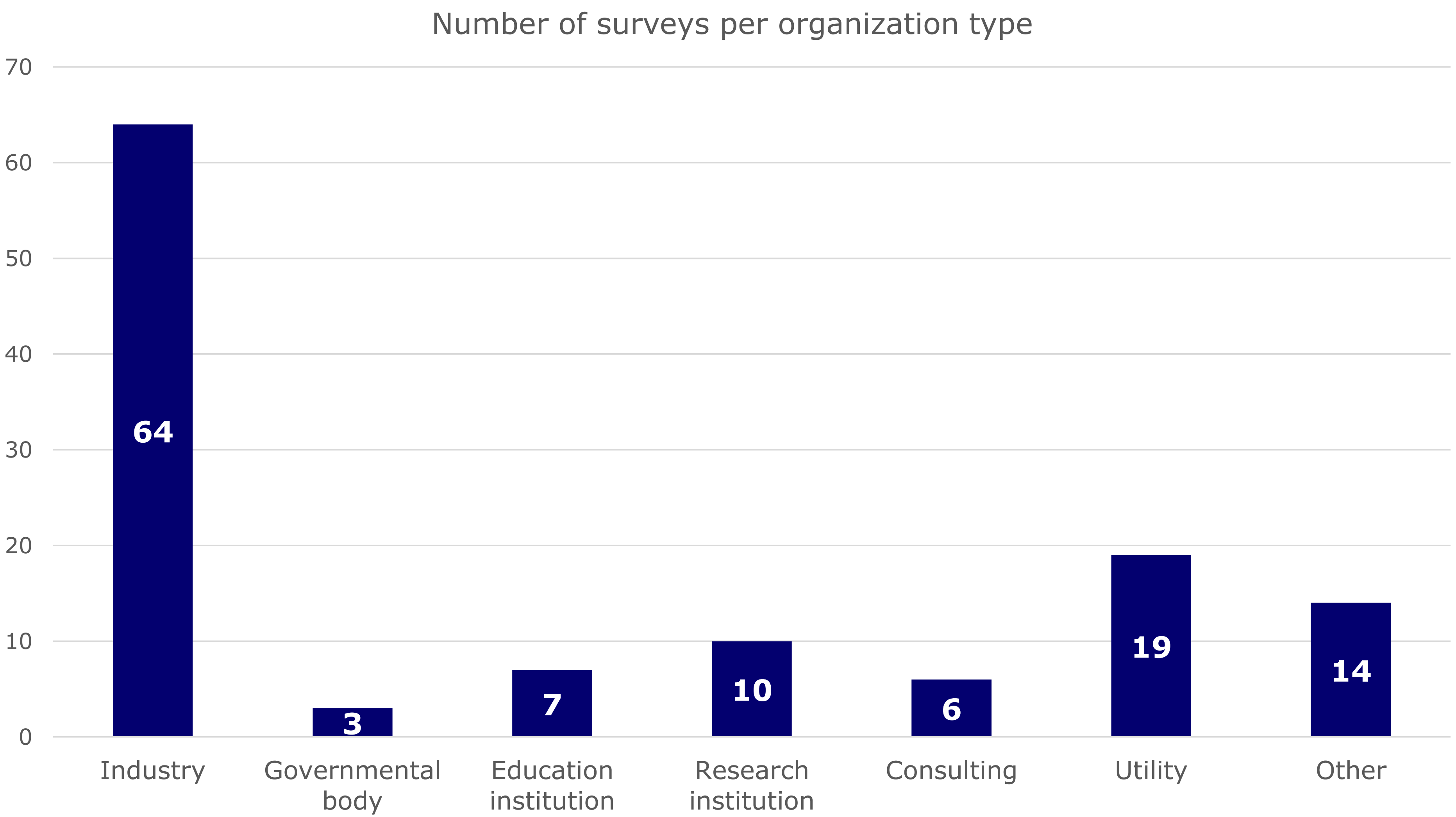
- 131 universities share information online
- ➢ http://atlas.uni-set.eu
- Participation through the UNI-SET Universities Survey
- ➢ http://universities.uni-set.eu/
- ➢ Survey report released soon!



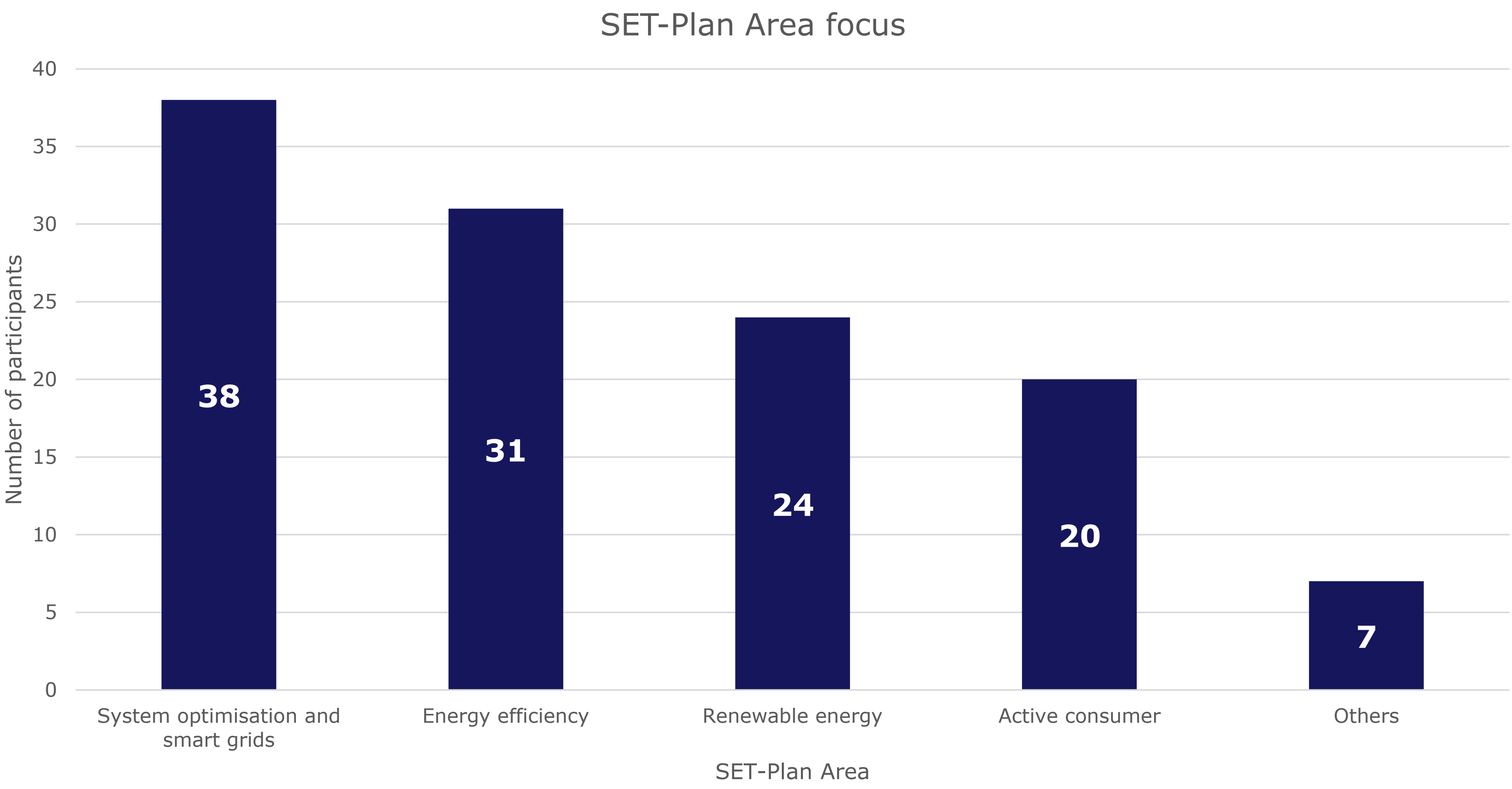
UNI-SET Employers Survey
SIZE OF ORGANIZATIONS



UNI-SET Employers Survey
TYPE OF ORGANIZATIONS



UNI-SET Employers Survey
BRIDGE TO SET PLAN AREAS



UNI-SET Employers Survey: PPRELIMINARY LIST OF PROFESSIONAL SKILLS

WG TOPIC	TECHNICAL SKILLS	ENGINEERING METHODS & OTHER SKILLS	SOFT SKILLS	LANGUAGES & EXTRACURRICULAR TRAININGS
GENERAL	•Electrical engineering •Power systems •Data analysis •Software development	•Project management •Innovation management •Business development •Identification & formulation of problems	•Teamwork •Multidisciplinary •Analytical skills	•English: full professional proficiency
ENERGY EFFICIENCY	•Chemistry •Electrical engineering •Heating •Thermodynamics	•Analyzing, comparing, and evaluating complex products •Business development •Design & modelling methods •Project management	•Adaptability •Creativity	•English: professional proficiency •Additional economics/business degree
SMART SYSTEMS	•Economy •Electricity and gas markets •Smart distribution systems	•Analyzing, comparing, and evaluating complex products •Business development •Innovation methodologies •R&D	•Analytical skills •Presentation skills	•English: full professional working proficiency •Additional engineering degree •Industry involvement
RENEWABLES	•Electrical engineering •Renewable energy technology •Wind energy	•Analyzing, comparing, and evaluating complex products •Business development •Computational methods •Project management	•Entrepreneurial/economical aspects •Teamwork •Autonomy	•English: full professional proficiency •Industry involvement •Professional experience

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Building a community of university leaders and practitioners

- The Energy Clustering Events -

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UNI-SET Energy Clustering Events

Host	Norwegian University of Science and Technology	Politecnico di Torino	University Politehnica of Bucharest	Imperial College London	KU Leuven	Brussels
Main theme (SET-Plan Priority)	•"Human resources and new knowledge to build the future energy system"	•"Universities in the energy transition: Focus on energy efficient systems and nuclear safety"	•"Universities in the energy transition: Focus on smart energy systems and communities"	•"Universities in the Energy Transition: Focus on Sustainable Transport and Carbon Capture, Storage & Use"	•"Universities in the Energy Transition: Science & Skills for Renewables Integration"	•High-Level Conference "European Universities in the Energy Transition: Towards a Clean Energy Future"
Audience	University leadership, industry representatives, researchers, educational leaders, students etc.					
Date	24-26 February 2016	26-28 September 2016	21-23 November 2016	27-28 March 2017	31 May-2 June 2017	23-24 October 2017

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EUA-EPUE
- Contributions to EU Policy Development -

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EUA-EPUE role in European policy development (2013-2017)

- **2013:** Contribution to **SET-Plan Education and Training Roadmap**
- **2014**: Contribution to **SET-Plan Integrated Roadmap**
- **2015-2016:** 17 EUA-EPUE Input Papers submitted to EC for **SET-Plan Consultations on 10 Key Actions**
- **2016-2017:** Role of EUA-EPUE in 6 **SET-Plan Temporary Working Groups (TWGs)* and ETIP SNET**
- **June 2017:** EUA-EPUE in **EUSEW 2017**
- **December 2017:** EUA-EPUE in **2017 SET-Plan conference** (10 year anniversary of SET-Plan)

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MOBILISING THE RESEARCH, INNOVATION AND EDUCATIONAL CAPACITIES OF EUROPE'S UNIVERSITIES IN THE SET-PLAN

From the 'Roadmap for European Universities in Energy' to the 'Action Agenda for Europe's Universities'

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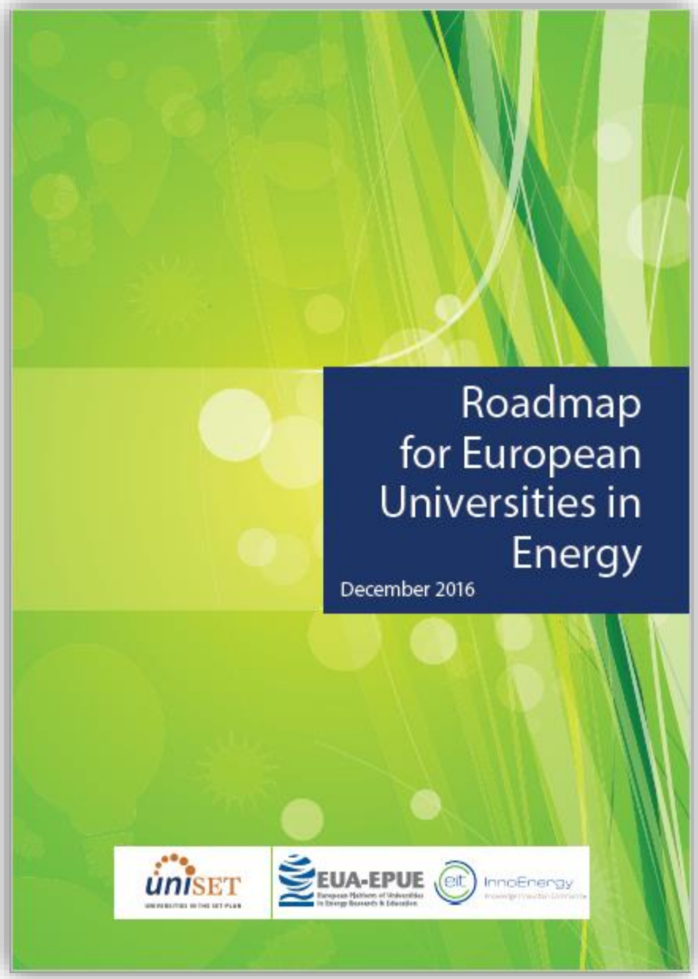
"Roadmap for European Universities in Energy" (December 2016)

- **Vision**: *"European 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"*
- **Main proposed actions:**
  1) ***Research and Education*** (mapping; repository of teaching and learning; platform for high-level dialogue; guidelines on multidisciplinary approaches; statements on major trends etc.)
  2) ***Collaboration*** (university networks; university-business cooperation; platforms of dialogue between sectors; international agenda etc.)
  3) ***Outreach to society*** (prosumers; local, regional and national communities etc.)



Impact of UNI-SET

Mobilisation of over 300 universities across Europe (so far) addressing the human resource challenge for the energy transition

First **European Atlas of Universities in Energy Research and Education,** a map of educational and research capacity of universities from 30 European countries

The first compilation of **professional profiles needed in the business sector**

A first investigation into new approaches in energy higher education and research for an **Action Agenda for Europe's Universities** (December 2017)

Coordinated, scientific policy input as a response of the university community to the ten SET-Plan Key Action Consolutations

Working in six workings groups towards **SET-Plan Implementation Plans**

The first **Roadmap for European Universities in Energy** (December 2016)

Cooperation with many other stakeholders

The future of EUA-EPUE and UNI-SET (2018 on)

- Continuing effort is needed to ensure development of the human resources required to implement the energy transition

- Important that this achieves multiple objectives
  - To further update the existing workforce in a flexible way, adapted to regional and local needs
  - To renew the education programs with the required cross disciplinary competencies to fathom the societal change needed
  - To compile learning material to be made available through a repository
  - To conduct the education in the knowledge triangle (education – research – innovation) with close cooperation with industry
  - The renewal and update of programmes need to be implemented by universities all over Europe (the Roadmap and the pan-European Agendas provide guidelines)

- The platform created through UNI-SET can be built on to reach these objectives

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Energy Transition and The Future of Energy Research, Innovation and Education - An Action Agenda for Europe's Universities

Dr Douglas Halliday, Durham University
Dr John Smith, EUA

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The Energy Challenge

"…requires new cross-disciplinary approaches, integrating different energy technologies, energy systems, energy economies and markets, and importantly, embracing new regulatory frameworks, and understanding consumer behaviour and societal and cultural dimensions."

What does it mean for universities?

- Upgrade & innovate own programmes
- Listen to societal needs & collaborate
- Modernise learning & teaching
- Break down disciplinary barriers
- More flexibility

An Action Agenda for Europe's Universities (1/2)

- Enable the **development of the actions set out in the Roadmap for European Universities in Energy**
- Adoption of **new innovative approaches to learning, teaching and research**: Novel framework and approach for structuring new energy-related programmes
- Bridging **skills gap** in higher education and business sector
- **Greater interaction** between universities and other energy stakeholders including European and national policy makers, industry and citizens
- **Specific examples** in key areas of energy technology: Energy Efficiency; Smart Grids and Systems, Integration of Renewables

Upcoming Publication: December 2017

An Action Agenda for Europe's Universities (2/2)

Four Working groups and chapters, including both technical/engineering and social science/humanities contents:

2) Energy efficiency

3) Smart grids & energy systems

4) Integration of renewables

1) Horizontal content of cross-disciplinary education and research programmes

Main recommendations

- Skills and knowledge development need to go hand in hand
- Focus on new learning and teaching approaches
- Rethink the role of the teacher
- Institutional support for interdisciplinary education and research
- Combine breadth and depth in T-shaped educational programmes
- Pay attention to Lifelong Learning
- Leverage digital opportunities
- New research approaches and methods – multiple perspectives

Pathways to the solution

- New technologies & ways of working require new skills
- Adapting curricula, learning & teaching
- Expansion of research-based learning, entrepreneurship & innovation skills – Creating solutions
- Learning and teaching in inter-/multidisciplinary challenges and teams - Communication
- More attention to holistic & systemic perspectives, especially for complex societal challenges such as energy – research methods and approaches
- Interface between technical solutions and society needs careful consideration
- However, need for specialised experts & scientists won't disappear – universities play critical role in training
- Developing new knowledge and understanding

Practical suggestions

Master-level education

- Expose students to the full breadth of the energy system in addition to the major field of study
- Tailored 'background components' to the main field of study
- Consider all aspects – conventional & renewable energy technologies, storage, systems, transport, heating cooling
- Public perception, energy practices, energy choices and prosumers, energy dialogues
- Economic and financial factors
- Energy policy

Doctoral education

- From "T -shaped" to "A-shaped"
- Breadth and context provides foundation
- Develop interdisciplinary research training
- New research methodologies across traditional subject boundaries
- Maintain requirement for original knowledge
- Structured doctoral education

Table - Principle

- To demonstrate the need for:
  - **Inter-disciplinary/cross-disciplinary** with
  - **generic** and
  - **Specific**,

    a table was constructed that provides **learning outcomes** for:
    - Understanding, Background Knowledge, **Comprehension** - General Appreciation
    - **Design and Implementation** - Deeper (Master level) Appreciation
  - and links it with the achieved
    - **Employment Skills**
- These are **sub-divided** in the following:
  - **Policy**
  - **Economic**
  - **Social**
  - **Technical**

Table Topics

- Table covers **24 topics**, of which … for example …
  - **Technical:**
    - Energy Infrastructure - Smart Grids - Distribution Networks
    - Simulation – Modelling
    - (Renewable) Technologies / Energy Sectors – Chemical (e.g. bio-fuels)
    - (Renewable) Technologies / Energy Sectors – Electrical / Thermal
    - Energy Efficiency
    - Energy System Control
    - …
  - **Non-Technical**:
    - Urban Planning
    - Building Design
    - Energy Communities – Society
    - Energy Market / Economic Models
    - …

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Examples of Challenges and Opportunities
- Smart Grids and Energy Systems -

Prof. Mihaela Albu, University Politehnica of Bucharest
Dr Wim Melis, University of Greenwich

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Future challenges and opportunities in the field of Smart Grids and Energy Systems - State-of-the-Art

- **Concept** of **"smart grids" still developing**: e.g. from decentralised production, over smart metering to DC distribution networks.
- Main aim is to **match generation and demand**, especially considering that **renewable generation is less reliable with regards to "controllability"** of generation.
- **Moving towards a carbon neutral** energy system **requires to move towards a "system of systems"**. This more holistic perspective aids in efficiency, but also justifies the **combination of different energy vectors** (electricity, heat, …).

Future challenges and opportunities in the field of Smart Grids and Energy Systems - State-of-the-Art

- Significant **challenges** with regards to:
  - **(inter-)connectivity**,
  - **security**,
  - **reliability** over the lifetime of a product.

  For example: an **energy system** can have a **life span** of 10, 20 or even 40 years, which means that there are e.g. **many versions** of Operating System/Software that will **change**, **often** with their **predecessors no longer supported.**

Future challenges and opportunities in the field of Smart Grids and Energy Systems - Master Level Programmes

- Individuals must have **develop wide general knowledge** (e.g. appreciate impact, context, etc.) besides being able to also **focus on the details of a very specific topic** (e.g. communication requirements for synchronized measurement systems, information flow in smart metering, power converters, FACTS etc).
- Programmes should combine (in proportion from 50/50 to 80/20), **specialist energy technology topics** (e.g. Energy Infrastructure, Smart Grids, Distribution and Transmission Networks, optimal control etc.) with **holistic/generic system aspects** - through e.g. **project/case studies** either within courses or across the programme.

Future challenges and opportunities in the field of Smart Grids and Energy Systems - Master Level Programmes

- In designing a new programme, it is important to address **challenges of the "energy system" as a whole:**
  - **Holistic perspective**, by integrating **most relevant energy vectors** and capturing their interplay in achieving an optimal system operation
  - **Long term vision** – the proposed energy system are designed to operate for a long time
  - **Integration of new technologies and markets** (WAMCS, V2G, prosumers' control etc.)
  - **[Defending] emerging concepts** (cell-based approach, energy communities, energy harvesting, distributed storage etc.)
  - **Headlines:** Reliability, security and energy efficiency/saving @ system level, self-sufficient energy user, quality of supply etc.
  - **Customer-centric** while identifying all stakeholders
  - Social responsibility and policy making

Future challenges and opportunities in the field of Smart Grids and Energy Systems - Doctorate/Research

- Aim is to ensure that Doctorate programmes result in a **well-rounded individual**, that appreciates the **context and impact** of his/her work in the wider picture, including: social, economical, political, environmental, etc.
- Both **"applied" and "fundamental" research** are **necessary**, but each dissertation should incorporate a section that focuses on the Impact and Context.
- **Visionary work** should be **encouraged** as a preparation **to react to disruptive technologies and markets,** e.g.: energy storage, energy harvesting, e-mobility, 5G, prosumers' aggregation, inertia-less systems etc.

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Examples of Challenges and Opportunities
- Energy Efficiency -

Prof. Giovanni Fracastoro, Politecnico di Torino
Prof. Michael Narodoslawsky, Technical University of Graz

EUA European University Association

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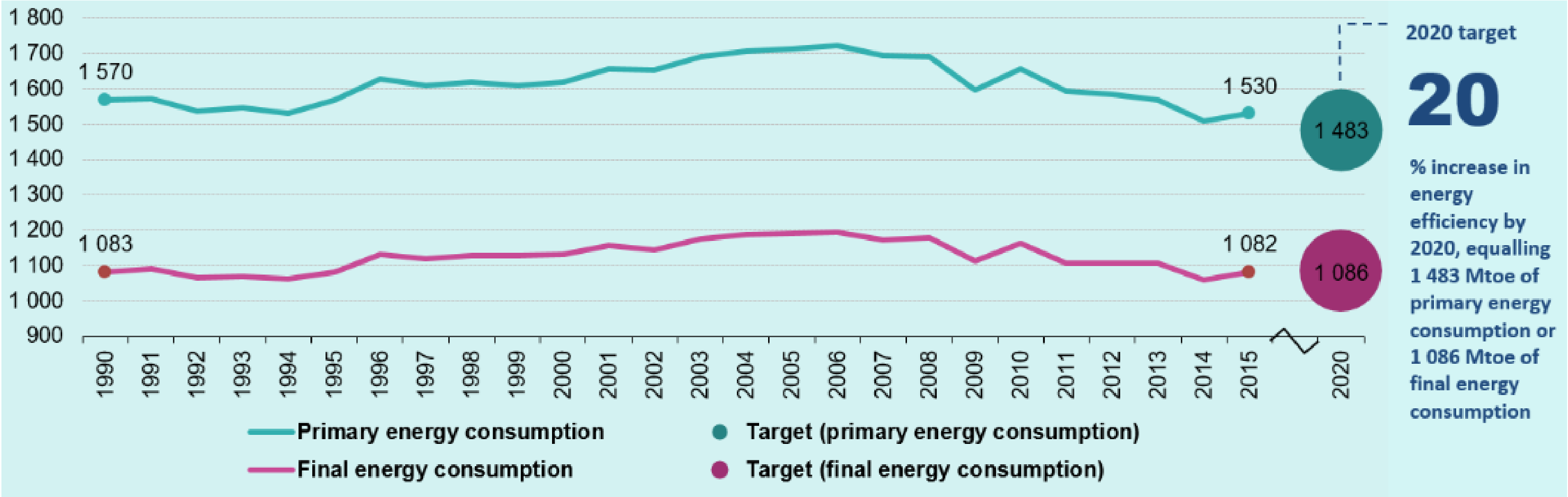
Future challenges and opportunities in the field of Energy Efficiency

State of the Art

- Increased energy efficiency is one of the cornerstones of both the 2020 and 2030 EU energy strategy. EU targets for *energy savings* compared with the business-as-usual scenario:
    - 20 % by 2020
    - 27 % by 2030



In 2015, the 2020 target was already almost reached

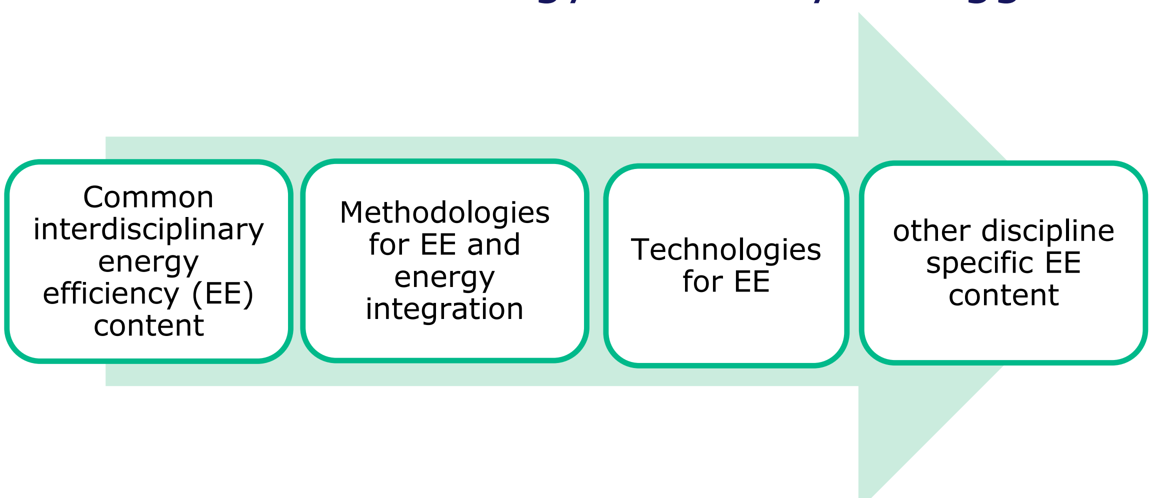
Future challenges and opportunities in the field of Energy Efficiency

State of the Art

- Out of 7600 research staff and 5000 PhD candidates at the UNI-SET university survey, over *25%* are engaged in energy efficiency and smart city fields.
- Learning how to *save* energy requires knowing how people *use* energy, and which *services* they eventually require: this is often more *complex* than learning a specific energy production technology.
- EE is a *competitor* of renewable energy technologies for investments, but also a necessary "*prerequisite*" which should be integrated with renewable energy (for instance, to reach a net ZEB).
- Energy efficiency cuts across sectors and technologies and requires *interdisciplinary and systemic approaches*.
- To be effective, measures for improving energy efficiency must always be seen in a context that includes a product/service *life cycle analysis* within a *local/regional energy system* including end users.

MSc programmes…

1. On one side, MSc for future leaders and experts in *all energy professions* should contain suitable *aspects* of energy efficiency.
2. On the other side, energy efficiency is such a wide topic that a MSc devoted to this subject should at least distinguish between Industry, Buildings, Transportation.
3. The following general approach to integrate the different contents of a MSc in energy efficiency is suggested:



Example 1

Energy efficiency in industry: contents and ILOs

Stage	Topic (for module)	Indicative Content	Intended learning outcome
Methodologies	Energy efficiency planning methods	"Thermoeconomy concept" methods like PINCH, exergetic analysis, process intensification and process synthesis methods (e.g. process network synthesis)	Development of energy efficiency scenarios for complex industrial processes
Technologies	Industrial energy efficiency technologies	Energy efficiency technologies like heat pumps and waste heat utilisation pathways	Application of energy efficiency technologies in industrial process design and process revamping
	Control strategies for energy efficiency	Control strategies for industrial equipment (compressors, pumps, etc.) and industrial sites in order to increase overall efficiency.	Ability to optimize process operation with regard to energy efficiency
	Waste heat management	Overview of the heat intensive industrial processes: steel making, metal processing, cement/glass production, … Conversion of heat into electricity Smart heat networks and usage	Ability to integrate industrial sites into their spatial context

Example 2

Energy efficiency in buildings: contents and ILOs

Stage	Topic (for module)	Indicative Content	Intended learning outcome
Methodologies	Energy efficiency planning methods.	Laws and regulations on buildings	Understanding the building design and construction process, its social, legal and economic constraints and its actors.
	Energy balance of buildings	Quasi-static and dynamic simulation methods	Use quasi-static and dynamic simulation methods in order to understand the thermal behavior of the building, indoor conditions and predict its seasonal energy demand
Technologies	Energy efficiency technologies in buildings	HVAC typologies	Choose and design an HVAC system which is suitable to the building use, the climate conditions and the available energy vectors
	Energy audit of existing buildings	Measuring devices for energy audit Energy audit process Identification of energy conservation opportunities	Design and carry on the energy audit of a building using the most suitable and cost-effective approach. Understand how to use measuring apparatuses (blower doors, IR cameras, thermometers, RH sensors…), their accuracy, limits of application
	Control strategies for energy efficiency	Control strategies for mechanical equipment (boilers, pumps, heat pumps, chillers, control systems, etc.).	Ability to optimize process operation with regard to energy efficiency

Future challenges and opportunities in the field of Energy Efficiency

Doctorate and research programmes recommendations

- As for MSc, Doctoral candidates in all energy relevant disciplines must have a fundamental understanding of
  - *Energy efficiency technologies in industry, buildings and transport*
  - *Energy efficiency planning methods in industry, buildings, transport and spatial planning*
  - *Actor interaction to achieve systemic energy efficiency*
  - *Behavioural aspects of energy efficiency*
  - *Simulation tools for the definition of heating/cooling energy demand*
- Needed research subjects (EUA-EPUE scientific policy input to the SET-Plan)
  - *Energy efficiency planning methods repository*
  - *Total site energy integration*
  - *Socio-technical transitions*
  - *Rebound effect, i.e. Jevon's paradox**
- All PhD candidates in EE should be aware of the *socio-economic motivation and future applications* of their research subjects

**In economics, the Jevons paradox occurs when technological progress increases the efficiency with which a resource is used, but the rate of consumption of that resource rises because of increasing demand.*

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Examples of Challenges and Opportunities
- Renewables Integration -

Prof. Johan Driesen , KU Leuven

European University Association

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Challenges and opportunities in the field of Renewables Integration

State of the art – Current issues for renewables integration research

- Treat system as whole – Energy Systems Integration
- Need to model, manage and plan for intermittent generation
- Need to manage demand to match generation as far as is practicable
- Essential role for energy storage
- Role of smart grids and our autonomous networks in controlling energy flows
- Variable generation and the grid
- Use of multiple energy vectors
- Advanced forecasting
- Faster dispatch and control strategies
- Role of Markets and market design
- Managing demand response

Challenges and opportunities in the field of Renewables Integration

- The basis of master curricula for renewable energy sources integration should enable every student to know two main aspects:

  How renewable energy sources interacts with the energy system and interacts with society: "system issues".

  Where the specific technology or energy vector their study "fits" in the energy system and society (in time and place, as well as for the interface)

- This includes
  - Renewable energy sources
  - Interfaces with the energy system
  - Energy services
  - Some notions of electricity systems, heat networks, fuel distribution, and hydrogen distribution
  - System interaction – balancing and storage
  - Business models

Challenges and opportunities in the field of Renewables Integration

The objective:

- After studying renewables integration, students should be able to discuss the following questions:
  - Who are the stakeholders playing a role in the integration of a certain RE?
  - What is best: electric vehicle hydrogen vehicle or biofuel vehicle, all "solar-based"?
  - On a given surface (km2), what is best to install: solar panels, wind turbines, biocrop field.
  - Where does a certain RE technology fits best?
  - What kind of storage is needed?

Thank you for your attention!

For more information go to

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European Universities in the Energy Transition: Towards a Clean Energy Future

Panel Discussion : Education, Research and Innovation in light of the Energy Challenge

Prof. Fernando Orejas Valdés, Vice-Rector for Research, Universitat Politècnica de Catalunya - BarcelonaTech (UPC)
Prof. Antonio Gomes Martins, Director, Energy for Sustainability, University of Coimbra
Prof. Martin Freer, Director, Birmingham Energy Institute, University of Birmingham

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European Universities in the Energy Transition: Towards a Clean Energy Future

Panel Discussion : "How can FP9 strengthen the link between research, innovation and education?"

Dr Gwennaël Joliff-Botrel, Head of Unit: 1. Strategy, Dir G — Energy, DG Research and Innovation, European Commission
Nils Røkke, SINTEF; Chair, European Energy Research Alliance (EERA)
Prof. Tadeusz Skoczkowski, Department of Rational Use of Energy, Warsaw University of Technology; Member, Horizon 2020 Advisory Group on Energy, Poland
Ward Snoeck, Global Business Development Manager, Bekaert
Prof. Rolf Tarrach, President, European University Association
Prof. Em Mary Ritter, Imperial College London; Former CEO, Climate-KIC; Research, Innovation and Science Policy (RISE) expert

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