Forward-looking university curricula and enterprises for renewable energies

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Abstract: The new EU Commission decided on a European 'Green Deal' having ten clear targets. This case study is suggested as a possible implementation of this 'Green Deal' with a focus on Eastern Europe. This article proposes a long-term strategy for higher education on renewable energies, as is additionally in line with the EU Renewed Agenda which requires: 1) *university curricula*: creating new and enhancing existing university curricula on renewable energy sources (RES), energy efficiency and climate protection; 2) *science-business cooperation*: preparing concrete and financeable projects in the fields of RES, circular economy and climate protection in order to implement the Paris targets and the Green Deal, including their financing. This case study means founding a prospective university-business network for Western and Eastern Europe and thus promoting social transition to sustainability.

Keywords: renewable energy; curricula; interdisciplinary projects; global warming; mitigation; project funding; enterprises; businesses; transition; energy transition; higher education institutions; HEI; twinning projects; Ukraine; Ukrainian Green Deal; Eastern Europe.

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Biographical notes: Gilbert Ahamer studied physics and technology – rather natural sciences, in order to 'understand' reality – and later economics and the environment. However, the complexities of real life seemed to be better covered by social sciences and humanities. Since 1990, he has been at the service of national, international and transnational institutions – including six universities, the Austrian Academy of Sciences, the International Institute for Systems Analysis and the European Commission. After being an EU adviser to five neighbouring countries, he currently tries to establish quality criteria for intercultural, interdisciplinary and interparadigmatic dialogue in peace and understanding.

1 Introduction: the target

The aim of this article is to present a plan for how to support and implement *energy transition* in different socio-political systems at the same time. In order to combine two aspects that resonate with the scope of this journal, the following proposal is made for a prospective university-business network, wherein the two components reinforce each other (Figure 1):

1 To design a *RES master curriculum* at universities which includes creating, providing and improving courses (seminars and lectures) annually. In an annual feedback cycle, courses are improved and adapted incrementally, and finally the curricula are formally endorsed by rectorates. Each university provides:
   - one new course developed during this project
   - one existing course that fits into the scope of courses already existing at target universities.

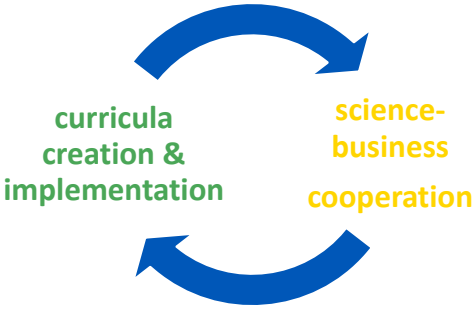
2 To iteratively identify, design, plan and substantiate through *science-business cooperation* three RES bankable projects to such a degree that these may be submitted to responsible national authorities after three years. Projects may include one on each of solar, wind and biomass energy. In an annual planning cycle, all experts contribute strategically, as do students during tailored seminars.

A new logo (Figure 2) represents the radiative power of this case study. Based on ten EU Green Deal targets (blue), this case study involves cooperation throughout science and business (yellow) and provides courses on 24 interdisciplinary areas (green).

Humanity faces global warming. The EU takes the most proactive stance to tackle it globally (EC, 2019; Delegation, 2019); and the role of education will be preeminent (EU, 2018).

This article combines traits of administrative or government reports with a scholarly article, and with this intentionally selected style tries to push forward actual and real implementation. It is structured into chapters in such a way as to take into account both science and administration; repetitions are due to diverse standpoints from which the issues of foresight, transnational cooperation, policy development, technology dissemination, didactics, renewable energy and societal transition are described.

Figure 1 This article's two main components enhance and reinforce each other: 'curricula implementation' and 'science-business cooperation' implemented iteratively (see online version for colours)



2 This case study is based on strategic policy documents

2.1 The European Green Deal is the starting point of a real-world transition

The 'Green Deal' (EU, 2020) was repeatedly declared by the new EU Commission President van der Leyen (EC President, 2020), and – given the broad consensus of scientists – must be implemented now. This is what climate science has been calling for decades [CAT, 2020; Carbon Brief, 2020; Oliver et al., 2018; UNFCCC, 2019; Chumakov, 2013; Duraković et al., 2012; Ahamer, (2019), 53ff].

Our European youth – our own sons and daughters – very explicitly require us to meet the declared targets, as we regularly see from the 'Fridays for Future Movement' (FFF, 2020) public actions. Our youth is the ultimate target of any educational system, and consequently their generic requirements are key to any activity in and for education.

All countries, even outside the EU, are called upon to participate substantially, reliably, professionally, and in the long term to reliably implementing a worldwide energy transition. An existing consortium (E-control, 2019; Twinning, 2018, 2019; Delegation, 2020) has been performing preparatory work over the past year.

Existing and politically agreed plans in many countries on a national level [such as the *National Integrated Energy and Climate Plans*, NECP (2020)] define policy and concrete targets for the share of renewable energies (RES) for the years leading up to 2030/2040.

This article suggests combining long-term and short-term views and thus amalgamating *two avenues of action* to facilitate the practical achievement of the Green Deal (as policy-relevant and legally materialised, e.g., in NECPs) for European countries:

1 In the long term, *the production of professionals* able to implement renewable energy sources (RES) on a technological, organisational, financial, social and environmental level: RES curricula

2 In the medium term, the planning of *three concrete* RES installations as visible cases while dealing with their technological, organisational, financial, social and environmental aspects: RES projects.

While supporting the EU role of taking the worldwide lead in climate protection, this case study

- develops new, innovative (Ahamer, 2015) and *transdisciplinary* teaching and learning on *RES*
- stimulates the *entrepreneurship* or entrepreneurial skills (Ahamer and Mayer, 2013) by activities of higher education institutions (HEI) and company staff for RES
- strongly and regularly facilitates the Europe-wide exchange, flow and *co-creation of knowledge* on RES (Öttl et al., 2014).

2.2 The energy transition builds on existing networks

Any techno-social transition endeavour will build on *existing and functioning* cooperation. The following examples of successful community building exercises are mentioned as a small sample:

- An in-depth dialogue during structured interviews within a RES Twinning project (Delegation, 2019; Twinning, 2019) supporting its national implementation in EU Programme countries (e.g., Ukraine).
- An authentic series of RES conferences (XVII International Communtech in Kyiv, 5–7.11.2019, Ukrainian RES Investment Forum 28.11.19, the International Symposium: Sustainable Development – State and Prospects, 19–22.2.2020 in Slavske near L'viv).
- The Ukrainian peer-reviewed journal entitled 'Environmental problems' (2019).
- Functioning networks of national agencies, universities and academies of sciences.

The analysis by Zhelnovach et al. (2020) provided an insight into the fact that the professional capacity to implement the Green Deal – meaning an energy transition towards a carbon-free energy system based on renewables – is needed.

Methodically based on Glaser and Strauss (1998), Häder (2006), Burzan (2015) amdand Schirmer (2009), the method used here was strongly inspired by 'grounded theory', because this field of RES actually deserves an open research design which allows for target setting and emphasis finding by interviewees themselves. The most valuable result from conversations with local experts was actually their view of what was essential, and why procedures had only worked in a suboptimal manner until now. Open, trustful conversations (which were possible after 2 hours of face-to-face encounters) resulted in very personal view being offered, including precise definitions and illustrations for corrupt features in energy administration. Judging by the considerable number of repetitions and by the interview partners' broadly distributed backgrounds from all five domains of the quintuple helix of innovation (industry, administration, university, media, and civil society), the validity of interview results (Whittemore et al., 2001; Barab and Squire, 2004; DBRC, 2003; McKenney and Reeves, 2012; Brown, 1992) was sufficiently high.

A more recent analysis was based on guided in-depth interviews during 2019 (methodically based on Collins, 1992; Raithel, 2008), with two dozen stakeholders representing all institutions of a national energy system and thus reflects the best available insight from practitioners. One key conclusion of this analysis was that better education for RES must be promoted (Ahamer, 2021a, 2021b).

Based on existing diagnoses, and in line with existing policy documents (EC, 2020a), a practically feasible core idea generated within this article includes:

- Creating and implementing a RES master curriculum in at least three European cities
- Establishing three concrete RES projects (e.g., from wind, solar, biomass) in Central and Eastern Europe. These projects emerge from the iterative self-responsible identification process among expert participants. The self-identification of suitable targets is a key element of constructivism, hence of any international cooperation.

The core process and added value is that both components complement each other (Figure 1), namely:

1 by practitioners teaching in the university curricula

2 by scientists advising for the project's practical implementation.

These procedures can be planned as biannual meetings in participating cities, while both meetings (for curricula and business) are held back-to-back, in order to allow almost all scientists to take part in business discussions and all business representatives to take part in curriculum discussions.

Here, lecturers serve as consultants for project planning, and consultants serve as lecturers.

While performing the mentioned Twinning project on RES, it became clear that Eastern Europe has an enormous potential for:

1 renewable sources

2 a highly educated and technologically skilled workforce for implementing RES.

During 24 interviews with leading institutions, needed future actions for implementing real-world climate protection actions became clear. Therefore, the most proactive cooperation partners from all sides (Twinning, 2019) are forming a nucleus for future action. In the methodological spirit of 'guided interviews' (Flick, 1995, 2002; Porst, 2014; Aprea, 2007, 2013), the previously prepared and communicated interview questions were (Ahamer, 2020):

1 What is the current situation in Ukraine regarding energy production?

2 What type of information do you think is needed for better promoting RES installations?

3 What obstacles are encountered when trying to install renewable energy in Ukraine, and what information is needed by whom to overcome these obstacles?

4 What type of mutual cooperation among stakeholders appears useful for prospective actors who plan to install renewable energy plants?

5 In your view, what type of additional interactive and cooperative (online) information platform can support the successful installation of renewable energy?

6 In your view, which rules and administrative procedures in Ukraine's practice should be changed in order to facilitate the successful installation of renewable energy?

2.3 Approaches to RES education based on existing literature

For the author, this entire endeavour of establishing RES curricula in Eastern Europe comes after a two decade-long period of having contributed to a transdisciplinary curriculum on 'environmental systems sciences' and having co-founded an inter-paradigmatic curriculum on 'global studies'. After several long-term projects in Eastern Europe, the need for sound and perseverating university education was felt by all partners jointly, and the conviction emerged that every partner should invest their already existing strategic assets.

As the influential article by Jennings (2009) enumerates, "modern renewable energy education includes a study of the technology, resources, systems design, economics, industry structure and policies in an integrated package", especially given that "there are more pitfalls in the use of renewables than there are in using the more mature conventional technologies and systems". Jennings (2009) sees multiple target groups for RES education as a result of our surveys and enquiries performed: (re)training of

professionals, technicians and tradespeople, initial training of scientists and engineers, training for financiers, investors and policy analysts; resources for schools on energy issues; and contemporary information about renewable energy technology for the general public. This spans an enormous field – and strong industrial traditions in Eastern Europe suggest the first item in this enumeration is what should be focussed on: *(re)training of professionals*.

Existing curricula at other universities are analysed in Jennings (2009, 438ff), their objectives and desirable features [Kandpal and Broman, (2014): 302ff; Jennings and Lund, 2001] as well as their modes and levels of teaching analysed, which include school level (Zografakis et al., 2008; Acikgoz, 2011). Levels of awareness about the RES of university students were analysed in Karatepe et al. (2012), Tortop (2012), Thomas et al. (2008), Bhattacharya (2001) and Karabulut et al. (2011), with a special emphasis on social questions such as "increasing public perception of renewable energy as an intrinsically reliable and *cost competitive* energy source" (Ciriminna et al., 2016) and the *energy justice* framework (Islar et al., 2017). Targeted *didactics* are advocated and described (Broman, 1994; Ott et al., 2018; Gutiérrez et al., 2018; Laaroussi et al., 2017) based on gap analyses (Lucas et al., 2018), including from the internet (O'Mara and Jennings, 2001).

The main findings by Lucas et al. (2018, p.449) are:

1 that in developing countries the shortage is more acute

2 that a mismatch exists between industry demand and education system offer

3 a mismatch exists in curricula suitability; (

4 a move towards online training for collaborating and learning by students and educators.

The present case study *answers* these needs.

2.4 Existing initiatives in RES education

The existing *European Master's Program in Renewable Energies* (e.g., Boreland et al., 2003) is an initiative proposed and developed by the Association of European Renewable Energy Research Centres (EUREC) and a university consortium and involves the following universities: MINES-ParisTech, France, Zaragoza University, Spain, Loughborough University, UK, Oldenburg University, Germany, Hanze University, The Netherlands. This more application-oriented degree course aims to train professionals who are able to familiarise themselves with the various areas and issues of renewable energy and also aims to develop these to high-level specialists (European Masters, 2020).

On a general level, *RES education and training is growing* in Europe [Watkinson et al., (2012), p.128]. As an example, 65 English-language Masters Courses in bioenergy were identified by these authors, based on an analysis of single university courses (p.133ff). The European Higher Education Area (EHEA) generally permits widespread use of created curricula (Martínez-García and Cosp-Vilella, 2017); and bilateral double master degrees enlarge their applicability beyond Europe, for example into the Mediterranean MENA area (Anany et al., 2013).

Collaboration equally takes place between *industry and academia* in RES course development and RES technological innovation: recently, Rokicki et al. (2020) analysed

the importance of EU higher education for achieving the objectives of a circular economy in the energy sector. Naturally, industry participation invokes challenge-based learning (Ibwe et al., 2018; Rauch, 2013, 2014, 2017, 2018, 2020a, 2020b, 2020c, 2020d). A balanced-scorecard approach was chosen by (de Andrade Guerra et al., 2018) to specify curriculum content and the approach of 'environmental economics' [as invented by former World Bank director Herman E. Daly in his book *Beyond Growth* (Daly, 1996)] is applied to energy by Bermejo (2014). Industrial innovation strategies have long included renewables and thus need highly qualified human resources (Wessner, 2013).

Overall, and based on decades of experience in post-Socialist countries, the real and practical implementation of *entrepreneurship* is the key success element, notably for RES (Runge, 2014) and sustainability in general (Jia et al., 2019).

Against the background of this literature analysis, the present approach has its novelty in multi-perspectivistic approaches from all stakeholders within classical and non-carbon energy economics and energy technologies, combined with the inclusion of real-world business projects in the RES sector – to date an absolute novelty in post-Soviet countries (Grechukhina, 2020; IRENA, 2014, 2017, 2018).

3 The role of higher education in social transitions

The EU (2017) 'Renewed Agenda for Higher Education' defines four aims on page 4 which are applicable for the strategic design of the present case study and have already been implemented by several partner institutions:

1 *Tackle future skills mismatches and promote excellence in skills development*: classical technological higher education is often focused on fossil energy systems, and lacks the inclusion of socio-economic (DiXi Group, 2020a) and financial knowledge. Partners provide *collaborative* open, online and blended learning (Ahamer, 2013a) which tutors can use onwards. For training students, involved agencies and businesses provide *real-world* cooperation with future *employers which* includes public participation (DiXi Group, 2020b).

2 *Build inclusive and connected higher education systems*: across Europe (and European Neighbourhood Countries), the urgently needed university education (Zhelnovach, 2020) on how to facilitate an 'energy transition' jointly with its socio-cultural triggers and *democratic challenges*, will be facilitated according to *Eastern Partnership (EaP)* policies[1] (EaP, 2020). Also, experience (e.g., AEE, 2020) leads to the suggestion of starting a HEI-VET dialogue on new professions such as 'solar plumbers'.

3 *Ensure that HEI contribute to innovation*: concrete input from HEI (Barz, 2016) into three *tangible innovation* projects (Suharevska and Blumberg, 2019) in business (Ahamer, 2011; Ahamer and Schrei, 2006) and industry (Lang et al., 2019; Ahamer and Jekel, 2010) is provided via the regularly built-in 'science-business links'.

4 *Support efficient and effective higher education systems*: in all participating countries, the perception of partners' daily teaching routines (Ahamer, 2013b, 2013c; Ahamer and Kumpfmüller, 2013) serves as a best-practice example (Dominković et al., 2016) to improve their own effectiveness (Mysak et al., 2017).

4 The functions within a proactive network

The "main emphasis is directed to projects which contribute to modernising Europe's higher education systems" as outlined by the "2017 EU Communication on the Renewed EU Agenda for Higher Education" (EU, 2018), "namely:

- to promote excellence in *skills development* and to tackle future skills mismatches
- to build *connected and inclusive* higher education systems
- to ensure that HEI will *contribute to innovation*
- to support *efficient and effective* higher education systems".

One highly recommended avenue is the European Research Area (ERA, 2020), which has already facilitated a multitude of trans-European research cooperation activities.

As mentioned before, the following plans require decidedly more ambition in order to actually implement RES projects:

- EU 'Green Deal' and EU RES policies [e.g., RES Directive: EU (2019), National renewable energy action plans 2020 and subsequent plans such as Euractiv (2020)]
- National 'Green Deals' and national RES plans
- Ukrainian 'Green Deal' (WKO, 2020) presented by the Ukrainian Energy Minister Orzhel on 21.2.2020 and national RES plans.

Very explicitly, "the [RES] Directive (EU, 2019) is promoting cooperation between EU countries plus cooperation with countries outside the EU) in order to help them achieve their RES targets. These cooperation mechanisms (EC 2020b) can be implemented as:

- transfers of RES
- joint RES projects
- joint RES support schemes" (EC, 2020c).

5 Roles and reflections within a network for transition

5.1 The logo serves as a graphical abstract

This chapter chooses to start with a graphic approach ('graphical abstract'), as is required in some high-ranking journals (WoS, 2020). Graphically, this case is symbolised by a logo in Figure 2. It contains three layers:

- blue = EU Green Deal targets
- yellow = science-business cooperation
- green = university courses.

The target of the logo is to demonstrate in graphical language that

- targets are the background against which all action is designed (ten blue rays)
- the ‘Green Deal’ in the meantime has become the background of all EU energy policy
- these targets point in different and diverse directions, thus embodying the transdisciplinary nature of the theme
- the radiative power of the team is portrayed (congruence of form and function)
- quick readers grasp the main meaning
- readership of this journal is multi-disciplinary; hence no discipline is discriminated against.

The match of targets by measures and partner institutions adheres to the same graphical representation.

Figure 2 A suggested project logo symbolises the radiating power towards fulfilling targets (see online version for colours)

The detailed symbolic meaning of this logo’s three layers:

- The outer blue ten-fold star represents *aims and targets* such as the ‘Green Deal’, non-carbon economy, no one left behind; its colour is the planet’s blue colour. Its pattern might arise in some of the targeted countries’ folkloristic artwork. The number of ten symbolises (interdisciplinary) *completeness* and dynamic balance.
- The yellow circular band in the middle stands for the *science-business* cooperation, representing the material bondage of human existence, materialised as economic viability and the real-world implementation of concrete renewable energy projects.

- The inner 24-fold green star denotes the radiating power of *curricula and university courses* through several layers of society, including the community of individual learners, collective academia, and national and European business. *Every partner is a ray of the sun*.

5.2 The core idea and its self-critical reflection

The *core idea* of this partner network includes [while in brackets including a self-critical reflection of the proposed approaches]:

- Creating and implementing a RES master curriculum in at least three European cities [sufficient links to existing initiatives should be guaranteed, such as the European Master's Program in Renewable Energies]
  1. Over the coming three years [systemic risks to an implementation within such a brief period should be dealt with and neutralised, especially institutional and structural weaknesses in Eastern Europe's academia and industry, as economic catch-up is still underway].
  2. With the aim of creating self-sufficient curricula at project's end by including tutors [the training of Eastern European staff members should be safeguarded despite well-known high employee turnover rates in the public sector due to low payment and better prospects in the private sector].
  3. According to a '3 thirds' system, describable roughly as follows:
     a. 1/3 already existing courses from target universities [their content should be quality-controlled during project lifetime, and made independent of acting individuals, given high volatility of staff]
     b. 1/3 'new courses' created anew [the planned quality check procedures should be implemented and a suitably wide range of review action should be met by in-depth improvements, taking into account recent worldwide research]
     c. 1/3 are 'existing courses' from partner institutions [same as above].
  4. Existing curricula already include many aspects of RES, incl. technical, economic, legal, organisational, etc. aspects and seminars/lectures on these themes – directed towards realistic implementation of renewable energy projects in the real world. Hence, a sufficiently wide variety of themes is needed. [it should be safeguarded that significant, typical and successful projects are selected from within Eastern Europe, because local experts best understand the local production framework].
- Establishing *science-business contacts on RES* in Central and Eastern Europe. For this target, several associations and economic stakeholders are valuable partners. A suitable target is to bring *three concrete RES* projects (e.g., from wind, solar, biomass) to such a concrete level of planning that these projects could be formally submitted to national administration. [The financing must be especially safeguarded, and therefore the opinion from IFIs (Ahamer, 2020) such as EBRD and EIB, bilateral development banks and global programs such as UNFCCC and GCF should be taken into account sufficiently early.].

The main aspects of so-called ‘Knowledge Alliances’ (KA, 2020) for higher education (HE) include [again, with a self-critical reflection of the proposed approaches]:

- “Innovation within HE as well as innovation through HE in enterprises”: by a *six-fold iterative* reflection and review of planned courses, a pedagogical approach and business cases [staff costs and academic culture must be maintained to allow ongoing cycles of improvement while working on all course content]
- Sustainability of university-business cooperation: through *systemic dialogue* among all stakeholders along the entire project’s duration [substantial interest from both sides should be maintainable, despite the lack of additional revenue for both industry and academia]
- “Impact going beyond a project’s lifetime and beyond those organisations involved in such an alliance”: by the independent three *accredited* curricula at project’s end and the three project proposals, which are then mature for *submission* to the administratively responsible national authorities. [When industrial projects shift from the sphere of academia into the sphere of industry, sharp conflicts of interest and highly diverse patterns of income will presumably become striking. Moreover, the unforeseeable and highly complex administrative hurdles for large-scale infrastructural endeavours such as power plants offer considerable risk of economic disequilibrium among partners.]

5.3 Critical reflection on the practical feasibility

Based on expert comments received in the framework of KA (2020), the following items should be added in critical self-reflection:

1 A professional and genuine needs analysis regarding:
   a the energy supply situation
   b the academic situation in the targeted countries is required as a prerequisite to build this project, and its results should be clearly demonstrated for all involved countries (not only for Ukraine)
2 Challenges within the present-day status of RES and energy supply should be identified (such as weak reliability of high-voltage grids that could only incompletely take on more and intermittent RES power supply).
3 Regarding university didactics, the pedagogic added value and progress (as compared to the status quo) should be better defined and ensured by well-defined project procedures. Novel pedagogy should be secured in more concrete terms.
4 Inter-country transferability should be better guaranteed by work packages to generalise findings of systemic, transnational relevance.
5 The annual cycle of improving the quality of course content should be clearly defined.
6 Each partner ought to have their own clearly defined responsibilities in the network.
7 Tasks and roles of industry and their stakeholders have to be clear from the outset.

8 Mechanisms of conflict resolution throughout project duration should be clearly defined.

9 The exploitation strategy is insufficiently detailed: who has what economic advantage?

6 The detailed procedures enhancing an energy transition

As mentioned, needs analysis has already been carried out by in-depth stakeholder interviews, analysis of policy documents (Twinning, 2019), literature analysis, and by drawing on decades-long practical experiences with transitional processes.

The entire idea of a Knowledge Alliance (KA, 2020) resides on the mutually beneficial exchange between theory and practice, as implemented in this article.

HEI face growing and changing societal demands, namely:

- Real-world issues become more and more transdisciplinary:
  1 democracy – social dynamics – economic nexus (e.g., in socio-cultural global change)
  2 nature – energy – water nexus (Romero-Lankao et al., 2017) as identified by the European Environment Agency (EAA)
  3 transnational and supranational interconnections rise in relevance: EU 'Energy Union' (EnU, 2020)
  4 behavioural co-determinants for a civil society's development are growing in importance.
- Resulting university didactics must follow these needs imposed by real-world development:
  1 create transdisciplinary curricula
  2 exert quality control on content, pedagogical and procedural levels within such curricula
  3 provide sound knowledge on international law and on supranational energy systems
  4 reflect experience in supranational negotiation procedures such as within IPCC, UNFCCC (EnU, 2020)
  5 include all involved socio-cultural and policy-making disciplines in the overall offer.

Based on the above analysis, this article suggests working on the following new and different strategies:

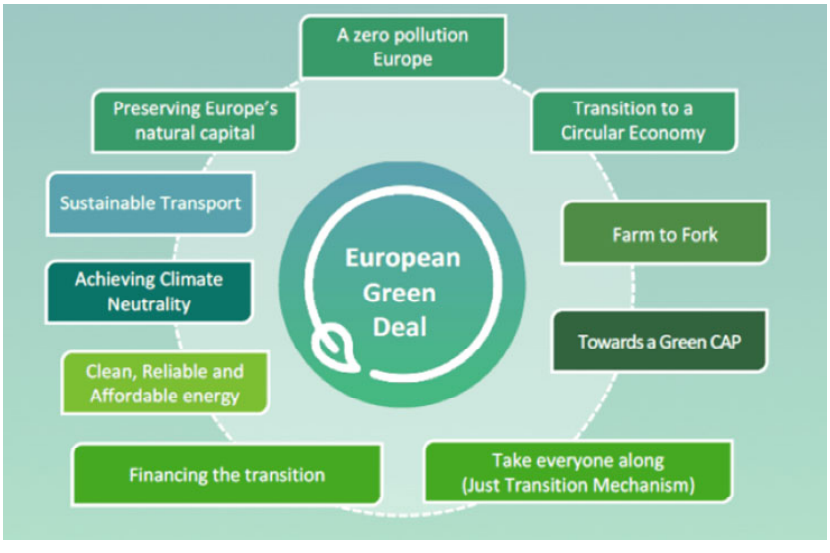
- While composing curricula, earlier decades of practical, political and industrial experience should be reflected. Here, previous analyses of transdisciplinary curricula exist such as 'global studies' (Bader et al., 2014), which was co-founded by the author in 2002–2016, concerning didactics, completeness of curricula, adaptiveness to real-world demands, lecturing quality, and inclusion of practical case studies.

- Built-in training modules for students to gain experience of negotiation situations already while at university. Here, analyses of didactics and social processes exist (Müller et al., 2013).
- Various interactive e-learning strategies, collaborative blended learning and open courseware exist, including experience in community-building web-based didactics, and analyses on regular quality improvements in curricula and curricula quality assessment (QA) (Bader et al., 2013).

The needs analysis regarding the domain of climate protection and renewable energies provides the following orientation:

- greater effort in climate protection is needed immediately
- as a main consequence, the share of renewable energies must be dramatically increased
- SDGs are to be fulfilled at the same time
- as a general background for the entire project, all the 'Green Deal' targets are to be fulfilled simultaneously, which is mirrored graphically in the circle in Figure 3.

Figure 3 The European Green Deal according to the new Commission Presidency, with its ten targets (see online version for colours)



Source: EC President (2020)

Furthermore,

- the potentials for RES in Europe are large and still untapped
- Ukraine has an especially large share, according to UNEP (2020) and the International RES Agency IRENA (2020)
- Ukraine declared a national 'Green Deal'[2], as did many other Central and Eastern European States.

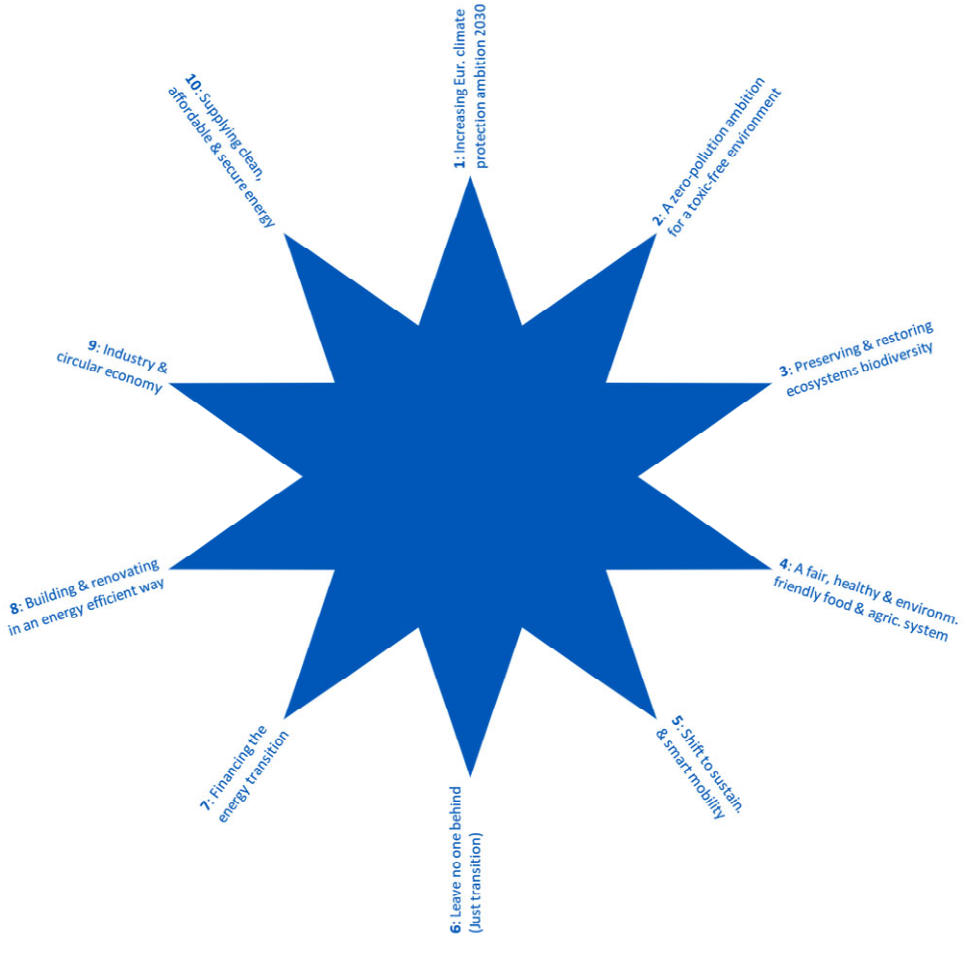
The following more detailed targets result from the above focus of this needs analysis.

7 Concrete implementation in order to fulfil the targets

As was logically derived in the previous chapters from hierarchically high EU policy targets, the ten targets of the EU 'Green Deal' represent the core of this article's motivation and aims.

Consequently, the *ten aims and targets* (Figure 4) form the background of this article. These ten targets are graphically slightly reordered according to a ten-fold star and appear equidistant from each other.

Figure 4 The ten aims and targets are the background of climate protection actions, graphically reordered from Figure 3 into an equidistant pattern of a 10-fold star (see online version for colours)



Note: The same aims are enumerated as text as follows below.

Written as text, these ten targets from Figure 3 and Figure 4 are (EC President, 2020):

1 increasing European climate protection ambition for 2030 and 2050

2 A zero-pollution ambition for a toxic-free environment

3 preserving and restoring ecosystems and biodiversity

4 a fair, healthy and environmentally friendly food system

5 accelerating the shift to sustainable and smart mobility

6 leave no one behind (just transition)

7 financing the transition

8 building and renovating in an energy and resource efficient way

9 mobilising industry for a clean and circular economy

10 supplying clean, affordable and secure energy.

How a proactive answer will address the existing problems and challenges is graphically represented by the logo in Figure 2: the yellow (science-business cooperation) and green (lectures) figures answer to (= lie above) the blue figure (targets).

This means that the totality of all action covers all targets of the Green Deal sufficiently and that the single contributions are well and evenly distributed across all targets.

Using the suitable strategy of a KA, the objectives will be achieved by coherent action:

- *transnational*: including several European countries
- *structured*: the lectures are structured along the ten Green Deal targets (discipline-wise), and into semester-wise cycles of action and reflection (time-wise)
- *result-driven*: the ultimate target is to see three functioning and self-responsible curricula working under their own steam, resources and convictions; as well as to see three ready project proposals
- between higher education and business: lecturers serve as consultants for project planning, and consultants serve as lecturers (Figure 1)
- *open to any discipline*: staff includes technologists, pedagogues, sociologists, physicists, chemical engineers, legal experts, biologists, ecologists, economists, policy makers and organisation experts.

With regard to RES and trans-European cooperation, the following is “essential:

- developing new, multidisciplinary and innovative approaches to learning and teaching
- stimulating entrepreneurship, i.e., the entrepreneurial skills of company staff and HEI
- facilitating the flow, exchange and knowledge co-creation.”

Thus, a first draft on how to select subject matters is graphically integrated into the targets and business themes (Table 1).

Especially here, the participation of organisations from Eastern and Western European countries provides genuine added value to any endeavour because of their intimate and long-standing knowledge of institutions, existing energy networks, political procedures, tacit influences on the energy market, and critical practical experiences. These are all essential for achieving the ultimate objectives of increasing RES shares across all of Europe.

The uniting band of science-business cooperation (Figure 5) symbolises lecturers serving as consultants for project planning, and consultants serving as lecturers, symbolised by the arrows pointing in both directions within the yellow crown. Through this synergistic architecture and procedural setup, optimal use is made of the joint resources, including lecturers (from universities) and business experts (from agencies and associations).

Figure 5 The uniting band of science-business cooperation is symbolised by the 14-fold yellow band showing concrete themes of science-business cooperation (see online version for colours)

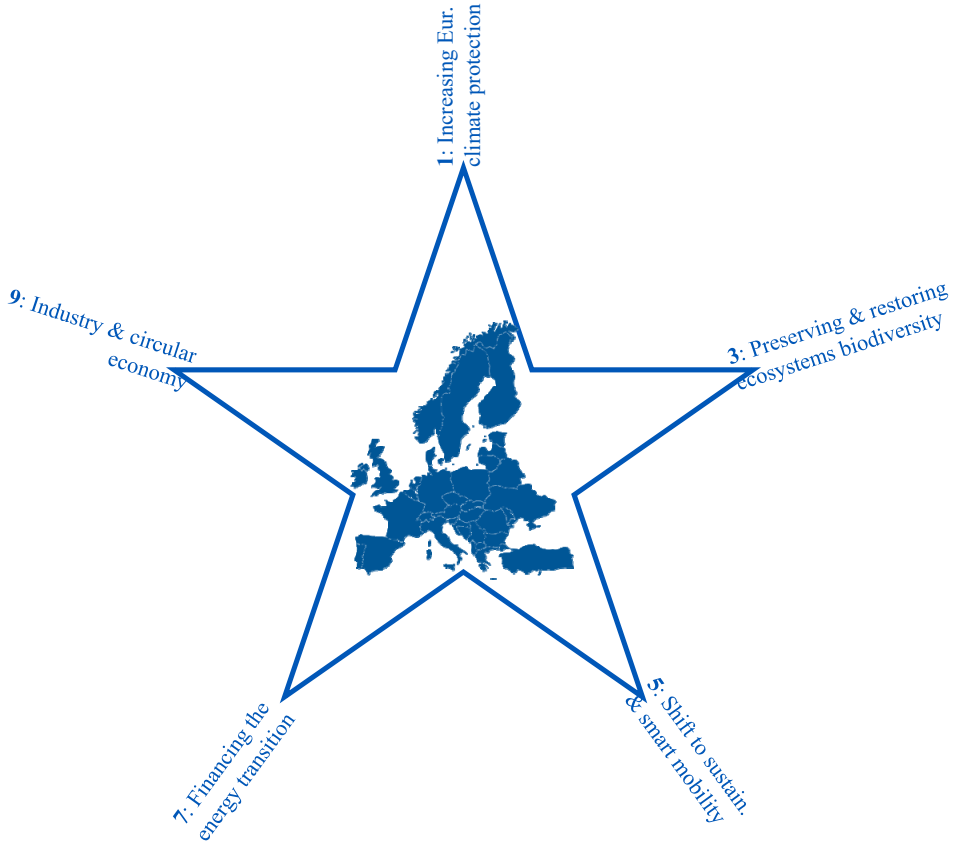
Note: In a manner analogous to Table 1, the science-business profiles of all partners were identified based on their earlier projects.

8 Compliance with European values

At the same time, any implementation should respond to the "2017 EU Communication on the Renewed EU Agenda for Higher Education" (KA, 2020), i.e.:

- Innovative, collaborative, case-study based, transdisciplinary teaching methods
- Encouraging students, teachers and tutors to acquire an entrepreneurial stance through joint work
- Merging practitioners' and academics' insight and knowledge through the development of three projects
- Facilitation of flow, exchange and knowledge co-creation by encouraging local tutors to take over.

Figure 6 Joint core values in a wider europe: sustainability, mutual respect and proactive responsibility (see online version for colours)



Thus, there exists added value generated through Europe-wide transnationality and clear transferability, including both EU and EaP countries (EaP, 2020, Figure 6).

Europeans have joint climate protection strategies plus joint cooperative didactics.

9 Detailed methodology

The methodological basis and key idea are that both aspects complement each other, namely

1 practitioners teaching in the university curricula

2 scientists counselling for the practical project implementation.

The procedures should include biannual meetings in different cities, back to back for 1 and 2, and with relevant RES conferences in the same city.

An overall methodology means that throughout all three years, every semester sees a cycle of:

1 *preparing* course materials and innovative didactics

2 *implementing* the lectures and cooperative seminars (partly in team teaching)

3 giving and receiving *feedback* on content and didactics from all students, tutors and colleagues

4 *improving* one's own course content and didactics

5 *providing* the improved course material for the public.

This methodology therefore comprises *six cycles of iterative improvement* for both:

1 curriculum content and didactics

2 three real-world RES project plans.

This iterative cycle of improving courses is modelled after the review system of a peer-reviewed journal.

In parallel, and during the same meeting days, the analogous cycle of iteratively planning concrete projects proceeds through the input of lecturers, professionals, and students who worked on it during seminars.

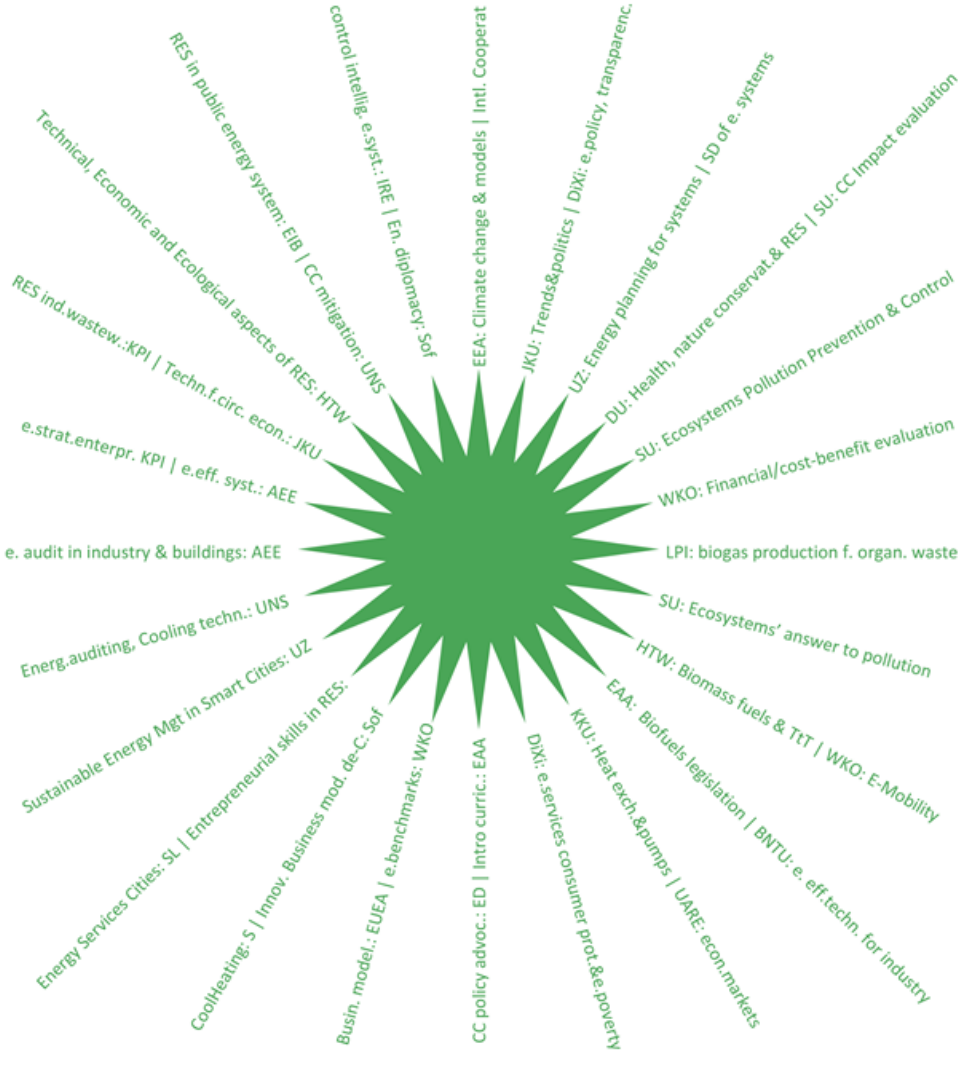
This overall two-fold iterative cycle of stepwise improvement lies at the heart of the procedural design (logo in Figure 1).

Quality assurance is "an intrinsic component within any project that ensures KA successfully delivering their expected results and achieving impacts going far beyond involved partner organisations. KA are required to achieve well-targeted dissemination activities reaching out to policy makers, stakeholders, enterprises and professionals."

KAs' impact shows societal and economic relevance and outreach. It induces and facilitates the required (societal, economic and social) transition of the energy system towards a non-carbon economy across all of Europe; transparently measurable by the RES share of the countries involved, and supported by the curricula's alumni. Thus, this action will provide pertinent measures for monitoring progress and assessing the expected (short plus long-term) impact across our European societies.

The comprehensive and coherent set of appropriate actions for meeting the identified needs which leads to the concrete results is shown in Figure 7.

Figure 7 A selection of the comprehensive bundle of activities is appropriate for meeting identified needs, including the green layer (= university courses according to the list following below), while the green layer is visible in Figure 4 and the yellow layer is visible in Figure 5 (all layers could be put upon each other, showing optically match between targets and fulfilment) (see online version for colours)



Notes: The detailed genesis of the allocation of single tasks to the targets was made after analysis of proven competencies within partner profiles, as documented on their institutional websites. All details are too voluminous to be presented here.

In a nutshell, for any transition endeavour the fundamental approach is responsibility-based proactivity and mutual professional respect. This is how Europe grows (Figure 6).

The detailed allocation of specialised HE courses (green in Figure 7) to the tasks prescribed by the EU 'Green Deal' (blue in Figure 4) is provided through the following list which results from in-depth analyses of the academic profiles of university curricula.

By the following concrete list, each single partner (see Figure 8) specifies the message of Figure 7 and enumerates suitable specific academic areas, based on their institutional profile. Detailed discussions and analyses of the respective existing curricula were undertaken. With each specific institution's contribution, the number in brackets refers to the 'Green Deal' target (Figure 4) and illustrates the even allocation of contributions to targets.

By virtue of the participating institutions, numerous facets of relevance for the 'Green Deal' could be included, such as energy, land use, food production, and many specialisations such as energy use in transport and agriculture.

Table 1 Concrete list of contributions to be allocated (green in Figure 7; abbreviations are explained in the table) to Green Deal targets (blue in Figure 4)

Contributing institution	*Lecture content contributed*
Environment Agency Austria (EAA), Vienna, Austria	• Climate change and climate models (1) • International cooperation (1/6/7) • Introduction to the cooperative RES curriculum and collaborative didactics (6) • Biofuels legislation (5) • EU energy policies and legislation
Johannes Kepler University (JKU) Linz, Austria	• A global perspective on the role of technologies and materials for sustainable development, energy scenarios and the energy transition and a circular economy (incl. a specific focus module on plastics) (9) • Global trends: sustainable development - world society and global politics - solving the climate crisis by renewable energies and circular economy (9)
Daugavpils University (DU), Daugavpils, Latvia	• Entrepreneurial skills enhancement in RES (7) • Health, nature conservation and renewable energy RES (3/4) • Youth policy making in renewable energy
Siauliai University (SU), Siauliai, Lithuania	• Climate change (CC) impact evaluation (3/4) • Ecosystems pollution prevention and control (3) • Prevention of biological air pollution for a toxic-free environment (2/3)
Hochschule für Technik und Wirtschaft (HTW) University of Applied Sciences, Berlin, Germany	• Sustainable bioenergy – technical, economic and ecological aspects (10) • Biomass based fuels for the mobility sector (5) • Train the trainer (TtT) program on bioenergy topics for young academics at HTW (10)
Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb (UZ)	• Sustainable energy management in smart cities (7/8) • Energy planning for systems with high shares of renewable energy sources (2)

Table 1 Concrete list of contributions to be allocated (green in Figure 7; abbreviations are explained in the table) to Green Deal targets (blue in Figure 4) (continued)

Contributing institution	*Lecture content contributed*
University in Novi Sad (UNS), Serbia	• CC mitigation: Renewable energy, energy efficiency and energy management techniques (7/10)
	• Developing and implementing innovative and multidisciplinary teaching methods with companies (9)
	• Renewable energy (solar, biomass all conversions, shallow geothermal, waste), clean energy technology, energy efficiency (10)
	• Energy management technics (building and industry), 2. Business planning in field of RES and EE projects, or maybe some course about financial engineering in field of RES and EE projects (8)
	• Energy auditing, cooling technics (because of climate influence) (8)
University of Sofia (Sof), Bulgaria (existing master program 'Energy markets and services')	• 'Sustainable development of energy systems' (2)
	• 'Renewable energy sources and bio-fuels' (economic perspective) (5/10)
	• Innovative business models for decarbonisation (6/7)
	• Geopolitics of renewable energy in the South-East European context (6/7)
	• Community energy- economic, social and regulatory aspects (6/7)
	• 'Energy diplomacy' course (6)
AEE INTEC, research company in Gleisdorf near Graz, Austria (AEE)	• How to perform an energy audit in industry and buildings (8)
	• Energy efficiency on system level (9)
	• IEA and international institutions (6)
Info on StadtLABOR Graz (SL), Austria	• Energy and cities: energy services and renewable sources (8)
Energieinstitut der Wirtschaft [= Energy Institute for Businesses], (EIB), Vienna	• E-Mobility, experiences/ good practice with recycling, methodology / knowledge transfer to users (5)
	• Development of renewable energy projects, energy/environmental technologies from Austria and good practice projects, financial/cost-benefit evaluation of energy measures, etc. (2)
	• Energy/environmental technologies from Austria and good practice projects, energy management (ISO 50001 standard), economic evaluation of energy measures, etc. (7)
SDEWES Centre, Serbia (S)	• Technical and economic aspects of energy transition (7)
	• experiences with municipalities in Serbia (mainly H2020 project CoolHeating) (8)

Table 1 Concrete list of contributions to be allocated (green in Figure 7; abbreviations are explained in the table) to Green Deal targets (blue in Figure 4) (continued)

Contributing institution	*Lecture content contributed*
L'viv Polytechnic National University (LPI), Ukraine	• Renewable energy sources (1/2/10): Prospects for biogas production from organic waste (4): classification of organic waste, promising technologies for biogas production, kinetics of methanogenesis, technologies of application of biogas in energy, environmental aspects of biogas prod., utilisation of waste biomass.
Kyiv Polytechnic National University (KPI), Ukraine	• preparation of energy strategies for enterprises in order to reduce energy consumption and increase the competitiveness of products (9)
	• implementing energy efficiency measures (10)
	• Renewable sources of energy from industrial wastewater, (9/3)
	• Energy carriers from biomass and wastes, (9/3)
	• Microalgae as a raw material for renewable energy, (3/4)
	• Methods for increased energy carriers yield. (4)
Academy of Sciences Ukraine, Institute for Renewable Energies (IRE NAS), Ukraine	• Ways to tackle climate change challenge (1)
	• Methods of research, formation and control of intelligent energy systems and complexes (1/10)
DiXi Group, Kyiv, Ukraine (builds up the Kyiv School of Energy Policy KSEP)	• Liaison with the Government of Ukraine on various levels to facilitate the project's official kick-start (like negotiations with potential beneficiaries, project registration, etc.); (1/6)
	• energy policy, open data in energy sector, general energy sector transparency issues, upstream sector regulation, NRA status and powers, energy services consumer protection and energy poverty, market monitoring, raising public awareness (1/6/10)
Kharkiv National Automobile and Highway University (KhU), Ukraine	• Assessing the impact of highways and automobiles on the environment, developing mechanisms for treating wastewater and exhaust gases, assessing the recreational potential of territories and environmental and economic assessment of investment processes (5/6)
V.N. Karazin Kharkiv National University (KKU), Ukraine	• Heat exchange equipment; heat pump installations; solar collectors; geothermal installations; facilities of the nuclear power complex; cryogenic equipment; systems of heat supply of buildings (10)
NGO Ecodia, Kyiv (ED), Ukraine	• climate change science (2/3)
	• climate change national and international policy and policy advocacy (2/6)
	• climate change mitigation, adaptation and nature-based solutions to adaptation (2/3)

Table 1 Concrete list of contributions to be allocated (green in Figure 7; abbreviations are explained in the table) to Green Deal targets (blue in Figure 4) (continued)

Contributing institution	*Lecture content contributed*
Ukrainian Association of Renewable Energy (UARE), Kyiv, Ukraine	• energy saving, energy efficiency, renewable energy generation: solar, wind, biomass, biogas, small hydropower (2), managing sustainable energy systems (9) • economic evaluations and energy markets modelling (6/7), legal framework: national and international (1), circular economy, sustainability and climate change (9)
European-Ukrainian Energy Agency (EUEA), Kyiv, Ukraine	• RES business modelling and implementation under the policy frame (7)
Belarusian National Technical University, (BNTU), Minsk, Belarus (has a similar existing master program)	• Sustainable management and energy efficient technologies for industry (9) • Existing cooperation with Belarus association 'renewable energy'.

The sum of all 40 lectures provided in Table 1 (with the realistic assumption of three ECTS per lecture, i.e., European credit transfer system) totals 120 ECTS, which is already equivalent to a master program. Therefore, the above list is sufficient. Preliminary subtotals of lectures being allocated to 'Green Deal' targets numbered 1 to 10 show that these are almost evenly distributed.

10 Underlying generation for this action plan

The above action plan was generated in cooperation with representatives of the following institutions (Figure 8) to whom the author expresses gratitude for in-depth discussion and further development of ideas: Environment Agency Austria (EAA), Vienna, Austria, Johannes Kepler University (JKU) Linz, Austria, Daugavpils University (DU), Daugavpils, Latvia, Siauliai University (SU), Siauliai, Lithuania, Hochschule für Technik und Wirtschaft (HTW) University of Applied Sciences, Berlin, Germany, Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb (UZ), Croatia, University in Novi Sad (UNS), Serbia, University of Sofia (Sof), Bulgaria, AEE INTEC, research company in Gleisdorf near Graz, Austria (AEE), Info on StadtLABOR Graz (SL), Austria, Energieinstitut der Wirtschaft, (EIB), Vienna, SDEWES Centre, (S), L'viv Polytechnic National University (LPI), Ukraine, Kyiv Polytechnic National University (KPI), Ukraine, Academy of Sciences Ukraine, Institute for Renewable Energies (IRE NAS), Ukraine, DiXi Group, Kyiv, Ukraine, Kharkiv National Automobile and Highway University (KhU), Ukraine, V.N.Karazin Kharkiv National University (KKU), Ukraine, NGO Ecodia, Kyiv (ED), Ukraine, Ukrainian Association of Renewable Energy (UARE), Kyiv, Ukraine, European-Ukrainian Energy Agency (EUEA), Kyiv, Ukraine, Belarusian National Technical University, (BNTU), Minsk, Belarus.

Figure 8 Geographical location of partners including all acronyms within a wider Europe (see online version for colours)

11 Conclusions and recommendations

This article develops the basis for cooperative action towards Europe-wide energy transition for the target of climate protection. This action plan includes:

1 University curricula: *transnationally* creating new and enhancing existing university curricula on RES, energy efficiency and climate protection.

2 Science-business cooperation: *transdisciplinarily* preparing concrete and financeable projects in the RES field, circular economy and climate protection in order to implement the Paris targets and the Green Deal, including their financing.

The core issue for this article is: how to create a knowledge-based society in European regions with relatively weaker administrative, political and social structures in such a way that they are capable of transposing the European 'Green Deal'?

The concrete type and number of science-business cooperation projects envisaged is:

- Three project proposals are used as cases studies, showing students the different steps and elements to be prepared from the initial screening of the legal environment (e.g., permitting process for construction, modalities for sale of renewable energy, etc.), to technical feasibility studies and planning, economic feasibility studies

and different sources for securing financing, including the good practices of EU-compatible involvement of citizens and NGOs that should be respected in the planning phase.

- The projects are optimally well distributed across:
  a the RES solar, wind and biomass
  b the scales, namely covering small (e.g., households or cooperatives), medium (e.g., municipalities) and large (e.g., industrial) installations.
- Innovative forms of social organisation are encouraged, such as energy cooperatives, prosumerism or similar.
- Stakeholders such as energy grid operators, local administrations, ministries (energy, regional development, economy, and others), EU Delegation, IFIs, banks, etc. should be integrated in the entire process.

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Notes

1 Namely including: "stronger economy (i.e., market opportunities and economic development); stronger governance (i.e., good governance and strengthening institutions); stronger connectivity (i.e., energy efficiency, connectivity, climate change and environment); stronger society (people-to-people contacts and mobility)."

2 Links to the Ukrainian Green Deal: https://www.kmu.gov.ua/en/news/yevropejska-zelena-ugoda-ye-chastinoyu-reform-i-zrostannya-ukrayini-dmitro-kuleba, https://www.euractiv.de/section/energie-und-umwelt/news/ukrainischer-green-deal-weniger-energieimporte-und-mehr-westliche-finanzierung/?_ga=2.102189124.414622698.1580903873-1721090768.1528030098, https://www.kyivpost.com/ukraine-politics/hotter-than-ever-ukraine-outlines-climate-strategy-after-eus-plan-for-carbon-neutrality.html, https://www.unian.info/economics/10847873-euractiv-ukraine-s-own-green-deal-aims-to-slash-energy-imports.html, https://www.ukrinform.net/rubric-polytics/2864544-honcharuk-and-timmermans-discuss-european-green-deal.html, https://dtek.com/en/media-center/press/dtek-will-lead-a-roundtable-discussion-in-support-of-eu-green-deal-at-the-world-economic-forum/, https://en.interfax.com.ua/news/economic/636518.html,

https://www.euractiv.com/section/energy-environment/news/ukraines-own-green-deal-aims-to-slash-energy-imports/, https://www.kyivpost.com/ukraine-politics/ukrainian-youth-to-join-friday-global-climate-strike.html, https://www.kyivpost.com/lifestyle/2000-in-kyiv-join-global-climate-strike-demand-government-action.html, https://www.youtube.com/watch?v=VBoUJ1S-kmc, etc.

Glossary for abbreviations

EAA	European Environment Agency
EaP	Eastern Partnership (of the EU)
EC	European Commission
EnU	Energy Union (of EU + partners)
ERA	European Research Area
EU	European Union
HE(I)	Higher Education (Institution)
KA	Knowledge Alliances
NECP	National Integrated Energy and Climate Plans
QA	Quality Assessment
RES	Renewable Energy Sources
VET	Vocational Education and Training

Note: Abbreviations of partner institutions are explained in Table 1 and before Figure 8.