UAS-PD program guideline

Professional Doctorate
Energy & Sustainability

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Glossary of terms used in the Formation Profile for the pilot of the Professional Doctorate Energy & Sustainability

Term	Description
Assessment Committee	Committee of examiners composed by the Graduate Committee with advice of the Supervisory Committee, chaired by the VaCo PD.
Cluster Energy and Sustainability	Part of the general PD programme related to the KIA Energy & Sustainability of the Dutch national government
Dissertation in Practice	End result of a successful PD trajectory. See PD portfolio.
Formation Profile	Normative description of the PD programme including objectives and assessment of the candidates
Graduate Committee	The administrative and responsible unit for the quality of the PD program.
Graduate Network	A cooperation of UASs that provides the PD ES as a joint programme.
Integrated Knowledge and Innovation Agenda	The Integral Knowledge and Innovation Agenda (IKIA) has been drawn up in order to be able to realise the goals of the Dutch Climate Agreement. It includes the development of the necessary knowledge and product innovation, e.g. the IKIA Energy and Sustainability aims to achieve the goal of reducing national greenhouse gas emissions by 49% in 2030 and 95% in 2050 compared to 1990.
Interdisciplinary research	This type of research looks beyond the boundaries of the research domain and uses concepts and ideas from other scientific fields.
Knowledge and Innovation Agenda	In this agenda the research and innovation tasks are elaborated for all themes and Technology Readiness Levels (TRLs). Aim is to provide the knowledge and innovation necessary to realise the goals of the Dutch Climate Agreement.
Learning Outcomes	The level and performance of a PD described in three roles: innovator, researcher and consultant. The professional doctor manifests in these three roles.
Multidisciplinary research	This type of research combines knowledge from different scientific fields. Researchers stay within the boundaries of their own domain.
(PD) candidate	Professionals that undertake the PD programme to qualify for the degree of Professional Doctorate.
PD portfolio or Dissertation in Practice	File containing the following products: PD project plan, deliverables, schedule/timeline, study results, recommendations & training and supervision plan. These products serve as evidence to assess the intended end level .
PD project plan	Study plan and practice-oriented research plan. Part of PD portfolio.
PD trajectory	Individual development project for obtaining the PD degree. It is a specific instance of the general programme.
PD programme	Collection of individual PD projects / trajectories.
Professional Doctorate	Official 3rd cycle degree of Universities of Applied Sciences.
Supervisory Committee	Team of supervisors chaired by the UAS professor who is the main supervisor.

Target groups	Sources for PD candidates: Professionals, University lecturers, Transferring students (research university), Transferring students (UAS).
Transition	The process or period of changing from one state or condition to another.
Transdisciplinary	Integrates concepts, methods and principles from different research domains and includes non-academic stakeholders in the process of knowledge production.
Transformative	Leading to a marked change in the development of someone or something.
Validation Committee	By the Dutch UAS cooperation, at National Level, a committee has been set up for assuring national quality for the UAS PD: the Validation Committee PD.

Glossary of abbreviations used in the Formation Profile for the pilot of the Professional Doctorate Energy & Sustainability

Abbreviation	**Full term**
COPL	Community of practice & learning
ES	Energy & Sustainability
IKIA	Integrated Knowledge and Innovation Agenda
KIA	Knowledge and Innovation Agenda
PD	Professional Doctorate
PD AP	Professional Doctorate Action Plan
PD-ES	Professional Doctorate applied to Energy and Sustainability
PD PP	Professional Doctorate Project Plan
TSP	Training & Supervision Plan
UAS	University of Applied Sciences
VaCo	Validation Committee

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1 Introduction

The HU University of Applied Sciences Utrecht (HU), Hanze University of Applied Sciences Groningen (Hanze), Saxion University of Applied Sciences, University of Applied Sciences InHolland and HAN University of Applied Sciences jointly developed this programme guideline for a Professional Doctorate (PD) in the cluster Energy and Sustainability. They did so based on the belief that the complexity[1] of the energy transition and society's transition towards a circular economy demands a PD (VH 2021).

Transitions are characterized by highly complex, so-called wicked problems (Rittel et al. 1973) involving a wide range of, often conflicting, stakeholder perspectives requiring deep collaboration (Nonaka, I., & Takeuchi, H. 2021; Grant, H. M. 2010). The Energy and Sustainability transition is not excluded from that, as highlighted in the recent article from Otten & Sint Nicolaas (2021) describing the Energy transition efforts in Deventer. Addressing these complex challenges requires highly skilled professionals dealing with uncertainty, ambiguity and lack of novel data (Hinske, C. 2013, 2016; Beehner, C. 2020; Waddel, 2016). An arbitrary selection: security of energy supply, regulated energy market, affordability, decarbonization, integration of energy measures in the built environment, public support, new supply chains and revenue models, social costs and geopolitics.

Wicked problems
The societal challenges related to Energy & Sustainability include numerous wicked problems (Levin et al., 2012; Van Berkel & Manickam, 2019). These problems can be characterised as follows:

1. Complex dependencies; solving one aspect of the problem creates or reveals other problems.
2. Stakeholders have radically different world views and different frames to understand the problem.
3. The constraints associated with the problem and the resources needed to solve the problem change over time. In such a dynamic world, it is essential to be flexible.
4. The problem has never been resolved definitively because the situation is constantly evolving.
5. The solution depends on how the problem is framed and vice versa.

Solutions from a technical perspective are often available. However, the complexity mentioned above hinders their introduction into practice if socio-economic, political and cultural dimensions are not considered. Innovative solutions often emerge from practice-oriented research projects, perhaps even more than from fundamental research projects. In this regard, design- and practice-oriented research at PD level is essential, using an inter- and transdisciplinary approach.

We expect a substantial practical impact from a PD since "societal actors" expressed the need for the type of transformative research a PD is executing. Consequently, a PD provides new career perspectives, both for researchers and practitioners.

[1] Following the work of Snowden & Bone (2007) and Sargut & McGrath (2011), complexity is defined as being concerned with the underlying cause-and-effect behind interactions between actors, events and entities, and whether the PD-ES candidate can determine this cause-and-effect.

Outline of this program guide

This program guideline of Energy and Sustainability starts with providing the programme profile of the Professional Doctorate programme Energy & Sustainability. The entry requirements and end level of the PD are described in chapter two. The end level is described by learning outcomes arranged in the three roles of a professional doctor: innovator, researcher and consultant.

The individual PD programme structure is described in chapter three with the pedagogical philosophy and the content of the programme.

The assessment by a portfolio is described in chapter four as well as its building blocks. The PD portfolio will be developed and updated throughout the PD programme to communicate, monitor, evaluate and assess the progress of the candidate from the start until the established degree. In chapter four the assessment is structured around the learning outcomes using the PD portfolio as input. The learning outcomes have to meet the level outlined in the Dublin descriptors for the 3rd cycle. This will be stipulated using indicators and detailed into rubrics.

Finally, in chapter five, attention is given to the fact that the participating UASs have to organise themselves in a virtual graduate school on energy and sustainability.

2 Programme Profile

2.1 Summary

The ongoing energy, sustainability, and circular economy transformations are full of complex challenges. Institutions of higher professional education have to make novel contributions. By applying existing and innovative ideas to complex "on the ground" challenges they are asked to create state-of-the-art solutions enhancing science and practice. Thus, the type of research in a PD addresses the complex and prior unknown interactions of interventions and elementary techniques between the problem and solution space. Using inter- and transdisciplinarity, the 3rd cycle of Universities of Applied Sciences (UAS) form highly skilled professionals essential to society (VH 2020). To address current societal challenges in Energy & Sustainability, inter-, transdisciplinarity and transformative research approaches are the basis in the research design (Wittmayer & Hölscher, 2018; Schneidewind, U., & Singer-Brodowski, M. 2014).

Five UASs jointly offer an innovative and distinctive programme for practice-oriented Professional Doctorates (PD). In this way, they contribute to generating solutions for the energy and sustainability transition, adhering to the research agenda's of LEVE and Urban Energy

To realise these multi-stakeholder innovations, highly skilled "translators and connectors" are needed to close the gap between fundamental research and practically usable solutions. We envision practitioners and drivers of practice-oriented research. With the professional doctorate, we provide a depth at the interface of research and practice necessary for societal transition actors and give original impulses to practice-oriented research.

We see four target groups for a professional PD in Energy and Sustainability:

- **The Professional**; With an abstraction ability rooted in practice, the professional can work on complex and wicked problems using scientific methods, creating social impact. S/he can use advanced knowledge to set a new course in practice. The professional has several years of work experience and acquired prior knowledge during technical master's programs or comparable preliminary stages.
- **The University Lecturer/Researcher** with primary technical education at the master's level wants to combine a practical approach with professional research skills. Due to the need at UASs for senior lecturers/researchers and the quality of education and research, the demand for more capacity and skills among lecturers and researchers increases.
- **The Transferring Student** type 1 has relevant practical experience from a technical master's at a research university or technical university. The Transferring Student knows relevant research and models but want to translate this knowledge into practice. S/he bases the choice for the PD on developing novel solutions with actors from society, using practice-oriented inter- and transdisciplinary research.
- **The Transferring Student** type 2 has obtained relevant practical experience from previous technical Master trajectories at the UAS level. The Transferring Student can work on complex and wicked problems by using scientific methods to create social impact. Subsequently, with that knowledge, s/he can generate societal innovations in processes and products.

All of the PD candidates should have experience (by working, practice or research) in the domain of Energy and Sustainability (see 2.4.1 Entry requirements). This applies to all target groups.

2.2 Focus

The energy transition in the Netherlands received a substantial boost with the Climate Agreement in 2019. The third cycle Energy and Sustainability domain can be delineated by the six missions and the Multi-Year Mission-driven Innovation Programs on the Integrated Knowledge and Innovation Agenda Climate and Energy (KIA theme Energy [link]).

Three goals are central to the KIA theme Climate and Energy:

1. A natural gas-free built environment;
2. A CO_2 free electricity system;
3. Climate-neutral and circular industrial processes.

The following six missions have been identified for the Energy and Sustainability domain:

- A completely CO_2-free electricity system in 2050;
- A CO_2-free built environment in 2050;
- In 2050, raw materials, products and processes will be net climate-neutral and at least 80% circular;
- Zero-emission mobility for people and goods in 2050;
- In 2050, the system of agriculture will be climate neutral;
- A robust and socially supported energy system.

The PD programme is linked to mission-driven research in Energy and Sustainability in the Netherlands. These missions lead and reinforce the research programs of the related professorships in the platforms of Urban Energy, the platform LEVE, and (relevant parts of) the platform NL/GO. Starting already from 2017, the professors in UASs related to Energy and Sustainability, intended to align their research agendas and profile. They share the conviction, that for societal urgent questions on Energy and Sustainability, all hands on deck are needed to find solutions and to make progress.

The PD research within the Energy & Sustainability cluster will contribute to the realisation of these six missions based on the knowledge and skills presented by the participating professorships. During the pilot phase the focus of the PD research will be on the energy transition, to ensure sufficient synergy between the PD candidates. The presidents of the platform of Urban Energy and of the platform of LEVE, are strongly involved in the development of this PD trajectory. Both platforms are involved and consulted on the content of the programme. Finally the participating UASs choose a strong focus for the PD pilot phase: reinforcing the energy transition by achieving the goals in the research agenda of LEVE and Urban Energy platforms.

The basis for the program lies in opening up the various specialisms at the participating UASs starting with these five, with their specific domain-specific focus:

- system approach on the level of urban areas, large-scale renovation, maintenance & asset management **(HU UAS)**;
- heat and system integration in the built environment **(Saxion UAS)**;

- the energy system, sustainable fuels and gases, hydrogen generation and application, supply chain development, system integration/sector coupling and open innovation **(Hanze UAS)**;
- wind energy, democratic energy infrastructure, energy transition in the agricultural sector, micro-grids & community storage **(InHolland)**;
- reliability and affordability of the electricity grid, system integration, mobile and stationary hydrogen applications, circular- and biobased economy **(HAN)**.

Examples of research questions (practical questions/themes) are:

- Which system integration issues arise from the Regional Energy Strategy plans, and how can they be solved?
- How can decision makers (leadership and management) activate and sustain the needed deep collaboration between relevant stakeholders to spur the transformation towards an energy-efficient, circular economy?
- To what extent can solar PVT combined with a local heat buffer form an alternative for natural gas-free heating homes? Is it an alternative to heat pump outdoor units, and if so, under which conditions?
- How can local, multi-commodity sustainable energy networks in industrial estates be set up and offset against each other?
- How can high-rise flats constructed in the 1960s and 1970s, such as Intervam, be renovated at scale, energy-producing, and attractive to residents?
- How can we strengthen the energy network with sustainably generated energy and use community storage?
- What does a circular renovation concept look like that offers both qualitative and financial added value for the user and the producer in the industrial supply chains of construction?

2.3 Added value

The practice-oriented research of the PD leads to functional solutions essential for the energy transition, transforming towards a circular economy and a sustainable society. Energy and sustainability address preeminently issues to which universities of applied sciences contribute in novel ways. Using existing and innovative ideas to complex "on the ground" challenges creates state-of-the-art solutions for science and practice. To arrive at genuinely innovative solutions, societal challenges require transdisciplinary research and crossovers that arise from practical challenges. From transdisciplinarity and crossovers in practice-oriented research, new concepts emerge across the boundaries of disciplines.

Research at UASs is defined as research rooted in professional practice, contributing to the improvement and innovation of that professional practice. This impact is achieved by generating knowledge and insights while offering valuable and usable products, designs and concrete solutions to practical problems. Companies and institutions recognise the issues outlined and associated complexity. They indicate that they require innovation and implementation power to be developed soon. Current Energy master's students and alumni stated their interest in an in-depth follow-up. They are looking for the connection with practice and creating solutions rather than basic scientific knowledge-creating questions.

Participants of the Urban Energy professorship platform summarised the added value of a PD as follows:

1. Opportunities for action research, significant from a transformative perspective;
2. PD solutions that fit in with practice;

3. Need for more researchers in practice-oriented research (lecturers, multiple projects);
4. Benefits for the business community if professionals were further to develop their competencies at the Level of a PD;
5. More applied research at Intermediate Vocational Education, UASs, industry (including, e.g. DNV, Tennet) and governments;
6. The necessity to close the gap between fundamental research and practical solutions, the so-called valley-of-death in innovation;
7. The development of a PD must take place according to the needs of the professional field and practice.

The career prospects for PDs are essentially built on needs that are currently not satisfied. There is a need for "system designers" who can make a difference in the energy transition. These are such complex challenges that, in some cases, a BSc or MSc fails to bridge the gap between theory and practice or to develop and manage the complexity of "wicked problems" and the needed approach. Many companies that play a driving role in the energy transition recognize this and appreciate the PD. A PD will be a valuable addition to the pallet, where nowadays mainly consultancy and larger companies contribute to the energy transition by developing systems, products or services. The idea is, of course, that a better prepared, trained and knowledgeable employee will be added than has been the case up to now.

Within UASs, the development of the PDs offers a reinforcement of the research groups with teacher-researchers who can better work on practice-oriented research and strengthen their links with practice.

It is known from contacts with the professional field that the need for a PD is topical, as described in this proposition. Companies like Seaport Groningen and Witteveen en Bos have already asked for this at Hanze UAS and Saxion UAS. During the preparation of this proposition, we presented a summary of this proposition to several companies and organisations, requesting a Letter of Support and whether they would like to participate in a domain-specific Task Force. Members of organisations such as Topsector Energy, 4TU Bouw and BTIC are also aware of this initiative.

In addition, we believe that developing a PD trajectory in energy and sustainability can make an excellent contribution to a career that can lead to a position as innovator, even as a research leader or future professor.

2.4 Programme level

The UAS PD program is a research driven innovation development program that leads to highly qualified research professionals who “learn to intervene in complex practices” at level EQF 8 (VH 2021). PD candidates learn to develop knowledge, processes and products for the creation and validation of interventions on complex issues. The PD program leads to independent research professionals who develop new generic knowledge around new interventions on a relevant challenge in society or in the field of work, with a possible impact on science – for example by publishing in scientific journals. An intervention in the research context during the PD-ES programme can consist of, for example, a set of actions, a process, a method, an approach, trading knowledge, a product or a prototype (demonstrator, simulation models, dashboards, software, (treatment) protocols etc.), developed by the PD candidate. The applied research on UASs differs from fundamental research, not in the sense of level but of orientation. Applied research is based on questions from practice (SIA, 2019). It focuses on developing system knowledge to improve and innovate professional practice and society:

practice-oriented and design. This difference is the essential distinction between fundamental and applied research as defined by the OECD:

> *Basic research* is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. *Applied research* is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a practical aim or objective (OECD 1981, p. 25).

The complexity of the issues is so high that it requires professionals from the 3rd cycle (level 8), as described in the Joint Quality Initiative, on the origin of the Dublin Descriptors:
Dublin descriptors 3rd cycle:

1. ***Knowledge and understanding:*** *[includes] a systematic understanding of their field of study and mastery of the methods of research associated with that field*
2. ***Applying knowledge:***
   "[is demonstrated by the] ability to conceive, design, implement and adapt a substantial process of research with scholarly integrity."
   "[is in the context of] a contribution that extends the frontier of knowledge by developing a substantial body of work some of which merits national or international refereed publication …"
3. ***Making judgements****:" [requires being] capable of critical analysis, evaluation and synthesis of new and complex ideas..."*
4. ***Communication:*** *"with their peers, the larger scholarly community and with society in general (dialogue) about their areas of expertise (broad scope)..."*
5. ***Learning skills:*** *expected to be able to promote, within academic and professional contexts, technological, social or cultural advancement.*

2.4.1 Entry requirements

Experience in the practice of Energy and Sustainability is required, not just on the subject. PD candidates should have experience by working, innovative or practice-oriented research within the domain. Their domain knowledge and research skills at starting level, are on master level. These competencies must be demonstrated by the candidate (with supporting documents or other evidence) and are assessed during the intake. During the pilot phase, when no alternative procedure is being put in place, candidates must demonstrate this with a master's degree. Candidates also prepare a comprehensive overview of the research topic they would like to investigate (see chapter 3).

As indicated in Figure 2, a candidate must be able to arrive at the following when working on a complex societal problem:

- Design of an (evidence-based) research process/project, inventorying and applying scientific methods, models and frameworks;
- Responsible data analysis, following mode 2 or 3 knowledge production (Anderson, Gold, Steward & Thorpe, 2015) and generating innovative insights from data;
- Translating and disseminating the developed insights and knowledge in the form of:
  - Learner-centred teaching, coaching and mentoring (e.g Kirschner & Hendrick, 2020).
  - Delivering ethical and science-based consulting and professional services in professional work contexts, drawing from well-tested approaches (e.g. Block, 2020; Migge, 2018; Burgess, 2020).

- Developing engaging, rigorous and relevant content such as publications in B & C-Level journals, radio shows, podcasts, news and magazine articles, blog posts, social media posts (video/ written), presentations or comparable products considering innovative approaches and framings (e.g. such as outlined in Hoffman, 2021 or Anderson, 2017).

2.4.2 Qualification descriptors

The PD can create generic new practical knowledge, processes and products for bringing about and validating interventions in complex issues. Her/his main way of learning, is learning-on-the-job as a result of the candidate working on a real-life issue and in doing so, learning to develop, test and, if possible, implement interventions.

From the professional doctorate standard (VH, 2021):

- Can apply current scientific insights, practical knowledge and self-developed new insights to real-life issues
- Develops new, well-substantiated innovations in practice on the basis of theory and practice-based research
- Can handle the varied complexity of issues, and develop interventions
- Can contribute to the solution of a socially complex issue by developing – in practice – own interventions that are practically implementable and can be used in several places
- Can use multidisciplinary working methods in a well-substantiated way
- Contributes to the development and innovation of the profession and organisation by knowledge development, personal development, product development and/or system development
- Developing as a person, as a professional and as an innovator
- Profession-oriented for, in and with practice
- Deepening and innovative
- Taking a theoretical and practice-oriented approach towards the professional practice
- Multidisciplinary, interdisciplinary and transdisciplinary (together with partners working in practice)
- Research as a component of the learning pathway and innovation process.

2.4.3 Distinction between PD, PhD, and PDEng

A (UAS) PD differs from a (WO) PhD. Although both programmes are at the same level (EQF 8), the orientation differs. A PhD program leads to independent researchers who create new conceptual knowledge, contributing to expanding scientific knowledge. A PD programme leads to independent researching professionals who are able to intervene and innovate in complex matters in practice.

A PD also differs from a PDEng. The PDEng is a two-year specialised technical designer programme with it's own degree. In a PDEng programme an engineer is taught to design in a professional context. In a PD program a professional learns to make interventions in complex problems from practice, by doing practice-based research. What the PDEng delivers is a specific new technical solution for products, processes and systems based on functional requirements and market demands as commissioned by a company. When completing his/her studies, the PDEng candidate delivers a technological artefact which will be assessed by an assessment committee, who will look at product quality and the design process. The practice-based research of a PD programme aims to deliver generic practical knowledge, processes or

products with a broader validity than only in one case. This can be enacted by doing research into the transferability of the intervention to other contexts through testing in several contexts. This requires more time than a PDEng program, as a result of which the duration of a PD program is three to four years. The candidate attending a PD program works on a real-life issue right from the start, and modular courses support this.

2.5 Programme characterization

The PD programme is about learning to achieve results in the complex world of the energy transition and consists of a combination of training and education (30 ECTS) and research on a practice-oriented case. The programme is offered both in a full-time and part-time variant, the fulltime variant, study load and duration are described in section 3.7.

The practice-oriented case in Energy and Sustainability adds issues related to climate adaptation, area development, infrastructure, food production, energy generation and delivery. Furthermore, circularity, digitalisation & smart technology, renewable energy generation and its embedding in the construction and built environment.

The education and training are designed and carried out jointly by several universities of applied sciences, with plenty of attention for deepening, professional development, and broadening.

A learning line for professionals is created to realise the connection of the PD to various professional master tracks of Engineering, Built Environment, Life Science, Technology and Engineering & Design and the first cycle and second cycle courses. In addition, there will also be an influx from master programs at Dutch research universities and technical universities. Depending on the previous education, the candidate will follow additional and in-depth courses during the PD programme. These are partly in-depth courses based on tailor-made work and individual learning paths and partly broadening courses, such as research methods and skills. The tailor-made program applies to professionals from the work field and students who continue their studies, with practical experience as essential key.

For this, we work closely with the mission-driven policy of the top sector KIA theme Energy & Sustainability and our partners from the business community for practical design issues. In addition, the experimental environments and lab facilities of the participating universities of applied sciences, such as the energy testing lab in Utrecht, the process and energy labs in Enschede and EnTranCe in Groningen, will be made available for this PD programme (see 3.2).

During the PD programme, there are times when the group of PDs in training, work together and when they follow very different in-depth or broadening courses. The PD programme leads to the engagement in the implementation of innovation in energy (transition) and sustainability, which is innovative and broadening for the relevant sector. The program is substantiated and supported by activities outlined in section 3.4.

We recognise various vital characteristics of a PD candidate, such as:

- Dealing with complexity and wickedness
- Innovativeness and creativity
- Research skills
- Consultancy skills (advise)
- Self-consciousness
- Writing skills, creating content

- Analytical skills
- Teaching, dissemination, engaging skills

Those characteristics are embedded in the learning outcomes as described in 2.6. The candidate must reflect on her/his skill development in the portfolio based on a PD project plan using vertical assessment, helping to substantiate and certify the personal development scientifically. The competence and knowledge development supports research and follow-up career: candidates themselves give substance to this through documentation of their development. The candidates follow a tailored set of educational modules at other (international) universities (see 3.2). The level of educational and research activities is based on the qualifications that belong to level 8.

2.6 Learning outcomes for Energy & Sustainability

In the PD at the end three roles will be recognized. The PD as an innovator, with transferable skills (problem-solving capacity, topicality, flexibility, relationship between target groups). As a researcher, applying theoretical and practical knowledge & methods concerning complex practical issues. The PD as consultant is involved in positioning, profiling and professionalisation the field of Energy and Sustainability, science and education. Each PD can combine and switch between roles and apply different accents of these roles depending on the context. The capability to act in these three roles at the desired level characterizes the term professional in PD. The learning outcomes are integrated and assessed by the performance indicators mentioned in 4.3.

PD as innovator:

a) The candidate has mapped out the complex practical question at the energy and sustainability interface and implemented an innovation in collaboration (co-creation) with relevant stakeholders and end-users (quadruple helix).
b) The candidate develops transferable approaches, concepts, products, services, processes and/or interventions that are demonstrable of value to the profession and end-users.
c) The candidate is agile and can act flexibly in the energy world. Developments and innovations in the (energy) world follow each other rapidly. A high degree of complexity, uncertainty, and “wickedness” requires an integral and system approach.
d) The candidate works in short cycles with intermediate products (semi-finished products) and makes these shareable.

PD as researcher:

a) The candidate uses state of the art scientific insights, practical knowledge and experience. S/he uses new insights to articulate practical problems in Energy and Sustainability to underpin their innovation. The PD research is in line with the research agenda of LEVE and Urban Energy.
b) The candidate makes a substantiated choice for a suitable (transformative) research methodology, considering a systemic approach, ethical issues and the aim to generate transformations that help society progress towards a sustainable future.
c) The candidate investigates (technical, social and/or economic) solutions/interventions and provides insight into how they fit into the (energy) system. Thus, s/he enables fact-based decisions for the energy transition and the transformation towards a sustainable society.

d) The candidate can critically analyse and synthesise new and complex ideas in response to a complex practical issue valorised and tested with relevant stakeholders and end-users.

PD as consultant:

a) The candidate contributes to the development and innovation of professional practice and organisation in a cross-domain manner by pushing the boundaries of knowledge, working methods and/or professionalisation.
b) The candidate valorises the developed approaches, concepts, products, services, processes and interventions. They are demonstrably valuable to the profession and end-users. In addition, the candidate considers the implications of decisions on society such as inclusiveness, sustainable development, environment and safety.
c) The candidate has developed as a leading professional (researcher, innovator/changer, consultant/project leader). In addition, s/he developed contextually relevant leadership skills (system leadership) and mature professional effectiveness in complex organizational domains.
d) The candidate can articulate and substantiate their innovations concisely to the various stakeholders. S/he can proactively communicate and engage in critical dialogue with professionals from multiple disciplines. S/he can do so at different levels and in different situations, on complex matters using various media and communication styles.

3. Programme structure

3.1 Pedagogical philosophy

The learning environment, or Applied Sciences Research School Energy & Sustainability, that we offer from the UASs within the Graduate Network Energy & Sustainability consists of three elements:

- customised personal learning paths and supervision,
- in-depth and broadening courses
- a rich learning environment with a lively community.

“The PD programme is a training in which practice-oriented research is central; research aimed at intervening in complex practices. Learning mainly occurs in and through the candidates' activities but less by the knowledge provided as instruction from a course. The activities in which learning will take place can only be determined to a limited extent in advance and will depend strongly on the practical issue on which the candidate is going to work. Who or what influences the activities and their pedagogical value by creating the right conditions. The pilots have to comprise and describe these conditions. This concerns an assignment or question and concrete tasks as input and cursory education for supporting knowledge. The candidate must work on the issue in a short cycle. Adding value for practice already arises during the process and not only at the end. Curriculum education consists of tailor-made education that support the objectives of the PD programme and that are in line with the candidate's prior knowledge. It also concerns the physical setting (for example, one's work situation) in which the learning takes place and the artefacts, tools, and other supportive resources. The pilots should also design a social setting, such as a team in which the practical issue is worked on, a supervision structure and a community of fellow students." (VH plan van aanpak 2019 p. 22/23)

Education in the PD programme is thus not curriculum-driven but rather a tailored learning process. The learning process is strongly dependent on the organisational and communicative qualities, the reflective capacity, and the candidate's initiative, in consultation with the supervisors. The PD trajectory is thus a flexible trajectory with a high degree of personalised learning, where the candidate chooses courses that are necessary to reach appropriate knowledge and skills for the specific issue the candidate is working on.

The core of the education lies in a portfolio on knowledge, skills and attitude, that the candidate builds during the PD programme, supported by a voucher system (as explained in 3.2). During the pilot, the assessment framework will be further detailed to guide the candidates during the process and to be able to assess the level.

There will be a clear distinction between supervising and assessing (see for more details chapter 4 Assessment). Supervisors cannot be members of the assessment committee. The main supervisor nominates the candidate to the assessment committee by accounting for the facts, informing the assessment committee about the quality and progress of the candidate.

3.2 Study load and duration

A full-time PD trajectory typically takes 3-4 years and consists of acquiring research skills, innovative research and personal and professional development (horizontal and vertical, but

in most cases vertical). The part-time PD trajectory has an envisioned nominal lead time of 5-6 years.
The output meets level 8 concerning the complexity, depth and volume of the investigation, independence and originality of the researcher and is trans-/interdisciplinary. The practice-oriented research project concerns a question from practice or society and demonstrable importance for practice and society. The scope is sufficiently large to be tackled utilising a substantial study in terms of volume and duration.

3.3 Content of the programme

The PD candidate has her or his home base at one of the participating UASs. Programme features include customisation, broadening, deepening, and an engaging learning environment. After mapping out the starting level of the individual candidate a tailor-made PD trajectory is assembled. The practical assignment is tailor-made and parts of the cursory education are tailor-made.

The customisation will be achieved by the PD candidate by agreeing with her or his supervisors about the details of the development process towards a PD. For customisation, the coaching of the PD during the training by the supervisors is critical.

Assuming that the PD candidates come from different fields of science and practice, the training and courses do focus mainly on broadening instead of deepening. All PD candidates work on questions rooted in the practical needs of societal actors.

In terms of broadening and deepening, the PD candidate will follow courses already available at Dutch and foreign universities or professional courses. These courses can include research skills, post-master level courses or professional development. Furthermore, the participating UASs themselves provide courses at the post-master level, e.g. project and research design, scientific writing, innovation skills, presentation skills, and research integrity". Finally, specific digital knowledge and knowledge of (integrality of) energy systems seem to be essential and has to be part of the program.

An example of a candidate's educational programme is shown in Table 1.

Table 1: Example of a PD course arrangement.

Course	European Credits
Knowledge development and research methods in energy transition (e.g. research themes in the LEVE, GO and UE platforms)	6
Implementation and transition processes	2
Documentation processes	2
Doctoral seminars (among which research integrity, open science)	10
Elective courses, e.g. business ecosystem design	10
Total	30

The UASs will jointly develop courses, with each UAS contributing its specialty, e.g. a course on inter- and transdisciplinary research methodology. The candidate obtains an equivalent of 30 ECTS .
The first phase of the formation will also prepare for the practical assignment and the research project. The courses must contribute to the delivery of concrete professional products

relevant to the assignment of the PD candidate. For example, courses on research methods or transdisciplinary science communication will result in a practice-oriented research plan. A module on writing academic publications contributes to producing a reviewed paper published at a conference or edited volumes published through open-source outlets such as Routledge, Springer or equivalents.

In addition to the network, the COPL (community of practice & learning), the engaging learning environments at the various UASs provide access to specific research facilities, such as:

- **Hanze UAS:** EnTranCe, BuildinG, Zernike Advanced Processing Facility testing ground, HydroHub electrolyser tesbed, Heat House climate room, WING Hydrogen value chain network
- **UAS Utrecht (HU):** the EnergieLab with a climate chamber, the Sustainable Energy Pilot garden, the Denver House, the Celcius House, the Circular InnovationLab and iLab
- **Saxion UAS:** the Lab for Sustainable Energy and Smart Energy, the Field Lab CIM, the City Lab and the lab for bioenergy and biobased process technology
- **InHolland UAS:** the knowledge workshop InHolland Composites and Innovation Labs.
- **HAN UAS:** Connectr – IPKW Arnhem (several learning communities; Energy for Sustainable Built Environment, Mobility Innovation Center, Hydrogen Lab), Spijkerkwartier, Elderveld Arnhem, Leermeester werkplaats Nijmegen.

As the PD trajectory is a practice-oriented professional doctorate, the candidates can frame the PD project plan (PD-PP see 4.1) around the Vitae researcher development framework (https://www.vitae.ac.uk/researchers-professional-development/about-the-vitae-researcher-development-framework) (see figure 1).

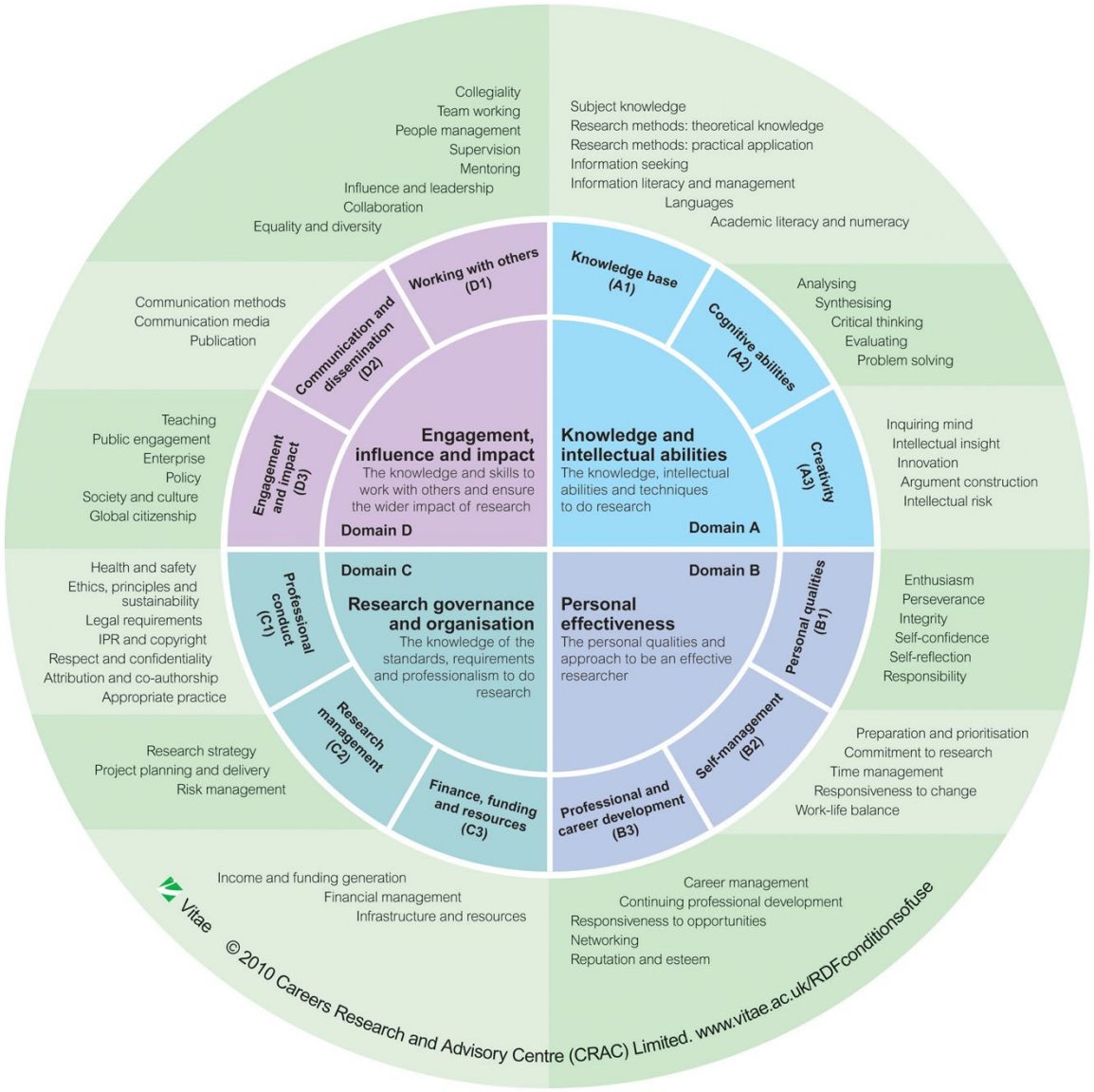

Figure 1: Vitae researcher development framework

Targeting specific professional development and change areas, candidates identify doctoral outcomes they wish to achieve through developing, implementing, and evaluating a project of relevance to their professional practice.

3.4 Matching and selection

To successfully handle a PD trajectory, candidates must have sufficient aptitude (cognitive and affective) to achieve performance within the context of complex and wicked societal issues. However, the formal admission requirements in themselves offer no/insufficient guarantee of success. Figure 2 visualises the different aspects, their relationships and system dynamics PD candidates should have on a basic level within the different areas of action and impact when entering a PD trajectory. These are further explained in Table2 and will be further developed during the PD trajectory.

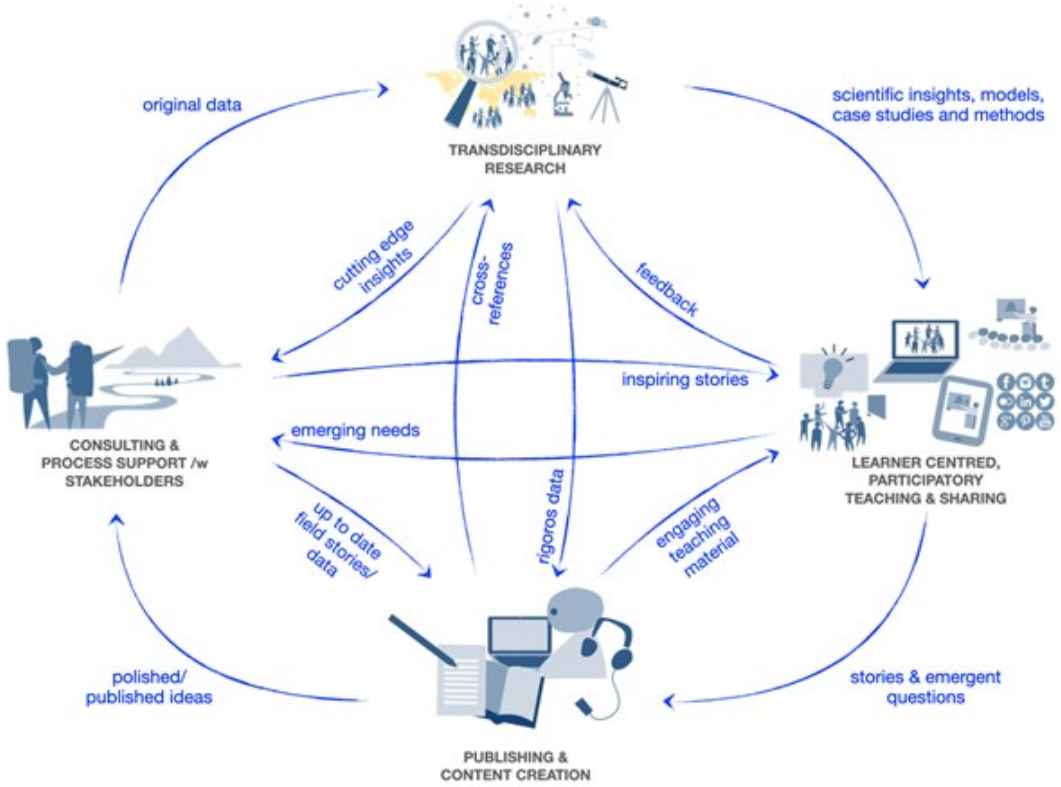

Figure 2: Visualisation of the different aspects of the PD trajectory, their relationships and matching-dynamics PD candidates should have with the different areas of action and impact during the PD (own depiction C. Hinske).

*NOTE: The **blue words** correspond to a statement located at an arrow (value flow) in Figure 2*

Activity Fields	The minimum set of activities to thrive in the Activity Fields	Recommended Selection Criteria to successfully handle a PD trajectory
Trans-, Inter- and Multidisciplinary practice-oriented Research	Inventory and generate **scientific insights, models, case studies and methods** for practical application. Develop **rigorous data** for publishing and content creation and formulate **cutting edge insights** for participating stakeholders. 1. Use **original data** generated through evidence-based analysis of the research (consulting and process support activities /w stakeholders) to ensure relevance. 2. Using **feedback** from learner-centered, participatory teaching and scientific sharing events to ensure rigor. **3. Cross-referencing** research with (own) published content, thus, anchoring it in the field of study and further develop the trans- and interdisciplinary research.	• willingness to **design**, **conduct** and **evaluate** action research projects • proven ability to **process and integrate feedback** for the betterment of the final product willingness to **develop models** and **methods** for practical application
Publishing and Content Creation	Create and publish original content/**polished ideas** in B and C-Level outlets, present **engaging (teaching) material** in the scientific community and build a body of applied knowledge that can be **cross-referenced**.	• proven ability to **create engaging content for target audiences**

	1. Use up-to-date **field stories/data** collected in processes /w stakeholders to ensure relevance, compatibility and impact. 2. Use of **rigorous data** from transdisciplinary research to ensure consistency and reliability of the content. 3. Use **stories & emergent questions** from learner-centered participatory teaching & sharing to enrich the content for the broader audience and make it relevant for higher education at UAS.	• willingness to **contribute and build a body of "practitioner and applied science knowledge"**, advancing the field of in practice and research interest
Learner Centered, Participatory Teaching and Insight Sharing	Develop teaching and practitioner oriented material for a general audience (e.g., students and societal stakeholders participating in the PD). Create **stories and** (trigger) **emergent questions** to increase the quality of publications and content creation. Identify **emerging needs**, bring them to processes with stakeholders, and provoke **feedback** loops to challenge and better ones own actions and research. 4. Use of **scientific insights, models, case studies and methods** created in actions and research to ensure consistency and reliability of the content. 5. Use of **inspiring stories** from consulting & process support /w stakeholders to stimulate commitment of learners. 6. Convert published content to **engaging teaching material** to involve students in learner-centered, participatory courses or programs.	• proven ability to **design science-based engaging interactions** for education • willingness to **provoke and facilitate triple loop/ transformative learning processes** (Hinske 2009)
Consulting & Process Support /w Stakeholders	Co-creation of **original actions and content with stakeholders** to further their success and the PD trajectory. Co-creation of **inspiring stories** through audio, video or text to enrich stakeholder learning and teaching & sharing. Aggregation of **up-to-date field stories/data,** to ensure the stakeholders find their project in relevant media outlets (audio, video, text) . 1. Deliver **polished/published ideas** to help stakeholder understand how the practical interventions are rooted in rigorous insights of the applied sciences. 2. Integrate **emerging needs,** identified in teachings, into processes with stakeholders to test assumptions, advance hypothesis building and develop actionable insights for stakeholders 3. Use **cutting-edge insights** from one's applied research to support and consult stakeholders who participate in the PD process.	• willingness to **co-create content with stakeholders** • willingness to **co-create** content and transform it into practitioner knowledge and content that furthers the applied sciences of this field • proven ability to **communicate complex theory to non-academic actors**

Table 2

The selection procedure:

Step 1:
The candidate writes a motivation letter with a CV, proves to own a relevant master's degree , or an equivalent level in a relevant domain. With this, the candidate demonstrates the basics needed to be suitable for a PD in ES. Furthermore, the candidate describes how s/he ensures to invest sufficient time in his PD process.

- The employer (UAS, company, institution or government) must declare to provide the financial means to carry out the PD process and budget them.
- The candidate adds a signed approval of the employer and direct supervisor. The employer commits (via a commitment letter which includes the financial statement mentioned above) to (co-)provide supervision (or at least cooperation) to the research (see requirements 3.4 supervision/supervision and support).

The intended main supervisor and one other member of the graduate committee nominate the potential PD candidate.

Step 2:
The candidate develops a preliminary PD Project Plan.
The plan includes:

- Research plan: Exploratory analysis (using literature research and short practitioner interviews) to write a draft research plan with research questions and outcomes that s/he tests with relevant stakeholders. Using this approach ensures that the research plan is rooted in the practitioners' needs, ensuring the relevance of the research scope. Additionally, the candidate demonstrates that s/he masters Figure 2 at the "beginner" level.
- Study plan: The candidate evaluates the required expertise and draws up a draft study plan, which modules s/he wants to follow, highlighting the relationship between the research and the study plan.
- The candidate discusses and defends the plan with the main supervisor and two members of the Graduate Committee, organised by the candidate.

The assessment of the entire selection process is the responsibility of the graduate committee.

3.5 Support and programme team

PD candidates are supervised from the PD programme by at least two professors, preferably from different universities of applied sciences from the graduate network. One professor of applied sciences is the main supervisor. In addition, there is a co-supervising professor of applied sciences whose knowledge and skills supplement the other supervisor. One of these two, has the right substantive expertise and a demonstrable track record in the domain (see also VH 2021 p23). The main supervisor is sufficiently present, has time and has a recognized position in relevant networks, including companies and research institutes. The supervisors have experience supervising master's students and PhD students and are aware of their biases and are open for self-reflection.

In addition to the two supervisors (the main supervisor and the co-supervisor), a supervisor from the professional field who has experience with research at the master's level is involved. If relevant, an international co-supervisor can also be requested. Together they are the supervisory committee.

1. Requirements for supervision: from the start (frequency see plan PD UAS), each PD candidate has to develop a personalised Training and Supervision Plan (TSP part of PD-PP). The personal training and supervision plan also includes the potential risks and risk abatement strategies. Facilitators are partners in the personal and research development of the PD candidate. PD candidates can also add their peers to their TSP in consultation with the supervisors.
2. The TSP includes annual progress meetings:
a. Formative and, if necessary, summative assessment of professional development and general research skills, including employing peers (colleague PDs).
b. Progress of the research plan based on (peer) review of intermediate products.

PD community
In the pilot, a PD community will be created and facilitated by the UASs. The PD candidates together form a community of practice & learning (COPL) across the universities of applied sciences (of the graduate network). A COPL initiator supervises the COPL from the doctorate school (one of the main supervisors, organised on a rotating basis by the network of affiliated colleges). A selection of lecturers and practical supervisors will join. In the COPL, there are several progress moments per year at which candidates can also invite peers.

In the COPL, the PD candidate organises relevant activities by, for example, inviting guest speakers or organising an excursion. They exchange their learning experiences and collaborate on relevant issues. Establishing a national UAS PD community on Energy and Sustainability stimulates the mutual learning of the PD candidates. The core activities of the PD Community of learners focus on personal and professional development (using a study plan and a training and supervision plan), research planning and progress (using a research plan) as part of de PD project plan. This concerns behavior, seeking discussion, undertaking solicited and unsolicited activities, exchanging and questioning each other – recognising each other's questions. The digital environment helps with this, but is not enough. They are using the experiences of the various candidates in a co-design model, ensuring the contribution of knowledge and expertise. Finally, several generations of PD candidates make up the composition of the COPL.

PD Programme team
The different PD trajectories within Energy & Sustainability make up the PD programme. During the pilot, the programme team consists of the members of the Graduate Network Energy & Sustainability. UAS supervisors are members of the Graduate Network, so are assessors. Having a pool of dedicated members of the Graduate Network, meeting the requirements as described above, makes it possible to watch over a separation between supervision and assessment. A supervisor of a specific candidate can never take place in the assessment committee of that candidate; however, s/he can certainly participate in the assessment committee of another candidate. The Graduate Committee (see 4.4, p31) leads the Graduate Network.

3.6 Embedding: UAS professors and international networks

The UASs facilitate the community (COPL) because they use their networks to enable the PD group to learn both within and outside the UAS. Based on education and research, the UASs can offer the PD the following in-depth knowledge:

UAS Utrecht: an integrated approach to energy in the built environment, energy transition issues in high-rise and net-zero energy homes, the connection of the building with its environment, neighbourhood-oriented strategies, linking opportunities for energy transition and health & wellbeing, construction process innovation, asset management & management, circular design, energy transition in construction, supply chain innovation, design and engineering of building components, performance guarantee and socio-economic issues, biobased building components, healthy & circular urban area development.
Saxion UAS: modelling of energy systems, design and operational control of energy systems, heat transition, natural gas-free options and networks, hybrid energy systems, sustainability transitions, activation of transformation ecosystems, circular economy, bioenergy systems, system integration issues, energetic renovation, business models, socio-economic and governance issues, energy transition, spatial development issues, social costs benefits analysis, biobased materials.
Hanze UAS: energy technology, hybrid energy systems, system integration, sustainable gases, sustainable fuels for mobility, supply chain optimisation hydrogen technology and applications, smart industries, lean production, bio-economy and circular economy.
InHolland: Resilient hydrogen systems, predictive maintenance for electrolysers and fuel cells, democratic energy infrastructure, socio-economic study into acceptance of community storage, energy transition in the Agri sector and built environment, circular heat and cold exchange, resilient integrated systems, digital twinning micro grids and community storage, lightweight design and bio-based composites.
HAN UAS: Social participative models, system integration and the electrical infrastructure, hydrogen applications – safety and acceptance, modelling and simulation of dynamic system behavior, clean and smart mobility, lean production, circular- and bio-obased economy.

4. Assessment

4.1 Assessment philosophy

Rationale for the assessment is:

a) Starting point for the assessment policy is that all examiners from the participating UASs, who are experts in determining the level are authorised by the Graduate Committee to assess.
b) The candidate builds up a portfolio. This portfolio contains regularly reviewed moments with assessors (peers and experts) concerning the TSP, the research plan and the training and supervision plan. The supervisors provide feedback, and the PD candidate processes it subsequently.
   Part of the candidate's portfolio is translatable to the European Credit Transfer and Accumulation System (ECTS).
c) The final assessment is the responsibility of the Assessment Committee, which is separated from the Supervisory Committee. The assessment committee is approved by the Graduate committee, consists of at least three members from the Graduate Network and reflects the stakeholders in the supervising committee. The assessment committee decides on go or no-go moments.
d) The final assessment involves questioning the candidate's entire portfolio through examiners, as well as experts from the relevant work field.

In three (25/30-50-80%) gatherings, the Portfolio Progress Assessments are assessed, and the candidate's progress is discussed. The first gathering takes place 9 to 12 months after the start of the study. The candidate and the main supervisor determine the date of the second gathering together – latest 24 months after the start. The goal of these Portfolio Progress Assessments is to monitor the development of the candidate and to provide feedback. They allow to address challenges early on and aid in addressing them by creating leeway for adjustments and changes.

The candidate's portfolio proves that her or his research and personal development progress qualifies her or him to graduate at level 8. To this end, the portfolio must provide information about the candidate's ability to design, test and implement science-based interventions for complex practical issues (in line with the learning outcomes as described in 2.6).

Portfolio
The portfolio consists of at least the following four building blocks in which the candidates explain why, how and which products they expect to deliver:

1. The **PD Project Plan** (PD-PP) clearly articulates the individuals personal and professional developmental pathway for the duration of the PD programme. The PD-PP is not seen as a fixed entity but as an organic live document adjusted and developed through the student journey. The PD-PP is discussed and reviewed regularly by the candidate and his/her supervisory team to offer formative feed-forward to facilitate learning (figure 2 in 3.2 can be used as a basis for these). The focus is on developing and demonstrating higher-order doctoral skills within the unique context of their professional practice. If appropriate, a representative from the candidates professional field may be involved in discussions of the feasibility of the work.

The PD-PP will have the same shape from the start of the trajectory until the end (indicated by different baselines: e.g., preliminary, initial, intermediate, final). With a formative assessment form to assess the portfolio in terms of level, the progress made on each block can be measured and related to the learning outcomes in 2.6. On each role, as mentioned in 2.6, the candidate adds evidence in the portfolio to demonstrate his or her competence. The PD-PP allows the candidate to give the PD trajectory a purposeful and verifiable place in her professional and personal vision. The PD-PP consists of:

- **Research plan (practice oriented):** A document, which sets out the rationale on the research project in a logical and concise manner. It includes the considered opinion of the PD in the research area of his or her choice. It is supported by evidence from the scientific and practical literature and should cover at least the following:
  - research question
  - hypotheses or suggested intervention
  - aims, objectives
  - research design or design of the intervention, methodology and ethics
  - financial plan[2]
  - review moments with peers and experts
  - relevance for society and practice (evidence of need from society and practice of the research or expected results from the intervention)
  - communication strategy to share the results
- **Training and Supervision Plan (TSP)**: A plan that includes the required training and supervision needed for the personal development objectives. It reflects personal and professional development based on agreed-upon self-evaluation criteria. It is about the candidate's attitude, motivation, expectations, personal goals, doubts and concerns.
-

2. **Final deliverables** consisting of:
   - The intervention or innovation
   - A set of agreed-upon products and results (solutions)
   - Documentation of the products, including the reflection on the development, implementation and effectiveness of these products;
   - Documentation / self reflection on personal development and professionalization related to the qualifications that belong to level 8.
   - An overview of the study results achieved in the specified courses.
3. **Schedule**: The project timeline in which relevant steps are visualised, as well as milestones and results.
4. **Recommendations**: feedback and recommendations by the supervising professors, and by representatives of the professional work field.

[2] The first supervisor mentions if project funds from a research group or other stakeholders are involved.

4.2 Assessment Program

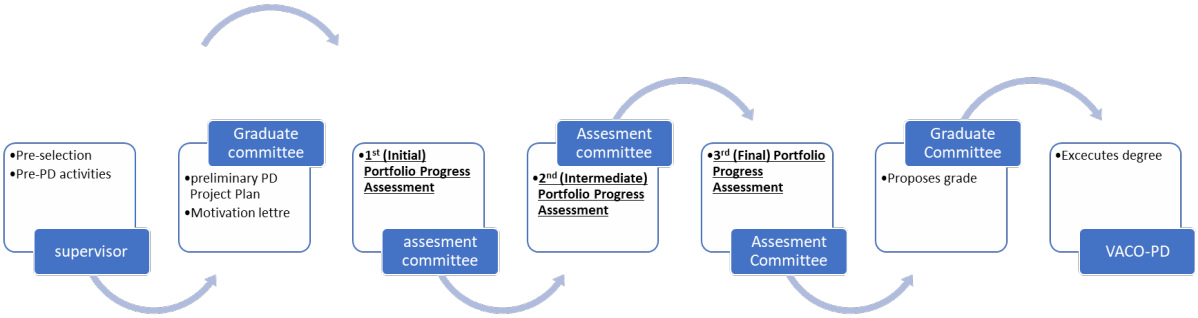

Figure 3, global process of (assessment) steps

1st (Initial) Portfolio Progress Assessment:
After 9-12 months, a go/no go moment takes place, based on progress and portfolio planning. The candidate discusses and defends the portfolio and the plans before a guidance and stakeholder group (organised by the candidate), with attendance of the main supervisor and one member of the assessment committee, as representatives of the Graduate Network (see VH 2021 p26).

- **Stakeholder Workshop:** The candidate organises a workshop that reflects the trans-/interdisciplinary nature of the process. It allows the stakeholder group (examinators, practitioners) to reflect on the results generating solid feedback for the Action Plan. This venture in itself tests many aspects of Figure 2.
- **Why, How & What:** Substantiated by a financial plan, the candidates explain why, how and which products they expect to deliver. The first supervisor mentions if project funds from a research group or other stakeholders are involved.
- **Academic Modules:** In the study plan, the candidates describe which modules they have followed and will follow, indicating how these relate to the research and development plan.
- **Academic Rigor & Social Relevance:** In the research plan, the candidate describes the status quo of his subject area or work situation through literature research and specifies the relevance of the research question for the development of this.

The candidate has obtained at least 10 ECTS credits (or equivalent) in training/courses. S/he shows this through his written self-reflection and substantiates this with the recommendations. The assessment is affected in a meeting with the candidate's main supervisor, who submits the results to the assessment committee.

2nd (Intermediate) Portfolio Progress Assessment:
After at least 24 months, based on progress and portfolio building, the candidate discusses and defends the portfolio and the plans before a guidance and stakeholder group (organised by the candidate), with attendance of the main supervisor.

- **Stakeholder Workshop:** The candidate organises a workshop that reflects the trans-/ interdisciplinary nature of the research process. It allows the stakeholder group (examinators, practitioners) to reflect on the research results generating solid feedback for the study and research plan.
- **Academic Modules:** In the study plan, the candidates describe which modules they have followed and will follow, indicating how these relate to the research and development plan.
- **Research Plan:** The candidate describes the relevance of the results for answering the research question and the development of his field (work situation), or the influence on the intervention. The candidate discusses the state-of-the-art knowledge through literature research and shows how the action plan relates to the research plan and the portfolio composition.

The candidate has obtained at least 15-20 ECTS credits. The candidate has a clearly defined research plan, is on schedule, and can indicate the relationship between the portfolio products, the research design, and the courses. The candidate shows this through his written self-reflection and substantiates this with the recommendations. In addition, the candidate presents the output/results of his research.

The candidate organises a Portfolio Progress Assessment workshop with peers, having the following parties present:

- Three members of the Graduate Network, including at least one member of the stakeholder group who has assessed the first portfolio progress assessment;
- The main supervisor and invited researchers;
- Two representatives of the professional field who assess the added value for the field/practice.
- One member of the assessment committee

The assessment committee decides on the assessment. In case the progress is not being considered as sufficient, the candidate should draft a recovery plan, addressing the concerns of the assessment committee.

3rd (Final) Portfolio Progress Assessment:

The PD process is complete when all requirements are met:

- Successfully obtaining 30 ECTS credits training;
- Successfully defending and explaining the coherence of her or his PD portfolio on all building blocks[3];
- Can convincingly demonstrate how his portfolio of products constitute interventions or innovations in the field of energy and sustainability (design, test, implement and applicable), including at least two peer-reviewed portfolio products.

The following parties are present at the final assessment:

- The assessment committee including at least two members of the assessment committee who assessed the first or second portfolio progress assessment;

[3] Each PD candidate does a critical analysis and reflection on the final deliverables, the entire PD process, the relevance of delivered output and detailed and substantiated advice to the professional field involved. Two peer reviews confirm the rigor and relevance of at least two products in the portfolio. To ensure academic rigor AND relevance for society and practice, scientists AND practitioners should conduct peer reviews.

- One member of the Graduate Committee;
- The main supervisor and any invited researchers;
- At least one representative of the professional field

After completing the final assessment, the assessment committee determines the result. For this, rubrics will be developed based on the performance indicators of 4.3. It proposes the candidate to the graduate committee if the evaluation is positive.

4.3 Assessment tools

The PD candidate carries out original and independent research worthy of publication (in academic and/or professional journals / C & B Level Journals). To cater to Mode 2 and Mode 3 level research (Anderson, L., Gold, J., Stewart, J., & Thorpe, R. 2015), and further distinguish PDs from PhDs, the candidate has to add other channels and will be assessed by alternative metrics as outlined by Hoffman, A. J. (2021a).

The candidate develops new knowledge or applications in complex practices that lead to innovations. The output (end products) can consist of a project report, research report or a series of publications. It can also be a performance practice and a research artefact or intervention (computer program, multimedia product, portfolio) related to the energy and sustainability research domain. To ensure the practical relevance and applied nature of the output, the scholarly use of social media, workshops, podcasts, vlogs, blogs, magazine articles and interviews, as proposed by Hoffman, A. J. (2021a) is encouraged. Analysing the usage and reach of the elements mentioned above help assess the applied research's impact, as well as relevance both for society and practice. They are substantiated through a vital document in the analysis and study plans demonstrating evidence and context of the study and its (expected) impact.

Every PD candidate makes a valuable contribution to implementing innovation in energy (transition) and sustainability. They do so by co-creating new products and services with stakeholders (Role of Innovator), by investigating, reflecting and documenting the process (Role of Researcher) in a way that stakeholders can replicate and multiply the innovation (Role of Consultant).

The following performance indicators can be used to assess the PD Portfolio or Dissertation in Practice on Energy and Sustainability (Costley & Fulton, 2019). The performance indicators are related to the roles and learning outcomes in 2.6.

The PD candidates will:

1. Demonstrate an understanding of and possible solution to the problem of practice.
    a. **Indicators**: Demonstrate an ability to address and/or resolve a practice problem and/or generate new approaches.).
    b. **Roles**: Researcher a.
2. Demonstrates the scholarly practitioner's ability to act ethically and with integrity, including implications for society.
    a. **Indicators**: findings, conclusions, and recommendations align with the data. Consequences for society)
    b. **Roles**: Researcher b, Consultant b
3. Demonstrates the scholarly practitioner's ability to execute systemic leadership and communicate effectively to an appropriate audience in a way that addresses academic practice and the needs of relevant stakeholders.

    a. **Indicators**: style is suitable for the intended audience, system leadership, mature professional effectiveness.
    b. **Roles**: Consultant c and d
4. Integrates both theory and practice to advance practical knowledge.
    a. **Indicators**: Integrates practical and research-based knowledge to contribute to the practical knowledge base; frames the study in existing research and theory and practice of energy (transition) and sustainability.
    b. **Roles**: Innovator b, Researcher a
5. Provides evidence of the potential impact on practice, policy, and / or future research in the field.
    a. **Indicators**: [The Output] indicates how its findings are expected to impact professional field or problem.)
    b. **Roles**: Innovator a, Consultant a
6. Uses methods […] that are appropriate to the problem of practice.
    a. **Indicators**: Identifies rationale for a method […] that is appropriate to the [outputs] in practice; effectively uses a method […] to address the problem of practice.) including short cyclic iterations in co-research with relevant stakeholders and an integral and system approach
    b. **Roles**: Innovator c and d, Researcher b
7. Develops new ideas/solutions in collaboration (co-creation) with relevant stakeholders, and new ideas /solutions are tested and valorized with relevant stakeholders.
    a. **Indicators**: tested ideas and solutions, impact measurement
    b. **Roles**: Researcher c and d, Consultant b

4.4. Quality assurance

In the pilot, the PD ES is developed as a joint program through a partnership of 5 UASs, with a specialisation in Energy and Sustainability. The ES Graduate Network forms this partnership. The Graduate Committee (GC) is the administrative and responsible unit for the quality of the PD program. It is a delegation of the Graduate Network (GN) of participating universities of applied sciences and professional parties.

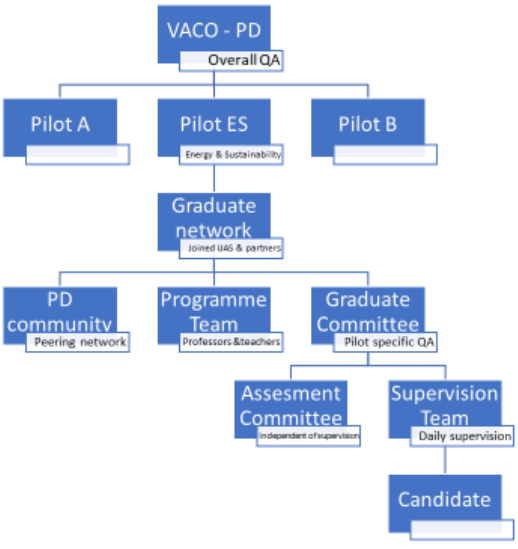

Figure 4 , global roles in the pilot programme

Duties of the Graduate Committee

- Have the PD program developed by members of the Graduate Network ES;
- Development of a joint assessment model;
- Agree on the design of the content of the courses, related curricula and monitor quality;
- Submit PD program proposal to VaCo-PD for approval;
- Organise calibration sessions with the main supervisor and co-supervisors to find and share joint standards (Andriessen, 2015);
- Confirm with the research lines from the platforms of Professors Urban Energy and LEVE (Energievoorziening in evenwicht);
- Lead the implementation of the PD program and monitor the quality;
- Agreement on each individual PD proposal and of the starting qualifications of the intended candidate before the start of a PD trajectory, after recommendation and nomination by one of the UAS in the Graduate Network ES;
- Approve Supervisory Committees; Assignment of the pool of lecturers authorised to supervise candidates as main supervisors and propose them to the assessment committee;
- Approve Assessment Committees, agree with the composition of the assessment committees on the recommendation of the supervising professor (ensures they reflect all relevant stakeholders);
- Agree to award the degree;
- Organise learning networks of PD candidates together with other Graduation Committees;
- Self-evaluation after four years for external evaluation.

Composition Graduate Committee ES

Criteria for Graduate Committee UAS members:

- Supervising capacity of the University of Applied Sciences (capacity senior staff for PD supervision) – this to offer the candidate sufficient certainty that supervision can be continued in the event of absence of the main supervisor.
- Relevant master's degree programmes qualified to generate future candidates with a master degree.
- Experience of the senior staff in supervising PhDs and/or DP.

Criteria for the composition of the Graduate Committee

- The committee consists of at least three professors
- The committee consists of an odd number of professors to speed up decision-making
- The relevant platforms are delegated to the cie
- In addition, there is room for additional professors and advisors with a special assignment

During the pilot phase, the following applies:

- In view of the relatively small number of candidates and the narrower focus of the energy transition chosen for the pilot phase, a relatively small committee is an obvious choice
- LEVE and Urban Energy, the relevant platforms, both provide a member for the cie
- To ensure compliance with international PD processes and developments therein, an advisor in this area is considered expedient.

By the Dutch UAS cooperation, at National Level, a committee has been set up for assuring national quality for the UAS PD: the Validation Committee PD (VaCo-PD). The PD ES program forms part of this national quality system and will thus be assessed and certified by the VaCo-PD. In the VaCo-PD are represented the employers/work field (Higher Education Committee of VNO-NCW/MKB Nederland), representatives of the professional group and representatives of knowledge institutions. The findings of the graduate committee established by the VaCo-PD are the baseline for the certification of the PD traject. Each Assessment Committee consists of one member of the VaCo-PD (VH 2021 p25) during the pilot phase.

At the start of the PD program, the VaCo-PD will assess the program on the following criteria:

- Academic level: do the attainment targets as formulated in the program profile match level EQF8 and the wishes and requirements of the professional field?
- Programme: has the program been designed so that the candidate can achieve the final objectives?
- Supervision and quality of lecturers: Are supervisors and lecturers sufficiently knowledgeable in terms of content and pedagogically?
- Assessment of the quality of the possible main representatives from the relevant professional domains.
- The final examination: is the assessment of the candidate valid, reliable and sufficiently independent?

5 Organisation

5.1 Collaboration of Universities of Applied Sciences

Giving PD Candidates access to the joint curricula, facilities, and expertise of the participating UAS institutions is key to the proposed programme. In essence, the participating UAS organise a virtual graduate school on sustainability and energy, building on the members' strengths. Consequently, managing this collaboration must be transparent and clear.

To ensure the quality and continuity of the PD programme, it should have a small coordinating office consisting of a programme manager and support staff. Their main task is to be the central communication hub for (potential) candidates, supervisors and committees, coordinate intake and assessment procedures, track candidates' progress and update the joined external website.

Between the UAS institutions joining forces in this pilot, a collaboration agreement has to be signed. During the pilot this agreement covers the collaboration between the 5 primary partners (UAS Utrecht, Hanze UAS, Saxion, InHolland UAS, HAN UAS). This inter-institutional agreement covers at least the following topics:

1. The organisation of a virtual graduate school will have a fixed yearly budget to cover
    a. the cost of organising, joint marketing, website, tracking of PD candidate results, and graduate committee and graduate network costs.
    b. The budget will have a fixed yearly fee for all partners and a component based on the number of PD candidates of the partner UAS.
2. Each partner UAS defines its relevant (master-level) modules, facilities, and professorships associated with the PD programme. The allocation of these resources can be subject to yearly change.
3. (Master-level) modules associated with the PD programme are open for all Energy & Sustainability PD candidates.
4. Credits of (master-level) modules followed at partner UAS must be respected and accepted by the sending UAS, if agreed on by the Graduate Committee.
5. The PD programme uses a fixed EC based price for followed programmes to settle costs between sending and receiving UAS.
6. The PD programme uses per salary group a fixed hourly rate for access to experts of other UAS partners within the PD programme. For example, HOT.
7. Costs for using experimental facilities are defined in transparent and individual, cost-based agreements between the sending and receiving UAS.
8. When PD candidates use partner facilities, these agreements cover responsibility issues (including Health Safety and Environment, HSE). The receiving UAS is responsible for HSE regarding the facilities, and the sending UAS is responsible for covering potential damage.
9. Depending on the master-level courses taken by the PD candidate, the final diploma will mention the respective UAS.

The collaboration agreements are signed for the total pilot period. Once a year during the pilot period, the partners will evaluate the collaboration, discuss progress and changes to the agreement.

For the first four years of the pilot, new UAS partners cannot enter the PD programme. After this period, potential UAS partners can apply for becoming new partners of the programme.

Criteria for new UAS partners are:

- A portfolio of relevant multi-. inter- and / or transdisciplinary research programmes;
- Good research groups track records in multi-, inter- and transdisciplinary research and its impact;
- Available (master-level) modules on relevant topics;
- Quality and quantity of guidance and supervision they can organise for future PD candidates,
- Experience of the research staff with supervising PD candidates in ES topics,
- The willingness to share costs as mentioned in 1,
- The willingness to co-develop relevant material and willingness to share material.

5.2 Information provision – Website

The website is a living platform and has a modern, rolling, clear/clean style. The online environment of the PD is hosted by one participating institution and managed by the "Coordinating Office". Content is co-created by the PD candidates, their supporting lecturers and engaged stakeholders. The PD candidates offer content related webinars, videos and written content catered to their specific target audiences. The structure ensures high visibility and impact in the stakeholder groups, creating exposure for content and people.

See appendix for Overview of Website Menu

5.3 Registration and tracking system

This proposed approach in this section is based on the following assumptions:

1. The group of candidates is small (+/-25 persons)
2. We are developing a pilot and not yet a fully matured program.
3. Each participating UAS already has its tracking system.

Taking the above as a starting point, we propose an agile solution that builds on existing infrastructures to avoid delays, undermining the purpose of the pilot.

1. We propose that the different UASs use their secure environments of registrations and tracking during the pilot.
2. All 4 items of the portfolio should be archived securely for QA of the PD pilot.
3. E.g. each UAS uses some HR system or student progress system.
    a. It is the candidates' responsibility to ensure that their activities are tracked in their dossier.
    b. It is the responsibility of, e.g. an HR manager to add the activities to the dossier.

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Appendix – envisioned website

Overview of website menu:

- **Home:** see Figure 2; clean structure and content that target audiences (see defenition on following pages) can grasp in under 10 seconds.
- **Impact:**
    - An essential and concise description of the PD program in Energy and Sustainability
    - This description is a 250 word summary of the purpose of the PD program. Details to be discussed with expert brand designer.
- **Impact Labs:** see Figures 3 and 4; the Impact Labs allow for strategic engagement of stakeholders, have meaningful conversations, develop relationships, do transdisciplinary research, increase employability, outreach etc.
    - There is a growing collection of digital formats such as summits/conferences, online workshops, hybrid workshops, digital speed dates, innovation labs, solution spaces, case clinics, et cetera.
    - The PD candidates are responsible for the content and execution of these labs. Meta-data and engagement analysis will be done together with the "Coordinating Office." This meta-data helps to evaluate the impact and relevance of the PD project, providing evidence of societal relevance.
    - The impact labs can also be used as a research methodology, which depends on the details of the PD trajectory.
    - PD candidates host them around specific topics. The labs are modular, allowing the PD candidate to use their prefered collaboration software, are video conference based, and should hold up to 500 people.
- **PD Candidates:**
    - A basic profile of PD candidate.
    - Highlighting the latest posts and impact labs.
- **Blog:**
    - Rolling collection of short articles and reflections targeting the stakeholder groups participating in the PD research.
    - The articles can be written alone but should be co-created together with the stakeholder groups.

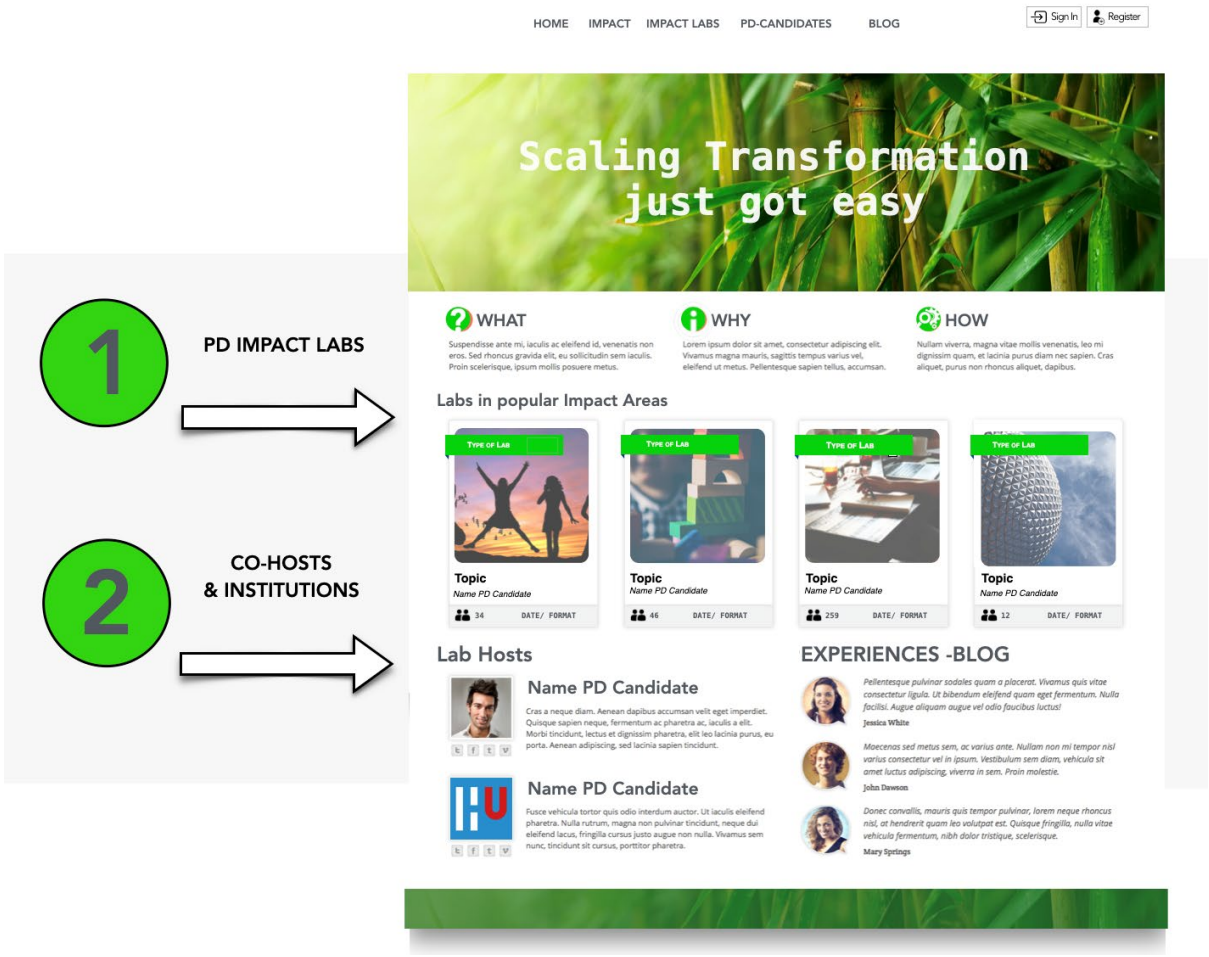


Figure 1: *View of the homepage/landing page.*

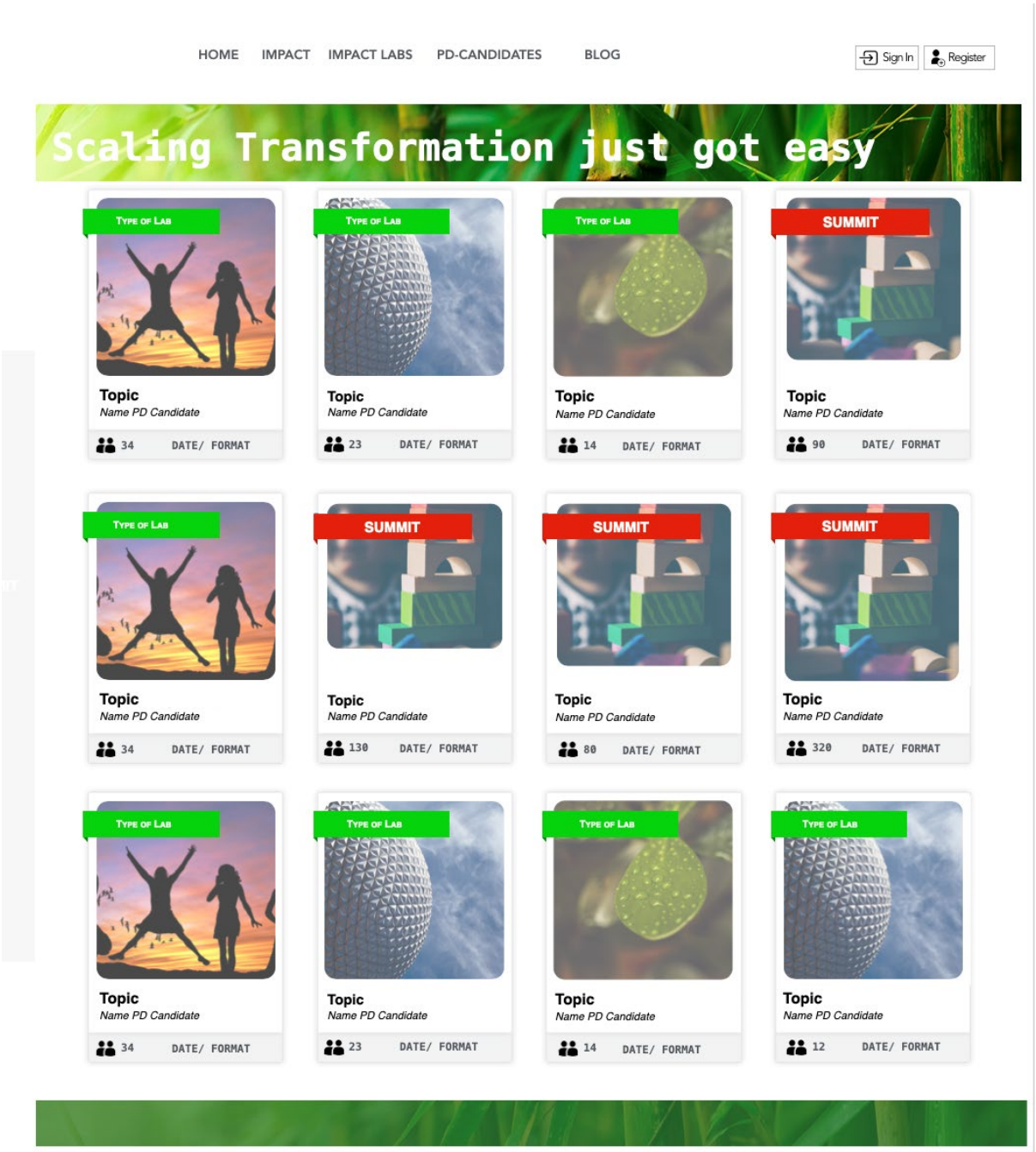
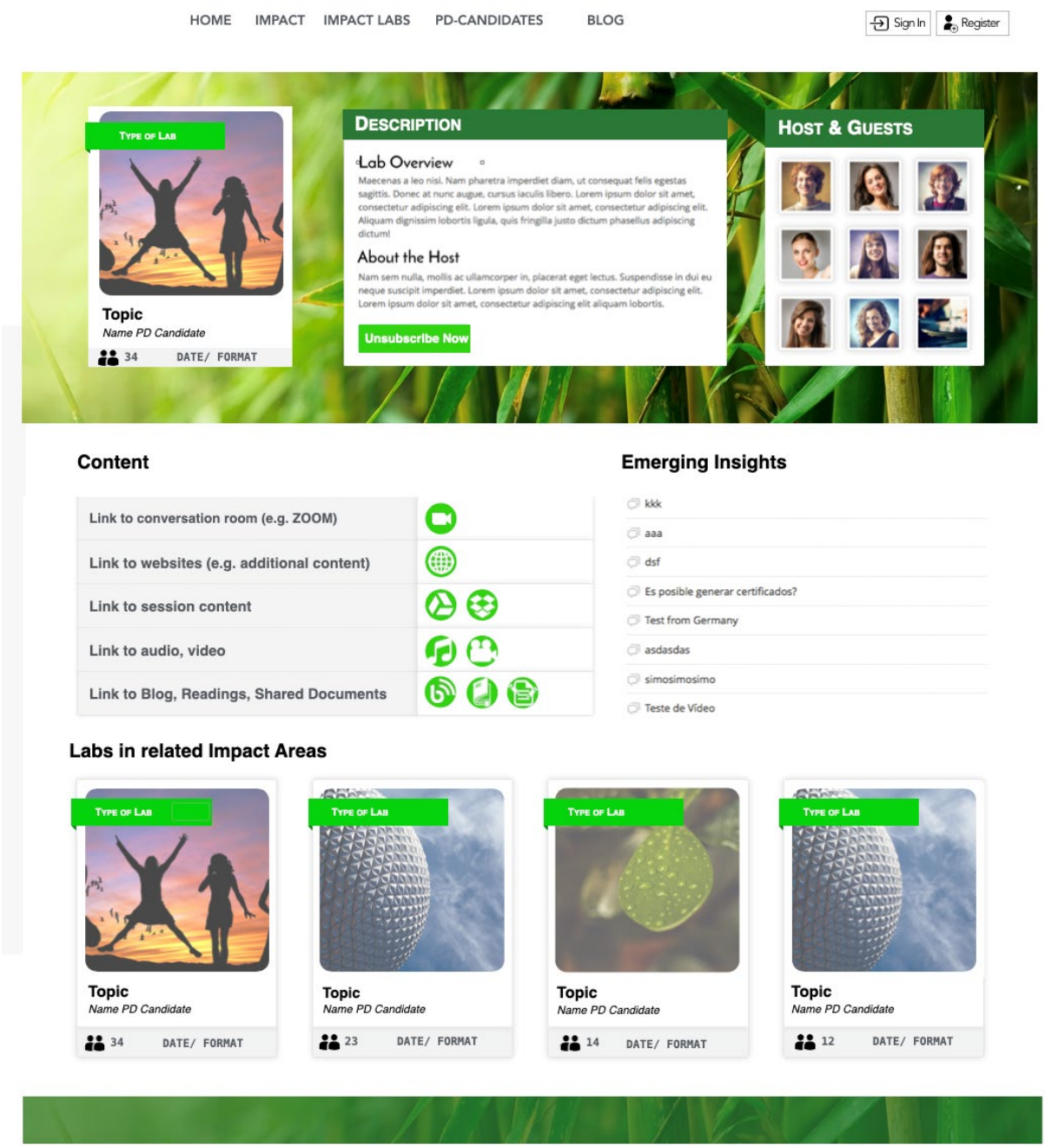


Figure 2: *Overview of the impact labs. To register for an impact lab, participants click on the tile and are prompted to enter the details. The PD candidate is responsible for the design, implementation and evaluation of the impact lab. Meta-data and engagement analysis will be done with the coordinating office.*


HOME
IMPACT
IMPACT LABS
PD-CANDIDATES
BLOG
Sign In
Register
TYPE OF LAB
Topic
Name PD Candidate
34
DATE/ FORMAT
DESCRIPTION
Lab Overview
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Unsubscribe Now
HOST & GUESTS
Content
Link to conversation room (e.g. ZOOM)
Link to websites (e.g. additional content)
Link to session content
Link to audio, video
Link to Blog, Readings, Shared Documents
Emerging Insights
kkk
aaa
dsf
Es posible generar certificados?
Test from Germany
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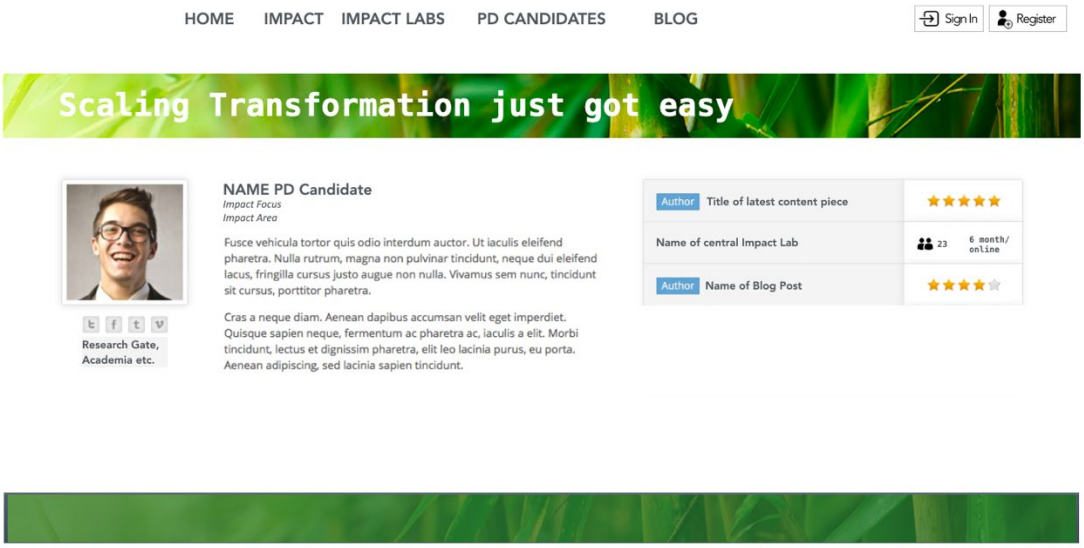

Figure 3: *Basic profile of the PD candidate. Here hyperlinks will be placed to ResearchGate, Academia, Medium, Facebook, Pinterest, TikTok, LinkedIn, et cetera. The latest blog post and impact labs are highlighted.*

The website (standing text, blog posts, Impact Labs) should fulfil the following criteria:

1. **Catering to Target Audience**: The target groups consist of internationally active persons and their institutions in the following three fields:
   - *Academia:* Established and upcoming scientists in the energy transition, resource efficiency, systems transformation and sustainability. University deans who decide on curricula and model courses.
   - *Professional International Public:* Journalists/science journalists, environmental technologists/engineers. The website neither aims at the general public nor the expert elite.
   - *Policy Makers:* Economics, science and environmental policymakers active or connected to institutions like Dutch ministries, UNEP, WRF, ERF, NRF, DIN and ISO standard setters.
2. **Adding Value to Target Audience:** The website content adds value for science-oriented and knowledgeable practitioners/decision-makers.
   - She is *willing to focus* while spending her scarce time and attention.
   - She wants to grasp content *quickly*.
   - She does *not want to re-read* sentences or paragraphs (no deep study of the text posted, e.g., blog posts).

Consequently, the website restricts slang, colloquialism, unreferenced opinions, and complex and multilayered string sentences.

3. **Higher Education:** List of courses in higher education for which the content needs to be relevant (undergraduate/graduate/PhD/PD/continuous education):
   - **Engineering**
   - **Natural sciences**
   - **Business and social sciences**
   - **…**