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ENGINEERING SKILLS REQUIREMENTS FOR SUSTAINABLE DEVELOPMENT AND ACHIEVING THE SDGS - OUTCOMES OF FOCUS GROUPS HELD IN IRELAND, FRANCE, DENMARK AND FINLAND AS PART OF A-STEP 2030 PROJECT ACTIVITY 1: TASK 2

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REPORT R2:
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Contents

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Executive Summary

This document reports on the outcomes of focus groups held in Ireland, France, Denmark and Finland as part of the A-STEP 2030 project. This project is an EU Erasmus + project funded under call number 2018-1-FR01-KA203-047854.

The aim of the Focus Groups, which were held with Engineering Academics, Engineering Students and Engineering Employers in Ireland, France, Denmark and Finland was to provide insights into research questions under three different themes. The first theme was to determine the extent of knowledge (of Academics, Students and Employers) about Sustainable Development (SD) in general and the Sustainable Development Goals (SDGs) in particular. The second set of questions related to current Sustainable Development related activities within engineering programmes and the third was to identify skills requirements for the future.

The key findings show that Energy and Environment are the words most associated with Sustainable Development, reflecting the pillar of Environment. There is evidence of the influence of national policies and initiatives in each country which raised awareness of particular issues such as Carbon Tax (Ireland), Circular Economy (Finland), Climate and Transport (Denmark) and Innovation (France). Participants were asked to name any of the SDG goals and the average number identified per person ranged from 2.1 in Ireland, 1.4 in France, 1.3 in Denmark and 1.0 in Finland. SDG 13 (Climate Action) tops the list with the greatest number of mentions and far exceeds awareness of other goals.

There was a range of views on how SD was included within engineering programmes, ranging from not covered at all to isolated standalone modules, integrated modules or specific projects which dealt with SD. Several barriers were highlighted which prevents the integration of SD in engineering programmes including; lack of academic staff knowledge on SD and other broad topics and the difficulties in changing the curriculum or finding space in the curriculum. Opportunities were also presented which included the use of new optional modules or the implementation of industry based or multidisciplinary projects.

Regarding the skills needed from engineers to solve the SDGs, many of the focus group outcomes presented both technical and non-technical skills and highlighted the importance of a balance between the two. “Communication” as a skill topped the list with followed by “Technical Skills”, “Critical thinking” and being “Ethical”. In the main, the consensus was that technical skills are still deemed important and students, academics and employers all agreed that the Universities are doing a good job of producing good technical engineering graduates. Employers say “We take that for granted”. Several examples were provided on how students could better develop the non-technical skills; working with external clients or communities, independent design work with little information and interdisciplinary projects.

These findings will be used to inform a new Model of Engineering Skills and Attributes needed to achieve the SDGs, which will be published as Intellectual Output 1 of the A-STEP 2030 project.

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1.0 Purpose of document

The document begins by explaining the purpose and aims of the overall research project and more specifically, the research questions associated with this particular activity (Activity 1: Task 2). This report also contributes to Intellectual Output 1. A summary is provided outlining how the research team agreed the procedure to carry out the focus groups and how ethical approval was obtained. Summary details about the focus group participants are also included.

The results of the focus groups are presented. Each focus group was divided into three sessions looking at different aspects and different research questions. Within these chapters, comparisons are made between different countries and between different participant groups with a horizontal (between groups) and transversal analyses (different themes).

The final section summarises the findings of the focus group activity and the results which are relevant to the overall research study.

2.0 Summary of Overall Research Project

The main objective of the A-STEP 2030 (Attracting diverSe Talent to the Engineering Professions of 2030) project is to develop new and innovative teaching approaches relevant to learners' values yet appropriate to teach a new set of skills and competencies needed for the future. Our goal is to create an attractive and fascinating learning environment thereby encouraging young people and adult learners with diverse backgrounds to engage in engineering studies and the profession as a whole.

The project comprises the following three activities:

Activity 1: Determine future roles and skills requirements of engineers to enhance the sustainable development of society.

Activity 2: Investigate the values, motivations and preferences of young people, students and adult learners to determine how this influences their future career choices and use this knowledge to make a career in engineering more attractive to all young people.

Activity 3: Develop new and innovative teaching and learning practices to respond to these findings.

The project consortium has 7 members from six EU countries (France, Denmark, Finland, Ireland, Sweden and Belgium) and 10 associated partners. The team includes four different European Higher Educational Institutes (HEIs) all involved in Engineering Education Research. (ENSTA Bretagne, France, TU Dublin, Ireland, Aalborg University, Denmark and Metropolia University, Finland). The team is also complemented by representatives from SEFI and BEST (Board of European Students of Technology) which represents HEI students in STEM, and Universum - experts in research relating to student motivations and career choices.

Figure 1 shows the main activities associated with the project. This report focuses on the result of Activity 1: Task 2: Identify engineering skills and competencies required to enable a successful and sustainable European society.

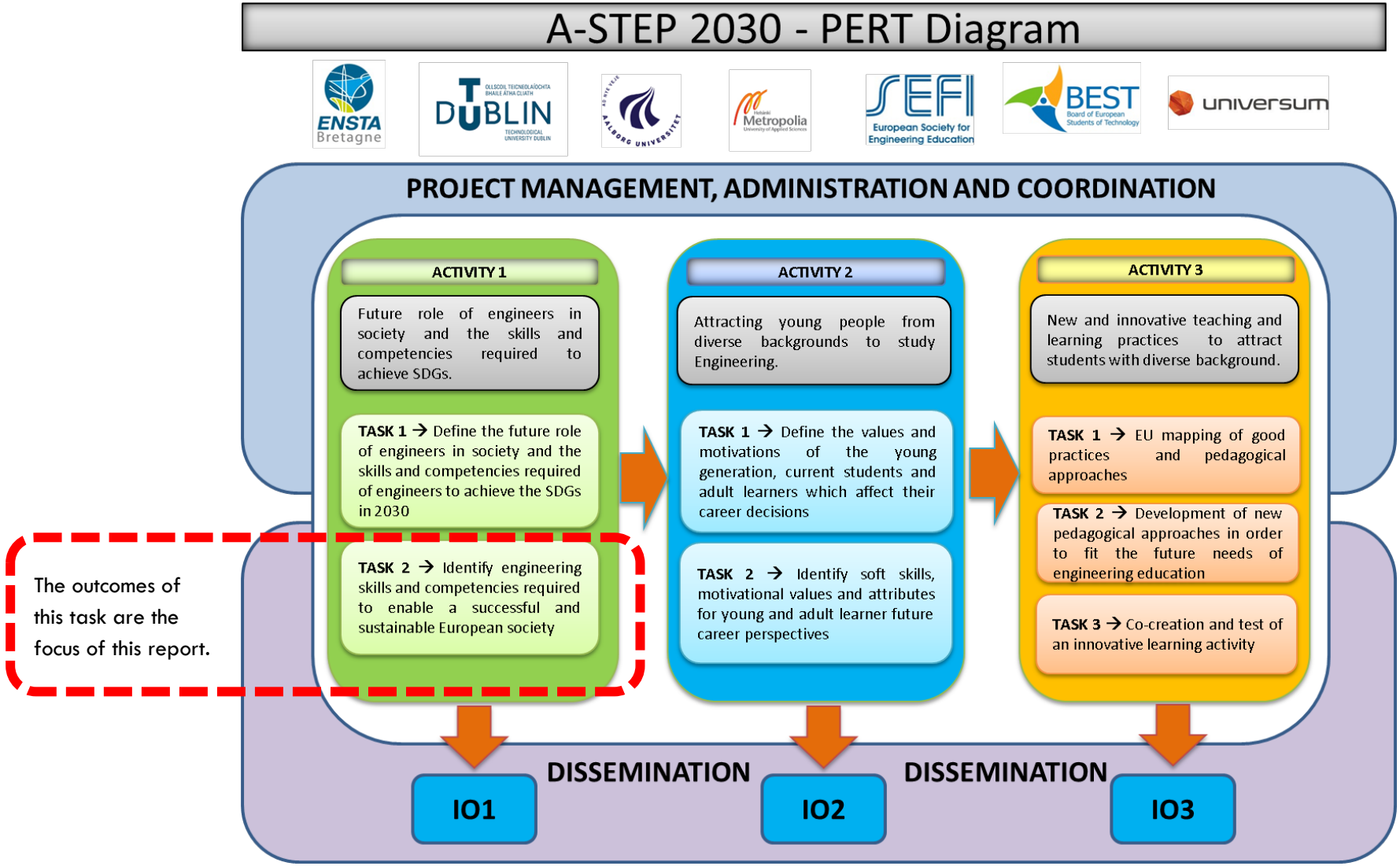


Figure 1: Overall Project details showing the aims of each activity.

3.0 Research Questions

The purpose of this Activity 1: Task 2 was to gain an insight into the different viewpoints of engineering students, academics and employers to identify engineering skills and competencies required to enable a successful and sustainable European society. To investigate our research question, we opted to use a qualitative research methodology. Focus groups were considered the most appropriate research method to collect insightful information on how each participant or participant group viewed the skills which were required of engineers to enhance the development of sustainable communities, economies, environments and industries across Europe. Focus groups were chosen as a method designed to give numerous views about a specific topic, allowing the focus group participants to interact with each other as well as with the moderator, generating a conversation rich in diverse views.

The focus groups sought to provide insights into the following questions, which have been derived from the literature review process and to allow comparison and contrast between different groups and countries involved in the study. The focus groups were split into three parts in order to generate activity and discussion. Each session looked at a different aspect. The first, to determine their extent of knowledge about sustainable development, the second to investigate current activities and the third, to identify skills requirements for the future. The research questions are as follows:

Session 1

1. To what extent are employers/academics/students aware of Sustainable Development (SD)?
2. To what extent are employers/academics/students aware of the Sustainable Development Goals?
3. To what extent do employers/academics/students think diversity is important in achieving SDGs?

Session 2

4. Do employers/academics/students currently engage in sustainable development related activities?

Session 3

5. What are the skills needed to prepare engineers to be more sustainable in the future?
6. Will these skills suffice to meet SDG 11 (Sustainable cities and communities) in particular?

7(a). For professionals and academics: Do engineers today possess these skills?

7(b). For students: Do engineering students develop these skills in their engineering programmes?

4.0 Overall outline of focus group activity including limitations

As the intention was to compare the results of each participant group across countries it was important that the outline for how the focus group was to be carried out was agreed between all academic partners. To this end, a Focus Group Instructions document was created and was reviewed and agreed by all parties. The document was used to ensure that each country used a similar invitation email, that the same questionnaires were used to collect quantitative data and that similar questions were asked in the focus groups. It is acknowledged however that focus groups, by their very nature cannot necessarily follow exactly the same structure, as the researcher should follow the line of conversation in each group. However, the use of an agreed process proved useful in ensuring that each group addressed the main research questions. Furthermore, the first focus group which was held during the Transnational Project Meeting in Dublin was observed by participants from each country in order that a similar process could be followed. It is important to note that focus groups in each country were facilitated within their native language and the lists of skills and relevant citations were then translated into English by each partner organisation. It is important to highlight this as a limitation of the work, as the frequency word lists were

then formed from translated concepts and terminology. Each partner created a report summarising the findings of the focus groups in each country, using an agreed report template. This was forwarded to the lead partner in this activity and formed the basis of this overall report, which summarises the findings.

5.0 Ethical Approval

It is important in any research work that involves human participants that researchers are mindful of the potential impact of the data collection on any participant. The Irish National Policy of maintaining integrity in research (IUA, 2014) and the European Code of Conduct for Research Integrity (ALLEA, 2017) provide guidance on undertaking research based on international best practice, ensuring integrity through good research practice. TU Dublin, as the lead partner on this activity took responsibility for gaining ethical approval for the focus group work. Ethical approval was granted by the TU Dublin Research Ethics and Integrity Committee on 18th May 2019: Reference: REC-18-184. Each partner also gained ethical approval for their focus groups in their respective Institutions.

6.0 Summary of focus groups participants

Each partner country undertook three focus groups, with engineering employers, engineering academics and engineering students. A summary of participants in the Focus Groups, their level of expertise and their type of discipline is shown in Tables 1 and 2. In total, there were 86 participants who engaged in focus groups as part of this study.

Table 1: No of focus group participants and level of expertise

	No of Students and no of years of study	No of Academics and length of academic experience	No of Employers and length of experience
Ireland	7	9	6
	1-5 years	1-20 years experience	1-41 years experience
France	9	7	8
	3-5 years	2-20 years experience	2-49 years experience
Denmark	7	8	6
	Not available	2-40 years experience	20-35 years experience
Finland	4	8	7
	2-3 years	8-24 years experience	15-37 years experience

Table 2: Discipline details of focus group participants

	Student Disciplines	Academic Disciplines	Employer Disciplines
Ireland	Mechanical Civil Manufacturing General Engineering	Civil & Structural Electrical and Electronic Mechanical Building Engineering Mechanical and Design	Electrical Civil Structural Telecoms/IT
France	IT- Artificial Intelligence Naval Architecture Hydrography Oceanography Business Management	IT Mechanical Human and Social Sciences Administration Quality Management & SD Foreign Languages	Electronics/signal processing Vehicle Architecture Hydrodynamic naval Pyrotechnic Electronics and Naval Architecture
Denmark	Disciplines not available	Environmental Planning Production Electronics Mathematics	Urban Development Agri-tech Technical Director CEE
Finland	Biotechnology Environmental Engineering Laboratory analytics Electric and Automation Engineering	Mechanical and Design ICT Chemical engineering Laboratory Science Environmental Engineering Automation	ICT Electrical Chemistry Physics

7.0 Session 1: Awareness of Sustainable Development, the SDGs and the impact of Diversity

The first session sought to investigate the participants awareness of the concept of Sustainable Development (SD) and of the Sustainable Development Goals (SDGs) which were launched by the United Nations General Assembly in 2015 (UN, 2015).

7.1 Words Associated with Sustainable Development

Participants were first asked to brainstorm (individually) the words or themes they associated with Sustainable Development and these terms were collected and collated on a whiteboard.

The words/themes associated with Sustainable Development (SD) were analysed using word frequency analysis and Figure 2 shows the overall word cloud for all countries and all groups, where the word used most frequently is shown as the largest word. It is important to note here that phrases were separated into words for the word cloud exercise in order to cut down the number of variations available. So for example a phase such as “Renewable Energy”, would be counted as both “renewable” and “energy”. Whilst this gives a representative response to this term, it is also important to note that the context of the word should also be considered, for example “Circular” was normally used within the phrase “Circular Economy”. Table 3 shows the frequency of the most highly ranked words created in this exercise, which corresponds to Figure 2.

Figure 2: Word cloud showing all words and themes associated with Sustainable Development [All countries, All groups]

Table 3: Frequency of most highly mentioned words.

Frequency of use	Term used		Frequency of use	Term used
65	Energy		**14**	Water
30	Environment		**13**	Efficiency
30	Renewable		**12**	Green
28	Recycle		**12**	CO2
26	Economy		**11**	Sustainable
22	Reduction		**10**	Materials
20	Waste		**10**	Circular
20	Clean		**10**	Climate
17	Consumption		**9**	Protection
17	Resources		**8**	Management
14	Education			

The results for each participant group were also analysed to contrast and compare different groups and different countries. Figure 3 summarises the word cloud results for each country. Figure 4 shows the individual word clouds associated with each participating group.

Fig. 3a: Word cloud for Ireland (All Groups)

Fig. 3b: Word Cloud for France (All Groups)

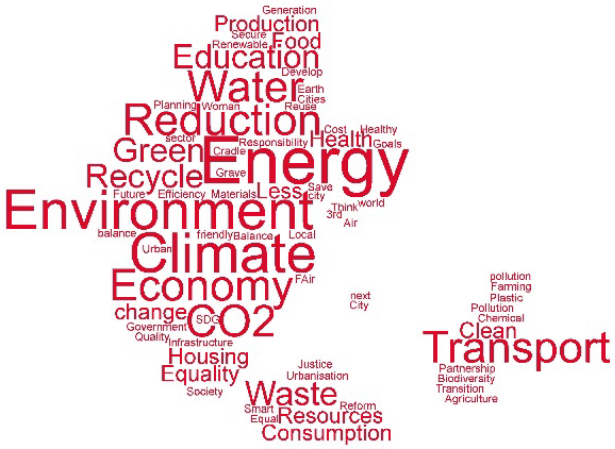


Fig. 3c: Word cloud for Denmark (All Groups)

Fig. 3d: Word Cloud for Finland (All Groups)

Figure 3: Words associated with SD for each participating country (shapes represent the shape of each country).

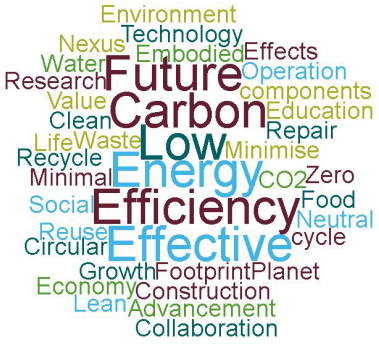
Country	Students	Academics	Employers
Ireland			
France			
Denmark	No data available		
Finland			

Figure 4: Words associated with SD for each participating country and participant group

7.2 RQ1: To what extent are employers/academics/students aware of Sustainable Development (SD)?

The literature review revealed that the concept of SD is typically described using three concepts or pillars, sometimes shown in Venn diagram format (Figure 5). The three aspects are; Social, Environment and Economy.

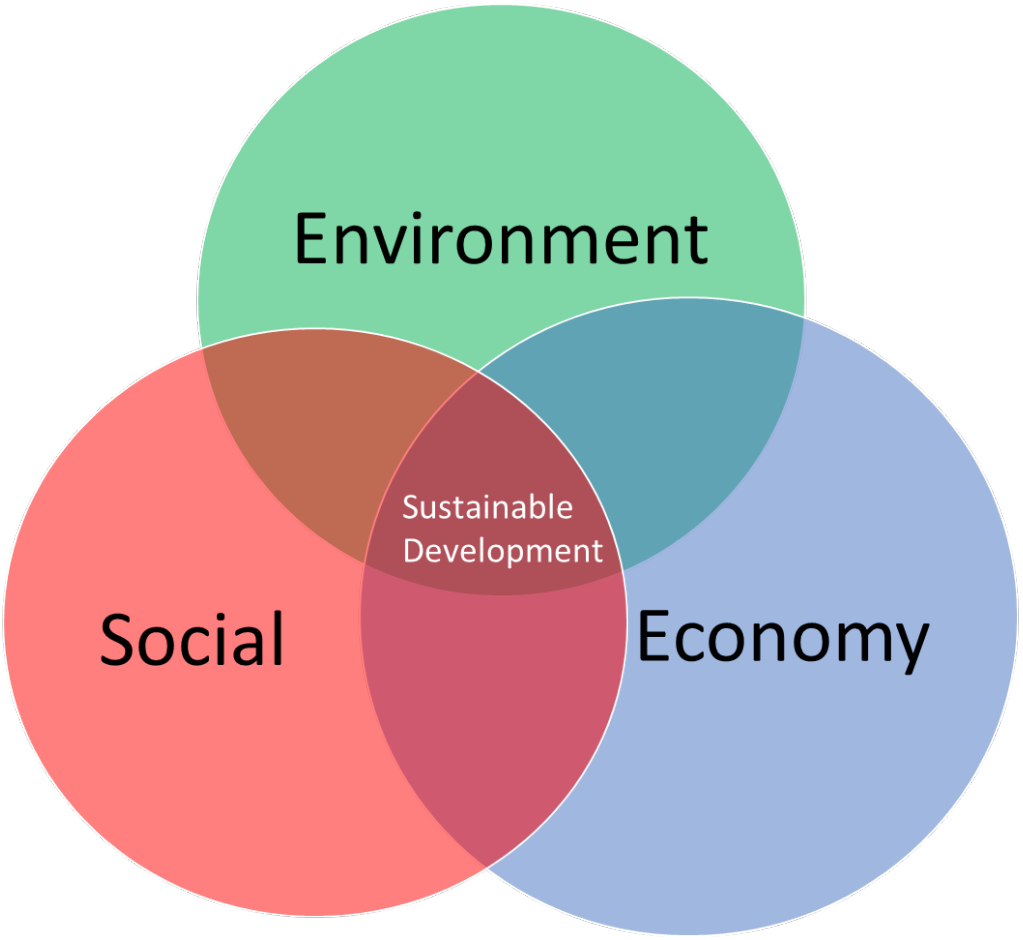


Figure 5: Concepts associated with Sustainable Development (adapted from Lozano, 2008)

The overall results of the word frequency exercise presented here suggest that "Energy" and the "Environment" are the two key aspects associated with SD with words such as "Renewable" and "Recycle" being included within those themes. These key words align very clearly to the pillar of Environment.

"Economy" and "Resources" and "Circular" are the most mentioned words associated with the pillar of Economy. Words associated with the third pillar, Society, are sparse, with only "Education" and to a lesser extent "Diversity" and "Equality" being included within this pillar.

The picture when we look at individual countries tells a similar story, with Energy and Environment standing out clearly in all countries. Ireland shows an increased awareness of the words "Carbon" and "Water", reflective of the current government focus on the introduction of carbon taxes and the ongoing discussion surrounding water bans and water charges. The words "Climate" and "Transport" are words associated with Denmark in particular.

In France, the words "Consumption", "Respect" and "Innovation" are highlighted, which do not appear to the same extent in other countries. The French government launched the PEPITE program in 2014 (www.pepite-france.fr) as an initiative in HEIs for boosting innovation, technology transfer and entrepreneurship. The main objective of this programme is to facilitate student entrepreneurs to create start-up companies and contribute to the innovation of the country. Consequently, at ENSTA Bretagne there are several specific training modules for innovation, and innovation capacity is viewed as a particularly important engineering skill.

In Finland, the theme of "Circular Economy" is shown as a key message associated with SD, reflective of the emphasis on the circular economy road map, which The Finnish Innovation Fund Sitra launched in autumn 2016 (Järvinen et al., 2019). Various projects have been funded including teaching development projects in all school levels from primary schools to higher education. One Focus Group student and two academics group's lecturers had been involved in circular economy development projects.

In Denmark, the topics of the "Economy", "Housing" and "Transport" are all highlighted as differing from other countries. Climate Change and Transport are key topics in Danish society at present. The focus groups in Denmark took place in Aalborg, a region dominated by many commuters. There is currently an ongoing debate around the construction of a new bridge and associated motorways across the fjord and about public transport in general. Housing is also considered as the highest potential for energy savings and this may be why these topics were highlighted in particular. Furthermore, in Denmark, the overall clustering framework of Environment, Society and Economy, all three aspects of SD were categorised in the discussion group.

All the student groups produced similar findings, except that in France, the use of words "Education" and "Management" in relation to SD stands out. Management in this context was mainly used in phrases such as "Waste Management", "Forest Management" and "Energy Management".

The academic groups showed differing foci with Irish academics concentrating on "Renewable" "Energy" and "Water" and offering words associated with specific technical solutions to SD, such as "Heat Source pumps" "Ground Source pumps" and "Rainwater harvesting." French academics brought out the idea of "Consumption" and "Resources" as a key theme.

Irish employers associate SD with the "Future" along with themes such as "Carbon" and "Efficiency", again perhaps reflective of the current government focus on carbon taxes (de Bruin and Yakut, 2019). French employers also highlight the word "Consumption" but also reflect the words "Global" and "Respect (of nature)" which is not typical of other employer groups. The words "Transport" and "Infrastructure" and "Urbanisation" also appear in the word cloud for Danish employers, similar to themes highlighted by the Danish academic group. The Finnish employers also highlight "Circular Economy", "Technology" and the "Future" with SD, showing a clear alignment with the Finnish academics.

7.3 RQ2: To what extent are employers/academics/students aware of the Sustainable Development Goals?

Participants were then also asked individually, if they could name any of the SDGs, without the researcher giving any introduction as to what the SDG goals were. This was also an individual exercise. Responses were collected, analysed and tagged to the relevant SDG where appropriate. Some participants gave specific responses which were easy to identify such as "Clean Water" (tagged as SDG 6) or "To make cities safe, inclusive and sustainable places" (tagged as SDG 11). Others gave responses which were interpreted and tagged to two different SDGs such as "To provide education to people in the 3rd world" which was tagged as SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities). Finally, seven responses were not deemed to be related to a specific SDG (although they reflected the concept of SD) and were therefore not tagged. These were; "Sustainability and long term vision", "Environmental Poverty", "Security", "Synergy of human being and nature", "Sustainable awareness building", "Technical" and "Social".

The quantitative results were then analysed to highlight the awareness of particular SDGs by country, and by participant group. Figure 6 shows the awareness of SDGs generally by country and indicates the average awareness per participant, calculated by dividing the number of SDGs goals identified by the number of participants in the group.

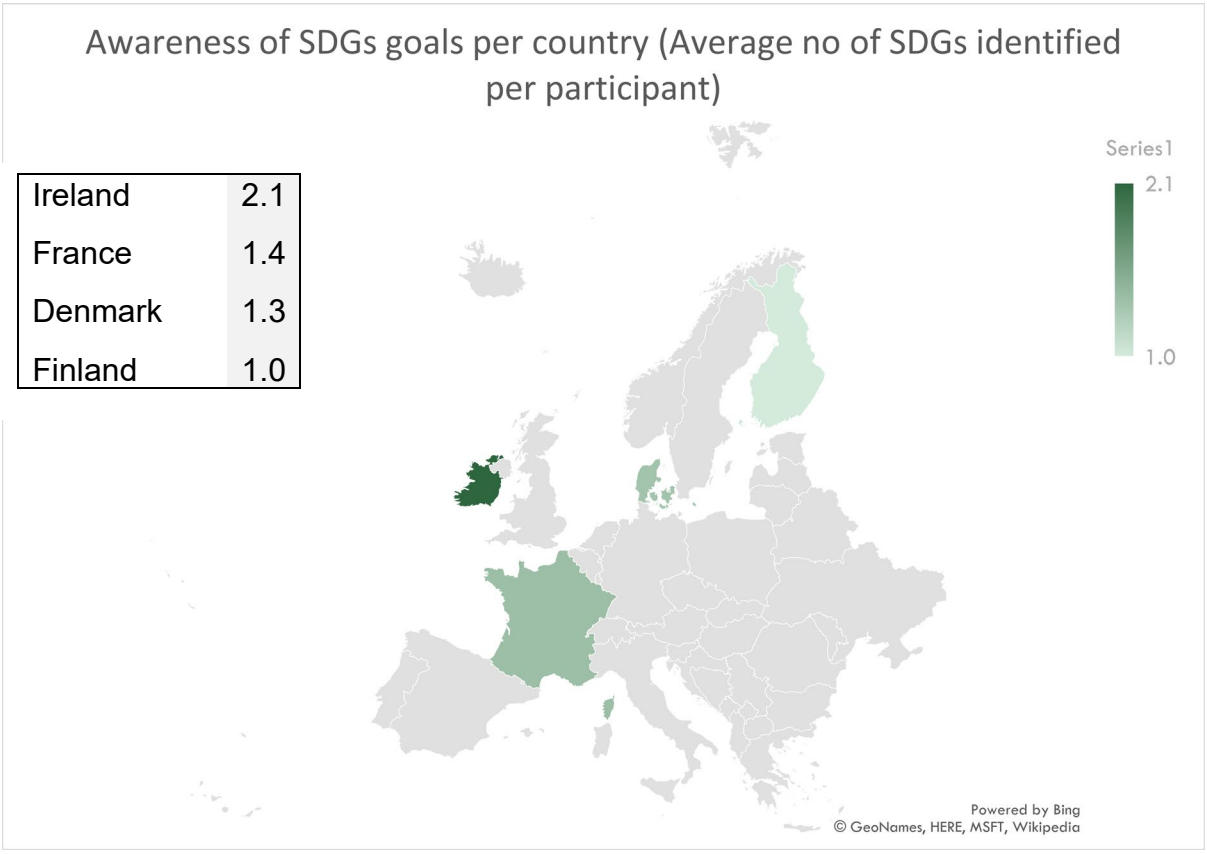


Figure 6: Average number of SDG goals identified per person in each country

Figure 7 and 8 show the differentiation in which particular goals were most often identified, indicating the level of general awareness of each individual SDG. These figures also show the number of goals identified by each country (Figure 7) and by each participant group (Figure 8).

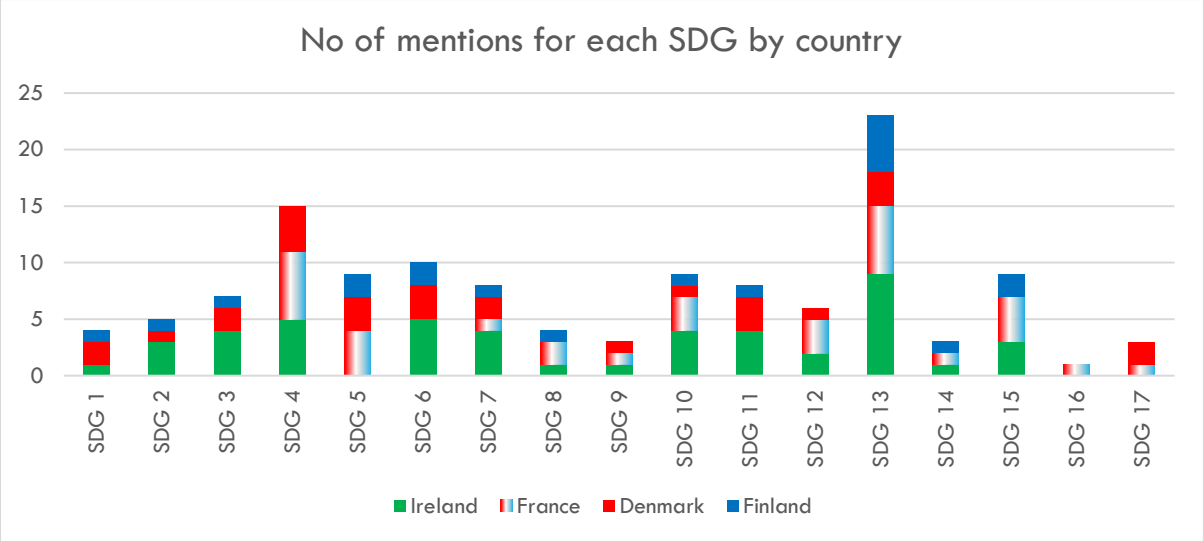


Figure 7: No of mentions for each SDG by country.

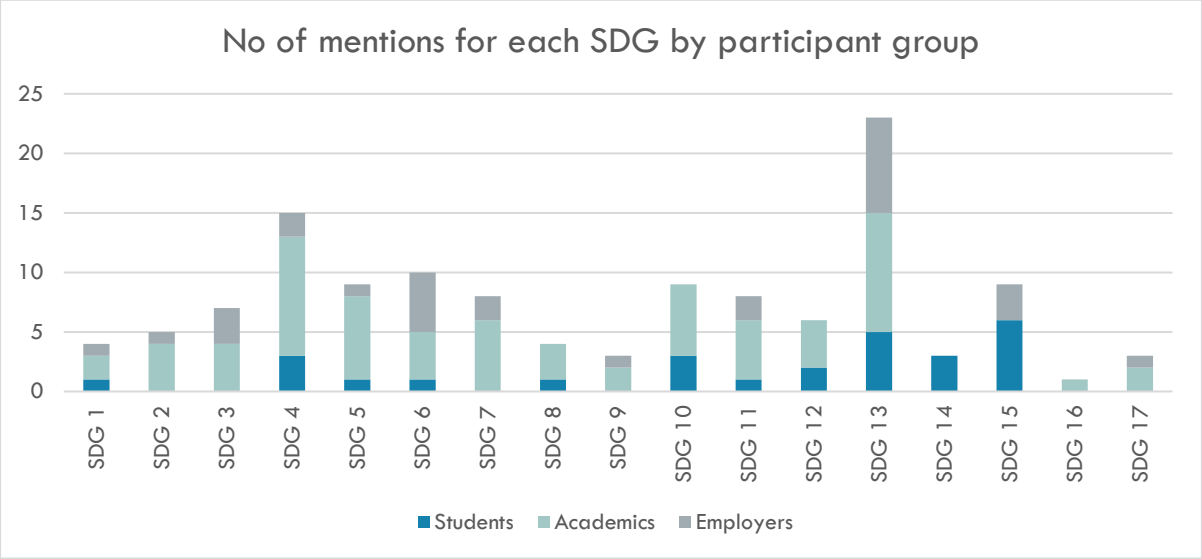


Figure 8: No of mentions for each SDG by participant group.

SDG 13 (Climate Action) tops the list with the greatest number of mentions (23), and far exceeds other goals. With 15 mentions, SDG 4 (Quality Education) comes in second place, followed by SDG 6 (Clean Water and Sanitation) with 10 mentions.

Perhaps surprisingly, SDG 5 (Gender Equality) comes in fourth place, along with SDG 10 (Reduced Inequalities) and SDG 15 (Life on Land). These particular SDGs (5 and 10) relate to the wider concepts of the SDGs, or align to the societal pillar of SD.

Students did not identify SDG 2 (Zero hunger) nor SDG 3 (Good Health and Well Being), whilst both were identified by Academics and Employers, perhaps reflective of the older age profile within these groups. Surprisingly, Academics, considering that they are mainly engineering academics, did not identify SDG 14 (Life below water) nor SDG 15 (Life on land) as SDGs, which it is proposed would be key considerations for Civil Engineers and Naval Architecture professions in particular.

Finally, in order to determine which participant group had the most awareness of SDGs generally, the number of SDGs identified per group were divided by the number of participants in each group to give

an average value per participant in each group. Refer to Figure 9. Please note there is no quantitative data available for students in Denmark.

Ireland tops the list with the best awareness of the SDGs, but this is differentiated significantly with a low awareness from students (compared to all countries) but the highest awareness from academics and employers. We can also see that overall, academics are the group which are most familiar with SDGs, perhaps as one academic noted, because any research proposal now requires that the researcher align the work with the SDG goals. Employers are in second place and noted in the Irish Focus Group, the importance of governmental policy in directing their business model towards the SDGs. Exceptions are in the case of Finland where students are the most aware and in France, where the employers were not able to identify any of the SDGs and in fact several employers had not heard of the SDGs before. Of particular note is the awareness of French students (where 5 out of 9 students were able to name an SDG). These French students had completed a (mainly social entrepreneurship project) on the SDGs as part of their extra-scholarly activities and SDG's were presented at the beginning of their project. In Denmark, students were more likely to discuss particular elements or technical aspects related to sustainability issues rather than the specific goals themselves.

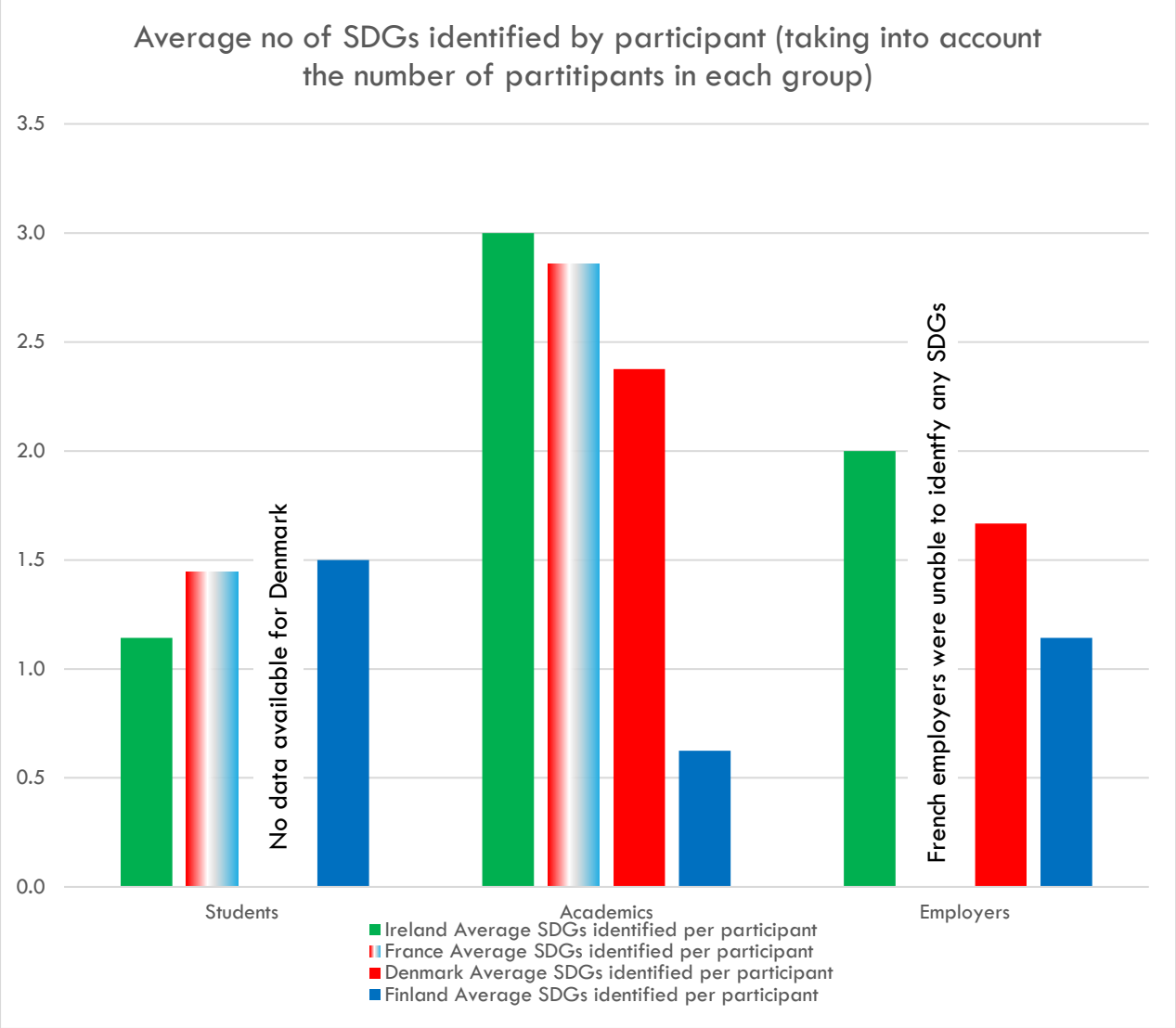


Figure 9: Average SDGs identified per participant in each country.

7.4 RQ3: To what extent do employers/academics/students think diversity is important in achieving the SDGs?

The final research question in Session 1 sought to ascertain participants' thoughts on the importance of Diversity in achieving the Sustainable Development Goals. They were asked to indicate to what extent diversity was important, with options for "Not important", Moderately important" and "Highly important".

Overall, 83% (64no) of respondents felt that diversity was highly important with only 1% (or 1 person) considering it not important as indicated in Figure 10.

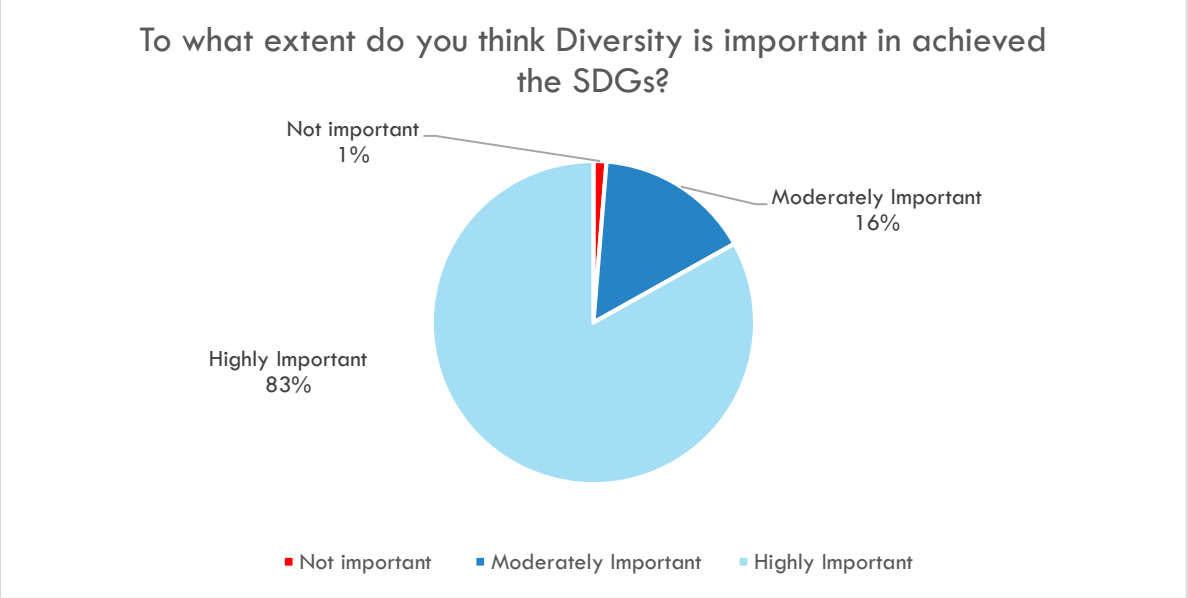


Figure 10: Views of participants on the importance of Diversity in achieving the SDGs

Whilst there was little difference in the view of Students, Academics and Employers overall, (Figure 11) the views differentiated by country show differences in the views of participants in Finland and Denmark compared to Ireland (Figure 12).

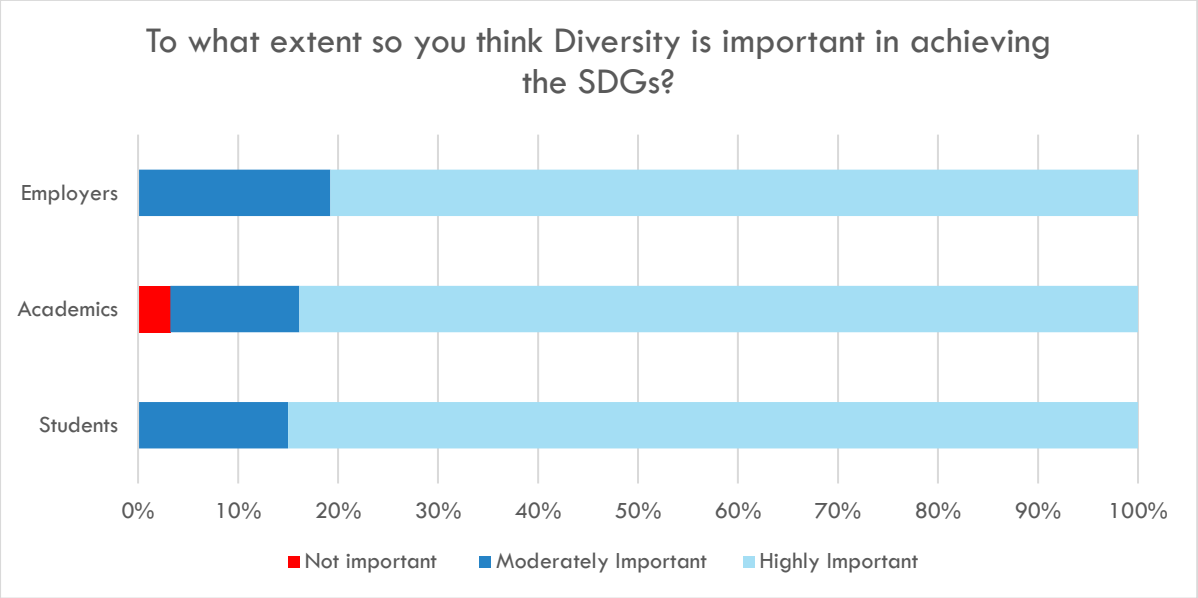


Figure 11: Views of participants on the importance of Diversity by participant group

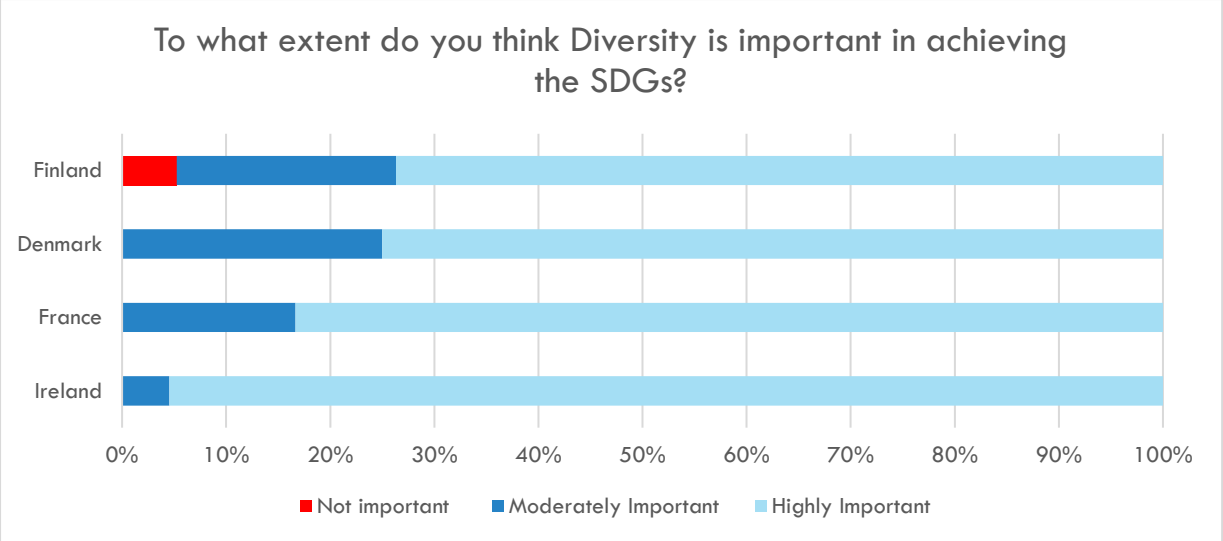


Figure 12: Views of participants on the importance of Diversity, differentiated by country.

The results showing a high level of diversity awareness in France is an interesting finding given the context of the study. This is because ENSTA Bretagne is considered as an elite engineering school within the French educational system, traditionally having a low level of diversity amongst students and academic staff.

In Ireland, it is interesting to note that in the academic group the split was 5 female and 4 male participants, a high level of gender diversity in the group. Furthermore, TU Dublin has recently created a new role with the university "Director of Equality, Diversity and Inclusion" and this may have some impact on the awareness of academic staff and students about the focus on diversity.

For students and academics at Aalborg University, Denmark and for employers in the region (with a strong affiliation to AAU) contextualized projects, interdisciplinarity and general awareness (through public debate & political focus for 30+ years) has a higher impact than an unspecified diversity term. In fact, the discussions revealed that it was not thought that "diversity" alone is the answer to solving the SDGs, but interdisciplinarity was much more important.

The discussion around diversity with regard to the Finnish academics' group, revealed that they considered diversity only in relation to gender diversity and felt that diversity wasn't a solution for SDG problems, contrasting with the wider understanding of diversity from the Danish group.

8.0 Session 2: Integration of SDGs in education and industry

The focus of session 2 was to investigate if and how the concept of sustainability and in particular the SDGs were integrated into engineering programmes in each country and the extent to which businesses were impacted by the SDGs. The overall research question for this session was:

Session 2

Do employers/academics/students currently engage in sustainable development related activities?

Upon completion of Session 1, participants were shown a short video to explain the SDGs and were provided with a leaflet giving a short explanation of each goal. This was to enable them to engage in Session 2 (detailed discussions about individual SDGs) with sufficient background knowledge.

Each participant was asked to complete a questionnaire which asked three key questions:

1) Please tick the SDGs which are of most concern (to your Institution or Company)
2) Of those you have chosen, please rank them in order of importance.

For students and academics:

3a) Of those you have chosen, please indicate to what extent they are included in your engineering programme

For employers:

3b) Of those you have chosen, please indicate to what extent your business is committed to achieving each SDG.

The purpose of this session was to be able to compare and contrast views of academics and students to see if the intentions of academic staff were translated to the student experience and to identify gaps where there are SDGs which employers need, and which are not being covered in the relevant engineering programmes.

Figure 13 shows the SDGs which were selected as those of most concern to Institutions or Companies whilst Figure 14 indicates the SDGs selected as "most" important.

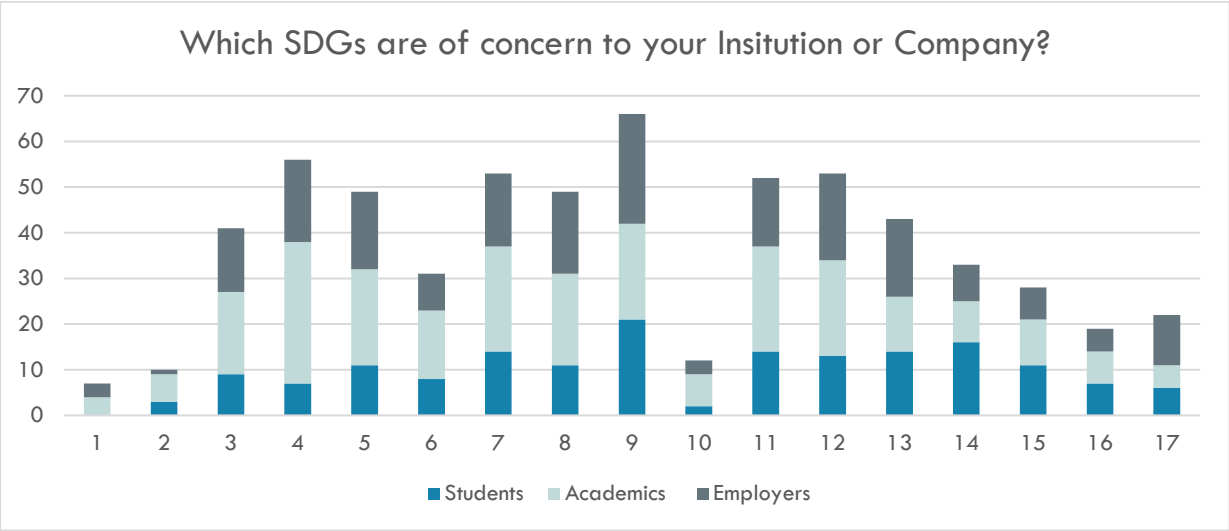


Figure 13: SDGs selected as those of concern to the Institution or Company.

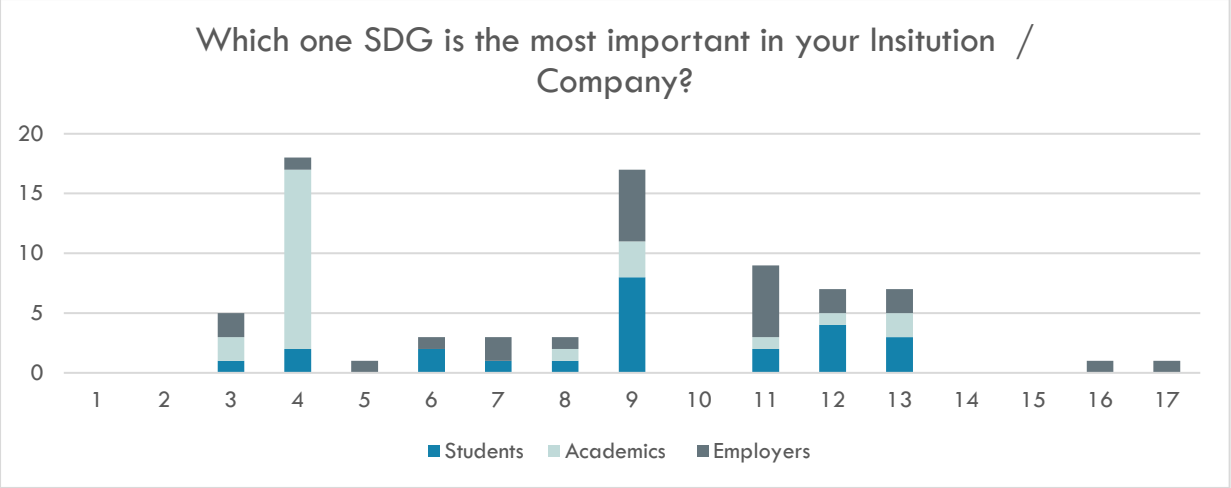


Figure 14: The most important SDG selected by participant groups

It is interesting to note here that when participants selected the SDGs of concern to the Institution or Company, there was a wide range of the SDGs selected. In fact, overall, each participant group selected every SDG at least once except for students who did not select SDG1 (No poverty), indicating that students do not believe academic institutions are concerned with relieving poverty. SDGs 1, 2 and 10 are those which were least selected suggesting achieving No Poverty, Zero Hunger and Reduced Inequalities are not of immediate concern to the Institutions or companies involved in this study. Those of most concern (overall) are SDGs 9 (Industry, Innovation and Infrastructure), 4 (Quality Education),12 (Responsible Consumption and Production) and 11 (Sustainable Cities and Communities) and 7 (Affordable and Clean Energy). Figure 13 shows the split of the one SDG goal of most concern and here it is clear to see that SDG 4 (Quality Education) is mostly prioritised by the academic community, reflecting the discussions within the academic groups that Quality Education was the SDG where they could make the most valuable contribution. Employers are most concerned with SDG 9 (Industry, Innovation and Infrastructure) and 11 (Sustainable Cities and Communities), reflective of engineering work and the built environment as a whole.

Figure 15 shows the results of the question on how well covered each SDG was within engineering programmes and aligns quite well with Figure 13, the SDGs of most concern.

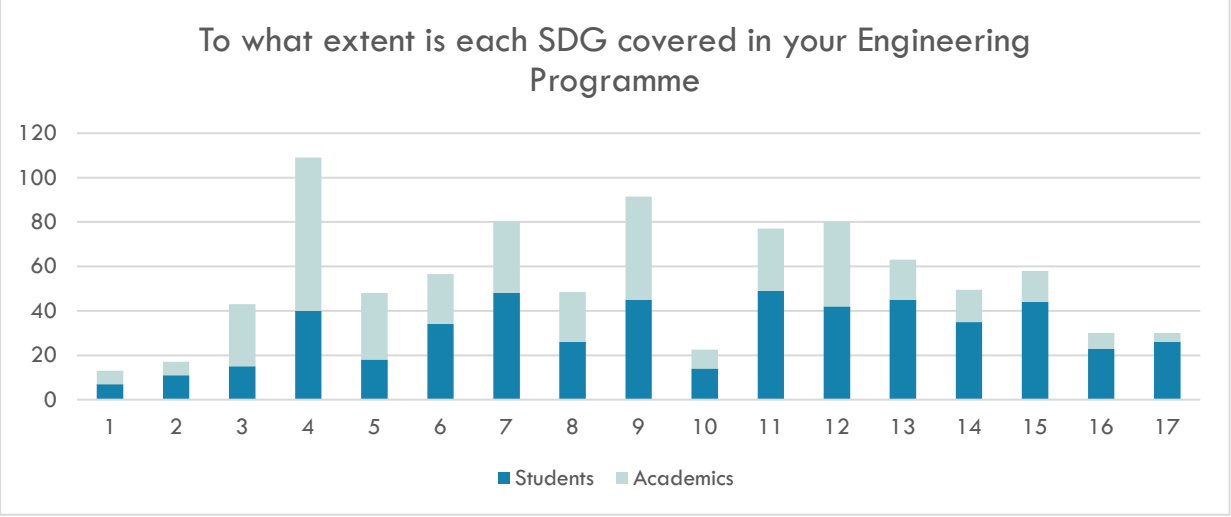


Figure 15: The extent to which each SDG is covered in engineering programmes (Student and Academic views only)

Of interest here is that in some cases the academics consider that a particular SDG is covered more than the students experience, for example SDG 3 (Good health and well-being), SDG 4 (Quality Education) and SDG 5 (Gender Equality). Conversely, students have also indicated that SDGs 11 (Sustainable cities and Communities),13 (Climate Action),15 (Life on Land),17 (Partnership for the goals) are covered to a higher extent in their programmes than academics believe.

8.1 RQ4. Do employers/academics/students currently engage in sustainable development related activities?

SDG 4(Quality Education) is quite highly rated by academics and students indicating that academics consider this is an important part of their role and students indicate that they are receiving a quality education. SDG 9 (Industry, Innovation and Infrastructure) is indicated as an SDG of most concern to Institutions and companies and also one which is covered well within engineering programmes. Even though SDG 10 (Reduced Inequalities) was not selected as an SDG of most concern, there is an indication that engineering programmes do raise this issue within the curriculum.

The focus group discussions also looked at specific aspects concerning the integration of SD and SDGs in the curriculum.

8.1.1 Extent of coverage of SD in engineering programmes.

There was a range of views on how SD was included within engineering programmes, ranging from not covered at all to isolated standalone modules, or specific projects which dealt with SD. The differentiation between theory and application of SDGs was also noted with the comment that practical application of SD was necessary to understand the implications.

SDGs or SD not covered

> *"The closest thing to water I've covered in first year is the water fountain outside the lecture theatre probably". Irish Student*
>
> *"In my schooling, I have never heard of SDGs". French Student*
>
> *"In technical courses, we never talk about environment". French Student*
>
> *"[Gender equality] in our courses, we do not talk about it". French Student*
>
> *"SDGs are not present in our programs". Finnish Academic*

Examples of isolated modules

> *"We do have a standalone module which covers how the manufacturing process can be made more environmentally friendly". Irish Student*
>
> *"In our economics module, we had to do a project on Sustainable Development Goals. And I think goal 11 is the one that I studied. So, yes, we gave a presentation on it too". Irish Student*
>
> *"I think it is isolated.. That there are some lecturers that focus on it more than others. Like if you're in Structural design, you learn about timber steel and concrete, you're not going to really cover it. It's more that if you're in water and environmental or hydraulics or geotechnical engineering". Irish Student*
>
> *"We've got like a professional practice module. Which is basically, pretty much all about sustainability. We're doing a project at the moment on energy and mine focussed on nuclear energy. It's kind of interesting researching those aspects of it….new ways people are doing….sustainability". Irish Student*

> *"In the module "big challenge", we have to develop a project about the impacts of a socio-technical object on the population". French Student*

> *"Nearly all SDGs have been to some extent covered during courses, but it is very fragmented". Finnish Student (Environmental Engineering Programme)*

Integrated Approach

> *"Yeah, it is done broadly across the board. But there are one or two modules that focus in on lean manufacturing and efficiency". Irish Student*

> *"We incite students to ask ethical questions…that means to educate our students to be responsible…in all students project, it was well developed this year in the framework of social innovation…we had an applied approach related to lots of SDG's…we had also the debating and critical thinking on sustainability…" French Academic*

> *"I have put nothing in the case of 'not covered" as for me all SDGs are covered in our engineering program. However, it is a question of communication and display because we cover all these subjects but is it not promoted, as it is natural for us….so there is work in making it more visible". French Academic*

Technical Modules only

> *"I put SDG 9 in first place…. to make a sustainable industry, innovation and create an infrastructure…however, I have to be honest, in my case it is based on a technical approach and not a sustainable practical approach…."French Academic*

> *"Clean water and Climate Action are two key modules in the Building Engineering programme". Irish Academic*

Practical Application

> *"When we train our students, they do that we say to do. They have no risk and responsibility. However, when they are in a real working situation, they have a responsibility and they have to be able to justify their actions and apply a global thinking…"French Academic*

> *"I think it should be integrated into the technical subjects. Mainly because engineering in general - you learn models that are theoretical and then learn that they're not perfect and I think that's due to a lot of things. That's due to cost, due to space restrictions. And restrictions - you know that aligns to the Sustainable Development Goals - like we won't be able to just frivolously use energy - that's a major restriction. And I think it should be incorporated into each module if possible". Irish Student*

Some students in particular, lamented the fact that most of their modules were technical modules and when the issue of economics was mentioned it was merely in relation to being economically profitable, with no reference to nature, or reducing consumption, but to optimise performance rather than preserve nature. Conversely, the academic view highlighted that when students are presented with opportunities to engage in SD related activities, that students found it difficult to think outside the realm of engineering.

> *"Our technical teachers, they have never addressed the subject of environment. In their training, at most they include economic approach to know what will be economically profitable but never consider the impact on the nature". French Student*

> *"In mechanics, we talk about reduced consumption but not for the nature but rather to optimise the performance". French Student*

> *"Within a public policy module, I introduced a project to get students to look at different public policies and got them to link to the SDGs, but they could not see beyond subjects they were studying. So much of what they were doing was focused on their own situation". Irish Academic*

> *"We asked them to work on the question of social innovation and felt their frustration at not being able to complete their project. We only asked them for the project idea creation and presentation but not the realisation of the project. However, they are used to working on technical projects from the beginning to the end….this is a problem and we have to find a solution as to how to motivate them. We have this need to go further… there is a work to do". French Academic*

Some modules and projects were mentioned by students in particular and it was acknowledged that some of the broader topics were indeed taught as Masters level but not at undergraduate level.

> *"At Masters level – yes there are modules in some of these, but not undergraduate. At Masters level, students are already set to a particular way of thinking, it's very difficult to change them. How do we get them to think in this way, earlier in the programme?" Irish Academic*

Danish academics acknowledged that there was a University branding exercise that noted a focus on SD, but that this strategy or purpose did not necessarily filter down to educational activities. They did note however that a group had recently been appointed to look at the inclusion of SD/SDGs in the study regulations. Furthermore, with regard to importance, they discussed from who importance would be judged and therefore how it would be implemented. For example, importance judged by the Rector would be implemented in the university strategy, by study boards in the curricula, by academic staff in teaching materials and by students in the focus of project reports.

8.1.2 Barriers

For students, the principal barriers to including SDGs in engineering programmes were the lack of academic staff knowledge, mentioned specifically in French, Finnish and Irish student focus groups. Irish academics also highlighted the lack of knowledge on broad issues as a potential barrier.

> *"Because our technical teachers were not born in it, they have never been educated with the concept of sustainable development while we are... " French Student*

> *"In the first year, there was a sudden change since the reform of the teaching program, we are much more aware of environmental issues…including the impact of innovation on the environment. The SHS (Human and Social Sciences) teachers are those who talk about it, not the technical teachers". French Student*

> *"A big barrier is the teachers, who don't know about these things". Finnish Student*

> *"In [redacted] engineering, in sustainable development there isn't enough research into materials. There is like a lack of knowledge for lecturers so they can hardly pass on the knowledge if they don't have it themselves". Irish Student*

> *"Determinants of Health are a key aspect of what we need to teach, but there are challenges in trying to integrate that into engineering programmes, because there is a knowledge base deficit in engineering academics". Irish Academic*

A lack of academic's conscience as well as the lack of collaboration between different technical and non-technical teachers was also highlighted.

> *"The technical teachers who are closest to the profession that we will have…..they do not talk about it at all. The SHS teachers, they do not necessarily know what the work of engineer means, but they try to adapt their projects to our future profession but they do not know too much about it. We feel their awkwardness; we feel that it does not stick what we will do. It does not work, they do not know what we are going to do. We do not have the opportunity to link the two". French Student*

A resistance to and difficulty in changing the engineering curriculum, as well as finding space within the curriculum were barriers also recognised by both students and academics.

> *"Even if we want to change the way to do the things according to our perception, teachers do not agree. …..I said that I would like to change things, they will tell you that it is good but they will not push in this direction. They train us to do the same thing they did". French Student*

> *"The problem is, where do we have the space in the programme? We'd like to do these things but what do we leave out?" Irish Academic*

> *"Semesterisation has limited what we can teach and how much time we have with them. Module descriptors too can be restrictive, you can't change them midway as the project develops". Irish Academic*

Furthermore, in an Irish context, engineering students noted the restrictive nature of engineering programmes, where very little choice of modules is offered. A Finnish student highlighted the importance of being exposed to relevant modules which bring issues such as SD into focus and a French student on the importance of linking both the technical and non-technical modules.

> *"I think the nature of my course is pretty restrictive in itself. Because we're doing everything, we can't go into specific detail on one thing. So like, we're not really learning anything to an important extent". Irish student*

> *"When I took a voluntary module "Circular Economy", I heard about these things. My student mates, who haven't chosen this module don't get any information about these things." Finnish Student*

> *"We need good practices to link these competencies [technical and transversal skills] because we have disconnected things now. Either we should have teachers who are very sensitive to this and who are able to include it in their teaching practices, or have……transversal subjects". French Student*

For academics in France, the dispersion of sustainable development in diverse modules and the lack of implementation of these courses in a real-life context were viewed as the main barriers. In Ireland, academics were concerned that here was no space in the programme to add more generic topics and the impact of governmental policy in relation to these goals. Finnish Academics also acknowledged the importance of exposing students to wider political topics.

> *"If I compare to [name of an engineering school], they have an important number of teaching hours dedicated to sustainable education. In our school, we have lot of different things everywhere but there is no a dedicated module with dedicated teaching hours…it could create a problem of justification and visibility…" French Academic*

> *"Where do we discuss these topics? In which subject matter could we talk about populism and socialism. In the future, maybe we should be doing this, but I can't see where it could fit in now". Irish Academic*

> *"It's difficult to discuss these matters without reference to politics. There are standard books for technical subjects, but how do you avoid the bias of individual lecturers when it comes to talking about political issues?" Irish Academic*

> *"In teaching we should guide students to get a bigger picture - e.g. EU legislations about responsibility issues." Finnish Academic*

Furthermore, Irish academics acknowledged that they did not feel they were best placed to teach some of the non-engineering topics. In Denmark, it is viewed that the focus on interdisciplinarity and cross-disciplinary collaboration diminishes this barrier.

> *"Our engineering students need more exposure to this. A lot of these goals relate to lifelong learning, not necessarily technical topics and we should bring in engineers or non-engineers to teach them about these". Irish Academic*

Limitations of recruitment policies for engaging specifically experienced staff (in relation to SD) in an Irish context was raised, however, opportunities to fulfil this need by employing guest lecturers or part-time staff was offered as a solution.

> *"The recruitment policy in the Institution limits us from employing experts in this field, we have to employ engineering lecturers. This is a different level, a different view but the lack of diversity in engineering academic staff is a barrier to integration of these". Irish Academic*

> *"I brought in guest lecturer, a lawyer to talk about tax and how companies can avail of tax initiatives with regard to innovation. The students were blown away by it. This was a whole new perspective that they hadn't thought about before". Irish Academic*

8.1.3 Opportunities

Focus groups participants indicated several opportunities to better include SDGs in engineering programmes.

French academic participants indicated that there were opportunities to enhance the curriculum with topics and new modules in regard to SD and SDGs by developing lifelong learning programmes and implementing new programmes applying learning by doing in a real situational context, or working on multi-disciplinary projects.

> *"Nearly all 17 if SDGs are a consequence of consumer greed in a small population of the world. Perhaps we should approach teaching about these by acknowledging where the problems lie. We have to massively change our lifestyles and that's what we're not willing to do". Irish Academic*

> *"I think it [teaching of sustainable development] could be integrated into the optional courses of "cultural openness development" what we have at school in the first year". French Student*

> *"Multi-professional innovation projects could be very good. Now we have had innovation projects within our own program." Finnish Student*

French students highlighted opportunities outside of the engineering curriculum such as the Enactus Association and the importance of participating in extra-curricular activities. They also proposed co-creation of their programme as a way to close the gap.

> *"In the Enactus student association, during the first year, we chose to work on the thematic of education and climate change from the SDGs….my project subject was about education. The Enactus presented the 17 SDGS and we were talking about it. Our social entrepreneurship project had to take into account at least one of the 17 objectives".*

> *"Students should to be more involved in their own study programme construction because as we said the problem that our teacher have not been as aware as we are about the issue of sustainable development… and as it is us, in some case more aware than they maybe. We have more access to the information we would be able to better include it…". French Student*

Working directly with industry was a proposed opportunity to integrate SD into the curriculum and this was recognised by French students and both Irish and Finnish employers. Danish students already have ample opportunities to work directly with industry through their semester projects. However, conversely, French employers noted that there was a lack of interest from employers in collaborating in regard to sustainable development.

> *"Use mentors (persons working in the field or retired persons) for students". Finnish Student*

The overall consensus was that integrating SD into technical courses would be the best way to teach it, however, both French students and Irish academics acknowledged that this would mean upskilling of many of the engineering lecturers.

> *"These goals should be integrated in the modules, because otherwise students will do the SDG nodule and then forget about it, it's much more effective and it's important enough that is should be integrated. The problem is then that you have re-educate your entire staff to be able to teach aspects of this". Irish Academic*

Engineers Ireland accreditation (in an Irish context) was offered as both an opportunity and a barrier to the implementation of the SDGs in engineering programmes in Ireland.

> *"In Engineers Ireland Accreditation, the main impact of the ethics programme outcome is – what are the Health and Safety Implications of your design, and that covers us. If you've Health and Safety in there, we're covered". Irish Academic*

> *"It is one of the programme outcomes within the EI accreditation that the engineer's role in the context of society is understood, so perhaps within that arena, we have space to explore it". Irish Academic*

8.1.4 Requirements of engineering Employers

The final research question sought to identify if there were gaps in the engineering curriculum in relation to what employers need from engineering graduates. Figure 16 shows a comparison between the extent of coverage of particular SDGs in engineering programmes and the extent to which businesses are committed to achieving each SDG.

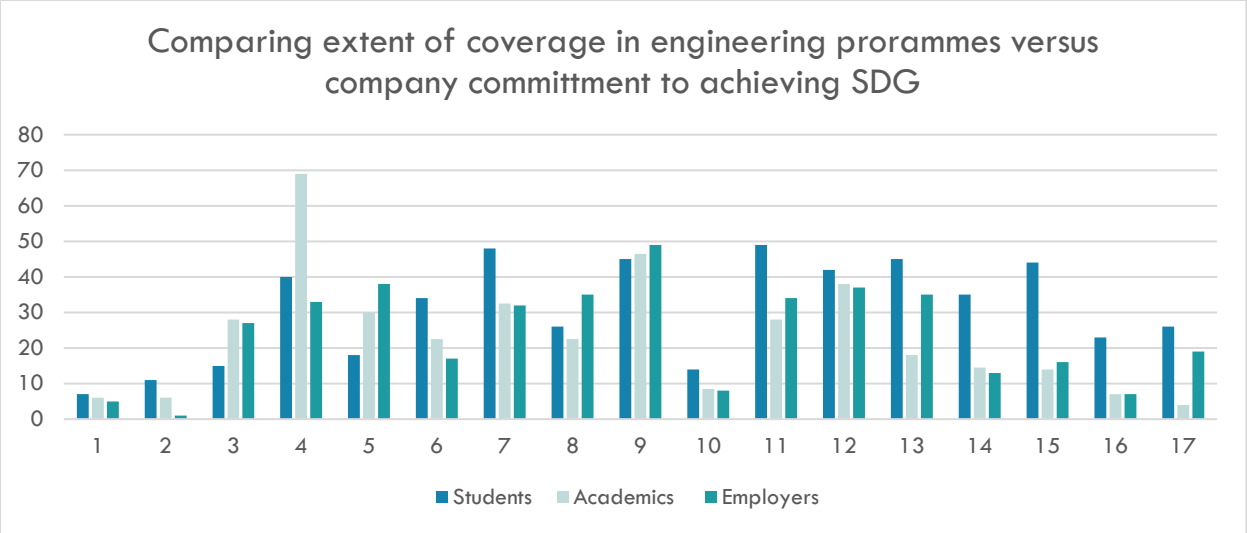


Figure 16: A comparison of the extent to which SDGs are covered in engineering programmes (Student and Academic views) compared to the committment of employers to achieve each SDG.

Overall, there are few significant gaps however, Gender Equality (SDG 5) is one SDG highlighted as being a commitment of employers, but not necessarily addressed within engineering programmes. SDG 17 (Partnership for the goals) is an issue for employers and students believe is covered within the programme, however this is not reflected in the views of academics. Finally, academics prioritise SDG 4 (Quality Education) which reflects their role.

9.0 Session 3: Skills needed to prepare engineers to achieve Sustainable Development and SDGs

The final session asked participants to consider the skills requirements that engineers needed in order to build a more sustainable future. The research questions associated with this session were:

Session 3

5.0 What are the skills needed to prepare engineers to be more sustainable in the future?

6.0 Will these skills suffice to meet SDG 11 (Sustainable cities and communities) in particular?

7(a). For professionals and academics: Do engineers today possess these skills?

7(b). For students: Do engineering students develop these skills in their engineering programmes?

This session began with a brainstorming session which identified a list of skills required to achieve the SDGs. The group then discussed the reasoning behind the choice of skills and why some may be more important than others. Summarised here are overall skills lists, by word frequency analysis and again, the specific skills lists identified by each participant group. For the word frequency analysis in this section, phrases were analysed rather than individual words. Figure 17 and Table 4 show the word cloud and list of most frequently used phrases associated with all participant groups and all countries and Figure 18 shows the skills lists per participating group.

Figure 17: Overall word cloud indicating skills requirements for Engineers to achieve the SDGs [All groups, All countries]

Table 4: Frequency of most highly mentioned skills [All groups, All countries]

Frequency of use	Term used	Frequency of use	Term used
14	Communication	4	Collaboration
11	Technical Skills	4	Innovation
6	Critical Thinking	4	Creativity
6	Ethical	4	Solutions
5	Project Management	4	Cultural
5	Open mindedness	4	Teamwork
4	Problem Solving		

The results for skills required noted by each country is also shown in Figure 18.

Fig. 18a: Word cloud for Ireland (All groups) n=89phrases

Fig. 18b: Word Cloud for France (All Groups) n=96phrases

Fig. 18c: Word cloud for Denmark (All Groups) n=61phrases

Fig. 18d: Word Cloud for Finland (All Groups) n=20phrases

Figure 18: Words associated with SD for each participating country.

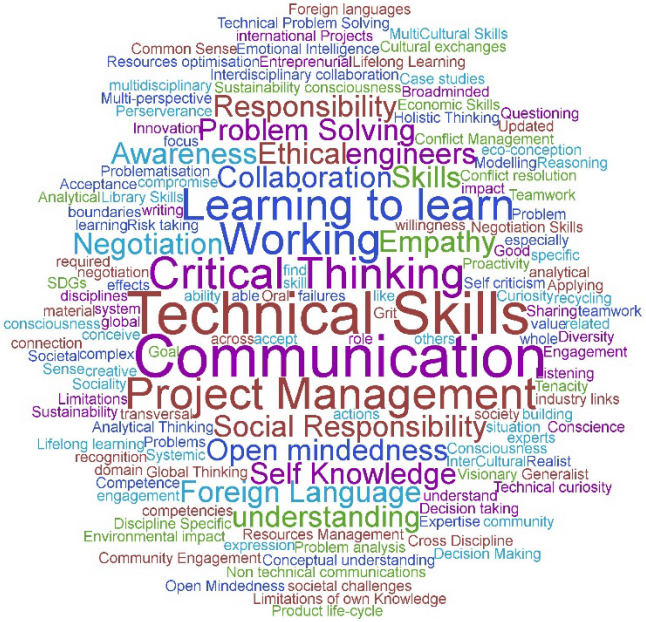
Students	Academics	Employers
		

Figure 19: Word clouds indicating skills requirements for Engineers to achieve the SDGs [All groups, All countries]

9.1 RQ5: What are the skills needed to prepare engineers to be more sustainable in the future?

Overall the skills requirements can be summarised into two broad categories, technical skills and non-technical skills. Furthermore, the non-technical skills can be further subdivided into different aspects as proposed in the framework shown in Figure 20.

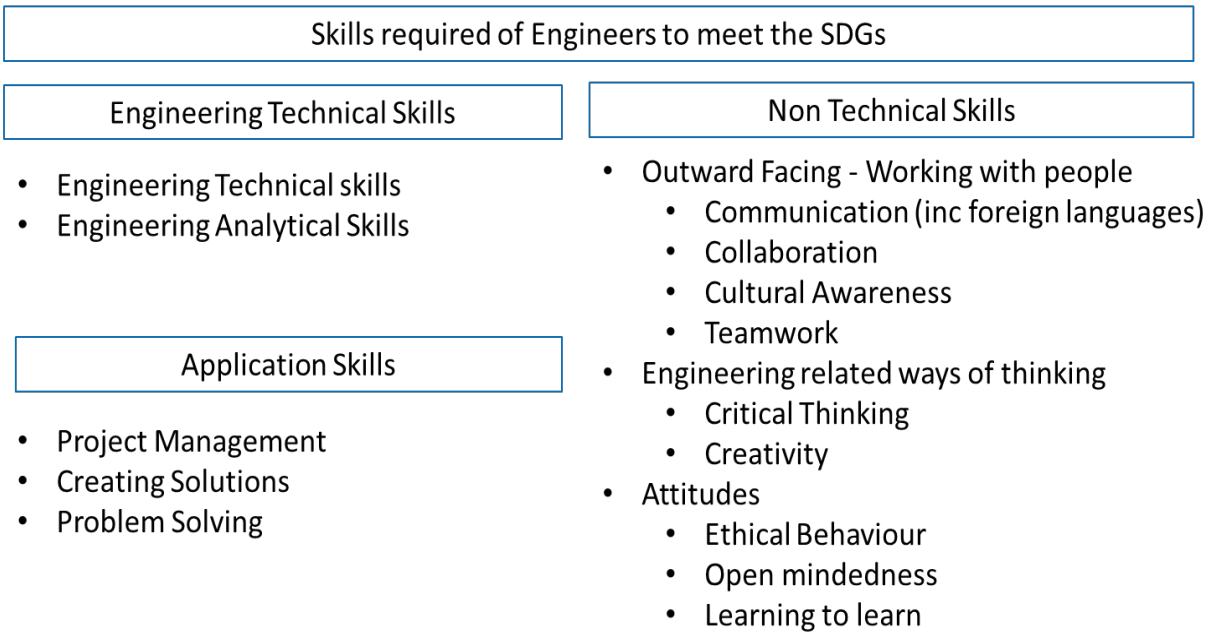


Figure 20: Proposed Framework of Skills Requirements for Engineers to meet the SDGs

"Communication" as a skill topped the list with 14 mentions, followed by "Technical Skills" (11), "Critical thinking" (6) and "Ethical" (6), "Project Management"(5) and "Open-mindedness" (5). It is clear that there is an acknowledgement that both technical and non-technical skills are required.

When we look at each participant groups, "Communication" and "Critical thinking or Think" is recognised by all as being an important skill. "Learning to Learn" is also a skill recognised by academics in particular.

The overall findings of this discussion for each country are included in Appendix B sorted by country and participant group. The next section summarises at high level the overall findings in relation to the skills requirements for engineers to achieve the SDGs.

9.1.1 Balance between technical and non-technical skills

Many of the focus group outcomes presented both technical and non-technical skills, and highlighted the importance of a balance between the two. There were varying views on this aspect with Irish employers suggesting that the role of the University was to teach student specific technical skills first and foremost and that other skills could be developed by industry. Irish academics had a similar view in that University cannot take all the responsibility for teaching the required skills (Particularly non-technical skills) as these can be influenced by the external environment, family influences and activities outside of university. Empathy and Emotional Intelligence were given as two such examples.

It was surprising to French employers that skills required to meet SD challenges included not technical but essentially non-technical skills like Open-mindedness, Cultural diversity, Ethics, Tolerance, Eco-responsibility Collaboration and Teamwork. Concerning technical skills, employers declared that these skills are well taught in French engineering schools, a view also held by Irish employers who felt that

good technical skills are the baseline that is expected from Irish graduates. In Finland, the Academics felt the best way to tackle the SDGs was for engineers to do their professional work as well as possible. Similarly, Danish employers noted the importance of transversal skills, but assume that hard-core technical skills do not need to be discussed much because they are taken for granted.

Danish academics described the skills in a "T" shape with the vertical part containing subject specific and disciplinary skills, and more technically methodological skills. The horizontal part of the T includes personal, social and collaborative skills. The horizontal part also connects with other horizontal parts for the (disciplinary & inter-disciplinary) collaboration and there is a necessary integration of vertical & horizontal skills.

9.1.2 Undergraduate versus Masters level

Irish academics noted that several modules which include themes relating to the SDGs are included at Masters Level, but very little at undergraduate level and this poses a difficulty in trying to get students to change their way of thinking when they get to masters level. Furthermore, Irish employers recognised that postgraduate courses may be more appropriate for teaching modules on business, management and economics and so on and that it was important for engineering graduates to have some work experience before returning to complete a Masters degree so they could put these topics in context.

In France, academics also noted that lifelong learning courses may be appropriate to better enhance knowledge around SD and SDGs.

9.1.3 Assessment of skills in engineering programmes

The general consensus from student groups was that the non-technical skills are assessed through continuous assessment (reports, projects, presentation) generally completed in teams and the technical skills are assessed through exams. Irish students proposed a change in the weighting of exams / continuous assessment as a way to encourage more development of the non-technical skills required.

Several examples were provided on how students could better develop the non-technical skills; working with external clients or communities, independent design work with little information, interdisciplinary projects. However, both Irish and Danish academics noted the importance of having a good grounding in disciplinary knowledge before being able to contribute to a multidisciplinary team project. Danish academics noted in particular that one person cannot be a civil **and** electrical **and** mechanical engineer **and** planner, that it is necessary to establish collaboration among people, each with their own package of subject specific technical skills **and** interdisciplinary communication & collaboration skills **and** holistic thinking. Engineers must also master collaboration across disciplines and boundaries, and the resulting communication with all relevant actors.

9.2 RQ6: Will these skills suffice to meet SDG 11(Sustainable cities and communities) in particular?

The discussion around specific skills requirements in relation to SDG 11 differed in each group and are summarised here.

In Ireland, the skills associated with SDG 11 did not differ significantly from the skills required for the future or for SD in general. There was an acknowledgement that both technical skills and non-technical skills will be needed.

Both Danish academics and employers made the assessment that Danish graduates tended to offer technical and transversal skills as those required to solve SDG 11 in particular. However, Danish employers noted the importance of understanding megatrends, being able to think holistically, being curious and innovative as skills specific to SDG 11.

In France, students selected security and environmental impact as skills associated with SDG 11, whereas employers and academics selected a subset of skills which included open-mindedness, ethics, partnership and collaboration , interpretation and IT skills, multicultural, learning to learn, and problematisation.

9.3 RQ7: Current skill sets of Engineers

The final research question sought to ascertain if employers, academics and students felt that current engineers already posses these skills or if students developed these skills within their engineering programmes.

The relevant research questions were:
7(a). For professionals and academics: Do engineers today possess these skills?
7(b). For students: Do engineering students develop these skills in their engineering programmes?

In the main, the consensus was that technical skills are still deemed important and students, academics and employers all agreed that the Universities are doing a good job of producing good technical engineering graduates. Employers say "We take that for granted". There was an acknowledgement that more could be done to implement opportunities to develop some of the non-technical skills in engineering students and suggestions were made on how that could be achieved. These were summarised in Section 9.1.

Danish employers also noted that they believed graduates currently possess the skills required, but may be react differently when confronted with the reality of implementing a project in a real life scenario.

10.0 Overall outcomes of Focus Groups in each country

This section summarises the overall findings of the focus groups in each country.

10.1 Overall comparison of Focus Groups in Ireland

In general, there was a better awareness of SD and SDGs from Employers and Academics than with Irish students. Academics acknowledged the focus on the SDGs in research applications as a way of increasing awareness. However, there was a call for better communication among the general public about the SDGs. Governmental influence and government policies have a big impact on employers and how they do business.

It was highlighted that social change, human behavioural change was needed to achieve the goals and this required bottom up social change from people on the street. Both academics and employers however noticed that the younger generation are more concerned than ever about environmental concerns and this is to be welcomed. This is a result of initiatives at school level such as the Green Flag Scheme (https://greenschoolsireland.org/).

The skills required to achieve SD include both technical and non-technical skills and there were mixed views on how well they were taught in universities. Students felt that the majority of modules and assessments concentrated on technical skills, but that non-technical skills were needed too.

Academics felt there were barriers to teaching students these non-technical skills which included a lack of expertise from engineering academics on some of the broader social goals and a lack of space in the curriculum. Engineers Ireland Accreditation was offered as both a barrier and an opportunity to initiate change in the curriculum in relation to these topics.

Whilst employers acknowledge that the non-technical skills were important, the message was that the technical skills should not be compromised. A further view was that the role of the university was to teach discipline specific skills and to teach engineers how to think, how to be analytical and that it was industry's role to teach the other aspects.

10.2 Overall comparison of Focus Groups in France

Concerning the key words associated to sustainable development, we could observe keywords related to the triangle of economy/ecology/society in all focus groups but with different drivers. For the student's focus group, ecology is of most importance and an impact on society and economy has a secondary role. However, academic and professional (employer) focus group participants' showed most interest in economy related to ecology and society in second place.

Professional participants had a particularly low level of SDGs awareness in contrast with academic participants' very high level of SDGs awareness. This was contradictory with the students' perception that academics' lack of sustainability awareness was viewed as a main barrier to the development of sustainability skills. However, the most surprising finding was that students only had a medium level of SDG's awareness contrary to our expectation of high students' SDGs awareness.

There was a consensus between students, academic and professional participants in engineering about the high importance of diversity in engineering education for achieving SDGs goals. This particularly high level of diversity awareness is an interesting finding given the context of our study. This is because ENSTA Bretagne is considered as an elite engineering school within the French educational system, traditionally having a low level of diversity amongst students and academic staff.

Academic participants selected all of the seventeen SDGs as being covered in their engineering programmes which indicates a comprehensive inclusion of SDGs in the engineering curriculum in diverse forms. There was a range of coverage of Sustainable development within engineering programmes, ranging from not covered at all to standalone modules, theory and application of SDGs in modules, to integrated across the programme. Students, academics and professional focus group participants ranked SDGs 9 and 4 as those to which they had the highest exposure.

For students, the principal barriers to include SDGs in engineering programmes were the lack of academic staff knowledge and conscience as well as the lack of collaboration between teachers and the difficulties in changing the curriculum. For academic teachers, the programme diversity, the dispersion of sustainable development in diverse modules and the lack of implementation of these courses in a real-life context are viewed as the main barriers. Focus groups participants indicated several opportunities to include SDGs in engineering programmes like the improvement of collaboration between academy and industry, developing lifelong learning programmes and implementing new programmes which apply learning by doing in a real situational context.

There was an agreement that technical skills are well taught in French engineering schools. However, there is a need to develop transversal skills for achieving SDGs goals in integrated programmes with the collaboration between technical and non-technical teachers for the development of interdisciplinary integrated engineering programmes. Students also pointed out that interdisciplinary teaching could not only save time but could also create synergy by having a very positive impact on the development of technical and non-technical skills at the same time.

10.3 Overall comparison of Focus Groups in Denmark

The specific background for the Danish focus groups is that all participants affiliate with Aalborg University which has had a close collaboration with industry throughout its 45 year history.

At AAU the transversal skills have been taught, supported and assessed as part of the engineering curriculum for 30+ years. Contextualized semester projects (ranging from disciplinary to interdisciplinary and multidisciplinary) serve as learning fora for students throughout their studies, and research has shown that employers are highly appreciative of graduates' technical and transversal skills.

However, the different groups are seemingly focusing differently:

- Students – more specific on cross-disciplinary sustainability issues and on skills relating to technical capability
- Academics – more specific on contextualizing educational programs for improved attainment of required skills
- Employers – more specific on innovative, inter-disciplinary and inter-personal skills

10.4 Overall comparison of Focus Groups in Finland

Between all participants of all focus groups there was quite a big difference in knowledge about SDGs. In all groups there was at least one person who knew them very well and others who didn't know very much. The atmosphere in all discussions was very good and it appeared that people were able to contribute freely.

Common in all groups' results was the need for broader understanding of global threats and the need to integrate these issues into engineering education. Academics and employers were worried about the reduction of basic professional skills. One participant offered the view that engineers can make the most contribution to the SDGs by doing their job as well as possible. Academics suggested that it is not difficult

to add SDG themes into education as long it broadens the lecturer's own thinking. So there is not so much of a juxtaposition between basic skills and SDGs as one may think. More systemic thinking is needed from lecturers in addition to students. Students had experienced lecturers who don't know or care about these things enough.

All groups underlined the importance of communication, especially multi-professional communication. Employers also raised the importance of networking and partnership as more important than previously in an engineer's work.

Academics noticed that they could encourage students to be more critical towards old habits.

All groups also raised the issue that in working life there is more of a need for understanding sustainable development. Environmental Engineering students have realised that there a possibility for them to work as sustainable consultants.

11.0 Conclusions

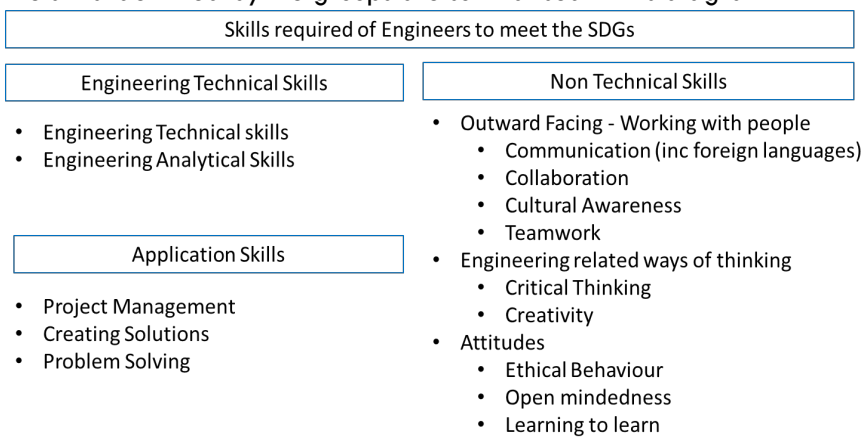
The purpose of Activity 1: Task 2 was to answer research questions in relation to awareness of SD and the SDGs, their implementation in engineering programmes and importance to businesses and the skills needed of engineers in the future.

This report outlines the awareness of SD and SDGs in engineering students, academics and employers in Ireland, France, Denmark and Finland. It summarises the ways in which SD and SDGs are implemented in engineering programmes and the skills required of engineers to meet the SDGs in the future. Summarised here in Table 5 are the key findings of this activity in relation to the initial research questions.

Table 5: Key findings of this activity in relation to the initial research questions.

	Research Question	Key findings
1.	To what extent are employers/ academics/ students aware of Sustainable Development (SD)?	• Overall results suggest that "Energy" and the "Environment" are the two key aspects most associated with SD, reflecting the pillar of Environment. • "Economy", "Resources" and "Circular" are the most mentioned words associated with the pillar of Economy. • The third pillar, Society was less well recognised, with reference to "Education" and to a lesser extent "Diversity" and "Equality" being included within this pillar. • There is evidence of the influence of national policies and initiatives in each country which raised awareness of particular issues such as Carbon Tax (Ireland), Circular Economy (Finland), Climate and Transport (Denmark) and Innovation (France).
2.	To what extent are employers/ academics/ students aware of the Sustainable Development Goals?	• Participants were asked to name any of the SDG goals and the average number identified per person ranged from 2.1 in Ireland, 1.4 in France, 1.3 in Denmark and 1.0 in Finland. • SDG 13 (Climate Action) tops the list with the greatest number of mentions (23), and far exceeds other goals. • With 15 mentions, SDG 4 (Quality Education) comes in second place, followed by SDG 6 (Clean Water and Sanitation) with 10 mentions. • SDG 5 (Gender Equality) comes in fourth place, along with SDG 10 (Reduced Inequalities) and SDG 15 (Life on Land). • These particular SDGs (5 and 10) relate to the wider concepts of the SDGs, or align to the societal pillar of SD which is surprising since the Society pillar was not well recognised as an aspect of SD in Research Question 1. • Overall, academics are the group which are most familiar with SDGs. • Employers are in second place and noted in the Irish Focus Group, the importance of governmental policy in directing their business model towards the SDGs. • Exceptions are in the case of Finland where students are the most aware and in France, where the employers were not able to identify any of the SDGs and in fact several employers had not heard of the SDGs before. • Of particular note is the awareness of French students (where 5 out of 9 students were able to name an SDG). These French students had completed a (social entrepreneurship project) on the SDGs as part of their extra-scholarly activities and SDG's were presented in their project. • In Denmark, students were more likely to discuss particular elements or technical aspects related to sustainability issues rather than the specific goals themselves

3.	To what extent do employers/ academics/ students think diversity is important in achieving the SDGs?	• Overall, 83% (64no) of respondents felt that diversity was "highly important", 16% (12no) chose "moderately important" and only 1% (or 1 person) considering it "not important". • Discussions in Denmark revealed that it was not thought that "diversity" alone is the answer to solving the SDGs, but interdisciplinarity was much more important. • In some instances, the term "diversity" was considered only in relation to gender and hence was not proposed as solution for SDG problems. • Thse findings indicate that there is a lack of awareness or conception of the term "diversity" in some instances.
4.	Do employers/ academics/ students currently engage in sustainable development related activities?	• Participants were invited to select those SDGs of most concern to their business or Institution and SDGs 9 (Industry, Innovation and Infrastructure) topped the list. • SDG 4 (Quality Education), SDG 12 (Responsible Consumption and Production), SDG 11 (Sustainable Cities and Communities) and SDG 7 (Affordable and Clean Energy) were also highlighted as important. • With regard to participant groups, SDG 4 (Quality Education) is mostly prioritised by the academic community. • Employers are most concerned with SDG 9 (Industry, Innovation and Infrastructure) and 11 (Sustainable Cities and Communities). • Students also selected SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production) as those of most concern. • There was a range of views on how SD was included within engineering programmes, ranging from not covered at all to isolated standalone modules, integrated modules or specific projects which dealt with SD. • Several barriers were highlighted which prevents the integration of SD in engineering programmes including; ○ Lack of academic staff knowledge on SD and broad topics such as politics ○ Lack of academic conscience about SD ○ Difficulties in changing the engineering curriculum ○ Finding space within the programmes ○ Restrictive nature of module choice in some engineering programmes ○ Lack of real-life projects to show the link between theory and practice ○ Difficulties in recruiting academic staff with the expertise to teach non-engineering topics. • However, the groups also offered some opportunities to enhance the curriculum; ○ New optional modules and lifelong learning programmes ○ Modules which incorporate real life situational contexts. ○ Working on multi-disciplinary projects ○ Involvement in extra-curricular activities and groups (eg ENACTUS) ○ Involve students in the co-creation of their programmes ○ Industry based projects. ○ Integration of SD topics and projects within existing modules. ○ Accreditation process could be an opportunity to influence the content of engineering programmes. • Overall, there are few significant gaps between those SDGs required by businesses and those taught in engineering programmes. However, Gender Equality (SDG 5) is one SDG highlighted as being a commitment of employers, but not necessarily addressed within engineering programmes. SDG 17 (Partnership for the goals) is an issue for employers and students believe is covered within the programme, however this is not reflected in the views of academics.

5.	What are the skills needed to prepare engineers to be more sustainable in the future?	Many of the focus group outcomes presented both technical and non-technical skills, and highlighted the importance of a balance between the two. The skills identified by the groups are summarised in this diagram:  • "Communication" as a skill topped the list with 14 mentions, followed by "Technical Skills" (11), "Critical thinking" (6) and "Ethical" (6), "Project Management"(5) and "Open-mindedness" (5). • Discussion ensued about the appropriate level to teach these types of non-technical skills and whether Masters courses or life long learning courses might be appropriate. • Danish academics described the skills in a "T" shape with the vertical part containing subject specific and disciplinary skills, and more technically methodological skills. • The general consensus from student groups was that the non-technical skills are assessed through continuous assessment (reports, projects, presentation) generally completed in teams and the technical skills are assessed through exams. Students proposed a change in the weighting of exams / continuous assessment as a way to encourage more development of the non-technical skills required. • Several examples were provided on how students could better develop the non-technical skills; working with external clients or communities, independent design work with little information and interdisciplinary projects.
6.	Will these skills suffice to meet SDG 11 (Sustainable cities and communities) in particular?	• In Ireland, the skills associated with SDG 11 did not differ significantly from the skills required for the future or for SD in general. • Both Danish academics and employers made the assessment that Danish graduates tended to offer technical and transversal skills as those required to solve SDG 11 in particular. However, Danish employers noted the importance of understanding megatrends, being able to think holistically, being curious and innovative as skills specific to SDG 11. • In France, students selected security and environmental impact as skills associated with SDG 11, whereas employers and academics selected a subset of skills which included open-mindedness, ethics, partnership and collaboration , interpretation and IT skills, multicultural, learning to learn, and problematisation.
7a.	For professionals and academics:	

	Do engineers today possess these skills?	• In the main, the consensus was that technical skills are still deemed important and students, academics and employers all agreed that the Universities are doing a good job of producing good technical engineering graduates. Employers say "We take that for granted". • There was an acknowledgement that more could be done to implement opportunities to develop some of the non-technical skills in engineering students and suggestions were made on how that could be achieved (RQ5).
7b.	For students: Do engineering students develop these skills in their engineering programmes?	

This report summarises the findings of the Focus Groups which formed part of Activity 1 Task 2. This report contributes to Intellectual Output 1 of the A-STEP 2030 project.

There are two follow-on activities within the project. Activity 2 aims to investigate the values, motivations and preferences of young people, students and adult learners to determine how this influences their future career choices. This work will include a comparison between each of the four countries involved as part of this report. It is intended that the findings from Activity 1 (The Future role and skills requirements of Engineers) and Activity 2 (The values and motivations of people) can be integrated to show the overlap between the skills needed in the future and the values of people. The knowledge gained from this mapping exercise will then be used to create a new and innovative teaching and learning activity to encourage and attract more people into the engineering profession in Europe.

All reports and further information relating to the A-STEP 2030 project is available at: https://www.astep2030.eu/en/project-reports

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Appendix A – Focus Group Discussions in relation to SD and SDGs

This Appendix provides detailed Focus Group Discussions on the concept of Sustainable Development and the SDGs from each country and each participant group.

Ireland	Summary Findings of Focus Groups
Ireland	**Students** **Sustainable Development and the SDGs** • Good key words associated with Sustainable Development including; Clean, Green, Zero Waste, Energy, Efficient, Progress, Change and Diversity. • Limited awareness of SDGs, only 1 out of 7 students was able to name any of them. It transpired that this student had to do a project on the SDGs last year, hence this knowledge. • 6 out of 7 students thought Diversity was 'Highly Important" for achieving the SDGs. • Fourteen of the SDGs were selected as having been covered in their engineering programmes. • Those that were not were (1: No poverty, 2: Zero Hunger and 17: Partnerships for the goals) • SDGs 9,11,14,15 were the SDGs most covered in engineering programmes. (9: Industry, innovation and Infrastructure, 11: Sustainable Cities and Communities, 14: Life below water, 15: Life on land) • SDG 6 and 9 were ranked with the highest exposure (6: Clean Water and Sanitation, 9: Industry, innovation and Infrastructure) followed by (11) Sustainable Cities and Communities and 12: Responsible Consumption and Production). • SDGs 7, 9 and 11 scored highest for integration throughout the programmes (7: Affordable and Clean energy, 9: Industry, innovation and Infrastructure, 11: Sustainable Cities and Communities) • SDGs 10, 16 and 17 scored the least for integration across programmes (10: Reduced inequalities, 16: Peace, justice and strong Institutions and 17: Partnerships for the goals) • There was a range of coverage of Sustainable development within engineering programmes, from not covered at all (in first year) to standalone modules, theoretical and application of SDGs in modules, to integrated across the programme. • Key issues which arose with regard to barriers to implementation of SDGs teaching included the restrictive nature of the programmes and the lack of knowledge of engineering academics in relation to sustainable development. • Students indicated that there were opportunities to enhance the curriculum with topics in regard to SD and SDGs. **Engineering Skills Requirements for SDGs.** • Skills required to meet SD challenges included mainly non-technical skills but included; Communication, Management, Teamwork, Technical skills, leadership, research and organisation. • General consensus was that the non-technical skills are assessed through continuous assessment (projects, presentation) and the technical skills are assessed through exams. • Students proposed a change in the weighting of exams / continuous assessment as a way to encourage more development of the non-technical skills required. • Most of the group suggested that there wasn't enough emphasis placed on the development of non-technical skills in their programmes.

	• However, one student did highlight the fact that it could have a negative impact on the development of technical skills. • Several examples were provided on how students could better develop the non-technical skills; working with external clients or communities, independent design work with little information, interdisciplinary projects.
Ireland	Academics Sustainable Development and the SDGs • Good awareness in general about SDGs within academic community, but mainly centred around the technical SDGs • Requirement to link research funding applications to SDGs has raised awareness. • High level goals are not effective unless there are tangible, measurable targets below them. These are of much better use. • Academics feel that the general public needs to be more educated on specific things they can do on an individual basis to achieve SDGs. • Some examples were provided where academics had integrated projects and assignments relating to the SDGs within their engineering programmes. Some modules covered the technical SDGs in particular such as Clean Water and Climate Change. • Engineering Academics feel that engineers are not necessarily best placed to teach about the SDGs, the themes are much broader and may need experts in broad fields to teach them, particularly politics, social science, behavioural science, human behaviour and so on. • The recruitment policies of the University can limit the employment of suitably qualified academics to teach these broad subjects. Engineering Departments are required to employ engineering academics. • The curriculum needs to change to incorporate opportunities to teach about the SDGs, but academics noted the difficult in finding space within the curriculum. Integrating them across modules was offered as the best solution, but it was recognised that engineering academics would need to upskill to be able to deliver this solution. • Several modules which include themes relating to the SDGs are included as Masters Level, but very little at undergraduate level and this poses a difficulty in trying to get students to change their way of thinking when they get to masters level. • Engineers Ireland Accreditation process presents both challenges and opportunities to integrate SDGs. • University cannot take all the responsibility for teaching the required skills (Particularly non-technical skills) as these can be influenced by the external environment, family influences and activities outside of university. Empathy and Emotional Intelligence are two such examples. • Multidisciplinary work is important, but students must have basic technical skills first before they can contribute to multidisciplinary team projects. Engineering Skills Requirements for SDGs. • Several modules which include themes relating to the SDGs are included as Masters Level, but very little at undergraduate level and this poses a difficulty in trying to get students to change their way of thinking when they get to masters level. • University cannot take all the responsibility for teaching the required skills (Particularly non-technical skills) as these can be influenced by the external environment, family influences and activities outside of university. Empathy and Emotional Intelligence are two such examples. • Multidisciplinary work is important, but students must have basic technical skills first before they can contribute to multidisciplinary team projects.

Ireland	Employers Sustainable Development and the SDGs • It is important to note that the Irish Government launched a Climate Action Plan on the day before this focus group was held. • Employers showed excellent awareness of the SDGs, mainly through the impact of governmental policy. It was felt that the government is not reaching it's targets and so it pushing this on to businesses. This is affecting how those businesses work. • One company noted that it's board had adopted the SDGs as part of it's strategy a few years ago and so there were a key part of their business. • Clients are also driving the push towards achieving these goals as their own companies have targets to meet and this requires engineers to design buildings that have BREAAM and LEED certification etc. • There was an acknowledgement that the younger generation are much more aware of and committed to issues surrounding the environment. This included young kids in school and young graduates joining the companies. • In some ways the goals are meaningless because they are so high level, but they are useful as a tool to gain international agreement. The targets at local level are much more useful. • It was acknowledged that the UN reports are very useful because they are becoming mainstream news and this raises awareness of Sustainable Development generally. • Cost is an issue when it comes to implementation of the goals themselves. People will say they are behind them but previous experience of such initiatives in Ireland has shown that when it comes down to individuals having to bear the cost of such initiatives, there is a lot of resistance. Examples provided were water charges and the same is expected with the proposed carbon taxes. • Views were expressed very much at high level about the impact of government. The impact of politics and in particular how the government is beholden to constituents which negates long term action with short term terms of office. • Bottom up and social change actions were lauded as the way to engage the public and get real sustainable action. The issues surrounding plastic • Some contradictions were expressed in that if better healthcare is achieved, it will add to the problem of increased population and will impact climate change , zero hunger etc. It will be difficult to achieve perfection in all of them. • Key SDGs for companies includes SDG 11, 7 3 and 6, reflecting the businesses associated with engineering in particular. Engineering Skills Requirements for SDGs. • There was an acknowledgement that the skills sets of engineers will change dramatically in the next 10 years, but these will mainly be technical skills. • Technical skills will remain important, and these should not be compromised by adding in additional non -technical skills. In fact one employer suggested that it was the University's role to develop the discipline specific technical skills in graduates and it was industry's role to get them to do the things that heir Clients want. • Writing, verbal communication, teamwork and multidisciplinary working were all skills required of engineering graduates. Furthermore, it was proposed that engineers will become interpreters of solutions, in recognition of the fact that many automotive tasks will be taken over by computers. To this extent, engineers needed to be able to interpret outputs and evolve those results into solutions for Clients. • Work placement was offered as one way to expose students to opportunities to develop those skills.

France	Summary Findings of Focus Groups
France	Students Sustainable Development and the SDGs • Good key words associated with Sustainable Development including: Ecology, Economy, Recycling, Education, Energy, Nature, Respect, Biodiversity, Environment, Innovation, Diversity and Culture. • Average awareness of SDGs, 5 out of 9 students was able to name any of them. These students had to do a (mainly social entrepreneurship project) on the SDGs last year in the framework of extra-scholar activities and SDG's were presented at the beginning of their project. • 8 out of 9 students thought Diversity was 'Highly Important" (and for one "Moderately Important" for achieving the SDGs) that is an interesting finding concerning the study context as ENSTA Bretagne is considered as an engineering school taking part of French elite education with a very low level of diversity. • Fourteen of the SDGs were selected as having been covered in their engineering programmes. • Those that were not were (1)No poverty(10) Reduce inequality (15) Life on land). • SDGs 5, 9, 7, 8 followed by 3, 4, 14 were the SDGs most covered in engineering programmes. (5. Gender equality, 9. Industry, innovation and Infrastructure, 7. Affordable and clean energy, 8. Decent Work and Economic Growth, 3. Good health and well-being, 4. Quality Education and 14: Life below water) • SDG 9 and 4 were ranked with the highest exposure (9. Industry, innovation and Infrastructure and 4. Quality Education) followed by 3, 7, 8, 13 (3: Good Health and well-being, 7. Affordable and Clean Energy, 8. Decent Work and Economic Growth, 13. Climate Action). • SDGs 8, 9 and 7 scored highest for integration throughout the programmes (8:Descent work and economic growth , 9: Industry, innovation and Infrastructure, 7: Affordable and clean energy) • SDGs 1, 6, 10 and 15 scored the least for integration across programmes (1. No poverty, 6. Clean Water and Sanitation, 10: Reduced inequalities and 15. Life on land) • There was a range of coverage of Sustainable development within engineering programmes, from not covered at all to standalone modules, theoretical and application of SDGs in modules, to integrated across the programme. • Key issues which arose with regard to barriers to implementation of SDGs teaching included the lack of the consciousness and knowledge of engineering academics in relation to sustainable development, lack of the collaboration between teachers and the difficulty to change the curricula (and habits). • Students indicated that there were opportunities to enhance the curriculum with topics in regard to SD and SDGs and highlighted also the role and importance of extra-scholar activities in it. Engineering Skills Requirements for SDGs. • Skills required to meet SD challenges included mainly non-technical skills but included; Ethics, Communication, Stress management, Economic knowledge, Ecologic consciousness and Personal engagement. • General consensus was that the non-technical skills are assessed through continuous assessment (reports, projects, presentation) generally completed in teamwork and the technical skills are assessed through exams or projects (practically in teamwork). • Students highlighted the importance of the development of the non-technical skills required by companies for the future working life. • Most of the group suggested creating collaboration between technical and SHS teachers for the development of interdisciplinary/transdisciplinary integrated learning programmes. They pointed out that it could spare time and make a synergy that could have a very positive impact on the development of technical skills.

France

Academics
Sustainable Development and the SDGs

- Most relevant key words associated with Sustainable Development: Economy, Ecology, Recycling, Resources, Reduce consumption, Renewable energy, Education, Social responsibility and Climate changes.
- Relatively high awareness of SDGs, 1 out of 7 academic participants was able to name any of them and showed interest to sustainable development issues.
- 6 out of 7 academic participants thought Diversity was 'Highly Important" (and for one "Moderately Important" for achieving the SDGs) that indicates a positive attitude for diversity in an engineering school historically with a quite low level of diversity.
- All of the seventeen the SDGs were selected as having been covered in their engineering programmes indicating a comprehensive inclusion of SDGs in engineering curriculum.
- SDGs 9, 4, 3, 5, 7, 12 were the SDGs most covered in engineering programmes. (9. Industry, innovation and infrastructure, 4. Quality education, 3. Good health and well-being, 5. Gender equality, 7. Affordable and clean energy and 12: Responsible consumption and production)
- SDG 4 was ranked with the highest exposure (4. Quality Education) followed by 3, 9 and 11 (3: Good Health and well-being, 9. Industry, innovation, infrastructure, 11. Sustainable cities and communities).
- SDGs 3 followed by 4, 5, 9 scored highest for integration throughout the programmes (3: Good Health and well-being, 4. Quality education, 5. Gender equality, 9: Industry, innovation and Infrastructure,)
- SDGs 13 and 17 scored the least for integration across programmes (13. Climate action and 17. Partnership for the goals).
- There was a range of coverage of Sustainable development within engineering programmes, from not covered at all to standalone modules, theoretical and application of SDGs in modules, to integrated across the programme.
- Key issues which arose with regard to barriers to implementation of SDGs teaching included the diversity of programmes, the dispersion of sustainable development courses in divers modules and lack of real work situation to put these courses in a real-life context.
- Academic participants indicated that there were opportunities to enhance the curriculum with topics in regard to SD and SDGs by developing the lifelong learning programmes and implementing new programmes applying learning by doing in a real situational context.

Engineering Skills Requirements for SDGs.

- Skills required to meet SD challenges included predominantly non-technical skills but included; Multiculturality, Learning to learn, Negotiation skills, Open mindedness, Global thinking, Ethics, Diversity, Self-knowledge, Sustainability consciousness and Collaboration.
- Technical skills are assessed in exams and/or through continuous assessment (reports, projects) in teamwork but without including sustainable development specifically in the assessment criteria's.

France	**Employers** **Sustainable Development and the SDGs** • Key words associated with Sustainable Development; Ecology, Environment, Economy, Global warming, Recycling, Renewable energy, Respect of the nature, Consumption and Innovation. • Particularly low level of SDGs; no one professional focus group participants was able to name any of them (several of them have never heard it before). • Six out of eight professional participants thought Diversity was 'Highly Important" (and for two "Moderately Important") for achieving the SDGs that shows clearly their awareness about the important of diversity. • Thirteen of the SDGs were selected as encountered in their professional work. • Those that were not were 1, 2, 10 and 15 (1. No poverty, 2. No hunger, 10. Reduce inequality and 15: Life and land). • SDGs 9, 4, 5, 8, 12 were the SDGs most encountered in their professional work. (9. Industry, innovation and Infrastructure, 4. Quality education, 5. Gender equality, 8. Decent Work and Economic Growth and 12. Responsible Consumption and Production). • SDG 9 was ranked with the highest exposure (9. Industry, innovation and Infrastructure) followed by 5, 7, 16 (5. Gender equality, 7. Affordable and Clean Energy, 16. Peace, justice and strong institutions). • SDGs 8, 9 and 12 scored highest importance and engagement for companies (8. Descent work and economic growth, 9: Industry, innovation and Infrastructure, 12. Responsible Consumption and Production). • SDGs 1, 2, 10 and 15 scored the least for companies' engagement (1. No poverty, 2. Zero huger, 10: Reduced inequalities and 15. Life on land). • There was a range of coverage of Sustainable development within engineering programmes, from not covered at all to standalone modules, theoretical and application of SDGs in modules, to integrated across the programme. • Key issues which arose with regard to barriers to implementation of SDGs teaching included the lack of the interests and collaboration of engineering professionals in relation to sustainable development. • Engineering professionals indicated that there were opportunities to enhance the engineering training focusing on innovation with topics in regard to SD and SDGs. **Engineering Skills Requirements for SDGs.** • It is surprising that skills required to meet SD challenges included not technical but essentially non-technical skills like Open-mindedness, Cultural diversity, Ethics, Tolerance, Eco-responsibility Collaboration and Teamwork. Concerning technical skills, professional participants declared that these skills are well taught in French engineering schools. • Professional participants pointed out that the development of the non-technical skills required by companies for achieving SDGs objectives. They suggested including the development transversal skills in the technical teaching programme. These integrated programmes would have a positive effect on the technical skill by putting them in a real working context.

Denmark	Summary Findings of Focus Groups
Denmark	Students Sustainable Development and the SDGs • Students communicates elements, which are more specifically addressing sustainability issues.
Denmark	Academics Sustainable Development and the SDGs Engineering Skills Requirements for SDGs. • The skills can be depicted as a "T": ○ Vertical part: At the lower end lie subject specific and disciplinary skills, above them the more technically methodical skills ○ Horizontal part: Personal, social and collaborative skills. ○ The horizontal part connects with other horizontal parts for the (disciplinary & inter-disciplinary) collaboration. ○ Necessary with integration of vertical & horizontal skills • Hard-core, solid technical skills required – however, if engineers have technical skills **only** that is clearly inadequate. • Technical skills are fundamental for analytical skills and modelling skills. • One person cannot be civil **and** electrical **and** mechanical engineer **and** planner – necessary to establish collaboration among people with each their packet of subject specific technical skills **and** interdisciplinary communication & collaboration skills **and** holistic thinking etc. • Engineers must master collaboration across disciplines and boundaries, and communication with relevant actors. • Generally, the academics view engineers' work situation as group/team-work and therefore the students' training must be contextualized accordingly. • Generally, the academics perceive that AAU graduates have acquired the skills listed. • Digital skills are embedded in the (required) application of digital tools in connection with the skills listed.
Denmark	Employers Sustainable Development and the SDGs Engineering Skills Requirements for SDGs. • Skills list; are very much focused on transversal skills – it seems like the employees expects the technical skills to be obvious skills if you have some an engineering education (hard-core technical skills are not that much discussed but taken for granted) • Creativity are mentioned and the 'room' for being creative – the young engineers should have the room to think out of the books – and a culture where it is ok to make 'mistakes' in a creative process / developing process • The 'old' generation need to give space …..

Finland	Summary Findings of Focus Groups
Finland	Students Sustainable Development and the SDGs • SDGs are quite seldom integrated into the engineering programs, it is done best in the Environmental Engineering Program. • Students think that SDGs should be seen in their studies. • They need more knowledge about environmental impacts of production and usage of different energy sources and materials. They have noticed that in companies there is a need for sustainable development consultancy and there is a possibility for engineers to find employment in this sector. • Students know that in working life there is need for multi-professional co-operation, which they suggest be integrated into their studies as well. • Students are not satisfied with the teachers' knowledge and willingness to integrate SDGs into their teaching.
Finland	Academics Sustainable Development and the SDGs • Engineers can best resolve SDGs by doing their professional work as well as possible. • Students should be able to conceive the global situation and understand the engineers' role in that whole system. There needs to be a change of the way of thinking, change in mindset. • Communication, especially with others who are not engineers, is even more important. To be taken into account in teamwork projects. We should encourage students to think critically and to challenge the habits we are used to. Gender equality is important in many engineering fields. More women in engineering education are needed. General understanding about SDGs is missing. SDGs can easily be integrated into students' project works and also other teaching only by changing the mindset.
Finland	Employers Sustainable Development and the SDGs • Universities have to take care, that students will learn the basic skills, which are needed in that profession, even though it can mean hard work. To work hard occasionally is also important in working life. • Besides the basic skills, the transversial skills listed above are more and more important - regeneration, especially sustainable regeneration, perspective skills for unities, curiosity, continuous learning, learn to learn, networking and partnership and system dynamics. • Universities could give students the possibility to study courses from totally different areas e.g. electronics and building sector. • Newly graduated students have difficulty in finding their first job, because companies very often demand workers to be able to do very special things like to use special programmes. This can be a problem for universities, how much time to spend on this type of skills compared to e.g. SDG integrated issues.