



# SUSTAIN-CE Project

## IO Number: 1 (Task 1.1)

### Output name: Methodology for quadruple helix co-creation

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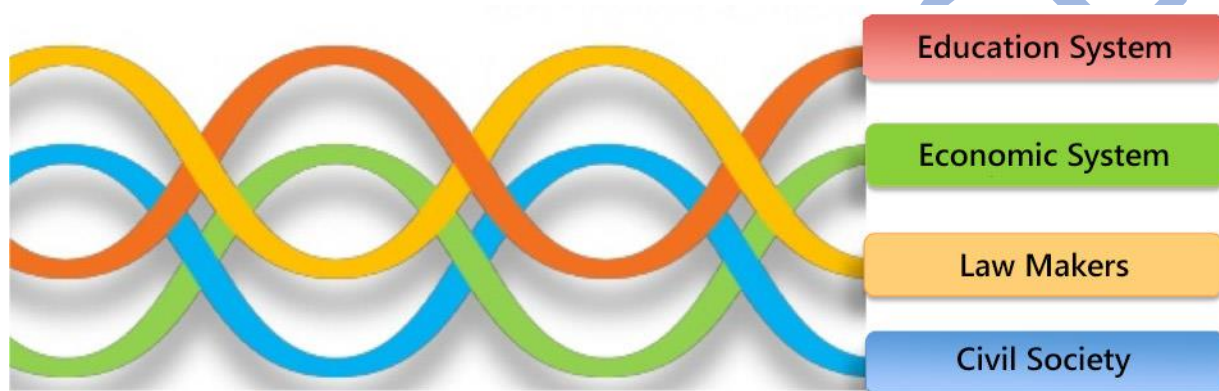


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## 1 Introduction

This document provides an overview on the open innovation & co-creation framework for the curriculum development methodology, hereafter referred as quadruple helix co-creation & open innovation toolkit that sustain the whole vision of SUSTAIN-CE in terms of ensuring a balanced view/insight of all the quadruple helix stakeholders in all the project deliverables with specific relation to the curriculum. This methodology is based upon the quadruple helix methodology developed within the DIGI-GRENT project (full permission for incorporation has been obtained).



## 2 Overview & Contextual Positioning of the Quadruple Helix

### 2.1 Overview

The roles of the quadruple helix co-creation & open innovation toolkit are:

- Ensure proper goal alignment, skill-gap assessment and mitigation in relation to the curriculum.
- Ensure proper face-to-face quadruple helix collaboration and co-creation during the transnational training sessions.
- Ensure proper understanding the-each quadruple helix actor in order to know how to engage them in the curriculum development and to ensure their sustainable co-creation around in an open-innovation manner.

### 2.2 General context

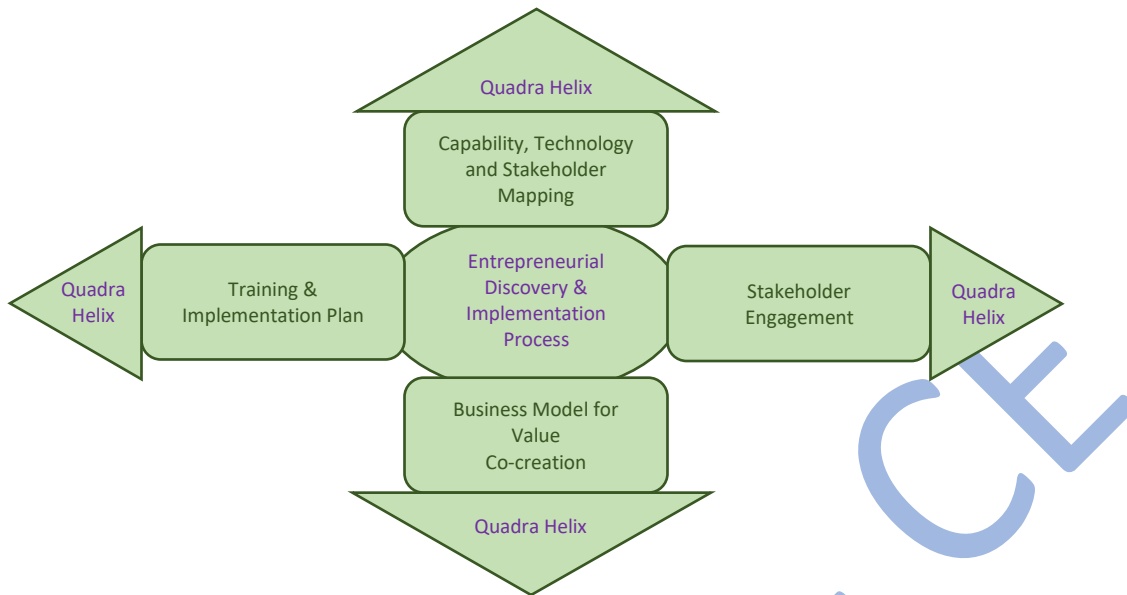
Quadruple helix co-creation & open innovation should be contextualised within the overall interpretation underlying the present situation of curriculum development and expressed in the project structure.

- Science, as any other institution of modernity (political institutions, trade unions, institutional religions, etc.), is suffering from the **shift from modern to post-modern society**. Quite paradoxically, while science is becoming technically stronger (in terms of impacts and results), it is also becoming socially weaker.

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- Some **critical issues** pertaining to science & curriculum development are, for example:
  - decreasing authoritativeness and social recognition of scientific institutions and, to a certain extent, decreasing credibility of scientists
  - growing diffusion (as an effect of the emergence of the so-called “post-factual age”) of societal views (of facts, events, processes) which are explicitly alternative or even opposite to those based on science, often propelled by anti-science attitudes and pseudo-scientific beliefs
  - ever-stronger connection between innovation, environmental and ethical and policy issues, triggering and feeding social tensions on controversial issues and “public battle” among experts
  - increasing sensitiveness of the public towards science-related risks
  - people’s decreasing trust in scientific institutions leading to a growing demand for accountability and transparency
  - need for science & innovation institutions to increasingly demonstrate their social, environmental and economic usefulness to citizens as taxpayers.
  
- It is easy to see that these critical issues are similar to those affecting the other social institutions of modernity. See for example some of the phenomena affecting **policy**:
  - decreasing authoritativeness, social recognition and credibility of politicians and political parties
  - growing diffusion of anti-political and populist views, leading to a decreasing people’s propensity to vote
  - ever-stronger connection between politics and ethical issues, especially regarding aspects like environmental sustainability, privacy, security, medical issues, or civil rights
  - increasing sensitiveness of the public towards risks connected to politics (for example, corruption, connections between politics and industry, high costs of political institutions, etc.)
  - people’s decreasing trust in politicians and political institutions leading to a growing demand for accountability and transparency
  - need for politicians and political institutions to increasingly demonstrate their capacity and usefulness to citizens as taxpayers
  - need for a better accountability of the environment towards fulfilling the SDG goals
  - all the above can be fulfilled through goal alignment, skill gap mitigation and co-creation



Therefore, there is a high need for a quadruple helix co-creation/communication in all aspects of nowadays society and especially in the prospect of curricula development.

One way of achieving a working quadruple helix to foster curriculum development is through co-creation. Chesbrough (2013) argued that cocreation is the cornerstone of open innovation practices in today's society. For example, through co-creation, academia can gain useful input from the other stakeholders, that will eventually lead to more market oriented curriculum and better prepared graduates (Chesbrough 2010; Chesbrough 2011). More recently, Carayiannis (2015) introduced the concept of targeted open innovation arguing that open innovation should be focused, strategic, and tailored to the current needs of the stakeholders, thus universities need to enhance their curricula accordingly. Hence, open innovation and co-creation between academia and stakeholders will highly increase academia's capacity of producing more market oriented curricula that will lead to graduates capable of being next generation leaders.

To this end, SUSTAIN-CE responds to this need by aiming to develop an innovative, transnational framework that will improve the knowledge and skills of academic institutions to produce more market/ oriented curricula, reducing the barriers in this field. The project consortium comprises key academics, investors, industry/employment associations, and societal growth partners (and associated partners) from different sectors who will co-create the envisaged curriculum and will pilot it through an open innovation and co-creation virtual learning environment (VLE). This outcome is directly pertinent to quadruple helix-academia cooperation for innovation and best practices with respect to curriculum development, and can also support policy reform in this area, leading to more prepared graduates ready for the sustainable civil engineering market. SUSTAIN-CE also follows up the recent plans of the EU to promote improved, efficient and clean operations by 2050 and is also relevant to the EU2030 targets for R&D, climate change, energy efficiency, circular economy, and social cohesion. This makes SUSTAIN-CE directly relevant to the current objectives of the participating & affiliated quadruple helix organizations.

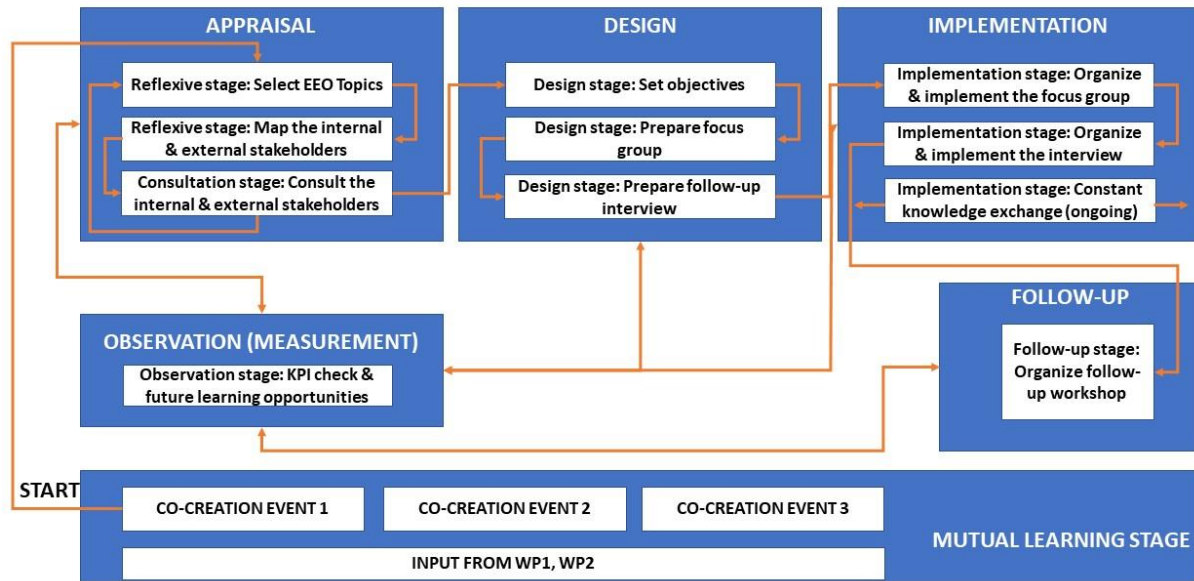
Additionally, SUSTAIN-CE is highly aligned at a policy level with the goals of Strategic Partnerships for academia-market-society collaboration and the promotion of innovation and best practices, with the Headline Education Target and with the EU Higher Education Modernisation Agenda. Similarly, SUSTAIN-

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CE is in line with the European cooperation in education and training (ET2020) strategy by fostering life-long-learning, improving the quality of education through stakeholder engagement, and promoting creative thinking towards.

### 3 Overall method for quadruple helix co-creation & open innovation



#### 3.1 Appraisal

The first main step in the implementation of the quadruple helix co-creation is the identification of the actual (ongoing/new) interests of the main initiating institution (in relation to the needs shown by IO1 Tasks 2 and 3) and description of its main features as exemplified in the table below:

<b>Organizer</b>	<name of the institution>
<b>Description</b>	<few lines denoting the main needs in relation to >
<b>Stakeholders</b>	<list which actors internal & external are involved>

#### 3.2 Mapping

The next step is the stakeholder mapping process (identify internal + external stakeholders).

<b>List the internal stakeholders</b>	Internal stakeholders can be: <ul style="list-style-type: none"> <li>• The research/teaching team (PDRAs, PhDCs, Academics, RAs, etc)</li> </ul>
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	<ul style="list-style-type: none"> <li>• Teaching coordinator / Teaching office</li> <li>• Finance team</li> <li>• Any subject related office</li> <li>• Digitalization team</li> <li>• Sustainability/Responsibility officers</li> <li>• Employability offices</li> </ul> <p>Provide a list with names, full titles/positions and contact of all the aforementioned stakeholders.</p>
<p><b>List the external stakeholders</b></p>	<p>External (quadruple helix) stakeholders can be:</p> <ul style="list-style-type: none"> <li>• Other external institutions interested in</li> <li>• Local/regional/national policy bodies</li> <li>• Other field-compatible research centres, researchers and companies</li> <li>• Citizens and NGOs</li> <li>• Influencers, industries</li> <li>• Business angel networks, investors</li> <li>• Regional funds authorities</li> <li>• Environmental organization &amp; certification authorities</li> <li>• Digital hubs</li> <li>• Open innovation &amp; citizen hub association</li> </ul> <p>How to identify the external stakeholders:</p> <ul style="list-style-type: none"> <li>• Undertaking a sectoral profile in the region/country to identify the key external players in this field</li> <li>• Undertaking a sectoral profile in other successful regions/countries from EU where the stakeholder-group is well-established in order to identify new relevant external stakeholders</li> <li>• Identification of the main regulatory framework that governs the sector in order to reach the responsible institution (that monitors/control the regulation)</li> <li>• Analysis of the regional/national innovation &amp; science communication policy framework in order to understand the actors involved</li> <li>• Analysis of similar research performed by fellow (or top performing) institutions in order to identify the names of the innovators in this field</li> </ul> <p>Provide a list with names, full titles/positions and contact of all the identified stakeholders.</p>



### 3.3 Consultation

After the stakeholders are mapped (identified), a consultation step will follow:

<b>Survey/Interview</b>	<p>An informal survey (2 responses per stakeholder type) targeting both internal &amp; external stakeholders will be implemented. The survey will contain the following items:</p> <ul style="list-style-type: none"> <li>• Description of the challenge (needs)</li> <li>• Description of the purpose of the co-creation</li> <li>• Assessment of the know-how/implementation of in the stakeholders' institution/work</li> <li>• Assessment of the stakeholder's institutional governance settings</li> <li>• Assessment of the stakeholder's interest, motivation, perceived usefulness of</li> <li>• Assessment of the relevance/usefulness of key related practices emerged from IO1</li> <li>• Qualitative input related to the quadruple helix implementation (how to bring the quadruple helix (related to the ongoing task of developing training outputs) together more effectively</li> <li>• Assessment of the stakeholder's interest in participating in the co-creation events, follow-up interview and follow-up workshop related to the envisioned experiment</li> </ul>
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The quadruple helix co-creation event design step consists of the blueprint required to engage quadruple helix stakeholders co-creation training outputs. In order to proceed to this stage, the stakeholder mapping and consultation must have been finalized to ensure that the entire stakeholder group and their views are properly considered in the experiment design process. As a guide for the design phase, the following table provides an overview:

### 3.4 Design

<b>Organizer</b>	<name>
<b>Topic</b>	<topic.. i.e. area >
<b>Objectives</b>	<p>Stipulate the objectives of the co-creation (based on the identified needs)</p> <p>Examples:</p> <ul style="list-style-type: none"> <li>• Identify how to facilitate the needs of civil engineering curricula/industry?</li> <li>• Assess what policy drivers would help to better facilitate circular civil engineering?</li> <li>• What are the key trends in and how do these affect society?</li> </ul>





<b>Focus group</b>	<p>Organize a first focus group with internal + external stakeholders in order to discuss the objectives of the quadruple helix co-creation. This implies:</p> <ul style="list-style-type: none"> <li>• Set the date &amp; time of the focus group (2.5h)</li> <li>• Send invitation to the identified stakeholders to participate in the focus group</li> <li>• Implement the focus group with the objectives that have been set.</li> </ul> <p>The goal of this focus group would be to open to the debate for the achievement/implementation of the previously set objectives. As a result, a clear set of actions will emerge. After this focus group, each stakeholder will be asked to “resume” their normal operation in their institutions and assess/identify how the objectives (through the emerged set of actions) can be implemented (in theory) and what changes/further actions would be required. Such changes can be operational, regulatory, etc. In any case, the idea is to minimize the effort for the stakeholders in order to ensure they participation.</p>
<b>Quadruple helix co-creation implementation approach</b>	<p>The multi-stakeholder management during the focus groups will be implemented following the forthcoming guideline(s):</p> <ul style="list-style-type: none"> <li>• Introductions &amp; overview on the research, chosen needs, objectives of the quadruple helix co-creation.</li> <li>• <u>For each stakeholder</u>: current awareness and interest related to the needs[repeat for each need]</li> <li>• <u>For the internal stakeholders</u>: what do you require from industry, NGOs and policy in order to better develop curricula into your ongoing teaching framework?</li> <li>• <u>For the internal stakeholders</u>: how can you better involve society in your teaching material design, implementation &amp; follow-up stages and how would this impact on embedding the chosen pillars in your curriculum?</li> <li>• <u>For industry &amp; NGOs</u>: what would make you engage more with universities (i.e. internal stakeholders) in order to properly facilitate the development of curricula? What</li> </ul>



	<p>perceived benefits do you foresee and what are the blockers?                  How is the policy framework supporting such engagement?</p> <ul style="list-style-type: none"> <li>• <u>For policy makers</u>: How should the co-creation between the internal stakeholders, society and industry evolve in order to properly contribute to the national/regional policies on supporting curricula? What are your main mechanisms to control and monitor the developments of curricula implementation (and how do you measure the impact (graduate know-how) at a local/regional/national level)?</li> <li>• <u>For industry &amp; policy</u>: Would you be willing to provide funding for boosting the embedment of the curricula in other universities?</li> <li>• <u>For society/NGOs</u>: How would you expect to be involved and contribute in the design, implementation and follow-up stages of this ongoing curriculum development? How will your contribution impact on embedding the curriculum in universities?</li> <li>• <u>Consensus</u>: Direct the discussions towards achieving (if possible) a consensus among the stakeholders and set the following next steps that each stakeholder will have to consider.</li> </ul>
<p><b>Follow-up interview/questionnaire</b></p>	<p>Organize a follow-up interview/questionnaire with (the same) internal + external stakeholders in order to discuss the follow-up on the actions set in the first focus group.</p> <p>The objective would be to understand to what extent the previously set actions can be implemented and if (perhaps) any other blockers are emerging while also updating on the research progress. This would enable the internal stakeholders to incorporate progress-feedback in their process of assessing the implementation of the curriculum. Guidelines:</p> <p>The targets upon which the progress should be reported are:</p>



	<ul style="list-style-type: none"> <li>○ <u>Internal stakeholders (as well as external researchers/universities)</u>: Identify how to involve the quadruple helix stakeholders for better boosting this co-creation for curriculum development. A practical approach could be adopted by the internal stakeholders by piloting the most relevant needs that have been debated during the co-creation meeting.</li> <li>○ <u>Policy makers</u>: identify what policy changes are required (and if they are feasible) to better support the quadruple helix co-creation around .</li> <li>○ <u>Industry &amp; NGOs</u>: identify potential cooperation opportunities with the internal stakeholders and what would be the framework/expected outcomes (win-win) in terms of enhancing the development of marker-oriented curricula.</li> <li>○ <u>Society &amp; NGOs</u>: identify the current/ongoing needs (based on the overall context discussed in the focus group &amp; related to the chosen needs) and propose ways for the internal stakeholders to account them in the research stages.</li> </ul> <p>Each stakeholder will be contacted by phone for a brief interview (30 minutes) in order to follow-up for each of the set targets.</p>
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### 3.5 Observation

The quadruple helix co-creation will be implemented based on the previously developed design. Throughout the implementation, inter-co-creation knowledge-exchanges (within SUSTAIN-CE) as will take place. During the implementation of the quadruple helix co-creation, the teams will promote an idea exchange among them so as to building a common view of the open innovation & knowledge-flows and to learn from each-other.

The ultimate role of observation is not to act as a corrective measure but to identify learning opportunities that will be discussed in the follow-up quadruple helix co-creation events. The observation will take place at the following stages:

- Initial stage (after the quadruple helix co-creation design is finalized)
- Mid-stage (after the follow-up interviews)
- Final stage (after the curricula is fully developed)

The observation will be based on the following co-creation KPIs:

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**Quantitative:**

- Representation of each internal & quadruple helix actor
- Interest in of each internal & quadruple helix actor [at the beginning & end of the co-creation ]
- Awareness of each internal & quadruple helix actor [at the beginning & end of co-creation ]
- Perceived usefulness of of each internal & quadruple helix actor [at the beginning & end of the co-creation]
- Number of best practices, curricula, case studies evaluated and highly rated by the stakeholders
- Number of internal stakeholders involved in the co-creation
- Number of quadruple helix consensus solutions (common agreed plans/steps) for supporting the collaboration around

**Qualitative:**

- Policy change recommendations
- Organizational change recommendations
- Industry proposals for collaboration with academia
- Society-driven proposals for collaboration with academia
- Observation of result/best practice multiplication in the quadruple helix ecosystem
- Number of civil engineering companies engaged through this exercise

## 4 Operationalizing the quadruple helix co-creation

The quadruple helix co-creation approach described in this document has been used in all of SUSTAIN-CE's outputs, however the best example (show-case) of how this is taken into practice is shown by each training event organized according to the Training Scheme Methodology document. Each training is basically a quadruple helix co-creation in which actors from each relevant quadruple helix sector gather in various setting (i.e. workshops, trainings, dissemination & co-creation sessions) in order to co-produce the targeted objectives. In the case of the training events the objectives would be to: pilot & subject to open innovation & co-creation the training material & VLE in a quadruple helix context, identify further trainings needs and raise awareness on . In order to organize these sessions, each training event organizer has utilized the quadruple helix co-creation guidelines for engaging the stakeholders and then they have operationalized the co-creation by relying on the training methodology.

## 5 List of SUSTAIN-CE Quadruple Helix Stakeholders

Country	Name of institution	Type (university, industry, government, NGO)	Website	Potential interest in engaging with SUSTAIN-CE
Greece	Aristotle University - School of Electrical and Computer Engineering	University	<a href="http://ee.auth.gr/en/">http://ee.auth.gr/en/</a>	Incorporating the SUSTAIN-CE curriculum
Greece	National Technical University - School of Civil Engineering	University	<a href="https://emp.gr">https://emp.gr</a>	Incorporating the SUSTAIN-CE curriculum
Greece	Democritus University of Thrace - School of Civil Engineering	University	<a href="https://www.duth.gr">https://www.duth.gr</a>	Incorporating the SUSTAIN-CE curriculum
Greece	University of Patra - School of Civil Engineering	University	<a href="https://www.upatras.gr">https://www.upatras.gr</a>	Incorporating the SUSTAIN-CE curriculum
Greece	University of Volos - School of Civil Engineering	University	<a href="https://www.uth.gr">https://www.uth.gr</a>	Incorporating the SUSTAIN-CE curriculum
Greece	CERTRH	Research Institution	<a href="https://www.certh.gr">https://www.certh.gr</a>	Incorporating the SUSTAIN-CE curriculum
Greece	Technical Chamber of Central Macedonia	NGO	<a href="https://www.teetkm.gr">https://www.teetkm.gr</a>	Incorporating the SUSTAIN-CE curriculum
Greece	Technical Chamber of Western Macedonia	NGO	<a href="https://www.teetdm.gr">https://www.teetdm.gr</a>	Incorporating the SUSTAIN-CE curriculum

Greece	Technical Chamber of Greece	NGO	<a href="https://www.tee.gr">https://www.tee.gr</a>	Incorporating the SUSTAIN-CE curriculum
Greece	Association of Civil Engineers (Greece)	NGO	<a href="https://www.spm.gr">https://www.spm.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Association of Civil Engineers (Thessaloniki)	NGO	<a href="https://www.spmthess.gr">https://www.spmthess.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Association of Architects (Thessaloniki)	NGO	<a href="https://www.sadas-pea.gr">https://www.sadas-pea.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Panhellenic Association of Engineers Contractors	NGO	<a href="https://www.pedmede.gr">https://www.pedmede.gr</a>	Promoting Sustainability/CE concepts in architectural education/industry/government
Greece	Hellenic Cement Industry Association	NGO	<a href="http://www.hcia.gr">www.hcia.gr</a>	Promoting Sustainability/CE concepts in ready mix concrete industry/government
Greece	Egnatia Odos	NGO	<a href="http://www.egnatia.eu">www.egnatia.eu</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Ministry of Environment and Energy	NGO	<a href="https://ypen.gov.gr">https://ypen.gov.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Perfecture of Central Makedonia	Government	<a href="http://www.pkm.gov.gr">www.pkm.gov.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Perfecture of Wstern Makedonia	Government	<a href="http://www.pdm.gov.gr">www.pdm.gov.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Thessaloniki Metropolitan Municipality	Government	<a href="https://www.thessaloniki.gr">https://www.thessaloniki.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Pylaia-Chortiatis Municipality	Government	<a href="https://www.pilea-hortiatis.gr">https://www.pilea-hortiatis.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Municipality of Kalamaria	Government	<a href="https://www.kalamaria.gr">https://www.kalamaria.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	Municipality of Kavala	Government	<a href="https://www.kavala.gov.gr">https://www.kavala.gov.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government

Greece	Pavlou Mela Municipality	Government	<a href="https://www.kalamaria.gr">https://www.kalamaria.gr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Greece	ANAKEM SA	Industry	<a href="http://www.anakem.gr">http://www.anakem.gr</a>	Incorporating Sustainability/CE concepts in construction projects
Greece	Titan (production of cement)	Industry	<a href="https://www.titan.gr">https://www.titan.gr</a>	Incorporating Sustainability/CE concepts in construction projects
Greece	Gek-Terna	Industry	<a href="https://www.gekterna.com">https://www.gekterna.com</a>	Incorporating Sustainability/CE concepts in construction projects
Greece	Eblekton	Industry	<a href="http://www.eblekton.gr">http://www.eblekton.gr</a>	Incorporating Sustainability/CE concepts in construction projects
Greece	Tekon	Industry	<a href="http://www.tekon.gr">www.tekon.gr</a>	Incorporating Sustainability/CE concepts in construction projects
Greece	KES (Steel Service Center)	Industry	<a href="https://www.kes.gr">https://www.kes.gr</a>	Incorporating Sustainability/CE concepts in construction projects
Portugal	Smart Waste Portugal	NGO	<a href="http://www.smartwasteportugal.com/">http://www.smartwasteportugal.com/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	LNEG - Science in Energy, Geology and Geological Resources	R&Di institution	<a href="https://www.lneg.pt/en/homepage/">https://www.lneg.pt/en/homepage/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	Oeste Sustentável	Enviornmental & Sustainability Agency	<a href="http://www.oestesustentavel.pt/">http://www.oestesustentavel.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	LiderA	Voluntary system that guides and certifies environments in the search for sustainability in buildings and other built environments	<a href="http://www.lidera.info/">http://www.lidera.info/</a> <a href="https://www.lidera4all.com/">https://www.lidera4all.com/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	COTEC	Business Association for Innovation	<a href="http://www.cotecportugal.pt/en/">http://www.cotecportugal.pt/en/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	IST - Instituto Superior Técnico	University	<a href="https://tecnico.ulisboa.pt/pt/">https://tecnico.ulisboa.pt/pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government / Incorporating the SUSTAIN-CE curriculum
Portugal	TICE	Association for Sustainable Production Technologies	<a href="https://www.tice.pt/">https://www.tice.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	PRODUTECH	Association for Sustainable Production Technologies	<a href="http://www.produtech.org/">http://www.produtech.org/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government

Portugal	IEFP	Portuguese Institute for Employment and VET	<a href="https://www.iefp.pt/">https://www.iefp.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government / Incorporating the SUSTAIN-CE curriculum
Portugal	European Association of Institutes for Vocational Training (EVBB)	Non-governmental organisation/association	<a href="https://evbb.eu/">https://evbb.eu/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	Education Institute (Lisbon University)	University	<a href="https://www.ulisboa.pt/">https://www.ulisboa.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	IAPMEI	Agency for Competitiveness and Innovation	<a href="https://www.iapmei.pt/">https://www.iapmei.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	Sustainable Habitat Cluster	Association of companies, municipalities, R&D centers, business associations and other entities that are committed to sustainability as a motto for Innovation and Competitiveness.	<a href="http://www.centrohabitat.net/en">http://www.centrohabitat.net/en</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government / Incorporating the SUSTAIN-CE curriculum
Portugal	Atlântica	University	<a href="https://www.uatlantica.pt/">https://www.uatlantica.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government / Incorporating the SUSTAIN-CE curriculum
Portugal	ASM Industries	Holding Company that operates in the field of manufacturing of steel equipment for renewable and marine industries	<a href="https://asm-industries.com/">https://asm-industries.com/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	Albino Teixeira – Construções, Lda	Construction Company	<a href="http://www.albinoteixeira.pt/">http://www.albinoteixeira.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	AROUCONSTRÒI	Construction Company	<a href="http://www.arouconstrois.com/en/">http://www.arouconstrois.com/en/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	BALTOR	Engineering and Construction company	<a href="https://www.baltor.pt/">https://www.baltor.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government



Portugal	TUBOGAL	Scaffolding assembly / disassembly services company	<a href="https://www.tubogal.com/">https://www.tubogal.com/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	PROZINCO	Steelwork and construction company	<a href="https://www.prozinco.net/en/">https://www.prozinco.net/en/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	AECOPS	Association of Construction and Public Works and Services Companies	<a href="http://www.aecops.pt/">http://www.aecops.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government / Incorporating the SUSTAIN-CE curriculum
Portugal	ENFORCE	Energy Engineering	<a href="https://www.enforce.pt/en/">https://www.enforce.pt/en/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	CONDURIL	Construction and Engineering company	<a href="https://www.conduril.pt/conduril_en.html">https://www.conduril.pt/conduril_en.html</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	Teixeira Durante	Construction and Engineering company	<a href="https://www.teixeiradurante.pt/en/">https://www.teixeiradurante.pt/en/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	APEMETA	Association of Portuguese Enterprises of Environmental Technologies	<a href="http://www.apemeta.pt/apemeta/home.aspx">http://www.apemeta.pt/apemeta/home.aspx</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Portugal	AERLIS	Association of companies for Lisbon and Seúbal Regions	<a href="https://www.aerlis.pt/">https://www.aerlis.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government / Incorporating the SUSTAIN-CE curriculum
Portugal	AIMMAP	Portuguese Association of metallurgical and metal-mechanic manufacturers	<a href="http://www.metalportugal.pt/">http://www.metalportugal.pt/</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government / Incorporating the SUSTAIN-CE curriculum
Turkey	Ege University	University	<a href="https://ege.edu.tr">https://ege.edu.tr</a>	Incorporating the SUSTAIN-CE curriculum
Turkey	9 Eylul University	University	<a href="https://www.deu.edu.tr">https://www.deu.edu.tr</a>	Incorporating the SUSTAIN-CE curriculum
Turkey	Izmir University of Economics	University	<a href="https://www.ieu.edu.tr">https://www.ieu.edu.tr</a>	Incorporating the SUSTAIN-CE curriculum
Turkey	Middle East Technical University	University	<a href="https://www.metu.edu.tr">https://www.metu.edu.tr</a>	Incorporating the SUSTAIN-CE curriculum
Turkey	Gebze Technical University	University	<a href="https://www.gtu.edu.tr">https://www.gtu.edu.tr</a>	Incorporating the SUSTAIN-CE curriculum
Turkey	TED University	University	<a href="https://www.tedu.edu.tr">https://www.tedu.edu.tr</a>	Incorporating the SUSTAIN-CE curriculum
Turkey	Atılım University	University	<a href="https://www.atilim.edu.tr">https://www.atilim.edu.tr</a>	Incorporating the SUSTAIN-CE curriculum

Turkey	Aydın Adnan Menderes University	University	<a href="https://www.adu.edu.tr">https://www.adu.edu.tr</a>	Incorporating the SUSTAIN-CE curriculum
Turkey	Izmir Chamber of Civil Engineers	NGO	<a href="https://izmir.imo.org.tr">https://izmir.imo.org.tr</a>	Promoting Sustainability/CE concepts in civil engineering education/industry/government
Turkey	Izmir Chamber of Architects	NGO	<a href="https://www.izmimod.org.tr">https://www.izmimod.org.tr</a>	Promoting Sustainability/CE concepts in architectural education/industry/government
Turkey	Turkish Constructional Steelwork Association	NGO	<a href="https://www.tucsa.org">https://www.tucsa.org</a>	Promoting Sustainability/CE concepts in constructional steelwork industry/government
Turkey	Turkish Ready Mix Concrete Association	NGO	<a href="https://www.thbb.org">https://www.thbb.org</a>	Promoting Sustainability/CE concepts in ready mix concrete industry/government
Turkey	Turkish Cement Manufacturers Association	NGO	<a href="https://www.tcms.org.tr">https://www.tcms.org.tr</a>	Promoting Sustainability/CE concepts in cement manufacturing industry/government
Turkey	Izmir Metropolitan Municipality	Government	<a href="https://www.izmir.bel.tr">https://www.izmir.bel.tr</a>	Incorporating Sustainability/CE concepts in city works
Turkey	Izmir Bornova Municipality	Government	<a href="https://www.bornova.bel.tr">https://www.bornova.bel.tr</a>	Incorporating Sustainability/CE concepts in city works
Turkey	Izmir Bayrakli Municipality	Government	<a href="https://www.bayrakli.bel.tr">https://www.bayrakli.bel.tr</a>	Incorporating Sustainability/CE concepts in city works
Turkey	Turkish Republic Environment and Urban Ministry Izmir Branch	Government	<a href="https://izmir.csb.gov.tr">https://izmir.csb.gov.tr</a>	Incorporating Sustainability/CE concepts in city works
Turkey	Yuksel Project	Industry	<a href="https://www.yukselproje.com.tr">https://www.yukselproje.com.tr</a>	Incorporating Sustainability/CE concepts in construction projects
Turkey	Freysas Freyssinet Structural Systems Inc.	Industry	<a href="https://www.freysas.com.tr">https://www.freysas.com.tr</a>	Incorporating Sustainability/CE concepts in construction projects
Turkey	Ulker Construction	Industry	<a href="http://ulkermuhendislik.com.tr/">http://ulkermuhendislik.com.tr/</a>	Incorporating Sustainability/CE concepts in construction projects
Turkey	Atilla Dural	Industry	<a href="http://www.atilladural.com">www.atilladural.com</a>	Incorporating Sustainability/CE concepts in construction projects
Turkey	Peri	Industry	<a href="https://www.peri.com.tr/">https://www.peri.com.tr/</a>	Incorporating Sustainability/CE concepts in construction projects

Turkey	Doka	Industry	<a href="https://www.doka.com/tr/index">https://www.doka.com/tr/index</a>	Incorporating Sustainability/CE concepts in construction projects
Turkey	Mimtek	Industry	<a href="http://www.mimtek.com.tr/">http://www.mimtek.com.tr/</a>	Incorporating Sustainability/CE concepts in construction projects
Turkey	Oyak Beton	Industry	<a href="http://www.oyakbeton.com.tr/">http://www.oyakbeton.com.tr/</a>	Incorporating Sustainability/CE concepts in construction materials
Turkey	Batı Beton	Industry	<a href="https://www.batibeton.com.tr/">https://www.batibeton.com.tr/</a>	Incorporating Sustainability/CE concepts in construction materials
Turkey	Geo enstütü	Industry	<a href="http://www.geoenstitu.com/">http://www.geoenstitu.com/</a>	Incorporating Sustainability/CE concepts in construction projects
Turkey	İzmir Demir Çelik	Industry	<a href="https://www.izdemir.com.tr/">https://www.izdemir.com.tr/</a>	Incorporating Sustainability/CE concepts in construction materials
Turkey	Habaş	Industry	<a href="https://www.habas.com.tr/">https://www.habas.com.tr/</a>	Incorporating Sustainability/CE concepts in construction materials
Turkey	Fibrobeton	Industry	<a href="https://fibrobeton.com.tr/">https://fibrobeton.com.tr/</a>	Incorporating Sustainability/CE concepts in construction materials



## 6 Benchmarked case studies of quadruple helix co-creation

Country / Region	Name of institution or Project that facilitated the co-creation	Subject of the course	Website	Innovative elements or success factors (if any)
UK, Greece, Italy, Poland	TranERGY project	Energy efficient operations	<a href="https://www.trainergy-project.eu">https://www.trainergy-project.eu</a>	Full course embedment in universities, quadruple helix participatory co-creation; piloting sessions
Turkey, Greece, Italy, Portugal, Belgium	iSTART	Virtual Environment Platform for Entrepreneurship education	<a href="https://istart.yasar.edu.tr/">https://istart.yasar.edu.tr/</a>	Co-creation of an entrepreneurship curriculum for face-to-face academies and a Virtual Learning Environment platform for supporting entrepreneurial education
Ireland, Netherlands, Germany, Lithuania, Romania, Hungary, Portugal, Spain, Greece	EMBRACE project	Corporate Social Entrepreneurship	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/612464-EPP-1-2019-1-IE-EPPKA2-KA">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/612464-EPP-1-2019-1-IE-EPPKA2-KA</a>	Establish a favourable climate for all quadruple helix actors to be actively informed of the need for Corporate Social Entrepreneurship; Co-design, co-create, co-develop and co-implement an innovative, multidisciplinary European Corporate Social Entrepreneurship Curriculum (ECSEC) to be incorporated into HEI education programmes across all disciplines.
Portugal, Spain, Italy, Germany	R&I Loop	Civic Universities	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2020-1-PT01-KA203-078366">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2020-1-PT01-KA203-078366</a>	<ol style="list-style-type: none"> <li>1) develop, test and mainstream a systemic and holistic approach that enhances the education, research and innovation links of HEIs;</li> <li>2) build, test and scale-up of capacitation actions for HEIs' teachers, researchers and staff to be better equipped to respond to social challenges and needs;</li> <li>3) design, test and mainstream of supporting tools that allow HEIs' to adopt a systemic holistic approach and improve their educational offer;</li> </ol>



				4) promote and enhance civic and social responsibility across relevant actors of the quadruple helix nodes.
Montenegro, Bosnia and Herzegovina, Slovenia	Youth 4 Open Innovation	Entrepreneurship, ICT and innovation to increase open innovation	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/618421-EPP-1-2020-1-ME-EPPKA2-CBY-WB">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/618421-EPP-1-2020-1-ME-EPPKA2-CBY-WB</a>	creation of one curriculum program for open innovation; 4 training programs for empowering open innovation skills of youth dealing with: technical, media literacy, interactive and research skills; 3 pilot open innovation projects developed on Hackathon (or similar) activity in Mostar and Bar; increased awareness of population, business and public sector on open innovation.
Romania, Greece, Austria, Germany	TraCCE	Creative and cultural entrepreneurship	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2020-1-RO01-KA203-079950">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2020-1-RO01-KA203-079950</a>	a higher education CCE Curriculum and a CCE Train the Trainers Toolkit that will be offered to academia & the CCE community (open access) through a virtual learning environment and piloted through two international workshops.
Germany, Greece, Italy, Cambodia, Thailand, Vietnam	SWAP project	Waste management	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/618723-EPP-1-2020-1-DE-EPPKA2-CBHE-JP">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/618723-EPP-1-2020-1-DE-EPPKA2-CBHE-JP</a>	Establishing Training Hubs for sustainable solid waste management, health and environmental risks related to improper waste treatment, and business operation
Netherlands, Slovakia, Bulgaria, Greece, Finland	INVEST project	establish a European university alliance	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/101004073">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/101004073</a>	Establishing the Living Lab's as innovative platforms for the quadruple helix (research, education, companies/NGO's and GO's) collaboration with the stakeholders from the regions, together with innovative solutions, such as Virtual Campus or the EDUC8EU integrated platform, the INVEST alliance will create perfect conditions to build a modern European University, satisfying needs and requirements of the new generation of Europeans as the leaders of introducing sustainable life in regions across the Europe, responding current global challenges determined within the UN Sustainable Development Goals.



Albania, Germany, Italy, Serbia	USIA project	strengthening institutional and human resources capacities in HEIs in Albania	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/618997-EPP-1-2020-1-AL-EPPKA2-CBHE-JP">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/618997-EPP-1-2020-1-AL-EPPKA2-CBHE-JP</a>	The project will establish and expand a Quadruple Helix network and online platform which will offer networking, matchmaking, brokerage, dissemination, competences development, support and valorisation for academic and non-academic actors.
Belgium, France, Croatia, Spain, Italy, Norway	Stride for Stride project	building up the concept of Regional Skills Ecosystems	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2020-1-FR01-KA202-080311">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2020-1-FR01-KA202-080311</a>	<ol style="list-style-type: none"> <li>1. Tackling skills intelligence and forecasting at regional level to build regional skills ecosystems, and</li> <li>2. involving all relevant actors featured in the quadruple helix interaction system to help building powerful skills intelligence tools, not only as external "validators" of the process, but as an intrinsic part of it.</li> </ol>
Greece, Poland, Romania, Bulgaria	ATSIV project	increase the professional competences of NGOs workers	<a href="http://ngotraining.eu/">http://ngotraining.eu/</a>	Development of a virtual learning environment (VLE) to enable continuous quadruple helix co-creation of the game based curriculum and best practices (also ensuring multi-stakeholder validation of the resources)
Bulgaria, Romania, Spain, Netherlands	Smart technologies by design	design thinking and disruptive innovation processes to develop smart city solutions	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2019-1-BG01-KA202-062298">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2019-1-BG01-KA202-062298</a>	Training program for smart disruptive innovation; Training toolkit for managers and owners of smart businesses; Digital platform for smart innovations
Germany, Poland, Austria, Slovenia, Hungary, Italy	NetHIIP project	smart specialization	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2019-1-HU01-KA203-061181">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2019-1-HU01-KA203-061181</a>	develop a transnational and digital incubation process that allows innovation to emerge by a bottom up process at HEIs in interaction with RIS3 actors.
Belgium, Finland, Spain, Portugal	NICCoLLa project	implementation of technology and ICT in the care and wellbeing sector	<a href="http://www.niccolla.eu">http://www.niccolla.eu</a>	Based on a quadruple helix approach and by involving relevant external stakeholders and target groups directly in the project activities, this transnational project will foster transnational, transdisciplinary co-creative learning and development, built around innovative learning methodologies such as hackathons, blended learning, and patient/client journeys.



Poland, Greece, Slovenia	NEXTLOG project	Digital, intelligent and sustainable logistics (DISL)	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2019-1-PL01-KA203-065731">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2019-1-PL01-KA203-065731</a>	co-create DISL curriculum and pilot it through an open innovation and co-creation virtual learning environment (VLE)
Germany, Sweden, Spain	IncluSTEM project	STEM	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2020-1-SE01-KA203-077917">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2020-1-SE01-KA203-077917</a>	Developing an “Onboarding Handbook”; Implementing STEM study-specific language courses in English, German, Spanish and Swedish online and offline; Create structure, content and teaching methods for “Training for employability”; Developing an action plan to set up job-matching schemes
Greece, United Kingdom, Italy, Spain, Romania, Bulgaria	Διάλογος project	fighting disinformation and false beliefs	<a href="https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2019-1-EL01-KA203-062969">https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2019-1-EL01-KA203-062969</a>	make the difference between the current, widespread, superficial, a-critical thinking about big and little issues, and a deeper, more complex and productive style of reasoning, able to generate new ideas, resolving conflicts, enriching the involved perspectives and deliver innovation for the benefit of the whole community through the adoption of the Open Innovation paradigm and the Quadruple Helix model
Belgium, Netherlands, Finland, South Africa	CASO project	improving health outcomes and performance of health systems	<a href="http://www.caringsociety.eu/">http://www.caringsociety.eu/</a>	(1) placing health(care) learners in community clinical settings; (2) teaching more basic healthy lifestyle and enhanced physical activity education and (3) involving local communities in health(care) education and focus on strengthening the competence level and professional position of the health(care) professional
Germany, Egypt, Spain, Italy, Greece	SureMap project	Sustainable Resources Management	<a href="https://suremap.eu">https://suremap.eu</a>	develop an interdisciplinary study program, offering MSc and advanced diplomas in Sustainable Resources Management
Netherlands, United Kingdom, Spain, Turkey, Finland, Lithuania	SESAME project	social enterprises	<a href="http://sesameproject.com/">http://sesameproject.com/</a>	a manual, a training on social enterprise, online toolkit, a European platform, local one-stop shops, and a mentor methodology.



United Kingdom, Spain, Belgium, Denmark, Norway	ALTAS project	assistive living technology (ALT) training courses for health and social care staff	<a href="http://www.altas.training/">http://www.altas.training/</a>	(1) develop a recognised standard, curriculum, course and qualification that will give professionals an incentive to add to their knowledge and skills; (2) stimulate demand for and increase the uptake of innovation through stakeholder engagement and co-creation of course development ; (3) provide the opportunity to continuously update the curricula and standards by linking the professionals to a strong knowledge cluster.
Italy, Spain, Sweden, Hungary	Smart Jump project	Creative and cultural entrepreneurship	<a href="http://www.smartjump.eu/">http://www.smartjump.eu/</a>	development of the Quadruple Helix model that aimed at developing female entrepreneurship
USA	U.S. Green Building Council	Green Building Design and Construction Curriculum Toolkit (LEED)	<a href="https://www.usgbc.org/resources/green-building-design-and-construction-curriculum-toolkit">https://www.usgbc.org/resources/green-building-design-and-construction-curriculum-toolkit</a> <a href="https://www.usgbc.org/resources/selected-courses-education-usgbc-subscription-support-higher-education-curriculum">https://www.usgbc.org/resources/selected-courses-education-usgbc-subscription-support-higher-education-curriculum</a>	Resources and activities to prepare higher education students for 21st century careers in green building and sustainability industries  Selected courses in Education @USGBC Subscription to support Higher Education Curriculum
West Lafayette, Indiana, USA	ASEE/Purdue University	Integrating Sustainability into Construction Education - Strategic Paper	<a href="https://peer.asee.org/integrating-sustainability-into-construction-education.pdf">https://peer.asee.org/integrating-sustainability-into-construction-education.pdf</a>	The faculty is already heavily involved in the change process: identifying faculty strengths, analyzing current curriculum, and establishing learning objectives and outcomes. Analysis of the existing curriculum and pedagogy identifies existing SDE and opportunities for vertical and horizontal integration. Active learning through PBL is the best application for learning SD within construction education courses. Learning from other institutions' challenges and successes is crucial to a seamless integration. Most notably, support of faculty in order to counteract resistance is key to success. Providing instructors with educational and implantation-related resources helps to provide relevance and positive associations with SDE integration.





				<p>The progress of SDE implementation depends upon the program's or intuition's ability develop a plan that keeps open lines of communication as a source of support for faculty in order to proactively address any challenges of SDE implementation.</p>
<p>The Kendeda Building For Innovative Sustainable Design</p>	<p>Georgia Institute of Technology</p>	<p>The Kendeda Building for Innovative Sustainable Design ("Kendeda Building") is the latest example of the Georgia Institute of Technology's sustainability leadership and innovation. Georgia Tech completed the building in September 2019 and constructed it to the Living Building Challenge 3.1 ("LBC") certification standard, the world's most ambitious building performance standard. For example, The Kendeda Building must produce more onsite renewable electricity than it uses and it has composting toilets that use a fraction of the water of conventional toilets. This Building Manual provides tips on usage, instructions for reserving space, and catering guidelines, as well as details on how to</p>	<p><a href="https://livingbuilding.gatech.edu/kendeda-building-innovative-sustainable-design">https://livingbuilding.gatech.edu/kendeda-building-innovative-sustainable-design</a></p>	<p>The most environmentally advanced education and research building ever constructed in the Southeast. The Living Building Challenge aligns with Georgia Tech's longstanding vision for the campus and provides a unique opportunity to physically demonstrate how Georgia Tech practices thoughtful stewardship of all of its resources and how its innovative thinking can transform future generations.</p>



		operate and maintain the building.		
Canada	The green building centre	Projects that emerge from our new research hub, facilitating applied research in green construction and sustainable building practices in the Canadian construction, engineering and IT sectors. Projects range from advanced prototyping to building information modelling to building automation.	<a href="https://www.georgebrown.ca/about/office-of-research-innovation/research-facilities/green-projects">https://www.georgebrown.ca/about/office-of-research-innovation/research-facilities/green-projects</a>	The Green Building Centre acts as a hub of research infrastructure that connects industry to economically meaningful applied research. This new research hub focus on the Canadian construction, engineering and IT sectors, facilitating applied research in green construction and sustainable building practices.
Australia	University of Technology, Sydney	Winemaking	<a href="https://doi.org/10.1080/08109028.2014.933599">https://doi.org/10.1080/08109028.2014.933599</a>	Triple Helix synergy of interactions among the research (academic), policy (government) and industry spheres in winemaking in Australia